DEPARTMENT OF THE AIR FORCE
HEADQUARTERS 377TH AIR BASE WING (AFMC)

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Mr. John Kieling, Manager
RCRA Permits Management Program
Hazardous Waste Bureau (HWB)
New Mexico Environment Department (NMED)
2905 Rodeo Park Road
Santa Fe New Mexico 87505

Dear Mr. Kieling

Attached please find *In-Well Treatment Interim Measures Work Plan Part 1-Data Gathering and Analysis Plan, Bulk Fuels Facility Spill, ST-106 & SS-111, Kirtland Air Force Base, New Mexico, dated December 2012*. This report has been prepared to summarize general activities and procedures leading to the design and installation of an in-well treatment system in soil vapor extraction (SVE) well KAFB-106160.

Please contact Mr. L. Wayne Bitner at (505) 853-3484 or at ludie.bitner@kirtland .af.mil or Ms. Victoria R. Martinez at (505) 846-6362 or at victoria.martinez@kirtland.af.mil if you have questions.

Sincerely

JOHN C. KUBINEC, Colonel,USAF
Commander

Attachment:
In-Well Treatment Interim Measures Work Plan Part 1-Data Gathering and Analysis Plan, BFF, Dec 2012

cc:
NMED-RPD (Davis), w/out attach
NMED-HWB (Moats, McDonald, Salem, Brandwein), w/ attach
NMED-GWQB (J. Schoeppner), w/ attach
NMED-OGC (L. Barnhart), w/out attach
EPA Region 6 (L. King), w/out attach
AFCEE/CMSE (Mr. Oyelowo), w/out attach
/EXEC (Mr. Urrutia), w/out attach
Public Info Repository (Central New Mexico), w/ attach
Administrative Record/Information Repository (AR/IR), w/ attach
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DECEMBER 2012

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JOHN C. KUBINEC, Colonel, USAF
Commander, 377th Air Base Wing

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KIRTLAND AIR FORCE BASE
ALBUQUERQUE, NEW MEXICO

In-Well Treatment Interim Measures Work Plan Part 1 - Data Gathering and Analysis Plan
Bulk Fuels Facility Spill
Solid Waste Management Units ST-106 and SS-111

December 2012

377 MSG/CEANR
2050 Wyoming Blvd. SE
Kirtland AFB, New Mexico 87117-5270

KIRTLAND AIR FORCE BASE
ALBUQUERQUE, NEW MEXICO

IN-WELL TREATMENT INTERIM MEASURES WORK PLAN
PART 1 – DATA GATHERING AND ANALYSIS PLAN

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

December 2012

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.
9201 East Dry Creek Road
Centennial, Colorado 80112

NOTICE

This report was prepared for the U.S. Army Corps of Engineers by Shaw Environmental & Infrastructure, Inc. for the purpose of aiding in the implementation of a final remedial action plan under the U.S. Air Force Environmental Restoration Program (ERP). As the report relates to actual or possible releases of potentially hazardous substances, its release prior to a final decision on remedial action may be in the public's interest. The limited objectives of this report and the ongoing nature of the ERP, along with the evolving knowledge of site conditions and chemical effects on the environment and health, must be considered when evaluating this report, since subsequent facts may become known which may make this report premature or inaccurate.

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13. ABSTRACT This In-Well Treatment Interim Measures Work Plan Part 1- Data Gathering and Analysis Plan, in conjunction with the Phase II Remediation Interim Measures Work Plan, was 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 Air Force. In the two 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. This Work Plan summarizes the general activities and procedures leading to the installation of the in-well treatment system in soil vapor extraction (SVE) well KAFB-106160 at KAFB BFF. A comprehensive design plan including engineering figures, a detailed construction schedule, and system design will be submitted during First Quarter Calendar Year 2013. Using a combination of SVE, in-well air stripping, air sparging, enhanced bioremediation and oxidation, and subsurface circulation and flushing within the wellhead system, the in-well system will treat vadose zone contamination, dissolved-phase contaminants at the groundwater/vadose zone interface, and the flooded non-aqueous phase liquid (NAPL) plume below the water table.

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JOHN C. KUBINEC, Colonel, USAF
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PREFACE

This In-Well Treatment Interim Measures Work Plan Part 1 – Data Gathering and Analysis Plan, describes the immediate actions Kirtland Air Force Base (KAFB) will take to remediate the Non-Aqueous Phase Liquid (NAPL) plume resulting from past operations at Solid Waste Management Units ST-106 and SS-111, collectively called the Bulk Fuel Facility Spill, at KAFB, New Mexico.

This work is being performed under the authority of the U.S. Army Corps of Engineers (USACE), Contract No. W912DY-10-D-0014, Delivery Order 0002. All work was conducted in October and November 2012 and final revisions were made in November 2012. Mr. Walter Migdal is the Project Manager for the USACE Albuquerque District. Mr. Wayne Bitner, Jr. is the KAFB Restoration Section Chief, and Mr. Tom Cooper is the Shaw Environmental & Infrastructure, Inc. Project Manager. This plan was prepared by

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

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ACRONYMS AND ABBREVIATIONS

°C	degrees Celsius
°F	degrees Fahrenheit
µg/L	micrograms per liter
3D	three-dimensional
Air Force	U.S. Air Force
ART	Accelerated Remediation Technologies, LLC
AST	aboveground storage tank
AvGas	aviation gasoline
BFF	Bulk Fuels Facility
bgs	below ground surface
BTEX	benzene, ethylbenzene, toluene, and xylene
cm	centimeter
COPC	contaminants of potential concern
CSIA	Compound Specific Isotope Analysis
EDB	ethylene dibromide
EPA	U.S. Environmental Protection Agency
FFOR	Former Fuel Offloading Rack
FOD	frequency of detection
ft	foot/feet
FWV	Field Work Variance
g/cm^3	grams per cubic centimeter
GPS	global positioning system
GRO	gasoline range organics
HWB	Hazardous Waste Bureau
IDW	investigation-derived waste
ICE	internal combustion engine
JP-4	jet propellant fuel-4
JP-8	jet propellant fuel-8
KAFB	Kirtland Air Force Base
LEL	lower explosive limit
MCL	maximum contaminant level
mg/kg	milligrams per kilogram
msl	mean sea level
NAPL	non-aqueous phase liquid
NMAC	New Mexico Administrative Code

ACRONYMS AND ABBREVIATIONS (concluded)

NMED	New Mexico Environment Department
NTU	nephelometric turbidity unit
PLC	programmable logic controller
PPE	personal protective equipment
ppm	parts per million
QC	quality control
QPCR	Quantitative Polymerase Chain Reaction
RCRA	Resource Conservation and Recovery Act
ROI	radius of influence
RSI	Remediation Service International
scfm	standard cubic feet per minute
SSHP	Site Safety and Health Plan
SVE	soil vapor extraction
SVEW	soil vapor extraction well
SWMU	Solid Waste Management Unit
TMB	trimethylbenzene
TPH	total petroleum hydrocarbon
USACE	U.S. Army Corps of Engineers

EXECUTIVE SUMMARY

This In-Well Treatment Interim Measures Work Plan Part 1- Data Gathering and Analysis Plan, in conjunction with the Phase II Remediation Interim Measures Work Plan, was 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 the two 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 (KAFB), New Mexico.

This Plan summarizes the general activities and procedures leading to the design and installation of the in-well treatment system in soil vapor extraction (SVE) well KAFB-106160 at KAFB BFF. A comprehensive design plan including engineering figures, a detailed construction schedule, and system design will be submitted during First Quarter Calendar Year 2013.

Using a combination of SVE, in-well air stripping, air sparging, enhanced bioremediation and oxidation, and subsurface circulation and flushing within the wellhead system, the in-well system will treat vadose zone contamination, dissolved-phase contaminants at the groundwater/vadose zone interface, and the flooded non-aqueous phase liquid (NAPL) plume below the water table. Data obtained from the operation of this technology will be used in the corrective measures evaluation to determine the final remedy.

Data have shown that migration of the NAPL plume has stabilized (see Quarterly Pre-Remedy Monitoring and Site-Investigation Reports for 2011 and 2012) Based on the analysis of the degradation indicator compounds and the spatial extent of the organic compounds, it appears that microbial degradation is limiting the extent of a majority of the organic compounds, including benzene; ethylbenzene; toluene; xylene; 1,2,4-trimethylbenzene; and naphthalene. Because the NAPL plume is stable, the measures outlined in this plan, and the Phase II Remediation Interim Measures Work Plan to be submitted December 2012, will replace the NAPL hydraulic containment system as the major interim measure for the BFF Spill. This in-well treatment interim measure focuses largely on the directive to remediate the existing NAPL plume (April 2, 2010, NMED letter); however, application of the in-well technology at other petroleum hydrocarbon impacted groundwater sites indicates that the system may have an effect on the dissolved phase plume as well.

1. INTRODUCTION

1.1 Overview

This In-Well Treatment Interim Measures Work Plan Part 1 – Data Gathering and Analysis 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. The interim measures described in this Plan pertain to the Kirtland Air Force Base (KAFB) Bulk Fuels Facility (BFF) Spill site located in the western portion of KAFB, New Mexico (Figure 1-1). The BFF Spill site is comprised of two Solid Waste Management Units (SWMUs) designated as SS-111 and ST-106. Although mitigation efforts at the two SWMUs are interrelated, the component of the BFF Spill project addressed in this Plan pertains to the non-aqueous phase liquid (NAPL)-impacted groundwater at SWMU SS-111. Investigation and remediation of the vadose zone near the Former Fuel Offloading Rack (FFOR), referred to as ST-106, is further addressed in the Vadose Zone Investigation Work Plan (USACE, 2011a).

This Plan, in conjunction with the Phase II Remediation Interim Measures Work Plan, contains a basic description of the major goals and components of the technical approach for addressing the requirement of the New Mexico Environment Department’s (NMED) letter, dated April 2, 2010 (Appendix A), to remediate the NAPL plume at the KAFB BFF Spill. A detailed discussion of the technical approach and design including engineering figures, a detailed construction schedule, and system design will be submitted during First Quarter Calendar Year 2013 in the In-Well Treatment Interim Measures Work Plan Part 2- Final Remediation Design Plan.

1.2 Scope of Activities

The scope of this In-Well Treatment Interim Measures Work Plan is to utilize a specialized, in-well treatment system for the remediation of NAPL-impacted groundwater at the BFF Spill site SWMU SS-111. Working with Accelerated Remediation Technologies, LLC (ART), the in-well system will be designed to retrofit an existing SVE well (SVEW) previously installed at the BFF Spill site to remediate aviation fuel contamination in the vadose zone that resulted from leaks in the former BFF primary fuel rack. The system will treat vadose zone contamination, dissolved-phase contaminants at the groundwater/vadose zone interface, and the flooded NAPL plume below the water table. Data obtained from the operation of this technology will be used in the corrective measures evaluation to determine the final remedy.

The in-well system will be installed in one of two existing SVEWs at the BFF. Both wells will be developed in late 2012, and sampled during First Quarter Calendar Year 2013. The sampling results will identify the baseline water quality parameters within the plume, and will be used to inform the operation of the in-well system. Following development and sampling, the in-well technology will be installed in SVEW KAFB-106160 (Figure 1-2). The remaining SVEW, KAFB-106161 will be used in conjunction with existing soil vapor monitoring wells as a monitoring point to determine technology effectiveness. Once installed, the in-well treatment system will operate in conjunction with the SVE treatment system described in the Phase II Interim Measures Work Plan (USACE, 2012a) to remediate the NAPL plume.

1.3 Approach and Implementation

Data developed during the past several years have revealed that there is a NAPL plume emanating from the BFF Spill (Figure 1-3) and that immediate action can mitigate the impact of the NAPL plume. This work plan defines interim measures that will be performed at the BFF that will mitigate the potential endangerment to the regional aquifer that provides drinking water for the Albuquerque Bernalillo County Water Utility Authority.

Data have shown that migration of the NAPL plume has stabilized (see Quarterly Pre-Remedy Monitoring and Site-Investigation Reports for 2011 and 2012 [USACE, 2012b]). Based on the analysis of the degradation indicator compounds and the spatial extent of the organic compounds, it appears that microbial degradation is limiting the extent of a majority of the organic compounds, including benzene, ethylbenzene, toluene, and xylene (BTEX); 1,2,4-trimethylbenzene (TMB); and naphthalene. Because the NAPL plume is stable, the measures outlined in this plan, and the Phase II Remediation Interim Measures Work Plan, will replace the NAPL hydraulic containment system as the major interim measure for the BFF Spill. This in-well treatment interim measure focuses largely on the directive to remediate the existing NAPL plume (April 2, 2010, NMED letter [Appendix A]); however, application of the in-well treatment technology at other petroleum hydrocarbon impacted groundwater sites indicates that the system may have an effect on the dissolved phase plume as well as the NAPL plume. This work plan outlines the data collection and analysis that will occur to inform the final in-well treatment design.

1.4 Data Gaps

Two data gaps remain that will inform the operation of the in-well treatment system. One outstanding data gap is data related to the aquifer conductivity near the SVEWs. This data gap will be addressed by slug testing in late 2012 (See Section 5.4). Slug testing will be performed to assess the hydraulic conductivity at wells KAFB-106160 and KAFB-106161, which will inform the operation of the in-well treatment system.

The second data gap pertains to the baseline groundwater quality parameters at the location of the SVEWs KAFB-106161 and KAFB-106160. Groundwater sampling, planned for First Quarter 2013, will measure these parameters, and fill this data gap (See section 5.5). The resolution of this data gap will inform the operation and monitoring of the in-well treatment system.

1.5 Regulatory Requirements

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, 20.4.1 New Mexico Administrative Code (NMAC);
- Resource Conservation and Recovery Act (RCRA);
- April 2 and August 6, 2010, regulatory correspondence between the NMED and the U.S. Air Force (Air Force) regarding the BFF Spill at KAFB (Appendix A); and
- KAFB Base-Wide Plans for Investigation under the Environmental Restoration Program (Tetra Tech, 2004).

1.6 Outstanding Permit Requirements

Data have shown that migration of the NAPL plume has stabilized (see Quarterly Pre-Remedy Monitoring and Site-Investigation Reports for 2011 and 2012). Analysis of the degradation indicator compounds and the spatial extent of the organic compounds, shows that microbial degradation is limiting the extent of a majority of the organic compounds in the NAPL plume, including BTEX; 1,2,4-TMB; and naphthalene.

The original phase II interim measure, the NAPL hydraulic containment system, was designed to contain the NAPL plume, not to remediate groundwater or the plume source. Because the NAPL plume is stable, the in-well treatment system along with the new SVE system, which will effectively treat contaminated groundwater and the NAPL plume source, will replace the implementation of the NAPL hydraulic containment system as the major interim measure for the BFF spill. As a result, NMED directives remain that are no longer applicable to the project. The resolutions to these outstanding permit requirements are outlined in Table 1-1.

1.7 Work Plan Organization

This In-Well Treatment Interim Measures Work Plan is organized into the following major sections:

- Section 1: Introduction
- Section 2: Project Management
- Section 3: Site Setting and Background
- Section 4: Site Conditions
- Section 5: Well Development and Sampling Methods
- Section 6: Soil-Vapor Extraction System
- Section 7: Description and Baseline Data Collection for In-Well Treatment System

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

Appendices to this work plan include:

- Appendix A: Regulatory Correspondence between the NMED Hazardous Waste Bureau (HWB) and the Air Force
- Appendix B: Project Schedule
- Appendix C: Project Forms
- Appendix D: Waste Management Plan

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2. PROJECT MANAGEMENT

2.1 Project Scheduling and Reporting Requirements

Shaw is responsible for planning, scheduling, and performing the project activities and field work, as well as documenting and reporting project activities on a daily basis. A project schedule is provided as Appendix B to this work plan. Shaw is also responsible for compliance with the applicable quality control (QC) requirements, overall project safety, the safety and health of workers under its direction, and performance of field activities according to the work plan, regulatory requirements, and this contract. The project-specific Accident Prevention Plan, which contains the Site Safety and Health Plan (SSHP), was submitted under separate cover (USACE, 2011b).

2.2 Project Organization and Resource Management

The organizational structure of the project team is shown on Figure 2-1.

Mr. Thomas Cooper is the Shaw Project Manager for all investigations and remedial work at SWMUs ST-106 and SS-111, collectively called the BFF Spill at KAFB, New Mexico. Mr. Cooper has overall responsibility for safety and quality on all projects. He manages and integrates team members and oversees cost and schedule monitoring and control. All project activities are coordinated through the USACE Project Manager, Mr. Walt Migdal. Mr. Migdal has direct communication with the KAFB Chief of Environmental Restoration, Mr. Wayne Bitner, Jr.

The project team includes corporate, managerial, and technical positions. Personnel at the work site vary in number, depending on the particular task being completed. According to the established chain of command, Shaw subcontractors report to Shaw, and Shaw reports to the USACE Project Manager. Figure 2-1 specifies Shaw personnel responsibilities and reporting lines. Communication pathways are also detailed in the Project Management Plan, provided under separate cover (USACE, 2011c). All Shaw personnel and Shaw subcontractors are required to have current hazardous waste training as defined by Title 29, Code of Federal Regulations, Section 1910.120. Shaw will directly supervise subcontractors performing field work at all times, and Shaw is responsible for the work performance of all subcontractors under its supervision.

2.3 Project Coordination

During field investigation activities, activity reports will be completed by the field team managers and provided to the Project Manager and client designee(s) on a weekly basis. These reports summarize field and QC activities that occurred during the course of field investigation activities. Field Work Variance (FWV) forms (Appendix C) will be filled out if there are any significant changes from the scope of work. If the FWV represents a major change, such as moving a well or boring location more than 100 feet (ft) in a given direction, the USACE, NMED, and KAFB will be notified, and the change will be approved prior to commencement. If the FWV is minor and the resolution is clearly outlined in the data quality objectives, the FWV will be filed; the change will be made in the field; and USACE, KAFB, the Project Manager, and the NMED will be notified of the change. NMED approval will be required for changes to previously approved work plans.

