KIRTLAND AIR FORCE BASE
ALBUQUERQUE, NEW MEXICO

Vadose Zone Investigation Work Plan

Bulk Fuels Facility Spill
Solid Waste Management Units ST-106 and SS-111

March 2011

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2050 Wyoming Blvd. SE
Kirtland AFB, New Mexico 87117-5270

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ALBUQUERQUE, NEW MEXICO

VADOSE ZONE INVESTIGATION WORK PLAN

BULK FUELS FACILITY SPILL
SOLID WASTE MANAGEMENT UNITS ST-106 AND SS-111

March 2011

Prepared for
U.S. Army Corps of Engineers
Albuquerque District
Albuquerque, New Mexico 87109

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Prepared by
Shaw Environmental & Infrastructure, Inc.
7604 Technology Way, Suite 300
Denver, Colorado 80237

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This Vadose Zone Investigation Work Plan was developed to address vadose zone contamination at the Bulk Fuels Facility (BFF) Spill at Kirtland Air Force Base. The work plan demonstrates the Air Force’s commitment to addressing fuel contamination resulting from past practices and events at the BFF Spill. The work plan outlines previous investigations performed at the BFF Spill and provides the sampling rationale and decision logic for defining the nature of fuels contamination of soil and vapor within the vadose zone. Vadose zone investigation activities described include subsurface geophysical investigations, soil and soil-gas vapor sampling, and installation of vapor monitoring points throughout the vadose zone. The geophysical investigation will provide information on subsurface geology and contaminant location and migration. Soil and vapor sampling will provide immediate, as well as long-term, sampling data on subsurface contaminant distribution in the vadose zone. The vadose zone investigation will be integrated with groundwater, interim measures, and light non-aqueous phase liquid containment investigations to provide the data necessary to supplement and optimize remedial efforts currently underway. Enhancement of current remedial operations will increase the contaminant mass removed from the vadose zone and groundwater, thus reducing the time required for cleanup.

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PREFACE

This Vadose Zone Investigation Work Plan was prepared by Shaw Environmental and Infrastructure, Inc. (Shaw) for the U.S. Army Corps of Engineers (USACE) under contract W912DY-10-D-0014, Delivery Order 0002. It pertains to the Kirtland Air Force Base (Kirtland AFB) Bulk Fuels Facility (BFF) Spill, Solid Waste Management Units ST-106 and SS-111, located in Albuquerque, New Mexico. This work plan was prepared in accordance with all applicable federal, state, and local laws and regulations, including the New Mexico Hazardous Waste Act; New Mexico Statutes Annotated 1978; New Mexico Hazardous Waste Management Regulations; Resource Conservation and Recovery Act; regulatory correspondence between the New Mexico Environment Department, Hazardous Waste Bureau and the Air Force, dated April 2 and August 6, 2010; and *Base-Wide Plans for Investigations Under the Environmental Restoration Program, 2004 Update.*

This work plan presents and describes all activities associated with the installation of soil boring and soil-vapor wells including locations, well installation method, initial sampling and testing, and borehole geophysical investigation.

The Vadose Zone Investigation Work Plan provides:

- Construction details, locations, and depths of proposed boring and soil-vapor monitoring wells;
- Field procedures, sampling and analysis, and related quality control protocols for soil analysis;
- Investigation-derived waste handling; and
- A proposed project schedule.

This work was performed under the authority of USACE Contract No. W912DY-10-D-0014, Delivery Order 0002. All work was conducted in October and November 2010 and final revisions were made in March 2011. Mr. Walter Migdal is the Project Manager for the USACE Albuquerque District. Mr. Wayne Bitner, Jr. is the Kirtland AFB Restoration Section Chief, and Mr. Tom Cooper is the Shaw Project Manager. This plan was prepared by Ms. Laura Kazzaz and Mr. Tom Cooper.

Tom Cooper, PG, PMP
Shaw Environmental & Infrastructure, Inc.
Project Manager

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ACRONYMS AND ABBREVIATIONS

3D	three dimensions
^oC	degrees Celsius
^oF	degrees Fahrenheit
ADR	automated data review
AFB	Air Force Base
AFCEE	Air Force Center for Engineering and the Environment
Air Force	U.S. Air Force
AmBe-241	americium-beryllium-241
API	American Petroleum Institute
APP	Accident Prevention Plan
ARCH	air rotary casing hammer
ASDE	after-survey depth error
AST	aboveground storage tank
ASTM	ASTM International
AvGas	aviation gasoline
BFF	Bulk Fuels Facility
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylenes
BWP	*Base-Wide Plans for Investigation under the Environmental Restoration Program, 2004 Update,* Kirtland AFB
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cm	centimeter
COPC	contaminant of potential concern
CRP	Community Relations Plan
CSM	conceptual site model
DoD	U.S. Department of Defense
DOT	U.S. Department of Transportation
DQCR	daily quality control report
DTIC	Defense Technical Information Center
EDB	ethylene dibromide
EIMS	Environmental Information Management System
ELAP	Environmental Laboratory Accreditation Program (DoD)
EM	electromagnetic
EM	Engineer Manual
EPA	U.S. Environmental Protection Agency
EPH	extractable petroleum hydrocarbons
ERP	Environmental Restoration Program
ERPIMS	Environmental Resource Program Information Management System
FCR	Field Change Request
FFOR	Former Fuel Offloading Rack
ft	foot/feet
ft/day	feet per day

ACRONYMS AND ABBREVIATIONS (continued)

GIS	Geographic Information System
GRO	gasoline range organics
He-3	helium-3
HWB	Hazardous Waste Bureau (NMED)
IDW	investigative-derived waste
JP-4	Jet Propellant-4 fuel
JP-8	Jet Propellant-8 fuel
KAFB	Kirtland Air Force Base
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
LDC	Laboratory Data Consultants, Inc.
LNAPL	light non-aqueous phase liquid
MA DEP	Massachusetts Department of Environmental Protection
mg/kg	milligrams per kilogram
mm	millimeter
MS	matrix spike
MSD	matrix spike duplicate
NAD83	North American Datum, 1983
NMED	The New Mexico Environment Department
NRC	National Research Council
NTIS	National Technical Information Service
O.D.	outside diameter
OSRTI	Office of Superfund Remediation and Technology Innovation (EPA)
OSWER	Office of Solid Waste and Emergency Response (EPA)
PE	Registered Professional Engineer
PID	photoionization detector
PMP	Project Management Professional
PPE	personal protective equipment
ppm	parts per million
PVC	polyvinyl chloride
QA/QC	quality assurance/quality control
QAPjP	BFF Spill Quality Assurance Project Plan
QC	quality control
RCRA	Resource Conservation and Recovery Act
RPD	relative percent difference

ACRONYMS AND ABBREVIATIONS (concluded)

SEDD	Staged Electronic Data Deliverable
Shaw	Shaw Environmental & Infrastructure, Inc.
SOP	standard operating procedure
SPR	standard penetration resistance
SPT	Standard Penetration Test
SSHP	Site Safety and Health Plan
SVE	soil-vapor extraction
SVM	soil-vapor monitoring
SVMW	soil-vapor monitoring well
SVOC	semivolatile organic compound
SWMU	Solid Waste Management Unit
TPH	total petroleum hydrocarbons
USACE	U.S. Army Corps of Engineers
USCS	Unified Soil Classification System
USF	Santa Fe Group
UTM	Universal Transverse Mercator
V.A.	Veterans Administration
VOC	volatile organic compound
VPH	volatile petroleum hydrocarbons

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EXECUTIVE SUMMARY

This Vadose Zone Investigation Work Plan, together with the Groundwater Investigation Work Plan, the Interim Measures Work Plan, and the Light Non-Aqueous Phase Liquid (LNAPL) Containment Interim Measure Work Plan, were developed in response to April 2, 2010, and August 6, 2010 correspondence from the New Mexico Environment Department (NMED) Hazardous Waste Bureau (HWB) to the U.S. Air Force (Air Force). In these letters, the NMED HWB required the Air Force to develop and submit work plans to address soil and groundwater contamination at the Bulk Fuels Facility (BFF) Spill at Kirtland Air Force Base (AFB), New Mexico. The work plans will be implemented concurrently to reduce the time required to address each item. Submittal of these work plans demonstrates the Air Force's commitment to addressing fuels contamination resulting from past practices and events at the BFF at Kirtland AFB.

This Vadose Zone Investigation Work Plan provides the sampling rationale and decision logic for defining the nature of the contaminants and delineating fuels contamination of soil and vapor within the vadose zone. The specific goals of the work plan are to:

- Estimate the amount of fuel that exists within the vadose zone as absorbed or residual liquid, or as soil gas;
- Identify the probable source of the LNAPL fuel plume; and
- Characterize the vadose zone geology, hydrology, hydrogeology, and soil/soil-vapor contamination in sufficient detail to prepare an updated conceptual site model, which incorporates current and potential soil and groundwater contamination pathways, vadose zone sources, and the distribution, fate, and transport of contaminants.

Vadose zone investigation activities include subsurface geophysical investigations, soil and soil-gas vapor sampling, and installation of vapor monitoring points throughout the vadose zone. The geophysical investigation will provide information on subsurface geology and contaminant location and migration. Soil and vapor sampling will provide immediate, as well as long-term, sampling data on subsurface contaminant distribution in the vadose zone.

The vadose zone investigation will be integrated with the groundwater investigation to provide data necessary to supplement and optimize remedial efforts currently underway at the BFF Spill. Enhancement of current remedial operations will increase the contaminant mass removed from the vadose zone and groundwater, thus reducing the time required for cleanup.

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1. INTRODUCTION

This Vadose Zone Investigation Work Plan was prepared by Shaw Environmental and Infrastructure, Inc. (Shaw) for the U.S. Army Corps of Engineers (USACE) under contract W912DY-10-D-0014, Delivery Order 0002. This work plan pertains to vadose zone investigations at the Kirtland Air Force Base (AFB) Bulk Fuels Facility (BFF) Spill, Solid Waste Management Units (SWMUs) ST-106 and SS-111 (collectively known as the "BFF Spill"). The BFF Spill site is located at Albuquerque, New Mexico (Figure 1-1).

This work plan was prepared in accordance with all applicable federal, state, and local laws and regulations, including the:

- New Mexico Hazardous Waste Act New Mexico Statutes Annotated 1978;
- New Mexico Hazardous Waste Management Regulations;
- Resource Conservation and Recovery Act (RCRA);
- Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA);
- April 2, 2010, and August 6, 2010 regulatory correspondence between the New Mexico Environment Department (NMED) Hazardous Waste Bureau (HWB) and the U.S. Air Force (Air Force) regarding the BFF Spill at Kirtland AFB (Appendix A, Attachments 1 and 2); and
- *Kirtland AFB, Base-Wide Plans for Investigations Under the Environmental Restoration Program, 2004 Update*

The field investigation, as presented in this work plan, describes the geophysical investigation, borehole and soil-vapor well installation, as well as soil and soil-vapor sampling. An evaluation of all existing and new data preparation of cross sections and plan views will be included in a Conceptual Site Model (CSM) section, to be included in the Quarterly Pre-Remedy Monitoring and Site Investigation Report (Quarterly Monitoring Report).

The U.S. Department of Defense (DoD) Kirtland AFB is conducting an investigation of contaminated groundwater at the BFF Former Fuel Offloading Rack (FFOR) (SWMU ST-106) and the associated light non-aqueous phase liquid (LNAPL) plume (SWMU SS-111, also known as the Phase-Separated Hydrocarbon BFF Remediation), collectively known as the BFF Spill. Previous investigations show that contamination caused by the BFF Spill represents a significant threat to human health and the environment, particularly public water supply wells adjacent to Kirtland AFB. The contamination also threatens Kirtland AFB and the Veterans Administration (V.A.) Hospital water-supply wells. This release of hazardous constituents was first discovered 10 years ago, however a complete characterization of the BFF Spill has not been completed. The large extent of this contamination and its proximity to water supply wells requires that action be taken.

This work plan describes the actions to investigate the vadose zone hydrology and geology of the affected area, to identify and characterize the source of the releases at the BFF Spill, and to identify the extent of soil and soil-gas contamination in the vadose zone from the surface to groundwater to complete the characterization of the vadose zone. The area covered under this work plan includes the tank farm, the ancillary piping between the farm, the FFOR, and the area east of the FFOR. This work plan describes in detail all research, locations, depths and methods of exploration, field procedures, sampling and analysis of soil and soil gas, related quality control procedures, and a schedule for implementation of the work.

Per the direction of the NMED HWB (Appendix A), a characterization will be performed of the soil and soil gas in the vadose zone at the FFOR. Additional characterization and field investigation is also needed at the east side of the BFF Spill to determine the full extent of petroleum hydrocarbons and hazardous constituents in soil and soil vapor beneath Tanks 2422 and 2420. Additional investigation will determine whether release(s) associated with this tank are the source of adsorbed-phase and vapor-phase petroleum hydrocarbons previously indentified in distal soil-vapor monitoring well (SVMW)-13 and SVMW-15. Additional characterization is also needed to complete the design and implement an appropriate final remedy.

The sampling rationale and decision logic for delineating the nature and extent of fuels contamination from past operations at the BFF Spill at Kirtland AFB are defined in this work plan. Activities described in the work plan are designed to define the nature of the contaminants and delineate fuels contamination of soil and vapor within the vadose zone at the following areas: the Tank Farm, pipeline, fuel offloading rack, fuel percolation area, and far field area north of the BFF Spill.

The objectives of implementing this work plan are as follows:

- Determine the amount of fuel that exists within the vadose zone as sorbed or residual liquid, or as soil gas.
- Identify the probable source of the LNAPL fuel plume.
- Describe the vadose zone hydrology, its relationship to groundwater contamination as it is encountered, and the potential for continuing groundwater contamination by the vadose zone.
- Characterize the vadose zone geology, hydrology, hydrogeology, and soil/soil-vapor contamination in sufficient detail to prepare an updated CSM, which incorporates current and potential soil and groundwater contamination pathways, vadose zone sources, and the distribution, fate, and migration of contaminants.

To achieve the stated objectives, nested soil-vapor monitoring (SVM) wells and geophysical investigation data will be used to:

- Estimate amount of residual fuel adsorbed to soil, as soil gas and as residual liquid in the soil.
- Determine the source of the LNAPL remaining in the vadose zone.
- Characterize the vadose zone hydrogeology in terms of LNAPL retention and migration pathways and the potential for long-term sources to groundwater contamination.
- Characterize the geology and extent of contamination in the soil and soil gas to determine distribution, fate, and migration of contaminants sufficient to support the selection of additional soil-vapor extraction (SVE) wells in the shallow, intermediate, and deep vadose zone that will be protective of human health and the groundwater.
- Modify the operation and evaluate the performance of SVE wells.

- Conduct a risk assessment utilizing soil-gas sample results by comparing to soil-gas screening concentrations presented in Table 2b in the U.S. Environmental Protection Agency's (EPA's) Subsurface Vapor Intrusion Guidance (2002) Generic Screening Levels for 1E-5 target cancer risk, for shallow and deep soil-gas concentrations.

A total of 35 nested SVM wells will be installed to a total depth of 450 feet (ft) below ground surface (bgs) within the BFF Spill area at Kirtland AFB. Nested wells consist of six small-diameter (0.75-inch) wells screened at intervals of 25, 50, 150, 250, 350, and 450 ft bgs as specified in the NMED regulatory correspondence (Appendix A).

This work plan will be implemented concurrently with the Groundwater Investigation Work, the Interim Measures Work Plan, and the LNAPL Containment Interim Measure Work Plan for the BFF Spill at Kirtland AFB. Together, implementation of these work plans will complete the delineation of fuels contamination, address continuation of existing interim measures, initiate LNAPL plume containment, and evaluate the potential of augmented or additional interim measures at the site.

1.1 Identification of Contaminants of Potential Concern

Petroleum contamination associated with the BFF Spill has been identified in subsurface soil, soil gas, and groundwater. Contamination appears to be a result of various releases that occurred over the operational history of the facility. Information is available on some of the releases whereas other releases are not well-documented and are inferred to have been ongoing for unknown periods of time. All contaminants of potential concern (COPC) at the BFF Spill are constituents of refined petroleum products and include, but are not limited to, the following: benzene, toluene, ethylbenzene, xylenes (BTEX), ethylene dibromide (EDB), and lead.

1.2 Scope of Activities

The Vadose Zone Investigation Work Plan describes all activities associated with the soil boring/soil-vapor monitoring wells, including locations, borings, soil sampling, and the borehole geophysical investigation to support the actions that Kirtland AFB is taking to begin the remediation at SWMUs ST-106 and SS-111, collectively called the BFF Spill, at Kirtland AFB. This work plan describes investigation requirements of the June 2, 2010 and August 6, 2010 the NMED letters (Appendix A, Attachments 1 and 2).

A comprehensive, site-specific CSM, using regional and site-specific information from previous investigations, will be included and updated in the Quarterly Monitoring Report. The CSM data, including geologic, hydrologic, and contaminant conditions will be a separate section in the quarterly report and will be updated with new data as it is collected during a quarter. The CSM section of the Quarterly Monitoring Report will present the current understanding of the sources, contaminants, and media that have been impacted by the activities at the BFF Spill, with particular emphasis on LNAPL migration and transport. The CSM section will address concerns stated in the June 2, 2010, and August 6, 2010 NMED letters (Appendix A, Attachments 1 and 2).

1.3 Data Gaps

Following previous investigations at the BFF Spill, data gaps related to the nature of the fuels contamination and the extent of contaminations resulting from past operational history at the BFF Spill were identified. The intent of the BFF Spill vadose zone investigation is to address the data gaps for the lateral and vertical delineation of vadose zone contamination and to provide data of sufficient quality to characterize the nature and extent of fuels-related soil and soil-vapor contamination and to support the development of a Corrective Measures Evaluation. Table 1-1 identifies data gaps and sections within the Vadose Zone Investigation Work Plan and other BFF Spill investigation and interim measures work plans that address the data gaps.

Implementation of this work plan will function as the BFF Spill vadose zone investigation and will accelerate implementation of the overall investigation. The BFF Spill vadose zone investigation will be performed in conjunction the groundwater investigation and evaluation of interim measures for the BFF Spill.

1.4 Report Organization

This report is organized into twelve major sections:

- Section 1: Introduction
- Section 2: Background Information
- Section 3: Site Conditions
- Section 4: Investigation Methods and Approach
- Section 5: Monitoring and Sampling
- Section 6: Project Schedule
- Section 7: Organizational Plan
- Section 8: Data Management Plan
- Section 9: Quality Assurance/Quality Control (QA/QC)
- Section 10: Waste Management
- Section 11: Accident Prevention Plan(APP)/Site Safety and Health Plan (SSHP)
- Section 12: Community Relations Plan

Figures and tables are provided in separate tabs following the body of the work plan.

Appendices to this work plan include:

- Appendix A: 2010 Regulatory Correspondence between the NMED HWB and the Air Force regarding the Kirtland AFB BFF Spill
- Appendix B: Project Schedule
- Appendix C: Waste Management Plan
- Appendix D: Field Forms
- Appendix E: BFF Spill Quality Assurance Project Plan (QAPjP)
- Appendix F: RTI Laboratories Laboratory-Specific SOP for Air Sample Collection

2. BACKGROUND INFORMATION

2.1 Site Description

Kirtland AFB is located in Bernalillo County, in central New Mexico, southeast of and adjacent to the City of Albuquerque and the Albuquerque International Sunport (Figure 1-1). The approximate area of the base is 52,287 acres.

2.2 Operational History

The BFF Spill site is located in the northwestern corner of Kirtland AFB (Figure 1-1). Historical aerial photography has revealed that the area was used for fuel storage and processing as early as 1951 (CH2M HILL, 2001). At that time, the fueling area was separated into a distinct tank holding area where bulk shipments of fuel were received (near the location of existing well Kirtland AFB-1066) and a separate fuel loading area where individual fuel trucks were filled. The truck loading area appears to have been approximately 250 ft north of the tank area.

Subsequent aerial photographs indicate that construction of the facility and associated infrastructure took place from 1951 until 1953. Once completed, the facility operated until it was removed from service in 1999, as a result of below grade line leakage along the offloading rack. Bulk storage for Jet Propellant-8 fuel (JP-8), diesel fuel, and aviation gasoline (AvGas) was managed in the eastern portion of the facility. A 250-gallon underground storage tank was located near the Pump House (Building 1033) (CH2M HILL, 2001). The three types of fuel handled by the BFF Spill were AvGas, Jet Propellant Fuel-4 (JP-4), and JP-8. Use of AvGas and JP-4 at Kirtland AFB was phased out in 1975 and 1993, respectively. JP-8 was handled through the FFOR until the leak was discovered in 1999.

The exact history of releases is unknown. Conceptually, releases could have occurred when fuel was transferred from railcars, through the FFOR, to the pump house and then to the bulk fuel storage containers on the south end of the site (Tanks 2420 and 2422). The probable release points have been investigated. Fuel transfer from railcars to the pump house was done under vacuum transfers. Transfer of fuel from the pump house to the bulk storage containers was performed under pressurized conditions. Fuel transfer infrastructure for vacuum transfers was exempt from pressure testing, whereas fuel infrastructure for pressurized transfer did undergo regular pressure testing. Only when the vacuum portion of the fuel system underwent pressure testing in 1999 was any problem noted in the fueling system.

At present, jet fuel is stored in two aboveground storage tanks (ASTs) (2.1 and 4.2 million gallons), diesel fuel is stored in two ASTs (one 5,000- and one 10,000-gallon), and unleaded gasoline is stored in one 10,000-gallon AST. The site currently has one temporary JP-8 offloading rack located in the southwest corner of the facility, west of the fuel loading structure (Building 2404). This rack was placed into service following the piping failure at the FFOR (SWMU ST-106). A second small offloading rack (Building 2401) is used for delivery of diesel and unleaded gasoline motor vehicle fuels.

Fuel delivered to the temporary JP-8 offloading rack is conveyed to the Pump House (Building 1033) via subsurface transfer lines. The fuel is then pumped to the JP-8 ASTs by piping of varying sizes that runs above ground for approximately 750 ft and runs belowground for approximately 300 ft. Figure 2-1 presents the infrastructure present at the eastern portion of the BFF Spill.

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3. SITE CONDITIONS

This section describes site conditions, including regional and site-specific geology, hydrogeology, and geochemistry. In addition, it presents the known extent of contamination, summarizes previous investigative results, and describes contaminants of potential concern and potential receptors.

3.1 Regional Geology

The geology of the Kirtland AFB area varies in accordance with the regional geology. The eastern portion of the base is mountainous, with elevations reaching 7,900 ft above mean sea level. These mountains are composed of Precambrian metamorphic and igneous (primarily granite) and Paleozoic sedimentary rock (primarily marine carbonates). The western portion of the base (which includes the BFF) lies within the Albuquerque Basin. Geologic features in this area of the basin include travertine and unconsolidated and semi consolidated piedmont deposits, as well as aeolian, lacustrine, and stream channel deposits.

In general, the surficial geology is characterized by recent deposits (i.e., mixtures of sandy silt and silty sand with minor amounts of clay and gravel), Ortiz gravel (i.e., alluvial piedmont sand and gravel deposits), and the Santa Fe Group (i.e., a mixture of sand, silt, clay, gravel, cobbles, and boulders). Generally, the northern and western portions of Kirtland AFB are dominated by unconsolidated geologic units; consolidated units predominate in the eastern half of the base.

Kirtland AFB lies within the eastern portion of the Albuquerque structural basin that contains the through-flowing Rio Grande. The basin is approximately 90 miles long and 30 miles wide. The deposits within the Albuquerque Basin consist of interbedded gravel, sand, silt, and clay. The presence of clay has significant implications for bulk hydrocarbon migration in the vadose zone. The thickness of basin-fill deposits in most of the basin exceeds 3,000 ft, though the thickness varies considerably because of the large amount of faulting in the basin.

Geologic materials of primary importance within the basin are the Santa Fe Group (USF) and the piedmont slope deposits. The USF consists of beds of unconsolidated to loosely consolidated sediments and interbedded volcanic rocks. The materials range from boulders to clay and from well-sorted stream channel deposits to poorly sorted slope wash deposits. Coalescing alluvial fans of eroded materials from the surrounding mountains were deposited unconformably over the Santa Fe Group, extending westward from the base of the Sandia and Manzano mountains to the eastern edge of the Rio Grande floodplain. The fan sediments range from poorly sorted mud flow material to well-sorted stream gravel; the beds consist of channel fill and interchannel deposits. The fan deposits range in thickness from 0 to 200 ft and thicken toward the mountains. The USF under the BFF Spill is further broken down into two depositional facies called the USF-1 and USF-2 (Hawley et al, 1995). As shown on Table 3-1, USF-1 is present from ground surface to approximately 86 ft bgs, then a transition occurs where USF-1 and USF-2 are interfingered to a depth of 117 ft bgs, under which USF-2 is present to a depth of greater than 500 ft bgs (CH2M HILL, 2008).

3.2 Site-Specific Geology

Soil types at the BFF Spill range from lean clays, silts, and sands to minor silty or sandy gravels. These soil can be correlated into several litho-stratigraphic zones discussed below.

- From the surface to approximately 85 ft bgs, the soil primarily consists of thick, discontinuous intervals of silt and silty or sandy clays.

- From approximately 86 to 144 ft bgs, two 3- to 25-ft-thick units of poorly graded fine-grain sands alternate with two silty, sandy, and lean clay units that are up to 25 ft in thickness.
- From approximately 144 to 270 ft bgs poorly graded fine-grained sands combine with well-graded fine- to coarse-grained sands.
- A significant 15-ft-thick clay zone occurs within the lower sandy zone at about 270 ft bgs.

Soils at the BFF Spill range from wet to dry. The finer-grained upper soil is generally moist while the coarser-grained deeper soil could be moist or dry. Several minor perched water-bearing zones are present in the vadose zone above the regional groundwater table at the BFF Spill. None of these water-bearing zones is substantial enough to merit the installation of a groundwater monitoring well. Some of these water-bearing zones below 400 ft bgs are probably remnants of the regional aquifer left behind as the water table has dropped. The regional water table varies with location within the Kirtland AFB and ranges from approximately 485 to 500 ft bgs.

3.3 Hydrogeology

The groundwater system at Kirtland AFB and in the Albuquerque area lies within the Albuquerque Basin, also referred to as the Middle Rio Grande Basin. The basin is part of the Rio Grande Rift. As the Rio Grande Rift spread, the Albuquerque Basin filled with sediments several miles thick, most of which are referred to as the USF. The unit consists of unconsolidated sediments that thin toward the basin boundary. Edges of the basin are marked by normal faults. Overlying the USF are the Pliocene Ortiz gravel and Rio Grande fluvial deposits.

Generally, the upper unit of the USF contains the most productive portion of the regional aquifer that supplies groundwater to the City of Albuquerque and Kirtland AFB. The unit is characterized by piedmont slope, river, and floodplain deposits. The ancestral Rio Grande formed a large aggradational plain in the central basin, depositing a mix of coarse- to fine-grained sands, silts, and clays with variable bed thickness.

Basin-fill deposits make up the aquifer in the Albuquerque Basin. Hydraulic conductivity values range from 0.25 ft per day (ft/day) to 50.0 ft/day due to large variations in the lithology of the basin-fill deposits. Clay layers have relatively low hydraulic conductivity, whereas gravel and cobble deposits have relatively high hydraulic conductivity. Deposits of interbedded gravel, sand, silt, and clay have intermediate hydraulic conductivity.

This principal aquifer underlies Kirtland AFB, with the basin fill in this area consisting of unconsolidated and semi-consolidated sands, gravels, silts, and clays of the USF; alluvial fan deposits associated with erosion of upland areas; and valley alluvium associated with stream development. The alluvium varies in thickness from a few feet near the mountains on the east side of the base to greater than 2,100 ft bgs at a location 5 miles southwest of the airfield. (Tetra Tech, 2004).

3.4 Geochemistry

Geochemical conditions are one factor that influences the transport and transformation of chemical compounds in the environment. Biodegradation often is a major transformation process for petroleum hydrocarbons and related compounds, and in general requires sufficient electron acceptors for microbial metabolism of petroleum hydrocarbons. In the presence of a carbon source (including fuels-related aromatic and aliphatic hydrocarbons), naturally occurring bacteria can use the fuel as food for growth and numerous naturally occurring compounds nitrate, iron, manganese, sulfate, carbon dioxide, etc. as electron acceptors, producing carbon dioxide, methane, and water (National Research Council [NRC], 2000). Microbial testing for soil was performed in 2009 and the results were that significant microbial action was detected at the location with high fuel contamination. (CH2M HILL, 2009).

3.5 Previous Investigations

3.5.1 Contaminant Sources

In November 1999, three known discharges occurred as a result of pressure testing of the lines that transfer fuel from the JP-8 offloading rack (Building 2405) to the pump house at the facility:

- Failure of one of the 14-inch-diameter belowground transfer pipelines (pipeline #22) during a hydrostatic pressure test;
- Failure of a cam-lock coupling during pressure test of the second belowground transfer pipeline (pipeline #23), and
- Failure of the second belowground transfer pipeline (pipeline #23) during a hydrostatic pressure test after the cam-lock coupling problem had been corrected.

Testing revealed that the primary belowground transfer pipeline (pipeline #22) had been in a state of failure for an unknown duration; therefore, the total amount of fuel released is unknown. The volumes of the second two discharges were estimated to be approximately 200 to 400 gallons and 30 gallons, respectively. For all discharges documented in November 1999, the product released was JP-8. However, due to the presence of multiple types of fuel contamination on the water table and the size of the LNAPL plume it is likely that the primary pipeline had been in a state of failure for many years. The presence of LNAPL fuel hydrocarbons on the water table also indicates that substantial releases have occurred and that a range of fuel types may have been released. Possible fuel types include AvGas, JP-4, and JP-8.

In 1951, the U. S. Government specified JP-4 (for Jet Propellant) as a 50-50 kerosene-unleaded gasoline blend (MIL-J-5624E). JP-4 was the primary Air Force jet fuel between 1951 and 1995. JP-4 is a mixture of aliphatic and aromatic hydrocarbons with a low flash point (0 degrees Fahrenheit [°F]/-18 degrees Celsius [°C]), if a lit match is dropped into JP-4, ignition does not occur.

JP-8 was specified by the U. S. Government in 1990 as a lower volatility replacement for JP-4. JP-8 is kerosene-based and has been used in nearly all jet aircraft, tactical ground vehicles, and electrical generators since 1996. Based on historical Air Force fuel usage, AvGas would have been in use from approximately the 1940s to 1975. EDB was added to the fuel as a lead scavenger and serves as a useful tracer of time frames. Likewise, the transition from JP-4 to JP-8 in 1993, it serves as another potential marker.

Over the past several years, potential sources in addition to the offloading rack were evaluated as possible contributors to LNAPL on the water table. These previously investigated potential sources include the pump house, a fueling island, underground piping, an evaporation pond, and areas where water from the bottom water holding tanks was released.

3.5.2 Past Investigative Results

As previously mentioned, in November 1999, three known discharges occurred as a result of pressure testing of the lines that transfer fuel from the JP-8 offloading rack (Building 2405) to the pump house at the facility. Subsequent investigations were conducted and the results are provided in the following reports:

- *Stage 1 Abatement Plan Report for the Bulk Fuels Facility (ST-106)* (CH2M HILL, 2001);
- *Stage 2 Abatement Plan Report for the Soil Vapor Extraction and Treatment System, Bulk Fuels Facility (ST-106), Kirtland AFB, New Mexico* (CH2M HILL, 2006a);
- *Stage 1 Abatement Plan Report, East Side of the Kirtland AFB Bulk Fuels Facility* (CH2M HILL, 2006b);
- *Semi-Annual Summary and Performance Report, October 2007 through March 2008, Bulk Fuels Facility* (CH2M HILL, 2008); and
- *Remediation and Site Investigation Report for the Bulk Fuels Facility* (CH2M HILL, 2009).

In the reports, soil data collected during the BFF Spill investigations are compared to the NMED's total petroleum hydrocarbon (TPH) Screening Guidelines to aid in defining extent of contamination (NMED, 2006). The petroleum product subgroup containing kerosene and jet fuel was selected as applicable for the BFF Spill site. The TPH toxicity for jet fuel is based on the weighted sum of the toxicity of the hydrocarbon fractions, which is reported as 30 percent for C11-C22 aromatics and 70 percent for C9-C18 aliphatics (NMED, 2006). Based on this assumed composition, the documented TPH screening guideline for potable water industrial direct exposure for jet fuel is 1,810 milligrams per kilogram (mg/kg) (NMED, 2006). The TPH screening guideline for vapor migration and inhalation of groundwater industrial direct exposure is 2,350 mg/kg (NMED, 2006).

Findings of these investigations are summarized below.

Stage 1 Abatement Plan Report (CH2M HILL, 2001)

In the soil investigations initiated immediately after the 1999 discovery of the fuel line leak, contamination was detected along the JP-8 offloading rack that supplies the 300-foot-long belowground pipeline. The horizontal extent of shallow contamination less than 40 ft bgs was delineated during the June 2000 direct push investigation portion of the Phase 1 investigation. This contamination appeared to be limited to within 50 ft lateral to the location where the pipelines went belowground.

The site investigations conducted during 2000 also included soil characterization at depth, extending down to the water table at select locations. Regional hydrostatic units and corresponding site-specific units are presented in Table 3-1. Contamination was identified in two deep soil borings (SB-25 and SB-26) installed during July 2000 using hollow stem auger drilling. These two borings were located on the eastern and western ends of the offloading rack. The maximum concentration detected in soil from boring SB-25 was 81,000 parts per million (ppm) TPH in the sample from 105 ft bgs, which is just below the Transition Zone between USF-1 and USF-2. The maximum concentration detected in boring SB-26 was 114,000 ppm TPH in the sample from 270 ft bgs, which is just above the Clay Zone that divides the USF-2 hydrostratigraphic unit.

Additional borings were installed to determine the horizontal extent of the soil that has TPH concentrations greater than 100 mg/kg. Based on data from the additional borings, soil contaminated in excess of the NMED TPH Screening Guidelines are limited to within approximately 310 ft of the surface; and within the area 65 ft south, 280 ft north, 400 ft east, and 175 ft west of the FFOR. The total area of soil affected by the petroleum hydrocarbon contamination is estimated to be 6.5 acres with depths of contamination extending to 310 ft bgs.

Stage 2 Abatement Plan Report (CH2M HILL, 2006a)

Additional borings were advanced in 2003 as part of a pilot test for SVE. All four soil-vapor monitoring wells included both soil and vapor sampling capabilities and were completed to depths of approximately 450 ft bgs. In addition to the anticipated intervals of petroleum-related contamination, two locations were found to have detections at the lowest sampling depth of 60 ft bgs.

Stage 1 Abatement Plan Report, East Side of the Kirtland AFB Bulk Fuels Facility, (CH2M HILL, 2006b)

In 2005, a shallow soil investigation of potential source areas on the east side of the BFF Spill was conducted. Soil samples were collected from the following areas:

- Former Wash Rack Drainfield
- Three fuel-storage ASTs
- Former Fuel/Water Evaporation Pond
- Recovered Liquid Fuel Collector Tank
- Primary fuel-storage ASTs and tank bottom water-holding tanks

The investigation included excavating test pits (TP-07, TP-08, and TP-09) and advancement of a direct-push borehole (SB-04) to 50 ft bgs. Additionally, a temporary soil-vapor monitoring point was installed in the direct-push borehole and monitored for hydrocarbon concentrations with field monitoring equipment for several quarters. Based on the visual observations, analysis of soil samples from the test pit and shallow soil sampling at this location and soil-vapor samples, substantial hydrocarbon impacts were not identified in the interval from the ground surface to 50 ft bgs. The only area where the NMED TPH guideline was exceeded was in the vicinity of the primary fuel storage ASTs and tank bottom water-holding tanks. The maximum petroleum hydrocarbon concentration was 2,400 mg/kg detected in the 15-ft bgs sample. None of the detections suggested that the area was a contributor to the soil-vapor profile at the BFF Spill.

Semi-Annual Summary and Performance Report (CH2M HILL, 2008)

In 2007, groundwater monitoring well KAFB-1066 was installed in the general vicinity of the east side of the BFF Spill. This monitoring well was installed between the presumed area of the storage tank associated with the 1951 rack operations and the location of the filling rack itself where tanker trucks would have been fueled. Well KAFB-1066 is roughly 75 ft north of the storage tank area associated with the 1951 operations. Additionally, 15 groundwater monitoring wells were installed between 2007 and 2008. These monitoring well installations are reported on in their respective Semi-Annual Summary and Performance Reports. Soil sampling was conducted at 20-ft intervals during advancement of the KAFB-1066 borehole, from 20 ft bgs to 480 ft bgs. The soil sample results did not suggest the presence of a large surface release of fuel in this area. However, there were detections of limited petroleum hydrocarbon concentrations (< 100 mg/kg) throughout much of the borehole length; and isolated, higher concentration detections of other fuel compounds such as toluene, benzene, xylenes, etc. at individual shallower depths of 40 ft and 140 ft bgs in the borehole. While the individual fuels-related detections in the borehole were not extremely high, the pattern of detections may be indicative of a predominantly stair-step lateral and vertical migration of near surface releases of fuel through the vadose zone.

Remediation and Site Investigation Report (CH2M HILL, 2009)

In 2009, soil boring investigations were conducted and four additional groundwater monitoring wells were installed at the BFF Spill to further evaluate other potential source areas. The soil data are consistent with previous sampling results and the effectiveness of the SVE system was indicated. LNAPL was not detected in samples collected from any of the newly installed wells.

3.5.3 Vadose Zone and Soil-Vapor Contaminant Distribution

Previous TPH vapor data suggest the movement of LNAPL through the vadose zone was offset to the east and north, presumably by fuel migration along dipping clay layers. The pathway will be refined/tested during the upcoming characterization effort. Conceptually, the TPH vapor results at 450 ft show the effect and correlate well with the distribution and orientation of LNAPL on top of the water table and groundwater contamination.

3.5.4 Light Non-Aqueous Phase Liquid Distribution

The greatest thickness of LNAPL occurs in the area to the east of the FFOR. LNAPL thickness is consistent with vadose zone migration of bulk LNAPL by following the water table toward the north and east. On October 4, 2010, measurements of LNAPL were obtained in monitoring wells that have historically had or potentially have measurable thickness of LNAPL (CH2M HILL, 2011). The currently known extent of the LNAPL plume is shown on Figure 2-1.

LNAPL thickness was detected in the following wells on October 10, 2010 (CH2M HILL, 2011):

- KAFB-1065 1.54-ft SVE
- KAFB-1066 1.04-ft SVE
- KAFB-1068 1.24-ft SVE
- KAFB-1069 1.10-ft
- KAFB-10610 0.15-ft
- KAFB 10614 0.21-ft
- KAFB-10628 0.22-ft

Measured thicknesses are greater at monitoring wells where active SVE is ongoing, possibly producing a mounding effect. The LNAPL plume extends approximately 2,600 ft long and is approximately 1,000 ft wide, trending along the groundwater flow direction.

3.5.5 Dissolved-Phase COPC Distribution

The distribution of dissolved-phased contaminants forms a halo around the LNAPL plume. As expected, concentrations of dissolved COPCs are detected at high concentrations very close to the LNAPL plume due to the dissolution of petroleum products into the groundwater and lower concentrations further from the LNAPL plume. The dissolved-phase COPC distribution is within the groundwater zone of saturation, and not within the soil-water unsaturated zone. The dissolved-phase plume extends approximately 4,500 ft along the axis of the plume trending along the groundwater flow direction. EDB is the most widely distributed COPC. The footprint of the dissolved-phase plume downgradient is elongated as the more mobile contaminants, such as benzene and EDB, are more quickly transported along with groundwater movement downgradient.

3.5.6 Site-Specific Fate and Transport

(To be included in the CSM section of the Quarterly Monitoring Report.)

3.5.7 Potential Receptors

(To be included in CSM section of the Quarterly Monitoring Report.)

3.5.8 Site-Specific Conceptual Model

The specific CSM will be included as a separate section in the Quarterly Monitoring report, which will also address data gaps as applicable. The CSM will include an in-depth discussion of the site geology; it will encompass the source areas, fuel percolation area, LNAPL plume floating on groundwater, and the dissolved-phase contaminant plume in groundwater. The applicable models will be illustrated through the liberal use of detailed, accurate, scaled geologic cross-sections; maps in plan view; and other figures to clearly and accurately show geologic features, hydrologic features, and contamination levels.

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4. INVESTIGATION METHODS AND APPROACH

Following previous investigations at the BFF Spill, data gaps were identified regarding the nature and extent of fuels contaminations as the result of past operational history at the BFF Spill. This work plan was developed to address the data gaps for the soil and vapor in the vadose zone, provide sufficient data and quality of data to adequately characterize the nature and extent of fuels-related contamination, and support the development of a Corrective Measures Evaluation.

This work plan will be implemented in conjunction with the BFF Spill Groundwater Investigation Work Plan, Interim Measures Work Plan, and LNAPL Containment Interim Measure Work Plan. Intrusive investigation, including drilling and sampling of soil and vapors, will determine the nature and extent of soil and vapor contamination at the BFF Spill and will provide insight into the chemical makeup and distribution of contaminants within the vadose zone. The Groundwater Investigation Work Plan and Interim Measures Work Plan will provide similar information and insight for the saturated zone and remedial measures.

4.1 Project Coordination

Prior to the commencement of work, a kickoff meeting will be held at Kirtland AFB, as appropriate. Invitees will include representatives from the USACE, Air Force Center for Engineering and the Environment (AFCEE), Kirtland AFB, NMED personnel, and the contractors conducting the work. The meeting will outline roles and responsibilities of all participants; review scope, schedule and procedures; and discuss base rules and security requirements. During the field implementation kick off meeting, a list of critical contacts within the field team, USACE, Kirtland AFB, and AFCEE will be compiled. This contact list will be used should immediate input be needed to any decision process critically impacting field work. This list will be reviewed and revised, as needed, on a monthly basis during the monthly conference call to account for future personnel absences.

A monthly conference call status meeting will be held among the field team, USACE, AFCEE, Kirtland AFB, and the NMED to discuss the progress of the field effort, upcoming field work, and consider any problems or issues that require resolution. Minutes of the meeting and action items will be documented by the field team managers, and circulated to the participants within 24 hours of the meeting. Conference calls will be implemented as deemed necessary.

During field investigation activities, daily quality control reports (DQCRs) will be completed by the field lead and provided to the project manager, and the USACE. DQCRs summarizes field activities and quality control (QC) activities that will occur each day. In compliance with the established *Base-Wide Plans for Investigation under the Environmental Restoration Program* (Tetra Tech, 2004), Field Change Request (FCR) forms will be filled out if there are any changes to the awarded scope of work approach. If the FCR represents a major change, such as moving a well or boring location, the USACE, AFCEE, and Kirtland AFB will be notified for approval and submittal to the NMED for approval prior to commencement.

4.2 Field Activities

The areas identified that need further investigation to characterize the full extent of lateral and vertical contamination in the vadose zone are:

- Tank Farm
- Pipeline

- Former Fuel Offloading Rack
- Fuel Percolator Area
- Farfield Area of Soil-Vapor Plume

Table 4-1 summarizes information about the soil borings/soil-vapor sampling wells and Table 4-2 presents the coordinates and purpose of the soil borings/soil-vapor wells. Figure 4-1 shows the soil borings/soil-vapor sampling wells locations and Figure 2-1 presents a detailed layout of the area. The number, locations, and depths of soil borings/soil-vapor wells are in accordance with Tables 1, 2, and 3 of the NMED letter from the Hazardous Waste Bureau, dated August 6, 2010 (Appendix A, Attachment 2). Sections 4.2.10 (Soil Borings/Drilling) and 5.1 (Soil Sampling) provide further discussion of the vadose zone investigation in these areas.

Field activities associated with this work plan include geophysics, soil borings/drilling activities, installation of soil-vapor monitoring wells, soil sampling and soil-vapor sampling. Soil and soil-vapor sampling are discussed in Section 5. Geophysics, soil borings/drilling activities, and installation of soil-vapor monitoring wells are discussed below.

4.2.1 Utilities Clearance

A utilities clearance will be conducted to locate all underground and suspended utilities both on Kirtland AFB property and off base. On-base utilities clearance activities will be conducted as prescribed by and in accordance with the Kirtland AFB site representative policies and procedures. Utilities clearance activities at adjacent residential neighborhoods and City of Albuquerque right-of-ways will be prescribed by and in accordance with State of New Mexico and City of Albuquerque utilities regulations.

All underground utilities will be clearly marked prior to the start of any intrusive activities. All intrusive activities will take into account any existing utilities, and will be located to avoid these utilities. The State of New Mexico's "New Mexico One Call" utility excavation clearance system will be utilized for all off-base drilling and excavation locations. Each well boring will be tested for utility clearance to 5 ft with a hand-auger or post-hole digger.

4.2.2 Site Survey

Land surveying activities may occur before, during, and after well installation activities. The survey will be conducted at locations on Kirtland AFB, adjacent residential neighborhoods, and City of Albuquerque right-of-ways. The survey will establish northings, eastings, and elevations at all locations. All survey points will be verified, determined, marked, and documented per all requirements as outlined in the Kirtland AFB Base-Wide Standard Operating Procedures (SOPs). A State of New Mexico registered professional land surveyor or licensed Professional Engineer will be utilized for well location verification and determination, excavation extents, temporary benchmarks as required for site controls, and as-built determination surveys,

Elevations for each survey point will be determined to the nearest 0.01 foot. The horizontal coordinates of each survey point will be determined to the nearest 0.01 foot and referenced to the New Mexico State Plane Coordinates. Horizontal coordinates will be based on the New Mexico State Plane Coordinate System, central zone (North American Datum, 1983 [NAD83]), as published by the National Geodetic Survey. Survey points will also be provided in Universal Transverse Mercator (UTM) coordinate system. Elevations will be determined to the nearest 0.01 foot and referenced to the 1988 National Geodetic Vertical Datum, as obtained from permanent benchmarks.

There will be two survey points for new and existing monitoring wells installed at the BFF Spill. The first survey point will be on north side of the well casing. The second survey location will be on the ground surface adjacent to steel protective casing or concrete well pad. Survey points at all other points, lines, and features will be have both horizontal and vertical control.

Daily reports will consist of the following: a tabulation of the location, identification, coordinates (both State Plane and UTM), and elevations of each point surveyed that day.

4.2.3 Borehole Geophysical Investigations

Borehole geophysics, consisting of induction, neutron, and gamma logging, will be conducted on 29 existing monitoring wells and the 35 new soil-vapor monitoring wells to be installed as described in this work plan. The deepest well installed at each of the 35 well clusters will be logged. Geophysical logging will aid in fully characterizing subsurface stratigraphy and the nature and extent of vadose zone and groundwater contamination. The ultimate goal of geophysical borehole logging investigations is to use the data to refine the CSM of the potential source location(s) and the extent of the LNAPL contamination, in order to optimize placement of remedial SVE and groundwater extraction wells and potential future monitoring wells. For this objective, it is expected that the top of the fine-grained clay and silt units in the vadose zone will need to be determined to a vertical precision of 1 ft using the geophysical logs. The specified precision requires that depth errors associated with the logging process will need to be closely monitored and meet the ASTM International (ASTM) standard (less than or equal to 0.4 % of the total depth logged). Additionally, the thickness of the lithologic units influences the shape of the log curve and therefore influences the ability to precisely define the top of the unit. In general, lithologic units whose thickness is less than approximately 1.5 to 2 times the borehole tool length may produce complex log responses that generally cannot be interpreted to a precision of 1 ft.

Borehole logging will follow standard industry practices such as those presented in the ASTM 5753 *(Standard Guide for Planning Borehole Geophysical Logging)*, ASTM D6274-01 (2007) (*Standard Guide for Conducting Borehole Geophysical Logging – Gamma)*, ASTM D6127 (*Standard Guide for Conducting Borehole Geophysical Logging: Neutron)*, and ASTM D6726-01 (2007) (*Standard Guide for Conducting Borehole Geophysical Logging: Electromagnetic Induction).*

4.2.3.1 Downhole Geophysical Logging

Geophysical techniques have proven to be valuable tools in determining lithology, porosity, and moisture condition of various stratigraphic units. Downhole geophysical logging will be conducted using a suite of logs to include medium and deep induction, neutron, and natural gamma (large-crystal) tools.

The logs will be run from at or above the groundwater table (approximately 500 ft bgs) to ground surface through polyvinyl chloride (PVC) well casing. Equipment will be decontaminated at each well location before conducting logging activities.

All logging equipment will be calibrated in accordance with manufacturer’s specifications. “Shop” calibrations will be performed within 30 days of the logging event. During the initial mobilization, operations will be confined to KAFB and before and after calibrations will be conducted for each logging tool at each well. During subsequent mobilizations, operations will occur in the neighborhoods surrounding KAFB. Due to the interferences anticipated in the neighborhoods (e.g., nulling the induction probe near large metal objects, power line interference, etc.) and safety factors associated with the neutron probe radioactive source, tool calibrations may be performed at a calibration site within the KAFB boundaries prior to and at the conclusion of each day’s activities.

The induction probe will be run free in casing during logging activities, and the neutron probe will be "sidewalled" using a bow spring or mechanical arm. This information will be recorded on the Shaw wireline logging summary sheet for each well.

A minimum of 100 ft of repeat log will be performed after the initial logging effort and the initial and repeat logs will be provided to the Shaw representative in hardcopy form for review. After completion of the borehole, a paper copy of the strip logs will be provided to the Shaw representative for review and approval. Digital data files for all logs also will be provided by the logging contractor at the end of the field day.

Geophysical logs will show results of induction logging (medium and deep) in ohm meters, neutron logging in American Petroleum Institute (API) neutron units, and gamma logging in API-calibrated counts per second. The results of each method will be plotted versus depth from the surface to total depth of the borehole for which the log represents. The name of the borehole, location of the borehole, the date(s) that the borehole was completed, the drilling method, after-survey depth error (ASDE), and the elevation of the top of the borehole will also be noted in the boring log. Data will be provided to the Shaw representative in hard copy and in digital format.

The logs will be evaluated /interpreted along with soil boring logs, well construction reports, and previous geophysical logs acquired in the surrounding area.

4.2.3.2 Induction Logging

Electromagnetic (EM) induction logs record the electrical conductivity (inverse of resistivity) of the materials surrounding the borehole. The conductivity is dependent on the porosity, permeability, type of material, moisture content, and total dissolved-solids concentration of the water within the unconsolidated materials or rocks.

EM-induction logging provides detailed stratigraphic information from dry, cased (PVC), or uncased holes. A small transmitter coil or array in the borehole probe induces eddy currents in the surrounding geologic material. The eddy currents generate a secondary magnetic field in the geologic materials. The strength of the magnetic field is controlled by the electrical properties of both geologic materials and groundwater. A receiver coil or array measures the strength of the quadrature component of the secondary magnetic field, and electronics in the instrument console convert the magnetic field strength to values of conductivity.

The probe proposed for use during the logging of SVM wells is 1.7 inches in diameter and 9 ft in length, with receiver arrays at 22 inches and 33 inches. The system operates at 25.6-kilohertz frequency and provides two conductivity measurements corresponding to "medium" (22-inch spacing) and "deep" (33-inch spacing) radii of investigation. The medium-induction component is most sensitive to material at a distance of approximately 3 to 12 inches from the center of the well, and the deep-induction component provides information at distances up to 20 to 30 inches (ASTM D6726-01 [2007], Advanced Logging Technology DIL 45 Correction Charts, and the Geonics EM39 Induction Manual). Consequently, borehole effects are minimized using the deep-induction component and the measured conductivity responds to the "true" formation conductivity.

Drift and noise are typically less than 1 millisiemen per meter and conductivity changes of a few percent can be resolved.

4.2.3.3 Gamma Logging

Gamma logs detect the amount of natural gamma radiation emitted by the rocks surrounding the borehole. Naturally occurring radiation comes from three principal areas: potassium-40, which occurs with all potassium minerals; uranium-238; and thorium-232, which are associated primarily with biotite. Clayey and shaley rocks typically have higher gamma radiation due to their composition of the weathering products of potassium feldspar and mica. The natural gamma tool is used for general lithologic identification and stratigraphic correlation. The typical radius of investigation for the natural gamma log is approximately 10 to 12 inches from the borehole wall.

The natural gamma probe utilizes a sodium-iodide, thallium-activated crystal to measure gamma-ray emissions from soil or rock. The method can be used in uncased, steel-cased, or PVC-cased wells.

The natural gamma crystal will be integrated with the induction and neutron probes for the logging of the SVM wells. A calibration certificate for the gamma will be provided by the logging contractor.

4.2.3.4 Neutron Logging

Neutron logging uses an active radioactive source to identify porous formations and lithology. The tool is also used to identify water saturation in vadose zones.

An americium-241 (beryllium-activated, americium-beryllium-241 [AmBe-241]) neutron source emits high energy (fast) neutrons into the formation. These neutrons diffuse through the formation and collide with the atoms present. Collisions with atoms that have a similar mass of neutrons, such as hydrogen, result in an exchange of energy. Thus, these neutrons are slowed down to thermal energies which can be detected by the helium-3 (He-3) detector. Since slowing is primarily due to collisions with hydrogen, neutron count rates represent the hydrogen content of the formation and can be interpreted in terms of porosity in water saturated formations.

