JUN 30 2010

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Mr. James Bearzi
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New Mexico Environment Department
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Mr. Bearzi

The attached Groundwater Investigation Work Plan for the Kirtland Air Force Base, Bulk Fuels Facility Spill, is being submitted to the New Mexico Environment Department (NMED), Hazardous Waste Bureau. The Plan is submitted as required by the NMED letter of 2 April 2010 addressed to 377 ABW/CC.

The Plan is designed to address the objectives identified in the NMED letter and represent the best technical effort of the Air Force to meet those objectives. Although the Plan addresses the objectives of your letter, they also propose some deviations from the approach mandated in your letter. These deviations are explained in the Plan. The Air Force is also designing a performance-based approach for the response action at the site as discussed by Mr. Terry Yonkers, Assistant Secretary of the Air Force for Installations, Environment and Logistics, and Mr. Ron Curry, New Mexico Secretary of the Environment, on 25 May 2010.

Performance-based approaches to remediation place additional responsibility and risk on the selected performance-based contractor (PBC) but are not prescriptive with regard to specific remediation and characterization approaches. Therefore, the U.S. Air Force anticipates that this work plan may be amended with NMED concurrence at a future date if the PBC identifies alternative characterization methodologies that are more appropriate to the remediation approach used by the PBC.

If you have any questions with regard to these submittals, please contact me at (505) 846-7377.

Sincerely

ROBERT L. MANESS, Colonel, USAF
Commander

Attachments:
1 Groundwater Investigation Work Plan (electronic and hardcopy)

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
HQ AFMC/A7AQ - Mr. Finke, w/o atchs
AFCEE, Mr. Oyelowo, w/o atchs
Admin. Record, CNM, Montoya Campus w atch
File

KIRTLAND AIR FORCE BASE
ALBUQUERQUE, NEW MEXICO

Groundwater Investigation Work Plan
Bulk Fuels Facility

June 2010

HQ AFCEE/ERD
Environmental Restoration Division
Brooks City-Base, Texas 78235-5344
USAF Contract No. FA8903-08-D-9770 Task Order No. 0123

KIRTLAND AIR FORCE BASE
ALBUQUERQUE, NEW MEXICO

Groundwater Work Plan
Bulk Fuels Facility

JUNE 2010

Prepared for
HQ AFCEE/ERD
Environmental Restoration Division
Brooks City-Base, Texas 78235-5344
USAF Contract No. FA8903-08-D-9770, Task Order No. 0123

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KIRTLAND AIR FORCE BASE
377th ABW Public Affairs

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ACRONYMS AND ABBREVIATIONS

AFB	Air Force Base
AFCEE	Air Force Center for Engineering and Environment
ARCH	Air Rotary Casing Hammer
AST	above ground storage tank
ASTM	American Society for Testing and Materials
bgs	below ground surface
BFF	Bulk Fuels Facility (BFF)
CSM	conceptual site model
COPC	contaminant of potential concern
BTEX	benzene, toluene, ethylbenzene and xylene
DQCRS	Daily Quality Control Summary Report
DMP	Data Management Plan
DQOs	data quality objectives
DRO	diesel range organics
EDB	ethylene dibromide; also known as 1,2-dibromethane
EPA	Environmental Protection Agency
ERP	Environmental Restoration Program
ft	feet
FCR	field change report
FSP	Field Sampling Plan
GMR-REF	Generalized Reciprocal Method Refraction
GPS	Global Positioning System
HASP	Health and Safety Plan
HWB	Hazardous Waste Bureau
ICE	internal combustion engine
IP/DCRES	induced polarization/direct current resistivity
IDW	investigative derived waste
LNAPL	light nonaqueous phase liquid
MSDS	Material Safety Data Sheets
MCL	maximum contaminant limit
MG	million gallons
mg/kg	milligrams per kilogram
NMED	New Mexico Environment Department
OSE	Office of the State Engineer
PAH	polyaromatic hydrocarbons
ppm	parts per million
PID	photo ionization detector
PVC	polyvinyl chloride
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
RES	resistivity
SVE	soil vapor extraction
SOP	Standard Operation Procedure
TPH	total petroleum hydrocarbons
SWMU	Solid Waste Management Unit
UFP	Uniform Federal Policy

USAF	United States Air Force
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USF	Santa Fe Group member
VOC	volatile organic compound

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EXECUTIVE SUMMARY

This Groundwater Investigation Work Plan along with the Vadose Zone Investigation Work Plan and the Interim Measures Work Plan were developed in response to correspondence to the Air Force from the New Mexico Environment Department (NMED) Hazardous Waste Bureau (HWB) dated April 2, 2010. In this letter, the NMED HWB required the development and submittal of three separate work plans to address soil and groundwater contamination at the Bulk Fuels Facility (BFF) at Kirtland Air Force Base, New Mexico. The three work plans will be implemented concurrently to reduce the time required to address each item. The submittal of these work plans demonstrates the Air Force's commitment to addressing fuels contamination resulting from past practices and events at the BFF at Kirtland AFB.

The Groundwater Investigation Work Plan outlines the previous investigations performed at the BFF. Using regional and site-specific information from the previous investigations, a site-specific Conceptual Site Model (CSM) was developed. The current understanding of the sources, contaminants, and media that have been impacted by the activities at the BFF are outlined in the CSM.

Using the current CSM to highlight data gaps and the Data Quality Objective process to determine the critical decisions, the Groundwater Investigation Work Plan provides the sampling rationale and decision logic for defining the nature of the contaminants and delineating fuels contamination of fuels within the groundwater. The specific goals of the Work Plan are to

- characterize the nature and the horizontal and vertical extent and the fate and rate of migration of groundwater contamination
- characterize the geology and hydrogeology at and below the water table, and
- characterize groundwater flow and velocity

Groundwater investigation activities include surface and subsurface geophysical investigations, the installation of groundwater monitoring wells in three distinct horizons, and analyses of the groundwater to determine the groundwater quality and to add to knowledge base of groundwater chemistry. The geophysical investigation will provide information on subsurface geology and contaminant location and migration. Groundwater sampling will provide immediate as well as long-term sampling data on subsurface contaminant distribution in different horizons within the aquifer.

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

1. INTRODUCTION

1.1 Objectives and Scope

This Groundwater Investigation Work Plan was developed to provide well installation and groundwater sampling rationale and decision logic for delineating the extent of fuels-related contamination in groundwater as the result of past operations at Solid Waste Management Units (SWMU) ST-106 and SS-111, the Bulk Fuel Facility (BFF), at Kirtland Air Force Base (AFB), New Mexico. The activities described in the work plan are designed to characterize dissolved-phase fuels contamination in groundwater (vertical) and horizontally that are the result of past practices at the BFF.

Specifically, this plan will provide

- Characterization of the nature, horizontal, and vertical extent and the fate and rate of migration of groundwater contamination.
- Characterization of the geology and hydrogeology at and below the water table.
- Characterization of groundwater flow direction and velocity.

This plan also defines

- Construction details, locations, and depths of proposed groundwater monitoring wells.
- Field procedures, sampling and analysis and related quality control protocols for groundwater analysis.
- Data analysis and reporting procedures (including proposed cross-sections and plan views of data).
- A proposed schedule that complies with Table 4 of the New Mexico Environment Department (NMED) letter of April 2, 2010.

1.2 Approach and Implementation

Following previous investigations at the BFF, data gaps related to the nature of the fuels contamination and the extent of contaminations resulting from past operational history at the BFF were identified. This work plan was developed to address the data gaps for the lateral and vertical delineation and to provide data of sufficient quality to adequately characterize the nature and extent of dissolved-phase fuels-related groundwater contamination and to support the development of a Corrective Measures Evaluation.

Implementation of this work plan will be performed in conjunction with the Vadose Zone Investigation Work Plan and the Interim Measures Work Plan prepared for the BFF. Surface and subsurface geophysical investigations will be performed initially to provide qualitative and quantitative information for further understanding the subsurface lithology, potential plume migrations, and suitable sampling/monitoring locations, and will aid in the refinement of the Conceptual Site Model (CSM). Subsequent intrusive investigations including drilling and installation of groundwater monitoring wells will determine the extent of groundwater contamination at the BFF and will provide insight into the chemical makeup and distribution of contaminants within the groundwater.

1.3 Background Issues

1.3.1 Regulatory Requirements

This Work Plan has been prepared in accordance with the Sampling and Analysis Plans/Work Plans outline provided to Kirtland AFB by the NMED (NMED, 1998).

The groundwater monitoring wells will be installed in compliance with applicable regulations of the NMED and the New Mexico Office of the State Engineer (OSE). Changes from NMED and/or OSE monitoring well installation or construction guidelines will be stated in this Work Plan.

1.3.2 Other Issues

On April 2, 2010, a letter was posted to Kirtland AFB transferring regulatory authority from the NMED Ground Water Quality Bureau to the NMED Hazardous Waste Bureau (HWB). A second letter also dated April 2, 2010, posted to Kirtland AFB from the NMED HWB, outlined requirements to provide work plans intended to address the vadose zone, groundwater, and interim measures to be employed at SWMU 106.

1.4 Data Quality Objectives Process

Data quality objectives (DQOs) are qualitative and quantitative statements that specify the quality of data generated to support decision making. DQOs are scoping and planning tools applicable to every data generation effort, and developing DQOs is a necessary step for project-specific plans. For each data collection task, DQOs will be developed during project scoping and will include a description of the purpose of the task, the specific activities to be performed, the intermediate and end uses of the generated data, and the resultant data quality that is required.

The DQO development process includes the following steps:

- Statement of the problem
- Identification of a decision that addresses the problem
- Identification of inputs that affect the decision
- Specification of the domain of the decision
- Development of logic statement
- Establishment of constraints on uncertainty
- Optimization of design for obtaining data

The DQO process is an iterative process that occurs at every stage throughout the project to ensure that the stakeholders obtain sufficient quantity and quality of data to provide the basis for decision making. The DQO development is consistent with U.S. Environmental Protection Agency (EPA) guidance (EPA, 2006) and the Uniform Federal Policy (UFP) Quality Assurance Project Plan (QAPP) (EPA, IDQTF, 2005) worksheets 10, 11, and 17. DQOs specific to the groundwater investigation are presented in Section 3.

2. BACKGROUND AND SETTING

2.1 Site Description

Kirtland AFB is located in Bernalillo County, in central New Mexico, southeast of and adjacent to the City of Albuquerque and the Albuquerque International Sunport (Figure 2-1). The approximate area of the base is 52,287 acres.

2. 2 Operational History

The Kirtland AFB BFF is located in the western part of Kirtland AFB (Figure 2-1). 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 feet (ft) north of the tank area.

Subsequent aerial photographs indicate that construction of the facility and associated infrastructure took place from 1951 until 1953. Once completed, the facility operated until it was removed from service in 1999, as a result of below-grade line leakage along the offloading rack. Bulk storage for jet fuel 8 (JP-8), diesel fuel, and aviation gasoline 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 fuel 4 (JP-4) and JP-8. The use of AvGas and JP-4 at Kirtland AFB was phased out in 1975 and 1993, respectively. JP-8 was handled through the Former Fuel Offloading Rack 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 Former Fuel Offloading Rack, to the pumphouse and then to the bulk fuel storage containers on the south end of the site (Tanks 2420 and 2422). The probable release points have been investigated and are summarized in subsequent sections. The fuel transfer from the railcars to the pumphouse was done under vacuum. The transfer of fuel from the pumphouse 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 unrequired pressure testing in 1999 was any problem noted in the fueling system.

At present, jet fuel is stored in two aboveground storage tanks (ASTs) (2.1 and 4.2 million gallons [MG]), diesel fuel is stored in two ASTs (5,000 and 10,000 gallons), and unleaded gasoline is stored in one 10,000-gallon AST. The site currently has one temporary JP-8 offloading rack located in the southwest corner of the facility, west of the fuel loading structure Building 2404. This rack was placed into service following the piping failure at the Former Fuel Offloading Rack (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 by piping of varying sizes that runs above ground for approximately 750 ft and runs below ground for approximately 300 ft. Figure 2-2 presents the infrastructure present at the eastern portion of the BFF.

2.3 Site Setting

A detailed discussion of base history, geology, and climate is included in Section 3 of the *Base-Wide Plans for Investigation Under the Environmental Restoration Program* (Tetra Tech, 2004). The information below synopsizes relevant information.

2.3.1 Regional Geology

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

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

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

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

2.3.2 Site-Specific Geology

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

- From the surface to about 85 ft bgs, the soils are primarily thick discontinuous intervals of silt and silty or sandy clays.

- From roughly 86 ft bgs to about 144 ft bgs, two 3-foot to 25-foot-thick units of poorly graded fine-grained sands alternate with two silty, sandy, and lean clay units that are up to 25 ft thick.

- From about 144 ft bgs to about 270 ft bgs are poorly graded fine-grained sands and well-graded fine- to coarse-grained sands.

Soils at the BFF range from wet to dry. The finer-grained upper soils are generally moist, while the coarser-grained deeper soils could be moist or dry. Several minor perched water-bearing zones are present in the vadose zone above the regional groundwater table at the BFF. None of these water-bearing zones are substantial enough to merit the installation of a groundwater monitoring well. Some of these water-bearing zones below 400 ft bgs are probably remnants of the regional aquifer left behind as the water table has dropped. The regional water table is present at approximately 485 ft bgs as indicated by wet, gravelly, sand drill cuttings (CH2M HILL, 2001).

2.3.3 Hydrogeology

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

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

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

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

2.3.4 Geochemistry

Geochemical conditions are one factor that influences the transport and transformation of chemical compounds in the environment. Biodegradation often is a major transformation process for petroleum hydrocarbons and related compounds and in general requires sufficient electron acceptors for microbial metabolism of petroleum hydrocarbons. In the presence of a carbon source (including 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 (NRC, 2000). Microbial testing for soils performed in 2009 found that significant microbial action was detected at the location with high fuel contamination (CH2M HILL, 2009).

2.4 Nature and Extent of Contamination

2.4.1 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 (Figure 2-2):

- 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)
- 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 light non-aqueous phase liquid (LNAPL) plume, it is likely that the primary pipeline had been in a state of failure for many years. The presence of LNAPL fuel hydrocarbons on the water table also indicates that substantial releases have occurred and that a range of fuel types may have been released. The possible fuel types include aviation gas, diesel, JP-4, and JP-8.

In 1951, the U. S. Government specified JP-4 (for Jet Propellant) as a 50-50 kerosene-unleaded gasoline blend (MIL-J-5624E). JP-4 was the primary USAF jet fuel between 1951 and 1995. JP-4 is a mixture of aliphatic and aromatic hydrocarbons with a low flash point (0°F/-18°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 USAF fuel usage, aviation gas would have been in use from approximately the 1940s to 1975. Dibromoethane (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 (see Section 2.3.2) as possible contributors to the LNAPL on the water table. These previously investigated potential sources include the pump house, a fueling island, underground piping, an evaporation pond, and areas where water from the bottom water holding tanks was released. No other areas with operational histories of handling the quantities of fuel necessary to produce the area of contamination seen at the BFF are evident with the exception of the bulk fuel ASTs. As discussed in Section 3.0 of this Work Plan, the bulk fuel ASTs will be investigated following the demolition of the standing ASTs. Demolition in this area is anticipated to be complete in the second quarter of 2011.

2.4.2 Investigative Results

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

- Stage 1 Abatement Plan Report (CH2M HILL, 2001)
- Stage 2 Abatement Plan Report (CH2M HILL, 2004)
- Stage 1 Abatement Plan Report, East Side of the Kirtland AFB Bulk Fuels Facility (CH2M HILL, 2006)
- Semi-Annual Summary and Performance Report (CH2M HILL, 2008)
- Remediation and Site Investigation Report (December, 2009)

Findings of these investigations are summarized below.

Stage 1 Abatement Plan Report (CH2M HILL, 2001)

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

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

Additional borings were installed to determine the horizontal extent of the soils that have TPH concentrations greater than 100 milligrams per kilogram (mg/kg). Based on data from the additional borings, soils contaminated in excess of the NMED TPH Screening Guidelines (Appendix A) are limited to within approximately 310 ft of the surface; and within the area 65 ft south (SB-29A), 280 ft north (SB-34), 400 ft east (SB-32), and 175 ft west (SB-33) of the Former Fuel Offloading Rack. The total area of soil affected by the petroleum hydrocarbon contamination is estimated to be 6.5 acres, with depths of contamination extending to 310 ft bgs.

Stage 2 Abatement Plan Report (CH2M HILL, 2004)

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

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

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

- Former Washrack Drainfield
- Three Fuel-Storage ASTs
- Former Fuel/Water Evaporation Pond
- Recovered Liquid Fuel Collector Tank
- Primary Fuel-Storage ASTs and Tank Bottom Water-Holding Tanks

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

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

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

Remediation and Site Investigation Report (CH2M HILL, 2009)

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

2.4.3 Identification of Contaminants of Potential Concern

Petroleum contamination associated with the BFF has been identified in subsurface soils, 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 contaminants of potential concern (COPC) at the BFF are constituents of refined petroleum products and include, but are not limited to, the following: benzene, toluene, ethylbenzene, xylenes, EDB, and lead.

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

Compound-specific groundwater maximum contaminant levels (MCLs), developed for the protection of human health, are presented in the New Mexico Administrative Code, Title 20 - Environmental Protection, Chapter 6 Water Quality, Part 2 - Ground and Surface Water Protection.

MCLs for compounds petroleum-related compounds are as follows:

- Benzene 0.01 mg/l
- Toluene 0.75 mg/l
- Ethylbenzene 0.75 mg/l
- Total xylenes 0.62 mg/l
- EDB 0.0001 mg/l

2.4.4 Vadose Zone and Soil Vapor Contaminant Distribution

Figures 2-3 through 2-6 (AFCEE, 2009) show the horizontal distribution of TPH in soil vapor at 150 ft bgs, 250 ft bgs, 350 ft bgs and 450 ft bgs (~30 ft above the water table). However, the TPH vapor data also suggest that the movement of LNAPL through the vadose zone was offset to the east and north, presumably by fuel migration along dipping clay layers. Conceptually, the TPH vapor results at 450 ft show the effect and correlate well with the distribution and orientation of LNAPL on top of the water table and with groundwater contamination.

2.4.5 Light Non-Aqueous Phase Liquid Distribution

The greatest thickness of LNAPL occurs in the area to the east of the Former Fuel Offloading Rack and is consistent with vadose zone migration of bulk LNAPL affected by clays dipping to the east and then following the groundwater table toward the north and east. Measurements of LNAPL were made on May 14, 2010, of monitoring wells that have historically had or potentially have measurable thickness of LNAPL. The measured thicknesses are shown on Figure 2-7. Measured product was detected on the following wells:

- KAFB-1068 3.8-ft SVE
- KAFB-1066 2.45-ft
- KAFB-1065 3.33-ft SVE
- KAFB-10614 0.23-ft.
- KAFB-1069 0.79-ft.
- KAFB-10610 1.18-ft.
- KAFB-10618 (sheen)

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

2.4.6 Dissolved Phase COPC Distribution

The distribution of dissolved-phase contaminants forms a halo around the LNAPL plume. As expected, concentrations of dissolved COPCs are detected at high concentrations very close to the LNAPL plume due to the dissolution of petroleum products into the groundwater and lower concentrations further from the LNAPL plume. The dissolved-phase plume extends approximately 4,500 ft along the axis of the plume, trending along the groundwater flow direction. EDB is the most widely distributed COPC. The footprint of the dissolved-phase plume downgradient is elongated as the more mobile contaminants such as benzene and EDB are more quickly transported along with groundwater movement downgradient. The dissolved phase plume is shown on Figure 2-7.

2.4.7 Site Specific Fate and Transport

In aerobic and anaerobic environments, benzene, toluene, ethylbenzene, xylenes (BTEX) can be degraded by microorganisms. Kinetic rates of BTEX degradation are highest under aerobic conditions. The natural abundance of electron acceptors like nitrate, manganese, iron, and sulfate are typically higher than contributions from oxygen and are typically more than sufficient to stabilize the advancement of a dissolved petroleum hydrocarbon plume (Rice et al., 1995; Mace et al., 1997; NRC, 2000). Methanogenesis is unique in that carbon dioxide, a biodegradation byproduct, is both produced and used as an electron acceptor. Thus, if methanogenesis is occurring at a site, electron acceptor limitations will not be expected to occur until all petroleum hydrocarbons and carbon residuals are fully degraded. EDB can degrade via aerobic and anaerobic biodegradation and abiotic hydrolysis.

In the vadose zone at BFF, aerobic biodegradation is expected to be a significant transformation mechanism. Natural fluctuations in barometric pressures create pressure differentials between the atmosphere and the subsurface, promoting air exchange and oxygen transfer. Biological sampling in the vadose zone has determined that a robust bacterial community that can contribute to degradation of hydrocarbons is present. In the saturated zone, both aerobic and anaerobic biodegradation are expected to occur (CH2M HILL, 2009).

The fuel “type” indicates that the release started before 1981 because of the presence of AvGas on the water table. EDB is detected on the leading edge of the plume, indicating that the source is AvGas. The presence of EDB and the lack of BTEX compounds are indicative of the natural attenuation occurring on the edges of the dissolved plume. EDB is a recalcitrant compound and slow to naturally attenuate by microbial means.

Vertical migration of LNAPL from the source area/release through the vadose zone is the primary mechanism of contaminant transport within the vadose zone at Kirtland AFB. The release of fuels in the source area was stopped in 1999. Residual fuel in the vadose zone will be entrapped by capillary forces in the soils. Only that part of the fuel that is present in the vadose zone at greater than residual saturation will continue to migrate.

A secondary transport mechanism within the vadose zone in the source area is within the soil vapor. Vapor phase contamination occurs as contaminants partition from entrapped LNAPL and soil water into soil gas. Vapor phase contamination will disperse in an approximately spherical pattern through the vadose zone surrounding the source area. For this reason, additional monitoring points have been located radially around the source area and vertically across the vadose zone to allow delineation of this spherical vapor plume. In addition to vapor migration vertically down to the groundwater table, vapor migration vertically upwards to the ground surface also is a potential.

Groundwater flow and hence contaminant transport is affected by both the regional groundwater flow and the localized effects of induced groundwater flow from pumping. Locally, the effects of pumping can induce increased gradients vertically and laterally. Transport of dissolved contaminants will be affected by both physiochemical retardation and biodegradation.

2.5 Potential Receptors

The Veterans Administration (VA) Medical Center water well and KAFB groundwater production wells KAFB-15 and KAFB-16 are located sidegradient of known areas of petroleum hydrocarbon contamination. The VA Medical Center Water well, KAFB groundwater production wells, and water utility authority well fields will be considered potential pathways of exposure until they can be excluded with defensible data. During the second quarter 2009 sampling, TPH-DRO was the only chemical detected in KAFB-16 well at 0.26 micrograms per liter (µg/L) but it was determined that this contaminant was likely introduced into the well through lubricating oil used for lubrication of the well pump. Water production wells KAFB-3 and Burton Well W-5 are located 3,800 and 3,700 ft, respectively, downgradient of the leading edge of the EDB plume and 5,400 ft and 4,800 ft, respectively, downgradient of the LNAPL plume. Well construction information and estimated capacities are presented in Table 2-2.

Table 2-2. Water Production Wells, Vicinity of Kirtland AFB Solid Waste Management Units (SWMU) ST-106 and SS-111

Well Name	Install Date	Total Depth (ft bgs)	Screen Interval (ft bgs)	Casing (in)	Est. Capacity (gpm)
Burton 5	1991	1,170	550-1,150	20	3,000
Ridgecrest 5	1990	1,550	690-1,530	20	3,000
VA	1956	997	No data	No data	No data
Kirtland 3	No data	No data	No data	No data	No data
Kirtland 15	1996	1,511	700-1,430	18	2,500
Kirtland 16	1996	1,511	710-1,400	18	2,500

Construction workers who may be exposed to subsurface soils are also potential receptors. However, the existing KAFB digging permit clearance process provides notification and protection against inappropriate exposures to construction workers.

Vapor intrusion may be a concern in any buildings located near the LNAPL release. An investigation of the potential for vapor intrusion was completed for two buildings overlying the LNAPL showed that risks associated with indoor air quality are acceptable. The report is currently in draft.

2.6 Conceptual Site Model Summary

The BFF CSM was developed using existing site-specific and regional data. The CSM will be refined as new data are collected.

The BFF site at Kirtland AFB is an area where substantial quantities of refined petroleum hydrocarbons have been released from the Bulk Fuel Storage area into a complex layered geology. This layered geology is expected to promote the lateral spreading of LNAPL hydrocarbons as they migrated downward in areas of substantial release.

Figure 2-8 is an idealized graphical representation of the BFF in a west-east projection. Surface features including buildings, structures roadways and roadways are shown for spatial orientation. The Former Fuel Offloading Rack location is shown and represents the area of release as described in Section 2.2.

Conceptually, as the fuel leaked it migrated vertically via gravity through the unsaturated vadose zone, filling pore space until the saturation limit was reached and then continuing vertical migration to groundwater. Vapor migration of fuels occurred laterally and vertically through the unsaturated pore spaces. Vertical migration of liquid product continued downward as the soil types dictated. Coarser grained soils were conducive of vertical migration along the path of least resistance. When finer-grained layers were encountered, as in the soils ranging from 0-300 ft bgs, the vertical migration slowed, producing a more lateral component to the migration. At the BFF this general direction is assumed to have an eastward and northern component. The liquids preferentially sought the path of least resistance and flowed along the layers of finer grained materials (silts and clays) until again reaching coarser material (sands and gravel) where vertical migration could again occur.

In time the liquid product reached the groundwater table. Initially the fuel dissolved into the water, first causing a sheen until dissolution ceased because of saturation, whereupon the LNAPL mounded up on the groundwater. Throughout this process, the dissolved product along with the LNAPL was carried in the direction of groundwater flow as shown in Figure 2-9.

At the time of first release, the direction of groundwater flow was to the southeast. However, because of increased water demand for the city of Albuquerque and the VA Hospital, more water was removed from the aquifer system. This continual pumping eventually altered the direction of groundwater flow and has lowered the water table approximately 100 ft since 1960. The change in flow direction and water level caused a buildup of fuel product in the newly unsaturated zone, producing a less than saturated fuel “smear” that continues to release contaminated vapor into the vadose zone. The current dissolved phase groundwater plume extends about 3,800 ft to the north-northwest from the source.

Elevated concentrations of TPH were detected just below the Transition Zone between USF-1 and USF-2 at 105 ft bgs and at 270 ft bgs, which is just above the Clay Zone that divides the USF-2 hydrostratigraphic unit. However, the detected presence of LNAPL hydrocarbons in groundwater monitoring wells indicates that these hydrocarbons have penetrated individual horizontal soil layers down to 500 ft bgs. The land use at the site is industrial in nature, with limited building occupancy and potential for exposure to subsurface contaminants other than during subsurface construction activities. Potential exposure pathways include off-base groundwater consumption and use.

The SS-111 plume was discovered in 2007 during the installation of monitoring well KAFB-1065 for ST106. LNAPL 1.5 feet thick was found on the surface of the groundwater at a depth of almost 500 ft. At the base boundary to the north, the LNAPL thickness is about 0.79 ft. An internal combustion engine (ICE)-driven SVE system was installed in the area of greatest contaminant thickness originally removed the equivalent of 300 gallons per day (gal/day) the ICE system is currently removing approximately 125 gpd. Investigating and remediating contamination 500 ft below grade poses a significant technical challenge.

3. DATA COLLECTION DESIGN AND PROCEDURES

3.1 Data Quality Objectives

The DQOs are the basis for the design of the data collection plan. These DQOs specify the type, quality, and quantity of data to be collected and how the data are to be used to make the appropriate decisions for the project. Table 3-1 summarizes the DQO development for this work plan. Details are provided below.

3.1.1 Geophysics

DQOs for the surface geophysics include the objective of refining the interpretation of subsurface geology and identification of the presence of silt and clay layers that affect the migration of the LNAPL from the source area to the water table. The surface geophysics study will also help in delineating the LNAPL plume within soil and groundwater. The data from the geophysics will be used to refine the locations for boring and for wells that will be installed in subsequent phases of the investigation. The differentiation of the edge of the LNAPL plume edge is an important decision-making criterion for monitoring well placement, because some well locations are designed to monitor the dissolved-phase plume while others are designed to monitor LNAPL thickness within the plume and groundwater contamination below the LNAPL plume. The DQOs for geophysical data collection are summarized in Table 3-1. The geophysics study area is shown on Figure 3-1. All newly installed wells will be geophysically logged to aid in the determination of geology in the vadose zone. The geophysical logging of these wells is covered in the vadose zone work plan.

3.1.2 Groundwater Sample Collection Data Quality Objectives

DQOs for groundwater samples include the contingency to expand locations laterally or vertically from the initially installed monitoring wells and/or piezometers (installed as part of this Groundwater Work Plan), where initial groundwater sample analytical results exceed MCLs or screening levels as presented in section 2.3.3. The direction and distance of a “stepped-out” or “deeper” location shall be dependent on the contaminant concentrations exceeding the MCLs, probable COPC contamination migration rates/distances, topographic obstructions, and drill rig accessibility. The DQOs for groundwater sample collection data are summarized in Table 3-1.\ Contingencies for additional expanded locations based on DQOs are identified in Table 3-2.

3.1.3 Groundwater and LNAPL Measurements

The DQO to characterize horizontal and vertical groundwater flow will be satisfied by collection of groundwater elevation measurements in the aquifer. Groundwater measurements will be collected from all new and existing monitoring wells on a monthly basis. The data will then used to calculate groundwater horizontal and vertical gradients, which determine groundwater flow directions. The groundwater flow direction will be used to refine, as applicable, the locations of proposed groundwater monitoring well nests to better investigate probable contaminant flow paths.

The DQOs associated with the collection of LNAPL measurements are to determine the extent of the LNAPL plume. The presence or absence of LNAPL within a well may affect the placement of other monitoring well nests that are proposed to be installed. The proposed well locations, shown on Figure 3-2, were selected based upon current understanding of the site. As additional information is collected, the CSM for the site may change, which may require a reevaluation of monitoring well locations based on the presence or absence of product within the newly installed monitoring wells.

The DQOs for groundwater and LNAPL measurements are summarized in Table 3-1.

3.2 Quality Assurance/Quality Control

Investigative activities being conducted as part of the BFF Groundwater Work Plan are similar to activities conducted as part of the Environmental Response Programs at the base in the past. Kirtland AFB currently has a Base-Wide Plan for Investigations under the Environmental Restoration Plan (ERP, 2004), which documents standard operating procedures for all investigative work conducted on the base. Included in the Appendices of the Base-Wide Plan for Investigations are the Field Sampling Plan (FSP), the Construction Quality Assurance/Quality Control (QA/QC) Plan, the QAPP, the Base-Wide Data Management Plan DMP, the Base-Wide Waste Management Plan (WMP), the Base-Wide Safety Plan, and the Permitting Plan. These plans were written to cover all environmental restoration activities conducted at Kirtland AFB and include

- Resource Conservation and Recovery Act (RCRA) facility investigations (RFIs)
- Solid Waste Management Unit assessments
- Risk assessments
- Corrective measures studies
- Corrective actions
- Monitoring of natural systems and treatment operations
- Other site investigations and associated work efforts

The Base-Wide Work Plan was prepared in accordance with the requirements and guidelines for data collection activities established by the EPA, the U.S. Army Corps of Engineers (USACE), the Air Force Center for Engineering and Environment (AFCEE), and the USAF. The purpose of the Base-Wide Plan is to provide a comprehensive set of strategies for conducting field sampling operations that are integral to the performance of a variety of environmental restoration activities. The Base-Wide Plan appendices include Standard Operating Procedures (SOPs). The SOPs have detailed QA/QC procedures that will be adhered to when conducting any ERP related work on the base. A UFP QAPP will be finalized for the Work Plan once a laboratory has been selected for the work contained within this document.

3.3 Field Activities

Field activities associated with this BFF Groundwater Work Plan include geophysical investigations, soil borings/drilling activities, soil sampling, groundwater monitoring well installation, well development, water level and LNAPL measurements, and groundwater sampling. Specific activities are defined below.

3.3.1 Surficial Geophysical Investigation

A combination of both surficial seismic and electrical techniques will be used to conduct this investigatory work. The rationale for surficial geophysical investigations is to attempt to map the extent of contamination as well as to determine the structure and nature of the underlying rock and soil materials that determine the LNAPL and soil vapor migration pathways. The ultimate goal of the geophysical investigations is to use the data to refine the CSM of the potential source location(s) and the extent of the LNAPL contamination, in order to optimize placement of borehole and monitoring well locations. This data is thus used maximize the efficiency of the overall drilling program by increasing confidence in each borehole location and depth. Proposed geophysical investigation locations are shown on Figure 3-1.

3.3.1.1 Seismic Refraction

Generalized Reciprocal Method Refraction (GMR-REF) is a surficial seismic refraction method that utilizes a sacrificially induced wave source to generate refracted waves off of subsurface structures and soil layers. Depending upon the type and frequency of the geophones (receiver) chosen for the survey, as well as the type of source wave generator, very thin structures and layers within the subsurface may be discernable. Subsurface soil conditions and relative density differences ultimately determine whether or not these layers or structures can be seen within the dataset. This survey allows for high resolution imaging of subsurface lithologic structure, which can affect LNAPL migration. In industry, seismic refraction is commonly used to define lithologic structure thousands of feet deep.

In order to collect the GRM-REF data needed to characterize the source area at the Kirtland AFB site, a survey transect will be placed as near to the source area as possible, in an orthogonal geometry (i.e., an East / West *and* a North / South transect). Data from these two transects will be collected ("shot") separately. Each seismic survey transect will consist of a 1,500-foot-long data collection cable, with 48 receiver ("take-out") locations. A 48-channel array will be used for each transect, with a total length per array of approximately 1,500 ft. The shot locations will occur at a distance equal to three to five times the target depth, in this case resulting in the maximum offset being at least 1,500 to 2,500 feet beyond each end of the array—that is, beyond the first and last geophone. The offset allows the source wave to penetrate to at least the depth of the target and allows for the refracted waves from the subsurface density boundaries to travel back to the surface within the range of the data collection array. Shots will be taken at various distances both past the ends (offset) as well as within the array, to build-up the GRM REF cross-sectional dataset. At each data collection location along the data cable, typically two to three geophones would be used. This arrangement allows for the cancellation of random noise within the data set and serves to magnify the arrivals of the refracted waves. In addition, the field geophysicist will typically test several temporary filter settings in order to better discern the quality of the data that is being returned to the data collection array.

The field data will be post-processed and cross sectional illustrations of the subsurface will be generated. The data will be vertically and laterally corrected as needed, using a combination of land survey (elevation) and Global Positioning System (GPS) data (horizontal). The GPS data will be initially in the field. When locations are final a surveyor licensed in the State of New Mexico will survey to an accuracy of 0.01 ft vertically and less than 1 ft horizontally.

3.3.1.2 Resistivity

The induced polarization direct current resistivity (IP/DCRES) method entails a surficial application of electrical current to the ground. In this case, a direct current system will be used. This method typically collects two kinds of data at the same time. The first is the resistivity (RES) of the subsurface soil, and the second is the soil's ability to be polarized (IP), or to hold a charge. RES data is used to discern changes in the soil's electrical resistance to current flow, which is directly correlated to soil type. IP data is used to determine soil types that typically have greater ability to become oriented to the current flow, within the electron/atomic scale. This data is also directly correlated to soil types.

The IP method has also been used to determine where nonconductive materials/fluids are present interstitially within the subsurface. Because of the high dielectric constant of petroleum hydrocarbons, they typically cause the electrons of the soil grains to remain oriented for a measurable period of time after the initial current is shut off, and thereby appear to give off a charge. This method has been used successfully to determine where LNAPL is present, with subsequent verification drilling and sampling.

To collect IP/DCRES data at the BFF site, a geometry similar to that discussed above for the seismic survey will be used for the data collection arrays. Each array transect will include 56 stakes, each stake being both an electrical source as well as a data collection point. The transects will be approximately 1,850 feet in length. This distance is required to order to ensure that the data is collected to the depth of the target, or 500 feet. Typically the maximum spacing (distance between the source and receiver electrodes) is typically three times the depth of penetration needed to see the deepest target. A slightly larger distance is used for insurance.

The field data will be post-processed, and cross sectional illustrations will be produced for both the IP and the DCRES data. Again, the data will be vertically and laterally corrected using a combination of land survey (elevation) and GPS data (horizontal) to an accuracy of 0.01 ft vertically and less than 1 ft horizontally, depending upon the GPS system used.

In addition to the transects run in the BFF area, two transects will be run on the north end of the plume for the purpose of delineating the width of the LNAPL plume.

3.3.1.3 Limitations of Surface Geophysical Methods

The methods described above are necessarily indirect surficial data collection techniques and results are dependent upon the geophysical characteristics of the subsurface materials. Ultimately, these characteristics will dictate the resolution and relative accuracy of the data collected. An initial evaluation of the limited subsurface data related to lithology at this site indicates that the site is a reasonable candidate for the implementation of these techniques. Extremely thin layers of clay and silt may not be discerned unless there is a clear and measurable density contrast between the layers. This includes the ability to discern NAPLs. Borehole data will be used to the maximum extent possible to correlate and calibrate the geophysical data with the subsurface lithologic structure.

3.3.2 Soil Borings/Drilling

A total of 23 soil borings are included as part of this BFF Groundwater Work Plan. The 23 boreholes will be advanced for the purpose of installing 15 monitoring wells and 37 piezometers, which include 19 nested locations where two wells will be installed in the same borehole. The correlation of soil borings/wells proposed for the Groundwater Investigation Work Plan, as compared to borings/wells shown on Table 5 of the NMED letter from the Hazardous Waste Bureau, dated 2 April 2010, is shown on Table 3-2. The number and location of the proposed borings/wells, included in this Work Plan, were primarily selected to define the nature and extent of the LNAPL and groundwater dissolved-phase contaminant plumes. The boring/well designations are included in Table 3-2 and 3-3. The boring/well locations are shown on Figure 3-2. The 23 borings will be advanced to the following horizons:

- Two boreholes advanced to the groundwater table (“A”) horizon.
- Five boreholes advanced to the “B” horizon.
- Sixteen boreholes advanced to the “C” horizon.

The anticipated depth to groundwater is approximately 500 ft bgs. The anticipated depths of the groundwater table (“A”) horizon monitoring well borings and “B” and “C” horizon piezometer borings are 510, 550, and 590 ft bgs, respectively. These horizons were primarily selected to define the vertical nature and extent of the groundwater dissolved-phase plume and to establish vertical hydraulic gradients. DQOs have been developed to address potential changes in well completion depths/screened intervals based on contaminant concentrations. NMED will be notified regarding any deviations in well constructions per Section 4.0.

Borehole advancement (drilling) will be performed by the air-rotary casing hammer (ARCH) method. The ARCH method utilizes steel insulator casing, advanced with drill bit/rod, to prevent borehole collapse. The minimum borehole diameter for portions of boreholes advanced to the water table will be 11¾ inches. The minimum borehole diameter for portions of boreholes advanced below the water table will be 9⅝ inches. A Rotosonic drill rig (second rig) will be used in conjunction with the ARCH rig at five proposed groundwater monitoring well/piezometer locations within the LNAPL footprint (KAFB-10630 through KAFB-10633, and KAFB-10635) to collect continuous core soil samples from the interval 450 to 510 ft bgs. The Rotosonic drilling method is not suitable for advancement of the diameter boreholes to completion depths required for well installation, as specified in this Work Plan. However, this method is appropriate for collecting the desired continuous core samples through the above noted interval. The Rotosonic rig will collect the samples through the steel insulator casing installed by the ARCH rig to 450 ft bgs. Following sample collection by the Rotosonic rig, the rig will move off the borehole and the ARCH rig will realign over the hole for completion of the drilling, soil sampling, and well installation. Soil sampling techniques are presented in the following section.

Activities associated with borehole advancement (drilling), equipment decontamination, investigative derived waste (IDW) handing, and borehole abandonment (if required) will be performed in accordance with the Base-Wide Plans for Investigations Under the Environmental Restoration Program, 2004 Update, Kirtland Air Force Base, Albuquerque, New Mexico (Tetra Tech, 2004) and other pertinent site documents.

3.3.3 Soil Sampling

Soil samples (drill cuttings) will be collected from the ARCH drill rig “cyclone” on representative 5-foot centers, and at changes in lithology/color, during advancement of each of the 23 boreholes. A geologist will lithologically log the samples and field screen them for volatile organic compounds (VOCs) using a photo ionization detector (PID). Because the ARCH drilling method uses air to lift cuttings from the borehole and creates varying amounts of friction heat, some of the VOCs will be driven off prior to field screening. Therefore, PID readings will primarily be used for health and safety purposes. These readings may also distinguish areas of no/low contaminant concentrations from those of gross/higher concentrations on a qualitative basis, but will not be used in any decisionmaking process. Continuous core soil samples will be collected from the section of borehole advanced by the Rotosonic drill rig - e.g., 450 ft bgs (50 ft above the water table) to 510 ft bgs (10 ft below the water table). These samples will be collected for the purpose of better understanding LNAPL distribution, mobility, migration potential and recoverability. These samples will be lithologically logged by a geologist and field screened using a PID. The cores will be photographed under UV and visible light conditions to evaluate water and LNAPL saturation. Representative soil samples from the core section(s) containing mobile LNAPL will analyzed for; grain size, residual LNAPL saturation (1,000 g method), water/LNAPL drainage capillary pressure and water/LNAPL relative permeability. In addition, a representative sample of LNAPL will be collected at each location, if present, and analyzed for viscosity, specific gravity, surface tension and interfacial tensions.

Additional soil samples are required to be collected from select boreholes for chemical analysis at a laboratory. This sampling/analysis is associated with the Vadose Zone Investigation Work Plan and is not included in, or part of, this Work Plan.

Activities associated with soil sampling, equipment decontamination, lithologic logging, field screening, and IDW handling will be performed in accordance with the Base-Wide Plans for Investigations Under the Environmental Restoration Program, 2004 Update, Kirtland Air Force Base, Albuquerque, New Mexico (Tetra Tech, 2004) and other pertinent site documents.

3.3.4 Groundwater Monitoring Wells

A total of 15 groundwater monitoring wells and 37 piezometers will be installed in 23 boreholes, including 20 “nested” locations, where two wells will be installed in a single borehole. The 15 proposed monitoring wells will be installed in the groundwater table (“A”) horizon, with an anticipated completion depth of 510 ft bgs. Twenty-one of the 37 piezometers will be installed in the “B” horizon, with an anticipated completion depth of 550 ft bgs. Sixteen of the 37 piezometers will be installed in the “C” horizon, with an anticipated completion depth of 590 ft bgs. Of the 20 nested well locations, four locations shall contain a groundwater table (“A”) and “B” horizon well and 16 locations will contain a “B” and “C” horizon well. The number and location of the proposed wells were primarily selected to define the nature and extent of the LNAPL and groundwater dissolved-phase contaminant plumes. Well installation IDs and corresponding horizons are included on Tables 3-1 and 3-2. The 23 borehole/well locations are shown on Figure 3-2. A schematic showing a well construction detail is included on Figure 3-3.

Monitoring well (“A” horizon) and piezometer (“B” and “C” horizon) construction will include the following:

- Five “A” horizon wells installed within the lateral extent of the LNAPL plume will be constructed using 4-inch diameter schedule 80 polyvinyl chloride (PVC) riser pipe and stainless steel screen (25-foot length, 0.010 slot, 10 feet below and 15 above water table).
- Six “A” horizon wells installed outside the lateral extent of the LNAPL plume will be constructed using 4-inch diameter schedule 80 PVC riser pipe and screen (25-foot length, 0.010 slot, 10 feet below and 15 feet above water table).
- One “B” horizon monitoring well will be constructed using 4-inch diameter schedule 80 PVC riser pipe and screen (10-foot length, 0.010 slot).
- Four “A” and “B” horizon nested wells will be constructed using 3-inch diameter schedule 80 PVC riser pipe and screen (10-foot length, 0.010 slot).
- Fifteen “B” and “C” horizon nested wells will be constructed using 3-inch diameter schedule 80 PVC riser pipe and screen (10-foot length, 0.010 slot).
- One “B” and “C” horizon nested wells will be constructed using 3-inch diameter schedule 80 PVC riser pipe and screen (KAFB10632B) for the “B” horizon well (KAFB10632C) and 2-inch diameter schedule 80 PVC riser pipe and screen. Both wells will utilize 10-foot length, 0.010 slot screens.

Non-Nested Wells: Filter pack (sand) will be placed adjacent to the well screen followed by a fine sand seal and bentonite chip seal. A cement/bentonite grout will extend from the bentonite chip seal to near ground surface. Surface completions will be within steel flush-mount protective covers (manholes) with gasketed bolt-down covers. A concrete surface seal will be placed around the manhole and will extend from the cement/bentonite grout to ground surface. The bentonite chip seal will be hydrated in lifts using a “clean” water source.

Nested Wells: Filter pack (sand) will be placed adjacent to the lowest nested well screen followed by a fine sand seal. A bentonite chip seal will extend from the top of the fine sand seal to just below the screen of the highest well. Filter pack and fine sand seal will be placed, as above, around the highest nested well. A bentonite chip seal will then be placed on the fine sand seal followed by a cement/bentonite grout extending from the bentonite chip seal to near ground surface. Surface completions will be within steel flush-mount protective covers (manholes) with gasketed bolt-down covers. A concrete surface seal will be placed around the manhole and extend from the cement/bentonite grout to ground surface. The bentonite chip seal will be hydrated in lifts using a “clean” water source.

Based on drilling and installation of existing site groundwater table (“A” horizon) monitoring wells, “blow-back” of “flowing” sands into the insulator casing may occur as the drill rod/bit is “tripped” out of the borehole, prior to setting the well. This may present a problem in installing a well to the desired depth. To minimize this effect to the maximum extent possible, boreholes may be over-drilled and/or potable water will be used to keep a positive water column head within the insulator casing as the drill rod/bit is tripped out and the well is installed. NMED will be notified regarding any deviations in well constructions per Section 4.0.

Monitoring well and piezometer locations are shown on Figure 3-2. A brief summary of the proposed monitoring wells and piezometers, including installation ID and type, co-installations, groundwater sampling, rationale, horizons, and contingencies is presented in Table 3-3. Contingencies are identified on Table 3-2, where additional monitoring well and/or piezometer installation may be required at locations “stepped-out” from or ‘deeper” than the proposed well(s), e.g., groundwater sample analytical results exceed MCLs. Stepped-out or deeper wells, if required, will be located as indicated on Table 3-3. Actual distances/depths may vary based on depth to groundwater, contaminant concentrations of the exceedence and drill rig accessibility. DQOs have been developed to address potential changes in well completion depths/screened intervals based on contaminant concentrations. NMED will be notified regarding any deviations in well constructions per Section 4.0.

Activities associated with groundwater monitoring well and piezometer installation, IDW handling and decontamination will be performed in accordance with the Base-Wide Plans for Investigations Under the Environmental Restoration Program, 2004 Update, Kirtland Air Force Base, Albuquerque, New Mexico (Tetra Tech 2004) and other pertinent site documents.

3.3.5 Well Development

All groundwater monitoring wells and piezometers will be fully developed following installation, with the exception of those monitoring wells located within the lateral extent of the product plume—e.g., where the LNAPL thickness if greater than 0.1 ft.. Eight monitoring wells (KAFB10630 through KAFB10633 and KAFB10635 through KAFB10638) are anticipated to be located within the lateral extent of the product plume (see Figure 3-2). These wells will not be developed because of probable bio-fouling of the well screens, as observed in previous development of existing wells screened across LNAPL. It is anticipated that seven monitoring wells and 37 piezometers will require development.

Activities associated with groundwater monitoring well and piezometer, IDW handling and equipment decontamination will be performed in accordance with the Base-Wide Plans for Investigations Under the Environmental Restoration Program, 2004 Update, Kirtland Air Force Base, Albuquerque, New Mexico (Tetra Tech 2004), and other pertinent site documents.

3.3.6 Groundwater Sampling

Groundwater samples will be collected on a quarterly basis (four events total) from the 15 proposed groundwater monitoring wells and 37 piezometers (up to 52 wells total). Groundwater samples will not be collected from monitoring wells screened across LNAPL, greater that 0.1 ft thick. It is possible that eight of the 15 monitoring wells (see Figure 3-2; KAFB10630 through KAFB10633 and KAFB10634 through KAFB10638) will not be sampled because of the presence of LNAPL. The 52 proposed wells include 15 groundwater table (“A”) horizon monitoring wells, 21 “B” horizon piezometers, and 16 “C” horizon piezometers. Groundwater samples will be field screening of dissolved oxygen, oxidation reduction potential, turbidity, conductivity, specific conductance, temperature, and ferrous iron. Groundwater samples will be analyzed at a laboratory for VOCs, TPH, and PAHs to determine groundwater quality beneath the site. Groundwater samples will also be analyzed at a laboratory for cations, anions, methane, iron, manganese, nitrate-nitrite, and sulfate-sulfide to determine if, and to what degree, natural attenuation is occurring. Well designations are included on Table 3-2, along with additional information. Well construction details are described above (Section 3.3.4). Well locations are shown on Figure 3-2.

Depth to product, depth to water, and product thickness will be measured in each groundwater monitoring well prior to sampling using an electronic oil-water interface probe or similar device. Eight monitoring wells (KAFB10630 through KAFB10633 and KAFB10635 through KAFB10638) are anticipated to be located within the lateral extent of the product plume (see Figure 3-2). Depth to water will be measured in each piezometer prior to sampling using an electronic water level indicator or similar device.

Activities associated with groundwater sampling and field screening, IDW handling, and equipment decontamination will be performed in accordance with the Base-Wide Plans for Investigations Under the Environmental Restoration Program, 2004 Update, Kirtland Air Force Base, Albuquerque, New Mexico (Tetra Tech, 2004) and other pertinent site documents.

3.3.7 Groundwater and LNAPL Measurements

After installation and development (as appropriate based on presence or absence of product) of each proposed groundwater monitoring well/piezometer nest, water level measurements will be collected to establish horizontal and vertical gradients to determine if an upward or downward vertical hydraulic gradients exist between the groundwater table (“A”), “B” and “C” horizons. If the wells are installed within the LNAPL plume an LNAPL thickness will be measured. During field operations associated with this Work Plan, depth to groundwater and product measurements will be taken on a monthly basis to create potentiometric surface maps indicating flow directions for all horizons. Monthly measurements will address any seasonal changes in flow directions within each aquifer horizon and gradients between horizons due to fluctuating pumping rates from the nearby water supply wells (refer to Table 2-2 for a listing of water supply wells). These measurements will also be taken during quarterly groundwater monitoring events.

Activities associated with groundwater and LNAPL measurements and equipment decontamination will be performed in accordance with the Base-Wide Plans for Investigations Under the Environmental Restoration Program, 2004 Update, Kirtland Air Force Base, Albuquerque, New Mexico (Tetra Tech, 2004) and other pertinent site documents.

4. PROJECT MANAGEMENT

4.1 Project Scheduling and Reporting Requirements

The proposed schedule for the implementation of the Groundwater Investigation Work Plan is shown in Appendix B. The report for the detailed characterization of the vadose zone at the BFF will be combined with the groundwater characterization results. The report will have figures, tables, and cross-sections detailing the historical results and the results from the most recent investigations. A refined Conceptual Site Model will be included. A preliminary outline for the report is included in Appendix C.

4.2 Project Coordination

Prior to the commencement of work, a kickoff meeting will be held at Kirtland AFB or at NMED, as appropriate. Invitees will include Kirtland AFB, AFCEE, NMED, and the contractors conducting the work. The meeting will outline roles and responsibilities of all participants, review scope, schedule, and procedures and will discuss base rules and security requirements. During the field implementation kickoff meeting, a list of critical contacts within the field team, AFCEE, Kirtland AFB, and NMED will be compiled for use should immediate input be needed to any decision process critically impacting field work. This list will be reviewed and revised as needed on a weekly basis (see below) during the weekly conference call to account for future personnel absences.

During field investigation activities, daily quality control summary reports (DQCRs) will be completed by the field team manager and will be provided to the project manager, client designee, and NMED designee on a daily basis. The DQCRs summarizes field activities and quality control activities that occurred during the day. In compliance with the established Basewide QAPP [Appendix D (Tetra Tech, 2004)] Field Change Request (FCR) Forms will be filled out if there are any changes from the approved scope of work. If the FCR represents a major change, such as moving a well or boring location, AFCEE, NMED, and Kirtland AFB will be notified and the change will be approved prior to commencement. If the FCR is minor and the resolution is clearly outlined in the DQOs, the FCR will be filed, the change will be made in the field, and AFCEE, the project manager, and NMED will be notified of the change.

Weekly conference calls will be held among the field team, AFCEE, Kirtland AFB, and NMED to discuss the progress of the field effort, upcoming field work, and consider any problems or issues that require resolution. Minutes of the meeting will be kept by the field team manager and will be circulated to the participants within 24 hours of the meeting.

4.3 Health and Safety Plan

A site-specific Health and Safety Plan (HASP) has been implemented for all previous work performed at the BFF. The Site-Specific HASP will be updated to include any changes in work procedures or health screening requirements that have been updated since implementation of previous site-specific HASPs. The site-specific HASP is included in Appendix D.

4.4 Investigation-Derived Waste Plan

All wastes generated during implementation of this Work Plan will be handled and disposed of according to the requirements as presented in the Base-Wide Plans for the Environmental Restoration Program, 2004 Update, Appendix D.

4.5 Community Relations Plan

A Community Relations Plan has already been developed and implemented for Kirtland AFB. Community information meetings including community outreach and presentations at neighborhood association meetings are ongoing. The Community Relations Plan is included in the Base-Wide Plans for the Environmental Restoration Program, 2004 Update in Appendix D

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Tables

Table 2-1. Hydrostratigraphic Units and Correspondence to Site-Specific Units

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

Source: CH2M HILL, 2003.

Table 3-1. DQO Summary Table

DQO Step	Details of DQO Step per EPA DQO Guidance (2006)	BFF Groundwater Investigation WP Topic 1	BFF Groundwater Investigation WP Topic 2	BFF Groundwater Investigation WP Topic 3	BFF Groundwater Investigation WP Topic 4	BFF Groundwater Investigation WP Topic 3
1) State the Problem**	Summarize the contamination problem requiring new data, resources available, CSM	Identify/locate geologic units controlling the migration of LNAPL	Qualitative LNAPL limits on groundwater table at the BFF unknown	Identification of groundwater gradient and probable contaminant flow paths at the site are required to predict current and future contamination trends and to support risk and IM assessments	Refine the delineation plume LNAPL plume in the BFF area.	Nature and extent of dissolved phase plume defined by new wells unknown
2) Identify the Decision	Identify the decision that requires new environmental data to address the contamination problem	Determine the location of fine grained lithologic units within the vadose zone at the BFF that control LNAPL migration	Determine the extent of the LNAPL plume on the water table.	Determine gradients and flow paths within all three groundwater horizons at the site.	Delineate contaminated vs. uncontaminated (from LNAPL plume) locations at BFF.	Determine the extent of the dissolved phase contaminant plume that exceeds the established MCLs for groundwater at the site.
3) Identify Inputs to the Decision	Identify the information needed to support the decision and specify which inputs require new environmental measurements	GMR REF (Seismic Refraction) data analysis from seismic refraction lines run in the BFF. Identify the areas where fine there are preferential flow paths limits of LNAPL using its chemical properties as a non conducting material.	IP/DCRES Seismic (resistivity) data analysis from seismic resistivity lines run in the BFF. Identify the limits of LNAPL using its chemical properties as a non conducting material.	Collect groundwater monitoring levels and calculate groundwater elevations and flow patterns. Collect synoptic data set from all newly installed and existing groundwater monitoring wells	LNAPL thickness measurements in proposed monitoring wells installed for the purpose of LNAPL plume delineation.	Groundwater samples collected from newly installed monitoring wells after installation and development has been completed. Samples will be analyzed for PAHs, VOCs and EDB
4) Define the Study Boundaries	Specify the spatial and temporal aspects of the environmental media that the data must represent to support the decision	Study boundaries are indicated on Figure 3-1.	Study boundaries are indicated on Figure 3-1.	All existing monitoring wells and newly installed A, B and C monitoring wells monthly during the completion of the groundwater investigation.	Proposed monitoring wells installed within the LNAPL plume as currently delineated.	All newly installed monitoring wells.
5) Develop a Decision Rule	Develop a logical "if…then" statement that defined the conditions that would cause the decision maker to choose among alternative actions	If proposed groundwater monitoring wells being for the purpose of monitoring contamination within the LNAPL plume do not address areas that have been delineated as possible preferential flow paths for LNAPL to the groundwater table consider modifying proposed well locations within the LNAPL plume.	If proposed groundwater monitoring wells being installed for the purpose of monitoring contamination within the LNAPL plume are not within the plume delineated by the IP/DCRES analysis adjust the location of these points or eliminate them from the drilling program. If monitoring wells being installed to monitor/delineate the dissolved phase contaminant plume are located within the product boundary, adjust the locations of these points such that they are no longer within the boundary of the LNAPL plume.	Collect groundwater levels from all newly installed groundwater monitoring wells and existing monitoring wells as soon as enough new wells are installed to augment existing data. Calculate horizontal and vertical gradient to determine groundwater flow patterns and determine if the patterns are consistent with the current CSM on which the newly installed monitoring well locations are based. If the flow patterns are different evaluate the locations of any monitoring wells that have not been installed and adjust locations if necessary.	If proposed monitoring wells installed for the purpose of monitoring the LNAPL plume do not contain LNAPL determine if the data point adjusts the CSM enough that the proposed drilling program with regards to both the LNAPL and dissolved phase should be altered to reflect the new understanding of the site. Monitoring well locations should be adjusted or eliminated accordingly. LNAPL screening level 0.1 ft (< = stop; > = further assessment required)	If groundwater samples in monitoring wells proposed for the purpose of delineating the extent of the groundwater plume are impacted above MCLs, the dissolved phase plume has not been delineated and additional wells must be installed to complete the delineation. Table 3-1 outlines the contingency for each decision point (monitoring well) and defines the action that will be taken. Expert judgment regarding rate of contaminant movement, time since release, concentration gradients, and software programs such as GTS.
6) Specify Limits on Decision Errors***	Specify the decision maker's acceptable limits on decision errors, which are used to establish performance goals for limiting uncertainty in the data	Seismic refraction line spacing with sufficient density to define units to nearest 1 of a foot. Lines to extend up to 2500 feet past currently known boundaries.	Resistivity grids with sufficient density to define the lateral extent of free product 50 feet. Lines to extend 1500 feet.	Synoptic or near synoptic data for comparability. Heads measured to 0.01 feet. Precision to within a 0.01 ft measured using a water level indicator. All horizons measured.	Synoptic or near synoptic data for comparability. LNAPL thickness measured to 0.01 feet. LNAPL thickness measured to 0.01 feet. Precision to within a 0.01 ft measured using a product water interface probe.	QAPP from Base-Wide Work Plan to be utilized. A second confirmation sample will be collected from any monitoring wells that exceed MCLS prior to implementation of the contingency.
7) Optimized Design	Identify the most resource-effective sampling and analysis design for generating data that are expected to satisfy the DQOs.	Refraction survey conducted prior to drilling.	Resistivity surveys conducted prior to drilling.	Conducted monthly during groundwater investigation/drilling stage of the groundwater investigation.	Conducted monthly during groundwater investigation/drilling stage of the groundwater investigation.	Groundwater samples collected from newly installed monitoring wells after installation and development has been completed. Samples will be analyzed for PAHs, VOCs and EDB.

Table 3-2
Proposed Installation Correlation with NMED Location ID

NMED Table 5 Location ID	Easting	Northing	Horizon A	Horizon B	Horizon C	Corresponding Installation	Rationale for Location, Adjustment or Deletion
1	1542189	1476725	A	B	C	KAFB-10640	Moved approx. 550 ft west to balance coverage west of plume.
2	1541984	1476042					Deleted location. Western plume coverage by KAFB-10620 & 10640
3	1543703	1476600	A	B	C	KAFB-10643	Moved approx. 500 ft northeast to balance coverage northeast of plume.
4	1543372	1475065					Deleted location. Eastern plume coverage by KAFB-10617, 10619 & 10623
5	1543643	1477939	A			KAFB-10626	Well is installed.
6	1541430	1472370	A			KAFB-10627	Well is installed.
7	1542812	1473601	A	B		KAFB-10634	Colocated with SVMW33 (see note 2). "C" horizon contingent on "B" horizon results.
8	1542722	1477726	A	B	C	KAFB-10641	Moved approx. 750 ft west to balance coverage northwest of plume.
9	1543054	1477788					Deleted location. Coverage north of plume by KAFB-10641 & 10642
10	1543774	1477304	A	B	C	KAFB-10642	Moved approx. 500 ft northwest to balance coverage north of plume.
11	1541774	1473718	A	B	C	KAFB-10632	Colocated with SVMW26 (see note 2).
12	1542362	1473801	A	B	C	KAFB-10633	As specified in 2 Apr 2010 letter.
13	1542305	1474340	A			KAFB-10628	Well is installed.
14	1542736	1474715					Deleted location. LNAPL/plume coverage by KAFB-10610 & 10619
15	1542860	1475860					Deleted location. Interior plume coverage by KAFB-10617, 10637, 10638 & 10639
16	1542189	1475207	A	B		KAFB-10636	Moved approx. 100 ft west to balance coverage along leading edge of LNAPL plume. "C" conting. on "B" results. Possible use as SVE/sparge location (see note 1).
17	1541891	1473151	A	B	C	KAFB-10631	Colocated with SVMW21 (see note 2). Moved approx. 150 ft northwest.
18	1542203	1474071	A	B	C	KAFB-10635	Colocated with SVMW27 (see note 2).
19	1542653	1475338	A	B	C	KAFB-10637	Colocated with SVMW30 (see note 2). Moved approx. 100 ft west to balance coverage along leading edge of LNAPL plume. Possible use as SVE/sparge location (see note 1).
20	1542535	1475975					Deleted location. Interior plume coverage by KAFB-10618, 10621 & 10636
21	1543199	1475767					Deleted location. Eastern plume coverage by KAFB-10617, 10622, 10623 & 10639
22	1543068	1476494	A	B		KAFB-10639	Moved approx. 350 ft south to balance interior plume coverage. "C" conting. on "B" results.

Additional Installation	Horizon A	Horizon B	Horizon C	Rationale
KAFB-1063		B	C	Provides vert. dissolved-phase plume definition in direction of supply wells. Assess horiz./vert. gradients.
KAFB-1064		B	C	Provides vert. dissolved-phase plume definition in direction of supply wells. Assess horiz./vert. gradients.
KAFB-10610		B	C	Provides vert. LNAPL/dissolved-phase interior plume definition. Assess horiz./vert. gradients.
KAFB-10611		B		Colocated with SVMW28 (see note 2). Provides vert. dissolved-phase eastern plume definition. Assess horiz./vert. gradients.
KAFB-10613		B	C	Provides vert. dissolved-phase plume definition in direction of supply wells. Assess horiz./vert. gradients.
KAFB-10619		B	C	Provides vert. dissolved-phase eastern plume definition. Assess horiz./vert. gradients.
KAFB-10623		B	C	Provides vert. dissolved-phase eastern plume definition. Assess horiz./vert. gradients.

Table 3-3. Well Location Table

Installation ID	Installation Type (Nature/Extent)	Co-Installations	Groundwater Sampling (Depth)	Rationale	Horizon	Contingency
KAFB10630	Nature and vertical extent of contaminants.		X	More closely defines the eastern extent of plume. Defines potential for vapor intrusion in Nat Guard Building. NMED 7 is contingent based upon soil, vapor and gw extent.	A	This monitoring well is located to assess the nature and lateral of the groundwater plume.
KAFB10631, B, C	Nature and vertical extent of contaminants	SVMW21	X	Moved from original location to the NW approx 150'. A Horizon: 4" WT well (ss screen) w/vapor monitoring points and soils sampling. B and C horizons: 40' and 80' screens. 3" PVC, PVC screens. Wells will assess NAPL thickness, dissolved plume thickness and GW gradient (vert. and horiz.).	A, B, C	If the C-horizon exceeds any MCL, an assessment of the deeper groundwater at this location will be required.
KAFB-10629	Horizontal and vertical extent of contaminants	SVMW20	X	Added well downgradient of new fuel ASTs. Will monitor vapors for new ASTs. WT screen PVC. Will assess upgradient water quality for the BFF during this investigation. Will assess horiz gradient.	A	If the A-horizon exceeds any MCL and gw concentrations in KAFB-10627 and 10616 remain below MCLs, additional assessment of the extent of the gw plume will be made within 750-ft. SE of this location.
KAFB-10632, B, C	Nature and vertical extent	SVMW26	X	Screens at WT, 40', 80'. Assess product thickness and dissolved thickness. Assess	A, B, C	If the C-horizon exceeds any MCL, an assessment of the deeper

Installation ID	Installation Type (Nature/Extent)	Co-Installations	Groundwater Sampling (Depth)	Rationale	Horizon	Contingency
				vertical and horizontal gradient. Potentially as SVE point (25' screen, more screen in vadose zone - 10-15' in vadose zone, at least 10' in water, stainless). B and C horizon: 3" wells, 10' PVC screens, separate boreholes.		groundwater at this location will be required.
KAFB-10633, B, C	Nature and vertical extent		X	Screens at WT and 40' and 80'. Assess product thickness and dissolved thickness. Assess vertical and horizontal gradient. Potentially as SVE point (25' screen, more screen in vadose zone - 10-15' in vadose zone, at least 10' in water). B and C horizons: 3" wells in same borehole. 10' PVC screens.	A, B, C	If the C-horizon exceeds any MCL, an assessment of the deeper groundwater at this location will be required.
KAFB-10611B	Horizontal and vertical extent of contaminants	SVMW28	X	Screen at 40'. Assess vertical distribution of dissolved plume. Assess horiz and vertical gradient. B horiz: 3" PVC well. 10'screen.	B	If the B-horizon exceeds any MCL, an assessment of the deeper groundwater at this location will be required.
KAFB-10635, B, C	Nature and vertical extent of contaminants	SVMW27	X	Screens at WT and 40' and 80'. Assess product thickness and dissolved thickness. Assess vertical and horizontal gradient. Potentially as SVE point (25' screen, more screen in vadose zone - 10-15' in vadose zone, at least 10' in water). B and C horizons: 3"	A,B,C	If the C-horizon exceeds any MCL, an assessment of the deeper groundwater at this location will be required.

Installation ID	**Installation Type (Nature/Extent)**	**Co-Installations**	**Groundwater Sampling (Depth)**	**Rationale**	**Horizon**	**Contingency**
				wells in same borehole. 10' PVC screens.		
KAFB-1064B, C	Vertical extent of contaminants		X	Screen at 40' and 80'. Assess horiz and vertical gradient. Provide GW data in B,C horizon near VA well. Potentially assess vertical migration of dissolved plume.	B,C	If the C-horizon exceeds any MCL, an assessment of the deeper groundwater at this location will be required. If gw concentrations exceed MCLs in the B- or C-horizons, corrective measures for the Veteran's Administration production well will be implemented.
KAFB-10619B, C	Vertical extent of contaminants	SVMW29	X	Screens at 40' and 80'. Assess vertical and horizontal distribution of dissolved plume. Assess horiz and vertical gradient.	B,C	If the B- or C-horizon exceeds any MCL additional assessment of the extent of the gw plume will be made within 750-ft. E of this location.

Installation ID	Installation Type (Nature/Extent)	Co-Installations	Groundwater Sampling (Depth)	Rationale	Horizon	Contingency
KAFB-10634, B	Horizontal and vertical extent of contaminants	SVMW33	X	2x3" PVC wells in A and B horizon.	A, B	If concentrations exceed MCLs in the A- or B-horizons, additional assessment of the extent of gw contamination may be required to the E of this location. If concentrations exceed MCLs in the B-horizon only, additional assessment may be necessary for the C-horizon at this location.
KAFB-1063B, C	Vertical extent of contaminants		X	Screen at 40' and 80'. Assess horiz and vertical gradient. Provide GW data in B,C horizon near VA well. Potentially assess vertical migration of dissolved plume.	B, C	If gw from A-, B-, or C-horizon exceeds MCLs, will install additional wells within 750-ft. W of this location and will prepare for interim action at KAFB-15.
KAFB-10613B, C	Vertical extent of contaminants		X	Screen at 40' and 80'. Assess horiz and vertical gradient. Provide GW data in B,C horizon near VA well. Potentially assess vertical migration of dissolved plume.	B, C	If gw from A-, B-, or C-horizon exceeds MCLs, will install additional wells within 750-ft. W of this location. If C-horizon exceeds MCLs, will continue to assess vertical extent at this location.
KAFB-10637, B, C	Nature of and vertical and horizontal extent of contaminants	SVMW30	X	2 boreholes. A Horiz: 4" inch across WT, Stainless screen. B/C Horiz: 3" PVC wells, 10' screens at 40 and 80.	A,B,C	If the C-horizon exceeds any MCL, an assessment of the deeper groundwater at this

Installation ID	Installation Type (Nature/Extent)	Co-Installations	Groundwater Sampling (Depth)	Rationale	Horizon	Contingency
						location will be required.
KAFB-10625B, C	Vertical and horizontal extent of contaminants		X	Screens at 40' and 80. Assess vertical and horizontal distribution of dissolved plume. Assess horiz and vertical gradient.	B,C	If the C-horizon exceeds any MCL, an assessment of the deeper groundwater at this location will be required.
KAFB-10641, B, C	Vertical and horizontal extent of contaminants		X	Moved over to west of Middle School (750'). Screens at WT, 40' and 80. Assess vertical and horizontal distribution of dissolved plume. Assess horiz and vertical gradient.	A,B,C	If gw from any horizon exceeds the MCLs, additional assessment will be made within 750-ft. of NW of this location.
KAFB-10640, B, C	Vertical and horizontal extent of contaminants		X	Moved 550' west. Screens at WT, 40' and 80'. Assess vertical and lateral distribution of dissolved plume. Assess horiz and vertical gradients.	A,B,C	If gw from any horizon exceeds the MCLs, additional assessment will be made within 750-ft. of WNW of this location.
KAFB-10643, B, C	Vertical and horizontal extent of contaminants		X	Moved 500 ' NE (moved off Gibson onto a side street). Screens at WT 40' and 80. Assess vertical and horizontal distribution of dissolved plume. Assess horiz and vertical gradient.	A,B,C	If gw from any horizon exceeds the MCLs, additional assessment will be made within 750-ft. of ENE of this location.

Installation ID	Installation Type (Nature/Extent)	Co-Installations	Groundwater Sampling (Depth)	Rationale	Horizon	Contingency
KAFB-10642, B, C	Vertical and horizontal extent of contaminants		X	Moved 550' NW (moved off Gibson onto a side street). Screens at WT 40' and 80. Assess vertical and horizontal distribution of dissolved plume. Assess horiz and vertical gradient .	A,B,C	If gw from any horizon exceeds the MCLs, additional assessment will be made @ KAFB-10626.
KAFB-10639, B	Vertical and horizontal extent of contaminants		X	Moved 350' SW (Monitor midplume concentrations vertically). Screens at WT and 40' in a single borehole. Assess horiz and vertical gradients.	A,B	If gw from the B horizon exceeds MCLs, then a C-horizon well will be installed.
KAFB-10623B, C	Vertical and horizontal extent of contaminants		X	1 borehole, 2x3" screens installed to 40 and 80. PVC screens. Assess vertical and horizontal distribution of dissolved plume. Assess horiz and vertical gradients.	B,C	If gw from any horizon exceeds the MCLs, additional assessment will be made within 750-ft. of E of this location.
KAFB-10610B, C	Vertical extent of contaminants		X	1 borehole, 2x3" screens installed to 40 and 80. PVC screens. Assess vertical and horizontal distribution of dissolved plume. Assess horiz and vertical gradients.	B,C	If gw from the C-horizon exceeds MCLs, then a deeper well will be installed.
KAFB-10636, B	Extent of NAPL, vertical extent of contaminants		X	1 borehole/location. Install a 4" well w/30' stainless screen (1/2 in water, 1/2 out of water). Also install a 2" PVC well w/10' screen to 40 '.	A,B	If gw from the B-horizon well exceeds the MCLs, a C-horizon well will be installed. If gw from either the B- or C-horizon wells exceed the MCLs then additional assessment may be

Installation ID	**Installation Type (Nature/Extent)**	**Co-Installations**	**Groundwater Sampling (Depth)**	**Rationale**	**Horizon**	**Contingency**
						necessary @ KAFB-10620.
KAFB-10638, B	Extent of NAPL, vertical extent of contaminants		X	1 borehole/location. Install a 4" well w/30' stainless screen (1/2 in water, 1/2 out of water). Also install a 2" PVC well w/10' screen to 40 '.	A, B	If gw from the B-horizon exceeds the MCLs, a C-horizon well will be installed.