Weekly briefings are held among the field team, USACE, KAFB to discuss progress of the field effort and upcoming field work, and to consider any problems or issues that require resolution. Working group meetings are held with the field team, UASCE, KAFB and NMED quarterly, or more frequently as necessary.

Mobilization of field staff (management, technical, subcontractors), equipment (vehicles, computers, global positioning systems [GPS], etc.), and material (safety supplies, etc.) will begin as soon as practical based on the schedule and weather.

A staging area has been set up at KAFB. This area contains office trailers, a laydown area, and work crew facilities; the staging area has been used for multiple phases of work for the KAFB BFF Spill project. An electrical subcontractor has been used for electricity hook-ups to the facilities, as needed.

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3. SITE SETTING AND BACKGROUND

3.1 Site Description

KAFB is located in southeast Albuquerque, Bernalillo County, New Mexico, and occupies 51,558 acres (Figure 1-1) KAFB is bounded to the north and west by the City of Albuquerque, to the south by the Pueblo of Isleta, and to the east by the Cibola National Forest. The installation is adjacent to the City of Albuquerque airport, named the Albuquerque International Sunport. The following sections provide a synopsis of relevant information regarding base operational history, geology, and climate.

3.2 Operational History

The KAFB BFF Spill is located in the western part of KAFB (Figure 3-1). Historical aerial photography has revealed that the area was utilized 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 KAFB-1066) and a separate fuel loading area where individual fuels 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 in 1953. Once completed, the facility operated until 1999 when it was removed from service as a result of below grade line leakage along the offloading rack. Bulk storage for Jet Propellant Fuel-8 (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 were aviation fuel (AvGas; high-octane gasoline), Jet Propellant Fuel-4 (JP-4) and JP-8. The use of AvGas and JP-4 at KAFB were 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 at the south end of the site (Tanks 2420 and 2422). The fuel transfer from the railcars to the pump house was done under vacuum. The 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 that was not required 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 (5,000- and 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 southwestern 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 the delivery of diesel and unleaded gasoline motor vehicle fuels.

The 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 via piping of varying sizes that runs above the ground for approximately 750 ft, and below the ground for approximately 300 ft. Figure 3-1 shows the infrastructure present within the eastern portion of the BFF.

4. 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 (COPCs).

4.1 Regional Geology

The geology at KAFB ranges from mountainous in the eastern extent of the installation to the Albuquerque Basin in the western portion of the installation. The area lies within the Rio Grande Rift, a major tectonic zone that represents the continental extension during the Cenozoic. The tilted fault-block mountains in the eastern portion of KAFB are composed of Precambrian metamorphic and crystalline bedrock and Paleozoic sedimentary rock. The KAFB BFF Spill site is located in the western portion of the installation, within the Albuquerque Basin. The dominant lithology of the Albuquerque Basin includes unconsolidated and semiconsolidated sedimentary deposits.

The Albuquerque Basin contains the through-flowing Rio Grande. Basin-wide, the sedimentary deposits are primarily interbedded gravel, sand, silt, and clay. Well graded and poorly graded gravel and sand are heterogeneous in vertical and lateral extent throughout the basin. In addition, silt and clay layers are of variable thickness and laterally discontinuous. The thickness of the basin fill deposits is variable throughout the basin due to normal faulting, but is thicker than 3,000 ft in most of the basin (Kelley, 1977).

The geologic materials of interest for the KAFB BFF Spill site are the upper portion of the Santa Fe Group and the piedmont slope deposits. The Santa Fe Group consists of beds of unconsolidated to loosely consolidated sediments and interbedded volcaniclastic and mafic rocks. The sedimentary materials within the Santa Fe Group range from boulders to clays and from well sorted stream channel deposits to poorly sorted slope-wash deposits. Silty alluvial fan sediments were deposited unconformably over the Santa Fe Group and extend westward from the base of the Sandia and Manzano mountains. Within the alluvial deposits, materials range from poorly sorted mud flow material to well sorted stream gravel. Beds consist of channel fill and interchannel deposits. The fan thicknesses range from 0 to 200 ft and thicken towards the mountains.

4.2 Site-Specific Geology

The NMED cross section transects (Quarterly Pre-Remedy Monitoring and Site-Investigation Reports April—June, 2012) show that the lithology consists of silty younger deposits (Unit A) overlaying the Santa Fe Group (Unit B); a system of unconsolidated Tertiary-aged fluvial deposits (ancestral Rio Grande lithofacies) and alluvial deposits from the Middle Rio Grande Basin. Unit A is approximately the top 100 to 150 ft below ground surface (bgs), which consists primarily of silt and silty sand with interbedded clay and poorly graded sand layers. Generally, this silty unit thickens eastward with the silt and clay layers varying from a few feet to 170 ft bgs in thickness as seen in KAFB-106135. Sand deposits within this unit consist of silty, well graded, and poorly graded sand intervals that range in thickness from 0 to 60 ft.

Underlying the silty slope deposits of Unit A is the upper portion of the Santa Fe Group (Unit B). This loose, unconsolidated depositional unit is observed in the subsurface geology at the BFF Spill site and is highly porous and permeable. As presented in the cross-sections, the upper portion of the Santa Fe Group is present at depths greater than 100 to 150 ft bgs and primarily consists of interbedded sand and gravel layers. The sand is generally poorly- to well-graded and sand layers range in thickness from 1 to 250 ft. Discontinuous gravel lenses, likely channel deposits, can be up to 50 ft in thickness within some regions, particularly to the north, and are of unknown lateral extent. Clay lenses are also observed heterogeneously within the Santa Fe Group, with the most notable lens approximately 35 ft in thickness at a depth of approximately 255 ft bgs. This lens is documented in the lithology logs for KAFB-106081 and KAFB-106066 (USACE, 2012b).

Geologic logs for existing and newly installed monitoring wells and geophysical logging data indicate a considerable amount of variability within the two depositional units. However, based on the lithologic logs and all five cross-sections, coarser materials, including gravel lenses, appear to be more concentrated in the northern portion of the study area, whereas finer, silt-rich sediments appear to be more ubiquitous in the southern portion of the site, near the FFOR area.

Presumably, the discontinuous silt and clay layers are zones of lower permeability and possibly can locally impede downward flow of water and NAPL through the sedimentary column. Whereas, the higher permeability sandy layers provide pathways for water and NAPL to easily migrate downward within the silty upper unit. Based on the detailed lithologic logs across the BFF Spill site, there appears to be no continuous silt/clay layers that impeded the downward migration of the NAPL.

4.3 Hydrogeology

The regional aquifer for the majority of the Albuquerque Basin is contained in the upper and middle units of the Santa Fe Group. The groundwater system at KAFB is also referred to as the Middle Rio Grande Basin. In general, the upper unit of the Santa Fe Group contains the most productive portion of the regional aquifer that supplies water to the City of Albuquerque, the Veterans Administration, and KAFB.

The following site-specific hydrogeology discussion is based upon data collected for the Quarterly Pre-Remedy Monitoring and Site-Investigation Reports April—June, 2012. Depths to water in the regional aquifer vary widely across the basin and are dependent on structural influence and pumping rates/volumes at production wells. Within the eastern extent of the basin, depths to water are approximately 190 ft bgs, whereas towards the western edge of the basin, depths to water are on the order of 450 to 570 ft bgs. Non-pumping depths to water measured at the BFF Spill site range from approximately 450 (Shallow Zone) to 544 ft bgs (Regional Aquifer). There is approximately at 36-ft downward head difference between the Shallow Zone and Regional Aquifer. This results in a non-uniform (downward) gradient of minus 0.2 ft/ft.

Historically, groundwater flow directions in the regional aquifer and at the BFF Spill site were generally westward toward the Rio Grande River. However, due to significant production well pumping for both the City of Albuquerque and KAFB, the groundwater flow direction for the BFF Spill site is approximately North 25 degrees to 35 degrees East as of June, 2012 (USACE, 2012b). This change in downgradient flow of the aquifer is predominately due to high pumping rates at the production wells, Ridgecrest 5 and Ridgecrest 3, with pumping rates of approximately 1,500 and 1,100 gallons per minute, respectively.

Based on analysis of historical water table elevations, water levels have declined approximately 140 ft (4,953-ft downward to 4,811-ft elevation) since 1949 with the majority of the water level decline (over 100 ft) since 1975. However, in recent years, groundwater levels at the site have risen between 4 and 8 ft since 2009 due to conservation practices implemented by the City of Albuquerque and the San Juan-Chama Diversion Project completed in December 2008.

The physical aquifer properties were quantified on remolded soil samples from screened intervals within the aquifer in order to model the NAPL and groundwater migration through time at the BFF Spill site. Based on these results, the dominate grain size of the screened intervals is medium-sized sand, with a mean porosity of 34.1% and an effective porosity of 27.4%. The mean permeability and hydraulic conductivity are approximately 4,700 milliDarcys and 4.6×10^{-3} centimeters (cm) per second, respectively.

4.4 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 fuel-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.

Based upon data obtained during Second Quarter 2012 monitoring activities, an evaluation of selected degradation indicator compounds was performed to relate various indicators to the extent of the NAPL area and dissolved plumes. The Second Quarter 2012 Report (USACE, 2012b) presents dot maps and detailed discussions of the findings for each of the following degradation indicator compounds: dissolved oxygen, oxidation-reduction potential, alkalinity, iron (only dissolved/filtered iron data were available, but as ferric iron is relatively insoluble in water, the majority of the dissolved iron is assumed to be ferrous iron), manganese, nitrogen (nitrate/nitrite), and sulfate. The analysis indicates the microbial degradation is substantially slowing the migration rate and limiting the extent of a majority of the organic compounds, including benzene, toluene, and total xylenes. However, the effect of microbial degradation of EDB is less apparent with no obvious plume pattern of degradation compounds to indicate EDB degradation.

4.5 Nature and Extent of Contamination

4.5.1 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, because of the presence of multiple types of fuel contamination on the water table and the size of the NAPL plume, it is likely that the primary pipeline had been in a state of failure for many years. The presence of NAPL fuel hydrocarbons on the water table also indicates that substantial releases have occurred and that a range of fuel types may have been released. Fuel types include AvGas, diesel, JP-4, and JP-8 (Tetra Tech, 2004).

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 (Tetra Tech, 2004). 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 serves as another potential marker.

Over the past several years, potential sources in addition to the offloading rack have been evaluated as possible contributors to NAPL 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.

4.5.2 Identification of COPC

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 have 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 COPCs at the BFF Spill Site are constituents of refined petroleum products and are described below according to area of contamination.

4.5.2.1 Vadose Zone COPC

The Second Quarter 2012 Monitoring Report (USACE, 2012b) discusses the screening analysis performed on soil vapor data to determine the compounds most frequently detected within the vadose zone. A compound was considered a COPC if the following criteria were met:

1. The total samples for a given parameter during the period of February 2007 and September 2011 was greater than 20.

2. More than 10% of the analytical results were detected for a given parameter.

Table 4-1 lists the COPCs for the KAFB BFF spill site vadose zone. The following compounds are determined to be vapor COPCs: 1,2,4-TMB; 1,3,5-TMB; 2-butanone; acetone; benzene; C5-C8 aliphatic hydrocarbons; C9-C10 aromatic hydrocarbons; C9-C12 aliphatic hydrocarbons; cyclohexane; ethylbenzene; heptane; isopropanol; m,p,o-xylenes; methylene chloride; n-hexane; propene; propylene; toluene; and total xylenes (in lieu of quantifying individual m,p,o-xylene isomers). Currently, there are no maximum contaminant level (MCL) standards for remediation of these vapor compounds.

4.5.2.2 Groundwater COPCs

A comprehensive screening analysis was performed on groundwater data from the First Quarter 2012 KAFB BFF spill site monitoring activities (USACE, 2012c). A compound was considered a COPC if all of the following criteria were met:

1. The total number of samples for a given parameter during the period between January 2009 and March 2012 was more than 20.

2. More than 5% of the analytical results were detected for a given parameter.

3. The maximum concentration was greater than the lowest regulatory concentration established by the NMED or U.S. Environmental Protection Agency (EPA). The lowest regulatory screening level used for each parameter was chosen based on a comparison between the EPA MCLs (2009), NMED Groundwater Standards (20.6.4 NMAC), and New Mexico Human Health Standards for drinking water.

The following compounds have been determined to be groundwater COPC in the shallow, intermediate, and deep zones of the aquifer and are presented in Table 4-1.

- Shallow Zone: EDB; 1,2-dichloroethane; benzene; bis(2-ethylhexyl)phthalate; dibenz(a,h)anthracene; ethylbenzene; iron; manganese; methylene chloride; naphthalene; nitrogen (nitrate as N); phenol; sulfate; tetrachloroethene; toluene; trichloroethene; and xylenes (total).

- Intermediate Zone: EDB; benzene; ethylbenzene; iron; manganese; and naphthalene.
- Deep Zone: EDB; bis(2-ethylhexyl)phthalate; and manganese.

4.5.3 NAPL Distribution

During the April through June 2012 reporting period, 0.64 ft of NAPL was observed in one well, KAFB-106076. All other wells that historically had NAPL now have no observable NAPL. This is attributed to the rising groundwater levels. Hydrographs located in Appendix F-1 of the Quarterly Pre-Remedy Monitoring and Site-Investigation Report, April–June 2012 show changes in historical groundwater and NAPL elevations in the KAFB monitoring wells where NAPL has been identified.

Based on the analysis of NAPL thickness data over time, it is apparent that the NAPL thickness observed in wells since 2009 has markedly declined as groundwater levels have risen. While this declining trend of NAPL thickness in wells could be mistaken to indicate that NAPL is no longer an issue at the site, because of the physics of NAPL migration, the reduction of NAPL thickness in wells more likely indicates that the NAPL interval is now flooded, with most of the NAPL being submerged below the water table. This is because the buoyancy force that could make the NAPL rise along with the rising water levels is controlled by the density difference between the fuel and water that causes the NAPL to "float" on the water table. Based on the NAPL data available for KAFB, this density difference is approximately 0.23 gram per cubic centimeter (g/cm^3). If the resulting buoyancy force is less than the displacement pressure (the capillary pressure required for NAPL to migrate into a soil pore space displacing the water), then the NAPL cannot rise when the water table rises.

4.5.4 Dissolved-Phase COPC Distribution

The distribution of dissolved-phase COPCs forms a halo around the NAPL plume. As expected, concentrations of dissolved COPCs are detected at high concentrations very close to the NAPL plume due to the dissolution of petroleum products into the groundwater and lower concentrations further from the

NAPL plume. The dissolved-phase plume as it is currently understood 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. The current known extent of the dissolved-phase plume is shown on Figure 1-3.

4.5.5 Site-Specific Conceptual Model

4.5.5.1 Vadose Zone Fate and Transport

Based on the three-dimensional (3D) distribution of soil and vapor concentration data in the vadose zone presented in the Quarterly Pre-Remedy Monitoring and Site Investigation Report from April – June 2012 (USACE, 2012b), a relatively simple vadose zone NAPL and vapor migration model becomes apparent:

- Based on historical analysis of water level data for water supply well KAFB-3, in the 1940s through most of the 1970s, the groundwater table was at a depth approximately 100 ft higher than the current 2012 water table. Beginning in 2009, the water table started rising in response to water conservation practices and municipal use of surface water resources. Water table changes have had a profound impact on the distribution of and future prognosis for vadose zone contamination.

- The low TPH and benzene soil concentrations and constant contaminant footprint at elevations of 5,000 ft above mean sea level (msl) (350 ft bgs) and above and expansion of the aerial extent and increase in concentrations at the elevation of 4,900 ft above msl (450 ft bgs) are definitive indicators that NAPL did not spread out substantially as it migrated through the vadose zone until it encountered the historical capillary fringe and water table, where it spread out in horizontal directions. If the vertical NAPL migration occurred over a widespread area or had spread out along vadose zone capillary barriers, it would be expected that higher soil and vapor concentrations would be observed at shallower elevations.

- As surface or near-surface releases of NAPL occurred at the facility, the NAPL essentially migrated vertically downward with some minor horizontal movement related to the heterogeneities in the lithologic intervals. Once the NAPL encountered the historical capillary fringe above the water table at a nominal depth of 400 ft bgs, the NAPL spread out horizontally away from the release areas. The NAPL then accumulated on the water table and started migrating in a northeasterly direction following the downgradient groundwater flow direction.

- As the water table declined as a result of regional groundwater extraction, the NAPL from the initial and subsequent releases followed the falling water table downward. Over time, this had the effect of creating a residual NAPL smear zone from nominal depths of 400 to 500 ft bgs. The recently acquired PneuLog®® data indicate that the water table was at approximately 350 ft when the NAPL releases started.

- As the water table started rising in 2009, the NAPL that could flow into monitoring wells (i.e., NAPL not already at residual saturation) became trapped below the water table. The reason is that the NAPL buoyancy force resulting from a density difference of 0.2 g/cm^3 is not sufficient to overcome the entry pressures and generate the upward hydraulic gradient required for the NAPL to rise along with the rising water table.

- Because vapor can migrate in the vadose zone, the vapor concentrations define the overall volume of the vadose zone that is affected by residual NAPL contamination in the soil. To a lesser extent, the vapor concentrations do define the areas of highest vadose zone contamination.

- Based on the 3D distribution of soil and vapor concentrations (USACE, 2012b), the majority of the vadose zone contaminant mass is located within 100 to 150 ft above the present-day water table at depths of 350 to 500 ft bgs.

- Based on a screening process that accounts for frequency of detection (FOD), the following compounds are determined to be COPCs: 1,2,4-TMB; 1,3,5-TMB; 2-butanone; acetone; benzene; C5-C8 aliphatic hydrocarbons; C9-C10 aromatic hydrocarbons; C9-C12 aliphatic hydrocarbons; cyclohexane; ethylbenzene; heptane; isopropanol; m,p,o-xylenes; methylene chloride; n-hexane; propene; propylene; toluene; and total xylenes (in lieu of quantifying individual m,p,o-xylene isomers).