For the logging of the SVM wells, a single He-3 detector will be used that is located 16 inches above the neutron source. The probe used for the SVM logging is 1.7 inches in diameter and 6.9 ft in length.

The necessary containers and safeguards for the transportation, storage, and use of nuclear source(s) will be provided. The operator will be properly trained, certified, and maintain the required licenses to handle nuclear source(s). Work will complete with all federal and state requirements for the use of active-source tools.

The neutron measurement uses a 1 or 3 curie AmBe-241 radioactive source. The neutron log can be presented in counts per second or porosity units. A casing collar locator measurement is a standard addition to the neutron log for well work.

4.2.3.5 Logging System and Requirements

A general procedure for the information recorded for a borehole geophysics survey will include recording all information necessary to correctly interpret the log, including:

- Project number;
- Well identification number;
- Well completion information;

- Location of the zero-depth reference of the log, which will be the ground elevation for the final processed data (if any other reference is used, such as the top of casing, it will be noted in the log header);
- Location of the ASDE reference point, which may be the top of the casing, ground level, or some other specified point;
- Height of the top of the casing above ground level;
- Depth of the bottom of the casing(s) and screen interval;
- Total depth geophysically logged (the greatest log depth reached in the hole will also be recorded for comparison to the drilling depth); and
- Total depth drilled.

4.2.3.6 Logging System

A Mount Sopris MGX digital logger (or equivalent) will be used. This facilitates interchanging probes as well as allowing the data to be collected on a DOS-based field notebook as the winch raises and lowers the probe. The logging system will be equipped with a 0.1- or 0.125-inch steel, armored, single conductor cable long enough to log the wells of interest.

4.2.4 Pre-Logging Requirements

Pre-logging activities include drilling and mobilization of the logging unit by the logging contractor to the borehole locations.

The following are basic pre-logging requirements:

- Boring logs will be prepared for each borehole during drilling for field comparison with the wireline logs. Zones of extensive circulation, lost circulation, suspected washouts, or drilling problems will be noted for anticipation of possible log response.
- Hole deviations will be recorded on the appropriate form(s) if directional surveys were run.
- A wireline logging summary will be filled out for each borehole. Information such as the tool, logging speed, repeat interval, depth reference, start and end time, calibration information, etc. will be recorded. A tool status report will be on site for all tools plus spares.
- A diagram will be drawn or one will be available from the logging contractor with the dimensions of every tool going into the hole. This will be provided at the beginning of the field program. A tool status report will be on site for all tools plus spares.
- All logging equipment will be properly decontaminated before arrival on site, between wells, and before leaving the site. The equipment will be decontaminated according to Section 4.3 of this work plan.
- For logging in cased holes, a “dummy” tool of the same dimensions may be used to ensure the working tool does not stick in the hole. This is especially useful for small-diameter PVC casing, which may flex when it is set in the borehole.

- For open-hole logging, the drilling contractor will circulate and condition the borehole appropriately to aid the geophysical logging of the hole. Such requirements will be discussed with the driller in the briefing.
- Just prior to logging, a mud sample will be circulated from the bottom of the hole and measured for the resistivity of the drilling mud, mud cake, and mud filtrate. The geophysical logging subcontractor will supply the mud meter and conduct the measurements.

4.2.5 Logging Requirements

The basic borehole geophysical logging process consists of the following:

- After mobilization to the borehole and decontamination of the equipment, the contractor connects the first tool to be run to the cable.
- The contractor conducts the "before" logging calibration check at the well or another pre-approved location at the start of the day to ensure the instrumentation is functioning properly. The calibration results are checked to ensure that they meet the required tolerances.
- The tool is placed in the hole and adjusted to "zero" depth at a pre-defined depth reference (e.g., top of casing). The contractor checks to ensure that all equipment is still functioning properly and then lowers the logging tool into the borehole.
- While the tool is lowered to the bottom of the hole, the logging tool response is monitored by the logging engineer.
- Once the tool is at the bottom of the hole, a final check is completed (instrument settings, logging scales, total depth, etc.). Logging is commenced up the hole at the proper speed (following logging contractor SOPs) and data are digitally recorded. The logging speed and sample interval are documented on the wireline summary sheet and log header for each well.
- The logging tool is then run up the hole at the proper speed and the up-log is generated.
- Once the upwards logging run is completed, the tool is placed back in the hole at a specified interval to collect a repeat section for QC purposes.
- Field copies of all logs are generated. The original and repeat log sections are checked for overall quality and repeatability.
- Post-logging calibration checks are performed at the well site or at the end of the day. If the main log is of appropriate quality and if the repeat and main log are in required agreement, the "after" calibration of the logging tool is then run. The calibration results are checked to ensure that they are within appropriate tolerances.
- The tool is then removed from the cable.
- If data are collected with another tool, the process above is repeated. If not, the logging unit and associated tools and equipment are decontaminated and prepared for transfer to the next borehole.

The following required items are necessary for effective implementation of the logging process and generation of useful logs of appropriate quality:

- The pullout strength of the cable socket, which connects the tool to the cable, will be known before entry into the hole.
- Calibration procedures, both in the shop and in the field, must be performed. The time and results of the last shop calibration for each tool must be documented.
- Field calibrations will be performed before and after logging and recorded on the wireline logging summary sheet.
- When logging tools are run in combination, all curves will be referenced to the same depth reference point (e.g., top of casing or ground level).
- A thermometer will be used on the first logging run of each logging trip, to record the maximum hole temperature, or a temperature probe will be run to the bottom of the borehole.
- Depth control will be used for each logging run. This is accomplished by placing the tool reference point at a known point (e.g., top of casing) and using that location as the "zero" reference for the logging run.
- The ASDE metric for the project will be 0.4 percent of the logged depth between the start and end of a logging run where the tool is referenced to a zero depth at a pre-defined point prior to and at the end of the logging sequence. The proposed ASDE is based on current ASTM standards and will ensure logging data are of sufficient quality to meet project objectives. The ASDE will be documented on the log header for each well.
- If logging tools are run in combination, the geologist should ensure that all curves are on the same depth. If sand or gravel is present at the base of the well, the geologist should ensure that the driller drills a rat hole deep enough so as to provide enough depth for the log's first readings to be in the sand or gravel.
- Down-logs will be recorded as each tool is run down the hole. This will provide an opportunity to properly adjust the instruments and provide for proper scaling of the up-log responses. Logging speed will be selected to give good thin bed resolution and proper log quality.
- The geologist should ensure that the driller drills a rat hole deep enough so as to provide enough depth for the log's first valid readings to be in the sand or gravel at the bottom of the well.
- Repeat sections will be run for all logs. The repeat sections will be selected based on zones of interest and will be a minimum of 100 ft in length. The curves from the repeat and original logs will then be checked. Electrical curves will overlay exactly, while nuclear logs will have statistical variations (usually no more than one chart division).
- For multiple logging runs (i.e., successively deeper runs in the same borehole), the later (deeper) runs will be logged up into the casing. The geophysicist should overlay at least 100 ft of all previous logging runs, compare data results, and ensure that results are reproducible.

Attention to detail during borehole geophysical logging, including equipment setup, calibration, and monitoring, is required for obtaining accurate and reliable data. Borehole geophysical logs are subject to a number of potential tool problems and operational errors. A Shaw QC representative will be present during the entire logging operation to provide oversight of the logging process. The Shaw QC representative will independently document the logging activities to ensure the data are of sufficient quantity and quality to meet project objectives. Any and all problems (including tool malfunction and significant downtime) and associated corrective actions will be recorded by the Shaw QC representative on the appropriate form(s) according to the project work plans.

Field copies of all logs will be provided to the Shaw QC representative at the end of each logging run. The QC representative will review the log and check the data for overall quality and repeatability (e.g., noise spikes, depth reference, drift of the EM log). Any potential quality issues will be brought to the attention of the contractor and resolved prior to demobilization from the site.

For the field logs (and final logs [see below]), all off-scale readings, drift adjustments, and first curve readings will be marked on the logs, and all curves identified and labeled. All post-logging field calibrations must be run for each tool and recorded on the log tails or headers. These will be checked with the pre-log calibrations, noting any changes.

A wireline logging summary sheet will be completed for each borehole. Header information will be thoroughly filled out, including equipment and calibration date. The type, temperature, and resistivity of any fluids and other associated measured parameters will be recorded, as applicable. Any unusual conditions, problems, or concerns regarding the logging run are to be included in the remarks section. Logging speeds, time constants, and tool model will be correctly recorded. The digital data for the original, repeat, and tool calibrations are digitally recorded and will be maintained as part of the official project record.

The logs will be completed to the satisfaction of the Shaw QC representative before the logging contractor is allowed to rig down. Final approval for acceptance of the quality of the log will rest with the QC representative and project manager.

- A general procedure for the information recorded for a borehole geophysics survey will include recording all information necessary to correctly interpret the log, including:
  - Total depth of the logger
  - Well identification number
  - Project number
  - Client bit size (or borehole diameter)
  - Casing size
  - Location of the zero-depth of the log, which may be the top of the casing, ground level, or some other specified point
  - Height of the top of the casing above ground level
  - Depth of the bottom of the casing(s)
  - Total depth drilled
  - Date of logging
  - Logging engineer

   – Logging speed
   – Sensitivity range setting(s)
   – Calibration and standardization data
   – Logging tool serial numbers
   – Any additional pertinent information

- Record the source-to-detector distance for nuclear radiation tools and the focusing width for focused resistivity tools.
- In resistivity logging, sample the drill hole fluid and record its resistivity so that true resistivity for the strata can be calculated.
- Clearly record calibration and standardization marks on all logs to demonstrate the relationship between the log scale and standard calibration procedures.
- Decontaminate logging tool and cable if necessary.

EM-induction logs record the electrical conductivity or resistivity of the rocks and water surrounding the borehole. The conductivity and resistivity are dependent on the porosity, permeability, and clay content of the rocks and by the dissolved-solids concentration of the water within the rocks. The EM-induction probe is designed to maximize vertical resolution and depth of investigation and to minimize the effects of the borehole fluid.

A calibration certificate for the induction logging will be provided.

4.2.6 Post-Logging Requirements

A predetermined number of final log prints will be provided within two weeks of completing the final logging run, including the final composite logs. Any and all information required for entry on the field logs above will be included on the final log prints. In addition to the hardcopy logs and raw and final processed digital data will be delivered within two weeks of project completion.

4.2.7 Reporting

4.2.7.1 Daily Field Reports

Field record of the operation of site activities, including boreholes logged and support activities such as equipment decontamination will be available to the Site Supervisor at the completion of each day’s work.

At a minimum, the following data will be included in the daily reports:

- Dates and times of beginning and completion of work;
- A list of employees at the site and their work locations (borehole number);
- The number and location of boreholes logged, including depth or total logging footage performed;
- A list of major on-site equipment and location (borehole or equipment decontamination location); and
- Any problems encountered, including standby time recorded.

4.2.7.2 Final Report

Three copies of the paper strip logs and report and digital (MSWord [text], PDF [figures], ASCII [logging data]) copies, on compact disk, will be provided. Each log title block will include as a minimum the borehole number, probe type, module adjustments, logging speed, depth footage (vertical scale), horizontal units and scale, depth to groundwater and calibration(s). The report will include field and data processing procedures, figures representing the data, and an interpretation minimally identifying relatively more permeable zone, stratigraphy, and structure as applicable.

4.2.8 Technical Review

All borehole geophysical logging plans, scopes-of-work, field procedures, field quality control documentation, logs, and associated reports will undergo technical review by a geophysicist.

The technical review, at a minimum, will consider and evaluate the following pre-logging items:

- Data collection objectives and requirements
- Site geology
- Scope of work
- Vendor qualifications and equipment
- Field procedures

The post-logging technical review will consider and evaluate the following minimum items:

- Field documentation, including problems encountered and corrective actions taken
- Equipment calibration/certification
- Review and quality of the logs relative to the requirements and the project work plans
- Calculations and data interpretation

Any issues raised during the pre-logging technical review will be resolved between the reviewer and staff planning the program before conducting the logging. Issues raised during the post-logging review will be resolved before external submission of the results. The technical review comments and issues, and corresponding resolution, will be documented and filed with the project records.

4.2.9 Borehole Geophysics Equipment Decontamination

All downhole logging equipment and materials will require decontamination before use, between each borehole, and before demobilization. Equipment will be thoroughly decontaminated between boreholes. All equipment will be cleaned before mobilization.

4.2.10 Soil Borings/Drilling

A total of 35 soil borings will be advanced to approximately 450 ft bgs. Each boring at each location will be drilled from the surface to the water table, and completed as a permanent soil-gas monitoring well. Figures 2-1 and 4-1 shows the locations. The following is a summary of the soil borings for each area:

- **Tank Farm -** Eight deep and five shallow soil borings/soil-vapor wells will be completed in the tank farm area within 60 days following demolition of the fuel tanks and site restoration. Depending on what is found, additional soil borings/soil-vapor wells may be needed. Eight deep soil borings to 450 ft and five shallow soil borings to a depth of at least 20 ft will be completed at Tank Farm locations (Figure 2-1).

- **Pipeline -** The pipeline that runs between the tank farm, the pump house, and the FFOR has not been investigated. Five deep soil borings/soil-vapor wells will be completed along the buried and exposed portions of the pipeline. Five deep soil borings/soil-vapor wells will be completed to 450 ft. Figure 2-1 shows locations of soil boring/soil-vapor wells.

- **Former Fuel Offloading Rack -** Six deep soil borings/soil-vapor wells will be completed at the FFOR to determine the full extent of contamination. Soil borings/soil-vapor wells will be completed at the locations shown on Figure 2-1.

- **Fuel Percolation Area -** Eight deep soil borings/soil-vapor wells will be completed in order to significantly improve characterization of this area. The eight soil borings/soil-vapor wells locations are shown on Figure 2-1.

- **Farfield Area of Soil-Vapor Plume -** Eight deep soil borings/soil-vapor wells will be completed at locations north of the Fuel Offloading Rack and the fuel percolation area to investigate the concentrations of hazardous constituents in soil gas that overlies groundwater in these areas. Soil-vapor well locations are shown on Figures 2-1 and 4-1.

Each well boring will be tested for utility clearance to 5 ft with a hand-auger or post-hole digger. Borehole advancement (drilling) will be performed using the air-rotary casing hammer (ARCH) method. The ARCH method uses steel insulator casing, advanced with drill bit/rod, to prevent borehole collapse. Deep vadose zone wells will be installing a nest of 6 wells screened at different intervals (25, 50, 150, 250, 350, and 450 ft bgs). The deepest well (450 ft bgs) will to be a 3-inch PVC well and the remaining will be ¾ inch wells. Each borehole will be drilled as a 11-¾ inch outside diameter (O.D.) casing that telescopes down to 9-5/8-inch O.D. casing at 150 ft.

Borehole drilling equipment will be thoroughly decontaminated between boreholes. All soil cuttings will be placed into the provided roll-offs. All soil and solid wastes resulting from drilling and sampling activities will be contained in roll-off bins and all liquid will be contained in U.S. Department of Transportation (DOT) approved, 55-gallon drums. All drums containing wastewater will be transported to a central location on Kirtland AFB.

Geologic logs will be prepared for each borehole showing relative to borehole depth the rock types, thickness of rock units, and water-bearing zones (including that at and below the water table). The name of the borehole, location of the borehole, the date(s) that the borehole was completed, the drilling method, and the elevation of the top of the borehole will also be noted on the boring log. The data will be provided to the NMED in both hard copy and in digital format. See Section 4.2.10.1 below for details regarding logging.

The following elements regarding soil borings will be followed:

- All drilling will conform to state and local regulations. Permits, applications, and other documents required by state and local authorities will be obtained.

- Locations of all borings will be approved in writing by the NMED before drilling begins.

- The drill rig will be decontaminated in accordance with SOP B1.11 (Equipment Decontamination). Use of disposable equipment is preferred. If disposable equipment is unavailable, use of decontaminated equipment is allowed. Equipment will be decontaminated per the requirements of SOP B1.11. All sampling equipment which may not be decontaminated will be disposed of in accordance with the project-specific addenda to the Waste Management Plan (Appendix C).

- The drill rig will not leak any fluids that may enter the hole or contaminate equipment that is placed in the hole. The use of rags or diapers to absorb leaking fluids is unacceptable. All leaking fluids will be caught in a proper container until the leak is repaired. If sample integrity could be comprised by leaking drill rig fluids, then sample operation may be shut down until the leak is repaired.

- No fluids will be used to advance soil borings.

- Surface water and extraneous materials will not enter the boring.

- All trash and drill cuttings will be disposed.

- Before digging begins a digging permit, the Base Civil Engineering Work Clearance Request form needs to be completed and approved by the Chief of Operations or Chief of Engineering and Environmental Planning at the base. The work clearance request is processed just before the start of work and is valid for 30 days. If delays are encountered and the conditions at the job site change (or may have to be changed) or the project extends past 30 days, this work clearance request must be reprocessed.

- The type of information that must accompany this permit includes:

  - Location
  - Work order/job number
  - Contract number
  - If the area has been staked/clearly marked or not
  - A sketch of the excavation
  - Type of facility work involved, i.e., pavements, drainage systems, railroad tracks, overhead or underground utility or communications, aircraft or vehicular traffic flow, security, etc.
  - Date clearance requested and terminated
  - Requesting official, phone number, and organization

Activities associated with borehole advancement (drilling), equipment decontamination, handling of investigative-derived waste (IDW), and borehole abandonment (if required) will be performed in accordance with the *Base-Wide Work Plans for Investigation under the Environmental Restoration Program* (Tetra Tech, 2004) and is discussed in the following sections.

4.2.10.1 Borehole Logging

Each boring will be fully described on a boring log similar or equivalent to that shown in Appendix D, Form 1 and in accordance with ASTM D5434 *(Standard Guide for Field Logging of Subsurface Explorations of Soil and Rock*). The a qualified geologist will log the boring as it is being drilled by recording relevant data, listed below, on either the boring log.

Data to be included in the logs, as applicable, are:

- The identifying number and location of each boring will be noted.

- All measurements will be accurate to one-tenth of a foot.

- Drilling logs and other scaled drawings will be drawn at a scale of 1 inch = 1 ft. (Note: for wells deeper than 200 ft, the scale may be adjusted to a more practical ratio. In addition, if sampling intervals are greater than 10 ft apart, the log can be represented with breaks in order to skip unlogged intervals).

- Soils will be classified in accordance with the Unified Soil Classification System (USCS). These classifications will be prepared in the field by the geologist and will be subject to revision based on laboratory tests or subsequent review.
- A full description of soil samples will be made. For split-spoon, thin-wall, soil-core, or otherwise intact samples, the description will include but not be limited to the USCS two-letter classification, plus a more complete verbal description of color, consistency, soil moisture, grain size, and size distribution.
- Depth limits and the type and number of each sample taken will be indicated. All samples will be numbered consecutively.
- The number of blows required for each 6-inch penetration of split-spoon sampler and for each 12-inch penetration of casing will be indicated, as well as hammer weight and length of fall for split-spoon or driven samplers; and hydraulic pressure used to push thin-wall tubes. If thin-wall tubes are pushed manually, that will be indicated.
- The start and finish times for all rock coring runs will be noted, including a description and depth of any drilling anomalies such as voids, loss of fluids or air, odors, etc.
- Depth to water as first encountered during drilling, along with the method of determination, will be noted. Any distinct water-bearing zones below the first zone also will be noted. Other observations during drilling will be noted, such as bit chatter, rod binding, rod drops, flowing or heaving sands, bit pressure, rod rotations per minute, and water pressure.
- If drilling fluid is used, the fluid losses, interval over which they occur and the quantity losses, lost will be recorded.
- A general description of the drilling equipment used will be provided. This description, including such information as rod size, bit type, pump type, rig manufacturer, and model, may be provided in a general legend.
- Dates and times of start and completion of boring will be indicated.
- The names of the contractor, driller, and rig geologist will be noted.
- The size and length of casing or auger used in each borehole will be noted.
- Observations of visible contamination for each sample or from contaminated cuttings will be made.
- Field instrument readings will be noted.

As the boring is drilled, the qualified geologist will evaluate adjacent samples recovered, together with observation of the drill cuttings, wash water (if any), drill performance, etc., to determine appropriate stratigraphic definitions or distinctions within the soil column. Such contacts or breaks between strata must be determined by the rig geologist and indicated on the boring log. If such information is not provided, the log is nothing more than a listing of individual sample descriptions. In general, a stratigraphic unit contains only similar soil that can be classified within the same two-letter

USCS classification category symbol. In some cases, significant differences in soil color, grain size distribution, strength, etc., would be sufficient to classify soil having the same two-letter USCS classification category symbol into two or more distinct strata.

After the qualified geologist has indicated the appropriate stratigraphic breaks on the log, he/she will develop and record an appropriate description for each defined stratigraphic unit. Each description will contain information about the color, grain size distribution, consistency, moisture, etc., and the appropriate two-letter USCS classification category symbol. The boring logs will be reviewed and approved by a registered Professional Geologist as they are completed.

Classification of Soils

All classification data will be written directly on the boring log (if there is enough space) or in a field logbook. The method of deriving the classification will be described, or reference to this guideline or other manuals will be made. Handling of samples during soil classification will be coordinated with chemical sampling activities, if appropriate.

USCS Classification

Soils are to be classified according to the USCS (ASTM D2488-09a, *Standard Practice for Description and Identification of Soils [Visual-Manual Procedure]*). This method of classification is detailed in Appendix D, Form 2. This classification method identifies soil types on the basis of grain size and liquid limits, and categorizes them by two-letter symbols.

In the USCS system, fine-grained soil, or fines, are classified as those which will pass through a No. 200 U.S. standard sieve (0.074 millimeters [mm]) and are of two types: silt “M” and clay “C.” Some classification systems define size ranges for these soil particles, but for field classification purposes, they are identified by their respective behaviors only. Organic material “O” is a common component of soil but has no size range, and is recognized by its composition.

Gravely soil is identified by a “G” as the first letter in the two-letter symbol, whereas sandy soil is identified with an “S.” The term, “rock fragments,” will be used to indicate granular materials resulting from the breakup of rock. These materials are normally angular, indicating little or no transport from their source. When the term, “rock fragments” is used, it will be followed by a size designation, such as ¼- to ½-inch diameter or “coarse-sand size,” either immediately after the entry or in the remarks column. The USCS classification will not be affected by this variation in terms.

The second letter in the two-letter USCS symbol provides information about the grain size distribution of granular soil, or the plasticity characteristics of fine-grained soil. These second-letter modifiers are “P” well sorted, “W” well graded/poorly sorted, “C” clayey, “M” silty, “L” low plasticity, or “H” high plasticity. Note that the term, “poorly graded,” implies a uniform grain size distribution and is the same as “well sorted.”

Color

Soil colors will be described using a single color descriptor preceded, when necessary, by a modifier to denote variations in shade or color mixtures. A soil could therefore be referred to as “gray” or “light gray” or “blue-gray.” Since color can be used in correlating units between sampling locations, it is important that color descriptions be kept consistent throughout field operations.

Colors must be described while the sample is still moist. Soil samples will be broken or split vertically to describe colors. Soil sampling devices tend to smear the sample surface creating color differences between the sample interior and exterior. In accordance with ASTM D1535-08e1 (*Standard Practice for Specifying Color by the Munsell System*), Munsell color charts or equivalent must be used based on project requirements.

Relative Density and Consistency

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

The density of non-cohesive, granular soil is classified according to standard penetration resistances obtained from split-spoon sampling methods that are in accordance with ASTM D1586-08a (*Standard Test Method for Standard Penetration Test [SPT] and Split-Barrel Sampling of Soils*) and are detailed in SOP B2.3 (Subsurface Soil Sampling, Split Spoon Sampling Procedure section). Those designations are:

Standard Penetration Resistance (SPR)

Designation	Blows per ft
Very Loose	0 to 4
Loose	5 to 10
Medium Dense	11 to 30
Dense	31 to 50
Very Dense	Over 50

Standard penetration resistance is the number of blows required to drive a split-barrel sampler with a 2-inch O.D., 12 inches into the material using a 140-pound hammer falling freely through 30 inches. The sampler is driven through an 18-or 24-inch sample interval and the number of blows is recorded for each 6-inch increment. The density designation of granular soil is obtained by adding the number of blows required to penetrate the second and third 6 inches of each sample interval. It is important to note that if gravel or rock fragments are broken by the sampler or if rock fragments are logged in the tip, the resulting blow count will be erroneously high, reflecting a higher density than actually exists. This will be noted on the log and referenced to the sample number.

The consistency of cohesive soil is determined by performing field tests and identifying the consistency as shown in Appendix D, Form 2. The consistency of cohesive soil is determined either by blow counts or most accurately by a pocket penetrometer or field Torvane device in accordance with ASTM D2573-08 (*Standard Test Method for Field Vane Sheer Text in Cohesive Soil*). The SPR can be applied to cohesive soil as follows:

Designation	SPR (blows per ft)
Very soft	<2
Soft	2-4
Medium Soft	4-8
Stiff	8-15
Hard	>30

The pocket penetrometer method is conducted on a selected sample of the soil, preferably the lowest 0.5 ft of the sample in the split-spoon sampler. The sample will be broken in half and the penetrometer pushed into the end of the sample to determine the consistency. Do not determine consistency by attempting to penetrate a rock fragment. If the sample is decomposed rock, it is classified as a soft, decomposed rock fragment rather than a hard soil. The pocket penetrometer or Torvane may be used in conjunction with blow counts to determine cohesive soil consistency.

Soil Component

In nature, soil is comprised of particles of varying size and shape and are combinations of the various soil types. Appendix D, Form 2 lists grain size classifications to be used in describing soil or rocks. The following terms are useful in the description of soil components:

The Identifying Proportion of the Component	Defining Range of Percentages by Weight
Trace	0-10 percent
Little	11-20 percent
Some	21-35 percent
Most	36-50 percent

Moisture

Moisture content is estimated in the field according to four categories: dry, moist, wet, and saturated. In dry soil, there appears to be little or no water. Saturated samples obviously have all the water they can hold. Moist and wet classifications are somewhat subjective and often are determined by the individual's judgment. A suggested parameter for judging this in a fine-grained soil would be calling a soil wet if rolling it in the hand or on a porous surface liberates water, i.e., dirties or muddies the surface. Whatever method is adopted for describing moisture, it is important that the method used by an individual remains consistent throughout an entire drilling job. Laboratory tests in accordance with ASTM D2216-10 (*Standard Test Methods for Laboratory Determination of Water [Moisture] Content of Soil and Rock by Mass*) or field tests for water content will be performed if the natural water content is important.

Stratification

Stratification can only be determined after the split-spoon sampler is opened. The stratification or bedding thickness for soil and rock is dependent on grain size and composition. The classification to be used for stratification description is described below:

Thickness Approximate English(Metric) Equivalent Classification

Metric	English	Classification
>1 meter	> 3.3 ft	Very thick
30 centimeter (cm) -1 meter	1.0 ft -3.3 ft	Thick bedded
10 cm-30 cm	4.0 in -1.0 ft	Medium bedded
3 cm -10 cm	1.0 in -4 in	Thin bedded
1 cm -3 cm	2/5 in -1 in	Very thin bedded
3 mm -1 cm	1/8 in -2/5 in	Laminated

Thickness Approximate English(Metric) Equivalent Classification

Metric	English	Classification
1 mm -3 mm	1/32 in -1/8 in	Thinly laminated
<1 mm	<1/32 in	Micro laminated

4.2.11 Soil-Vapor Monitoring Wells

Thirty-five "nested" soil-vapor monitoring wells will be installed in soil borings. Soil boring/soil-vapor monitoring well locations are shown on Figures 2-1 and 4-1. Each nested well location will include six individual (one 3-inch diameter and five 3/4-inch diameter), schedule 80, PVC soil-vapor monitoring wells installed in the same borehole. The nested wells will include a 10-ft length of machine slotted (0.050-inch) screen. Anticipated depths of the nested wells will be 25, 50, 150, 250, 350, and 450 ft bgs. Actual well depths may vary and are dependent on lithology observed during the advancement (drilling) of each borehole (e.g., screens will be placed in transmissive zones). Clays will be avoided. If proposed vapor-monitoring points are screened in zones determined to be fine grained lithology, the screen interval may be adjusted up or down to the nearest coarser grained unit, if the unit is located within 20 ft of the proposed 150-, 250-, 350-, and 450-ft screened intervals. For the 50- and 25-ft screened intervals, the coarser grained unit must be within 5 ft of the proposed screen location. If there is no coarser grained interval located within the 20 ft of the proposed screened interval, the screen vapor point will be installed as originally proposed. (Fine grained units are defined as units coarser than ML or CL as presented in the USCS.) If deviations are required, the NMED will be notified in writing of the deviation and written approval received. Filter pack (sand) will be placed around the lowest nested well screen followed by a fine sand seal. A bentonite chip seal will extend from the top of the fine sand seal to just below the screen for the next lowest well. This process will be completed for each nested well screen/riser pipe. Surface completions of the nested wells will be within steel flush-mount protective covers (manholes) with gasketed bolt-down covers. The bentonite seal for the highest well will extend to the base of the protective cover skirt. Bentonite chip seals will be hydrated in lifts using a "clean" water source. A typical SVM well installation is shown on Figure 4-2.

The SVM nests will be constructed using 3- and ¾-inch diameter, flush threaded, Schedule 80, PVC casing and 10 ft of 0.050- inch factory slotted screen. An engineered filter 0.25/8 Colorado silica sand pack will be installed in the annular space between the riser/screen and the borehole from 1 ft below to 1 ft above the screened interval. The filter pack will be slurried with clean potable water and tremied into place to prevent bridging and to ensure continuous placement, while the drive casing is slowly removed. A 10-ft hydrated bentonite seal will be emplaced above the sand filter pack and incrementally hydrated with potable water in 1-ft lifts. After the last lift has hydrated for 2 hours, a high solids bentonite grout will be emplaced by tremie pipe to 1 ft below the next higher point, except for the 25-ft sample point. The 25-ft sampling point will have a bentonite-cement grout placed above the seal extending to within 1.5 ft of the surface. Each sampling string will be marked to identify the screen depth as it has been emplaced. The nest will be completed as a surface completion with a 4-x-4-ft concrete pad, sloped to direct runoff away from the well. Surface completions of the nested wells will be within steel flush-mounted. protective covers (manholes) with gasketed bolt-down covers, and each sample string will be fitted with an adaptor and push-to-connect for ¼-inch tubing for connection to the vapor sampling device.

Activities associated with soil-vapor monitoring well installation will be performed in accordance with the *Base-Wide Plans for Investigations Under the Environmental Restoration Program, Kirtland Air Force Base* (Tetra Tech, 2004), the site-specific QAPjP, and other pertinent site documents. SVM well boring will be logged by a qualified geologist. The boring logs will be reviewed and approved by a registered Professional Geologist as they are completed.

If a soil-vapor well is installed as a permanent monitoring point, the well will not be sampled before the expiration of the 24-hour equilibration period following completion of installation. Information on the design and construction of SVM wells will be recorded as with groundwater monitoring wells as applicable.

SVM wells will be designed and constructed in a manner that will yield high quality samples. The design and depth of installation will be approved by the NMED.

4.2.12 Borehole Abandonment

If needed, all borehole abandonment procedures will be performed in accordance with all federal, state, and local regulations. Well abandonment will be supervised by a qualified geologist or hydrogeologist and the details recorded on the Well Abandonment Form as shown in Appendix D, Form 3.

Unless otherwise specified, monitoring wells will be abandoned as described below:

- Prior to abandonment, the borehole or well will be probed to determine the total open depth of the hole or well casing, respectively. Water level measurements will also be measured and recorded.
- All stainless steel or steel existing well casings will be completely removed or drilled out to the total depth of the well to avoid groundwater contamination due to corrosion. PVC casings may remain in place.
- A plugging material consisting of one or a combination of the following materials will be used:
  - Neat cement with not more than 5 percent by weight of bentonite;
  - Bentonite slurry (which can include polymers designed to retard swelling);
  - High solids grout ; or
  - Pelletized medium grade or crushed bentonite.
- Cement and bentonite slurries will be pumped into place in a continuous operation with a grout pipe introducing the plugging material at the bottom of the well and moving the pipe progressively upward as the well is filled. This method will be repeated to within 2 ft bgs unless otherwise specified.
- The well casing will be severed at least 2 ft bgs, if not required to be completely removed, and a cement plug larger in diameter than the well bore will be constructed over the well bore and completed flush with the ground surface.
- When using pelletized or crushed bentonite, the bentonite will be poured down the hole in 3- to 5-ft lifts and hydration using clean potable water between lifts. This method will be repeated to within 2 ft bgs unless otherwise noted.

4.3 Equipment Decontamination

The objective of field decontamination is to remove contaminants of concerns from sampling, drilling, and other field equipment to concentrations that will not impact study objectives. Kirtland AFB Base-Wide SOP B.1-11 (Equipment Decontamination) will be used by field personnel responsible for cleaning sampling or other equipment in the field.

Specification for Decontamination Materials:

- Use a standard brand of phosphate-free laboratory detergent, either liquid or powder, preferably Liquinox® or (Alconox®).
- Use tap water from any municipal water treatment system or use bottled drinking water. Soap and tap water will remove the gross contamination from the sampling equipment.

4.3.1 Handling and Containers for Cleaning Solutions

Improperly handled cleaning solutions may easily become contaminated, thereby jeopardizing the validity of the sample data. Containers will be constructed of the proper materials to ensure their integrity.

The following containers will be used for storing the specified cleaning materials:

- Soap—Keep in clean containers until use. It will be poured directly from the container into the wash bucket or tub.
- Tap water—Keep in clean tanks, hand-pressure sprayers, or squeeze bottles, or apply directly from a hose.
- Deionized water—Store in clean containers that can be closed when not in use. It may be applied from squeeze bottles.

4.3.2 Decontamination of Large Equipment

The following procedure will be used to decontaminate large pieces of equipment, such as casings, auger flights, pipe and rods, and those portions of the drill rig that may stand directly over a boring or well location or that come into contact with casing, auger flights, pipe, or rods. This procedure will also be employed for the decontamination of heavy machinery such as backhoes, excavators, etc.

- Wash the external surfaces of equipment with high-pressure, hot water and Liquinox®, or Alconox, or an equivalent non-phosphate, laboratory-grade, detergent. If necessary, scrub until all visible dirt, grime, grease, oil, loose paint, rust flakes, etc., have been removed. The inside surfaces of equipment that come in direct contact with the media being sampled also will be washed as described above. Specific decontamination instructions will be included in project-specific addenda.
- Rinse with potable water.
- Perform this decontamination procedure before equipment is used and between each well or other sampling locations.

4.3.3 Decontamination of Sampling Equipment

The following procedure will be used to decontaminate devices such as split-spoons, bailers, sample trays, spatulas, spoons and augers that come in direct contact with the sample media:

- Wash and scrub equipment using tap water and laboratory detergent. Wire or plastic bristle brushes can be used.
- Rinse with tap water, removing all visible dirt and soap residue.

- Rinse with deionized water.
- Place onto clean plastic sheeting and allow to completely air dry.
- If not used immediately, wrap in aluminum foil.

Decontamination of sampling equipment will be kept to a minimum in the field and, whenever possible, dedicated sampling equipment will be used. Decontamination fluids will be disposed as required by the project-specific Waste Management Plan (Appendix C). Personnel directly involved in equipment decontamination will wear appropriate personal protective equipment (PPE) as specified in the SSHP.

Whenever possible, decontamination pads provided by Kirtland AFB will be used to clean large equipment. In other instances, a decontamination pad may need to be constructed at the investigation site.

4.3.4 Construction of a Decontamination Pad

Decontamination pads constructed in the field will meet the minimum specifications described below:

- The pad will be constructed in an area known or believed to be free of surface contamination. A temporary pad will be lined with a water impermeable material with no seams within the pad. The material will be either easily replaced (disposable) or repairable.
- The location of the pad will be out of the work zone and situated not to interfere with other work in progress.
- The pad will not leak excessively. Any sump or pit will be lined.
- Sawhorses or racks constructed to hold equipment while being cleaned will be high enough above the ground surface to prevent equipment from being splashed and re-contaminated.
- Water collected on the pad will be containerized and disposed of as per the IDW Disposal Plan. Small amounts of water will be left to evaporate.

4.3.5 Personal Protective Equipment

Personnel directly involved in equipment decontamination will wear appropriate PPE as specified in the SSHP, which was provided under separate cover (Shaw, 2011). Appropriate PPE will be selected based on the level of contamination present or suspected at the site. Care will be taken so the selected PPE protects decontamination workers from unnecessary contact with soil or decontamination fluids.

The following is a list of the minimum PPE required to perform decontamination activities:

- Safety glasses with splash shields or goggles and latex gloves will be worn during all cleaning operations. For decontamination activities involving large amounts of water, rain suits or aprons and rubber over-boots will also be worn.
- No eating, smoking, drinking, chewing, or any hand-to-mouth contact will be permitted during cleaning operations.
- Field equipment decontamination will be conducted in accordance with ASTM D5088-02(2008) (*Standard Practice for Decontamination of Field Equipment Used at Nonradioactive Waste Site*)

requirements and ASTM D5608-10 (*Standard Practices for Decontamination of Field Equipment Used at Low Level Radioactive Waste Sites*) as applicable.

4.4 Investigation-Derived Waste

All IDW will be handled in accordance with the project-specific Waste Management Plan provided in Appendix C. In general, all soil cuttings generated by the drilling of soil borings will be containerized in roll-off containers at the drilling location. Composite soil samples will be collected from each roll-off for waste disposal characterization. Water produced from sampling will be containerized and characterized for waste disposal. All PPE (e.g., sampling gloves) will be disposed with municipal waste.

5. MONITORING AND SAMPLING

All soil and soil-gas samples and geophysical data collected during the field effort will support delineation of lateral and vertical distribution of volatile organic compounds (VOCs) that volatize from LNAPL in the subsurface, either as residual masses in the soil or from the floating pool at the water table. This information will be used to refine the CSM and to determine the requirements of the shallow/intermediate SVE system.

The USACE will notify the NMED no less than 15 days before field sampling or other field activities and will provide the NMED the opportunity to collect split samples upon request. In addition, the NMED will be notified in writing a minimum of 15 days before implementation of this Vadose Zone Investigation Work Plan.

5.1 Soil Sampling

Soil samples collected during the drilling of SVM wells will be analyzed to estimate the amount of residual fuel adsorbed to soil, as soil gas and as residual liquid in the soil. The following bullets summarize soil sampling that will be performed to further characterize the vadose zone in areas needing further investigation. See Table 4-1 for details on sampling and Figures 2-1 and 4-1 for locations.

- **Tank Farm -** Soil samples from the five shallow borings will be collected at depths of 0, 5, 10, 15, and 20 ft. Soil samples from eight deep borings will be collected at a frequency of at least one sample every 10 ft for the first 50 ft, and at least one sample thereafter every 50 ft to total depth, and at least one sample at total depth in each boring. These samples will be analyzed for VOCs, semivolatile organic compounds (SVOCs), total petroleum hydrocarbons (gasoline & diesel) (TPH) and lead.

- **Pipeline -** Soil samples from five deep borings will be collected and analyzed for VOCs, SVOCs, TPH, and lead. Soil samples from the deep borings will be collected at a frequency of one sample every 10 ft for the first 50 ft, and one sample thereafter every 50 ft to total depth, and at least one sample at total depth in each boring.

- **Former Fuel Offloading Rack -** Soil samples from six deep borings will be collected and analyzed for VOCs, SVOCs, TPH, and lead. Soil samples from the deep borings will be collected at a frequency of one sample every 10 ft for the first 50 ft, and one sample thereafter every 50 ft to total depth, and at least one sample at total depth in each boring.

- **Fuel Percolation Area -** Soil samples from six deep borings will be collected and analyzed for VOCs, SVOCs, TPH, and lead. In addition, soil samples from two deep borings will be collected and analyzed for VOCs, SVOCs, volatile petroleum hydrocarbons (VPH) and extractable petroleum hydrocarbons (EPH) (Massachusetts Department of Environmental Protection [MA DEP], 2004a, 2004b), and lead. Soil samples from the deep borings will be collected at a frequency of one sample every 10 ft for the first 50 ft, and one sample thereafter every 50 ft to total depth, and at least one sample at total depth in each boring.

- **Farfield Area of Soil-Vapor Plume -** Soil samples from eight deep borings will be collected and analyzed for VOCs, SVOCs, TPH, and lead. Soil samples from the deep borings will be collected at a frequency of one sample every 10 ft for the first 50 ft, and one sample thereafter every 50 ft to total depth, and at least one sample at total depth in each boring.

Additional soil samples will be collected and analyzed if evidence of contamination is observed outside the planned sampling intervals.

In addition, soil samples containing LNAPL will be sent to the laboratory and analyzed for TPH, VOCs, SVOCs, and lead.

Soil samples will be collected using split-spoon samples at 10-ft intervals to 50 ft and at 50-ft intervals, and at changes in lithology to the total depth and at least one sample at total depth in each boring. The soil samples, and soil samples (drill cuttings) collected from the drill rig "cyclone," will be lithologically logged and field screened for VOCs using a photoionization detector (PID) as specified in the Kirtland AFB Base-Wide SOP B3.1 (Photoionization Detectors and Organic Vapor Analyzers). "Drill cutting" samples will be collected at 5-ft (minimum) intervals and at changes in lithology and/or color. PID readings will be used for health and safety purposes and will be submitted to the laboratory with samples for chemical analysis, as an indicator of relative contaminant levels for use by the lab.

For soil samples collected for VOC analysis, the samples will be collected from the sampler before lithologic logging and any disturbance to the sample core. Sample collection for VOC analyses will be in accordance with EPA SW-846 Method 5035 and the NMED requirements. Samples will be collected using EnCore (or similar type) samplers. If conditions exist that make the use of this type of sampler impractical (collection of samples from soil cuttings or dry or gravelly conditions) then discrete grab samples will be collected in a 4-ounce jar and prior to homogenization with as little disturbance as possible.

5.1.1 Split-Spoon Sampling Procedure

The following procedure will be used for split-spoon sampling:

- Samplers will wear appropriate PPE as outlined in the SSHP. In addition, samplers will don new sampling gloves at each location.

- Boreholes will be drilled to the desired sampling depth. Split-spoon will be driven into the undisturbed soil that is to be sampled.

- A stainless-steel, 2-inch (or 3-inch) O.D. split-spoon sampler will be driven with blows from a 140-pound (or 300-pound) hammer falling 30 inches until either approximately 2 ft has been penetrated or 100 blows within a 6-inch interval have been applied. This process is referred to as the Standard Penetration Test (ASTM D1586-08a, *Standard Test Method for Standard Penetration Test [SPT] and Split-Barrel Sampling of Soils)*. A decontaminated split-spoon will be used for each sample collected for chemical analyses.

- Soil borings designated for engineering parameters such as Atterberg limits, permeability, sieve analysis, etc., will be obtained using a Shelby tube in accordance with ASTM 1557-09 (*Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort*). Shelby tubes can be used when cohesive materials are encountered, and when an undisturbed sample is required for testing.

- The number of blows required for each 6 inches of penetration or fraction thereof will be recorded.

- The first 6 inches is considered to be a seating drive. The sum of the number of blows required for the second and third 6 inches of penetration is termed the penetration resistance. If the sampler is driven less than 2 ft, the penetration resistance is still the blows encountered for the second and third 6-inch intervals. If more than 50 blows have been counted for a particular 6-inch interval, then refusal will be entered on the log.

- The sampler will be brought to the surface and both ends and one-half of the split-spoon removed so that the recovered soil rests in the remaining half of the barrel. The split-spoon will be placed on clean polyethylene sheeting. The approximate recovery (length), USCS classification, composition, color, moisture, etc., of the recovered soil will be described thoroughly. A copy of a typical bore log form is shown in Appendix D, Form 1.
- NOTE: If soil samples are being collected for VOC analysis, those samples will be collected from the sampler before lithologic logging and any disturbance to the sample core.
- Sample collection for VOC analyses will be in accordance with EPA SW-846 Method 5035 and the NMED requirements. Samples will be collected before homogenization from the split-spoon core, using EnCore (or similar) samplers.
- The remaining contents of the split-spoon will be entered into a disposable sample tray/pan or decontaminated stainless-steel pan. Samples will be homogenized according to procedures specified in Kirtland AFB Base-Wide SOP B2.5 (Sample Homogenization). The remaining jars will be filled with soil using stainless-steel spatulas or spoons.
- The split-spoon sampler will be decontaminated in accordance with the procedures outlined in Kirtland AFB Base-Wide SOP B1.11 (Equipment Decontamination).
- Analytical samples will be placed in a sample cooler and chilled to 4°C. Samples will be shipped to the laboratory within 24 hours.
- The field logbook, sample log sheet, labels, custody seals, and chain-of-custody forms for analytical samples will be filled out.
- Work will be conducted in accordance with other applicable requirements such as:
  - ASTM D1452-09 (*Practice for Soil Exploration and Sampling by Auger Borings*);
  - ASTM D1586-08a (*Standard Test Method for Standard Penetration Test [SPT] and Split-Barrel Sampling of Soils*); and
  - ASTM D4220-95(2007) (*Standard Practices for Preserving and Transporting Soil Samples*).

Soil samples collected for the purpose of analyzing for VOCs and TPH-gasoline range organics (GRO) will not be mixed to homogenize samples for any reason. All collected soil samples will be analyzed by a DoD Environmental Laboratory Accreditation Program (ELAP)-certified laboratory. The remaining portions of the sample will be used for field screening and logging.

Activities associated with soil sampling, equipment decontamination, handling of IDW, lithologic logging, and field screening will be performed in accordance with the Kirtland AFB *Base-Wide Plans for Investigations Under the Environmental Restoration Program, 2004 Update,* as discussed in Section 4.

Soil samples (drill cuttings) will be collected from the ARCH drill rig “cyclone” on representative 5-ft centers, and at changes in lithology/color, during advancement of each of the 40 boreholes. A qualified geologist will lithologically log the samples and field screen them for VOCs using a PID. Because the

ARCH drilling method uses air to lift cuttings from the borehole and creates varying amounts of friction heat, some of the VOCs will be driven off before field screening. Therefore, PID readings will primarily be used for health and safety purposes. These readings may also distinguish areas of no/low contaminant concentrations from those of gross/higher concentrations on a qualitative basis, but will not be used in any decision making process.

Table 5-1 lists sample requirements for analytical testing, including sample containers, preservation, and holding time for each parameter.

Activities associated with soil sampling, equipment decontamination, lithologic logging, field screening, and IDW handling will be performed in accordance with *Base-Wide Plans for Investigations Under the Environmental Restoration Program, 2004 Update* and other pertinent site documents.

5.1.2 Sampling Equipment Decontamination

The following procedure will be used to decontaminate devices such as split-spoons, bailers, sample trays, spatulas, spoons, and augers that come in direct contact with the sample media:

- Wash and scrub equipment using tap water and laboratory detergent. Wire or plastic bristle brushes can be used.
- Rinse with tap water, removing all visible dirt and soap residue.
- Rinse with deionized water.
- Place on to clean plastic sheeting and allow to completely air dry.
- If not used immediately, wrap in aluminum foil.

Decontamination of sampling equipment will be kept to a minimum in the field and, whenever possible, dedicated sampling equipment will be used. Decontamination fluids will be disposed as required by the project-specific addenda to the Waste Management Plan (Appendix C). Personnel directly involved in equipment decontamination will wear appropriate PPE as specified in the SSHP.

5.2 Standards for Subsurface Soil Sampling

Soil samples being collected for VOC analysis, those samples will be collected from the sampler before lithologic logging and any disturbance to the sample core.

Sample collection for VOC analysis will be in accordance with EPA SW-846 Method 5035 and the NMED requirements. Samples will be collected using EnCore (or similar type) samplers. If conditions exist that make the use of this type of sampler impractical (collection of samples from soil cuttings or dry or gravelly conditions), then a discrete grab samples will be collected in a 4-ounce jar, and before homogenization with as little disturbance as possible.

5.2.1 Split-Spoon Sampling Procedure

The following procedure will be used for split-spoon sampling:

- Samplers will wear appropriate PPE as outlined in the SSHP. In addition, samplers will don new sampling gloves at each location.

- Boreholes will be drilled to the desired sampling depth. Split-spoon will be driven into the undisturbed soil that is to be sampled.
- A stainless-steel, 2-inch (or 3-inch) O.D. split-spoon sampler will be driven with blows from a 140-pound (or 300-pound) hammer falling 30 inches until either approximately 2 ft has been penetrated or 100 blows within a 6-inch interval have been applied. This process is referred to as the Standard Penetration Test (ASTM D1586-08a, *Standard Test Method for Standard Penetration Test [SPT] and Split-Barrel Sampling of Soils*). A decontaminated split-spoon will be used for each sample collected for chemical analyses.
- Soil borings designated for engineering parameters such as Atterberg limits, permeability, sieve analysis, etc., will be obtained using a Shelby tube in accordance with ASTM 1557-09 (*Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort)*. Shelby tubes can be used when cohesive materials are encountered, and when an undisturbed sample is required for testing.
- The number of blows required for each 6 inches of penetration or fraction thereof will be recorded.
- The first 6 inches is considered to be a seating drive. The sum of the number of blows required for the second and third 6 inches of penetration is termed the penetration resistance. If the sampler is driven less than 2 ft, the penetration resistance is still the blows encountered for the second and third 6-inch intervals. If more than 50 blows have been counted for a particular 6-inch interval, then refusal will be entered on the log.
- The sampler will be brought to the surface and both ends and one-half of the split-spoon removed so that the recovered soil rests in the remaining half of the barrel. The split-spoon will be placed on clean polyethylene sheeting. The approximate recovery (length), USCS classification, composition, color, moisture, etc., of the recovered soil will be described thoroughly. A copy of a typical bore log form is shown in Appendix D, Form 1.
- NOTE: If soil samples are being collected for VOC analysis, those samples will be collected from the sampler before lithologic logging and any disturbance to the sample core.
- Sample collection for VOC analyses will be in accordance with EPA SW-846 Method 5035 and the NMED requirements. Samples will be collected before homogenization from the split-spoon core, using EnCore (or similar) samplers.
- The remaining contents of the split-spoon will be entered into a disposable sample tray/pan or decontaminated stainless-steel pan. Samples will be homogenized according to procedures specified in Kirtland AFB Base-Wide SOP B2.5 (Sample Homogenization). The remaining jars will be filled with soil using stainless-steel spatulas or spoons.
- The split-spoon sampler will be decontaminated in accordance with the procedures outlined in Kirtland AFB Base-Wide SOP B1.11 (Equipment Decontamination).
- Analytical samples will be placed in a sample cooler and chilled to 4°C. Samples will be shipped to the laboratory within 24 hours.
- The field logbook, sample log sheet, labels, custody seals, and chain-of-custody forms for analytical samples will be filled out. Example copies of these forms are included in the QAPjP prepared for this investigatory work (Appendix E).

5.2.2 Field Quality Control

Field QC samples will be collected throughout field investigation activities to ensure the integrity and reproducibility of the vadose zone investigation data. Field QC samples include duplicates, trip and field blanks for VOC analysis, and equipment blanks for non-dedicated sampling equipment. Field duplicates will be collected at a frequency of 10 percent of total number of environmental samples or a minimum of one per each event. Trip blank samples will accompany each shipment of water samples to the laboratory for VOC analysis. One field bank will be collected per day for groundwater sampling. Sampling equipment rinse blanks will be collected for soil and groundwater at a rate of 5 percent of the total number of environmental samples, when non-dedicated sampling equipment is being utilized. A temperature blank will be included with each shipment of soil and water samples from the field to the off-site laboratory.

5.2.3 Data Reporting

Results of the soil-gas survey will be used to qualitatively describe the areal extent of volatile contamination. They will also be used to determine the locations of subsequent soil borings and monitoring wells. For overall characterization of the site, soil-gas results are secondary to the soil and groundwater results. In addition, soil-gas results cannot be used to describe the extent of semivolatile or heavy metals contamination.

5.2.4 Sample Packaging and Shipping

The primary objective of sample packaging and shipping requirements is to maintain sample integrity from the time a sample is collected until it is received at the analytical laboratory. Chain-of-custody forms, sample labels, custody seals, and other sample documents will be completed as specified in the QAPjP, provided in Appendix E. Specific procedures for packaging and shipping of environmental samples are presented below.

- A sample label is attached to the sample bottle and completed with indelible ink.
- A picnic cooler (such as a Coleman or other sturdy cooler) is typically used as a shipping container. In preparation for shipping samples, the drain plug is taped shut so that no fluids, such as melted ice, will drain out of the cooler during shipment. A large plastic bag may be used as a liner for the cooler and packing material, such as bubble wrap, or Styrofoam beads, will be placed in the bottom of the liner.
- The containers are placed in the lined picnic cooler. Cardboard separators may be placed between the containers at the discretion of the shipper.
- Unless indicated in project-specific requirements, all samples for chemical analysis must be shipped cooled to 4 degrees °C with ice. All samples will require icing prior to shipping.
- The liner will be taped closed, if used, and sufficient packing material will be used to prevent sample containers from making contact or rolling around during shipment.
- A copy of the chain-of-custody form will be placed inside the cooler.
- The cooler is closed and taped shut with strapping tape (filament-type).