Sampling and analysis of water samples:

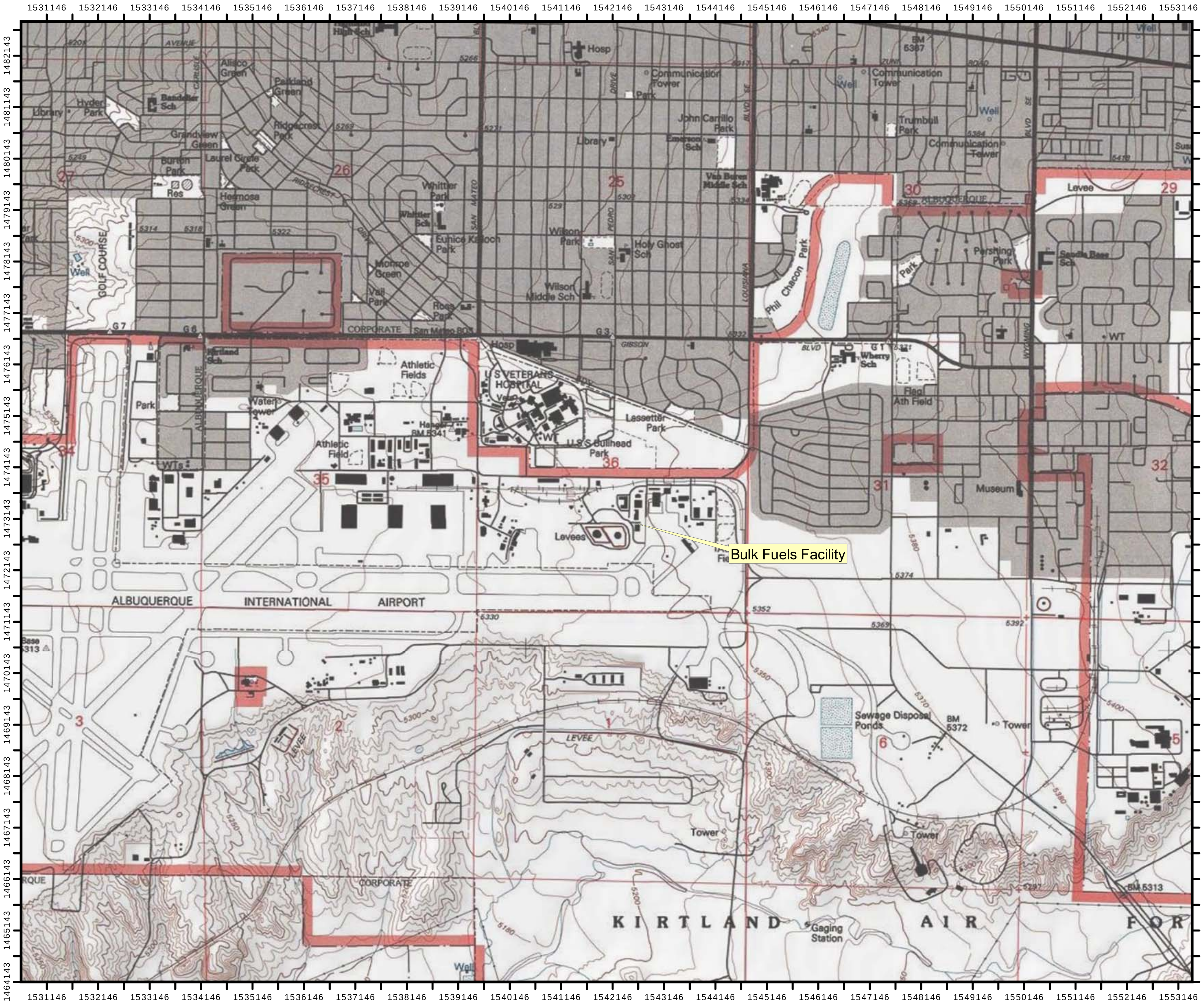
VOC, TPH, PAHs and TOC, low detection method for EDB (<0.02 µg/L)

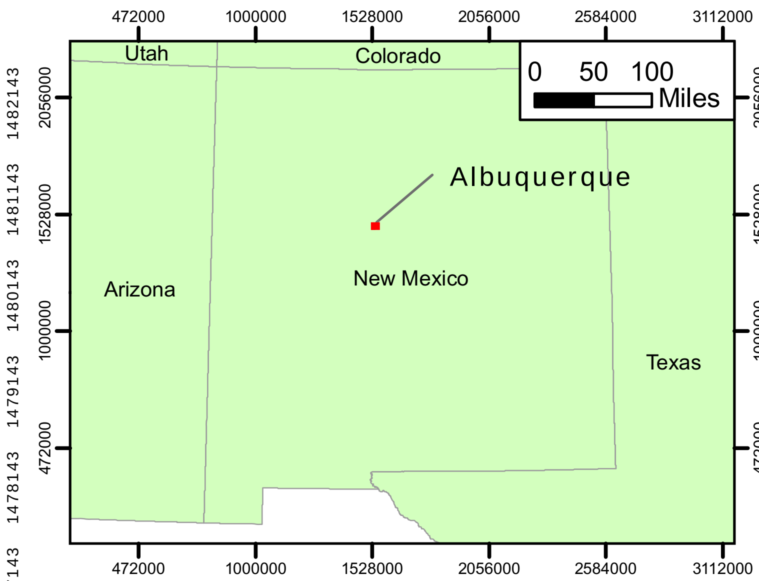
Natural Attenuation parameters: cations, anions, methane, Fe, Mn, nitrate-nitrite, sulfate-sulfide

Field measured parameters: Temperature, pH, specific conductance, ORP, ferrous iron

Groundwater wells screened across the water table within LNAPL footprint will require special development protocol (provided in IM work plan)

Figures



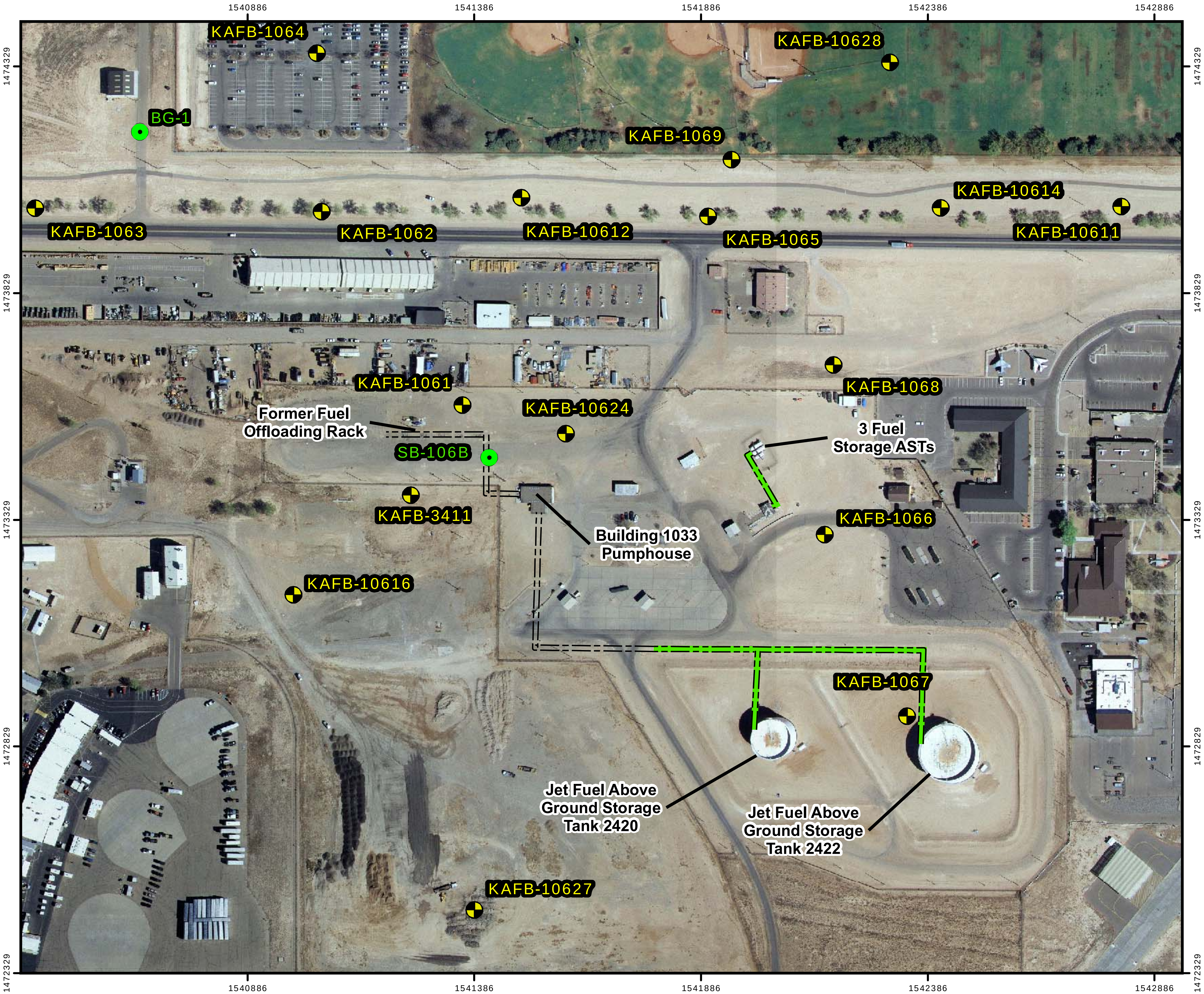


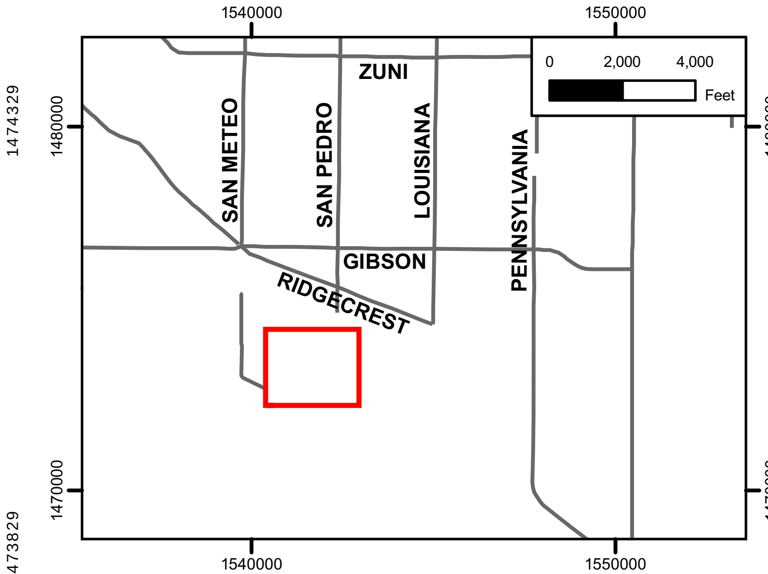
Bulk Fuels Facility
Kirtland AFB, New Mexico

Figure 2-1

Site Location Map

Revision Date: 18 May 2010





LEGEND

- Groundwater Monitoring Wells
- Soil Borings (Approximate Location)
- Aboveground Fuel Transfer Lines
- Underground Fuel Transfer Lines
- 1541850 NM Central State Plane Feet, NAD 83

LNAPL = light non-aqueous phase liquid fuel product

0 112.5 225 450 Feet

N

Bulk Fuels Facility
Kirtland AFB, New Mexico

Figure 2-2

Site Plan

Revision Date: 28 May 2010

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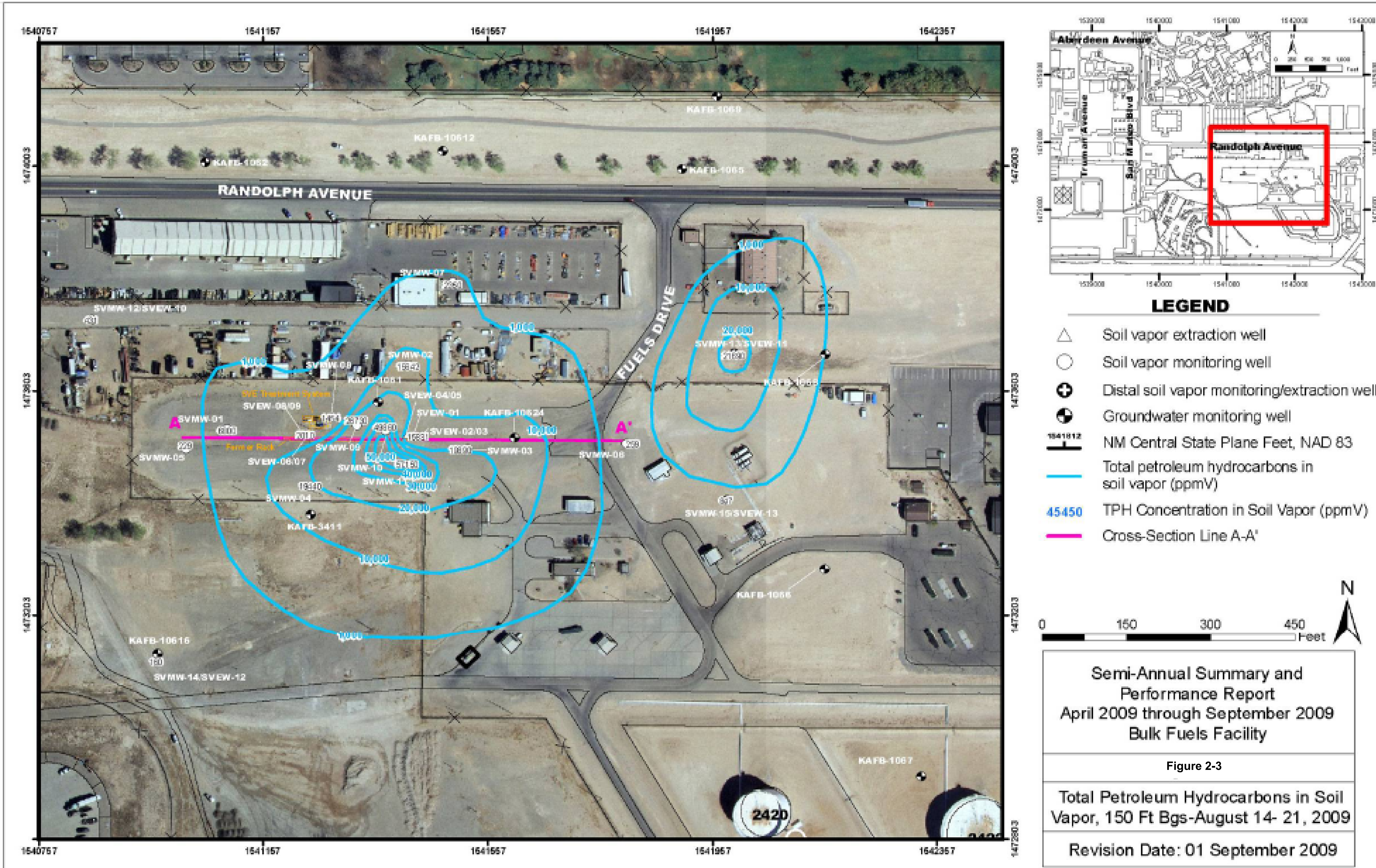
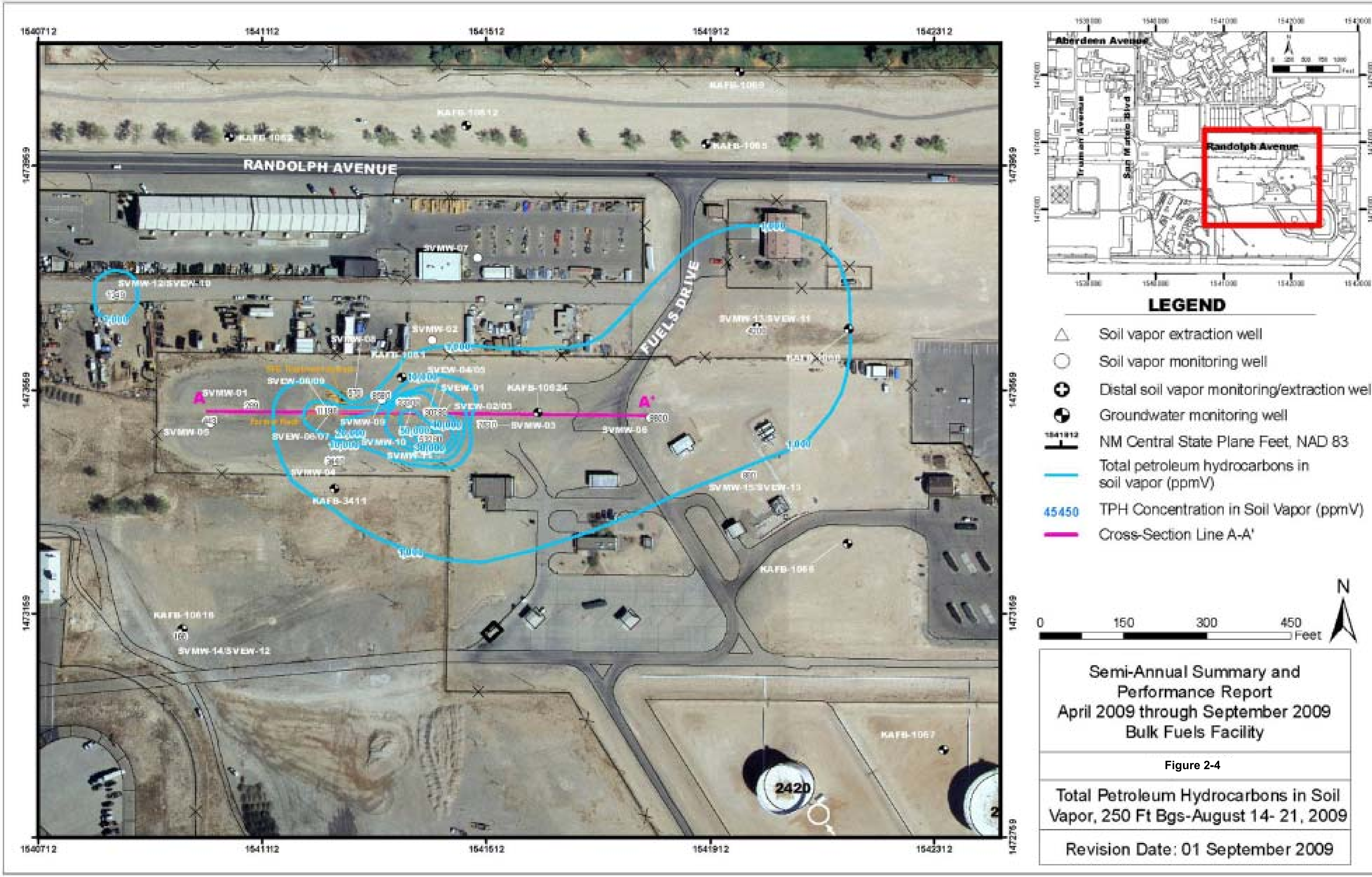


Source: CH2M HILL 2009



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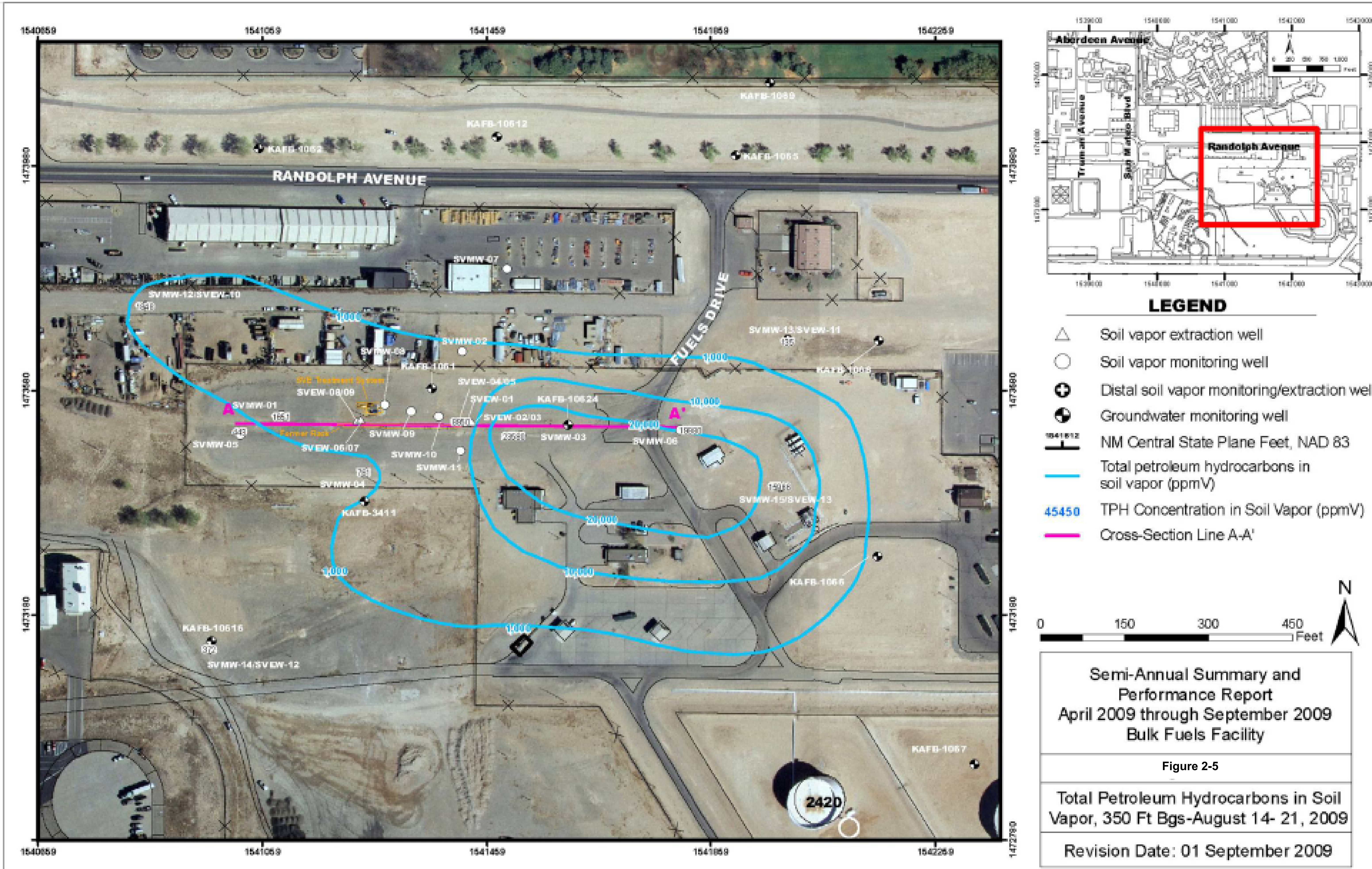

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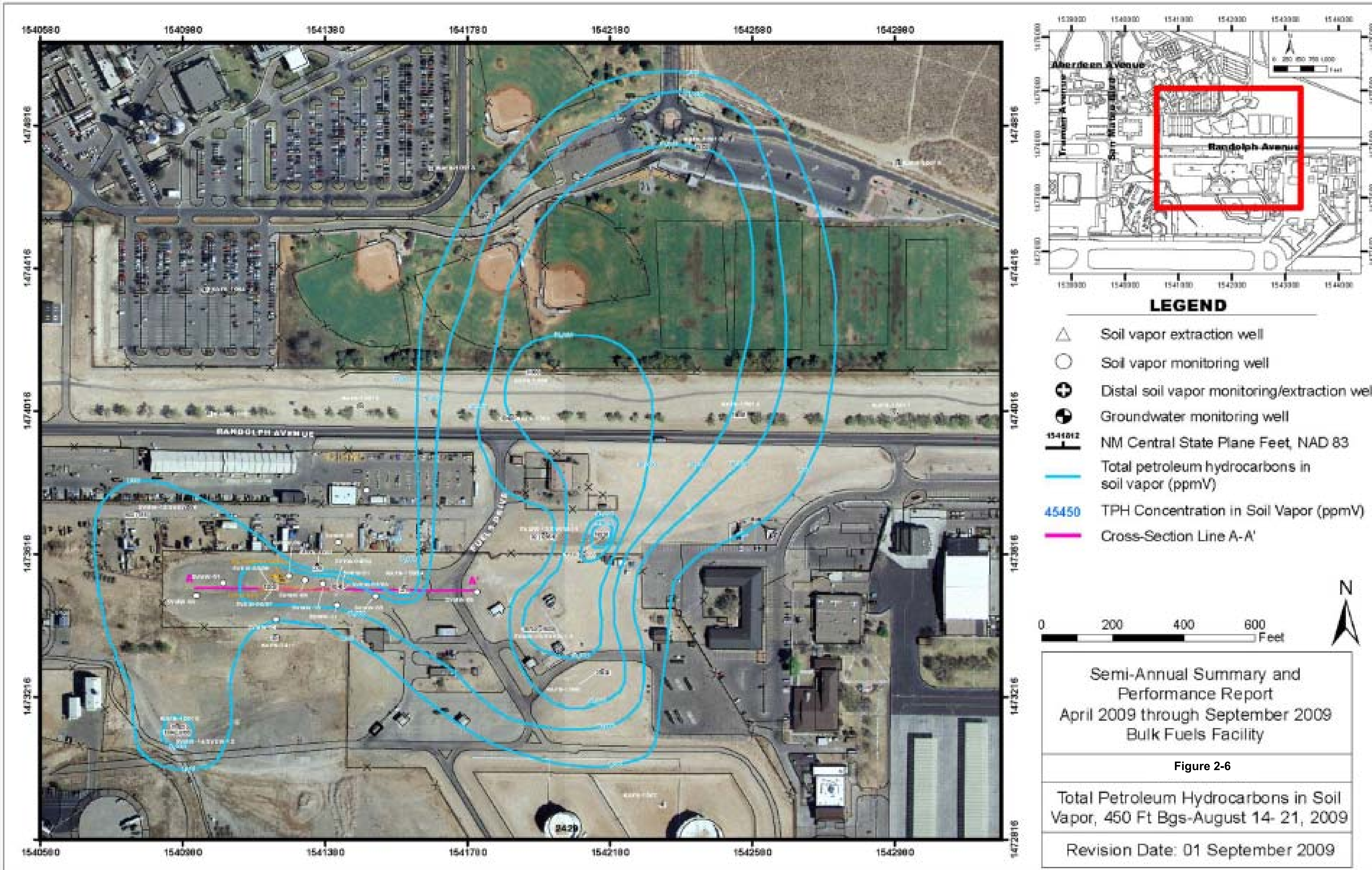

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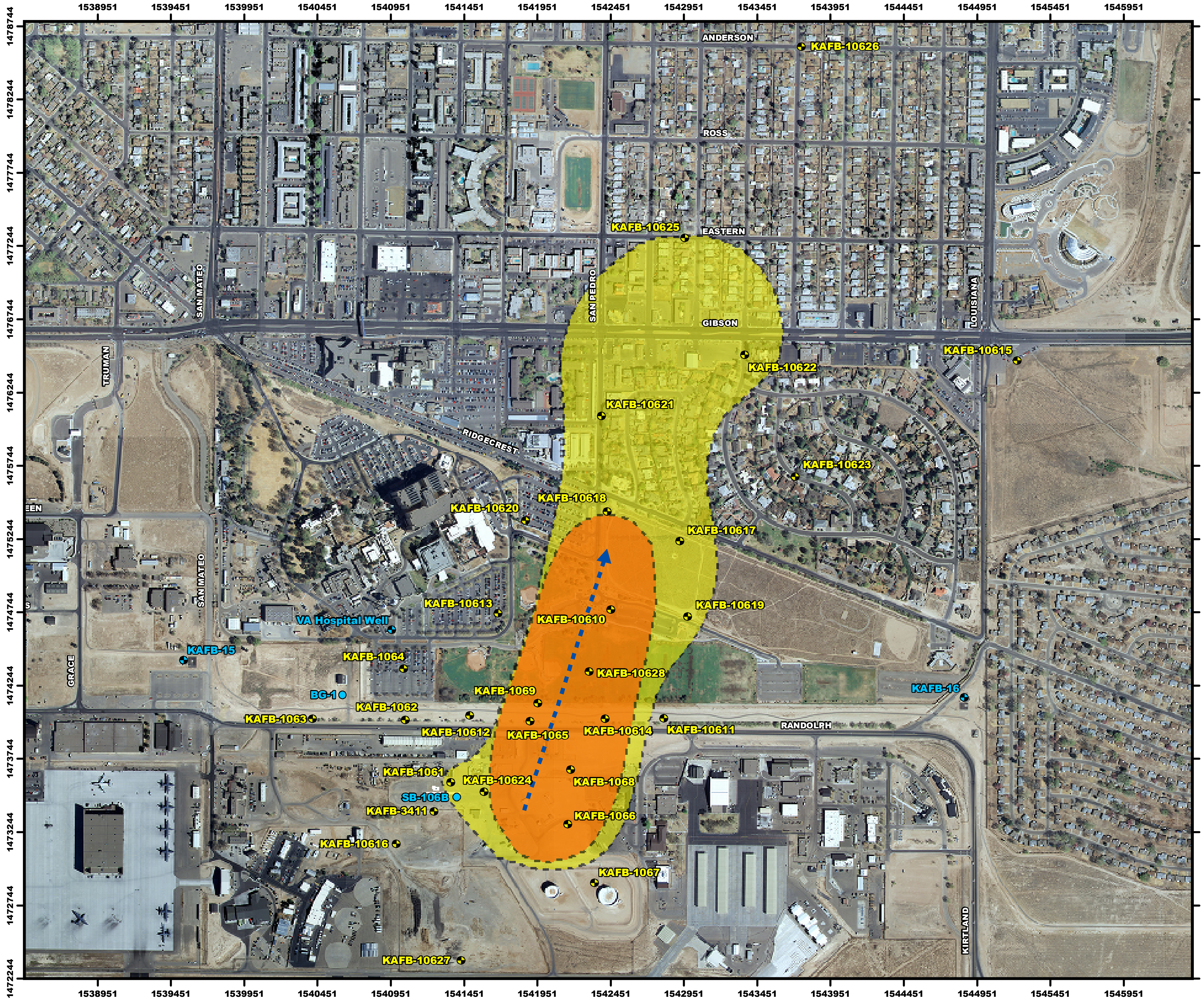
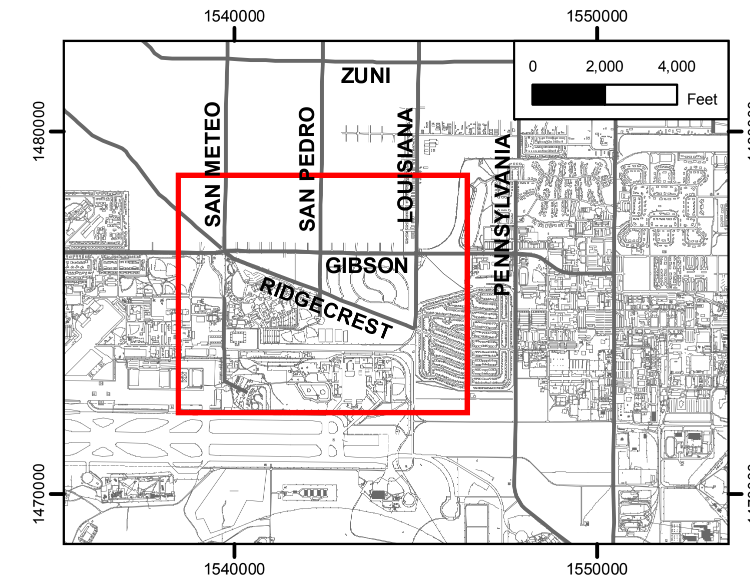




LEGEND

- Nearest Groundwater Production Wells
- Groundwater Monitoring Wells
- Soil Borings (Approximate Location)
- Estimated Extent of LNAPL with Thickness >0.01 Foot
- Estimated Extent of EDB in Groundwater >0.05 ug/L (Q1-2010)
- Approximate Groundwater Flow Direction
- 1541850 NM Central State Plane Feet, NAD 83

LNAPL = light non-aqueous phase liquid fuel product
EDB = ethylene dibromide
ug/L = micrograms per liter

0 350 700 1,400 Feet

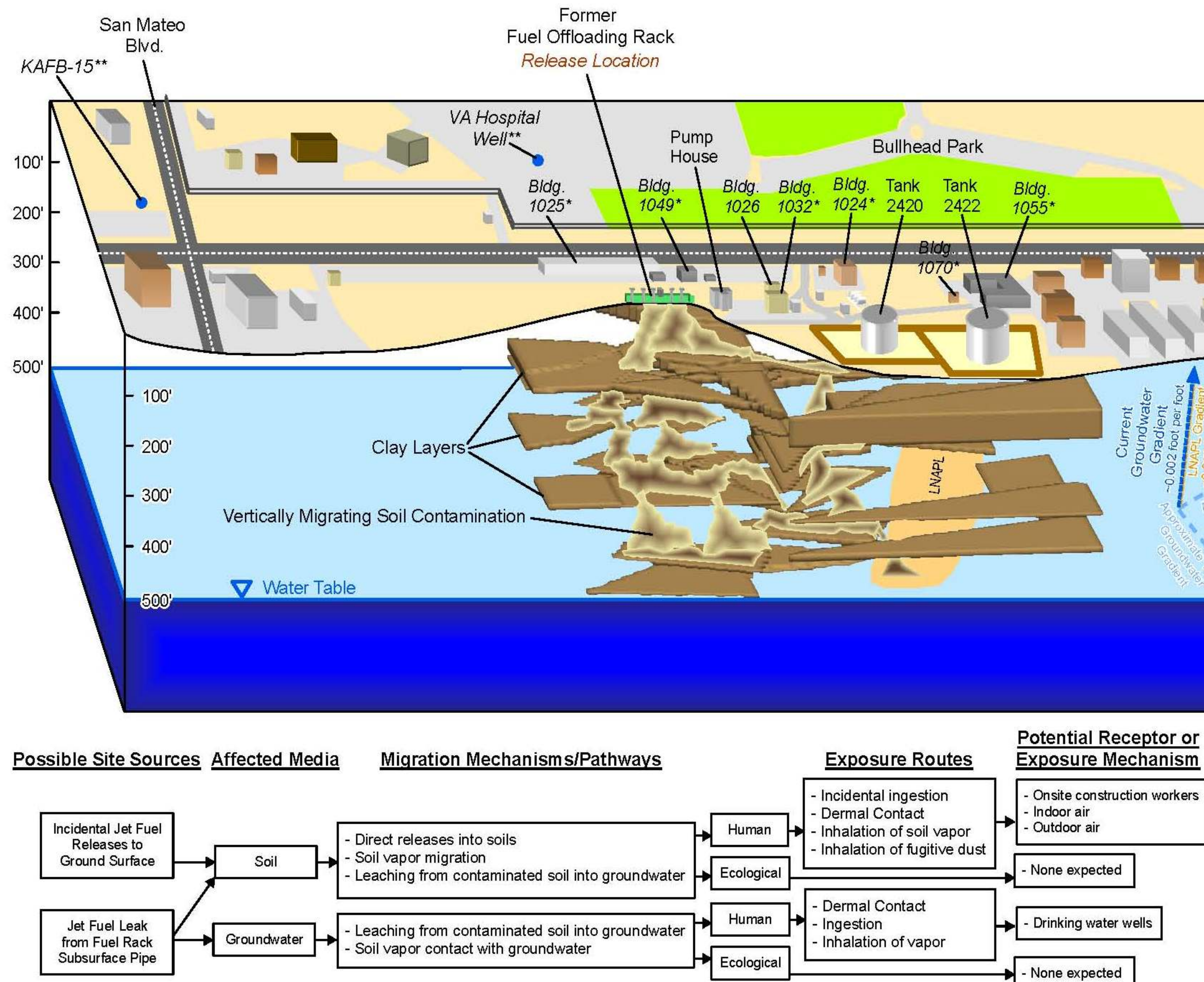
N

Bulk Fuels Facility
Kirtland AFB, New Mexico

Figure 2-7

LNAPL Thickness and Groundwater Quality

Revision Date: 31 May 2010



Notes:

* *Potential Receptor Indoor Air (to be determined)*

** *Potential Receptor Groundwater*

Revision Date: 2/9/2010	CSM_Fig1.mxd

CONCEPTUAL SITE MODEL

Kirtland Air Force Base - Albuquerque, New Mexico

Bulk Fuels Facility Source Area

Figure 2-8

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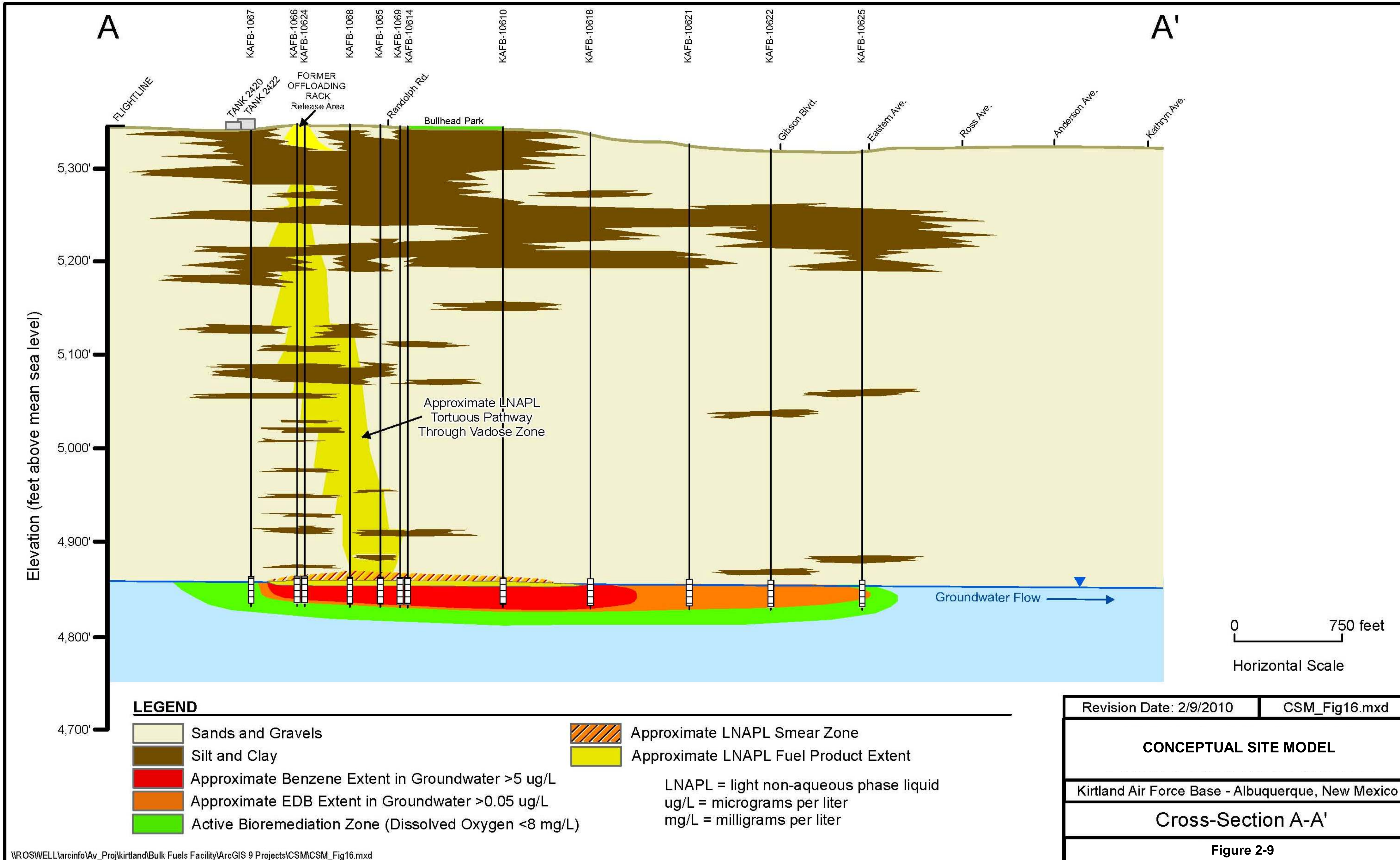
Source: CH2M Hill 2010



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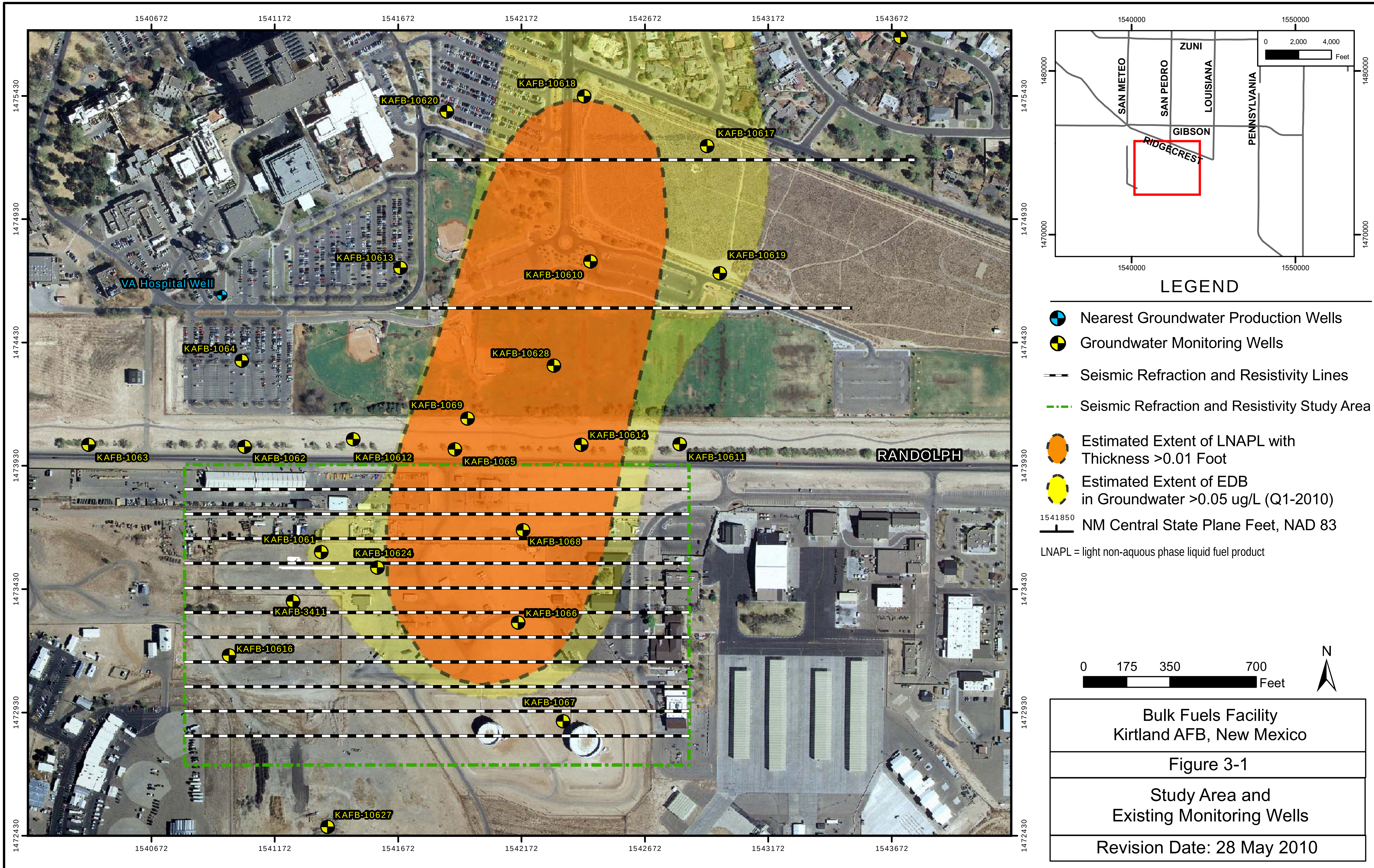

Bulk Fuels Facility
Kirtland AFB, New Mexico

Figure 3-1

Study Area and
Existing Monitoring Wells

Revision Date: 28 May 2010

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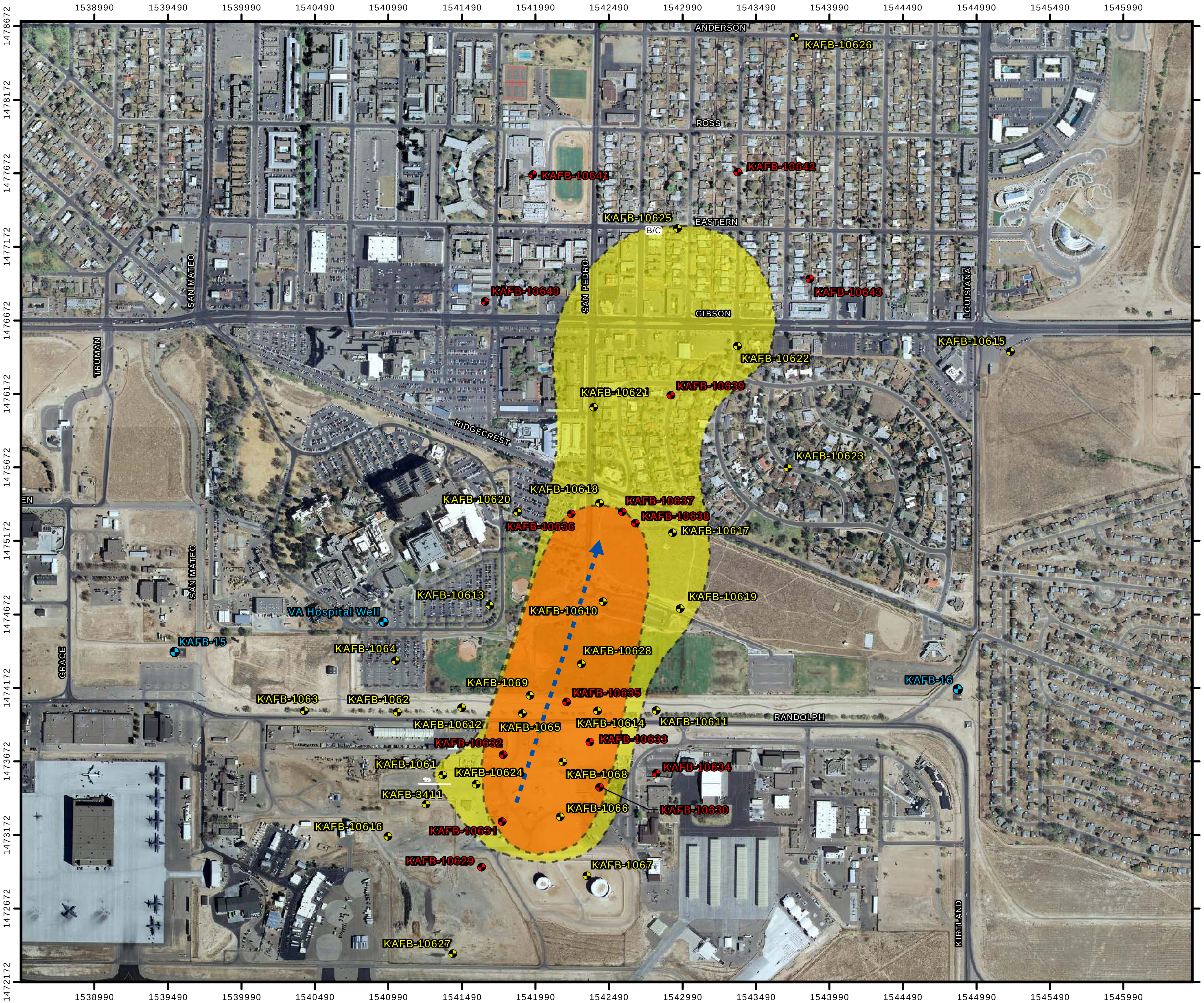
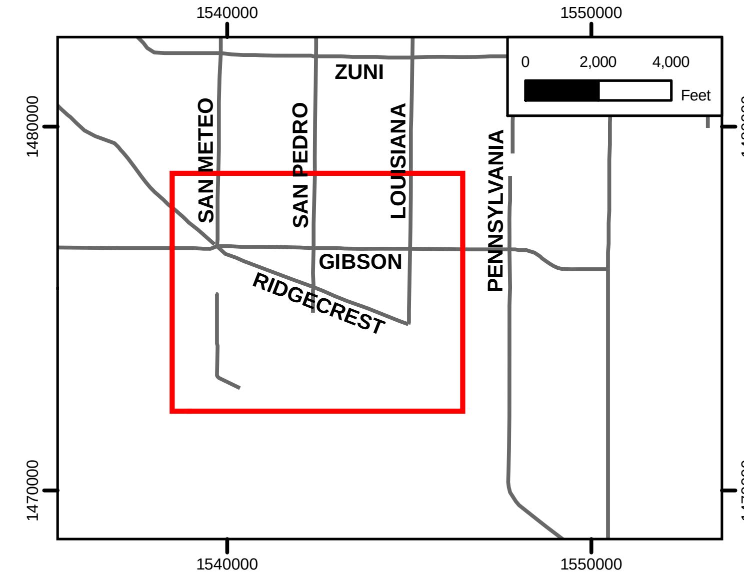




LEGEND

- Nearest Groundwater Production Wells
- Groundwater Monitoring Wells
- Proposed Groundwater Monitoring Wells
- Estimated Extent of LNAPL with Thickness >0.01 Foot
- Estimated Extent of EDB in Groundwater >0.05 ug/L (Q1-2010)
- Approximate Groundwater Flow Direction
- 1541850 NM Central State Plane Feet, NAD 83

LNAPL = light non-aqueous phase liquid fuel product
EDB = ethylene dibromide
ug/L = micrograms per liter

0 350 700 1,400 Feet

N

Bulk Fuels Facility
Kirtland AFB, New Mexico

Figure 3-2

Proposed
Groundwater Monitoring Wells

Revision Date: 28 May 2010

AECOM

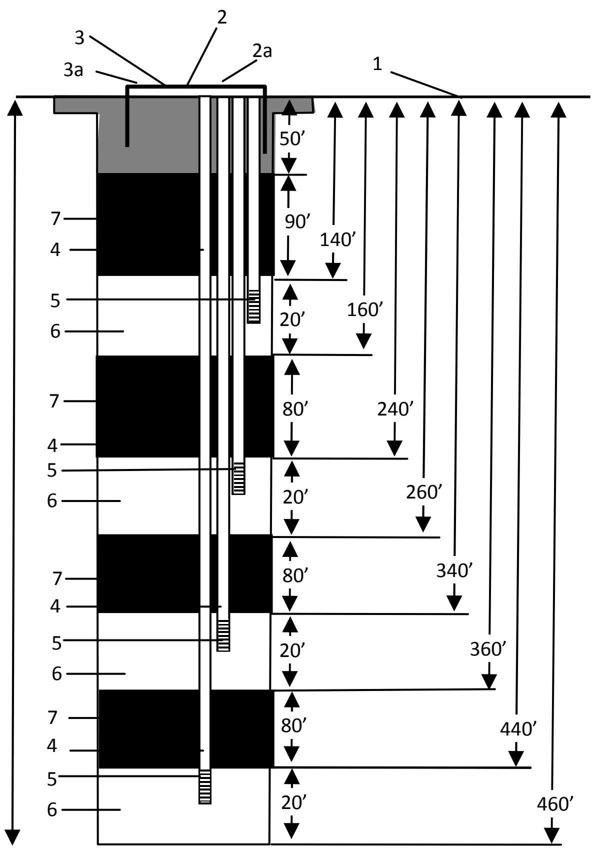
Figure 3-3
Typical Soil Vapor Monitoring Well Installation

PROJECT: KAFB Bulk Fuels Facility LOCATION:

DRILLING CONTRACTOR:

DRILLING METHOD AND EQUIPMENT USED: Air Rotary Casing hammer, Speedstar 30K DRILLER:

WATER LEVEL: START: END: LOGGER:



1. Ground elevation at well: TBD
2. Top of casing elevation: Surface elevation
a) vent hole? well: No
3. Wellhead protection cover type: Surface completion
a) weep hole?: No
b) concrete pad dimensions: 4' x 4'
4. Dia./type of well casing: 3/4' PVC
5. Type/slot size of screen: PVC 0.050" slot
6. Typescreen filter: 8-16 Filter Sand
a) thickness installed
7. Type of seal: Hydrated bentonite chips
a) thickness installed

Development method
Estimated purge volume
Development time

Comments: Borehole drilled to 460 bgs
All depths below ground surface

Well vault will need to be of sufficient size for access to all wells

11 3/4'	0 – 260 ft bgs
9 5/8'	252 – 520 ft

Not to scale

Appendices

Appendix A

NMED Guidance: NMED TPH Guidelines

NEW MEXICO ENVIRONMENT DEPARTMENT TPH SCREENING GUIDELINES
October 2006

In some instances, it may be practical to assess areas of soil contamination that are the result of releases of petroleum products such as jet fuel and diesel, using total petroleum hydrocarbon (TPH) analyses. TPH results may be used to delineate the extent of petroleum-related contamination at these sites and ascertain if the residual level of petroleum products in soil represents an unacceptable risk to future users of the site. Petroleum hydrocarbons represent complex mixtures of compounds, some of which are regulated constituents and some compounds that are not regulated. In addition, the amount and types of the constituent compounds in a petroleum hydrocarbon release differ widely depending on what type of product was spilled and how the spill has weathered. This variability makes it difficult to determine the toxicity of weathered petroleum products in soil solely from TPH results; however, these results can be used to approximate risk in some cases, depending upon the nature of the petroleum product, the release scenario, how well the site has been characterized, and anticipated potential future land uses. In some cases, site clean up cannot be based solely on results of TPH sampling. The New Mexico Environment Department (NMED) will make these determinations on a case by case basis. If NMED determines that additional data are necessary, these TPH guidelines must be used in conjunction with the screening guidelines for individual petroleum-related contaminants in Table 3 and other contaminants, as applicable.

The screening levels for each petroleum carbon range from the Massachusetts Department of Environmental Protection (MADEP) Volatile Petroleum Hydrocarbons/Extractable Petroleum Hydrocarbons (VPH/EPH) approach and the percent composition table below were used to generate screening levels corresponding to total TPH. Except for waste oil, the information in the compositional assumptions table was obtained from the Massachusetts Department of Environmental Protection guidance document *Implementation of the MADEP VPH/EPH Approach* (October 31, 2002). TPH toxicity was based only on the weighted sum of the toxicity of the hydrocarbon fractions listed in Table 1.

Table 1. TPH Compositional Assumptions in Soil

Petroleum Product	C11-C22 Aromatics	C9-C18 Aliphatics	C19-C36 Aliphatics
Diesel #2/ new crankcase oil	60%	40%	0%
#3 and #6 Fuel Oil	70%	30%	0%
Kerosene and jet fuel	30%	70%	0%
Mineral oil dielectric fluid	20%	40%	40%
Unknown oil[a]	100%	0%	0%
Waste Oil[b]	0%	0%	100%

[a] Sites with oil from unknown sources must be tested for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), metals, and polychlorinated biphenyls (PCBs) to determine if other potentially toxic constituents are present. The TPH guidelines in Table 2 are not designed to be protective of exposure to these constituents therefore they must be tested for, and compared to, their individual NMED soil screening guidelines.

[b] Compositional assumption for waste oil developed by NMED is based on review of chromatographs of several types of waste oil. Sites with waste oil must be tested for VOCs, SVOCs, metals, and PCBs to determine if other potentially toxic constituents are present. The TPH guidelines in Table 2 are not designed to be protective of exposure to these constituents therefore they must be tested for, and compared to, their individual NMED soil screening guidelines.

A TPH screening guideline was calculated for each of the types of petroleum product based on the assumed composition from Table 1 for petroleum products and the direct soil standards incorporating ceiling concentrations given in the MADEP VPH/EPH Excel spreadsheet for each of the carbon fractions. Groundwater concentrations are based on the weighted sum of the noncarcinogenic toxicity of the petroleum fractions.

Method 1 from the MADEP VPH/EPH document was applied, which represents generic cleanup standards for soil and groundwater. Method 1 applies if contamination exists in only soil and groundwater. The MADEP VPH/EPH further divides groundwater into standards. Standard GW-1 applies when groundwater may be used for drinking water purposes. GW-1 standards are based upon ingestion and use of groundwater as a potable water supply. The TPH screening guidelines for sites with potable groundwater are presented in Table 2a.

Table 2a. TPH Screening Guidelines for Potable Groundwater (GW-1)

TPH			**Concentration in Groundwater (mg/L)**
Petroleum Product	**Residential Direct Exposure (mg/kg)**	**Industrial Direct Exposure (mg/kg)**	
Diesel #2/crankcase oil	520	1120	1.72
#3 and #6 Fuel Oil	440	890	1.34
Kerosene and jet fuel	760	1810	2.86
Mineral oil dielectric fluid	1440	3040	3.64
Unknown oil[a]	200	200	0.2
Waste Oil[b]	2500	5000	Petroleum-Related Contaminants
Gasoline	Not applicable	Not applicable	Petroleum-Related Contaminants

[a] Sites with oil from unknown sources must be tested for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), metals, and polychlorinated biphenyls (PCBs) to determine if other potentially toxic constituents are present. The TPH guidelines in Table 2 are not designed to be protective of exposure to these constituents therefore they must be tested for, and compared to, their individual NMED soil screening guidelines.

[b] Compositional assumption for waste oil developed by NMED is based on review of chromatographs of several types of waste oil. Sites with waste oil must be tested for VOCs, SVOCs, metals, and PCBs to determine if other potentially toxic constituents are present. The TPH guidelines in Table 2 are not designed to be protective of exposure to these constituents therefore they must be tested for, and compared to, their individual NMED soil screening guidelines.

The second standard is GW-2, which is applicable for sites where the depth to groundwater is less than 15 feet from the ground surface and within 30 feet of an occupied structure. The structure may be either residential or industrial. GW-2 standards are based upon "inhalation exposures that could occur to occupants of the building impacted by volatile compounds, which partition from the groundwater" (MADEP 2001). The GW-2 screening guidelines ONLY apply for the evaluation of inhalation exposures. If potential ingestion or contact with contaminated soil and/or groundwater could occur, then the screening guidelines provided in Table 2.a should be applied. Table 2.b lists the TPH screening guidelines for the inhalation scenario.

Table 2b. TPH Screening Guidelines – Vapor Migration and Inhalation of Groundwater (GW-2)

TPH			Concentration in Groundwater (mg/L)
Petroleum Product	**Residential Direct Exposure (mg/kg)**	**Industrial Direct Exposure (mg/kg)**	
Diesel #2/crankcase oil	880	2200	30.4
#3 and #6 Fuel Oil	860	2150	35.3
Kerosene and jet fuel	940	2350	15.7
Mineral oil dielectric fluid	1560	3400	10.4
Unknown oil [a]	800	2000	50.0
Waste Oil [b]	2500	5000	Petroleum-Related Contaminants
Gasoline	Not applicable	Not applicable	Petroleum-Related Contaminants

[a] Sites with oil from unknown sources must be tested for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), metals, and polychlorinated biphenyls (PCBs) to determine if other potentially toxic constituents are present. The TPH guidelines in Table 2 are not designed to be protective of exposure to these constituents therefore they must be tested for, and compared to, their individual NMED soil screening guidelines.

[b] Compositional assumption for waste oil developed by NMED is based on review of chromatographs of several types of waste oil. Sites with waste oil must be tested for VOCs, SVOCs, metals, and PCBs to determine if other potentially toxic constituents are present. The TPH guidelines in Table 2 are not designed to be protective of exposure to these constituents therefore they must be tested for, and compared to, their individual NMED soil screening guidelines.

Mineral oil based hydraulic fluids can be evaluated for petroleum fraction toxicity using the screening guidelines from Tables 2a and 2b specified for waste oil, because this type of hydraulic fluid is composed of approximately the same range of carbon fractions as waste oil. However, these hydraulic fluids often contain proprietary additives that may be significantly more toxic than the oil itself; these additives must be considered on a site- and product-specific basis (see ATSDR hydraulic fluids profile reference). **Use of alternate screening guideline values requires prior written approval from the New Mexico Environment Department.** TPH screening guidelines in Tables 2a and 2b must be used in conjunction with the screening levels for petroleum-related contaminants given in Table 3 because the TPH screening levels are NOT designed to be protective of exposure to these individual petroleum-related contaminants. Table 3 petroleum-related contaminants screening levels are based on the *NMED Technical Background Document for Development of Soil Screening Levels, Rev 4.0 (June 2006).*

The list of petroleum-related contaminants does not include polyaromatic hydrocarbons (PAHs) with individual screening levels that would exceed the total TPH screening levels (acenaphthene, anthracene, flouranthene, flourene, and pyrene). In addition, these TPH screening guidelines are based solely on human health, not ecological risk considerations, protection of surface water, or potential indoor air impacts from soil vapors. Potential soil vapor impacts to structures or utilities are not addressed by these guidelines. Site-specific investigations for potential soil vapor impacts to structures or utilities must be done to assure that screenings are consistently protective of human health, welfare or use of the property. NMED believes that use of these screening guidelines will allow more efficient screenings of petroleum release sites at sites while protecting human health and the environment. Copies of the references cited below are available on the MADEP website at http://www.state.ma.us/dep/bwsc/vph_eph.htm and the NMED website at http://www.nmenv.state.nm.us/HWB/guidance.html.

Revised Table 3. Petroleum-Related Contaminants Screening Guidelines

Petroleum-Related Contaminants	Values for Direct Exposure to Soil		NMED DAF[a] 20 GW Protection (mg/kg in soil)	NMED DAF[b] 1 GW Protection (mg/kg in soil)
	NMED Residential SSL (mg/kg)	NMED Industrial SSL (mg/kg)		
Benzene	1.03E+01	2.58E+01	2.01E-02	1.00E-03
Toluene	2.52E+02	2.52E+02	2.17E+01	1.08E+00
Ethylbenzene	1.28E+02	1.28E+02	2.02E+01	1.01E+00
Xylenes[c]	8.20E+01	8.20E+01	2.06E+00	1.03E-01
Naphthalene	7.95E+01	3.00E+02	3.94E-01	1.97E-02
2-Methyl naphthalene[d]	5.00E+02	1.00E+03	---[e]	---[e]
Benzo(a)anthracene	6.21E+00	2.34E+01	1.09E+01	5.43E-01
Benzo(b)fluoranthene	6.21E+00	2.34E+01	3.35E+01	1.68E+00
Benzo(k)fluoranthene	6.21E+01	2.34E+02	3.35E+02	1.68E+01
Benzo(a)pyrene	6.21E-01	2.34E+00	2.78E+00	1.39E-01
Chrysene	6.15E+02	2.31E+03	3.48E+02	1.74E+01
Dibenz(a,h)anthracene	6.21E-01	2.34E+00	1.04E+01	5.18E-01
Indeno(1,2,3-c,d)pyrene	6.21E+00	2.34E+01	9.46E+01	4.73E+00

[a] DAF - Dilution Attenuation Factor

[b] For contaminated soil in contact with groundwater.

[c] Based upon total xylenes

[d] No NMED value available, value taken from Massachusetts Contingency Plan, 310 CMR 40.0985, 4/3/06.

[e] No NMED value available and leachability-based value for DAF =1 or 20 not established in the Massachusetts Contingency Plan, 310 CMR 40.0985, 4/3/06.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 1997. Toxicological Profile for Hydraulic fluids.

Massachusetts Department of Environmental Protection, Bureau of Waste Site Cleanup and Office of Research and Standards. 1994. “Background Documentation for the Development of the MCP Numerical Standards.”

Massachusetts Department of Environmental Protection, Bureau of Waste Site Cleanup and Office of Research and Standards. 2002. “Characterizing Risks Posed by Petroleum

Contaminated Sites: Implementation of the MADEP VPH/EPH Approach," Policy, October 31, 2002.

Massachusetts Department of Environmental Protection, Bureau of Waste Site Cleanup and Office of Research and Standards. 2003. "Updated Petroleum Hydrocarbon Fraction Toxicity Values for the VPH/EPH/APH Methodology." November 2003.

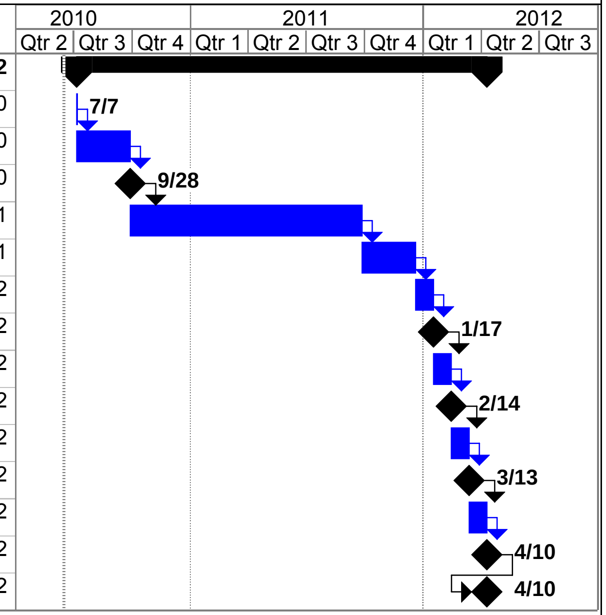
New Mexico Environment Department, Hazardous Waste Bureau and Groundwater Quality Bureau Voluntary Remediation Program. 2006. "Technical Background Document for Development of Soil Screening Levels." June 2006. Revision 4.0.

Appendix B

Project Schedule

Appendix C
Project Schedule

ID	Task Name	Duration	Start	Finish
1	**Compliance Schedule for Groundwater Investigation**	**460 days**	**Wed 7/7/10**	**Tue 4/10/12**
2	Submit Groundwater Investigation Plan to NMED	1 day	Wed 7/7/10	Wed 7/7/10
3	NMED Review/AFCEE Comment Resolution	60 days	Wed 7/7/10	Tue 9/28/10
4	Assumed NMED Approval of Investigation Plan	0 days	Tue 9/28/10	Tue 9/28/10
5	Field Work	260 days	Wed 9/29/10	Tue 9/27/11
6	Report Results of Groundwater Sampling	60 days	Wed 9/28/11	Tue 12/20/11
7	Groundwater Sampling & Analysis 1st Quarter	20 days	Wed 12/21/11	Tue 1/17/12
8	Submit Groundwater Sampling 1st Quarter Report	0 days	Tue 1/17/12	Tue 1/17/12
9	Groundwater Sampling & Analysis 2nd Quarter	20 days	Wed 1/18/12	Tue 2/14/12
10	Submit Groundwater Sampling 2nd Quarter Report	0 days	Tue 2/14/12	Tue 2/14/12
11	Groundwater Sampling & Analysis 3rd Quarter	20 days	Wed 2/15/12	Tue 3/13/12
12	Submit Groundwater Sampling 3rd Quarter Report	0 days	Tue 3/13/12	Tue 3/13/12
13	Groundwater Sampling & Analysis 4th Quarter	20 days	Wed 3/14/12	Tue 4/10/12
14	First Four Quarters Groundwater Sampling & Analysis Complete	0 days	Tue 4/10/12	Tue 4/10/12
15	Submit Groundwater Sampling 4th Quarter Report	0 days	Tue 4/10/12	Tue 4/10/12



Project: App. D GW proj Schedule.mpp
Date: Tue 6/15/10

Task | Milestone | Summary

Appendix C

Preliminary Report Outline

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Appendix D

Base-Wide Plans for Investigation Under the Environmental Restoration Program

KIRTLAND AIR FORCE BASE
ALBUQUERQUE, NEW MEXICO

BASE-WIDE PLANS FOR INVESTIGATIONS UNDER THE ENVIRONMENTAL RESTORATION PROGRAM 2004 UPDATE

APRIL 2004

Prepared For
U.S. ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
OMAHA, NEBRASKA

TERC CONTRACT NO. DACW45-94-D-0003
DELIVERY ORDER 39, WORK AUTHORIZATION DIRECTIVE 7

Prepared By
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ACRONYMS

AFB	Air Force Base
AFCEE	Air Force Center for Environmental Excellence
CRP	Community Relations Plan
ERP	Environmental Restoration Program
EPA	United States Environmental Protection Agency
ft	foot/feet
NMED	New Mexico Environment Department
RAB	Restoration Advisory Board
RCRA	Resource Conservation and Recovery Act
SNL	Sandia National Laboratory
USACE	U.S. Army Corps of Engineers
USAF	U.S. Air Force

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1. INTRODUCTION

Kirtland Air Force Base (AFB) in Albuquerque, New Mexico, instituted a base-wide planning initiative to streamline activities associated with its environmental restoration program in 1996. This revision to the Base-Wide Plans provide updated information on Kirtland AFB key personnel and organizational structure, revisions to site maps and tables, and updated hydrogeological information. The Base-Wide Plans have also been reformatted and new plans will be added to reflect the current stage of the Kirtland AFB Environmental Restoration Program (ERP), including approved plans and procedures to address work involving ordnance and explosives.

1.1 Purpose and Scope

Kirtland AFB has been implementing its environmental restoration program in accordance with requirements set forth by the U.S. Environmental Protection Agency (EPA) and the New Mexico Environment Department (NMED). In October 1990, the EPA issued a Resource Conservation and Recovery Act (RCRA) permit under the Hazardous and Solid Waste Amendments of 1984. This permit expired and a new one will be issued with a consent order. The permit regulates activities related to hazardous substances and generation of hazardous wastes. The focus of the permit is the investigation and restoration of areas believed to be adversely affected by introduced contaminants.

A key component of the activities being targeted is the development of plans that are stipulated within the RCRA permit. These plans encompass the following requirements:

- Project management
- Data collection quality assurance
- Data management
- Health and safety
- Waste management and minimization
- Community relations

Kirtland AFB developed the Base-Wide Plans to address work common to all environmental restoration program activities. The Base-Wide Plans are a reference document for approved procedures to implement project-specific work at Kirtland AFB. These plans will be amended as needed to streamline environmental restoration activities

1.2 Overview of Base-Wide Plans

The Base-Wide Plans establish baseline environmental conditions and accepted procedures to facilitate expedited actions on Kirtland AFB. Baseline conditions represent the current understanding of surface and subsurface environmental features at a given area of concern, including the nature and extent of man-made contaminants. Accepted procedures have been utilized routinely in the past and comply with permit conditions as well as industry standards.

Kirtland AFB will prepare project-specific work plans that address issues of specific interest that could not be included within the broad scope of the Base-Wide Plans. The project-specific work plans will reference the planning documents provided in the Base-Wide Plans. If a project-specific plan requires a procedure that has not yet been developed, the procedure will be presented within the project-specific work plan and amended to the Base-Wide Plans after approval. The environmental conditions and planning documents provided in the Base-Wide Plans will be amended as required to respond to project changes.

The planning documents are provided in the following appendices:

Appendix A Field Sampling Plan

Appendix B Standard Operating Procedures

Appendix C Quality Assurance Project Plan

Appendix D Data Management Plan

Appendix E Investigation Derived Waste Management Plan

Appendix F Base-Wide Health and Safety Plan

Appendix G Construction Quality Assurance/Quality Control Plan

Appendix H Permitting Plan

Appendix I Community Relations Plan (CRP) (To be provided at a later date)

Appendix J Land Use Plan (To be provided at a later date)

Appendix K Document Content and Style guide (To be provided at a later date)

The Base-Wide Plans will be distributed on a controlled basis. Copyholders will receive periodic or as-needed revisions with an accompanying control distribution sheet. The control distribution sheet will specify the old sections to be removed from the binder and the new sections to be incorporated.

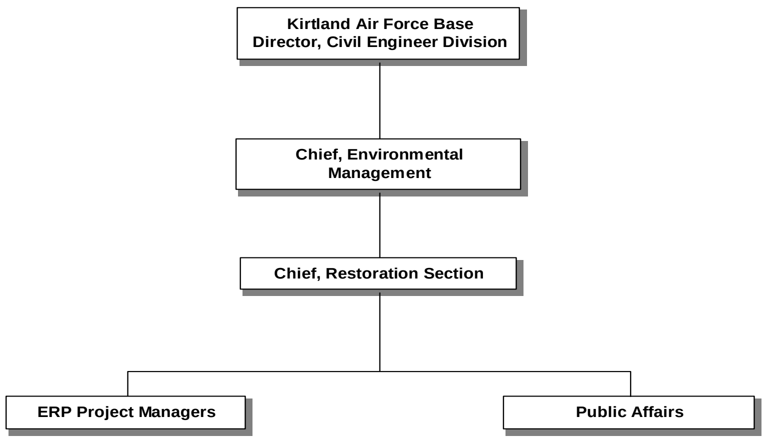
2. PROJECT MANAGEMENT PLAN

The following sections of the Base-Wide Plans provide roles and responsibilities of key project personnel, regulatory coordination, and the management approach to completing projects under the ERP.

2.1 Roles and Responsibilities of Key Personnel

Figure 2-1 depicts the current project organization chart for the ERP at Kirtland AFB. The roles and responsibilities of each team member are as follows.

Figure 2-1. Environmental Management Organization Chart



Mr. Brent Wilson is the Director, Kirtland AFB Civil Engineer Division. In this role, Mr. Wilson is responsible for coordinating all government and contractor civil engineering functions on Kirtland AFB.

Mr. John Poland is the Division Chief for the Environmental Management Branch. In this role, Mr. Poland is responsible for planning and programming all environmental areas, conducting the environmental impact analysis process, and preparing budget submissions for environmental compliance programs, environmental restoration programs, conservation programs, and the pollution prevention program

Mr. Carl Lanz is the Chief of the Restoration Section. In this role, Mr. Lanz is responsible for implementing the base environmental restoration program. He is the Air Force point of contact for all regulatory and technical issues associated with the base environmental restoration program. Mr. Lanz coordinates efforts that involve EPA, the New Mexico Environment Department (NMED), Air Force Center for Environmental Excellence (AFCEE) staff and contractors, as well as U.S. Army Corps of Engineers (USACE) staff and contractors.

Mr. Mark Holmes and Mr. Jerry Sillerud support Mr. Lanz as ERP Project Managers. They are responsible for the day-to-day operations at the Environmental Restoration sites.

Mr. Steve Milligan supports Mr. Lanz as the Public Affairs Specialist for the ERP. Mr. Milligan coordinates all community and public relations, and facilitates the quarterly public meetings.

Personnel descriptions and resumes of key contractors are to be provided in project-specific work plans.

2.2 Regulatory Coordination

Regulatory coordination is the responsibility of Kirtland AFB. Copies of reports, plans, permit applications, design documents, and data summaries will be provided to both EPA and NMED by Kirtland AFB Environmental Restoration staff. Assigned individuals from Kirtland AFB will also coordinate meetings, site visits, and teleconference calls.

2.3 Management Approach

The management approach to completing investigations and corrective measures under the ERP involves the use of contractors for technical assistance and field implementation with federal government oversight. As discussed in section 2.1, Environmental Restoration personnel have access to contractors using funding mechanisms through government clients.

2.3.1 Execution of Project-Specific Planning and Work Plan Development

Project-specific work plans will be prepared as addenda to the volumes contained within the Base-Wide Plans. Only the sections that are pertinent to planned activities will be referenced within the project-specific plans. Sections within the Base-Wide Plans that are not appropriate for planned activities will not be referenced within the project-specific plans. If a section within a project-specific plan references the Base-Wide Plan and contains a deviation from the Base-Wide Plans, the deviation will be identified and proper justification will be provided. The Base-Wide Plans may be amended to incorporate the deviation if it is determined to be significant and affects site operations throughout the base.

Minimum elements of a project-specific work plan for investigations include the following (EPA, 1994):

- Purpose/Objectives
- Project Management
- Data Collection/Quality Assurance
- Data Management and Reporting
- Health and Safety Plan
- Public Involvement Plan
- Schedule for Facility Completion
- Waste Management and Minimization

Minimum elements of a project-specific work plan for corrective action activities include the following (EPA, 1994):

- Introduction/Purpose
- Project Management
- Project Schedule
- Corrective Action Quality Assurance/Quality Control Programs

- Waste Management Procedures
- Sampling and Analysis
- Corrective Action Contingency Procedures
- Corrective Action Safety Procedures
- Documentation Requirements
- Cost Estimate

Additional items may be required by the respective contract or delivery order.

2.3.2 Project Schedules

Project schedules will be developed on a project-specific basis and incorporated into project-specific work plans. Schedules will be prepared utilizing a critical path method. Major project activities and milestone critical paths will be identified along with their associated project duration.

2.3.3 Project Submittals

All submittals will be prepared in accordance with the Kirtland AFB Restoration Branch, Document Style Guide (USAF, 1997). Document content will be dictated by contractual requirements (e.g., AFCEE or USACE requirements). The number of submittals should be coordinated with the individual Remedial Project Managers prior to delivery. Kirtland AFB will provide submittals to regulatory agencies for review. The regulatory agencies include EPA and NMED; however, some local agencies affiliated with Bernalillo County and the city of Albuquerque may also be included on the submittal distribution list. In addition, other parties listed in the CRP distribution list may receive submittals for review according to their agreements with Kirtland AFB.

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3. BASELINE ENVIRONMENTAL CONDITIONS

This section provides a description and maps of Kirtland AFB baseline environmental conditions of meteorology, geology, and hydrogeology at Kirtland AFB for use and reference in project-specific work plans.

3.1 Kirtland AFB Description

Kirtland AFB is located southeast of Albuquerque, New Mexico, adjacent to and east of the Albuquerque International Airport. The base is within Bernalillo County and has a total area of 52,287 acres. Figure 3-1 depicts the base and its surrounding areas.

Kirtland AFB is bounded on the east by the Cibola National Forest, on the south by the Isleta Indian Reservation, and to the north and west by the city of Albuquerque. The Isleta Indian Reservation land adjacent to the southern boundary of the base is undeveloped. Another undeveloped parcel of land (approximately 11,500 acres) owned by the state of New Mexico lies adjacent to the western border of the southern portion of the base.

The mission of Kirtland AFB is diverse and encompasses facets of aviation training, academics, technical training, supply depot, defense-readiness flying, and research and development. Waste generation has resulted from petroleum, oils, and lubricants, solvents, and other materials, including radioisotopes used to support these base missions. Table 3-1 provides a summary of historical operations at Kirtland AFB and activities that have used or generated hazardous substances. Figure 3-2 shows the current ERP sites at Kirtland AFB.

3.1.1 Meteorology

The climate of Kirtland AFB and the surrounding vicinity is classified as "arid continental." The mean annual precipitation is 8.4 inches and the mean annual snowfall is 1.25 inches. The average monthly precipitation in the Albuquerque area varies from less than 1 inch (November through March) to over 1.25 inches in July and August. Winters are typically dry with monthly snowfalls seldom exceeding 3 inches. Snow generally melts within 24 hours outside of the mountain areas. Typically, summer rains in the form of brief but locally heavy thunderstorms account for almost half of the annual moisture. Potential evapotranspiration (evaporation occurring when no soil-water deficit exists) for the Albuquerque area is 30.9 inches. Actual evapotranspiration has been determined to be about 95 percent of precipitation in the climatic regime, with the remaining five percent divided equally between runoff and recharge.

Meteorological data collected at the Albuquerque International Airport show that the prevailing wind direction from May through October is south or southeast and the mean wind speed is seven to nine knots. From November through April the prevailing wind direction is north or northeast and the mean wind speed is 6 to 9 knots.

Flooding is not a common occurrence at Kirtland AFB; however, localized flooding may occur for brief periods where surface drainage is confined within erosional features such as arroyos.

3.1.2 Geology

The geology of the Kirtland AFB area is complex and varied based on the regional geology. The eastern portion of the base is mountainous with elevations reaching 7,900 feet (ft). These mountains are partially composed of Precambrian crystalline and Paleozoic marine carbonate rock. The western portion of the base lies within the Albuquerque-Belen Basin. Geologic features in this area of the basin include travertine and unconsolidated and semi-consolidated pediment deposits; and aeolian, lacustrine, and stream channel deposits. In general, the surficial geology is characterized by recent deposits (i.e., mixtures of sandy silt and silty sand with minor amounts of clay and gravel), Ortiz gravel (i.e., alluvial pediment sand and gravel deposits), and the Santa Fe Group (i.e., a mixture of sand, silt, clay, gravel, cobbles, and boulders). A geologic map of Kirtland AFB and the surrounding area is depicted in Figure 3-3.

Generally, unconsolidated geologic units dominate the northern and western portions of Kirtland AFB; consolidated units predominate in the eastern half of the base.

Kirtland AFB lies within the eastern portion of the Albuquerque-Belen structural basin that contains the through-flowing Rio Grande river. The basin is approximately 90 miles long and 30 miles wide. The deposits within the Albuquerque-Belen Basin consist of interbedded gravel, sand, silt, and clay. The thickness of basin-fill deposits in most of the basin is greater than 3,000 ft, although the thickness varies considerably because of the large amount of faulting in the basin.

The geologic materials of primary importance within the basin are the Santa Fe Group and the piedmont slope deposits. The Santa Fe Group is comprised of beds of unconsolidated to loosely consolidated sediments and interbedded volcanic rocks. The materials range from boulders to clay and from well-sorted stream channel deposits to poorly sorted slopewash deposits. Coalescing alluvial fans of eroded materials from the surrounding mountains were deposited unconformably over the Santa Fe Group, extending westward from the base of the Sandia and Manzano Mountains to the eastern edge of the Rio Grande floodplain. The fan sediments range from poorly sorted mudflow material to well-sorted stream gravel, and the beds consist of channel fill and interchannel deposits. The fan deposits range in thickness from 0 to 200 ft and thicken toward the mountains.

Kirtland AFB is located near the western edge of the Manzaño uplift, near a zone of pervasive faulting at the uplift margin. This fault zone is approximately 35 miles long and 2 miles wide. The Hubbell Springs fault exhibits outstanding fault scarps in the area. The Hubbell Springs fault is significant due to its apparent control over groundwater movement. It has been reported that east of the fault, depths to groundwater are generally less than 100 ft. Springs have been observed along the fault alignment. West of the Hubbell Springs fault, depths to groundwater abruptly increase to 400 ft to 500 ft below the ground surface.

Surface soils consist predominantly of well-drained gravelly sands containing varying amounts of silts and clays. The following associations and their geologic attributes have been mapped within Kirtland AFB:

- Deep Soils on Flood Plains and Dissected Terraces

  — Gila-Vinton-Brazito Association, consisting of well-drained loamy soils

  — Bluepoint-Kokan Association, which consists of sandy, gravelly soils

Figure 3-1. Kirtland AFB Location Map

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Table 3-1. History of Base Operations at Kirtland AFB

Period	Types of Operations	Aircraft	Chemical Use Activities
Pre-1928	Rangeland	None	None
1928-1930	Construction of Oxnard Field	None	Construction
1930-1939	Refueling/maintenance stop, Airfield expansion	Miscellaneous Bomber Aircraft	Fuel/oil storage, Construction/demolition
1939-1941	Aircraft mechanic training	Keystone LB-7 Bombers	Fuel/oil storage
1941	Construction of Army Air Base	LB-7 Bombers	Construction/demolition
1941-1944	Training of signal, ordnance, medical, chemical warfare units; flight training school; aircraft mechanic training	Boeing 307 Stratoliners, Beechcraft AT-11s; LB-7, B-17, B-18, B-24 Bombers	Construction/demolition, fuel/oil storage, weapons storage, bombing runs, landfills
1944-1948	Training activities, support for B-29 bombers, aircraft salvage and scrapping, construction of Sandia Base, Armed Forces Special Weapons Project	LB-7, Boeing 307 Stratoliners, Beechcraft AT-11s, B-17s, B-18As, B-29 Bombers, ordnance, Curtis P-40s, Bell P-39s, P-47 Thunderbolts, P-51 Mustangs	Fuel/oil storage, weapons storage, weapons handling, metal smelting, disposal of chemical wastes, landfills, sewage treatment, construction/ demolition, explosives and weapons handling and storage
1949-1959	Sandia Base operated by Western Electric for the atomic Energy commission (AEC), Site Able/Manzano Base operated by Armed Forces Special Weapons Project	B-45, B-47, Martin B-57, Convair F-102, B-52	Engineering and development of weapons, explosives testing, weapons storage, fire training, equipment maintenance, landfills, low-level radioactive waste disposal, radiation testing, sewage treatment, design/development of weapons and new ordnance components, explosives testing, field testing for component survivability, pesticide usage
1960-1976	Research and Development		Storage, development, and testing of weapons systems; support to tenant units including DOE; pesticide usage; landfills; low-level radioactive waste disposal; radiation training; fire training, sewage treatment; EOD; explosives testing
1976-1984	1550th Aircrew Training and Testing Wing (ATTW) of MAC Aerospace Rescue and Recovery Service, 1606th Air Base Wing, Research and Development	UH-1, H-3E, CH53, HH-53, HC-13H, HC-130P, TH-1F, MH-53, H-60, MH-60G, UH-60A, UH-60L	Fuel/oil storage; equipment maintenance; fire training; landfills, low-level radioactive waste disposal; radiation training; EOD, pesticide usage; explosives testing
1984-1994	1550th Combat Crew Training Wing, 1606th Air Base Wing, 377th Air Base Wing, 542nd Crew Training Wing	UH-1, H-3E, CH53, HH-53, HC-13H, HC-130P, TH-1F, MH-53, H-60, MH-60G, UH-60A, UH-60L	Fuel/oil storage; equipment maintenance; fire training; landfills; radiation training; EOD; pesticide usage; explosives testing
1994-present	377th Air Base Wing, 58th Special Operations Wing	C-12, UH-1H, UH-1N, MH-53A, MH-53J, HC-130, MC-130P, MC-130H, HH-60G	Fuel/oil storage; equipment maintenance; fire training; landfills; radiation training; EOD; pesticide usage; explosives testing

AEC Atomic Energy Commission
ATTW Aircrew Training and Testing Wing
DOE Department of Energy
EOD Explosive Ordnance Disposal
N/A Not applicable

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Figure 3-2. Location of Environmental Restoration Program Sites

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Figure 3-3. Geologic Map of Albuquerque Area

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- Deep Soils on Alluvial Fans, Mesas, and Piedmonts

  — Madurez-Wink Association, which consists of well-drained loamy soils

  — Tijeras-Embudo Association, which consists of well-drained loamy, gravelly soils

- Shallow to Deep Soils on Mountains and Foot Slopes

  — Seis-Orthids Association, consisting of loamy, stony, cobbly soils

  — Kolob-Rock Outcrop Association, consisting of loamy, stony soils and rock

3.1.3 Hydrogeology

The groundwater system at Kirtland AFB and in the Albuquerque area lies within the Albuquerque-Belen Basin, which is also referred to as the Middle Rio Grande Basin. The basin is part of the Rio Grande Rift. As the Rio Grande Rift spread, the Albuquerque Basin filled with sediments several miles thick, most of which is referred to as the Santa Fe Group. The unit consists of unconsolidated sediments, which thin toward the basin boundary. Edges of the basin are marked by normal faults. Overlying the Santa Fe Group are the Pliocene Ortiz gravel and Rio Grande fluvial deposits (SNL, 2002).

Generally, the upper unit of the Santa Fe Group contains the most productive portion of the regional aquifer that supplies groundwater to the city of Albuquerque and Kirtland AFB. The unit is characterized by piedmont slope, river, and flood plain deposits. The ancestral Rio Grande formed a large agradational plain in the central basin, depositing a mix of coarse- to fine-grained sands, silts, and clays with variable bed thickness (SNL, 2002).

The groundwater investigations at Kirtland AFB indicate that there is a regional aquifer at a depth of approximately 500 ft below ground surface, and there are multiple shallow zones of perched water, which may not be continuous, present at approximately 300 to 400 ft below ground surface.

The shallow system is defined as a saturated zone above the regional water table and separated from the regional aquifer by an unsaturated interval. This shallow groundwater system is present over an area that extends south to the Kirtland AFB Golf Course, north to SNL Tech Area I, to the west of Tech Area II, and to the east of LF-008 (SNL, 2002) as shown in Figure 3-4. Lithology and water chemistry information indicated that the perched aquifer might be comprised of smaller, more discontinuous sand channels, whereas the regional unit is a larger, more consistent sand layer. At LF-008, where five wells have been completed in the perched aquifer, the perched system consists of multiple zones of saturation and ranges up to a thickness of 125 ft. The thick zone of saturation is probably the result of recharge from the Tijeras Arroyo.

Historically, water in the regional aquifer has flowed from the basin margins toward the Rio Grande. Currently, heavy pumping by Kirtland AFB and the city of Albuquerque has formed a depression, directing water toward the northwestern portion of the base. Flow directions observed within the regional aquifer at Kirtland AFB confirm these general flow directions. Water in the regional aquifer converges in the northwestern portion of the base between LTM sites LF-008 and the Sewage Lagoons. In the southern portion of the site, groundwater flows to the west from the Manzano uplift, and from the south into the central portion of the base. Groundwater flow directions at LTM program sites are shown on Plate 1.

3.1.4 Geochemical Trends in the Regional Aquifer

Several water types are present in the Albuquerque Basin (Plummer et al., 2000, Section C) that represent different sources of recharge to the basin including those from the Rio Grande, Tijeras Arroyo, Tijeras Fault zone, and Eastern Mountain Front. General characteristics of these waters were described in the study. Recharge from the Eastern Mountain Front occurs along the entire mountain front of the basin. This water type is characterized by relatively low specific conductance and chloride and is a calcium-sodium-bicarbonate (Ca-Na-HCO_3) type. Groundwater from crystalline rocks of the Tijeras Fault zone has mixed with water from the Eastern Mountain Front, resulting in groundwater with high conductance, chloride, and bicarbonate. Along the Tijeras Arroyo, groundwater is characterized by high conductance, sulfate, and nitrate and is a calcium-bicarbonate type. Waters influenced by recharge from the Rio Grande are generally higher in silica and potassium, with calcium elevated related to sodium.

The evaluation of regional groundwater at Kirtland AFB demonstrates that two main water types are present, indicating different water sources. The major distinction observed at the sites is that groundwater in the southeastern portion of the base, including Manzano Landfill (LF-020) and Lake Christian (OT-046), has a stronger sulfate and higher chloride signature, and is present at elevations 300 to 600 ft higher than the other regional groundwater at the base. Groundwater in the central portion of the base, including Landfill 2 (LF-002), Landfills 4, 5, and 6 (LF-008), Tijeras Arroyo, SWMU 8-28 (ST-250), and McCormick Ranch/Range (OT-028), have very similar water types and groundwater flow directions indicate that the aquifer is continuous from the southern and eastern areas into the central portion of Kirtland AFB. The groundwater in this area is generally dominated by calcium and bicarbonate. The Golf Course Main Pond wells (KAFB-0608, KAFB-0609, and KAFB-0610) appear to indicate transitional groundwater is present, with sulfate concentrations that are intermediate between groundwater in the uplifted area and groundwater typical of the central portion of the base. The well at Radioactive Burial Site 11 (RW-06), KAFB-6301, has a stronger bicarbonate signature than others in this transitional region. Groundwater in the northwestern portion of the base (Landfill 1 [LF-001], Fire Training Area [FT-13], and Building 1033 [ST-341]) is similar to the groundwater in the central portion, but has slightly higher sodium/calcium ratios. Groundwater in the northwestern portion of the base generally flows to the north and east, converging with the groundwater from the south and west in the north-central portion of the base. The chemical composition of groundwater in well KAFB-8351 at SWMU 8-35 (ST-214) does not fit into the chemical and geographic pattern observed in the other wells, and may represent a different water source.

Concentrations of iron, selenium, dissolved solids, and nitrate nitrogen have been elevated in some wells at Kirtland AFB over the last few sampling events. Many of these detections can be explained in the context of sitewide and basinwide water quality trends (iron, selenium, and nitrate nitrogen). Water quality in the Albuquerque Basin has been degraded from the combined effects of decreasing water levels and increasing development. Low water conditions associated with less recharge and slower circulation in aquifer formations have been shown to result in groundwater with higher concentrations of dissolved solids (Hem, 1989). Elevated nitrate concentrations have been identified in the basin that is the result of increasing numbers of septic systems.

The quality of groundwater in the Albuquerque Basin is influenced by the effects of excess irrigation waters mixing with groundwater in the aquifer, in some cases resulting in higher dissolved solids concentrations (United States Geological Survey [USGS, 2000]). Sources of lower quality water in the basin include septic systems, residual minerals from evapotranspiration, urban runoff, and application of agricultural chemicals. Nitrates are of particular concern in the Albuquerque area as evidenced by a large zone of nitrate contamination along the Rio Grande flood plain near Albuquerque; nitrate concentrations have doubled and tripled between 1977 and 1990 from use of septic tanks. In some areas, the high nitrate levels have resulted in zones of low oxygen in the groundwater. Nitrates are consistently detected in groundwater samples collected from monitoring wells on Kirtland AFB and will continue to be monitored as part of current projects. The nitrate contamination on the base could potentially be flowing into the groundwater at the depression area in the northwestern portion of the base. Heavy pumping of the groundwater by Kirtland AFB and the city of Albuquerque has caused this depression. The USGS has also identified exceedances of drinking water standards for dissolved solids, sulfate, chloride, iron, and manganese in eastern Bernalillo County. Concentrations of these constituents increased significantly during the 1990s as water levels in the area dropped (USGS, 1996). A major source of dissolved solids in the basin is reported to be calcite, gypsum, and halite in the basin fill sediments (Houser, 1999). A study of water in the Tijeras Arroyo indicated that dissolved solids often exceeded 500 mg/L (Thomas, 1995).

In a description of aquifers found in sediments that are generally resistant to weathering (resistate aquifers), Hem (1989) describes waters in the Santa Fe Formation of the Albuquerque Basin. Some of the waters from this formation have very low solids content resulting from interaction with silica-rich igneous rocks; however, the major ion concentrations found in many of the Kirtland AFB wells, particularly the perched aquifer, may represent waters that come from an aquifer with sluggish circulation due to the decreasing water volumes, as evidenced by the lowering of water levels in these units. In these waters, flushing of solutes is retarded, resulting in higher concentrations of major ions and probably trace metals.

Elevated iron concentrations have been reported in groundwater from the Santa Fe Group in the Albuquerque area (Plummer, et al., Section R). Based on sequential extraction analyses, it is reported that iron arises from geochemical exchange with the aquifer rock materials. Sediments from three wells in the Santa Fe Group were exposed to various reagents to mimic weathering in order to estimate water-soluble, ligand- or anion-exchangeable fractions, and those less-mobile fractions from metal oxides, sulfide, and organic complexes, and silicates. The iron was primarily found in metal oxides and silicates. In contrast, iron from the lower Kachina Formation was primarily found in sulfide minerals.