- The radius of influence (ROI) testing of SVEWs conducted in November and December 2011 shows that the ROI of SVE within the BFF Spill site is most likely between 220 and 300 horizontal ft. This estimate is based on the analysis of ROI test 5DTKAFB106149-484. A vertical ROI has not yet been determined.

4.5.5.2 Groundwater Fate and Transport

As with the vadose zone model, the groundwater contamination conceptual site model is relatively

straightforward:

- Current groundwater flow directions are toward the Ridgecrest water supply wells (Ridgecrest-5 and Ridgecrest-3) with average groundwater velocity of 95 ft/yr and a range of 18 to over 300 ft/yr to the northeast at a direction of North 25 degrees to 35 degrees East. Overall, vertical groundwater flow direction is down — a downward flow velocity has not been determined at this time. As previously discussed in the Fourth Quarter 2011 report (USACE, 2012d), EDB and TPH-gasoline range organics (GRO) plume maps confirm this plume migration direction and general velocity. The EDB plume is moving at least 50 ft/yr to the northeast simply based on plume extent.

- As previously discussed in the Fourth Quarter 2011 report (USACE, 2012d), the NAPL viscosity is such that NAPL should be able to flow to groundwater wells. However, the rising water table has resulted in much of the NAPL being trapped below the water table, and remediation NAPL recovery is likely to be problematic. NAPL chemistry defines the source strength for groundwater contamination. For example, the benzene concentration in the KAFB-1066 NAPL, similar to gasoline, is 2,200,000 micrograms per liter (µg/L); the benzene concentration in KAFB-106076 NAPL, similar to jet fuel, is 400,000 µg/L. While EDB was not detected in either NAPL sample, the detection limit was 1,000 µg/L.

- As illustrated in the time-series graphs, concentrations for KAFB-1065 (the contaminated well with the longest data record) and the NAPL chemical composition, the NAPL on top of and below the water table will act as a persistent source of groundwater contamination for the indefinite future. Appendix F presents time-series plots.

- Microbial degradation of organic compounds has fundamentally limited the downward movement of the vast majority of the individual compounds in the NAPL as well as the TPH-diesel range organics compounds. Furthermore, there is sufficient organic carbon in the aquifer (average concentration of 230 mg/kg) to retard the migration of organic compounds that will partition onto carbon. The compounds that are currently being actively degraded and/or retarded include benzene, ethylbenzene, toluene, xylene, 1,2,4-TMB, and naphthalene. Other NAPL compounds are almost certainly being degraded and retarded; more definitive analysis will be conducted and presented in future monitoring reports.

- Based on a screening process that accounts for FOD (5%) and comparison between maximum detected concentrations and NMED and EPA regulatory screening levels, the following analytes are determined to be groundwater COPCs:

  - Shallow Zone: EDB; 1,2-dichloroethane; benzene; bis(2-ethylhexyl)phthalate; dibenz(a,h)anthracene; ethylbenzene; iron; manganese; methylene chloride; naphthalene; nitrogen (nitrate as N); phenol; sulfate; tetrachloroethene; toluene; trichloroethene; and xylenes (total).

  - Intermediate Zone: EDB; benzene; ethylbenzene; iron; manganese; and naphthalene.

  - Deep Zone: EDB; bis(2-ethylhexyl)phthalate; and manganese.

- Additional screening will be conducted over the next year to determine which, if any, of these inorganic analytes in this COPC list are related to background concentrations. Those constituents determined to be related to background will be deleted from the COPC list.

- EDB has migrated the full length of the current monitoring network and was detected above the EPA MCL (0.05 µg/L) in samples from 30 of 51 shallow wells, 11 of 27 intermediate wells, and 3 of 28 deep wells during the Second Quarter 2012 monitoring event. EDB is the one compound that was detected in the Shallow, Intermediate, and Deep Zones in the farthest downgradient well cluster (GWM 10; KAFB-106055, KAFB-106057, and KAFB-106058) for the last three quarters.

- The concentration patterns of both EDB and TPH-GRO indicate two release periods of NAPL containing EDB. EDB concentrations (Shallow Zone) in the immediate vicinity of the NAPL plume mostly range from 1 to 10 µg/L, with hot spots of up to 320 µg/L. Approximately 500 ft downgradient of the northern edge of the NAPL plume, the concentrations decline to less than 1 µg/L, followed by concentration increases to greater than 1 µg/L at the downgradient edge of the monitoring well network. TPH-GRO (Intermediate Zone) has a similar pattern with high concentrations in the NAPL area, a low concentration area approximately 500 ft downgradient of the northern edge of the NAPL plume, and higher concentrations in the downgradient monitoring wells.

5. WELL DEVELOPMENT AND SAMPLING METHODS

This section describes the basic approach, methods, and operational procedures to be used during data collection and analysis for the design of in-well treatment at KAFB. A detailed design plan will follow at a later date. The ultimate purpose of the interim measures and field activities described in this work plan is to remediate the NAPL plume in accordance with the NMED letter dated April 2, 2010. This section describes the basic approach to the implementation of the in-well technology.

5.1 Mobilization

Mobilization of field staff (management, technical, subcontractors), equipment (vehicles, computers, GPS, etc.), and material (safety supplies, etc.) will begin as soon as practical based on the schedule and weather, and is currently planned for late 2012 to early 2013.

5.2 Site Preparation

The project site may require initial preparation activities prior to conducting interim measures operations. Those activities are described in the following sections.

5.2.1 Permitting

The following permits will be necessary in order to comply with State and KAFB regulations:

- Albuquerque Environmental Health Department Air Quality Authority-To-Construct Permit #1984
  - This Permit will be modified to include the planned SVE system’s Catalytic Oxidation exhaust, which will include the operation of the in-well treatment system. A full description of the system’s specifications and exhaust will be included in the permit modification.

- KAFB Request for Environmental Impact Analysis
  - This form has been submitted and approved. This form gives approval for the installation of natural gas and electrical lines that supply the SVE system.
  - This form also provides a checklist that ensures that all other necessary forms and permits have been or will be obtained for operating the system.

5.2.2 Utilities Clearance

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

All underground utilities shall 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.

5.2.3 Waste Handling

All investigation-derived waste (IDW) generated during remediation activities will be properly characterized, contained, disposed of, and otherwise managed in accordance with all federal, state, and local laws and regulations. Disposal of waste specific to the operation and maintenance of the in-well technology will be described in a detailed design plan to be submitted at a later date. All other IDW will be handled in accordance with the waste management plan described in the Phase II Remediation Interim Measures Plan (USACE, 2012a) included in the work plan as Appendix D.

5.3 Well Development

Wells KAFB-106160 and KAFB-106161 will be developed to improve hydraulic communication between the well and aquifer before analytical groundwater sampling takes place. The wells were installed during First Quarter 2012. Groundwater sampling and reporting requirements will be conducted as directed in NMED's letter of June 4, 2010 (Appendix A), and as specified in Permit Part 6.5.17.5. The following procedure will be followed for the development of the SVEWs:

- Development will consist of swabbing, bailing, and pumping until little or no sediment enters the well based on visual observation of water removed from the well. The development and purge water will be contained in a temporary tank to be temporarily located at each well head.
- Following swabbing and bailing, the well will be continuously pumped using an electric submersible or pneumatic, drive positive-displacement, or bladder pump. Temperature, pH, specific conductivity, and turbidity will be monitored during pumping, and readings will be taken at regular time intervals. At a minimum, the well will be developed until the column of water in each well is free of visible sediment, and the pH, temperature, conductivity, turbidity, and specific conductance have stabilized within 10 percent, and turbidity is less than 10 nephelometric turbidity units (NTU). If these parameters have not stabilized, development will be stopped and the NMED contacted for resolution on how to proceed with well development.
- If water was introduced to a borehole during drilling and completion, then, at a minimum, the same volume amount of water will be removed from the well during development.
- Once development is complete, a sample of the development water will be collected for waste characterization purposes.
- If the addition of water is necessary to facilitate surging and bailing, only formation water previously pumped from that well into the purge tank may be used. At the completion of the well development activities at each well, a turbidity confirmation sample will be collected from each well.
- The site geologist will monitor and record on the Well Development Record form, depicted in Appendix D, Form 8, and in the field logbook all field parameters, such as pumping rates, pH, temperature, specific conductance, and pertinent information.

5.4 Slug Testing

After development, wells KAFB-106160 and KAFBB-106161 will be slug tested. A slug test is an aquifer test in which the water level in a well is "instantaneously" changed by removing, adding, or displacing a known volume of water. Water may be displaced using a solid polyvinyl chloride (PVC) plastic or stainless-steel slug or by increasing the pressure in the well (pneumatic method). The water-level response is then monitored in the well until it has stabilized. Slug tests are used to estimate aquifer properties, as the water-level response is generally proportional to aquifer transmissivity and hydraulic conductivity. The tests require rapidly recorded and accurate water-level data.

Slug testing will be performed to assess the hydraulic conductivity at wells KAFB-106160 and KAFB-106161, which will inform the operation of the in-well treatment system. Slug tests will be performed in accordance with the procedure described below:

1. Equipment to be used will be inspected to ensure that it is in good working order.
2. Measuring and testing equipment will be calibrated and tested before use in accordance with manufacturer's specifications.
3. Before testing, water levels and the bottom of the well will be measured using an electric sounding device or a weighted steel tape and recorded.
4. The wellhead will be visually inspected for damage or obstructions that could hinder transducer or slug insertion or removal. The pressure transducer will be secured so that it will not move during the test.
5. The height of the water column in the well will be calculated and used to determine the location of the transducer.
6. If a physical slug is used, the location of the slug will be planned so that the height of the water column will totally immerse the slug for a slug-in test, but will also allow concurrent use of the pressure transducer. The slug will be lowered to just below the static water level. For a slug-out test, the slug will be removed to just above the static water level.
7. The recording frequency of the data logger will be set to record at logarithmically increasing intervals.
8. The data logger will begin logging and the water level will be displaced concurrently and as quickly as possible. If a physical slug is used, the slug will not be allowed to free-fall when lowering.
9. The water level change will be monitored with the pressure transducer/data logger until the level has stabilized.
10. Once the slug test is completed, a water level will be obtained and the time recorded.

11. The slug test data will be reviewed and if necessary, the test will be repeated with appropriate changes as determined by the field hydrologist conducting the test.

12. Once the tests are determined to be satisfactory, downhole equipment will be removed from the well and the wellhead secured.

5.5 Groundwater Analytical Sampling

Groundwater sampling consists of measuring groundwater and LNAPL levels, and use of low-flow purging and sampling to collect a representative groundwater sample for field and laboratory analysis. The two existing SVEWs, KAFB-106161 and KAFB-106160 will be sampled once under the scope of this work plan. Both SVEWs will be sampled in January, 2013. Groundwater sampling will be performed in accordance with the KAFB RCRA permit part 6.5.1.7.3.

5.5.1 Measuring Groundwater and LNAPL Levels

Depth to LNAPL, depth to water, and LNAPL thickness will be measured if either SVEW has NAPL present, using an electronic, oil-water, interface probe, or similar device. Measurements will be made immediately before purging and sampling. Standard procedures when conducting depth to LNAPL, depth to water, and LNAPL thickness are as follows:

1. Arrange the sequence of measurements from least uncontaminated well to most contaminated wells to minimize cross contamination.

2. Check operation of measurement equipment aboveground. Before opening the well, don personal protective equipment (PPE) as required by the SSHP.

3. Lower interface probe into the well and note depth to LNAPL, depth to groundwater, and total well depth. All measurements will be taken from the surveyed reference mark located on the top edge of the well casing. Measurements are to be made to the nearest 0.01 ft (0.3 cm).

4. Record all information on the field form (well sampling form) and/or in the field logbook.

5. Record well number, top of casing elevation, well diameter, and ground surface elevation, if available.

6. Record the time and day of the measurement.
7. Clean all groundwater level measurement devices before and after each use to prevent cross-contamination of wells.

5.5.2 Monitoring Well Purging

All sample monitoring wells will be purged using low-flow purging techniques before sample collection.

5.5.3 General Pre-Monitoring Well Sampling Requirements

1. Samples will not be collected within two weeks of well development.
2. Appropriate PPE, as outlined in the SSHP, will be worn. In addition, samplers will don new sampling gloves at each individual well before beginning sampling.
3. The exterior of the monitoring well will be visually examined for signs of damage or tampering and recorded in the field logbook.
4. The well cap or outer steel casing lid will be unlocked.
5. PID, lower explosive limit (LEL), and oxygen readings will be taken with the appropriate meter(s) at the well head immediately upon opening the cap and information recorded in field logbook. If high concentrations are detected, the appropriate measures, as outlined in the SSHP, will be taken.
6. The static water level and the LNAPL depth and thickness in the well will be measured with an electronic water level indicator and recorded in the field logbook. The total depth of the well will be measured to verify original construction details and determine if any appreciable fines have entered the well, which may cause problems during sampling and/or potential problems with analytical data. The water level indicator will be rinsed with deionized water in between individual wells to prevent cross-contamination.
7. Well Purge and Water Quality Field Data Sheet (Appendix D) will be used in the field to perform well volume calculations. The information required for the calculation includes well depth (measured from top of casing to bottom of well), well casing diameter, static water level (measured from top of casing) and the borehole diameter. Appendix D, lists quick conversions for water volumes.

5.5.4 Low-Flow Purging Requirements

1. Monitor the following field parameters while purging: dissolved oxygen, pH, oxidation reduction potential, turbidity, conductivity, specific conductance, and temperature.
2. Continuously monitor the water level and potential subsequent drawdown with an electric water level indicator. If the static water level before purging is within the screened interval, the drawdown will not exceed a distance of 25 percent of the length of the saturated screened interval. If the water level falls below the 25-percent drawdown level, the pumping rate will be decreased to stabilize the water level to prevent cascading and potential loss of volatiles, excessive turbidity, and entrapment of air in

the filter pack. If the static water level is above the screened interval, acceptable drawdown is defined as the lowering of the water level to the top of the screened interval. If continued drawdown occurs below the top of the screened interval, the pump rate will be decreased to stabilize the water level to prevent atmospheric contact with the filter pack and formation, which could alter redox chemistry of the well.

Note: In wells with slow recharge rates, it may be necessary to stop the pump and allow the well to recharge in order to remain at or above the drawdown limit. If this is necessary, be certain not to allow any water in the tubing to back flush into the well when purging recommences.

Purging will be considered complete when a minimum of one saturated screen volume, calculated according to the formula presented in Appendix D, has been removed and the groundwater quality parameters have stabilized according to the requirements listed below:

- Dissolved oxygen ± 0.3 milligrams per liter
- Oxidation reduction potential ± 10 millivolts
- Turbidity < 10 NTUs or ± 10% when < 10 NTUs cannot be achieved
- Conductivity ± 3 % µohms/cm
- pH ± 0.1 units
- Temperature ± 10 % °C or °F

In the event the pump seizes and locks up during purging or sampling activities and it is necessary to jiggle or move the pump within the well, purging will be re-initiated beginning with the first step of this procedure.

5.5.5 Groundwater Sample Collection

All groundwater samples will be collected using the dedicated, low-flow, submersible pump installed in the sample well. Samples will be collected for field parameter and laboratory analysis. Collection of groundwater samples will follow the following procedures:

1. Flow rates for sampling with low-flow pumps will be maintained at 1 liter per minute or less.
2. Sample containers will be labeled before sample collection.

3. Samples for volatile organic analysis (VOA) will be collected first. The samples will be carefully filled to avoid overflow and potential loss of preservative and tapped so entrapment of air is minimized and no head space exists. If bubbles appear, the vial will be refilled or a new vial will be used if a sample preservative (i.e., hydrochloric acid) is used.

4. Samples for non-VOA will be collected following the volatile organic sample collection. Samples for dissolved metals analysis may be field-filtered according to procedures presented below. If field filtration is not performed, the sample container must be clearly marked to state “laboratory filtration required.”

5. Samples for field parameter measurements will be collected last.

6. Analytical samples will be placed in a cooler and chilled to 4°C. Samples will be shipped to the appropriate laboratory within 24 hours. The sample cooler will be shaded from direct sunlight immediately after collection.

7. The well will be closed and the well cap re-locked.

8. The field logbook, sample log sheet, custody seals and chain-of-custody forms will be filled out.

9. Filter of field samples (dissolved iron and manganese) will use a cellulose-based membrane filter of 0.45-micron, nominal pore size. The sample must be filtered immediately after collection to minimize changes in the concentration of the substance of interest. Samples are only passed through the filtration apparatus once. Samples are then preserved immediately as required. All paperwork accompanying samples to the laboratory will clearly state that the samples have been field-filtered, in order to avoid second filtration at the laboratory. Field filtering of water samples will be conducted as follows:

10. The sample will be poured into the filter apparatus and filtered through a cellulose-based membrane filter of 0.45-micron, nominal size. To condition the filter, half of the sample volume will be passed through the filter apparatus and filter paper and then discarded. The full sample volume will then be filtered and collected in the appropriate sample container. Samples are only passed through the filter once.

11. Samples will be preserved immediately, as required.

12. Analytical samples will be placed in a cooler and chilled to 4°C. Samples will be shipped to the appropriate laboratory within 24 hours.

13. The field logbook, sample log sheet, labels, custody seals, and chain-of-custody forms will be filled out during sample collection.