- Custody seals are placed on the cooler. Placing clear tape over the custody seals can help to prevent them from being accidentally torn or ripped off.

- The cooler of samples will be shipped via an overnight carrier. A standard air bill is necessary for shipping environmental samples.

5.3 Vadose-Zone Sampling and Analysis

Quarterly vadose-zone monitoring of soil gas will be conducted starting in 2011 following installation of the 35 SVMWs wells. Sampling of the 35 vadose zone investigation SVMWs wells will be included with existing 15 SVMWs sampled under pre-remedy monitoring activities. Sampling will continue until Remedy In Place is achieved or an approved change is made by the NMED. Samples will be collected from the 35 SVMWs. These samples will be sent for laboratory analysis. Field measurement parameters will be collected for hydrocarbon concentration, percent oxygen, carbon monoxide, and carbon dioxide using the Horiba emissions analyzer. To maximize efficiency, vadose-zone monitoring will be conducted in conjunction with groundwater monitoring.

5.3.1 Well Purging

Soil-vapor well purging and sampling will be conducted in accordance with RTI Laboratories, Inc.'s SOP for air sample collection (Appendix F). To collect a representative sample, each well will be purged before sampling to remove stagnant air from the well casing and any associated piping. Purging and sampling of a well will be conducted after the well pressure has been measured and recorded. Exceptions will be made for vapor-extraction wells that are actively open to the treatment unit as the treatment engines continuously purge the well and associated piping during operation. For each well, the volume (in cubic feet) of casing and any associated piping will be calculated, and the purge pump will be operated long enough to remove three casing/piping volumes before sampling the well.

5.3.2 Soil-Gas Sample Collection

A total of 215 vapor points will be sampled during quarterly sampling events of the 15 existing SVMWs and 35 new vadose zone investigation SVMWs. Samples will be collected using passive Bottle-Vac™ canisters with a controlled-flow pump system. The Bottle-Vac™ canisters will be obtained from the specialty air laboratory that will ensure that they are certified clean for use. Soil-vapor sampling will be performed in accordance with approved EPA methodologies, MA DEP methodologies, the *Base-Wide Plans for Investigation under the Environmental Restoration Program, 2004 Update,* Kirtland AFB (BWP) SOPs (Tetra Tech, 2004), and the BFF Spill QAPjP.

Vadose-zone sampling and monitoring documentation will be recorded in field logbooks and on field forms as specified in the BWP SOPs. Sample information will be recorded on chain-of custody forms (Appendix D, Form 4), and samples will be packaged for shipment to the off-site laboratory in accordance with the BWP SOPs, the BFF Spill QAPjP (Appendix E), and manufacturer's recommendations.

Vapor samples will be collected from all monitoring intervals (all depths) for each SVMW. The soil concentration of soil vapor will be continually monitored with an appropriate field instrument (e.g., PID of appropriate lamp energy) while purging. Samples will be collected after field instrument readings have stabilized within ±10 percent for three consecutive measurements and after the sampling tubing and the soil-gas monitoring well have been purged to remove all stagnant vapor. Soil-gas measurements taken in the field during purging, the data and time of each measurement, and the type and serial number of field instrument used will be recorded in a logbook.

Samples from the SVEWs will be analyzed quarterly in the field using a Horiba Mexa 554J emissions analyzer for the following parameters:

- Petroleum-hydrocarbon concentration in parts per million by volume
- Percent oxygen
- Carbon monoxide
- Carbon dioxide
- Pressure measurements with a Magnehelic® gauges in units of inches of water

Quarterly vapor samples will be analyzed by an off-site specialty analytical laboratory that maintains a current DoD ELAP certification or equivalent for performing the required vapor analyses. Sample analysis will be performed for this program in accordance with the *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition, Compendium Method TO-15* (EPA, 1999); the *Method for the Determination of Air-Phase Petroleum Hydrocarbons (APH), Final, Revision 1* (MA DEP, 2009); and ASTM approved methodologies.

Vapor samples will be analyzed for the following list of parameters:

- Volatile organics – EPA TO-15 (EPA, 1999)
- APH – Method MA DEP (2009)
- TPH/ gasoline range organics – EPA TO-15 (EPA, 1999) (after 4 quarters of APH data are collected)
- Fixed gases (oxygen, nitrogen, carbon monoxide, carbon dioxide, methane) – ASTM D2504

5.3.3 Field Quality Control

Field QC samples will be collected throughout quarterly monitoring activities to ensure the integrity and reproducibility of groundwater and soil-vapor monitoring data. Field QC samples for pre-remedy monitoring activities include field duplicate samples, matrix spike samples, trip and field blanks for VOC analysis, equipment rinse blanks for non-dedicated sampling equipment, and temperature blanks. Field QC samples for quarterly groundwater monitoring will be collected at the following frequency:

- Field duplicate samples (water/vapor) - 10 percent of total number of environmental samples per event.

- Matrix spike/matrix spike duplicate samples (water) – 5 percent of total number of environmental samples per event.

- Equipment rinse blank samples (water) – 5 percent of total number of environmental samples per event, collected using non-dedicated sampling equipment.

- Field blank samples (water) – 5 percent of total number of environmental samples per event for VOCs only.

- Trip blank samples (water/vapor) – one per each shipment of groundwater and vapor samples per event for VOCs only.

- Temperature blank (water) – 1 per each shipment of environmental samples.

5.3.4 Sample Packaging and Shipping

Sample packaging and shipping requirements are designed to maintain sample integrity from the time a sample is collected until it is received at the analytical laboratory. All chain-of-custody forms, sample labels, custody seals, and other sample documents will be completed as specified in BFF Spill QAPjP (Appendix E). Specific procedures for packaging and shipping of environmental samples are presented below.

1. A sample label, completed with indelible ink, will be attached to the sample bottle.

2. A picnic cooler (e.g., Coleman or other sturdy cooler) will typically be used as a shipping container. In preparation for shipping samples, the drain plug will be taped shut so that no fluids, such as melted ice, will drain out of the cooler during shipment. A large plastic bag may be used as a liner for the cooler. Packing material, such as bubble wrap, or Styrofoam beads, will be placed in the bottom of the liner.

3. The containers will be placed in the lined picnic cooler. Cardboard separators may be placed between the containers at the discretion of the shipper.

4. All samples for chemical analysis must be shipped cooled to 4°C with ice. All samples will require icing before shipment. A temperature blank will be included in each shipment of water and soil samples.

5. The liner will be taped closed, if used, and sufficient packing material will be used to prevent sample containers from making contact or rolling around during shipment.

6. A copy of the chain-of-custody form will be placed inside the cooler.

7. The cooler will be closed and taped shut with strapping tape (filament-type).

8. Custody seals will be placed on the cooler. Clear tape will be placed over the custody seals to help prevent them from being accidentally torn or ripped off.

9. The cooler of samples will be shipped via an overnight carrier. A standard air bill is necessary for shipping environmental samples.

5.4 Reporting

A Quarterly Monitoring Report will be submitted within 60 days after the end of each quarterly period or other NMED-agreed-upon submittal date. The quarterly periods will extend from January – March, April – June, July – September, and October – December for years 2011 through 2014. Quarterly reports will be provided to Kirtland AFB, USACE, and AFCEE for review and approval prior to submittal to the NMED.

The report will document the monitoring, investigation, and remediation activities performed during the period and will provide the following detailed information:

- Summary of all BFF Spill site-wide field activities;
- Descriptions of installed groundwater and soil-gas monitoring wells and surveyed locations;
- Geologic and geophysical logs of wells and boreholes installed;

- Water levels and water-level maps;
- LNAPL measurements;
- Plume contaminant maps and cross-sections;
- Field and analytical laboratory data for groundwater, soil, soil gas, and trend graphs;
- Data validation summary of laboratory data and discussion of data quality;
- Summary of operation, maintenance, and performance of the SVE and groundwater systems; and
- Certification page signed by the Kirtland AFB Environmental Restoration Section Chief or Base designee.

Groundwater flow will be assessed in three dimensions (3D) using standard geographical information systems (GIS) gridding techniques to interpolate groundwater head (elevation) data into a 3D grid. Once this head grid is developed, associated GIS methods will be used to generate conventional plan-view hydraulic head maps and vertical cross-sections for the quarterly reports. The same 3D grid will be used to generate particle tracking maps for assessment of capture by the LNAPL containment system. Consistent plan-view maps and sections will be provided in the quarterly reports with adjustments as warranted as additional data become available.

Vadose-zone soil-gas and dissolved-groundwater concentration data will be evaluated in a similar manner using 3D GIS methods to interpolate concentration grids for the various compounds of concern. Separate grids will be developed for the vadose-zone soil-gas and dissolved-groundwater plumes because they represent separate environmental media. Associated GIS methods will be utilized with the 3D grids to generate conventional plan-view plume concentration maps and vertical cross-sections for the quarterly reports. For consistency in data evaluation, the same plan-view maps elevations and vertical section locations used for the groundwater head data will be used for the dissolved groundwater plumes. Vadose-zone soil-gas maps and sections will be consistent between the quarterly reports to allow for efficient data analysis.

6. PROJECT SCHEDULE

The project schedule is provided in Appendix B of this work plan.

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7. ORGANIZATIONAL PLAN

7.1 Overall Project Organization

The organizational structure of our team is shown in Figure 7-1.

7.2 Responsibilities, Qualifications, and Authority of Key Personnel

Table 7-1 summarizes the responsibilities, qualifications, and authorities of project team members.

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8. DATA MANAGEMENT PLAN

Environmental laboratory services will be provided only by laboratories compliant with the *DoD Quality Systems Manual for Environmental Laboratories, Version 4.1* (DoD, 2009) or a most recent version and that hold a current DoD ELAP accreditation for all appropriate analytical methods (DoD, 2009). Three laboratories will provide analytical results in support of the BFF Spill project. Each laboratory will provide electronic data in both Staged Electronic Data Deliverable (SEDD) and the Environmental Resources Program Information Management System (ERPIMS) format. The SEDD deliverable will be used for applying the electronic data review process. The ERPIMS deliverable will be validated for upload to the Air Force data repository. All analytical data generated in support of the BFF Spill remediation will be uploaded to the Air Force Data Repository.

8.1 EPA Level III Data Review

Analytical data generated in support of the Kirtland BFF Spill project will undergo an EPA level III data review by a project chemist. An automated data review (ADR) software, developed by Laboratory Data Consultants, Inc. (LDC), will be used to perform 100 percent EPA Level III data review. The data review will be performed for groundwater and soil-vapor analytical data obtained from each of the pre-remedy quarterly monitoring events. In addition, the project chemist will use the ADR software to conduct 100-percent, EPA Level III data review of the analytical data collected during the vadose zone and groundwater investigations, and Interim Measure field sampling activities. The data review will be performed using the quality control criteria specified the following documents:

- The QAPjP (Appendix E);
- *DoD Quality Systems Manual for Environmental Laboratories, Version 4.1* (DoD, 2009);
- *Test Methods for Evaluating Solids Waste, SW846 Physical/Chemical Methods* (EPA, 2007 and updates);
- USACE, *Environmental Quality - Guidance for Evaluating Performance-Based Chemical Data, Engineer Manual (EM) 200-1-10* (2005);
- *USEPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review* (June 2008); and
- *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review* (January 2010).

The following QC elements will be included in the EPA Level III data review:

- Laboratory method blanks
- Sample extraction and analysis holding times
- Surrogate spike recoveries
- Laboratory control sample (LCS)/laboratory control sample duplicate (LCSD) recoveries
- Matrix spike (MS)/matrix spike duplicate (MSD) recoveries
- Relative percent difference (RPD) for duplicate samples
- Initial calibrations
- Continuing calibrations
- Trip and field blank data (water samples for volatiles only)

- Field duplicate samples

Note that due to laboratory information system limitations, laboratories may not be able to provide initial and continuing calibration results in SEDDs. In this case, the project chemist will manually review the calibration data and document review findings in a database and data review worksheets.

Data will be validated and flagged with the following data qualifiers as applicable:

- ***J+ qualifier*** denotes the analyte was positively identified, but the associated numerical value is estimated with a potential high bias.
- ***J- qualifier*** denotes the analyte was positively identified, but the associated numerical value is estimated with a potential low bias.
- ***U qualifier*** denotes the analyte was analyzed for, but was not detected.
- ***R qualifier*** denotes the data are unusable due to deficiencies in the ability to analyze the sample and meet QC criteria and data quality objectives.

As a result of the ADR process, EPA qualifiers will be electronically generated and assigned to the sample results that were outside of established control criteria. The qualified data will then be exported to a contractor database for data users and for report tables and figure preparations. EPA level III data review findings will be summarized and documented with each Quarterly Monitoring Report and in other reports containing analytical data.

An Environmental Information Management System (EIMS) will be used for sample planning, data loading, data management, and data reporting. This system supports all aspects of the project from the planning stages throughout the project lifecycle and ultimately data archiving, and thus maintains the integrity of all project-related data. Each step of the data management process will be performed in accordance with the site-specific QAPjP (Appendix E) and applicable *Base-wide Plans for Investigation under the Environmental Restoration Program, 2004 Update,* Kirtland AFB, New Mexico. All quarterly monitoring field data, including but not limited to water level data, survey data, boring logs, and well construction logs, will be uploaded into the contractor EIMS and will be linked with validated analytical results in order to generate output files that will be used to populate Environmental Restoration Program Tools and generate ERPIMS Version 5.0 submittals. ERPIMS data submittals will be reviewed for accuracy and completeness before submittal. ERPIMS submittals will be provided to the Air Force, at a minimum, every 6 months or as appropriate for data generation for uploading to the Air Force data repository. Submittals will be deemed complete upon receipt of the insertion letter from the Air Force.

Site characterization data will be mapped using a GIS. The GIS dataset will be accompanied by metadata conforming to the Federal Geographic Data Committee's Content Standard for Digital Geospatial Metadata and the Army Installation Geospatial Information and Services Metadata Standard , v1, which is compliant with Spatial Data Standards for Facilities, Infrastructure, and Environment v2.6. The horizontal accuracy of GIS data will be tested in accordance with the National Standard for Spatial Data Accuracy and results will be recorded in the metadata. All data will be provided in the Universal Transverse Mercator projection in the appropriate zone, and will have a datum of NAD83. The GIS effort will involve preparation, analysis, processing, and interpretation of data acquired from munitions constituent sampling and analysis, geophysical surveys, and intrusive investigations. The GIS coordinator will register and process all survey and intrusive field data such that it can easily be incorporated into the Kirtland AFB and Army Mapper database. The GIS analysts will prepare maps depicting site-specific attributes for continuous updates to be provided to project stakeholders. No data will be released to project stakeholders without the approval of the USACE.

All project-related data will be maintained and archived in the electronic project files on the corporate server and will be made available to the government as necessary. All data generated in support of this contract will be maintained in accordance with the contract requirements.

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9. QUALITY ASSURANCE/QUALITY CONTROL

A comprehensive QAPjP document has been developed to be implemented in support of sampling and analysis activities for the BFF Spill. This document is presented in Appendix E.

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10. WASTE MANAGEMENT

All wastes generated during implementation of this work plan will be handled and disposed of according to the requirements as presented in the Waste Management Plan (Appendix C).

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11. ACCIDENT PREVENTION PLAN/SITE SAFETY AND HEALTH PLAN

The APP, including the SSHP (Attachment 10) for the Kirtland AFB BFF Spill investigation work, was submitted under separate cover (Shaw, 2011).

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12. COMMUNITY RELATIONS PLAN

A Community Relations Plan (CRP) is being developed and submitted under separate cover in accordance with contract No. W912DY-10-D-0014, Delivery Order 0002 and the Kirtland AFB Base-Wide Community Relations Plan. Community information meetings, including community outreach as well as presentations at neighborhood association meetings, are provided upon request. Below is a general approach to supporting community relations. For details, see the CRP being submitted under separate cover.

The CRP identifies activities designed to aid information sharing between the project and local community in understanding the bulk fuels contamination associated with the Kirtland AFB BFF Spill. The CRP also outlines the types of information to be provided and how that information will be distributed to surrounding communities and other interested stakeholders. The CRP includes the following information:

- Project background and history;
- Local demographic, site historical, and technical data; and
- Proactive communication strategies based on the compiled data.

The outreach strategy developed meets current regulatory standards and Air Force communication needs and requirements. This strategy will also respond to community's needs and desire for information about the ongoing remediation field activities associated with the BFF Spill. Community relations work will be conducted in accordance with the appropriate regulatory guidance, including EPA's *RCRA Public Participation Manual, 1996 Edition, EPA530-R-96-007* (EPA, 1996), and *Superfund Community Involvement Handbook, EPA 540-K-05-003* (EPA, 2005).

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FIGURES

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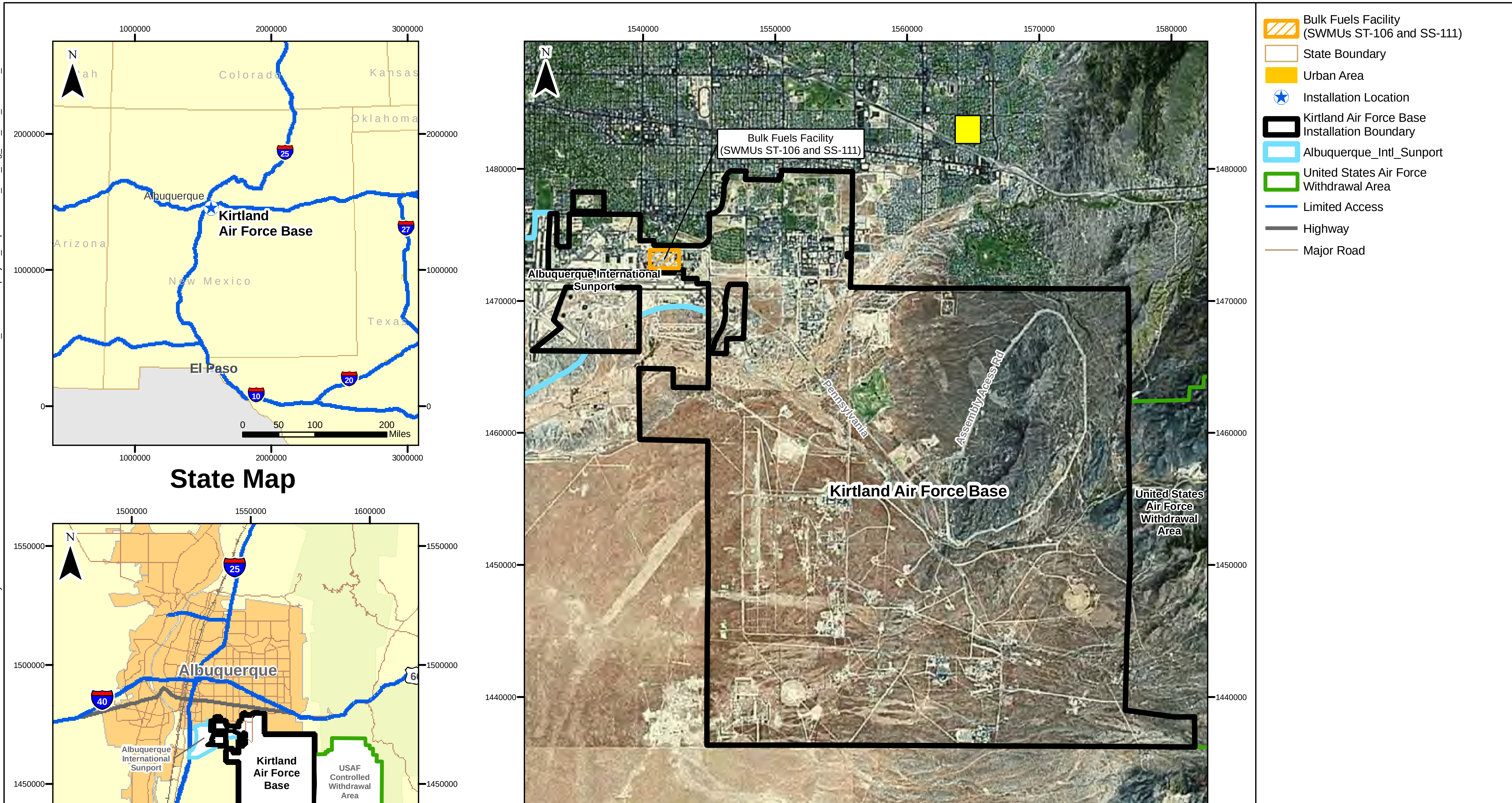

Projection : NAD_1983_StatePlane_New_Mexico_Central_FIPS_3002_Feet

BULK FUELS FACILITY
KIRTLAND AIR FORCE BASE, NEW MEXICO

FIGURE 1-1

SITE LOCATION MAP

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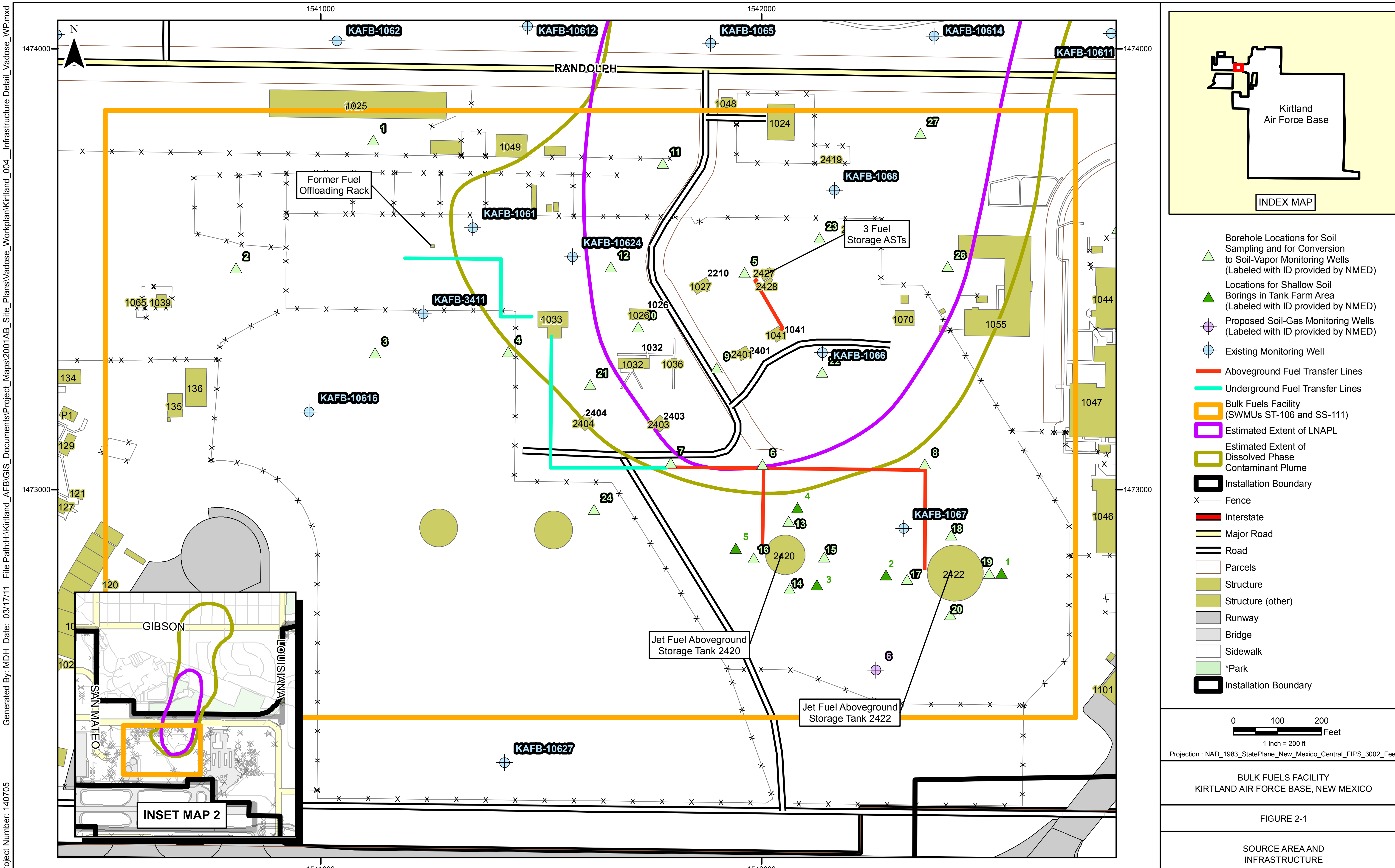

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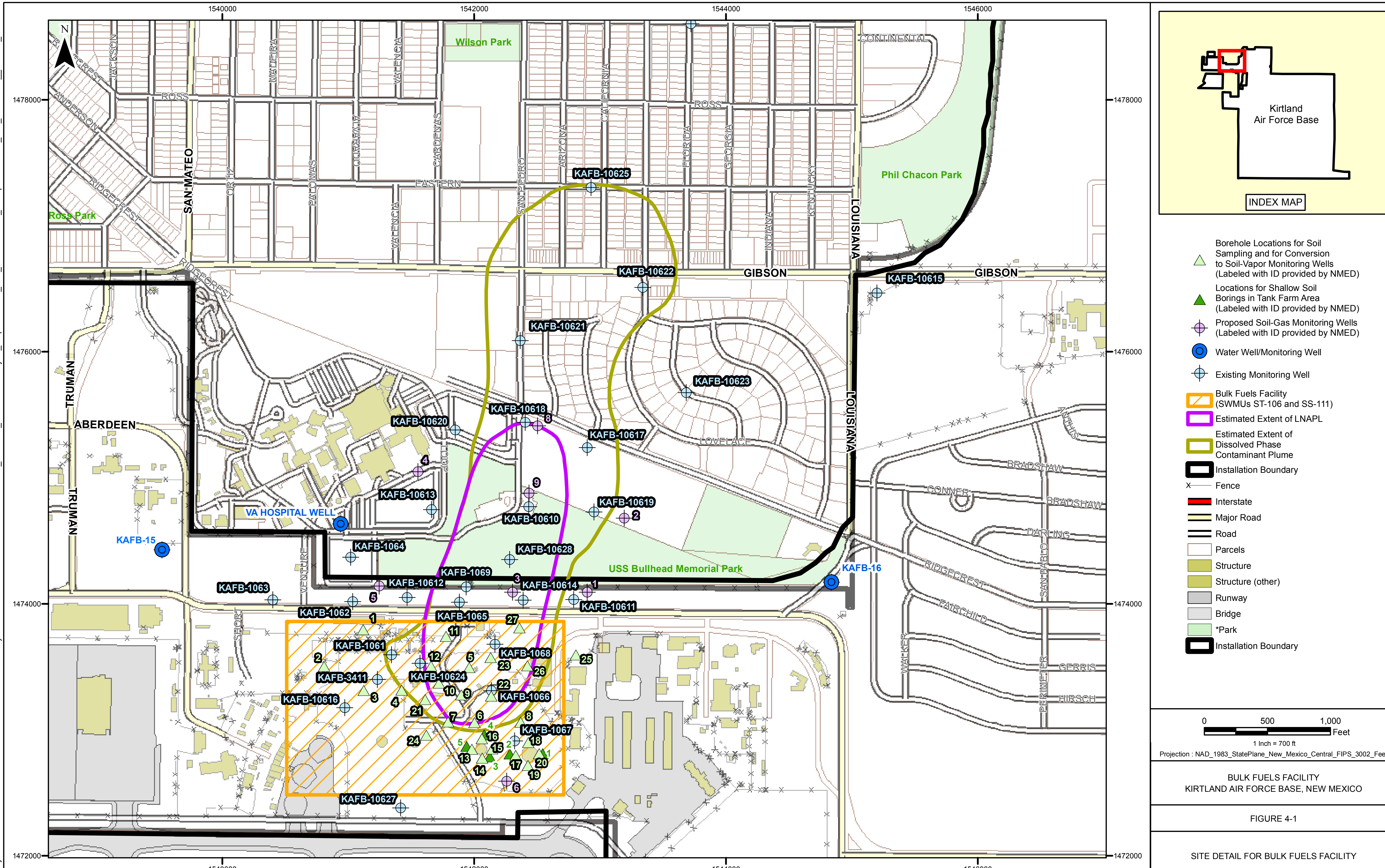

FIGURE 4-1

SITE DETAIL FOR BULK FUELS FACILITY

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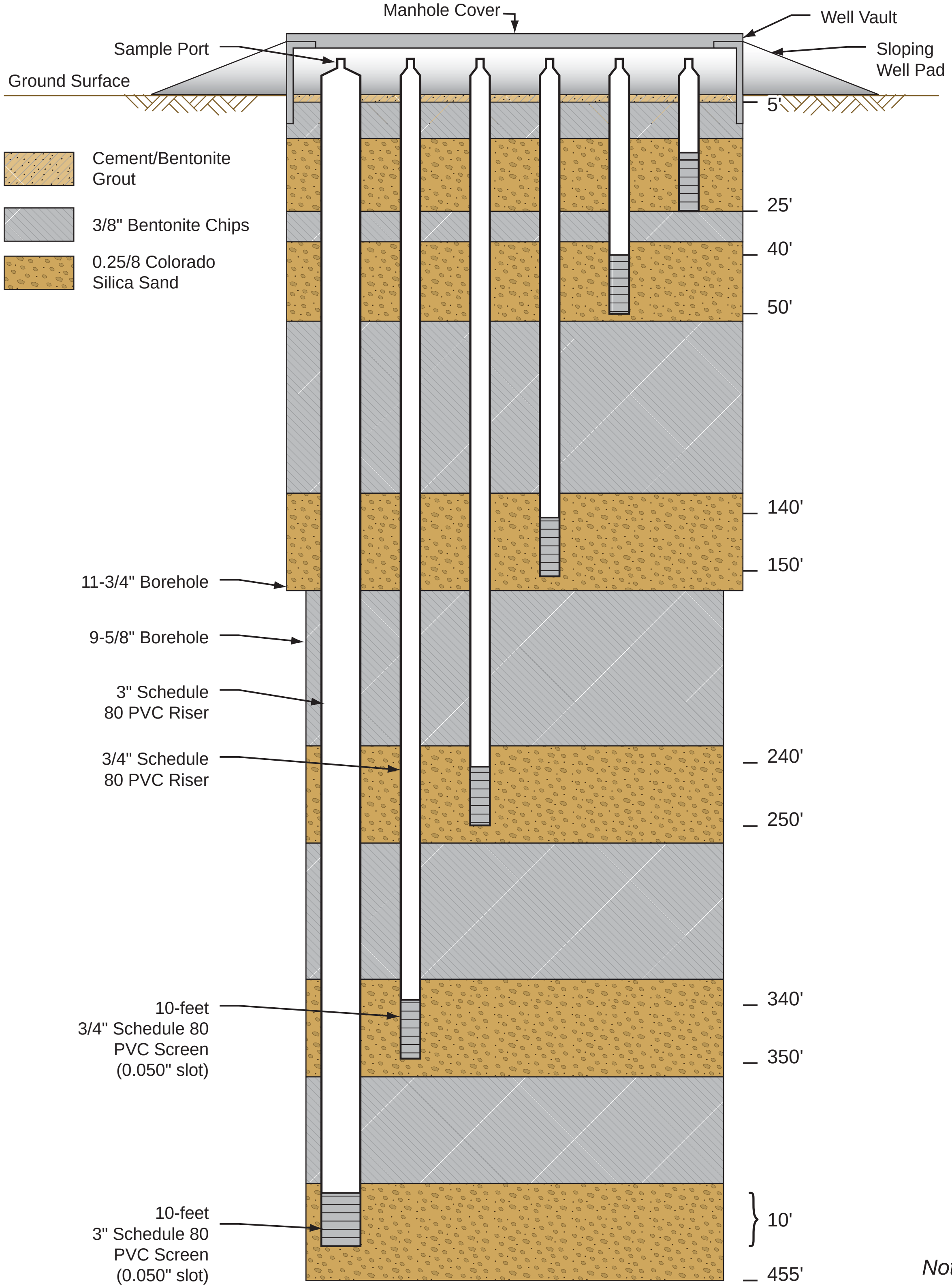

Not to Scale

BULK FUELS FACILITY
KIRTLAND AIR FORCE BASE, NEW MEXICO

FIGURE 4-2

GENERAL SOIL VAPOR
MONITORING WELL DESIGN

Project Number: 140705

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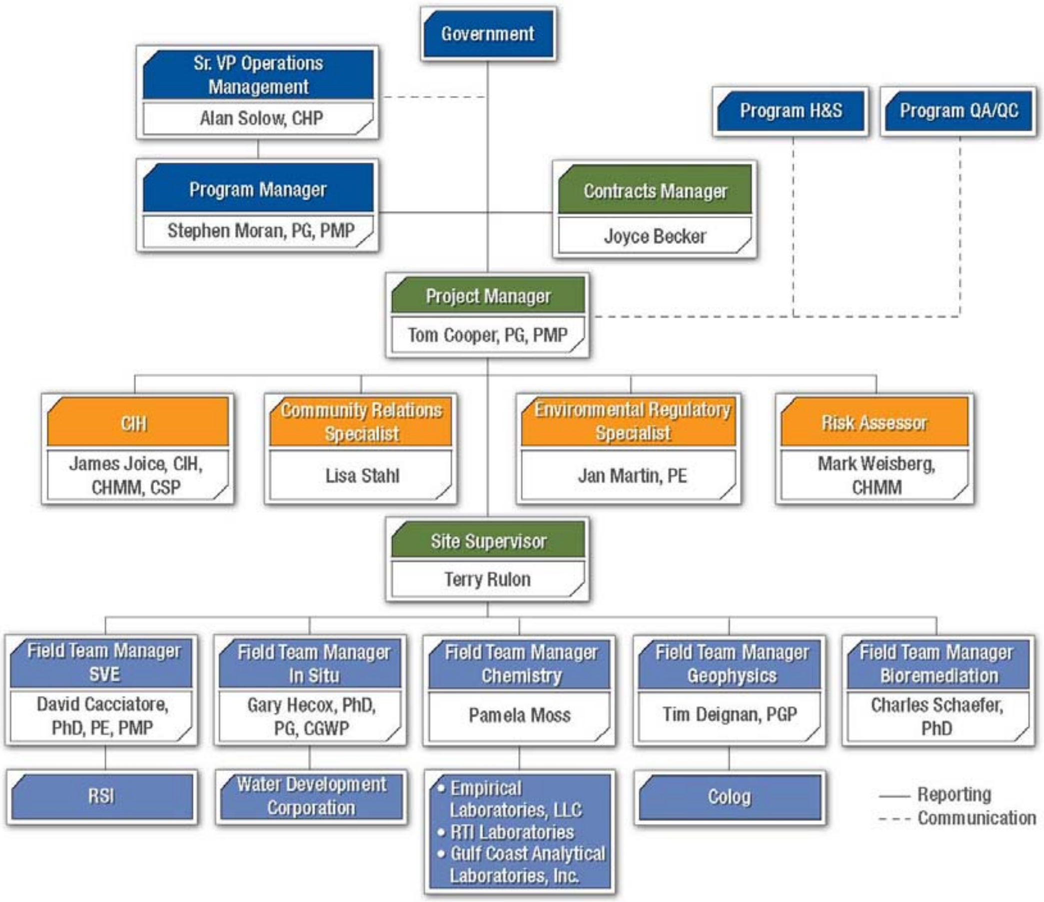
Figure 7-1. Project Organization



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TABLES

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Table 1-1. Data Gaps Summary

Data Gap	Work Plan	Section
Determine the amount of fuel that exists within the vadose zone.	Vadose Zone Investigation Work Plan	Section 4.2.3, 4.2.10, 4.2.11, and 5.1
	Interim Measures Work Plan	Section 4.5.2 and 4.6.2
Identify the source of the light non-aqueous phase liquid (LNAPL) fuel plume.	Interim Measures Work Plan	Sections 4.6.2 and 4.6.3
Characterize the vadose zone hydrology and its relationship to the groundwater.	Vadose Zone Investigation Work Plan	Section 4.2.3 and 4.2.11
	Interim Measures Work Plan	Sections 4.6.2 and 4.6.10
Characterize the geology and extent of contamination in the soil and soil gas to determine distribution, fate, and migration of soil contaminants and vapors.	LNAPL Containment Work Plan	Sections 5.2.3 and 5.2.4
	Vadose Zone Investigation Work Plan	Section 5.1 and 5.3
	Interim Measures Work Plan	Sections 4.5.2, 4.6.2, and 4.6.11
Characterize contaminants within soils around fuel storage tank and piping.	Vadose Zone Investigation Work Plan	Section 4.2.10, 4.2.11, and 5.1
	Interim Measures Work Plan	Section 4.5.2
Characterization of contaminants within soils around Former Fuel Offloading Rack (FFOR).	Vadose Zone Investigation Work Plan	Section 4.2.10, 4.2.11, and 5.1
	Interim Measures Work Plan	Sections 4.5.2 and 4.6.2
Amount and source areas of fuel in the vadose zone (e.g., tanks, pipes, FFOR).	Vadose Zone Investigation Work Plan	Section 4.2.10, 4.2.11, and 5.1
	Interim Measures Work Plan	Section 4.5.2

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Table 3-1. Hydrostratigraphic Units and Correspondence to Site-Specific Units

Regional Unit (Depositional Facies)	Site-Specific Zones	Description	Thickness	Approximate Depth Interval	SVMW Screened Intervals
USF-1 (Distal alluvial piedmont fan deposits from the Sandia uplift)		Thick discontinuous intervals of silt (ML) and silty or sandy clays (CL) w/minor lean clays (CL)	74' to 94'	Surface to ≈86' bgs	50' to 52.5' bgs
Transition Zone (Inter-tongued USF-1 and USF-2)	Upper transition sands (USF-2)	Poorly graded sand (SP) buff colored, fine-grained	15' to 25'	≈86' bgs to ≈107' bgs	97' to 102.5' bgs
	Upper transition fines (USF-1)	Primarily silty, sandy, and lean clays (CL) with minor silt (ML) zones	13' to 25'	≈107' bgs to ≈125' bgs	
	Lower transition sands (USF-2)	Poorly graded sand (SP) buff colored, fine-grained	3' to 15'	≈125' bgs to ≈140' bgs	
	Lower transition fines (USF-1)	Primarily silty, sandy, and lean clays (CL)	0' to 10'	≈140' bgs to ≈144' bgs	
USF-2 (Stacked sequence of braided river-channel deposits [Ancestral Rio Grande] and inter-bedded fine- to medium-grained sediments of diverse origin)	Upper Ancestral Rio Grande deposits	Poorly graded fine-grained sands (SP) and well-graded fine- to coarse-grained sands (SW) buff colored, w/trace of gravels.	117' to 140'	≈144' bgs to ≈270' bgs	147' to 152.5' bgs, 229' to 231' bgs, 250' to 252.5 bgs
	Clay Zone	Lean clay (CL) brown, moist to wet, very stiff w/minor sandy and silty clay (CL)	0' to 15'	≈270' bgs to ≈280' bgs	
	Lower Ancestral Rio Grande deposits	Poorly graded fine-grained sands (SP) and well-graded fine- to coarse-grained sands (SW) buff colored, w/higher fraction of gravel (GW) and fine-grained (GM) zones	>137'	≈280' bgs to >517' bgs	287.5' to 305' bgs

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Table 4-1. Kirtland AFB Vadose Zone Investigation - Field Sampling and Quality Control Sample Summary

Matrix	Analytical Group	No. of Primary Sampling Locations	No. of Field Samples	No. of Field Duplicates	No. of MS/MSDs	No. of Field Blanks	No. of Equipment Rinsates	No. of Trip Blanks	Total No. of Samples to Laboratory
Soil Sampling									
Soil	VOCs – SW846 8260B	35 deep/5 shallow(1)	515	52	26	1 per week	26	1 per shipment	619 plus blanks
Soil	VPH/EPH – MA DEP	2 deep	28	3	2	1 per week	2	0	35 plus blanks
Soil	TPH gas/ diesel – SW846 8015B	33 deep/5 shallow	487	49	25	1 per week	25	0	586 plus blanks
Soil	SVOCs – SW846 8270D	35 deep/5 shallow	515	52	26	1 per week	26	0	619 plus blanks
Soil	Lead – SW846 6010C	35 deep/5 shallow	515	52	26	1 per week	26	0	619 plus blanks
Soil Vapor Sampling									
Vapor	VOCs –EPA TO-15	35(2)	210	21	0	0	0	1 per shipment	231 plus blanks
Vapor	TPH Gas – EPA TO-15	35	210	21	0	0	0	0	231
Vapor	APH – MA DEP (4 qtrs)(3)	35	210	21	0	0	0	0	231
Vapor	Fixed Gases – ASTM 2504(4)	35	210	21	0	0	0	0	231
Soil IDW Sampling (estimated)									
Soil	Ignitability, Corrosivity, Reactivity – 40CFR Part 261	80(5)	0	0	0	0	0	0	80
Soil	TCLP VOCs – SW846 1311/8260B	80	0	0	0	0	0	0	80
Soil	TCLP SVOCs – SW846 1311/8270C	80	0		0	0	0	0	80
Soil	TCLP Pesticides – SW846 1311/8081	80	0	0	0	0	0	0	80
Soil	TCLP Herbicides – SW846 1311/8151	80	0	0	0	0	0	0	80
Soil	TCLP Metals – SW846 1311/6010B/7470A	80	0	0	0	0	0	0	80
Soil	BTEX – SW846 8260B/8021B	80	0	0	0	0	0	0	80
Soil	TPH Gas/Diesel– SW846 8015B	80	0	0	0	0	0	0	80

Matrix	Analytical Group	No. of Primary Sampling Locations	No. of Field Samples	No. of Field Duplicates	No. of MS/MSDs	No. of Field Blanks	No. of Equipment Rinsates	No. of Trip Blanks	Total No. of Samples to Laboratory
Decontamination Water Sampling (estimated)									
Water	VOCs – SW846 8260B	40(5)	0	0	0	0	0	0	40
Water	SVOCs – SW846 8270C	40	0	0	0	0	0	0	40
Water	TPH Gas/Diesel – SW846 8015B	40	0	0	0	0	0	0	40
Water	Lead – SW846 6010B	40	0	0	0	0	0	0	40

Notes:

1. 35 deep borings – 14 samples each; 5 shallow borings – 5 samples each
2. 35 soil vapor wells – 6 samples each
3. APH – air-phase petroleum hydrocarbon (to be collected 4 quarters, replaced with TPH gas)
4. Fixed gases – oxygen, nitrogen, carbon monoxide, carbon dioxide, and methane
5. Number of IDW soil and decontamination water samples estimated pending number of rolloffs and storage containers required

APH = air-phase petroleum hydrocarbon
ASTM = ASTM International
BTEX = benzene, toluene, ethylbenzene, and xylene
CFR = Code of Federal Regulations
EPA = U.S. Environmental Protection Agency
EPH = extractable petroleum hydrocarbon
MA DEP = Massachusetts Department of Environmental Protection
MS/MSD = matrix spike/matrix spike duplicate
SVOC = semivolatile organic compound
TCLP = toxic characteristic leaching procedure
TPH – total petroleum hydrocarbon
VOC = volatile organic compound
VPH – volatile petroleum hydrocarbon

Table 4-2. Soil Borings Locations and Correlation to NMED Letters Dated April 2, 2010, and August 6, 2010

Location #	Easting	Northing	Characterization Purpose	NMED April 2 Letter	NMED August 6th Letter
Deep Wells Soil Borings for Conversion to Soil Vapor Monitoring Wells					
1	1541119	1473793	Fuel Offloading Rack	Table 2, Location #1	Table 1, Location #1
2	1540808	1473503	Fuel Offloading Rack	Table 2, Location #2	Table 1, Location #2
3	1541123	1473310	Fuel Offloading Rack	Table 2, Location #3	Table 1, Location #3
4	1541425	1473313	Fuel Offloading Rack and Piping	Table 2, Location #4	Table 1, Location #4
5	1541961	1473492	Fuel Percolation Area	Table 2, Location #5	Table 1, Location #5
6	1542002	1473057	Piping	Table 2, Location #6	Table 1, Location #6
7	1541794	1473061	Piping	Table 2, Location #7	Table 1, Location #7
8	1541270	1473058	Piping	Table 2, Location #8	Table 1, Location #8
9	1541898	1473276	Fuel Percolation Area	Table 2, Location #9	Table 1, Location #9
10	1541720	1473369	Fuel Percolation Area	Table 2, Location #10	Table 1, Location #10
11	1541776	1473740	Fuel Offloading Rack	Table 2, Location #11	Table 1, Location #11
12	1541658	1473505	Fuel Offloading Rack	Table 2, Location #12	Table 1, Location #12
13	1542061	1472928	Fuel Tanks Farm	Table 2, Location #13	Not applicable (NA)
14	1542063	1472775	Fuel Tanks Farm	Table 2, Location #14	NA
15	1542142	1472847	Fuel Tanks Farm	Table 2, Location #15	NA
16	1541982	1472845	Fuel Tanks Farm	Table 2, Location #16	NA
17	1542330	1472796	Fuel Tanks Farm	Table 2, Location #17	NA
18	1542430	1472897	Fuel Tanks Farm	Table 2, Location #18	NA
19	1542516	1472810	Fuel Tanks Farm	Table 2, Location #19	NA
20	1542428	1472716	Fuel Tanks Farm	Table 2, Location #20	Table 1, Location #20
21	1541611	1473238	Fuel percolation area	Table 2, Location #21	Table 1, Location #21
22	1542137	1473266	Fuel percolation area	NA	Table 1, Location #22

Table 4-2. Soil Borings Locations and Correlation to NMED Letters Dated April 2, 2010, and August 6, 2010 (concluded)

Location #	Easting	Northing	Characterization Purpose	NMED April 2 Letter	NMED August 6th Letter
23	1542131	1473571	Fuel percolation area	NA	Table 1, Location #23
24	1541620	1472955	Far field	NA	Table 1, Location #24
25	1542807	1473592	Fuel percolation area	NA	Table 1, Location #25
26	1542422	1473506	Fuel percolation area	NA	Table 1, Location #26
27	1542360	1473808	Fuel percolation area	NA	Table 1, Location #27
1	1542900	1474092	Far Field	NA	Table 2, Location #1
2	1543194	1474680	Far Field	Table 3, Location #2	Table 2, Location #2
3	1542306	1474093	Far Field	Table 3, Location #3	Table 2, Location #3
4	1541555	1475049	Far Field	Table 3, Location #4	Table 2, Location #4
5	1541248	1474141	Far Field	Table 3, Location #5	Table 2, Location #5
6	1542259	1472591	Far Field	Table 3, Location #6	Table 2, Location #6
8	1542504	1475414	Far Field	NA	Table 2, Location #8
9	1542436	1474878	Far Field	Table 3, Location #9	Table 2, Location #9
Shallow Borings					
1	1542544	1472810	Tank Farm	NA	Table 3, Location #1
2	1542282	1471806	Tank Farm	NA	Table 3, Location #2
3	1542125	1472784	Tank Farm	NA	Table 3, Location #3
4	1542081	1472959	Tank Farm	NA	Table 3, Location #4
5	1541941	1472867	Tank Farm	NA	Table 3, Location #5

Table 5-1. Sample Requirements for Analytical Testing

Matrix	Parameter[1]	Container[2,3]	Preservation	Maximum Holding Times[4] Extraction	Analysis
Low-Concentration Samples					
Water	Volatiles	2 x 40-mL[5] G, Septa Vial	Ice to 4°C 4 drops conc. HCl or sodium bisulfate ($NaHSO_4$) to pH<2	---	14 days
Water	SVOCs	2 x 1-L[5,6] amber G	Ice to 4°C	7 days	40 days
Water	Metals[6]	1 x 1-L P	Nitric acid (HNO_3) to pH<2		6 months[7]
Water	TPH –gas TPH – diesel	2 x 40-mL[5] G, Septa Vial 2 x 1-L G	Ice to 4°C		14 days
Water	Common parameters	1 x 1-L[8] G	Ice to 4°C		28 days[8]
Soils/Sediments	Volatiles	3 – 5 gram Encore	Ice to 4°C		48 hr, 14 days frozen
Soils/Sediments	SVOCs, PCBs, pesticides	1 x 8-oz G	Ice to 4°C	14 days	40 days
Soils/Sediments	Metals, cyanide, TPH	1 x 8-oz G 5-gram Encore for TPH-gas	Ice to 4°C		6 months,[7] 14 days, 48 hr, 14 days frozen
Vapor	VOCs/ TPH gas/ APH	1 x 1-L Bottle Vac	None	N/A	30 days
Vapor	Fixed gases	1 x 1-L Tedlar bag	None	N/A	30 days
Medium-Concentration Samples					
Water/Liquid	Volatiles	2 x 40-mL G	Ice to 4°C[5]		14 day
Water/Liquid	SVOCs[5]	2 x 32-oz wide-mouth jars, G	Ice to 4°C[5]	7 days	40 days
Water/Liquid	PCBs[5], pesticides	2 x 32-oz wide-mouth jar G	Ice to 4°C[5]	7 days	40 days
Water/Liquid	Metals	1 x 16-oz wide-mouth jar, G	HNO_3 to pH<2		6 months[7]
Water/Liquid	Explosives	2 x 1-L amber G	Ice to 4°C	7 days	40 days
Water/Liquid	Cyanide	1 x 1- L P	Sodium hydroxide (NaOH) to pH>12 Ice to 4°C		14 days
Soils/Sediments	Volatiles	3- 5 gram Encore	Ice to 4°C		48 hr, 14 days frozen
Soils/Sediments	SVOCs, PCBs, pesticides	1 x 8-oz wide-mouth jar, G	Ice to 4°C	14 days	40 days

Table 5-1. Sample Requirements for Analytical Testing (concluded)

Medium-Concentration Samples (continued)					
				Maximum Holding Times[4]	
Matrix	**Parameter[1]**	**Container[2,3]**	**Preservation**	**Extraction**	**Analysis**
Soils/Sediments	Metals, cyanide, TPH	1 x 8-oz wide-mouth jar, G 5-gram Encore for TPH-gas	Ice to 4°C		6 months,[7] 14 days, 48 hr, 14 days frozen
Liquid	All organic and inorganic analyses	1 x 8-oz wide-mouth jar, G		See comment 9	
Solids	All organic and inorganic analyses	2 x 8-oz wide-mouth jars, G		See comment 9	

1 SVOC = semivolatile organic compound; TPH = total petroleum hydrocarbon; VOC = volatile organic compound; PCB = polychlorinated biphenyl; APH = air phase hydrocarbon;.

2 All containers must have Teflon-lined seals (Teflon-lined septa for volatile organic analysis [VOA] vials).

3 L = liter; G = glass; P = high-density polyethylene. Sample preservation will be done in the field immediately upon sample collection. If water samples are filtered in the field, differential pressure methods using 45-micron filters will be used, and preservatives added after filtration. VOA samples should never be filtered.

4 When only one holding time is given, it implies total holding time from sampling until analysis.

5 Samples with residual chlorine present will be dechlorinated with sodium thiosulfate as specified in SW-846 (third edition).

6 Three bottles are required on at least 5 to 10 percent (but at least one) sample so that the laboratory can perform all method quality control checks for SW-846 method.

7 Total recoverable metals for water samples. Holding time for mercury is 28 days in glass; for hexavalent chromium is 24 hours.

8 Chlorine, bromine, fluorine, nitrate, nitrite, phosphate, sulfate; 1 L for each method; orthophosphate requires filtration. Holding time for extraction is 48 hours for nitrate, nitrite, and phosphate if not preserved with sulfuric acid to pH<2.