Elevated concentrations of selenium have been detected in the groundwater underlying Kirtland AFB. Selenium has been studied extensively in the Central Valley of California and other arid environments similar to the Albuquerque Basin where high volumes of irrigation water are used. Selenium has been shown to mobilize from evaporite minerals resulting in high concentrations in irrigation return flows. Selenium is not attenuated by the physical, chemical, and biological properties of the soil like other minerals in agricultural settings (Allen, Perdue, and Brown, 1993, p. 338).

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Figure 3-4. Extent of Perched Groundwater System

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APPENDIX A

Field Sampling Plan

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TABLES

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ACRONYMS

°C	degrees Celsius
AFB	Air Force Base
AFCEE	Air Force Center for Environmental Excellence
BWP	Base-Wide Plan
BWHSP	Base-Wide Health and Safety Plan
COC	Chain-of-Custody
DCQAP	Data Collection Quality Assurance Plan
DPT	Direct-Push Technology
DQO	Data Quality Objectives
EOD	Explosives Ordnance Disposal
EPA	U.S. Environmental Protection Agency
ERP	Environmental Restoration Program
ft	feet
FSP	Field Sampling Plan
IRP	Installation Restoration Program
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
QC	Quality Control
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
SOP	Standard Operating Procedure
SSHP	Site-Specific Safety and Health Plan
SWMU	Solid Waste Management Unit
USACE	U.S. Army Corp of Engineers
USAF	U.S. Air Force
UST	Underground Storage Tank
VOC	Volatile Organic Compound

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1. INTRODUCTION

This Base-Wide Field Sampling Plan (FSP) has been prepared as part of the Kirtland Air Force Base (AFB) Base-Wide Plan (BWP) required to support environmental restoration activities at Kirtland AFB in Albuquerque, New Mexico. This appendix was previously included as part of the Data Collection Quality Assurance Plan (DCQAP), Volume II of the BWP as Part I of the DCQAP.

Environmental restoration activities at Kirtland AFB include:

- Resource Conservation and Recovery Act (RCRA) facility investigations (RFIs)
- Solid Waste Management Unit assessments
- Risk assessments
- Corrective measures studies
- Corrective actions
- Monitoring of natural systems and treatment operations
- Other site investigations and associated work efforts

This FSP has been prepared in accordance with the requirements and guidelines for data collection activities established by the U.S. Environmental Protection Agency (EPA), the U.S. Army Corps of Engineers (USACE), Air Force Center for Environmental Excellence (AFCEE) and the U.S. Air Force (USAF).

1.1 Purpose and Scope

The purpose of this Base-Wide FSP is to provide a comprehensive set of strategies for conducting the field sampling operations that are integral to the performance of a variety of environmental restoration activities. This FSP provides the framework and the criteria for establishing project specific FSPs, which will be issued as addenda to this document.

The extent to which this Base-Wide FSP will apply to the project-specific FSPs, either wholly or in part, will depend upon the nature and scope of the individual projects. The specific project requirements will be addressed in the project-specific addenda. Detailed Standard Operating Procedures (SOPs) for all tasks necessary to complete field investigations are provided in Appendix B of the BWP. During the course of these projects, new or different procedures may be incorporated. Any such changes or additions will be described in both the Base-Wide and project-specific FSPs in the form of revisions or addenda, following approval by Kirtland AFB, AFCEE (as appropriate), USACE (as appropriate), and the regulatory agencies.

1.2 Organization of Field Sampling Plan

The FSP includes discussions related to site background information, sampling procedures, and management of field operations. The FSP is organized as follows:

- Section 1.0—Overview of the FSP
- Section 2.0—Field investigation objectives
- Section 3.0—Address the design of data collection operations
- Section 4.0—Sampling equipment description and associated quality control (QC) procedures for a wide variety of field activities
- Section 5.0—Summary of the methods to be utilized for making field measurements
- Section 6.0—Sample handling and analysis requirements
- Section 7.0—Overview of field quality assurance/quality control (QA/QC) procedures.
- Section 8.0—Summary of site management and record-keeping requirements
- References

2. FIELD SAMPLING OBJECTIVES

Several field investigations and corrective actions have taken place at Environmental Restoration Program (ERP) sites and non-ERP sites at Kirtland AFB. For all future investigations and corrective actions, the FSP should be consulted for developing project-specific FSP addenda that will be included in the project-specific work plan. For most projects, detailed sampling programs are required to meet project objectives associated with field investigations and corrective actions.

The objective of sampling programs is to generate analytical and test data that support:

- Defining the nature and extent of contamination in accordance with regulatory requirements
- Collecting data that is of sufficient quality for evaluating risk to human health and the environment
- Complying with federal, state, and local regulatory agency requirements for material collection, treatment, discharge, transport, storage, and containment activities
- Performing corrective action activities in a safe manner
- Meeting performance criteria of systems and components
- Implementing corrective action technologies, methods, and processes (both proven and innovative) in a controlled manner
- Achieving remediation goals
- Monitoring and evaluating process conditions to assess the progress of corrective and remedial actions

Project-specific sampling objectives will be established and documented within project-specific addenda to the component of the BWP. The samples collected during site investigation and remedial activities may include soil (surface and subsurface), sediment, groundwater, surface water, waste materials, leachate, soil gas, ambient air, and discharge and effluent materials.

The analytical and test data required to support the sampling objectives will be determined during project scoping activities. The following should be considered when establishing project-specific sampling objectives:

- Anticipated/intended uses for analytical and test data
- Sampling design and rationale
- Type, location, and frequency of samples
- Regulatory requirements

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3. DESIGN OF DATA COLLECTION OPERATIONS

3.1 Sample Location and Frequency

The location and frequency of samples collected will be representative of the media sampled and apply to the intended data use. Maps showing intended sampling locations will be included as figures in the project-specific FSPs. The rationale for selecting these sampling locations will be documented in the project-specific addenda. In general, this rationale will include a review of existing and historical information about the sites or any activities which have occurred on the site. This information may include interviews, literature searches, aerial photographs, etc. which will help target suspected areas of contamination. Suspect areas will be the focus of additional investigations as warranted by the site histories and may include radiological surveys, soil gas surveys, and geophysical surveys. These extrusive surveys will further narrow the suspect areas and suggest areas to concentrate the intrusive activities such as soil sampling and groundwater sampling. Downgradient receptors locations such as arroyos and wells will be identified.

Information obtained from the extrusive activities and the site's physical environmental setting will assist in choosing the sample locations and the number of samples to be collected. The number of samples collected may also be supported by statistical calculations, as appropriate. The location, number, and description of stations sampled will be provided according to the needs of a specific project. The selection of background locations will be based on visual observation, knowledge of past activities, and results from other studies and projects. Similarly, locations for field monitoring and field screening analysis will be developed.

The selection of locations and frequency of samples that will be collected for an initial, or Phase I, site investigation can be planned after the following activities have been completed:

- Collect and review existing information such as site history and waste disposal practices
- Formulate the site conceptual model

The site history and waste disposal practices of the site will be researched by using available historical documents, waste management records, previous investigations, and interviews to establish an accurate picture of the past site activities. The preliminary data collection and review will help to formulate a site conceptual model. If a Phase II program is to be implemented, information available from the Phase I program must be taken into consideration before sampling can take place. Table 3-1 presents the activities associated with site investigations. These activities are listed in the order that they must occur to fully characterize a site based on an initial Phase I investigation and any necessary subsequent investigations.

A site conceptual model should include the following items which are required to develop a site-specific sampling strategy:

- Identification of potential contaminants at the site
- Identification of media affected by direct release of contaminants
- Evaluation of media potentially affected by current transport of contaminants

Table 3-1. Activities Associated with Site Investigations

Investigation Activities	Activity Elements	Key Points and References
Collection and review of existing information	Compile site history	Research facility historical records (3,6)
	Research environmental setting	Use previous investigations and documents available through libraries and data repositories (3,6)
	Identify potential contaminants	Refer to facility waste management records (3,6)
	Determine current and historical contaminant releases	Refer to facility waste management records (3,6)
Formulate site conceptual model	Identify media affected by direct release of contaminants	Locate point of release [typically soil (e.g., surface spill, leaking UST)] (3,6,9,12)
	Evaluate media potentially affected by current transport of contaminants	Determine effect of environmental conditions on deeper soil, groundwater, surface water, and air within or downgradient of study area (1,3,6,9,12)
	Determine media possibly affected by future transport outside of study area	Determine effect of environmental conditions on deeper soil, groundwater, surface water, and air within or downgradient of study area Use transport models if applicable (6,9,12)
Plan initial field sampling program	Establish program objectives	Characterize site contamination through implementation of a work plan (4,6,7)
	Define study and background areas	Evaluate the site conceptual model (3,4,6,7)
	Determine media to be sampled	Evaluate the site conceptual model (3,4,6,7)
	Plan sampling methods	Refer to EPA and other regulatory documents for most effective sampling methods (1,4,11,12)
	Establish sampling locations and frequency	Refer to EPA and other regulatory guidance for appropriateness and applicability in using statistical methods to determine sample size and locations (3,4,6,7,11,12,13)
	Define the analytical program	Establish potential contaminants of concern based on site activities and release(s) (3,6,7)
	Establish QA/QC objectives and procedures	Refer to EPA and other regulatory guidance for establishing Data Quality Objectives (DQOs) and procedures (3,4,6,7,11,12)
Conduct initial field data collection program	Employ field screening techniques	Refer to EPA guidance on soil gas, direct push sampling, and use of on-site analyses (11,12)
	Conduct initial sampling	Institute EPA, regulatory, and client-specific protocol and procedures (1,11,12)
	Collect environmental data	Include hydrogeological, geological, and geotechnical information, as well as climatological data (3,6,7)
	Analyze samples for selected constituents	Use EPA or client-specified laboratory and analytical protocol (2)

Table 3-1. Activities Associated with RCRA Facility Investigations (Concluded)

Investigation Activities	Activity Elements	Key Points and References
Evaluate data and report results	Compare analytical results to appropriate background conditions	Determine presence of site contamination with reference to background (1,5,6,7,10,11,13)
	Evaluate potential for intermedia contaminant transport	Determine effects of environmental conditions on deeper soil, groundwater, surface water, and air within or downgradient of study area Use transport models if applicable (1,9,12)
	Characterize site conditions and assess contaminant distribution	Evaluate site contamination by using statistics, kriging, creating plume maps, and graphics useful for interpretation. Appropriateness and applicability of software usage should be in line with EPA and regulatory guidelines. (3,5,9,10,11,12,13)
	Compare results to health and environmental criteria	Conduct a baseline risk assessment following EPA and regulatory guidance (7)
	Present and summarize results in a factual manner	Produce a Phase I RFI report (6)
Determine data gaps	Evaluate need to collect additional samples within study area	Characterize additional potential sources within a study area (3,6)
	Evaluate need to collect additional samples outside of study area	Characterize the potential for contaminant migration outside or downgradient of the study area (1,9,12)
	Add or delete constituents of concern	Evaluate whether analytes from Phase I should still be considered contaminants of concern, or should be removed from the program analyte list. (3,6)
Conduct a subsequent data collection program based on data needs identified in the initial phase	Collect additional samples	Institute EPA, regulatory, and client-specific protocol and procedures (1,11,12)
	Analyze samples for selected constituents	Use EPA or client-specified laboratory and analytical protocol (2)
	Evaluate data and report results	Produce a site investigation or RFI report (6)

NOTE: References for Table 3-1 are located in the References section. The number indicating the appropriate reference is located at the end of the citation.

- Determination of media that could be affected in the future by downgradient or offsite contaminant migration

If the site conceptual model lacks any information necessary to accurately define site contamination, statistical procedures will be used to determine sample locations and frequency. Guidance used to develop statistical sampling plans will come from the following documents:

- Preparation of Soil Sampling Protocols: Sampling Techniques and Strategies (EPA, 1992)

- Statistical Methods for Environmental Pollution Monitoring (Gilbert, 1987)

3.1.1 Determination of Sample Frequency

It is important when, evaluating analytical data using statistics, to have a number of measurements to generate meaningful and defensible results. Thus, the frequency of samples collected during a field program must support the program Data Quality Objectives (DQOs) for precision and accuracy. Methods prescribed by EPA (1992) and Gilbert (1987) can be used to determine an adequate population size such that an estimated mean of the population achieves a prespecified accuracy with respect to program DQOs. These methods assume that data are uncorrelated over any period of time or where the distance between data points is sufficiently large and data are normally distributed. All of these methods specify at least one statistical variable that is either estimated based on pre-existing data or data from an area geochemically similar to the study area, or is estimated based on professional judgment. It is preferable to use pre-existing or similar data if they are available.

3.1.2 Determination of Sample Locations

Sample locations can be determined for sites where there is a lack of information in the site conceptual model. If source areas or the extent of contamination within a site are not known, statistical techniques will be used to determine sample locations. Statistical calculations for these sample location determination methods are expressed as functions of probability and the size of the site. These two factors will be taken into account when evaluating and implementing the appropriate statistically-based sampling approach. These statistical sampling approaches include:

- ***Simple random sampling***—This approach is appropriate where there is inadequate information on the possible nature and extent of contamination to develop a site conceptual model.

- ***Stratified random sampling***—This approach takes into account environmental factors and contaminant physical characteristics to increase data precision while controlling sources of variation. This sampling technique takes into account the lateral and vertical nonhomogeneity of the environmental media of interest.

- ***Systematic sampling***—This approach attempts to provide a better coverage from samples collected in a regular pattern, such as a grid. Where geostatistical techniques will be used to interpret data, systematic sampling is strongly recommended.

- ***Search sampling***—This approach determines sampling of contaminant point sources ('hot spots') within a site. The size of the point source and the size of the study area are taken into account to define a grid spacing that will sample the 'hot spot' based on a specified probability. This technique can be used in areas where point-source contamination is probable.

3.2 Sample Designation

3.2.1 Kirtland AFB Site Samples

An established numbering system will be used for designating samples collected during restoration activities. The numbering system will consist of an alpha-numeric code which will identify the sampling site, media, location, sampling event, and contain a sequential sample number.

The following is a general guide for sample designation:

AAXX	**AA**	**NN**	**XX**
Sampling Site Code	Media Type	Specific Location	Sample Depth or Other Identifier

Symbol Definition:

A = Alphabetic
N = Numeric
X = Alphabetic or Numeric

Example Scenario: The following presents example codes that may be used on the project. Specific codes will be defined in project-specific addenda.

- Sampling Site Code: This code defines the site within Kirtland AFB. Examples include:

  —LF01 = Landfill No. 1

  —RW-04 = Radioactive Burial No. 4

  —FT-13 = Kirtland AFB Fire Training Area

  —WP-16 = Manzaño Sewage Treatment Facility

- Media Type Code: This code identifies the source/media of the sample.

  —SS = Surface Soil

  —SB = Subsurface Soil

  —GW = Ground Water

  —TB = Trip Blank

  —FB = Field Blank

  —AR = Air Sample

  —EB = Equipment Blank

- Specific Location Code: This code identifies the location of the source/media.

  —01 = Location No. 1

  —99 = Location No. 99

- Sampling depth or other identifier: This code determines the depth or other parameters specific to a particular sample.

  —0218 = Well KAFB-0218 (for wells)

  —02 = 2-to-4-ft depth interval (for soil)

For example, the first sample obtained from subsurface soil Location 3 at a depth of 2 to 4 ft depth from Landfill No. 1 will be identified as LF01SB0302. If a particular code in the numbering system is not used or not applicable, then it will be replaced with a zero or a project-specific code will be defined. For the case of duplicates or split samples, an additional pair of numbers will be added onto the end of the sample ID signifying the number sample obtained from that location. For example, adding "02" at the end of the sample ID above would indicate that it was a duplicate sample.

Analytical laboratories normally assign another identification number for each of the samples for their internal tracking and control of the samples. Some software used by the laboratories for reporting results may allow only a certain number of characters/digits for the sample designation. Sometimes the laboratory may abbreviate the sample designation when reporting the results. In such cases, it is recommended that the laboratory be requested to provide a table that lists the actual sample number cross-referencing the sample number used to report the results. This procedure will insure proper tracking and accurate accounting for all the samples.

3.2.2 Field QC Samples

In addition to the regular site samples, the following field QC samples may be collected during sampling events. The distribution of the field QC samples by site, sampling round, etc., will be specified in the project-specific plans. The frequency of these samples will comply with the following requirements presented in the QAPP (Appendix C of the BWP).

- Trip Blank
- Ambient Field Blank
- Equipment Blank
- Temperature Blank
- Duplicate

On large sample size projects, a frequency of 5 percent field QC samples may be required. The percentages will be determined in the project-specific addenda. It should be specified in project-specific addenda when a "source water" analysis is required for water used in decontamination processes.

4. SAMPLING EQUIPMENT AND PROCEDURES

4.1 General

The samples collected during field investigation and restoration activities may include soil (surface and subsurface), sediment, groundwater, surface water, potable water, waste materials, leachate, and ambient air and effluents from treatment operations. Different types of sampling devices may be necessary to accomplish sampling activities. The selection of a device will be based on applicability, compatibility with analytical considerations, safety, representativeness, practicability, and economics. All equipment will be decontaminated between sampling locations according to Appendix B, SOP B1.10 of the BWP, unless the equipment used is dedicated for a particular sampling location.

Section 4.2 provides an introduction to the Standard Operating Procedures (SOPs) for sampling various media. Section 4.3 provides guidance for collecting field QC samples. Procedures for decontamination of field equipment are provided in Section 4.4 and Appendix B of the BWP. Project-specific plans may append additional SOPs based on project requirements and site conditions. The Kirtland AFB SOPs were created from USACE, AFCEE, and EPA guidance sources.

4.2 Sampling Procedures

The SOPs for sampling various media are presented in Appendix B, Sections B1, B2, B4, and B6, and include the following procedures:

- General Procedures
  - —SOP B1.1 Borehole and Sample Logging
  - —SOP B1.2 Borehole Geophysical Logging
  - —SOP B1.3 Monitoring Well Installation
  - —SOP B1.4 Monitoring Well Development
  - —SOP B1.5 Monitoring Well Abandonment
  - —SOP B1.6 Temporary Well-Point of Hydro-Punch Type Sampling
  - —SOP B1.7 Soil Gas Investigation
  - —SOP B1.8 Surficial Geophysical Surveys
  - —SOP B1.9 Land Surveys
  - —SOP B1.10 Meteorological Monitoring
  - —SOP B1.11 Equipment Decontamination
- Soil Sampling Procedures
  - —SOP B2.1 Sediment Sampling

- —SOP B2.2 Surface Soil Sampling
- —SOP B2.3 Subsurface Soil Sampling
- —SOP B2.4 Test Pit Sampling
- —SOP B2.5 Sample Homogenization

- Water Sampling Techniques
  - —SOP B4.1 Monitoring Well Sampling
  - —SOP B4.2 Potable Water Sampling
  - —SOP B4.3 Surface Water Sampling
  - —SOP B4.4 Field Filtration

- Miscellaneous Sampling Techniques
  - —SOP B6.1 Drum Sampling
  - —SOP B6.2 Tank Sampling
  - —SOP B6.3 Wipe Sampling
  - —SOP B6.4 Concrete Sampling
  - —SOP B6.5 Air Sampling/Air Monitoring

Additional procedures provided in this update to the SOPs includes data evaluation protocol for using NMED-approved background values for soil and groundwater and using NMED guidance for evaluating risk. Also included in Appendix B is a memorandum for *Radioactively-Contaminated or Mixed Waste Sites in the U.S. Air Force* that provides guidance applicable to radioactive sites designated at Kirtland AFB.

4.3 Guidance for Field Quality Control Samples

4.3.1 Trip Blank

A trip blank is a VOC sample vial filled in the laboratory with Type II Reagent Grade Water, transported to the site, handled like a sample, and returned to the laboratory for analysis. Trip blanks will not be opened in the field. The trip blank for soils is identical to the trip blank for water samples and is handled and analyzed in the same manner.

4.3.2 Temperature Blank

A temperature blank consists of a 40-milliliter VOC vial filled with Type II Reagent Grade water and placed in the middle of the cooler or another representative location during packing of the cooler. The temperature blank is used to measure the actual temperature of the samples in the cooler as received by the laboratory. The temperature is measured by placing a thermometer directly into the vial.

4.3.3 Ambient Field Blank

An ambient blank is Type II Reagent Grade Water that is poured into a sample container at a sampling site. It will be handled like a sample and transported to a laboratory for analysis.

4.3.4 Field Duplicate

A field duplicate is an additional sample collected independently at a sampling location so that two sets of samples are collected during a single act of sampling. Field duplicates will be identified such that laboratory personnel are unable to distinguish them from normal field samples unless otherwise specified in the project-specific plan.

4.3.5 Equipment Blank

An equipment blank is Type II Reagent Grade Water that is poured into or pumped through the sampling device, transferred to a sample bottle, and transported to a laboratory for analysis.

4.4 Equipment Decontamination

The methods for the proper decontamination of all field sampling equipment are detailed in Appendix B, SOP B1.10. Procedures differ according to the type and the intended use of the sampling equipment, as well as guidelines specified by government agencies. All equipment that may directly or indirectly contact samples will be decontaminated in a designated decontamination area. This includes casing, drill bits, auger flights, the portions of drill rigs that stand above boreholes, sampling devices, and instruments, such as slugs and sounders, and buckets of excavators. Care will be taken to prevent the sample device from coming into contact with potentially contaminating substances, such as tape, oil, engine exhaust, corroded surfaces, and dirt.

4.5 Field Measurements

This section identifies the elements to be considered during field measurements and outlines the SOPs to be used when collecting specific types of data. Generally, field measurements include, but are not limited to: temperature, pH, oxidation reduction potential, conductivity, turbidity, dissolved oxygen, width, depth, and flow rate of streams; water levels; and well depth. Field screening techniques such as soil gas, field gas chromatography, and x-ray fluorescence also fall under this category. The Base-Wide Health and Safety Plan (BWHSP), Appendix F of this BWP, project-specific addenda, and the Contractor's Site-Specific Safety and Health Plan (SSHP) will be used as guidance when measurements are made for health and safety monitoring.

The following elements should be considered when developing project-specific addenda:

- Parameters to be measured in the field and the type of equipment to be used
- Intended use of these measurements
- Rationale for selecting a particular equipment or technique
- Detection limits and QA/QC requirements for each piece of equipment
- Calibration and preventive maintenance requirements

The SOPs for measurement activities outline the specific steps to be followed when collecting data using field instrumentation. These guidelines have been developed from manufacturers' operations manuals and standard industry practices. In some cases, the procedures specified in this document may not apply precisely to the actual field equipment being used. Deviations from the SOPs presented herein will be addressed in project-specific addenda.

The SOPs for measurement procedures presented in Appendix B, Sections B3 and B5 include:

- Soil Screening Techniques
  - —SOP B3.1 Photoionization Detectors and Organic Vapor Analyzers
  - —SOP B3.2 Methods for Using Portable Gas Chromatographs
  - —SOP B3.3 Headspace Screening
- Water Screening Techniques
  - —SOP B5.1 pH
  - —SOP B5.2 Specific Conductance
  - —SOP B5.3 Water Temperature
  - —SOP B5.4 Dissolved Oxygen
  - —SOP B5.5 Oxidation-Reduction Potential
  - —SOP B5.6 Water Levels
  - —SOP B5.7 Aquifer Testing

5. SAMPLE HANDLING AND ANALYSIS

5.1 Sample Packaging and Shipping

The objective of the sample packaging and shipping requirements is to maintain sample integrity from the time a sample is collected until it is received at the analytical laboratory. Chain-of-Custody (C-O-C) forms, sample labels, custody seals, and other sample documents will be completed as specified in Section 6.0 of the Quality Assurance Project Plan (QAPP), Appendix C of the BWP (previously Part II of the DCQAP). Specific procedures for packaging and shipping of environmental samples are presented below. These procedures are general and project-specific plans should be consulted for more stringent or additional requirements:

- A sample label is attached to the sample bottle filled out with indelible ink.
- A picnic cooler (such as a Coleman or other sturdy cooler) is typically used as a shipping container. In preparation for shipping samples, the drain plug is taped shut so that no fluids, such as melted ice, will drain out of the cooler during shipment. A large plastic bag may be used as a liner for the cooler and packing material, such as bubble wrap, or Styrofoam beads, should be placed in the bottom of the liner.
- The containers are placed in the lined picnic cooler. Cardboard separators may be placed between the containers at the discretion of the shipper.
- Unless indicated in project-specific requirements, all samples for chemical analysis must be shipped cooled to 4 degrees Celsius (°C) with ice. All samples will require icing prior to shipping.
- The liner should be taped closed, if used, and sufficient packing material should be used to prevent sample containers from making contact or rolling around during shipment.
- A copy of the C-O-C form should be placed inside the cooler.
- The cooler is closed and taped shut with strapping tape (filament-type).
- Custody seals are placed on the cooler. Placing clear tape over the custody seals can help to prevent them from being accidentally torn or ripped off.
- The cooler of samples should be shipped via an overnight carrier. A standard airbill is necessary for shipping environmental samples.

5.2 Sample Analytical Requirements

Sample containers, preservation techniques, sample volumes, and holding times will be in accordance with the requirements specified in Table 5-1 of the QAPP. Analytical procedures will be in accordance with Section 8.0 of the QAPP. Project-specific plans will provide additional information, if required, based on the requirements of planned activities.

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6. FIELD QA/QC PROGRAM

The objective of the field QA/QC Program is to ensure that all field operations, sampling, and measurements produce results that:

- Are of known quality and in compliance with specified data quality objectives
- Are traceable, technically accurate, legally defensible, and have definable characteristics

Fundamental mechanisms for achieving established quality goals can be categorized as prevention, quality assessment, and correction, and include the following:

- Prevention of errors by planning and careful selection of methods, processes, and resources
- Quality assessment through a program of audits and surveillance activities
- Correction of processes to prevent recurrence of conditions adverse to quality
- Incorporation of new processes as they develop to increase quality

The following items are controlled activities to ensure effective implementation of the field sampling program:

- Written and approved SOPs for all field activities; these procedures are detailed in Appendix B of the BWP
- Collection of field QC samples at the required frequency; these requirements are detailed in the QAPP, Appendix C of the BWP
- Equipment calibration in accordance with the approved procedures and manufacturer's recommendation
- Documentation and record-keeping activities.
- Audits, surveillance activities, and a corrective action program.

Project-specific plans will be developed based on the above guidelines and in accordance with individual project requirements. The project-specific plans will include the following items in the QA/QC program section:

- Identify and describe the parameters that will be controlled during field operations
- Identify the frequency of control checks and sources of any control materials
- Provide the acceptance criteria for each parameter that is controlled
- Describe the actions required in the event that controlled parameters exceed acceptance criteria

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7. SITE MANAGEMENT AND RECORD-KEEPING

7.1 Site Management

This section summarizes the various measures required to implement field sampling activities. Site access and security, temporary facilities and utilities, waste management, spill and discharge control measures, and contingency plans are some of the items that must be considered in developing project-specific plans. This section contains a general discussion of these considerations and broadly describes the elements associated with them. Each project-specific plan will address these topics on an individual basis, providing greater detail as required by the activities conducted at the site.

7.1.1 Site Access and Security

Kirtland AFB maintains responsibility for all base access and security measures required to gain access to the base. Site security at areas of concern undergoing remedial activities will be performed in accordance with requirements presented in the BWHSP (Appendix F), project-specific addenda, and the SSHP.

7.1.2 Temporary Facilities

Temporary support facilities for remedial operations will be identified in the project-specific addenda. Facilities may include office trailers, storage trailers, shower facilities, break trailers, temporary treatment units, connections to utilities, equipment storage yards, and access roads.

7.1.3 Waste Disposal

Waste disposal for the activities to be implemented at Kirtland AFB are addressed in the Investigation-Derived Waste Management Plan, Appendix E of this BWP.

7.1.4 Contingency Plans

The development of contingency strategies is necessary for the successful and timely completion of the environmental restoration operations at Kirtland AFB. Prior to initiating field activities, plans will be developed based upon the individual scope of work projected for each site. In the event that a problem or interruption occurs during the field activities, the Kirtland ERP Remedial Project Manager and the project geologist will be notified and consulted before implementation of alternate strategies. Other project team members may be contacted and consulted depending upon the importance of the problem and the applicability to the team member. The following outlines some of the potential problems and alternative solutions that may be encountered in the field.

Potential Problem	Alternatives
Inclement weather	• Alter procedure to compensate • Conduct alternate activities • Cease operations
Instrument or equipment failure or breakdown	• Repair or replace equipment • Conduct alternate activities • Cease operations

Potential Problem	Alternatives
Sick, injured or absent personnel	• Replace personnel • Operate with reduced staff • Treat personnel, continue operations • Conduct alternate activities • Cease operations
Change of scope due to unanticipated site characteristics or change in strategy	• Alter procedure to compensate • Conduct alternate activities • Cease operations
Unanticipated accident or emergency	• Delay operations until situation is managed • Conduct alternate activities • Cease operations

7.2 Record-Keeping

Field records sufficient to recreate all sampling and measurement activities will be maintained and will meet all Environmental Restoration Program Information Management Systems data loading requirements. The requirements listed in this section apply to all measuring and sampling activities. Requirements specific to individual activities are included in the section that addresses each activity. The information will be recorded with indelible ink in a permanently bound notebook with sequentially numbered pages. These records will be archived in an easily accessible form and made available to the USAF upon request.

The following information will be recorded in the log book for all activities:

- Location
- Date and time
- Identity of people performing activity and any visitors
- Weather conditions

A summary of all site activities and level of personnel protection will be recorded in the log book. No erasures will be permitted. If an incorrect entry is made, the data will be crossed out with a single strike mark, and initialed and dated. At the completion of all entries for a given task or at the end of the day, the log book will be signed and dated.

- The following additional information will be recorded for all field measurements:
- The numerical value and units of each measurement
- The identity of and calibration results for each field instrument

The following additional information will be recorded for all sampling activities:

- Sample type and sampling method

- The identity of each sample and depth(s), where applicable, from which it was collected
- The amount of each sample
- Sample description (e.g., color, odor, clarity)
- Identification of sampling devices
- Identification of conditions that might affect the representativeness of a sample (e.g., refueling operations, damaged casing)

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APPENDIX B

Standard Operating Procedures For Field Investigations

The Standard Operating Procedures for Kirtland Air Force Base field investigation activities are included in this Appendix. It is understood at all times that the site-specific requirements supersede these generic requirements.

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CONTENTS (Continued)

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TABLES

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FIGURES

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ACRONYMS

°C	degrees Celsius
AmBe-241	Americium-Beryllium-241
AFB	Air Force Base
AFCEE	Air Force Center for Environmental Excellence
ASTM	American Society for Testing and Materials
BWHSP	Base-Wide Health and Safety Plan
BWP	Base-Wide Plan
C-O-C	Chain-of-Custody
COC	contaminants of concern
DPT	direct-push technology
DQCR	Daily Quality Control Report
EM	electromagnetometry
EMI	electromagnetic induction
EPA	U.S. Environmental Protection Agency
ft	foot/feet
FOL	Field Operations Leader
GC	gas chromatograph
GPR	ground-penetrating radar
He-3	Helium-3
HNO_3	nitric Acid
hz	hertz
Khz	kilohertz
mg	milligrams
mL	milliliters
mm	millimeters
MeV	megaelectron volts
mv	millivolt

ACRONYMS (Concluded)

NaOH	sodium hydroxide
NBS	National Bureau of Standards
OVA	organic vapor analyzer
pH	potential of Hydrogen
PID	photoionization detector
PM-10	particulate matter less than 10 microns
PPE	personal protective equipment
PVC	polyvinyl chloride
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RQD	rock quality designation
SOP	standard operating procedure
SPR	standard penetration resistance
SSHP	Site-Specific Safety and Health Plan
TOC	total organic carbon
TSP	total suspended particulate
USACE	U.S. Army Corps of Engineers
USCS	Unified Soil Classification System
VDL	variable density log
VOC	volatile organic compounds
WMP	Waste Management Plan

SOP B1.1 Borehole and Sample Logging

Drilling Logs and Documentation

Each boring will be fully described on a boring log similar or equivalent to that shown in Figure B1.1-1 and in accordance with ASTM D5434**.** The rig geologist will log the boring as it is being drilled by recording relevant data, listed below, on either the appropriate boring log or in a bound field logbook. Boring log forms may be transcribed from a field logbook, but must be completed at a minimum on a weekly basis. Data that will be included in the logs, when applicable, are:

- Identifying number and location of each boring.
- All measurements shall be accurate to one-tenth of a foot.
- Drilling logs and other scaled drawings should be drawn at a scale of 1 inch = 1 foot. (note: for wells deeper than 200’, the scale may be adjusted to a more practical ratio. In addition, if sampling intervals are greater than 10 ft. apart the log can be represented with breaks in order to skip unlogged intervals)
- Soil classifications in accordance with the USCS. These classifications will be prepared in the field by the geologist and will be subject to revision based on laboratory tests or subsequent review.
- Rock classifications in accordance with the procedures and guidelines described in the below section on Rock Classification.
- A full description of soil samples. For split-spoon, thin wall, soil core, or otherwise intact samples, the description will include but not be limited to the USCS two-letter classification, plus a more complete verbal description of color, consistency, soil moisture, grain size and size distribution.
- Depth limits, type and number of each sample taken. All samples will be numbered consecutively.
- The number of blows required for each 6-inch penetration of split-spoon sampler and for each 12-inch penetration of casing; hammer weight and length of fall for split-spoon or driven samplers; hydraulic pressure used to push thin-wall tubes. If thin-wall tubes are pushed manually, that will be indicated.
- The start and finish times for all rock coring runs including a description and depth of any drilling anomalies such as voids, loss of fluids or air, odors, etc.
- Depth to water as first encountered during drilling, along with the method of determination. Any distinct water-bearing zones below the first zone also will be noted. Other observations during drilling will also be noted, such as bit chatter, rod binding, rod drops, flowing or heaving sands, bit pressure, rod rotations per minute, and water pressure.
- If drilling fluid is used, the fluid losses, interval over which they occur and the quantity losses, lost will be recorded.

- A general description of the drilling equipment used. This description, including such information as rod size, bit type, pump type, rig manufacturer, and model, may be provided in a general legend.

- Dates and times of start and completion of boring.

- Names of Contractor, driller and rig geologist.

- Size and length of casing or auger used in each borehole.

- Observations of visible contamination for each sample or from cuttings that appear contaminated.

- Field instrument readings.

As the boring is drilled, the rig geologist will evaluate adjacent samples recovered, together with observation of the drill cuttings, wash water (if any), drill performance, etc., to determine appropriate stratigraphic definitions or distinctions within the soil column. Such contacts or breaks between strata must be determined by the rig geologist and indicated on the boring log. If such information is not provided, the “log” is nothing more than a listing of individual sample descriptions. In general, a stratigraphic unit contains only similar soils which can be classified within the same two-letter USCS classification category symbol. In some cases, significant differences in soil color, grain size distribution, strength, etc., would be sufficient to classify soils having the same two-letter USCS classification category symbol into two or more distinct strata.

After the rig geologist has indicated the appropriate stratigraphic breaks on the log, he/she should develop and record an appropriate description for each defined stratigraphic unit. Each description should contain information about the color, grain size distribution, consistency, moisture, etc., and the appropriate two-letter USCS classification category symbol.

Classification of Soils

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

USCS Classification

Soils are to be classified according to the USCS (ASTM D2487). This method of classification is detailed in Figure B1.1-2. This method of classification identifies soil types on the basis of grain size and liquid limits, and categorizes them by two-letter symbols.

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

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

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

Color

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

Colors must be described while the sample is still moist. Soil samples should be broken or split vertically to describe colors. Soil sampling devices tend to smear the sample surface creating color differences between the sample interior and exterior. In accordance with ASTM D1535, Munsell Color Charts or equivalent must be used based on project requirements.

Relative Density and Consistency

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

The density of noncohesive, granular soils is classified according to standard penetration resistances obtained from split-spoon sampling methods that are in accordance with ASTM D1586 and are detailed in SOP B2.3, Split Spoon Sampling Procedure section. Those designations are:

Standard Penetration Resistance (SPR)

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

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

The consistency of cohesive soils is determined by performing field tests and identifying the consistency as shown in Figure B1.1-2. The consistency of cohesive soils is determined either by blow counts or most accurately by a pocket penetrometer or field Torvane device in accordance with ASTM D2573-72–*Method for Field Vane Sheer Text in Cohesive Soil*. The SPR can be applied to cohesive soils as follows:

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

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

Soil Component

In nature, soils are comprised of particles of varying size and shape and are combinations of the various soil types. Figure B1.1-2 lists grain size classifications to be used in describing soils or rocks. The following terms are useful in the description of soil components:

The Identifying Proportion of the Component	Defining Range of Percentages by Weight
trace	0-10 percent
little	11-20 percent
some	21-35 percent
“and”	36-50 percent

Moisture

Moisture content is estimated in the field according to four categories: dry, moist, wet, and saturated. In dry soil, there appears to be little or no water. Saturated samples obviously have all the water they can hold. Moist and wet classifications are somewhat subjective and often are determined by the individual’s judgment. A suggested parameter for judging this in a fine-grained soil would be calling a soil wet if rolling it in the hand or on a porous surface liberates water, i.e., dirties or muddies the surface. Whatever method is adopted for describing moisture, it is important that the method used by an individual remains consistent throughout an entire drilling job.

Laboratory tests in accordance with ASTM D2216 or field tests for water content should be performed if the natural water content is important.

Stratification

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

Thickness (Metric)	Approximate English Equivalent	Classification
>1 meter	> 3.3 ft	Very thick
30 cm - 1 meter	1.0 ft - 3.3 ft	Thick Bedded
10 cm - 30 cm	4.0 in - 1.0 ft	Medium Bedded
3 cm - 10 cm	1.0 in - 4 in	Thin Bedded
1 cm - 3 cm	2/5 in - 1 in	Very Thin Bedded
3 mm - 1 cm	1/8 in - 2/5 in	Laminated
1 mm - 3 mm	1/32 in - 1/8 in	Thinly Laminated
<1 mm	<1/32 in	Micro Laminated

Classification of Rocks

Rocks are grouped into three main divisions: sedimentary, igneous and metamorphic. Sedimentary rocks are by far the most predominant type exposed at the earth's surface. The following basic names are applied to the type of rocks found in sedimentary sequences:

- ***Sandstone***—Made up predominantly of granular materials ranging between 1/16 and 2 inches diameter.
- ***Siltstone***—Made up of granular materials less than 1/16-inch diameter. Fractures irregularly.
- ***Claystone***—Very fine-grained rock made up of clay and silt-size materials. Fractures irregularly. Very smooth to touch. Generally has irregularly spaced pitting on surface of drilled cores.
- ***Shale***—A fissile, very fine-grained rock. Fractures along bedding planes.
- ***Limestone***—Rock made up predominantly of calcite. Effervesces upon the application of hydrochloric acid.
- ***Coal***—Rock consisting mainly of organic remains.
- ***Others***—Numerous other rock types are present in the geologic section. Their overall abundance is dependent upon the geographical locations.

In classifying a sedimentary rock the following characteristics should be noted:

- Rock Type
- Color

- Bedding Thickness
- Hardness
- Fracturing
- Weathering
- Mineralogy (if discernible)
- Other Characteristics

All classification data should be written directly on the boring log or in a field log book. The method of deriving the classification should be described or reference to this guideline or other manuals used should be included.

Rock Type

As described previously, there are numerous names for sedimentary rocks. In most cases a rock will be combination of several rock types, therefore a modifier such as sandy siltstone or a silty sandstone can be used. The modifier indicates that a significant portion of the rock type is composed of the modifier. Other modifiers can include carbonaceous, calcareous, siliceous, etc.

Grain diameters are used for the classification of classic sedimentary rock. The following is the Udden-Wentworth classification that will be assigned to sedimentary rocks. The individual boundaries are slightly different than the USCS subdivision for soil classification. For field determination of grain sizes, a scale can be used for the coarse grained rocks.

Particle Name	**Grain Size Diameter**
Cobbles	> 64 mm
Pebbles	4 - 64 mm
Granules	2 - 4 mm
Very Coarse Sand	1 - 2 mm
Coarse Sand	0.5 - 1 mm
Medium Sand	0.25 - 0.5 mm
Fine Sand	0.125 - 02.5 mm
Very Fine Sand	0.0625 - 0.125 mm
Silt	0.0039 - 0.0625 mm
Clay	< 0.0625 mm

Color

The color of a rock can be determined in the same manner as for soil samples. Rock core samples should be classified while wet, when possible, and air-cored samples should be scraped clean of cuttings prior to color classifications. Munsell Color Charts or equivalent may be used if required for the project.

Stratification

The bedding thickness designations applied to soil classification will also be used for rock classification.

Hardness

The hardness of a rock is a function of the compaction, cementation, and mineralogical composition of the rock. A relative scale for sedimentary rock hardness is as follows:

- ***Soft***—Weathered, considerable erosion of core, easily gouged by screwdriver, scratched by fingernail. Soft rock crushes or deforms under pressure of a pressed hammer. This term is always used for the hardness of the saprolite (decomposed rock which occupies the zone between the lowest soil horizon and firm bedrock).

- ***Medium soft***—Slight erosion of core, slightly gouged by screwdriver, or breaks with crumbly edges from single hammer blow.

- ***Medium hard***—No core erosion, easily scratched by screwdriver or breaks with sharp edges from single hammer blow.

Note the difference in usage here of the words "scratch" and "gouge." A scratch should be considered a slight depression in the rock (do not mistake the scraping off of rock flour from drilling with a scratch in the rock itself), while a gouge is much deeper.

Fracturing

The degree of fracturing of a rock is described by measuring the fractures of joint spacing. After eliminating drilling breaks, the average spacing is calculated and the fracturing is described by the following terms:

Very broken—Less than 2 inches

Broke—2 inches to 1 ft

Blocky—1 to 3 ft

Massive—3 to 10 ft

Artificial breaks can be distinguished from natural partings by several criteria. Drilling breaks are generally relatively sharp edged and the newly exposed rock surfaces are invariably fresher in appearance (less weathered) than natural breaks. Core pieces on each side of a drilling break usually fit perfectly back together, whereas natural breaks may exhibit gaps and clay films or seams, oxidation stains, or mineralization. Do not confuse drill cuttings or drilling mud on a fractured surface with a natural clay film or seam.

The structural integrity of the rock can be approximated by calculating the RQD of cores recovered. The RQD is determined by adding the total lengths of all pieces exceeding 4 inches and dividing by the total length of the coring run, to obtain a percentage:

$$RQD = \left(\frac{r}{l}\right) \times 100$$

where:

r = Total length of all pieces of the lithologic unit being measured, which are greater than four inches in length, and have resulted from natural breaks. Natural breaks include slickensides, joints, compaction slicks, bedding plane partings (not caused by drilling), friable zones, etc

l = Total length of the coring run

Weathering

The degree of weathering is a significant parameter that is important in determining weathering profiles and is also useful in engineering designs. The following terms can be applied to distinguish the degree of weathering:

- ***Fresh***—Rock shows little or no weathering effect. Fractures or joints have little or no staining and rock has a bright appearance.

- ***Slight***—Rock has some staining (i.e., discoloration along joints, cracks or exposed surfaces) which may penetrate several centimeters into the rock. Clay filling of joints may occur. Feldspar grains may show some alteration.

- ***Moderate***—Most of the rock, with exception of quartz grains, is stained. Rock is weakened due to weathering and can be easily broken with hammer.

- ***Severe***—All rock, including quartz grains, is stained. Some of the rock is weathered to the extent of becoming a soil. The rock is very weak and crumbly.

Other Characteristics

The following items should be included in the rock description:

- Description of contacts between two rock units. These can be sharp or gradational.

- Description of any cavities or bugs, including fillings, if present.

- Description of any joints or fractures.

- Notation of joints or fractures with depth, any unusual staining (not weathering), approximate angle from horizontal, any mineral filling or coating, degree of weathering and interpretive, relative degree of groundwater movement through the fracture.

As an attachment to the log, additional information should be provided, including an estimation of the degree of cementation and type of cement for granular sedimentary rocks; a description of the texture and fabric of the rock (i.e., the shape and relationship of component particles or crystals); and the structure of macroscopic features of the rock mass. Generally, rock structure is best seen in the outcrop rather than the hand specimen, but some indication of structure (e.g., horizontal or dipping beds, open joints) can be obtained from core samples.

Numerous classification schemes for igneous and metamorphic rocks are available. Compton, 1962 *Manual of Field Geology*, John Wiley & Sons, Inc. New York and *Classification of Rocks*, Quarterly of the Colorado School of Mines, Volume 50, Number 1, January 1955 are preferred. Igneous and metamorphic rocks that may be encountered at Kirtland AFB will be classified according to the procedures outlined in *Classification of Rocks*.

Igneous rock classification is based on texture and mineralogy. The distinction between intrusive and extrusive (volcanic) igneous rocks is not specifically addressed by rock classification schemes but is indicated by texture, which is a function of cooling history, and is determined by field relationships. Metamorphic rock classification is based primarily on structure and mineralogy. Directional or nondirectional structure is and important attribute in determining nomenclatures. Because metamorphic rocks derive from preexisting igneous or sedimentary rocks which have undergone a chemical or physical change after their original metamorphic rocks are divided into two groups:

- those formed by regional metamorphism, and
- those formed by contact metamorphism (Hurlbut, 1971, *Dana's Manual of Mineralogy*, 18th Edition, John Wiley & Sons, Inc.).

Igneous rock will be classified based on granularity or the absence of visible grains, the relationship between grains, the proportions of essential rock-forming minerals, color, and the presence and type of visible accessory minerals.

Metamorphic rocks will be classified on the basis of directional or nondirectional structure, the type of directional structure if any, mineralogy, and color.

In addition to standard classification of igneous and metamorphic rocks, other features will be described, Physical features of crystalline rocks that may contribute to groundwater or contaminant migration will be described and characterized. Joints or fractures will be mapped, widths measure, and their aspect and degree of interconnections described. Fracture-filling minerals will be described and sampled if necessary to determine potential interactions between these minerals and potential contaminants.

The predominant local bedrock encountered at Kirtland AFB is the Tertiary Santa Fe Formation. The Santa Fe Formation consists of light brown to reddish-brown clays and mudstones, and sands and gravels which are indurated with caliche. The Santa Fe Formation should be noted and described on the boring log when encountered in core or cuttings.

References for Other Applicable ASTM Standards

ASTM D2488 – Description and Identification of Soils (Visual-Manual Procedure)

ASTM D 4318 – Liquid Limit, Plastic Limit, and Plasticity Index of Soils

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Figure B1.1-1. Typical Bore Log Form Used to Describe Split Spoon Samples

HTRW DRILLING LOG	DISTRICT					HOLE NUMBER
1.COMPANY NAME	2.DRILL SUBCONTRACTOR					SHEET 1 OF SHEETS
3.SITE	4.LOCATION					
5.NAME OF DRILLER	6.MANUFACTURER'S DESIGNATION OF DRILL					
7.SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	8.HOLE LOCATION					
	9.SURFACE ELEVATION					
	10.DATE STARTED			11.DATE COMPLETED		
12.OVERBURDEN THICKNESS	15.DEPTH GROUNDWATER ENCOUNTERED					
13.DEPTH DRILLED INTO ROCK	16.DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED					
14.TOTAL DEPTH OF HOLE	17.OTHER WATER LEVEL MEASUREMENTS (SPECIFY)					
18.GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19.TOTAL NUMBER OF CORE BOXES			
20.SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	SVOC	Pest/PCB	Cyanide/TRPH	21.TOTAL CORE RECOVERY %
	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23.SIGNATURE OF INSPECTOR		
22.DISPOSITION OF HOLE					SCALE	1 inch = 1 foot

LOCATION SKETCH/COMMENTS

PROJECT	HOLE NO.

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Figure B1.1-1. Typical Bore Log Form Used to Describe Split Spoon Samples (Concluded)

HTRW DRILLING LOG	SITE	LOCATION	HOLE NUMBER
PROJECT #	DISTRICT	INSPECTOR PATRICIA WESTON	SHEET 2 OF SHEETS

ELEV. (a)	DEPTH (ft.) (b)	DESCRIPTION OF MATERIALS (c)	USCS CLASS. (d)	FIELD SCREEN RESULTS (e)	REMARKS (f)
	1				
	2				
	3				
	4				
	5				
	6				
	7				
	8				
	9				
	10				
	11				
	12				
	13				
	14				
	15				
	16				
	17				
	18				
	19				
	20				

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Figure B1.1-2. The Unified Soil Classification System (USCS)

Revised 07-12-02

UNIFIED SOIL CLASSIFICATION SYSTEM

UNIFIED SOIL CLASSIFICATION AND SYMBOL CHART

COARSE-GRAINED SOILS
(more than 50% of material is larger than No. 200 sieve size.)

GRAVELS More than 50% of coarse fraction larger than No. 4 sieve size	Clean Gravels (Less than 5% fines)	
	GW	Well-graded gravels, gravel-sand mixtures, little or no fines
	GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines
	Gravels with fines (More than 12% fines)	
	GM	Silty gravels, gravel-sand-silt mixtures
	GC	Clayey gravels, gravel-sand-clay mixtures
SANDS 50% or more of coarse fraction smaller than No. 4 sieve size	Clean Sands (Less than 5% fines)	
	SW	Well-graded sands, gravelly sands, little or no fines
	SP	Poorly graded sands, gravelly sands, little or no fines
	Sands with fines (More than 12% fines)	
	SM	Silty sands, sand-silt mixtures
	SC	Clayey sands, sand-clay mixtures

FINE-GRAINED SOILS
(50% or more of material is smaller than No. 200 sieve size.)

SILTS AND CLAYS Liquid limit less than 50%	ML	Inorganic silts and very fine sands, rock flour, silty of clayey fine sands or clayey silts with slight plasticity
	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
	OL	Organic silts and organic silty clays of low plasticity
SILTS AND CLAYS Liquid limit 50% or greater	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
	CH	Inorganic clays of high plasticity, fat clays
	OH	Organic clays of medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS	PT	Peat and other highly organic soils

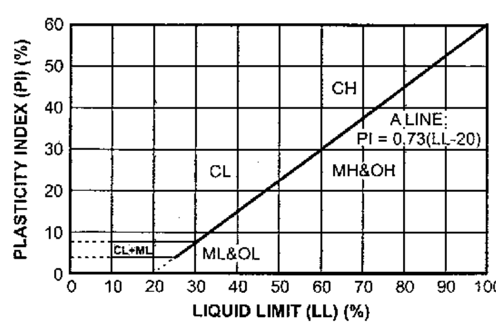
LABORATORY CLASSIFICATION CRITERIA

GW	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{D_{30}}{D_{10} \times D_{60}}$ between 1 and 3	
GP	Not meeting all gradation requirements for GW	
GM	Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
GC	Atterberg limits above "A" line with P.I. greater than 7	
SW	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{D_{30}}{D_{10} \times D_{60}}$ between 1 and 3	
SP	Not meeting all gradation requirements for GW	
SM	Atterberg limits below "A" line or P.I. less than 4	Limits plotting in shaded zone with P.I. between 4 and 7 are borderline cases requiring use of dual symbols.
SC	Atterberg limits above "A" line with P.I. greater than 7	

Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows:

Less than 5 percent .... GW, GP, SW, SP
More than 12 percent .... GM, GC, SM, SC
5 to 12 percent .... Borderline cases requiring dual symbols

PLASTICITY CHART



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SOP B1.2 Borehole Geophysical Logging

Geophysical techniques have proven to be valuable tools in determining lithology, porosity and moisture condition of various stratigraphic units. This information is useful in the decision making process for choosing monitoring well completion intervals and characterizing hydrogeology. Logging suites are determined by the information required. The following is a brief description of various borehole geophysical instruments and measurements.

Temperature Measurement and Fluid Resistivity Measurement

A temperature log is the first measurement performed in a borehole. This probe continuously records borehole fluid temperature immediately surrounding a thermal sensor as the probe is lowered downhole. The logging equipment is calibrated to present data in degrees Celsius (or other appropriate temperature scale). Temperature data can provide information concerning fluid flow in or out of the borehole, which is reflected by changes in the thermal gradient.

Fluid resistivity logs are run in conjunction with temperature logs and record borehole fluid resistivity directly as the borehole fluid passes between electrodes. Changes in fluid resistivity can indicate in-flow or out-flow of water as well as water quality. In highly resistive environments some of the electrical current leaks into the formation and the tool thus behaves somewhat like a micro-resistivity probe. Localized portions of the log appear to respond as fractures.

Natural Gamma Measurement

The natural gamma measurement detects natural gamma radiation occurring in lithology and is recorded in counts per second. This log, which exhibits relative changes in natural (or man-made) radiation, is used for general lithologic identification and stratigraphic correlation. Natural occurring radiation comes from three principal areas: potassium 40 which occurs with all potassium minerals, uranium-238, and thorium-232 which is associated primarily with biotite. The typical radius of investigation for the natural gamma log is approximately 10 to 12 inches from the borehole wall.

Electric Measurements

Several types of electrical measurements can be performed in the borehole. Electrical measurements can only be run below fluid level since fluid is required to complete the electrical circuit between the probe and the borehole wall. If no fluid is available, the induction measurements can be performed with different instrumentation (e.g., Geonics EM-39).

The Single Point Resistance log measures direct resistance between an electrode on the downhole probe and a surface reference point electrode. The relatively shallow radius of investigation (approximately 5 to 6 inches) enables precise recording of formation contacts and fracture zones. The log response, measured in ohms, is strongly affected by lithology, resistance of the drilling fluid, quality of the surface contact, and the rugosity (e.g. irregularity) of the borehole. It is therefore only qualitative in nature.

The Spontaneous Potential log basically utilizes the same electrical configuration as the Single Point Resistance and is used to measure variations in natural electrical potential. This potential, measured in millivolts (mvs), results from one of three principal causes:

- Electrochemical potential from a contrast between the resistivities of the borehole fluid and the formation pore water,

- Redox potential or the oxidation/reduction of sulfide mineralization such as pyrite, and
- Electromechanical potential or streaming potential from fluid flow directly into or out of the formation.

The 16-inch Short Normal Resistivity and 64-Inch Long Normal Resistivity logs measure apparent formation resistivity, utilizing both current and potential electrodes in the borehole and a reference surface electrode. The formation resistivity, measured in ohm-meters, is affected by grain size, porosity, and pore fluid. The 16- and 64-inch normal is a quantitative measurement. The radius of investigation of this tool is related to the spacing between the current and potential electrodes, which in this case is 16 or 64 inches. In highly resistive formations, the radius of investigation is reduced. In hard, low porosity crystalline formations with very fresh pore water, the apparent resistivity is high. Fracturing in a crystalline environment has the effect of increasing apparent porosity and thus reducing apparent resistivity.

The Guard Resistivity measurement is a focused resistivity log. It consists of two guarding electrodes and a current electrode. In the fluid-filled portion of the borehole, the log is used for very thin bed resolution and to approximate formation resistivity.

The Induced Polarization (IP) log is a time domain measurement of the residual charge storage (or decay or secondary voltage) after the formation has been excited with a constant current pulse that is then turned off. Measurement of the secondary voltage corresponds to the polarizability of the formation. The secondary voltage is normalized with respect to the primary voltage pulse with IP effect expressed as the ratio of secondary voltage to primary voltage. Log values are displayed as a “percentage” with 1 percent IP response corresponding to 10 mV/v.

IP logs are generally used qualitatively to semi-qualitatively to detect disseminated sulfide (pyrite) and sometimes montmorillonite clay.

Caliper Measurement

The caliper log is a mechanical three-arm or a single-arm measurement that physically determines the average diameter of a borehole. The diameter increases in cavities and, depending on the drilling techniques used, in weathered zones. An apparent decrease in borehole diameter may result from mud or drill cutting accumulation along the sides of the borehole and in the bottom of a boring. Data from the caliper log is used to vertically locate cavities or washouts and to diameter that directly affects the response of other measurements.

Sonic Measurement A sonic log shows travel times of acoustic waves through rock in microseconds. It is sometimes accompanied by an amplitude log and a Variable Density Log (VDL) of the full sonic waveforms. Spacings from 18 to 60 inches or more can be made depending on the specific objectives. Sonic logs can only be obtained in a fluid filled borehole. Additionally, high-quality sonic logs may not be acquired where the formation is not fully saturated or poorly consolidated even if the borehole is fluid filled in this region.

The transmitter on the sonic probe emits an approximate 30 Khz ultrasonic pulse twice a second. This waveform passes through the borehole fluid in all directions at the fluid velocity (approximately 5000 ft per second). When it reaches the borehole wall, the waveform travels through the rock mass at higher velocities and is refracted to 2 different receivers on the logging probe 1 ft apart.

Waveforms obtained at each receiver can be recorded digitally every 4 micro-seconds for approximately 1 millisecond (255 records after a predetermined delay time (e.g., 110 micro-seconds after the transmitter fires). The uphole instrumentation automatically picks the time between the first compressional P wave arrival at each receiver and an amplitude of the first arriving P wave. This delta T log is in microseconds per ft and is directly related to compressional wave velocity. The amplitude log is related to the signal strength of the first compressional wave arrival. Amplitude is relative as displayed from 0 to 255 (8-bit resolution) with 0 being the lowest amplitude and 255 the highest amplitude. Digitized waveforms from each receiver can be displayed and reprocessed for subsequent waveform analysis. Ideally, the first arriving P wave, the shear S wave, and the tube or Stoneley wave are all recorded in 1-millisecond record.

Discontinuities such as weathering or fracturing affect waveforms arriving at the receiver. These effects are due to increased travel time (lower velocity), reduced amplitude, and distorted waveforms. VDLs in these zones show ‘chevron’ type features propagating along the entire waveform. The thickness of the discontinuity can be measured by subtracting the transmitter/receiver spacing from the recorded vertical distortion. For example, if the recorded vertical distortion is 48 inches on the 36-inch transmitter/receiver VDLs, the rock discontinuity is approximately 12 inches.

In its simplest form, the FWS log can be used as a cement bond log with a VDLs display. In more sophisticated applications, waveform analysis can provide compressional and potentially shear velocities, and information about the Tube or Stoneley wave amplitudes.

Gamma-Gamma Density Measurement

The principle behind density logging is detecting Compton-scattered gamma rays originating form a 0.1 curies radioactive Cesium-137 source. The dual collimated gamma ray detectors are located at discrete distances from the source. This arrangement results in a directional-oriented tool which obtains measurements while flush against the borehole wall. Gamma ray intensity (measured at the detectors in counts per second) for a specific density range is inversely proportional to bulk density of the adjacent material.

The dual detector probe is designed to quantitatively measure bulk density at two different radii which vary depending upon the density of the medium and source strength. Using observed gamma-gamma intensities and the caliper reading, a compensated density log can be calculated compensating for near borehole effects.

Empirical measurements of depths of investigation and apparent densities for the dual detector probe have been made in the laboratory on various configurations of casing completions. These results are used to support interpretation of field data. The distinct density differences of grout, alluvium, air, and water allows a means of monitoring well completion evaluation when the density logs are run in cased wells.

Neutron Measurement

The neutron measurement is a single function radiation probe which detects thermal neutrons using a Helium-3 (He-3) detector. An Americium-241 (Beryllium-activated Americium-Beryllium-241 [AmBe-241]) neutron source emits high energy (fast) neutrons into the formation. These neutrons diffuse through the formation and collide with the atoms present. Collisions with atoms nearest the mass of neutrons, such as hydrogen, results in an exchange of energy. Thus, these neutrons are slowed down to thermal energies which can be detected by the He-3 detectors. Since slowing is primarily due to collisions with hydrogen, neutron count rates represent the hydrogen content of the formation and can be interpreted in terms of porosity. This measurement can be compensated by using two different source-detector spacings and taking the ratio of these measurements.

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

Borehole Video Survey

The video survey utilizes a specialized closed-circuit system capable of visually inspecting boreholes. The picture image is recorded to a VHS videocassette through a professional video cassette recorder and then viewed for interpretation on a high-resolution monitor.

The survey is usually performed from the surface downward in order to minimize the disturbance in the borehole fluid. Depth is recorded to the nearest one-tenth of a ft and displayed on the image. Logging speed is variable. A borehole video survey can be performed in an open well or in a cased well that is dry or contains clear fluid.

Borehole Deviation

Borehole orientation (azimuth and inclination angle) measurements are made with a magnetic based digital probe. The inclination angle is acquired with accelerometers and can be measured inside metal casing in addition to an open hole. The azimuth readings may be affected inside ferrous casing.

Induction Measurement

A small transmitter coil in the borehole probe induces eddy currents in the surrounding geologic material. The eddy currents generate a secondary magnetic field in the geologic materials. The strength of the magnetic field is controlled by the electrical properties of both geologic materials and groundwater. A receiver coil in the borehole measures the strength of the quadrature component of the secondary magnetic field and electronics in the instrument console convert the magnetic field strength to values of conductivity. A focusing coil in the borehole probe causes measurement sensitivity to peak about 12 inches away from the borehole axis; consequently, borehole effects are minimized and the measured electrical conductivity responds to formation and groundwater changes.

Drift and noise are typically less than 1 millisiemen per meter and conductivity changes of a few percent are easily resolved. The intercoil spacing resolves conductivity layers 20 inches thick. The system may detect layers that are thinner than 20 inches; however, the measured value is the product of conductivity contrast times layer thickness.

The borehole induction system measures bulk conductivity resulting from the electrical properties of geologic materials and contained groundwater. In general, conductivity will increase as clay content increases and as ionic strength of groundwater increases. It may be difficult to identify contaminated groundwater in sediments that contain variable amounts of clay. In these environments, comparison of conductivity logs to natural gamma logs may enable discrimination between clayey sediments and zones of contaminated groundwater. However, it is important to note that very small variations in clay content may result in large changes in conductivity. These small variations in clay content may not be resolved with natural gamma log.

The borehole induction system can be used in boreholes that range from 2 to 8 inches in diameter without significant borehole effects. Conductivity measurements may be acquired in both the vadose and saturated zones, in open holes or through PVC casing. Measurements may not be taken through steel or black iron casing. The maximum depth of measurement for the most induction logging systems is 650 ft (200 meters).

A general procedure for the information recorded for a borehole geophysics survey will include:

- Record all information necessary to correctly interpret the log including:
  - — Well identification number
  - — Project number
  - — Client Bit Size (or borehole diameter)
  - — Casing size
  - — Location of the zero-depth of the log, which may be the top of the casing, ground level, or some other specified point
  - — Height of the top of the casing above ground level
  - — Depth of the bottom of the casing(s)
  - — Total depth drilled
  - — Date of logging
  - — Logging engineer
  - — Logging speed
  - — Sensitivity Range setting(s)
  - — Calibration and standardization data
  - — Logging tool serial numbers, and
  - — Any additional pertinent information
- Record the source-to-detector distance for nuclear radiation tools and the focusing width for focused resistivity tools.
- In resistivity logging, sample the drill hole fluid and record its resistivity so that true resistivity for the strata can be calculated.
- Clearly record calibration and standardization marks on all logs to demonstrate the relationship between the log scale and standard calibration procedures.
- Assemble the downhole logging tool.
- Decontaminate logging tool and cable if necessary.

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SOP B1.3 Monitoring Well Installation

Different methods exist for the installation of monitoring wells. This SOP outlines the suggested procedure currently implemented on Base that is proven reliable for successful installation of problem-free monitoring wells. Any deviations from this procedure must be addressed in the project-specific plan must include an approved site-specific SOP..

The monitoring well program is designed to provide groundwater sampling points onsite as well as upgradient and downgradient of the site so that groundwater contamination may be characterized. Figures B1.3-1, B1.3-2, and B1.3-3 illustrate typical construction details for three types of monitoring wells, an overburden monitoring well, a double-cased monitoring well, and a double-cased open hole bedrock monitoring well.

Monitoring Well Installation Procedure

Proposed monitoring wells will be installed in accordance with the following procedure:

- Wear appropriate PPE as specified in the BWHSP (Appendix F of the BWP) and the SSHP.

- Drill borehole to the total depth using an air rotary casing hammer (ARCH) or drill rig (bit size of 8 or 10 inches). Temporary surface casing to the water table may be used to stabilize the upper portion of the drill hole, but casing must be removed as filter pack and bentonite-cement grout are installed.

- The appropriate depth will be determined in the field and is dependent on the occurrence of significant water. If significant groundwater is encountered during drilling, drilling will cease, and the hole will be allowed to equilibrate for approximately 1 hour. If a determination is made that the upper-most perched aquifer (or regional if it is determined to be the upper-most aquifer) has been reached, well installation will be completed within this zone.

- Soil samples will be collected at specified intervals as detailed in the project-specific addenda. Split-spoon samples may be screened for volatile organic compounds using the real-time air monitoring equipment. Saturated soil samples may be checked for permeability in order to establish the best interval for screen placement. One sample from each well in the screened depth may be collected for geotechnical parameters.

- Well construction will require flush-threaded Schedule 80 polyvinyl chloride (PVC) casing and 25 to 40 ft of 0.01-inch Schedule 80 slotted screen with a 5-ft sump. The length of the screen will be determined based on pending discussion with the New Mexico Environment Department (NMED). The well diameter will be specified in the project-specific plan.

- For a 4-inch diameter well the borehole will be drilled with 11 ¾-inch outer-diameter drive casing to 200 ft bgs. Collect and log soil cuttings at 5- to 10-ft intervals or at changes in lithology. Cutting samples will be collected from the cyclone. Install 200 ft of 9 5/8-inch casing inside the 11 ¾-inch casing and advance the 9 5/8-inch casing to approximately 400 ft bgs. Collect and log soil cuttings at 5- to 10-ft intervals or at changes in lithology.

- If the boring is overdrilled beyond the bottom of the proposed sump elevation by more than 10 ft, backfill the borehole with filter pack material to an elevation approximately 5 ft below the proposed bottom of sump elevation

- Use a 5-ft PVC sump, 25-40 ft of 0.01-inch PVC slotted screen, and blank casing to the top of the well stick-up. The top of the screened interval will be at least 5 ft above the existing water table. The sump will extend 5 ft below the bottom of the screened interval. Centralizers will be installed at 40-ft intervals and at the top and bottom of the screened interval in all wells deeper than 50 ft.

- Once the casing has been slowly removed from the borehole, backfill the borehole and annular space from a maximum of 1 ft below the bottom of the sump to a minimum of 2 ft above the well screen with a filter pack (10/20 silica sand). The filter pack will be placed using a tremie pipe to avoid bridging and ensure a continuous filter pack throughout the screened interval of the well. Next, a bentonite chip seal will be installed for a thickness of 10–20 ft and hydrated with potable water every 1 ft to ensure a competent seal. The thickness of the seal will be dependent on the lithology of the aquifer formation such that the bentonite seal extends form the top of the filter pack to within 5 ft of the most consolidated uit above the water table. The bentonite seal will be a minimum thickness of 5 ft. Installation of a thicker bentonite seal is currently used for monitoring wells at the Kirtland AFB to ensure that there will be no intrusion of grout from above the seal into the filter pack material below the seal.

- Install a 20 percent high solids bentonite grout mixture over the bentonite seal using a tremie pipe. The mixture will consist of 20 percent by weight of sodium bentonite powder. Install the bentonite grout to within 30 to 50 ft of the surface. The high-solids bentonite grout is currently and successfully used for well installation at the base to inhibit intrusion of grout into the well’s filter pack and screen.

- To the surface, install a cement/bentonite grout mixture over the high-solids bentonite grout using a tremie pipe. The mixture will consist of 94 pounds of Portland cement to 7 gallons of approved water and 3 percent by weight of sodium bentonite powder.

- Install an 8-inch by 5-ft protective round steel casing and a 4-ft by 4-ft by 4-inch concrete pad mounded in such a way as to direct surface runoff from the casing. Install 4-inch by 5-ft steel bollards around each well on the outside of the concrete pad. Drill a drain hole in the protective casing above the concrete surface. In locations subject to freezing, the finished pad must be designed to resist damage caused by frost heaving.

- An approximate stick-up height of 3 ft is required for each well to accommodate the dedicated pump system.

- The well will be equipped with a security lock. All locks will be keyed alike. The well will be tagged with a corrosion-resistant identification stamped on the protective casing which identifies the well number, depth, date of installation, and the adjusted top of casing elevation. The well will also be clearly designated as a monitoring well. The casing will be coated with protective paint as required by the base.

- Some wells may have to be finished flush with the ground or pavement if they are in areas of heavy traffic. This requirement shall be stipulated in the project specific addenda. Flush finished wells shall also be equipped with a lock and shall be protected from the entry of surface fluids into the well. Protective posts shall not be required on flush-finished wells.

- Continuously log soil cuttings throughout the drilling operation in accordance with SOP B1.1, Borehole and Sample Logging. Document the findings on the soil boring log sheet.

- After completion of the well a well alignment test to verify plumbness and integrity of well is recommended. The recommended method to test well plumbness and alignment is as follows:

  — A 10-ft long section of pipe, ½ inch less in diameter than the inner diameter of the well riser pipe, shall be run through the entire length of the well to check the alignment. The result of such test shall be recorded on the Daily Quality Control Reports (DQCRs) and the installation diagram. The pipe section shall be decontaminated with steam prior to the test. Adequate precautions shall be taken to prevent cross-contamination of wells with cable or rope used to conduct the test.

  — The pipe must pass freely for the entire depth of the well.

Well construction diagrams will be submitted to the client for approval. These forms will at a minimum include the following information:

- Project and site names, well number and the total depth of the well.

- Depth of any grouting or sealing, the amount of cement and/or bentonite used, and the total depth of the boring.

- Depth and type of well casing.

- Static water level upon completion of the well and after well development.

- Installation date or dates, and name of the driller and the geologist installing the well. Each installation diagram will be signed by the preparer.

- All pertinent construction details of the monitoring wells, such as depth to and description of all backfill materials installed (such as gravel pack, bentonite, and grout); gradation of gravel pack; length, location, diameter, slot size, material and manufacturer of well screen(s); position of centralizers; and location of any blank pipe installed in the well.

- Description of surface completion, including protective steel casing, protective pipes, and concrete surface seal.

- A description of any difficulties encountered during well installation.

- Survey coordinates and the elevation of top of ground and top of well riser.

- A brief stratigraphic log will be presented on the well installation diagram showing depths to and descriptions of major lithologic changes encountered in the boring.

References for Other Applicable ASTM Standards

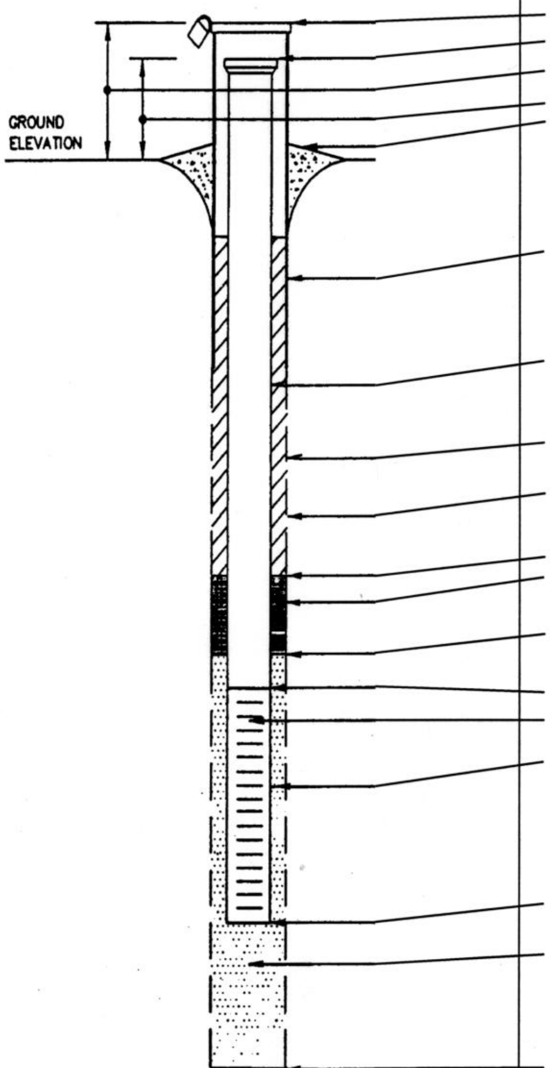
ASTM D4750 – Determining Subsurface Liquid Levels in a Borehole or Monitoring Well

Figure B1.3-1. Overburden Monitoring Well Construction Diagram

OVERBURDEN
MONITORING WELL
CONSTRUCTION DIAGRAM

WELL NO. ______________

PROJECT ______________	DRILLER ______________
PROJECT NO. ______________	DRILLING METHOD ______________
DATE __________ BORING NO.: __________	DEVELOPMENT METHOD ______________
ELEVATION ______________	
FIELD GEOLOGIST ______________	



NOT TO SCALE

ELEVATION OF TOP OF SURFACE CASING: ________
ELEVATION OF TOP OF RISER PIPE: ________
STICK-UP TOP OF SURFACE CASING: ________
STICK-UP RISER PIPE: ________
TYPE OF SURFACE SEAL: ________________

I.D. OF SURFACE CASING: ______________
TYPE OF SURFACE CASING: ______________

RISER PIPE I.D. ______________
TYPE OF RISER PIPE: ______________

BOREHOLE DIAMETER: ______________

TYPE OF BACKFILL: ______________

ELEVATION/DEPTH TOP OF SEAL: ________
TYPE OF SEAL: ______________

DEPTH TOP OF SAND PACK: ________

ELEVATION/DEPTH TOP OF SCREEN: ________
TYPE OF SCREEN: ______________
SLOT SIZE X LENGTH: ______________
TYPE OF SAND PACK: ______________

ELEVATION/DEPTH BOTTOM OF SCREEN: ________

ELEVATION/DEPTH BOTTOM OF SAND PACK: ________
TYPE OF BACKFILL BELOW OBSERVATION WELL: ______________

ELEVATION/DEPTH OF HOLE: ________

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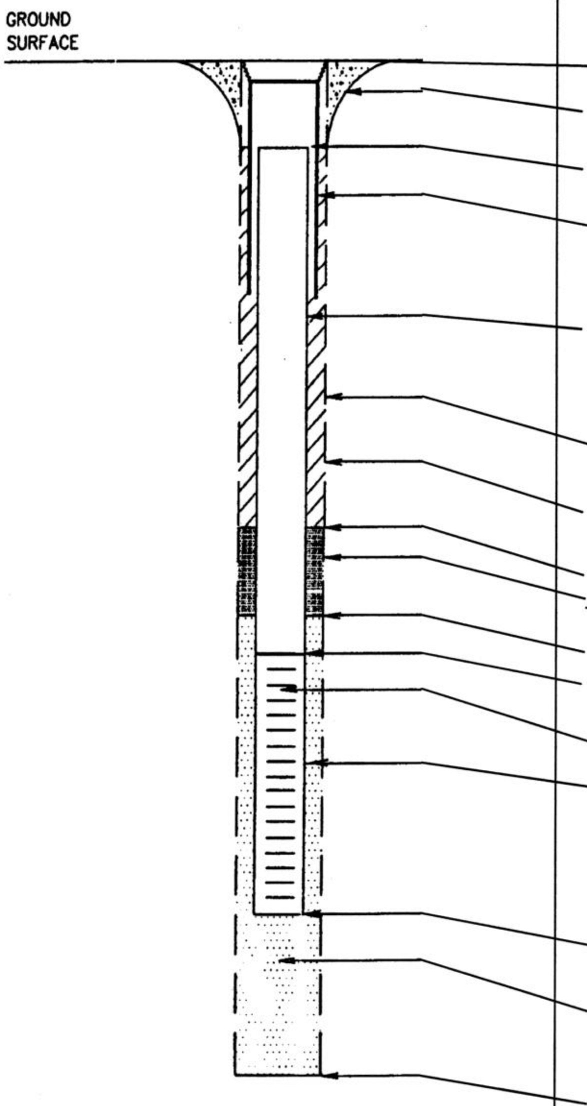
Figure B1.3-2. Overburden Monitoring Well Construction Diagram for Wells with a Flush-Mount Surface Completion

UNCONSOLIDATED
MONITORING WELL
CONSTRUCTION DIAGRAM

WELL NO. ______________

PROJECT ______________	DRILLER ______________
PROJECT NO. ______________	DRILLING METHOD ______________
DATE ______________ BORING NO.: ______________	DEVELOPMENT METHOD ______________
ELEVATION ______________	
FIELD GEOLOGIST ______________	



ELEVATION OF TOP OF SURFACE CASING: ________
TYPE OF SURFACE SEAL: ________________
GROUND SURFACE ELEVATION: ________
ELEVATION OF TOP OF RISER: ________

I.D. OF SURFACE CASING: ______________
TYPE OF SURFACE CASING: ______________
____

RISER PIPE I.D. ______________
TYPE OF RISER PIPE: ______________

BOREHOLE DIAMETER: ______________

TYPE OF BACKFILL: ______________
____

ELEVATION/DEPTH TOP OF SEAL: ________
TYPE OF SEAL: ______________
____

ELEVATION/DEPTH TOP OF SAND PACK: ________
ELEVATION/DEPTH TOP OF SCREEN: ________

TYPE OF SCREEN: ______________
SLOT SIZE X LENGTH: ______________
TYPE OF SAND PACK: ______________
____

ELEVATION/DEPTH BOTTOM OF SCREEN: ________
ELEVATION/DEPTH BOTTOM OF SAND PACK: ________
TYPE OF BACKFILL BELOW OBSERVATION WELL: ______________
____

ELEVATION/DEPTH OF HOLE: ________

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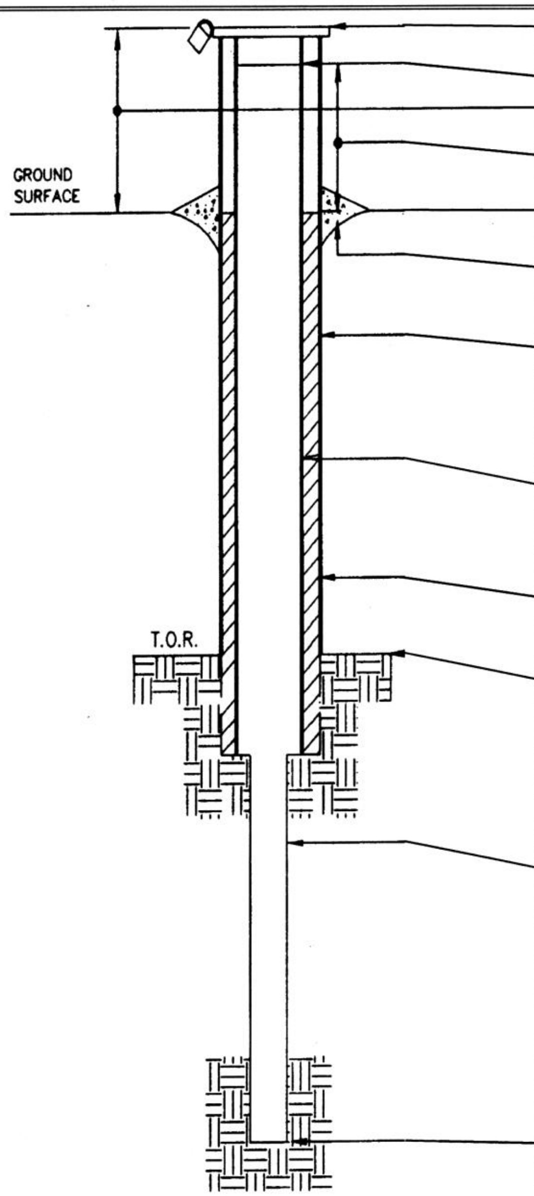
Figure B1.3-3. Double Cased Monitoring Well Construction Diagram

DOUBLE CASED
OPEN HOLE BEDROCK
MONITORING WELL
CONSTRUCTION DIAGRAM

WELL NO. ______________

PROJECT ______________
PROJECT NO. ______________
DATE ______________ BORING NO.: ______________
ELEVATION ______________
FIELD GEOLOGIST ______________

DRILLER ______________
DRILLING METHOD ______________
DEVELOPMENT METHOD ______________



ELEVATION OF TOP OF OUTER CASING: ________

ELEVATION OF TOP OF INNER CASING: ________
STICK-UP OF OUTER CASING: ________

STICK-UP OF INNER CASING: ________

GROUND SURFACE ELEVATION: ________

TYPE OF SURFACE SEAL: ______________
____

I.D. OF OUTER CASING: ______________
TYPE OF CASING: ______________
DEPTH OF OUTER CASING: ______________

I.D. OF INNER CASING: ______________
TYPE OF CASING: ______________
DEPTH OF INNER CASING: ______________

TYPE OF CASING SEAL: ______________

ELEVATION/DEPTH TO TOP OF ROCK: ________

DIAMETER OF HOLE IN BEDROCK: ________
DESCRIPTION OF BEDROCK:
____
____
____
____
____
____

ELEVATION/DEPTH OF HOLE: ________

Field Forms Templates (FF-4 BED-2CAS)
Proprietary Information

Version Date: 08/01/2001
Version 1

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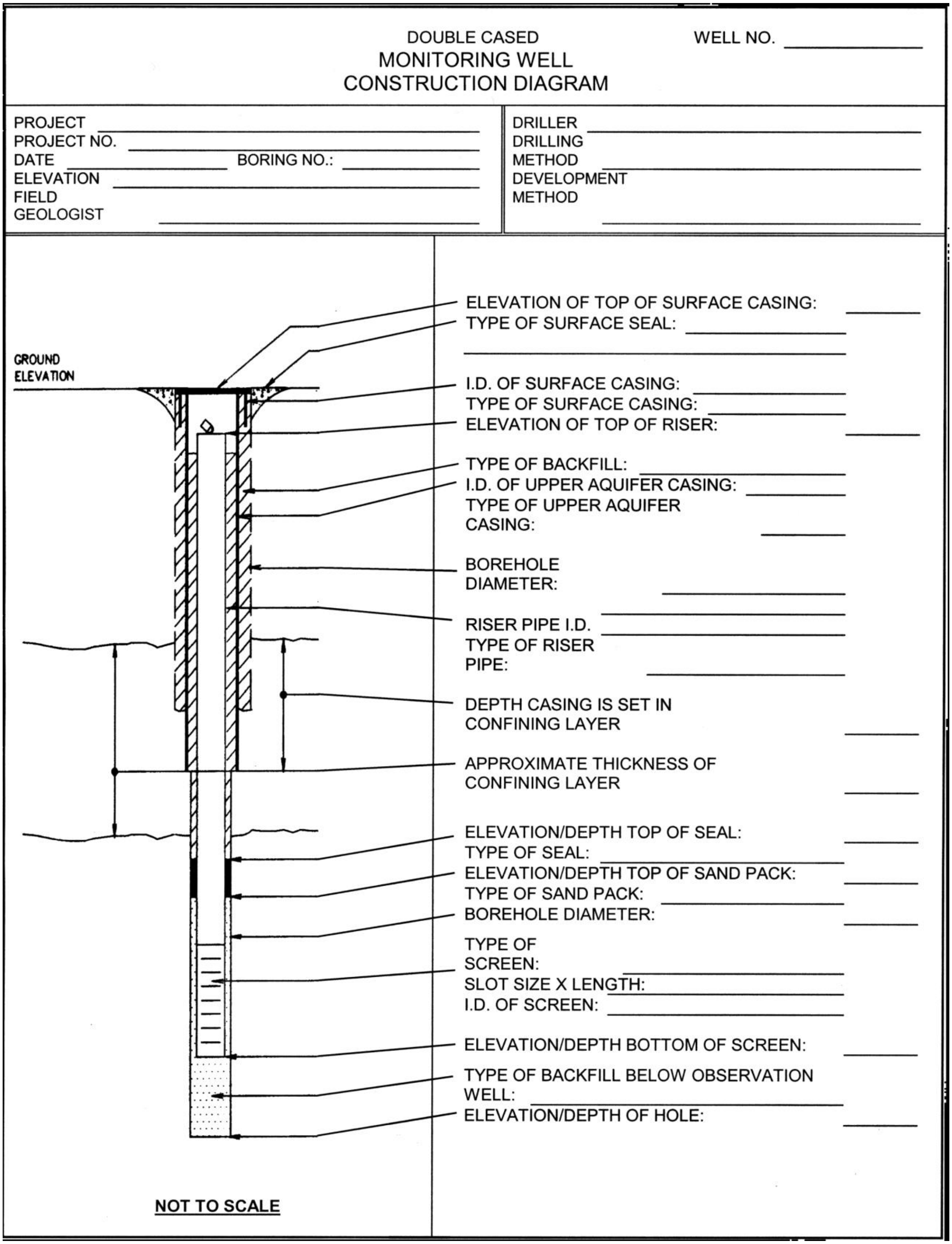
Figure B1.3-4. Double Cased Monitoring Well Construction Diagram for Wells with a Flush-Mount Surface Completion



DOUBLE CASED
MONITORING WELL
CONSTRUCTION DIAGRAM

WELL NO. ______________

PROJECT ______________
PROJECT NO. ______________
DATE ______________ BORING NO.: ______________
ELEVATION ______________
FIELD GEOLOGIST ______________

DRILLER ______________
DRILLING METHOD ______________
DEVELOPMENT METHOD ______________

GROUND ELEVATION

ELEVATION OF TOP OF SURFACE CASING: ________
TYPE OF SURFACE SEAL: ______________
I.D. OF SURFACE CASING: ______________
TYPE OF SURFACE CASING: ______________
ELEVATION OF TOP OF RISER: ________
TYPE OF BACKFILL: ______________
I.D. OF UPPER AQUIFER CASING: ________
TYPE OF UPPER AQUIFER CASING: ________
BOREHOLE DIAMETER: ______________
RISER PIPE I.D. ______________
TYPE OF RISER PIPE: ______________
DEPTH CASING IS SET IN CONFINING LAYER ________
APPROXIMATE THICKNESS OF CONFINING LAYER ________
ELEVATION/DEPTH TOP OF SEAL: ________
TYPE OF SEAL: ______________
ELEVATION/DEPTH TOP OF SAND PACK: ________
TYPE OF SAND PACK: ______________
BOREHOLE DIAMETER: ________
TYPE OF SCREEN: ______________
SLOT SIZE X LENGTH: ______________
I.D. OF SCREEN: ______________
ELEVATION/DEPTH BOTTOM OF SCREEN: ________
TYPE OF BACKFILL BELOW OBSERVATION WELL: ______________
ELEVATION/DEPTH OF HOLE: ________

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SOP B1.4 Monitoring Well Development

General Monitoring Well Development

Monitoring well development shall be preformed within one week after installation but no sooner than 48 hours after grout installation. The following procedure should be followed for the development of all newly installed wells on Base:

- Initial development will consist of swabbing, bailing, and pumping until little or no sediment enters the well (approximately 2 hours). Contain the development and purge water in a temporary tank to be installed at each wellhead.