Each newly installed monitoring well will be sampled for the following field and laboratory analysis:

- Field Parameters/Analysis
  - dissolved oxygen
  - oxidation reduction potential
  - conductivity

- turbidity
- pH
- temperature
- alkalinity – Hach field kit

- Laboratory Analysis
  - Volatile organic compounds – SW846 8260B
  - EDB – SW846 8011
  - TPH gasoline/diesel range organics – SW846 8015B [modified] TPH volatile petroleum hydrocarbon/extractable petroleum hydrocarbon – Massachusetts Department of Environmental Protection (MA DEP, 2004a,b) (four quarters only for risk assessment purposes)
  - Semivolatile organic compounds - SW846 8270C
  - cations (calcium, potassium, magnesium, sodium) – SW846 6010C
  - anions (chloride, sulfate, nitrate) – EPA 300.0
  - total lead – SW846 6010C
  - ammonia nitrogen – SM 4500B,D
  - dissolved iron and manganese – SW846 6010C
  - alkalinity (carbonate and bicarbonate – SM 2320B
  - total sulfide – SM 4500 S-2CF

5.6 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 the Construction Quality Assurance Plan (Appendix C). 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.

5.7 PPE

Personnel directly involved in equipment decontamination shall wear appropriate PPE as specified in the SSHP (USACE, 2011b). Appropriate PPE will be selected based on the level of contamination present or suspected at a site. Care will be taken to ensure that the selected PPE will protect decontamination workers from unnecessary contact with soil or decontamination fluids.

6. SOIL-VAPOR EXTRACTION SYSTEM

A new SVE and treatment system is being installed at the BFF. With the implementation of the Phase II Remediation Interim Measure, the current ICE unit-based SVE action will be replaced with a system designed for longer-term operation, as described in the Phase II Interim Measures Work Plan (USACE, 2012a). The installation of the SVE system will increase hydrocarbon removal from the BFF vadose zone soil. Extracted vapor will be remediated at a new high-capacity treatment system, which will be operational by the end of Fourth Quarter 2012.

Once installed, the in-well treatment system and the SVE treatment system will operate in conjunction to remediate contaminated groundwater and the NAPL plume. The following sections summarize the current extraction wells and treatment systems in comparison with the planned system.

Based on the soil and soil vapor data that has been collected at the site, the SVE system is designed to have the flexibility to manage the wide range of inlet gas hydrocarbon concentrations that are expected. The system components meet the requirements of NFPA 91, *Standard for Exhaust Systems for Air Conveying Vapors, Gases, Mists, and Noncombustible Particulate Solids*. It will extract and treat 1,600 scfm of air with hydrocarbon concentrations of up to 25% of the LEL (or 3,450 ppm by volume GRO). If inlet air from the extraction wells exceeds this level, dilution air will be pulled into the system. If inlet air is below the design level, the heat recovery and catalytic options will reduce fuel consumption under these conditions.

The SVE system will operate in conjunction with the in-well system installed at KAFB-106160. The well casing is 6-inch stainless steel with stainless steel centralizers. The well screen is 6-inch, 0.050-slot wire-wrapped stainless steel set in a 50-ft section and a 40-ft section separated by 10 ft of casing. From the bottom of the 40-ft section of the 6-inch, 0.050-slot screen, a 6-inch, 0.030-slot wire-wrapped stainless steel screen is continued to 525 ft bgs. The bottom of the sump is set at 530 ft bgs and is 5 ft in length. The SVEW design was constructed for multi-purpose applications and, as such, was screened across the water table, providing an option to adapt the well for future groundwater extraction if required.

Piping will run from the individual vacuum recovery well heads and will join into a single high-density polyethylene pipe that will run to the SVE system (Figure 6-1). The SVE process is designed to maximize the volatilization of low-molecular weight compounds by pulling air from the vadose zone of the soil layer. The air is extracted using a motor driven vacuum blower, built by Global Technologies, which creates vacuum on the influent lines, and at low pressure, discharges the air to the treatment system. Upstream of the vacuum blower a demister system is installed which separates entrained water in the system. A knockout tank and demister filter condense water, which can then be collected and pumped to a collection/treatment system. Inlet filters to the vacuum blower reduce particulate in the blower, while also lowering sound levels created by suction. Silencers are installed at the discharge of the blower to reduce sound output of the unit. Vapor will then move from the blower skid to the Aguil Model 20 Catalytic Oxidizer adjoined to the 30 ft steel stack. The units will be constructed off-site and delivered to the BFF after the concrete pad has been poured and set.

The remediation compound will contain all the aboveground components for performing SVE remediation. The remediation will be anchored on a 50 ft by 18 ft concrete pad, and the steel stack will be placed on a 6 ft by 6 ft concrete pad adjoining the larger pad. The entire system will be surrounded by a secured fence

A catalytic oxidizer was chosen for the system because of the close proximity to the BFF, and in order to comply with regulations dictating the LEL on KAFB. A detailed description of both the blower skid and catalytic oxidizer are presented in the Phase II Remediation Interim Measures Plan (USACE, 2012a). The proposed thermal oxidizer skid is a Dual Thermal/Catalytic Oxidizer System, complete with a combustion air blower, exhaust stack, and all instrumentation and controls. Hydrocarbon destruction efficiency for the proposed component is at least 98% of GRO at 1,600 scfm. The dual thermal/catalytic oxidizer system can run in pure thermal oxidation mode when SVE gas is high in hydrocarbons and in catalytic mode (to reduce fuel consumption) when gas concentrations taper off. An optional heat recovery exchanger is available and will probably be purchased. Cost savings from reduced fuel consumption at low inlet hydrocarbons will likely offset initial cost of the heat recovery exchanger. Auxiliary fuel in all cases is natural gas.

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7. DESCRIPTION AND BASELINE DATA COLLECTION FOR IN-WELL TREATMENT SYSTEM

7.1 Description of In-Well System

The following is a summary of the in-well system technology. This Plan summarizes technologies utilized by the in-well treatment system in SVEW KAFB-106160 at KAFB BFF. A comprehensive design plan including engineering figures, a detailed construction schedule, and system design will be submitted during First Quarter Calendar Year 2013.

Working with the subcontractor ART to inform its design, the in-well technology will utilize a combination of in situ air stripping, air sparging, SVE, enhanced bioremediation and oxidation, and subsurface circulation and flushing within the wellhead system (Figure 7-1).The air sparging component results in reduced water density and lifting (mounding) of the water table in the vicinity of the well. This in turn causes a net negative gradient to the well resulting in water flowing back towards the well. Vacuum pressure (the SVE component) is applied atop of the well point to extract entrained gasses from the subsurface. The negative pressure from vacuum extraction creates additional water mounding, boosts the net gradient back towards the well and removes vapors from the unsaturated zone and well annulus. A submersible pump is placed at the bottom of the well to re-circulate water to the top of the well column for downward discharge through a spray head - similar to what occurs in a packed-column air-stripping tower. In addition to the air stripping resulting from the pumping/cascading, the pumped, stripped, highly oxygenated water will flow down the well annulus and over the mounded water back into the aquifer and vadose zone – hydraulically enhancing the ROI. These combined synergistic technology effects will set up a circulation zone surrounding the well that will further enhance cleanup.

In summary, contaminants are stripped from the water as a result of the combined effects of in-well air stripping and in-well air sparging. The “radius of remediation”, will be created by a combination of negative gradient as a result of air sparging, additional negative gradient resulting from the application of vacuum extraction, and subsurface water circulation induced by a submersible pump (Pucke et al., 2004). This may result in effective remediation of the dissolved groundwater contaminant plume, while the SVE simultaneously remediates the vadose zone. The full effect on the dissolved phase plume is unknown at this point, but results of the application of similar in-well treatment systems at other remediation sites suggest that this in-well system may reduce EDB concentrations in the plume.

7.2 In-Well Technology Well Selection, Development, and Sampling

In-well treatment will be installed in KAFB-106160 (Figure 6-1), one of two existing SVEWs at the BFF completed both in the vadose zone and below the water table. Well KAFB-106161 will be used as a monitoring point to monitor and determine technology effectiveness. The vapor wells currently monitored under the SVE Monitoring Plan will be included in monitoring long-term vapor monitoring of the in-well system. A detailed description of monitoring, operations, and maintenance will be included in the final design plan to be submitted in the First Quarter Calendar Year 2013.

Both SVEWs, KAFB-106160 and KAFB-106161, will be developed in December, 2013 using the standard combination of swabbing and pump purging used for development of monitor wells described in Section 5. Each well will be slug tested to determine hydraulic conductivity of the aquifer.

Groundwater sampling will be performed on both wells in accordance with the KAFB RCRA permit part 6.5.1.7.3 upon completion of development. Specifically samples will be collected for laboratory analyses of:

- Dissolved oxygen
- ORP
- Temperature
- pH
- VOCs—8260 and 8011
- Total dissolved solids
- Major cations and anions (Ca, Mg, Na, K, HCO3, SO4, Cl, NO3),

- Manganese (total and dissolved)
- Iron (total and dissolved).

The results of groundwater sampling will be used to design the configuration and assess anticipated performance of the in-well system

7.3 Data Management, Modeling, and Analysis

All data and analysis for the in-well treatment system and the SVE system as a whole will be included in the current Quarterly Pre-Remedy Monitoring and Site Investigation Report. A detailed description of data management, modeling and analysis will be included in the design plan to be submitted in the First Quarter Calendar Year 2013. The data and modeling will be managed in the project environmental database and geographical information system (GIS).

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FIGURES

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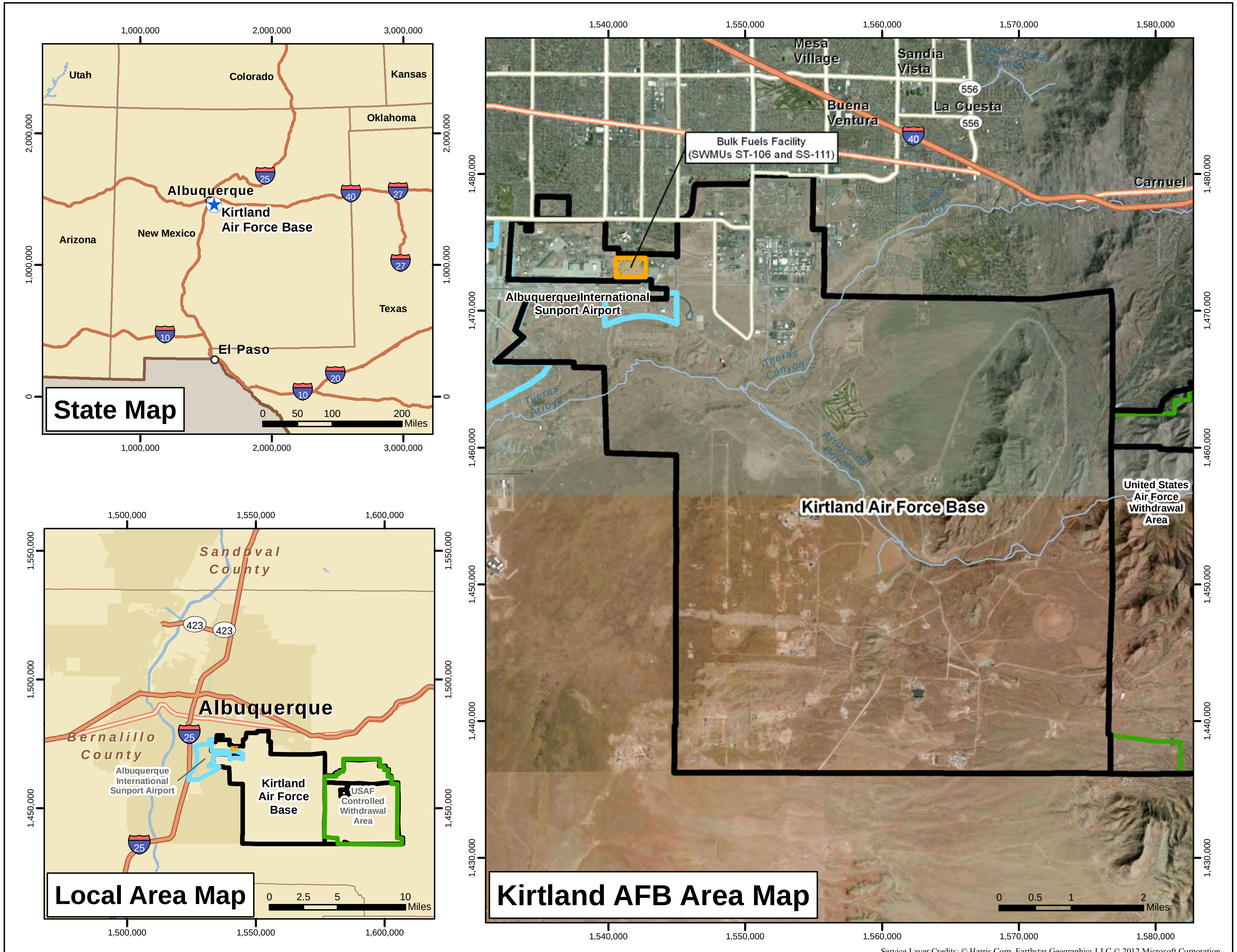

Legend

- Installation Location
- Kirtland Air Force Base Installation Boundary
- Bulk Fuels Facility (SWMUs ST-106 and SS-111)
- Albuquerque International Sunport Airport
- United States Air Force Withdrawal Area
- Major Highways
- Highways
- Major Roads
- Rivers
- Urban Areas
- Counties
- States

N

Revision Date: 11/27/12

Projection : NAD83 State Plane New Mexico Central FIPS3002 Feet

IN-WELL TREATMENT
INTERIM MEASURES WORK PLAN PART 1 - DATA GATHERING AND ANALYSIS PLAN
BULK FUELS FACILITY
KIRTLAND AIR FORCE BASE, NEW MEXICO

FIGURE 1-1

SITE LOCATION MAP

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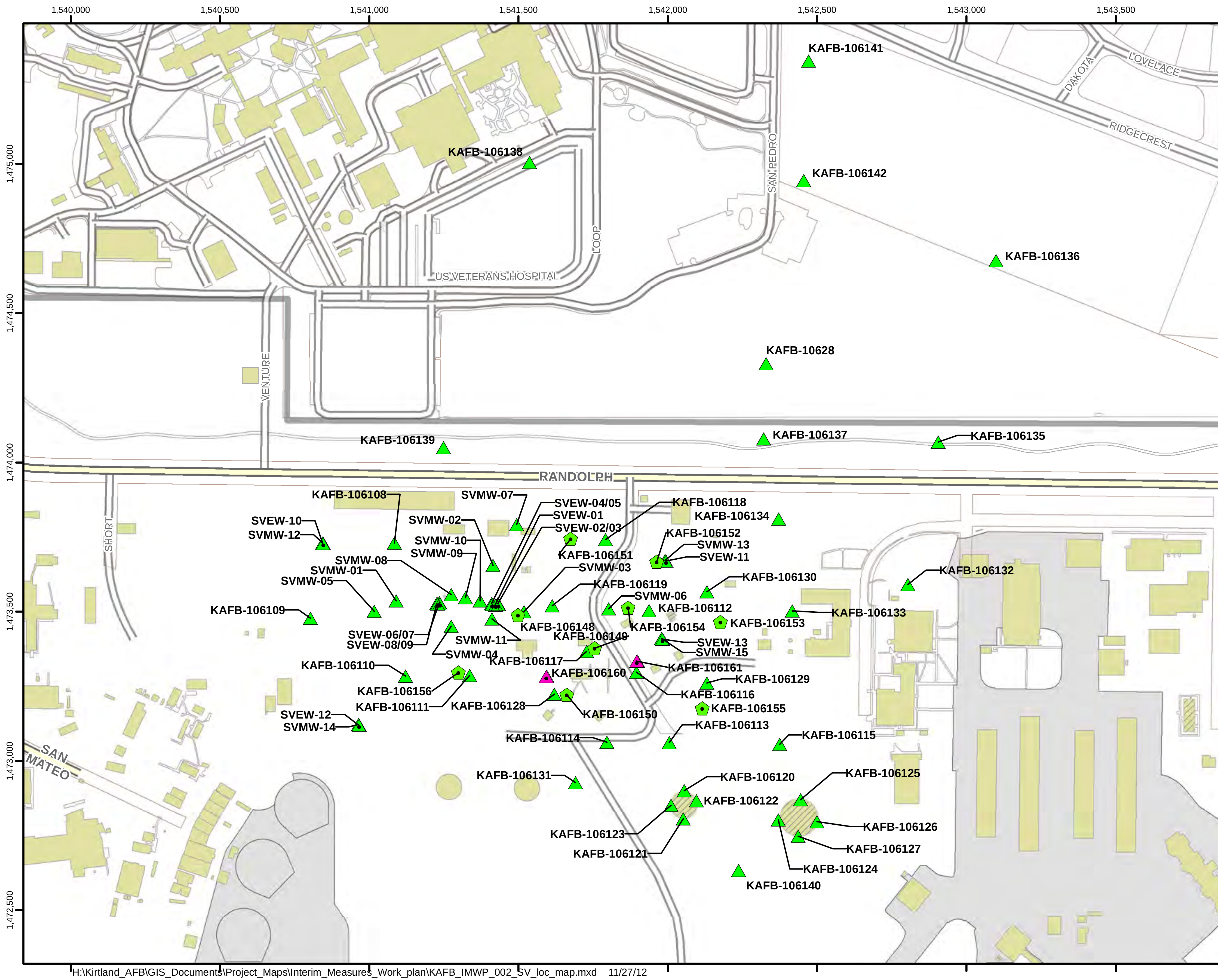
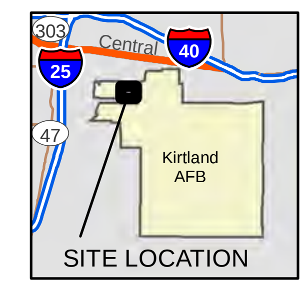


Legend

- SVE Remediation Well
- Pneulog Cluster
- SVE Extraction Well
- SVM Cluster



Revision Date: 11/27/12

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0 175 350 700

Feet

1 inch = 350 feet

Projection : NAD83 State Plane New Mexico Central FIPS3002 Feet

IN-WELL TREATMENT INTERIM MEASURES
WORK PLAN PART 1 -
DATA GATHERING AND ANALYSIS PLAN
BULK FUELS FACILITY
KIRTLAND AIR FORCE BASE, NEW MEXICO