9 Holding times for medium-concentration samples are the same as those specified for low-concentration samples.

Table 7-1. Project Team Members' Qualifications, Responsibilities, and Authorities

Position	Qualifications	Duties and Responsibilities	Authority Level
Project Manager	• Tom Cooper, PG, PMP • Mr. Cooper is a Professional Geologist (PG) and Project Management Professional (PMP) with 11 years of experience as a hydrogeologist on complex groundwater remediation projects and 5 years of experience as a project manager for firm-fixed-price, performance-based acquisition (PBA) projects, including hybrid PBAs with options. He has expert knowledge of groundwater and soil sample collection/data evaluation and has extensive experience working proactively with clients and regulators to determine the best technologies to reach remedial performance objectives. • Mr. Cooper has served as the project manager for DoD projects at Former Air Force Plant PJKS (PJKS), Pueblo Chemical Depot, and Vandenberg AFB. For these projects, he established strong and cooperative working relationship with his clients as well as state and EPA regulators. At PJKS, he successfully negotiated with regulators to implement an environmental covenant and technical impracticability waiver as opposed to a pump-and-treat system. The environmental covenant saved the Air Force millions of dollars. At Pueblo, Mr. Cooper developed ten remedy-specific work plans that were approved within the first year of the project. He and his team then completed installation of eight in situ bioremediation systems within the second year of the project.	• Manages task order (TO) deliverables, schedules, and budgets • Implements procedures to eliminate conflicts, errors, and omissions and ensure the accuracy of all output • Establishes and maintains close communication and coordination with the USACE for the duration of the project • Assigns scientists, engineers, and select subcontractors • Procures services, equipment, and supplies as needed • Ensures personnel follow approved work plans/specs • Tracks materials and resources and justify change orders • Coordinates subcontractors' work to ensure compliance with safety and health, quality, and contract procedures	• Full responsibility and authority to execute TOs • Approves subcontractor invoices, project charges, and deliverables • Implements corrective action • Stops work for non-compliance/safety violation
Site Supervisor	• Terry Rulon • Mr. Rulon has over 22 years as a site supervisor on restoration, remediation, demolition, and hazardous waste sites. His role has been primarily bid preparation, estimating, overall site management, and field work on numerous complex environmental projects throughout the U.S. • Mr. Rulon's experience includes, but is not limited to, management of contaminated soil remediation, in situ bioremediation of groundwater for chlorinated compounds, shock-sensitive chemical packaging, and emergency response actions.	• Tracks progress of daily well installation production and soil excavation • Schedules manpower and balancing project resources • Schedules use of equipment • Manages sampling of environmental media and IDW, handling of IDW, and coordination of IDW disposal. • Manages operation and maintenance of all equipment • Addresses field issues to keep project on schedule • Communicates daily with project manager to keep project on schedule	• Supervises field TO engineering and design staff • Manages subcontractors • Implements corrective action • Stops work for non-compliance/safety violation

Table 7-1. Project Team Members' Qualifications, Responsibilities, and Authorities (continued)

Position	Qualifications	Duties and Responsibilities	Authority Level
Field Team Manager – Soil-Vapor Extraction (SVE)	• David Cacciatore, PhD, PE, PMP • Dr. Cacciatore is a registered Professional Engineer (PE) and PMP with 7 years of experience designing and implementing SVE/bioremediation systems for environmental remediation projects. He has designed and implemented a wide range of bioremediation technologies, including monitored natural attenuation (MNA). Dr. Cacciatore has served as the Designer of Record on plans and reports for several high-profile projects at sites including Hunters Point Naval Shipyard and Treasure Island in California. He has played an integral role in supporting negotiations with regulators to gain approval of the remedies and cleanup goals for these projects. Dr. Cacciatore has authored/co-authored 11 technical papers/ presentations at industry conferences on the design and implementation of bioremediation and other remedial methods.	• Identifies, trains, mentors, and assigns qualified engineering staff to tasks/projects • Ensures compliance and consistency of engineering and technical program execution across all TOs • Provides professional engineering certification of drawings, specifications, and documents as necessary • Ensures compliance with all applicable engineering and design codes, standards, and guidance	• Supervises field TO engineering and design staff • Defines qualifications and requirements of engineering and technical staff at TO level • Evaluates performance of engineering staff and provides feedback, including recommendations, to project manager • Stops work for non-compliance/safety violation
Field Team Manager – In Situ	• Gary Hecox, PhD, PG, CGWP • Dr. Hecox is a PG and Certified Groundwater Professional (CGWP) with 32 years of experience in hydrogeology, GIS development and application, contaminant investigations, risk analysis, and remediation. He is a technical expert in non-aqueous phase liquid (NAPL) assessment and remediation, groundwater modeling, geostatistics, statistics, and error analysis. • Dr. Hecox has served as Shaw's senior scientist/engineer for federal remediation projects dealing with in excess of 5 million gallons of light, non-aqueous phase liquid (LNAPL) contamination. He specializes in designing and implementing process treatment systems such as for the chemical stabilization of soils and groundwater. He has provided technical input and strategy support in Resource Conservation and Recovery Act (RCRA) site remediation negotiations and technical impracticability waivers for various federal sites. Dr. Hecox also developed and deployed new technologies and applications of geographical information system (GIS) for hydrogeologic assessments.	• Prepares groundwater modeling to assist with the design of remediation systems • Executes the MNA evaluation study • Evaluates and documents all hydrogeologic data to confirm LNAPL and plume containment	• Supervises field TO design staff • Defines qualifications and requirements of technical staff at TO level • Evaluates performance of technical staff and provides feedback, including recommendations, to project manager • Stops work for non-compliance/safety violation

Table 7-1. Project Team Members' Qualifications, Responsibilities, and Authorities (continued)

Position	Qualifications	Duties and Responsibilities	Authority Level
Field Team Manager – Bioremediation	• Charles Schaefer, PhD • Dr. Schaefer has 14 years of experience with assessing the fate and transport of organic contaminants in soil and groundwater systems. His work has included design and performance of laboratory scale experiments, mathematical and numerical modeling, and conceptual design and evaluation of field-scale bioremediation systems. He has taught graduate-level courses in contaminant hydrogeology, and has been successful in attaining research funding from the EPA, DoD, and the U.S. Department of Energy (DOE). Dr. Schaefer's research has included development of experimental methods to evaluate new and emerging technologies including ethylene dibromide degradation in Shaw's treatability study laboratories located in Lawrenceville, New Jersey and Knoxville, Tennessee. As a result of his research, he has developed and published several conceptual and mathematical models that have been used to better understand, interpret, and predict contaminant fate and transport. • Dr. Schaefer has been the lead engineer and/or technical manager on several field projects, many of which have used innovative investigation and treatment technologies. His key contributions include the conceptual design and performance evaluation of an air sparging/soil vapor extraction Superfund site in New Jersey; development of a transport model to evaluate contaminant biodegradation in an engineered biocell at a Superfund site in Delaware; and development and implementation of an innovative cosolvent technology for investigation of dense, non-aqueous phase liquid (DNAPL) in bedrock.	• Identifies, trains, mentors, and assigns qualified engineering staff to tasks/projects • Ensures compliance and consistency of engineering and technical program execution across all TOs • Provides professional engineering certification of drawings, specifications, and documents as necessary • Ensures compliance with all applicable engineering and design codes, standards, and guidance	• Supervises field TO engineering and design staff • Defines qualifications and requirements of engineering and technical staff at TO level • Evaluates performance of engineering staff and provides feedback, including recommendations, to project manager • Stops work for non-compliance/safety violation

Table 7-1. Project Team Members' Qualifications, Responsibilities, and Authorities (continued)

Position	Qualifications	Duties and Responsibilities	Authority Level
Field Team Manager – Chemistry	• Pamela Moss • Ms. Moss has 32 years of experience in chemical quality control, analytical chemistry, and project management in support of federal contracts. Ms. Moss supported projects at Kirtland AFB from 1996 to 2010. During this time, she managed in excess of $5 million in analytical laboratory services. She has also participated in RCRA site investigations, remedial actions, long-term groundwater monitoring, compliance monitoring and sampling programs, which included hazardous wastes and routine and non-routine analytical parameters for groundwater, drinking water, soil, and air. • Ms. Moss has 14 years of experience at Kirtland AFB participating in regular communications and negotiating with the New Mexico Environmental Department (NMED) to ensure compliance with all applicable regulations. Ms. Moss also has extensive knowledge and experience implementing federal programs in accordance with the USACE; DoD Quality Systems Manual for Environmental Laboratories (QSM); and EPA requirements, protocols, and analytical methodologies.	• Approves project-specific data quality objectives (DQOs) that will meet the project-specific performance standards • Determines appropriateness of sampling procedures, analytical methods, and laboratory quality systems • Approves the final QAPP • Verifies the selection of appropriately qualified laboratories • Coordinates field and laboratory quality assurance surveillance per contract specifications • Notifies the project manager of any problems or nonconformance issues • Directs the performance of data review per contract specifications • Oversees data management and ERPIMS submittals	• Supervises field scientists and technical staff • Defines qualifications, requirements, and assigns engineering and technical staff at TO level • Evaluates performance of technical staff and provides feedback, including recommendations, to project manager • Stops work for non-compliance/safety violation
Field Team Manager – Geophysics	• Tim Deignan, PGP • Mr. Deignan is a registered PGP with more than 21 years of experience, which include executing multiple projects at Kirtland AFB. As a recognized subject matter expert, Mr. Deignan has also donated his time to serve as an archeological expert for efforts at Kirtland AFB. His experience includes design and management of integrated geophysical programs to investigate and assess sites and geotechnical, geologic, hydrogeologic, and cultural resource features. He specializes in high-resolution, integrated geophysical programs for environmental remediation and munitions investigations. • Mr. Deignan works with numerous state and federal agencies to increase the usability of results for geophysical and statistical sampling data, and is integral in developing more adequate and innovative sampling approaches. He is a two-time recipient of the Industry Recognition Award from the Interstate Technology and Regulatory Council.	• Functions in lead technical role for efforts requiring expert level support • Identifies, trains, mentors, and assigns qualified technical staff to tasks/projects • Ensures compliance and consistency of technical program execution • Ensures compliance with all applicable federal, state, and local regulations • Serves as the project geophysicist of record	• Supervises field scientists and technical staff • Defines qualifications, requirements, and assigns engineering and technical staff • Evaluates performance of technical staff and provides feedback, including recommendations, to project manager • Stops work for non-compliance/safety violation

Table 7-1. Project Team Members' Qualifications, Responsibilities, and Authorities (continued)

Position	Qualifications	Duties and Responsibilities	Authority Level
Environmental Regulatory Specialist	• Jan Martin, PE • Ms. Martin is a New Mexico-registered PE with more than 24 years of experience ensuring compliance on complex environmental investigation and remediation projects. Located in Shaw's Albuquerque office, Ms. Martin has executed a number of environmental remediation projects for DoD in New Mexico and other states, including active installations under the Installation Restoration Program at Wright-Patterson AFB, and Formerly Used Defense Sites (FUDS) at the Former Walker AFB in Roswell, New Mexico and at a FUDS adjacent to Kirtland. • She has worked with DoD clients, EPA regulators, and private and tribal stakeholders to ensure compliance on projects conducted under RCRA as well as various DoD programs, state statutes, and regulations. Ms. Martin has prepared remedial investigation, engineering evaluation/cost analyses, and feasibility study reports, various decision documents, land use control plans, Operating Properly and Successfully (OPS) documents, RCRA closure and corrective action documents, and design analysis documents including plans and specifications.	• Identifies regulatory requirements and oversees implementation of environmental regulatory requirements • Supports project manager in regulatory interaction • Works closely with the installation representatives to ensure that environmental policies and procedures are implemented • Stops work for non-compliance/safety violation	• Reports regulatory updates to project manager • Coordinates regulatory meeting in concert with project manager • Maintains list of team personnel who have authority to contact regulatory agencies • Stop-work authority
Risk Assessor	• Mark Weisberg, CHMM • Mr. Weisberg, a Certified Hazardous Materials Manager (CHMM), has prepared hundreds of risk assessments at more than 25 Army/DoD facilities, including Former Walker AFB in Roswell, New Mexico. At Walker, he prepared NMED-approved screening-level environmental risk assessments for sites throughout the base. He has more than 20 years of experience in ecology and environmental assessment, where he has been responsible for supervising and conducting risk assessments and RCRA facility investigations at numerous hazardous, toxic, and radioactive waste sites for the Army, Air Force, and Navy. His areas of expertise include ecological and human health risk assessment; toxicology; statistical analysis; water quality; site assessment; and federal, state, and local permit preparation.	• Functions in lead technical role for efforts requiring expert level support • Identifies, trains, mentors, and assigns qualified technical staff to tasks/projects • Ensures compliance and consistency of technical program execution • Ensures compliance with all applicable federal, state, and local regulations	• Supervises field scientists and technical staff • Defines qualifications, requirements, and assigns engineering and technical staff • Evaluates performance of technical staff and provides feedback, including recommendations, to project manager • Stops work for non-compliance/safety violation

Table 7-1. Project Team Members' Qualifications, Responsibilities, and Authorities (continued)

Position	Qualifications	Duties and Responsibilities	Authority Level
Certified Industrial Hygienist (CIH)	• James Joice, CIH, Certified Safety Professional (CSP), CHMM • Mr. Joice, Shaw's CIH for the Huntsville Worldwide Environmental Remediation contract, has 30 years of experience managing the health and safety for projects and programs at hundreds of environmental remediation sites. He has extensive experience establishing and maintaining health and safety plans and procedures where EPA Levels A, B, and C personal protective equipment (PPE) were required. • He regularly supervises project safety personnel; monitors subcontractor activities; develops, implements, and enforces site-specific accident prevention plans (APPs) and site safety and health plans (SSHPs); audits sites for compliance with health and safety (H&S) program requirements; conducts personnel training, and verifies regulatory compliance. He has also prepared and implemented H&S programs for several PBA and firm-fixed-price contracts.	• Implements and oversees H&S program and plans • Develops, implements, and oversees APPs inclusive of SSHPs and directs/approves any changes • Notifies Contracting Officer of changes in the approved plan within 48 hours • Interfaces with the USACE on H&S program requirements • Assesses risk and ensures engineering controls and/or appropriate PPE are used for worker and public protection	• Approves APPs/SSHPs and all modifications before issuance to the USACE • Manages H&S Program and directs training and required attendance • Investigates safety concerns raised by staff • Investigates any accidents • Stops work for non-compliance/safety violation
Community Relations Specialist	• Lisa Stahl • Ms. Stahl is a senior community relations specialist/anthropologist with 17 years professional experience that includes active participation on projects in New Mexico. Ms. Stahl provided public involvement and social science support for efforts at both the Los Alamos National Laboratory as well as Pueblo of Isleta. • She has 17 years of experience working with a variety of assessment tools and information; establishing positive working relationships with multiple stakeholders; and preparing and distributing various bilingual outreach materials to a variety of end-users. • Ms. Stahl specializes in identifying and facilitating community perspectives into program and policy processes through active involvement and regular communication with members of the community. She is also skilled at writing innovative public participation strategies tailored and targeted to the specific needs and concerns of the community. • Her various experiences have included liaison activities between project staff and communities, conducting community assessments, evaluating various public programs, and providing community involvement support to a variety of government clients.	• Performs community outreach to facilitate offsite drilling program • Establishes and maintains regular communication regarding project and field efforts with all members of the community • Plans, organizes, and participates in public meetings regarding the project, including working with all applicable parties to prepare for public meetings • Prepares and advertises public notices as necessary • Prepares project fact sheets and facilitates distribution of fact sheets and other presentation materials • Performs research and community interviews to gather needed information	• Reports updates to project manager • Coordinates public meetings in concert with project manager • Maintains list of team personnel who have authority to conduct community interviews • Stops work for non-compliance/safety violation

Table 7-1. Project Team Members' Qualifications, Responsibilities, and Authorities (concluded)

Role	Subcontractor	Duties and Responsibilities	Authority Level
Driller	Water Development Corporation	• Installs groundwater, soil-vapor monitoring, and soil-vapor extraction wells • Uses direct-push methods to advance soil borings • Collects continuous soil samples • Collects soil-vapor samples	• Stops work for non-compliance/safety violation
Laboratory	Empirical Laboratories, LLC – groundwater sample analysis Gulf Coast Analytical Laboratories, Inc. – soil sample analysis RTI Laboratories – soil-vapor sample analysis	• Conducts analytical services in accordance with the Uniform Federal Policy – Quality Assurance Project Plan and DoD QSM • Provides analytical data in electronic PDF format • Provides ERPIMS-formatted deliverables	• Stops work for non-compliance/safety violation
Transportation and Disposal	Rhino	• Furnishes trucks, drivers, and all associated services required for transporting hazardous waste oil mixtures from Kirtland AFB to an offsite disposal facility • Ensures compliance with federal, state, and local environmental regulations • Provides all equipment and materials required for performing work at the disposal site	• Stops work for non-compliance/safety violation
SVE Unit Service Maintenance Provider	Remediation Services Int'l	• Provides support maintenance and repairs as needed for the SVE units	• Stops work for non-compliance/safety violation associated with the systems

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APPENDIX A

2010 Regulatory Correspondence between the NMED HWB and the Air Force regarding the Kirtland AFB, BFF Spill

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ATTACHMENT 1

April 2, 2010 Correspondence from the NMED HWB to Colonel Michael S. Duvall, Base Commander, 377 ABW/CC regarding SWMUs ST-106 and SS-111, BFF Spill, Kirtland AFB

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AR Doc # 3451

NEW MEXICO
ENVIRONMENT DEPARTMENT

Hazardous Waste Bureau

2905 Rodeo Park Drive East, Building 1
Santa Fe, New Mexico 87505-6303
Phone (505) 476-6000 Fax (505) 476-6030
www.nmenv.state.nm.us

BILL RICHARDSON
Governor

DIANE DENISH
Lieutenant Governor

RON CURRY
Secretary

SARAH COTTRELL
Deputy Secretary

CERTIFIED MAIL - RETURN RECEIPT REQUESTED

April 2, 2010

APR 19 2010

Colonel Michael S. Duvall
Base Commander
377 ABW/CC
2000 Wyoming Blvd. SE
Kirtland AFB, NM 87117-5606

Mr. John Pike
Director, Environmental Management Section
377 MSG/CEANR
2050 Wyoming Blvd., Suite 116
Kirtland AFB, NM 87117-5270

RE: SOLID WASTE MANAGEMENT UNITS ST-106 AND SS-111, BULK FUELS FACILITY SPILL
KIRTLAND AIR FORCE BASE
EPA ID# NMD9570024423, HWB-KAFB-10-004

Dear Colonel Duvall and Mr. Pike:

As you are aware, the U. S. Department of Defense Kirtland Air Force Base ("Permittee") is conducting an investigation of contaminated groundwater at the Bulk Fuels Facility Former Fuel Offloading Rack (Solid Waste Management Unit ["SWMU"] ST-106) and the associated Light Non-Aqueous Phase Liquid ("LNAPL") plume (SWMU SS-111, or Phase-Separated Hydrocarbon Bulk Fuels Facility Remediation) (collectively, the "Bulk Fuels Facility Spill"). Data submitted by the Permittee show that the contamination caused by the Bulk Fuels Facility Spill represents a significant threat to human health and the environment, particularly to well water in urban neighborhoods adjacent to Kirtland Air Force Base ("KAFB"). Despite the fact that this release of hazardous constituents was first discovered 10 years ago, the Permittee has not completely characterized the Bulk Fuels Facility Spill, nor conducted adequate remediation.

As stated in the New Mexico Environment Department ("Department") Ground Water Quality Bureau ("GWQB") letter enclosed with this letter, the GWQB has transferred oversight of the Bulk Fuels Facility Spill to the Hazardous Waste Bureau ("HWB"), which will direct corrective action at the Bulk Fuels Facility Spill pursuant to the New Mexico Hazardous Waste Act ("HWA") NMSA 1978, §74-4-1 to 74-4-14 and the Hazardous Waste Management Regulations ("HWMR", 20.4.1 NMAC).

Releases of hazardous waste or hazardous constituents are subject to corrective action under Sections 3004(u) and (v) and 3008(h) of the Resource and Conservation Recovery Act "RCRA"; 42 U.S.C. §§ 6924(u) and (v) and 6928(h); Sections 74-4-4(A)(5)(h) and (i), 74-4-4.2(B), and 74-4-10(E) of the HWA; and the HWMR at 40 C.F.R. Part 264, Subpart F (incorporated by 20.4.1.500 NMAC).

Pursuant to 20.4.1 NMAC incorporating 40 CFR § 264.101(a), the Permittee must institute corrective action as necessary to protect human health and the environment for all releases of hazardous waste or constituents from any SWMU. Additionally, in accordance with 20.4.1 NMAC incorporating 40 CFR § 264.101(c), the Permittee must implement corrective actions beyond the facility boundary.

Section R.5 of the Hazardous and Solid Waste Amendments ("HSWA") Module IV of the Permittee's RCRA Permit states:

> The Permittee shall conduct those investigations of SWMUs previously identified with known or suspected releases of contamination as necessary to protect human health and the environment to: characterize the facility (Environmental Setting); define the source (Source Characterization); define the degree and extent of contamination (Contamination Characterization); and to identify actual or potential receptors.

Additionally, pursuant to Section R.5(b):

> The Permittee shall collect analytical data to completely characterize the waste and areas where waste have been placed, including: type, quantity, physical form, disposition (containment or nature of deposits), and the facility characteristics affecting releases.

And, in accordance with Section R.5(c):

> The Permittee shall collect analytical data on groundwater, soils, surface water, sediment, and subsurface gas contamination when necessary to characterize contamination from a SWMU. The data shall be sufficient to define the extent, origin, direction and rate of movement of the contaminant plumes.

Therefore, in accordance with Section K.1 of the HSWA Module IV of the Permittee's RCRA Permit, the Permittee is directed to immediately implement interim measures to remediate the LNAPL plume, to excavate and remove structures and contaminated soil in the vadose zone at and in the vicinity of the Former Fuel Offloading Rack, to install additional wells, and continue operation of the existing soil-vapor extraction units as directed below. Additionally, pursuant to Section R.5 of Module IV of the Permit, the Permittee is directed to immediately complete characterization of contaminated soil and soil-gas in the vadose zone, and to immediately complete characterization of the dissolved-phase contamination in groundwater. Furthermore, in accordance with Section M.1 of Module IV of the Permit, the Permittee will be directed by NMED to conduct one or more Corrective Measures Evaluations. The Permittee shall comply with the detailed instructions specified below by the indicated deadlines.

A. REQUIREMENT FOR COMPLETING CHARACTERIZATION OF CONTAMINATION IN THE VADOSE ZONE

The Department finds that contaminant characterization is inadequate at the tank farm, the piping extending from the tank farm to the Former Fuel Offloading Rack, and areas in the vicinity of the Former Fuel Offloading Rack. More specific details on this finding are presented in the next two paragraphs.

Based on information provided by the Permittee, only four soil borings have been completed at the fuel tanks and no borings have been completed along the ancillary piping leading from the fuel tanks to the Former Fuel Offloading Rack. The four soil borings at the tanks were completed to shallow depths ranging from 25-48 feet. Diesel Range Organics ("DRO") contamination was detected in all four boreholes, with the highest concentrations (1800-2400 mg/kg) found in borehole SB-09. A number of hazardous constituents were also detected in soil samples from SB-09 and SB-06. Despite these findings, the Permittee did not determine the extent of contamination near the tanks. The latter is particularly notable given that the Permittee's *Stage 1 Abatement Plan Report* (February 8, 2006) contains the following recommendation (in Section 4.4):

> It is recommended that additional field investigation at the east side of the Bulk Fuels Facility be conducted to determine the full extent of petroleum hydrocarbons in soil and soil vapor beneath Tank 2422...Additional investigation will also determine whether release(s) associated with this tank are the source of sorbed-phase and vapor-phase petroleum hydrocarbons previously indentified in distal monitoring wells SVMW-13 and SVMW-15.

To date, the Permittee has not conducted the additional field investigation to determine the full extent of petroleum hydrocarbons and hazardous constituents in soil and soil vapor around the Bulk Fuels Facility.

The Permittee has also not completed characterization of the contaminated soil in the vicinity of the Former Fuel Offloading Rack, as previous investigative efforts seem to have been arbitrarily terminated once Total Petroleum Hydrocarbons ("TPH") concentrations in soil were found to be less than 100 mg/kg. Additional soil borings should have been completed to investigate the full extent of soil contamination above background levels regardless of the concentration levels of the contaminants. Similarly, characterization of soil-gas contamination near the Former Fuel Offloading Rack is inadequate; investigative efforts appear to have been terminated once TPH concentrations were found to be below 1000 ppmv in the area. Additional soil-gas monitoring wells should have been installed to investigate the full extent of soil-gas contamination from the surface to groundwater, even in areas where the contamination is less than 1000 ppmv.

Thus, the Permittee has not adequately characterized LNAPL contamination in the vadose zone. Characterization must be complete to design and implement an appropriate final remedy. Accordingly, pursuant to the deadlines established below, the Permittee must:

1. Determine the amount of fuel that exists within the vadose zone as sorbed or residual liquid, or as soil gas.
2. Identify the source of the LNAPL fuel plume.
3. Describe the vadose zone hydrology, its relationship to observed and potential to-be-discovered groundwater contamination, and the potential for continuing contamination of groundwater by vadose zone contamination sources.
4. Characterize the geology and extent of contamination in the soil and soil gas to determine distribution, fate, and migration of contaminants.

Therefore, on or before **June 7, 2010**, the Permittee must submit to the Department for its review and approval a Vadose Zone Investigation Plan that describes the additional actions the Permittee will take to investigate the vadose zone hydrology and geology of the affected area, to identify and characterize the source of the releases at the Bulk Fuel Facility, and to identify the extent of soil and soil-gas contamination in the vadose zone from the surface to groundwater. The area covered under this Vadose Zone Investigation Plan must include the tank farm and the ancillary piping between the farm and the Former Fuel Offloading Rack. The Vadose Zone Investigation Plan must describe in detail all research, locations, depths and methods of exploration, field procedures, sampling and analysis of soil and soil gas and related quality control procedures. The Vadose Zone Investigation Plan shall also describe the results and the means (for example, cross-sections, plan views) by which these results will be reported after the investigation is completed, and a schedule for implementation of the work that complies with the compliance schedule in Table 1 of this letter.

Table 1. Compliance Schedule for Vadose Zone Investigation

Task	**Date Due**
Submit Vadose Zone Investigation Plan to the Department	June 7, 2010
Complete all subsurface-soil sampling and installation of all soil-gas monitor wells	Within 12 months after Department approval of Vadose Zone Investigation Plan

Report results for subsurface-soil sampling	Within 15 months after Department approval of Vadose Zone Investigation Plan
Complete first four quarters of soil-gas sampling and analysis	Within 24 months after Department approval of Vadose Zone Investigation Plan
Soil-gas sampling	Quarterly after well installations completed
Submit quarterly soil-gas monitoring reports to the Department	60 days after the quarter during which sampling occurred

Furthermore, in addition to any other locations the Permittee identifies, the locations listed in Table 2 of this letter shall be included in the Vadose Zone Investigation Plan and must be sampled for contaminants in soil and soil gas (all coordinates in this table are State Plane Coordinates in feet, NAD83). Soil samples shall be collected at a frequency of at least one sample every 10 feet for the first 50 feet, and at least one sample thereafter every 50 feet to total depth, and at least one sample at total depth in each boring. Each boring at each location shall be drilled from the surface to the water table, and each boring shall be completed as a permanent soil-gas monitoring well. All of the soil-gas monitoring wells shall be capable of yielding discrete samples of soil gas recovered from depths of 25, 50, 150, 250, 350, and 450 feet below the ground surface. While the Permittee shall continue to analyze samples for TPH and hazardous constituents, the investigation shall not be limited to only those areas containing or suspected to contain TPH at concentrations of greater than 100 mg/kg (100 ppm) in soil or 1000 ppmv in soil gas. Instead, investigation of the Bulk Fuels Facility Spill shall be designed to determine the full extent of contamination above background levels regardless of contaminant concentration levels.

Table 2. Borehole locations for soil sampling and for conversion to soil-gas monitoring wells.

Location #	Easting	Northing	Characterization Purpose
1	1541119	1473793	Step out from Fuel Offloading Rack beyond 100 mg/kg contaminated zone
2	1540808	1473503	Step out from Fuel Offloading Rack
3	1541123	1473310	Step out from Fuel Offloading Rack
4	1541425	1473313	Step out from Fuel Offloading Rack
5	1541961	1473492	Path from Fuel Offloading Rack to LNAPL Plume
6	1542002	1473057	Piping
7	1541794	1473061	Piping
8	1542370	1473058	Piping
9	1541898	1473276	Path from Fuel Offloading Rack to LNAPL Plume
10	1541720	1473369	Step out from Fuel Offloading Rack

11	1541776	1473740	Step out from Fuel Offloading Rack
12	1541658	1473505	Path from Fuel Offloading Rack to LNAPL Plume
13	1542061	1472928	Fuel tanks
14	1542063	1472775	Fuel tanks
15	1542142	1472847	Fuel tanks
16	1541982	1472845	Fuel tanks
17	1542330	1472796	Fuel tanks
18	1542430	1472897	Fuel tanks
19	1542516	1472810	Fuel tanks
20	1542428	1472716	Fuel tanks
21	1541611	1473238	Piping

In addition to any other location identified by the Permittee, the locations listed in Table 3 of this letter shall also be included in the Vadose Zone Investigation Plan to be sampled for contaminants in soil gas (all coordinates in this table are State Plane Coordinates in feet, NAD83). Each boring at each location listed in Table 3 shall be completed as a permanent soil-gas monitoring well. All of the soil-gas monitoring wells shall be capable of yielding discrete samples of soil gas recovered from depths of 25, 50, 150, 250, 350, and 450 feet below the ground surface.

Table 3. Locations for soil-gas monitoring wells.

Location #	Easting	Northing	Characterization Purpose
1	1543058	1474093	Characterize outside of LNAPL Plume
2	1543194	1474680	Characterize outside of LNAPL Plume
3	1542306	1474093	Characterize within LNAPL Plume
4	1541555	1475049	Characterize outside of LNAPL Plume
5	1541248	1474141	Characterize outside of LNAPL Plume
6	1542259	1472591	Characterize outside of LNAPL Plume
7	1540667	1472823	Characterize outside of LNAPL Plume
8	1542525	1475459	Characterize within LNAPL Plume
9	1542436	1474878	Characterize within LNAPL Plume

B. REQUIREMENT FOR COMPLETING CHARACTERIZATION OF DISSOLVED-PHASED CONTAMINANTS IN GROUNDWATER

The Permittee has not adequately characterized the dissolved-phase contamination in the groundwater and has not analyzed groundwater samples from wells located in the LNAPL plume area. The final remedy for the Bulk Fuels Facility Spill cannot be determined until this characterization work has been completed. Additionally, the Permittee has not installed any groundwater monitoring wells to investigate the vertical extent of the dissolved-phase groundwater contamination, the effects of vertical gradients, and the geology of the aquifer at any appreciable depth below the water table. The dissolved-phase plume is approaching one or more

Water Utility Authority well fields. Given that the pumping of water supply wells is known to induce vertical gradients in groundwater and can cause significant components of vertical flow in the vicinity of such wells, vertical characterization of groundwater quality and geology is required.

The leading edge and the eastern and western margins of the plume are undefined, and the nature and concentrations of contaminants in the core of the plume are poorly characterized because existing wells are located too far apart (generally at distances greater than 500 feet). Additionally, only one upgradient well has been installed that may yield groundwater samples that are free from contamination. Given the magnitude of this spill, several upgradient wells should be installed that are screened at different depths at and below the water table to ensure that all areas of contaminated groundwater have been located, and that the background wells are truly monitoring background water quality.

Therefore, on or before **July 7, 2010**, the Permittee must submit to the Department for its review and approval a Groundwater Investigation Plan that describes the additional actions the Permittee will take to characterize the nature, horizontal and vertical extent, and the fate and rate of migration of the groundwater contamination. The Groundwater Investigation Plan shall include construction details and the locations and depths of the groundwater monitoring wells to be installed, actions to characterize the geology and hydrogeology at and below the water table, and the groundwater flow direction and velocity. The plan shall also present details on field procedures, and the sampling and analysis of groundwater and related quality control. The Groundwater Investigation Plan shall describe the results, the means (*e.g.*, cross-sections, plan views) by which these results will be reported after the investigation is completed, and a schedule for implementation of the work that complies with the compliance schedule in Table 4 of this letter.

Table 4. Compliance Schedule for Groundwater Investigation

Task	**Date Due**
Submit Groundwater Investigation Plan to the Department	July 7, 2010
Complete installation of all wells	Within 12 months after Department approval of Groundwater Investigation Plan
Submit well installation report to the Department	Within 15 months after Department approval of Groundwater Investigation Plan
Complete first eight quarters of groundwater sampling and analysis	Within 36 months after Department approval of Groundwater Investigation Plan

Groundwater Sampling	Quarterly after well installations completed
Submit quarterly groundwater monitoring reports to the Department	60 days after the quarter during which sampling occurred

In addition to any locations the Permittee identifies, the Groundwater Investigation Plan shall also include a description of the installation of groundwater monitoring wells at the locations listed in Table 5 of this letter (all coordinates in this table are State Plane Coordinates in feet, NAD83). Three groundwater monitoring wells shall be installed at each of the cluster well locations listed in Table 5. The screen depths shown in Table 5 are distances (in feet) that the top of the screens shall be set below the water table. Screen lengths for wells shall not exceed 15 feet, with the exception that wells screened across the water table (those with screen depths of zero in Table 5) shall have screens 20 feet long, with no more than 15 feet of said screen length situated below the water table.

In addition to any other tools the Permittee identifies, the Groundwater Investigation Plan shall also include details describing the geophysical logging of all existing and new wells using induction (deep), neutron, and gamma (large crystal) tools. Geophysical logging at the cluster well locations listed in Table 5 is required in only the well at each location having the deepest screened interval.

Table 5. Cluster well locations and screen depths relative to the water table.

Location #	Easting	Northing	Screen Depths	Characterization Purpose
1	1542189	1476725	0, 15, 40	Plume margin
2	1541984	1476042	0, 15, 40	Plume margin
3	1543703	1476600	0, 15, 40	Plume margin
4	1543372	1475065	0, 15, 40	Plume margin
5	1543643	1477939	0, 15, 85	Leading edge and deep characterization
6	1541430	1472370	0, 15, 40	Background water quality
7	1542812	1473601	0, 15, 40	Plume margin
8	1542722	1477726	0, 15, 40	Leading edge
9	1543054	1477788	0, 15, 40	Leading edge
10	1543774	1477304	0, 15, 40	Leading edge
11	1541774	1473718	0, 15, 85	Plume core, deep delineation
12	1542362	1473801	0, 15, 85	Plume core, deep characterization
13	1542305	1474340	0, 15, 85	Plume core, deep characterization
14	1542736	1474715	0, 15, 85	Plume core, deep characterization
15	1542860	1475860	0, 15, 85	Plume core, deep characterization
16	1542189	1475207	0, 15, 85	Plume core, deep characterization
17	1541891	1473151	0, 15, 85	Plume core, deep characterization
18	1542203	1474071	0, 15, 85	Plume core, deep

				characterization
19	1542653	1475338	0, 15, 85	Plume core, deep characterization
20	1542535	1475975	0, 15, 85	Plume core, deep characterization
21	1543199	1475767	0, 15, 85	Plume core, deep characterization
22	1543068	1476494	0, 15, 85	Plume core, deep characterization

C. REQUIREMENT FOR INTERIM MEASURES

In its October 28, 2009 letter, the GWQB wrote:

> The New Mexico Environment Department (NMED) has determined, based on information generated by Kirtland Air Force Base (KAFB) during its investigations, that the scale and observed impact of the Light Non-Aqueous Phase Liquid (LNLAP) hydrocarbon contamination of groundwater associated with the SS-111 Bulk Fuels Facility constituting the majority of the KAFB ST-106 LNAPL plume has been largely defined. This plume of LNAPL hydrocarbons has been found to have contaminated groundwater over a substantial area that is the source of drinking water supplies for the City of Albuquerque and is also located in the vicinity of several public water supply wells. The volume of LNAPL hydrocarbons on groundwater, which has been estimated by KAFB to be in the millions of gallons, will take a substantial period of time to remediate. Currently, the majority of the LNAPL hydrocarbon plume is located off of KAFB property and is not being actively remediated.

The Permittee's records indicate that the LNAPL and dissolved-phase plumes have migrated horizontally a distance of about 0.5 mile and 0.9 miles, respectively, from the area of the Former Fuel Offloading Rack.

Interim measures are required to reduce or prevent the migration of contaminants, or to reduce or prevent human or environmental exposure to contaminants while long-term corrective action remedies are evaluated and implemented. Section K.1 of the HSWA Module IV of the Permit states:

> If during the course of any activity initiated under this module, the Administrative Authority determines that a release or potential release of hazardous constituents from a SWMU poses a threat to human health and the environment, the Administrative Authority may specify interim measures. The Administrative Authority will determine the specific measure, including potential permit modifications, and the schedule for implementing the required measures.

Additionally, Section K.2 of Module IV of the Permit states:

The following factors may be considered by the Administrative Authority in determining the need for interim measures.

1. Time required to develop and implement a final remedy;
2. Actual and potential exposure to human and environmental receptors; and
3. The potential for the further degradation of the medium absent interim measures.

The Department has determined that the Bulk Fuel Facility Spill poses a threat to human health and the environment, and furthermore, endangers the groundwater resource – including water supply wells – relied upon by the Albuquerque Bernalillo County Water Utility Authority for delivery of safe drinking water to its customers. The contamination also threatens KAFB water supply wells, and those that supply the Veterans Administration ("VA") Hospital. The large size of the LNAPL plume and its proximity to these water supply wells requires that urgent action be taken to prevent the LNAPL plume from contaminating more of Albuquerque's drinking-water supply.

The Permittee has estimated the volume of fuel released from the Bulk Fuels Facility to range from about 1-2 million gallons, but the actual volume could be considerably larger because characterization of the vadose zone is inadequate. For example, the Department has estimated the volume of sorbed fuel at or greater than 100 ppm in soil to be about 4.8 million gallons; this does not include fuel in soil gas, fuel dissolved in groundwater, and floating fuel forming the LNAPL plume. The Department has estimated the fuel included in the LNAPL plume to be approximately 3 million gallons, giving a total volume of fuel sorbed to soil and that contained within the LNAPL plume at nearly 8 million gallons. The Permittee's records indicate that it has installed and is operating "interim ICE SVE" units on the Permittee's property; however, these four soil-vapor extraction (SVE) units are not an adequate interim measure to address the existing ground water contamination, including the LNAPL plume that has migrated beyond the facility boundary. From April 2003 to September 2009, these SVE units have extracted an estimated 286,600 gallons of fuel. From April through September 2009, the average extraction rate has declined by 25 per cent. The average extraction rate for each SVE unit is about 2,975 gallons per month.

At the rate of extraction achieved so far by the existing SVE units, the operation of these units would take over 14 years to remove 2 million gallons of fuel. This length of time is unacceptable because additional groundwater within the capture zone of Water Utility Authority water supply wells could become contaminated before the remediation could be completed. Furthermore, should the Department's calculations prove to be more accurate than the Permittee's estimated volume of fuel, it would take over 56 years for the remediation of the fuel to be completed.

Additionally, although the Permittee knows that considerable volumes of fuel have leaked from the Former Fuel Offloading Rack, the Permittee has not removed all of the structures associated with the Former Fuel Offloading Rack (mostly the underground portions of the original structures), and has not excavated and removed contaminated soil around the Former Fuel Offloading Rack. The Permittee has instead abandoned the structures and contaminated soil in place. Soil containing considerable amounts of sorbed fuel, thus containing high concentrations of hazardous constituents, must exist at the Former Fuel Offloading Rack at shallow depths, posing a continuing source of contamination and threat to the groundwater resource.

Therefore, on or before **June 7, 2010,** the Permittee must submit to the Department for its review and approval an Interim Measures ("IM") Plan that describes what immediate actions it will take to remediate and stop the migration of the LNAPL plume. The IM Plan must also describe excavation and removal of all structures of the Former Fuel Offloading Rack, including the underground components, and the excavation and removal of contaminated soil at and in the vicinity of the Former Fuel Offloading Rack to a depth of at least 20 feet. The IM Plan must also include an implementation schedule showing that remediation of the LNAPL plume will be completed within five years of the Department's approval of the IM Plan, and that excavation and removal of structures and contaminated soil at and in the vicinity of the Former Fuel Offloading Rack will be completed within one year of the Department's approval.

Furthermore, on March 16, 2010, the Permittee sent a *Stage 2 Abatement Plan Modification Addendum* (dated March 16, 2010) concerning the proposed installation of three additional offsite groundwater monitoring wells. The March 16 submittal does not address the deficiencies identified by the GWQB in its letters of June 23 and October 28, 2009. This plan would not adequately characterize the LNAPL plume, the dissolved-phase groundwater contamination, or contaminated soil and soil gas at the Bulk Fuels Facility. However, given the urgency to complete characterization and implement an effective remedy, the NMED nevertheless approves the March 16, 2010, submittal as a second and separate interim measure, subject to the modifications described herein:

1. The March 16 plan proposes that well screens are to be constructed with lengths of 25 feet or more. Screen lengths for the wells shall not exceed 20 feet, with 15 feet of screen situated below the water table, and 5 feet of screen constructed above the water table.
2. The March 16 plan proposes that wells completed in the area of the LNAPL plume will not be developed after installation, and proposes that groundwater samples will not be acquired for laboratory analysis from wells located within the area of the LNAPL plume. Although existing wells within the area of LNAPL plume have in the past served only as sampling points to measure LNAPL thickness and as soil-vapor extraction points, these wells must now also be available to sample groundwater below the floating LNAPL so that concentrations of dissolved-phase contaminants can be assessed in this area. This same requirement will also apply to all future wells installed to address the Bulk Fuels Facility Spill, including the wells required under this letter. Thus, all wells that address the Bulk Fuels Facility Spill, including those located within the LNAPL

plume area, shall be properly developed to reduce turbidity and to remove residual drilling fluids (if any).

3. Groundwater at all wells within the LNAPL plume shall be sampled for laboratory analysis of hazardous constituents (volatile and semi-volatile organic compounds) and TPH after the wells are developed.
4. Proposed wells KAFB-10626 and KAFB-10628 shall be installed across the water table at the locations proposed in the March 16 plan. These two wells correspond to locations #5 and 13, respectively, in Table 5 above.
5. Proposed well KAFB-10627 shall be installed at location #6 listed in Table 5 above, which is a different location than that proposed by the Permittee in the March 16 submittal.
6. A tremie pipe shall be used to install the filter pack and seal for each well, and to place grout.
7. Grout shall be placed in lifts, with the first lift no greater than 100 feet in length and subsequent lifts no greater than approximately 200 feet. All lifts shall be allowed to dry until stable before the next lift is placed.
8. The March 16 plan does not contain a schedule for implementation. The March 16, 2010, plan shall be implemented **within two weeks** of approval from the City of Albuquerque to access the City property (e.g., Bullhead Park), to the extent access from the City is required for well installation. The Permittee shall otherwise implement the submittal **immediately**. All work shall be completed no later than **July 6, 2010**, or **90 days** after required access from the City is granted, whichever is later. Completion includes development of all new and existing wells that have not been previously developed, and the sampling of all wells within the LNAPL plume.
9. Sampling results (from item #3) above shall be reported to the NMED in writing on October 5, 2010, or 120 days after required access from the City is granted, whichever is later.

Table 6. Compliance Schedule for Interim Measures

Task	Date Due
Submit Interim Measures Plan to the Department	June 7, 2010
Complete excavation and removal of structures and soil at Former Fuel Offloading Rack	Within one year of approval of Interim Measures Plan
Complete remediation of LNAPL plume	Within five years of approval of Interim Measures Plan

Implement March 16, 2010 Stage 2 Abatement Plan Modification Addendum with required modifications	Immediately, except within two weeks of gaining permission for that portion of the March 16 Plan that requires access to City property.
Submit report to the Department on well installations conducted under March 16 Plan	July 6, 2010, or 90 days after required access from the City is granted, whichever is later
Submit report to the Department on groundwater sampling results conducted under March 16 Plan	October 5, 2010, or 120 days after required access from the City is granted, whichever is later

Until such time that the IM Plan is approved by the NMED, the Permittee shall continue to operate the four SVE units already in service 24 hours per day, 7 days a week, except when necessary to perform maintenance or repairs. If maintenance or repairs are necessary, the maintenance or repairs shall be completed as quickly as practicable, and the unit returned to service immediately after maintenance or repairs are completed. Any maintenance or repairs that will take more than 3 calendar days shall be reported in writing to the Department within 24 hours of discovery that the maintenance or repairs will take more than 3 days. The Permittee shall explain in the report why the maintenance or repairs will take more than 3 calendar days and why the delay is beyond the control of the Permittee.

D. REQUIREMENT TO CONDUCT A CORRECTIVE MEASURES EVALUATION

In accordance with Section M.1 of HSWA Module IV of the Permit, if the Administrative Authority has reason to believe that a SWMU has released concentrations of hazardous constituents, or if the Administrative Authority determines that contaminants present a threat to human health and the environment given site-specific exposure conditions, the Administrative Authority may require a Corrective Measures Study (herein referred to a Corrective Measures Evaluation, or "CME"). With this letter, the Department hereby notifies the Permittee that it is required to conduct a CME for the Bulk Fuels Facility Spill. The CME shall be conducted to develop remedial alternatives that, if implemented, would be appropriate to effectively arrest and remediate contamination in the vadose zone, the LNAPL plume, and the dissolved-phase groundwater contamination in a reasonable period of time. A CME Report shall be prepared that describes in detail the results of the CME. The CME Report shall be submitted to the Department within 180 days after the Department notifies the Permittee that characterization of the Bulk Fuels Facility Spill has been completed and approved by the Department. The CME and CME Report shall also be completed in accordance with Sections O and S of HSWA Module IV of the Permit.

E. REPORTING REQUIREMENTS

The investigation plans required under this letter shall include relevant maps and cross-sections that show concentration data for contaminants and other relevant information with supporting data posted on the maps and cross-sections in a legible manner, and clearly showing which borings/wells contributed data towards construction of the maps and cross-sections and which did not. Tables including all existing soil borings, soil-gas monitoring wells, and groundwater monitoring wells, listing their surveyed location, sampling points and maximum depth of exploration shall also be included in the reports and plans. For soil-gas monitoring wells, tables and graphs shall also be included providing trends of TPH concentrations versus time for the depths below ground surface of 25, 50, 150, 250, 350, and 450 feet.

F. CONCLUSIONS

The requirements in this letter to conduct corrective action at the Bulk Fuel Facility Spill are mandatory. If the Permittee fails to comply with the directives of this letter, the Department may take the following actions, or some combination of the following actions, to enforce these requirements: 1) issue a compliance order under section 74-4-10 of the HWA seeking injunctive relief or civil penalties for noncompliance; 2) file a civil action under sections 74-4-10 and 74-4-10.1(E) of the HWA or section 7002(a) of RCRA, 42 U.S.C. § 6972(a), seeking injunctive relief or civil penalties; or 3) file an action seeking criminal penalties under section 74-4-11 of the HWA. This list of authorities is not exhaustive and NMED reserves its rights to take any action authorized by law to enforce the requirements of the HWA and the HWMR.

The Permittee shall respond directly to my attention, with copy to Mr. Bill Olson of the GWQB, and Mr. William Moats (NMED HWB, 5500 San Antonio NE, Albuquerque, NM 87109), on all correspondence and required plans and reports related to the Bulk Fuels Facility Spill upon receipt of this letter, unless otherwise directed by HWB. All submittals and correspondence must be submitted in hardcopy and electronic format. Assessment of fees for the submittal of corrective action documents pursuant to 20.4.2. NMAC shall be made under separate cover.

If you have any questions or comments concerning the technical matters in this letter, you may contact William McDonald or Sid Brandwein of my staff at (505) 222-9582 and (505) 222-9504, respectively. If you have other questions or comments, I may be contacted directly at 505-476-6000.

Sincerely,

James P. Bearzi
Chief
Hazardous Waste Bureau

cc: M. Leavitt, Director, NMED WWMD
J. Kieling, NMED HWB
W. Moats, NMED HWB
B. McDonald, NMED HWB
S. Brandwein, NMED HWB
B. Olson, Chief, NMED GWQB
A. Puglisi, NMED GWQB
B. Swanson, NMED GWQB
L. Barnhart, NMED OGC
B. Gallegos, AEHD
B. Gastian, ABCWUA
L. King, EPA-Region 6

File: Reading and KAFB 2010

ATTACHMENT 2

August 6, 2010 Correspondence from the NMED HWB to Colonel Robert L. Maness, Base Commander, 377 ABW/CC, regarding SWMUs ST-106 and SS-111, BFF Spill, Kirtland, AFB

Directive for Conducting Interim Measures and Notice of Disapproval, Interim Measures Work Plan, June 2010 Vadose Zone Work Plan, June 2010 Groundwater Investigation Work Plan, June 2010

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NEW MEXICO
ENVIRONMENT DEPARTMENT

Hazardous Waste Bureau

BILL RICHARDSON
Governor

DIANE DENISH
Lieutenant Governor

2905 Rodeo Park Drive East, Building 1
Santa Fe, New Mexico 87505-6303
Phone (505) 476-6000 Fax (505) 476-6030
www.nmenv.state.nm.us

RON CURRY
Secretary

SARAH COTTRELL
Deputy Secretary

CERTIFIED MAIL - RETURN RECEIPT REQUESTED

August 6, 2010

Colonel Robert L. Maness
Base Commander
377 ABW/CC
2000 Wyoming Blvd. SE
Kirtland AFB, NM 87117-5606

Mr. John Pike
Director, Environmental Management Section
377 MSG/CEANR
2050 Wyoming Blvd., Suite 116
Kirtland AFB, NM 87117-5270

RE: BULK FUELS FACILITY SPILL, SWMUS ST-106 AND SS-111
DIRECTIVE FOR CONDUCTING INTERIM MEASURES AND NOTICE OF DISAPPROVAL
INTERIM MEASURES WORK PLAN, JUNE 2010;
VADOSE ZONE WORK PLAN, JUNE 2010;
GROUNDWATER INVESTIGATION WORK PLAN, JUNE 2010
KIRTLAND AIR FORCE BASE, EPA ID# NM9570024423
HWB-KAFB-10-015, HWB-KAFB-10-016, HWB-KAFB-10-019

Dear Col. Maness and Mr. Pike:

The contamination caused by the Bulk Fuels Facility Spill at Kirtland Air Force Base (KAFB) represents a significant threat to human health and the environment, particularly to well water that supplies drinking water to portions of Albuquerque, KAFB, and the Veterans' Administration Hospital. Even though this release was first discovered 10 years ago, the U. S. Air Force (Permittee) has not characterized the nature and extent of Bulk Fuels Facility Spill, nor conducted adequate remediation. The threat posed by this release demands immediate and aggressive action as called for in the New Mexico Environment Department's (NMED's) April 2, 2010 letter.

The NMED has reviewed the Interim Measures Work Plan (June 2010), Vadose Zone Work Plan (June 2010), and Groundwater Investigation Work Plan (June 2010) regarding the KAFB Bulk Fuels Facility Spill, Solid Waste Management Units (SWMUs) ST-106 and SS-111. The plans were submitted in response to the NMED's letter of April 2, 2010, which concerned the need for additional site characterization and interim measures to remediate contamination in groundwater, source areas, and fuel floating on the water table.

NMED finds that all three plans are deficient. This Notice of Disapproval (NOD) is issued to the Permittee with the intent that the Permittee correct the deficiencies identified herein. This NOD includes general comments that apply to all three documents, and general and specific comments concerning deficiencies found in each of the individual plans. These comments comprise Part 1 of this letter.

Due to the urgent need to accelerate certain aspects of remediation and characterization, the Permittee is also directed herein to implement interim measures in the form of additional soil vapor extraction and to take various other actions including establishing sentry groundwater monitoring wells and providing NMED certain critical information. This direction comprises Part 2 of this letter, and also sets forth requirements related to well construction, sampling of environmental media, field and laboratory quality assurance, and reporting.

PART 1

A. Deficiencies Common to All Three Plans

1. Appendix A of the Vadose Zone and Interim Measures Work Plans and Appendix D of the Groundwater Investigation Work Plan – Appendix A and Appendix D are exactly the same plan (about 500 pages, dated April 2004), appended to and occupying 80% or more (by number of pages) of the Vadose Zone, Interim Measures, and Groundwater Investigation Work Plans. Although the plan presented in Appendices A and D is voluminous, it is only a general plan that lays out the Permittee's internal requirements for conducting corrective action for the entire base. Furthermore, the copies of this plan provided to the NMED are missing figures (Figure 3-4), have their own appendices that are noted as "to be provided at a later date", and, in places, have outdated information (Table B7.2-1, page B-177 of Appendix B of Appendix A).

Because Appendices A and D are not specific to the Bulk Fuels Facility Spill, they do not describe in sufficient detail how, for example, project organization, data management, and quality assurance will be implemented under the Vadose Zone, Groundwater Investigation, and Interim Measures Work Plans. For example, under the project management plan, the organizational chart only shows KAFB management. The field sampling plan discusses the various types of field quality control (QC) samples that could be utilized during an investigation, but does not set forth the specific types of QC samples that should be prepared or collected for the Bulk Fuels Facility Project. Furthermore, because it is only a general plan for the entire base, the plan does not commit to the collection of QC samples for any project.

Appendices A and D must be deleted from the Vadose Zone, Groundwater Investigation, and Interim Measures Work Plans. They have little value because they do not contain the appropriate level of detail for characterization and clean up of the Bulk Fuels Facility Spill and do not commit the Permittee to do anything. The Permittee shall revise the Vadose Zone, Groundwater Investigation, and Interim Measures Work Plans to include the appropriate level of detail and commitment on project organization, data management, and field and laboratory quality assurance.

2. Appendix B of the Vadose Zone and Interim Measures Work Plans and Appendix A of the Groundwater Investigation Work Plan – These appendices include only a 2006 NMED guidance document. The guidance is outdated and adds little, if any, value to the Vadose Zone, Interim Measures, and Groundwater Investigation Work Plans, and thus, must be deleted from all three plans. NMED guidance documents may be cited, if necessary, in future submittals.
3. Community Relations - The community relations plan is not included in Appendix A of the Vadose Zone and Interim Measures Work Plans and Appendix D of the Groundwater Investigation Work Plan. Instead, the appendices state "*Appendix I, Community Relations Plan, (to be provided at a later date)*". The Permittee shall revise the Vadose Zone, Interim Measures, and Groundwater Investigation Work Plans to include a community relations plan specific to the Bulk Fuels Facility spill. The plan must specify how the Permittee will inform the public, including the Albuquerque Bernalillo County Water Utility Authority (WUA), the City of Albuquerque, and the Veterans Administration of progress made on characterization and clean up of the Bulk Fuels Facility spill.