- Following initial development, 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 after every well volume is purged. Pumping will continue until these parameters have stabilized (less than 0.2 pH units or a 10 percent change for the other parameters between 4 consecutive readings) and the water is clear and free of fines. The main goal of well development is to reduce the turbidity to less than 10 NTUs (however, under 100 NTUs is acceptable). If these parameters have not stabilized after 4 hours of continuous pumping, the well will be allowed to sit overnight and development will continue the following day for a maximum of two hours. If the turbidity still does not fall below 100 NTUs, the client project geologist will be contacted and further direction will be sought.

- Once development is complete a sample of the purge 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 sample from the well will be collected and immediately photographed to document the results of the procedure. The photograph will be a 35-mm color photo, and submitted as part of the well installation diagram. The photograph shall be a suitably back-lit close up which shows the clarity of the water. Fines remaining in the water shall not be allowed to settle out prior to taking the photograph, the depth of any sediment which collects in the bottom of the jar after the sample is allowed to settle shall be noted on the Well Construction Diagram (USACE Geology SOS).

- The site geologist will monitor and record on the well development record form, depicted in Figure B4.1-1, and in the field log book all field parameters such as pumping rates, pH, temperature, specific conductance and pertinent information.

Monitoring Well Development using Phosphate-Free Dispersant

Phosphate-Free Dispersant (PFD) can be used during the development of wells that were drilled using mud rotary techniques. A PFD disperses mud, sediment, and clay from the producing formation and filter pack within the screened interval. The removal of these blocking agents may potentially increase well productivity and reduce the total development time. The following parameters should be known prior to treatment:

- Well diameter

- Length of screened interval
- Depths of screened intervals
- Depth to water
- Total depth of well
- Surface completion of well
- Treatment length

The above parameters will determine the size and type$^{=}$ of injection equipment required to introduce the PFD/water solution into the well. This SOP is applicable to the use of Aqua-Clear® PFD.

Chemical mixing

Solution preparation is accomplished using the following procedures:

- To determine the amount of Aqua-Clear® PFD to use, perform this simple calculation:

  Aqua-Clear® PFD (gallons) = 0.002 x water volume in screened interval (gallons).

  The recommended concentration of Aqua-Clear® PFD is 0.2% by volume. This equates to 1 gallon of Aqua-Clear® PFD for every 500 gallons of water.

- Due to the high viscosity of the Aqua-Clear® PFD, it is necessary to pre-mix the dispersant with water (from an approved source) at the surface before injecting the solution into the well. This pre-mix solution should be of an adequate volume to allow even distribution throughout the treatment zone, and dictates the size of the injection equipment to be used. This pre-mix solution could be anywhere from 50 to 300 gallons and will be determined onsite. The concentration of the solution will be stronger than the recommended concentration to ensure there is enough Aqua-Clear® PFD in the pre-mix solution to achieve the desired concentration of 0.2% in the treatment zone when mixed with water.

- To determine the volume of water required to prepare the pre-mix solution, perform the following calculations:

$$\text{Well Volume (gallons)} = \pi r^2 h(7.48) \times 2$$

Where: r = casing radius in feet (ft)

h = height of water column associated with treatment length (ft)

This calculation takes into account the screen-area casing volume, water in the filter pack, and water in the formation interface. Use this volume in the calculation to determine the amount of Aqua-Clear® PFD to be used (step 1). The manufacturer recommends doubling the calculated volume.

Chemical application

The solution will be applied in accordance with the following guidelines:

- If the dispersant is to be used for development of a shallow well, the Aqua-Clear® PFD/water solution may be poured directly into the well.
- For deeper wells the Aqua-Clear® PFD/water solution must be injected down the well using a tremie line with an isolating injection tool set at the depth of the desired screen interval to be treated. The injection tool will be flanged on both ends of the desired screened interval treatment length to isolate the area for treatment. This will ensure the solution is evenly distributed throughout the screen and that the desired concentration of the Aqua-Clear® PFD/water solution is achieved.
- Set the injection tool at the desired treatment depth.
- Inject the solution into the tremie line under enough pressure to ensure the solution is dispersed into the filter pack. This can be accomplished using a transfer pump configuration.
- Repeat the treatment until the entire occluded screen interval has been treated.

Agitation

At a minimum, the PFD solution should remain in the well for 24 hours. During this time the following agitation activities should be implemented:

- After injection of the Aqua-Clear® PFD/water solution is complete, immediately start agitation of the solution in the well. Agitation ensures the solution is thoroughly blended and dispersed into the filter pack and formation interface.
- Agitation activities using a surge and swab technique should be performed every 2 hours. The screen intervals will be agitated for approximately ½ hour and allowed to set for 1.5 hours. This will be repeated every 2 hours throughout the day. The solution will then be allowed to set overnight. The agitation activities will then resume for another full day. These steps are repeated until the operator is satisfied that maximum benefit has been obtained.

Pumping

The pumping of the well is the same as described in the General Monitoring Well Development procedure if this is for a newly installed well. However, if the treatment is used to redevelop a well to increase flow rates then the following guidelines should be considered:

1. If the well is a monitoring well then the purge water will be contained and the water quality monitored as described in the General Monitoring Well Development procedure. A test of the containerized water for parameters that are currently being monitored at the site will be performed.
2. If the well being treated is a domestic/municipal well then the purge water can be discharged to the surface with the appropriate approvals and water quality parameters monitored as described in the General Monitoring Well Development procedure.

3. If the well is a production well then the purge water could be monitored for turbidity only and the discharge water will continue to be pumped into the assigned discharge zone for the well.

4. Monitoring of the well performance should be performed to determine the success of the treatment and assess the need for any future equipment modifications.

References for Other Applicable ASTM Standards

ASTM D4750 – Determining Subsurface Liquid Levels in a Borehole or Monitoring Well

Figure B1.4-1. Well Development Record and Water Quality Field Data Sheet

Well Development Record and Water Quality Field Data Sheet

Page 1 of ______

Project: ______ Well No: ______

Project No.: ______

Date: ______ *Samplers:* ______

Time Start: ______

Time Finish: ______ Checked by: ______

Well Information

Depth to Water: ______ ft. Casing Diameter: ______ in. = ______ ft. Casing Stickup: ______ ft.

Bottom of Screen: ______ ft. Borehole Diameter: ______ in. = ______ ft. Screened Interval: ______ ft.

Sample Depth: ______ ft. Saturated Screen Well Volume: ______ gallons

Drawdown Limit: ______ ft. Calculations: Casing Volume (CV) = π (cr^2) h (7.48)

Note: All depths measured from top of casing.

Filter Pack Volume (FPV) = π (br^2 – cr^2)[BS-(TS or H)] P (7.48)

Saturated Screen Well Volume = CV + FPV

Calculation Notes: cr = casing radius; h = bottom of screen – depth of water in ft.; If TS>H use TS, if TS<H use H

br = borehole radius; P = estimated porosity of filter pack (35%); BS = bottom of screen

H = depth to water; TS = top of screen

Field Equipment

pH Meter: ______ Serial No.: ______ Water Level Meter: ______ Serial No.: ______

Conductivity Meter: ______ Serial No.: ______ Turbidity Meter: ______ Serial No.: ______

Temperature Meter: ______ Serial No.: ______ Bailer: ______ Size: ______

Sample Equipment *(check one)*

☐ *Submersible Pump* *Pump Type (circle one):* *Piston* *Bladder* *Impeller*

☐ *Disposable Teflon Bailer* *Pump Model:* ______

Serial No.: ______

Field Chemistry

pH ______ = @ ______ ºC pH ______ = @ ______ ºC pH ______ = @ ______ ºC Time ______

Conductivity Standard: ______ µmhos/cm @ 25ºC Reading ______ µmhos/cm @ ______ ºC Time ______

Turbidity Standard: ______ N.T.U. @ 25ºC Reading ______ N.T.U. @ ______ ºC Time ______

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Figure B1.4-1. Well Development Record and Water Quality Field Data Sheet (Concluded)

Well Development Record and Water Quality Field Data Sheet

Page 2 of ________

Project: ____________________ Well No: ____________________

Project No.: ____________________ ____________________

Date: ____________________ *Samplers:* ____________________

Time Start: ____________________ ____________________

Time Finish: ____________________ Checked by: ____________________

Field Chemistry (cont'd)

Time	Volume gallons	Temp. ºC	pH	Conductivity µmhos/cm	Turbidity N.T.U.	Comments

Was well sampled after development? ___YES ___NO

Sample Method:______________________________

Sample Name:______________________________

Analyses:______________________________

____

____

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SOP B1.5 Monitoring Well and Borehole Abandonment

All well and borehole abandonment procedures will be performed in accordance with all federal, state, and local regulations. Well abandonment will be supervised by a qualified geologist or hydrogeologist and the details recorded on the Well/Borehole Abandonment Form, depicted in Figure B1.5-1. Unless otherwise specified, monitoring wells will be abandoned as described below:

- Wear appropriate PPE as specified in the BWHSP (Appendix F of the BWP) and the SSHP. In addition, samplers will don new sampling gloves at each location.

- Prior to abandonment, the borehole or well will be probed to determine the total open depth of the hole or well casing, respectively. Water level measurements should also be measured and recorded.

- All stainless steel or steel existing well casings should be completely removed or drilled out to the total depth of the well to avoid groundwater contamination due to corrosion. PVC casings may remain in place.

- A plugging material consisting of one or a combination of the following materials will be used:

  — Neat cement with not more than 5 percent by weight of bentonite;

  — Bentonite slurry (which can include polymers designed to retard swelling);

  — High solids grout

  — Pelletized medium grade or crushed bentonite.

- Cement and bentonite slurries will be pumped into place in a continuous operation with a grout pipe introducing the plugging material at the bottom of the well and moving the pipe progressively upward as the well is filled. This method will be repeated to within 2 ft below the ground surface unless otherwise specified.

- The well casing will be severed at least 2-ft below the ground surface, if not required to be completely removed, and a cement plug larger in diameter than the well bore will be constructed over the well bore and completed flush with the ground surface.

- When using pelletized or crushed bentonite, the bentonite will be poured down the hole in 3- to 5-ft lifts and hydration using clean potable water between lifts. This method will be repeated to within 2 ft below the ground surface unless otherwise noted.

References for Other Applicable ASTM Standards

ASTM D5299 – Decommissioning of Groundwater Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities

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Figure B1.5-1. Well Abandonment Form

Well Abandonment Form

Project Name	Borehole Number
Location	Well Number
Project Number	Page ______ of ______

Logged By	Checked By	Reason For Abandonment
Driller		
Drilling Method		Measured Depth of Well / Depth to Water
Sampling Method		Was Old Well Removed? Yes No Partial
Start Date	End Date	Drilled Diameter / Quality of Backfill (Gal)

DEPTH (feet)	SAMPLE NUMBER	MATERIAL DESCRIPTION	BACKFILL DESCRIPTION	WELL CONSTRUCTION DETAILS	WELL SCHEMATIC
				TOP OF SEAL ______	
				TOP OF SAND ______	
				TOP OF SCREEN ______	
				WATER LEVEL ______	
				DEPTH OF WELL ______	
				DEPTH OF HOLE	

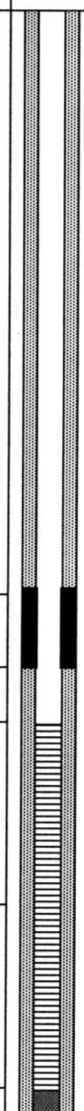

Figure B1.5-1. Well Abandonment Form (Concluded)

Denver Federal Center Boring Log	Project Name Contractor Project Number	Boring Number Page ______ of ______

Depth (ft-bgs)	Blows/6" (recovery)	PID (ppm)	Graphic Log	MATERIAL DESCRIPTION	REMARKS

SOP B1.6 Temporary Well-Point or Hydropunch-Type Sampling

Temporary well-point or hydropunch-type sampling is designed to provide a groundwater sample from a designated depth or depths at a given location. The sample is obtained on the day of performing the operation leaving an abandoned borehole. The equipment used for extracting the groundwater samples consists of a drill rig, setup for hollow-stem auger drilling or other method, and a Hydropunch ™ or equivalent sampling device. The hydropunch-type sampling device consists of a steel point driven by an outer steel casing to the desired depth below the base of the auger. The casing is pulled back 3 to 3.5 ft exposing the screen (stainless steel) at the driven depth through which the groundwater sample is obtained. An appropriately sized bailer of appropriate composition is used to withdraw the groundwater sample after sufficient recharge time has elapsed.

The SOP for hydropunch sampling is as follows:

- Wear appropriate PPE as specified in the BWHSP (Appendix F of the BWP) and the SSHP. In addition, samplers will don new sampling gloves at each location.
- Decontaminate the well-point. If the bailer is not composed of Teflon® or stainless steel, decontamination may consist of Liquinox® wash, potable water rinse and distilled water rinse. A chemical decontamination could adversely affect the bailers.
- Begin drilling the borehole, of sufficient diameter for the hydropunch sampler, by advancing the hollow stem auger to a depth less than 4 ft above the desired sampling depth. The Hydropunch ™ sampler is then placed at the bottom of the borehole.
- Drive the well-point sampler (hydropunch) at least 4 ft beyond the bottom of the borehole (base of hollow-stem auger) to the desired groundwater sampling depth.
- Withdraw the outer steel casing of the hydropunch 3 to 3½ ft to allow water to flow into the screen of the sampler.
- Allow a minimum of 15 minutes and a maximum of 2 hours for formation groundwater to fill the inside of the screen. If 2 hours is insufficient time for enough water to enter the screen to generate a sample, remove the sampler and abandon the borehole or drill to the next sample depth.
- No purging will be performed prior to sampling. Carefully lower the decontaminated bailer of appropriate composition (i.e. Teflon® or stainless steel) to the bottom of the screen. Carefully withdraw the bailer and fill the sample container. Project-specific requirements should be presented in a project-specific addenda to the QAPP. Record in log book sample depth, time of installation and filling of sample bottles, sample description and field measurements, if applicable.
- Preserve, cool, and package the sample bottles as required for shipment to the laboratory within 24 hours.
- If the last sample depth is completed, withdraw the well-point or hydropunch steel casing and abandon the borehole according to appropriate requirements. If another sampling depth is required at the same boring, remove the well-point screen and drill to less than 4 ft above the next sample depth. Repeat the above procedures for sample collection.

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SOP B1.7 Soil Gas Investigation

The objectives of the soil gas investigation will be to identify possible source areas and to help determine the extent of VOC and SVOC migration in the soil and groundwater. The procedures presented in this SOP provide instructions for both active and passive soil gas sample collection, although passive sample collection is the preferred method. Any other soil gas sampling techniques required by a project that do no relate to this SOP should be presented in the project-specific addenda to the BWP as part of the project work plan.

Passive Soil Gas Sample Collection

Passive soil gas sampling will be performed using the Gore-Sorber® or EMFLUX® methods for soil gas sample collection and analysis. The Environmental Technology Verification Reports produced by the U.S. Environmental Protection Agency for Soil Gas Sampling Technology for the Gore-Sorber® Screening Survey (EPA, 1998) and EMFLUX® Soil Gas Investigation System (EPA, 1998) can be referenced for further information.

Sample Material Emplacement

- A 5/8-inch-diameter, solid steel probe, will be driven into the ground (using DPT or manual method) and withdrawn. The depth to which the steel probe is driven, typically 3 to 4 ft, will vary based on site conditions.

- A hollow sampling probe will be inserted approximately 2 ft into the hole. The sampling probe will have an outside diameter slightly larger than 5/8 inch to provide a seal preventing ambient air from entering the sample hole.

- The insertion tool used to emplace the sampler will be inserted through the sampling probe to the desired depth and removed once placement is complete. The sample probe will then be removed from the hole leaving the sampler in place. The hole should immediately be plugged so no gases can escape. Gore-Sorber® samplers should remain in place for 10 to 14 days and EMFLUX® samplers should remain in place for at least 3 days.

Sample Analysis

W.L. Gore and Associates, Inc. will perform all analytical laboratory work when Gore-Sorber® samplers are utilized and a certified and contracted laboratory will perform the passive soil gas analysis on the EMFLUX® samplers.

Active Soil Gas Sample Collection

Equipment

A portable gas chromatograph (GC) (such as a Photovac Model 10S70) will be used to analyze the soil gas samples. The GC will be configured with an isothermal oven and a PID. The GC computer will be programmed to recognize and quantify the project-specific chemicals of concern (COC) as defined in the project-specific addenda. In addition, the pattern generated by the government-supplied fuel sample will be qualitatively identified if benzene, toluene, ethylbenzene, and xylenes are the project specific COCs.

Calibration

The GC should be calibrated according to manufacturers' instructions relative to the COCs upon consultation with the project chemist or designee.

The GC will be calibrated daily prior to commencing fieldwork and that calibration will be verified throughout the day. An aliquot of vapor from the working standard will be injected into the GC. The GCs computer will be programmed to quantitatively recognize the chromatographic peaks of each soil gas target compound. Nontarget volatile organic compounds present in soil gas samples will be reported as unknowns.

Sample Collection

Active soil gas samples will be collected in the following manner:

- A 5/8-inch diameter, solid steel probe, will be driven into the ground and withdrawn. The depth to which the steel probe is driven, typically 3 to 4 ft, will vary based on site conditions and as specified in the project addenda.

- A hollow sampling probe will be inserted approximately 2 ft into the hole. The sampling probe will have an outside diameter slightly larger than 5/8 inch to provide a seal preventing ambient air from entering the sample hole.

- A hand-operated vacuum pump will be attached to the sample probe using a Teflon®/stainless steel fitting. Approximately 10 probe volumes of air will be purged from the sample probe to ensure the soil gas sample is not diluted by the air in the sample probe.

- A 1.0 mL aliquot of soil gas will be collected using a Hamilton Gas-Tight syringe. The syringe will be inserted through a septum on the Teflon® sample tube, upstream of the vacuum pump.

- The 1.0 mL soil gas aliquot sample will be immediately injected into the GC for analysis.

Quality Control

QC samples will be run throughout the field investigation to ensure the integrity and reproducibility of the data. A minimum of 20 percent of the samples analyzed will be for QC purposes or as indicated in the project-specific addenda. QC samples will be analyzed randomly or in response to suspected interferences. QC samples will include field duplicates, calibration standards, equipment and instrument blanks, and method blanks (background). Field duplicates involve analysis of 2 or more samples from the same hole and are used to check the reproducibility of the sampling and analysis procedures. Calibration standards involve re-analysis of the standard over the course of the day and are used to confirm the calibration of the GC. Equipment blanks involved analysis of ambient air drawn through the decontaminated sample probe when it is not in a sample hole (probe blanks), or analysis of an aliquot of hydrogen-free air in the sample syringe (syringe blanks); these blanks are used to verify adequate decontamination of the sample probe and syringe, respectively. Instrument blanks involve analysis with no injection (no injection blanks) and are used to determine if there is any carryover contamination in the GC. Method blanks involve analysis of ambient air and are used to assess the presence of background contamination.

If instrument blanks indicate there is contaminant carryover in the GC, the GC will be decontaminated using heat, ambient air, or hydrocarbon-free air. If equipment blanks indicate there is contamination of the syringe, the syringe will be decontaminated by exposure to heat, replacement of syringe parts, or replacement of the syringe until the syringe is adequately decontaminated. If equipment blanks indicate contamination of the probe, the probe will be decontaminated by either wet or dry methods until the probe is adequately decontaminated.

Data Reporting

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

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SOP B1.8 Surficial Geophysical Surveys

Many types of geophysical surveys are available to assist in the overall analysis of a site, including resistivity, magnetometry, electromagnetic induction (EMI), seismic refraction, and ground penetrating radar (GPR). The measurement of subsurface resistivity is applicable to determine and provide indirect information on the porosity and permeability of subsurface materials, degree of saturation, subsurface materials, subsurface lithology, dissolved electrolyte plumes, and presence of buried wastes. The application of magnetic surveys centers on confirming the presence or absence of buried ferromagnetic objects. EMI can be useful for locating and mapping subsurface utilities, trenches, buried objects, and contaminant plumes. Seismic refraction is an effective method for the determination of the depth and thickness of subsurface geologic layers, including the depth to bedrock or water table. GPR can be a powerful tool for locating and mapping metallic and non-metallic items such as buried drums, foundations, non-containerized wastes, underground utilities, and many other artifacts.

At Kirtland AFB, it is anticipated that the geophysical methods to be employed will be limited to the investigation of buried wastes and plume delineation through magnetometry surveys, EMI, and GPR. These methods are described in this section. Should it be advantageous to use resistivity or refraction techniques at one or more of the sites, these will be discussed in detail in project-specific addenda.

In the EMI method, the electrical conductivity of a geohydrologic section is measured by transmitting a relatively high-frequency electromagnetic field into the earth that produces eddy currents. These currents generate secondary electromagnetic fields that are detected by a receiver. The eddy currents are induced in the earth by an above-ground transmitter coil, and the resulting secondary electromagnetic fields are coupled to an above-ground receiver coil. Thus, EMI measurements do not require direct ground contact, and surveys across a line or area may be performed quite rapidly.

Magnetometry consists of measuring local variations in the earth's magnetic field along a traverse or across an area on the surface. Because the intensity of the earth's magnetic field depends in part on the magnetic susceptibility of subsurface materials, knowledge of variations in field intensity provides an indication of variations in the distribution of materials with different magnetic susceptibilities.

GPR operates on the principle of time-domain reflectometry, in which the difference in strength and the time delay between a transmitted electromagnetic pulse and its reflection from an object are measured. The time delay (t) is directly related to the propagation velocity of the electromagnetic waves (v) and to the distance between the transmitter and the object (D) as follows:

$$t = \frac{2D}{v}$$

Because GPRs are normally used at or near the surface of the ground, the distance D corresponds to the depth of buried targets that scatter the radar signals.

Borehole geophysical surveys utilize acoustic, electrical, magnetic, electromagnetic, and passive and natural radiation source methods to determine the geohydrologic characteristics surrounding a borehole. Data acquired with appropriate QA/QC procedures are repeatable and comparable over different time periods, which provides the opportunity to evaluate changes over time. Often times the log suite selected investigates a larger borehole volume than can be evaluated using only the drill cuttings or samples, therefore, characteristics of the medium outside of the borehole diameter can be inferred.

Ground Penetrating Radar

The strength of a radar signal is a complex function of the distance traveled through the medium and the dielectric constant, the magnetic permeability and the electrical conductivity of the medium. Radar signals are attenuated rapidly in materials with high electrical conductivity. The attenuation of radar signals in subsurface media is a strong function of the mineralogy and the water content. Thus, materials such as dry sands and gravels are least absorptive of radar signals, whereas wet mineralogic clays are saline soils can be highly absorptive. The absorptive properties of the medium limit the penetration depth, i.e., the depth at which targets can be detected.

GPR surveys are usually performed by establishing a grid of parallel survey lines across the site and moving the radar antenna along each of these lines. A suitable means must be provided for determining the location of the radar unit along each of the lines, and for documenting this information on the recording medium. Typical systems measure the time and velocity of antenna motion, or determine the position of the antenna by synchronization signals from the wheels or tracks of the vehicle used to tow the antenna. Simpler systems have used aluminum foil strips placed across the path of the antenna to provide unambiguous location information directly on the radar traces. Global positioning system (GPS) measurements can be integrated with the radar data in "open" areas void of dense canopy.

To determine the depth of anomalies noted on radar traces, the travel time data actually recorded are corrected to depth using measured or estimated wave velocities. The velocity of electromagnetic waves in the subsurface medium at the site can be determined by excavation to observed targets and measuring their depths, or by acquiring data over objects at a known depth (e.g. underground utilities). The velocity should be determined at several points in the area of interest. Alternatively, the velocity can be estimated based on the subsurface medium's characteristics in comparison to other media with known velocities.

For determination of large-scale subsurface geologic features or to detect larger buried targets, reconnaissance-type, low-resolution surveys are typically performed with a track spacing of 5 to 15 ft or more. Surveys to detect small discrete targets may require a track spacing as close as 2 to 5 ft.

Reflected radar signals are electronically processed and displayed as an intensity-modulated time spectrum, where the time of the signal response is related to the target depth. Typically, the data are digitally recorded on the internal hard drive or small field computer, which is commonly built into the radar systems.

Although much of the data obtained in a GPR survey are automatically recorded by the instrumentation, additional information to unambiguously identify and to interpret each profile should be recorded on standard data sheets. As a minimum the data sheet should contain the following information:

- Project name and location with state planar coordinate information
- Company or organization
- Date and time of day
- Operator(s) name
- Instrument make, model, serial number, and calibration date/frequency (if applicable)
- Weather, surface topography, vegetation, and soil descriptions

- Relevant notes, remarks or comments about the survey
- Visible metal objects and their locations in the vicinity such as fencing, electric poles, railroad tracks, power lines, large radio frequency transmitters, etc.
- Antenna frequencies
- File designation (e.g., File 1 = Line 0, start 0,0, end 0,150, marks =25 ft)

Electromagnetic Induction (EMI) Surveys

For most EMI surveys, known or assumed geohydrologic features of the site, potential source locations and migration characteristics of hazardous constituents, are used to select specific techniques and equipment to establish appropriate locations and depth extents for anticipated geophysical measurements. A positioning system (e.g., GPS, Robotic Total Station, etc.) is selected to provide positioning information for the geophysical sensor, and a generalized grid system is generated at the site of investigation to guide field personnel across the survey area. Depending upon the specific EMI instrumentation used, continuous or "point" measurements are recorded by field personnel over the area of interest.

Information obtained during an EMI survey should be recorded digitally with the instrumentation, in the field log book, or on applicable field data sheets. At a minimum, the heading for each data sheet should contain the following information:

- Project name and location with state planar (or other) coordinate information
- Company or organization
- Date and time of day
- Operator(s) names
- Instrument make, model, serial number, and calibration date/frequency (if applicable)
- Weather (especially thunderstorms), surface topography, vegetation, and soil descriptions
- Relevant notes, remarks or comments about the survey
- Visible metal objects and their locations in the vicinity such as fencing, electric poles, railroad tracks, power lines, large radio frequency transmitters, etc.
- Specific method/technique identification
- Instrumentation test location (according to the survey plan)
- Coil types and configuration

Several of the more common and cost-effective EMI techniques that may be used at Kirtland AFB are detailed below.

- Frequency Domain Measurements:

  — The frequency domain EMI technique is a geophysical method in which a time-varying electrical current is induced into the ground with a transmitter coil, and the resultant magnetic fields are measured with a receiver coil. The flow of electrical current in the ground can be interpreted in terms of the apparent ground conductivity.

  — The transmitter coil induces small amplitude currents (eddy currents) in the earth. Most EMI techniques employ frequencies from a few-hundred to several-thousand hertz (hz). These eddy currents produce a magnetic field that is measured by a receiver coil located a fixed distance from the transmitter coil. Under certain constraints, the measured response is proportional to the ground conductivity. The quantity actually measured at the receiver coil is the voltage of the signal, and is expressed in mvs, or equivalently in parts per thousand of the transmitted signal.

  — The electromagnetic instrument response at the receiver coil can be divided into two distinct components differing in phase by 90 degrees. The in-phase response tends to emphasize the presence of metallic materials. The quadrature (i.e., "out-of-phase") response most readily characterizes the apparent ground conductivity. The signal amplitude for the quadrature and in-phase responses are dependent upon the transmitter frequency, transmitter/receiver separation distance, and the conductivity of the ground. Under certain constraints, the quadrature response is linearly related to the ground conductivity.

  — Conductivity contrasts in the earth can be caused by natural phenomena such as lithologic changes, or by man-made phenomena such as disturbed ground, buried materials, or contaminants in the soil or groundwater. Generally, man-made materials that are metallic can produce large contrasts in conductivity with the surrounding geologic material.

  — The EMI quadrature phase data are most useful for determining lateral changes in conductivity that may be related to manmade waste materials and/or natural geologic conditions. The factors that primarily affect the ground conductivity are the subsurface moisture content, conductivity of the moisture, and type of material in the vicinity of the instrument. EMI in-phase data are most useful for providing information on surface and subsurface metallic material.

  — The maximum depth of investigation of the EMI instrumentation is primarily a function of the frequency employed and the transmitter/receiver coil separation. The EM-31 manufactured by Geonics Limited, utilizes a fixed frequency of 9.8 kilohertz (Khz) and a coil separation of 12 ft. The maximum depth sensitivity of the EM-31 is approximately 18 ft. The EM-38, another system manufactured by Geonics Limited, uses a frequency of 14.2 Khz and a coil separation of 3 ft to achieve a maximum penetration (i.e. depth of sensitivity) of approximately 5 ft. These 2 instruments are primarily used to cost-effectively delineate lateral conductivity changes at a site.

  — If it is necessary to determine the change of conductivity with depth, other EMI instrumentation exists. These techniques are often referred to as "electromagnetic sounding" techniques in the geophysical community. The data can be useful for determining the approximate vertical contact between landfill materials and native geology if a sufficient contrast in conductive properties exists. The method is not very useful for determining this contact if the transmitter/receiver separation is greater than the width of the landfill (i.e., it is not the best method to employ if most of the waste materials are confined within "thin" trenches).

— The Geonics Limited EM-34 has the ability to utilize 3 frequencies from 0.4 Khz to 6.4 Khz and coil separations of 10, 20, and 40 meters. By varying the frequency and/or coil orientation at a constant coil separation, the system is sensitive to variations in conductivity at different depths. The maximum depth sensitivity of the EM-34 system is approximately 200 ft. The Max-Min EMI sounding system manufactured by Apex Parametrics has the ability to utilize 10 frequencies from 220 Hz to 56 Khz and coil separations of 25 to several hundred ft. Again, by varying the frequency at a user-defined constant coil separation, the system is sensitive to variations in conductivity at different depths.

— EMI sounding techniques are generally more cost effective than direct current resistivity techniques, however, the methodology used should be carefully selected by experienced personnel after a thorough review of the program objectives and site specific variables.

- Time Domain Measurements-Geonics EM-61:

— The EM-61 time domain EMI technique is a geophysical method primarily designed for detecting metallic objects. Numerous primary electromagnetic pulses (150 per second) are directed into the ground with a coil, and the secondary magnetic field generated within the subsurface is measured during the time between pulses. For metallic targets, the secondary magnetic field exists for longer periods of time when compared to the secondary magnetic field response from natural earth materials. By measuring the secondary magnetic field at a specific time, the relative response between metallic and natural earth materials is at a maximum.

— The EM-61 system consists of various geometries of coils, coil sizes and time gates of measurement. The utilization of 2 coils permits the EM-61 to discriminate between shallow and deep targets, much like a vertical magnetic gradiometer. The EM-61 has the ability to detect a single 55-gallon drum at a depth approaching 10 ft in optimum conditions.

Magnetic Surveys

There are a variety of different types of magnetometers designed for specific situations. In general, magnetometers detect man-made items and features that are ferrous (i.e., contain iron). Natural features that have different amounts of magnetite and other magnetic minerals (e.g., fault contact between intrusive gabbro and limestone) can also be identified using magnetometry.

Magnetic measurements are generally made in a series of parallel lines across the survey area. The desired resolution and the size and depth of the objects of interest determine the location and spacing of measurement stations or survey lines. Data are digitally recorded, and the resulting magnetic intensities at locations across the survey area are used to infer the presence of magnetic anomalies. Because of the phenomenon of temporal magnetic drift (usually diurnal), a magnetic survey should include a base station at which magnetic measurements are made at regular intervals. The base station is later used to correct all field survey data for the earth's natural diurnal magnetic field changes. At a minimum, the following information should be recorded during the survey.

- Project name and location with state planar (or other) coordinate information
- Company or organization
- Date and time of day
- Operator(s) names
- Instrument make, model, serial number, and calibration date/frequency (if applicable)
- Weather (especially thunderstorms), surface topography, vegetation, and soil descriptions
- Relevant notes, remarks or comments about the survey
- Visible metal objects and their locations in the vicinity such as fencing, electric poles, railroad tracks, power lines, large radio frequency transmitters, etc.
- Specific method/Technique identification
- Instrumentation test location (according to the survey plan)
- Sensor configuration and ground clearance (e.g., vertical gradiometer, sensor separation 2 ft, lower sensor 2½ ft above ground surface, sensor orientation vertical)
- Base station(s) location

Special care must be taken with handling of the magnetometer during use. A qualified and trained technician will be allowed to operate the magnetometer. The operator must not take measurements with the sensor near ferromagnetic objects such as belt buckles or steel-toed/shank boots. The orientation of the magnetometer and its height from the ground must also be carefully controlled during operation. Recorded data must be annotated with station locations to allow construction of a site magnetic map. Manufacturer’s specifications and operational procedures including calibration and maintenance will be adhered to.

SOP B1.9 Land Surveys

A state-licensed professional surveyor will perform surveys. Signed and sealed originals of all field notes, survey plats and drawings shall be submitted to the Contractor. Surveys should at a minimum conform to the requirements stated in Article 12.8.2 of the New Mexico Administrative Code (NMAC), Minimum Standards for Surveying In New Mexico. The methods and tolerances provided in USACE Engineering Manual (EM 1100-1-1005) should also be consulted when performing surveys.

Monitoring Wells—Coordinates and elevations will be established for each monitoring well. The coordinates will be to the closest 0.1ft and referenced to the State Plane Coordinate System. If the State Plane Coordinate System is not available an existing local grid system will be used. A ground elevation to the nearest 0.01 ft and an elevation for the top of the well riser to the closest 0.01 ft will be obtained for each well. All positions and coordinates of all permanent points within the control traverse will be shown.

Soil Borings/Sampling Points—All soil sampling locations will be located horizontally and vertically as required following procedures outlined in the previous paragraph.

Physical Features—At each site, all above-ground and, where possible, underground physical features will be either verified with previous mapping or determined as required. All above ground physical features will be located/verified to the nearest ft. Permanent control monuments will be placed in accessible locations within the limits of the work if no existing permanent monuments are located within 1,000 ft of a site. One set of monuments is allowable for adjacent sites. These monuments will be set no closer than 500 ft to each other. The permissible error for the traverse closure of permanent control monuments is 1/5,000 ft.

Documentation and Deliverables—The location, identification, coordinates, and elevations of the wells and monuments will be plotted on maps with a scale large enough to show their location with reference to other structures at the individual sites. A tabulated list of the monitoring wells and monuments, copies of all field books, and all computation sheets will be prepared and submitted to the Contractor. The tabulation will consist of the designated identification number of the well or monument, and its northing (X-coordinate), easting (Y-coordinate), and elevation.

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SOP B1.10 Meteorological Monitoring

Meteorological monitoring will be conducted only when environmental restoration activities dictate. A meteorological station shall be set up at a designated site to provide continuous recording of meteorological parameters applicable to atmospheric transport and dispersion of air contaminants. At field sites that are immediately adjacent to the Albuquerque International Airport/Kirtland AFB flight facilities, meteorological data provided by the Airport can be used to establish the atmospheric conditions at the subject sites, provided that the data meets the QA/QC levels required by the dispersion models and includes the necessary model parameters. At Kirtland AFB locations either in remote areas or at Interservice Nuclear Weapons School sites, where thorium hydroxide sludge was spread on the ground to resemble a nuclear weapons accident, meteorological instruments employed on 10 meter towers should be used to characterize the meteorology of the sites.

The four basic parameters normally monitored include wind speed and direction, ambient temperature, and sigma theta (used as an indicator of atmospheric stability). At those sites where the soil may contain a significant amount of volatile compounds, the station will include sensors for recording soil temperatures and solar radiation. Both parameters may be used to estimate source emission terms of hazardous air contaminants.

The onsite meteorological system will provide several functions. These include:

- Provide real-time data to be used in siting of upwind (background) and downwind samplers.
- Provide a data record to indicate the variability of wind flow from suspected sources to air samplers during the sampling period.
- Provide a data record to estimate atmospheric dilution rates and meteorological effects on source strength during the sampling period and.
- Provide real-time data to be used by the Site Health and Safety Officer to estimate atmospheric diffusion of air emissions, to ensure the safety of on and offsite personnel.

Meteorological parameters to be collected include:

- Wind speed to indicate the potential degree of dust suspension
- Wind direction to indicate the direction of the potential wind transport mechanism
- Precipitation to assess soil moisture conditions
- Stability to indicate onsite stability for dispersion of contaminants
- Barometric pressure to indicate corrections of flow rates to standard temperatures and pressure
- Ambient air temperature to indicate the potential of volatile suspension

Calibrations will be performed in accordance with manufacturers' recommendations. All calibrations and system checks must be properly documented. The meteorologist will also insure that all strip charts are properly labeled and will perform data reduction after the completion of the monitoring program.

Once installed, the meteorological monitoring system should be fully calibrated on a semi-annual basis using certified and traceable physical standards and test equipment. Semi-annual audits of the meteorological monitoring systems should also be performed by fully independent qualified experts using separate equipment and standards.

The meteorologist should ensure that station calibration and time accuracy is checked at the beginning and end of the monitoring period and that periodic checks of the system for proper operation are performed. These checks will include time accuracy, strip chart trace legibility and reasonableness of recorded data.

Where feasible, the system should be checked at the beginning and end of each workday and a minimum of one other time during the day.

Meteorological data should be compiled on sampling days and correlated with particulate sampling results. The location of the meteorological station and rain gauge will be based upon a review of the actual site layout. Data summaries should be compiled on a quarterly and annual basis.

Daily Meteorological Station Inspection

- Open chart recorder and check the integrity of each trace. Verify reference time on chart corresponds to the time of day. Check paper supply to ensure that enough paper is available for uninterrupted operation through the next day (or weekend). Initial chart paper, record inspection on chart paper and into field log book and data sheets.

- Inspect rain gauge and record any precipitation data into field log book and onto data sheets. Empty rain gauge and clean funnel of any foreign material.

- Inspect meteorological tower mast for stability and integrity.

- Calibrate station weekly using a four-digit voltmeter according to manufacturer’s instructions. Record all data in the field log book.

SOP B1.11 Equipment Decontamination

The objective of field decontamination is to remove contaminants of concerns from sampling, drilling and other field equipment to concentrations that will **not** impact study objectives. This SOP was developed for use by field personnel who are responsible for cleaning sampling or other equipment in the field.

Specification for Decontamination Materials

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

Handling and Containers for Cleaning Solutions

Improperly handled cleaning solutions may easily become contaminated, thereby jeopardizing the validity of the sample data. Containers should be constructed of the proper materials to ensure their integrity. The following containers should be used for storing the specified cleaning materials:

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

Decontamination of Large Equipment

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

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

Decontamination of Sampling Equipment

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

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

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

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

Construction of a Decontamination Pad

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

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

Personal Protective Equipment

Personnel directly involved in equipment decontamination shall wear appropriate PPE as specified in the BWHSP (Appendix F of the BWP) and the SSHP. The appropriate PPE is selected based on the level of contamination present or suspected at the site. Care should be taken so the selected PPE protects decontamination workers from unnecessary contact with soils or decontamination fluids. The following is a list of the minimum PPE required to perform decontamination activities:

- Safety glasses with splash shields or goggles and latex gloves will be worn during all cleaning operations. For decontamination activities involving large amounts of water, rain suits or aprons and rubber over-boots should also be worn.

No eating, smoking, drinking, chewing, or any hand-to-mouth contact should be permitted during cleaning operations.

References for Other Applicable ASTM Standards

ASTM D5088 – Decontamination of Field Equipment Used at Nonradioactive Waste Sites

ASTM D5608 – Decontamination of Field Equipment Used at Low Level Radioactive Waste Sites

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SOP B2.1 Sediment Sampling

Sediment sampling will be performed by the following procedure:

- Wear appropriate PPE as specified in the BWHSP (Appendix F of the BWP) and the SSHP. In addition, samplers will don new sampling gloves at each location prior to sampling.

- Use of disposable sample equipment is preferred. If disposable sample equipment is unavailable, use of decontaminated sample equipment is allowed. Sample equipment shall be decontaminated per the requirements of SOP B1.10, Equipment Decontamination. All sampling equipment which may not be decontaminated should be disposed of in accordance with the project-specific addenda to the WMP (Appendix E of the BWP).

- Scrape away surficial organic material (grass, leaves, etc.).

- If there is any surface water flow, sampling will proceed in an upstream direction. After organic materials have been scraped away, obtain a sediment sample using the scoop by scooping material from the surface to 6 inches below surface, or the depth specified in the project specific addendum.

- Record appropriate air monitoring analyses.

- Sample collection for VOC and total organic carbon (TOC) analyses will be in accordance with U.S. EPA SW-846 Method 5035 and NMED requirements. Samples will be collected using EnCore® (or similar) samplers. If conditions exist that make the use of this type of sampler impractical (such as dry or gravelly conditions), another method may be used and should be addressed in the project-specific work plan. If another method is used, such as a discrete grab sample collected in a 4-ounce jar, the sample should be collected prior to homogenization with as little disturbance as possible.

- Homogenize samples according to the procedures specified in SOP B1.12, Sample Homogenization. Fill jars with sediment using stainless steel spatulas or spoons. The sample jar quantities and sizes are dependent on the analyses being run and are detailed in Table 5-1 of the QAPP (Appendix C of the BWP).

- Place analytical samples in cooler and chill to 4°C. Samples will be shipped to the laboratory within 24 hours.

- Decontaminate scoop as specified in SOP B1.10.

Fill out field log book, sample log sheet, custody seals, labels, and C-O-C forms. Example copies of these forms are included in the QAPP (Appendix C of the BWP). Soil classification should be recorded in the field log book. Classify soils in accordance with the requirements of SOP B1.1, Borehole and Sample Logging.

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SOP B2.2 Surface Soil Sampling

Surface soil sampling will be performed by the following procedure:

- Wear appropriate PPE as specified in the BWHSP (Appendix F of the BWP) and the SSHP. In addition, samplers will don new sampling gloves at each location.
- Use of disposable sample equipment is preferred. If disposable sample equipment is unavailable, use of decontaminated sample equipment is allowed. Sample equipment shall be decontaminated per the requirements of SOP B1.10, Equipment Decontamination. All sampling equipment which may not be decontaminated should be disposed of in accordance with the project-specific addenda to the WMP (Appendix E of the BWP).
- Scrape away surficial organic material (grass, leaves, etc.).
- Obtain soil sample using a scoop/trowel, after organic materials have been scraped away, by scooping soil from the surface to 36 inches below surface or the depth specified in the project-specific addendum.
- Record appropriate air monitoring results.
- Sample collection for VOC and total organic carbon (TOC) analyses will be in accordance with U.S. EPA SW-846 Method 5035 and NMED requirements. Samples will be collected using EnCore® (or similar) samplers. If conditions exist that make the use of this type of sampler impractical (such as dry or gravelly conditions), another method may be used and should be addressed in the project-specific work plan. If another method is used, such as a discrete grab sample collected in a 4-ounce jar, the sample should be collected prior to homogenization with as little disturbance as possible.
- Homogenize samples according to the procedures specified in SOP B2.5, Sample Homogenization. Fill jars with soil using disposable sample equipment or decontaminated stainless steel spatulas or spoons.
- Place analytical samples in cooler and chill to 4°C. Samples will be shipped within 24 hours to an appropriate laboratory.
- Sample equipment should be disposed in accordance with the WMP (Appendix E of the BWP) or decontaminated as specified in SOP B1.10.
- Fill out field log book, sample log sheet, custody seals, labels, and C-O-C forms. Example copies of these forms are included in the QAPP (Appendix C of the BWP). Soil classification should be recorded in the field log book. Classify soils in accordance with the requirements of SOP B1.1, Borehole and Sample Logging.

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SOP B2.3 Subsurface Soil Sampling

The following elements regarding soil borings should be considered when developing project-specific plans:

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

- The location of all borings will be approved in writing by the base before drilling commences.

- The drill rig will be decontaminated in accordance with SOP B1.10. Use of disposable equipment is preferred. If disposable equipment is unavailable, use of decontaminated equipment is allowed. Equipment shall be decontaminated per the requirements of SOP B1.10. All sampling equipment which may not be decontaminated should be disposed of in accordance with the project-specific addenda to the WMP (Appendix E of the BWP).

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

- No fluids will be used to advance soil borings.

- A standard penetration test will be performed each time a split spoon sample is taken. The test will be performed in accordance with ASTM D-1586. Sampling for lithologic logging should be continuous especially near ground surface in the area of potential contamination sources. The depth to which continuous lithologic sampling is completed will be determined on a site-by-site basis after review of site specific stratigraphic data collected during previous investigations. In most cases, the collection of continuous lithologic samples should begin at the ground surface and continue until the water table is encountered.

  NOTE: If soil samples are being collected for VOC or total organic carbon (TOC) analysis, those samples should be collected from the sampler prior to lithologic logging and any disturbance to the sample core.

  The method of continuous sample collection is dependent on the drilling method used. Common sampling methods include split-spoon samplers, thin-walled samplers, and core barrels. All of these sampling devices can be used with minimal disturbance of the sample.

- Sample collection for VOC and TOC analyses will be in accordance with U.S. EPA SW-846 Method 5035 and NMED requirements. Samples will be collected using EnCore® (or similar) samplers. If conditions exist that make the use of this type of sampler impractical (collection of samples from soil cuttings or dry or gravelly conditions), another method may be used and should be addressed in the project-specific work plan. If another method is used, such as a discrete grab sample collected in a 4-ounce jar, the sample should be collected prior to homogenization with as little disturbance as possible.

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

- Boreholes will be abandoned as specified in project-specific addenda.

- All trash and drill cuttings will be disposed as dictated in project-specific addendum to the WMP (Appendix E of the BWP).

- Subsurface soil samples may also be collected using a stainless steel hand auger or split-spoon sampler. Project-specific addenda will specify the method to be used on the basis of field requirements.

- Lithologic logging is necessary to determine the physical characteristics of the subsurface. This information will be used in conjunction with contaminant chemical and physical data to determine how the contaminant will move from its source to potential receptors. This data will also be used for evaluating the feasibility of various remediation technologies for cleanup of subsurface contamination. The stratigraphy at Kirtland AFB is complex with lateral variation of highly heterogeneous alluvial fan and axial ancestral Rio Grande lithofacies. Small lenses of clay or sand present in these lithofacies can determine how a contaminant is transported from the source site. These lenses may be missed if lithologic sampling is not continuous.

- Before digging begins a digging permit, "*Base Civil Engineering Work Clearance Request*" form, needs to be completed and approved by the Chief of Operations or Chief of Engineering and Environmental Planning at the base in accordance with Appendix H, Permitting Plan. The work clearance request is processed just prior to the start of work and is valid for 30 days. If delays are encountered and the conditions at the job site change (or may have to be changed) or the project extends past 30 days, this work clearance request must be reprocessed. The type of information that must accompany this permit includes:

  — Location

  — Work order/job number

  — Contract number

  — If the area has been staked/clearly marked or not

  — A sketch of the excavation

  — Type of facility work involved, i.e. Pavements, drainage systems, railroad tracks, overhead or underground utility or communications, aircraft or vehicular traffic flow, security, etc.

  — Date clearance requested and terminated

  — Requesting official, phone number, and organization

Hand Auger Sampling

The following procedure will be used for hand auger sampling:

- Wear appropriate PPE as specified in the BWHSP (Appendix F of the BWP) and the SSHP. In addition, samplers will don new sampling gloves at each location.

- Use a decontaminated hand-driven 6-inch stainless steel bucket auger. The diameter of the auger may be modified to suit site-specific conditions and shall be specified in the project-specific addendum.

- Begin turning the auger in a clockwise direction and continue until the desired sampling depth is obtained.

- Remove the auger and collect samples for VOC and total organic carbon (TOC) analyses in accordance with U.S. EPA SW-846 Method 5035 and NMED requirements. Samples will be collected directly from the soil in the auger with as little disturbance as possible, using EnCore® (or similar) samplers. If conditions exist that make the use of this type of sampler impractical (such as dry or gravelly soil conditions), another method may be used and should be addressed in the project-specific work plan. If another method is used, such as a discrete grab sample collected in a 4-ounce jar, the sample should be collected prior to homogenization with as little disturbance as possible.

- Empty remaining contents of the auger into a decontaminated stainless steel pan. Homogenize samples according to the procedures specified in SOP B2.5, Sample Homogenization. Fill jars using a stainless steel spatula or spoon.

- If it is determined that the sample volume is insufficient to satisfy the analytical requirements, another sample must be obtained from a location immediately adjacent to the first sample.

- Decontaminate according to the procedures outlined in SOP B1.10.

- Place analytical samples into the shipping cooler and chill on ice to 4°C, if required. Prepare sample(s) for delivery to the laboratory for analysis within 24 hours of collection.

- Fill out field log book, sample log sheet, custody seals, labels, and C-O-C forms. Example copies of these forms are included in the QAPP (Appendix C of the BWP).

Split-Spoon Sampling Procedure

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

- Wear appropriate PPE as outlined in the BWHSP (Appendix F of the BWP) and the SSHP. In addition, samplers will don new sampling gloves at each location.

- Drill borehole to the desired sampling depth. Drive split-spoon into the undisturbed soil, which is to be sampled.

- A stainless steel 2-inch (or 3-inch) outside diameter split-spoon sampler will be driven with blows from a 140-lb (or 300-lb) hammer falling 30 inches until either approximately 2 ft has been penetrated or 100 blows within a 6-inch interval have been applied. This process is referred to as the Standard Penetration Test (ASTM D 1586-74). A decontaminated split-spoon will be used for each sample collected for chemical analyses.

- Soil borings designated for engineering parameters such as Atterberg limits, permeability, sieve analysis, etc., will be obtained using a Shelby tube according to ASTM 1557. Shelby tubes can be used when cohesive materials are encountered, and when an undisturbed sample is required for testing.

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

- Bring the sampler to the surface and remove both ends and one-half of the split-spoon so that the recovered soil rests in the remaining half of the barrel. Place split-spoon on clean polyethylene sheeting. Describe thoroughly the approximate recovery (length), Unified Soil Classification System (USCS) classification, composition, color, moisture, etc., of the recovered soil. A copy of a typical bore log form is depicted in Figure B1.1-1.

  NOTE: If soil samples are being collected for VOC or total organic carbon (TOC) analysis, those samples should be collected from the sampler prior to lithologic logging and any disturbance to the sample core.

- Sample collection for VOC and total organic carbon (TOC) analyses will be in accordance with U.S. EPA SW-846 Method 5035 and NMED requirements. Samples will be collected prior to homogenization from the split-spoon core, using EnCore® (or similar) samplers. If conditions exist that make the use of this type of sampler impractical (such as dry or gravelly soil conditions), another method may be used and should be addressed in the project-specific work plan. If another method is used, such as a discrete grab sample collected in a 4-ounce jar, the sample should be collected prior to homogenization with as little disturbance as possible.

- Empty remaining contents of the split-spoon into a disposable sample tray/pan or decontaminated stainless steel pan. Homogenize samples according to the procedures specified in SOP B2.5, Sample Homogenization. Fill remaining jars with soil using stainless steel spatulas or spoons.

- Decontaminate split-spoon sampler according to the procedures outlined in SOP B1.10.

- Place analytical samples in sample cooler and chill to 4°C. Samples will be shipped to the laboratory within 24 hours.

- Fill out field log book, sample log sheet, labels, custody seals, and C-O-C forms for analytical samples. Example copies of these forms are included in the QAPP (Appendix C of the BWP).

Rock Core Sampling

After rock coring has been completed and the core recovered, the rock core will be carefully removed from the barrel, placed in a core tray (previously labeled “top” and “bottom” to avoid confusion), classified, and measured for percentage of recovery as well as the rock quality designation (RQD). See the Classification of Rocks section in SOP B1.1 for a description of how to measure the RQD of a core. Each core will be described and classified in the field log book or on appropriate forms described in SOP B1.1, Borehole and Sample Logging.

After sampling, rock cores must be placed in the sequence of recovery in well-constructed wooden boxes or manufactured plastic core boxes provided by the drilling contractor. Rock cores from two different borings will not be placed in the same core box unless accepted by the Field Geologist. The core boxes should be constructed to accommodate at least 20 linear ft of core in rows of approximately 5 ft each and should be constructed with hinged tops secured with screws and a latch to keep the top securely fastened down. Wood partitions will be placed at the end of each core run and between rows. The depth from the surface of the boring to the top and bottom of the drill run and run number will be marked on the wooden partitions with indelible ink. Any core loss areas will be spaced with wooden blocks, polyvinyl chloride (PVC) pipe, or other sturdy material so that the entire core run is represented. The order of placing cores will be the same in all core boxes. The top of each core obtained should be clearly and permanently marked on each box. The width of each row must be compatible with the core diameter to prevent lateral movement of the core in the box. Similarly any empty space in a row will be filled with an appropriate filler material or spacers to prevent longitudinal movement of the core in the box.

The inside and outside of the core-box lid will be marked by indelible ink to show all pertinent data on the box’s contents. At a minimum, the following information must be included:

- Project name
- Project number
- Boring number
- Footage (depths)
- Run number(s)
- Recovery
- Box number (x of y)

It is also useful to draw a large diagram of the core in the box, on the inside of the box top. This provides more room for elevations, run numbers, recoveries, comments, etc., than could be entered on the upper edges of partitions or spaces in the core box.

For easy retrieval when core boxes are stacked, the sides and ends of the box should also be labeled and include project number, boring number, top and bottom depths of core, and box number.

A photograph of the recovered core and the labeling on the inside cover will be taken. If moisture content is not critical, the core should be wetted with potable tap water and wiped clean for the photograph (This will help to show true colors and bedding features in the cores).

Due to the weight of the core, two people should always handle a filled core box. Core boxes temporarily stored onsite should be protected from the weather. The core boxes should be removed from the site in a careful manner as soon as possible.

Thin Wall (Shelby Tube) Sampling

When it is desired to take undisturbed samples of soil, thin-walled seamless tube samplers (Shelby tubes) will be used. These samples are not recommended by the EPA for environmental samples. Tube samplers, whether of carbon steel or stainless steel, should not be used for taking VOC samples. The following method applies:

- Clean out the hole to the sampling elevation being careful to minimize the chance for disturbance or contamination of the material to be sampled. In saturated materials, withdraw the drill bit slowly to prevent loosening of the soil around the hole and maintain the water level, if present, in the hole at or above groundwater level.

- The use of bottom discharge bits or jetting through an open-tube sampler to clean out the hole will not be allowed. Any side discharge bits are permitted.

- The sampler must be of a stationary piston-type to limit sample disturbance and aid in retaining the sample. Either the hydraulically operated or control rod-activated type of stationary piston sampler may be used. Prior to inserting the tube sampler in the hole, check to insure that the sampler head contains a check valve. The check valve is necessary to keep water in the rods from pushing the sample out of the tube sampler during sample withdrawal and to maintain suction within the tube to help retain the sample.

- With the sampling tube resting on the bottom of the hole and any water level in the boring at the natural groundwater level or above, push the tube into the soil by a continuous and rapid motion, without impacting or twisting. In no case will the tube be pushed further than the length provided for the soil sample. Allow a free space in the tube for cuttings and sludge. Data to be recorded on the sampling tube when sampling with Shelby Tubes include the maximum pressure exerted for the push, and duration in seconds of the push.

- After pushing the tube, the sampler should sit from 5 to 15 minutes in the borehole prior to removal. Immediately before removal, the sample must be sheared by rotating the rods with a pipe wrench a minimum of two revolutions.

- Upon removal of the sampler tube from the hole, measure the length of sample in the tube and also the length penetrated. Remove disturbed material at both ends of the tube and measure the length of sample again. After removing at least 1-inch of soil from the lower end and after inserting an impervious disk, seal both ends of the tube with at least ½-inch of wax applied in a way that will prevent the wax from entering the sample. Newspaper or other types of filler must be placed in voids at either end of the sampler prior to sealing with wax. Place plastic caps on the ends of the sampler, tape them into place, and dip the ends in wax to seal them.

- Affix labels to the tubes, as required, and record sample number, depth, penetration, and recovery length on the label. Mark the same information and "'up" direction on the tube with indelible ink, and mark the end of the sample. Complete C-O-C and other required forms. Do not allow tubes to freeze, and store the samples vertically (with the same orientation they had in the ground, i.e., top of sample is up) in a cool place out of the sun at all times. Ship samples protected with suitable resilient packing material to reduce shock, vibration, and disturbance.

- Using soil removed from the ends of the tube, carefully describe the sample using the methods presented in SOP B1.1.

- When thin-wall tube samplers are used to collect soil for certain chemical analyses, it may be necessary to avoid using wax, newspaper, or other fillers. Project-specific addendum will address specific materials allowed dependent on analytes being tested.

Thin-walled undisturbed sampling are sometimes difficult to collect because thin-walled tube samplers are restricted in their usage by the consistency of the soil to be sampled. Often very loose and/or wet samples cannot be retrieved by the samplers, and soils with a consistency in excess of very stiff cannot be penetrated by the sampler. Devices such as Dension or Pitcher cores can be used in conjunction with the tube samplers to obtain undisturbed samples of stiff soils. Using these devices normally increases sampling costs and therefore their use should be weighed against the increased cost and the need for an undisturbed sample. In any case, if a sample cannot be obtained with a tube sampler, an attempt should be made with a split-spoon sampler at the same depth so that at least a sample can be obtained for classification purposes.

Direct Push Sampling for Soil and Groundwater

Direct push technology (DPT) will be used to rapidly collect soil and water samples whenever possible. This technique provides for collection of undisturbed samples and does not generate soil cuttings. This section discusses the DPT method only.

The contractor will need a copy of the DPT subcontractor work plan, waste containers, and appropriate health and safety gear. All additional equipment and materials will be provided by the DPT subcontractor. The DPT subcontractor should be equipped with a rig capable of pushing 30 ft and collecting soil and groundwater samples from any interval within that depth. Equipment should include at minimum the following items:

- Hydraulic ram with hammer assembly

- 1- to 1.5-inch diameter drill rods

- Stainless steel piston-type, split-spoon, or equivalent soil sampling device that allows for lithologic characterization and retrieval of at least 400 milliliters (mL) of sample volume

- Geoprobe®, Hydrocone®, bailer, Teflon® tubing and peristaltic pump, or equivalent water sampling device

- Small diameter PVC riser and screen to make temporary wells if recovery is too slow

- Decontamination equipment

- Health and safety equipment

If a situation arises in which the groundwater recharge is too slow to allow for efficient sampling, a temporary PVC well can be installed for sampling at a later time. This well, however, must be installed according to the following specifications:

- The well will be narrower in diameter than the DPT borehole, leaving annular space around the casing
- The well will be installed between 2 and 5 ft into the water table
- New PVC casing and screen will be used, decontaminated with a stream cleaner and rinsed with copious quantities of deionized water
- Installation of well materials will occur with clean decontaminated gloves
- The well will be sampled and removed within 48 hours of installation
- If left unattended or overnight, locking well caps should be used, or a seal should be used that can indicate tampering
- One volume of the sampling device will be purged prior to sampling

General Methodology

- Verify that the subcontractor has the necessary drilling and sampling equipment, as well as proper decontamination supplies.
- Confirm that sampling locations are staked and that the clearances from all on-Base and off-Base utilities have been obtained. Do not begin the sampling until proper digging permits have been obtained and all of the utilities have been marked.
- Locate the sample location and position the DPT rig. If the sample point is on thick asphalt or concrete, the DPT subcontractor will use a hammer-drill or equivalent to drill a hole through the pavement.
- Verify that the sampling tip has been properly decontaminated, as specified in SOP B1.10 before beginning penetration.

Soil Sampling Methodology

- For soil sampling, hydraulically advance the sampler to above the target sample interval, unlock the piston point, and advance the sampling device through the sampling interval.

  — Pull the rods using the hydraulic apparatus and remove the sample insert or split spoon.

  — Log the soil and collect the required samples as specified in the project specific addendum.

- Continue sampling at additional depth intervals or abandon the borehole, as appropriate for the location

Groundwater Sampling Methodology

- If groundwater sampling is necessary, advance the sampler into the water table and collect a sample with the sampling device as specified in SOP B4.1.

- Collect and manage all wastes as specified in the project-specific addenda to the WMP (Appendix E of the BWP).

- Abandon all boreholes and repair pavement before moving to a new site as specified in SOP B1.4.

Comments

- If a buried object impedes the DPT sampler or if an insufficient sample volume is recovered, reposition the rig in a location to satisfy the intent of the original sample point and try again. Note this on the borehole logging form.

- If the total recovered sample volume is insufficient for both screening and laboratory analysis, a second hole will be pushed as close as possible to the original hole and an additional sample will be taken from the same depth interval. The two samples will be composited prior to sampling for chemical analysis.

References for Other Applicable ASTM Standards

ASTM D1452 – Soil Investigation and Sampling by Auger Borings

ASTM D1586 – Penetration Test and Split-Barrel Sampling of Soils

ASTM D4220 – Preserving and Transporting Soil Samples

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SOP B2.4 Test Pit Sampling

The following procedure will be used for test pit excavation and sampling:

- Wear appropriate PPE as required in the BWHSP (Appendix F of the BWP) and the SSHP. In addition, samplers will don new sampling gloves at each location.

- Using a backhoe or other appropriate heavy equipment, excavate the trench to the actual size and depth as outlined in the project specific addenda. Place excavated materials on plastic sheeting.

- A sample from near the surface may be taken by advancing a 3½-inch decontaminated stainless steel hand auger (or hand scoop) from 0 to 6 inches. If the depth of the test pit precludes the use of a hand auger to obtain a sample, then the bucket of the backhoe will be used. The sample will be obtained from the base of the excavation at the required depth with the bucket and then using a hand auger or hand scoop a sample will be extracted from the middle of the bucket. Personnel should not enter an excavation if it is over 4 ft deep.

- If staining is present, the test pit should be extended out, along the proposed length of the test pit, based upon field observations and in consultation with base personnel. Notes on the depth of contamination, layers present, and any field measurements (e.g. PID readings) should be included in the field log book. If visibly contaminated soils stop, the last sample should be from “clean” soil at the end of the excavation. The total of samples per test pit will be specified in site-specific addenda, but may be determined in the field based on site conditions.

- Sample collection for VOC and total organic carbon (TOC) analyses will be in accordance with U.S. EPA SW-846 Method 5035 and NMED requirements. Samples will be collected using EnCore® (or similar) samplers. If conditions exist that make the use of this type of sampler impractical (collection of samples from the backhoe bucket or dry or gravelly conditions), another method may be used and should be addressed in the project-specific work plan. If another method is used, such as a discrete grab sample collected in a 4-ounce jar, the sample should be collected prior to homogenization with as little disturbance as possible.

- Empty contents of auger into a stainless steel pan or disposable sample tray.

- Fill jars with soil using stainless steel spatulas or spoons. All soil samples for chemical analyses, except VOC and TOC, must be homogenized by vigorous mixing in stainless steel pans with stainless steel spoons prior to being put into containers. VOC and TOC samples must be taken as discrete grab samples. These should be taken immediately from the hand auger, and properly packaged. All samples should be homogenized in accordance with SOP B2.5.

- Place analytical samples in cooler and chill to 4°C. Samples will be shipped within 24 hours.

- Fill out field log book, sample log sheet labels, custody seals, and C-O-C forms. Example copies of these forms are included in the QAPP (Appendix C of the BWP).

- A hand-sketched map of the trench showing the stained soils and soil layers should be included in the field log book. If contaminated soils and debris are located in the test pits (as proof of previous trenching), the area will be marked for future surveying purposes as required by the project-specific addenda.

- After completion of the trench, the test trenches will be backfilled. Trenches, which have not been completed at the end of the day, may remain open if appropriate markings and barricades are placed fully enclosing the trench. Marking and barricades shall be in accordance with the BWHSP (Appendix F of the BWP) and the SSHP. If a trench has not been completed and is backfilled at the end of a day, it may be restarted the next day from the point at which excavation ceased. The soils from the deeper portion of the trench will be returned to the trench first. The segregated upper soil will be added to the trench last. Disposition of contaminated backfill should be consistent with the project-specific addenda to the WMP (Appendix E of the BWP).

- Revegetation will be performed as required.

- If a buried drum is encountered, work will immediately cease. The team leader will contact the Restoration Section, who will respond to the area and determine if activities may continue. In the event that buried drums or other containers are expected to be encountered or are discovered during the pit excavating activities, test pit sampling will be performed using the following procedures:

- Wear appropriate health and safety equipment as required in the BWHSP (Appendix F of the BWP) and the SSHP.

- Identification of the depth to the top of the buried drums and the perimeter of the buried drum area will be attempted from a geophysical survey as described in SOP B1.7. The perimeters will be adequately marked off using flagging tape.

- A backhoe will be used to remove the excess soil from above the buried drums. An area of soil adjacent to the perimeter of the buried drums will also be excavated. Care will be taken not to penetrate the drums with the backhoe.

- Continuous monitoring will be conducted using real-time air monitoring equipment as required in the BWHSP (Appendix F of the BWP) and the SSHP.

- If required, drums in such deteriorated condition that a potential for release is evident will be packaged in an over-packed drum.

- If required, drums will be sampled following the procedures outlined in SOP B6.1.

- Low hazard and known content drums may be moved with hand trucks or cradles. Mechanical drum handling equipment usually consists of a backhoe or front-end loader equipped with a drum grappler. Drums shall be transported utilizing front-end loaders or forklifts with drum grapplers, or with modified carrying platforms to preclude spark generation. Following the removal of the drums from the excavation, soil samples should be collected following the procedures outlined previously.

SOP B2.5 Sample Homogenization

The following guidelines and procedures shall be used for sample homogenization:

- Remove sample from sampling device and place in sample tray or pan. Use of disposable sample equipment is preferred. If disposable sample equipment is unavailable, use of decontaminated sample equipment is allowed. Decontaminate sample equipment according to the procedures specified in SOP B1.10.
- Scrape the soil from the sides, corners, and bottom of the tray or pan.
- Roll the soil to the middle of the tray or pan, and initially mix.
- Quarter the sample and move the quarters to the four corners of the tray or pan. Each quarter of the sample should then be mixed individually.
- Roll the quarters to the center of the tray or pan and mix the quarters together.
- Dispose of sample equipment in accordance with the project-specific addenda to the WMP (Appendix E of the BWP) or decontaminate sample equipment as necessary.

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SOP B3.1 Photoionization Detectors and Organic Vapor Analyzers

A photoionization detector (PID) is used to detect the concentration of organic gases in air. During field investigations, this particular instrument, along with an organic vapor analyzer (OVA) serves several functions. First, and most importantly, it is used to protect the health and safety of the field personnel by providing information concerning the presence and concentration of contaminants encountered. Second, the information gained from the instrument is often used to dictate whether or not to continue the field investigation (i.e., drilling and sampling vertically or horizontally to delineate the extent of contamination). In addition, the field screening capabilities of the instrument can be used to determine which samples will be selected for laboratory analysis. The use of this instrument for health and safety considerations is described in the BWHSP (Appendix F of the BWP) and the SSHP.

The PID and the OVA have some important limitations. The instruments can only monitor certain vapors and gases in air. Many nonvolatile liquids, toxic solids, particulates and other toxic gases and vapors cannot be detected. Because the types of compounds that the PID and OVA can potentially detect are only a fraction of the chemicals possibly present at an incident, a zero reading does not necessarily signify the absence of air contaminants.

The instruments are also non-specific, and their responses to different compounds are relative to the calibration settings. In addition, the reading shown on the meter represents the total volatile organic concentrations rather than any one compound. The PID cannot detect methane, and neither instrument can be used as an indicator for combustible gases or oxygen deficiency. In the presence of methane, the PID will register lower levels for organic contaminants that are present due to the interference caused by the methane.

The operating instructions for the actual field instruments to be used onsite (such as PIDs and OVAs) should be described in the project-specific addenda.

The PID or OVA must be calibrated daily, at a minimum, before work commences. The instrument should be recalibrated after prolonged periods of downtime (such as a shutdown of drilling activities). Extreme temperatures (< 40°F or > 85°F) can sometimes cause the instrument to behave erratically and in error. If a malfunction occurs the instrument shall be recalibrated. When possible, the PID or OVA should be sheltered from extreme temperatures and foul weather conditions.

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SOP B3.2 Methods for Using Portable Gas Chromatographs

Purpose

This guideline describes sampling and analytical methods currently accepted for performing soil gas surveys. Soil gas surveys are effective qualitative screening tools for characterizing volatile organic contamination at hazardous waste sites. A soil gas survey, when performed properly, can delineate groundwater contamination, define the areal extent of soil contamination, help pinpoint source areas, indicate possible migration pathways, and show overall “clean” and “dirty” areas of a particular site. Soil gas is useful for initial site characterization, groundwater contamination mapping, and source delineation for sites where volatile organic compounds may be present. Soil gas surveys cannot detect semivolatile organic or heavy metal contamination.

Scope

Two types of soil gas sampling methods are available—active soil gas sampling and passive soil gas sampling. Active soil gas sampling is the more common method. It consists of advancing a probe into the soil and extracting a gas sample under vacuum. The sample is then analyzed in the field or sent to an onsite laboratory for analysis. Passive soil gas sampling is the less common method. It consists of burying a passive soil gas sampler in the soil, leaving it for several days to months, retrieving it, and sending it for laboratory analysis. Passive sampling has several disadvantages relative to active sampling. The primary disadvantage is that two mobilizations are required—one to bury the samplers, and one to retrieve them. In addition, the results are not available from the laboratory for at least one and often several weeks. Thus the passive method does not conform well to the tight-scheduled nature of many environmental restoration assignments. Procedures for performing passive soil gas investigations are not included in this guideline.

The accuracy of results from soil gas screening will depend on the limitations of the sampling methods and analytical instruments. These limitations are discussed in below. In general, the technique is not intended to accurately determine volatile organic compound concentrations in soil and groundwater. Rather, it is a qualitative screening tool used to provide a preliminary definition of the areal extent of contamination. These data are then used to determine the locations in which to place soil borings and groundwater monitoring wells. Subsequent analysis of soil and groundwater samples may, however, provide some means of correlating the soil gas results to the soil and groundwater results.

Definitions

Soil Gas—The gas that is present in the interstitial spaces between soil particles. Soil gas cannot be present in soil that is 100 percent saturated with water; therefore, soil gas is present only above the water table.

Probe—A general term that denotes the device used to advance the hole and collect the soil gas sample.

VOCs—As defined by EPA chemical analysis methods 8010, 8020, and 8240, a volatile organic is a compound with a boiling point of less than 125 degrees Celsius (°C). The compound should also have a vapor pressure greater than 1 mm of mercury at 25°C to be effectively detectable in soil gas. Solvents such as trichlorethylene and fuels such as gasoline are volatile organics. Pesticides are not considered volatile organics. The most common compounds included in soil gas surveys are dichloroethylene, trichloroethylene, tetrachloroethylene, trichloroethane), benzene, toluene, ethylbenzene and xylenes. Also commonly included are gasoline, diesel, and jet fuel.

Standards—Chemical compounds of known purity and concentration used for calibration of analytical instruments. Specific chemical compounds are selected as standards if site history or previous investigation indicates that the compounds may be present at the site.

Real-time Results—Results of soil gas analyses available within minutes or hours of sample collection.

Active Soil Gas Sampling—Collection of a soil gas sample by applying a vacuum to a probe advance into the soil.

Passive Soil Gas Sampling—Collection of a soil gas sample by burying a soil gas sampler containing an adsorbent material. The sampler is left in place for anywhere from several days to 2 months and then sent for laboratory analysis.

Gas Chromatograph—Analytical instrument used for analysis of soil gas samples using the principles of gas chromatography. For real-time results, portable GCs are used. For near real-time results, lab GCs set up at the site are used.

Temperature Ramp—A controlled increase in temperature in the GC oven. Temperature ramps are used in bench and laboratory GC ovens to reduce analysis time and facilitate the orderly volatilization of compounds through the analytical column. Minimum useful ramp is 10°C per minute.

Detection Limits—The minimum concentration detectable by the GC. For the compounds of primary interest, the GC should be capable of detection limits of 0.01 microliters of vapor per liter of air, commonly referred to as parts per million.

Responsibilities

Soil Gas Team Leader—Coordinates the entire soil gas program with the site manager and the Field Operations Leader (FOP). He determines appropriate sampling and analysis equipment, adjusts sampling locations based on field conditions, and may also serve as field chemist or field sampler.

Field Chemist—Responsible for the proper setup and calibration of analytical equipment used at the site and for analyzing samples and performing the necessary QA/QC. If necessary, he adjusts the sampling and analysis program to ensure the collection of quality data. The field chemist should have a degree in chemistry or chemical engineering or experience with analytical chemistry instrumentation.

Field Sampler—Responsible for the collection of soil gas samples and for carrying out other functions of the soil gas survey at the direction of the team leader.

Guidelines

A soil gas survey is designed to detect the presence of VOCs in the interstitial spaces between soil particles in the vadose zone. The source of these compounds can be surface soil contamination, subsurface soil contamination, or groundwater contamination. The volatile compounds migrate from the source through the vadose zone in a gaseous state via convection and passive diffusion. The contaminants migrating via convection are driven by changes in atmospheric pressure or by fluctuations in the groundwater table. The contaminants migrating via passive diffusion are driven by concentration gradients present between the contaminant source and areas with no contamination.

The rate of migration through the soil pores depends on a variety of factors including the volatility and water solubility of the compounds of interest, concentration gradients, soil porosity, soil type, and soil moisture content. The rate of migration is greatest and thus the use of soil gas screening is most applicable to compounds of high vapor pressure and low water solubility. The best sites for soil gas surveys are those with porous soils (sands or gravels) that facilitate migration of the soil gas.

Soil gas screening is a rapid method for characterizing horizontal extent of volatile organic contamination at a site. Soil gas surveys are generally performed prior to the drilling of soil borings and the installation of monitoring wells. The results of the soil gas survey are used to locate both monitoring wells and soil borings inside and outside of contaminated areas. By using soil gas surveys to determine locations, the number of monitoring wells and soil borings installed may be optimized. A reduction in the number of monitoring wells and soil borings reduces the number of samples collected for laboratory analysis. Many of the soil gas screening methods currently being used provide immediate chemical analysis results in the field. These results allow the survey to be directed by incoming data and provide information to direct the collection of subsequent soil gas samples.

The following guidelines describe procedures for performing soil gas investigations using active soil gas sampling methods.

In general, a soil gas survey consists of the following steps: (1) Applicability Determination: This determines if the method is applicable and cost effective for the given site. (2) Sampling and Analysis: This includes planning: to determine the sampling locations; sampling when a probe is driven into the ground and the soil gas is brought to the surface for collection; and analysis when a sample is analyzed using a field or laboratory instrument. (3) Data Interpretation. The data collected are analyzed to provide an indication of contaminants and contaminant patterns present. Recommendations concerning contaminant extent and the need for additional investigations are made based on the results.

Determination of Applicability of the Method:

Prior to performing a soil gas survey, it is determined if the method will be effective for the site and for the contaminants of concern. The following are the necessary conditions and prerequisites for an effective soil gas survey:

- VOCs are suspected to be present in the soil or groundwater.
- Soil is not saturated from a recent rain event or significant snow melt.
- Water table is at least 2 ft below the surface.

The following are site characteristics that are advantageous, but not absolutely necessary, for an effective soil gas survey:

- The presence of high permeability soils. High clay or organic carbon content in the soil impedes migration and thus the detection of low concentrations of contaminants.
- Groundwater at less than 30 ft, if groundwater contamination is to be tracked. Groundwater depth is not important for establishing the extent of soil contamination.
- Temperatures above 0 degrees centigrade. Ambient temperatures below 0 degrees centigrade impede the ability of soil gas screening to detect low concentrations of contaminants.

— A knowledge of contaminants that may be present at the site.

— Historical information on potential source areas.

If available, the results of any previous site investigations should be reviewed. Monitoring well and soil boring logs and the results of chemical analyses could be especially useful.

Sample Collection

Sampling and analysis consist of determination of sampling locations, mobilization, sample collection, and sample analysis. Specific QA/QC is addressed for each aspect of sampling and analysis.

Determination of Sampling Locations

Prior to performing a soil gas survey, pre-determined sampling locations should be established. In general, an unbiased grid should be set up across the site or in selected areas of a very large site. For reference, a 25-ft by 25-ft grid is considered small, and a 200-ft by 200-ft grid is considered large. In addition to the unbiased grid, additional sample locations should be placed in known and suspected source areas. Potential source areas include surface or underground tank areas, bermed areas, spill sites, areas of discolored soil, areas of stressed vegetation, pits, lagoons, waste piles, chemical storage areas, loading docks, product transfer areas, and dry drainage ditches.

If the grid is staked prior to mobilization, the soil gas survey can be finished in a shorter time than if the soil gas team has to stake sampling locations. An accurately surveyed grid for a soil gas survey is preferred, but a grid produced with a compass and tape measure is acceptable. If the soil gas survey offers real-time results (the preferred method), the initial grid can be augmented to reflect the initial results, so additional samples in excess of these of the original grid should be expected and budgeted accordingly. A real-time soil gas survey will typically include a 25 percent increase in the number of samples relative to the number of samples in the original grid.

If the survey doses not offer real-time results, the field team will not know which areas require additional samples and will be unable to adequately define the extent of contamination. Therefore, a tighter initial grid (2 to 4 times the number of samples required for real-time analysis) should be used across the entire site to ensure adequate definition of contamination.

Mobilization

Prior to mobilization, a utilities survey should be conducted to determine the location of buried power, telephone, sewer, gas, or water lines. Upon arriving at the site, the soil gas field team will perform an initial site inspection. This inspection should be conducted with the FOL, or someone else familiar with the site, to explain the site characteristics. All sampling and analysis equipment should be unpacked a setup to ensure that all equipment has arrived and is working properly.

Sample Collection

Active soil gas collection consists of augering a hole or driving a probe into the ground, inserting and sealing a sampling probe into the hole, applying a vacuum to the probe, and collecting a sample.

Where possible, the probe is driven into the ground manually. One common method consists of using a hand-operated slide hammer to drive a 5/8-inch diameter steel rod 3 to 4 ft into the ground. Asphalt can easily be penetrated with this method. Hydraulic pounding equipment can also be used to drive the rod. In some cases, due to hard or cobbly soil, the presence of a concrete pad, or a depth requirement beyond that obtained by hand, the hole must be advanced with some type of drilling apparatus (i.e., hand auger, rock drill, pothole digger, etc.). As an alternative to pounding a probe, a hole can be augered using hand or powered equipment.

A sampling hole depth of a least 2 ft is required to ensure the exclusion of ambient air and provide adequate contaminant detections. Advancing the sampling hole to greater depths will facilitate the detection of contamination in deeper soil intervals and groundwater. For most sites with soil contamination or relatively shallow groundwater, a depth of 3 to 4 ft provides adequate detection capabilities with a reasonable number of samples each day. Typically, if the holes can be advanced manually, an average of 15 to 25 samples can be collected daily. If the holes are advanced with the use of powered equipment, an average of 10 to 20 samples can be collected daily.

After the sampling hole is advanced, a sampling probe is placed in the hole. The sampling probe may have an open end or slots to allow gas flow into the probe. The slots or open end must be protected from becoming plugged. Some methods combine the pounding and sampling probe in a single unit. For sampling holes with a diameter of less than 1-inch, soil should be packed around the probe to minimize the introduction of ambient air into the hole. For larger diameter sampling holes, a packer, preferably an inflatable one, should be used to exclude ambient surface air.

After the sampling probe is in place, the soil gas is drawn to the surface using a vacuum pump. The pump can be hand or power operated. Several sampling probe volumes should be removed to purge the probe of ambient surface air. The gas is then collected using a syringe or pumped into a bag or bottle. The sample collection container must be clean, inert, and have appropriate seals. Sampling bags should be made of Tedlar®, sampling bottles should be amber glass with Teflon® seals, and syringes should be gas-tight glass and Teflon®. To prevent contamination of the sample from the pump, the sample should be collected upwind of the pump. The sample is then either analyzed onsite with a portable GC or sent to the onsite lab.

Sampling Equipment Decontamination

To avoid cross-contamination and the possibility of false positive readings, the sampling probes and sample collection equipment should be decontaminated between each use. The probes can be washed with Liquinox® or other laboratory-type detergent and rinsed with deionized water. If this too is found to be inadequate, the sampling equipment can be heated to volatilize any remaining organic compounds. Sampling equipment should never be decontaminated with solvents since the solvents and contaminants in the solvents will interfere with subsequent analyses. By periodically analyzing two ambient air samples, one collected with the sampling equipment (called a probe blank) and one collected without, the soil gas team can confirm the effectiveness of the decontamination by comparing the two analyses (they should be identical).

Sample Analysis

The most common methods available to analyze soil gas samples are: (1) field analysis with a portable gas chromatograph, and (2) onsite laboratory analysis with a laboratory-grade gas chromatograph.

Field Analysis with a Portable Gas Chromatograph

This method entails analyzing the soil gas samples with a portable gas chromatograph set up in the field. Portable units, such as a Photovac Model 10S PLUS, can be used. This analysis method has the inherent advantage of giving the user immediate results, so the survey can be directed based on the incoming data. This is the most common method for analysis of soil gas samples.