FIGURE 1-2

SOIL VAPOR MONITORING LOCATIONS

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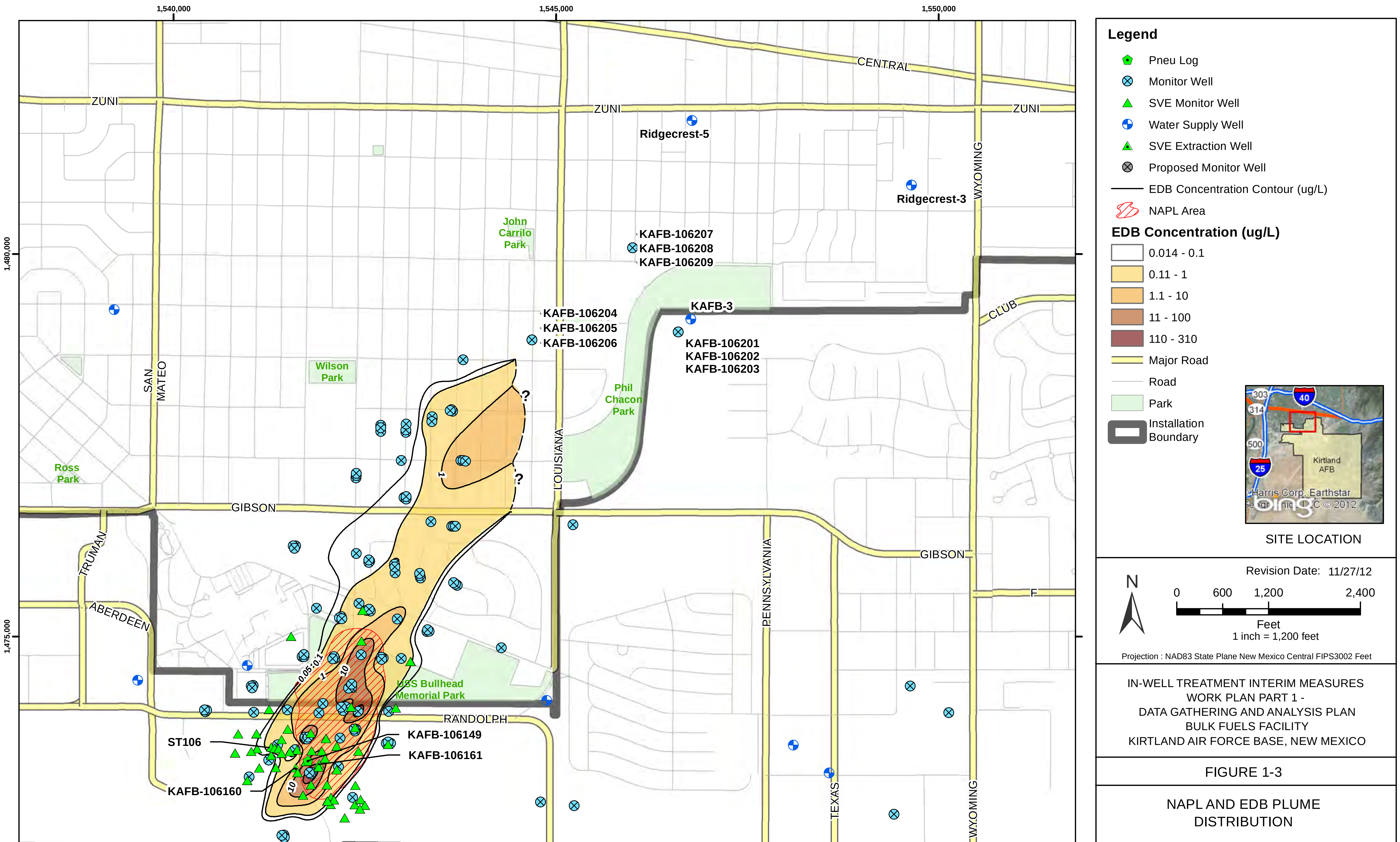

IN-WELL TREATMENT INTERIM MEASURES
WORK PLAN PART 1 -
DATA GATHERING AND ANALYSIS PLAN
BULK FUELS FACILITY
KIRTLAND AIR FORCE BASE, NEW MEXICO

FIGURE 1-3

NAPL AND EDB PLUME DISTRIBUTION

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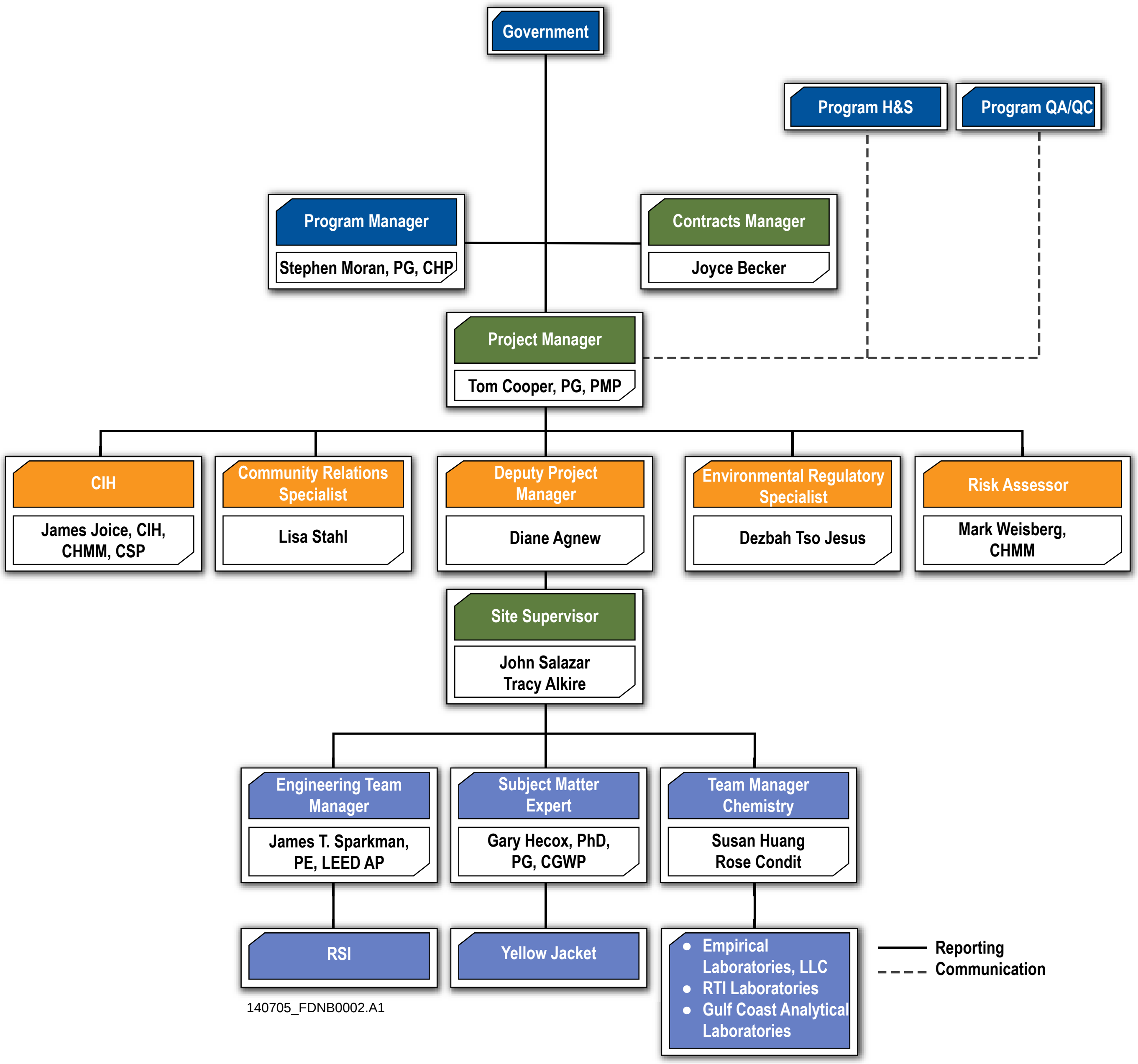
Figure 2-1. Project Organization



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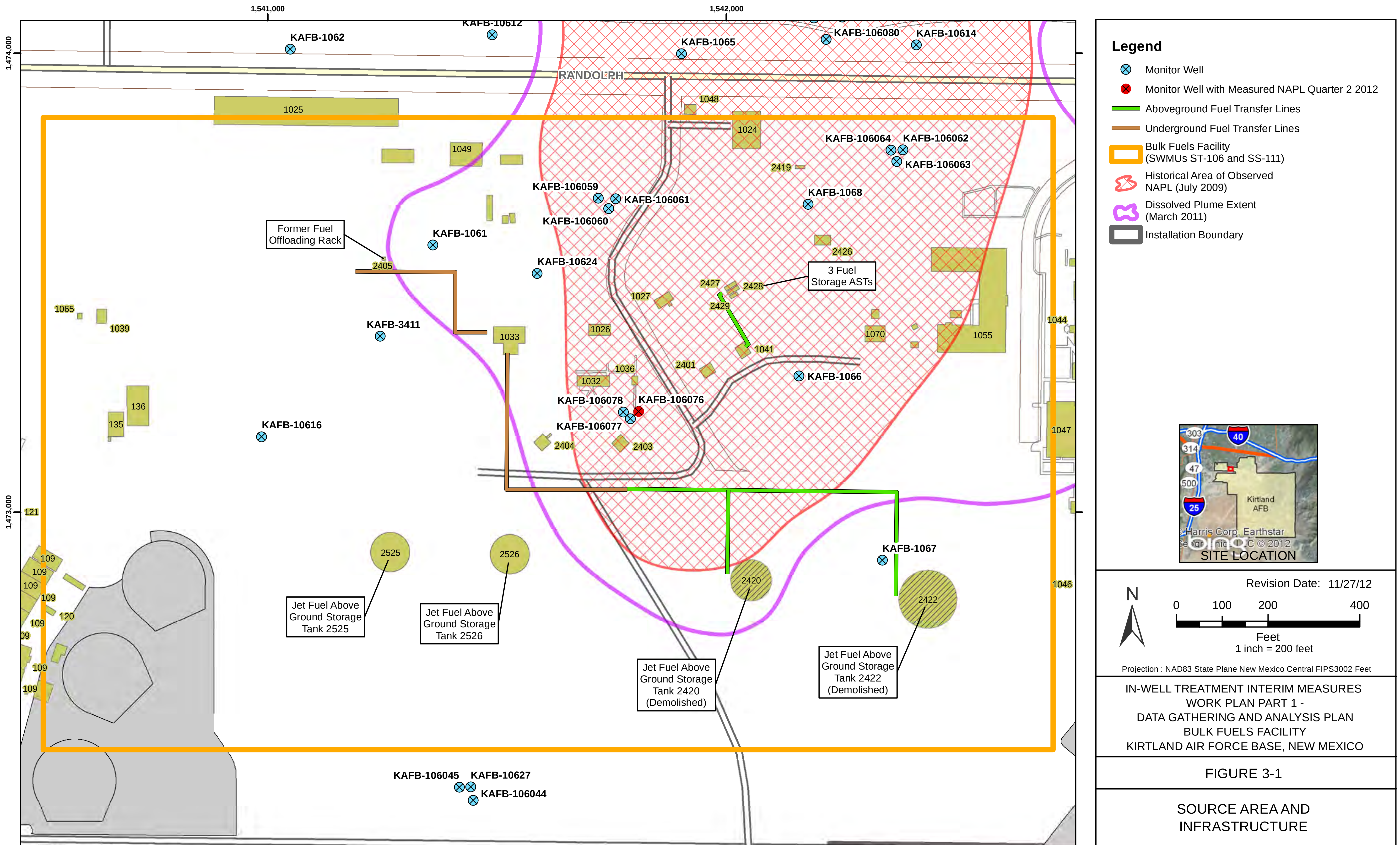

Revision Date: 11/27/12

Projection : NAD83 State Plane New Mexico Central FIPS3002 Feet

IN-WELL TREATMENT INTERIM MEASURES
WORK PLAN PART 1 -
DATA GATHERING AND ANALYSIS PLAN
BULK FUELS FACILITY
KIRTLAND AIR FORCE BASE, NEW MEXICO

FIGURE 3-1

SOURCE AREA AND
INFRASTRUCTURE

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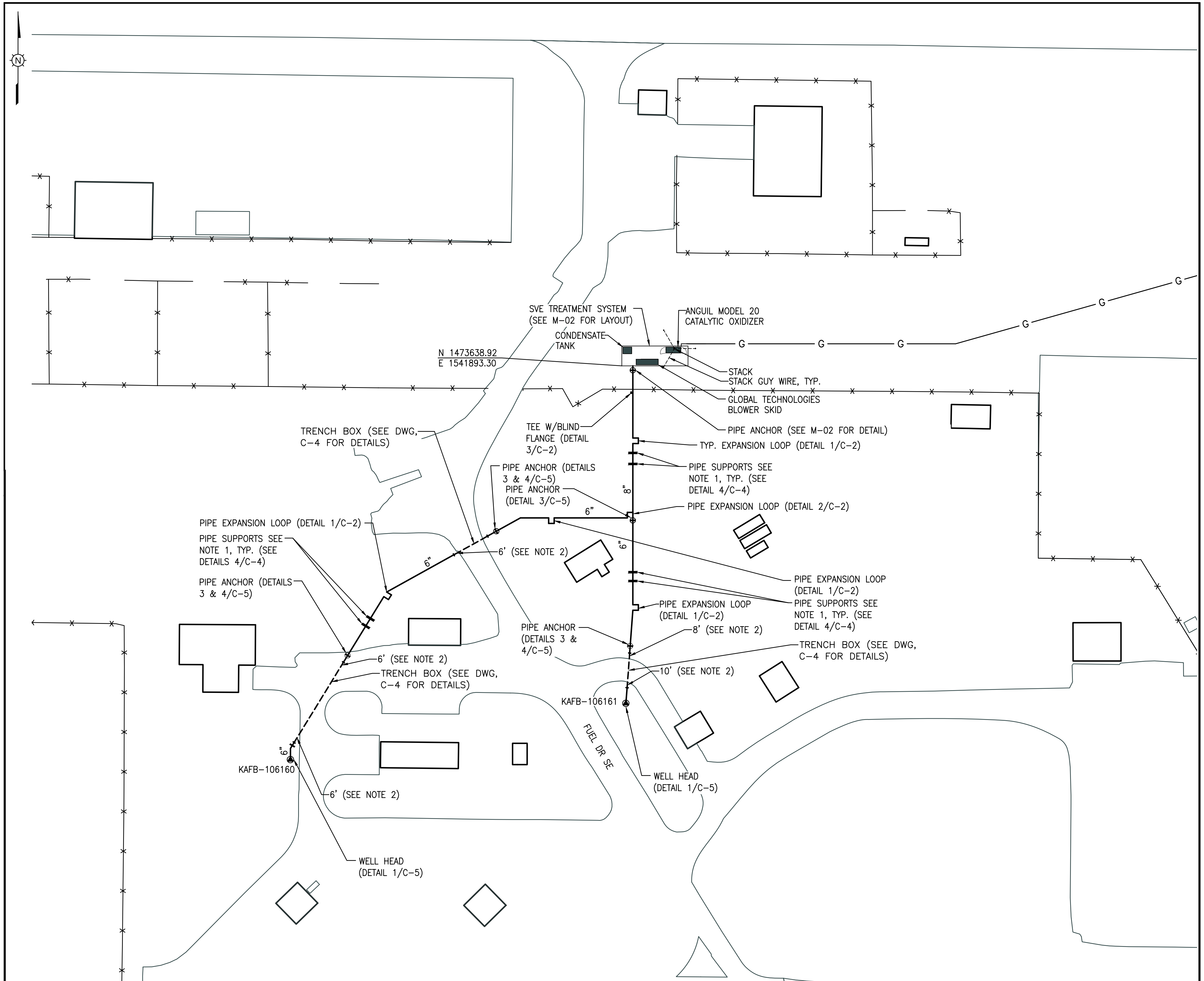
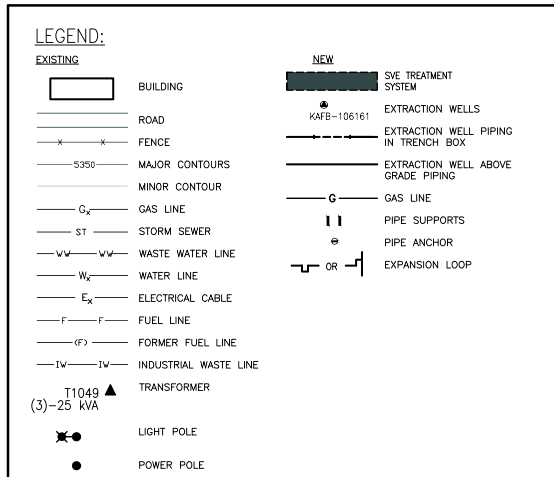
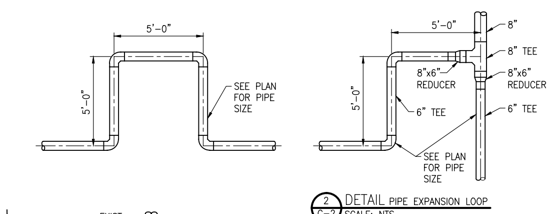


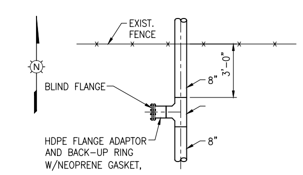


NOTES:

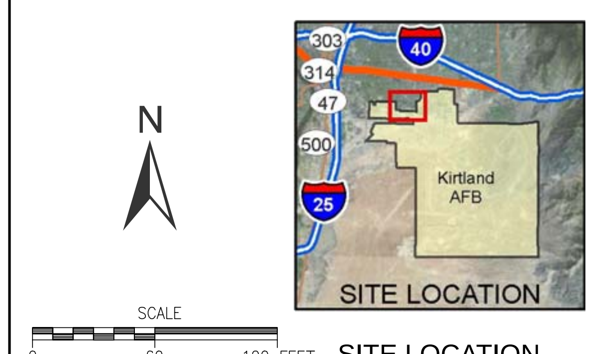
1. VACUUM PIPING WILL BE SUPPORTED BY 4"x4" PRESSURE TREATED POSTS LAID HORIZONTALLY ON GRADE EXCEPT WHERE NOTED BY PIPE ANCHORS. 6"ø PIPING SHALL BE SUPPORTED EVERY 8'-0" OC. 8"ø PIPING SHALL BE SUPPORTED EVERY 10'-0" OC.
2. MINIMUM DISTANCE REQUIRED FROM EDGE OF PAVED ROAD TO OUTSIDE DIAMETER OF PIPE.