4. Schedules – Characterization and clean up of the Bulk Fuels Facility Spill is expected to be a large, complex, and interactive project with many deadlines that will have to be met by the Permittee. The Gantt charts provided in the Interim Measures, Groundwater Investigation, and Vadose Zone Work Plans do not contain sufficient detail and are unacceptable because they over simplify field work on the schedules as only a few tasks. A Gantt chart showing all major tasks, their dependency if any on other tasks, and their early/late starts, early/late completions and critical paths must be provided in each of the plans. NMED expects that charts of sufficient detail would likely require presentation on sheets larger than 11" x 17".

The Permittee must also submit to the NMED a Gantt chart that integrates all of the work to be done under the three plans. This Gantt chart must be submitted with the Vadose Zone Work Plan.

5. Organization - The organization plans in the Interim Measures, Groundwater Investigation, and Vadose Zone Work Plans only include mention of a project manager and a field team manager, and again reference the general site plan under Appendix A of the Vadose Zone and Interim Measures Work Plans and Appendix D of the Groundwater Investigation Work Plan. NMED notes that there are personnel mentioned by name under the Project Management Plan of Appendix A and Appendix D that have not worked for the Permittee at KAFB for the last several years.

It is likely that more than a project manager and a field team manager will be required to manage and execute a project of this size and complexity. Furthermore, it is unclear if there will be a separate field team manager for different tasks, such as conducting geophysical logging, drilling and installation of wells, operating and maintaining soil vapor extraction (SVE) units, and sampling of environmental media. Also, the plans do not include details on the responsibilities and the qualifications of the personnel (by position) that will be involved.

Simply stating that a kick off meeting " ...will outline roles and responsibilities of all participants..." is not acceptable. It must be clearly understood in writing prior to project start who (by position) will be responsible for overseeing and conducting the myriad of events that need to happen such as field work, interpretation and management of various data, data validation, updating of the conceptual site model, communicating and reporting, and so forth. The Permittee must revise the Interim Measures, Groundwater Investigation, and Vadose Zone Work Plans to correct these deficiencies.

6. Data Management **-** The Data Management Plan provided in Appendix D of Appendix A of the Vadose Zone and Interim Measures Work Plans and Appendix D of Appendix D in the Groundwater Investigation Work Plan is a general plan for entire base (see Comment #1 of Section A, Part 1) and, thus, is not specific to the Bulk Fuels Facility Spill. The plan specifically fails to provide detail concerning the types of data that are to be managed, schedules for data submittals and entries into the database, how accuracy and completeness of the data will be ensured, and data availability to the NMED. The Permittee must revise the Interim Measures, Groundwater Investigation, and Vadose Zone Work Plans to correct these deficiencies.

7. Identification of and Approach to Addressing Data Gaps **-** Section 1.2 of each of the plans states "following previous investigations at the BFF, data gaps were identified...". Because these work plans are meant at a minimum to address data gaps identified in NMED's letter of April 2, 1010, the Permittee must list the data gaps that apply to each of the three plans, as appropriate for the topic of the plan, and indicate where in each of the plans the data gaps are addressed. The Permittee must revise the Interim Measures, Groundwater Investigation, and Vadose Zone Work Plans to include a description of the data gaps identified by the NMED and point specifically to where in each the document these data gaps are addressed.

8. Extent of Contamination and Clean Up Criteria **–** The extent of contamination in the various media (soil, soil vapor, groundwater) shall be based upon determining at what locations hazardous constituents occur at levels that exceed approved background concentrations. This was stated in the NMED's letter of April 2, 2010, and applies to all RCRA facilities in New Mexico that must conduct correction action.

Regarding clean up criteria, any soil contamination left in place within 20 feet of the surface must meet NMED's risk requirements for an acceptable level of risk for all hazardous constituents (10^{-5} for carcinogens and Hazards Index < 1 for noncarcinogens under a residential land-use scenario). Any soil contamination left in place at any depth must also have sufficiently low concentrations of hazardous constituents to be protective of groundwater. The Permittee may use the NMED's Soil Screening Levels in lieu of conducting a baseline risk assessment to determine the risk of contaminants.

While the use of total petroleum hydrocarbons (TPH) as an indicator of contamination is convenient for field screening, the risk to human health and the environment must be assessed through the use of laboratory analysis of hazardous constituents (e.g., benzene, toluene, ethylene dibromide (EDB), naphthalene, xylenes). The Permittee must revise the Interim Measures, Groundwater Investigation, and Vadose Zone Work Plans accordingly.

9. Site Specific Conceptual Model - The plans continue to provide what appears to be an outdated conceptual model of geologic, hydrologic, and contaminant conditions. However, regardless of the use of current data or the lack thereof, graphical representations of the conceptual model are of poor quality because the graphics are not always legible, are often too small to convey details, don't present sufficient numbers of cross-sections, and rely too much on the presentation of cartoons in lieu of detailed and accurate drawings (for example, Figures 2-8 and 2-9 in the Groundwater Investigation Work Plan).

NMED expected more in the discussion of site specific geology, as what was provided is similar to that presented in reports for the last 8 years or so. A site conceptual model encompassing the source area(s), the fuel percolation area, the light non-aqueous phased liquid (LNAPL) plume floating on groundwater, and the dissolved-phase contaminant plume in groundwater must be included in each of the plans. The model should be illustrated through the liberal use of detailed, accurate, and scaled geologic cross-sections, maps in plan view, and any other necessary graphical representations to clearly and accurately show geologic and hydrologic features, and contaminant levels.

NMED suggests that the geophysical logs, especially the electric logs, for KAFB-0115, KAFB-10624, KAFB-16 and Ridgecrest-3 wells would be useful for assisting in the interpretation of the stratigraphy of the area of interest, as these logs clearly show certain stratigraphic horizons in the vadose zone that are distinctive and widespread units ("marker beds"). The site-specific conceptual model in the Interim Measures, Groundwater Investigation, and Vadose Zone Work Plans must be revised to correct the above noted deficiencies.

10. Failure to Provide Graphics and Data Submittals – Section E of NMED's April 2, 2010 letter states "The investigation plans required under this letter shall include relevant maps and cross-sections that show concentration data for contaminants and other relevant information with supporting data posted on the maps and cross-sections in a ***legible*** (emphasis added) manner, and clearly showing which borings/wells contributed data towards construction of the maps and cross-sections and which did not. Tables including all existing soil borings, soil-gas monitoring wells, and groundwater monitoring wells, listing their surveyed location, sampling points and maximum depth of exploration shall also be included in the reports and plans. For soil-gas monitoring wells, tables and graphs shall also be included providing trends of TPH concentration versus time for the depths below ground surface of 25, 50, 150, 250, 350, and 450 feet."

Many of the figures in the Interim Measures, Groundwater Investigation, and Vadose Zone Work Plans are illegible and the required tables and graphs were not included, or were not provided in the format required. These tables and graphs are necessary to assess the adequacy of proposed locations of borings/wells/SVE units. These tables and graphs of the required types, formats, and in legible form must be included in the revised Interim Measures, Groundwater Investigation, and Vadose Zone Work Plans.

11. Quality Assurance (QA)/Quality Control (QC) plan - The Quality Assurance Plan provided in Appendix D of Appendix A (or Appendix D of Appendix D in the GW Plan) is a general plan for the entire base (see Comment #1, Section A, Part 1 of this letter) and is not specific to the Bulk Fuels Spill Project. The Interim Measures, Groundwater Investigation, and Vadose Zone Work Plans must specify exactly what field and laboratory quality control samples are to be prepared or collected, as appropriate, and other aspects about quality control that are important to the Bulk Fuels Facility project, including the quality control targets that will be considered acceptable for each of the analytes of concern for each given media. The Permittee must revise the Interim Measures, Groundwater Investigation, and Vadose Zone Work Plans to correct these deficiencies.

12. Certification Statements - The Vadose Zone, Interim Measures, and Groundwater Investigation Work Plans and associated transmittal letters do not contain the required signed certification statement under RCRA and the New Mexico Hazardous Waste Act. Pursuant to 20.4.1.900 NMAC, incorporating 40 C.F.R. § 270.1 1 (d)(1), all plans and reports shall include a certification, signed by a chief or senior executive officer of the Facility stating:

> I certify under penalty of law that this document and all attachments were prepared under my direction or supervision according to a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

The revised Vadose Zone, Interim Measures, and Groundwater Investigation Work Plans or associated transmittal letters must include this signed certification.

13. Waste Management - The Waste Management Plan provided in Appendix E of Appendix A of the Vadose Zone and Interim Measures Work Plan, and Appendix E of Appendix D in the Groundwater Investigation Work Plan) is a general plan for entire base (see Comment #1, Section A, Part 1 of this letter) and is not specific to the Bulk Fuels Facility Spill project.

Investigation Derived Waste (IDW) includes, but is not limited to, general refuse, drill cuttings, excess sample material, water (e.g., decontamination, development, purge), spent materials, and used disposable equipment generated during the course of investigation, corrective action, or monitoring activities. All IDW shall be properly characterized and disposed of, and otherwise managed in accordance with all federal, state, and local laws and regulations. The Permittee shall include a description of the anticipated IDW management process as a revision to the Interim Measures, Groundwater Investigation, and Vadose Zone Work Plans.

B. Interim Measures Work Plan

1. General Comments on Interim Measures Work Plan

The Interim Measures Work Plan was to address two major requirements of NMED's letter of April 2, 2010: 1) remove the Fuel Offloading Rack and excavate to a depth of 20 feet contaminated soil surrounding the Fuel Offloading Rack; and 2) conduct interim measures to remediate the LNAPL plume within five years. This Part (Part 1) of this letter addresses the deficiencies on addressing the first requirement; Part 2 addresses the second requirement to immediately take action to remediate the LNAPL plume floating on the groundwater. Rather than complying with NMED's April 2, 2010 direction to take immediate action vis à vis LNAPL remediation, the Permittee proposes characterization of the vadose zone for some unspecified time period, followed later by SVE. More specifically, the Interim Measures Work Plan includes: testing six wells to determine LNAPL transmissivity (Tn); conducting air sparging and multi-phase extraction pilot tests, and conducting characterization studies using PneuLog tests.

NMED emphasizes that interim measures are actions quickly taken to reduce or prevent the migration of contaminants, or reduce or prevent exposure to contaminants while long-term remedies are evaluated. While characterization studies may be useful for improving remediation efforts, or for proposing and designing a final remedy, interim measures for remediating LNAPL floating on groundwater need to be implemented immediately. Any effort to successfully remove LNAPL floating on groundwater must also involve the removal of LNAPL from the source(s) and fuel percolation areas within the vadose zone.

2. Specific Comments on Interim Measures Work Plan

1. Page 2-10, Section 2.4 – This section of the plan indicates that the Permittee is preparing a report on indoor air quality, and that the report is currently in draft. A copy of the final indoor air quality report must be provided to the NMED by **October 6, 2010**, and as indicated in the Compliance Schedule of Table 5 of this letter.
2. Page 3-1, Section 3 - Throughout Section 3 (for example, Sections 3.2, 3.2.2, 3.4.1, 3.4.2, 3.5) the Permittee states its intent to characterize and excavate only soils with "mobile LNAPL", and to leave any other contaminated soil for later remediation under the Corrective Measures Implementation Plan (CMI), which the Permittee referred to as a Corrective Measures Evaluation (CME). The term "mobile LNAPL" was coined by the Permittee and apparently means soil containing such a high concentration of fuel contamination that the soil is dripping wet with fuel.

The reasons given by the Permittee not to excavate other contaminated soils (soil without mobile LNAPL) is that a risk assessment would have to be developed separately for such soils, and the Permittee expresses its desire to delay excavation of such soils until long-term corrective actions are initiated for the site. Due to the urgent need for action at this site, such an approach is not acceptable. The Permittee can rapidly develop target clean up goals based on NMED's risk requirements noted above, or simply use NMED's soil screening levels for hazardous constituents. Soils do not need to be dripping wet with fuel to pose a risk to human health or the environment. NMED estimates that a Corrective Measures Implementation Plan will not be approved for at least several years because of the inadequate state of site characterization today. Leaving contaminated soil in the ground that poses a significant risk to human health or the environment for what will likely be a fairly long time period before long-term corrective actions are initiated is unacceptable. As indicated in Comment #8 in Section A of Part 1 of this letter, all contaminated soil to a depth of 20 feet that represents an unacceptable risk to human health or the environment shall be excavated and removed from the Fuel Offloading Rack area.

As mentioned above, due to the urgent need to accelerate remediation, the Permittee is directed in Part 2 of this letter to implement interim measures, which includes removal of the remaining components of the Fuel Offloading Rack and excavation of contaminated soil. This work shall be completed in accordance with the Interim Measures Work Plan as modified by the requirements of this letter and in accordance with the Compliance Schedule in Table 5 of this letter.

3. Page 3-2, Section 3.2.2 – This section indicates that soil samples will be analyzed in the laboratory only if samples do not respond to a field test kit. This is an unacceptable approach. The Permittee shall use laboratory analysis all soil samples in shallow borings for TPH, VOCs, SVOCs, and lead.

4. Page 3-4, Section 3.4.2 – This section indicates that a detailed excavation plan for the Fuel Offloading Rack will be submitted to the NMED at a later date. NMED's April 2, 2010 letter intended for the Interim Measure Work Plan to be the detailed plan.

The excavation of contaminated soil and removal of structures at the Fuel Offloading Rack is a relatively simple "dig and haul" operation, and represents by far the easiest of the two major interim measures that the Permittee was directed to accomplish in NMED's letter of April 2, 2010. NMED requires the Permittee to begin excavation and removal of structures at the Fuel Offloading Rack immediately (see Section A of Part 2 of this letter).

5. Page 4-1, Section 4.2 – In part, this section states "Kirtland AFB proposes to install an IRM to remove, to the extent practicable within five years of work plan approval, mobile LNAPL present at the water table that has the potential to migrate along the water table and potentially further endanger the regional aquifer that provides drinking water for ABCWUA. Immobile LANPL and sorbed and dissolved fuel contamination in groundwater will be addressed by the future CME."

The NMED finds several unacceptable concepts related to these statements. First, as previously mentioned, NMED does not agree with the Permittee-coined terms "mobile LNAPL" and "immobile LNAPL." The point of the interim measure is to clean up contamination (LNAPL) that poses a threat to groundwater, regardless of contaminant concentrations. Even LNAPL that is not migrating along the water table has the potential to contaminate groundwater with concentrations of hazardous constituents that are at unsafe levels for human consumption. Second, the phrase "to the extent practicable" suggests that the Permittee has already admitted defeat without even attempting to clean up the groundwater and the floating LNAPL. Third, the LNAPL floating on the water table endangers water supply wells in addition to those operated by the WUA. Lastly, like the cleaning up of contaminated soil around the Fuel Offloading Rack, the Permittee is stating its desire to delay clean up for at least several years while a final remedy through an approved CMI Plan is implemented, which is unacceptable. The Permittee must revise the Interim Measures Work Plan to remove the above-noted deficiencies.

6. *Page 4-4, Section 4.6* - In the last paragraph the Permittee states that "Routine system optimization will be performed ... to maintain the highest mass extraction rate..."

The Permittee shall revise this section to explain in detail how the system will be optimized.

7. *Page 5-1, Section 5* - The Permittee states: "Vadose zone interim remedial measures will be implemented if data collected during the PneuLog profiling, supplemented by results of the concurrent vadose zone investigation, identify the presence of potentially mobile LNAPL within the vadose zone."

As mentioned above, the NMED does not agree with the Permittee-coined terms "mobile LNAPL" and "immobile LNAPL." It should be inarguable that fuel infiltrated from near or at the ground surface and has percolated through the vadose zone to groundwater. Some fuel is likely still draining to groundwater. However, hazardous constituents can still migrate to groundwater as vapor even in areas where the draining of liquid fuel to groundwater has stopped or never took place. The Permittee must revise the Interim Measures Work Plan to indicate that remediation of the vadose zone will be conducted to accomplish clean up of LNAPL floating on the groundwater, regardless of whether fuel-saturated conditions exist in the vadose zone in a given area.

8. *Page 5-2, Section 5.2* - The fourth paragraph states: "PneuLog will be performed at three locations...starting from the point(s) of release to the water table."

Figure 5-1 shows the proposed locations for PneuLog testing about 750 feet northeast of the Fuel Offloading Rack and approximately 750 feet north of the southern extent of the LNAPL plume that is floating on groundwater. According to the conceptual model provided in the Interim Measures Work Plan, the proposed locations for PneuLog testing could lead to missing the path of percolation that the fuel took to groundwater.

The Permittee must revise the Interim Measures Work Plan to include some PneuLog testing in the fuel percolation area. See Comment #4 in Section C of Part 1 of this letter for information on the area NMED has identified as the fuel percolation area. Indicate also in the Interim Measures Work Plan the significance of using three locations for PneuLog testing and explain in more detail how the air flow potential of the geologic units will be assessed and used in the design to optimize SVE.

The Interim Measures Work Plan shall also be revised to indicate that geologic and geophysical (induction, gamma, and neutron) logs will be made for the boreholes used for PneuLog testing.

9. *Figures.* Figures 2-2 through 2-5 are very difficult, and in some cases impossible to read. Cross-section A-A' is not the view seen in Figure 2-8.

The Permittee shall revise the Interim Measures Work Plan to include corrected and legible figures.

C. Vadose Zone Work Plan

1. General Comments on Vadose Zone Work Plan

In NMED's letter of April 2, 2010, the Permittee was directed to submit a Vadose Zone Investigation Plan that describes the additional actions the Permittee will take to investigate vadose zone hydrology and geology, to identify and characterize the source of the releases at the Bulk Fuel Facility, and to identify the extent of soil and soil-gas contamination in the vadose zone from the surface to groundwater. The Vadose Zone Plan was to describe in detail all research, locations, depths and methods of exploration, field procedures, sampling and analysis of soil and soil gas and related quality control procedures, the results and the means by which the results are to be reported, and a schedule of the work.

The Vadose Zone Work Plan that has been submitted is inadequate to accomplish the objectives established in NMED's letter of April 2, 2010. A major reason is that the proposed borings and soil-vapor wells are located too far apart to characterize in adequate detail the contaminant and geologic conditions in the vadose zone. NMED therefore directs herein a general increase in the number of sampling points. The Permittee shall revise the Vadose Zone Work Plan to include all of the soil borings and soil-vapor well installations required by this letter.

For the convenience of providing further discussion in this letter, NMED has divided the vadose zone into five principal areas: the tank farm, pipeline, Fuel Offloading Rack, fuel percolation area, and the far field area of the soil-vapor plume. Each of these areas is discussed below.

1. Tank Farm – Contamination is known to occur from the surface to deep levels at the Tank Farm. In its letter of April 2, 2010, NMED directed that nine deep soil borings/soil-vapor wells be completed in the tank farm area; the Permittee proposed only three. Through its direction in it April 2, 2010 letter, NMED was hoping to avoid the time-consuming process of "dickering" with the Permittee on numbers of borings (and wells, to be discussed later). Nevertheless, in the interest of comity and upon further consideration, NMED agrees that by adjusting locations and completing some shallow borings, the tank farm area could be covered at least initially by five deep soil borings/soil-vapor wells and five shallow soil borings. Depending on what is found, additional soil borings/soil-vapor wells may be needed, and NMED reserves its rights to require such additional borings, wells, or both in the future.

The Permittee shall complete the soil borings/soil-vapor wells at locations #16, 17, 19 and 20; and the soil vapor well at location #6 that are listed in Tables 1 and 2 of this letter, respectively, and shown on Figure 1 enclosed with this letter. The Permittee shall also complete shallow soil borings to a depth of at least 20 feet at locations #1 through 5, which are listed in Table 3 of this letter and shown also on Figure 1. Soil samples from the shallow borings shall be collected at depths of 0, 5, 10, 15, and 20 feet and shall be analyzed for TPH, VOCs, SVOCs, and lead.

2. Pipeline – The Permittee has not investigated the pipeline that runs between the tank farm, the pump house, and the Fuel Offloading Rack. In NMED's letter of April 2, 2010, the Permittee was directed to complete four deep soil borings/soil-vapor wells along the buried and exposed portions of the pipeline. The Permittee proposed none.

In lieu of completing deep soil borings/soil-vapor wells, the Permittee proposed to complete shallow borings along the buried portion of the pipeline extending south of the pump house. However, the Vadose Zone Work Plan is unclear as to the number of shallow boreholes that would be completed. Additionally, the proposed plan is inadequate because the entire length of pipeline between the tank farm and the Fuel Offloading Rack is not included in the investigation.

The Permittee shall complete the deep soil borings/soil-vapor wells at locations #4, 6, 7, 8, and 24 that are listed in Table 1 of this letter and shown on Figure 1. The Permittee shall also complete shallow borings along the entire length of the pipeline between the tank farm and the Fuel Offloading Rack, regardless of whether the pipeline runs underground or on the surface. The borings shall be spaced at intervals not to exceed 25 feet and are to be located on both sides of the pipeline. Soil samples from the shallow borings shall be collected at depths of 0, 5, 10, 15, and 20 feet. The soil samples from deep and shallow borings shall be analyzed for TPH, VOCs, SVOCs, and lead. Depending on the results, NMED may require further investigation of this area, including more and deeper borings.

3. Fuel Offloading Rack – The Fuel Offloading Rack is supposedly the main source of the fuel spill, but it has not been adequately characterized since discovery of the fuel leak 10 years ago. Previous investigative efforts appear to have been arbitrarily terminated once TPH concentrations were found to be less than 100 mg/kg in soil and below 100 ppmv in soil vapor. In NMED's letter of April 2, 2010, the Permittee was directed to complete a ***minimum*** of six deep soil sampling/vapor wells at the Fuel Offloading Rack to determine the full extent of contamination; the Permittee proposed four. NMED reaffirms its previous direction. The Permittee shall complete the soil borings/soil-vapor wells at locations #1, 2, 3, 4, 11, and 12 that are listed in Table 1 of this letter and shown in Figure 1.

4. Fuel percolation area – This area, east of the Fuel Offloading Rack, is currently believed to constitute the core of the contamination in the vadose zone, and represents the place where fuel presumably migrated to groundwater. In NMED's letter of April 2, 2010, the Permittee was directed to complete a ***minimum*** of six deep soil sampling/vapor wells in order to significantly improve characterization of this area. This is critical to understanding the amount of fuel contamination in the vadose zone that must be remediated. The Permittee proposed to complete only two of the deep soil sampling/vapor wells that the NMED specified.

The Permittee did, however, propose an additional 3 deep soil sampling/vapor wells at locations further to the east. NMED agrees that these latter locations are necessary to properly characterize this area. Thus, to improve the understanding of the amount of fuel contamination in the vadose zone that must be remediated, the Permittee shall complete the soil borings/soil-vapor wells at locations #5, 9, 10, 21, 22, 23, 25, 26, and 27 listed in Table 1 and shown on Figure 1.

5. Far field area of Soil-Vapor plume – In its letter of April 2, 2010, NMED directed the Permittee to install six soil-vapor wells at locations north of the Fuel Offloading Rack and fuel percolation area to investigate the concentrations of hazardous constituents in soil gas that overlies groundwater in these areas. The Permittee shall complete the soil-vapor wells at locations #1, 2, 4, 3, 5, 6, 8, and 9; and the soil boring/soil-vapor well at location #24, that are listed in Tables 2 and 1, respectively, and shown on Figure 1.

6. Sampling Requirements Applicable to all Five Vadose Zone Areas - Soil samples from the deep borings shall be collected at a frequency of at least one sample every 10 feet for the first 50 feet, and at least one sample thereafter every 50 feet to total depth, and at least one sample at total depth in each boring. Each deep boring at each location shall be drilled from the surface to the water table, and each deep boring shall be completed as a permanent soil-gas monitoring well. The soil-gas monitoring wells shall be capable of yielding discrete samples of soil gas recovered from depths of 25, 50, 150, 250, 350, and 450 feet below the ground surface.

All boreholes that will have soil-vapor monitoring wells constructed in them shall be logged using induction (medium and deep), neutron, and gamma tools. Geologic logs shall also be prepared for these boreholes showing the geologic conditions from the surface to the total depth of each borehole.

The coordinates in Tables 1-3 are State Plane Coordinates in feet, NAD83. All boring/soil vapor well locations are also shown on Figure 1 enclosed with this letter.

Table 1. Borehole Locations for Soil Sampling and for Conversion to Soil-Vapor Monitoring Wells.

Location #	Easting	Northing	Characterization Purpose
1	1541119	1473793	Step out from Fuel Offloading Rack
2	1540808	1473503	Step out from Fuel Offloading Rack
3	1541123	1473310	Step out from Fuel Offloading Rack
4	1541425	1473313	Step out from Fuel Offloading Rack and piping

5	1541961	1473492	Fuel percolation area
6	1542002	1473057	Piping
7	1541794	1473061	Piping
8	1542370	1473058	Piping
9	1541898	1473276	Fuel percolation area
10	1541720	1473369	Fuel percolation area
11	1541776	1473740	Step out from Fuel Offloading Rack
12	1541658	1473505	Fuel percolation area and Fuel Offloading Rack
16	1541992	1472768	Fuel tanks
17	1542229	1472916	Fuel tanks
19	1542485	1472911	Fuel tanks
20	1542428	1472716	Fuel tanks
21	1541611	1473238	Fuel percolation area
22	1542137	1473266	Fuel percolation area
23	1542131	1473571	Fuel percolation area
24	1541620	1472955	Far Field and piping
25	1542807	1473592	Fuel percolation area
26	1542422	1473506	Fuel percolation area
27	1542360	1473808	Fuel percolation area

Table 2. Locations for Soil-Gas Monitoring Wells.

Location #	Easting	Northing	Characterization Purpose
1	1542900	1474092	Far Field
2	1543194	1474680	Far Field
3	1542306	1474093	Far Field
4	1541555	1475049	Far Field
5	1541248	1474141	Far Field
6	1542259	1472591	Far Field and fuel tanks
8	1542504	1475414	Far Field
9	1542436	1474878	Far Field

Table 3. Locations for Shallow Soil Borings in Tank Farm Area.

Location #	Easting	Northing
1	1542544	1472810
2	1542282	1472806
3	1542125	1472784
4	1542081	1472959
5	1541941	1472867

The Permittee shall revise the Vadose Zone Work Plan to incorporate the general comments and correct the deficiencies noted above.

2. Specific Comments on Vadose Zone Work Plan

1. Downhole Geophysical Logging - Section 3.2.1.1, Table 3-1, Topic 3, states "If proposed vapor monitoring points are screened in zones determined to be fine grained lithologic units adjust the screen location vapor monitoring points up or down to the nearest coarser grained unit."

Because individual fine grained or coarse grained beds do not necessarily extend laterally for any significant distances, any geophysical logs used to adjust screen locations must be generated for that particular borehole.

The Permittee must revise the Vadose Zone Work Plan to indicate the maximum distance that screened zones are to be adjusted from the required screen depths should adjustment be necessary. For screens that are to be set 100 feet apart as directed under this letter, the Permittee may adjust screens by no more than 25 feet. For screens that are to be set 25 feet apart, the Permittee may adjust screens by no more than 5 feet.

2. Seismic Refraction, Section 3.2.1.2 - NMED encourages the use of geophysical techniques; however, NMED is doubtful that seismic refraction will prove useful in this case. NMED is concerned that refraction will only detect shallow loose material near the surface, somewhat more dense subsurface material, and saturated material beginning at the water table. Although KAFB is free to conduct the refraction survey, the NMED will not allow such survey to delay completion of other work required for characterizing and cleaning up the Bulk Fuels Facility Spill.

If the Permittee proceeds with conducting the refraction survey, the following issues must be addressed in the revised work plan.

A. Explain why seismic refraction was chosen and not shallow reflection.

B. Explain how seismic refraction is expected to identify the difference between a fine-grained unit and a coarse-grained unit above the saturated zone at depths of 450-500 feet (see DQO step 5 for topic 1 on Table 3-1). Table 3-1, DQO step 6, topic 1 implies that refraction will be able to define a unit within 1-foot depth at a depth of 500 feet. These Data Quality Objectives cannot likely be achieved.

C. If the 1-foot depth is actually referring to the location of geophones, specify what the QC targets are for the seismic survey (for example, how close should the interpreted seismic interface be to the actual depth to water). Specify the site-specific conceptual model of the seismic layering. Indicate the expected thicknesses versus depth of units to be detected.

D. Explain what seismic source is planned to be used in this "noisy" environment that can carry an off-the-end shot for the 1500 foot line. Conceptually, specify how many shot points and what locations are planned per line.

E. Figure 3-1 shows 13 seismic lines that are all oriented in an east-west direction. Section 3.2.1.2 discusses orthogonal lines. Clarify how many lines are planned. Specify how the orthogonal lines will be placed, and show them on a corrected Figure 3-1. Explain why the proposed seismic lines are shown crossing buildings.

3. Resistivity, Section 3.2.1.3 – Like the refraction survey discussed in the proceeding comment, the NMED is doubtful that the IP/RES techniques will prove useful in this case. Although KAFB is free to conduct the resistivity survey, the NMED will not allow such a survey to delay completion of other work required for characterizing and cleaning up the Bulk Fuels Facility Spill.

If the Permittee proceeds with conducting the survey, the following issues must be addressed in the revised work plan.

A. As described in Section 3.2.1.3 of the plan, 56 stakes are proposed to be situated along 1,850 feet transects. This amounts to an electrode separation of about 30 feet, which would yield a shallowest apparent resistivity of the upper nominal 30 feet, with a value every 30 feet horizontally. Explain how the resistivity survey is expected to provide good results with all the surface interferences, cultural conditions, pipelines, surface topography changes, utilities, and other conditions known to be present at the site. Explain how close, for example, does the interpreted depth to groundwater need to be to meet the "Specify Limits on Decision Errors" concept on Table 3-1. Specify the QC procedures to be performed, such as calibrating to a known resistance and reciprocity tests.

B. Explain why the proposed resistivity lines are shown crossing buildings.

C. Indicate whether the geophysical parameters measured in the Sunbelt Geophysics report were taken into account in planning the resistivity investigation.

D. Specify what size transmitter is to be used to be able to measure the appropriate parameters with appropriate detail at large depths, and what electrode arrays are to be used.

E. Indicate if an analysis has been conducted modeling what MN, AB, and AB-MN spacings seem plausible based upon site-specific resistivities (estimated from resistivity or induction logs) and equipment specifications.

F. F. Indicate and explain the computer model by which the data are to be interpreted.

4. Page 3-5, Section 3.2.3 – Substitute semi-volatile organic compounds (SVOCs) for polycyclic aromatic hydrocarbons (PAHs) and add lead to the parameters to be analyzed for in soil. The Permittee must revise the Vadose Zone Work Plan accordingly.

5. Page 3-6, Section 3.2.3 – The first paragraph on this page says that soil samples containing LNAPL will not be sent to the laboratory for chemical analysis. All soil samples, including those containing LNAPL, must be sent to a laboratory and analyzed for TPH, VOCs, SVOCs, and lead. The Permittee must revise the Vadose Zone Work Plan accordingly.

6. Page 3-6, Section 3.2.4 – This section states that screens on soil-vapor monitoring wells will be set to "anticipated depths" of 25, 50, 150, 250, 350, and 450 feet. The Permittee must revise the Vadose Zone Work Plan to indicate the maximum distance that screened zones are to be adjusted from the required screen depths, should adjustment be necessary. For screens that are to be set 100 feet apart as directed under this letter, the Permittee may adjust screens by no more than 25 feet. For screens that are to be set 25 feet apart, the Permittee may adjust screens by no more than 5 feet. The Permittee must revise the Vadose Zone Work Plan accordingly.

7. Cross-section "A-A" - Cross-section A-A' location shown on Figures 2-2 through 2-5 does not correspond to Cross-Section A-A' shown in Figure 2-8. Supply the intended cross-section A-A' with data shown clearly and legibly, and with appropriate data.

D. Groundwater Investigation Work Plan

General Comments on Groundwater Investigation Work Plan

In NMED's letter of April 2, 2010, the Permittee was directed to submit a Groundwater Investigation Work Plan that describes the additional actions the Permittee will take to characterize the nature, horizontal and vertical extent, and the fate and rate of migration of the groundwater contamination. The Groundwater Investigation Work Plan was also to include construction details and the locations and depths of the groundwater monitoring wells to be installed, actions to characterize the geology and hydrogeology at and below the water table, groundwater flow direction and velocity, field procedures, and the sampling and analysis of groundwater and related quality control. The Groundwater Investigation Work Plan was also to describe the means (*e.g.*, cross-sections, plan views) by which results would be reported after the investigation and include a schedule to complete the work.

The leading (northern) edge and the eastern and western margins of the dissolved-phase and LNAPL plumes are as yet undefined, and the nature and concentrations of contaminants in the core of each of the plumes are poorly characterized because existing wells are located too far apart (generally at distances greater than 500 feet), vertical characterization information is nonexistent, and water quality beneath the LNAPL plume has not been assessed. Additionally, the vertical extent of contaminated groundwater, key aspects of the hydrology of the groundwater (hydraulic conductivity, velocity), and the geology (horizontal and vertical characteristics) of the saturated zone are poorly defined or are unknown.

In general, the Groundwater Investigation Work Plan proposes too few wells, both in a vertical and horizontal sense, than is needed to adequately characterize the geology, hydrology, and the nature and extent of contamination over such a large area of groundwater contamination. As mentioned earlier, NMED was hoping to avoid the time-consuming process of "dickering" with the Permittee on numbers of borings and wells by providing clear and specific direction in its April 2, 2010 letter. Nevertheless, in the interest of comity and upon further consideration, NMED agrees that by adjusting locations some well locations directed in NMED's April 2, 2010 letter can be replaced with some proposed by the Permittee in the Groundwater Investigation Work Plan. NMED nonetheless directs an increase in the number of sampling points over that proposed by the Permittee, with the goal of achieving adequate site characterization more quickly to address the urgent matter of cleaning up the Bulk Fuels Facility Spill. Depending on what is found, additional wells may be needed, and NMED reserves its rights to require such additional borings, wells, or both in the future. The Permittee shall revise the Groundwater Investigation Work Plan to include all of the well installations required by this letter.

NMED has identified several other general deficiencies with the Groundwater Investigation Work Plan, which includes issues related to background water quality, vertical characterization, water quality beneath the LNPAL plume, rate of contaminant migration, cluster/nested wells, and characterization of plume cores and margins. These general deficiencies are discussed below.

1. Background Water Quality - Only two upgradient wells have been installed that potentially may yield groundwater samples that are free from contamination. Both of these wells were only recently completed; none is screened appreciably below the water table to provide vertical characterization of water quality, geology, and hydrologic conditions. The Permittee must complete the background cluster/nested wells at location #6 listed in Table 4 of this letter and shown on Figure 2 (enclosed).

2. Vertical Characterization – The plan identifies proposed wells that are to be screened at various depths below the water table as "B" and "C" wells, with the "C" wells the deepest screened well at a given cluster/nested well location. Due to urgency of this matter, the NMED does not approve of "C" well installation being contingent on "B" well results. Given that the pumping of water supply wells is known to induce vertical gradients in groundwater, can cause significant components of vertical flow in the vicinity of such wells, and draws water preferentially from productive zones that may be deeper than the water table, vertical characterization of groundwater quality, hydrology, and geology is required for all well installations specified by this letter.

3. Water Quality Beneath the LNAPL Plume - Although the lack of water quality information was identified specifically by the NMED as a data gap, the Groundwater Investigation Work Plan states that groundwater at well locations within the boundaries of the LNAPL plume will not be sampled and analyzed. This is an unacceptable approach. Knowledge of water quality beneath the LNAPL plume is crucial to understand the full extent and magnitude of the groundwater contamination.

4. Rate of Contaminant Migration - Although a critical question to be answered, it was not clear in the Groundwater Investigation Work Plan if the Permittee has a plan to address the rate of migration of either the dissolved-phase or LNAPL contaminant plumes, and in particular, the time it would take for the dissolved-phase plume to reach surrounding well fields. The Permittee must clarify this point.

5. Cluster versus Nested Wells – The NMED has no objections to the use of nested wells instead of cluster wells, provided the nested wells are properly constructed. However, in this case the NMED will not accept wells that are constructed with 3-inch diameter casing and screens. Three-inch diameter casing and screens are inappropriate for constructing groundwater monitoring wells that will be installed to depths of 500 feet or more. The Permittee shall design wells to be constructed in cluster or nested configurations using casing and screen that are no smaller than 5 inches in diameter. The borehole surrounding the well casing for a nested or cluster well must be of sufficient diameter to allow for an adequate annular space between the borehole and well casing and screen. The annular space must be of sufficient size to allow for proper construction of filter packs and seals, and for the installation of grouting (see the groundwater monitoring well construction requirements set forth in Part 2 of this letter).

6. Characterization of Plume Cores – The dissolved-phase and LNAPL plumes extend off base to nearly 0.9 to 0.5 miles, respectively from the presumed source, yet a total of only eight wells currently exist off-base to characterize the cores of both plumes. Of these eight wells, this includes two wells where groundwater has not been sampled for water quality in the past and one well that was only very recently installed at Bullhead Park for which no water quality data has been submitted to the NMED.

In NMED's letter of April 2, 2010, the Permittee was directed to install groundwater monitoring wells at a ***minimum*** of eight additional locations to characterize the concentrations of contaminants, and the geologic and hydrologic conditions that exist off-base in the plume cores; instead, the Permittee proposed only four.

To achieve the objective of providing initial plume-core characterization, the Permittee shall install the groundwater monitoring wells at locations #11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, and 23 listed in Table 4 and shown on Figure 2.

7. *Characterization of Plume Margins* – Only five existing wells define the edge of the plume off-base (including one well recently installed). In NMED's letter of April 2, 2010, the Permittee was directed to install groundwater monitoring wells at a ***minimum*** of eight additional locations to characterize the concentrations of contaminants, and the geologic and hydrologic conditions that exist off base along the plume margins; instead, the Permittee proposed five.

To adequately provide initial plume-edge characterization, the Permittee shall install the groundwater monitoring wells at locations #1, 2, 3, 4, 5, 7, 8, 9, 10, 24, 25, 26, 27, and 28 that are listed in Table 4 and shown on Figure 2.

Three groundwater monitoring wells shall be installed at different depths at each of the well locations listed in Table 4. The screen depths shown in Table 4 are distances (in feet) that the top of the screens shall be set below the water table, except wells screened across the water table (those with screen depths of zero in Table 4) may have screens that extend above the water table. Screen lengths for wells shall not exceed 15 feet, with the exception that wells screened across the water table shall have screens 20 feet long, with no more than 15 feet of screen length situated below the water table.

The geologic conditions encountered from the surface to the total depth of the borings at each well location shall be logged. Boreholes completed for well installations at all locations shall also be logged using induction (medium and deep), neutron, and gamma (large crystal) tools. Geophysical and geologic logging at a given cluster well location is required only in the well at the location having the deepest screened interval.

Coordinates in Table 4 are State Plane Coordinates in feet, NAD83. All of the locations listed in Table 4 are also shown on Figure 2 enclosed with this letter.

Table 4. Well locations and screen depths relative to the water table.

Location #	Easting	Northing	Screen Depths	Characterization Purpose
1	1542189	1476725	0, 15, 40	Plume margin, deep characterization
2	1541984	1476042	0, 15, 40	Plume margin, deep characterization
3	1543703	1476600	0, 15, 40	Plume margin, deep characterization
4	1543372	1475065	0, 15, 40	Plume margin, deep characterization
5	1543643	1477939	0, 15, 85	Plume margin, deep characterization
6	1541430	1472370	15, 40*	Background water quality, deep characterization

7	1542812	1473601	0, 15, 40	Plume margin, deep characterization
8	1542722	1477726	0, 15, 40	Plume margin, deep characterization
9	1543054	1477788	0, 15, 40	Plume margin, deep characterization
10	1543774	1477304	0, 15, 40	Plume margin, deep characterization
11	1541774	1473718	0, 15, 85	Plume core, deep characterization
12	1542362	1473801	0, 15, 85	Plume core, deep characterization
13	1542305	1474340	15, 85*	Plume core, deep characterization
14	1542736	1474715	0, 15, 85	Plume core, deep characterization
15	1542860	1475860	0, 15, 85	Plume core, deep characterization
16	1542189	1475207	0, 15, 85	Plume core, deep characterization
17	1541731	1473291	0, 15, 85	Plume core, deep characterization
18	1542203	1474071	0, 15, 85	Plume core, deep characterization
19	1542565	1475360	0, 15, 85	Plume core, deep characterization
20	1542535	1475975	0, 15, 85	Plume core, deep characterization
21	1543199	1475767	0, 15, 85	Plume core, deep characterization
22	1543068	1476494	0, 15, 85	Plume core, deep characterization
23	1541968	1474648	0, 15, 85	Plume core, deep characterization
24	1541682	1474703	15, 40*	Plume margin, deep characterization
25	1541025	1474360	15, 40*	Plume margin, deep characterization
26	1540407	1474016	15, 40*	Plume margin, deep characterization
27	1543712	1475683	15, 40*	Plume margin, deep characterization
28	1543364	1477684	0, 15, 40	Plume margin, deep characterization

* - water table well already exists

The Permittee shall revise the Groundwater Investigation Work Plan to incorporate the general comments and correct the deficiencies noted above.

Specific Comments on Groundwater Investigation Work Plan

1. Page 3-6, Section 3.3.4 and Figure 3-3 – Well construction details are missing, as the wrong figure was submitted for a well construction diagram in the Work Plan. The Permittee shall revise the Groundwater Investigation Work Plan to correct the deficiency noted above.

2. *Page 3-4, Section 3.3.2* – This section states that "NMED will be notified regarding any deviations in well constructions per Section 4.0." Aside from the fact that there is no Section 4.0, well construction and any changes thereto must be approved in advance by the NMED. E-mail or telephone approval may suffice to facilitate in-field decision-making. The Permittee shall revise the Groundwater Investigation Work Plan accordingly.

3. *Page 3-5, Section 3.3.3* – Soil samples shall be collected at well locations #11, 12, 17, and 18 listed in Table 4 from the deepest borehole at each location. The samples shall be collected at a frequency of at least one sample every 10 feet for the first 50 feet of the borehole, then at least one sample every 50 feet to the bottom of the borehole, and at total depth of the borehole. The soil samples must be analyzed in the laboratory for TPH, VOCs, SVOCs, and lead. The Permittee shall revise the Groundwater Investigation Work Plan accordingly.

4. *Page 3-7, Section 3.3.5* – This section indicates that wells screened below the water table will be considered by the Permittee to be "piezometers" (normally for measuring only hydraulic head). Groundwater samples must be collected from all wells, regardless if the wells are screened at the water table or deeper, and all samples must be analyzed for TPH and hazardous constituents. The Permittee shall revise the Groundwater Investigation Work Plan accordingly.

5. *Page 3-7, Section 3.3.5* – This section states that wells located within the area of the floating LNAPL will not be developed. All wells, including those within the LNAPL plume, shall be properly developed to provide representative water samples. The Permittee shall revise the Groundwater Investigation Work Plan accordingly.

6. *Page 3-7, Section 3.3.6* – This section states that groundwater at wells located within the area of the floating LNAPL will not be sampled. Groundwater in all wells will be sampled, including those within the LNAPL plume. The Permittee shall revise the Groundwater Investigation Work Plan accordingly.

7. *Page 3-7, Section 3.3.6* – For analysis of groundwater samples, add lead and substitute SVOCs for PAHs, and dissolved iron and dissolved manganese for iron and manganese, respectively. Samples must not be filtered, except for sample fractions for dissolved iron and dissolved manganese.

Add alkalinity and pH to the list of field parameters.

The Permittee shall revise the Groundwater Investigation Work Plan accordingly.

8. *Page 3-6, Section 3.3.4* - It is not clear how many wells are actually proposed because wells KAFB-10629, KAFB-10630, and KAFB-10638 are not listed on Table 3-2 of the Groundwater Investigation Work Plan. The Permittee must clarify or resolve this discrepancy in a revision to the Groundwater Investigation Work Plan.

9. *Page 3-1, Section 3.1.1* - Indicate what geophysical logs will be run and at what stage of the borehole/well installation process. The discussion should be included in Section 3.3 instead of Section 3.1.1. The Permittee shall revise the Groundwater Investigation Work Plan accordingly.

10. *Page 3-2, Section 3.3.1* - See specific Comments #2 and 3 for the Vadose Zone Work Plan regarding surface geophysical surveys.

PART 2

A. Direction to Conduct Interim Measures and Other Actions

In NMED's letter of April 2, 2010, the Permittee was informed that the NMED has determined that the Bulk Fuel Facility Spill poses a threat to human health and the environment, and furthermore, endangers the groundwater resource – including water supply wells – relied upon by the WUA for delivery of safe drinking water to its customers. The contamination also threatens KAFB and the Veterans Administration ("VA") Hospital water-supply wells. The large extent of this contamination and its proximity to water supply wells requires that urgent action be taken.

The NMED has estimated that nearly 8 million gallons of fuel have been released at the Bulk Fuels Facility. The Permittee is operating four SVE units on the Permittee's property; however, these soil-vapor extraction units will not clean up the contamination thus far known to occur from the Bulk Fuels Facility Spill in a reasonable time frame. Because the Permittee's Interim Measures Work Plan does not contain any interim measures that could be implemented immediately, the NMED herein is directing the Permittee to:

1. conduct additional soil vapor extraction,
2. improve the Operation and Maintenance Plan for the SVE units,
3. begin immediate excavation of contaminated soil at the Fuel Offloading Rack,
4. provide an estimate of the contaminant migration rate,
5. install sentry wells,
6. log existing wells, including using geophysical methods,
7. submit critical data to the NMED, and
8. provide adequate funding to the WUA for sampling and analysis of well water.

SVE and these other actions must be initiated or completed, as appropriate, by the deadlines indicated in this letter and in the Compliance Schedule in Table 5. Additionally, this letter specifies minimum requirements that the Permittee must meet regarding well installations, well development, sampling, geophysical logging, preparing geologic logs, notification of activities, field and laboratory quality control, and reporting.

1. Soil Vapor Extraction

a. The Permittee has demonstrated that SVE has worked to remove contaminate vapors from the vadose zone. The Permittee shall install and operate additional SVE units at the following locations:

i. No later than **October 6, 2010** (Table 5) at existing groundwater monitoring wells KAFB-3411, KAFB-10614, and KAFB-10624, which are located in the core of the vadose zone contamination.
ii. No later than **November 8, 2010** (Table 5) at soil boring/soil-vapor monitoring well locations #4, 5, 9, 10, 11, 12, and 21 that are listed in Table 1 of this letter. These wells, to be located in the core of contamination, should be designed to serve both as vapor extraction wells and as soil-vapor monitoring wells. The Permittee must also conduct geologic logging and borehole geophysical logging at each location. The Permittee shall comply with the collection and analysis of soil samples as specified in Part 1 of this letter for well installations.
iii. No later than **October 6, 2010** (Table 5) or 60 days after required access is granted, which ever is later, at existing groundwater monitoring wells KAFB-10617 and 10618 which are located at the northern extent of the LNAPL plume.
iv. No later than **November 8, 2010** (Table 5) or 60 days after required access is granted, which ever is later, at existing groundwater monitoring wells KAFB-10610 which is located at the northern extent of the 1-foot thick layer of LNAPL plume.
v. No later than **November 8, 2010** (Table 5) or 60 days after required access is granted, which ever is later, locations #3, 8 and 9 on Table 2 of this letter shall be made ready for conducting future soil vapor extraction by completing soil-vapor monitoring/extraction wells at this location. The Permittee must conduct geologic logging and borehole geophysical logging at this location and shall comply with the collection and analysis of soil samples as specified in Part 1 of this letter for well installations.

b. The Permittee shall continue to operate SVE units at the locations of the four existing SVE units (located at the Fuel Offloading Rack, KAFB-1065, KAFB-1066, and KAFB-1068).

Until such time that the interim measures plan is approved by the NMED, the Permittee shall continue to operate all SVE units 24 hours per day, 7 days a week, except when necessary to perform maintenance or repairs. If maintenance or repairs are necessary, the maintenance or repairs shall be completed as quickly as practicable, and the unit returned to service immediately after maintenance or repairs are completed. Any maintenance or repairs that will take more than 3 calendar days shall be reported in writing to the NMED within 24 hours of discovery that the maintenance or repairs will take more than 3 days. The Permittee shall explain in the report why the maintenance or repairs will take more than 3 calendar days and why the delay is beyond the control of the Permittee.

The SVE units shall be similar to those currently in use for the Bulk Fuels Facility Spill and shall be capable of extracting soil vapor at a minimum flow rate of 27 SCFM. The SVE units shall also average over a period of 12 months an operating efficiency (operating time relative to down time) of no less than 85%. The SVE units shall meet the regulatory requirements for air emissions enforced by the City of Albuquerque Environmental Health Department. The Permittee is responsible for obtaining all necessary permissions and permits to construct and operate the SVE units.

If the City of Albuquerque Environmental Health Department will not issue an air permit to operate the SVE units specified by this letter, the Permittee shall immediately notify the NMED in writing and shall substitute a different technology for conducting SVE and treating emissions that will meet the regulatory requirements enforced by the City of Albuquerque Environmental Health Department and the deadlines set forth in this letter in the Compliance Schedule shown in Table 5.

2. Operation and Maintenance (O&M) Plan

The Permittee shall modify its O&M Plan to reduce down time of SVE units by maintaining in inventory commonly-needed spare parts for maintenance and repairs, and keeping a spare engine available for SVE units that suffer catastrophic engine failures. The spare parts and engine shall be maintained by the Permittee in inventory by **September 7, 2010**. The Permittee shall provide NMED with a written list of the spare parts and spare engine kept in inventory by **October 6, 2010** (Table 5).

3. Excavation of Soil and Removal of Fuel Offloading Rack

The Permittee shall by **October 6, 2010** (Table 5) begin removal of the remaining components of the Fuel Offloading Rack and excavation of contaminated soil to 20 feet. The excavation of soil and removal of the Fuel Offloading Rack shall be completed by **October 6, 2011** (Table 5), and a report on completion of the work submitted to the NMED by **January 15, 2012** (Table 5). Any soil contamination left in place must meet NMED's requirements for clean up (see Comment # 8 of Section A of Part 1 of this letter). The Permittee may use direct push sampling and field analysis to help determine which soils require excavation. However, laboratory analysis shall be conducted to determine the concentrations of hazardous constituents in soil for the purpose of defining the final extent of excavation, for risk assessment, and for waste determinations.

Soil shall be sampled to determine whether all contaminated soil that poses an unacceptable risk to human health or the environment has been removed to a depth of at least 20 feet. Soil samples shall be analyzed in the laboratory for TPH, VOCs, SVOCs, and lead, and collected on all sides and the bottom of the excavation at a spacing not to exceed 25 feet.

4. Estimates of Contaminant Migration Rate

The Permittee must provide NMED by **September 7, 2010** (Table 5) with calculations showing the estimated velocity of and the travel time for the dissolved-phase contaminant plume to first reach the closest well in the Ridgecrest well field, the Veteran Administration (VA) Hospital Well, and KAFB production wells KAFB-3, KAFB-15, and KAFB-16. The calculations shall consider the direction and gradient of groundwater flow, and the geologic and hydrologic properties of the aquifer under a worse-case scenario. The Permittee shall provide the source of all information used to support the required calculations.

5. Installation of Sentry Wells

a. The Permittee must install groundwater monitoring wells (water table, intermediate, and deep wells referred to as A, B, and C wells) at location #28 of Table 4 of this letter, north of the leading edge of the dissolved-phase contaminant plume, by no later than **November 8, 2010** (Table 5) or 90 days after required access is granted, which ever is later. These wells will serve as sentry wells for the northern extent of the dissolved-phase plume.
b. The Permittee must install B and C groundwater monitoring wells at existing well locations KAFB-10613 and KAFB-1064, near the V.A. Hospital, by no later than **November 8, 2010** (Table 5) or 90 days after required access is granted, which ever is later. These wells will serve as sentry wells for the V.A. Hospital.
c. The Permittee must install A, B, and C groundwater monitoring wells at location #3 listed in Table 4 of this letter, on the east edge of the dissolved-phase contaminant plume, by no later than **November 8, 2010** (Table 5) or 90 days after required access is granted, which ever is later. These wells will serve as sentry wells for the northeastern extent of the dissolved-phase plume.
d. The Permittee must install A, B, and C groundwater monitoring wells at location #1 listed in Table 4 of this letter, on the west edge of the dissolved-phase contaminant plume no later than **November 8, 2010** (Table 5) or 90 days after required access is granted, which ever is later. These wells will serve as sentry wells for the northwestern extent of the dissolved-phase plume.
e. The Permittee must also conduct geologic and borehole geophysical logging of each well discussed in paragraphs a-d of this section. Geologic logging must be completed during the drilling of the boreholes; geophysical logging must be completed within 30 days of well completion (Table 5). Copies of the geologic and geophysical logs must be provided to the NMED by the submittal dates for quarterly reports specified in NMED's letter of June 4, 2010.