With the portable gas chromatograph, a gas sample is injected directly into the machine using a gas-tight syringe. The GC then chromatographically separates and detects the organics present. The results are recorded in the form of a chromatograph. Each peak on the chromatograph is indicative of a single compound. The area under the peak is indicative of the concentration of that compound.

In most cases, the portable GCs use flame ionization detectors (FIDs) or PIDs for detection. FIDs detect all hydrocarbons, but for that reason can suffer from interference. Photoionization detectors detect most compounds except methane and halogenated alkanes. For sites where low levels of chlorinated compounds are expected, electron-capture detectors are used. electron capture detectors are selective detector allowing considerable lower detection limits for halogenated compounds than do the PID or FID.

Using a portable GC, the soil gas samples are analyzed anywhere from a few minutes to several hours after collection. The results are then available to direct additional soil gas identification and quantification of each compound present in the sample is possible. To be quantified, standards of the compounds present in a sample must be included in the instrument calibration.

Calibration

Standards should be prepared each day and can consist of one or several of the compounds suspected to be present at the site. An alternative to preparing standards on site is having gas standards prepared by a specialty gas vendor. The instrument should be calibrated at the beginning of each day and the calibration should be checked at the end of each day and at least every ten samples.

Standards can be prepared by several procedures, each of which is acceptable if performed properly. Preferably, the standards should be prepared in glass bottles fitted with Teflon® septa, but inert gas sampling bags are also acceptable. The preferred standard preparation method is to inject calculated volumes of spectroscopic-grade liquid reagents into an amber glass bottle that has been filled with hydrocarbon-free air. The vapor from that bottle is used to produce serial dilutions in other bottles. Another method is to collect headspace vapor above a liquid solvent of interest and inject it into a bottle and again make serial dilutions. If the vapor is collected above a liquid solvent, the solvent must be kept in a temperature-controlled bath. If a laboratory-type GC is used, standards can be prepared in methanol. Methanol-based standards are prepared by serial dilution from spectroscopic-grade liquid reagents and may be used for up to one week.

Calibration consists of injecting the standard into the gas chromatograph and setting the integrator to recognize and quantify the peaks in the standard. Standards are run throughout the soil gas program to check the calibration and the GC. Following the initial calibration, calibration should not be changed unless the integrator is not recognizing or quantifying the compounds in the standard.

Analysis

Sample analysis consists of injecting the sample into the calibrated gas chromatograph. A chromatogram is produced, and the integrator will identify the peaks in the standard. If the field chemist determines that the identification or quantification is not correct, manual identification and quantitation can be done. Manual identification consists of identifying the peak based on retention time, peak shape, and interfering peaks. Manual quantitation consists of determining concentration by measurement of peak height or area. In addition to identifying the compounds present in the standard, a qualitative determination based on retention times should be made for any unknown peaks recorded on the chromatogram. These unknowns should be reported with retention times and peak area. Multiple peak responses, which may be indicative of the presence of fuel products, should also be noted.

Results are reported in concentrations of contaminants in the soil gas. Units must be specified in absolute units such as mass per liter of soil gas or vapor volume per liter of soil gas. Generalized units such as parts per million or parts per billion are not to be used unless they are also specified in absolute units.

Onsite Laboratory Analysis

With onsite laboratory analysis, the soil gas samples are collected, packaged for shipment, and sent to the onsite laboratory for analysis. Since gas samples degrade rapidly, sample analysis should be the same day. Samples should be stored on ice in a dark container.

All collection, calibration, and analysis procedures listed for field analysis with a portable GC apply, except a bench or laboratory GC may be substituted. Onsite laboratory analysis provides higher level quality analytical results if the proper QA/QC is performed.

Quality Assurance/Quality Control (QA/QC)

QA/QC samples will be run throughout the field operation to ensure the quality and reproducibility of the data. A minimum of three QA/QC samples will be run every twenty samples. Additional QA/QC samples will be run if the field chemist determines that they are required.

For sample collection, QA/QC should ensure maximum uniformity in the collection procedures, the effective exclusion of ambient air, the collection of sample duplicates and method blanks and equipment decontamination. All pertinent information about the sampling equipment, process, and especially any site observations should be recorded in the soil gas log book.

Standards will be run at least every 10 unique samples to confirm the calibration of the GC. Sample duplicates (2 samples from the same point) will be run every 20 samples to check the reproducibility of the sampling and analysis procedures.

No-injection, ambient air, and probe blanks will be run to check for carry-over (cross-contamination) between samples. No-injection blanks consist of running an analysis but not injecting a sample into the GC. They are run to determine if contamination is present in the GC. They will be run at least once per day. Syringe blanks consist of injecting hydrocarbon-free air into the GC. They will be run at least once per day. Probe blanks consist of pumping ambient air through the sampling probe, collecting a sample, and analyzing the sample. They are used to determine the concentrations of contaminants in the ambient air. Probe blanks will be run at least once every 10 unique samples.

The following are the data quality objectives for the soil gas results.

QA/QC Sample	Minimum Frequency	Acceptable Range
Standard	1 per 10 samples	The standard run before the first sample each day must be within 25 percent of the calibrated concentration and within 10 percent of the calibrated retention time. Due to degradation of the standards during the day, subsequent standards run that day are used to confirm retention time only. Retention time must stay within 10 percent of the calibration.
Sample Duplicate	1 per 20 samples	Results must be within 50 percent of each other for the compound detected at the highest concentration.
No-Injection Blank	once per day	Results must be less than 10 percent of the concentration of the standard.
Syringe Blank	once per day	Results must be less than 10 percent of the concentration of the standard.
Probe Blank	1 per 10 samples	Results must be less than 10 percent of the concentration of the standard or less than 10 percent of the previous sample, which ever is greater.

Data Reporting

Following the completion of the soil gas survey, a letter report is prepared. It contains site maps showing the soil gas sampling locations. Maps are also prepared that contain a posting of the soil gas results or, if contaminants are detected at several adjacent samples, contours of the results. The report will contain a table of the soil gas results and a description of the sampling and analysis procedures.

At locations where contaminants are detected in the soil gas, those same contaminants are expected to be present in the soil or groundwater. In areas where the concentration gradients are steep, contaminants are expected to be present in the soil and possibly the groundwater. Steep gradients are loosely defined as a change in concentration by a factor of 100 over a horizontal distance of 50 ft. In areas where concentration gradients are gentle, widespread soil contamination or groundwater contamination is expected. Gentle concentration gradients are loosely defined as a change in concentration by a factor of 5 or less over a horizontal distance of 50 ft.

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

SOP B3.3 Headspace Screening

When headspace screening is specified, soil samples will be screened for VOCs in the field at the time of sample collection. Field screening will utilize an OVA equipped with either PID or a FID. If a high humidity condition exists during the time period when field activity is to be performed, the FID is recommended since a PID is not a reliable screening instrument under these conditions. The ionization potential of the lamp for the PID will be optimum for the contaminants of concern. Field screening will be performed in accordance with the following procedures.

Soil Samples

- Immediately upon opening the split-spoon (or other sample retrieval device) and after collecting the volatile organic sample (if required), a representative portion of the sample will be collected and placed in a clean, contaminate-free jar. The sample may be placed in a new, clean, plastic sandwich bag inside a jar to minimize the number of new jars required. If the plastic bag method is utilized, readings will be taken inside empty bags to ensure no external contamination is being introduced.

- If the volume of sample recovered is insufficient for all analytical requirements, then the material used in the headspace readings could be utilized for any non-volatile sampling requirements (i.e., the headspace material could be used to fulfill geotechnical testing requirements). If due to insufficient sample volume an additional sample was retrieved immediately below the initial attempt, an additional headspace reading is not required.

- Seal each jar with at least one continuous sheet of aluminum foil, using the jar lid to secure the foil.

- Vigorously agitate the sample jar for at least 15 seconds and then allow a minimum of 10 minutes (or as the environmental conditions dictate) for the sample to adequately volatilize.

- During cold weather the samples will be warmed to room temperature prior to taking the headspace measurement. Since a temporary shelter (i.e. van) is generally used to protect the field instruments, especially during inclement weather, warming the samples to room temperature should not be a problem.

- Re-shake the jar and then remove the jar lid. Quickly insert the vapor sampling probe through the aluminum foil and record the maximum meter response (which should be within the first 2 to 5 seconds). Erratic responses should be evaluated in terms of high organic vapor concentrations or conditions of elevated headspace moisture.

- Record headspace screening data on the boring log and any other appropriate documentation (e.g., sample transmittals, field logbooks, etc.), as appropriate.

- The screening instrument will be calibrated according to the appropriate standard span gas and will be calibrated a minimum of twice daily and before use after a long shut-down period (i.e., lunch breaks, equipment breakdowns, weather-related breaks, etc.).

- If sample jars are to be re-used in the field, jars must be cleaned according to the field decontamination procedures for cleaning of sampling equipment. In addition, headspace readings must be taken to ensure no residual organic vapors exist in the cleaned sample jars.

- Any deviation(s) from the approved procedures must be noted on the drill logs and the DQCR and a basis stated for the deviation(s). DQCRs are discussed in the QAPP (Appendix C of the BWP).

Water Sample

For volatile organic compound screening of water samples, the same general procedures apply as for soil sample screening. However, only new glass jars should be used to contain the sample during the screening operation. Each empty jar must be pre-screened to assure that no extraneous substances are contained in the sample container which might affect the screening results.

SOP B4.1 Monitoring Well Sampling

The following guidelines and procedures will be used for sampling monitoring wells at Kirtland AFB. This Standard Operating Procedure (SOP) just provides general procedures for low-flow and non low-flow methods of monitoring well sampling. Please refer to project-specific work plans for any deviations from the procedures outlined in this SOP.

General Pre-Sampling Requirements

- Monitoring wells will be sampled in order of increasing contamination unless the wells are equipped with dedicated systems.
- Samples will not be collected within 2 weeks of well development.
- Samples to be analyzed for volatile and gaseous constituents will not be withdrawn with pumps that exert a vacuum on the sample (e.g., centrifugal).
- Wear appropriate personal protective equipment (PPE) as outlined in the BWHSP (Appendix F of the BWP) and the SSHP. In addition, samplers will don new sampling gloves at each individual well prior to sampling.
- Visually examine the exterior of the monitoring well for signs of damage or tampering and record in the field logbook.
- All purging and sampling equipment will be decontaminated as specified in SOP B1.11 and will be protected from contamination until ready for use. If a centrifugal or submersible pump is used, discard pump suction line after each well. If the sampling equipment is dedicated to a specified well, the previous step may be eliminated. Portions of the pumps that contact the sample must be made of stainless steel and/or Teflon®.
- Unlock well cap or outer steel casing lid.
- Take photoionization detector (PID), lower explosive limit, and oxygen readings, with the appropriate meter(s), at the well head immediately upon opening the cap and record in field log book. If high concentrations are detected, take the appropriate measures as outlined in the BWHSP (Appendix F of the BWP) and the SSHP.
- Measure the static water level in the well with an electronic water level indicator as described in SOP B5.6 and record in the field logbook. Measure the total depth of the well 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 the analytical data. The water level indicator will be rinsed with deionized water in between individual wells to prevent cross-contamination.
- Calculate the volume of water in the well in gallons according to the Well Purge and Water Quality Field Data Sheet (Figure B4.1-1). This sheet is a typical well purge data sheet that 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. Table B4.1-1 lists quick conversions for water volumes.

Monitoring Well Purge Procedures

Non Low-Flow Well Purging Procedure

- Purge three to five well volumes of water from the well using one of the methods described below:

  — Pump with a submersible pump equipped with a check valve to avoid backflush and polyethylene tubing. For a non-dedicated system, set intake at the surface level of the groundwater and start pump; continue to lower the intake line through the well to just above screen depth ensuring that all standing water in the well has been purged. If the system is dedicated, it is not necessary to move the intake from it's set position.

  — Pump with a centrifugal pump and polyethylene tubing. For a non-dedicated system, set intake at the surface level of the groundwater and start pump; continue to lower the intake line through the well to just above screen depth ensuring that all standing water in the well has been purged. If the system is dedicated, it is not necessary to move the intake from its set position. Discard the suction line after each well unless the tubing is dedicated.

  — Bail well with a stainless steel or Teflon® bailer and Teflon®-coated stainless steel wire. Hand bailing the monitoring well is not a highly recommended purge method and should only be utilized as a last resort..

- Measure and record temperature, pH, specific conductance, turbidity, dissolved oxygen and ORP as each volume of groundwater is purged.

- After purging, allow the static water level to recover to approximately 80% of its static level or for 16 hours after purge completion, whichever comes first.

- When a well is pumped dry before three to five well volumes have been purged, the sample will be collected as soon as a sufficient amount of water has re-entered the well.

- Obtain the sample from the well after the required volume of groundwater has been purged and the temperature, pH, specific conductance, dissolved oxygen, ORP and turbidity have stabilized according to the stabilization requirements on Table B4.1-1. If the parameters do not stabilize within 3 to 5 well volumes the client should be notified and the well should be considered for additional purging or redevelopment.

Low-Flow Purging with Dedicated Submersible Pumps

- The pump intake shall be set at the bottom of the screened interval of each well where the depth to water (DTW) is within the screened interval. Where the DTW is above the screened interval, pump intakes shall be set at the top of the screened interval.

- Begin purging at a rate of approximately one liter per minute or as slow as the conditions and dedicated system allow (if greater than one liter per minute).

- Continuously monitor the water level and potential subsequent drawdown with an electric water level indicator. If the static water level prior to purging is within the screened interval, the drawdown shall 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 should 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 backflush into the well and when purging recommences start at a slower rate to avoid increasing turbidity.

- Purging will be considered complete when a minimum of one saturated screen volume, calculated according to the formula presented in Table B4.1-1, has been removed and the groundwater quality parameters have stabilized according to the stabilization requirements (Table B4.1-1).

- 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, the purging will be re-initiated beginning with the first step of this procedure.

Low-Flow Purging with Non-Dedicated Submersible Piston Pumps

- Prior to deploying the pump, it shall be decontaminated in accordance with procedures specified in SOP B1.11, Equipment Decontamination. If sample collection tubing is non-dedicated, it shall also be decontaminated prior to deployment.

- Collect an equipment blank as described in the Field Sampling Plan (Appendix A)

- Measure the static water level in the well.

- If the DTW is within the screened interval set the pump intake at the bottom of the screened interval. If the DTW is above the screened interval the pump intake shall be set at the top of the screened interval.

- Begin purging at a rate of approximately one liter per minute or as slow as the conditions and dedicated system allow (if greater than one liter per minute).

- Continuously monitor the water level and potential subsequent drawdown with an electric water level indicator. If the static water level prior to purging is within the screened interval, the drawdown shall 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 should 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 backflush into the well and when purging recommences start at a slower rate to avoid increasing turbidity. See section on Low-Flow Purging of Wells with Low Recharge.

- Purging will be considered complete when a minimum of one saturated screen volume, calculated according to the formula presented in Table B4.1-1, has been removed and the groundwater quality parameters have stabilized according to the stabilization requirements (Table B4.1-1).

- 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, the purging will be re-initiated beginning with the first step of this procedure.

Low-Flow Purging with Non-Dedicated Submersible Piston Pumps in Wells with Low Recharge Rates

- The pump intake shall be set approximately two feet above the bottom of the well.

- Measure the static water level in the well.

- Begin purging at a rate of approximately one liter per minute or as slow as the conditions and dedicated system allow (if greater than one liter per minute) until a minimum of one well casing volume is removed or the water level reaches the pump intake, whichever occurs first.

- Allow static water level to recover to approximately 80 percent of its static level or for 16 hours after purge completion, whichever occurs first.

- When sufficient time has passed, measure the water level to confirm 80 percent recharge.

- In the event that the pump is withdrawn from the well decontaminate the exterior of the pump and submerged portion of the tubing bundle with an Alconox® wash and deionized water rinse. Collect an equipment blank prior to redeployment of the pump system.

- Set the intake of the pump at the bottom of the screened interval, pump at a low flow rate and collect groundwater quality parameters for temperature, pH, specific conductance, turbidity, dissolved oxygen and ORP at 0.25 gallon intervals. Monitoring will continue until the groundwater quality parameters have stabilized according to the stabilization requirements presented in Table B4.1-1. **Note: The drawdown shall be monitored continuously during purging and shall not exceed a level less than one foot above the pump intake.**

- Prior to collecting samples, the volume of sample and the volume of the tubing bundle shall be calculates. If the volume of the tubing bundle exceeds the volume of the samples to be collected by more than one gallon the pump may be lowered to a minimum of two feet above the bottom of the well.

- Once readings have stabilized and the pump has been lowered (if the criteria for lowering is satisfied) commence sample collection. Continue to monitor drawdown during sample collection. In the event that the water level reaches a depth of 1 foot above the intake, pumping shall cease until the well has recharged to a level adequate to fill more sample bottles completely.

Sample Collection

- Sample collection will be with a low-flow submersible pump. Flow rates for sampling with low-flow pumps shall be maintained at 1 liter per minute or less.

- Sample containers shall be labeled prior to sample collection.

- Samples for volatile organic analysis shall be collected first. The samples shall 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.

- Samples for non-volatile organic analysis shall be collected following the volatile organic sample collection. Samples for dissolved metals analysis may be field filtered according to SOP B4.4. If field filtration is not performed the sample container must be clearly marked to state "laboratory filtration required".

- Place analytical samples in a cooler and chill to 4 degrees Celsius. Samples will be shipped to the appropriate laboratory within 24 hours. The sample cooler shall be shaded from direct sunlight immediately after collection.\

Post-Sample Collection Requirements

- Re-lock well cap.

- Fill out field logbook, sample log sheet, custody seals and Chain-of-Custody forms. Example copies of these forms are included in the QAPP (Appendix C of the BWP)

- Decontaminate purging and sampling equipment according to the procedures specified in SOP B1.11.

References for Other Applicable ASTM Standards

ASTM D4750 – Determining Subsurface Liquid Levels in a Borehole or Monitoring Well

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Figure B4.1-1. Well Purge and Water Quality Data Sheet

Well Purge and Water Quality Field Data Sheet

Page 1 of ______

Project:	______	Well No:	______
Project No.:	______		______
Date:	______	*Samplers:*	______
Time Start:	______		______
Time Finish:	______	Checked by:	______

Well Information

Depth to Water: ______ ft. Casing Diameter: ______ in. = ______ ft. Casing Stickup: ______ ft.

Bottom of Screen: ______ ft. Borehole Diameter: ______ in. = ______ ft. Screened Interval: ______ ft.

Sample Depth: ______ ft. Saturated Screen Well Volume: ______ gallons

Drawdown Limit: ______ ft. Calculations: Casing Volume (CV) = π (cr^2) h (7.48)

Note: All depths measured from top of casing.

Filter Pack Volume (FPV) = π (br^2 – cr^2)[BS-(TS or H)] P (7.48)

Saturated Screen Well Volume = CV + FPV

Calculation Notes:	cr = casing radius	h = bottom of screen – depth of water in ft.	If TS>H use TS, if TS<H use H
	br = borehole radius	P = estimated porosity of filter pack (35%)	BS = bottom of screen
	H = depth to water	TS = top of screen	

Field Equipment

pH Meter:	______	Serial No.:	______	Water Level Meter:	______	Serial No.:	______
Conductivity Meter:	______	Serial No.:	______	Turbidity Meter:	______	Serial No.:	______
Temperature Meter:	______	Serial No.:	______	Bailer:	______	Size:	______

Sample Equipment (check one)

☐ *Submersible Pump* *Pump Type (circle one):* *Piston* *Bladder* *Impeller*

☐ *Disposable Teflon Bailer* *Pump Model:* ______

Serial No.: ______

Field Chemistry

pH ______ = @ ______ °C pH ______ = @ ______ ºC pH ______ = @ ______ ºC Time ______

Conductivity Standard: ______ µmhos/cm @ 25ºC Reading ______ µmhos/cm @ ______ ºC Time ______

Turbidity Standard: ______ N.T.U. @ 25ºC Reading ______ N.T.U. @ ______ ºC Time ______

Figure B4.1-1. Well Purge and Water Quality Data Sheet (Concluded)

Page 2 of ________

Water Quality Field Data Sheet

Project:	________	Well No:	________
Project No.:	________		________
Date:	________	*Samplers:*	________
Time Start:	________		________
Time Finish:	________	Checked by:	________

Field Chemistry (cont'd)

Time	Volume gallons	Temp. ºC	pH	Conductivity µmhos/cm	Turbidity N.T.U.	Comments

Table B4.1-1. Quick Conversions for Water Volumes

Conversions for low flow purge volumes

Monitoring well casing only

Size	Conversion	
2”	0.17	Multiply the height of the water column in the well (Bottom of screen - DTW)
4"	0.65	Multiply the height of the water column in the well (Bottom of screen - DTW)
5"	1.02	Multiply the height of the water column in the well (Bottom of screen - DTW)
6"	1.47	Multiply the height of the water column in the well (Bottom of screen - DTW)

Note: With a dedicated system, where the water is above the top of screen multiply the conversion by the screen length. With a non-dedicated system the whole water column must be included in the calculation.

Monitoring well casing/Borehole size configuration

2”/6”	0.46	Multiply the occluded screened interval only to get additional volume in gallons
2”/8”	0.86	Multiply the occluded screened interval only to get additional volume in gallons
4"/8"	0.69	Multiply the occluded screened interval only to get additional volume in gallons
4”/10”	1.20	Multiply the occluded screened interval only to get additional volume in gallons
4”/12”	1.83	Multiply the occluded screened interval only to get additional volume in gallons
5"/8"	0.56	Multiply the occluded screened interval only to get additional volume in gallons
5"/10"	1.071	Multiply the occluded screened interval only to get additional volume in gallons
5"/12"	1.70	Multiply the occluded screened interval only to get additional volume in gallons
6"/12"	1.54	Multiply the occluded screened interval only to get additional volume in gallons

Add the two results together to obtain the saturated casing volume in gallons.

Water quality stabilization parameters:

Parameters are stabled after 4 consecutive readings are within the ranges listed below:
The pH range is 6.5 – 8.5. Check meter calibration if current readings are outside this range.
Ensure the water quality meter pH is calibrated with either the 4.0/7.0 or 7.0/10.0 pH standard.

Stabilization Requirements

Temp.	pH	Cond.	Tubidity	Dissolved Oxygen	ORP
± 1°C/2°F	± 0.1 units 6.5 - 8.5	± 3 % µmhos/ cm	<10 NTUs or ± 10% when <10 NTUs cannot be achieved	± 0.3 mg/L	± 10 millivolts

Miscellaneous Notes

3.785 Liters = 1 gallon

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SOP B4.2 Potable Water Sampling

Potable water samples may be collected during the remedial activities in order to ascertain whether contaminants originating from Kirtland Air Force Base (AFB) are adversely affecting nearby private or public water supply wells as well as onsite potable water sources. The procedures listed below will be followed:

- Wear appropriate PPE as outlined in the Base-Wide Health and Safety Plan (BWHSP) [Appendix F of the Base-Wide Plan (BWP)] and the Contractor's Site-Specific Safety and Health Plan (SSHP). In addition, samplers will don new gloves at each sampling location prior to collecting samples.

- Inspect the well including pump, storage tanks, and any treatment systems present.

- Sample access point should be chosen as close to the well head as possible prior to where the water enters any storage tank or any treatment systems.

- If the volume of purged water cannot be determined, the well will be evacuated for a minimum of 15 minutes. If the volume can be calculated, a minimum of 3 to 5 well volumes should be purged unless the well is in continuous use. If the well is used for industrial production, the pumping rate should be noted and the tap for sampling purged for 15 minutes. An outside faucet can be used for purging.

- Measure and record in field log book temperature, potential of hydrogen **(**pH), and specific conductance.

- Samples will be obtained by capturing the water directly from the access point into the sample container. Bottles for volatile organic compounds (VOCs) should contain the preservatives prior to sampling. Pre-preserved containers shall be obtained from the contracted laboratory.

  NOTE: Filtration for dissolved metals is discussed in SOP B4.4, Field Filtration.

- Place analytical samples in cooler and chill to 4°C. Samples will be shipped to the appropriate laboratory within 24 hours.

- Fill out field log book, sample log sheet, labels, custody seals, and Chain-of-Custody (C-O-C) forms. Example copies of these forms are included in the Quality Assurance Project Plan (QAPP) (Appendix C of the BWP).

- A tap must be free of any aerator, strainer, hose attachment, or water purification devices prior to sampling. When sampling chlorinated water for organics and bacterial analyses, sample bottles pre-preserved with sodium thiosulfate will be employed. Guidance is provided in the *Manual for the Certification of Laboratories Analyzing Drinking Water* [U. S. Environmental Protection Agency (EPA) 570/9-82-002, October 1982].

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SOP B4.3 Surface Water Sampling

Surface water sampling will be performed by the following procedure:

- Wear appropriate PPE as outlined in the BWHSP (Appendix F of the BWP) and the SSHP. In addition, samplers will don new sampling gloves at each location prior to sampling.
- A Teflon® or stainless steel scoop or beaker, or sample bottles may be used to collect the samples. The project-specific addendum will specify the sampling equipment to be used.
- Measure and record temperature, pH, specific conductance, and dissolved oxygen (if required) as described in SOPs B3.1, B3.2, B3.3 and B3.4, respectively.
- Water samples will be collected prior to sediment samples and collected in ascending order from the most downstream point first, to the farthest upstream sampling location. Care should be exercised when pouring the water in the sample bottles to minimize aeration of those samples collected for volatile organic analysis, and prevent overfilling of those sample bottles that contain preservatives. Samples shall be placed in pre-preserved containers.
- Samples to be analyzed for volatile constituents will be collected from the first beaker or scoop. The vials will be filled and tapped so that the entrainment of air is minimized and no headspace exists. If bubbles appear, refill the vial. These samples will not be composited, homogenized, or filtered.

  NOTE: Filtration for dissolved metals is discussed in SOP B4.4, Field Filtration.

- Place analytical samples in a cooler and chill to 4°C. Samples will be shipped to the appropriate laboratory within 24 hours.
- Decontaminate beaker or scoop as specified in SOP B1.10.
- Fill out field log book, sample log sheet, labels, custody seals, and C-O-C forms. Example copies of these forms are included in the QAPP (Appendix C of the BWP).
- Permanently mark the sampling location with a flagged stake in the stream bank.

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SOP B4.4 Field Filtration

The rationale for collecting the filtered samples will be clearly defined in the project-specific addenda. Filter apparatus must be made of polyethylene, polypropylene, or borosilicate glass. The filter used will be 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 the samples to the laboratory should clearly state that the samples have been field-filtered, in order to avoid second filtration at the laboratory. Field filtering of water samples should be conducted as follows:

- The filter apparatus will be decontaminated and clean.
- Pour the sample into the filter apparatus and filter sample through a cellulose-based membrane filter of 0.45-micron nominal size. Samples are only passed through the filter once.
- Preserve sample immediately as required.
- Place analytical samples in cooler and chill to 4°C. Samples will be shipped to the appropriate laboratory within 24 hours.
- Fill out field log book, sample log sheet, labels, custody seals, and C-O-C forms. Example copies of these forms are included in the QAPP (Appendix C of the BWP).

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SOP B5.1 pH

The following procedure is used for measuring groundwater pH with a pH meter:

- The instrument and batteries should be checked and calibrated in the laboratory prior to initiation of the field effort.
- The accuracy of the buffer solutions used for field and laboratory calibration should be checked. Buffer solutions need to be changed due to degradation upon exposure to the atmosphere. The date of preparation of each buffer should be included on the bottle label.
- Immerse the tip of the electrodes in water overnight. If this is not possible due to field conditions, immerse the electrode tip in water for at least an hour before use. The electrode tip may be immersed in a rubber or plastic sack containing buffer solution for field transport or storage. This is not applicable for all electrodes as some must be stored dry.
- Make sure all electrolyte solutions within the electrode(s) are at their proper levels and that no air bubbles are present within the electrode(s).
- Immerse the electrode(s) in a pH-7 buffer solution.
- Adjust the temperature compensator to the proper temperature (on models with automatic temperature adjustment, immerse the temperature probe into the buffer solution). Alternately, the buffer solution may be immersed in the sample and allowed to reach temperature equilibrium before equipment calibration. It is best to maintain buffer solution at or near expected sample temperature before calibration.
- Adjust the pH meter to read 7.0.
- Remove the electrode(s) from the buffer and rinse well with deionized water. Immerse the electrode(s) in pH-4 (for water with pH of 1 to 7) or pH-10 (for water with pH of 7 to 12) buffer solution and adjust the slope control to read the appropriate pH. At least three successive readings during calibration, one minute apart, should be within +0.1 pH unit. For best results, the standardization and slope adjustments should be repeated at least once daily before use.
- Immerse the electrode(s) in the unknown solution, slowly stirring the probe until the pH stabilizes. Stabilization may take several seconds to minutes. If the pH continues to drift, the sample temperature may not be stable, a chemical reaction (e.g., degassing) may be taking place in the sample, or the meter or electrode may be malfunctioning. This must be clearly noted in the log book.
- Read and record the pH of the solution, after adjusting the temperature compensator to the sample temperature. pH should be recorded to the nearest 0.1 pH unit. Also record the sample temperature.
- Rinse the electrode(s) with deionized water.
- Keep the electrode(s) immersed in water when not in use.

The sample used for pH measurement should never be saved for subsequent conductivity or chemical analysis. All pH electrodes leak small quantities of electrolytes (e.g., sodium or potassium chloride) into the solution. Precipitation of saturated electrolyte solution, especially at colder temperatures, or in cold water, may result in slow electrode response. Any visual observation of conditions that may interfere with pH measurement, such as oily materials, or turbidity, should be noted in the field log book.

SOP B5.2 Specific Conductance

The steps involved in taking specific conductance measurements are listed below:

- Check batteries and calibrate instrument before going into the field.
- Immerse the electrode in water overnight. If this is not possible due to field conditions, immerse the electrode at least one hour before use.
- Calibrate the instrument between each measurement or groups of closely spaced measurements. Potassium chloride standard solutions with a specific conductance closest to the values expected in the field should be used.
- Rinse the electrode with one or more portions of the sample to be tested.
- Immerse the electrode in the sample and measure the conductivity.
- Read and record the results in a field log book. Report the results to the nearest ten units for readings under 1000 micromhos per centimeter (µmhos/cm) and the nearest 100 units for readings over 1000 µmhos/cm. Adjust the temperature setting to the sample temperature.
- Repeat the procedure with fresh sample until reproducible (i.e., ± 5 percent) results are obtained.

If the specific conductance measurements become erratic, or inspection shows that any platinum black has flaked off the electrode, replatinization of the electrode is necessary. See the manufacturer's instructions for details.

Note that specific conductance is occasionally reported at temperatures other than ambient.

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SOP B5.3 Water Temperature

Water temperature may be measured with either a thermometer or temperature meter. The following procedure is applicable to both instruments:

- Rinse the thermometer or temperature probe with a portion of the collected sample.

- Immerse the thermometer or probe in the sample until temperature equilibrium is obtained (1- to 3-minutes). To avoid the possibility of contamination, the thermometer should not be inserted into samples which will undergo subsequent chemical analysis.

- Record values in a field log book to the nearest 0.5°C.

- If a temperature meter or probe is to be used, the instrument should be calibrated according to the manufacturer's recommendations and a National Bureau of Standards (NBS) certified thermometer or one that is traceable to NBS certification before field use. Cross-checking and duplicate field analyses should agree within ± 0.5°C. A cross-check with a calibrated NBS certified thermometer will be made at least semiannually.

- Rinse the thermometer or probe with distilled water.

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SOP B5.4 Dissolved Oxygen

Probes differ as to specifics of use. Follow the manufacturer's instructions to obtain an accurate reading. The following general steps should be used to measure the dissolved oxygen concentration:

- The equipment should be calibrated and its batteries checked in the laboratory before going to the field.
- The probe should be conditioned in a water sample for as long a period as practical before its use in the field. Long periods of dry storage followed by short periods of use in the field may result in inaccurate readings.
- The instrument should be calibrated in the field before each measurement or group of closely spaced measurements by placing the probe in a water sample of known dissolved oxygen concentration (i.e., determined by Winkler method) or in a freshly air-saturated water sample of known temperature. Dissolved oxygen values for air-saturated water can be determined by consulting a table listing oxygen solubility as a function of temperature and salinity.
- The instrument probe should be immersed in a flow-through cell or directly into the water column of the well for the most accurate measurement.
- Record the dissolved oxygen content and temperature of the sample in a field log book. Read the dissolved oxygen dial to the nearest 0.1 milligram per liter (mg/L).
- Recalibrate the probe when the membrane is replaced, or as needed. Follow the manufacturer's instructions. Duplicate analyses should agree within ± 0.1 mg/L.

Note that although *in-situ* placement of the probe is preferable, since sample handling is not involved,. thismay not always be practical. Be sure to record whether the liquid was analyzed *in-situ*, or if a sample was taken. If a sample is taken special care should be taken during collection to avoid turbulence, which can lead to increased oxygen solubility and positive test interference.

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SOP B5.5 Oxidation-Reduction Potential

The following procedure is used for measuring oxidation-reduction potential:

- The equipment should be calibrated and its batteries checked in the laboratory before going to the field.
- Check that the platinum probe is clean and the platinum bond or tip is unoxidized. If dirty, polish with emery paper or, if necessary, clean the electrode using aquaregia, nitric acid, or chromic acid, in accordance with manufacturer's instructions.
- Thoroughly rinse the electrode with distilled water.
- Verify the sensitivity of the electrodes in accordance with the manufacturer's instructions.
- After the assembly has been checked for sensitivity, wash the electrodes with three changes of deionized water or with a flowing stream of water from a wash bottle. Place the sample in a clean glass beaker or sample cup and insert the electrodes. Set temperature compensator to the sample temperature. Provide adequate agitation throughout the measurement period. Read the millivolt (mV) potential of the solution, allowing sufficient time for the system to stabilize and reach temperature equilibrium. Measure successive portions of the sample until readings on two successive portions differ by no more than 10 mV. A system that is very slow to stabilize properly will not yield a meaningful oxidation-reduction potential. Record all results in a field log book, including oxidation-reduction potential (to nearest 10 mV), sample temperature, and pH at the time of measurement.

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SOP B5.6 Water Levels

Water levels will be measured using an electric water level indicator. The steps to be followed are as follows:

- Check operation of recording equipment above ground. Prior to opening the well, don personal protective equipment as required.
- Record all information specified below on a Groundwater Level Data form or in the field logbook if the form is not available.
- Record well number, top of casing elevation and surface elevation if available. Well diameter and total depth should be recorded. Water levels will be taken from the surveyed reference mark on the top edge of the inner well casing.
- Use a decontaminated water level indicator to record water level to the nearest 0.01 ft (0.3 cm).
- Record the time and day of the measurement.
- Many water level measuring devices have marked metal or plastic bands clamped at intervals along the measuring line used for reference points to obtain depth measurements. The spacing and accuracy of these bands will be checked frequently as they may loosen and slide up or down the line, resulting in inaccurate reference points.
- All groundwater level measurement devices must be cleaned before and after each use to prevent cross-contamination of wells.

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Figure B5.6-1. Groundwater Level Data Form

Page ____ of ____

Site: ______________________ Name: ________________________________

Date: ______________________ Project: ________________________________

Well ID	Time	Top of Casing	Well Depth (ft)	Depth to Water (ft)	Comments (pH, temperature, specific conductance)

Measurement Reference Point from: ___ Top of Ground or ___ Top of Casing

Weather Conditions:____

____

____

Other Significant Observations:____

____

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SOP B5.7 Aquifer Testing

The following SOP describes the general guidelines to be used when performing several types of aquifer tests. More specific procedures will be presented in project-specific addenda, if applicable. Many factors influence the design of specific aquifer tests, such as well or borehole size, depth to water or depth of water, anticipated recovery rate, present or final use of the well/borehole, spatial location, end use of the data, or type of available testing equipment. This SOP does not attempt to address all of these variables, but provides the user with descriptions of the general types of tests available.

In-Situ Hydraulic Conductivity Tests

In-situ hydraulic conductivity tests approximate the hydraulic conductivity of the formation only across the interval tested. The disturbance to the formations caused by drilling and the potential turbulence from the well screen can influence the data. The diameter of the well is critical to the computation of the hydraulic conductivity, and the effective diameter of well can be increased considerably by the well development process. Poor well efficiency caused by inappropriate slot size, poor condition of the well screen, or a poorly designed gravel pack could produce results not representative of the tested formation. Hydraulic conductivity tests in wells should be conducted only after the well has been fully developed. Slug test evaluation formulas assume an instantaneous initial change in water level in the tested interval. Tests performed after extended periods of pumping or water addition may yield inaccurate results. Slug tests provide only rough estimates of hydraulic conductivity, and should not be run in preference to aquifer tests.

Slug Tests in Borings

Slug tests can be performed in borings while the boring is being advanced. This permits testing of formations at different depths throughout the drilling process. Boreholes to be tested should be drilled using casing or hollow stem augers, so that discrete depths may be investigated. Various tests and testing methods are described below. The decision of which test to use is dependent upon aquifer conditions, geologic conditions, drilling methods, and project objectives. The test method selected will be described in the project-specific addenda.

Both rising head and falling head hydraulic conductivity tests can be performed in saturated formations during drilling. There are several ways the tests can be performed. One way entails setting the casing flush with the bottom of the boring when the desired testing depth has been reached. The hole is then cleaned out to remove loose materials, and the drill bit and rods carefully withdrawn from the boring or raised well above the water level. After the water level in the boring has stabilized, the static water level is measured and recorded. The water level should then be raised (falling head test) or lowered (rising head test) and the change in water level measured at selected time intervals.

Measurements should be taken at least every ½ minute for the first 10 minutes, then at predetermined intervals after that. Depending on the response time of the aquifer, measurements may need to be taken more frequently and transducers and data loggers may be required. Figure BA5.7-1 shows a standard form for recording water level changes during testing. The rate of change of water levels will be used to calculate hydraulic conductivity. The test should be conducted until the water level again stabilizes, or for a minimum of 20 minutes. In low permeability formations it is not always practical to run the test until the water level stabilizes, as it may take a long time to do so. The top of the well casing should be used as the reference point for all water level measurements.

A second method consists of placing a temporary well with a 5-ft screen into the cleaned out boring, pulling the drilling casing back to expose the screen and allow the formation to collapse around the screen (or placing a sand/gravel pack around the screen if the formation does not collapse), and performing the appropriate hydraulic conductivity test in the well, as described for the first method. Again, the test should be conducted until the water level stabilizes or for a minimum of 20 minutes. This method allows for testing a larger section of the formation and results in more reliable hydraulic conductivity estimates.

A variation of the falling head test is the constant head test, in which water is added to the boring at a measured rate sufficient to maintain the water level in the boring at a constant height above the static water level in the boring. The discharge rate into the boring or well is measured once a stable elevated level has been achieved for a period of time, usually 10 to 20 minutes, and the hydraulic conductivity calculated from this. After the test is over, additional information can be gathered by measuring the rate of the drop in water level in the boring (for saturated formations). A limitation of the test is that foreign water is introduced into the formation which must be removed from the well area by natural or artificial means before a representative groundwater sample is obtained. This method of testing may be use in both saturated and unsaturated formations and is the only hydraulic conductivity test (except for Packer Tests in some cases) that can be performed in unsaturated formations. This test method may be necessary for highly permeable materials, in which the water level recovers rapidly.

Slug Testing in Wells

Hydraulic conductivity tests can also be performed in completed wells. Prior to testing, the well should be thoroughly developed and water levels allowed to stabilize in order to obtain accurate results. After the water level has stabilized, it should be raised or lowered and the rate of recovery measured as described for tests in boreholes. An advantage of using a solid cylinder of known volume to change the water level is that no water is removed or added to the monitoring well. This eliminates the need to dispose of contaminated water. Constant head tests can also be performed in wells, using the same procedures as described for constant head tests in borings.

The following data should be obtained when performing an *in-situ* hydraulic conductivity test in addition to the static water level and all time and water level measurements. This data should be recorded in a field logbook or on the data sheet depicted in Figure B5.7-1.

- Ground elevation
- Reference elevation
- Depth of test run
- Casing diameter
- Length of uncased borehole
- Identification of equipment used
- Well pipe and screen diameter and length
- Screen slot size

- Procedures used
- Borehole/gravel pack size (if known)

Packer Testing

Inflatable packer tests are commonly used to isolate a test zone within the borehole to perform rising or falling head and pressure tests. Packer tests will be conducted according to US Bureau of Reclamation Earth Manual DES-18 or ASTM D4630-86, Test Method for Determining Transmissivity and Storativity of Low Permeability Rocks by *In-Situ* Measurements Using the Constant Head Injection Test and ASTM D4631-86, Test Method for Determining Transmissivity and Storativity of Low Permeability Rocks by *In-Situ* Measurements Using the Presence Pulse Technique.

The usual procedure for packer testing is to drill the hole, remove the core barrel or tool, seat the packer, make the test, remove the packer, drill the hole deeper, set the packer again to test the newly-drilled section, and repeat the test. If the geology is such that the hole would remain open, the boring could be drilled to the final depth and cleaned. Two packers would then be set apart at least five times the diameter of the borehole. The bottom packer would be plugged and the perforated pipe would go between the packers.

Pressure measurements of the test zone from the beginning of curvature of the upper and lower packer should be recorded, condition of the packers and air lines should be checked, and depth of packer placement recorded. The hole should be tested from the bottom upward. Additional information to be collected includes the test interval and the pressure of water being injected into the well.

Pump Tests

This guideline outlines the methods for determining aquifer characteristics from pumping tests. The methods described may be used for both unconfined and confined aquifers. Values obtained are intended to be representative of the conditions of the aquifer over a large volume of pumping water.

The procedure consists of pumping from a well at a certain rate for a specific length of time and measuring the rate of response of the surrounding aquifer to pumping, through taking periodic water level measurements in both the pumping well and in any nearby observation wells. The hydraulic characteristics of the aquifer are then found by evaluating the data gathered, using an appropriate formula.

The determination of aquifer characteristics from aquifer test data by graphical methods is most common. Most methods are derived from the Theis nonequilibrium formula. The assumptions inherent in the formulas used in calculating the aquifer characteristics must be evaluated to insure validity of the formula under the actual conditions at the site being investigated.

Planning for the Pump Test

The location of an aquifer test is determined largely by the size of the area, the uniformity and homogeneity of the aquifers involved, and known or suspected recharge or barrier boundary conditions. The hydrogeological conditions of the site should not change over short distances and should be representative of the area under study.

As much information as possible should be collected and evaluated before running an aquifer test. This includes groundwater flow direction, hydraulic gradients, regional water level trend, the existence of other pumping wells in the vicinity of the test area, the expected groundwater quality of the discharge water, and the expected specific capacity of the pumping well.

Pumping equipment should conform to the size of the well. Drilling logs, data about well construction, and performance characteristics of the other wells in the area should be examined if available. Transmissivities may be estimated from the boring logs and preliminary testing. Any number of observation wells may be used. The number chosen depends on maintaining a balance between cost and the need to obtain the maximum amount of the accurate and reliable data.

The spacing of the observation wells should be determined based on expected drawdown conditions and preliminary pumping results. Generally, two observation wells are sufficient to achieve desired objectives. However, further definition of consistency requires up to four observation wells. In addition, under high transmissivity conditions, additional wells at greater distances will provide good representative average values. On the other hand, areas with low transmissivity might not provide sufficient response under low pumping rates to necessitate any observation wells. Under this situation, single well tests are used. The ultimate decision on the number of wells required for adequate pump tests is a function of expected conditions, project objectives, and cost.

If a pumping well does not fully penetrate an unconfined aquifer (any well open or screened through at least 85 percent of the saturated thickness of the aquifer may be considered as fully penetrating), the observation wells should be located at a minimum distance equal to 1-1/2 to 2 times the aquifer thickness from a partially penetrating pumping well to overcome distortions of flow pattern due to partial penetration.

If testing a confined aquifer which is not thick, the pumping well should be screened for the entire thickness of the aquifer. For an artesian aquifer the water level in the pumping well should not be allowed to fall below the bottom of the upper confining bed during the aquifer test.

Preparation for Testing

For a few days before starting an aquifer test, water levels in the pumping well and observation wells should be measured at about the same time each day to determine whether there is a measurable trend in groundwater levels. If such a trend is apparent, a curve of the change in depth versus time should be prepared and used to correct the water levels read during the test.

Pumping wells should undergo preliminary pumping prior to the actual test. This will enable fines to be flushed from the formation and a steady flow rate to be established. The preliminary pumping should determine the maximum drawdown in the well and establish the pumping rate for the later test. Step testing should be performed to determine the proper pumping rate for the long-duration pumping test to follow. The aquifer should then be given time to recover before the pumping test is begun.

Barometric changes may affect water levels in wells, particularly in confined aquifers. An increase in barometric pressure may cause a decrease in the water level. Any change in barometric pressure during the test should be recorded, in order to correct the water level measurements taken during the pumping test, if required.

A record should be maintained in the field log book of the times of pumping and discharge of other pumping wells in the area, if their radii of influence intersect the cone of depression of the pumping well.

All measurements and observations should be recorded in a field log book or on the form depicted in Figure B5.7-2.

Pumping Phase

Immediately before the pump is started, the water levels will be measured in all wells to determine the static water levels upon which all drawdowns will be based. These data and the time of measurement will be recorded on the forms depicted in Figure B5.7-2.

Water pumped from an unconfined aquifer during a pumping test will be disposed of in such a way so that the aquifer is not recharged by infiltration during the test, as recharge would influence the results obtained. Also, if contaminated water is pumped during the test, the water will be managed in accordance with the project-specific addenda to the WMP (Appendix E of the BWP).

The test pumping rate is highly dependent on aquifer conditions, and wells construction/development can range from less than 1 gallon per minute to hundreds of gallons per minutes. The well discharge should be measured frequently throughout the test and should be controlled to keep it as constant as possible after the initial excess discharge has been stabilized. This can be done by using a control valve.

The tone or rhythm of the pump engine provides a check of performance. If there is a sudden change in tone, the discharge should be checked immediately and proper adjustments made to the control valve or to the engine speed if necessary.

At least ten observations of drawdowns within each log cycle of time should be measured in the pumping well and observation wells. A continuous recorder on the nearest observation wells to the pumping well is extremely useful. A suggested schedule for measurements is as follows:

- 0 to 10 minutes—0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 4, 5, 6.5, 8, and 10 minutes. It is important in the early part of the test to record with maximum accuracy the time at which readings are taken.
- 10 to 100 minutes—10, 15, 20, 25, 30, 40, 50, 65, 80 and 100 minutes.
- Then at 1- to 2-hour intervals to completion.

Initially, there should be enough field personnel to station one person at each well used in the pumping test (unless a remote water-level measuring system and electronic data logger has been installed). After the first 2- hours of the pumping test, two people are usually sufficient to continue the test.

The total pumping time for a test depends on the type of aquifer and degree of accuracy desired. Economizing on the period of pumping is not recommended. More reliable results are obtained if pumping continues until the cone of depression reaches a stabilized condition. The cone of depression will continue to expand at a slower rate until recharge of the aquifer equals the pumping rate and a steady-state condition is established. The time for steady-state flow to occur may vary from a few hours to years, although 1 to 3 days is most common.

Under average conditions it is good practice to run the pumping phase of an aquifer test in a confined aquifer for at least 24 hours and in an unconfined aquifer for a minimum of 72 hours. A longer period of pumping may reveal the presence of boundary conditions not previously known. Preliminary field plotting of drawdown data should be conducted during the test to monitor how the test is progressing and how much longer it should be continued. If time or budget constraints preclude long-term aquifer tests, shorter-term tests, 2- to 4-hours in length, can be used to estimate aquifer characteristics in some cases. Drawdowns may not be noted in observation wells during short-term tests, so discharge/drawdown data from the pumping well is critical.

Recovery Phase

When the pump is stopped at the conclusion of the pumping phase, the drawdown and time at which it was shut down are recorded on forms depicted in Figure B5.7-2. The rate of recovery of the water level in the wells will then be measured. The same procedure and time pattern for taking water levels is followed as at the beginning of a test.

The recovery data should be recorded until water levels stabilize, or as long as possible within project constraints.

Figure B5.7-1a. Aquifer Tests Form – Pumping Well

Site Name:	**Geologist:**
Type of Test:	**Discharge measured by;**
Location/ Well No.:	**Drawdown measured by:**
Test No.:	**Water level measurement reference point:**
Start Date:	**Static depth to water before test:**
Start Time:	**Water sample collected? Yes ☐ No ☐**
Duration:	

Date	Time	Depth to water (ft)	Drawdown (ft)	Elapsed Time (min)	Manometer Reading (in)	Discharge (gal/min)	Remarks

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Figure B5.7-1b. Aquifer Test Form – Observation Well

Site Name:	**Geologist:**
Type of Test:	**Drawdown measured by:**
Location/Well No.:	**Water level measurement reference point:**
Test No.:	**Barometric Pressure:**
Start Date:	**Static water level before test:**
Duration:	**Water sample collected? Yes ☐ No ☐**

Date	Time	Depth to water (ft)	Drawdown (ft)	Elapsed Time (min)	Manometer Reading (in)	Discharge (gal/min)	Remarks

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Figure B5.7-2. Pump Test Data Sheet

PROJECT NAME:______________________________________
PROJECT NUMBER:______________________________________
DATE(S) OF TEST:______________________________________
REMARKS:______________________________________

WELL IDENTIFICATION ID:____________________________
MEASURING POINT:__________________ ELEV.:________
DISTANCE FROM PUMPING WELL (r, ft);________________
PUMPING RATE (Q):____________________________

DATE	TIME (24 Hr)	PUMP TIME (T, Min)	TIME SINCE (T=, Min)	T/T=	WATER LEVEL HELD (Ft)	WATER LEVEL CORRECTION (Ft)	WATER LEVEL D. T. W. (Ft)	DRAWDOWN (S, Ft)	RESIDUAL DRAWDOWN (S=, Ft)	CALCULATED RECOVERY (S-S= , Ft)	REMARKS

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SOP B6.1 Drum Sampling

Field sampling procedures for the collection of drum contents using a glass pipette are is as follows:

NOTE: If drum is bulging, leaking, or indicates a potential to rupture, the drum shall not be approached. Only remote opening and sampling shall be performed in this case.

- A level "B" respiratory protection reconnaissance will be conducted around the perimeter of the drum location area(s) unless otherwise required. During the reconnaissance, monitoring will be conducted using real-time air monitoring instruments as required in the BWHSP (Appendix F of the BWP) and the SSHP. Visual observations will be made of the drum conditions. All information is to be recorded in the field log book.

- Perimeters of the drum location area(s) will be cordoned off and identified as a restricted, controlled access area.

- Drums to be sampled are to be identified by placing colored index cards on the top of the drums. Care is to be taken to avoid any physical contact with the drums.

- Drums to be opened manually will be opened via a bung cap located on the top drum cover using a spark-proof bung wrench. In the event a top cover bung is not present, a remote controlled drum opener will be used.

- After opening the drum, a liquid phase sample will be collected using a glass pipette, 3- to 4-ft in length. The sample will be transferred to a sample bottle via the pipette. Care is to be taken not to spill any sample onto the ground surface.

- Upon completion of sampling, the pipette is to be disposed of into the drum from which it was used to sample. If necessary, the glass pipette will be broken inside of the drum.

- After disposing of the pipette into the drum, the opening on the drum cover will be closed by replacing the bung cap. If no bung cap was present, the hole will be closed using a fiberglass epoxy mix. Red flagging tape will then be tied around the drum indicating that the drum was sampled. The drum will be marked, with an indelible marker such as a paint marker, to indicate more details such as sample/drum number, date, etc.

- At the completion of the drum-sampling program, all of the drums will be moved to a designated storage area.

- Place analytical samples in cooler and chill to 4°C. Samples will be shipped within 24 hours to a laboratory.

- Fill out field log book, sample log sheet, custody seals, labels and C-O-C forms. Examples of the forms in included in the QAPP (Appendix C of the BWP).

Drums in a deteriorated condition such that a potential for release is evident will be packed in a salvage drum or in an over-packed drum, with the latter being preferred. Drums with openings sealed with a fiberglass epoxy mixture will be over-packed.

NOTE: Sampling of drums containing solid material such as investigation-derived waste (i.e. excess soil, soil cuttings, excess groundwater, decontamination water, etc.) will proceed according to the Standard Operating Procedures for Soil Sampling and Groundwater Sampling, SOP Sections B2 and B4.

SOP B6.2 Tank Sampling

Field sampling procedures for collecting samples of tank contents using a Teflon® bailer with a Teflon®-coated stainless steel wire cord or an open-tube sampler are as follows:

Teflon® Bailer

- Wear appropriate PPE as required in the BWHSP (Appendix F of the BWP) and the SSHP.
- Gain access (e.g., steps, ladder, man-lift, etc.) to the top of the tank.
- Slowly open release valve (if any) to bring the tank to atmospheric pressure. Properly control all sources of hazardous energy in accordance with BWHSP (Appendix F of the BWP) and the SSHP.
- Loosen access port/cover bolts and remove port/cover.
- If no access port/cover is available, unscrew cap of top opening.
- Use of disposable sample equipment is preferred. If disposable sample equipment is unavailable, use of decontaminated sample equipment is allowed. Sample equipment shall be decontaminated per the requirements of SOP B1.10, Equipment Decontamination. Insert a Teflon® bailer into tank slowly to allow stratified content (if any) to fill the bailer.
- Retrieve the bailer and wipe it with a disposable absorbent pad (place the pad in a 55-gallon drum).
- Transfer the sample(s) into appropriate containers as required by the project-specific addenda.
- Repeat the previous step until enough sample volume is obtained, as required.
- If using bottom valve, place the sample container below the valve and turn the valve slowly and easy to ensure a slow, controlled flow of sampling material.
- Cap the sampler container, place in double plastic bag, attach label, record all pertinent data in the field log book and complete the C-O-C form.
- Preserve and/or place sample(s) on ice, if required.
- Prepare sample(s) for delivery to the laboratory within 24 hours of collection.

Open Tube Sampler

- Use of disposable sample equipment is preferred. If disposable sample equipment is unavailable, use of decontaminated sample equipment is allowed. Sample equipment shall be decontaminated per the requirements of SOP B1.10. Insert a sampler into tank until it reaches the bottom.
- Place thumb securely over open end of tube and carefully retrieve the sampler.

- Transfer the sample(s) directly into appropriate containers.
- Repeat the previous step until enough sample volume is obtained, as required.
- Cap the sampler container, place in double plastic bag, attach label, record all pertinent data in the field log book, and complete the C-O-C form.
- Preserve and/or place sample(s) on ice, if required.
- Prepare sample(s) for delivery to the laboratory within 24 hours of collection.

If tanks are found to contain solid materials, the following sampling procedures will be followed using a rust-free carbon steel sample trier.

Sample Trier

Follow the first five steps as for a Teflon® bailer sampler.

- Use of disposable sample equipment is preferred. If disposable sample equipment is unavailable, use of decontaminated sample equipment is allowed. Sample equipment shall be decontaminated per the requirements of SOP B1.10. Insert a trier into the tank and into the solid material.
- Rotate the trier once or twice to cut a core of the material.
- Slowly retrieve the trier, making sure that the slot is facing upward.
- Transfer the sample into appropriate container with the aid of a stainless steel spatula.
- Repeat the previous step at two or more different points inside the tank until enough sample volume is obtained, as required.
- Cap the sample container, place in a double plastic bag, attach label, record all pertinent data in the field log book, and complete the C-O-C form.
- Preserve and/or place sample(s) or ice, if required.
- Prepare sample(s) for delivery to the laboratory within 24 hours of collection.

SOP B6.3 Wipe Sampling

The following procedure shall be implemented for wipe sampling.

Materials Required:

- Pre-preserved and solvent rinsed, 3-inch by 3-inch cotton swabs/sterile pads as provided by the contracted laboratory and as appropriate to the required analytical methodology.
- Deionized water
- Stainless steel, polyethylene or Teflon® clamps
- Appropriate sample bottles

Procedures

- Wear appropriate PPE as required in the BWHSP (Appendix F of the BWP) and the SSHP.
- Mark off a square area, of a size sufficient to give the required amount of sample for each fraction as provided in the analytical methodology to be used.
- Wipe the sampling area back and forth repeatedly, applying moderate pressure, with the cotton swab/sterile pad. Wipe the entire area so to insure all the sample material is picked up.
- Place the used swab/pad in the appropriate sample container.
- Use of disposable sample equipment is preferred. If disposable sample equipment is unavailable, use of decontaminated sample equipment is allowed. Sample equipment shall be decontaminated per the requirements of SOP B1.10, Equipment Decontamination.
- Submit a clean swab/pad as a blank.
- Cap sample container, attach label, place in a double plastic bag, record all pertinent data in the field log book, and complete the C-O-C form and sample log sheet.
- Place analytical samples in cooler and chill to 4°C.
- Prepare sample(s) for delivery to the laboratory within 24 hours after collection.

NOTE: The cotton swabs/pad will be held in stainless steel, Teflon® or polyethylene clamps, when collecting metal samples and in stainless steel or Teflon® clamps when collecting organic samples.

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SOP B6.4 Concrete Sampling

This SOP details the procedures required to collect concrete samples for chemical analysis:

- Wear appropriate PPE as required in the BWHSP (Appendix F of the BWP) and the SSHP. Each member of the sampling team should don new gloves at each sampling location.

- Place clean plastic sheeting on ground, concrete, or floor surface within sample area.

- Using a hand- or truck-mounted drill and a decontaminated coring bit, collect a core sample of the concrete. If possible, the diameter of the sample should be of sufficient size to satisfy the sample volume requirements. If water or air are used to provide cooling for the coring bit, then the water must be from an approved source, and proper precautions (filters, clean lines, etc.) must be taken to ensure that contaminants are not introduced into the air from an outside source.

- Transfer the core to the appropriate sample container.

- Cap the sampler container, place in double plastic bag, attach label, record all pertinent data in the field log book, and complete the C-O-C form.

Samples collected for VOC analysis should not be crushed and ground in the field. It is permissible for all other analyses.

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SOP B6.5 Air Sampling/Air Monitoring

This SOP details the general sampling and analytical methods for determining the air quality at Kirtland AFB during activities associated with the Installation Restoration Program. The following criteria will be used as guidelines in developing the required plans for site specific operations:

- Applicability of the sampling apparatus to the ultimate goals of the air sampling program and the end user of the data.
- Range of the instrument to perform the operation satisfactorily throughout the time period and conditions of the field activities.
- Precision of the data via collocated samplers and design specifications.
- Accuracy of the sampling equipment and its ability to provide representative data.

Reference methods, sampling apparatus, sampling media, and analytical methods for the monitoring of total suspended particulates (TSP), particulate matter less than 10 microns (PM-10), VOCs, semivolatile organic compounds (SVOCs), metals, mercury, asbestos, and/or radioactivity should be specified on a project-specific basis and presented in the project-specific addenda to the BWP. The metals samples are taken from the TSP filters. Airborne samples are typically taken either during remedial work hours or over 24-hour periods.

The air quality monitoring systems are to be calibrated on a quarterly basis using certified and traceable physical standards and test equipment. More frequent calibrations should be performed if recommended by the manufacturer or if recommended in method guidance documents. Independent audits of the air quality monitoring systems are to be performed quarterly. All audits must be performed by fully independent qualified experts using separate equipment and standards.

Concurrent with the air sampling program, meteorological data should be collected continuously onsite using a portable meteorological station or referring to nearby permanent meteorological stations, provided that the permanent stations are collecting data that includes the meteorological parameters required for dispersion modeling and that the data meets appropriate quality assurance/quality control (QA/QC) standards.

Table B6.5-1 Air Quality and Analytical Methods

Parameter	Reference Method	Sampling Apparatus	Sampling Media	Analytical Method
TSP	40 CFR Part 50, Appendix B	High-Volume Air Sampler	Quartz Fiber Filter	Gravimetric
PM-10	40 CFR Part 50, Appendix J	High Volume Air Sampler with Size-Selective Inlet	Quartz Fiber Filter	Gravimetric
VOCs	EPA Method TO-1 EPA Method TO-14	Controlled Flow Sampling Pump Controlled Flow Pump System	Tenax Tube, Tenax Backup Tube Train Passive Canister	GC/MS GC/MS
SVOCs	EPA Method TO-4	Modified High-Volume Air Sampler	Quartz Perfilter, Polyurethane Foam Filter	GC/MS
Metals	40 CFR Part 50, Appendix G	High Volume Air Sampler	Quartz Fiber Filter	ICP
Mercury	AIHA, 1976	Controlled Flow Sampling Pump	Hydrar Adsorbent Tube	AA Cold Vapor
Asbestos	NIOSH 7300	Controlled Flow Sampling Pump	Polycarbonate Filter	Phase Contrast Microscopy
Radioactivity	ISC Method 601 (Lodge, 3rd Edition)	High Volume Air Sampler	Membrane Filter	Alpha Counting

FOOTNOTES

AA Atomic Absorption

AIHA American Industrial Hygiene Association

CFR Code of Federal Regulations

EPA U.S. Environmental Protection Agency

GC/MS Gas chromatography/mass spectrometry

ICP Inductively coupled plasma emission spectrometry

ISC Intersociety Committee

NIOSH National Institute of Occupational Safety and Health

PM-10 Particulate matter less than 10 microns

SVOCs Semivolatile organic compounds

TSP Total suspended particulates

VOCs Volatile organic compounds

SOP B7.1 Approved Background Concentrations for Kirtland AFB

This SOP provides the NMED-approved background values for soil and groundwater that should be used to evaluate the potential for contamination at sites across Kirtland AFB. Tables B7.1-1 through B7.1-5 present the background values approved by NMED and presented in communication from the NMED-HWB in 1997 (NMED 1997). The Naval Facilities Engineering Command Guidance for Environmental Background Analysis, Volume I: Soil, April 2002 is available as a reference for the evaluation of background data. Background values are used for comparative purposes to assess the levels of inorganic and radiological parameters that naturally occur in soil and groundwater. Background values are used to screen chemicals of concern in human health and ecological risk assessments. Concentrations of inorganic and radiological parameters that exceed NMED-approved background values may indicate contamination at a site due to a previous release.

Some parameters may not be accounted for in the list of NMED-approved background values. In cases where NMED-approved background values are not available, background values from literature may be used with approval from Kirtland AFB Environmental Management in concurrence with NMED. Literature values are often referenced from sources such as *Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States* (Shacklette and Boerngen 1984). NMED has indicated that the Shacklette and Boerngen reference is suitable for use on Kirtland AFB projects in instances where background values are not available from NMED.

References

NMED, 1997. Letter from Robert S. Dinwiddie, Hazardous Waste Bureau (formerly Hazardous and Radioactive Materials Bureau [HRMB]), to Michael Zamorski, Acting Area Manager of the Kirtland Area Office for the Department of Energy. RE: Request for Supplemental Information: Background Concentrations Report, SNL/KAFB. September 24, 1997.

Shacklette, H.T. and J.G. Boerngen, 1984. *Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States.* U.S. Geological Survey, Professional Paper 1270.

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Table B7.1-1. Approved Background Concentrations of Inorganic Constituents in Soil for Kirtland AFB

COC	Depth	Area Group	HWB Median (mg/kg)	HWB Maximum Sample Value (mg/kg)	HWB Maximum Background (mg/kg) [(1)]
Antimony	Surface / Subsurface		NA	NA	
		N/T/SW/CTF/Off	--	--	3.9
Arsenic	Surface		2.5	8.4	
		N/SW/CTF/ Off	--	--	5.6
	Subsurface	N/T/SW/Off	--	--	4.4
		CTF	--	--	7
Barium	Surface		90.5	200	
		N/Off	--	--	200
		T	--	--	281
		SW/CTF	--	--	130
	Subsurface	SW/CTF	--	--	214
		N/T/Off	--	--	200
Beryllium	Surface / Subsurface		< 1	< 1	
		N/T	--	--	0.80
		SW/CTF/Off	--	--	0.65
Cadmium	Surface		< 1	< 1	
		N/SW/CTF/ Off	--	--	< 1
		T	--	--	< 1
	Subsurface	N/T/SW/CTF/Off	--	--	0.9
Total Chromium	Surface		8.0	20.0	
		N/SW/CTF/ Off	--	--	17.3
		T	--	--	21.8

Table B7.1-1. Approved Background Concentrations of Inorganic Constituents in Soil for Kirtland AFB (Continued)

COC	Depth	Area Group	HWB Median (mg/kg)	HWB Maximum Sample Value (mg/kg)	HWB Maximum Background (mg/kg) (1)
Total Chromium (Cont'd)	Subsurface	N/CTF/Off	--	--	12.8
		T	--	--	16.2
		SW	--	--	15.9
Chromium-6 (Cr^{+6})	Surface / Subsurface		NA	NA	
		SW	--	--	1
Cobalt	Surface		5.0	9.3	
		N/Off	--	--	7.1
		T	--	--	9.3
		SW/CTF	--	--	5.2
	Subsurface	N/Off	--	--	8.8
		T	--	--	9.3
		SW/CTF	--	--	5.2
Copper	Surface		10.0	17	
		N	--	--	17
		T	--	--	17
		SW/CTF/Off	--	--	15.4
	Subsurface	N	--	--	17
		T	--	--	17
		SW/CTF/Off	--	--	18.2
Lead	Surface		11	39	
		N/T	--	--	39
		SW/CTF/Off	--	--	21.4
	Subsurface	N/T	--	--	11.2
		SW/CTF/Off	--	--	11.8

Table B7.1-1. Approved Background Concentrations of Inorganic Constituents in Soil for Kirtland AFB (Continued)

COC	Depth	Area Group	HWB Median (mg/kg)	HWB Maximum Sample Value (mg/kg)	HWB Maximum Background (mg/kg) (1)
Mercury	Surface		< 0.25	< 0.25	
		N/T/SW/CTF/Off	--	--	< 0.25
	Subsurface	N/T/SW/CTF/Off	--	--	< 0.1
Nickel	Surface / Subsurface		8.0	21.0	
		N/Off	--	--	25.4
		T	--	--	21.0
		SW/CTF	--	--	11.5
Selenium	Surface / Subsurface		NA	NA	
		N/T/SW/CTF/Off	--	--	< 1
Silver	Surface		< 1	< 1	
		N/SW/CTF/Off	--	--	< 1
	Subsurface	N/SW/CTF/Off	--	--	< 1
Thallium	Surface / Subsurface		< 1	2	
		N/T/SW/CTF/Off	--	--	< 1.1
Tin	Surface / Subsurface		< 10	< 10	
		N/T/CTF/Off	--	--	< 10
Total Uranium	Surface		NA	NA	
		N/T/SW/CTF/Off	--	--	3.42
	Subsurface	N/SW	--	--	2.3
Vanadium	Surface		23.0	33.0	
		N/T	--	--	33.0
		SW/CTF/Off	--	--	20.4

Table B7.1-1. Approved Background Concentrations of Inorganic Constituents in Soil for Kirtland AFB (Concluded)

COC	Depth	Area Group	HWB Median (mg/kg)	HWB Maximum Sample Value (mg/kg)	HWB Maximum Background (mg/kg) [(1)]
	Subsurface	N/T	--	--	33.0
		SW/Off	--	--	21.5
Zinc	Surface / Subsurface		32.0	76	
		N	--	--	76
		T	--	--	76
		SW/CTF/Off	--	--	63
Zirconium	Surface / Subsurface		NA	NA	
		Off	--	--	9.2

FOOTNOTES

1 Use the HWB Maximum Background Concentration for soils to establish background concentrations for assessments

2 EPA Lifetime Health Advisory

3 EPA Proposed MCL

4 NO3 / NO2 could not be readily established for Kirtland AFB area on a size-wide basis (Moses and Winz, 1995)

5 Maximum Contaminant Level actually applies to Radium 226 + Radium-228

COC Contaminant of Concern

EPA U.S. Environmental Protection Agency

HWB New Mexico Environment Department Hazardous Waste Bureau

Kirtland AFB Kirtland Air Force Base

MCL EPA Maximum Contaminant Level

mg/kg milligram per kilogram

NA Not analyzed

pCi/g Picocuries per gram

-- Not included on Table

NO3/NO2 Nitrate and Nitrite as Nitrogen

Area Groups:

N : North

T : Tijeras

SW : Southwest

CTF : Coyote Test Field

Off : Off-size (?) off-site

LC : Lower Canyon

UC : Upper Canyon

CB : Canyons Background

Source: Letter dated September 24, 1997 from New Mexico Environment Department Hazardous Waste Bureau to Mr. Michael J. Zamorski, Acting Area Manager, Kirtland Area Office, U.S. Department of Energy

Table B7.1-2. Approved Background Concentrations of Radiological Constituents in Soil for Kirtland AFB

COC	Depth	Area Group	HWB Median (pCi/g)	HWB Maximum Sample Value (pCi/g)	HWB Maximum Background (pCi/g) (1)
Cesium-137	Surface	--	0.411	3.545	--
		N/Off	--	--	0.836
		T	--	--	0.908
		SW/CTF	--	--	0.664
	Subsurface	N/Off	--	--	0.084
		SW	--	--	0.079
Radium-226	Surface	--	1.992	3.827	--
		N/SW	--	--	2.30
	Subsurface	N/SW	--	--	1.76
		T	--	--	0.90
Radium-228	Surface	--	NA	NA	--
		N	--	--	1.33
		SW	--	--	1.01
	Subsurface	N	--	--	1.20
		T	--	--	0.70
		SW	--	--	0.93
Strontium-90	Surface	--	NA	NA	--
		S/T/SW/Off	--	--	1.08
Thorium-232	Surface / Subsurface	--	0.950	1.540	--
		N	--	--	1.54
		SW/Off	--	--	1.01
Thorium-234	Surface / Subsurface	--	NA	NA	--
		N/SW	--	--	1.4

Table B7.1-2. Approved Background Concentrations of Radiological Constituents in Soil for Kirtland AFB (Concluded)

COC	Depth	Area Group	HWB Median (pCi/g)	HWB Maximum Sample Value (pCi/g)	HWB Maximum Background (pCi/g) (1)
Uranium-234	Surface / Subsurface	--	0.78	1.29	--
		N	--	--	1.6
		SW	--	--	1.6
Uranium-235	Surface / Subsurface	--	0.06	0.12	--
		N/CTF	--	--	0.18
		SW	--	--	0.16
Uranium-238	Surface / Subsurface	--	0.850	1.400	--
		N/Off	--	--	1.3
		SW	--	--	1.4

FOOTNOTES

[1] Use the HWB Maximum Background Concentration for soils to establish background concentrations for assessments

[2] EPA Lifetime Health Advisory

[3] EPA Proposed MCL

[4] NO3 / NO2 could not be readily established for Kirtland AFB area on a size-wide basis (Moses and Winz, 1995)

[5] Maximum Contaminant Level actually applies to Radium 226 + Radium-228

COC Contaminant of Concern

EPA U.S. Environmental Protection Agency

HWB New Mexico Environment Department Hazardous Waste Bureau

Kirtland AFB Kirtland Air Force Base

MCL EPA Maximum Contaminant Level

mg/kg milligram per kilogram

NA Not analyzed

pCi/g Picocuries per gram

-- Not included on Table

NO3/NO2 Nitrate and Nitrite as Nitrogen

Area Groups:

N : North

T : Tijeras

SW : Southwest

CTF : Coyote Test Field

Off : Off-size (?) off-site

LC : Lower Canyon

UC : Upper Canyon

CB : Canyons Background

Source: Letter dated September 24, 1997 from New Mexico Environment Department Hazardous Waste Bureau to Mr. Michael J. Zamorski, Acting Area Manager, Kirtland Area Office, U.S. Department of Energy

Table B7.1-3. Approved Background Concentrations of Radiological Constituents in Soil—Canyons Study – for Kirtland AFB

COC	Area Group	HWB Median (pCi/g)	HWB Maximum Sample Value (pCi/g)	HWB Maximum Background (pCi/g) [(1)]
Cesium-137	--	0.411	3.545	--
	LC	--	--	1.55
	UC	--	--	0.515
	CB	--	--	1.063
	Fan	--	--	0.664
Radium-226	--	1.992	3.827	--
	UC	--	--	2.66
	LC/UC/Fan	--	--	2.60
Radium-228	--	NA	NA	--
	LC/UC/Fan	--	--	1.080
Strontium-90	--	NA	NA	--
	LC/UC/Fan	--	--	1.08
	S/T/SW/Off	--	--	1.08
Thorium-232	--	0.950	1.540	--
	LC/UC/Fan	--	--	1.03
Thorium-234	--	NA	NA	--
	LC/UC/Fan	--	--	2.31
	CB	--	--	2.31
Uranium-234	--	0.780	1.290	--
	LC/UC/Fan	--	--	2.31
Uranium-235	--	0.06	0.12	--
	LC/UC/CB/Fan	--	--	0.16
Uranium-238	--	0.850	1.400	--
	LC/UC/Fan	--	--	2.31

Table B7.1-3. Approved Background Concentrations of Radiological Constituents in Soil—Canyons Study—for Kirtland AFB (Concluded)

FOOTNOTES

[1] Use the HWB Maximum Background Concentration for soils to establish background concentrations for assessments

[2] EPA Lifetime Health Advisory

[3] EPA Proposed MCL

[4] NO3 / NO2 could not be readily established for Kirtland AFB area on a size-wide basis (Moses and Winz, 1995)

[5] Maximum Contaminant Level actually applies to Radium 226 + Radium-228

COC	Contaminant of Concern
EPA	U.S. Environmental Protection Agency
HWB	New Mexico Environment Department Hazardous Waste Bureau
Kirtland AFB	Kirtland Air Force Base
MCL	EPA Maximum Contaminant Level
mg/kg	milligram per kilogram
NA	Not analyzed
pCi/g	Picocuries per gram
--	Not included on Table
NO3/NO2	Nitrate and Nitrite as Nitrogen

Area Groups:

N :	North	LC :	Lower Canyon
T :	Tijeras	UC :	Upper Canyon
SW :	Southwest	CB :	Canyons Background
CTF :	Coyote Test Field		
Off :	Off-size (?) off-site		

Source: Letter dated September 24, 1997 from New Mexico Environment Department Hazardous Waste Bureau to Mr. Michael J. Zamorski, Acting Area Manager, Kirtland Area Office, U.S. Department of Energy

Table B7.1-4. Approved Background Concentrations of Inorganic Constituents in Groundwater for Kirtland AFB

COC	EPA Analytical Method	EPA MCL (µg/L)	HWB 95th Percentile or UTL (µg/L)	HWB Maximum Background (µg/L)
Antimony	6010	6	NA	6
Arsenic	6010	50	NA	14
Barium	6010	2000	200	120
Beryllium	6010	4	NA	4
Cadmium	6010	5	< 1	0.47
Total Chromium	6010	100	51	43
Chromium-6 (Cr^{+6})	6010	100	NA	< 10
Cobalt	6010	50 (2)	< 10	2.5
Copper	6010	1300 (2)	< 50	< 50
Lead	6010	15	13	10
Mercury	7470	2	NA	2
Nickel	6010	100	25	28
				28
Selenium	6010	50	NA	5
Silver	6010	50	NA	< 10
Thallium	6010	2	NA	2
Tin	7870	--	NA	50
Total Uranium	--	20 (3)	NA	5.2
Vanadium	6010	20 (2)	13	13
				4.1
Zinc	6010	5000	2230	260
				470
Zirconium	--	--	NA	--
(NO_3/NO_2)	353.2	10000	-- (4)	4000

Table B7.1-4. Approved Background Concentrations of Inorganic Constituents in Groundwater for Kirtland AFB (Concluded)

FOOTNOTES

[1] Use the HWB Maximum Background Concentration for soils to establish background concentrations for assessments

[2] EPA Lifetime Health Advisory

[3] EPA Proposed MCL

[4] NO3 / NO2 could not be readily established for Kirtland AFB area on a size-wide basis (Moses and Winz, 1995)

[5] Maximum Contaminant Level actually applies to Radium 226 + Radium-228

COC	Contaminant of Concern
EPA	U.S. Environmental Protection Agency
HWB	New Mexico Environment Department Hazardous Waste Bureau
Kirtland AFB	Kirtland Air Force Base
MCL	EPA Maximum Contaminant Level
mg/kg	milligram per kilogram
NA	Not analyzed
pCi/g	Picocuries per gram
--	Not included on Table
NO3/NO2	Nitrate and Nitrite as Nitrogen

Area Groups:

N :	North	LC :	Lower Canyon
T :	Tijeras	UC :	Upper Canyon
SW :	Southwest	CB :	Canyons Background
CTF :	Coyote Test Field		
Off :	Off-size (?) off-site		

Source: Letter dated September 24, 1997 from New Mexico Environment Department Hazardous Waste Bureau to Mr. Michael J. Zamorski, Acting Area Manager, Kirtland Area Office, U.S. Department of Energy

Table B7.1-5. Approved Background Concentrations of Radiological Constituents in Groundwater for Kirtland AFB

COC	EPA MCL (pCi/L)	HWB 95th Percentile or UTL (pCi/L)	HWB Maximum Background (pCi/L)
Cesium-137	--	NA	9.3
Radium-226	5 (5)	NA	2.7
Radium-228	5 (5)	NA	4.7
Radium-222	300 (3)	NA	300
Strontium-90	--	NA	< 1.6
Thorium-232	--	NA	0.17
Thorium-234	--	NA	< 104
Uranium-234	--	NA	7
			18
Uranium-235	--	NA	0.41
			0.76
Uranium-238	--	NA	3.0
			7.4

FOOTNOTES

1 Use the HWB Maximum Background Concentration for soils to establish background concentrations for assessments

2 EPA Lifetime Health Advisory

3 EPA Proposed MCL

4 NO3 / NO2 could not be readily established for Kirtland AFB area on a size-wide basis (Moses and Winz, 1995)

5 Maximum Contaminant Level actually applies to Radium 226 + Radium-228

COC Contaminant of Concern
EPA U.S. Environmental Protection Agency
HWB New Mexico Environment Department Hazardous Waste Bureau
Kirtland AFB Kirtland Air Force Base
MCL EPA Maximum Contaminant Level
mg/kg milligram per kilogram
NA Not analyzed
pCi/g Picocuries per gram
-- Not included on Table
NO3/NO2 Nitrate and Nitrite as Nitrogen

Area Groups:

N : North LC : Lower Canyon
T : Tijeras UC : Upper Canyon
SW : Southwest CB : Canyons Background
CTF : Coyote Test Field
Off : Off-size (?) off-site

Source: Letter dated September 24, 1997 from New Mexico Environment Department Hazardous Waste Bureau to Mr. Michael J. Zamorski, Acting Area Manager, Kirtland Area Office, U.S. Department of Energy

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SOP B7.2 Use of NMED Soil Screening Levels

This SOP just provides a general procedure for data assessment of soil analytical results using New Mexico Environment Department Soil Screening Levels (SSLs).

NMED-HWB produced guidance in December 2000, with a subsequent update in January 2001, for use in evaluating the potential for human health risk at sites where there were past releases or disposal activities that may impact human health and the environment. This guidance document was modeled after guidance available from the EPA and provides a step-by-step approach to developing SSLs that can be used to assess the need for further risk evaluation. NMED developed New Mexico-specific SSLs based on parameters more appropriate for sites within the state relative to climate, exposure, and soil properties. NMED SSLs are presented in Table B7.2-1.

The evaluation of analytical data for Kirtland AFB projects must follow the risk-based soil-screening approach presented in the guidance from NMED (NMED, 2000) which is described below:

1. Determine the analytes detected in soil samples collected from the site

2. Evaluate data for metals and radionuclides with concentrations exceeding NMED-approved background values for Kirtland AFB, or literature values available from the U.S. Geological Survey (Shacklette and Boerngen 1984), and for all organic compounds that were detected in samples

3. Calculate a ratio for each metal and organic compound determined from step 2 as the appropriate exposure point concentration divided by the NMED SSL

4. For each toxicity endpoint calculate a sum of the ratios for the analytes specific to each endpoint (e.g., sum of carcinogenic ratios and sum of noncarcinogenic ratios)

5. Compare endpoint ratios to 1.0. If ratios exceed 1.0 there is a potential that unacceptable risk exists at the site due to exposure to soil and further risk evaluation should be considered.

6. If endpoint ratios are less than 1.0 there is acceptable risk due to exposure at the site and there is no need for further risk evaluation.

Data for soil samples should also be compared to groundwater protection dilution-attenuation factor 20 (DAF20) values. DAF20 values were adjusted for toxic pollutants listed in the Water Quality Control Commission table for groundwater standards (NMAC 20.6.2). The DAF20 values for each chemical should be adjusted based on the number of toxic pollutants presented in soil specific to each landfill as presented in NMED guidance. DAF20 values present a value at which leaching of a contaminant from soil could occur. Although concentrations of chemicals in soil greater than DAF20 values indicates a potential for leaching, the DAF20 values do not take into account vertical contaminant migration to groundwater. Groundwater at Kirtland AFB ranges from 100 to 500 ft below ground surface; thus, a site-specific evaluation of contaminant migration should be conducted to determine the potential for contaminant leaching from soil and subsequent unsaturated (vadose) zone migration to the water table. Several tools are available to evaluate vadose zone contaminant migration including the computer models SESOIL and VLEACH.

Refer to following document for guidelines and procedures for the NMED-HWB SSL guidance. Table A-1 from the guidance document (NMED 2000) is included in this SOP as Table B7.2-1.

NMED, 2000. *Technical Background Document for Development of Soil Screening Levels*, Hazardous Waste Bureau and Ground Water Quality Bureau Voluntary Remediation Program. December 2000. Updated January 2001 with revised levels for select PAHs.