2 C-2 DETAIL PIPE EXPANSION LOOP
SCALE: NTS



3 C-2 DETAIL TEE W/BLIND FLANGE FACING WEST
SCALE: NTS



SITE LOCATION

IN-WELL TREATMENT
INTERIM MEASURES WORK PLAN PART I -
DATA GATHERING AND ANALYSIS PLAN
BULK FUELS FACILITY
KIRTLAND AIR FORCE BASE, NEW MEXICO

FIGURE 6-1

SOIL VAPOR EXTRACTION AND THERMAL TREATMENT SYSTEM SITE PLAN

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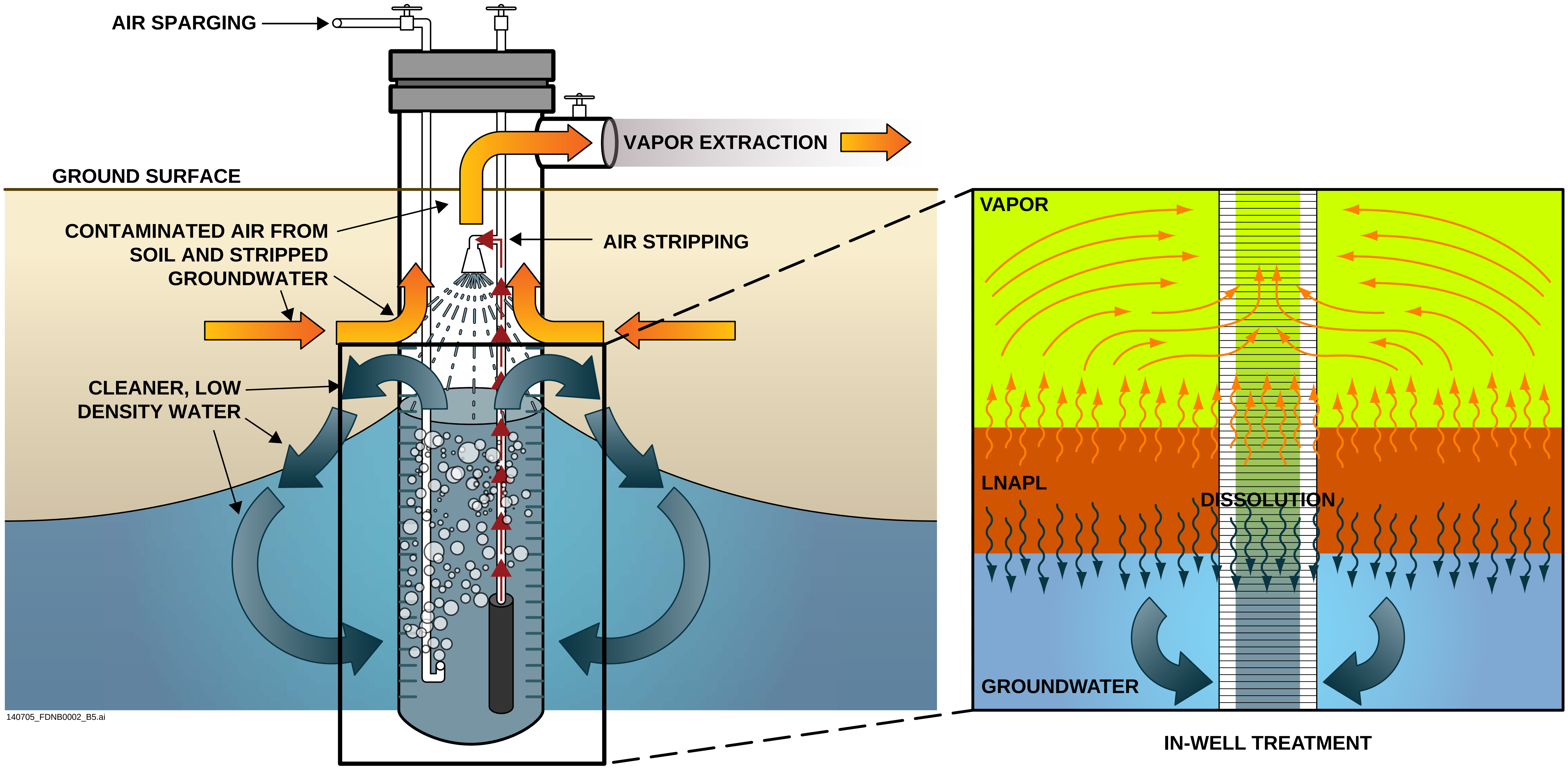

FIGURE 7-1

SUMMARY OF IN-WELL TREATMENT SYSTEM

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TABLES

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Table 1-1. Outstanding Permit Requirements

NMED Requirement	Applicable Letter or Meeting	Resolution
Permittee will conduct pump tests at the planned extraction wells to estimate hydraulic conductivity and specific yield	Meeting of March 7, 2011	Because these two requirements pertain to the extraction wells, which were to be implemented as part of the hydraulic containment system, they are no longer necessary for the completion of interim measures.
Permittee must obtain a hazardous waste permit to treat contaminated groundwater produced by pump testing at planned extraction wells	24-Feb-12	

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Table 4-1. COPCs at Kirtland AFB Bulk Fuels Facility

Parameter	Vadose Zone	Groundwater		
		Shallow	Intermediate	Deep
1,2,4-TMB	X			
1,3,5-TMB	X			
2-Butanone	X			
1,2-dibromoethane (EDB)		X	X	X
1,2-dichloroethane		X		
Acetone	X			
Benzene	X	X	X	
bis(2-Ethylhexyl)phthalate		X		X
C5-C8 Aliphatic Hydrocarbons	X			
C9-C10 Aromatic Hydrocarbons	X			
C9-C12 Aliphatic Hydrocarbons	X			
Cyclohexane	X			
Dibenz(a,h)anthracene		X		
Ethylbenzene	X	X	X	
Heptane	X			
Iron		X	X	
Isopropanol	X			
m,p-Xylenes	X			
Manganese		X	X	X
Methylene chloride	X	X		
n-Hexane	X			
Naphthalene		X	X	
Nitrogen, Nitrate (As N)		X		
Phenol		X		
Propene	X			
Propylene	X			
Sulfate (as SO4)		X		
Tetrachloroethene		X		
Toluene	X	X		
Trichloroethene		X		
Xylene, o-	X			
Xylenes, total (in lieu of m,p,o-Xylenes)	X	X		

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APPENDIX A

Regulatory Correspondence between the NMED HWB and the Air Force

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ATTACHMENT 1

April 2, 2010 Correspondence from the NMED HWB to Colonel Michael S. Duvall, Base Commander, 377 ABW/CC, and Mr. John Pike, Director, Environmental Management Section, 377 MSG/CEANR, Re: SWMUs ST-106 and SS-111, BFF Spill, Kirtland AFB

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AR Doc # 3451

BILL RICHARDSON
Governor

DIANE DENISH
Lieutenant Governor

NEW MEXICO ENVIRONMENT DEPARTMENT

Hazardous Waste Bureau

2905 Rodeo Park Drive East, Building 1
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SARAH COTTRELL
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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

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, SWMUs ST-106 and SS-111, BFF Spill, Kirtland AFB

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CEANR

NEW MEXICO
ENVIRONMENT DEPARTMENT

Hazardous Waste Bureau

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Governor

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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.

Reporting Requirements

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 3

August 6, 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: BFF Spill, SWMUs ST-106 and SS-111, Directive for Conducting Interim Measures and Notice of Disapproval, Kirtland AFB

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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™) 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™) 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™) 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

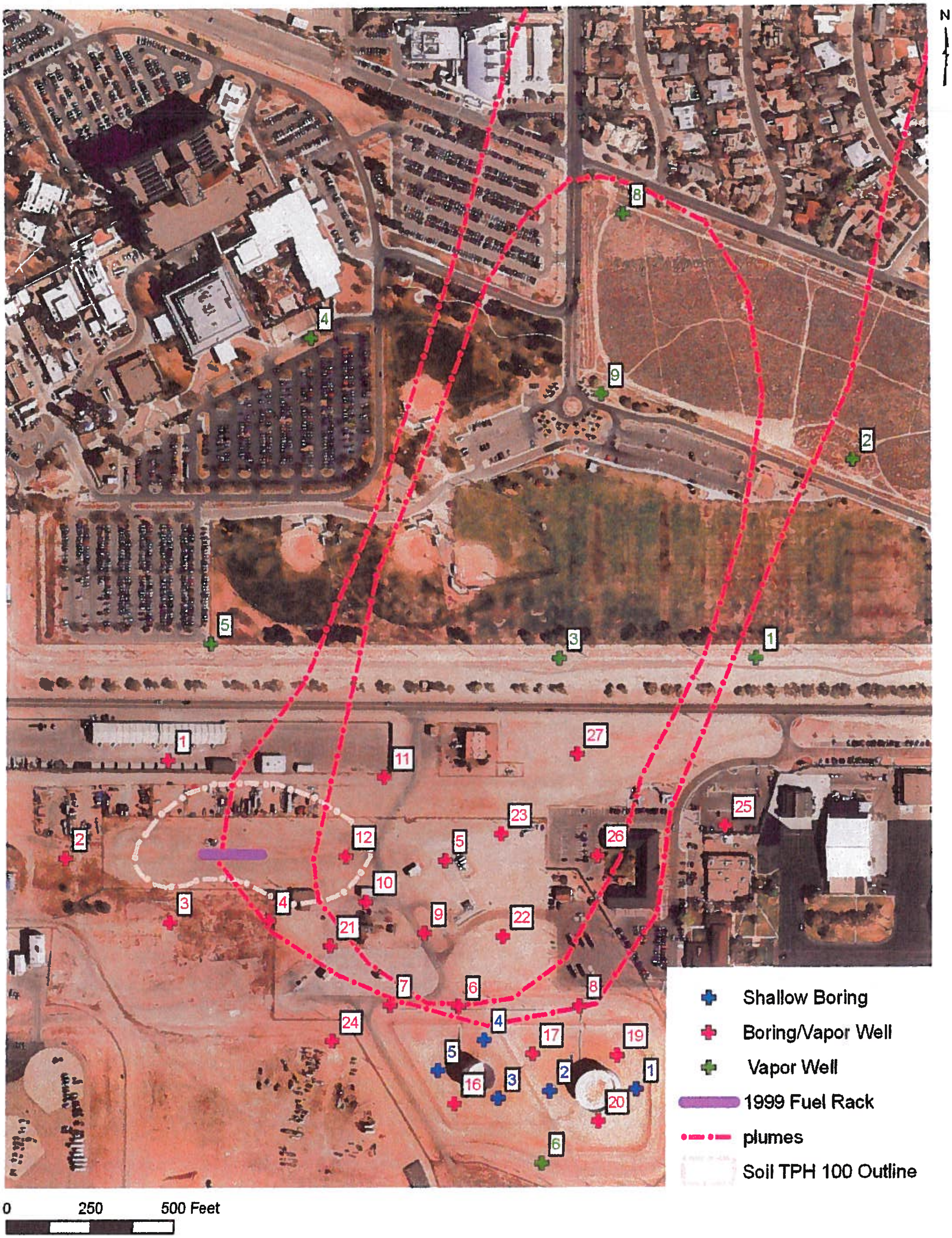

Figure 1. Soil Boring and
Soil-Vapor Monitoring Well Locations

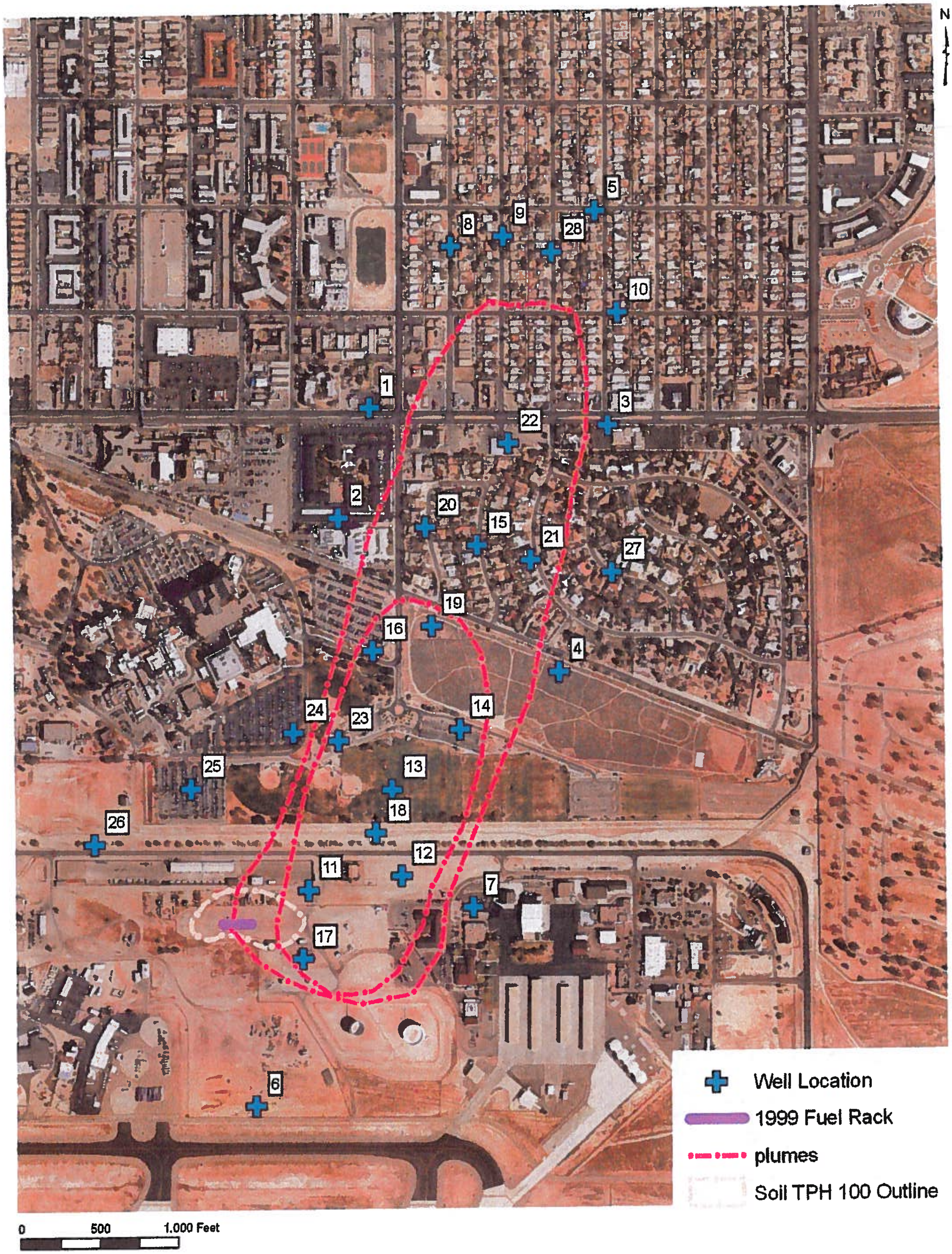

Figure 2. Groundwater Monitoring Well Locations

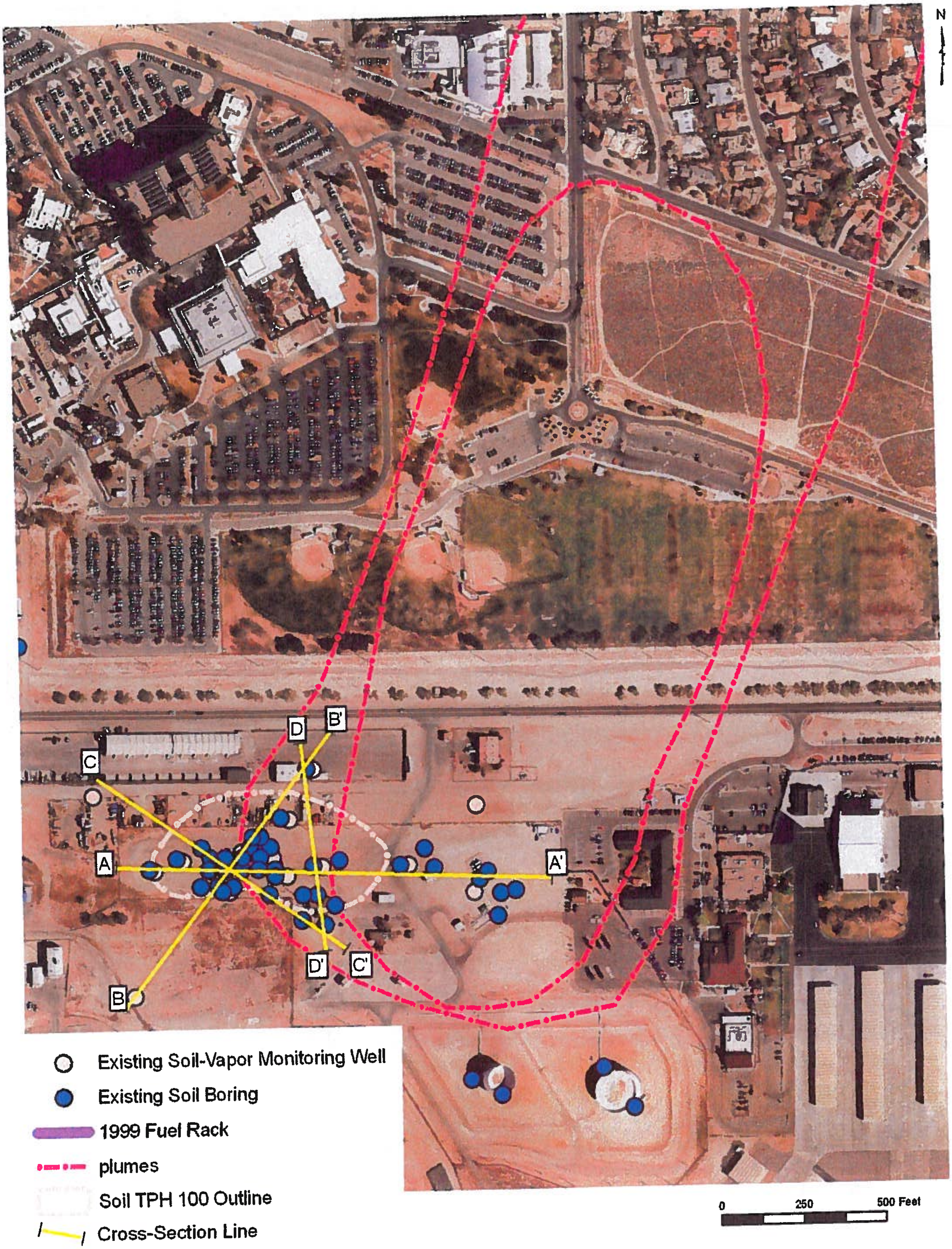

Figure 3 Existing Soil Boring, Soil-Vapor Monitoring Well and Cross-Section Locations