Wells constructed in cluster or nested configuration must meet the requirements set forth in Comment # 5 of Section D of Part 1 of this letter. Groundwater samples shall be collected and analyzed in a laboratory at a quarterly frequency from each sentry well in accordance with the direction in NMED's letter of June 4, 2010, and directions under this letter.

6. Geophysical logging of Existing Wells

The Permittee must conduct borehole geophysical logging (medium and deep induction, gamma, and neutron) at all existing groundwater monitoring wells. Copies of the geophysical logs must be provided to the NMED by **October 6, 2010** (Table 5).

7. Submitting Critical Data to NMED

The Permittee failed to provide certain critical information required in NMED's April 2, 2010 letter. The Permittee must provide the following information to the NMED by **September 7, 2010** (Table 5):

i. tables in electronic format (Excel^{TM}) showing the locations (x, y, z), sampling points, and maximum depths of all soil borings and vapor and groundwater monitoring wells;
ii. Survey plats for all wells.
iii. tabulated data in electronic format (Excel^{TM}) and graphs showing hydrocarbons (HC) and trends of major hazardous constituent (such as benzene, toluene, ethylene dibromide, xylenes, naphthalene, ethylbenzene, and lead) concentrations versus time for soil vapor for each extraction and each soil-vapor and groundwater monitoring well, as applicable.
iv. tabulated data in electronic format (Excel^{TM}) and graphs showing trends of TPH and major hazardous constituent (such as benzene, toluene, ethylene dibromide, xylenes, naphthalene, ethylbenzene, and lead) concentrations versus time for groundwater for each groundwater monitoring well.
v. Cross-sections showing the geology of the site drawn to a horizontal scale of 1 inch equals 50 feet, a vertical scale of 1 inch = 50 feet, and along the orientations A-A', B-B', C-C', and D-D' as shown on Figure 3 enclosed with this letter.
vi. Cross-sections showing the geology of the site drawn to a horizontal scale of 1 inch equals 300 feet, a vertical scale of 1 inch = 50 feet, and along the orientations A-A', B-B', C-C', and D-D' as shown on Figure 4 enclosed with this letter.
vii. Cross-sections showing concentrations of major hazardous constituents in soil, drawn to a horizontal scale of 1 inch equals 50 feet, a vertical scale of 1 inch = 50 feet, and along the orientations A-A', B-B', C-C', and D-D' as shown on Figure 3 enclosed with this letter.
viii. Cross-sections showing concentrations of major hazardous constituents in soil vapor, drawn to a horizontal scale of 1 inch equals 50 feet, a vertical scale of 1 inch = 50 feet, and along the orientations A-A', B-B', C-C', and D-D' as shown on Figure 3 enclosed with this letter.
ix. Cross-sections showing concentrations of major hazardous constituents in groundwater, drawn to a horizontal scale of 1 inch equals 300 feet, a vertical scale of 1 inch = 50 feet, and along the orientations A-A', B-B', C-C', and D-D' as shown on Figure 4 enclosed with this letter.

8. Sampling and Analysis of Water Production Wells

NMED understands that the Permittee is providing funding to the WUA to analyze groundwater samples from WUA water-supply wells threatened by contamination originating from the Bulk Fuels Facility Spill. NMED has also become aware that the analytical method used by the WUA to test for ethylene dibromide (EDB) is 524.2 rather than Method 504.1, the latter which is normally used for purposes of determining compliance with Safe Drinking Water Act.

NMED does not consider analysis by Method 524.2 to be sufficiently sensitive to provide adequate early-warning protection for the WUA wells. The Permittee shall continue to collaborate with the WUA to ensure that water quality is safe for human consumption, but will also ensure the samples are analyzed by Method 504.1. The Permittee shall provide copies of the laboratory results to the NMED in quarterly reports in accordance with the reporting requirements of NMED's letter of June 4, 2010.

B. Technical Requirements for Conducting Interim Measures

1. Notification of Sampling and other Field Activities

The Permittee shall notify the NMED in writing of field sampling or other field activities undertaken in accordance with the requirements of this letter, and shall provide the NMED the opportunity to collect split samples upon request by the NMED. For such sampling or other field activities, the Permittee shall provide the NMED with as much advance notice as is practicable, but no less than 15 days prior to the conduct of such sampling. The Permittee shall notify the NMED in writing a minimum of 15 days prior to the implementation of the Interim Measures, Groundwater Investigation and Vadose Zone Work Plans. Notification of sampling or other field activities may be made by email, fax, or letter.

2. Soil-Vapor Well Construction

Soil-vapor monitoring wells shall be designed and constructed in a manner that will yield high-quality samples. Soil vapor wells shall not be installed with the use of any fluids. Soil vapor wells may be completed by backfilling with native materials. The Permittee shall not sample the well before the expiration of the 24-hour equilibration period following completion of installation. Information on the design and construction of soil-vapor monitoring wells shall be recorded as for groundwater monitoring wells.

3. Groundwater Monitoring Well Construction

Groundwater monitoring wells shall be designed and constructed in a manner that will yield high quality samples, ensure that the well will last the duration of the project, and ensure that the well will not serve as a conduit for hazardous constituents to migrate between different stratigraphic units or aquifers. The design and construction of groundwater monitoring wells shall comply with the guidelines established in various RCRA guidance, including, but not limited to:

EPA, *RCRA Groundwater Monitoring Technical Enforcement Guidance Document*, OSWER-9950.1, September, 1986; and

Aller, L., Bennett, T.W., Hackett, G., Petty, R.J., Lehr, J.H., Sedoris, H., Nielsen, D.M., and Denne, J.E., *Handbook of Suggested Practices for the Design and Installation of Groundwater Monitoring Wells*, EPA 600/4-89/034, 1989.

1. Drilling Methods

The Permittee shall abide by the following conditions:

1. Drilling shall be performed in a manner that minimizes impacts to the natural properties of the subsurface materials;
2. Drilling shall be performed in a manner that contamination and cross-contamination of groundwater and aquifer materials is avoided;

1. The drilling method shall allow for the collection of representative samples of rock, unconsolidated sediment, and soil;
2. The drilling method shall allow the Permittee to determine when the appropriate location for the screened interval(s) has been encountered;
3. The drilling method shall allow for the proper placement of a filter pack and annular sealant for each monitored zone, and the borehole diameter shall be at least four inches larger in diameter than the nominal diameter of the well casing and screen to allow adequate space for emplacement of the filter pack and annular sealants;
4. The drilling method shall also allow for the collection of representative groundwater samples; and
5. Drilling fluids, including air, shall be used only when minimal impact to the surrounding formation and groundwater can be ensured.

All drilling equipment shall be in good working condition and capable of performing the planned tasks. Drilling rigs and equipment shall be operated by properly trained crews. Drilling equipment shall be properly decontaminated before initiation of drilling for each boring. Precautions shall be taken to prevent the migration of contaminants between geologic, hydrologic, or other identifiable zones during drilling and well installation activities.
The drilling and sampling shall be conducted under the direction of a qualified engineer or geologist. Known site features and/or site survey grid markers shall be used as references to locate each boring prior to surveying the location.

2. Well Construction Materials

When selecting construction materials, the primary concern shall be selecting well construction materials that will not contribute to or remove hazardous waste or constituents from groundwater samples. Other factors to be considered include the tensile strength, compressive strength, and collapse strength of the materials; the length of time the monitoring well will be in service; and the material's resistance to chemical and microbiological corrosion.

3. Design and Construction of Screens and Filter Packs

Screens and filter packs shall be designed to allow accurate sampling of the saturated zone that the well is intended to sample, minimize the passage of formation materials (turbidity) into the well, and ensure sufficient structural integrity to prevent the collapse of the intake structure. The filter pack shall be installed in a manner that prevents bridging and particle-size segregation. Filter packs shall be installed by the tremie pipe method. At least two inches of filter pack material shall be installed between the screen and the borehole wall, and two feet of filter pack material shall extend above the top of the screen. A minimum of six inches and a maximum of two feet of filter pack material shall also be placed under the bottom of the screen. The precise volume of filter pack material required shall be calculated and recorded before placement, and the actual volume used shall be determined and recorded during construction. Any significant discrepancy between the calculated and actual volume shall be explained. Prior to installing the filter pack annular seal, a one to two-foot layer of chemically inert fine sand shall be placed over the filter pack to prevent the intrusion of annular sealants into the filter pack.

4. Design and Construction of Annular Seals

The annular space between the casing and the borehole wall shall be properly sealed to prevent cross-contamination. The materials used for annular sealants shall be chemically inert with respect to the highest anticipated concentration of chemical constituents expected in the groundwater. The precise volume of annular sealant required shall be calculated and recorded before placement, and the actual volume shall be determined and recorded during construction. Any significant discrepancy between the calculated volume and the actual volume shall be explained.

During construction, an annular seal shall be placed on top of the filter pack. This seal shall normally consist of a high solids (10 to 30 percent) bentonite material in the form of bentonite pellets, granular bentonite, or bentonite chips. The seal shall be placed in the annulus through a tremie pipe. A tamping device shall be used to ensure that the seal is emplaced at the proper depth. The bentonite seal shall be placed above the filter pack with a minimum of two-foot vertical thickness. The bentonite seal shall be allowed to completely hydrate in conformance with the manufacturer's specifications prior to installing the overlying annular grout seal.
A grout seal shall be installed on top of the filter pack seal. The grout shall be placed into the annular space by the tremie pipe method, from the top of the filter pack annular seal to within a few feet of the ground surface; however, the grout shall be installed at intervals necessary to allow it time to cure and not damage the filter pack or filter pack annular seal during installation of the grout. The grout seal shall be allowed to cure for a minimum of 24 hours before the concrete surface pad is installed. All grouts shall be prepared in accordance with the manufacturer's specifications.

5. Surface Completion Methods

Monitoring wells may be completed either as flush-mounted wells, or as above-ground completions. A surface seal shall be installed over the grout seal and extended vertically up the well annulus to the land surface. The lower end of the surface seal shall extend a minimum of one foot below the frost line to prevent damage from frost heaving. The composition of the surface seal shall be neat cement or concrete. In above-ground completions wherein the well casing rises or sticks up above ground level, a three-foot square by four-inch thick concrete surface pad shall be installed around the well immediately after the protective casing is installed. The surface pad shall be sloped so that drainage will be off the pad and away from the protective casing. In addition, a minimum of one inch of the finished pad shall be below grade or ground elevation to prevent washing and undermining by soil erosion.

Protective casing with a locking cover shall be installed around the well casing (stickup or riser) to prevent damage or unauthorized entry. The protective casing shall be anchored in the concrete surface pad below the frost line and extend at least several inches above the casing stickup. A weep hole shall be drilled into the protective casing just above the top of the concrete surface pad to prevent water from accumulating and freezing inside the protective casing. A cap shall be placed on the well riser to prevent the entry of foreign materials into the well, and a lock shall be installed on the cover of the protective casing to provide security against tampering. If a well is located in an area that receives vehicular traffic, a minimum of three bumper guards consisting of steel pipes three to four inches in diameter and a minimum of five-feet in length shall be installed next to the concrete surface pad. The bumper guards shall be installed to a minimum depth of two feet below the ground surface in a concrete footing and extend a minimum of three feet above ground surface. The pipes that form the bumper guards shall be filled with concrete to provide additional strength, and shall be painted a bright color to make them readily visible.
If flush-mounted completions are required (e.g., in active roadway areas), a protective structure such as a traffic-rated utility vault or meter box shall be installed around the casing. In addition, measures should be taken to prevent the accumulation of surface water in the protective structure and around the well intake. These measures shall include outfitting the protective structure with a steel lid or manhole cover that has a rubber seal or gasket, and ensuring that the bond between the cement surface seal and the protective structure is watertight. A lock shall be installed on the lid or cover of the protective structure to prevent unauthorized access to the well.

6. Well Development Methods

All monitoring wells shall be developed to create an effective filter pack around the screen, correct damage to the formation caused by drilling, remove residual drilling mud or other drilling additives, if present, and fine particles from the formation near the borehole, and assist in restoring the original water quality of the aquifer in the vicinity of the well. Monitoring wells shall be developed until the column of water in each well is free of visible sediment, and the pH, temperature, turbidity, and specific conductance have stabilized to within 10%. If a well is pumped dry, the water level shall be allowed to sufficiently recover before the next development period is initiated.

If water is introduced to a borehole during drilling and completion, then at minimum the same volume of water shall be removed from the well during development. In addition, the volume of water withdrawn from or introduced into a well during development shall be recorded. Well development must be completed within 30 days of installation.

4. Surveying Requirements for Groundwater Monitoring and Soil-Vapor Wells

The horizontal and vertical coordinates of the measuring point at the top of each monitoring well casing and the ground surface elevation at each monitoring well location shall be determined by a registered New Mexico professional land surveyor or licensed Professional Engineer. Horizontal coordinates shall be measured in accordance with the State Plane Coordinate System. Horizontal positions shall be measured to the nearest 0.1 foot, and vertical elevations shall be measured to the nearest 0.01 foot.

5. Well Completion Reports

For each monitoring well, the Permittee shall submit to the NMED a completion summary report which shall include a well construction log and diagram, a geologic log, and a well development log. The report for each well shall be submitted in accordance with the quarterly schedule set forth in NMED's letter of June 4, 2010.

6. Well Construction Diagrams and Logs

Information on the design, construction, and development of each monitoring well shall be recorded. Construction diagrams and logs shall include the following information:

1. Well, boring name/number;
2. Date/time of construction;
3. Borehole diameter and casing diameter;
4. Surveyed location coordinates;
5. Total depth, expressed both as depth below ground surface and elevation above sea level;
6. Name of drilling contractor;
7. Casing length;
8. Casing materials;
9. Casing and screen joint type;
10. Screened intervals, expressed both as depth(s) below ground surface and elevation(s) above sea level;
11. Screen materials;
12. Screen slot size and design;
13. Filter-pack material and size;
14. Filter-pack volume (calculated and actual);
15. Filter-pack placement method;

16. Filter-pack interval(s), expressed both as depth(s) below ground surface and elevation(s) above sea level;
17. Annular sealant composition;
18. Annular sealant placement method;
19. Annular sealant volume (calculated and actual);
20. Annular sealant interval, expressed both as depth below ground surface and elevation above sea level;
21. Surface sealant composition;
22. Surface seal placement method;
23. Surface sealant volume (calculated and actual);
24. Surface sealant interval, expressed both as depth below ground surface and elevation above sea level;
25. Surface seal and well apron design and construction;
26. Development procedure and turbidity measurements;
27. Well development purge volume(s) and stabilization parameter measurements;
28. Type, design, and construction of protective casing;
29. Type of cap and lock;
30. Ground surface elevation above sea level;
31. Survey reference point elevation above sea level on well casing;
32. Top of casing elevation above sea level;
33. Top of protective steel casing elevation above sea level;
34. Drilling method(s); and
35. Types, quantities, and dates/times that additives were introduced, if any.

7. Measurement of Groundwater Levels

Groundwater levels shall be measured in all monitoring wells associated with the Bulk Fuels Facility Spill within 72 hours from the start of monitoring the water level in the first well. Groundwater levels shall be obtained prior to purging for any sampling event. Measurement data and the date and time of each measurement shall be recorded on a field log. The depth to groundwater shall be measured to the nearest 0.01 foot. The depth to groundwater shall be recorded relative to the surveyed well casing rim.

8. Sampling of Environmental Media

Sampling of environmental media (groundwater, soil, and soil vapor) shall comply with the requirements set forth in NMED's letter of June 4, 2010, and in accordance with the additional requirements provided herein.

1. Soil Sampling Requirements

Relatively undisturbed discrete soil and rock samples shall be obtained during the advancement of each boring for the purpose of logging and analytical testing. A split-barrel sampler lined with brass sleeves, a coring device, or other method approved in advance by the NMED shall be used to obtain samples during the drilling of each boring.

Soil samples are subject to the same field quality assurance, laboratory quality assurance, data validation, and reporting requirements as for groundwater and soil-vapor samples; including requirements to collect or prepare, as appropriate, and analyze field quality control samples. Soil samples collected for the purpose of analyzing for VOCs and SVOCs shall not be mixed to homogenize samples for any reason.

2. Groundwater Sample Collection

Groundwater samples shall be obtained within eight hours of the completion of well purging. Groundwater in monitoring wells with low recharge rates and that purge dry shall be sampled when the water level in the well has recovered sufficiently to collect the required samples. Sample collection methods shall be documented in field monitoring logs. Samples shall be placed into appropriate clean containers. Decontamination procedures shall be established and, implemented, for nondedicated water sampling equipment.

The Permittee shall obtain groundwater samples for dissolved metals analysis using disposable in-line filters with a 0.45 micron mesh size.

9. Field Quality Control

Field duplicates shall consist of two samples collected sequentially. Field duplicate samples shall be collected and analyzed at a frequency of at least 10 percent of the total number of environmental samples submitted for analysis. At a minimum, one duplicate sample per sampling event shall always be collected and analyzed.

Field blanks shall be prepared and analyzed at a frequency of no less than one per day. Field blanks shall be generated by filling sample containers in the field with deionized water and submitting the field blank, along with the groundwater samples, to an analytical laboratory.

Equipment blanks shall be prepared and analyzed at a rate of at least five percent of the total number of environmental samples submitted for analysis, but no less than one equipment blank per sampling day. Equipment blanks shall be generated by rinsing decontaminated sampling equipment with deionized water, and capturing the rinsate water in an appropriate clean container. The equipment blank then shall be submitted with the groundwater samples to the analytical laboratory for the same analyses as the environmental samples.

Trip blanks shall be prepared using deionized water. Trip blanks shall be managed exactly the same as environmental samples. Trip blanks shall accompany sampling personnel into the field throughout sampling activities, and then shall be placed into a shipping container with environmental samples for shipment to the analytical laboratory. Trip blanks shall be analyzed at a frequency of one for each shipping container holding samples for VOC analysis.

10. Laboratory Quality Assurance

The Permittee shall ensure that contract analytical laboratories maintain internal quality assurance programs in accordance with EPA and industry-accepted practices and procedures. At a minimum, the laboratories shall use a combination of standards, blanks, surrogates, duplicates, matrix spike/matrix spike duplicates (MS/MSD), and other laboratory control samples to assess data quality. The laboratories shall establish control limits for individual chemicals or groups of chemicals based on the long-term performance of the test methods. In addition, the laboratories shall establish internal QA/QC procedures that meet EPA's laboratory certification requirements. Specific procedures to be completed are identified in the following sections. If a laboratory is unable or unwilling to meet the requirements of this Permit, the Permittee shall select a different laboratory that can and will meet the requirements.

1. Laboratory Equipment Calibration Procedures

The laboratories' equipment calibration procedures, calibration frequency, and calibration standards shall be in accordance with the EPA test method requirements and documented in quality assurance and standard operating procedures manuals. All instruments and equipment used by laboratories shall be operated, calibrated, and maintained according to manufacturers' guidelines and recommendations. Operation, calibration, and maintenance shall be performed by personnel who have been properly trained in these procedures. A routine schedule and record of instrument calibration and maintenance shall be kept on file at the laboratories.

2. Laboratory QC Samples

Analytical procedures shall be evaluated for quality by analyzing reagent blanks or method blanks, surrogates, MS/MSDs, and laboratory duplicates, as appropriate for each method. At a minimum, laboratories shall analyze laboratory blanks, MS/MSDs, and laboratory duplicates at a frequency of at least one in 20 for all batch runs requiring EPA test methods and at a frequency of at least one in 10 for non-EPA test methods. All laboratory quality control data reported with the Facility's sample analysis results must be related to the analysis of the Facility's samples.

11. Data Validation

The Permittee shall evaluate all sample data, and all field and laboratory QC results for acceptability. Each group of samples shall be evaluated using data validation guidelines contained in EPA guidance documents, the latest version of SW-846, and industry-accepted methods and procedures. Additionally, the Permittee shall evaluate all data for compliance with the following parameters:

1. Representativeness -- The Permittee shall implement procedures to assure representative samples are collected and analyzed, such as repeated measurements of the same parameter at the same location over several distinct sampling events. The Permittee shall note any procedures or variations that may affect the collection or analysis of representative samples and shall qualify the data accordingly;

2. Comparability -- To assure comparability of data, the Permittee shall implement standard collection and analytical procedures, and shall report analytical results in appropriate units for comparison with other data (e.g., past studies, comparable sites, screening levels, and cleanup standards). Any procedure or variation that may affect comparability shall be noted, and the data shall be qualified appropriately;

3. Completeness -- The Permittee shall evaluate all laboratory data for completeness with respect to data quality objectives. The degree of completeness shall be reported with the data in any reports in which the data are referenced;

4. Accuracy -- The Permittee shall evaluate all data for accuracy with respect to percent recovered of spiked samples. Results shall be reported for each analyte in any report in which the data are cited; and

5. Precision -- The Permittee shall evaluate all data for precision with respect to RPDs of duplicate samples. Results shall be reported for each analyte in any report in which the data are cited.

12. Waste Management

Waste management of investigation derived waste shall be in accordance with that set forth in Part 1 of this letter.

13. Geophysical Logs

Geophysical logging shall be conducted using induction (deep, medium), neutron, and gamma (large crystal) tools. Geophysical logging at cluster/nested well locations is required in only the well at each location that has the deepest screened interval.

Geophysical logs submitted to the NMED must show results of the induction logging (medium and deep) in millimhos per meter, neutron logging in American Petroleum Institute (API) neutron units, and gamma logging in API calibrated counts per second, the results of each method plotted versus depth from the surface to total depth of the borehole for which the log represents. The name of the borehole, location of the borehole, the date(s) that the borehole was completed, the drilling method, and the elevation of the top of the borehole shall also be noted on the boring log. The data must be provided to the NMED in hard copy and in digital format.

14. Field and Geologic Logs

The physical characteristics of soil and rock samples, such as mineralogy and lithic content, ASTM soil classification, moisture content, texture, color, presence of stains or odors, field screening results, depth, location, method of sample collection, the presence of any water-bearing zones and any unusual or notable conditions encountered during drilling shall be recorded in a field log. Field logs shall be completed by a qualified geologist.

The Permittee shall prepare geologic logs for each borehole showing relative to borehole depth the rock types, thickness of rock units, and water bearing zones (including that at and below the water table). The name of the borehole, location of the borehole, the date(s) that the borehole was completed, the drilling method, and the elevation of the top of the borehole shall also be noted on the boring log. The data must be provided to the NMED in hard copy and in digital format.

15. Reporting

Unless specified otherwise in this letter, the Permittee shall report to the NMED the information that is required by NMED's letter of June 4, 2010, and by the indicated schedules in that letter. Reporting for the additional SVE units required to be installed under Part 2 of this letter shall also be in accordance with NMED's letter of June 4, 2010.

Final Direction

The Permittee shall meet the deadlines specified in the Compliance Schedule of Table 5 of this letter. The Interim Measures, Groundwater Investigation, and Vadose Zone Work Plans must be completely revised and resubmitted. The Permittee shall submit to NMED by **September 7, 2010** (Table 5) revisions of the Vadose Zone, Interim Measures, and Groundwater Investigation Work Plans that correct the deficiencies noted herein and incorporate the requirements set forth in this letter. The Permittee shall also implement the interim measures and other actions as directed under Part 2 of this letter by the dates indicated and in accordance with the schedule in Table 5.

The investigation plans required under this letter shall include relevant maps and cross-sections that show concentration data for contaminants and other relevant information with supporting data posted on the maps and cross-sections in a legible manner, and clearly showing which borings/wells contributed data towards construction of the maps and cross-sections and which did not. Tables including all existing soil borings, soil-gas monitoring wells, and groundwater monitoring wells, listing their surveyed location, sampling points and maximum depth of exploration shall also be included in the reports and plans. For soil-gas monitoring wells, tables and graphs shall also be included providing trends of TPH concentrations versus time for the depths below ground surface of 25, 50, 150, 250, 350, and 450 feet.

To the extent any requirement of this letter requires access to property not owned or controlled by the Permittee, the Permittee shall use its best efforts to obtain access from the present owners of such property to conduct the required activities. In the event that access is not obtained when necessary, the Permittee shall immediately notify the NMED in writing regarding its best efforts and its failure to obtain such access.

Table 5. Compliance Schedule.

Revisions to Work Plans	
Submittal	Due Date
Interim Measures Work Plan	September 7, 2010
Vadose Zone Work Plan	September 7, 2010
Groundwater Investigation Work Plan	September 7, 2010
Other Document Submittals	
Indoor Air Quality Report	October 6, 2010
Interim Measures and other Actions	
Install and operate SVE units at KAFB-3411, KAFB-10614, and KAFB-10624	October 6, 2010
Install and operate SVE units at soil boring/monitoring well locations #4, 5, 9, 10, 11, and 12 (see Table 1)	November 8, 2010 or 60 days after required access is granted, which ever is later
Install and operate SVE units at KAFB-10617 and KAFB-10618	October 6, 2010
Install and operate SVE units at soil boring/monitoring well location KAFB-10610	November 8, 2010 or 60 days after required access is granted, which ever is later
Prepare for SVE operation at soil boring/monitoring well locations #3, 8, and 9 (see Table 2)	November 8, 2010 or 60 days after required access is granted, which ever is later
Operate SVE units at Fuel Offloading Rack and KAFB-1065, KAFB-1066, and KAFB-1068	Immediately, except operation of SVE Unit at Fuel Offloading Rack may be temporarily suspended while excavating soil and removing remaining components of the Fuel Offloading Rack.
Maintain spare parts and spare engine for SVE units in inventory	September 7, 2010
Report that spare parts and spare engine for SVE units is in inventory	October 6, 2010
Begin excavation of contaminated soil and removing remaining components of the Fuel Offloading Rack.	October 6, 2010
Complete excavation of contaminated soil and	October 6, 2011

removing remaining components of the Fuel Offloading Rack.	
Report on completion of excavation of contaminated soil and removing remaining components of the Fuel Offloading Rack.	January 15, 2012
Submit estimate of contaminant migration rate to NMED	September 7, 2010
Complete A, B, and C sentry wells at location #28 (see Table 4)	November 8, 2010 or 90 days after required access is granted, which ever is later
Complete B and C sentry wells at KAFB-10613 and KAFB-1064	November 8, 2010 or 90 days after required access is granted, which ever is later
Complete A, B, and C sentry wells at location #3 (see Table 4)	November 8, 2010 or 90 days after required access is granted, which ever is later
Complete A, B, and C sentry wells at location #1 (see Table 4)	November 8, 2010 or 90 days after required access is granted, which ever is later
Complete geologic logs of new wells at locations #1, 3, 28, KAFB-10613 and KAFB-1064	During drilling of each well
Complete geophysical logs of new wells at locations #1, 3, 28, KAFB-10613 and KAFB-1064	Within 30 days of well completion
Submit copies of geologic and geophysical logs for locations #1, 3, 28, KAFB-10613 and KAFB-1064	In accordance with NMED letter of June 4, 2010
Submit copies of geophysical logs of existing wells	October 6, 2010
Submit critical data to NMED (Section A.7 of Part 2).	September 7, 2010
Notification of sampling and other field activities (Section B.1 of Part 2)	No less than 15 days prior to implementation
Submit geologic and geophysical logs for sentry wells	In accordance with NMED letter of June 4, 2010
Submit water quality data for WUA wells	In accordance with NMED letter of June 4, 2010
Submit well completion reports	In accordance with NMED letter of June 4, 2010
Submit report on all SVE units	In accordance with NMED letter of June 4, 2010
Report to NMED if any SVE units will not receive an air emissions permit to operate	Immediately
Report to NMED down time of SVE units that will exceed a duration of 72 hours	Within 24 hours of discovery that repairs or maintenance will take more than 72 hours to complete

The Permittee shall respond directly to my attention, with copy to Mr. Bill Olson of the NMED's Ground Water Quality Bureau, and Mr. William Moats (NMED HWB, 5500 San Antonio NE, Albuquerque, NM 87109), on all correspondence and required plans and reports related to the Bulk Fuels Facility Spill, unless otherwise directed by NMED. All submittals and correspondence must be submitted in hardcopy and electronic format.

If you have any questions regarding the technical aspects of this letter, please contact Mr. William Moats of my staff at (505) 222-9551. Any other questions should be directed to me at 505-476-6016.

Sincerely,

James P. Bearzi
Chief
Hazardous Waste Bureau

Enclosures: Figures 1-4

cc: J. Kieling, NMED HWB
W. Moats, NMED HWB
W. McDonald, NMED HWB
S. Brandwein, NMED HWB
B. Olsen, HWB GWQB
A. Puglisi, HWB GWQB
B. Swanson, HWB GWQB
L. Barnhart, NMED OGC
B. Gallegos, AEHD
B. Gastian, ABCWUA
L. King, EPA-Region 6 (6PD-N)
File: Reading and KAFB 2010

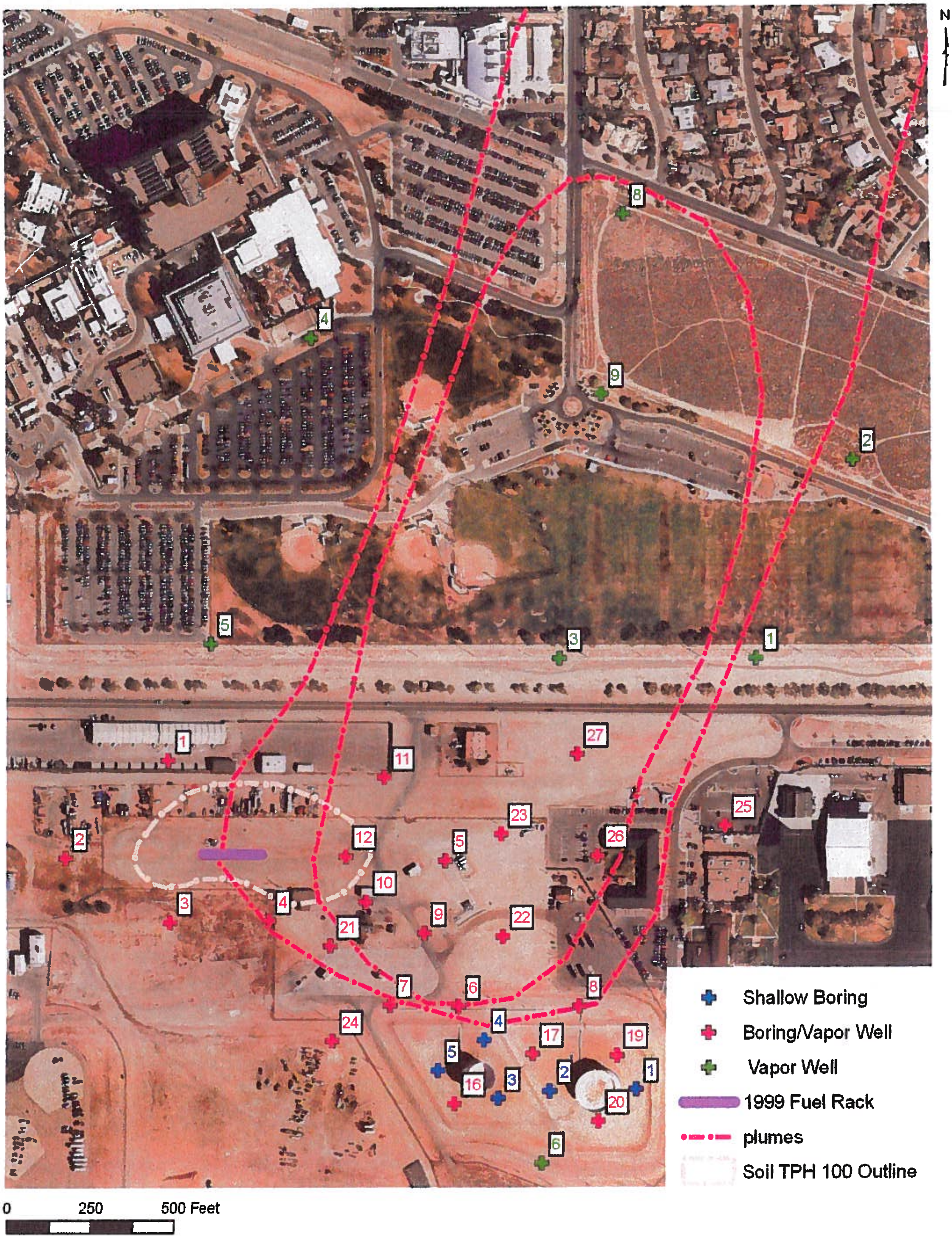

Figure 1. Soil Boring and
Soil-Vapor Monitoring Well Locations

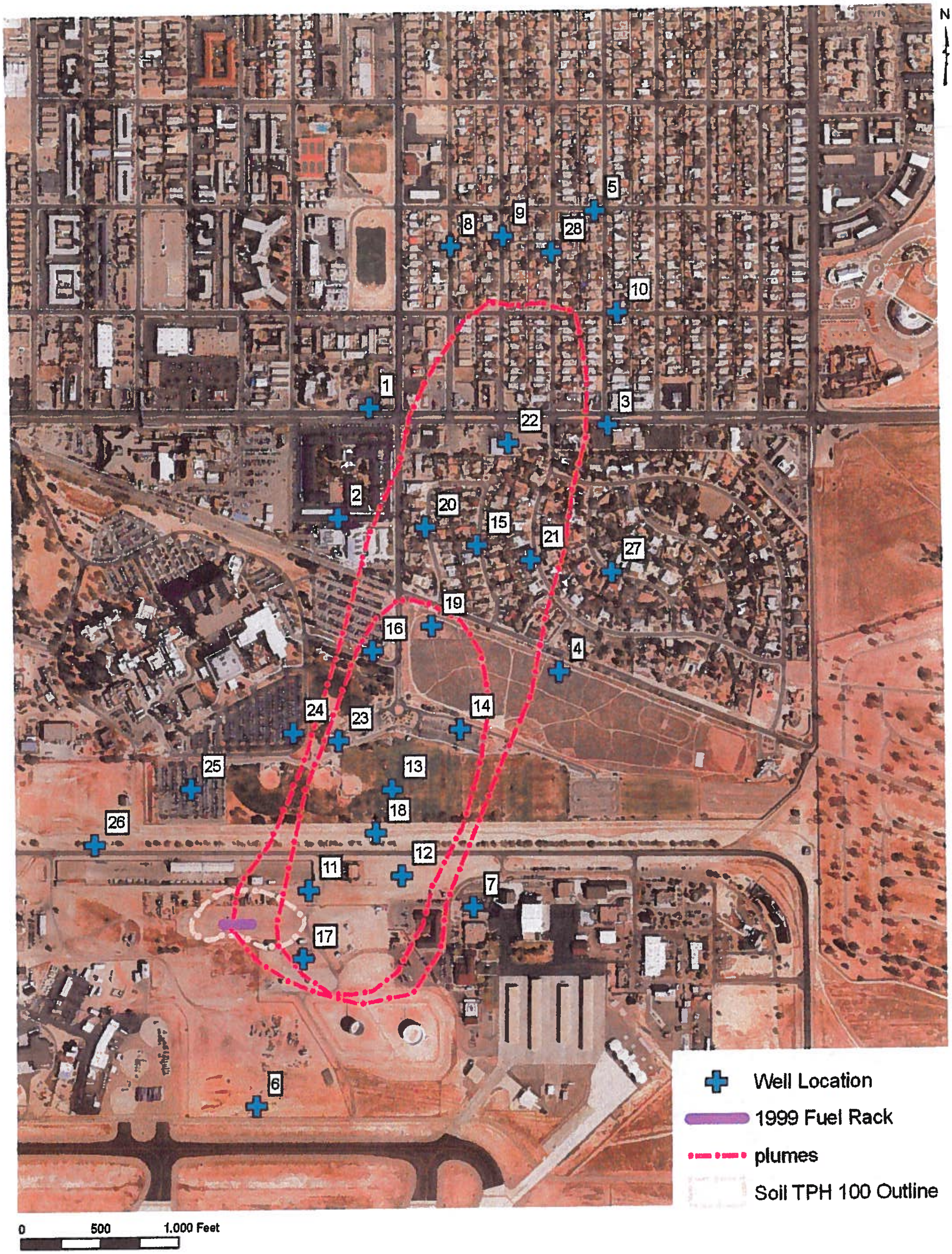

Figure 2. Groundwater Monitoring Well Locations

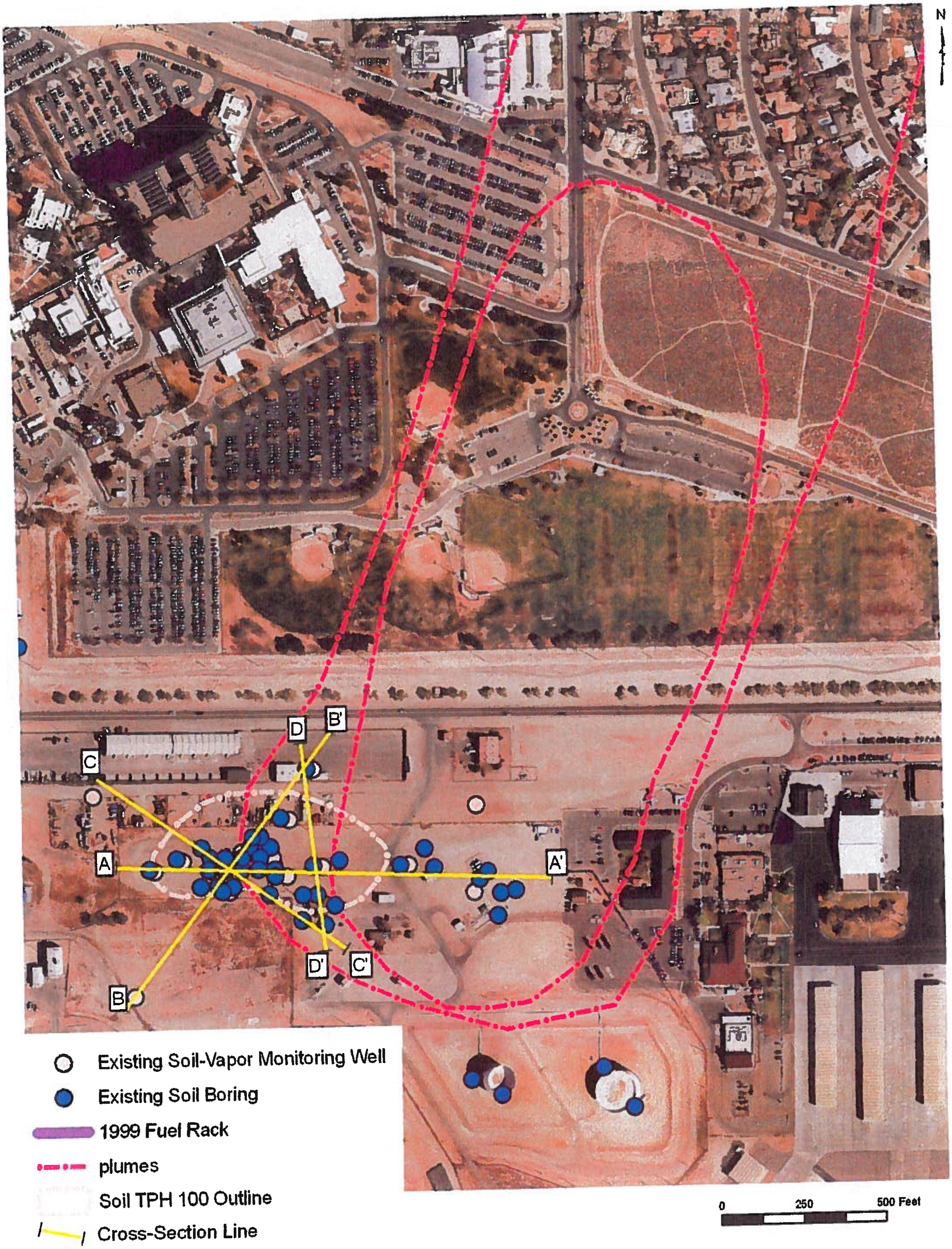

Figure 3 Existing Soil Boring, Soil-Vapor Monitoring Well and Cross-Section Locations

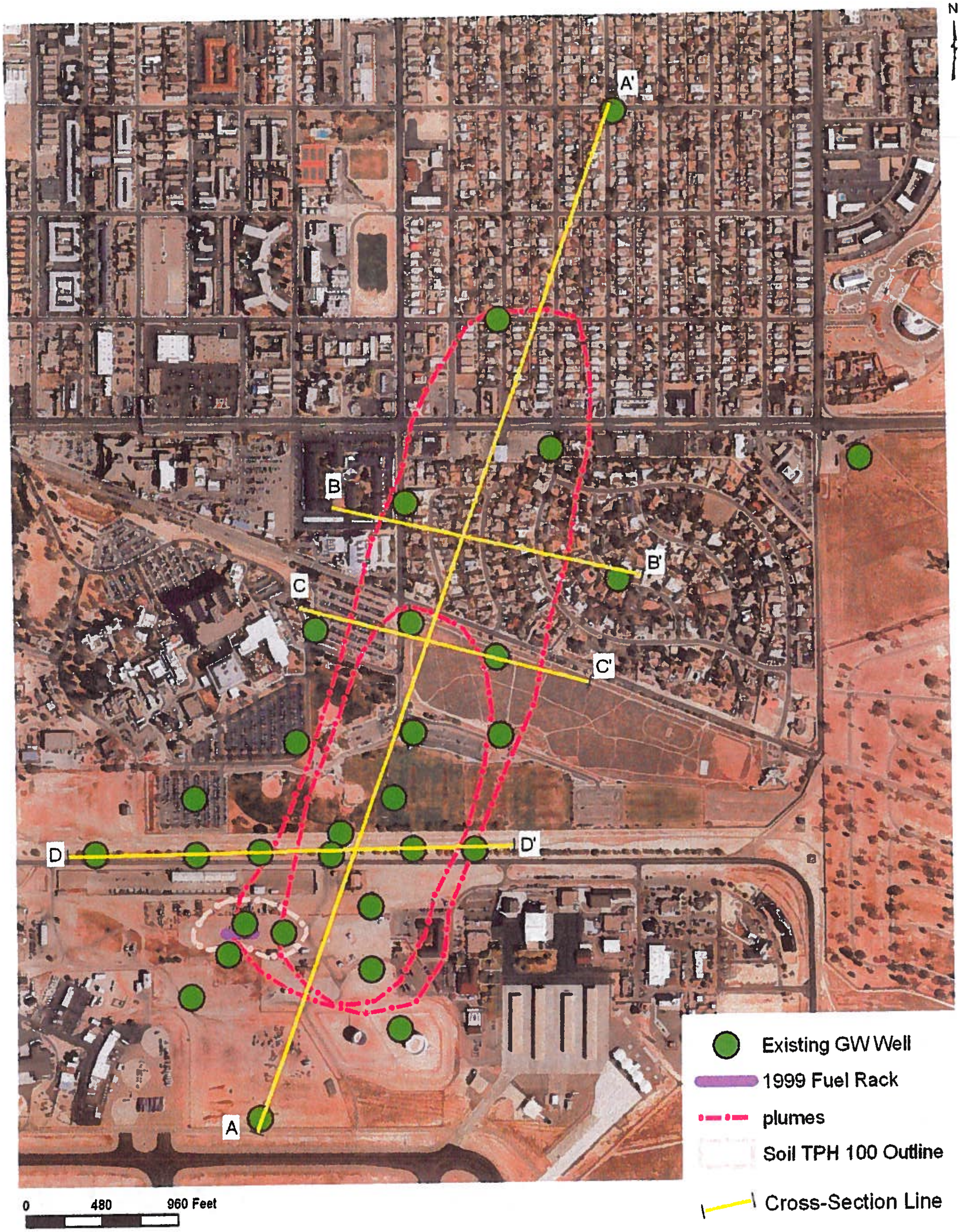

Figure 4. Existing Well and Cross-Section Locations

ATTACHMENT 3

June 4, 2010 Correspondence from the NMED HWB to Colonel Robert L. Maness, Base Commander, 377 ABW/CC and Mr. John Pike, Director, Environmental Management Section, 377 MSG/CEANR

Re: Reporting, Sampling and Analysis Requirements, Solid Waste Management Units ST-I06 AND SS-111, Bulk Fuels Facility Spill, Kirtland AFB

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A R Doc # 3459

CEANR

NEW MEXICO
ENVIRONMENT DEPARTMENT

Hazardous Waste Bureau

BILL RICHARDSON
Governor

DIANE DENISH
Lieutenant Governor

2905 Rodeo Park Drive East, Building 1
Santa Fe, New Mexico 87505-6303
Phone (505) 476-6000 Fax (505) 476-6030
www.nmenv.state.nm.us

RON CURRY
Secretary

SARAH COTTRELL
Deputy Secretary

CERTIFIED MAIL - RETURN RECEIPT REQUESTED

June 4, 2010

Colonel Robert L. Maness
Base Commander
377 ABW/CC
2000 Wyoming Blvd. SE
Kirtland AFB, NM 87117-5606

Mr. John Pike
Director, Environmental Management Section
377 MSG/CEANR
2050 Wyoming Blvd., Suite 116
Kirtland AFB, NM 87117-5270

**RE: REPORTING, SAMPLING, AND ANALYSIS REQUIREMENTS SOLID WASTE MANAGEMENT UNITS ST-106 AND SS-111
BULK FUELS FACILITY SPILL
KIRTLAND AIR FORCE BASE, EPA ID# NM9570024423
HWB-KAFB-10-004**

Dear Colonel Maness and Mr. Pike:

This letter sets forth reporting, sampling, and analysis requirements related to the characterization and remediation of contaminated groundwater at the U. S. Air Force Kirtland Air Force Base ("Permittee") Solid Waste Management Units ST-106 and SS-111, collectively known as the Bulk Fuels Facility Spill. In the past, the Permittee has submitted semiannual reports concerning the Bulk Fuels Facility Spill to the New Mexico Environment Department (NMED) Groundwater Quality Bureau. However, due to the severity and urgency of this matter, NMED directs that reporting occur on a more frequent basis. This letter describes how the Permittee must submit reports to the NMED from this time forward. In addition, this letter also sets forth general sampling and analysis requirements to ensure that groundwater and soil-gas data are of high quality and representative of the conditions present in the field.

<u>Reporting Requirements</u>

All characterization and remediation activities and data concerning the Bulk Fuels Facility Spill that have been completed or acquired during the last semiannual reporting period (October 2009 through March 31, 2010) are to be reported to the NMED no later than June 30, 2010.

After June 30, 2010, quarterly reports must be submitted by the Permittee to the NMED for its review and approval. Quarterly reporting shall continue until such time that corrective action is deemed complete for the Bulk Fuels Facility Spill by the NMED, or until NMED approves in writing a different schedule.

Quarterly periods for each year and the due dates for corresponding quarterly reports are summarized in the following table.

Quarter	**Period**	**Due Date of Quarterly Report**
1	January 1 through March 31	May 30
2	April 1 through June 30	August 29
3	July 1 through September 30	November 29
4	October 1 through December 31	February 28 of the following year

Each quarterly report shall provide detailed information on all characterization and remediation activities that took place during the period covered by the report, including, but not limited to, as applicable for the reporting period, field and laboratory analytical results for groundwater, soil, and soil gas; graphs showing trends of major contaminants versus time, a table of surveyed well locations; descriptions of the installation of groundwater and soil-gas monitoring wells; measurements of light non-aqueous phase liquid (LNAPL); table of water levels; water-level map; plume contaminant maps and cross-sections; and geologic and geophysical logs of wells and boreholes. Each quarterly report shall also describe the operation, maintenance, and performance of the four soil-vapor extraction (SVE) systems. Each quarterly report shall also include all field and laboratory quality control data for the reporting period and a discussion of data quality as it relates to accuracy, precision, representativeness, and completeness for each analytical parameter that is to be reported.

In addition to the above reporting requirements, the NMED may require submission of data at any time. The Permittee will be notified in writing of any such required submissions and their associated submission due dates.

Also, pursuant to 20.4.1.900 NMAC (incorporating 40 C.F.R. § 270.11(d)(1)), all quarterly reports shall include a certification, signed by a chief or senior executive officer of the Facility, stating:

> I certify under penalty of law that this document and all attachments were prepared under my direction or supervision according to a system designed to assure that qualified personnel

> properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

General Sampling and Analysis Requirements

Groundwater and soil-gas monitoring shall be conducted on a quarterly basis with all groundwater and soil-gas monitoring wells sampled each quarter. Sample collection and analysis must be conducted in manner that yields results of high quality and are representative of the conditions of their respective media in the field. Field quality control samples, including duplicates, field blanks, equipment rinsate blanks, and trip blanks shall be collected or prepared as appropriate and analyzed for quality control purposes. Chain-of-custody and proper shipping and handling procedures shall be followed to ensure the integrity of samples.

At a minimum, groundwater shall be sampled and analyzed in a laboratory for volatile organic compounds (VOCs), total petroleum hydrocarbons (TPH), lead, major ions (calcium, magnesium, potassium, sodium, sulfate, carbonate, bicarbonate, chloride), nitrate, ammonia, sulfide, dissolved iron, and dissolved manganese. Except for sample fractions taken for dissolved iron and manganese, groundwater samples shall not be filtered. Groundwater shall also be sampled and analyzed in the field for temperature, pH, specific conductance, alkalinity, turbidity, dissolved oxygen, and Eh.

Groundwater samples shall be obtained from a well only after temperature, pH, and specific conductance measurements have stabilized within ±10% for three consecutive measurements and after purging at least one well-bore volume of stagnant water. A well-bore volume is herein defined as the volume of water in the saturated filter pack plus the volume of all standing water within the well screen and casing, including the sump. Field measurements taken during purging, including purge volumes and the date and time of each measurement, and the type and serial number of each field instrument used shall be recorded in a log book. The thickness of LNAPL shall be measured and recorded for every well location where LNAPL is present.

The detection limit for each groundwater constituent shall not exceed 50% of the constituent's U. S. Environmental Protection Agency's Maximum Concentration Level or its New Mexico Water Quality Control Commission standard (20.6.2.3103 NMAC), whichever is more stringent. For naturally occurring groundwater constituents, the detection limit for a given constituent shall also not exceed the constituent's background concentration as approved by the NMED for the KAFB area.

Soil-gas samples shall be collected from all monitoring intervals (all depths) for each soil-gas monitoring well. At a minimum, soil gas shall be sampled and analyzed in a laboratory for VOCs. The Permittee shall continually monitor the concentrations of soil vapor with an appropriate field instrument (e.g., photoionization detector of appropriate lamp energy) while purging. The Permittee shall collect soil-gas samples only after field instrument readings have stabilized within ±10% for three consecutive measurements and after the sampling tubing and the soil-gas monitoring well have been purged to remove all stagnant vapor. Soil-gas measurements taken in the field during purging, the date and time of each measurement, and the type and serial number of field instrument used shall be recorded in a log book.

The reporting and sampling and analysis requirements set forth in this letter are in effect, until and unless superseded by subsequent direction in an approved work plan or implementation plan.

If you have any questions concerning the technical matters in this letter, you may contact William McDonald or Sid Brandwein of my staff at (505) 222-9582 and (505) 222-9504, respectively. If you have other questions, you may contact me directly at 505-476-6000.

Sincerely,

James P. Bearzi
Chief
Hazardous Waste Bureau

cc: M. Leavitt, Director, NMED WWMD
J. Kieling, NMED HWB
W. Moats, NMED HWB
B. McDonald, NMED HWB
S. Brandwein, NMED HWB
B. Olsen, HWB GWQB
A. Puglisi, HWB GWQB
B. Swanson, HWB GWQB
L. Barnhart, NMED OGC
B. Gallegos, AEHD
B. Gastian, ABCWUA
L. King, EPA-Region 6
File: Reading and KAFB 2010
KAFB-10-004

ATTACHMENT 4

December 10, 2010 Correspondence from the NMED HWB to Colonel Robert L. Maness, Base Commander, 377 ABW/CC and Mr. John Pike, Director, Environmental Management Section, 377 MSG/CEANR

Re: Bulk Fuels Facility Spill (SWMUS ST-106 and SS-111), Notice of Partial Approval with Modification and Notice of Disapproval, Interim Measures, Vadose Zone, and Groundwater Investigation Work Plans, HWB-KAFB-10-015, HWB-KAFB-10-016, HWB-KAFB-10-019

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NEW MEXICO
ENVIRONMENT DEPARTMENT

Hazardous Waste Bureau

BILL RICHARDSON
Governor

DIANE DENISH
Lieutenant Governor

2905 Rodeo Park Drive East, Building 1
Santa Fe, New Mexico 87505-6303
Phone (505) 476-6000 Fax (505) 476-6030
www.nmenv.state.nm.us

RON CURRY
Secretary

SARAH COTTRELL
Deputy Secretary

CERTIFIED MAIL - RETURN RECEIPT REQUESTED

December 10, 2010

Colonel Robert L. Maness
Base Commander
377 ABW/CC
2000 Wyoming Blvd. SE
Kirtland AFB, NM 87117-5606

Mr. John Pike
Director, Environmental Management Section
377 MSG/CEANR
2050 Wyoming Blvd., Suite 116
Kirtland AFB, NM 87117-5270

RE: BULK FUELS FACILITY SPILL (SWMUS ST-106 AND SS-111)
NOTICE OF PARTIAL APPROVAL WITH MODIFICATIONS AND NOTICE OF DISAPPROVAL
INTERIM MEASURES, VADOSE ZONE, AND GROUNDWATER INVESTIGATION WORK PLANS, NOVEMBER 2010
KIRTLAND AIR FORCE BASE, EPA ID# NM9570024423
HWB-KAFB-10-015, HWB-KAFB-10-016, HWB-KAFB-10-019

Dear Col. Maness and Mr. Pike:

The New Mexico Environment Department (NMED) has reviewed the revised Interim Measures, Vadose Zone, and Groundwater Investigation Work Plans, concerning the Kirtland Air Force Base (KAFB) Bulk Fuels Facility Spill, Solid Waste Management Units (SWMUs) ST-106 and SS-111. The revised plans were submitted November 4, 2010, in response to the NMED's Notice of Disapproval (NOD) issued August 6, 2010.