Table B7.2-1. NMED Soil Screening Levels

Chemical	Residential Soil (mg/kg)	Endpoint	Industrial/Occupational Soil (mg/kg)	Endpoint	Construction Worker Soil (mg/kg)	Endpoint	VOC	DAF 1 (mg/kg)	DAF 20 (mg/kg)
Acenaphthene	2.8E+03	nc[a]	4.9E+03	nc[a]	1.1E+04	nc[a]	X	3.E+03	6.E+04
Acrolein	9.9E-02	nc	7.7E-02	nc	4.1E-01	nc	X	8.E-06	2.E-04
Acrylonitrile	1.9E+00	ca	4.6E+00	ca	2.8E+01	nc	X	7.E-05	1.E-03
Aldrin	2.9E-01	ca	1.2E+00	ca	1.6E-02	nc		6.E-03	1.E-01
Aluminum	7.4E+04	nc	1.0E+05	max	7.5E-01	nc		8.E-01	2.E+01
Anthracene	1.6E+04	nc[a]	3.4E+04	nc[a]	6.2E+04	nc[a]	X	6.E+01	1.E+03
Antimony	3.0E+01	nc	9.2E+01	nc	1.1E+02	nc		3.E-03	5.E-02
Arsenic	3.9E+00	ca	1.7E+01	ca	1.9E-02	ca		3.E+00	6.E+01
Barium	5.2E+03	nc	1.5E+04	nc	7.7E-02	nc		4.E+01	8.E+02
Benzene	6.4E+00	ca	5.6E+00	nc	2.9E+01	nc	X	3.E-03	6.E-02
Benzidine	2.1E-02	ca	8.9E-02	ca	1.3E-03	ca		5.E-07	1.E-05
Benzo(a)anthracene	6.2E+00	ca	2.6E+01	ca	9.4E-01	ca		2.E+00	4.E+01
Benzo(a)pyrene	6.2E-01	ca	2.6E+00	ca	9.4E-02	ca		6.E+00	1.E+02
Benzo(b)fluoranthene	6.2E+00	ca	2.6E+01	ca	9.4E-01	ca		8.E-01	2.E+01
Benzo(k)fluoranthene	6.2E+01	ca	2.6E+02	ca	9.4E+00	ca		8.E+00	2.E+02
Beryllium	1.5E+02	nc	4.4E+02	nc	3.1E-03	nc		1.E-02	2.E-01
□-BHC	9.0E-01	ca	3.9E+00	ca	4.6E-02	ca		2.E-05	4.E-04
□-BHC	3.2E+00	ca	1.4E+01	ca	1.6E-01	nc		2.E-03	4.E-02
□-BHC	4.4E+00	ca	1.9E+01	ca	1.6E-01	nc		4.E-04	7.E-03
Bis(2-chloroethyl) ether	4.4E+00	ca	1.9E+01	ca	2.5E-01	ca		2.E-05	3.E-04
Bis(2-chloroisopropyl) ether	6.9E+01	ca	2.9E+02	ca	8.3E+00	ca		5.E-04	9.E-03
Bis(chloromethyl) ether	2.2E-02	ca	9.3E-02	ca	1.3E-03	ca		9.E-08	2.E-06
Boron	5.5E+03	nc	1.3E+04	nc	3.1E+00	nc		1.E-01	3.E+00
Bromodichloromethane	9.6E+00	ca	2.2E+01	ca	4.5E+02	ca	X	3.E-02	7.E-01
Bromomethane	3.7E+00	nc	3.0E+00	nc	1.5E+01	nc	X	2.E-03	4.E-02
2-Butanone	3.7E+04	nc	8.9E+04	nc	1.5E+02	nc		3.E-01	7.E+00
tert-Butyl methyl ether	6.1E+03	nc	1.5E+04	nc	4.5E+02	nc		4.E-03	8.E-02
Cadmium	7.0E+01	nc	1.9E+02	nc	4.7E-02	ca		8.E-01	2.E+01
Carbon tetrachloride	1.6E+00	nc	1.3E+00	nc	6.8E+00	nc	X	5.E-03	1.E-01
Chlordane	1.6E+01	ca	7.0E+01	ca	1.1E-01	nc		4.E-01	8.E+00
Chlorobenzene	1.4E+02	nc	1.2E+02	nc	1.9E+02	sat	X	5.E-02	1.E+00
Chloroform	3.8E-01	nc	3.0E-01	nc	1.6E+00	nc	X	3.E-02	5.E-01
Chloromethane	1.2E+01	ca	2.5E+01	ca	6.0E+02	ca	X	5.E-04	1.E-02
Chromium III	1.0E+05	max	1.0E+05	max	1.0E+05	max		9.E+00	2.E+02
Chromium VI	2.3E+02	nc	6.6E+02	ca	1.0E-03	ca		1.E+00	2.E+01
Chrysene	6.1E+02	ca[a]	2.5E+03	ca[a]	6.4E+03	nc[a]	X	5.E+01	1.E+03

Table B7.2-1. NMED Soil Screening Levels (Continued)

Chemical	Residential Soil (mg/kg)	Endpoint	Industrial/Occupational Soil (mg/kg)	Endpoint	Construction Worker Soil (mg/kg)	Endpoint	VOC	DAF 1 (mg/kg)	DAF 20 (mg/kg)
Cobalt	4.5E+03	nc	1.3E+04	nc	1.6E-01	nc		8.E-03	2.E-01
Copper	2.8E+03	nc	8.5E+03	nc	1.0E+04	nc		4.E+02	7.E+03
Cyanide	1.2E+03	nc	3.0E+03	nc	1.1E+01	nc		5.E-02	1.E+00
DDD	2.4E+01	ca	1.0E+02	nc	2.7E-01	nc		3.E+00	6.E+01
DDE	1.7E+01	ca	7.5E+01	ca	2.7E-01	nc		1.E+01	3.E+02
DDT	1.7E+01	ca	7.5E+01	ca	2.7E-01	nc		7.E-01	1.E+01
Di(2-ethylhexyl) phthalate	3.5E+02	ca	1.5E+03	ca	1.2E+01	nc		4.E-01	9.E+00
Dibenz(a,h)anthracene	6.2E-01	ca	2.6E+00	ca	9.4E-02	ca		5.E-01	9.E+00
1,2-Dibromoethane	5.3E-02	ca	2.1E-01	ca	1.4E+00	ca	X	2.E-05	4.E-04
1,2-Dichlorobenzene	8.5E+01	sat	8.5E+01	sat	8.5E+01	sat	X	4.E-01	9.E+00
1,3-Dichlorobenzene	1.2E+01	nc	1.1E+01	nc	5.0E+01	nc	X	4.E-03	8.E-02
1,4-Dichlorobenzene	3.2E+01	ca	5.7E+01	sat	5.7E+01	sat	X	8.E-02	2.E+00
3,3-Dichlorobenzidine	1.1E+01	ca	4.5E+01	ca	6.5E-01	ca		3.E-04	5.E-03
Dichlorodifluoromethane	9.0E+01	nc	7.1E+01	nc	3.8E+02	nc	X	6.E+00	1.E+02
1,1-Dichloroethane	5.6E+02	nc	4.6E+02	nc	1.2E+03	sat	X	7.E-03	1.E-01
1,2-Dichloroethane	3.3E+00	ca	7.2E+00	ca	4.3E+01	nc	X	1.E-03	2.E-02
cis-1,2-Dichloroethene	4.1E+01	nc	3.3E+01	nc	1.7E+02	nc	X	2.E-02	3.E-01
trans-1,2-Dichloroethene	6.0E+01	nc	4.9E+01	nc	2.5E+02	nc	X	2.E-02	4.E-01
1,1-Dichloroethene	8.1E+00	ca	3.4E+01	ca	1.7E+00	ca		3.E-03	5.E-02
Dichloromethane	6.5E+02	ca	2.7E+03	ca	1.8E+02	ca		2.E-02	4.E-01
2,4-Dichlorophenol	1.8E+02	nc	4.4E+02	nc	1.6E+00	nc		2.E-02	4.E-01
1,3-Dichloropropene	7.8E-01	ca	1.7E+00	ca	3.1E+01	nc	X	2.E-04	5.E-03
Dieldrin	3.0E-01	ca	1.3E+00	ca	1.8E-02	ca		1.E-04	2.E-03
Diethyl phthalate	4.9E+04	nc	1.0E+05	max	4.3E+02	nc		8.E+00	2.E+02
Dimethyl phthalate	1.0E+05	max	1.0E+05	max	5.4E+03	nc		6.E+01	1.E+03
Dibutyl phthalate	6.1E+03	nc	1.5E+04	nc	5.4E+01	nc		9.E+00	2.E+02
2,4-Dinitro-2-methylphenol	1.2E+02	nc	3.0E+02	nc	1.1E+00	nc		1.E-02	2.E-01
2,4-Dinitrophenol	1.2E+02	nc	3.0E+02	nc	1.1E+00	nc		1.E-02	2.E-01
2,4-Dinitrotoluene	1.2E+02	nc	3.0E+02	nc	1.1E+00	nc		1.E-02	2.E-01
1,2-Diphenylhydrazine	6.1E+00	ca	2.6E+01	ca	3.8E-01	ca		1.E-04	3.E-03
Endosulfan	3.7E+02	nc	8.9E+02	nc	3.2E+00	nc		3.E-01	6.E+00
Endrin	1.8E+01	nc	4.4E+01	nc	1.6E-01	nc		3.E-04	7.E-03
Ethylbenzene	6.8E+01	sat	6.8E+01	sat	6.8E+01	sat	X	4.E-01	8.E+00
Fluoride	3.7E+03	nc	8.9E+03	nc	1.4E+04	nc		3.E-01	5.E+00
Fluoranthene	2.3E+03	nc	5.3E+03	nc	2.1E+01	nc		9.E+01	2.E+03
Fluorene	2.1E+03	nc[a]	4.0E+03	nc[a]	8.0E+03	nc[a]	X	3.E+00	6.E+01

Table B7.2-1. NMED Soil Screening Levels (Continued)

Chemical	Residential Soil (mg/kg)	Endpoint	Industrial/Occupational Soil (mg/kg)	Endpoint	Construction Worker Soil (mg/kg)	Endpoint	VOC	DAF 1 (mg/kg)	DAF 20 (mg/kg)
Fluorotrichloromethane	1.2E+04	nc	3.0E+04	nc	3.1E+01	nc		7.E-02	1.E+00
Heptachlor	1.1E+00	ca	4.5E+00	ca	6.4E-02	ca		4.E-03	8.E-02
Hexachlorobenzene	3.0E+00	ca	1.3E+01	ca	1.8E-01	ca		2.E-04	3.E-03
Hexachlorobutadiene	1.2E+01	nc	3.0E+01	nc	1.1E-01	nc		7.E-02	1.E+00
Hexachlorocyclopentadiene	4.2E+02	nc	1.0E+03	nc	1.1E-02	nc		1.E-02	3.E-01
Hexachloroethane	6.1E+01	nc	1.5E+02	nc	5.4E-01	nc		9.E-03	2.E-01
HMX	3.1E+03	nc	7.4E+03	nc	1.1E+04	nc		1.E-03	2.E-02
Indeno(1,2,3-c,d)pyrene	6.2E+00	ca	2.6E+01	ca	9.4E-01	ca		2.E+00	4.E+01
Iron	2.3E+04	nc	6.9E+04	nc	8.0E+04	nc		2.E-01	3.E+00
Isophorone	5.1E+03	ca	2.2E+04	ca	1.1E+02	nc		1.E-01	3.E+00
Lead	4.0E+02	NC	1.0E+03	nc	1.0E+00	nc		8.E-03	2.E-01
Lead (tetraethyl-)	6.1E-03	nc	1.5E-02	nc	2.3E-02	nc		1.E-02	2.E-01
Manganese	7.8E+03	nc	1.4E+04	nc	7.5E-03	nc		3.E-02	7.E-01
Mercury and compounds	2.3E+01	nc	6.9E+01	nc	8.0E+01	nc		1.E-01	2.E+00
Mercury (elemental)	6.5E+00	nc	2.0E+01	nc	4.6E-02	nc		1.E-01	2.E+00
Mercury (methyl)	6.1E+00	nc	1.5E+01	nc	2.3E+01	nc		1.E-03	2.E-02
Molybdenum	3.8E+02	nc	1.2E+03	nc	1.3E+03	nc		2.E-01	3.E+00
Naphthalene	5.3E+01	nc[a]	4.3E+01	nc[a]	2.2E+02	nc[a]	X	1.E-02	2.E-01
Nickel	1.5E+03	nc	4.4E+03	nc	3.1E-02	nc		1.E+01	3.E+02
Nitrate	9.8E+04	nc	1.0E+05	max	8.6E+02	nc		2.E+00	3.E+01
Nitrite	6.1E+03	nc	1.5E+04	nc	5.4E+01	nc		2.E-01	3.E+00
Nitrobenzene	1.7E+01	nc	2.1E+01	nc	6.6E+01	nc	X	9.E-04	2.E-02
Nitroglycerin	3.5E+02	ca	1.5E+03	ca	2.1E+01	ca		3.E-02	6.E-01
N-Nitrosodiethylamine	3.2E-02	ca	1.4E-01	ca	1.9E-03	ca		9.E-07	2.E-05
N-Nitrosodimethylamine	9.5E-02	ca	4.0E-01	ca	6.0E-03	ca		1.E-05	2.E-04
N-Nitrosodi-*n*-butylamine	2.2E-01	ca	5.4E-01	ca	9.3E+00	ca	X	1.E-05	2.E-04
N-Nitrosodiphenylamine	9.9E+02	ca	4.2E+03	ca	6.0E+01	ca		9.E-02	2.E+00
N-Nitrosopyrrolidine	2.3E+00	ca	9.7E+00	ca	1.4E-01	ca		6.E-06	1.E-04
Aroclor 1016	3.9E+00	nc	8.9E+00	nc	3.8E-02	nc		2.E-04	3.E-03
Aroclor 1221	2.2E+00	ca	9.2E+00	ca	1.5E-01	ca		2.E-04	3.E-03
Aroclor 1232	2.2E+00	ca	9.2E+00	ca	1.5E-01	ca		2.E-04	3.E-03
Aroclor 1242	2.2E+00	ca	9.2E+00	ca	1.5E-01	ca		2.E-04	3.E-03
Aroclor 1248	1.1E+00	nc	2.5E+00	nc	1.1E-02	nc		8.E-01	2.E+01
Aroclor 1254	1.1E+00	nc	2.5E+00	nc	1.1E-02	nc		8.E-01	2.E+01
Aroclor 1260	1.1E+00	nc	2.5E+00	nc	1.1E-02	nc		8.E-01	2.E+01
Pentachlorobenzene	4.9E+01	nc	1.2E+02	nc	4.3E-01	nc		6.E-03	1.E-01

Table B7.2-1 NMED Soil Screening Levels (Concluded)

Chemical	Residential Soil (mg/kg)	Endpoint	Industrial/Occupational Soil (mg/kg)	Endpoint	Construction Worker Soil (mg/kg)	Endpoint	VOC	DAF 1 (mg/kg)	DAF 20 (mg/kg)
Phenanthrene	1.8E+03	nc	4.4E+03	nc	1.6E+01	nc		4.E+03	8.E+04
Phenol	3.7E+04	nc	8.9E+04	nc	3.2E+02	nc		2.E-03	4.E-02
Pyrene	1.8E+03	nc[a]	4.3E+03	nc[a]	6.7E+03	nc[a]	X	3.E-02	6.E-01
RDX	4.4E+01	ca	1.9E+02	ca	1.6E+00	nc		2.E-03	4.E-02
Selenium	3.8E+02	nc	1.2E+03	nc	1.3E+03	nc		3.E-01	5.E+00
Silver	3.8E+02	nc	1.2E+03	nc	1.3E+03	nc		4.E-01	8.E+00
Strontium	3.7E+04	nc	8.9E+04	nc	1.0E+05	max		4.E+00	7.E+01
1,2,4,5-Tetrachlorobenzene	1.8E+01	nc	4.4E+01	nc	1.6E-01	nc		2.E-03	4.E-02
1,1,2,2-Tetrachloroethane	3.6E+00	ca	8.2E+00	ca	1.6E+02	ca	X	2.E-03	3.E-02
Tetrachloroethene	4.9E+01	ca	1.0E+02	sat	1.0E+02	sat	X	5.E-03	1.E-01
Thallium	6.1E+00	nc	1.8E+01	nc	2.1E+01	nc		5.E-04	1.E-02
Toluene	1.8E+02	sat	1.8E+02	sat	1.8E+02	sat	X	2.E-01	5.E+00
Toxaphene	4.4E+00	ca	1.9E+01	ca	2.6E-01	ca		5.E-04	1.E-02
Tribromomethane	6.1E+02	ca	2.6E+03	ca	1.1E+01	nc		2.E-02	3.E-01
1,2,4-Trichlorobenzene	5.2E+02	nc	5.3E+02	sat	5.3E+02	sat	X	5.E-01	1.E+01
1,1,1-Trichloroethane	5.1E+02	sat	5.1E+02	sat	5.1E+02	sat	X	3.E-02	5.E-01
1,1,2-Trichloroethane	7.9E+00	ca	1.8E+01	ca	1.6E+02	nc	X	3.E-03	6.E-02
Trichloroethene	1.6E+01	ca	1.8E+01	nc	9.2E+01	nc	X	4.E-02	7.E-01
2,4,5-Trichlorophenol	6.1E+03	nc	1.5E+04	nc	5.4E+01	nc		6.E-01	1.E+01
2,4,6-Trichlorophenol	4.4E+02	ca	1.9E+03	ca	2.7E+01	ca		1.E-02	2.E-01
2,4,6-Trinitrotoluene	3.1E+01	nc	7.4E+01	nc	2.7E-01	nc		4.E+01	7.E+02
Vanadium	5.3E+02	nc	1.6E+03	nc	1.9E+03	nc		4.E-02	9.E-01
Vinyl chloride	2.1E-01	ca	4.5E-01	ca	1.0E+01	ca	X	3.E-04	6.E-03
Xylenes	6.3E+01	sat	6.3E+01	sat	6.3E+01	sat	X	5.E+00	1.E+02
Zinc	2.3E+04	nc	6.9E+04	nc	8.0E+04	nc		6.E+01	1.E+03

NOTES:

ca – carcinogenic effect basis
nc – noncarcinogenic effect basis
sat – soil saturation limit basis
max – low toxicity maximum, health based SSL exceeds [105] mg/kg

NMED – New Mexico Environment Department
VOC – Volatile organic compound
DAF – Dilution attenuation factor
[a] Compound is solid at ambient soil temperature, so risk-based level is used even though this level exceeds soil saturation (US EPA, 1996a)

1) Soil screening levels are taken form the New Mexico Environment Department document *Technical Background Document For Development Of Soil Screening Levels* (December 2000, January 2001).

2) Soil Screening Levels for residential soil, industrial/occupational soil, and construction worker soil are based on the combined exposure through direct soil ingestion, inhalation of fugitive dust (and fumes for VOCs), and dermal exposure to soil

SOP B7.3 Radioactively-Contaminated or Mixed Waste Sites in the U.S. Air Force

This SOP is a technical memorandum prepared by CH2M Hill for Kirtland AFB. As requested, the following is a summary of the regulatory jurisdiction of radioactive materials/wastes and, in particular, radioactively-contaminated or mixed waste sites in the U.S. Air Force.

Introduction

Radioactive materials are regulated under the Atomic Energy Act (AEA). The radioactive materials regulated under the AEA include source, special nuclear, and byproduct materials. These are defined in the AEA as follows:

- Byproduct material — (1) any radioactive material (except special nuclear material) yielded in or made radioactive by exposure to radiation incident to the process of producing or utilizing special nuclear material, and (2) the tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content (Section 11(e));

- Source material — (1) uranium, thorium, or any other material that is determined by the NRC pursuant to the provisions of Section 61 of the AEA to be source material; or (2) ores containing one or more of the foregoing materials, in such concentration as the NRC may by regulation determine from time to time (Section 11(z)); and

- Special nuclear material — (1) plutonium, uranium enriched in the isotope 233 or the isotope 235, and any other material that the NRC, pursuant to the provisions of Section 51 of the AEA, determines to be special nuclear material, but does not include source material; or (2) any material artificially enriched by any of the foregoing, but does not include source material (Section 11(aa)).

Regulatory authority over radioactive materials is provided by the Nuclear Regulatory Commission (NRC), an Agreement State, or the U.S. Department of Energy (DOE). NRC or an Agreement State typically regulate the commercial and non-DOE federal facilities, while DOE is self-regulating.

Radioactive materials when mixed with hazardous wastes become mixed wastes. These mixed wastes are regulated jointly under the AEA and the Resource Conservation and Recovery Act (RCRA). The EPA and/or an authorized state regulate the hazardous waste component/aspect and the NRC, an Agreement State, or the DOE regulate the radioactive component/aspect.

Agreement States

An Agreement State is a state that has a signed agreement between the governor of the state and the NRC transferring regulatory authority to the State for AEA materials within that state. The Agreement State typically regulates all sources of radiation in the State, except for reactors, large quantities of special nuclear material for which NRC retains authority, and Areas of Exclusive Federal Jurisdiction (i.e., designated areas, such as at or on certain military bases, where for national security reasons, the Federal Agency believes it needs exclusive control) within Agreement States. Prior to signing an agreement with a state, the NRC must make a determination that the state's program is compatible with the NRC's and that the program will protect public health and safety. There are currently 32 Agreement States, including New Mexico.

New Mexico Radiation Control Bureau and Regulations

Within the NMED, the Radiation Control Bureau regulates the uses of sources of radioactivity and radiation within the State. The New Mexico Agreement State Director is William Floyd, Manager, Radiation Control Bureau.

The New Mexico Radiation Protection regulations are found in Chapter 3 of Title 20 of the New Mexico Environmental Protection Regulations (20 NMAC 3). In the general provisions at 20 NMAC 3.1, source material is defined as “uranium or thorium, or any combination thereof, in any physical or chemical form.” In 20 NMAC 3.3, Licensing of Radioactive Materials, exemptions from licensing are provided for certain types of source material, including the following:

- source material in any chemical mixture, compound, solution, or alloy in which the source material is by weight less than 0.05 percent of the mixture, compound, solution, or alloy

- uranium contained in counterweights installed in aircraft, rockets, projectiles, and missiles, or stored or handled in connection with installation or removal of such counterweights (under certain conditions).

20 NMAC 3 Subpart 4, Standards for Protection Against Radiation, “establishes standards for protection against ionizing radiation resulting from activities conducted pursuant to *licenses or registrations* [emphasis added] issued by the Department.” Therefore, if the type of radioactive material present at the site is exempt and/or the radiation did not result from licensed activities, the New Mexico Radiation Protection Regulations may not be applicable. However, as discussed in the following section, the Department of the Air Force has a Master Materials License from the NRC which grants regulatory authority to the Department of the Air Force for the receipt, possession, distribution, use, transportation, transfer, and disposal of radioactive material at Air Force activities. Exceptions are for reactors and associated radioactivity, nuclear weapons, and some components of weapons delivery systems.

Radioactive Material Within the Department of Air Force

The Department of the Air Force has a Master Materials License from the NRC which grants regulatory authority to the Air Force for the receipt, possession, distribution, use, transportation, transfer, and disposal of radioactive material at Air Force activities. Exceptions are for reactors and associated radioactivity, nuclear weapons, and some components of weapons delivery systems. Air Force Radioactive Material Permits are issued within the Air Force to maintain control over all radioactive material used in the Air Force.

Key Air Force policy and instructions pertaining to radioactive material include:

- Air Force Policy Directive (AFPD) 40-2, Radioactive Materials (Non-Nuclear Weapons), April 8, 1993, and

- Air Force Instruction (AFI) 40-201, Managing Radioactive Materials in the U.S. Air Force, September 1, 2000.

In AFPD 40-2, it states, that “[t]he Air Force will fully comply with Federal regulations for control of radioactive material.” The AFPD also defines the Air Force Master Materials License as “the single Nuclear Regulatory Commission license issued to the US Air Force Radioisotope Committee delegating to the Air Force regulatory authority over Byproduct, Source, and limited quantities of Special Nuclear

Material used by the Air Force." Further, the AFPD defines source material as "uranium or thorium or any combination thereof in any physical or chemical form; or ores that have, by weight, one-twentieth of 1 percent (0.05 percent) or more of uranium, thorium, or any combination thereof. Source material does not include special nuclear material" (i.e., plutonium, uranium-233, or enriched uranium).

AFI 40-201, for which compliance is mandatory, "sets forth how Air Force employees and activities acquire, receive, store, distribute, use, transfer, or dispose of any item or part that contains radioactive material not expressly excluded in this AFI from the purview of the AFI." Within the regulatory authority discussion in Chapter 2 of the AFI, it states that "Federal agencies are subject to NRC regulatory authority" and "within an Agreement State, the state has regulatory authority over non-federal activities conducted on installation property; which is not under exclusive federal jurisdiction." Further, pertaining to the regulation of mixed waste, AFI 40-201 states that the NRC regulates the byproduct, source, and special nuclear material constituents and that the EPA regulates the hazardous chemical and naturally occurring and accelerator produced radioactive material (NORM and NARM, respectively) constituents, with neither agency having exclusive jurisdiction over mixed waste. AFI 40-201 also states that generators of mixed waste must meet both the NRC and EPA rules unless exempted from the rules.

However, within the regulatory authority chapter of AFI 40-201, it further states that "the Air Force has regulatory authority, or receives it from the NRC through the USAF Master Materials License, for:

- 2.6.1. Receipt, storage, internal distribution, use, transfer, and disposal by Air Force organizations of Byproduct, Source, and limited quantities of Special Nuclear Material.

- 2.6.2. Production, receipt, storage, distribution, use, transfer, and disposal by Air Force organizations of Naturally Occurring and Accelerator Produced Radioactive Material.

- 2.6.3. Receipt, storage, distribution, use, transfer, and disposal by Air Force organizations of radioactive materials classed as 91b Material.

- 2.6.4 Receipt, storage, distribution, use, transfer, and disposal of Naturally Occurring and Accelerator Produced Radioactive Material and radioactive materials classed as 91b Material by non Air Force organizations on Air Force installations where exclusive federal jurisdiction exists."

According to the AFI, the Air Force Safety Center, Division of Weapons, Space, and Nuclear Safety (AFSC/SEW) "provides regulatory oversight for the remediation of radioactive waste disposal sites and accident sites involving 91b Materials."

Section 3.10 of the AFI, Managing and Remediating Low Level Radioactive Waste Burial Sites, states that low-level radioactive waste (LLRW) burial sites are to be managed and remediated in accordance with "AFI 32-7020, *The Environmental Restoration Program* and policies established by HQ USAF/IL and this instruction." It notes that remediation of radiological waste burial sites requires prior approval by AFMOA/SGOR.

Section 3.10.7 of AFI 40-201 states "Work plans and health and safety plans for remediation of radioactive waste burial sites, to include waste disposal procedures, must be coordinated as follows:

- 3.10.7.1. All plans will be submitted to AFIERA/SDRH, Air Force Radioactive and Mixed Waste Office, DSN 240-3486) for approval during the project planning stage.

- 3.10.7.2. Plans for sites containing or suspected to contain only 91b Materials shall be submitted to the Directorate of Nuclear Surety of the Air Force Safety Agency (AFSC/SEW), Kirtland AFB, NM.

- 3.10.7.3. Plans for site containing or suspected to contain Byproduct, Source, or Special Nuclear Material as defined in Title 10, Code of Federal Regulations (CFR) Parts 30, 40, and 70 shall be submitted to the RIC Secretariat (AFMOA/SGOR) for review.

- 3.10.7.4. Plans for site containing or suspected to contain Naturally Occurring and Accelerator Produced Radioactive Materials shall be submitted to the RIC Secretariat (AFMOA/SGOR) for review.

- 3.10.7.5. Sites containing or suspected to contain mixtures of the above types of materials or must be handled on a case-by-case basis. Contact AFSC/SEW and/or AFMOA/SGOR for guidance on sites containing mixtures of the above types of materials.

- 3.10.7.6. If, during the course of remediation, a site is found to contain NRC Regulated or Naturally Occurring and Accelerator Produced Radioactive Materials where they were not expected, work must stop and the Installation RSO must immediately notify AFMOA/SGOR. The project manager will then be required to submit the remediation plan to AFMOA/SGOR."

Conclusion

Based on the policy and instructions of the Air Force and under the authority granted to them by the NRC in the Air Force Master Materials License, it appears that the Air Force self-regulates remediation of radioactive materials/constituents at their bases. Further, it appears that the NRC has relinquished regulatory authority and, therefore, the NRC and NMED do not have any regulatory authority over the remediation of radioactive materials/constituents at the Kirtland Air Force Base. However, the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) is still endorsed by the Department of Defense for planning, performing, and assessing building surface and surface soil to meet established dose or risk-based release (i.e., radioactive cleanup) criteria.

References

Radioactively-Contamination or Mixed Waste Sites in the U.S. Air Force; Kirtland AFB Technical Memorandum, February, 3 2003

APPENDIX C

Quality Assurance Project Plan

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TABLES

FIGURES

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ACRONYMS

AFB	Air Force Base
AFCEE	Air Force Center for Environmental Excellence
ASTM	American Society of Testing and Materials
BWHSP	Base-Wide Health and Safety Plan
BWP	Base-Wide Plan
C-O-C	Chain-of-Custody
DCQAP	Data Collection Quality Assurance Plan
DMP	Data Management Plan
DQCR	Daily Quality Control Report
DQO	Data Quality Objective
EPA	Environmental Protection Agency
ERPIMS	Environmental Restoration Program Information Management System
FCR	Field Change Request
FOL	Field Operations Lead
FSP	Field Sampling Plan
GC	Gas Chromatograph
ICP	Inductively Coupled Plasma
IDL	Instrument Detection Limit
LCS	Laboratory Control Standard
LCSD	Laboratory Control Standard Duplicate
MDL	Method Detection Limit
mg/L	milligrams per liter
MSA	Method of Standard Additions
MS	Mass Spectroscopy
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NCR	Nonconformance Report
NIST	National Institute of Standards and Technology
PARCC	Precision, Accuracy, Representativeness, Completeness, and Comparability
PID	photoionization detector
PM	Project Manager
PQL	Practical Quantitation Limit
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QAO	Quality Assurance Officer
QC	Quality Control

ACRONYMS (Concluded)

QCSR	Quality Control Summary Report
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RPD	Relative Percent Difference
SHSS	Site Health and Safety Specialist
SOP	Standard Operating Procedure
SSHP	Site-Specific Safety and Health Plan
USACE	U.S. Army Corps of Engineers
USAF	U.S. Air Force
VOC	Volatile Organic Compound
XRF	X-Ray Fluorescence

1. INTRODUCTION

This Base-Wide Quality Assurance Project Plan (QAPP) has been prepared as part of the Kirtland Air Force Base (AFB) Base-Wide Plan (BWP) required to support environmental restoration activities at Kirtland AFB in Albuquerque, New Mexico. Environmental restoration activities include Resource Conservation and Recovery Act (RCRA) Facility Investigations (RFIs), Interim Corrective Actions (ICAs), Corrective Actions (CAs), monitoring of natural systems and treatment operations, and other associated work efforts. This appendix was previously included as part of the Data Collection Quality Assurance Plan (DCQAP) in Volume II of the BWP as Part I of the DCQAP.

Environmental restoration activities planned for Kirtland AFB include:

- Resource Conservation and Recovery Act (RCRA) Facility Investigations (RFIs)
- Interim Corrective Actions
- Corrective actions
- Monitoring of natural systems and treatment operations
- Other associated work efforts

2.1 Purpose

The purpose of this Base-Wide QAPP is to describe the policies, objectives, concepts, systems, and procedures to support the implementation of environmental restoration activities at Kirtland AFB. This QAPP identifies and describes the elements of the quality assurance/quality control (QA/QC) system integral to the performance of environmental restoration activities. The QAPP provides the framework and criteria for establishing project-specific planning documents to plan, implement, and assess the effectiveness of services associated with projects at the base. Effective implementation of individual QA/QC requirements, procedures, instructions, and reports developed from this QAPP, together with project-specific addenda, will ensure that:

- All project activities are conducted in a safe manner protecting the public, base personnel, property, and the environment.
- All environmental data are of the appropriate type and are of known, acceptable, and defensible quality needed for their intended use.
- All remedial/removal activities (e.g., waste collection, waste treatment, waste containment, waste storage, and waste transport) are performed in accordance with defined requirements and expectations.
- All work is performed in compliance with governing regulatory and contractual requirements.

The QAPP has been prepared in accordance with the requirements and guidelines established by the United States Environmental Protection Agency (EPA) and the United States Air Force (USAF), in conjunction with base contractors. The references used in preparing this document are:

- Quality Systems Manual for Environmental Laboratories, Version 2 Draft Final, Department of Defense, March 2002
- General Chemistry Supplement to the Scope of Services for Studies, USACE, 1996
- Chemical Data Quality Management for Hazardous Waste Site Remedial Activities, ER 1110-1-263, USACE, 1990
- Requirements for Preparation of Sampling and Analysis Plans, EM200-1-3, USACE
- Requirements for Quality Assurance Project plans for Environmental Data Operations, EPA QA/R-5, 1994
- Quality Assurance Project Plan, Version 3.0, Air Force Center for Environmental Excellence, 1998

2.2 Scope and Applicability

The general environmental restoration activities covered by this QAPP include, but are not limited to:

- Collection of environmental data including field measurement and analytical data.
- Performance of multimedia chemical and radiochemical analyses and physical testing for a variety of parameters of interest.
- Analysis, assessment/evaluation, and reporting of environmental data.
- Identification and characterization of contamination.
- Determinations of background concentrations of constituents.
- Determination of environmental and human health risks.
- Corrective measures studies.
- Performance of RCRA corrective actions.
- Remedial/removal activities (e.g., waste collection, waste treatment, waste containment, waste storage, and waste transport).
- Long-term monitoring to comply with federal, state, and local regulations.

This Base-Wide QAPP provides the framework and the criteria for establishing project-specific QAPPs which will be addenda to this document. The extent, to which this Base-Wide QAPP applies to the project-specific QAPPs, either wholly or in part, will depend on the nature and scope of the individual projects. The specific project requirements will be addressed in the project-specific addenda.

2. PROJECT DESCRIPTION

2.3 Site Description

A description of Kirtland AFB and its history is outlined in Section 2.0 of the Field Sampling Plan (FSP), (Appendix A of the BWP). The description includes the geographical location, topography, approximate size, and past uses of Kirtland AFB. A project-specific description will be given in, or referenced in, the project-specific addendum for each work effort.

2.4 Project-Specific Scope and Objectives

Collection and analysis of environmental samples is an integral part of environmental restoration activities at Kirtland AFB. This Base-Wide QAPP provides the outline for developing site-specific plans which will direct data collection efforts to support the ultimate remediation of sites. The scope and objectives of project-specific environmental restoration activities at Kirtland AFB include:

- Confirm the presence or absence of contaminants
- Define the nature and extent of contaminants
- Characterize contaminant release and migration mechanisms
- Provide data to support human health and ecological risk assessments
- Identify areas requiring remedial or removal actions
- Provide data for compliance with monitoring or discharge criteria
- Generate data to support studies, designs, and plans necessary to implement corrective actions

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3. PROJECT ORGANIZATION AND RESPONSIBILITIES

Implementation of the QAPP requires that the project staff is aware of QA/QC procedures and goals. QA/QC responsibilities lie principally with the Project Manager (PM) and the QA PM. Key project staff may also include the Field Operations Lead (FOL), QA Officer, Safety Professional, and the Site Health and Safety Specialist (SHSS). Additional project staff may include, but are not limited to, Sample Coordinator, Data Validation Coordinator, Project Scientists, Project Engineers, and various support staff.

A brief description of key project personnel are presented in this section. The project-specific QAPP will identify the individuals required to perform the activities associated with the project. Additionally, the project-specific QAPP will append or modify the duties and responsibilities of each of the project staff.

2.5 Project Manager

The Project Manager is responsible for overall technical and administrative activities for the project. He/she directs the development of field programs, data evaluation, development of conclusions and recommendations, and preparation of the technical documents. Specific duties and responsibilities of the PM include:

- Maintain regular contact with the appropriate Contract Officer and Kirtland AFB and provide status reports.
- Direct all technical and administrative aspects associated with individual corrective actions and project task(s).
- Evaluate project-specific procedures and plans, and ensure that all procedures, project plan elements, and specifications can be implemented on schedule and within budget, and are in compliance with applicable regulations.
- Evaluate project schedule and budget to recommend and justify change orders.
- Develop and/or modify a critical path method or similar method to track project materials and resources and to identify key project milestones.
- Prepare specifications for subcontractors and equipment procurement.
- Direct subcontractor and equipment procurement.
- Recommend change orders to the appropriate Contract Officer and Kirtland AFB.
- Interface with Project Scientists and Engineers on relevant issues and methods of resolution.
- Interface with the Health and Safety Manager and QA Manager to ensure compliance of approved plans.
- Recommend a team of professionals to accomplish each corrective action or task activity.
- Manage the activities of the professionals assigned to individual projects.

- Monitor task costs and schedules.
- Interface with Kirtland AFB on logistics, site access, or other issues pertaining to the execution of a specific task.
- Prepare progress and financial reports as required.
- Implement required field activities and ensure compliance with all regulatory requirements.

2.6 Quality Assurance (QA) Project Manager (PM)

The QA PM has the authority to act on behalf of the PM onsite-related issues affecting the quality of the work performed. He/she has the authority to stop work when poor quality conditions are identified and to direct the removal and replacement or re-performance of the defective work. He/she interfaces with the PM on issues affecting the quality of work performed. Administratively, the QA PM reports directly to the Corporate QA Manager to ensure the necessary independence for unbiased and objective assessments. The QA PM's responsibilities include:

- Provide and maintain an effective control QA/QC system for all project activities.
- Assign a QA Officer (QAO) for a specific task, if required.
- Develop project-specific quality plans and procedures.
- Monitor QA/QC activities to ensure conformance with authorized policies, procedures, and sound practices; recommend improvements as necessary.
- Inform the PM of nonconformances to the QAPP.
- Ensure that all records, logs, standard procedures, and project plans are maintained in a retrievable fashion, and that controlled copies of standard procedures and project plans are distributed to all appropriate personnel.
- Ensure that a document control system is established and maintained for the project.
- Perform audits and surveillance of project activities to ensure that project procedures are followed. The QA PM has the authority to require re-performance of any activity determined to have been adversely affected by improper application of prescribed procedures with the concurrence and approval of the PM.
- Maintain awareness of the entire project to detect any conditions that may affect quality.
- Monitor corrective action documentation for conditions adverse to quality, verify implementation of corrective action, track and analyze corrective action, and close corrective action documentation upon completion of corrective action.
- Concur with nonconformance report (NCR) dispositions, and maintain a system for tracking and analyzing NCRs.
- Direct stop-work order until poor quality conditions have been corrected.

2.7 Safety Professional

The Safety Professional is responsible for implementing and overseeing the contract Health and safety Program and to develop, implement, and approve all Site-Specific Health and Safety Plans (SSHP). Additional duties and responsibilities of the Safety Professional may be found listed in Appendix F of the BWP.

2.8 Field Operations Lead

The FOL provides onsite supervision of day-to-day field activities for the project. In addition, the FOL is responsible for implementation of all field QA/QC procedures as defined in the QAPP and FSP (Appendix A of the BWP), for safety-related issues as defined in the Base-Wide Health and Safety Plan (BWHSP) (Appendix F of the BWP), in the project-specific SSHP, and any project-specific addenda. Specific duties and responsibilities of the FOL include the following:

- Act as the point of contact for all interactions and communications with the client, project management staff, site support staff, visitors onsite, laboratories, and government representatives onsite.
- In charge of mobilization and demobilization of equipment and supplies.
- Schedule and coordinate all field activities.
- Oversee and ensure that all field activities are performed in accordance with approved plans and procedures.
- Ensure that all required media samples and QC samples are collected, packaged, and shipped to the analytical laboratory.
- Initiate a Field Change Request (FCR) depending upon site conditions for approval by the PM.
- Implement approved field changes.
- Implement a corrective action program if deficient conditions are identified.
- Ensure that all documentation is completed as required.
- Ensure all field instruments are calibrated as required and implement a preventive maintenance program.
- Prepare reports.

2.9 Quality Assurance Officer (QAO)

The QAO reports directly to the QA PM. The QAO has experience with the work being implemented, and have sufficient knowledge of audits and surveillance activities. The QAO’s authorities and responsibilities include:

- Assist the QA PM in the performance of his/her duties when directed.

- Authorize the issuance of NCRs and recommend stop-work orders to the QA PM when necessary.
- Perform inspections, including periodic audits and surveillance, of field activities and assist the QA PM in performing his/her activities.
- Inspect and document the implementation of corrective action(s).
- Remain on the project site when directed by the QA PM.

2.10 Site Health and Safety Specialist

The SHSS will be present onsite as required during field operations and is responsible for all health and safety activities and the delegation of duties to the health and safety staff in the field. The SHSS ensures that all elements of the approved site health and safety plan are implemented and enforced onsite. Duties and responsibilities for the SHSS are detailed in Section 2.0 of the BWHSP (Appendix F of the BWP).

2.11 Subcontractor Qualifications

The minimum qualifications for project subcontractors are summarized in the following subsections.

3.1.1 Analytical Laboratory

The analytical laboratory's qualifications will include current USACE analytical method certification, and or National Environmental Laboratory Accreditation Program (NELAP) accreditation. The analytical laboratory project manager will have ultimate responsibility for overall quality of work performed at the analytical laboratory, and is responsible for ensuring that work is performed according to the USACE Chemistry Scope of Services (SOS) and this QAPP.

3.1.2 Geotechnical Laboratory

Geotechnical laboratory testing will be performed as required on a project-specific basis, by a USACE approved laboratory. The laboratory project manager is responsible for ensuring that work is performed according to the USACE Chemistry SOS, the QAPP, and project requirements.

3.1.3 Drilling Subcontractor

Project-specific drilling requirements will be performed by a USACE approved drilling subcontractor, licensed in the State of New Mexico. The assigned representative will be responsible to ensure that work is completed in accordance with project-specific requirements and the USACE Geology SOS.

3.1.4 Surveying Subcontractor

Topographic and site surveying will be completed by a licensed surveyor registered in the state of New Mexico. The surveyor will be required to produce computer-generated maps that are based upon the New Mexico State Plane Coordinate System.

4. QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA

Field and laboratory data will be collected during environmental restoration activities at Kirtland AFB. The overall QA objective is to develop and implement environmental restoration activities that will provide data of known and acceptable quality.

2.12 Data Quality Objectives

Data quality objectives (DQOs) are qualitative and quantitative statements that specify the quality of data generated to support decision making. DQOs are scoping and planning tools applicable to every data generation effort and developing DQOs is a necessary step for project-specific plans. For each data collection task, DQOs will be developed during project scoping and include a description of the purpose of the task, the specific activities to be performed, the intermediate and end uses of the generated data, and the resultant data quality which is required.

4.1.1 DQO Development Process

The DQO development process includes the following steps:

- Statement of the problem
- Identification of a decision that addresses the problem
- Identification of inputs that affect the decision
- Specification of the domain of the decision
- Development of logic statement
- Establishment of constraints on uncertainty
- Optimization of design for obtaining data

4.1.2 Analytical Data Categories

Based on the end use of the data, different levels of data quality may be required. Five analytical levels are available depending on intended use of the data and QA/QC methods required to achieve the desired level of quality. These five levels of analytical approach that are applicable to achieving the goals of the environmental restoration activities are defined as follows:

- **Screening Data.** Data generated using rapid methods of analysis with less rigorous QC requirements. Screening data will provide analyte identification and will be semi-quantitative. Examples of screening data include field test measurements such as temperature and pH measurements, dissolved oxygen, turbidity, conductivity. Screening data may possess limitations for usability.

- **Definitive Data.** Data generated using rigorous analytical methods such as EPA reference methods. Data are analyte specific with confirmed identification and quantitation. Methods include standardized QC and documentation. Definitive data may be generated using on-site analytical techniques and off-site laboratory analysis. There are no restrictions on the usability of definitive data.

2.13 Data Quality Indicators

The precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters are indicators of data quality. Ideally, the end use of the measurement data should define the necessary PARCC parameters. The following sections discuss data quality indicators as they apply to measurement of data, including field and laboratory analyses. Limits for precision and accuracy are matrix, method, and project specific and should be specified in the project-specific QAPP addendum.

4.1.3 Precision

Analytical precision is the measurement of the variability associated with duplicate analyses. Precision can be determined by analysis of field duplicate samples, laboratory control sample or matrix spike duplicate samples, or laboratory duplicate sample analysis. Precision is reported as the relative percent difference (RPD) between the analyses. .

4.1.3.1 Field Precision Objectives

Field precision is assessed through the collection and analysis of field duplicates and replicates at a frequency of 1 duplicate for every 10 water samples and 1 replicate for every 10 soil/sediment samples. Precision of field instruments is in accordance with the following:

Instrument	Objective	Corrective Action
Photoionization Detector (PID)	±20 percent from calibration reading at a specified space setting	Return instrument for maintenance
Flame Ionization Detector	±20 percent from calibration reading at a specified space setting	Recalibrate

4.1.3.2 Laboratory Precision Objectives

Precision will be determined through the comparison of matrix spikes and matrix spike duplicates (MS/MSD) for the organic analytical work performed at Kirtland AFB. The laboratory will select 1 sample in 20 project samples and split the sample into three aliquots. The first aliquot will be analyzed routinely for organic target compounds while the aliquot(s) will be spiked with known quantities of the parameters of interest prior to analysis. The relative percent difference (RPD) will be calculated and used as an indication of the precision for the analyses performed.

Precision for the inorganic analyses will be evaluated by comparing laboratory duplicate analysis of an environmental sample. The laboratory will select 1 sample in every 20 project samples and split the samples into three aliquots. The first aliquot will be analyzed routinely for inorganic parameters, while the second aliquot will serve as a duplicate, and the third aliquot will be spiked with known quantities of target analytes prior to analysis. The RPD of the unspiked duplicate samples will be calculated and used as a measure of precision for the inorganic analyses.

The equations to be used for precision are presented in Section 13.0 of this QAPP. Precision control limits (objectives) will be as specified by the analytical methods.

4.1.4 Accuracy

Accuracy is the degree of agreement between an observed value and an accepted reference value.

4.1.4.1 Field Accuracy Objectives

Sampling accuracy will be determined by collecting and analyzing field and trip blank samples, and adhering to all sample handling, preservation, and shipping requirements. For on-site field test kits and meters, accuracy will be determined by analysis of calibration standards prior to sample collection.

4.1.4.2 Laboratory Accuracy Objectives

Accuracy is expressed as the percent recovery of standards and matrix spikes. The equation to be used for accuracy is presented in Section 13.0 of this QAPP. Accuracy control limits will be as specified by the analytical methods. Standards measure the bias of the analytical system–reagents, equipment, instrumentation, and analyst technique. Matrix and surrogate spikes measure sample matrix effects as well as the analytical system bias. In general, calibration and laboratory control standards are used to monitor and control the analytical system, while matrix spikes are used to screen for matrix effects.

System monitoring compounds (surrogates) will be spiked into all blanks, standards, and environmental samples (including matrix spike/matrix spike duplicate samples) prior to purging or extraction for organic sample analysis. Surrogates are compounds that are chemically representative of the method target compounds. After analysis is performed, surrogate percent recoveries are calculated. These surrogate percent recoveries will show the efficiency by which the analytical system is measuring known amounts of different compounds. Surrogate recoveries can, however, be influenced by matrix interference. Therefore, data for different matrices are compiled by laboratories, and statistically based limits are established for solid and aqueous matrix percent recoveries.

Method blank analyses also monitor and control the bias of the analytical system by measuring trace levels of contamination. In general, method blanks containing target analyte(s) at levels greater than the detection limits trigger the need for corrective action.

Accuracy in the laboratory will be measured by analyzing matrix spikes at a frequency of 1 for every 20 project samples. In addition, quantifiable accuracy will be determined with each batch of samples prepared and analyzed by the use of laboratory control standards (LCS).

4.1.5 Representativeness

Representativeness expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition.

Representativeness in the laboratory is ensured by using the proper analytical procedures and meeting sample holding times. Analyzing and assessing field duplicated samples will be used to assess representativeness as well as precision. Sampling networks are designed to provide data representative of facility conditions. During development of sampling networks, consideration is given to past site practices, existing analytical data, physical setting and processes, and constraints inherent to the environmental restoration program. The rationale of sampling networks is discussed in detail in the FSP (Appendix A of the BWP). Representativeness will be ensured through the implementation of approved, consistent procedures.

4.1.6 Comparability

Comparability is an expression of the confidence with which one data set can be compared with another.

4.1.6.1 Measures to Ensure Comparability of Field Data

Comparability is dependent upon the proper design of the sampling program and will be satisfied by ensuring that the FSP (Appendix A of the BWP) and project specific addenda is followed and that proper sampling techniques are used.

4.1.6.2 Measures to Ensure Comparability of Laboratory Data

Planned analytical data will be comparable when similar sampling and analytical methods are used and documented in the QAPP. Comparability is also dependent on similar QA objectives. To optimize comparability, EPA-established methods and protocols will be used whenever possible to collect and analyze samples. By using specific sampling and analytical procedures, including the reporting of the analytical data using common standard units, all data sets will be comparable at each specific site at Kirtland AFB and between sites at Kirtland AFB to ensure that decisions and priorities are based on a consistent database.

All solid matrix results for the specified analytical methods will be reported on a dry weight basis. All organic analyses will be reported as micrograms per kilogram for soil and milligrams per liter (mg/L) for water; most inorganic analyses will be reported in milligrams per kilograms for soil and mg/L for water; and radiological data will be reported in picocuries per gram for soil and picocuries per liter for water.

4.1.7 Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under normal conditions.

4.1.7.1 Field Completeness Objectives

Field completeness is a measure of the amount of valid measurements obtained from all the measurements taken in the project. The equation for completeness is presented in Section 13.0 of this QAPP. Field completeness objectives for Kirtland AFB projects will be greater than 90 percent.

4.1.7.2 Laboratory Completeness Objectives

Laboratory completeness is a measure of the amount of valid measurements obtained from all measurements taken in the project. The equation for completeness is presented in Section 13.0 of this QAPP. Laboratory completeness objectives for projects will be greater than 95 percent.

2.14 Level of Field Quality Control Effort

Equipment rinse blank, trip blank, ambient field blank, and QA replicate samples will be collected and analyzed on a project-specific basis to assess the quality of the data resulting from the field sampling and analytical programs. Equipment rinse blanks consisting of distilled water will be submitted to the analytical laboratories to provide the means to assess the quality of the data. Equipment blank samples will be analyzed to check for potential contamination resulting from improper decontamination procedures that may result in sample contamination. Trip blanks will be used to assess potential VOC contamination in water samples as a result of sample shipment and storage.

Field QC samples will be collected as specified in the project-specific QAPP, and a minimum of five percent for field duplicates and equipment blanks. Trip blanks samples will accompany each cooler of water samples for VOC analysis. Ambient blanks for VOC analysis will be collected on a project-specific basis.

2.15 Laboratory Quality Assurance Program

Laboratories performing work in support of Kirtland AFB will maintain current certification by USACE. AFCEE, or NELAP, as appropriate. In addition, the laboratories will maintain a current approved QAPP including standard operating procedures (SOPs) for the following:

- Sample receipt and logging
- Sample storage
- Preventing sample contamination
- Security for laboratory and samples
- Standards purity/preparation
- Maintaining instrument records and log books
- Sample analysis and data control systems
- Glassware cleaning
- Technical and managerial review of laboratory operation and data package preparation
- Internal review of QA and QC data
- Sample analysis, data handling, and reporting
- Chain-of-custody procedures and document control
- Laboratory data validation/laboratory self-inspection system
- Data management and handling

Laboratory QA samples will be analyzed in accordance with method-specific and program- specific protocols. These samples will include method blanks, LCS, matrix spikes and matrix spike duplicate (MS/MSD), and laboratory duplicates.

Method blank samples are generated within the laboratory and used to assess contamination resulting from sample preparation and extraction procedures. Method duplicate samples are analyzed for inorganic methods to confirm sampling and analytical reproducibility. MS/MSD samples provide information about effects of the sample matrix on sample digestion and analysis. One MS/MSD will be analyzed for every 20 or fewer investigative samples. MS/MSD samples are analyzed for organic analyses only. MS samples are typically analyzed for inorganic analysis methods.

5. FIELD INVESTIGATION PROCEDURES

2.16 Sampling Protocols

Specific procedures for sampling are presented in as Standard Operating Procedures, Appendix B of the BWP. These protocols describe procedures for collecting representative samples of groundwater, potable water, surface water, sediment, surface soil, subsurface soil, test pits, drums, tanks, wipes, concrete, and air. Cross-contamination of samples from external sources will be controlled through proper decontamination of sampling equipment as well as following good sampling techniques.

Sampling programs will be planned in detail and presented in project-specific FSPs. The Base-Wide FSP (Appendix A of the BWP) provides guidelines to establish project-specific FSPs.

Sampling programs will be planned in detail and presented in project-specific FSPs. The Base-Wide FSP (Appendix A of the BWP) provides guidelines to establish project-specific FSPs.

2.17 Sample Volume, Holding Times, Containers, and Preservation

The preservation, holding times, and the containers to be used must be specified in the project-specific plans and this information should include the recommended sample volumes, sample containers, preservatives, and holding times for the analytical methods which may be used during the course of the project-specific field program. Tables 5-1 and 5-2 present recommended sample volumes, sample containers, preservatives, and holding times for analytical and geotechnical analyses.

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Table 5-1. Sample Requirements for Analytical Testing

Matrix	Parameter[1]	Container[2]	Preservation[3]	Maximum Holding Times	
				Extraction	Analysis
Low Concentration Samples					
Water	Volatiles	2 x 40 mL[8] G, Septa Vial	Ice to 4°C 4 drops Conc. HCl or $NaHSO_4$ to pH<2	---	14 d
Water	B/N/A	2 x 1 L[5,8] amber G	Ice to 4°C	7 d	40 d
Water	PCBs, Pesticides	2 x 1 L[5,8] amber G	Ice to 4°C	7 d	40 d
Water	Metals[6]	1 x 1 L P	HNO_3 to pH<2	---	6 mo[6]
Water	TRPH	2 x 1 L G	Ice to 4°C	---	28 d
Water	Common Parameters	1 x 1 L[7] G	Ice to 4°C	---	28 d[7]
Water	Explosives	2 x 1 L amber G	Ice to 4°C	7 d	40 d
Water	Cyanide	1 x 1 L P	NaOH to pH>12 Ice to 4°C	---	14 d
Soils/Sediments	Volatiles	2 x 40 mL G or 2 x 125 mL G, Septa vial	Ice to 4°C	---	14 d
Soils/Sediments	B/N/A, PCBs Pesticides	1 x 8 oz G	Ice to 4°C	14 d	40 d
Soils/Sediments	Metals, Cyanide, TRPH	1 x 8 oz G	Ice to 4°C	----	6 mo[6], 14 d, 28 d
Soils/Sediments	Explosives	1 x 4 oz G	Ice to 4°C	14 d	40 d
Medium Concentration Samples					
Water/Liquid	Volatiles	2 x 40 mL G	Ice to 4°C[8]	---	14 d
Water/Liquid	B/N/A[5]	2 x 32 oz wide mouth jars, G	Ice to 4°C[8]	7 d	40 d
Water/Liquid	PCBs[5], Pesticides	2 x 32 oz wide mouth jar G	Ice to 4°C[8]	7 d	40 d
Water/Liquid	Metals	1 x 16 oz wide mouth jar, G	HNO_3 to pH<2	---	6 mo[6]
Water/Liquid	Explosives	2 x 1 L amber G	Ice to 4°C	7 d	40 d
Water/Liquid	Cyanide	1 x 1 L P	NaOH to pH>12 Ice to 4°C	---	14 d
Soils/Sediments	Volatiles	2 x 40 mL G or 2x125 mL G	Ice to 4°C	---	14 d
Soils/Sediments	B/N/A, PCBs Pesticides	1 x 8 oz wide mouth jar, G	Ice to 4°C	14 d	40 d
Soils/Sediments	Metals, Cyanide, TRPH	1 x 8 oz wide mouth jar, G	Ice to 4°C	----	6 mo[6], 14 d, 28 d
Soils/Sediments	Explosives	1 x 4 oz G	Ice to 4°C	14 d	40 d

Table 5-1. Sample Requirements (Concluded)

High Concentration Samples					
				Maximum Holding Times	
Matrix	Parameter[1]	Container[2]	Preservation[3]	Extraction	Analysis
Liquid	All organic and inorganic analyses	1 x 8 oz wide mouth jar, G	---	See comment 9	
Solids	All organic and inorganic analyses	2 x 8 oz wide mouth jars, G	---	See comment 9	

FOOTNOTES

1 B/N/A = Base/Neutral/Acid extractables, TRPH = Total Recoverable Petroleum Hydrocarbon

2 All containers must have Teflon-lined seals (Teflon-lined septa for VOA vials).

G = Glass; P = High Density polyethylene

3 Sample preservation will be done in the field immediately upon sample collection. If water samples are filtered in the field, differential pressure methods using 45 micron filters will be used, and preservatives added after filtration. VOA samples should never be filtered.

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

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

6 Total Recoverable Metals for water samples. Holding time for Hg is 28 days in glass; for Cr(VI) is 24 hours.

7 Cl^-, Br^-, F^-, NO_3^-, NO_2^-, PO_4^{3-}, SO_4^{2-}; 1 L for each method; orthophosphate requires filtration. Holding time for extraction is 48 hours for NO_3^-, NO_2^-, PO_4^{3-} if not preserved with H_2SO_4 to pH<2.

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

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

Table 5-2. Sample Requirements for Geotechnical Testing

Geotechnical Testing And Analysis			
Matrix	**Parameter[1]**	**Testing Method**	**Container/Preservation[3]**
Water/Slurry	pH Density Viscosity Filtrate	ASTM D4972 API standard 13B API standard 13B API standard 13B	4-oz. glass jar (analyze immediately) N/A N/A N/A
	Maximum Density	ASTM D698-78	1 x 5-gallon Bucket
Borrow Soil	Moisture Content Lab Max Dry Density Gradation Atterberg #200 Sieve	ASTM D2216-80 ASTM D698-78 or D1557 ASTM D422-90 ASTM D 4318 ASTM D 1140	1 x 5-gallon Bucket 1 x 5-gallon Bucket 1 x 5-gallon Bucket
Synthetic Liners	Material Thickness Bonded Seam Strength Peel Adhesion Strength	ASTM D374-88 ASTM D3083-89 ASTM D3083-89	N/A 2 ft x 1 ft piece with seam centered 2 ft x 1 ft piece with seam centered
Placement of Borrow Soil/Slurry	In-place Density In-place Moisture Content Density Permeability (Shelby) Sieve Analysis	ASTM D2922-80 or ASTM D1556-82 ASTM D3017-88 ASTM D 4380 ASTM D 5084 ASTM D 422	N/A N/A N/A Minimum 3-inch Diameter 1 x 5-gallon Bucket
Riprap	Specific Gravity Freeze-Thaw Magnesium Sulfate soundness	ASTM C127-88 AASHO T103-83 ASTM C88-90	Large Wooden Box Large Wooden Box Large Wooden Box
Bedding	Material Gradation	ASTM C136-84a	2 x 5-gallon Bucket
Placement of Concrete	7-day Comp. Strength 28-day Comp. Strength Slump Temperature Air Content	ASTM C39 ASTM C39 ASTM C143 Thermometer ASTM C231, C173, or C138	1 Cylinder 2 Cylinders, 1 Spare N/A N/A N/A

FOOTNOTES

API American Petroleum Institute

ASTM American Society for Testing and Materials

Comp. compressional

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6. SAMPLE CUSTODY AND RECORD-KEEPING

The history of each sample and its handling is documented from its collection through all transfers of custody until it has reached an analytical laboratory. Internal laboratory records then document the custody of the sample through its final disposition.

6.1 Field Custody Procedures

6.1.1 Field Documentation

Field logbooks will provide the means of recording all data collection activities. When *in-situ* or field measurements are made, the data are recorded directly in the field logbook, with identifying information (project code, station numbers, station location, date, time, samplers), field observations, and remarks.

Samples for laboratory analysis will be collected following the procedures provided in the SOPs (Appendix B of the BWP). The equipment used to collect samples will be noted in the field logbook, along with the time of sampling, sample description, depth or other location characteristics, and volume and number of containers. A sample identification number will be assigned prior to sample collection. A sample label identifies the sample container. The information recorded on the sample label includes sampling location, date and time, type of analysis required, and preservation notes. The sample label also contains an appropriate place for designating the sample as a grab or a composite and identifying the type of sample (water, soil, etc.) collected for analyses.

After collection, separation, identification, and preservation, the sample is maintained under chain-of-custody (C-O-C) procedures until it is in the custody of the analytical laboratory, at which time the analytical laboratory will implement an internal C-O-C procedure. Samples will be traceable from the time they are collected until they or their derived data are used in the final report. In order to maintain and document sample possession, the following C-O-C procedure should be implemented:

- Samples will be collected as described in SOPs (Appendix B of the BWP) and the FSP (Appendix A of the BWP) and project-specific addenda. Only enough of the sample should be collected to provide a good representation of the medium being sampled. To the extent possible, the quantity and types of samples and the sample locations will be determined before the actual fieldwork. As few people as possible should handle the samples.

- The field sampler will be personally responsible for the care and custody of the samples collected until they are properly transferred or dispatched.

- Log books and other records must be signed and dated.

- When photographs are taken to document the sampling procedure, the name of the photographer, date, time, site location, and site description should be entered sequentially in the logbook as photos are taken. Once developed by a laboratory or downloaded from a digital camera, the photographic prints will be serially numbered corresponding to the log book descriptions.

- When video documentation is utilized, audio documentation of the film, date, time, site location, and site description will be given.

- Sample labels will be completed for each sample using waterproof ink unless prohibited by weather conditions (e.g., a log book notation should explain that a pencil was used to fill out the sample label because a ball point pen would not function in freezing weather).

6.1.2 Transfer of Custody and Shipment

The following procedures will be implemented when transferring and shipping samples:

- Samples are accompanied by a C-O-C record. A typical C-O-C record is depicted in Figure 6-1. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the record. This record documents sample custody transfer from the sampler, often through another person, to the analyst in the laboratory.

- Samples will be packaged properly for shipment and dispatched to the appropriate laboratory for analysis, with a separate custody record accompanying each shipment (e.g., one for each field laboratory, one for samples shipped, driven, or otherwise transported to the laboratory). Shipping containers will be sealed for shipment to the laboratory. The method of shipment, courier name(s), air bill number, and other pertinent information will be entered in a comment section on the custody record.

- When samples are shipped to the laboratory, they must be placed in coolers or other container and sealed with custody seals. Custody seals must include the signature of the individual shipping the samples and the date the shipping container was sealed. When samples are shipped, two or more seals are to be placed on each shipping container, with at least one at the front and one at the back, located in a manner that would indicate if the container was opened during transit. Wide, clear tape will be placed over the seals to ensure that seals are not accidentally broken during shipment. Nylon packing tape may be used providing that it does not completely cover the custody seal. Completely covering the seal with this type of tape may allow the label to be peeled off. Alternatively, evidence tape may be substituted for custody seals.

- If samples are subject to interim storage before shipment, custody seals or evidence tape can be placed over the lid of the jar or across the opening of the storage box or refrigerator. Evidence tape may also be used to seal the plastic bags or metal cans that are used to contain samples in the cooler or shipping container. Sealing individual sample containers assures that sample integrity will not be compromised if the outer container seals are accidentally broken.

- All shipments will be accompanied by the C-O-C record identifying its contents. The original C-O-C record will accompany the shipment and the copy will be retained in the project files.

- All shipments must be in possession of contractor personnel until released to the carrier, and a receipt is obtained.

- If sent by mail, the package will be registered with return receipt requested. If sent by common carrier or air, proper documentation will be maintained.

Figure 6-1. Typical Chain-of-Custody Record

PROJ. NO.	PROJECT NAME
SAMPLERS : (Signatures)	

STA.NO.	DATE	TIME	COMP	GRAB	STATION LOCATION	PRESERVATIVE	NO. OF CONTAINERS						REMARKS

Relinquished by: *(Signature)*	Date	Time	Received by: *(Signature)*	Relinquished by: *(Signature)*	Date	Time	Received by: *(Signature)*
Relinquished by: *(Signature)*	Date	Time	Received by: *(Signature)*	Relinquished by: *(Signature)*	Date	Time	Received by: *(Signature)*
Relinquished by: *(Signature)*	Date	Time	Received for Laboratory by: *(Signature)*	Remarks			

2.18 Laboratory Custody Procedures

The laboratory will be responsible for custody and tracking of samples upon receipt at the facility. The laboratory will have a written QA program for all analytical activities. The following custody procedures provide the basic requirements to be implemented by the laboratory:

- A designated sample custodian accepts custody of the shipped samples and verifies that the information on the sample labels matches that on the C-O-C records. If discrepancies are observed, they are entered under a comment section and the field sampling team and/or project management must be notified immediately for resolution. The custodian then enters the sample label data into a bound log book which is arranged by project code and station number.

- The laboratory custodian will use the sample label number and/or assign a unique laboratory number to each sample label and will assure that all samples are transferred to the proper analyst or stored in the appropriate secure area.

- The laboratory custodian will store the samples in a designated area. Appropriate analysts sign for and take samples from the storage area under controlled conditions. Laboratory personnel are responsible for the care and custody of samples from the time they are received until the sample is exhausted or returned to the custodian.

- When sample analyses and necessary QA checks have been completed in the laboratory, the unused portion of the sample and the sample container must be disposed of as required.

- The laboratory will maintain records of all identifying sample labels and other QA documentation. Samples received by the laboratory will be retained until analyses and QA checks are completed.

2.19 Record-keeping

6.1.3 Field Records

Field records include completed copies of the C-O-C records, the project log book(s), photographs, video tapes, documentation of reagent sources (i.e., decontamination water, preservatives, standards for field analyses), field sampling forms, soil boring logs, well construction logs, and copies of the completed shipping forms, as applicable.

A bound field logbook will be maintained by the sampling team leader to provide daily records of significant events, observations, and measurements during field investigations. All entries will be signed and dated. Designated members of the field investigation team are to will also be assigned a log book, which will be kept as permanent records in the project file.

Field logbooks are intended to provide sufficient data and observations to enable participants to reconstruct events that occurred during field projects. The field logbook entries will be factual, detailed, and objective. A numbering system will be assigned to field notebooks for ease of reference and reconstruction of field events. A record of the numbering system and the individuals assigned field logbooks will also be maintained.

Unless restricted by weather conditions, all original data recorded in field logbooks and on sample labels, C-O-C records, and receipt-for-samples forms are written in waterproof black ink. These accountable, serialized documents will not be destroyed or thrown away, even if they are illegible or contain inaccuracies that require a replacement document.

If an error is made on an accountable document assigned to one person, that individual may make corrections by crossing out the error, entering the correct information. The erroneous information will not be obliterated. Any error discovered on an accountable document will be corrected by the person who made the entry. All corrections will be initialed by the person who made the entry and dated.

For all photographs taken, a photographic log will be maintained to record the date, time, subject, frame and roll number (if applicable), and name of the photographer.

6.1.4 Laboratory Data Deliverables

Laboratories will submit all sample results and QC information as required by their contract and project-specific requirements. The deliverables may include a hardcopy data package including instrument data, and also electronic data files. Electronic data formats may include Environmental Resources Program Information Management System (ERPIMS) data deliverables, or laboratory standard electronic data files. The laboratory will also comply with data archiving as required by the contract.

Two levels of hardcopy data package deliverables are defined for environmental restoration activities at Kirtland AFB, screening and definitive. Deliverables for each level are described in the following sections. The data package requirement is driven by the end use of the data and the project–specific requirements.

6.3.2.1 Screening Data Package

At a minimum the screening data package will include the following documentation:

- Sample identification number
- Preparation and analysis method
- Sample detection limits
- Sample results
- Date and time of sample collection
- Sample analysis date
- Equipment calibration
- QC sample results

6.3.2.2 Level II Deliverables

At a minimum the definitive data package will include the following documentation:

- Cover page–laboratory identification, project name, client, official signature
- Case narrative–nonconformances and corrective action, explanation of data qualifiers, factors affecting sample results
- Analytical results–field sample ID, lab sample ID, matrix, preservation, sample date, sample preparation and analysis date, method numbers, instrument data if required, data qualifiers, confirmation data, concentration units, dilution factors
- Reporting limits
- Sample receipt and tracking documentation
- QA/QC information–QC sample and spike recoveries and control limits, calibration data, nonconformance reports, corrective action reports
- Form I (no tentatively identified compounds [TICs])

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7. CALIBRATION PROCEDURES AND FREQUENCY

2.20 General

Measuring and test equipment used in the field and the laboratory will be controlled by formally prescribed calibration requirements. Equipment will be of the type, range, accuracy, and precision necessary to provide data compatible with the data quality requirements. When available, accepted procedures published by the American Society for Testing and Materials (ASTM), the EPA, the National Institute of Standards and Technology (NIST), or manufacturer equipment manuals will be used. Variances from these procedures will be justified and documented in the project-specific plans. Each calibration procedure will also include the acceptance criteria and the conditions that will require recalibration or repair.

The frequency of calibration will be determined based on the following:

- Type of equipment
- Inherent stability
- Manufacturer recommendations
- Values given in published sources
- Intended use
- Instrument response to spot checks with standards
- Instrument performance and response time
- Experience

2.21 Responsibilities

7.1.1 Analytical Laboratory Equipment and Instrumentation

The Laboratory Manager is ultimately responsible for ensuring that calibration requirements are met. The laboratory will maintain documentation of calibration as required by the method and according to contract requirements. The frequency of calibration will be as specified by the analytical method.

7.1.2 Field Equipment and Instrumentation

The FOL, or designee, at the site will be responsible to assure the following procedure is implemented:

Establish a protocol which will include the field measuring and testing devices requiring calibration and the frequency of calibration for each device based on manufacturer's suggestions and procedures

Assure that the field measuring and testing devices used are of the proper range, type, and accuracy for the tests being performed

Implement a system for issuing, collecting, and returning all field measuring and testing devices and assure that methods are employed to for proper handling, storage, and care of the test equipment in order to maintain its required accuracy

If necessary as required by the project, coordinate with the Kirtland AFB Radiation Safety Officer is ensured to obtain the required permit to operate x-ray fluorescence (XRF) devices at on base.

2.22 Out-of-Calibration Equipment

The following procedures will be implemented for out-of-calibration equipment:

- Any test equipment determined to be out of calibration will be recalibrated as often as necessary to maintain accuracy. When test equipment is found to be out of calibration, damaged, lost, or stolen, an evaluation will be made to ascertain the validity of previous test results since the last calibration check. If it is necessary to assure the acceptability of suspect items, the originally required tests will be repeated using properly calibrated equipment.
- Any test equipment consistently found to be out of calibration will be repaired or replaced.

2.23 Calibration Procedures for Laboratory Equipment

Calibration procedures and frequency specified in the contract analytical laboratory's procedures will be followed.

2.24 Calibration Procedures for Field Equipment

Several types of test equipment may be used during the course of a field program and may include, but not be limited, to the following:

- pH meter
- Temperature meter
- Specific conductivity meter
- Turbidity meter
- PID
- Combustible gas indicator
- Organic vapor analyzer
- XRF analyzer
- Field GC
- Metal detector

- Geophysical surveying equipment (e.g., ground-penetrating radar assembly, magnetometer, electromagnetic induction instrument)

All field equipment should be calibrated and maintained based on the manufacturer’s procedures. Calibration records should be entered in a designated log book to maintained throughout the course of the field program for ultimate storage in the project files.

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8. ANALYTICAL PROCEDURES

Project-specific plans must list all field and laboratory analytical methods and references to be used for each project. For nonstandard methods, a copy of the analytical method will be included in the project-specific plans. If necessary, the project-specific QAPP should include a discussion of the effects of any modifications made to the analytical methods. Method-specific reporting limits and precision and accuracy objectives should also be documented in the project-specific QAPP.

2.25 Laboratory Analyses

The project-specific plans will present the requirements relevant to analyses of samples collected during environmental restoration activities. Analytical methods for chemical analysis are taken principally from the latest revision and update of the following references:

- *Test Methods for Evaluating Solid Waste*, SW-846 Third Edition (EPA, 1986 and updates);
- *Methods for Chemical Analysis of Water and Wastes*, EPA Manual 600/4-79-020
- *ASTM Standards*, Volume 04.08
- *Standard Methods for the Examination of Water and Wastewater*, 17th Edition, American Public Health Association, American Water Works Association, Water Pollution Control Federation, 1989.

Analytical methods for radiochemical analysis are taken principally from the following sources:

- *Prescribed Procedures for Measurement of Radioactivity in Drinking Water*, EPA Environmental Monitoring and Support Laboratory, Cincinnati, OH (EPA-800/4-80-032, August 1980).
- *Interim Radiochemical Methodology for Drinking Water*, EPA-600/4-75-008, March 1976.
- *Eastern Environmental Radiation Facility*, Montgomery, AL, “Radiochemical Procedures Manual,” EPA 520/5-84-006, August 1984.
- “*Radiochemical Analytical Procedures for Analysis of Environmental Samples*,” EMSL-LV-0539-17, March 1979.
- “*Standard Methods for the Examination of Water and Wastewater*,” 17th Edition, American Public Health Association, American Water Works Association, Water Pollution Control Federation, 1989.
- *Annual Book of ASTM Standards, Vol. 11.02*, American Society for Testing and Materials.
- “*Methods for Determination of Radioactive Substances in Water and Fluvial Sediments*,” Book 5, 1989. Techniques of Water Resources Investigations of the United States Geological Survey, Chapter A5.

- Environmental Measurements Laboratory, US Department of Energy, "*EML Procedures Manual, 27th Edition*."

- *Method 913-Radon in Drinking Water by Liquid Scintillation*, Environmental Monitoring and Support Laboratory, Las Vegas, NV.

- Appendix D, Analytical Test Procedure, "*The Determination of Radon in Drinking Water*," p 22, Two Test Procedures for Radon in Drinking Water, Interlaboratory Collaborative Study, EPA/600/2-87/082, March 1987.

2.26 Field Analyses

Field analysis procedures should be implemented in accordance with the manufacturer's instructions and SOPs. Field analyses may include testing for VOCs using PID/FID or gas chromatograph, metals using XRF, and immunoassay testing kits for hydrocarbons.

2.27 Method Detection, Quantitation, and Reporting Limits

The method detection limit (MDL) is the minimum concentration of a compound that can be measured within a given matrix with a 99 percent confidence that the concentration is greater than zero. The MDL is determined by the laboratory for each analytical method and compound. MDL studies should be conducted by the laboratory on an annual basis.

The method quantitation limit (MQL) is an established concentration at five to ten times the MDL value for a specific analyte and accounts for sample matrix effects during analysis. Values reported below the MQL should be flagged as an estimated quantity. The laboratory is required to run a standard at the MQL to ensure the reporting level can be achieved.

The method reporting limit (MRL) is a values below which the laboratory reports a result as non-detected. The MRL may be based on project-specific target levels, regulatory action levels, or instrument and method capability. The MRL is adjusted based on sample matrix and dilution effect. The MRL cannot be below the MQL.

9. INTERNAL QUALITY CONTROL CHECKS

This section describes all specific QC checks to be addressed for both field and laboratory analysis in order to comply with the requirements of the project investigation.

2.28 Field Quality Control Checks

QC procedures for field measurements will include:

- Calibrating the instruments as described in Section 7.0 of this QAPP
- Measuring duplicate samples
- Checking the reproducibility of measurements by taking multiple readings on a single sample or reference standard
- Comparing field measurements with NIST or other approved and traceable standards

QC samples will be collected using methods described in the FSP (Appendix A of the BWP) and any project specific addenda to evaluate the quality of the associated samples. The field QC samples will include the following at the recommended frequencies:

- ***Trip blank***—High grade laboratory water sampled that accompanies each cooler of samples for VOC analysis to the laboratory. This sample is to be analyzed for volatile compounds only.
- ***Ambient field blank***—Collected during VOC sampling as required by project. The sample is to be analyzed for VOCs only.
- ***Equipment blank***—Collected during sampling to ensure thorough equipment decontamination activity. Equipment blanks will be collected immediately after the equipment has been decontaminated. This blank will be analyzed for all laboratory analyses requested for environmental samples collected at the site.
- ***Field Duplicates*****—**Field duplicates will be collected at a frequency of ten percent or as specified in the project-specific QAPP. Both the sample and its associated duplicate will be analyzed for the same parameters in the laboratory.
- ***Field Replicates***—QA samples collected during sampling and sent to the USACE ECB laboratory for analysis. These samples are collected on a project-specific basis.

2.29 Laboratory Quality Control Checks

Laboratory QC checks include several procedures to ensure laboratory accuracy and precision during sample analysis. Types of laboratory quality control samples used during laboratory analyses include the following:

- ***Method Blanks***—Method blanks consist of an analyte-free matrix to which all reagents are added in the same volumes or proportions as used in sample processing. A method blank is analyzed with each sample batch. The method blank sample is carried through the complete sample preparation and analytical procedure. The method blank is used to document contamination resulting from the analytical process. For a method blank to be acceptable for use with the accompanying samples, the concentration in the blank of any analyte of concern should not be higher than the highest of either:

— The method detection limit, or

— Five percent of the regulatory limit for that analyte, or

— Five percent of the measured concentration in the sample.

- ***Calibration Blanks***—Calibration blanks are prepared with standards to create a calibration curve. They differ from the other standards only by the absence of analyte and provide the "zero-point" for the curve. A linear regression is established with a point at the origin. This is associated with an initial calibration.

- ***Internal Standards***—Internal standards are measured amounts of certain compounds added after sample preparation or extraction. They are used in an internal standard calibration method to correct sample results suffering from capillary column injection losses, purging losses, or viscosity effects. Internal standard calibration is currently used for volatile and semivolatile organic extractables by GC/MS.

- ***Surrogates***—Surrogates are measured amounts of certain compounds added before sample preparation or extraction for organic analyses. The amount spiked is dependent on the method of analysis. The recovery of a surrogate is measured to determine systematic extraction problems. Surrogates are added to all samples analyzed for chlorinated pesticides, GC/MS extractables, herbicides, explosives, petroleum hydrocarbons, and VOCs.

- ***Matrix Spikes***—Matrix spikes are aliquots of samples to which known amounts of analyte have been added. They are subjected to the same sample preparation or extraction procedure and analyzed as samples. The amount of spike added will be as specified in the analytical method. Spikes are prepared and analyzed at a frequency of at least 1 per 20 project samples. The percent spike recovery measures sample matrix interference effects, and reflects the accuracy of the determination. Percent spike recoveries are calculated as follows:

$$\%REC = \frac{SR - USR}{SA} \times 100$$

where,

SR	=	the observed analyte concentration in the spiked sample
USR	=	the analyte concentration in the original sample
SA	=	the analyte concentration added to the spiked sample

- Duplicates and Matrix Spike Duplicates—Duplicates are additional aliquots of samples subjected to the same preparation and analytical scheme as the original sample. In cases where a stable, reproducible standard is available, matrix spike duplicates are substituted for duplicates. Duplicates (or matrix spike duplicates) are prepared and analyzed on a daily basis and at a frequency of at least 1 per every 20 samples. The RPD between duplicates or matrix spike duplicates measures the precision of a given analysis. RPDs are calculated as follows:

$$\%RPD = \frac{R_1 - R_2}{R_{av}} x\,100$$

or

$$\%RPD = \frac{S_1 - S_2}{S_{av}} x\,100$$

where,

R_1 and R_2	=	duplicate determinations of the analyte in the sample
S_1 and S_2	=	the observed concentrations of analyte in the spike and its duplicate
R_{av}	=	(R1+R2)/2
S_{av}	=	(S1+S2)/2

- **Laboratory Control Sample (LCS)/Laboratory Control Sample Duplicate (LCSD)**—Laboratory control standards are aliquots of organic-free or deionized water to which known amounts of analyte have been added for water matrices. Other reference materials may be used for other matrices. They are subjected to the sample preparation or extraction procedure and analyzed as samples. The stock solutions used for LCSs are purchased or prepared independently of calibration standards. The LCS recovery tests the function of analytical methods and equipment. LCS/LCSDs are prepared and analyzed on a daily basis or at a frequency of 1 per 20 samples. Laboratory control limits are calculated when 20 data points become available.

In addition to the aforementioned QC samples, the following QC parameters are utilized as part of the QA/QC program for environmental samples collected at Kirtland AFB:

- ***Holding Times***—Holding time compliance (see Table 5-1) is carefully monitored through internal laboratory procedures.

- ***ICP Interference Check Samples***—These samples are run, as necessary, as a check on inter-elemental interferences during ICP analyses.

- ***Single Spike Analysis for Metals Analyzed by Furnace***—Each sample is run as a post-digestion spike. Where matrix interference is indicated, the sample is run by Method of Standard Additions (MSA).

- ***ICP Internal Standardization***—Internal standardization is an acceptable substitute for MSA in ICP analyses, and may be used by the analytical laboratory.

- ***ICP Linear Ranges***—Are evaluated on a quarterly basis and will be reported by the analytical laboratory.

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10. DATA VALIDATION, REDUCTION, AND REPORTING

10.1 Data Validation

The following section describes the procedures pertaining to data validation of both the field and the analytical laboratory data.

10.1.1 Laboratory Data

Laboratory data will be validated according to procedures outlined in the current EPA National Functional Guidelines for Organic Data Review, and EPA National Functional Guidelines for Inorganic Data Review (Functional Guidelines), EPA Region 6 and NMED guidance, and USACE and USAF requirements as appropriate. For analytical methods with nonexistent data validation guidelines, SOPs will be developed prior to evaluation. Data validation procedures will be documented in the project-specific QAPP.

Criteria to be evaluated for organic analyses include, but are not limited to:

- C-O-C quality
- Holding times
- Instrument calibration
- Blanks (including method, trip, ambient air, and equipment)
- Method reporting limits
- Laboratory corrective actions
- Surrogate monitoring compound recovery
- MS/MSD recovery
- Internal standard performance
- Data completeness

Results, which do not meet acceptance criteria as provided in the Functional Guidelines, or project requirements will be qualified with the appropriate data flags.

Criteria to be evaluated for inorganic analyses include:

- C-O-C quality
- Holding times
- Instrument calibration

- Blanks (including method, calibration, and equipment)
- Method reporting limits
- Laboratory corrective actions
- Inductively coupled plasma (ICP) interference check,
- MS/MSD recovery
- LCS recovery
- Review of furnace analytical spike recovery or method of standard additions
- Serial dilution analyses
- Data completeness

Results which do not meet acceptable criteria as provided in the Functional Guidelines or SOPs will be qualified with the appropriate qualifier code.

Following the validation procedure, a summary report will be prepared which briefly outlines the rationale for and the significance of all qualifier codes applied to the analytical data. The following data validation qualifiers may be added to the data based upon the merit of the QC results associated with the data:

U — Value is a non-detect as reported by the laboratory, or has been qualified as a false positive based on contamination found in associated blanks.

R — Value is considered to be unreliable and is unusable due to significant noncompliance with associated QC criteria.

J — Positive value is considered to be an estimate based on associated QC parameter exceedances.

UJ — Detection limit is considered to be estimated based on associated QC parameter exceedances.

10.1.2 Field Records

Field documentation will ensure sample integrity and provide sufficient technical information to recreate each field event. All field data will be reviewed to ensure that:

- Proper field procedures are implemented
- Appropriate documentation is available for each activity
- Field instruments are calibrated as required
- Required number and type of field QC samples are collected

- Numerical value and units of each field measurement are documented
- Field equipment is decontaminated as specified

Any deficient condition that may potentially affect the sample integrity and/or data quality will be discussed with the field personnel immediately upon discovery. Field corrective measures will be implemented as discussed in the FSP (Appendix A of the BWP) and any project specific addenda. A report identifying all deficient conditions will be prepared and submitted as stated in the DMP.

2.30 Data Reduction

Data reduction frequently includes computation of analytical results from raw instrument data and summary statistics, including standard errors, confidence intervals, test of hypothesis relative to the parameters, and model validation. Procedures address the reliability of computations and the overall correctness of the data reduction. The numerical transformation algorithms used for data reduction will be verified against a known problem set to ensure that the reduction methods are correct. Standard analytical procedures will be used for analytical and data reduction.

The data generated will be used to satisfy individual project requirements. The equations and the typical calculation sequence that should be followed to reduce the data to the acceptable format are instrument- and method-specific.

Auxiliary data produced for internal records and not reported as part of the analytical data include the following: laboratory worksheets, laboratory notebooks, sample tracking system forms, instrument logs, standard records, maintenance records, calibration records, and associated QC. These sources will document data reduction and will be available for inspection during audits and to determine the validity of data.

A multidisciplinary team (e.g., chemists, hydrologists, QA officers) will review field records and laboratory data to determine if any environmental data are not representative of environmental conditions due to deviations from acceptable field or laboratory practices. Such data will not be used.

2.31 Reporting

Following validation, a data-validation report summary will be prepared if required in the project scope of work. This report will document the reason for all qualifiers applied to the analytical data during the data validation process. All laboratory problems or results not meeting QC criteria will also be identified and the impact to data usability discussed. All investigation reports will include a summary of data quality and data validation.

As required, analytical data will be provided by the laboratory in electronic format. The format may include the laboratory standard format or the ERPIMS electronic format as required for specific projects.