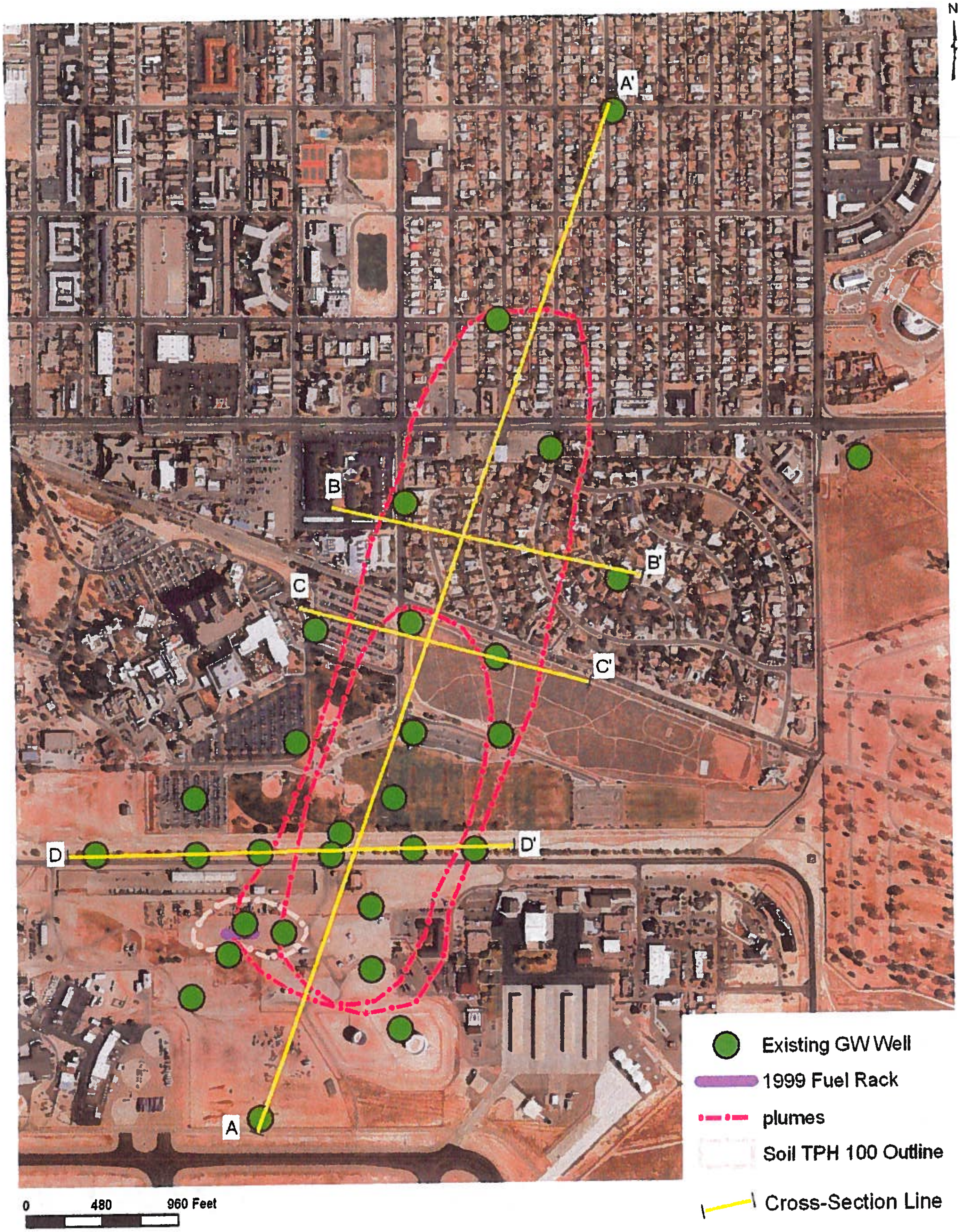

Figure 4. Existing Well and Cross-Section Locations

ATTACHMENT 4

May 5, 2011 Correspondence from Mr. Thomas F. Berardinelli, 377 ABW/DS, KAFB, to Mr. John Kieling, Manager, RCRA Permits Management Program, NMED HWB, Re: Summary of decisions made at the 7 March 2011 NMED HWB and KAFB meeting

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AR Doc # 3537

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS 377TH AIR BASE WING (AFMC)

MAY 05 2011

Mr. Thomas F. Berardinelli
377 ABW/DS
2000 Wyoming Blvd SE
Kirtland AFB NM 87117-5000

Mr. John Kieling
Hazardous Waste Bureau
New Mexico Environment Department
2905 Rodeo Park Dr East, Bldg 1
Santa Fe NM 87505-6303

Mr. Kieling

This letter is to summarize the decisions agreed to at the 7 March 2011 Kirtland Air Force Base (AFB)-New Mexico Environment Department-Hazardous Waste Bureau (NMED-HWB) meeting. The meeting was held to discuss the 21 February 2011 NMED letter (Atch 1) requiring continuous coring with laboratory measurements for grain size, hydraulic conductivity, porosity, specific yield, and compressibility. As agreed, the desired hydraulic parameters of hydraulic conductivity, specific yield, and grain size will be obtained through a combination of pumping tests, slug tests, and samples collected during drilling. Collecting hydraulic data in this fashion will result in the most suitable data to evaluate and design the LNAPL containment system and inform future final remedy evaluations.

Pumping tests of the planned extraction wells will result in estimations of hydraulic conductivity, as well as specific yield. The pump test will also allow for the estimation of both vertical and horizontal hydraulic conductivity, through the monitoring of monitoring wells at the three depths (shallow, intermediate, and deep).

Slug tests will be conducted on all of the field groundwater monitoring well locations, as shown in the attached Figure 1-1. The slug test results will be analyzed following the oscillating slug test method (provided separate) and will yield hydraulic conductivity data most suited to monitoring contaminant migration rates. The other wells in a cluster may also be monitored during slug testing to provide an additional estimate of aquifer anisotropy.

In addition to these tests, drill cutting samples will be collected from the cyclone collection device at five foot intervals across the screened interval. The most representative sample, submitted for analysis, will be reconsolidated and tested for hydraulic conductivity, specific yield, and grain size. The grain size analysis results will be used to estimate porosity for the screened intervals.

Based on the above information, it was agreed that continuous coring of the screened interval will not be required. Also, analysis of samples for compressibility will not be required.

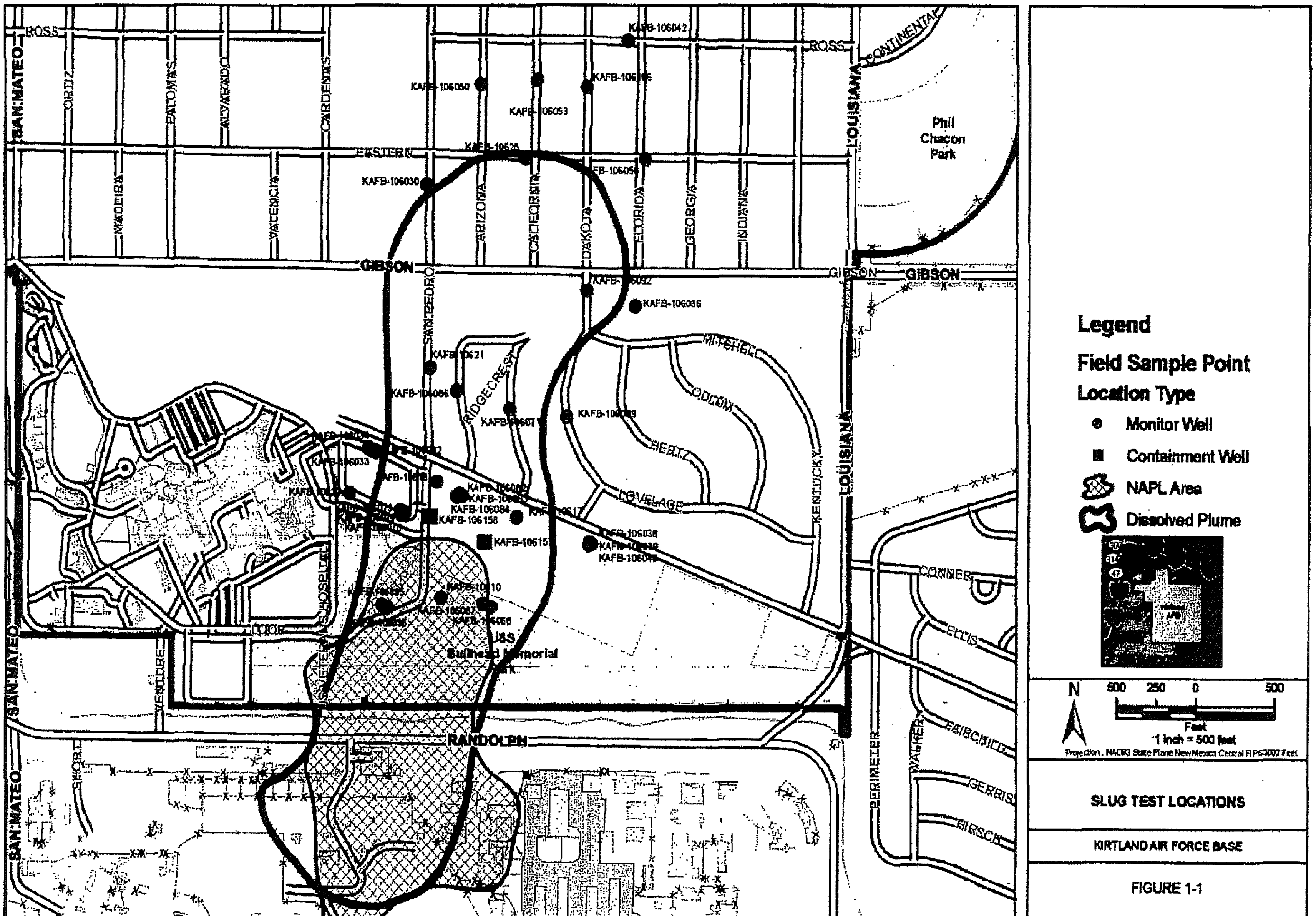
If you have any questions with regard to these submittals, please contact Mr. John Pike at (505) 846-8546.

Sincerely

THOMAS F. BERARDINELLI
Director of Staff

2 Attachments:
1. 21 Feb 2011 NMED LETTER - "DIRECTION TO ACQUIRE HYDRAULIC INFORMATION BULK FUELS FACILITY SPILL (SWMUS ST-I06 AND SS-111) KIRTLAND AIR FORCE BASE EPA ID# NM9570024423"
2. Figure 1-1: KAFB_003_Slug_Test _Locations

cc:
NMED HWB - Mr. Moats, w/ atchs electronic and hardcopy
NMED GWQB - Mr. Olson, w/ atchs electronic and hardcopy
NMED HWB - Mr. McDonald, w/o atchs
NMED HWB – Mr. Brandwein, w/o atchs
USEPA-Region 6 (6PD-N), Ms. King, w/o atchs
AFCEE, Mr. Oyelowo, w/o atchs
USACE, Mr. Midgal, w/o atchs
Admin. Record, CNM, Montoya Campus w atch
File



SAN MATEO
ROSS
ORTIZ
PALOMAS
ALVARADO
CARDENAS
MADEIRA
VALENCIA
EASTERN
ARIZONA
CACIEORRA
DAKOTA
FLORIDA
GEORGIA
INDIANA
LOUISIANA
GIBSON
CONTINENTAL
Phil Chacon Park
SAN PEDRO
RIDGECREST
MITCHELL
ODLUM
HERTZ
LOVELACE
KENTUCKY
HOSPITAL
LOOP
VENTURE
RANDOLPH
SHORT
PERIMETER
CONNER
ELLIS
WALKER
FAIRCHILD
GERRIS
HIRSCH
KAFB-106042
KAFB-106050
KAFB-106053
KAFB-106030
KAFB-106036
KAFB-106084
KAFB-106158
KAFB-106038
KAFB-106033
Bullhead Memorial Park
Legend
Field Sample Point
Location Type
Monitor Well
Containment Well
NAPL Area
Dissolved Plume
N
500 250 0 500
Feet
1 inch = 500 feet
SLUG TEST LOCATIONS
KIRTLAND AIR FORCE BASE
FIGURE 1-1

SUSANA MARTINEZ
Governor

JOHN A. SANCHEZ
Lieutenant Governor

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

DAVE MARTIN
Secretary

RAJ SOLOMON, P.E.
Deputy Secretary

CERTIFIED MAIL - RETURN RECEIPT REQUESTED

February 21, 2011

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: DIRECTION TO ACQUIRE HYDRAULIC INFORMATION
BULK FUELS FACILITY SPILL (SWMUS ST-106 AND SS-111)
KIRTLAND AIR FORCE BASE
EPA ID# NM9570024423

Dear Col. Maness and Mr. Pike:

On December 1, 2010, the U.S. Air Force (the Permittee) submitted a plan to contain light nonaqueous phase liquid (LNAPL) at Solid Waste Management Units (SWMUs) ST-106 and SS-111, Kirtland Air Force Base (KAFB) Bulk Fuels Facility Spill. While the plan is conceptual in nature, it calls for extraction wells designed to create a capture zone for the LNAPL and an infiltration well to disposition the extracted and treated water. To refine the plan, and collect data crucial for development and design of final remedies for groundwater contamination, key aspects of the geologic and hydrologic conditions of the groundwater need to be determined. The need for this information was previously communicated to the Permittee in correspondence dated August 6 and April 2, 2010.

The ongoing drilling for the Bulk Fuels Facility Spill project provides an excellent opportunity to obtain this information and assess the horizontal and vertical variability of several important hydraulic parameters through the sampling of aquifer materials, likely at a reduced overall cost for the project. Thus, pursuant to Part 6.5.17.1 of the Permittee's Hazardous Waste Facility Permit, the Permittee must collect undisturbed, representative samples of the saturated zone encountered at the location of each well screen for each groundwater monitoring well listed under NMED's letter of August 6, 2010, for which drilling begins on or after **February 25, 2011**. The samples must be analyzed in the laboratory for grain-size distribution, saturated hydraulic conductivity (vertical and horizontal by the constant or falling head methods, as appropriate), porosity, and specific yield. Samples must also be collected from the saturated zone encountered at the location of each well screen for the wells screened across the water table at locations # 14, 16, and 22 of NMED's letter of August 6, 2010, and analyzed in the laboratory for compressibility. All samples must be described for their geologic characteristics (mineralogy and texture) and assigned the appropriate classification under the Unified Soil Classification System. The field data and results of the sampling and laboratory analysis must be submitted in a report to the NMED by **August 1, 2011.**

NMED invites the Permittee to meet to discuss this direction in more detail, and to consider additional or alternative parameters that might be useful in future corrective actions at the Bulk Fuels Facility Spill project. NMED will provide its comments on the LNAPL containment plan under separate cover.

Please contact William Moats at (505) 222-9551 of my staff to arrange the aforementioned meeting, or if you or your staff have any questions.

Sincerely,

James P. Bearzi
Chief
Hazardous Waste Bureau

cc: R. Solomon, Acting Director, NMED WWMD
J. Kieling, NMED HWB
W. Moats, NMED HWB
W. McDonald, NMED HWB
S. Brandwein, NMED HWB
B. Olson, 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 2011

ATTACHMENT 5

February 24, 2012 Correspondence from the NMED HWB to Colonel John Kubinec, Base Commander, 377 ABW/CC, and John Pike, Director, Environmental Management Services, 377 MSG, Re: Letter Addendum of February 7, 2012 for LNAPL Containment Well Development, LNAPL Containment Well Interim Measures Work Plan Part 1, Characterization, BFF Spill, SWMUs ST-106 and SS-111, Kirtland, AFB

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NEW MEXICO
ENVIRONMENT DEPARTMENT

Hazardous Waste Bureau

SUSANA MARTINEZ
Governor

JOHN A. SANCHEZ
Lieutenant Governor

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Santa Fe, New Mexico 87505-6303
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www.nmenv.state.nm.us

DAVE MARTIN
Secretary

BUTCH TONGATE
Deputy Secretary

CERTIFIED MAIL - RETURN RECEIPT REQUESTED

February 24, 2012

Colonel John Kubinec
Base Commander
377 ABW/CC
2000Wyoming Blvd. SE
Kirtland AFB, NM 87117-5606

John Pike
Director, Environmental Management Services
377 MSG
2050 Wyoming Blvd. SE, Suite 116
Kirtland AFB, NM 87117-5270

RE: LETTER ADDENDUM OF FEBRUARY 7, 2012 FOR LNAPL CONTAINMENT WELL DEVELOPMENT, LNAPL CONTAINMENT WELL INTERIM MEASURES WORK PLAN PART 1, CHARACTERIZATION, BULK FUELS FACILITY SPILL, SOLID WASTE MANAGEMENT UNITS ST-106 AND SS-111 KIRTLAND AIR FORCE BASE, EPA ID# NM9570024423 HWB-KAFB-10-037

Dear Col. Kubinec and Mr. Pike:

The New Mexico Environment Department (NMED) is in receipt of the above referenced letter addendum submitted for Kirtland Air Force Base (KAFB)(Permittee) under cover letter from Mr. Thomas Berardinelli to Mr. John Kieling, dated February 7, 2012.