NMED finds the plans to be deficient, and provides the following comments. However, NMED must also ensure that commencement of the vadose zone and groundwater investigations and interim measures not be further delayed. NMED is therefore partially approving with modifications the Work Plans in accordance with Permit Part 1.38 of the Permittee's Hazardous Waste Operating Permit (Permit), issued July 15, 2010. Those aspects of the Work Plans that are approved with modifications are addressed in Part 1 of this letter. Under Part 1 of this letter, the Permittee must conduct certain activities to begin the investigation of the vadose zone and groundwater at the Bulk Fuels Facility immediately, and to conduct interim measures at the former Fuel Offloading Rack, prior to approval of the remainder of the Work Plans. These activities are to be conducted as described in this letter, and without delay. The work to be conducted under Part 1 must also be included in the revised Work Plans even if the Permittee believes that such work has been completed when it submits the revised Work Plans for approval. NMED reserves the right to require the Permittee to correct work completed under Part 1 that does not meet the corrective action requirements of Permit Part 6 or the modifications specified in this letter for such work.

Part 2 of this letter concerns those aspects of the Work Plans that are disapproved. The Permittee is further directed, in Part 2 of this letter, to make additional revisions to the three Work Plans, which are necessary before NMED can approve the plans.

PART 1
PARTIAL APPROVAL WITH MODIFICATIONS

The Permittee must begin immediate investigation of the vadose zone and groundwater in accordance with the corrective action requirements of Permit Part 6, and with the modifications to the three Work Plans that are specified in this letter. The Permittee shall also complete the removal of the former Fuel Offloading Rack and the excavation of contaminated soil exceeding NMED Soil Screening Levels (SSLs).

A. Installation of New Groundwater Monitoring Wells

NMED approves the well installations as described in the revised Groundwater Investigation Work Plan submitted November 4, 2010 with the following modifications. The Permittee shall therefore immediately commence installation of the 78 groundwater monitoring wells provided for in Section 5.2.4 of the revised Groundwater Investigation Work Plan. The installation of the wells shall be completed by **April 28, 2011** (Appendix B of the Groundwater Investigation Work Plan).

Because steel well screens and casing would render most of the geophysical logs useless the Permittee must use polyvinyl chloride (PVC) screens and casing for the deep wells. The Permittee may substitute PVC screens and casing for the intermediate-depth wells, and may use PVC screens and casing for wells screened across the water table at locations where LNAPL is not present.

Section 5.2.4.1 of the Groundwater Investigation Work Plan, *Monitoring Well Installation Procedures*, item #6 states that three PVC centralizers would be used in well construction, one installed directly above and one below the well screen and one installed at the midpoint of the well. In lieu of a centralizer installed at the midpoint, the Permittees shall install PVC centralizers approximately every 100 feet between the top of screen and the ground surface.

The borehole of each well shall be logged in accordance with Permit Part 6.5.15 by a registered professional geologist.

Screen lengths for wells shall not exceed 15 feet, with the exception that wells screened across the water table shall have screens 20 feet long, with no more than 15 feet of screen length situated below the water table.

Each of the new wells shall be developed pursuant to Permit Part 6.5.17.10.6. Pursuant to Permit Part 6.5.17.3, initial groundwater samples shall be obtained from newly-installed monitoring wells within 30 days after completion of well development. Groundwater sampling and reporting requirements shall be conducted as directed in NMED's letter of June 4, 2010, and as specified in Permit Part 6.5.17.5.

B. Development of Existing Wells

In NMED's letter of April 2, 2010, the Permittee was directed to develop all existing wells located within the LNAPL plume, and to make such wells available to sample groundwater below the floating LNAPL so that concentrations of dissolved-phase contaminants can be assessed in this area. This work was to be completed by July 6, 2010. The Permittee failed to complete this work. Furthermore, the revised Groundwater Investigation Work Plan does not contain any provisions for developing the existing wells within the LNAPL plume.

NMED is again directing the Permittee to develop all existing wells located within the LNAPL plume, and to make such wells available to sample groundwater. Well development shall be conducted in accordance with Permit Part 6.5.17.10.6. The work must be completed no later than **February 15, 2011**.

C. Geophysical Logging of Existing Wells

In the August 6, 2010, NOD, the Permittee was directed to conduct borehole geophysical logging (medium and deep induction, gamma, and neutron) at all existing groundwater monitoring wells, and to submit copies of the geophysical logs to the NMED by October 6, 2010. The Permittee failed to complete this work on time, but provides for the geophysical logging of existing wells in the revised Groundwater Investigation Work Plan.

NMED approves the Permittee's proposal to conduct borehole geophysical logging (medium and deep induction, gamma, and neutron) at all existing groundwater monitoring wells. Copies of the logs must be submitted to the NMED by no later than **February 15, 2011**.

D. Completion of Soil Borings

NMED approves the projects in Sections D and E of this letter as described in the revised Vadose Zone Investigation Work Plan submitted November 4, 2010 with the following modifications The Permittee shall immediately complete the 35 deep and 5 shallow soil borings provided for in Section 5.2.10 of the revised Vadose Zone Investigation Work Plan. The work shall be completed by **February 11, 2011**(Appendix B of the Vadose Zone Investigation Work Plan). Each deep boring at each location shall be drilled from the surface to the water table.

Soil samples from the deep borings shall be collected at a frequency of at least one sample every 10 feet for the first 50 feet, and at least one sample thereafter every 50 feet to total depth, and at least one sample at total depth in each boring. The soil samples shall be analyzed for TPH, VOCs, SVOCs, and lead.

Soil samples from shallow borings shall be collected at depths of 0, 5, 10, 15, and 20 feet and shall be analyzed for TPH, VOCs, SVOCs, and lead.

Each soil boring shall be logged in accordance with Permit Part 6.5.15 by a registered professional geologist.

E. Installation of New Soil-Gas Monitoring Wells

The Permittee shall immediately install the 35 soil-gas monitoring wells provided for in Section 5.2.11 of the revised Vadose Zone Investigation Work Plan submitted November 4, 2010. The well installations shall be completed by **February 11, 2011** (Appendix B of the Vadose Zone Investigation Work Plan).

The soil-gas monitoring wells shall be capable of yielding discrete samples of soil gas recovered from depths of 25, 50, 150, 250, 350, and 450 feet below the ground surface.

The borehole of each well shall be logged in accordance with Permit Part 6.5.15 by a professional geologist.

Vapor sampling and reporting requirements shall be conducted as directed in NMED's letter of June 4, 2010.

F. Geophysical Logging of New Groundwater and Soil-Vapor Wells

NMED approves the Permittee's proposal to conduct borehole geophysical logging (medium and deep induction, gamma, and neutron) at all new groundwater and soil-vapor monitoring wells. Copies of the logs must be submitted to the NMED by no later than **June 1, 2011**.

G. Interim Measures at Former Fuel Offloading Rack

The NOD issued August 6, 2010, specified that the Permittee begin removal of the remaining components of the former Fuel Offloading Rack and excavation of contaminated soil exceeding NMED SSLs to 20 feet (SSLs shall be those based on residential land use) by October 6, 2010. The Permittee was also instructed that laboratory analysis of soil samples shall be conducted to determine the concentrations of hazardous constituents for the purpose of defining the final extent of excavation, for risk assessment, and for waste determination. NMED approves the Permittee's proposal for sample analysis, with the following modification: Soil samples shall be analyzed in the laboratory for TPH, volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), and lead, and collected on all sides and the bottom of the excavation at a spacing not to exceed 25 feet. Additionally, the excavation of soil and removal of the former Fuel Offloading Rack shall be completed by October 6, 2011, and a report on completion of the work submitted to the NMED by January 15, 2012.

NMED approves the Permittee's soil sampling plan except as modified below. Section 4.5.2 of the Interim Measures Work Plan, *FFOR Soil Investigation and Sampling*, indicates that the direct-push technology (DPT) samples are to be collected at the former Fuel Offloading Rack (FFOR) and along the remaining aboveground and underground piping on 25-ft centers. The Permittee does not adequately describe the locations of the samples nor are the locations individually depicted on Figure 4-2. No additional sampling is proposed for the known three locations of pipeline leaks, which occurred approximately 18 ft, 150 ft, and 200 ft from the west end of FFOR.

For underground piping from Building 1033 (Pump House) to its terminus at the west end of the FFOR, the Permittee shall instead collect soil samples on 10-ft centers along a line oriented directly over what was once the centerline of the now-excavated pipeline (hereafter referred to as the former pipe centerline). Soil samples shall also be collected at locations spaced no further than 10 ft apart along two lines oriented parallel to the former pipe centerline, with the two lines situated no further than 5 ft from and on opposite sides of the former pipe centerline. Sampling shall also be conducted directly beneath each of the three known leak locations.

At each of the three known leak locations, sampling shall be increased by collecting soil samples at 5 ft by 5 ft grid nodes.

At each sampling location, soil samples shall be collected at depths of 0, 5, 10, 15, and 20 feet.

If lead, VOCs, or SVOCs are detected in soil at concentrations exceeding the NMED SSLs at a given location, the soil at the location shall be excavated, removed from the site, and properly disposed of. The Permittee shall also increase the sampling grid at the location by using the same method as directed above for sampling the three known leak locations, and collect and analyze the additional samples. Expansion of sampling and the collection and analysis of additional samples shall continue until all soil containing VOCs, SVOCs, or lead at concentrations exceeding the NMED SSLs have been excavated.

Section 4.5.2.1, Bullet 4, of the Work Plan states "The field Geologist will collect samples for laboratory analysis that appear to contain the greatest degree of contamination based on visual observation and headspace VOC screening…", suggesting that not all samples will be submitted to the laboratory for analysis. Because headspace analysis will not detect lead and may not detect SVOCs, all soil samples must be submitted to the laboratory for analysis.

Confirmation samples are samples collected to verify that all contaminated soil with concentrations of hazardous constituents exceeding the NMED SSLs has been excavated and removed. In Section 4.5.3.6, *Confirmation Sampling*, the Interim Measures Work Plan indicates that confirmation samples will not be collected from the sidewalls of the excavation. In contrast, the Interim Measures Work Plan in Section 4.5.1 indicates that sidewalls will be sampled for confirmation.

Confirmation samples must be collected from the bottom and sides of all excavations at intervals not to exceed 25 feet. This includes any areas excavated to depths of 20 ft. The Permittee can collect sidewall conformation samples ahead of, behind, or through shoring via portholes cut through the shoring.

Excavation of contaminated soil at the former Fuel Offloading Rack must be completed by **October 6, 2011**.

H. Piping From Building 1033 to Tanks

NMED approves the Permittee's soil sampling plan, except as modified below. The Permittee must excavate to a depth of up to 20 feet any contaminated soil exceeding NMED SSLs that occurs along the piping from Building 1033 to the jet-fuel fuel storage tanks. In lieu of what the Permittee proposed, for the underground and aboveground piping from Building 1033 to the jet-fuel storage tanks, the Permittee shall collect soil samples at locations spaced no further than 20 ft apart along two lines oriented parallel to the pipe centerline, with the two lines situated no further than 5 ft from and on opposite sides of the pipeline. Soil samples shall be collected at depths of 0, 5, 10, 15, and 20 feet and shall be analyzed in the laboratory for TPH, VOCs, SVOCs, and lead.

If lead, VOCs, or SVOCs are detected in soil at concentrations exceeding the NMED SSLs at a given location, the soil at the location shall be excavated and removed from the site for proper disposal. The Permittee shall also increase sampling at the location by using the same method as directed above for sampling the three known leak locations at the former Fuel Offloading Rack, and collect and analyze the additional samples. Expansion of the sampling and the collection and analysis of additional samples shall continue until all soil containing VOCs, SVOCs, or lead at concentrations exceeding the NMED SSLs are excavated and removed from the site for disposal.

Section 4.5.2.1, Bullet 4, of the Work Plan states "The field Geologist will collect samples for laboratory analysis that appear to contain the greatest degree of contamination based on visual observation and headspace VOC screening…", suggesting that not all samples will be submitted to the laboratory for analysis. Because headspace analysis will not detect lead and may not detect SVOCs, all soil samples shall be submitted to the laboratory for analysis.

Confirmation samples must be collected from the bottom and sides of all excavations at intervals not to exceed 25 feet. This includes any areas excavated to depths of 20 ft. The Permittee can collect sidewall conformation samples ahead of, behind, or through shoring via portholes cut through the shoring.

Sampling along the pipeline from Building 1033 to the storage tanks shall be completed by **March 7, 2011**.

I. Soil-Vapor Extraction

In the August 6, 2010, NOD, the Permittee was directed to install and operate additional SVE units, or prepare for SVE operations at the following 16 locations: existing groundwater monitoring wells KAFB-3411, KAFB-10614, KAFB-10624, KAFB-10617, KAFB-10618, and KAFB-10610, at soil boring/soil-vapor monitoring well locations # 4, 5, 9, 10, 11, 12, and 21 listed in Table 1 of the NOD, and soil-vapor monitoring well locations #3, 8 and 9 on Table 2 of the NOD. The Permittee did not accomplish this work, and did not propose any alterative work for NMED to consider. Furthermore, the Permittee has not done anything in the past four months to accelerate the reduction of the soil-vapor mass in the vadose zone at the Bulk Fuels Facility.

Nevertheless, NMED has reconsidered its earlier position to expand the number of SVE Units. Instead of expanding the number of operating SVE Units, the Permittee is directed to prepare the locations of existing groundwater monitoring wells KAFB-3411, KAFB-10614, KAFB-10624, KAFB-10617, KAFB-10618, and KAFB-10610 for conducting SVE by no later than **February 15, 2011**. The Permittee is also directed to prepare an SVE Optimization Plan for the four existing SVE Units, with the concept that the four SVE units will be moved periodically between the six aforementioned locations and the four locations where SVE is currently conducted to maximize the removal of contaminants (by mass) via vapor extraction. Furthermore, the Permittee must propose in the SVE Optimization Plan alternative technologies for the removal and treatment of soil-vapor contamination that do not rely on the use of internal combustion engines. The SVE Optimization Plan must be submitted to NMED by **March 31, 2011**.

J. Special Tests under Interim Measures Work Plan

NMED approves the ROI, hydrocarbon baildown, and Pneulog tests. The Permittee shall conduct the Radius of Influence, the Hydrocarbon Baildown, and PneuLog tests by **April 6, 2011**; **March 2, 2011**; and **December 21, 2011**, respectively.

K. Collection of LNAPL Sample

The Permittee shall collect a sample of LNAPL from one of the groundwater monitoring wells within the LNAPL plume and provide the sample to the Scientific Laboratory Division (SLD) of the New Mexico Department of Health by no later than **March 31, 2011**. The Permittee shall notify the NMED in writing of the delivery of the LNAPL sample to the SLD no later than **1 business day** following delivery of the sample.

The Permittee is directed to conduct all activities required in Part 1 of this letter in accordance with the terms described in each section of this letter and to resubmit the Work Plans with the required revisions along with the changes required by Part 2 of this letter. Any portion of a Work Plan that was not specifically approved and modified as described above is disapproved and must be corrected as described in Part 2.

PART 2
PORTIONS OF WORK PLANS THAT ARE DISAPPROVED

A. Deficiencies Common to All Three Plans

1. Part 1, A.7 of the NOD issued on August 6, 2010, required that the Permittee list the data gaps that apply to each of the three plans, as appropriate for the topic of a plan. The Permittee was also instructed to revise the Interim Measures, Groundwater Investigation, and Vadose Zone Work Plans to include a description of at least the data gaps identified by the NMED and point specifically to where in each of the documents the data gaps are addressed.

This deficiency was not corrected in any of the revised Work Plans submitted on November 4, 2010. The NMED is directing the Permittee again to revise the Interim Measures, Groundwater Investigation, and Vadose Zone Work Plans to include a description of the data gaps identified by the NMED and point specifically to where the data gaps are addressed in each of the documents.

2. Part 1, A.9 of the NOD issued on August 6, 2010, required that the Permittee include a site conceptual model encompassing the source area(s), the fuel percolation area, the light non-aqueous phased liquid (LNAPL) plume floating on groundwater, and the dissolved-phase contaminant plume in groundwater in each of the plans. However, none of the revised Work Plans contains a site conceptual model. Instead, the issue was addressed under the Work Plans by stating that a model will be provided later by the Permittee.

The NMED is directing the Permittee again to revise the Interim Measures, Groundwater Investigation, and Vadose Zone Work Plans to include a site conceptual model encompassing the source area(s), the fuel percolation area, the light non-aqueous phased liquid (LNAPL) plume floating on groundwater, and the dissolved-phase contaminant plume in groundwater in each of the plans. The model should be illustrated through the liberal use of detailed, accurate, and scaled geologic cross-sections, maps in plan view, and any other necessary graphical representations to clearly and accurately show geologic and hydrologic features, and contaminant levels. NMED invites the Permittee to meet to discuss NMED's expectations with respect to the conceptual model and graphic representation of data.

3. Part 1, A.10 of the NOD issued on August 6, 2010, required that the Permittee meet Section E of the NMED's letter of April 2, 2010, which directed that investigation plans are to include relevant maps and cross-sections that show concentration data for contaminants and other relevant information with supporting data posted on the maps and cross-sections, and clearly show which borings/wells contributed data towards construction of the maps and cross-sections and which did not. Additionally, tables including all existing soil borings, soil-gas monitoring wells, and groundwater monitoring wells, listing their surveyed location, sampling points and maximum depth of exploration were also to be included in the plans. For soil-gas monitoring wells, tables and graphs were also to be included providing trends of TPH concentration versus time for the depths below ground surface of 25, 50, 150, 250, 350, and 450 feet.

The required maps, cross-sections, tables, and graphs were not included in the Work Plans submitted November 4, 2010. Revise the Work Plans accordingly.

4. Appendix E, Uniform *Federal Policy-Quality Assurance Project Plan* – This plan is incorporated into the Vadose Zone Investigation, Groundwater Investigation, and Interim Measures Work Plans. The plan, as written, appears to be a combination of many types of plans, such as project management, training, data validation, quality assurance, and sampling and analysis plans. Additionally, much of the information presented appears to be overly burdensome and not particularly useful in the present format. For example, a tabulated listing of field quality control samples to be collected for every quarter/year is unnecessary as the types and frequencies of such samples are not likely to change every quarter or even every year. Listings of quality control targets (in particular, limits for laboratory control samples) from three different entities are also not useful – instead only those that will actually be used for this particular project should be listed.

The Permittee must revise Appendix E into multiple appendices to separate the various types of plans (e.g. project management, training, data validation, quality assurance, and sampling and analysis). The various listings of laboratory analytes per media (QAPP Worksheet # 18a-c), field quality control samples (QAPP Worksheet # 20a-c), quality control targets (Appendix A of Appendix E) should be revised to simplify the information presented and contain only the necessary information to support the Bulk Fuels Facility Spill project. Some tables, such as QAPP Worksheets # 3, 4, 9, 16, 24c, 25, 28a-d, do not provide useful information to the NMED and should be deleted.

NMED is expecting a Quality Assurance (QA) Plan that contains specific quality assurance and quality control activities for the Bulk Fuels Facility Spill project. The QA plan is to integrate all technical and quality aspects of the project to ensure that the necessary type and quality of data are obtained to adequately characterize the release, the contaminated media, and for conducting and verifying clean up. NMED invites the Permittee to meet and discuss NMED's expectation with respect to what should be in the QA Plan, as well as project management, training, data validation, and sampling and analysis plans.

B. Groundwater Investigation Work Plan

1. The Permittee must describe in the first paragraph of Section 5.2.5 what geophysical logging has been previously conducted at existing wells.

2. The last paragraph on page 5-19, Section 5.2.5.1, states "The logs will be run from the groundwater table (approximately 500 ft bgs) to ground surface through the well casing." Correct the text to read "The logs will be run from the bottom of the well to the ground surface." Also, change all references to "groundwater table" in the Groundwater Investigation Work Plan to the correct term "water table".

3. The first sentence on page 5-20, Section 5.2.5.1, references a proposed seismic survey. Discuss the survey, or remove the reference to the seismic survey if such a survey will not be conducted.

4. Section 5.2.5.2, *Induction Logging*, on page 5-22, 3rd paragraph, 1st sentence states: "The borehole induction system can be used in boreholes that range from 2 to 8 inches diameter without significant borehole effects." Because the Permittee is proposing to drill boreholes with diameters of 9-5/8 and 11-3/4 inches, indicate whether the borehole induction system can be used properly in boreholes with diameters greater than 8 inches, or modify the plan to indicate that another, more appropriate tool will be used to log the boreholes.

5. Section 5.2.5.2, *Induction Logging*, page 5-22, the last sentence of the 3rd paragraph states; "The maximum depth of measurement for the most induction logging systems is 650 ft (200) meters)." Explain what this sentence means, as wells many thousands of feet deep are logged using induction logging. If the sentence is incorrect, correct the sentence or delete it from the Work Plan.

6. The last paragraph and bullets in Section 5.2.5.2, *Induction Logging*, discusses general procedures for all geophysical logging. This discussion needs to be moved to a more general section, such as Section 5.2.5 *Logging Requirements*. Also:

   a. Add total depth from the logger to the list of bullets.

   b. Add the same information to the list of bullets that is to be recorded in the first bullet of Section 5.2.3.2 of the Vadose Zone Investigation Work Plan (e.g., logging tool serial number, sensitivity range setting).

   c. The Permittee must include the measured deviation between the "zero point" of the tool at ground level at the start of the logging run and after completing the logging run.

7. Describe in Section 5.2.5.1 of the Work Plan if tools are to be run centralized, decentralized, or free in casing and describe where that information will be recorded.

8. Section 5.2.6.1, Logging System, p.5-25, last sentence, states "The logging system will be equipped with.... cable long enough to log 600-ft.depths." Because some of the groundwater monitoring wells may be 610-620 ft deep, the logging system must be capable of logging the full depth of all wells, even those in excess of 600 ft depth.

9. Table 4-1, Data Quality Objectives Summary Table, in the 3rd and 4th column in row 4, *Define the Study Boundary* states "Study boundaries are indicated on Figure 2-1". Many wells are outside the study boundary shown on the figure. Correct the statement or the figure as appropriate.

Revise Table 4-1 in accordance with the directives in this letter, or delete the table. Although the Permittee may use the EPA's DQO process to plan work, NMED prefers that Table 4-1 and Section 4 be deleted from the Work Plan, as they add little additional useful information. Items in the table should be included in the text of the Work Plan with additional details and as modified in accordance with the directives of this letter.

10. Table 4-1, Data Quality Objectives Summary Table, in the 3rd and 4th column in row 6, *Specify Limits on Decision Errors* states "Borehole geophysics measurements obtained is less than 1 ft." Explain what this sentence means, especially in light of the second sentence in Section 5.2.5.2 on page 5-22, which states "The intercoil spacing resolves conductivity layers 20 inches thick." See comment # 9 above about the deletion of Table 4-1 and Section 4.

11. Section 5.2.7, *Borehole Geophysics Equipment Decontamination* – Revise the Work Plan to indicate clearly that both the cable and probe will be decontaminated.

12. The 2nd paragraph, last sentence of the *Preface* states "Part II will consist of the evaluation of all existing and new data, and development of the risk assessment (including the conceptual site model), and the Groundwater Investigation Report (including cross sections and plan views)."

Revise the Work Plan to include a detailed description of what is to be included in the Part II Work Plan. NMED notes further that the inclusion of a "report" in a work plan is unusual and generally inappropriate. Information derived from newly completed work is normally submitted as a stand alone report, not as a section of a work plan.

Furthermore, the schedule in Appendix B lists the Part II Work Plans as being submitted by August 6, 2011. Because the contents of the Phase II plans are unknown to the NMED, the NMED can not agree to this submittal due date.

13. There are few details of reporting in the Work Plan, and most of those are aimed at the geophysical logging. Revise the Work Plan to include details for reporting on well installation, monitoring, and sampling results.

14. Section 3.5.3, *Identification of Contaminants of Potential Concern*, page 3-10 lists WQCC water quality standards from 20.6.2 NMAC. The cleanup levels for groundwater shall be the New Mexico Water Quality Control Commission (WQCC) water quality standards (20.6.2.3103 and 20.6.2.4103 NMAC) and the drinking water maximum contaminant levels (MCLs) adopted by EPA under the Federal Safe Drinking Water Act (42 U.S.C. §§ 300f to 300j-26). If both a WQCC standard and a MCL have been established for a contaminant, then the most stringent of the two levels shall be the cleanup level for that contaminant.

If a WQCC standard or MCL has not been established for a contaminant, the EPA Regional Screening Level (RSL) (EPA, 2009) for tap water shall be used as the cleanup level. If a RSL for tap water does not exist for a contaminant, and toxicological information is available, the Permittee shall propose a cleanup level based on a residential scenario, a total target human health excess cancer risk level of 10^{-5} and for non-carcinogenic contaminants a HQ of one (1.0). Revise the Work Plan accordingly.

See Permit Section 6.2.3.1.

15. Section 3.5.4, *Light Non-Aqueous Phase Liquid Distribution*, contains a list of wells where LNAPL has been detected. Add well KAFB-10628 to the list.

16. Section 5.2.3.1, page 5-6, 3rd bullet, discusses a scale of 1 inch =10 feet for drilling logs for wells shallower than 200 feet, but does not address a scale for wells greater than 200 feet. Because all wells are likely to be greater than 200 feet deep, identify the scale to be used.

17. Section 5.2.4, Groundwater Monitoring Wells, page 5-14, 2nd paragraph, last sentence states "A schematic showing a well construction detail is included in Appendix D, Forms 4, 5, 6, and 7." None of the four forms seems to fit the proposed construction details with a single cased, telescoped borehole, as shown on Figure 5-1. Revise the Work Plan to include appropriate well-construction field forms.

18. Section 5.2.4.3, *Well Development*, 2nd bullet discusses stabilization of groundwater field parameters during well development. Water stability indicators must be as described in the Permit, not as listed in this section, or as listed in Appendix D. Form 8, *Well Development Record and Water Quality Field Data Sheet (Continued 5 of 6).*

19. Appendix D. Form 8, *Well Development Record and Water Quality Field Data Sheet (Continued 5 of 6)* lists conversion factors to determine the volume of well water to be purged for development and sampling based upon the height of the water column in the well. A distinction is made between a dedicated and non-dedicated system. NMED does not recognize such a

distinction and requires that all well development meet Permit Part 6.5.17.10.6 and that well purging be conducted as directed in NMED's letter of June 4, 2010, and Permit Part 6.5.17.4.

20. Appendix C, *Waste Management Plan*, Table 2 implies that the preferred method of disposal of non-hazardous waste water, a form of investigation-derived waste (IDW), is to discharge it to the ground surface. NMED encourages the Permittee to dispose such non-hazardous waste water into the City of Albuquerque's Publically-Owned Treatment Works (POTW) sewer system. Furthermore, all such water must be containerized and tested prior to disposal in accordance with 20.4.1.300 NMAC incorporating 40 CFR § 262.11. Waste water from one well can not be commingled with that from any other well or wells unless demonstrated not to be a hazardous waste.

21. The Permittee shall address the following concerning Appendix E, *Uniform Federal Policy-Quality Assurance Project Plan.*

a) Appendix E is shown as "(Pending Review)". This suggests that Appendix E is a draft document. Revise the Work Plan to contain only finished products, ready for NMED review.

b) Appendix E, page 77, Section 17.2, first paragraph, correct "April 2009" to the appropriate date.

c) Appendix E, page 77, Section 17.2 must clearly state quarterly groundwater monitoring will occur until a change is approved by NMED.

d) Describe what risk evaluation the Permittee is expecting to do and why.

e) List the data quality objectives that the QAPP must address.

f) Describe the Quality Assurance for geophysical logging.

g) Appendix E, Section 17.5 (and elsewhere) – Samples must be analyzed at an EPA-certified laboratory. Also, the Permittee must indicate whether the referenced Department of Defense Environmental Laboratory Accreditation Program (DoD ELAP) laboratory is EPA-certified. Revise the Work Plan accordingly.

h) Appendix E, Section 17.8, *Investigation-Derived Waste* –This section needs to clearly state that no IDW water from individual wells will be comingled before appropriate testing.

i) Appendix E, Section 17.9.4 states that no trip blanks will be collected for soil samples for VOC analysis. Revise the Work Plan to indicate that trip blanks are required for soil samples that are to be analyzed for VOCs.

j) Appendix E, Section 17.9 must include percent frequency of field quality control samples in each subsection. The sampling frequency must be as described in Permit 6.5.17.6.

k) Appendix E, Section 17.9.5, states field (ambient) blanks will be collected for groundwater only. Revise the Work Plan to include field blanks for soil sampling.

l) Appendix E mainly addresses sampling only for laboratory and field analyses. Other field activities, such as surveying and geophysical logging need to be addressed.

m) Appendix E, Section 17.2.2, *MNA Groundwater Monitoring*, states "30 groundwater monitoring wells will be installed for the monitored natural attenuation (MNA) investigation effort." Specify which wells these are and the purpose of this monitoring given that NMED has not made any decision concerning MNA as a remedy. Additionally, Section 11.2 of Appendix E, indicates that there are 35 wells to be included in the study. Specify which number of wells is correct.

22. Revise the Work Plan to provide for the collection and maintenance of representative soil samples encountered during well installations and to indicate that said samples will be made available for NMED inspection upon request by the NMED. Additionally, Section 11.2 of Appendix E indicates that there are 35 wells to be included in the study. Specify which number of wells is correct.

23. Revise the Work Plan to specify the frequency that soil samples will be tested for grain size via sieve analysis. Indicate the specific sieve screen sizes that will be utilized for the testing.

24. Table 6-2 lists only two soil samples each to be collected for grain size, residual LNAPL saturation, Water/LNAPL Drainage Capillary Pressure and Water LNAPL Relative Permeability and only one LNAPL sample each for testing for viscosity, fluid density and surface and interfacial tension. Revise the Work Plan to describe why these few numbers of samples are sufficient for the range of conditions at the site. Also, clarify in the table if the column titled "No. of Field Samples" is correct, and if the column "Total No. of Samples to Laboratory" is correct.

25. Saturated hydraulic conductivity and porosity are important variables in groundwater flow considerations. Specify field or laboratory tests that will be conducted to arrive at a range of site specific values. Revise the Work Plan to indicate how values for saturated hydraulic conductivity and porosity will be assessed.

C. Vadose Zone Investigation Work Plan

1. Geophysics – Revise the Vadose Zone Investigation Work Plan in accordance with the above Comments 1-8 and 10-11 concerning Groundwater Investigation Work Plan.

2. Geophysical logging is proposed in soil-gas wells with 2-inch casing. Confirm that all tools fit in 2-inch casing, given the neutron probe is described as being 60 mm in diameter (2.36 inches, see page 5-24 of the Groundwater Investigation Work Plan, first paragraph, last sentence) or make an appropriate change in tool size or casing size.

3. For the soil vapor wells, describe where the 2-inch casing will be located in the borehole (e.g., in the center, closer to one side), and if so, how geophysical logging conducted in the 2-inch casing could be affected by the other soil-vapor monitoring points attached to 0.75-inch diameter casing in the same nested borehole.

4. The Work Plan does not include a detailed discussion of soil-vapor sampling. Revise the Vadose Zone Investigation Work Plan to include a section describing soil-vapor sampling in detail, with discussion of sampling methods, analytical methods, sampling frequency, laboratory and field quality control, handling, shipping and packaging, and reporting of results.

5. Section 5.2, top line on page 5-3 references Table 4 of the August 6, 2010, NOD for number, location, and depths of soil borings/soil-vapor wells. The table number is incorrect. The correct reference is Tables 1, 2 and 3.

6. Table 5-2 of the Work Plan does not show an exact correspondence to the August 6 letter. However, NMED will accept the locations as described in Table 5-2.

7. Section 5.2.10, *Soil Borings/Drilling*, page 5-18, last sentence, 1st paragraph, mentions "10 ¾" O.D. casing whereas Figure 5-2 shows "11 ¾" casing. Correct, as appropriate, the figure or the text.

8. Section 5.2.10, *Soil Borings/Drilling*, page 5-18, last sentence, 1st paragraph, mentions telescoping to a smaller diameter borehole at 200 feet, while Figure 5-2 shows telescoping to a smaller diameter borehole at 150 feet. Correct, as appropriate, the figure or the text.

9. Revise the Work Plan to add total depth from the logger to the first bullet of Section 5.2.3.2.

10. In the bullets of Section 5.2.3.2, define what "Assemble the downhole logging tool" means as a type of information recorded, or remove the bullet.

11. Section 6.1, *Soil Sampling*, Revise the Work Plan to indicate that additional samples will be collected and analyzed, beyond those obtained at the planned sampling intervals, if field evidence suggests contamination may be present as required in Permit Part 6.5.11.

12. Describe what will be submitted in Part 2 Vadose Zone Investigation Work Plan, indicate when the information will it be submitted, and explain why any of the information that was required by November 8, 2010, was not included in Part 1.

13. Appendix E, Section 17.3, *Pre-remedy Quarterly Monitoring Program – Soil Vapor*, discusses soil-vapor monitoring. Describe the risk evaluation the Permittee is proposing to conduct and the purpose of the evaluation. Revise the Work Plan to state that soil-gas

monitoring will be conducted quarterly until a change in frequency or termination of soil-gas monitoring is approved by the NMED.

14. Table 5-2 – Correct the date of the "August 8" letter to "August 6" in the title and last column heading.

15. Table 5-2 – Correct the locations listed in the last column under Shallow Borings. The same location is given for the five separate borings. Revise the Work Plan to correct the location numbers.

16. There are few details of reporting in the Work Plan, and most of those are aimed at the geophysical logging. Revise the Work Plan to include details for reporting on well installation, monitoring, and sampling results.

17. Section 5.2.11, Soil Vapor Monitoring Wells, p.5-27, 1st paragraph, discusses movement of the monitoring point by up to 20 feet if the point lies in a fine-grained layer. This is acceptable for the four deepest points (150, 250, 350, 450) but not for the two shallow points (25, 50). Movement of up to +/-5 feet for the shallow points will be acceptable. Screen depths can only be changed if the adjustment sets the screen in a more permeable geologic unit.

18. Section 5.2.11, Soil Vapor Monitoring Wells, p.5-27, 1st paragraph, states "If a large deviation is required, the NMED will be notified in writing of the deviation." All deviations must have prior written approval from NMED.

D. Interim Measures Work Plan

1. Section 2. 4.5.3.2, Waste Profiling – The Work Plan states that soil will be characterized in place by sampling waste, but is unclear how sample locations will be selected and at what frequency that samples will be collected. Revise the Work Plan accordingly.

2. Section 4.6.11, Radius of Influence (ROI) Testing – The Work Plan does not indicate which existing wells will be used for the testing. Revise the Work Plan to list the wells to be used in the ROI tests.

3. Section 4.6.2.4 states that soil-gas wells will be constructed with 2-inch casing. Figure 4-4 indicates that the deepest monitoring point will be constructed using 3-inch casing. Revise the Work Plan to indicate the correct casing diameter. If 2-inch casing is correct, confirm that all geophysical tools will fit in 2-inch casing, given the neutron probe is described as being 60 mm in diameter (2.36 inches, see p.5-24 of the Groundwater Investigation Work Plan, first paragraph, last sentence) or make an appropriate change in tool size or casing size.

If 2-inch casing is correct, describe where the 2-inch casing will be located in the borehole (e.g., in the center, closer to one side), and if so, how geophysical logging conducted in the 2-inch casing could be affected by the other soil-vapor monitoring points attached to 0.75-inch diameter casing in the same nested borehole.

Final Direction

The Permittee must meet the deadlines specified in the Compliance Schedule at the end of this letter. The Interim Measures, Groundwater Investigation, and Vadose Zone Work Plans must be revised and resubmitted by the Permittee to the NMED for its review and approval by **March 31, 2011**. The revisions of the Vadose Zone, Interim Measures, and Groundwater Investigation Work Plans must address the comments noted herein and incorporate the requirements set forth in this letter. The Permittee shall also implement the interim measures and other actions as directed under Part 1 of this letter by the dates indicated and in accordance with the Compliance Schedule.

To the extent any requirement of this letter requires access to property not owned or controlled by the Permittee, the Permittee shall use its best efforts to obtain access from the present owners of such property to conduct the required activities. In the event that access is not obtained when necessary, the Permittee shall immediately notify the Department in writing regarding its best efforts and its failure to obtain such access.

The Permittee must document all field activities in accordance with Permit Part 6.5.2. All equipment that is not disposable must be decontaminated pursuant to Permit Part 6.5.3. All equipment that requires calibration must be calibrated as required under Permit Part 6.5.4. Sample handing, shipping, and custody procedures must comply with Permit Part 6.5.5. The collection and management of investigation-derived waste must conform to Permit Part 6.5.7. Well and boring locations must be surveyed in accordance with Permit Part 6.5.8. Field quality control samples must be collected and analyzed for all environmental media pursuant to Permit Parts 6.5.14 and 6.5.17.6. Laboratory analyses, including laboratory quality control samples, must be conducted as required under Permit Part 6.5.18. Field and laboratory quality control data must be reviewed and validated in accordance with Permit Part 6.5.18.3. Reporting of field activities, including sampling and analysis results, completion of soil borings, geologic and geophysical logging, and well installations, must be as directed by NMED's letter of June 4, 2010, for quarterly reporting.

The requirement under Permit Part 6.1.2 that the Permittee is to notify the NMED a minimum of 15 days in advance of field activities is waived for the work to be completed in the following sections of Part 1 of this letter: *A. Installation of New Groundwater Monitoring Wells, B. Development of Existing Wells, C. Geophysical Logging of Existing Wells, D. Completion of Soil Borings, Installation of New Soil-Gas Monitoring Wells, and I. Soil-Vapor Extraction.* The Permittee shall instead notify the NMED of these field activities by e-mail or letter by no later than the date that each of the activities begins.

Compliance Schedule

Revisions to Work Plans	
Submittal	**Due Date**
Interim Measures Work Plan	March 31, 2011
Vadose Zone Work Plan	March 31, 2011
Groundwater Investigation Work Plan	March 31, 2011
Well Installations, Soil Borings, Interim Measures, and other Actions	
Activity	**Completion Due Date**
Complete installation of new groundwater monitoring wells	April 28, 2011
Complete development of existing wells	February 15, 2011
Complete geophysical logging of existing wells	February 15, 2011
Complete soil borings	February 11, 2011
Complete installation of new soil-gas monitoring wells	February 11, 2011
Complete geophysical logging of new groundwater and soil-gas wells	June 1, 2011
Complete excavation of soil at former Fuel Offloading Rack	October 6, 2011
Complete investigation of piping from Building 1033 to storage tanks	March 7, 2011
Complete preparation of locations for soil-vapor extraction	February 15, 2011
Submit SVE Optimization Plan to NMED	March 31, 2011
Complete Radius of Influence tests	April 6, 2011
Complete Hydrocarbon Baildown tests	March 2, 2011
Complete PneuLog tests	December 21, 2011
Provide LNAPL sample to Scientific Laboratory Division of NM Department of Health	March 31, 2011
Notify NMED that LNAPL sample has been delivered to Scientific Laboratory Division of NM Department of Health	No later than 1 business day following delivery of the sample.

LNAPL Plume

NMED's directives as expressed in its April 2, 2010, letter and the August 6, 2010, NOD required the Permittee to provide an Interim Measures Work Plan to conduct interim measures to remediate the LNAPL plume within five years. The revised Interim Measures Work Plan submitted November 4, 2010, does not contain such a plan. Rather than complying with NMED's direction to take immediate action to conduct LNAPL remediation, the Permittee proposes in the revised Interim Measures Work

Plan to conduct various tests. This same approach was proposed in the Permittee's June 18, 2010 version of the Work Plan, and was found unacceptable by NMED (*see* August 6, 2010 NOD).

On December 1, 2010, the Permittee submitted a separate plan to contain the LNAPL plume by proposing to pump and treat contaminated groundwater at the leading edge of the LNAPL plume. NMED will review this plan to determine whether it meets NMED's directives of April 2, 2010, and the NOD issued August 6, 2010, and otherwise proposes a sound technical approach. NMED's action on that plan will be provided under separate cover.

The Permittee must respond to this letter to my attention, with copy to Mr. Bill Olson of the NMED Ground Water Quality Bureau, and Mr. William Moats (NMED HWB, 5500 San Antonio NE, Albuquerque, NM 87109), on all correspondence and required plans and reports related to the Bulk Fuels Facility Spill, unless otherwise directed by NMED. All submittals and correspondence must be submitted in hardcopy and electronic format.

Please contact me directly at 505-476-6016 should you have any questions. Questions of a technical nature may also be directed to William Moats of my staff at (505) 222-9551.

Sincerely,

James P. Bearzi
Chief
Hazardous Waste Bureau

cc: J. Kieling, NMED HWB
W. Moats, NMED HWB
W. McDonald, NMED HWB
S. Brandwein, NMED HWB
B. Olson, NMED GWQB
B. Swanson, NMED GWQB
L. Barnhart, NMED OGC
B. Gallegos, AEHD
B. Gastian, ABCWUA
L. King, EPA-Region 6 (6PD-N)
T. Chapman, DOH SLD
File: Reading and KAFB 2010

APPENDIX B

Project Schedule

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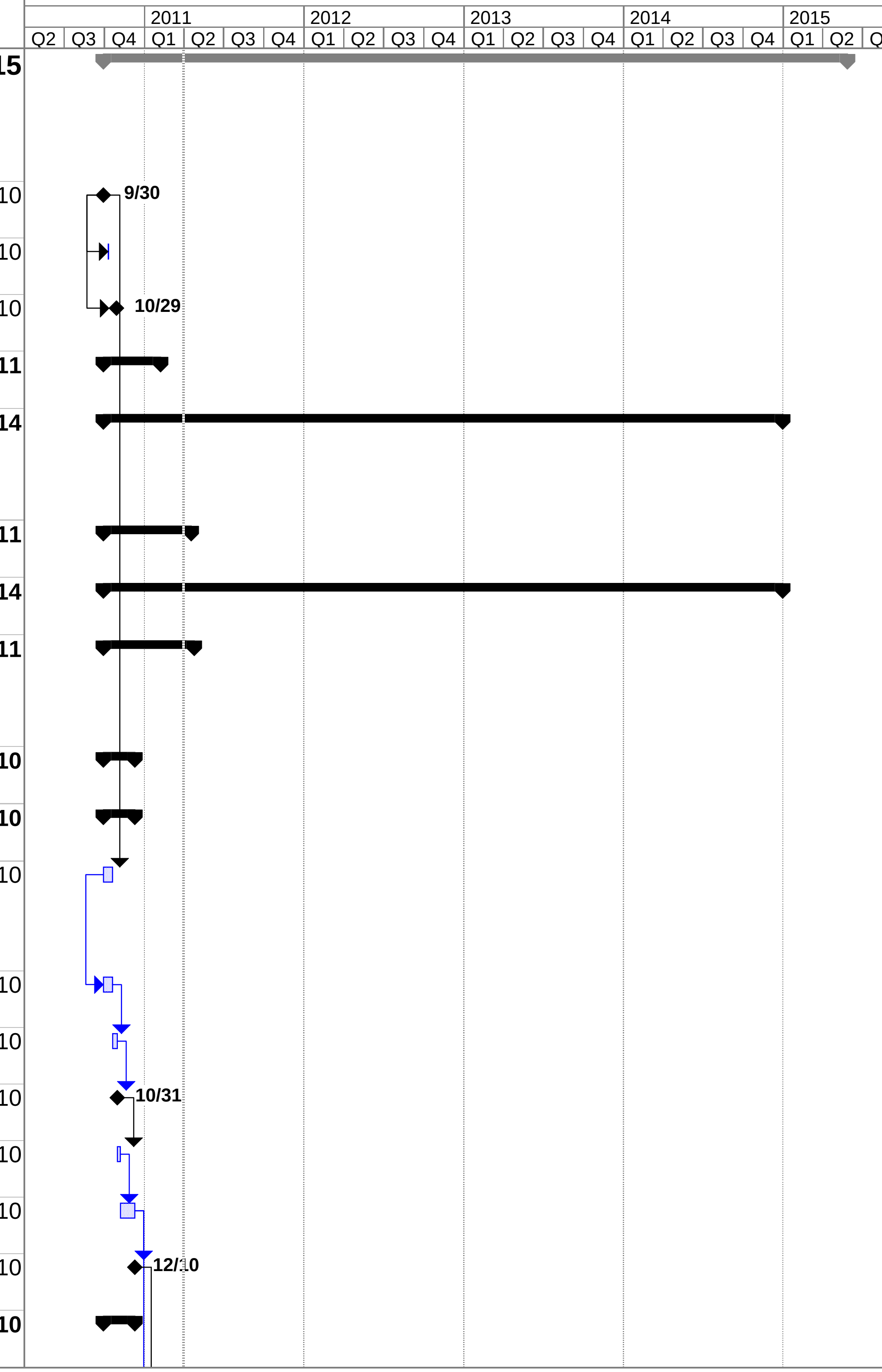
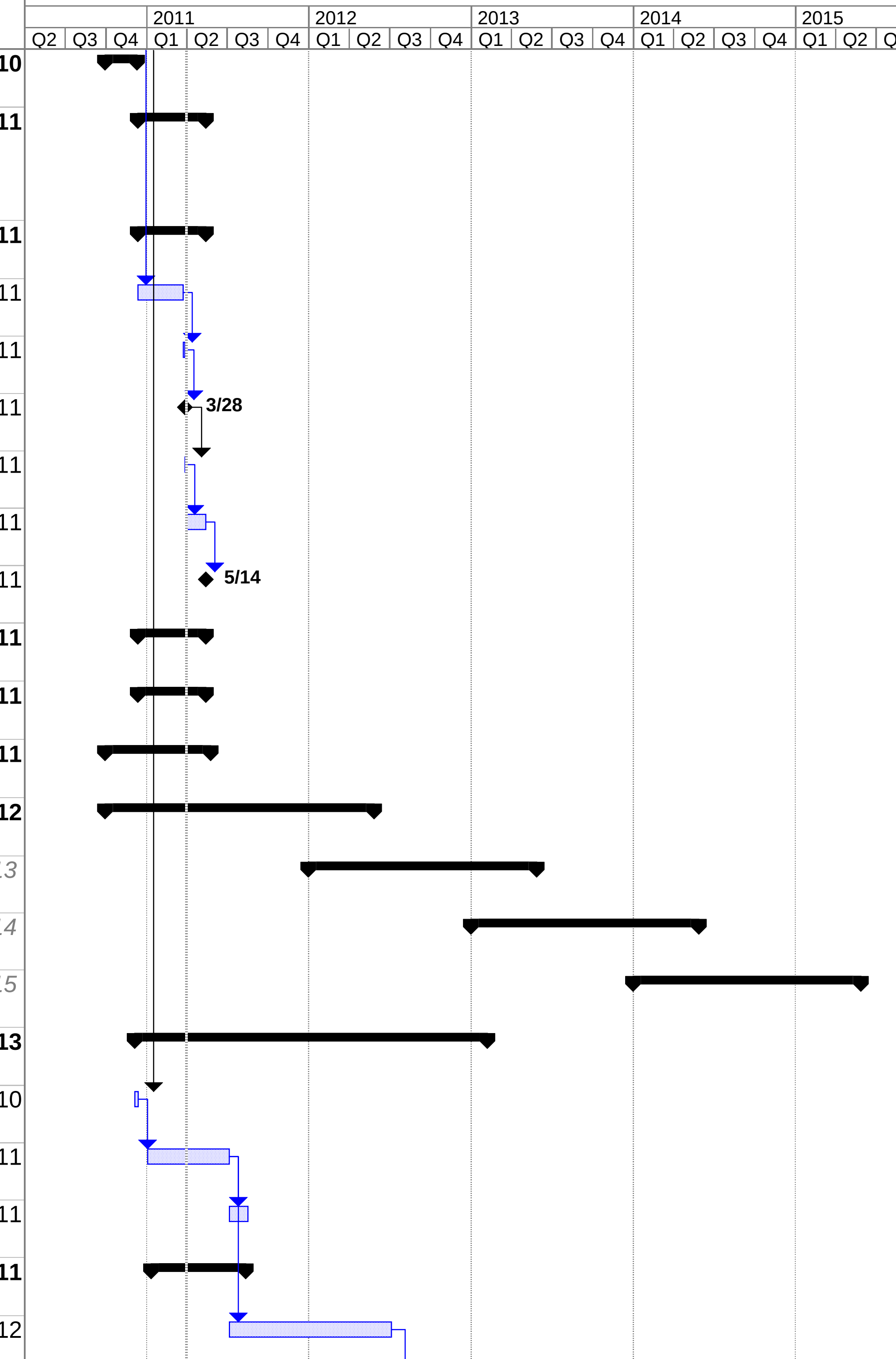
Activity ID	QA PM	CLIN Sub-CLIN	Task Name	Duration	Start	Finish
0		2001	**Kirtland Air Force Base Environmental Remediation Services at Bulk Fuels Facility (BFF)**	**1702 days**	**Thu 9/30/10**	**Thu 5/28/15**
1			Task Order Award/Notice to Proceed	0 days	Thu 9/30/10	Thu 9/30/10
2			Project Kick-Off Meeting	1 day	Mon 10/11/10	Mon 10/11/10
3			Submit Well Permit Application	0 days	Fri 10/29/10	Fri 10/29/10
4		**2001AA**	**Project Management Plan (PMP) and Quality Assurance Surveillance Plan (QASP)**	**131 days**	**Thu 9/30/10**	**Mon 2/7/11**
12		**2001AB**	**Site Plans in Accordance w / Performance Work Statement (PWS) and Community Relations**	**1554 days**	**Thu 9/30/10**	**Wed 12/31/14**
13			**Community Relations Plan (CRP)**	**201 days**	**Thu 9/30/10**	**Mon 4/18/11**
23			**Community Relations**	**1554 days**	**Thu 9/30/10**	**Wed 12/31/14**
99			**Pre-Remedy Monitoring Work Plan, Health and Safety Plan (HASP), Quality Assurance Project Plan (QAPP)**	**208 days**	**Thu 9/30/10**	**Mon 4/25/11**
110			**Vadose Zone, Groundwater and Interim Measures Work Plans - Part I**	**72 days**	**Thu 9/30/10**	**Fri 12/10/10**
111			**Investigation Work Plan for the Vadose Zone at the BFF**	**72 days**	**Thu 9/30/10**	**Fri 12/10/10**
112			Prepare Draft Final Investigation Work Plan for the Vadose Zone (Revise Existing Plan/Incorporate Regulator Comments)	21 days	Thu 9/30/10	Wed 10/20/10
113			Prepare Draft ROE	21 days	Thu 9/30/10	Wed 10/20/10
114	QA		Army/Air Force Review	11 days	Thu 10/21/10	Sun 10/31/10
115	PM		Army/Air Force Approval of Draft Final	0 days	Sun 10/31/10	Sun 10/31/10
116			Prepare Final Vadose Zone Investigation Work Plan	7 days	Mon 11/1/10	Sun 11/7/10
117	QA		Regulator/Stakeholder Review	33 days	Mon 11/8/10	Fri 12/10/10
118	PM		Conditional Notice to Proceed	0 days	Fri 12/10/10	Fri 12/10/10
119			**Investigation Work Plan for Groundwater at the BFF**	**72 days**	**Thu 9/30/10**	**Fri 12/10/10**



Project: Kirtland Air Force Base Envir
Date: Wed 3/30/11

Task | Critical Task | Progress | Milestone | Summary | Rolled Up Task | Rolled Up Critical Task | Rolled Up Milestone | Rolled Up Progress | Split | External Tasks | Project Summary | Group By Summary | Deadline