For consistent reporting of analytical data in tabular format within reports and deliverables, the follwing information must be presented to meet the requirements of the NMED:

- Sample location ID
- Sample date

- Sample depth (as appropriate for soil)
- Analytes by individual name
- Method reporting limits
- Nondetections reported as less-than value relative to reporting limit
- Background values (as appropriate for metals and radionuclides)
- Risk evaluation information (screening levels, risk results as appropriate)

11. PERFORMANCE AND SYSTEMS AUDITS

2.32 General

The purpose of performance and system audits is to assure that the sampling and analysis activities are performed in accordance with the procedures established in the FSP (Appendix A of the BWP), this QAPP and any project-specific addenda. The field and laboratory audits include two independent parts: internal and external audits. Internal audits of field activities will be conducted by the QA PM, QAO, or their designee. External audits of field activities may be conducted by Kirtland AFB, USACE, or other government agencies, as needed. Internal audits of laboratory activities will be conducted by the analytical laboratory's QA Manager or his/her designee. External audits of laboratory activities may be conducted by the QA PM, Kirtland AFB or other government agencies.

11.1.1 Field System Audit

Shortly after field systems are operational, the QA PM, QAO, or their designee will conduct a field audit covering, at a minimum, the following onsite activities:

- ***Organization and Responsibility***—To determine whether the QA organization is operational
- ***Collection of samples***—To assure that written procedures are available and are being followed
- ***C-O-C procedures***—To assure that the appropriate steps have been followed in the traceability of sample origin
- ***Operational procedures***—To assure that the appropriate QC checks are being made in the field and records of these checks are maintained
- ***Equipment and Instruments***—To determine that specified equipment and instrument is available and in working order
- ***Training***—To assure that sampling crews are adequately trained
- ***Records***—To assure that record-keeping procedures are operational
- ***Corrective action***—To verify that the appropriate chain of command is followed in responding to out-of-control situations and that they are properly reported

11.1.2 Resolution of Discrepancies

If there are any discrepancies, deficiencies or indeterminate results, the individual performing the audit will take the necessary action to ensure appropriate corrective actions are taken and completed prior to documenting acceptance of the activities performed. If resolution cannot be reached, work will be stopped by the QA PM and the problems will be brought to the attention of the PM or delegated representative to attain resolution.

The PM or delegated representative will evaluate the problems, provide solutions, and verify implementation of solutions prior to allowing the activity to resume.

11.1.3 Nonconformance/Stop-Work

Nonconformance/Stop-Work will be implemented as described in Section 14.0 of this plan.

2.33 Laboratory Performance and System Audits

11.1.4 Performance Audits

Performance audits will be conducted by using performance evaluation samples and blind QC samples to assess the laboratory precision and accuracy of the total measurement system or portions thereof. The frequency of these audits will depend on the nature of the site being investigated and the end use of the analytical data.

11.1.5 System Audits

System audits will include examination of laboratory documentation on sample receiving, sample log-in, sample storage, C-O-C procedures, sample preparation and analysis, calibration and instrument operating records, personnel training and qualification, and nonconformance reporting and resolution.

Any discrepancies identified during the audit will be resolved and corrected as discussed in Section 14.0 of this plan.

2.34 Audit Reports

Field and laboratory audits will be documented in audit reports. Each audit report will identify the auditor and the activities audited at the site or in the laboratory. Individuals contacted and their functional roles will be identified in the report.

The audit report will identify conformance and non-conformance with SOPs and technical requirements. If resolution to non-conformances is obtained during the audit, the audit report will identify the resolution. Other discrepancies will be addressed as discussed in Section 14.0 of this plan.

12. PREVENTIVE MAINTENANCE

2.35 General

The objective of the preventive maintenance program for sampling and analytical equipment is to avoid generating spurious environmental measurements that could endanger site personnel, lead to inappropriate remedial responses, or impede an enforcement action. An adequate preventive maintenance program increases reliability of a measurement system and prevents instruments and equipment from failing during use. The following factors will be addressed in each project-specific preventive maintenance program:

- Instruments and equipment that are subject to wear, deterioration, or other changes in operational characteristics
- Spare parts necessary to minimize down time
- Optimum frequency of maintenance as depicted in equipment maintenance schedules

Analytical laboratories will have SOPs for preventive maintenance of each measurement system and necessary support equipment. Laboratory maintenance activities will be documented in log books. Field sampling and analytical equipment maintenance will be conducted as recommended by the instrument manufacturer. Field maintenance activities will be documented in dedicated log books.

2.36 Field Sampling and Analytical Equipment

All sampling and analytical equipment will be maintained to the manufacturers' specifications and in operational condition. Routine preventive maintenance as well as per-use inspections and checkout will be conducted to assure proper operation of the various pieces of equipment. Preventive maintenance procedures for field analytical equipment should be implemented as required by the equipment manufacturer.

2.37 Support Equipment

Support equipment is defined as all equipment not previously discussed that will at some point be required for completing an environmental monitoring or measurement task. This equipment may include safety devices, storage and transportation containers, wind indicators, cameras, and communications gear. For preventive maintenance purposes, support equipment should be periodically inspected to maintain the performance standards necessary for proper and efficient execution of all tasks and responsibilities. Appropriate and sufficient replacement parts or equipment will be available for all of these categories of equipment so that sampling and monitoring tasks are not substantially impeded or delayed.

2.38 Laboratory Analytical Equipment

As part of their QA/QC program, the analytical laboratory will implement a routine preventive maintenance procedure. This will minimize the occurrence of instrument failure and other system malfunctions. Designated laboratory personnel will regularly perform routine scheduled maintenance and repair of all instruments. All laboratory instruments will be maintained in accordance with manufacturers' specifications.

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13. DATA ASSESSMENT

The goal of the program is to provide analytical data of consistent and known quality for determining the nature and extent of contamination, assessing risks, instituting corrective actions, and/or identifying and mitigating threats to public health and the environment. Protocols and methodologies are therefore designed to provide data of known quality in strict accordance with QA procedures and C-O-C requirements.

2.39 Formulas

13.1.1 Precision

Multiple aliquots of the samples are spiked and each aliquot is treated exactly the same throughout the analytical method. Spikes are added at approximately 10 times the method detection limit. The percent difference between the values of the duplicates, as calculated below, is taken as a measure of the precision of the analytical method.

$$\%RPD = \frac{2 \times (D1 - D2)}{(D1 + D2)} \, x \, 100$$

where: RPD = Relative percent difference
D1 = First sample value
D2 = Second sample value (duplicate)

13.1.2 Accuracy

A control standard is prepared by adding a known amount of pure compound to a blank matrix (before any extraction is performed). A standard reference material may also be used as both the matrix (i.e., reagent grade silica sand) and as the added compound. These samples measure the accuracy of analytical operations in a standard matrix.

Accuracy as percent recovery (P) is calculated as:

$$P = \frac{Experimental\,Value}{True\,Value} \, x \, 100\%$$

A sample spike is prepared by adding a known amount of a pure compound to the environmental sample before any extraction is performed. The compound is the same or similar (as in isotopically labeled compounds) as that being assayed in the environmental sample. These spikes simulate the background and interferences found in the actual samples, and calculated percent recovery of the spike is taken as a measure of the accuracy of the total analytical method. It is calculated as follows:

$$P = \frac{100(OH - X)}{T}$$

where: P = Percent recovery
OH = Measured analyte concentration
X = Measured analyte concentration in the sample before the spike is added
T = Concentration of spike

13.1.3 Completeness

Assessment of data completeness includes the review of the following:

- Required samples and analyses have been processed (both field measurements and laboratory data)
- Complete records and documentation exist for each parameter analyzed and for associated QC samples
- Specified procedures have been implemented
- Electronic data packages are completed as required

Completeness will be measured as:

$$C = \frac{V}{T} x\, 100$$

where: C = Completeness of data in percent
V = Number of required measurements judged valid
T = Total number of required measurements

2.40 Field Measurements

Field data will be reviewed by the Project QA Officer for accuracy, precision, and completeness, taking into account overall objectives, background data points, and field QA/QC samples as defined in Section 4.0 of this plan. The field results will be reviewed for compliance with established QC criteria specified in this QAPP, the FSP (Appendix A of the BWP) and any project-specific addenda. Accuracy of field measurements will be assessed using daily instrument calibration, calibration check, and analysis of blanks. Precision will be assessed on the basis of reproducibility by multiple readings of a single sample and on the basis of duplicate sample readings. Data completeness will also be assessed. The equations for calculating precision, accuracy, and completeness are presented in Section 13.1 of this plan. If additional requirements are required for a specific project, they will be defined in the project-specific plans.

2.41 Laboratory Data

Assessment of data in terms of the PARCC parameters is an integral part of laboratory verification process. Laboratory data are reviewed in two stages; the first stage is at the laboratory and the second stage by independent data validator(s).

After data have been generated by the analyst or instrument, they will be submitted to a qualified peer (another analyst, QA Manager, group supervisor, or equivalent) for review. The initial review performed at the laboratory is for transcription errors, calculation errors, holding times, a check for completeness, contractual requirements, and to ensure that data meet the QC criteria established by the analytical method. If data exceeds QC criteria, appropriate corrective actions will be implemented, if applicable. If not, the data will be reported as such with a detailed description of the QC exceedance noted in the case narrative.

An independent team (independent of the laboratory and the data user) of data validators will perform the second stage data review. Detailed description of data validation procedures are presented in Section 10.0 of this plan.

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14. CORRECTIVE ACTION

Corrective action is the process of identifying, recommending, approving, and implementing measures to counter unacceptable procedures or out-of-control performance, which can affect data quality. Corrective action can occur during field activities, laboratory analyses, data validation, and/or data assessment. Corrective action may range from documenting in project files that a deviation occurred to resampling/reanalysis, to redoing the project activity affected by the deviation. All corrective action proposed and implemented will be documented in the regular QA reports to management. Corrective actions for field operations will be implemented after approval by the PM, or his/her designee. For laboratory analyses, the Laboratory Manager will approve the corrective actions. Corrective actions based on data validation and data assessment activities will be implemented after approval by the PM.

2.42 Field Corrective Action

14.1.1 Deviations and Corrective Action

A deviation is a deficiency in characteristics, documentation, procedures, or a departure from a requirement that renders the quality of an item, datum, or activity unacceptable or indeterminate. A deviation can be a condition in which characteristics of an item or service do not conform to prescribed limits as follows:

- Unavailability or inadequacy of a required document
- Failure to fulfill a regulatory requirement
- Failure of a procedure to yield the intended results
- An unapproved variation from the FSP (Appendix A of the BWP), this QAPP, and any project-specific addenda

In general, the field team, PM, QA PM, and QAO may identify the need for corrective action. The field staff, in consultation with the FOL, will recommend a corrective action. The PM will approve the corrective action, which will be implemented by the field team.

Corrective action resulting from internal field audits will be implemented immediately if data may be adversely affected due to unapproved or improper use of approved methods. The QA PM will identify deficiencies and recommend corrective action to the PM. Implementation of corrective actions will be performed by the FOL and field team.

14.1.2 Nonconformance Report

A nonconformance report (NCR) will be issued for each deficient/nonconforming condition identified (i.e., when unacceptable procedural practices or conditions are identified). The person identifying the deficient/nonconforming condition will prepare the NCR.

The NCR will fully describe the conditions requiring corrective action, will indicate the nature of the corrections required, and will specify a schedule for compliance. The final authority for issuance of an NCR rests with the QA PM through PM.

A typical nonconformance report is shown in Figure 14-1.

14.1.2.1 Stop-Work Order

If corrective actions are insufficient, resolution cannot be reached, or results of prior work are indeterminate, work may be stopped by a Stop-Work Order. The Stop-Work Order can only be authorized by the PM or QA PM in writing. If there is a disagreement between these personnel, the differences will be brought to the attention of succeeding levels of management until resolution is achieved.

The conditions for which the Stop-Work Order was issued will be described in sufficient detail to allow proper evaluation of the problems and to affect proper corrective action. Documentation of discussions, telephone conference notes, or correspondence which describe the actions taken to evaluate the problems, provide solutions, and verify implementation of solutions will be attached to the Stop-Work Order and fully referenced in the appropriate spaces. Work will not continue until the Stop-Work Order has been rescinded by the individual that authorized the order.

14.1.2.2 Cause and Action to Prevent Recurrence

The QA PM will track the NCRs, analyze the corrective actions required, and take the necessary steps to resolve the causes of the nonconforming conditions in order to prevent recurrence.

2.43 Field Changes

The PM or his/her designee is responsible for all site activities. In this role, the PM at times is required to adjust the site programs to accommodate project-specific needs. Field changes may be required when the sample network is changed (i.e., reduction/addition of samples, sampling locations other than those specified in the FSP, etc.), sampling procedures require modification due to unexpected conditions, or it is not possible to implement corrective actions for deficient/nonconforming condition. In addition, the appropriate Contract Officer must be notified prior to the implementation of any changes in the sampling plans

When it becomes necessary to modify a field program, the FOL or designated field lead will notify the PM of the anticipated changes and implement the necessary changes. When a change is determined to be necessary, the initiator of the change will submit a written notification and a copy will be filed in the project records. If unacceptable, the action taken during the period of deviation will be evaluated in order to determine the significance of any departure from established program practices and action taken.

The changes in the program are documented on a field change request (FCR) form that is signed by the initiator and PM. A typical FCR form utilized to document field changes is shown in Figure 14-2. The FCRs for each project will be numbered serially starting with the number "1".

The PM is responsible for the controlling, tracking, and implementing identified changes. Completed FCRs are distributed to affected parties and those parties to whom copies of affected plans were assigned. Completed FCRs are maintained in the project files.

Figure 14-1. Nonconformance Report

TYPICAL NONCONFORMANCE REPORT

REPORT NO(1) ____________________

CLIENT OR PROJECT (2)		DRAWING NO/SPEC NO. (3)
SUPPLIER, CONSTRUCTION QC OR CONTRACTOR (4)	P. O. NO. (5)	
DESCRIPTION OF COMPONENT, PART OR SYSTEM (6)		

I. DESCRIPTION OF NONCONFORMANCE (7) *(Items involved, Specifications, Code or Standard to Which Items Do Not Comply, Submit Sketch (If Applicable)*

NAME AND SIGNATURE OF PERSON REPORTING NONCONFORMANCE (8)	TITLE/COMPANY	DATE (9)

II. RECOMMENDED DISPOSITION (10) *(Submit Sketch If Applicable)*

NAME AND SIGNATURE OF PERSON RECOMMENDING DISPOSITION (11)	TITLE/COMPANY	DATE (12)

III. EVALUATION OF DISPOSITION BY FOSTER WHEELER ENVIRONMENTAL. REASON OF DISPOSITION (13)

IV. CORRECTIVE ACTION (14) ☐ Required ☐ Not Required

V.(15) ☐ ENGINEERING	☐ QUALITY ASSURANCE	☐ CONSTRUCTION	☐ OTHER
NAME (SIGNATURE)	NAME (SIGNATURE)	NAME (SIGNATURE)	NAME (SIGNATURE)
DATE	DATE	DATE	DATE
☐ ACCEPTED ☐ REJECTED ☐ ACCEPTED WITH COMMENTS	☐ ACCEPTED ☐ REJECTED ☐ ACCEPTED WITH COMMENTS	☐ ACCEPTED ☐ REJECTED ☐ ACCEPTED WITH COMMENTS	☐ ACCEPTED ☐ REJECTED ☐ ACCEPTED WITH COMMENTS

VI. VERIFICATION OF DISPOSITION ☐ REQUIRED ☐ NOT REQUIRED (16)
(17) BY ________________________ SIGNATURE____________________________ TITLE ______________________ DATE ____________

Figure 14-2. Typical Field Change Request Form

FIELD CHANGE REQUEST

PROJECT	PROJ. NO.	FIELD CHANGE NO.

TO ______ DEPT. ______ LOCATION ______ DATE ______

RE: ☐ DRAWING NO. ______ TITLE ______

☐ SPEC NO. ______ TITLE ______

☐ OTHER. ______

1. DESCRIPTION (Items involved, submit sketch if applicable)______

2. REASONS FOR CHANGE (If from disposition of nonconformance report, list report number)______

3. RECOMMENDED DISPOSITION ☐ MINOR CHANGE ☐ MAJOR CHANGE

4. RESIDENT ENGINEER (Signature)	DATE	PROJECT SUPT. CONCURRENCE (Signature)	DATE

5. DISPOSITION

☐ NOT APPROVED (Give Reason)

☐ CONSIDERED MINOR CHANGE - Approval per Recommended Disposition - Design Documents will not be normally revised; field to maintain as-built records

☐ CONSIDERED MAJOR CHANGE - Action will be taken as prescribed on DCN -

LEAD DISCIPLINE ENGINEER OR DESIGNEE (Signature)	DATE	PROJECT ENGR OR DESIGNEE (Signature)	DATE

Project Engineer signs and returns to LDE for transmittal to Resident Engineer with copies to:

Project Manager ______ *Others as Required*______

*Project Supt.*______

*Project Files*______

2.44 Data Validation and Data Assessment Corrective Action

Corrective actions may be required for field activities and analytical work based on the outcome of data validation and data assessment activities as well as site audits. Corrective actions may include resampling and reanalysis, especially when critical sample results are rejected during the data validation process.

The following situations require corrective action based on data validation and data assessment:

- Critical sample results are rejected
- Background sample data are rejected
- Excessive blank contamination, rendering data to be questionable
- QC criteria exceeding allowable limits
- Results with extremely high detection limits
- Data completeness not meeting project requirements (90 percent for field data, 95 percent for analytical data)
- Proper procedures not implemented in the field or in the laboratory
- Data is not legally defensible

All corrective actions of this type will be documented by the Data Validator(s) and Data Officer or designee and approved by the PM.

2.45 Laboratory Corrective Action

Corrective action in the laboratory may occur prior to, during, and/or after analyses. The laboratory must perform corrective actions on all out-of-control events (e.g., initial calibration, continuing calibration, verification, blanks, spikes, etc.) immediately and must bring analytical processes into control prior to proceeding with the analyses. Corrective action reports must be prepared for each out-of-control event, and must document the actions taken, the resolution of the problem, and the return to analytical control. If corrective action does not rectify the situation, the laboratory will contact the PM for resolution.

14.1.3 Sample Control Nonconformance

The following conditions constitute a sample control nonconformance, which typically occurs prior to analyses:

- Incorrect/incomplete or missing C-O-C
- Custody seal not intact
- Broken sample container
- Insufficient sample volume

- Incompatible sample container or cap
- Incorrect sample pH (aqueous samples)
- Incorrect temperature preservation
- Headspace in VOA vials or TOX bottles (aqueous samples)
- Missed hold time upon sample receipt
- Insufficient information available to log in samples
- Multiple phases

When a sample control nonconformance occurs, the person identifying the nonconformance will complete a laboratory NCR and forward it to the laboratory project manager for the job. The laboratory project manager then reviews the NCR and contacts the client. If there is a question in regard to resampling, the contractor will contact their client to discuss the situation in detail. The laboratory project manager initiates any corrective actions. All communications require documentation.

14.1.4 Sample Analyses Nonconformance

The following conditions constitute a sample analysis nonconformance, which normally occurs during or after analysis:

- Failure to perform the required QC checks
- Failure to meet calibration criteria
- QC criteria exceedance
- Error in data reduction or reporting
- Blanks contain target analytes above acceptable levels
- There are unusual changes in detection limits
- Unusual sample response during analysis that is likely to adversely affect the results or precludes completion of analysis

When a sample analysis nonconformance occurs, the person identifying the nonconformance prepares a NCR and forwards it to the group leader who will take the corrective action, and places a copy in the project files. The group leader (or designee) reviews the corrective action and concurs or requests further action. He/she ensures that the action is implemented.

15. QUALITY ASSURANCE REPORTS TO MANAGEMENT

Deliverables associated with the tasks identified in the project-specific addenda and monthly progress reports will contain separate QA sections in which data quality information is summarized. QA reporting will be an integral part of the comprehensive QA Program. QA reporting will address both field and laboratory efforts.

2.46 Frequency of Quality Assurance Reports

The QA PM or designee will prepare and provide a QA report to the PM and other appropriate project personnel on the performance of the QA Program on a regular basis throughout the duration of data-generating projects as required by the contract.

2.47 Contents of Quality Assurance Reports

The reports to management will contain:

- Results of all system and performance audits conducted during the period
- Data validation memoranda and data assessment reports
- Listing of the nonconformances issued during the period, related corrective actions undertaken, and an assessment of the results of these actions
- Identification of significant QA problems and recommended solutions
- Information reflecting on the achievement of specific data quality objectives
- Updates on training provided and changes in key personnel

15.1.1 Project-Specific Daily Quality Control Report (DQCR)

During field investigation activities, DQCRs will be compiled and sent out to the client designee. on a daily basis. However, should problems arise during project related activities, the client will be notified immediately. DQCRs will include, but not be limited to, the following list of topics:

- Date (and corresponding sequential report number)
- Location of the work (including installation, site, boring, etc.)
- Weather information (including temperature, wind speed and direction, humidity, precipitation, etc.)
- Work performed and personnel performing the work
- Sampling performed (including specifics such as location, type of samples, log number, etc.)
- Field analysis performed (including results, instrument checks and calibration, problems, etc.)

- Problems encountered and corrective actions taken (including specifics regarding sampling problems and alternate sampling methods utilized.)
- Quality control activities
- Verbal or written instructions from government personnel
- Calibration procedures and recording
- Names of all personnel on-site (including their corporate, government, or other affiliations, their job titles, and their job functions and/or reasons for being on-site)
- Equipment used
- Health and Safety considerations (including site control measures, levels of personal protection required, on-site monitoring activities and results, accidents, etc.)
- Deviations from approved work plan
- General and specific remarks
- Expected activities for the next working day
- Distribution list for the DQCRs
- Signature and job title of the DQCRs preparer
- Drill logs completed as outlined in the General Geology Scope of Work or other appropriate guideline.

15.1.2 Quality Control Summary Report (QCSR)

The QCSR documents quality control practices and results implemented on a project-specific basis. Issues covered in this report will include a discussion of all data points which may have been influenced or compromised and their effect on achieving the Data Quality Objectives for the project. The QCSR will be summarized in all project-specific summary reports. An example of the elements required for this level of effort include:

- Project description
- Sampling and analysis scope
- Laboratory quality control activities
- Field quality control activities
- Data evaluation
- Analytical data results

- Discussion of qualified data
- Internal quality control reporting.
- Lessons learned
- Conclusions and recommendations

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REFERENCES

Air Force Center for Environmental Excellence (AFCEE) 1993. Handbook for the Installation Restoration Program (IRP) Remedial Investigation/Feasibility Studies (RI/FS), September 1993.

EPA 1980. *Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans,* (QAMS-005/80, December 29, 1980 and revised February 1983).

EPA 1989. *RCRA Facility Investigation Guidance, Volume. I: Development of an RFI Work Plan and General Considerations for RCRA Facility Investigations* (EPA 530/SW-89-031, May 1989).

USACE 1990. *Chemical Data Quality Management for Hazardous Waste Site Remedial Activities* (ER 1110-1-263, October 1, 1990).

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APPENDIX D

Data Management Plan

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TABLES

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ACRONYMS

AFB	Air Force Base
AFCEE	Air Force Center for Environmental Excellence
ASTM	American Society for Testing and Materials
CDLT	Contractor Data Loading Tool
DMP	Data Management Plan
DMS	Data Management System
DQO	Data Quality Objectives
EDMS	Electronic Data Management System
EPA	United States Environmental Protection Agency
ERP	Environmental Restoration Program
ERPIMS	Environmental Restoration Program Information Management System
FSP	Field Sampling Plan
IRP	Installation Restoration Program
ITIR	Informal Technical Information Report
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
SOP	Standard Operating Procedure
USACE	U.S. Army Corps of Engineers
USAF	U.S. Air Force

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1. INTRODUCTION

1.1 Purpose and Scope

This base-wide Data Management Plan (DMP) describes the policies, objectives, concepts, systems, and procedures to be used for the management of all data generated or gathered during environmental restoration activities at Kirtland Air Force Base (AFB). Environmental restoration activities include environmental investigations, monitoring activities, interim remedial or removal actions, corrective measures studies, treatability or pilot studies, full-scale remediation, and system operation monitoring. Sources of data may include field measurement data, well installation information, analytical data, and existing and/or historic project data.

Data management describes managing the data from the time of planning through ultimate use, including collection, analysis and reporting, validating, reduction and assessment, and presentation. Through this plan, the associated supporting documentation, field records, laboratory reports, and project data files will be managed to ensure that data generated during the environmental restoration activities are consistent, accurate, and defensible. To ensure that data and supporting documentation are accessible over the life of the Environmental Restoration Program (ERP), formerly the Installation Restoration Program (IRP), as well as on-going base compliance activities with the Resource Conservation and Recovery Act (RCRA), the information should be stored in a centralized file system.

The goals of data management are to:

- Archive project data and procedures to substantiate conclusions and recommendations drawn from project activities
- Provide timely access to an organized body of data to facilitate analysis and decision making throughout the project
- Provide a useful centralized index of project information
- Present project information in tabular and graphic form
- Communicate data to Kirtland AFB electronically
- Provide convenient and efficient access to project data for all aspects of the base ERP and RCRA compliance program

1.2 Applicability

This DMP provides the framework and the criteria for establishing project-specific DMPs pursuant to the needs of individual projects. The extent, to which this base-wide DMP applies to the project-specific DMPs, either wholly or in part, will depend on the nature and scope of the projects and their associated data-generation requirements. Effective implementation of this DMP, coupled with project-specific addenda, will ensure that:

- All data collection activities and associated fieldwork are performed in accordance with approved plans

- Environmental data are of the appropriate type and are of known, acceptable, and defensible quality needed for their intended use

- Data review and data assessment activities are performed consistently

- Data reporting and data presentation meets project requirements

- Data transfers and data archives are performed in a systematic manner

- Data is tracked from the time of collection through final disposition

2. DATA QUALITY OBJECTIVES

Data Quality Objectives (DQOs) are scoping and planning tools applicable to every environmental sample collection effort. The establishment of DQOs is a necessary step in the generation of any project-specific addendum. DQOs are quantitative and qualitative descriptions of the data required to support decision making. As target values for data quality, they are not necessarily criteria for acceptance or rejection of data. The DQO process generates a logical set of decisions that determines whether collection of samples is necessary; types of samples to collect, including quality control samples; design of the sample collection effort, including location and number of samples; analytical requirements, including precision, accuracy, comparability, completeness, and sensitivity of the method; and if there is sufficient confidence that the data will fulfill requirements.

DQOs outlining the decision-making process and specifying the quality and quantity of data required to support decisions will be presented in the project-specific Quality Assurance Project Plan (QAPP). A general description of the DQO process is outlined in Section 4.0 of the base-wide QAPP. Since the data required for environmental restoration activities are based on end use of the data to be collected, different uses require different levels of data quality. There are five analytical levels that may be assigned to data depending on intended use of the data and the Quality Assurance/Quality Control (QA/QC) methods required to achieve the desired level of quality. These analytical levels are discussed in detail in the referenced section of the QAPP.

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3. PARTICIPANTS AND RESPONSIBILITIES

Individuals responsible for implementing the DMP will be involved in one, or more, of the following activities:

- Field sampling coordination
- Data review
- Database management
- Data evaluation
- Document control

Table 3-1 provides typical activities performed within the five tasks and includes the responsibilities of the individuals performing those activities. These functional activities and responsibilities may be appended or modified to satisfy project requirements. Table 3-1 also provides individuals who may be involved in each of the functional tasks. One individual may at times perform multiple functions within different tasks depending on the nature and scope of the project. Project-specific addenda will identify the names, functions, and responsibilities of individuals, as necessary, based on project requirements.

Table 3-1. Participants in the Data Management System

Functional Task	Typical Activities	Responsibilities	Individuals Involved
1. Field Sampling Coordination	▪ Forecast and schedule sampling activities ▪ Coordinate sample collection, shipment, and analysis ▪ Communicate and coordinate with laboratories ▪ Generate field measurement data ▪ Generate analytical data	▪ Perform all sampling activities in accordance with project procedures and approved plans ▪ Collect, preserve, package, and ship samples to the laboratory ▪ Transmit field data to database management task personnel for Electronic Data Management System (EDMS) entry ▪ Submit field records to data review management task personnel for review and archival ▪ Laboratory is responsible for performing all requested analyses in accordance with approved methods and submit data as required	▪ Field Operations Lead ▪ Sample Coordinator ▪ Sample Collectors ▪ Analytical Laboratory (onsite and offsite) ▪ Field Geologists ▪ Health and Safety Personnel ▪ Surveyors
2. Data Review	▪ Review field data to ensure data meets the intended use ▪ Review analytical data to ensure that project Data Quality Objectives (DQOs) are met ▪ Check data completeness to ensure all data deliverables are present	▪ Perform data review/validation as per approved procedures ▪ Assign data review/validation qualifiers to the data based on merits of quality control criteria ▪ Prepare data review/validation reports ▪ Communicate with the field personnel on deficient field activities ▪ Coordinate with the laboratory to resolve any non-conformance to analytical methods ▪ Transmit data qualifiers to database management task personnel for EDMS entry ▪ Submit all records, reports, and supporting documentation to records management task personnel for archival	▪ Field Data Reviewers ▪ Analytical Data Validators ▪ Project Chemists

Table 3-1. Participants in the Data Management System (Concluded)

Functional Task	Typical Activities	Responsibilities	Individuals Involved
3. Database Management	▪ Coordinate and control all data flow activities from various sources ▪ Organize the received data in the EDMS ▪ Upload and download data files to and from the EDMS	▪ Receive data from field measurements, laboratory analyses, or historical data ▪ Upload, download, back-up all data files as required ▪ Track data from various sources and identify any missing data ▪ Submit data files to the U.S. Army Corps of Engineers (USACE) and Kirtland Air Force Base as specified ▪ Maintain the EDMS (both hardware and software) in working condition	▪ Database Controller ▪ Data Entry Personnel ▪ Hardware and Software Professionals
4. Data Evaluation	▪ Perform risk assessments ▪ Perform investigations and studies ▪ Prepare designs and drawings ▪ Recommend corrective actions ▪ Prepare reports ▪ Present data in tabular or graphical form	▪ Use data as needed and as specified in project plans ▪ Perform data assessment to support decision-making processes ▪ Analyze the data, prepare reports, and present data in a usable manner consistent with project objectives ▪ Submit all reports to records management personnel	▪ Risk Assessment Specialists ▪ Report Preparation Team ▪ Project Scientists and Engineers
5. Document Control	▪ Coordinate and control all records, reports, and supporting documentation ▪ Organize and maintain all files as required ▪ Catalogue and index all files in a centralized file system	▪ Receive files from various sources ▪ All files received are archived and retrieved under controlled conditions ▪ Catalogue and index all files in a centralized file system in a manner which prevents loss, damage, or other detrimental condition of the records	▪ Document Control Staff ▪ File Clerks

FOOTNOTES

Note: Individuals may be involved in multiple activities in different tasks as required by the nature and scope of the project.

DQO Data Quality Objectives

EDMS Electronic Data Management System

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4. DATA MANAGEMENT SYSTEM

The Data Management System (DMS) is an integral part of a systematic program for planning, implementing, assessing, reporting, and making decisions during environmental restoration activities.

Individuals involved in each of the data streams will be responsible for accurately implementing the procedures identified in this DMP and will comply with the requirements specified in project-specific addenda.

This DMP will refer to the following U.S. Environmental Protection Agency (EPA) and U.S. Air Force (USAF) documents:

- *RCRA Facility Investigation (RFI) Guidance, Vol. 1: Development of an RFI Work Plan and General Considerations for RCRA Facility Investigations*. EPA 530/SW-89-031, May 1989.
- *Environmental Restoration Program Information Management System (ERPIMS) Data Loading Handbook*-Version 2.2, January 1991.
- *Handbook for the Installation Restoration Program (IRP): Remedial Investigation/Feasibility Studies (RI/FS)*, September 1993.

These three documents will be referred to as the RFI Guidance, the ERPIMS Data Loading Handbook, and the IRP Handbook, respectively. The ERPIMS Data Loading Handbook is available online at http://www.afcee.brooks.af.mil/ms/irp_sw.asp.

4.1 Field Sampling Coordination

Performance of this task in the DMS may involve the following individuals:

- Field Operations Lead
- Sample Coordinator
- Sample Collectors
- Analytical Laboratory (onsite and offsite)
- Field Geologists
- Health and Safety Personnel
- Surveyors

In summary, the following activities will be performed for Field Sampling Coordination:

- Perform and coordinate all field sampling activities
- Collect field measurement data
- Collect, preserve, package, and ship samples to the laboratory

- Coordinate sample analysis with the laboratory

- Transmit field data to the database manager for entry into the EDMS and transmit field records to data review personnel for review and archival.

- Laboratory performs all the analyses and transmits the data electronically to Database Management personnel for entry into EDMS and hard copy to data review personnel for validation.

4.1.1 Reporting

Upon completion of project scoping and planning activities, environmental restoration will commence. Field sampling and data generation activities will be consistent with approved project-specific addenda.

All required samples will be collected and documented in a bound, numbered field logbook. The field logbook will be used to permanently record all field procedures, measurements, sample locations, sample types, unique sample identification numbers, and general observations. The specific parameters for which each sample is to be analyzed will also be recorded. A unique sample identification number will be assigned as specified in the project-specific Field Sampling Plan (FSP). Additional record-keeping requirements are discussed in Section 7.2, of the FSP. If required by the project, the Field Operations Lead, or designee, will record all information for the field programs as specified in the ERPIMS Data Loading Handbook.

The field measurement data will be entered into the EDMS by the designated database manager. If required by the project, the data will meet all ERPIMS data submittal requirements. Hard copies of these data and supporting documentation will be reviewed by data review personnel.

All samples collected for laboratory analysis will be packaged and shipped to the analytical laboratory in accordance with the requirements specified in Section 5.0 of the FSP. Field documentation (chain-of-custody, logbooks, boring logs, well purge data, etc.) will be archived in a centralized file system by document control personnel.

4.1.2 Laboratory Data Generation

Upon receipt of samples at the laboratory, a laboratory identification number will be assigned by the laboratory and used to track the samples through the analytical process. Any problems encountered during sample shipment and the condition of the sample at receipt will be documented by the laboratory.

The laboratory will maintain notebooks and other records that will be used to permanently record all laboratory data. The laboratory will then transmit the analytical results electronically to Database Management personnel for entry in EDMS. The format for the electronic data transfer will be consistent with the requirements specified in the ERPIMS Data Loading Handbook if required by the project. Additionally, the laboratory will submit the analytical data along with all supporting documentation (calibration, QC data, case narrative, raw data, etc.) to Data Review Management personnel for validation.

4.2 Data Review

Performance of this task may involve data validators, field records reviewers, and chemists.

The purpose of data review is to ensure that the data comply with the DQOs established for the project. Data validation is an independent, systematic process that compares a body of data against a set of pre-established performance and QC criteria so that the data can be demonstrated to be technically adequate for their intended use and legally defensible. The outcome of the review step is a set of data with known and defensible quality. Checklists and/or standard operating procedures (SOPs) will be used to facilitate uniform review of the data. These checklists and/or SOPs will be included in the project-specific DMP and will be consistent with the project-specific work plan, the EPA Contract Laboratory Program National Functional Guidelines for Organic and Inorganic Data Review (EPA 1994a and EPA 1994b respectively), and EPA Region 6 requirements.

In summary, the following functional activities will be performed by Data Review Management personnel:

- Review all field measurement data and field records
- Validate all analytical data
- Assign data usability qualifiers and prepare a Data Review Report
- Communicate with the field personnel on deficient field activities
- Coordinate with the laboratory to resolve any non-conformance to analytical methods
- Transmit data qualifiers to the database manager for entry into the EDMS and submit all records and reports to Records Management personnel for archival in the project files.
- Data review generally falls into two categories, depending upon whether the data are field- or laboratory-generated. These two categories are discussed in detail in Sections 4.2.1 and 4.2.2, respectively.

4.2.1 Field Data Review

All field data will be reviewed to ensure that:

- Proper field procedures are implemented
- Appropriate documentation is available for each activity
- Field instruments are calibrated as required
- Required number and type of field QC samples are collected
- Numerical value and units of each field measurement are documented
- Field equipment is decontaminated as specified

Any deficient condition that may potentially affect sample integrity and/or data quality will be discussed with the field personnel immediately upon discovery. Field corrective measures will be implemented as discussed in the FSP.

Upon completion of the field data review, the qualifiers attesting to the usability of the data will be assigned and transmitted to the database manager for entry into the EDMS. All reports and field records will be submitted to Records Management personnel for archival in the project files (Records Management Task).

4.2.2 Analytical Data Validation

Depending upon project requirements, different levels of analytical data validation may be specified. In general, analytical data will be validated to ensure that:

- The laboratory procedures conform to the prescribed analytical method
- The samples are analyzed within the method-specified holding times
- All QC samples are analyzed at the required frequency
- The QC criteria are within specified limits
- The instrument used is calibrated as required by the method
- Appropriate detection limits are achieved
- No numerical/transcription errors are present
- The data package is complete and required documentation is provided

At a minimum, the following items will be reviewed, as applicable, to validate the data depending on project requirements:

- Sample holding times
- Instrument performance
- Calibration (initial and continuing)
- Blanks
- Surrogate recovery
- Internal standard recovery
- Matrix spike/matrix spike duplicate
- Field and laboratory duplicate precision
- Laboratory control sample
- Interference check sample
- Inductively-coupled plasma serial dilution results

- Compound identification and result verification
- Reported detection limits
- Radiometric and gravimetric yields
- Data completeness

Evaluation of the data may result in requests for missing data from the laboratory, revisions of erroneous data, and qualifications of data. Based upon the merit of the quality control results associated with each sample, qualifiers indicating the degree of usability will be applied, as necessary. Three levels of data qualification may be applied: fully usable, rejected, or estimated.

Upon completion of data validation, the qualified data will be transmitted to Database Management personnel for entry into the EDMS. Additionally, all reports, data packages, and any addenda information provided by the laboratory will be submitted to Records Management personnel for archival in the project files.

4.3 Database Management

Performance of this task may involve a database controller, data entry clerks, and hardware and software professionals.

Typical functional activities of database manager include:

- Receive data from field measurements and laboratory analysis in electronic media and/or hard copy form
- Upload the received data into the EDMS
- Download the data to the data user
- Organize the data in accordance with the requirements specified in the ERPIMS Data Loading Handbook when required.
- Submit ERPIMS data files to USAF as specified in the ERPIMS Data Loading Handbook, and as required by the project.
- Incorporate any historical data into the EDMS
- Track data from various sources and identify any missing data
- Communicate with individuals transmitting data to the EDMS
- Back-up the data periodically
- Maintain the EDMS (both hardware and software) in working condition

4.4 Data Evaluation

The individuals associated with this task consist of end users of the data, including risk assessment specialists, report preparers, and Project Scientists and Engineers.

Data may be used for the following purposes:

- Identification of potential contamination
- Confirmation of contamination
- Characterization of contamination
- Determination of environmental and human health risks
- Monitoring of response/removal actions (corrective actions)
- Evaluation of remedial alternatives
- Monitoring compliance with regulations

4.4.1 Data Presentation

Based on the end use, data may be assessed/analyzed and presented in one of the three basic approaches:

- Tabular Displays
- Graphic Displays
- Statistical Analysis

Tabular summarization will be used to present the results of all data collection efforts. These tables will be generated from the project database. Table 4-1 is an example of a proposed format for either soil or groundwater results. Graphical and statistical analyses will be used to further determine the presence or absence of potential contaminants at each site.

Graphical methods are particularly useful for comparing detectable concentrations and detection limits to federal or state regulatory limits by pictorially presenting analytical data. The following types of graphs may be utilized:

- Scatter plots
- Vertical bar charts
- Contour plots

Table 4-1. Example of Data Summary Table

Sample ID	Sample Depth (bgs)	VOCs by EPA Method 8260B (µg/kg)						
		Acetone	Carbon Disulfide	Ethyl-benzene	Methylene Chloride	1,1,2 – Trichloro-ethane	m-,p-Xylenes	o-Xylene
Reporting Limit	--	10	4	4	4	4	4	4
SS103DP010501	5	16	ND	ND	7 *B* (B)	ND	ND	ND
SS103DP011001	10	ND	ND	ND	6 *B* (B)	ND	ND	ND
SS103DP011501	15	ND	ND	ND	7 *B* (B)	ND	ND	ND
SS103DP012001	20	16	ND	ND	8 *B* (B)	ND	ND	ND
SS103DP012501	25	13	ND	ND	6 *B* (B)	ND	ND	ND
SS103DP013001	30	15	ND	ND	7 *B* (B)	ND	ND	ND
SS103DP013501	35	ND	ND	ND	7 *B* (B)	ND	ND	ND
SS103DP013502	35	18	ND	ND	6 *B* (B)	ND	ND	ND
SS103DP014001	40	ND	ND	ND	6 *B* (B)	ND	ND	ND
SS103DP020501	5	11	ND	ND	6 *B* (B)	ND	ND	ND
SS103DP021001	10	ND	ND	ND	7 *B* (B)	ND	ND	ND
SS103DP021501	15	ND	ND	ND	5 *B* (B)	ND	ND	ND
SS103DP021502	15	10	ND	ND	7 *B* (B)	ND	ND	ND
SS103DP022001	20	46	ND	ND	6 *B* (B)	ND	ND	ND
SS103DP022501	25	ND	ND	ND	14 *B* (B)	ND	ND	ND
SS103DP023001	30	ND	ND	ND	6 *B* (B)	ND	ND	ND
SS103DP023501	35	ND	ND	ND	5 *B* (B)	ND	ND	ND
SS103DP024001	40	18	ND	3	5 B (B)	ND	24	3
Background Values	--	--	--	--	--	--	--	--
Maximum Detection	--	71	2	4	--	2	26	3
NMED SSL	--	--	--	68,000 ^{sat}	650,000 ^{ca}	7,900 ^{ca}	--	--
Risk Ratio	--	--	--	<SSL	--	2.53E-04	--	--
NMED DAF 20	--	--	--	8,000	400	12	--	--

FOOTNOTES

ca carcinogen

DAF 20 Dilution-Attenuation Factor 20 value

NMED New Mexico Environment Department

sat SSL based on soil saturation limit of compound

SSL soil screening level

In addition, the following American Society for Testing and Materials (ASTM) standards should be considered for use on a project-specific basis as warranted by project-specific DQOs:

- ASTM D5924-96e1 – Standard Guide for Selection of Simulation Approaches in Geostatistical Site Investigations (1994)
- ASTM D5922-96e1 – Standard Guide for Analysis of Spatial Variation in Geostatistical Site Investigations (1996)
- ASTM D5923-96e1 – Standard Guide for Selection of Kriging Methods in Geostatistical Site Investigations (1996)

4.4.2 Reporting

Various reports may be generated during the course of environmental restoration activities, including interim, draft, and final reports. In addition, monthly progress reports and Informal Technical Information Reports (ITIRs) are also required. The ITIRs will be prepared as described in Section 4.0 of the IRP Handbook. The guidance given in the Handbook includes recommended table formats for reporting analytical results, extraction and analysis dates and holding times, QC data, and cross-referencing sample identification data.

Formats for project deliverables should follow the Kirtland AFB document style guide (Reference). An electronic copy of all final reports should be transmitted to Kirtland AFB along with the required paper copies. All deliverables should also be maintained in the project files as required by the contract.

As required, data will be organized, reported, and submitted according to the ERPIMS requirements contained in the ERPIMS Data Loading Handbook.

The ASCII data files specified in the ERPIMS Data Loading Handbook will be submitted according to the current ERPIMS protocol. The ERPIMS data files will be submitted to the USACE or the U.S. Air Force Center for Environmental Excellence (AFCEE), as required by the contract, with subsequent delivery to AFCEE for management in the central data repository for USAF programs.

A transmittal letter will accompany data file submittals stating contract number, delivery order, number, work authorization directive number. The transmittal letter will also identify which submittal group and file names are included. Data submitted in the ERPIMS data files will be in accordance with the appropriate valid value lists found in the appendix to the ERPIMS Data Loading Handbook.

All data submitted will correspond exactly with the data contained in the original laboratory reports and other documents associated with sampling and laboratory tasks. All files delivered will be error free and in compliance with the ERPIMS Data Loading Handbook. Any errors identified by USACE or AFCEE-ESO in the submittals will be corrected.

The current version of ERPTOOLS PC ERPIMS data files. The current version of ERPTOOLS PC contains validation checks to ensure that the data files conform to requirements in the ERPIMS Data Loading Handbook. The following is a list of the file names that may be submitted depending on the task order requirements, and a description for each:

- CON Contract Information

- LDI Location Definition Information
- SLXI Site and Location Information
- WCI Well Completion Information
- GWD Groundwater Level Data
- SAMP Environmental Sampling Data
- CALC Calculated Hydrologic Parameters
- LTD Lithologic Description Information
- TEST Sample Preparation Information
- RES Analytical Results

4.5 Document Control

Typical functional activities of document control personnel include the following:

- Receive field and laboratory data and all supporting documentation
- Receive data review reports
- Receive historical data
- Receive ERPIMS data reports and files
- Receive data analysis/assessment reports
- Receive technical reports and submittals
- Catalogue and organize all files and reports received consistent with project-specific requirements
- Monitor the control of records

All records received will be maintained and stored in the project files until relinquished to USACE, AFCEE, or Kirtland AFB. The records should be readily retrievable for review purposes by data users and regulatory agencies. The records will be controlled in a manner which prevents loss, damage, or other detrimental conditions to the records.

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REFERENCES

AFCEE 1993. *Handbook for the Installation Restoration Program (IRP): Remedial Investigation/ Feasibility Studies (RI/FS),* September 1993.

USAF 1991. *Environmental Resources Program Information Management System (ERPIMS) Data Loading Handbook*-Version 4.0, October 1997.

EPA 1989. *RCRA Facility Investigation Guidance, Vol. 1: Development of an RFI Work Plan and General Considerations for RCRA Facility Investigations,* EPA-530/SW-89-031, May 1989.

EPA 1994a. *EPA Contract Laboratory Program National Functional Guidelines for Organic Data Review*, EPA-540/R-94/012, February 1994.

EPA 1994a. *EPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*, EPA-540/R-94/013, February 1994.

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APPENDIX E

Waste Management Plan

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ACRONYMS

AFB	Air Force Base
AOC	Area of Contamination
ACM	asbestos-containing material
ARAR	Applicable or Relevant and Appropriate Requirements
BTEX	benzene, toluene, ethylbenzene, and xylenes
BWP	Base-Wide Plan
BWHSP	Base-Wide Health and Safety Plan
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
DOT	Department of Transportation
EPA	U. S. Environmental Protection Agency
FSP	Field Sampling Plan
HWB	Hazardous Waste Bureau
IDW	Investigation-Derived Waste
LDR	Land Disposal Restriction
mg/kg	milligrams per kilogram
NMED	New Mexico Environment Department
NMAC	New Mexico Administrative Code
NPDES	National Pollution Discharge Elimination System
PCB	polychlorinated biphenyl
pCi/g	picocuries per gram
PCS	petroleum-contaminated soil
PPE	personal protective equipment
ppm	parts per million
RCRA	Resource Conservation and Recovery Act
SSHP	Site-Specific Safety and Health Plan
SW	Solid Waste
SWB	Sold Waste Bureau
TCLP	Toxicity Characteristic Leaching Procedure
TRPH	total recoverable petroleum hydrocarbons
TSDF	Treatment, Storage and Disposal Facility
TSCA	Toxic Substances Control Act

ACRONYMS (Concluded)

WMP	Waste Management Plan

1. INTRODUCTION

This document will serve as the base-wide Waste Management Plan (WMP) for environmental restoration activities to be performed at Kirtland Air Force Base (AFB). The WMP governs the minimization, generation, management, storage, transport, and disposal of wastes that are routinely encountered during environmental restoration activities. The primary focus of the WMP is the management of investigation-derived waste (IDW). Wastes generated during the execution of remedial actions will be governed by this plan to the extent that they can be predicted and easily accommodated within the scope of the WMP.

1.1 Purpose

The purpose of this plan is to describe the anticipated approach and procedures for waste management. During environmental investigations and remedial actions, waste will be generated that:

- May contain hazardous substances as defined by the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA).
- May be listed as a hazardous waste under the Resource Conservation and Recovery Act (RCRA).
- May be characteristic hazardous waste under RCRA.
- May be Special Waste regulated under the New Mexico Special Waste Requirements Regulations.
- May contain polychlorinated biphenyls (PCBs) regulated under the Toxic Substances Control Act (TSCA).
- May contain asbestos regulated under TSCA, Occupational Safety and Health Administration, or National Emission Standards for Hazardous Air Pollutants.
- May be radioactive or mixed waste regulated under the State of New Mexico Radiation Protection Regulations.

The intent of waste management, particularly IDW management, is to leave the site in no worse condition after the implementation of activities than existed prior to the activities and to comply with federal and state waste management regulations and applicable or relevant and appropriate requirements (ARARs) to the extent practicable. These management procedures are directed toward waste minimization to reduce the quantity of waste that will require treatment, storage, and disposal.

1.2 Scope

To effectively manage the bulk of wastes expected to be generated from the base Installation Restoration Program, this WMP was prepared in accordance with the U. S. Environmental Protection Agency (EPA) guidance document *Management of Investigation-Derived Wastes During Site Inspections*, Office of Emergency Response Directive 9345.3-02, dated May 1991.

The most important elements of the IDW management approach, as listed in the above referenced guidance, are to:

- Leave a site in no worse condition than existed prior to the investigations.
- Remove those wastes that pose an immediate threat to human health or to the environment.
- Leave onsite wastes that do not require offsite disposal or extended above-ground containerization.
- Store onsite waste that is contaminated but not hazardous for treatment during the remedial action.
- Comply with federal ARARs.
- Comply with state ARARs.
- Carefully plan and coordinate for IDW management.
- Minimize the quantity of generated wastes.

These elements can also be applied to certain wastes generated during remedial actions.

1.3 Definitions

Cross-contamination—Spread of chemicals from one item to another or from one location to another.

Debris—A solid material exceeding a 60 mm particle size that is intended for disposal that can be classified as a manufactured object, plant or animal matter, or natural geologic material. The following materials are not debris—any material for which a specific treatment standard is provided in RCRA Subpart D, Part 268; process residuals such as smelter slag and residues from treatment of waste, wastewater sludges, or air emission residues; and intact containers of hazardous waste that are not ruptured and that retain at least 75 percent of their original volume.

Decontamination Fluids—Fluids generated after decontamination of equipment. Fluids include soapy water, rinse water, solvents (e.g., isopropanol), and contaminated media removed from equipment during the decontamination process.

Dewatering Fluids—Liquid waste generated from dewatering operations in excavations, retention ponds, and drainage channels.

Disposable Equipment—Equipment that cannot be decontaminated at the conclusion of an environmental restoration activity and requires disposal. IDW disposable equipment includes bailers, coliwasas (samplers designed to permit representative sampling of multiphase wastes from drums and other containerized wastes), jars and containers, plastic sheeting, foil, disposable laboratory equipment, etc. Disposable equipment from remedial activities includes small tools, barrier materials, decontamination pad equipment, hoses, chains, timber, survey stakes, etc.

Free Liquids—Liquids that readily separate from the solid portion of a waste under ambient temperature and pressure.

Hazardous Waste—Defined by 40 CFR Part 261, as any material that fulfills the following requirements:

- Solid waste

- Not excluded from regulation under Subparts C or D
- Listed hazardous waste (Subpart D), or contains a waste listed in Subpart D
- Exhibits any of the characteristics (ignitability, corrosivity, reactivity or toxicity) in Subpart C.

Mixed Waste—Radioactive waste that also contains a hazardous waste component regulated under RCRA (see definition of hazardous waste). Although not strictly a "mixed waste," radioactive waste containing TSCA-regulated waste (e.g., PCBs, asbestos) or naturally-occurring radioactive materials are also considered to be a mixed waste under this plan.

PPE—Coveralls, gloves, respirator cartridges, tape, boots, etc.

Purge Water—Groundwater pumped from a borehole (monitoring well) prior to sampling.

Radioactive Waste—Waste that contains higher than background levels of radioactivity, or is otherwise not releasable for use by the general public. Waste that can be disposed of without regard to its radioactivity is not considered "radioactive waste."

Remediation Waste—Any media or debris resulting from environmental restoration activities that meet the definition of solid waste in 40 CFR Part 261.

Representative Sample—A sample of a universe or whole (e.g., waste pile, lagoon, groundwater) which can be expected to exhibit the average properties of the universe or whole.

Soil Cuttings—Excess soil removed by the direct push and hollow-stem auger drilling techniques.

Special Waste—New Mexico defines "Special Waste" as the following types of solid wastes that have unique handling, transportation, or disposal requirements to assure protection of the environment and the public health and safety:

- Treated formerly characteristic hazardous wastes
- Packing house and killing plant offal
- Asbestos waste
- Ash
- Infectious waste
- Sludge
- Industrial process waste
- Residue from a spill of a chemical substance or commercial product (including contaminated soils)
- Dry chemicals which, when wetted, become characteristically hazardous

The New Mexico Environmental Department (NMED) also defines petroleum-contaminated soil (PCS) as "Special Waste" if the sum of benzene, toluene, ethylbenzene, and xylene isomer concentrations is greater than 500 milligrams per kilogram (mg/kg), with benzene individually greater than 10 mg/Kg, and total petroleum hydrocarbon concentration greater than 1,000 mg/Kg.

1.4 Assumptions

The WMP is based on the field sampling and analysis requirements set forth in the addenda to the Base-Wide Plan (BWP), the Field Sampling Plan (FSP), (Appendix A of the BWP), the health and safety requirements set forth in the Base-Wide Health and Safety Plan (BWHSP) (Appendix F of the BWP), the Contractor's Site-Specific Safety and Health Plan (SSHP) and the following assumptions:

- Hazardous waste determinations will be made through generator knowledge or testing (40 CFR 262.11).
- Kirtland AFB is the generator and will review and approve the waste determinations and the waste codes proposed for hazardous waste.
- Kirtland AFB will identify any potential listed waste on the site by providing process knowledge information and/or existing analytical data.
- Kirtland AFB will review and approve the treatment, storage, and disposal facilities (TSDFs) that are proposed for offsite waste storage, treatment, and/or disposal.
- Kirtland AFB will sign all waste documentation, including state-approved forms, TSDF waste profile sheets, RCRA Land Disposal Restriction (LDR) certifications, manifests, and shipping papers. PPE will be treated as potentially contaminated waste unless generator knowledge indicates otherwise.
- Non-hazardous trash will be double-bagged, containerized, and kept segregated from chemically contaminated waste and will be disposed in an approved landfill.

1.5 IDW Minimization

A primary goal of the WMP is to minimize, to a practical extent, the volume of waste that will be generated, stored, and removed from the site for disposal. In order to minimize the volume of waste, the following general rules will be applied:

- Do not contaminate materials unnecessarily.

  — Plan work ahead, based on the work procedure to be used.

  — Take only the material (i.e., chemicals) needed to perform the work activity. Additional material can be brought to the work location if it is found to be necessary. Materials can be stored in large containers but the smallest reasonable container will be used to transport the material to the location where it is needed.

  — Maintain cleaning and extra sampling supplies outside any potentially contaminated area to keep them clean and to minimize additional waste generation.

— Maintain or construct prefabricated materials, barriers, support equipment, etc., outside potentially contaminated areas.

— Perform mixing of detergents or decontamination solutions outside potentially contaminated areas.

— Do not place media considered hazardous for different reasons together.

— Use drop cloths or other absorbent material to contain small spills or leaks.

— Avoid a bellows effect when double-bagging contaminated materials.

— Use containers to minimize the spread of contamination.

— Do not place contaminated materials with clean materials.

— Cover wooden pallets inside the exclusion zone with plastic.

- Decontaminate and re-use material and equipment when practical.

- Use volume reduction techniques when practicable.

— Verify that waste containers are solidly packed to minimize the number of containers.

— Use only the size of container to meet needs (i.e., do not use a drum or garbage can when a small polyethylene bag will do).

— Use less hazardous substances whenever possible (i.e., bring only the volume of standard solutions needed for testing, use minimal amounts of decontamination water and solvent rinses).

— Use direct push, hydropunch, or and other waste minimizing sample acquisition techniques whenever possible.

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2. REGULATORY REQUIREMENTS

NMED regulates environmental activities in the State of New Mexico. As discussed in Section 2.0 of the FSP (Appendix A of the BWP), much of the environmental restoration work at Kirtland AFB is under the jurisdiction of both NMED and the EPA Region 6. Hazardous waste, special waste, radioactive/mixed waste, PCBs, and asbestos may be generated during the performance of environmental restoration activities. The following federal and state Regulations are applicable to planned environmental restoration activities:

- 40 CFR Parts 190 - 256 EPA regulations for solid waste
- 40 CFR Parts 260 - 299 EPA regulations for identification and management of hazardous waste
- 40 CFR Part 761 EPA regulations for management of PCBs
- 40 CFR Part 61 and 40 CFR 763 EPA regulations for management of asbestos
- 10 CFR 19, 20, 21, 30, 40, 70, and 71 for management of radioactive materials
- 49 CFR Parts 100-178 Department of Transportation (DOT) rules for hazardous materials transport
- 20 New Mexico Administrative Code (NMAC) Chapter 9, New Mexico Solid Waste Management Regulations
- 20 NMAC Chapter 4, New Mexico Hazardous Waste Management Regulations
- 20 NMAC Chapter 5, New Mexico Underground Storage Tanks Regulations
- 20 NMAC Chapter 9, New Mexico Special Waste Requirements Regulations
- 20 NMAC Chapter 2, New Mexico Air Quality Regulations
- 20 NMAC Chapter 6, New Mexico Water Quality Control Commission Regulations
- 20 NMAC Chapter 3, New Mexico Radiation Protection Regulations
- 20 NMAC Chapter 11, Albuquerque/Bernalillo County Air quality Control Board

Although NMED is the cognizant Agreement State agency, the regulation of radioactive sources, byproducts, or special nuclear materials at federal facilities is under the jurisdiction of the U.S. Nuclear Regulatory Commission, Region IV. The NMED, Hazardous Waste Bureau (HWB) regulates the use, possession, transfer, and disposal of naturally-occurring radioactive materials.

For this plan, the federal regulations will be referenced in the regulations except where New Mexico regulations are more stringent.

2.1 Waste Characterization and Classification

All waste streams including, but not limited to, sludge, soil, well development and purge water, decontamination rinsate, and debris will be sampled and waste-classified in accordance with 40 CFR 262.11 and 20 NMAC Chapter 9, Part 1, Section 704, which require the generator to determine if a waste is a listed or characteristic hazardous waste, or New Mexico Special Waste. Documentation of all waste classifications must be maintained in the generator's file.

Site characterization data may be used, or representative samples will be obtained in accordance with the federal and New Mexico Hazardous Waste Management Regulations, the New Mexico Special Waste Requirements Regulations, and applicable project-specific requirements, which includes sampling for other known or suspected contaminants (e.g., PCBs or asbestos).

Sampling requirements will be specified on a project-specific basis, and may include the following:

- Ignitability
- Corrosivity
- Reactivity
- Toxicity Characteristics [totals or Leaching Procedure (TCLP)]
- Paint Filter Test
- Additional parameters as identified by NMED
- RCRA Subtitle C listed wastes

Toxicity Characteristic results will be compared against the criteria listed in Table 2-1.

If the above tests do not apply, New Mexico allows documentation of a special waste by its appropriate regulated statutes such as TSCA, the Federal Insecticide, Fungicide and Rodenticide Act, or other applicable statutes.

2.2 Hazardous Waste

New Mexico Hazardous Waste Management Regulations are found in 20 NMAC, Chapter 4. RCRA Subtitle C and the New Mexico Hazardous Waste Management Regulations govern the generation, treatment, storage, and disposal of hazardous waste from point of generation through ultimate disposal. All waste streams must be classified in order to determine proper management practices. The NMED HWB oversees management of the hazardous waste program in New Mexico. The state is authorized to implement most of the federal RCRA program; however, they are not authorized for the RCRA Corrective Action program or the used oil program in 40 CFR Part 279. New Mexico does not classify additional wastes as state hazardous wastes in addition to the federal hazardous wastes, nor does New Mexico have separate criteria for characterizing hazardous waste.

The state does have a fee program requiring generators and TSDFs to pay annual fees to meet necessary expenses in the administration and operation of the state hazardous waste program. Kirtland AFB will pay applicable fees as generator of the hazardous waste.

Table 2-1. RCRA Toxicity Characteristic Criteria

EPA Hazardous Waste Code	Constituent	TCLP Leachate Maximum (milligrams per liter)	Maximum Totals Conversion for Solids (mg/kg)
Metals			
D004	Arsenic	5.0	100
D005	Barium	100.0	2000
D006	Cadmium	1.0	20
D007	Chromium (total)	5.0	100
D008	Lead	5.0	100
D009	Mercury	0.2	4
D010	Selenium	1.0	20
D011	Silver	5.0	100
Insecticides/Herbicides			
D012	Endrin	0.02	0.4
D013	Lindane	0.4	8
D014	Methoxychlor	10.0	200
D015	Toxaphene	0.5	10
D016	2,4-D	10.0	200
D017	2,4,5-TP Silvex	1.0	20
Other Organics			
D018	Benzene	0.5	10
D019	Carbon tetrachloride	0.5	10
D020	Chlordane	0.03	0.6
D021	Chlorobenzene	100	2000
D022	Chloroform	6.0	120
D023	o-Cresol*	200.0	4000
D024	m-Cresol*	200.0	4000
D025	p-Cresol*	200.0	4000
D026	Cresols*	200.0	4000
D027	1,4-Dichlorobenzene	7.5	150
D028	1,2-Dichloroethane	0.5	10
D029	1,1-Dichloroethylene	0.7	14
D030	2,4-Dinitrotoluene	0.13	2.6
D031	Heptachlor (and epoxide)	0.008	0.16
D032	Hexachlorobenzene	0.13	2.6
D033	Hexachlorobutadiene	0.5	10
D034	Hexachloroethane	3.0	60
D035	Methyl ethyl ketone	200.0	4000
D036	Nitrobenzene	2.0	40
D037	Pentachlorophenol	100.0	2000
D038	Pyridine	5.0	100
D039	Tetrachloroethylene	0.7	14
D040	Trichloroethylene	0.5	10
D041	2,4,5-Trichlorophenol	400.0	8000
D042	2,4,6-Trichlorophenol	2.0	40
D043	Vinyl chloride	0.2	4

* If cresol isomers cannot be differentiated, total cresols are used

2.3 Special Waste

New Mexico Special Waste Regulations are found in 20 NMAC Chapter 9, Part 1, Section 700 through Section 712. Management of special wastes is under the control of the Solid Waste Bureau (SWB). A definition of Special Waste is included in the Definitions section of this plan. All disposal facilities managing a special waste must have a Waste Disposal Plan for that waste. If they do not, they must not accept the waste, or it is the responsibility of the generator to prepare and submit a Waste Disposal Plan to the SWB for approval prior to disposal.

Special Waste must comply with the following requirements:

- Special wastes must either be treated prior to disposal and/or isolated in their disposal to ensure a minimum of exposure to the public.
- All special waste must be disposed of only at solid waste facilities permitted for disposal of special waste.
- All special wastes must be manifested in accordance with Section 712 of the New Mexico Special Waste Requirements Regulations, as specified in Section 5.5.1.1 of this plan.
- Storage of special waste will occur only at an approved special waste storage area.
- Special waste will not be stored longer than 45 days, unless approved in advance by NMED.
- All containers of special waste to be stored or disposed of will be clearly labeled, indicating the contents and potential health, safety, and environmental hazards associated with the waste.
- The physical and chemical characteristics of all special wastes will be documented prior to storage, transportation, or disposal, by means of:

  — Records of the results of analysis performed in accordance with Section 704 as applicable

  — Detailed descriptions of the generator's knowledge of specific wastes

- Transporters of any type of waste must be registered.

2.4 Surface and Groundwater Discharges

New Mexico Water Management Regulations are found in 20 NMAC 6.2 through 6.4. The NMED Groundwater Bureau manages discharges to groundwater. Discharges to groundwater (which includes discharges to the ground surface) require submittal of a discharge plan to NMED; approval to discharge is issued through a letter from the Bureau. The Surface Water Quality Bureau manages discharges to surface water (both ephemeral and perennial). The state is not authorized to implement the National Pollution Discharge Elimination System (NPDES) program. NPDES permits for discharges to surface water must be obtained from EPA Region 6.

3. WASTE MANAGEMENT CONTROL MEASURES

This section describes the various waste management control measures planned for each potential waste stream. The waste management measures include segregation, containment, marking and labeling, logging, and tracking.

3.1 Waste Characterization and Classification

To determine proper waste management requirements for waste generated during project activities, waste characterization may be necessary. Unless a waste determination can be made based on generator knowledge and site data, all waste streams will be sampled and characterized in accordance with 40 CFR 262.11 regulations. If samples for classifying waste are deemed necessary to meet characterization requirements, representative samples will be taken and analyzed in accordance with federal regulations and New Mexico Hazardous Waste Management Regulations and Solid Waste Management Regulations. Waste streams, including but not limited to debris and soil, decontamination water, and PPE, will be sampled and/or characterized using generator knowledge, TCLP testing, or total recoverable petroleum hydrocarbons (TRPH) analysis, depending on the nature of the material and expected contaminant. Generator knowledge is expected to be the primary means of characterizing wastes generated during this project. The basis for characterization will be material data safety sheets for materials brought onsite, prior site assessment data, and observations made and analyses conducted during site activities.

Waste will first be characterized to determine whether it is a hazardous or special waste; waste is determined to be characteristically hazardous on the basis of its chemical constituents or physical properties. Listed wastes are specifically identified in 40 CFR Part 261, Subpart D. New Mexico special waste, which includes PCS, is identified as soil contaminated with a TRPH concentration greater than 1000 mg/kg, a benzene concentration that exceeds 10 mg/kg and a total benzene, toluene, ethylbenzene, and xylenes (BTEX) concentration that exceeds 500 mg/kg. Asbestos waste will be categorized using the definitions specified in 20 NMAC 9.1, Solid Waste Regulations.

Characteristic hazardous waste includes those wastes that exhibit toxicity in excess of the values indicated in 40 CFR Part 261, Subpart C. As previously discussed, any waste generated will first be characterized (if possible) based on generator knowledge. If generator knowledge is not sufficient to make an adequate determination, an exceedance of a toxicity characteristic will be determined through the waste's constituent concentration comparisons with listed TCLP regulatory levels.

PCS will be characterized using results from analysis for the toxicity parameters of volatile organic compounds, semivolatile organic compounds, pesticides, herbicides, and target analyte list metals. The analysis will be performed in accordance with EPA SW-846, Test Methods for Evaluating Solid Waste, Third Edition and Updates (EPA, 1986). The analytical results will be compared to 20 times the toxicity characteristic values for TCLP analytes. The 20-times value accounts for the sample dilution factor associated with the TCLP analysis. If an analyte concentration exceeds 20 times the TCLP regulatory level, then a TCLP analysis will be performed for that analyte to enable a direct comparison of the specific constituent concentration to the TCLP regulatory levels.

The 20-times value above is related to the dilution factor used in the TCLP test. Consequently, TCLP analyses may not have to be performed if the total value is less than 20 times the indicated regulatory level for a particular constituent. Hydrocarbon contamination will be determined through testing for using EPA Method 9071A/418.1 or other approved method.

Documentation of all proposed waste classifications (supported by generator knowledge or through chemical analyses) will be provided to Kirtland AFB for final waste stream characterization approval.

3.2 Hazardous Waste Management

RCRA Subtitle C and the New Mexico Hazardous Waste Management Regulations (20 NMAC 4.1) govern hazardous waste management from the point of generation, through storage and treatment (if necessary), to its ultimate disposal. The NMED-HWB oversees management of the hazardous waste program in New Mexico.

Hazardous waste must comply with the following requirements:

- Waste generated during project activities must be characterized chemically or by using generator knowledge to determine if it is a hazardous waste (as discussed in Section 4.1).
- Hazardous waste must be managed in accordance with 40 CFR Part 262—Standards Applicable to Generators of Hazardous Waste.
- Hazardous waste transported offsite must be manifested in accordance with 40 CFR Part 262, Subpart B—Manifests, and accompanied by LDR certification notices as per 40 CFR 268—Waste Analysis and Recordkeeping.
- Small quantities of hazardous waste must be stored in accordance with 40 CFR Part 265, Subpart I—Use and Management of Containers.
- All containers of hazardous waste to be stored or disposed will be clearly marked with a completed hazardous waste label indicating the starting date of accumulation, EPA identification number, EPA waste code, and DOT labels and markings.
- Hazardous waste may be stored onsite for a maximum of 90 days. An initial accumulation start date (defined as the first date waste is placed in the container) will be placed on the container and recorded in a log book. A determination of whether a waste, once generated, is hazardous by using generator knowledge, chemical analyses, or other information will be made within 15 days.
- Hazardous waste must be disposed only at a hazardous waste disposal facility approved by Kirtland AFB and permitted for the disposal of the particular type of hazardous waste generated. Hazardous waste disposal activities will be contracted, coordinated, and arranged for by Kirtland AFB personnel. Under no circumstances will the Contractor's personnel sign hazardous waste manifests.

3.3 New Mexico Special Waste Management

New Mexico Special Waste Regulations are found in 20 NMAC 9.1; management of special wastes is under the control of the NMED-SWB.

With regard to this project, New Mexico special wastes (i.e., solid wastes that have unique handling, transportation, or disposal requirements to ensure protection of the environment and the public's health and safety) potentially includes PCS and ACM. For Kirtland AFB, New Mexico has defined PCS as special waste if the TRPH concentration is greater than 100 mg/kg.

Special wastes (PCS and ACM) must comply with the following requirements:

- Special wastes must either be treated prior to disposal and/or isolated in their disposal to ensure a minimum of exposure to the public.
- All special wastes must be disposed of only at solid waste facilities permitted for disposal of special wastes.
- All special wastes must be manifested in accordance with Section 712 of the New Mexico Special Waste Regulations.
- Storage of special wastes will occur only at an approved special waste storage area in a bermed area containing an impermeable membrane liner. Special wastes will not be stored longer than 45 days, unless approved in advance by NMED.
- All containers of special wastes to be stored or disposed will be clearly labeled, indicating the contents and potential health, safety, and environmental hazards associated with the waste.
- The physical and chemical characteristics of all special wastes will be documented prior to storage, transportation, or disposal by the following means:
- Records of the results of analysis performed in accordance with Section 704 of the New Mexico Special Waste Regulations, as applicable
- Detailed descriptions of the generator's knowledge of specific wastes
- ACM managed in accordance with Section 705 of the New Mexico Special Waste Regulations, as applicable
- Transporters of any type of regulated special waste must be registered with the NMED-SWB

3.4 Waste Containerization, Storage, and Disposal

Prior to generation, container selection will be performed by DOT-trained personnel, based on type and quantity of waste to be generated. Containers may include DOT specification drums, roll-offs, or tanks for regulated hazardous material. DOT specification containers are not required for material which does not meet a DOT hazard class, such as PCS, which may be transported in a dump truck).

The Contractor shall select temporary staging and storage areas in accordance with the project specific addenda. Areas to be used for staging or storage of hazardous waste or NMED special waste will be properly designated, demarcated and prepared. The designated areas will include spill containment and control equipment, fire suppression equipment (as applicable), and secondary containment (as applicable) in accordance with 40 CFR Part 262, New Mexico Special Waste Regulations, Kirtland AFB Base-Wide Spill Prevention Control and Countermeasure Plan, Kirtland AFB Base-Wide Stormwater Pollution Prevention Plan and the Contractor's project-specific addenda to these plans. The area will be secured with some type of fence or barrier, and a sign reading "DANGER-UNAUTHORIZED PERSONNEL KEEP OUT" will be posted at the entrance and all sides of the enclosure. Waste may also be stored in Kirtland AFB's approved waste storage area with appropriate demarcations and barriers.

Under no circumstances should solid residues from a known contaminant concentration be combined with other residues containing suspected but unknown contamination, regardless of whether the container is filled or not. To minimize the number of containers, contaminant concentration residues containing similar waste characteristics can be combined. Wastes collected from potentially contaminated sites or areas of such sites that were known to have managed listed hazardous wastes will be put into separate containers.

Wastes will be containerized according to the source of the wastes material. Soil and water wastes generated during field activities will be containerized separately. Wastes generated from different borings and monitoring wells may be containerized together to minimize the number of containers, provided they are from the same site.

Containers will be segregated according to their content. For example, all soil cuttings will be stored away from all waste water (purge, development, and decontamination waters) and PPE. The goal is to separate waste as accurately as possible into categories which are intended to match waste acceptance criteria of available disposal facilities.

Applicable field segregation categories will be determined based on "Process Knowledge" provided by Kirtland AFB, such as site history, previous characterization data, field screening, or change in coloration or odor. Although this information is mostly qualitative, prudent application can support strategies which minimize total handling, characterization, and disposal costs.

Soil must pass the paint filter test in order to be accepted at a landfill. Containers of drill cuttings with a high moisture content will be filled to approximately one to two feet below the rim. Bentonite will be added to the top of the soil cutting until it has fully to absorbed excess liquids in drill cuttings. Bentonite will not be mixed in with the soil cuttings. The addition of bentonite will be logged in the field book. The waste composition section of the disposal facility's waste profile sheet will include the percentage of bentonite in the drum. Radioactive waste for land disposal will not contain any free-standing water, as defined in license conditions of the waste-receiving facility.

Waste material must be classified according to EPA and DOT criteria prior to affixing labels. At the time of generation and until sample analysis or other information proves that the material is a hazardous waste or special waste, all waste containers will be labeled indelibly with paint markers and include the following information:

- Source and location (boring number)
- Contents and quantity of material in the container
- Potential health, safety and environmental hazards
- Accumulation start date (the date the first drop of material was put in the container)
- Date container sampled
- Analytical Parameters
- "ANALYSIS PENDING"

Upon classification, appropriate hazardous/nonhazardous and DOT labels will be applied, complete with the proper information specific to each waste stream. Containers that are determined to contain hazardous waste will immediately be labeled with a completed commercial EPA "HAZARDOUS WASTE" label, which will include the original accumulation start date and other requested information. Figure 4-1 presents a typical hazardous waste label. DOT information for hazardous materials, including proper shipping descriptions and hazard class labels, will be added prior to shipping. DOT functions, as required by 49 CFR Part 172, Subpart H, will be conducted by DOT-trained personnel.

Once wastes are determined to be hazardous, a description of the waste generated (including origin, volume, accumulation date, number of containers, and ultimate disposition, e.g., offsite TSDF, etc.) will be entered into an electronic waste-tracking system. The tracking system will be routinely updated upon the generation of new wastes and following transport of wastes offsite.

Radioactive waste having an average total radionuclide concentration of at least 2,000 picocuries per gram will be packaged, labeled, transported, and managed in accordance with DOT regulations in 49 CFR.

An inventory of waste containers will be maintained for later submittal to and inspection by Kirtland AFB.

Containers or roll-offs confirmed to contain PCS shall be labeled using the following format:

"PETROLEUM-CONTAMINATED SOIL"
ORIGIN: EXCAVATION MATERIAL-PETROLEUM HYDROCARBONS
CONTAMINATED SOILS—GASOLINE, DIESEL, HYDRAULIC FLUID
(WHICHEVER APPLIES)

Containers or roll-offs confirmed to contain ACM shall be labeled using the following format:

"DANGER CONTAINS ASBESTOS FIBERS
AVOID CREATING DUST
CANCER AND LUNG DISEASE HAZARD"

All hazardous waste stored in drums will also be stored on wooden pallets in a predesignated container storage area equipped with appropriate fire control and spill containment and control equipment. The container storage area and all containers of hazardous waste will be inspected and logged weekly on an inspection log while field work is in progress. Inspection will encompass evaluation for proper labeling, secure closure, the condition of each container, number of containers, and condition of the storage area. All containers will be checked to ensure labels and markings are in good condition. Any signs of deterioration, leaking, or dents will be noted, and containers will be immediately over-packed, if necessary. Inspection results will be provided to Kirtland AFB.

Containers of RCRA hazardous waste will be transferred to the TSDF after waste characterization, as indicated below:

- For the duration of any project, hazardous wastes (including soil, debris, decontamination liquids, and PPE) generated or removed through corrective action activities at any site will be sent to an offsite TSDF that has been approved by Kirtland AFB.

- Soil determined to be a hazardous or special waste will be transported offsite by an EPA-permitted hazardous waste transporter or special waste transporter to an approved hazardous waste or special waste treatment/disposal facility.

- Noncontaminated soil will be stockpiled and managed to prevent washout and wind dispersion and used as backfill and construction material as appropriate.

- Nonhazardous debris and soil will be sent offsite to an approved, permitted solid waste landfill.

- Decontamination water, if determined to be nonhazardous and meeting NMED groundwater discharge requirements, will be discharged to the ground following submittal of an Notice of Intent and subsequent NMED approval. Any discharges will be coordinated with Kirtland AFB Environmental personnel.

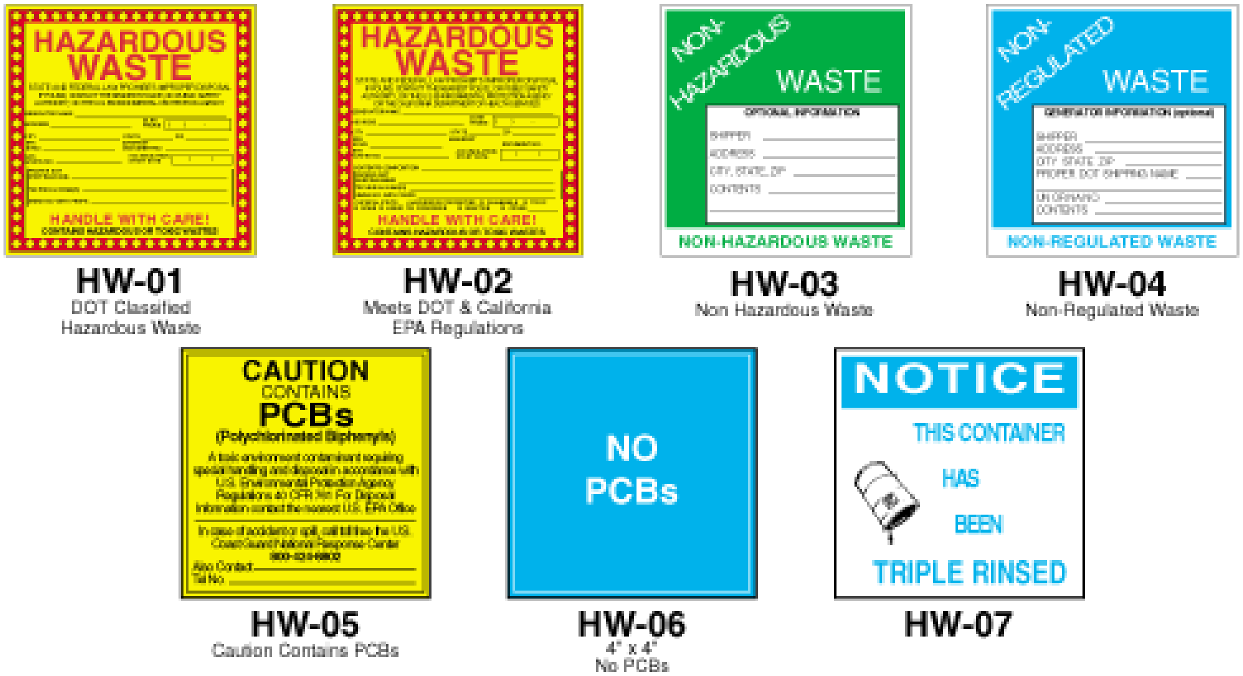
- Decontamination pad materials (i.e., liners and solids/liquids residues) will be characterized based on decontamination water characterization. If determined to be nonhazardous, the materials will be managed as nonhazardous solid waste. If determined to be a hazardous waste, the materials will be disposed of at an approved hazardous waste treatment/disposal facility.

- PPE will be thoroughly decontaminated. The decontaminated PPE will be double-bagged (plastic) and managed as nonhazardous solid waste.

- Used oil and empty oil filters generated from vehicle and equipment maintenance activities will be collected by the equipment maintenance subcontractor, who will be responsible for transporting the used oil and oil filters, under a “Bill of Lading,” to an approved offsite recycling facility.

Kirtland AFB will be responsible for the final selection of any transporter or TSDF used for waste management.

Figure 3-1. Typical Hazardous Waste Labels



HW-01 DOT Classified Hazardous Waste

HW-02 Meets DOT & California EPA Regulations

HW-03 Non Hazardous Waste

HW-04 Non-Regulated Waste

HW-05 Caution Contains PCBs

HW-06 4" x 4" No PCBs

HW-07

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4. SUMMARY OF EXPECTED IDW AND REMEDIAL ACTION WASTE STREAMS

This section summarizes the various types of IDW and remedial action waste streams that may be encountered during environmental restoration activities at Kirtland AFB.

4.1 Types of IDW

The anticipated IDW streams associated with investigation activities will result from soil, sediment, and water sampling, and the related decontamination and cleanup activities associated with environmental investigations. Specifically, the expected IDW streams can be categorized as follows:

- Soil cuttings and drilling mud
- Purge and well development water
- Water, solvents, or other fluids used to decontaminate field equipment and PPE
- Nonhazardous demolition debris, such as concrete rubble, bricks, rebar of various thickness, scrap metal, metal piping, electrical-related components (wire, metal conduit, electrical boxes, outlets, etc.), asphalt, sheet metal, polyvinyl chloride pipe and fittings
- Used oil (including engine/motor oil, hydraulic fluid, transmission fluid, greases, antifreeze/coolant, etc.) and oil filters from vehicle and equipment maintenance operations
- Used diesel fuel
- Used antifreeze
- Solid Waste (trash)
- PCS from equipment leaks
- Potential asbestos waste contained within the boilers, from demolition activities, and from landfill remediation
- Disposable PPE, equipment and debris

The various sources of the IDW are described in the following sections. All sampling activities will have disposable PPE and sampling equipment associated with them. Control measures for the IDW streams are described in Section 4.0. Table 3-1 summarizes applicable waste management, transportation and disposal requirements for each of the waste streams.

4.1.1 Soil Cuttings and Stockpiles

Soil IDW will consist of soil removed from borings and monitoring well installations and as the result of excavation activities. Soil cuttings will be placed drums or roll-off containers. If approved by the Kirtland AFB project manager, soil cuttings may be managed as like soil stockpiles on site in a designated area that is lined in plastic sheeting and covered when soil is not being staged. Designated soil piles will be bermed to prevent runoff. At the end of the work shift and at the end of the excavation activity, until waste disposition is determined, the soil stockpiles must be secured to prevent tampering and potential runoff.

Containers of soil cuttings will be identified with a particular boring, well, or pit. However, to minimize the number of drums generated during an investigation, it may be necessary to mix soils from several sources, provided those sources are from the same general location. Documentation will be maintained to identify the source of the soils (including depths) containerized in a particular drum. The documentation will specify which samples sent for laboratory analysis correspond to the drum contents. The description of the waste/soil, boring location, and general observations will also be noted in the field log book. The logbook control number and page where the drum waste is described will be noted in a dedicated drum log sheet.

4.1.2 Drilling Mud

Drilling muds are defined as those materials/additives required during the reaming of boreholes to maintain the integrity of the borehole wall and/or to expedite the drilling of the borehole. Though generally fluid in nature, these muds will be referred to as solids in this document. Drilling mud will be isolated from soil cuttings. In limited instances, it may be acceptable to combine drilling mud with soil cuttings to reduce the number of drums. In either case, careful documentation will be made in the field log book and the drum log sheet indicating which wells the drilling mud came from. If samples of the mud are collected and sent for analysis, documentation will indicate which samples correspond to the contents of the drum and adequate information will be included in the drum log sheet.