NMED approves the technical aspects of conducting the enhanced well development as described in the subject letter addendum, but understands that groundwater to be removed from the extraction well is expected to contain hazardous waste, specifically benzene at a concentration in excess of 0.5 mg/L. **A hazardous waste permit is required to treat such groundwater before the water can be discharged to the ground or otherwise land disposed.** For the groundwater to no longer contain benzene, the groundwater must be treated such that the benzene concentration is less than 0.5 mg/L. Additionally, all underlying hazardous constituents (UHCs) that may be present in the groundwater must also be treated if necessary to the appropriate treatment standards found in 20.4.1.800 NMAC incorporating 40 CFR § 268.48. For example, organic compounds such as toluene, ethylene dibromide, and xylene should be evaluated to determine if they are

UHCs and if they require treatment.

Although the NMED can issue an emergency permit under 20.4.1.900 incorporating CFR § 270.61 for treatment of hazardous waste as part of conducting the enhanced well development, the Permittee did not request an emergency permit and did not provide the minimum information necessary for the NMED to issue an emergency permit. The letter addendum did not provide information concerning what is to be analyzed, the analytical methods to be employed, the frequency of sampling prior to and after treatment, and the records and certifications that are required to be kept concerning the generation and treatment of characteristic wastes.

Should you have any questions regarding this matter please contact Mr. William Moats of my staff at 505-222-9551.

Sincerely,

John E. Kieling
Acting Chief
Hazardous Waste Bureau

cc: W. Moats, NMED HWB
W. McDonald, NMED HWB
S. Brandwein, NMED HWB
J. Schoeppner, NMED GWQB
B. Gallegos, AEHD
B. Gastian, ABCWUA
L. King, EPA-Region 6 (6PD-N)
File: KAFB 2012 and Reading

APPENDIX B

Project Schedule

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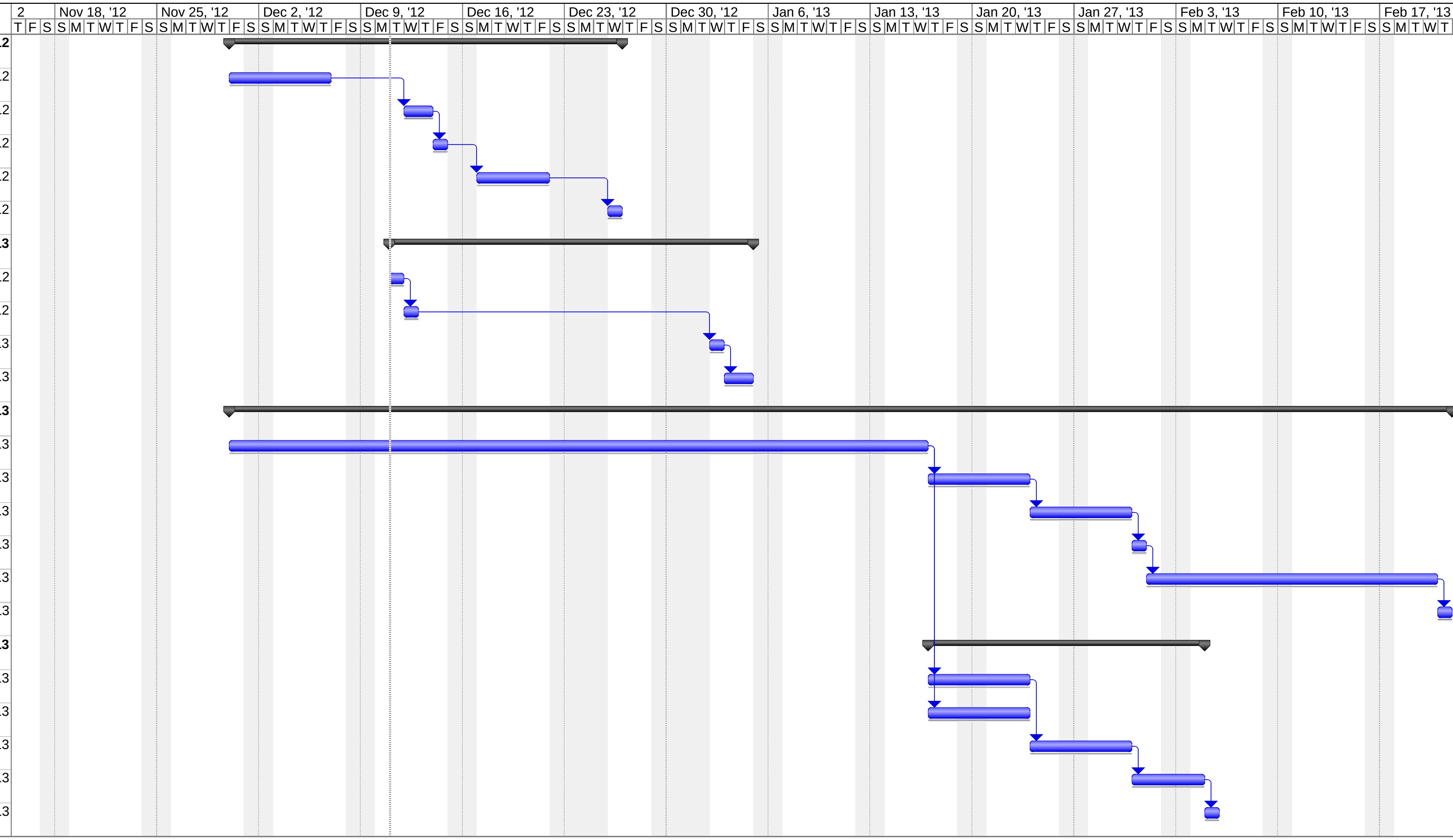
ID		Task Name	Duration	Start	Finish
1		**Part I Work Plan**	**17 days**	**Fri 11/30/12**	**Wed 12/26/12**
2		USACE and KAFB Review	5 days	Fri 11/30/12	Thu 12/6/12
3		Staffing for Commander Signature	2 days	Wed 12/12/12	Thu 12/13/12
4		Submit Part I WP to NMED	1 day	Fri 12/14/12	Fri 12/14/12
5		NMED Review Part I WP	5 days	Mon 12/17/12	Fri 12/21/12
6		NMED Approval of Par I WP	1 day	Wed 12/26/12	Wed 12/26/12
7		**Part I Data Collection**	**15 days**	**Tue 12/11/12**	**Fri 1/4/13**
8		Development of KAFB-106160	1 day	Tue 12/11/12	Tue 12/11/12
9		Development of KAFB-106161	1 day	Wed 12/12/12	Wed 12/12/12
10		Sample KAFB-106160 & KAFB-106161	1 day	Wed 1/2/13	Wed 1/2/13
11		Lab Analysis of KAFB-106160 & KAFB-1061	2 days	Thu 1/3/13	Fri 1/4/13
12		**Part II Design Plan**	**56 days**	**Fri 11/30/12**	**Thu 2/21/13**
13		Prepare Part II Design Plan	30 days	Fri 11/30/12	Wed 1/16/13
14		USACE and KAFB Review	5 days	Thu 1/17/13	Wed 1/23/13
15		Staffing for Commander Signature	5 days	Thu 1/24/13	Wed 1/30/13
16		Submit Part II Design Plan to NMED	1 day	Thu 1/31/13	Thu 1/31/13
17		NMED Review of Part II Design Plan	14 days	Fri 2/1/13	Wed 2/20/13
18		NMED Approval of Part I Design Plan	1 day	Thu 2/21/13	Thu 2/21/13
19		**ART System Construction**	**13 days**	**Thu 1/17/13**	**Mon 2/4/13**
20		Electrical Utility	5 days	Thu 1/17/13	Wed 1/23/13
21		Installation of in-well equipment	5 days	Thu 1/17/13	Wed 1/23/13
22		Compressor Delivery and Installation	5 days	Thu 1/24/13	Wed 1/30/13
23		System Start-up	3 days	Thu 1/31/13	Mon 2/4/13
24		ART System Operation Begins	1 day	Tue 2/5/13	Tue 2/5/13



Project: In Well Treatment Schedule 12
Date: Tue 12/11/12

Task | Progress | Summary | External Tasks | Deadline
Split | Milestone | Project Summary | External Milestone

APPENDIX C

Project Forms

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Shaw™ Shaw Environmental, Inc.

FIELD ACTIVITY DAILY LOG

DAILY LOG			
DATE			
NO.			
SHEET OF			

PROJECT NAME:	PROJECT NO.:
FIELD ACTIVITY SUBJECT:	
DESCRIPTION OF DAILY ACTIVITIES AND EVENTS:	
VISITORS ON SITE:	CHANGES FROM PLANS AND SPECIFICATIONS, AND OTHER SPECIAL ORDERS AND IMPORTANT DECISIONS:
WEATHER CONDITIONS:	IMPORTANT TELEPHONE CALLS:
SHAW PERSONNEL ON SITE:	
SIGNATURE:	DATE:

Shaw™ Shaw E & I

CHAIN OF CUSTODY

Ref. Document # ____________

Page ______ of ____

Project Number: ____________

Project Name / Location: ____________

Purchase Order #: ____________

Project Contact: ____________
(Name & phone #)

Shipment Date: ____________

Waybill/Airbill Number: ____________

Lab Destination: ____________

Lab Contact Name / ph. #: ____________

Send Report To: ____________

Phone/Fax Number: ____________

Address: ____________

City: ____________

Sampler's Name(s): ____________

Sample ID Number	Sample Description	Collection Information			Matrix	# of containers	Container type	Preservative						Analyses Requested									Turn Around Time Requested
		Date	Time	G/C				HCL	NaOH	HNO_3	H_2SO_4	Ice											

Special Instructions:

QC/Data Package Level Required:
I II III IV/Project Specific: ____________

Relinquished By:	Date: / Time:	Received By:	Date: / Time:
Relinquished By:	Date: / Time:	Received By:	Date: / Time:
Relinquished By:	Date: / Time:	Received By:	Date: / Time:

G/C Codes

C = Composite G = Grab

Matrix Codes

DW = Drinking Water SO =Soil
GW = Ground Water SL = Sludge
WW = Waste Water CP = Chip Samples
SW = Surface Water WP = Wipe Samples
LIQ = Other Liquid SOL = Other Solid
AS = Air Sample SED = Sediment

COC Continuation Page

COC Ref. Document # ____________ Page ______ of ______

Project Number: ____________ Shipment Date: ____________

Project Name / Location: ______________________________

		Collection Information						Preservative						Analyses Requested										
Sample ID Number	Sample Description	Date	Time	G/C	Matrix	# of containers	Container type	HCL	NaOH	HNO_3	H_2SO_4	Ice												Turn Around Time Requested

Project Name: ____ Project No. ______________________________ Page ______________

TEST EQUIPMENT LIST AND CALIBRATION LOG

Equipent Number and Use (Screening or Analytical)	Equipment Name (Manufacturer and Model ID)	Date and Time (of Califbration)	Calibration Standard Used (Mnaufacturer and Lot Number)	Equipment Reading (Include Units and Tolerances)	Comments (and/or Observations)	Initials (of Person)

Shaw Shaw Environmental, Inc.

GROUNDWATER PURGE LOG

Kirtland Air Force Base, Bulk Fuels Facility Spill

Project Name: ______________________ **Well ID No.:** ______________________

Site / SWMU No.: ______________________ **Date:** ______________________

Weather: ______________________ **Time:** ______________________

Field Crew: ______________________ **Crew Signature:** ______________________

Review Signature: ______________________ **Date Review:** ______________________

WELL OBSERVATIONS

Protective Casing / Vault: - Intact - Damaged - **Locked:** Yes - No **Well ID Mark:** Yes - No

Notes: ____

CALCULATIONS

(A) Depth to Well Bottom	ft
(B) Pre-Purge Depth to Water	ft
(C) Water Column Height (A-B)	ft
(D) Casing Factor: 4"=0.65 5"=1.02	
(E) One Well Casing Volume (C x D):	gal
(F) Depth to Top of Screen	ft
(G) Depth to Bottom of Screen	ft
(H) Saturated Filter Pack Length (G –F, or B)	ft
(I) Casing/Borehole Factor 4/10 = 1.2, 5/10 = 1.07, ________	

(J) Filter Pack Volume (H x I)	gal
(K) Min Purge Volume (E + J)	gal
EQUIPMENT / MODEL	**ID NUMBER**
Parameter Meter	
Turbidity Meter	
Pump	
Field Alkalinity	

PURGING INFORMATION

Description first water purged:

____

Date and / or Time	Gallons Removed	Depth to Ground-water (Ft)	Temp (°C)	pH	Spec Cond (μS/cm²)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Comment
Values Prior to Sampling									

Field Alkalinity Result ______________________

Note: For calculations, additional casing factors (D) and casing/borehole factors (I) can be found in the *Groundwater Investigation Work Plan, Part I: Field Investigation Activities*

Shaw™ Shaw Environmental, Inc.

Well Development Record

Project Name: KAFB BFF

Location: KAFB

Well/Piez. No.: ____

Personnel: ____

Date Installed: ____

Date: ____

Csg. Diameter (I.D.): ____

Samplers: ____

Total Depth (ft. BGL): ____

Method of Development:

☐ Surging ☐ Bailing ☐ Pumping ☐ Other (State Method)

☐ Original Development ☐ Redevelopment

Development Date: ____

Depth to Water Before Developing Well: ____

Vol. (V) Purge Factor Volume to Purge

Height of Water Column: ____ feet = ____ gal.* ____ = ____

$$V=(B * r_c^2 * L_c * 7.48)+(B * (r_w-r_c)^2 * L_s * \O_s * 7.48)= \_\_\_\_ \text{gallons}$$

Depth Purging From: ____ feet

Time Purging Begins: ____

Weather: ____

Screened Interval (ft BGL): ____

Equipment Nos.: pH Meter: ____ **EC Meter:** ____ **Turbidity Meter:** ____

Equipment Decontaminated Prior to Development: Y ____ N ____

Describe: ____

Collected Sample of Water Added to Well: Y ____ N ____

Describe: ____

Date	Time	Water Level (ft. Below TOC)	Volume Removed (gal.)	Temp.°C	pH	EC (ms/cm)	Turbidity N.T.U.	Comments

Notes:

* Water Levels - Reported to the nearest 0.01 foot
* pH - Reading rounded to 0.1 pH units
* Water temperature - Reported to nearest 0.1C
* Turbidity report in NTV nearest whole #

Where:

B=3.14

$\O_s$= porosity of the sand pack

r_c= radius of the well casing and screen in feet

L_c= length of water column inside the casing and screen in feet

r_w= radius of the well bore in feet

L_s= length of saturated portion of the sand pack in feet

7.48 gallons/cubic foot= conversion from cubic feet to gallons

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Field Work Variance No. ____________________

Page ______ of ______

FIELD WORK VARIANCE

Project Name/Number ____________________

Contract No. ____________________

Applicable Document(s) ____________________ Date

Problem Description:

Recommended solution:

Impact on present and completed work:

Requested by:

Recommended solution/disposition:

Clarification ☐ Minor Change ☐ Major Change ☐

Signature ____________________ Date ____________________

Technical Reviewer

Shaw Environmental Inc, Approvals: *If Major Change:*

Signature ____________________ Date 08/01/2011 Signature ____________________ Date ____________________

Project/Task Manager *Sr. Project Manager*

Signature ____________________ Date ____________________

Project QC System Manager

USACE Approval: *If Major Change:*

Approved ☐ Rejected ☐ Signature ____________________ Date ____________________

USACE PM or COR

Final Description

Signature ____________________ Date ____________________

Shaw® Shaw Environmental, Inc.

Field Work Variance No. ____________________

Page ______ of ________

FIELD WORK VARIANCE CONTINUATION SHEET

Continue FWV discussions below by noting section title(s) to be continued (i.e., Problem Description, Solution/disposition, Final Disposition, etc). Use additional continuation sheets as needed.

References:

APPENDIX D

Waste Management Plan

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WASTE MANAGEMENT PLAN

Investigation-derived waste generated may include nonregulated or recyclable materials associated with routine, scheduled engine maintenance including used air filters, used oil filters, spark plugs, motor oil, and anti-freeze. Additionally, during periods of cold temperatures, the system may generate condensate from the extracted soil vapor, which will be captured in integrated knock-out system drums and manifested as hazardous waste. Soil-vapor condensate generated by the SVE remediation system will be disposed of off-site as hazardous waste. All drums of condensate will be manifested as hazardous waste for flammable liquids, unless otherwise specified, and contain benzene and water.

During operations, scheduled maintenance of the SVE remediation system will occur regularly and consist of oil and filter changes at a minimum, and additional maintenance tasks performed at monthly, quarterly, semiannual, and annual intervals. Waste oil and waste anti-freeze will be stored in 55-gallon, U.S. Department of Transportation, closed-top, steel drums at a pre-approved location. Once full, the drums will be picked up for recycling by a vendor providing the service to Kirtland AFB.