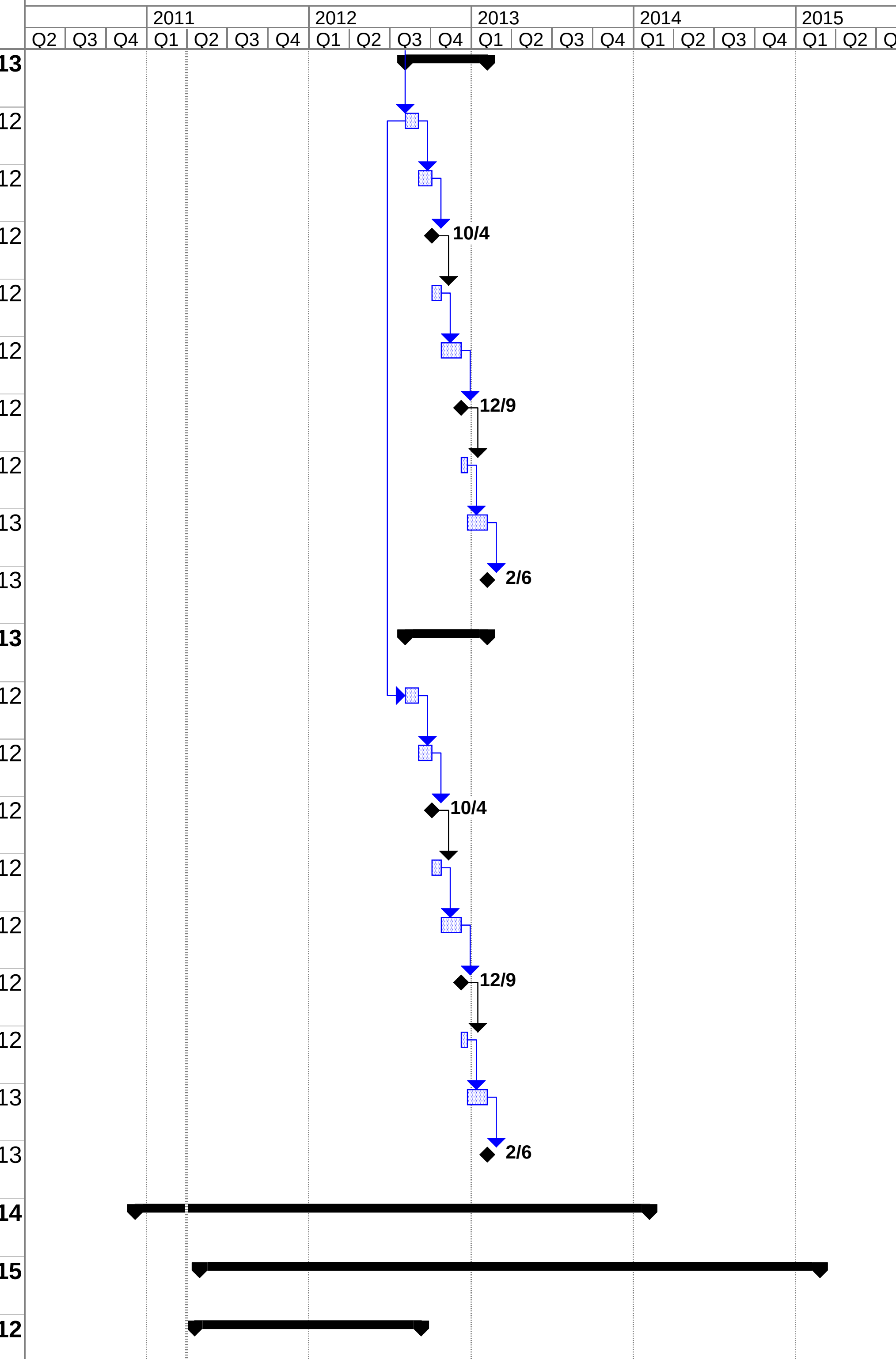
Activity ID	QA PM	CLIN Sub-CLIN	Task Name	Duration	Start	Finish
127			**Interim Measures Work Plan**	**72 days**	**Thu 9/30/10**	**Fri 12/10/10**
134			**Vadose Zone, Groundwater and Interim Measures Work Plans - Response to Comments (RTCs)**	**153 days**	**Mon 12/13/10**	**Sat 5/14/11**
135			**Investigation Work Plan for the Vadose Zone at the BFF**	**153 days**	**Mon 12/13/10**	**Sat 5/14/11**
136			RTCs on Investigation Work Plan for the Vadose Zone	102 days	Mon 12/13/10	Thu 3/24/11
137	QA		Army/Air Force Review	4 days	Fri 3/25/11	Mon 3/28/11
138	PM		Army/Air Force Approval	0 days	Mon 3/28/11	Mon 3/28/11
139			Prepare Final Vadose Zone Investigation Work Plan	2 days	Tue 3/29/11	Wed 3/30/11
140	QA		Regulator/Stakeholder Review	45 days	Thu 3/31/11	Sat 5/14/11
141	PM		Regulator/Stakeholder Approval	0 days	Sat 5/14/11	Sat 5/14/11
142			**Investigation Work Plan for Groundwater at the BFF**	**153 days**	**Mon 12/13/10**	**Sat 5/14/11**
149			**Interim Measures Work Plan**	**153 days**	**Mon 12/13/10**	**Sat 5/14/11**
156			**Light Non-Aqueous Phase Liquid (LNAPL) Containment Work Plan**	**238 days**	**Thu 9/30/10**	**Wed 5/25/11**
168		**2001BA**	**Pre-Remedy Quarterly Monitoring and SVE Operation FY 2011**	**606 days**	**Thu 9/30/10**	**Sun 5/27/12**
267		*2001BB*	*Pre-Remedy Quarterly Monitoring and SVE Operation FY 2012*	*514 days*	*Sun 1/1/12*	*Tue 5/28/13*
379		*2001BC*	*Pre-Remedy Quarterly Monitoring and SVE Operation FY 2013*	*513 days*	*Tue 1/1/13*	*Wed 5/28/14*
491		*2001BD*	*Pre-Remedy Quarterly Monitoring and SVE Operation FY 2014*	*513 days*	*Wed 1/1/14*	*Thu 5/28/15*
603		**2001CA**	**Complete Investigation at BFF Vadose Zone**	**794 days**	**Mon 12/6/10**	**Wed 2/6/13**
604			Mobilize Personnel and Equipment	6 days	Mon 12/6/10	Mon 12/13/10
605			Install 35 6-ported Nested Soil Vapor Monitoring Wells	132 days	Tue 1/4/11	Wed 7/6/11
606			Down Hole Geophysical Logging at 35 New Vapor Monitoring Wells	30 days	Thu 7/7/11	Wed 8/17/11
607			**Well Completion Logs**	**213 days**	**Wed 1/12/11**	**Fri 8/12/11**
629			Sampling, Analysis and Validation at BFF Soil Vapor Wells (quarterly - 1 year)	365 days	Thu 7/7/11	Thu 7/5/12



Project: Kirtland Air Force Base Envir
Date: Wed 3/30/11

Task		Milestone	◆	Rolled Up Critical Task		Split		Group By Summary	
Critical Task		Summary		Rolled Up Milestone	◇	External Tasks		Deadline	⇩
Progress		Rolled Up Task		Rolled Up Progress		Project Summary			

Activity ID	QA PM	CLIN Sub-CLIN	Task Name	Duration	Start	Finish
630			**Risk Assessment**	**185 days**	**Mon 8/6/12**	**Wed 2/6/13**
631			Prepare Draft Risk Assessment	30 days	Mon 8/6/12	Tue 9/4/12
632	QA		Army/Air Force Review	30 days	Wed 9/5/12	Thu 10/4/12
633	PM		Army/Air Force Approval	0 days	Thu 10/4/12	Thu 10/4/12
634			Prepare Draft Final Risk Assessment	21 days	Fri 10/5/12	Thu 10/25/12
635	QA		Regulator/Stakeholder Review	45 days	Fri 10/26/12	Sun 12/9/12
636	PM		Receive Regulator/Stakeholder Comments	0 days	Sun 12/9/12	Sun 12/9/12
637			Prepare Final Risk Assessment	14 days	Mon 12/10/12	Sun 12/23/12
638	QA		Regulator/Stakeholder Review	45 days	Mon 12/24/12	Wed 2/6/13
639	PM		Regulator/Stakeholder Approval	0 days	Wed 2/6/13	Wed 2/6/13
640			**Vadose Zone Investigation Report**	**185 days**	**Mon 8/6/12**	**Wed 2/6/13**
641			Prepare Draft Vadose Zone Investigation Report	30 days	Mon 8/6/12	Tue 9/4/12
642	QA		Army/Air Force Review	30 days	Wed 9/5/12	Thu 10/4/12
643	PM		Army/Air Force Approval	0 days	Thu 10/4/12	Thu 10/4/12
644			Prepare Draft Final Vadose Zone Investigation Report	21 days	Fri 10/5/12	Thu 10/25/12
645	QA		Regulator/Stakeholder Review	45 days	Fri 10/26/12	Sun 12/9/12
646	PM		Receive Regulator/Stakeholder Comments	0 days	Sun 12/9/12	Sun 12/9/12
647			Prepare Final Vadose Zone Investigation Report	14 days	Mon 12/10/12	Sun 12/23/12
648	QA		Regulator/Stakeholder Review	45 days	Mon 12/24/12	Wed 2/6/13
649	PM		Regulator/Stakeholder Approval	0 days	Wed 2/6/13	Wed 2/6/13
650		**2001CB**	**Complete Investigation for BFF Groundwater**	**1158 days**	**Tue 12/7/10**	**Thu 2/6/14**
726		**2001DA**	**Installation of Interim Measure (IM) for Light Non-Aqueous Phase Liquid (LNAPL)**	**1397 days**	**Sat 4/30/11**	**Wed 2/25/15**
874		**2001EA**	**Interim Measure (IM) for Vadose Deep / Shallow Zone**	**510 days**	**Wed 4/20/11**	**Mon 9/10/12**



Project: Kirtland Air Force Base Envir
Date: Wed 3/30/11

Task		Milestone		Rolled Up Critical Task		Split		Group By Summary	
Critical Task		Summary		Rolled Up Milestone		External Tasks		Deadline	
Progress		Rolled Up Task		Rolled Up Progress		Project Summary			

Activity ID	QA PM	CLIN Sub-CLIN	Task Name	Duration	Start	Finish
931		**2001GA**	**Groundwater IM**	**667 days**	**Tue 2/1/11**	**Wed 11/28/12**

Timeline: 2011, 2012, 2013, 2014, 2015 — Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3

Project: Kirtland Air Force Base Envir
Date: Wed 3/30/11

Legend: Task; Critical Task; Progress; Milestone; Summary; Rolled Up Task; Rolled Up Critical Task; Rolled Up Milestone; Rolled Up Progress; Split; External Tasks; Project Summary; Group By Summary; Deadline

APPENDIX C

Waste Management Plan

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KIRTLAND AIR FORCE BASE
ALBUQUERQUE, NEW MEXICO

WASTE MANAGEMENT PLAN
BULK FUELS FACILITY SPILL
SOLID WASTE MANAGEMENT UNITS ST-106 AND SS-111

March 2011

Prepared for
U.S. Army Corps of Engineers
Albuquerque District
Albuquerque, New Mexico 87109

USACE Contract No. W912DY-10-D-0014
Delivery Order 0002

Prepared by
Shaw Environmental & Infrastructure, Inc.
7604 Technology Way, Suite 300
Denver, Colorado 80237

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TABLES

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ACRONYMS AND ABBREVIATIONS

ABCWUA	Albuquerque Bernalillo County Water Utility Authority
AFB	Air Force Base
BTEX	benzene, toluene, ethylbenzene, and xylenes
CFR	Code of Federal Regulations
CHOX	chemical oxidation
CMBST	high-temperature organic destruction
DOT	U.S. Department of Transportation
EPA	U. S. Environmental Protection Agency
IDW	investigation-derived waste
INCIN	incineration
LF	landfill
mg/kg	milligrams per kilogram
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
PCB	polychlorinated biphenyl
PPE	personal protective equipment
RCRA	Resource Conservation and Recovery Act
STABL	stabilization
SVOC	semivolatile compound
TCLP	toxicity characteristic leaching procedure
TPH	total petroleum hydrocarbons
VOC	volatile organic compound
WMP	Waste Management Plan
WWT	wastewater treatment

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1. INTRODUCTION

This document will serve as the Waste Management Plan (WMP) for environmental activities performed at Kirtland Air Force Base (AFB) in support of investigation of the BFF Spill, under U.S. Army Corps of Engineers contract W912DY-10-D-0014, Delivery Order 0002. The WMP governs the minimization, generation, management, storage, and transport and disposal of wastes that are routinely encountered during these environmental activities. The primary focus of this WMP is the management of investigation-derived waste (IDW). Wastes generated during the execution of remedial actions will be governed by this plan to the extent that they can be predicted and easily accommodated with the scope of this WMP.

1.1 Purpose

The purpose of waste management, particularly IDW management, is to leave the site in no worse condition after the implementation of activities than existed before the activities began, and to comply with federal and state waste management regulations and applicable or relevant and appropriate requirements to the extent practicable. These management procedures are directed toward waste minimization to reduce the quantity of waste that will require treatment, storage, or disposal.

1.2 Definitions

Cross-contamination—spread of chemicals from one item to another or from one location to another.

Debris—a solid material exceeding a 60 millimeters particle size that is intended for disposal that can be classified as a manufactured object, plant, or animal matter, or natural geologic material. The following materials are not debris—any material for which a specific treatment standard is provided in Resource Conservation and Recovery Act (RCRA) Subpart D, Part 268; process residuals such as smelter slag and residues from treatment of waste, wastewater sludges, or air emission residues; and intact containers of hazardous waste that are not ruptured and that retain at least 75 percent of their original volume.

Decontamination Fluids—fluids generated after decontamination of equipment. Fluids include soapy water, rinse water, solvents (e.g., isopropanol), and contaminated media removed from equipment during the decontamination process.

Dewatering Fluids—liquid waste generated from dewatering operations in excavations, retention ponds, and drainage channels.

Disposable Equipment—equipment that cannot be decontaminated at the conclusion of an environmental restoration activity and requires disposal. IDW disposable equipment includes bailers, coliwasas (samplers designed to permit representative sampling of multi-phase wastes from drums and other containerized wastes), jars and containers, plastic sheeting, foil, disposable laboratory equipment, etc. Disposable equipment from remedial activities includes small tools, barrier materials, decontamination pad equipment, hoses, chains, timber, survey stakes, etc.

Free Liquids—liquids that readily separate from the solid portion of a waste under ambient temperature and pressure.

Hazardous Waste—a solid waste is a hazardous waste if it is not excluded from regulation as a hazardous waste and exhibits any characteristic of hazardous waste identified in Subpart C and/or D of 40 Code of Federal Regulations (CFR) part 261.

Mixed Waste—radioactive waste that also contains a hazardous waste component regulated under RCRA (see definition of hazardous waste). Although not strictly a mixed waste, radioactive waste containing wastes regulated by the Toxic Substances Control Act (e.g., polychlorinated biphenyls [PCBs], asbestos) or naturally occurring radioactive materials are also considered to be a mixed waste under this plan.

Personal Protective Equipment (PPE)—coveralls, gloves, respirator cartridges, tape, boots, etc.

Purge Water—groundwater pumped from a borehole (monitoring well) prior to sampling.

Radioactive Waste—waste that contains higher than background levels of radioactivity, or is otherwise not releasable for use by the general public. Waste that can be disposed of without regard to its radioactivity is not considered radioactive waste.

Remediation Waste—any media or debris resulting from environmental restoration activities that meet the definition of solid waste in 40 CFR Part 261.

Representative Sample—a sample of a universe or whole (e.g., waste pile, lagoon, groundwater) that can be expected to exhibit the average properties of the universe or whole.

Soil Cuttings—excess soil removed by the direct-push and hollow-stem auger drilling techniques.

Special Waste—New Mexico defines "Special Waste" as the following types of solid wastes that have unique handling, transportation, or disposal requirements to ensure protection of the environment and public health and safety:

- Treated formerly characteristic hazardous wastes
- Packing house and killing plant offal
- Asbestos waste
- Ash
- Infectious waste
- Sludge
- Industrial process waste
- Residue from a spill of a chemical substance or commercial product (including contaminated soils)
- Dry chemicals, which when wetted, become characteristically hazardous

The New Mexico Environment Department (NMED) also defines petroleum-contaminated soil as "Special Waste" if the sum of benzene, toluene, ethylbenzene, and xylene (BTEX) isomer concentrations is greater than 500 milligrams per kilogram (mg/kg), with benzene individually greater than 10 mg/kg, and total petroleum hydrocarbon (TPH) concentration greater than 1,000 mg/kg.

1.3 IDW Minimization

A primary goal of the WMP is to minimize, to a practical extent, the volume of waste that will be generated, stored, and removed from the site for disposal. In order to minimize the volume of waste, the following general rules will be applied:

- Do not contaminate materials unnecessarily:
  - Plan work ahead, based on the work procedure to be used.

- Take only the material (i.e., chemicals) needed to perform the work activity. Additional material can be brought to the work location if it is found to be necessary. Materials can be stored in large containers but the smallest reasonable container will be used to transport the material to the location where it is needed.
- Maintain cleaning and extra sampling supplies outside any potentially contaminated area to keep them clean and to minimize additional waste generation.
- Maintain or construct prefabricated materials, barriers, support equipment, etc., outside potentially contaminated areas.
- Perform mixing of detergents or decontamination solutions outside potentially contaminated areas.
- Do not place media considered hazardous for different reasons together.
- Use drop cloths or other absorbent material to contain small spills or leaks.
- Avoid a bellows effect when double-bagging contaminated materials.
- Use containers to minimize the spread of contamination.
- Do not place contaminated materials with clean materials.
- Cover wooden pallets inside the exclusion zone with plastic. Decontaminate and re-use material and equipment when practical. Use volume reduction techniques when practicable.
- Verify that waste containers are solidly packed to minimize the number of containers.
- Use only the size of container to meet needs (i.e., do not use a drum or garbage can when a small polyethylene bag will do).
- Use less hazardous substances whenever possible (i.e., bring only the volume of standard solutions needed for testing, use minimal amounts of decontamination water and solvent rinses).
- Use direct-push, hydropunch, or any other waste minimizing sample acquisition techniques whenever possible.

1.4 Regulatory Context

NMED regulates environmental activities in the State of New Mexico. Environmental restoration work at Kirtland AFB is under the jurisdiction of both NMED and the U.S. Environmental Protection Agency (EPA), Region 6. Consequently, the following federal and state regulations form the regulatory context in from which waste management decision making at Kirtland AFB will derive:

- 40 CFR Parts 260 -299, EPA regulations for identification and management of hazardous waste
- 40 CFR Part 761, EPA regulations for management of PCBs
- 49 CFR Parts 100-178, U.S. Department of Transportation (DOT) rules for hazardous materials transport

- 20 New Mexico Administrative Code (NMAC) Chapter 9, New Mexico Solid Waste Management Regulations
- 20 NMAC Chapter 4, New Mexico Hazardous Waste Management Regulations
- 20 NMAC Chapter 5, New Mexico Underground Storage Tanks Regulations
- 20 NMAC Chapter 9, New Mexico Special Waste Requirements Regulations
- 20 NMAC Chapter 6, New Mexico Water Quality Control Commission Regulations

2. WASTE MANAGEMENT APPROACH

From the time that waste is generated through its ultimate disposal, waste will be managed in compliance with applicable regulatory requirements and in a manner that is protective of human health and the environment. All waste will be managed in compliance with applicable federal, state, local, and Kirtland AFB regulations. A regulatory expert will be actively involved in all planned activities to ensure that the appropriate characterization strategy will be used on a waste-to-waste basis. Furthermore, once characterization data are available, the regulatory expert will interpret the data and in combination with all other associated site history and project circumstance, provide a path forward for managing each waste generated in a timely and compliant manner.

2.1 Project-Specific Wastes

IDW anticipated to be generated during BFF Spill investigation and remediation field activities will consist of contaminated environmental media and associated waste materials from soil (excavation and sampling), drill/soil cuttings (from boreholes and well installation), monitoring well purge and development water, decontamination water, and water generated from pump tests. Waste material associated with these activities includes disposable PPE, disposable sampling equipment (e.g., scoops, bowls), and other inert materials (e.g., plastic, rope, tape, and paper).

2.2 Waste Accumulation and Storage Areas for Containers

Wastes governed by this plan shall be properly managed in an appropriate waste accumulation or storage area from the time it is generated until it is removed from the area (e.g., for disposal or further management). These areas will be, when practical, within the area of contamination at the point of generation. Otherwise waste containers will be staged at strategic and secure areas onsite until waste is properly disposed.

Waste accumulation and storage areas will be kept orderly and clear of non-waste-related items at all times. Minimum standards for the accumulation of waste in containers will be implemented at waste storage areas to ensure that waste is managed in a protective manner. Waste staging areas are not bound by specified time limits as are hazardous waste accumulation/storage areas. Inspections will be required weekly and will included visual confirmation of the following:

- Container is closed securely and/or locked.
- Container is in good condition (i.e., no excessive rust or dents that could compromise container integrity).
- All container labels are legible.
- Pertinent information is marked on drum/label (i.e., site of origin, waste contents, date of generation).
- Waste volume in container has not changed since the last inspection (only for containers where a visual assessment of volume is possible).

2.3 Container Management

IDW may be contained in drums, roll-off boxes, polyethylene tanks, or similar containers. IDW that is placed in a container (i.e., drum, roll-off box) will be managed in accordance with the following practices:

- Containers will be inspected upon receipt and/or before use to ensure the structural integrity of the containers.

- Only DOT-compliant containers will be used to accumulate, store, or transport waste generated at Kirtland AFB.

- Containers used for management of bulk IDW will be secured with a mechanism to prevent tampering. All access points to IDW containers (e.g., drum bungs, roll-off tarps) will be tightened with tools, as necessary, to prevent casual access.

- Once IDW is placed in the container, an appropriate label will be affixed to the container. The label must include the following basic waste identification information:

  - A unique container number
  - Accumulation start date
  - Site identification
  - Contents (e.g., soil, purge water)
  - Emergency contact information
- Drums will be positioned to allow for clear observation of labels and visual inspections for potential leaks. If an aisle is required in the drum storage area in order for a clear visual inspection of the drums, a minimum of three feet aisle space is recommended.

- Containers must always be closed, unless waste is being added to the container.

- Once the waste evaluator has fully characterized a particular waste stream, appropriate label(s) and markings will be placed on the container to reflect the characterization. Any previous labels or markings that were not accurate will be removed.

- Unless special circumstances warrant, IDW from different area of contaminations will not be mixed within a single container.

2.4 Additional Requirements for Hazardous Waste Containers

IDW that has been characterized as hazardous waste will be accumulated or stored in accordance with 40 CFR 262. The following requirements are applicable to only hazardous waste and are in addition to the general container management requirements.

- Containers of fully characterized hazardous waste accumulated in a generator 90-day area will have a hazardous waste label affixed to them and will be marked with the following information:

  - Generator information (name, address)
  - Kirtland EPA identification number
  - Applicable EPA waste number(s) (e.g., D008, F001)
  - Accumulation start date
  - Proper DOT shipping name
  - Appropriate DOT hazard class sticker(s)

In accordance with applicable state and federal hazardous waste and/or DOT regulations additional markings and/or labels may be required in preparation for transport of waste containers off-site.

2.5 Waste Staging Area for Stockpiles

Waste staging areas are defined strictly for the purposes of this plan, as areas within an area of contamination that will be used for the accumulation of stockpiling of soil or water, awaiting further management (e.g., treatment, disposal). Waste staging areas will be established within the boundaries of an area of contamination. Waste staging areas will be established and maintained by the contractor field team manager. For the purpose of the BFF spill remediation activities, centralized waste staging will be located at the BFF spill site location at Kirtland AFB.

2.6 Waste Characterization

IDW will be characterized using data obtained from the analysis of environmental samples collected during the investigation and quarterly monitoring activity that generated the waste, through analysis of samples collected directly from the waste, through knowledge of waste-generating process, or through a combination of these methods. A hazardous waste evaluation will occur for all waste generated at the site. If a particular waste meets the definition of a solid waste and is not excluded from regulation, it will then be determined if the waste meets the criteria of hazardous (characteristic and/or listed) or non-hazardous.

For the purpose of the BFF project, the Kirtland AFB active onsite landfill (LF-268) will be used for disposal of solid non-hazardous wastes. Kirtland AFB currently requires all waste being disposed at LF-268 to be analyzed for the following list of parameters for submittal in order to obtain approval for disposal at the landfill. The requirements include the following:

- Ignitability characteristic as defined in 40 CFR Part 261,
- Corrosivity characteristic as defined in 40 CFR Part 261,
- Reactivity characteristic as defined in 40 CFR Part 261, and
- Toxicity characteristic as defined by EPA Test Method 1311, toxicity characteristic leaching procedure (TCLP) for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), RCRA l metals, herbicides, and pesticides

Analysis for petroleum hydrocarbons is only required for wastes suspected of having petroleum-based contamination. The required petroleum hydrocarbon analyses include:

- TPH by EPA Test Method 8015B
- BTEX by EPA Test Method 8260B or 8021B

Table 1, Landfill-268 Waste Acceptance Criteria, summarizes acceptable levels that are applicable when utilizing the onsite landfill for waste disposal.

Table 1 – Kirtland AFB Landfill-268 Waste Acceptance Criteria

Constituent	Regulatory Level*	Constituent	Regulatory Level*
Arsenic (D004)	5.0 mg/L	Hexachlorobenzene (D032)	0.13 mg/L
Barium (D005)	100.0 mg/L	Hexachlorobutadiene (D033)	0.5 mg/L
Benzene (D018)	5.0 mg/L	Hexachloroethane (D034)	3.0 mg/L
Cadmium (D006)	1.0 mg/L	Lead (D008)	5.0 mg/L
Carbon Tetrachloride (D019)	0.5 mg/L	Lindane (D013)	0.4 mg/L
Chlordane (D020)	0.03 mg/L	Mercury (D009)	0.2 mg/L
Chlorobenzene (D021)	100.0 mg/L	Methoxychlor (D014)	10.0 mg/L
Chloroform (D022)	6.0 mg/L	Methyl ethyl Ketone (D035)	200.0 mg/L
Chromium (D007)	5.0 mg/L	Nitrobenzene (D036)	2.0 mg/L
o-Cresol (D023)	200.0 mg/L	Pentachlorophenol (D037)	100.0 mg/L
m-Cresol (D024)	200.0 mg/L	Pyridine (D038)	5.0 mg/L
p-Cresol (D025)	200.0 mg/L	Selenium (D010)	1.0 mg/L
Cresol (D026)	200.0 mg/L	Silver (D011)	5.0 mg/L
2,4-D (D016)	10.0 mg/L	Tetrachloroethylene (D039)	0.7 mg/L
1,4-Dichlorobenzene (D027)	7.5 mg/L	Toxaphene (D015)	0.5 mg/L
1,2-Dichloroethane (D028)	0.5 mg/L	Trichloroethylene (D040)	0.5 mg/L
1,1-Dichloroethylene (D029)	0.7 mg/L	2,4,5-Trichlorophenol (D041)	400.0 mg/L
2,4-Dinitrotoluene (D030)	0.13 mg/L	2,4,6-Trichlorophenol (D042)	2.0 mg/L
Endrin (D012)	0.02 mg/L	2,4,5-TP (Silvex) (D017)	1.0 mg/L
Heptachlor (D031)	0.008 mg/L	Vinyl Chloride (D043)	0.2 mg/L
BTEX	50 mg/kg	Benzene	10 mg/kg
TPH	100 mg/kg		

* 40 CFR 261.24, Table 1

In addition to the analytical thresholds, listed, the following LF-268 guidance to generators needs to be adhered to in considering the landfill as a disposal option for IDW.

1. The Kirtland AFB civil engineer and Kirtland AFB Landfill require that soil and/or debris from any restoration site or monitoring well installation have analytical documentation characterizing the waste prior to consideration for disposal. Analytical requirements will be based on the specific site knowledge of the Restoration project manager and/or site engineer.

2. Minimum analytical requirements necessary for soil and debris characterization derived from restoration site or monitoring well activities are defined above (See Table 1, Landfill-268 Waste Acceptance Criteria). For waste and debris that have been characterized during the completion of site

activities, analyses previously generated during the characterization process may be used in determination of suitability for disposal.

3. Soil or debris that has been analyzed for hazardous constituents and does not exceed any RCRA regulatory limits (40 CFR 261.24 Table 1) may be disposed of in the Kirtland AFB landfill. Soil and debris containing hazardous constituents exceeding regulatory limits and/or illustrating hazardous waste characteristics will be disposed of at a facility permitted to accept hazardous wastes following appropriate DOT procedures.

4. Petroleum-contaminated soil that has a total BTEX concentration greater than 50 mg/kg, or a benzene concentration greater than 10 mg/kg, or a TPH concentration greater than 100 mg/kg is considered a special waste. Special wastes will not be disposed of in the Kirtland AFB landfill but will be disposed of at a facility permitted to handle special wastes.

5. Kirtland AFB retains the right to reject all material for disposal into the Kirtland AFB Landfill on a case-by-case basis, even if the waste does not exceed regulatory limitations.

6. If a waste is approved for disposal at the Kirtland AFB landfill, a Kirtland AFB Landfill Pass will be issued to the requestor for the waste hauling vehicle. When using a government vehicle to haul waste to the Kirtland AFB landfill, a waste disposal authorization letter is required but a Kirtland AFB landfill pass is not.

The LF-268 specific waste characterization process and analytical requirements will be sufficient to make a general waste determination and allow for appropriate waste management onsite or off site. If the waste exceeds any of the levels listed in the Table 1, with the exception of the TPH and BTEX parameters, the waste will be considered a hazardous waste. That waste will then have to be profiled, treated, and disposed of offsite as a hazardous waste according to the level and type of contamination indicated in the waste characterization results.

In the event there are other reasons why the waste cannot be disposed of at the onsite landfill and all of the waste acceptance criteria are met, that waste will be managed as NMED special waste and shipped offsite accordingly.

The field team manager will stage IDW pending analysis (i.e., waste that is not fully characterized) at the site of origin pending the receipt of analytical data and subsequent characterization, unless otherwise directed by Kirtland AFB personnel. IDW that is generated outside of the Kirtland AFB installation boundary will not be staged at the site of origin. Such wastes will be staged at a waste staging area within the installation boundary at the BFF site.

2.7 Waste Management Implementation

If it is determined that the LF-268 analytical waste acceptance criteria are satisfied, the following information will be presented in a "waste profile" format that will be used consistently to represent each individual waste stream encountered and considered for onsite disposal.

- Submit a memorandum requesting authorization to dispose of investigative-derived debris to the appropriate Solid Waste program manager.
  - Kirtland AFB Activities: Mr. Steven C. Kitt, 377 MSG/CEANC at 846-9014 or Steven.kitt@kirtland.af.mil

- Include in the submittal the name and phone number of the point of contact overseeing the activity, the location from which the waste was generated/site identifier, waste analytical results, hauling companies to be used to transport the waste to the landfill, roll-off identification numbers, and license plate numbers of transport vehicles, if not using roll-offs for waste containment.

As stated, if for any reason waste is not accepted for onsite disposal, arrangements will be made to manage the waste offsite in a compliant manner. Licensed and/or permitted facilities will be used for the purpose of transportation and disposal of waste from Kirtland AFB, as deemed necessary. Waste profile documentation will be prepared for review and signature by Kirtland AFB before shipment offsite. Upon receipt of the signed profile packages waste removal will be coordinated to ensure proper management of all waste being offered for disposal.

In a letter received from the Albuquerque Bernalillo County Water Utility Authority (ABCWUA), dated February 11, 2011, the ABCWUA states that non-hazardous water cannot be disposed of in the Albuquerque Publically Owned Treatment Works system. As a result, the decision tree provided by the NMED Groundwater Quality Bureau will be used for handling of non-hazardous waste water.

Table 2 lists the projected wastes to be generated during activities and the proposed analytical suite, the means of containerizing, probable waste status determinations and the two most likely methods of treatment and disposal.

Table 2 – Management of Projected Waste Streams

Waste Description	Characterization	Containerization	Waste Status	Treatment/Disposal
IDW Soils	LF 268 Suite	-Roll-off -Drum	Non-Hazardous	Direct Land Disposal 1.) LF268 2.) NMED permitted Subtitle D Landfill
IDW Soils	LF268 Suite	-Roll-off -Drum	Hazardous D004-D011 D018-D043	STABL, CHOX, and Land Disposal 1.) WCS Hobbs, NM 2.) Clean Harbors Deer Trail, CO
IDW Water, well purge water, well development water	-LF268 (exclude BTEX, TPH) -WWT specific parameters as needed	-Drum or bulk storage tank	Non-Hazardous	1.) Discharge to ground surface per approval 2.) On-site WWT
Aviation Fuel	-Total Metals -Total VOCs -Flash Point -pH -PCB	-Drum	Hazardous D018	CMBST, INCIN 1.) Off-site Fuel Blending 2.) Off-site Incineration
Spent Carbon	-TCLP Metals -Total VOCs -Flash Point -pH -PCB	-Drum	Hazardous D018	CHOX, INCIN & Land Disposal 1.) Clean harbors 2.) Rhino Environmental
SVE Condensate	-TCLP Metals -TCLP VOC's -Total VOC's -Flash Point -pH	-Drum	Hazardous D018	CHOX, WWT 1.) Clean Harbors 2.) Safety Kleen 3.) Other off-site WWT
Used Oil	Generator Knowledge	-Drum	NA	Recycled

Based on existing information, this table depicts an anticipated approach to waste streams generated in support of the BFF Spill field activities. However, if circumstances and/or analytical results deviate from the expected, necessary adjustments will be made to onsite waste handling and treatment and disposal selection. All procedures for handling and disposal of wastes, including necessary adjustments, will be in accordance with applicable federal and state regulations (see Section 1.4). Any significant adjustments to procedures will be transmitted to stakeholders during monthly status meetings, DQCRs, and other ad hoc meeting/conference calls as discussed in Section 5.1 of the work plan.

All documentation generated in managing each waste stream will be kept on file and provided to the appropriate Kirtland AFB environmental staff.

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APPENDIX D

Field Forms

Form 1: Visual Classification of Soils Form

Form 2: Soil Vapor Monitoring Well Construction Diagram

Form 3: Well Abandonment Form

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Visual Classification of Soils

Shaw Environmental & Infrastructure, Inc.

Project Number:	Project Name:	
Boring Number:	Coordinates:	Date:
Elevation:	GWL: Depth Date/Time:	Date Started:
Engineer/Geologist:	Depth Date/Time:	Date Completed:
Drilling Methods:		Page: of

Depth ( )	Sample Type & No.	Blows on Sampler per ( )	Recovery ( )	Description	USCS Symbol	Measured Consistency (TSF)	Well Construction	Remarks

Notes:

Drilling Contractor: ______________________________

Drilling Equipment: ______________________________

Driller: ______________________________

____

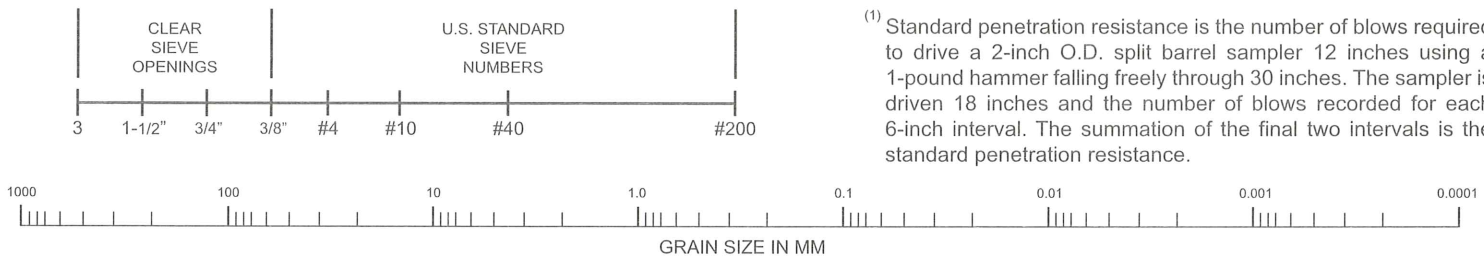
Consistency of Cohesive Soils

Consistency	Unconfined Compressive Strength (Tons per Square Foot)
Very Soft	Less than 0.25
Soft	0.25 to 0.50
Firm	0.50 to 2.0
Hard	2.0 to 4.0
Very Hard	More than 4.0

Density of Granular Soils

Density	Standard Penetration Resistance[1]
Very Loose	0-4
Loose	5-10
Medium Dense	11-30
Dense	31-50
Very Dense	Over 50

[1] Standard penetration resistance is the number of blows required to drive a 2-inch O.D. split barrel sampler 12 inches using a 1-pound hammer falling freely through 30 inches. The sampler is driven 18 inches and the number of blows recorded for each 6-inch interval. The summation of the final two intervals is the standard penetration resistance.



Cobbles	Gravel		Sand			Silt and Clay
	Coarse	Fine	Coarse	Medium	Fine	

USCS CLASSIFICATION FOR SOILS

Coarse-Grained Soils

Clean Gravels (little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines
	GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines
Gravel with Fines (appreciable amount of fines)	GM	Silty gravels, gravel-sand-silt mixtures
	GC	Clayey gravels, gravel-sand-clay mixtures
Clean Sands (little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines
	SP	Poorly-graded sands, gravelly sands, little or no fines
Sands with Fines (appreciable amount of fines)	SM	Silty sands, sand-silt mixtures
	SC	Clayey sands, sand-silt mixtures

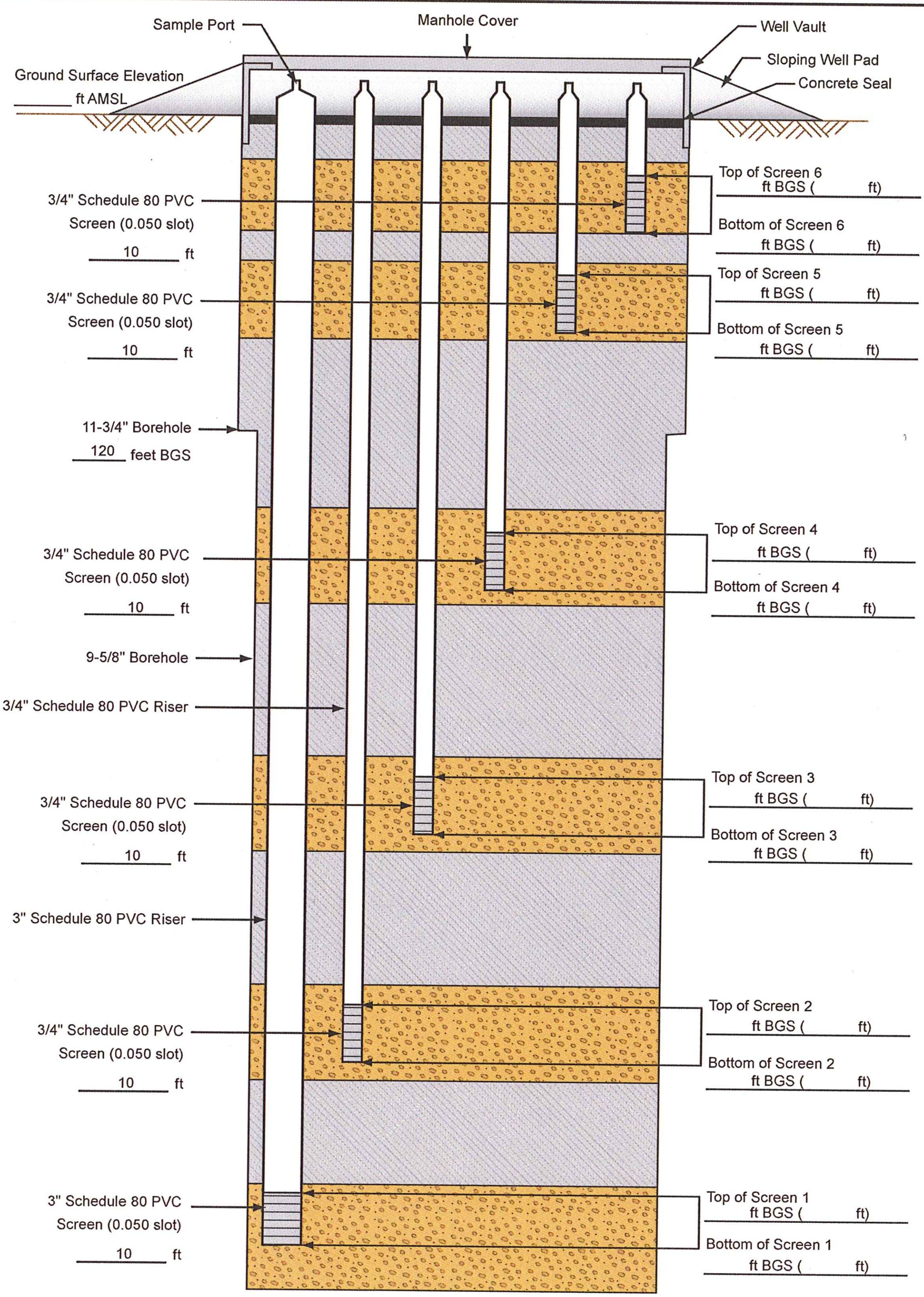
Fine-Grained/Highly Organic Soils

Silts and Clays Liquid Limit (less than 50)	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity
	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
	OL	Organic silts and organic silty clays of low plasticity
Silts and Clays Liquid Limit (greater than 50)	MH	Inorganic silts, micaceous or diatomaceous; fine, sandy or silty soils
	CH	Inorganic clays or high plasticity, fat clays
	OH	Organic clays of medium to high plasticity, organic silts
Highly Organic Soils	PT	Peat, humus, swamp soils with high organic contents

Form Number: 252_2
Rev. 05-12-09

Nested Soil Vapor Well Completion Diagram for KAFB-______________

Installation Start Date/Time: ______________
Installation End Date/Time: ______________

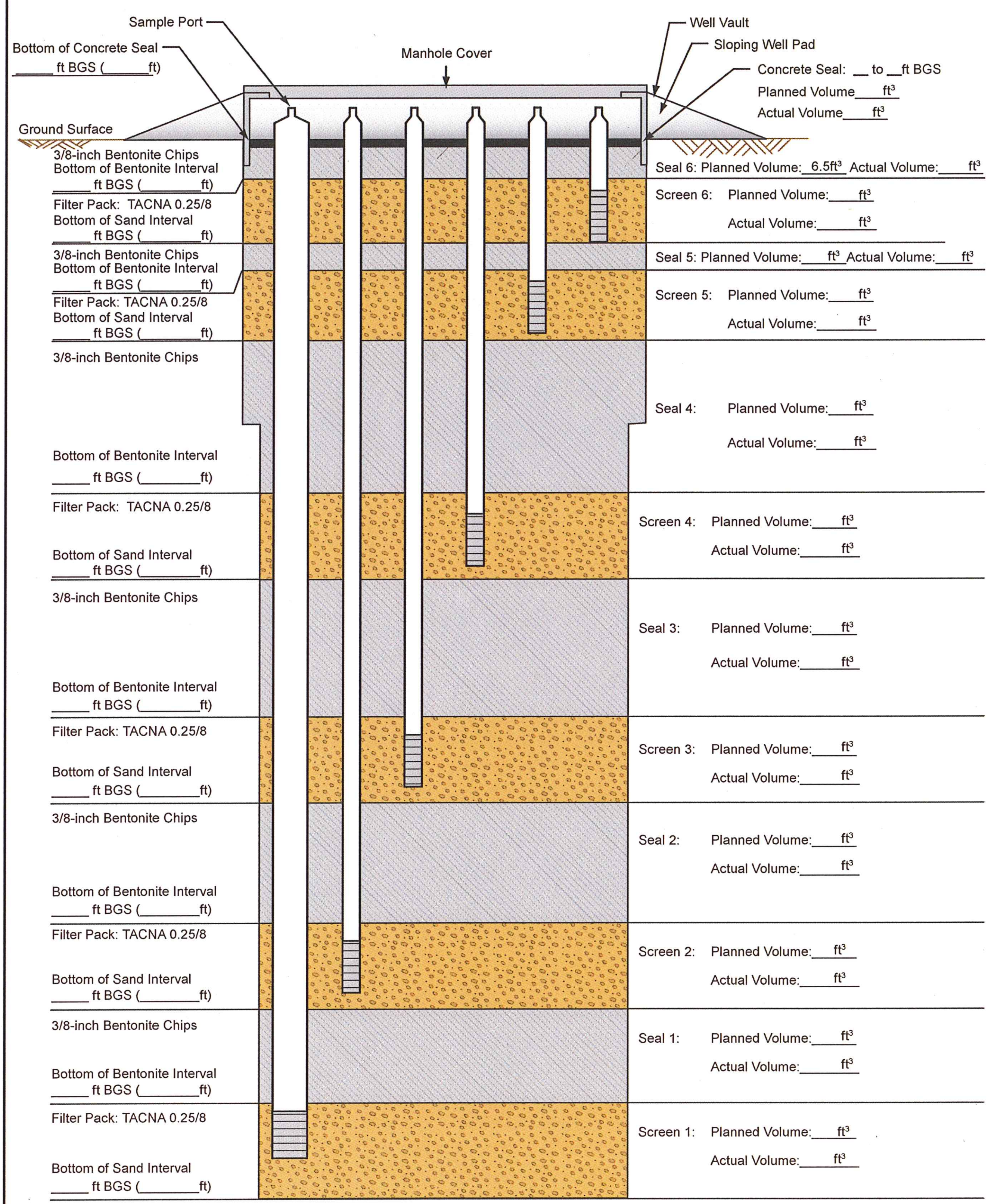


Total Depth
_______ft BGS (ft)

(elevation) is Above Mean Sea Level
AMSL = Above Mean Sea Level

Not to Scale
BGS = Below Ground Surface

Nested Soil Vapor Well Completion Diagram for KAFB-____________



(elevation) is Above Mean Sea Level
All Materials Placed with Tremie Pipe

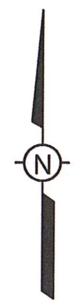
Not to Scale
BGS = Below Ground Surface

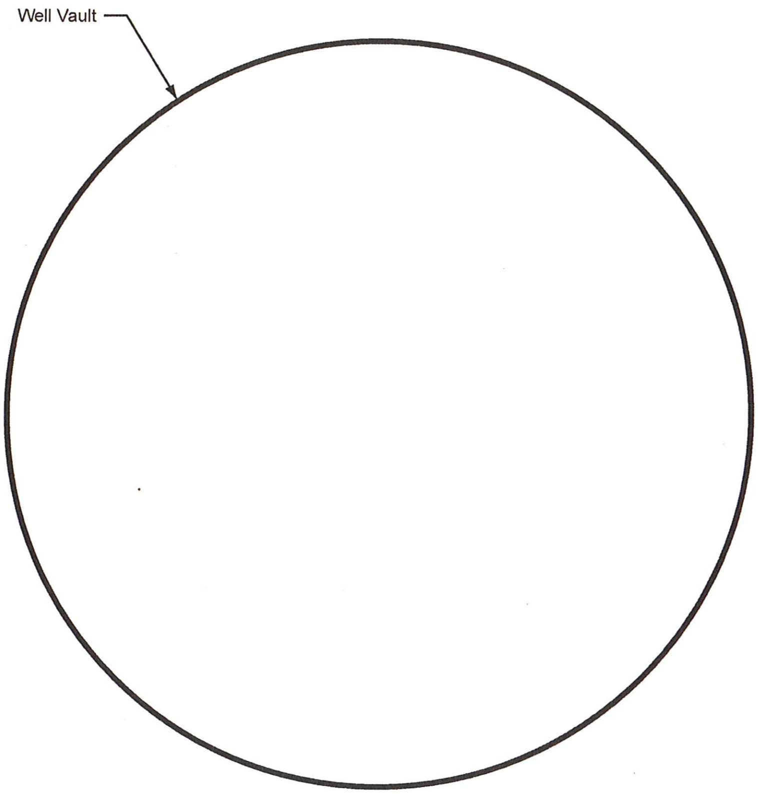
Nested Soil Vapor Well Completion Diagram
Map View for KAFB-________

Top of Well Vault Elevation:________(ft)

Northing: ____________

Easting:_____________





Well Number	Well Diameter (in)	Well Depth (ft BGS)	Screened Interval (ft BGS)	Northing	Easting	Elevation (ft AMSL)

Form 3. Well Abandonment Form

Well Abandonment Form	Project Name	Borehole Number
	Location	Well Number
	Project Number	Page ____ of ____

Logged By	Checked By	Reason For Abandonment
Driller		
Drilling Method	Measured Depth of Well	Depth to Water
Sampling Method	Was Old Well Removed? Yes No Partial	
Start Date	End Date	Drilled Diameter / Quality of Backfill (Gal)

DEPTH (feet)	SAMPLE NUMBER	MATERIAL DESCRIPTION	BACKFILL DESCRIPTION	WELL CONSTRUCTION DETAILS	WELL SCHEMATIC
				TOP OF SEAL	
				TOP OF SAND	
				TOP OF SCREEN	
				WATER LEVEL	
				DEPTH OF WELL	
				DEPTH OF HOLE	

Form 3. Well Abandonment Form (concluded)

Denver Federal Center Boring Log	Project Name	Boring Number
	Contractor	
	Project Number	Page ______ of ______

Depth (ft-bgs)	Blows/6" (recovery)	PID (ppm)	Graphic Log	MATERIAL DESCRIPTION	REMARKS

APPENDIX E

BFF Spill Quality Assurance Project Plan (QAPjP)
(submitted under separate cover)

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APPENDIX F

RTI Laboratories, Inc
Laboratory-Specific SOP for Air Sample Collection

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ACRONYMS AND ABBREVIATIONS

%	percent
”	inches
H20	water
FID	flame ionization detector
FRA	flow restrictor assembly
L	liter
mL/min	milliliter per minute
O.D.	outside diameter
PID	photoionization detector
ppmv	parts per million by volume
SOP	standard operating procedure
VOC	volatile organic compound

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1. SAMPLE TRAIN PURGING

1.1 Soil gas sample collection requires purging to flush stagnant gas from the soil gas probe prior to collection of a sample for laboratory analysis, much the same as purging stagnant water from a well prior to collection of a groundwater sample.

1.2 Purging can be performed in a variety of different ways. Vacuum pumps, personal monitoring pumps and a Tedlar™ bag/lung box apparatus are some of the procedures used. If field testing is to be performed, it is important that the sampling be performed before it goes through any kind of pump other than a personal monitoring pump, to avoid contamination of the sample. 1-3 L at a purge rate of 200-2000 mL/min should be sufficient for purging the sample train.

2. STATIC PRESSURE MEASUREMENT

2.1 Prior to sampling, the static vacuum or pressure in the soil gas probe should be measured and recorded. This is analogous to measuring a static water level in a groundwater monitoring well. These data can be used to assess whether and to what extent pressure gradients might influence soil gas flow. Connect a vacuum gauge to the valve at the top of the soil gas probe using tubing provided with the vacuum gauge. Level and zero the gauge. Open the valve and record the average reading. It may be necessary to shield the vacuum gauge from any wind, which can cause the readings to fluctuate. Record the static pressure or vacuum, along with the date, time, temperature and weather conditions.

3. LEAK CHECKING

3.1 Perform a “shut-in” test, where the pump is used to exert a pressure or vacuum on the sampling train, then all valves are closed and the pressure or vacuum is observed over time to ensure it does not dissipate. A target vacuum or pressure level of 100 in-H20 is appropriate, to maximize the resolution of the observations, and the stress on the sample train.

4. FIELD SCREENING

4.1 Field screening of total VOC vapor concentrations is conducted during purging to verify stable readings before collection of soil gas samples for laboratory analysis. Stable readings will typically be defined as reading that vary by less than 10% from previous readings and show no consistent trend in either increasing or decreasing concentrations.

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4.2 Samples of the extracted soil gas should be collected for field screening using a portable FID or PID after every purge volume removed (or 1 L if the purge volume is smaller). The FID or PID should be calibrated according to manufacturer's instructions to a span gas (i.e. isobutylene or hexane) of known concentration (typically 50 or 100 parts per million by volume [ppmv]) and to zero gas (in areas of poor outdoor air quality) or ambient outdoor air, immediately prior to use. The calibrations should be confirmed several times during the day to assess potential instrument drift. If the readings show more than 10% drift against the standard gas, or more than +/- 1 ppmv of zero gas or ambient air, the instrument should be recalibrated. The FID or PID reading will be made by connecting the Tedlar bag to the instrument and allowing the instrument to draw a sub-sample at ambient pressure (the bag must not be squeezed because this can cause a bias in the calibration). The time and the steady reading are recorded.

5. COLLECTION OF SAMPLES FOR LABORATORY ANALYSIS

5.1 Samples are collected in Bottle-Vac containers attached to a QT-connector and flow restrictor assembly (FRA). The tubing from the sampling site must be attached to the end of the FRA. To ensure the best seal, a 316-stainless steel union should be attached to the end of the FRA and seated with a ¼” Vespel/graphite or Teflon ferrule. This end of the union must be ¼” swagelok. If non-1/4” O.D. tubing is going to be attached, the other end of the union must be the size appropriate for the O.D. of the tubing that will be attached to it. The tubing should be attached with a Vespel/graphite or Teflon ferrule. See the figures at the end of this document for pictures of the sampling train.

5.2 Only after all of the connections are made, should the QT-connector be attached to the Bottle-Vac, as this is what initiates the sampling

31628 Glendale Street ● Livonia, Michigan 48150-1827
Phone (734) 422-8000 ● Fax (734) 422-5342
Website www.rtilab.com