4.1.3 Purge and Development Water

Monitoring wells will be purged during development and prior to sampling as described in the project-specific addenda, the FSP (Appendix A of the BWP), and the standard operating procedures (Appendix B of the BWP).

Well purge and development water will be containerized separately from soil cuttings, drilling mud, PPE, and other solid waste. Documentation will be maintained to correlate representative environmental or drum samples sent for analyses with waste contained in a particular drum. It will be acceptable to mix water from different wells, provided that proper documentation is maintained and that non-hazardous materials are not mixed with hazardous materials.

4.1.4 Decontamination Fluids

Equipment will be decontaminated as described in the project-specific addenda, the FSP (Appendix A of the BWP), and the standard operating procedures (Appendix B of the BWP). Decontamination water, which includes decontamination fluids or solvents such as acetone or nitric acid, will not be containerized with well purge/development water because of their different waste classifications. The former liquid waste will be collected and disposed of, as necessary, in a drum dedicated for this type of waste. Excess sample preservatives must be stored separately from decontamination fluids and disposed of properly. Notations on preservative type will be made in the log book and on the drum.

Table 4-1. Waste Management Summary Requirements

Waste Types	Characterization Requirements	Applicable Regulations	Allowable Containment	Storage Requirements	Transportation Requirements	Disposal Requirements
Petroleum-Contaminated Soil (PCS)	Need to determine whether excavated soil is a hazardous or special waste. Representative sample to be taken from stockpiled or containerized soil. Use material safety data sheets to characterize contaminants based on knowledge of petroleum, oil, and lubricants used in site equipment. If analysis is necessary, perform Toxicity Characteristic Leaching Procedure (TCLP) analysis and/or Total Recoverable Petroleum Hydrocarbons (TRPH) analysis using the U.S. Environmental Protection Agency (EPA) Methods 9071A/418.1	20 New Mexico Administrative Code (NMAC) 4.1 "Identification & Listing of Hazardous Waste" and "Standards Applicable to Generators of Hazardous Waste" 40 Code of Federal Regulations (CFR) 268.48—Land Disposal Restriction (LDR) and Universal Treatment Standards (UTS) 40 CFR Part 262—Generator Standards 20 NMAC 9.1 Special Waste Requirements	Special Waste: PCS will be temporarily stockpiled (or containerized) within a bermed, lined containment structure. A cover shall be used to prevent runon of precipitation. Hazardous Waste: Department of Transportation (DOT)-approved 55-gallon metal drums (1A2) or roll-offs that must be kept sealed when not being loaded or unloaded.	Special Waste: Maximum onsite storage for PCS special waste is 45 days. Use sign or label as indicated. Store at temporary storage area designated by Kirtland Air Force Base (AFB) personnel. Hazardous Waste: 90-day storage limit if determined to be a hazardous waste and must be labeled with a completed hazardous waste label. Waste to be stored at a predesignated 90-day storage area prior to moving to Defense Reutilization and Marketing Office. NOTE: Storage clock starts from the date that waste is generated.	Special Waste: PCS shipped offsite must be accompanied by NMED special waste manifest. Containers must be labeled indicating contents and the potential health, safety, and environmental hazards associated with the waste. Hazardous Waste: Hazardous waste manifest and DOT placarding. Must use an EPA-permitted Must also have LDR certifications as necessary.	Special Waste: PCS special waste can be disposed only in an approved offsite solid waste facility authorized for special wastes. PCS special waste containing free liquid cannot be sent to a landfill and must pass the paint filter test before it can be landfilled. Hazardous Waste: Must be disposed at an approved offsite RCRA Treatment, Storage, and Disposal Facility (TSDF), which is also approved under the EPA Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Offsite Rule. Nonhazardous, non-PCS soil will be used for backfill or construction material.

Table 4-1. Waste Management Summary Requirements (Continued)

Waste Types	Characterization Requirements	Applicable Regulations	Allowable Containment	Storage Requirements	Transportation Requirements	Disposal Requirements
Used Oil (Motor Oil, Hydraulic Fluid, and Greases) and Oil Filters. The best management practice for each of these areas are described in the following sections.	Spent oil filters and oil will be handled as a non-RCRA hazardous waste. "Drained" oil filters to be managed as a nonhazardous solid waste. Recycling of used oil and oil filters is recommended.	40 CFR Part 279—Standards for Generators of Used Oil	DOT-approved 55-gallon (bunghole-type) metal drums (1A1) or DOT-approved portable tanks (DOT 51, 52, 53, 56, 57 and 60) that must be sealed when not being loaded/filled or unloaded.	Nonhazardous Waste: Containers must be labeled "Used Oil" and containers must be stored within secondary containment structures within the staging area.	Used oil and empty oil filters generated from vehicle and equipment maintenance activities will be collected by the equipment maintenance subcontractor, who in turn will be responsible for transporting the used oil and oil filters under a "Bill of Lading" to an appropriate offsite recycling facility.	An approved recycling facility will be utilized for used oil and empty oil filters generated from vehicle and equipment maintenance activities. "Drained" oil filters can also be disposed of as a solid waste.
Solid Waste (SW) (Trash)	Trash will be managed as a SW. Unused materials will either be returned to manufacturer or will be used on other projects.	20 NMAC 9.1 "Solid Waste Management Regulations"	Place in specified dumpsters or containers	No specific requirements. Store at area designated by Kirtland AFB personnel.	Not Applicable	Trash to be disposed at the base's solid waste landfill or other approved facility. Unused materials to be either returned to supplier or used for other projects.

Table 4-1. Waste Management Summary Requirements (Continued)

Waste Types	Characterization Requirements	Applicable Regulations	Allowable Containment	Storage Requirements	Transportation Requirements	Disposal Requirements
Used Diesel Fuel	Used diesel fuel will be managed as a non-RCRA hazardous waste. If contaminated with other materials, appropriate sampling and TCLP analysis is required to characterize the material as hazardous or non-hazardous waste. Recycling of used diesel fuel is recommended.	20 NMAC 9.1 “Solid Waste Management Regulations” 20 NMAC 4.1 “Identification & Listing of Hazardous Waste” and “Standards Applicable to Generators of Hazardous Waste” 40 CFR 268.48— LDR and UTS 40 CFR Part 262—Generator Standards.	DOT-approved 55-gallon (bunghole-type) metal drums (1A1) or DOT-approved portable tanks (DOT 51, 52, 53, 56, 57 and 60) that must be sealed when not being loaded/filled or unloaded.	Nonhazardous Waste: Containers must be labeled “Used Diesel Fuel” and containers must be stored within secondary containment structures within the staging area. Hazardous Waste: 90-day storage limit if determined to be a hazardous waste and must be labeled with a completed hazardous waste label. Waste to be stored at a predesignated 90-day storage area prior to moving to Defense Reutilization and Marketing Office. NOTE: Storage clock starts from the date that waste is generated.	Used diesel fuel generated from vehicle and equipment maintenance activities will be collected by the equipment maintenance subcontractor, who in turn will be responsible for transporting the used diesel fuel under a “Bill of Lading” to an appropriate offsite recycling facility. Hazardous Waste: Hazardous waste manifest and DOT placarding. Must use an EPA-permitted approved transporter. Must also have LDR certifications as necessary.	An approved recycling facility will be utilized for used diesel fuel generated from vehicle and equipment maintenance activities. Hazardous Waste: Must be disposed at an approved offsite RCRA TSDF.

Table 4-1. Waste Management Summary Requirements (Continued)

Waste Types	Characterization Requirements	Applicable Regulations	Allowable Containment	Storage Requirements	Transportation Requirements	Disposal Requirements
Used Antifreeze	Used antifreeze will be handled as a non-RCRA hazardous waste. If contaminated with other materials, appropriate sampling and TCLP analysis is required to characterize the material as hazardous or non-hazardous waste. Recycling of used antifreeze is recommended.	20 NMAC 9.1 "Solid Waste Management Regulations" 20 NMAC 4.1 "Identification & Listing of Hazardous Waste" and "Standards Applicable to Generators of Hazardous Waste" 40 CFR 268.48— LDR and UTS 40 CFR Part 262—Generator Standards.	DOT-approved 55-gallon (bunghole-type) metal drums (1A1) or DOT-approved portable tanks (DOT 51, 52, 53, 56, 57 and 60) that must be sealed when not being loaded/filled or unloaded.	Nonhazardous Waste: Containers must be labeled "Used Antifreeze" and containers must be stored within secondary containment structures within the staging area. Hazardous Waste: 90-day storage limit if determined to be a hazardous waste and must be labeled with a completed hazardous waste label. Waste to be stored at a predesignated 90-day storage area prior to moving to Defense Reutilization and Marketing Office. NOTE: Storage clock starts from the date that waste is generated.	Used antifreeze generated from vehicle and equipment maintenance activities will be collected by the equipment maintenance subcontractor, who in turn will be responsible for transporting the material under a "Bill of Lading" to an appropriate offsite recycling facility. Hazardous Waste: Hazardous waste manifest and DOT placarding. Must use an EPA-permitted approved transporter. Must also have LDR certifications as necessary.	An approved recycling facility will be utilized for used antifreeze generated from vehicle and equipment maintenance activities. Hazardous Waste: Must be disposed at an approved offsite RCRA TSDF

Table 4-1. Waste Management Summary Requirements (Concluded)

Waste Types	Characterization Requirements	Applicable Regulations	Allowable Containment	Storage Requirements	Transportation Requirements	Disposal Requirements
Asbestos Waste / Asbesots-Containing Material (ACM)	Need to determine whether material is a hazardous or special waste. Representative sample to be taken and analyzed per the project specific addenda.	20 NMAC 9.1 "Solid Waste Management Regulations" 40 CFR Part 61, Subpart M, *Regulations for Asbestos Containing Material*	Special Waste: Containers for the temporary storage and disposal of ACM will meet the requirements specified in 49 CFR Part 173.216 and 20 NMAC 9.1 Section 705	Special Waste: Maximum onsite storage for PCS special waste is 45 days. Use sign or label as indicated. Store at temporary storage area designated by Kirtland AFB personnel.	Special Waste: PCS shipped offsite must be accompanied by a NMED special waste manifest. Containers must be labeled indicating contents and the potential health, safety, and environmental hazards associated with the waste. Transportation documentation will comply with DOT regulations 49 CFR 100–178 and 40 CFR Part 61, Subpart M, and 20 NMAC 9.1 Section 705	Special Waste: PCS special waste can be disposed only in an approved offsite solid waste facility authorized for special wastes.
Disposable Personal Protective Equipment (PPE)	Decontaminated PPE will be handled as a SW and no analysis is required. If not decontaminated, then need to determine whether the PPE is a hazardous waste or not using generator knowledge or by running a total analysis[1] or a TCLP.	20 NMAC 9.1 "Solid Waste Management Regulations" 20 NMAC 4.1 "Identification & Listing of Hazardous Waste" and "Standards Applicable to Generators of Hazardous Waste" 40 CFR 268.48— LDR and UTS 40 CFR Part 262—Generator Standards.	Hazardous Waste: DOT-approved 55-gallon Metal drums (1A2) that must be kept closed when not being loaded or unloaded. Nonhazardous Waste: Double-bagged in plastic bags.	Hazardous Waste: 90-day storage limit if determined to be a hazardous waste. Must be labeled with a completed hazardous waste label. Waste to be stored at a predesignated 90-day storage area. NOTE: Storage clock starts from the date that waste is first generated.	Hazardous Waste: Hazardous waste manifest and DOT placarding. Must use an EPA permitted approved transporter. Must also have LDR certifications as necessary.	Hazardous Waste: Must be disposed at an approved offsite RCRA TSDF. Nonhazardous solid waste to be disposed at the base's solid waste landfill or other approved facility.

[1] If a total analysis is chosen and the results indicate that a constituent is more than 20 times the appropriate Toxicity Characteristic level, then a TCLP will have to be run.

ACM	asbestos-containing material
AFB	Air Force Base
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
DOT	Department of Transportation
EPA	U. S. Environmental Protection Agency
LDR	Land Disposal Restrictions
NMAC	New Mexico Administrative Code
PCS	petroleum-contaminated soil
PPE	personal protective equipment
TCLP	Toxicity Characteristic Leaching Procedure
TRPH	total recoverable petroleum hydrocarbons
SW	Solid Waste
UTS	Universal Treatment Standards

Steam-cleaning rinsate will be containerized separately from other liquids such as well purge/development water unless the rinsate is non-hazardous. Likewise, water generated from decontamination of radioactive materials will also be segregated from other decontamination water. Decontamination water may be containerized in bulk form, accumulating a larger volume, which will be sampled, analyzed, and characterized based on known contaminants as well as analytical results. However, no purposeful dilution of hazardous wastewater with non-hazardous wastewater will be performed.

4.1.5 Personal Protective Equipment

Disposable PPE includes the following:

- Tyvek full-body coveralls
- Chemical-resistant surgical-type gloves
- Cotton work gloves
- Chemical-resistant boot covers
- Respirator filters (respirators may be needed based upon air monitoring action levels)

Protective clothing and used disposable sampling equipment will be containerized together and separated from other solid and liquid wastes. Protective clothing and sampling equipment is typically collected on a daily basis in plastic garbage bags and disposed of in a drum or storage container dedicated for this type of waste. Personal protective equipment worn by observers or other site personnel who do not come in any contact with contaminated media can be disposed of as domestic waste. If proper decontamination steps are followed, protective equipment, clothing, and/or miscellaneous sampling equipment solid wastes may be considered non-hazardous. If disposable PPE and equipment are used, they must be managed as a listed hazardous waste if they are used to handle listed hazardous waste. If disposable PPE and equipment are used to manage characteristic hazardous waste, based on a generator determination, they should be managed as a solid waste unless extremely contaminated.

4.1.6 Other IDW Streams

Drilling materials such as filterpack sand or bentonite grout/seals that have not been in contact with site soils or water will be handled as non-hazardous, non-radioactive waste. If these materials are containerized for the purpose of tidiness, they will be clearly marked as non-hazardous/non-radioactive, and stored in an area separate from the other drums.

4.2 Types of Remedial Action Wastes

4.2.1 RCRA Waste Piles

Soil generated from a remedial action that is a listed or characteristic hazardous waste must be stored in containers, containment buildings, or be managed under the requirements for RCRA Temporary Units, Corrective Action Management Units, or Staging Piles in 40 CFR Part 264.552, Part 264.553, or part 264.554, respectively. If the response action is being conducted under CERCLA authority, only the substantive requirements of these regulations are applicable or relevant and appropriate. RCRA hazardous waste may also be managed in a designated Area of Contamination (AOC) on a CERCLA site, which allows waste to be moved around the site without triggering RCRA LDRs or RCRA landfill minimum technology requirements.

4.2.2 Special Waste Petroleum Soil Stockpiles

Unless generated as part of a CERCLA response action, storage of PCS must be approved by the NMED SWB prior to generation of soil (20 NMAC 9.1). Soil piles must comply with the requirements for special waste in Section 2.3 of this plan and:

- Non-hazardous PCS may be stored onsite temporarily provided it is stored in a bermed area with an impermeable liner and protection from disbursement by wind.

- Non-hazardous PCS soil will not be stored for longer that 45 days, unless otherwise approved by the NMED SWB.

- Soil cannot contain free liquids and must pass the paint filter test.

4.2.3 PCBs

PCBs in concentrations greater than 50 parts per million (ppm) are regulated under TSCA. Management of all PCB waste material over 50 ppm is regulated by the TSCA Branch of EPA Region 6. PCB wastes over 50 ppm (excluding PCB bulk remediation waste) can only be stored onsite for 30 days unless they are stored in a facility that meets the requirements for storage facilities outlined in 40 CFR 761.65. PCB waste with concentrations less than 50 ppm must be stored in a facility approved by NMED. If a RCRA hazardous waste also contains PCB wastes over 50 ppm, the more stringent of the RCRA and TSCA regulations apply. Pursuant to 40 CFR, Part 761.61 and Part 761.65, PCB bulk remediation waste may be stored for up to 180-days.

4.2.4 3.2.4 Asbestos

Asbestos containing materials (ACM) is a NMED Special Waste and management and disposal of wastes containing asbestos shall be in accordance with 20 NMAC 9.1, Section 705.

4.2.5 Hazardous Debris

All debris must be evaluated on a project-specific basis to determine testing requirements. The evaluation will also determine if it is a hazardous debris or is contaminated with a listed hazardous waste, PCBs, or asbestos. Decontaminated or non-contaminated metal debris will be managed as scrap metal for recycling. Management of all debris will be addressed in project-specific addenda.

4.3 Radioactive Wastes and Mixed Wastes

Both IDW and remediation wastes may be categorized as radioactive waste if environmental restoration activities occur in an area known to contain radioactive materials. Radioactive waste will be segregated from other types of waste and placed in separate containers. Radioactive mixed waste will be further segregated from non-hazardous radioactive waste. Containers of radioactive and mixed waste will be maintained in controlled areas at all times and will be labeled on at least two sides (e.g., top and side) using magenta-on-yellow or black-on-yellow labels containing the words, “Caution-Radioactive Material” and the trifoil radiation symbol. Radioactive mixed waste will also be marked to identify the chemical hazard of the waste. When full, containers will be transferred to the control of Kirtland AFB authorized personnel for storage in a location authorized under the base’s radioactive materials license, pending transfer to an authorized disposal facility. Unless specifically stated otherwise, management of radioactive waste will follow the requirements identified in Section 4.0 of this plan.

5. HAZARDOUS WASTE GENERATOR REQUIREMENTS

5.1 Annual Hazardous Waste Fee Regulations

Hazardous waste generators, importers, and TSDFs are required to submit annual fees to the NMED HWB. Regulations governing the fee program are contained in 20 NMAC 4.2 and 4.3. Kirtland AFB will be responsible for complying with annual waste fee regulations; project-specific plans will include forecasts of waste volumes, which will be factored into the ultimate calculation of fee for the base.

5.2 Soil

Soil, including drill cuttings and soil stockpiles that have been tested and are not hazardous waste or New Mexico Special Waste, may be put into the borehole, excavation left onsite, or disposed at the Kirtland AFB active landfill upon approval by base Environmental Management Personnel. The intended placement of drill cuttings onsite will be clearly addressed in project-specific addenda. Disposition of drill cuttings must be approved in writing by Kirtland AFB prior to conducting this activity.

5.2.1 Containerization

The cuttings from all investigations except background investigations (where an approval to leave the cuttings onsite has been obtained from the state in advance) will be containerized as specified in Section 4.1.1 of this plan. Drums or bulk containers will be used, depending on the classification and volume of material to be generated. Waste material must be classified according to EPA and DOT criteria prior to affixing labels. Upon classification, the Kirtland AFB Chief Regulatory Specialist will direct the application of appropriate hazardous/non-hazardous waste and DOT labels complete with proper information specific to each waste stream. Each container will be marked and labeled as required by EPA and DOT, if applicable. All DOT functions will be conducted by trained personnel as required by 49 CFR Subpart H.

Containers of hazardous waste will be inspected and logged weekly while the field work is in progress. Inspection will encompass proper labeling, secure closure, condition of each container, number of containers, and condition of the storage area. Any signs of deterioration, leaking, or dents will be noted, and containers will be immediately overpacked, if necessary. Standing water will be removed from the containment area as necessary. Inspection results will be provided to Kirtland AFB. The containers will be signed over to Kirtland after waste characterization, as defined in Section 2.0 of this plan.

5.2.2 Sampling

The IDW drill cutting samples will be collected in accordance with the project-specific addenda, the FSP (Appendix A of the BWP), standard operating procedures included as Appendix B of the BWP and federal and state sampling requirements. Testing specified in Section 2.1 of this plan to determine if cuttings are listed or characteristic hazardous waste or special waste will be performed as necessary. When appropriate, TCLP or total testing will include inorganic and organic parameter identification and quantification under procedures set forth in 40 CFR 260.20 and 260.21. In addition, soil samples may also need to be tested for PCBs, be subjected to a paint filter test, or other tests required by TSDFs for offsite disposal.

For waste streams determined to be hazardous wastes, a one-quart representative sample of the material must be submitted to the disposal facility with the Waste Profile Sheet for analysis as a part of the facility's waste acceptance process.

Environmental water and soil samples which are not suspected of meeting a DOT hazard class are not subject to hazardous materials shipping regulations. Samples known or suspected of meeting a DOT hazard class will be shipped in compliance with all applicable DOT regulations. Any personnel shipping a hazardous material sample must be trained in accordance with HM126-F and HM181.

Radioactive samples having an average radionuclide concentration of at least 2,000 picocuries per gram (pCi/g) will be shipped in accordance with DOT regulations in 49 CFR.

5.2.3 Storage

The containers will be staged and stored in Kirtland AFB's approved storage facility. Containers holding radioactive waste will be maintained in an authorized, controlled area.

5.2.4 Disposal

After tests results are received, if any of the IDW are determined to be hazardous or contain contaminants, the IDW will be treated and disposed of offsite as necessary.

5.2.4.1 Non-Contaminated Waste

Disposal of soil in New Mexico that is determined to be below regulatory standards after testing is regulated on a project-specific basis, and may possibly be allowed to remain onsite. A Disposal Management Plan with supporting analytical documentation must be completed and submitted to NMED for approval.

If the state authorizes onsite disposal of the non-contaminated cuttings, the cuttings will be spread around the borehole from which the cuttings were generated in such a manner as to minimize wind or surface water erosion. This will be accomplished by spreading the soil out over a minimum area at least ten feet from the hole in a downgradient area.

IDW which is found to contain chemicals and/or metals at levels below the RCRA characteristic waste levels may be regulated as special waste in New Mexico. Special waste and non-regulated soil which cannot remain onsite will be disposed of offsite in a licensed landfill and in compliance with the EPA Offsite Rule requirements for Subtitle D facilities.

Prior to shipment, a brief review will be conducted by the Kirtland AFB Chief Regulatory Specialist to determine disposal facility compliance with the Offsite Rule.

5.2.4.2 RCRA Hazardous Waste

If the test results indicate the cuttings are listed or characteristic hazardous wastes, the wastes will be disposed of at a fully permitted RCRA Subtitle C facility that is in compliance with the EPA Offsite Rule requirements for Subtitle C facilities. The facility must meet LDR requirements and must provide treatment of wastes prior to disposal as required under the LDR, as necessary to meet the LDR standards. Prior to shipment, a brief review will be conducted by the Kirtland AFB Chief Regulatory Specialist to determine disposal facility compliance with the Offsite Rule.

5.2.4.3 Radioactive Waste

If test results indicate the IDW is a radioactive waste, disposal may occur at either of two facilities: Envirocare of Utah or US Ecology near Richland, Washington, depending on the concentration of the radionuclides. Approval for export is required from the Rocky Mountain Compact, and approval for import is required from the Northwest Compact if the radioactive material is a source, special nuclear, or byproduct material. If the US Ecology facility is used, a Site Use Permit must be obtained from the Department of Ecology, State of Washington. For either disposal site, specific authorization and application to the site operator is required to verify that transfer of the waste material meets the specific terms of the license of the receiving facility. Prior to shipment of the waste, Kirtland AFB will have a copy of the license of the receiving facility. Manifesting of the waste will conform to the requirements of 10 CFR.

5.2.4.4 Radioactive Mixed Waste

Disposal of radioactive-mixed waste should be conducted in concurrence with the Kirtland AFB Radioactive Waste Disposal Plan (USAF, 1996). If the waste is a radioactive mixed waste, disposal may occur at Envirocare of Utah, depending on the concentration of contaminants, permitting status, and licensing status of Envirocare for the wastes.

Prior to disposal of the waste, it must be demonstrated that the waste meets RCRA LDRs. Envirocare has limited treatment capability and may be able to treat the waste in addition to providing disposal services. Approval for export is required from the Rocky Mountain Compact, and approval for import is required from the Northwest Compact if the radioactive material is a source, special nuclear, or byproduct material. Specific authorization from and application to the site operator is required to verify that transfer of the waste material meets the specific terms of the license of the receiving facility.

Prior to shipment of the waste, Kirtland AFB will have a copy of the license of the receiving facility. Manifesting of the waste will conform to the requirements of 10 CFR 20 in addition to those for hazardous waste (i.e., two manifests, each referencing the additional hazard of the other). Kirtland AFB will review and sign documentation, and receive a copy. Prior to shipment, a brief review will be conducted by the Kirtland AFB Chief Regulatory Specialist to determine disposal facility compliance with the Offsite Rule.

5.3 Well Development, Purge, and Decontamination Water

Well development, purge, and decontamination water which may be contaminated or characteristically hazardous (e.g., corrosive) will be collected at the site and stored in containers as described in project-specific addenda until test results are received. Water will be discharged to the Kirtland AFB wastewater treatment system, allowed to evaporate, or disposed of offsite, depending upon the contaminants of concern, their relative concentrations, and seasonal considerations.

5.3.1 Containerization

The well development, purge, and decontamination water will be containerized within drums or bulk containers specified by the Kirtland AFB Chief Regulatory Specialist. Upon classification of material, a proper shipping name will be determined. In the event the chosen packaging is not the specification packaging for the material, over-packing will be necessary. Each container will be properly marked and labeled as required by EPA and DOT, and as identified in project-specific addenda.

Containers will be inspected and logged weekly. Weekly inspections will encompass proper labeling, secure closure, condition of each container, and number of containers. Any signs of deterioration, leaking, or dents will be noted, and containers will be immediately overpacked, if necessary. Standing water will be removed from the containment area as necessary. Inspection results will be provided to Kirtland AFB.

5.3.2 Sampling

The well development, purge, and decontamination water samples will be collected in accordance with the project-specific addenda, the FSP (Appendix A of the BWP), standard operating procedures included as Appendix B of the BWP. Analyses specified in Section 2.1 of this plan will be performed to determine if the water is listed or characteristically hazardous waste. If required, TCLP testing will include inorganic and organic parameter identification and quantification under procedures set forth in 40 CFR 260.20 and 260.21. In addition, waste anticipated to be discharged to the Kirtland AFB wastewater treatment system or transported offsite will also be tested as directed by the receiving facility. Samples will be taken on an as-needed basis when process knowledge or existing analytical data is not sufficient to characterize the water.

For waste streams determined to be hazardous wastes, a one-quart representative sample of the material may be required to be submitted to the TSDF with the Waste Profile Sheet for analysis as a part of the facility's waste acceptance process. A sample may also be required to accompany the Waste Profile Sheet for special waste.

If water is found to be radioactive waste or radioactive mixed waste, there is no offsite disposal option. Radioactive and radioactive mixed waste will be containerized and transferred to Kirtland AFB personnel for further treatment, storage, and disposal.

Environmental water and soil samples which are not suspected of meeting a DOT hazard class are not subject to hazardous materials shipping regulations. Samples known or suspected of meeting a DOT hazard class must be shipped in compliance with all applicable DOT regulations.

5.3.3 Storage

The containers will be staged and stored at locations approved by NMED and specified within the project-specific WMP. All drums will be stored on wooden pallets. Storage of containers holding radioactive liquid waste will be in a controlled area, as authorized in Kirtland AFB’s radioactive materials license.

5.3.4 Disposal

Currently the NMED Groundwater Protection and Remediation Bureau, Remediation Section, has not issued guidance specific to the discharge to the ground of smaller quantities of well development purge water from investigations. It may be possible to discharge small quantities of well development and purge water to the ground; however, each case must be reviewed in advance by NMED prior to granting approval. Approval must be obtained in writing from Kirtland AFB and NMED prior to discharging well development and purge water to the ground. An NPDES permit must be obtained from EPA Region 6 prior to discharging water to surface water.

5.3.4.1 Special Waste

All special waste will be containerized and discharged to the Kirtland AFB wastewater treatment system, if it meets acceptable criteria, or disposed of offsite. The facility waste profile sheet and supporting documentation will be completed, reviewed and signed by Kirtland AFB prior to submittal for waste stream acceptance at the TSDF. Prior to shipment, a brief review will be conducted by the Kirtland AFB Chief Regulatory Specialist to determine disposal facility compliance with the Offsite Rule.

5.3.4.2 RCRA Hazardous Waste

If test results indicate that water is a listed or characteristic hazardous waste, the waste will be disposed of at a fully permitted RCRA Subtitle C facility that is in compliance with the EPA Offsite Rule requirements for Subtitle C facilities. The approved TSDF's Waste Profile Sheet, LDR form, and supporting analytical documentation will be completed, reviewed, and signed by Kirtland AFB prior to submittal for waste stream acceptance at the TSDF. Prior to shipment, a limited review with EPA Region 6 and NMED will be conducted by the Kirtland AFB Chief Regulatory Specialist to determine disposal facility compliance with the Offsite Rule. Kirtland AFB will participate in all meetings with NMED and/or EPA officials, if necessary, regarding waste classification determinations.

5.3.4.3 Disposal of Radioactive Waste

Radioactive waste will be containerized and transferred to Kirtland AFB for further treatment, storage, or release. Disposal of radioactive-mixed waste should be conducted in accordance with the Base's Radioactive Waste Disposal Plan (USAF, 1996).

5.3.4.4 Disposal of Radioactive Mixed Waste

Radioactive mixed waste will be containerized and transferred to Kirtland AFB for further treatment, storage, or release.

5.4 Personal Protective and Disposable Equipment

5.4.1 Containerization

PPE will be double-bagged and containerized in DOT-approved, 55-gallon drums or bulk storage containers as described in project-specific addenda. The containers will be labeled as identified in Section 4.1.5 of this plan.

5.4.2 Characterization and Sampling

PPE will be characterized based on process knowledge provided by Kirtland AFB and analytical results. If sufficient information does not exist to characterize waste, the PPE will be sampled. The proposed classifications will be reviewed and approved by Kirtland AFB.

PPE will be monitored for radiation after use in areas known or suspected of containing radioactive materials. PPE will be surveyed using appropriate instrumentation in the contamination reduction zone. If radiation levels are near background, PPE will be considered non-radioactive waste. If surveys determine that PPE radiation levels are above background levels (e.g., twice background or higher), it will be managed as solid radioactive or solid radioactive mixed waste, depending on the chemical contaminants present.

5.4.3 Storage

PPE that is potentially contaminated will be containerized and stored until analytical results are complete.

5.4.4 Disposal

PPE will be disposed of at an approved landfill that is in compliance with the EPA Offsite Rule requirements for Subtitle D facilities.

5.5 Documentation

The information contained in this section applies to all IDW managed during environmental data collection activities. Field records will be kept of all disposal activities. The logs and records will include the following information as required for the type of waste generated:

- Description of generating activities
- Location of generation (including depth, if applicable)
- Type of waste
- Date and time of generation
- Date and time of disposal of each type
- Disposal location of each type
- Disposal method
- Description of any waste sampling, including:

  — Type of test

  — Laboratory where sample is to be sent

  — Sampling method

  — Name of sampler
- Name of person recording information
- Name of field manager at time of generation and at time of disposal
- Test results
- Inspection logs
- Waste documentation, including:

— Waste profile sheets

— LDR certification

— Hazardous Waste Manifest

— Radioactive Waste Manifest (Radioactive Shipping Report), as appropriate

— Trip tickets or bills of lading

- Copies of any state or local permits or approvals

5.5.1 Transportation

Transportation of DOT hazardous materials will be conducted in compliance with DOT regulations (49 CFR 100-177) and by personnel trained according to the requirements of HM181 and HM-126F. Containers will be marked, labeled, and/or placarded prior to offsite transport. TSDF waste profile sheets, LDR notifications, waste manifests, and shipping documents will be prepared for Kirtland AFB to review and sign.

All waste transporters used for Kirtland AFB projects will be registered with NMED.

5.5.1.1 Hazardous Waste Manifests and LDR Certification

Hazardous waste generated at the site will be stored onsite a maximum of 90 days prior to transportation for treatment or disposal. The 90-day accumulation period will begin when contaminated material is first put into a container.

All hazardous waste transported from the site will be accompanied by a Hazardous Waste Manifest. New Mexico does not have a state manifest, so the receiving state manifest must be used, unless that state does not have a state manifest, and then a Uniform Hazardous Waste Manifest may be used.

Kirtland AFB personnel will be responsible for reviewing and signing all waste documentation, including waste profiles, manifests, and LDR notifications (manifest packages). The person who signs the manifest for Kirtland AFB will be trained in both RCRA and DOT regulations and the Occupational Safety and Health Administration (OSHA) regulation 1910.120. Prior to signing the manifest, the designated Kirtland AFB official will ensure that pre-transport requirements of packaging, labeling, marking, and placarding are met according to 40 CFR 262.30-262.33 and 49 CFR 100-177.

For special waste, a manifest containing the following information will accompany each load of special waste originating or to be disposed of in New Mexico, as specified in Section 702.C:

- Name, address and phone number of the generator
- Name, address and phone number of any and all transporters in the order each will be transporting the waste
- Name, site address, phone number and identification number of the solid waste facility to which the waste is to be delivered
- Type and proper name of waste being shipped

- Total weight or volume of waste prior to shipment from generator
- Total weight or volume of waste received at solid waste facility
- Type and number of containers in shipment
- Any special handling instructions
- Date and location the waste was delivered
- Date of receipt from the generator and total weight or volume of the special waste will be provided by the transporter
- If more than one transporter is used, each transporter will provide the date of receipt and total weight or volume of said waste received from the previous transporter

The manifest will be signed by the generator and each transporter of the special waste, and by the solid waste facility operator. All signatories will be duly authorized agents of their organizations. Significant discrepancies will be reported to the NMED SWB within 24 hours of discovery.

A Kirtland AFB representative will sign the completed manifest certification by hand and obtain the handwritten signature of the initial transporter and date of acceptance on the manifest.

Kirtland AFB will receive one copy of the manifest; the remaining copies will be given to the transporter. The manifest will be returned to the Kirtland AFB signatory official for record-keeping. Copies of all manifests for waste generated at the site will also be kept in a central file as specified in the Data Management Plan, Appendix D of the Base-Wide Plan. The state copy of the manifest will be sent to the state by Kirtland AFB.

A LDR form will accompany the shipment of hazardous waste to the TSDF. The TSDF must be notified prior to sending the IDW. The following items must accompany the notification, and are included in a facility specific form:

- EPA and New Mexico Hazardous Waste Generator ID number (provided by Kirtland AFB)
- Manifest number, including state disposal application number
- Waste analysis data
- If the waste is also restricted, corresponding concentration-based or technology-based treatment standards or prohibition

5.5.1.2 Special Waste

If it is transported offsite, the waste must have a New Mexico Special Waste manifest. Kirtland AFB will sign completed shipping papers, as required.

5.5.2 RCRA Record-keeping and Reporting Requirements

The designated Kirtland AFB manifest signatory official will be responsible for ensuring that all RCRA record-keeping requirements are met according to 40 CFR 262.20-262.44, including retention of signed copies of manifests from the designated facility which received the waste. The copy must be maintained for a period of at least three years from the date the waste was accepted by the initial transporter. Additionally, biennial and exception reporting must be submitted, as necessary, according to 40 CFR 262.41 and 262.42, respectively. Additional reporting may be required according to 40 CFR 262.43.

5.5.3 Radioactive Waste Record-keeping and Reporting Requirements

The designated responsible official for Kirtland AFB will be responsible for maintaining official copies of paperwork required under the Kirtland AFB radioactive materials license, including records of occupational exposure of contractor personnel, copies of all surveys performed to confirm compliance with the radioactive materials license, copies of all radioactive materials shipments, and records describing inventories of all radioactive materials generated by investigational and remediation activities.

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REFERENCES

USAF 1996. *Radioactive Waste Disposal Plan*. February 1996.

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APPENDIX F

Base-wide Health and Safety Plan

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TABLES

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ACRONYMS

ACGIH	American Conference of Governmental Industrial Hygienists
AFB	Air Force Base
AHA	Activity Hazard Analysis
APR	air purifying respirator
BWHSP	Base-Wide Health and Safety Plan
CFR	Code of Federal Regulations
CPR	cardiopulmonary resuscitation
CRC	contamination reduction corridor
dBA	decibels, A-scale
EHS	Environmental Health and Safety
EM	Engineers Manual
°F	degrees Fahrenheit
FOPS	Falling Object Protective System
ft	foot/feet
GFCI	Ground Fault Circuit Interrupters
kV	kilovolt
m	meters
mm	millimeters
MSDS	Material Safety Data Sheet
NEC	National Electrical Code
NIOSH	National Institute for Occupational Safety and Health
NMOC	New Mexico One Call, Inc
OSHA	Occupational Safety and Health Administration
PM	Project Manager
PPE	personal protective equipment
RCRA	Resource Conservation and Recovery Act
RPM	Remedial Project Manager
SCBA	self-contained breathing apparatus
SHSP	Site-Specific Health and Safety Plan
SHSS	Site Health and Safety Specialist
TWA	time-weighted average

ACRONYMS (Concluded)

USACE	U.S. Army Corps of Engineers
WBGT	Wet Bulb Globe Temperature

1. INTRODUCTION

1.1 Purpose And Scope

This Base-Wide Health and Safety Plan (BWHSP) applies to all Environmental Restoration work performed by Contractors at the Kirtland Air Force Base (AFB), New Mexico.

1.2 Application

This Health and Safety Plan is a site-wide health and safety plan which addresses all aspects of health and safety for field activities at Kirtland AFB that will remain constant. Specific work efforts will require that a project-specific addendum be developed to address the applicable hazards, procedures, and control methods.

1.3 Applicable Standards, Regulations, And Guidance Documents

Adherence to applicable portions of federal, local, national consensus organization, and corporate health and safety standards, regulations, and guidance manuals is required during field activities. These include, but may not be limited to, the following:

- 29 Code of Federal Regulations (CFR), Part 1910, Occupational Safety and Health Standards, General Industry.
- 29 CFR, Part 1926, Occupational Safety and Health Standards, Construction Industry.
- 10 CFR, Part 20, Nuclear Regulatory Commission.
- Air Force Center for Environmental Excellence guidance.
- U.S. Army USACE of Engineers (USACE) Safety and Health Requirements Manual, Engineers Manual (EM) 385-1-1, 3 September 1996.

Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices, American Conference of Governmental Industrial Hygienists (ACGIH), most current publication.

Occupational Safety and Health Guidance for Hazardous Waste Site Activities, U.S. Department of Health and Human Services et al., October 1985.

1.4 Summary Of Major Risks

The Site-Specific Health and Safety Plan (SHSP) for each project will describe the major risks for the specific work proposed in a project. Kirtland AFB has activities associated with aircraft, maintenance, storage, research activities, and transportation. The desert climate also poses a physical risk of exposure to extremely dry and hot temperatures. There is a potential for contact with insects, rodents, and snakes. There is potential contamination in various areas of the facility. Contaminants may include fuels, solvents, metals, oils, polychlorinated biphenyls, radionuclides, and pesticides.

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2. PROJECT ORGANIZATION AND RESPONSIBILITIES

2.1 Program Manager

The Program Manager has the overall responsibility for the health and safety of site personnel at all projects under their contract. The Program Manager will ensure that adequate resources are provided to the field health and safety staff to carry out their responsibilities as outlined below. The Program Manager will also ensure that fieldwork is scheduled with adequate personnel and equipment resources to complete the job safely.

2.2 Project Manager

The Project Manager (PM) is responsible for managing all technical and business aspects of the project. This includes the development of the best technical approach and budget for the contract task order scope, managing technical, cost, schedule, and project issues as work progresses, and subcontractor oversight. The PM will also ensure that adequate personnel and resources are available to complete the project safely and to ensure that:

- All projects are implemented in compliance with all environmental, safety and health laws and regulations.
- Environmental Health and Safety (EHS) plans are developed, approved, and implemented in accordance with Contractor requirements.
- Personnel understand the requirements of the project EHS plan(s) and each individual understands his/her responsibility for plan implementation.
- Personnel have all required training and are capable of performing all assigned tasks.
- Facilities and equipment meet Contractor and government regulations.
- Work rules are enforced.
- Inspections and incident investigations are conducted per program requirements. The PM or designated manager will conduct monthly health and safety inspections of the job site.
- Effective corrective actions are implemented in a timely manner following inspections, audits, incident investigations, etc.
- Clients are notified of Contractor incident reporting procedures.
- Appropriate disciplinary action is implemented by line supervision when necessary.

2.3 Project Superintendent

The Project Superintendent is responsible for ensuring that all work is performed in accordance with the project work plan requirements and specifications in a safe and healthful manner. As a line manager, the Project Superintendent has the same responsibilities for health and safety program implementation as the PM. The Project Superintendent will:

- Ensure that work crews have adequate resources to effectively conduct field activities.
- In conjunction with the Site Health and Safety Specialist (SHSS) assure that proper protective equipment is being used by all personnel.
- Ensure that appropriate disciplinary actions are taken when health and safety requirements are not being followed or when unsafe practices occur.
- Oversee work practices to verify they are in accordance with the project-specific work plan and SHSP.
- Understand and be familiar with the SHSP.
- Participate in the daily tailgate safety meetings.
- Observe project personnel for signs of chemical or physical trauma.
- Immediately notify the SHSS and the Safety Professional of any illness, accident, injury or near miss.
- Correct any hazards disclosed by project workers or the SHSS.

The Project Superintendent has the authority to suspend field activities if personnel do not comply with the SHSP requirements and if the health and safety of personnel are in danger.

2.4 Safety Professional

The Safety Professional is responsible for implementing and overseeing the Contract Health and Safety Program and to develop, implement, and approve all SHSPs. Any changes to the established Contract Health and Safety Program or the SHSP is at the direction and approval of the Safety Professional, with concurrence of the Contracting Officer. The Safety Professional or designee will not necessarily be onsite during all remedial activities, but will be readily available for consultation when required.

The Safety Professional supervises and directs the activities of the SHSS. The Safety Professional has the authority to stop unsafe operations, remove unqualified personnel from the work area, and approve changes to the SHSP. Duties of the Safety Professional include:

- Oversee all aspects of the SHSP from development to implementation
- Advise the SHSS on all related health and safety aspects
- Review site-specific plans for completeness and compliance
- Review other site documents as they affect health and safety (e.g., Activity Hazard Analyses, Sampling Plans)
- Review and evaluating all monitoring results
- Establish and monitor all related health and safety procedures through site safety inspections and audits

- Ensure that Contractor employees receive required EHS regulatory training
- Fulfill the specific responsibilities for project EHS personnel that are identified within each EHS procedure
- Function as a technical resource for all environmental compliance, safety, loss control, and industrial hygiene issues

2.5 Site Health And Safety Specialist

The SHSS will be present onsite as required during the conduct of field operations and is responsible for all health and safety activities and the delegation of duties to the health and safety staff in the field. The SHSS is responsible for implementation of the SHSP, overseeing that appropriate personal protective equipment (PPE) is used relative to the hazard which may be encountered, verifying that communication systems are in place, monitoring conformance with safety and emergency response procedures, giving safety briefings, seeing that safety equipment is maintained, and conducting safety drills and exercises. The SHSS or designee is responsible for the setup and execution of decontamination procedures. The SHSS has stop work authorization, which will be executed upon determination of an imminent safety hazard or potentially dangerous situation. Work cannot restart until clearance has been authorized by the SHSS. The SHSS is responsible for maintaining the site health and safety log books.

The SHSS possesses the knowledge and experience necessary to ensure that all elements of the approved SHSP are implemented and enforced onsite and has the responsibility to:

- Ensure that employees understand the requirements of Contractor EHS programs and procedures through training and communication.
- Develop or assist with the development of EHS plans in conjunction with project personnel.
- Assist management with EHS plan implementation.
- Perform specific tasks in accordance with EHS plans.
- Fulfill the specific responsibilities for project EHS personnel that are identified within each EHS procedure.

Additional responsibilities, include but are not limited to:

- Investigation of all accidents, injuries, illnesses, near-misses and other incidents.
- Assuring that employees are trained on the hazards of hazardous substances used on any project. Maintain Material Safety Data Sheet file to provide easy access to all employees. Inspects to assure all containers are labeled.
- Assuring that the SHSP is read, understood, and signed by all field personnel including subcontractors.
- Assuring that tailgate safety meetings are conducted on days that work is performed. Assures that documentation of all meetings and any other additional training is documented.

- Assessing employee exposure through specified monitoring protocols and ascertaining that protective measures are appropriate.

- Verifying that project safety equipment is inspected as required by EHS program.

- Reporting to the responsible person within 24 hours, all incidents required to be reported by EM 385-1-1. Immediately report any fatal injury or three or more persons admitted to a hospital to Occupational Safety and Health Administration (OSHA).

- Verification that all personnel have the necessary training and medical clearance prior to entering the exclusion zone or contamination reduction zone of any site. The SHSS will inform the Project Superintendent of any site personnel with medical restrictions.

- Determining and posting routes to medical facilities and emergency phone numbers. Arrange for emergency transportation to medical facilities.

- Maintaining training records and medical certifications for all onsite personnel including subcontractors.

- Serving as the Project Hazard Communication Coordinator

2.6 Site Personnel

The PM or Site Superintendent will select, as needed, personnel to function as supervisors. Supervisors will assure that their subordinates comply with all requirements of this plan. A list of personnel authorized to have access to the remediation or work site will be compiled and maintained onsite by the SHSS. This list will include contractor employees, subcontractors, and representatives of governmental agencies that may require access, where possible. All authorized personnel shall meet the requirements of the contract task order SHSP and be approved by the SHSS or Project Superintendent prior to entering any exclusion zone or controlled area when potentially hazardous activities are being conducted.

Although the employer is responsible for providing a safe and healthful work place, each employee is responsible for their own safety as well as the safety of those around them. Employees will use all equipment provided in a safe and responsible manner as directed by the Superintendent. All Contractor personnel will follow the policies set forth in this SHSP and in Contractor specific Environmental Health and Safety Programs. Each employee is responsible for immediately reporting any injuries, incidents, and safety infractions to a project supervisor or the SHSS so treatment can be obtained and/or corrective action taken. Equipment operators are responsible for the maintenance, inspection, and safe operation of their equipment. They will report any equipment malfunctions or necessary repairs to a project supervisor.

2.7 Subcontracted Personnel and Third Parties

All subcontracted personnel are responsible for compliance with this SHSP and other applicable regulations. Subcontractor personnel must receive a briefing from the SHSS prior to unescorted access to the project site. They must fulfill the requirements established by this plan and the site-specific plans. They must acknowledge receipt of the plan and the hazard communication briefing. Onsite subcontractors are responsible for providing their personnel with appropriate PPE as specified by the plan. Subcontractor and third party personnel have the authority to request a work area hazard assessment by the SHSS prior to the commencement or continuation of work.

Subcontractors will:

- Provide updated documentation of all training (HAZWOPER refresher training, waste management training, etc.) and medical certification for work in the exclusion zone and contamination reduction zone.

- Report all incidents and accidents immediately to the Project Superintendent or the SHSS.

- Have a Drug Free Workplace Program in compliance with the Federal Drug Free Workplace Act.

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3. SITE HISTORY AND DESCRIPTION

Kirtland AFB is located southeast of Albuquerque, New Mexico, adjacent to and east of the Albuquerque International Airport. The base is within Bernalillo County and has a total area of 52,287 acres.

Kirtland AFB is bounded on the east by the Cibola National Forest, on the south by the Isleta Indian Reservation, and to the north and west by the city of Albuquerque. The Isleta Indian Reservation land adjacent to the southern boundary of the base is undeveloped. Another undeveloped parcel of land (approximately 11,500 acres) owned by the State of New Mexico lies adjacent to the western border of the southern portion of base.

The mission of Kirtland AFB is diverse and encompasses facets of aviation training, academics, technical training, supply depot, defense-readiness flying, and research and development. To support these missions, quantities of petroleum, oils, and lubricants, solvents, and other materials, including radioisotopes and other radioactive materials, have been used with resultant wastes generated.

Site specific descriptions and maps will be provided in the SHSP.

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4. POTENTIAL HAZARDS

The SHSP for each project will discuss the specific chemical, physical, and environmental hazards to workers on each specific site. The SHSP will discuss each contaminant and include information such as exposure limits and signs and symptoms of exposure. The SHSP will discuss site-specific physical hazards identified with the site including those associated with construction, use of heavy equipment, fire hazards, and electrical hazards. This BWHSP discusses the general hazards associated with most projects. The SHSP will describe site-specific environmental hazards, although most environmental hazards are associated with the physical location of the base and weather conditions such as heat stress, noise, and flora and fauna contact, and are, therefore, described in this BWHSP.

4.1 Chemical Hazards

The chemicals believed to be on a specific site, based on analytical data provided by previous investigations, will be discussed in each SHSP. Material Safety Data Sheets (MSDS) for the contaminants and any additional chemicals found on a site or brought onto a site will be acquired and reviewed with all personnel during daily safety meetings. An attachment to the site SHSP will contain the MSDSs. The Safety Professional and the SHSS will specify the levels of protection and air-monitoring requirements based initially on the data provided or obtained prior to remediation work. These requirements may change as the site conditions are more fully evaluated when work is underway.

Contractor-specific protective equipment requirements, combined with the requirement to wash arms, face, and hands before eating or smoking, should prevent exposure through these routes. In addition, the project SHSS and project supervisors observe and warn the crew members to be aware of the initial symptoms of chemical exposure. The amount of exposure depends primarily on the specific activities undertaken and the care with which the activities are performed. A supervisor will remove any crew member from the work site and have the worker medically evaluated if the following initial symptoms persist and are unexplained by other causes (such as allergy, common cold, heat stress, etc.):

- Dizziness or stupor
- Nausea, headaches, or cramps
- Irritation of the eyes, nose, or throat
- Euphoria
- Chest pains and coughing
- Rashes or burns

4.2 Hazard Communication Program

The purpose of a Hazard Communication or Employee Right-To-Know program is to ensure that the hazards of all chemicals located at this field project site are communicated according to 29 CFR, Part 1926.59 regulations to all Contractor personnel and subcontractors. This program requires:

Container Labeling—Personnel will ensure that all drums and containers are labeled according to contents. These drums and containers will include those from manufacturers and those produced onsite by operations. All incoming and outgoing labels will be checked for identity, hazard warning, and name and address of responsible party.

MSDSs—There will be an MSDS located onsite for each hazardous chemical used or known to be onsite.

Employee Information and Training—Training employees on chemical hazards is accomplished through formal safety training conducted annually and informal safety meetings. Project-specific chemical hazards are communicated to employees through an initial site orientation meeting and during daily safety meetings held at field projects.

4.3 Environmental Hazards

The SHSS or a supervisor will discuss environmental hazards associated with each site at the orientation meeting prior to start up of remediation activities. As stated earlier, most environmental hazards are found base-wide and are a general concern to every project on Kirtland AFB.

4.3.1 Weather and Heat Stress

With the possible combination of ambient factors such as high air temperature, a few days with high relative humidity, low air movement, high radiant heat, and protective clothing, the potential for heat stress is a concern. The potential exists for:

- Heat rash
- Heat cramps
- Heat exhaustion
- Heat stroke

The following paragraphs describe a typical heat stress management and prevention program. At 75 degrees Fahrenheit (°F), ambient temperature, the supervisor onsite initiates the procedures in the program.

Heat stroke, heat cramps, and heat exhaustion are covered in detail during the 40-Hour OSHA 29 CFR, Part 1910.120 courses. In addition, this information is discussed during a safety "tailgate" meeting before each workday where heat stress may be a factor. Workers are encouraged to increase consumption of water and electrolyte-containing beverages such as Gatorade during warm weather. Water and electrolyte-containing beverages will be provided onsite and will be available for consumption during work breaks.

At a minimum, workers will break every two hours for 10 to 15 minute rest periods. In addition, workers are encouraged to take rests whenever they feel any adverse effects, especially those effects that may be heat-related. The frequency of breaks may need to be increased upon worker recommendation or decision of the SHSS and a supervisor.

Heat stress is a significant potential hazard associated with the use of PPE in hot weather environments. Local weather conditions may require restricted work schedules in order to protect employees. A Wet Bulb Globe Temperature (WBGT) Index is used to establish a work/rest cycle. If the measured WBGT exceeds 86°F (76°F when workers are wearing semipermeable or impermeable clothing), the work rest cycle in Table 4-1 will be implemented. The use of the work/rest cycle, as well as training on signs and symptoms of heat stress, will help prevent heat-related illnesses from occurring. Table 4-1 will be used as guidance.

Table 4-1. Permissible Heat Exposure Threshold Limit Values[1]

Work/Rest Regimen	Work Load		
	Light	**Moderate**	**Heavy**
Continuous work	82[2]	80	77
75 percent work, 25 percent rest, 3 each hour	87	82	78
50 percent work, 50 percent rest, each hour	89	85	82
25 percent work, 75 percent rest, each hour	90	88	86

FOOTNOTES

[1] Values are given in °F WBGT
[2] When workers are wearing semi-permeable or impermeable clothing, subtract 10°F from the WBGT value.
[3] Rest means minimal physical activity. Rest will be accomplished in the shade. Any activity requiring only
minimal physical activity, e.g., filling out log books, can be performed during rest periods.The signs of frostbite range from sudden blanching or whitening of the skin, to a waxy or white appearance and firmness to the touch (with tissue beneath resilient), to tissues that are cold, pale,

Conditions involving acclimatization and individual responses to heat may require that variances from the table be used. It is unacceptable for any worker to experience heat stress.

Heat stress can manifest in several forms. The most prevalent manifestations of heat stress are:

- Heat cramps—The signs and symptoms of heat cramps are severe muscle cramps (usually in the legs and the abdomen), exhaustion often to the point of collapse, and dizziness or periods of faintness.

  First aid for heat cramps includes shade, rest, and fluid replacement. Normally, the individual will recover within one-half hour. If the individual is not better within 30 minutes, the individual will be transported to a hospital for medical attention.

- Heat exhaustion—The signs and symptoms of heat exhaustion are rapid and shallow breathing, weak pulse, cold and clammy skin with heavy perspiration, pale skin, fatigue and weakness, dizziness, and elevated body temperature.

  First aid for heat exhaustion includes cooling the victim, elevating the feet, and replacing fluids. If the individual is not better within 30 minutes, the individual will be transported to the hospital for medical attention.

- Heat stroke—The signs and symptoms of heat stroke are dry/hot/red skin, body temperature approaching or above 105°F, large (dilated) pupils, and loss of consciousness. The individual may go into a coma. **This condition is classified as a medical emergency, requiring immediate cooling of the patient and transport to a medical facility.**

Sunburn is not a condition of heat stress, but may aggravate and add to the potential for heat stress conditions. The signs and symptoms of sunburn are reddened skin, pain, swelling, and possible blisters, nausea, vomiting, and chills. First aid includes cold water on burned area and elevation of burned limbs. Medical help will be sought if pain, chills, and vomiting persist. To reduce the risk of infection, blisters will not be broken. Sunscreen may be required depending upon the climatic conditions.

The best way to avoid heat stress is prevention. This can be accomplished by taking required rest breaks as dictated by WBGT readings or when feeling any of the symptoms of heat stress, eating a balanced diet, regularly drinking plenty of water (not soft drinks or alcohol), and allowing the individual to acclimatize to potential heat stress conditions by slowly increasing time in the field.

4.4 Cold Stress

Cold stress is a danger at low temperatures and when the wind chill factor is low. Adequate insulated clothing will be provided when air temperature is below 40°F. In addition, reduced work periods followed by rest in a warm area may be necessary in extreme conditions. Table 4-2 provides detailed requirements for cold stress.

Table 4-2. Requirements for Cold Stress

Temperatures Equivalent Chill °C	Less Than °F	Action
16	60.8	If fine detailed work is required, keep workers' hands warm with warm air jets, radiant heaters, or contact warm plates
16	60.8	Sedentary work may require gloves
4	39.2	Light work may require gloves
4	39.2	Don protective clothing appropriate for the level of cold and physical activity
2	35.6	If worker becomes wet, provide change of clothing and treat for hypothermia
-1	30.2	Cover metal handles and controls with thermal insulating material
-7	19.4	Moderate work may require gloves
-7	19.4	Workers will be warned about contact frostbite
-7	19.4	Heated warm up shelters will be provided and workers will be encouraged to use them
-17.5	0	Hands will be protected by mittens
-32	-25.6	No continuous exposure for skin

The best treatment for cold stress is prevention. If the equivalent chill temperature exceeds levels in Table 4-2, the work/warm-up schedule in the table will be followed. In general, work will be limited when outside air temperatures fall below 0°F. Cold stress can result in frostbite and/or hypothermia.

The signs and symptoms of mild hypothermia are shivering, numbness, and drowsiness. First aid for mild hypothermia includes using heat to raise the individual's body temperature. Heat may be applied to the person in the form of heat packs, hot water bottles, and blankets. The signs and symptoms of severe hypothermia are unconsciousness, slowed respiration or respiratory arrest, slowed pulse or cardiac arrest, irrational or stuporous state, and muscular rigidity. First aid for sever hypothermia includes handling the individual very gently; rough handling may set off lethal heart rhythms. The severely hypothermic individual will not be rewarmed; to do so will cause the heart to develop a lethal heart rhythm. Severe hypothermia is a **medical emergency** and the individual will be transported to a medical facility immediately. and solid. Frozen tissue is a **medical emergency** and the victim must be transported to a medical facility immediately. First aid for other forms of frostbite includes covering the affected area with warm hands, placing the area under the clothing and against the skin of a companion, and retreating to a warm area. The affected body part will not be rubbed or massaged, nor will snow be applied.

4.4.1 Hearing Conservation Program

On projects where noise levels may exceed a time-weighted average (TWA) of 85 dBA (decibels, A-scale), hearing protection will be made available to all exposed employees. Additionally, sound level monitoring may be conducted onsite. All Contractor personnel on project sites should have annual audiograms. Personnel with a standard threshold shift will be restricted from high noise exposure or will be required to wear hearing protection at all times. Contractors are required to have a hearing conservation program in compliance with OSHA regulations (29 CFR, Part 1910.95).

4.4.2 Biological Hazards

Biological hazards may be encountered onsite. Workers should anticipate the increased likelihood of encounter with these hazards, especially in and around buildings and in undeveloped outdoor areas. Animal bites and insect stings can cause localized swelling, itching, and minor pain that can be handled by first aid treatment. In sensitized individuals, however, effects can be more serious such as anaphylactic shock, which can lead to severe reactions in the circulatory, respiratory, and central nervous system, and in some cases, even death. The SHSS will identify personnel with a known reaction to bites and stings at the pre-job safety orientation meeting. Personnel will not attempt to capture or feed any wild or semi-wild animals such as cats, rats or ground squirrels due to the possibility of a bite or parasitic infestation.

Animal and bird droppings often contain mold, fungus, viruses, or bacteria that represent a significant respiratory hazard including lung diseases and allergies. Personnel will not touch visual droppings and will wear gloves and Tyvek protective wear, at a minimum, when going into normally limited access areas such as crawl spaces and high ceilings that may have become refuges or nesting areas.

The hanta virus is sometimes transmitted by rodents found in the Southwestern United States and causes respiratory distress, sometimes with fatal consequences. Similarly, rats transmit the arenavirus. Transmission of the hanta virus or arenavirus occurs with exposure to rodent droppings. Good hygiene practices such as washing hands and face prior to eating and drinking will help to minimize the potential for exposure to the hanta virus. While work is in progress, use of high efficiency particulate air (High Efficiency Particulate Air, P-100) filter cartridges and work practices that minimize generation of dust and aerosols, will help protect employees. Avoiding areas where there are concentrations of mouse droppings (hanta virus) or rat droppings (arenavirus), for example, minimizes exposure to either virus. The virus can be inhaled in the dust from areas where mice or rats have nested or left their droppings. Minimizing dust inhalation or avoiding these areas will lessen the risks of exposure. Any work in such areas should be done only with full Level C protection including, at a minimum, a P-100 air-purifying respirator. Thorough washing of hands and face after removing the PPE will further minimize the potential for exposure.

Personnel must use extreme caution when walking through an area, around buildings, and near objects such as drums and containers where a snake is likely to rest during the daytime. If a snake is encountered, slowly and quietly back away from the snake and inform all personnel of its location. Do not attempt to move or kill a snake as certain snakes are protected under state and federal laws. In the event of snakebite, do not try to move the affected individual. Wipe off the skin, as the venom will attack intact skin. Do not suck out the venom. Do not cut open the wound. Do not apply ice or ice packs. Do not use a tourniquet. Do not administer alcohol or medications. Call for medical assistance.

4.4.3 Storm Protection

If a warning of gale-force winds is issued, take precautions to minimize danger to persons, and protect the work and any nearby property. Precautions will include the closing of all openings; removing loose materials, tools and equipment from exposed locations; and removing or securing scaffolding and other temporary work. Close all openings in the work site if storms of a lesser intensity pose a threat to property. The SHSS will ascertain predicted daily weather conditions by listening to daily weather forecasts on radio or television. If particularly ominous weather conditions are predicted, the SHSS will monitor radio broadcasts regularly or through National Weather Service reports. Workers will not enter any excavations during a rainstorm. The supervisor or SHSS will stop all work when wind speeds are 25 miles per hour or higher. The supervisor and the SHSS will assess what work procedures can be safely performed when wind conditions exceed 25 miles per hour. They will give consideration to fugitive dust and odor emissions, the safety of equipment in high winds, and protection of workers from flying debris and dust in windy conditions. No crane or boom work is permitted in winds at 25 miles per hour or higher. (Certain crane manufacturers may specify lower wind speed limitations for safe operations. The SHSS must ensure that operational limitations of these cranes are not exceeded.)

4.5 Physical Hazards

There are numerous physical hazards associated with a project, which if not identified and addressed, could present accidents and personal injury to the work force, as well as operational problems. Some of these are described in this section and in Section 10 of this plan. Any site-specific rules are to be stated in the SHSP. All Contractor personnel will follow these requirements as specified here and in the SHSP. Supervisors will observe the general work practices of each worker and enforce safe procedures to minimize physical hazards. Hard hats, safety glasses, and safety boots are required in all areas of the work site, unless specifically exempted by the Safety Professional, SHSS, or a supervisor.

4.5.1 Tripping, Slipping, and Falling Hazards

Supervisors will remind personnel and subcontractors daily to maintain sure footing on all surfaces. The supervisor and/or the SHSS will inspect all work areas prior to the start of work to look for hazards. Any personnel working six feet (ft) above any surface, including persons on man lifts, are required to wear safety harnesses and safety lanyards. The SHSS will inspect these before use. In order to minimize tripping hazards caused by debris, job supplies, and equipment, personnel will remove this material from the work areas daily and stockpile the materials and place equipment in storage areas. The SHSS will enforce this "housekeeping" effort throughout the day. Workers will not work near the edges of excavations without fall protection.

4.5.2 Head and Back Injuries

At a minimum, workers will don hard hats, safety boots, and safety glasses prior to performing any site activities. This will prevent minor injuries caused by bumping one's head while working around and under piping and other process related structures or equipment. Personnel are instructed in proper lifting techniques and will not lift heavy items without assistance. Each worker will not lift more than 50 pounds. Objects heavier than 50 pounds require assistance from another person. Supervisors will use mechanical lifting equipment whenever possible to minimize worker exposure to lifting hazards.

4.5.3 Falling Objects

All items raised will be slowly lowered to the ground using a grapple and/or skip bucket. No personnel will work under equipment at any time. Also, the SHSS will ensure that an adequate area is clear of personnel while the equipment is in operation. Dump truck drivers will remain in their trucks while soil and debris is placed in their trucks, if their trucks are equipped with a Falling Object Protective System (FOPS). If their trucks are not equipped with FOPS, the drivers will get out of their trucks and stand clear of the loading operation. Workers will not work under other workers who are on scaffolds or levels higher than them unless those levels have protection to prevent objects from falling on workers below.

4.5.4 Heavy Equipment and Traffic

The use of heavy equipment for debris removal, excavation, and lifting presents the greatest potential for injury to personnel. In order to minimize these hazards, the PM and the supervisor will designate routes for mobilization through Kirtland AFB and establish specific traffic patterns. All trucks and heavy equipment will have spotters for backing maneuvers. Only qualified personnel will operate heavy equipment. Those crewmembers directly involved with spotting for the operator are the only personnel allowed in the vicinity of the heavy equipment. All others will remain a safe distance away from these operations.

Personnel needing to approach heavy equipment while operating will observe the following protocols:

- Make eye contact with the operator (and spotter)
- Signal the operator to cease heavy equipment activity
- Approach the equipment and inform the operator of intentions

All Contractor and Subcontractor personnel will follow all local traffic rules. Contractor vehicles will yield to all bikes and pedestrians. Personnel working in areas subject to vehicular traffic (i.e. streets, parking lots, etc.) will wear orange (or other high visibility color) safety vests. Flashing light or reflectorized barricades will be used for all roads that are blocked due to equipment or excavation. Coordinate all traffic management issues with the Kirtland AFB Remedial Project Manager (RPM) and Kirtland AFB security.

4.5.4.1 Site Pre-Inspection of Equipment

The projects will only use heavy equipment that is in safe working order. To maintain this policy, the project supervisor(s), the SHSS, and the equipment operator will inspect all equipment brought onto the project site for structural integrity, smooth operational performance, and proper functioning of all critical safety devices in accordance with the manufacturer's specifications and safety regulations. A competent person will inspect all equipment brought on to the site and certify that equipment has been inspected and is safe to operate. There will be an operator’s manual for each heavy equipment and vehicle. All equipment not conforming to the operational and safety requirements set forth during this inspection will not be put into service until all necessary repairs are made to the satisfaction of the inspection group.

4.5.4.2 Operator Qualifications

Only qualified operators familiar with the equipment to be used will be permitted to operate. Subcontractors will supply proof of their operator's capability and experience to operate the equipment in a safe manner. There are specific training requirements for industrial truck (forklift) operators and for crane operators. These requirements are specified in the U.S. Army USACE of Engineers EM 385-1-1 Safety and Health Requirements Manual. Safety considerations for cranes and heavy equipment are found in 29 CFR 1926.550 and 29 CFR 1926.602, respectively.

4.5.5 Electrical Hazards

Electrical hazards are addressed in 29 CFR 1910, Subpart S, and for construction activities in 29 CFR 1926, Subpart K. In order to prevent accidents caused by electric shock, the project SHSS will inspect all electrical connections on a daily basis. The SHSS will shutdown and lockout any equipment that is found to have frayed or loose connections until a qualified electrician is contacted and repairs are made. The equipment will be de-energized and tested before any electrical work is done. All equipment will be properly grounded prior to and during all work. In addition, Ground Fault Circuit Interrupters (GFCIs) will be installed for each circuit between the power source and tool for all outdoor use. In the event that generators are used to supply power, these generators will contain GFCIs.

Requirements for electrical safety include:

- All electrical wiring and equipment will be listed by a recognized testing laboratory. In New Mexico, the usual recognized testing laboratories are Underwriters Laboratory or the Canadian Standards Association.

- Live parts of wiring and equipment will be guarded to protect all persons or objects from harm. Uninsulated live wires must be placed at various heights and distances from the ground and from buildings depending on the voltage carried by those lines.

- Transformer banks and high voltage equipment will be protected from unauthorized access.

- A qualified electrician will perform all work on electrical power supplies and lines.

- Flexible cords (extension cords) will contain the number of conductors required for service plus a ground wire. Cords will rated for hard usage (S, SE, SEO, SO, SOO, ST, STO, STOO), (Note, this rating is not required to be listed on the cord itself, so check the wrapping or label that comes with the cord to assure that the cord meets this requirement.) Flexible cords are not allowed to pass through doors, windows, or be placed on the ground where they are subject to being run over by vehicles. If flexible cords must pass through walls, the cords will be protected by bushings or fittings.

- Flexible cords must be inspected on each day of use. No splices or fraying is allowed.

- Flexible cords will not be secured with staples, hung from nails or suspended by bare wire. (Plastic tie straps, commonly used today, are acceptable.)

- All portable lamps must have bulbs protected by a substantial guard and attached to the lampholder handle.

- All circuit breaker panels and electrical transformers and supply equipment must be labeled as to the voltage contained therein.

- All circuit breaker panels must be labeled as to what each breaker controls.

- All breaker panels and electrical panels must have a cover protecting any live exposed wires.

- At least a 30-inch clearance must be maintained on three sides of all circuit breaker boxes, transformers and electrical supply equipment so as to provide ready access to the equipment in the event of an emergency. A 36-inch clearance is required for higher voltages, so be sure that adequate clearance is provided.

- Circuit breaker boxes that are locked or kept in locked rooms must have a key readily available in the event of an emergency.

4.5.5.1 Portable Generators

Portable generators are used on many construction sites. Portable generators must meet the requirements for grounding as specified in the National Electrical Code (NEC) National Fire Protection Association 70. NEC 250-6 has certain exemptions for the grounding of portable and vehicle mounted generators. Refer to the code in EM 385-1-1, Section 11 for additional details. Portable generators will be operated in an open air area where there is sufficient ventilation as to prevent accumulation of exhaust gases including carbon monoxide.

4.5.5.2 Temporary Wiring

A qualified electrician will design temporary wiring. A qualified engineer will approve the design. The system will be tested as required by EM 385-1-1, Section 11. Temporary lighting will be protected by guards and will not be suspended by the wire. Exposed empty light sockets and broken bulbs are not permitted. Temporary lighting circuits will be separate from electrical tool circuits. Circuits will be labeled as "LIGHTS ONLY" or "TOOLS ONLY".

4.5.6 Control of Hazardous Energy (Lock Out/Tag Out)

Safety considerations for Lock Out/Tag Out are provided in 29 CFR 1910.147, which establishes the Control of Hazardous Energy. This program applies to all Contractor operations, except as follows:

- Work on cord and plug connected electrical equipment where the plug is under the control of the employee performing the work.

- Hot tap operations.

- Work involving minor changes and adjustments to equipment during routine operations (such as small tooling adjustments).

4.5.6.1 Tag Out

The use of tags without locks are prohibited, except in those cases where it is physically impossible to attach a locking device to an isolation point. When it is necessary to use tags without locks the following shall be completed.

- The isolation point shall be placed in the correct position to prevent the flow of energy;
- The device shall be physically disconnected;
- A tag shall be placed on the disconnected device; and
- Employees shall be warned not to tamper with the tag or isolation point.

4.5.6.2 Subcontractors

The supervisor shall be familiar with the nature of any subcontractor work onsite that may involve hazardous energy and assure that they follow work practices that are at least as strict as this procedure. For any lockout/tagout requirements, the supervisor shall review and approve all subcontractor work set up, apply his locks to the scheme, and sign the appropriate lockout/tagout procedure checklist.

4.5.6.3 Training

Following are the training requirements for various personnel involved with or affected by lockout/tagout.

- Authorized Employees shall receive training in the following prior to being allowed to use lockout/tagout procedures:

  — Recognition of hazardous energy sources;

  — Types and magnitudes of energies available at the site;

  — Methods and means needed for energy isolation and control; and

  — The requirements of this procedure and 29 CFR 1910.147.

- Affected Employees shall be instructed in the following:

  — Purpose of the lockout tagout program;

  — Use and requirements of this procedure and 29 CFR 1910.147;

  — Prohibitions of restarting or tampering with equipment that has been locked out

  — Prohibitions of tampering with locks and tags installed on equipment.

4.5.7 Confined Space Entry

A confined space is any enclosed area having a limited means of egress where ventilation is not adequate to remove a toxic or flammable atmosphere or oxygen deficiency, which may exist. Examples of confined spaces include, but are not limited to, the following: tanks; boilers; vessels; bins; manholes; tunnels; pipelines; underground utility vaults; or any open top space more than four ft in depth such as pits, tubes, trenches, or vessels.

29 CFR 1910.146 outlines procedures in detail. No confined space entry is allowed per this plan. Prior to the start and during the conduct of each Project, the Safety Professional, the SHSS and the project supervisor(s) will identify confined spaces or confined spaces created by the nature of the work. The

SHSS will identify these confined spaces and will not allow entry into these spaces. If a confined space requires entry, the plan will be modified and approved per the amendment procedure described in this BWHSP.

4.5.8 Fire and Explosion Hazards

Atmospheric testing with a combustible gas indicator must be performed to determine the potential for a flammable atmosphere. A hot work permit must be issued to control the presence of equipment or operations producing open flames or sparks. Hot work permits are found in the Permitting Plan, Appendix H. Permits are issued by the Kirtland AFB Fire Department. The SHSS must establish a fire prevention and protection program by insuring that flammable materials are properly stored and that safe work procedures and rules are followed. Smoking is not permitted anywhere on a project site except in designated areas.

4.5.9 Drilling

A survey of the job site to identify overhead electrical hazards, potential ground hazards, and underground utilities must be performed before placement of the drilling equipment. MSDSs for drilling fluids must be provided to the SHSS before the start of work. Supervisors will ensure that a call has been made to New Mexico One Call, Inc (NMOC), (505) 260-1990, and an AF Form 103, Dig Permit has been completed.

4.5.9.1 Housekeeping

The drilling safety supervisor shall understand and fulfill the responsibility for proper maintenance and good "housekeeping" on and around the drill rig. These requirements include, but are not limited to:

- Provide suitable storage locations for all tools, materials and supplies so that tools, materials and supplies can be conveniently and safely handled without hitting or falling on a member of the drill crew or a visitor.

- Avoid storing or transporting tools, materials or supplies within or on the mast (derrick) of the drill rig.

- Neatly stack pipe, drill rods, casing augers and similar drilling tools on racks or sills to prevent spreading, rolling or sliding.

- Place penetration or other driving hammers at a safe location on the ground or secure them to prevent movement when not in use.

- Keep work areas, platforms, walkways, scaffolding and other access ways free of materials, debris, and obstructions and substances such as ice, grease or oil that could cause a surface to become slick or otherwise hazardous.

- Keep all controls, control linkages, warning and operation lights and lenses free of oil, grease and/or ice.

- Do not store gasoline in any portable container other than a non-sparking, approved container with a flame arrester in the fill spout and having the word "gasoline" easily visible. A hazard communication label shall also be placed on all gasoline cans.

4.5.9.2 Maintenance

Proper maintenance will make drilling operations safer. Maintenance should be performed safely. These requirements include, but are not limited to:

- Keep drill rigs and associated equipment in good condition.
- Wear safety glasses when performing maintenance on a drill rig or on drilling tools.
- Shut down the drill rig engine to make repairs or adjustments to a drill rig or to lubricate fittings (except repairs or adjustments that can only be made with the engine running). Take precautions to prevent accidental starting of an engine during maintenance by locking, removing or tagging the ignition key.
- Always block the wheels or lower the leveling jacks or both and set hand brakes before working under a drill rig.
- When possible and appropriate, release all pressure on the hydraulic systems, the drilling fluid system and the air pressure systems of the drill rig prior to performing maintenance. In other words, reduce the drill rig and operating systems to a "zero energy state" before performing maintenance. Use extreme caution when opening drain plugs and radiator caps and other pressurized plugs and caps.
- Do not touch an engine or the exhaust system of an engine following its operation until the engine and exhaust system have had adequate time to cool.
- Never weld or cut on or near a fuel tank.
- Do not use gasoline or other volatile or flammable liquids as a cleaning agent on or around a drill rig.
- Follow the manufacturer's recommendations for applying the proper quantity and quality of lubricants, hydraulic oils and/or coolants.
- Replace all caps, filler plugs, protective guards or panels and high pressure hose clamps and chains or cables that have been removed for maintenance before returning the drill rig to service.
- Check the deadman switch daily. Ensure that its location is known to all drill rig crew personnel.

4.5.9.3 Hand Tools

There are almost an infinite number of hand tools that can be used on or around a drill rig and in repair shops and more than an equal number of instructions for proper use. "Use the tool for its intended purpose" is the most important rule. The following are a few specific and some general suggestions which apply to safe use of hand tools that are often used on and around drill rigs.

- When a tool becomes damaged, either repair it before using it again or discard it.

- When using a hammer wear safety glasses and require all others around you to wear safety glasses.

- When using a chisel wear safety glasses and require all others around you to wear safety glasses.

- Keep all tools cleaned and neatly stored when not in use.

- Use wrenches on nuts - do not use pliers on nuts.

- Use screwdrivers with blades that fit the screw slot.

- When using a wrench on a tight nut - first use some penetrating oil, use the largest wrench available that fits the nut, when possible pull on the wrench handle rather than pushing, and apply force to the wrench with both hands when possible and with both feet firmly placed. Don't push or pull with one or both feet on the drill rig or the side of a mud pit or some other blocking-off device. Always assume that you may lose your footing - check the place where you may fall for sharp objects.

- Keep all pipe wrenches clean and in good repair. The jaws of pipe wrenches should be wire brushed frequently to prevent an accumulation of dirt and grease which would otherwise build up and cause wrenches to slip.

- Never use pipe wrenches in place of a rod holding device.

- Replace hook and heel jaws when they become visibly worn.

- When breaking tool joints on the ground or on a drilling platform, position your hands so that your fingers will not be smashed between the wrench handle and the ground or the platform, should the wrench slip or the joint suddenly let go.

4.5.9.4 Clearing the Work Area

Prior to drilling, perform adequate site clearing and leveling to accommodate the drill rig and supplies and provide a safe working area. Drilling shall not be commenced when tree limbs, unstable ground or site obstructions cause unsafe tool handling conditions.

4.5.9.5 Start-up

- Instruct all visitors to "stand clear" of the drill rig immediately prior to and during starting of any an engine.

- Make sure all gear boxes are in neutral, all hoist levers are disengaged, all hydraulic levers are in the correct non-actuating positions and the cathead rope is not on the cathead before starting a drill rig engine.

- Start all engines according to the manufacturer's manual.

4.5.9.6 Safety During Drilling Operations

- Safety requires the attention and cooperation of every worker and site visitor.

- Do not drive the drill rig from hole to hole with the mast (derrick) in the raised position.

- Before raising the mast (derrick), look up to check for overhead obstructions.

- Maintain a minimum of 15-ft clearance from all overhead electric lines. See 29 CFR 1926.550 or EM 385-1-1, Section 11.E for additional guidance on operations adjacent to overhead lines.

- Before raising the mast (derrick), all drill rig personnel (with the exception of the operator) and visitors shall be cleared from the areas immediately to the rear and the sides of the mast. All drill rig personnel and visitors shall be informed that the mast is being raised prior to raising it.

- Before the mast (derrick) of a drill rig is raised and drilling is commenced, the drill rig must first be leveled and stabilized with leveling jacks and/or solid cribbing. The drill rig shall be re-leveled if it settles after initial set up. Lower the mast (derrick) only when the leveling jacks are down and do not raise the leveling jack pads until the mast (derrick) is lowered completely.

- Before starting drilling operations, secure and/or lock the mast (derrick) if required according to the drill manufacturer's recommendations.

- The operator of a drill rig shall only operate a drill rig from the position of the controls. If the operator of the drill rig must leave the area of the controls, the operator shall shift the transmission controlling the rotary drive into neutral and place the feed control lever in neutral. The operator shall shut down the drill engine before leaving the vicinity of the drill rig.

- Throwing or dropping tools shall not be permitted. All tools shall be carefully passed by hand between personnel or a hoist line shall be used.

- Do not consume alcoholic beverages or other depressants or chemical stimulants prior to starting work on a drill rig or while on the job.

- When encountering a "hot spot" during drilling operations involving volatiles, vacate the immediate area and allow the borehole to vent. Resume work after monitoring instruments indicate an atmosphere in compliance with the SSHP.

- If it is necessary to drill within an enclosed area, make certain that exhaust gases are vented out of the area. Exhaust gases can be toxic and some cannot be detected by smell.

- Clean mud and grease from your boots before mounting a drill platform and use hand holds and railings. Watch for slippery ground when dismounting from the platform.

- During freezing weather, do not touch any metal parts of the drill rig with exposed flesh. Freezing of moist skin to metal can occur almost instantaneously.

- All air and water lines and pumps should be drained when not in use if freezing weather is expected.

- All unattended boreholes must be adequately covered or otherwise protected to prevent drill rig personnel, site visitors or animals from stepping or falling into the hole. All open boreholes shall be covered, protected or backfilled adequately and according to local or state regulations on completion of the drilling project.

- "Horsing around" within the vicinity of the drill rig and tool and supply storage areas is not allowed, even when the drill rig is shut down.

- When using a ladder on a drill rig, face the ladder and grasp either the side rails or the rungs with both hands while ascending or descending. Do not attempt to use one or both hands to carry a tool while on a ladder. Use a hoist line and a tool "bucket" or a safety hook to raise or lower hand tools.

Use elevated derrick platforms with the following precautions:

- When working on a derrick platform, use a safety harness and a lifeline. The safety harness shall be at least four inches [100 millimeters (mm)] wide and shall fit snugly but comfortably. The lifeline, when attached to the derrick, shall be less than six ft [2 meters (m)] long. The safety harness and lifeline shall be strong enough to withstand the dynamic force of a 250-pound (115 kilograms) weight (contained within the belt) falling six ft (2 m).

- When climbing to a derrick platform that is higher than 20 ft (6 m), use a safety-climbing device.

- When a rig worker is on a derrick platform, fasten the lifeline to the derrick just above the derrick platform and to a structural member that is not attached to the platform or to other lines or cables supporting the platform.

- When a rig worker first arrives at a derrick platform, inspect the platform for broken members, loose connections and loose tools or other loose materials.

- Attach tools securely to the platform with safety lines. Do not attach a tool to a line attached to your waist or any other part of your body.

- When you are working on a derrick platform, do not guide drill rods or pipe into racks or other supports by taking hold of a moving hoist line or a traveling block.

- Do not leave loose tools and similar items on the derrick platform or on structural members of the derrick.

- A derrick platform over four ft (1.2 m) above ground surface shall be equipped with toe boards and safety railings that are in good condition.

- Workers on the ground or the drilling floor shall avoid working under rig workers on elevated platforms, whenever possible.

- Terminate drilling operations during an electrical storm and move the entire crew away from the drill rig.

4.5.9.7 *Safe Use of Wire Line Hoists, Wire Rope and Hoisting Hardware*

- The use of wire line hoists, wire rope and hoisting hardware shall be as stipulated by 29 CFR 1910, Subpart N, 29 CFR 1926.552, and the American Iron Steel Institute Wire Rope Users Manual.

- Visually inspect all wire ropes and fittings during use and thoroughly inspect them at least once a week for: abrasion, broken wires, wear, reduction in rope diameter, reduction in wire diameter, fatigue, corrosion, damage from heat, improper revving, jamming, crushing, bird caging, kinking, core protrusion and damage to lifting hardware. Replace wire ropes when inspection indicates excessive damage according to the Wire Rope Users Manual. Thoroughly inspect all wire ropes that have not been used for a period of a month or more before returning them to service.

- End fittings and connections consist of spliced eyes and various manufactured devices. Install all manufactured end fittings and connections according to the manufacturer's instructions and follow the manufacturer's load specifications.

- If a ball-bearing type-hoisting swivel is used to hoist drill rods, inspect and lubricate the swivel daily to assure that the swivel freely rotates under load.

- If a rod slipping device is used to hoist drill rods, do not drill through or rotate drill rods through the slipping device, do not hoist more than 1 ft (0.3 m) of the drill rod column above the top of the mast (derrick), do not hoist a rod column with loose tool joints and do not make up, tighten or loosen tool joints while the rod column is being supported by a rod slipping device. If drill rods should slip back into the borehole, do not attempt to break the fall of the rods with your hands or by tensioning the slipping device.

- Most sheaves on exploration drill rigs are stationary with a single part line. Never increase the number of parts of line without first consulting with the manufacturer of the drill rig.

- Wire ropes must be properly matched with each sheave—if the rope is too large, the sheave will pinch the wire rope; if the rope is too small, it will groove the sheave. Once the sheave is grooved, it will severely pinch and damage larger sized wire ropes.

The following procedures and precautions must be understood and implemented for safe use of wire ropes and rigging hardware:

- Use tool handling hoists only for vertical lifting of tools (except when angle hole drilling). Do not use tool handling hoists to pull objects away from the drill rig; however, drills may be moved using the main hoist if the wire rope is spooled through proper sheaves according to the manufacturer's recommendations.

- When stuck tools or similar loads cannot be raised with a hoist, disconnect the hoist line and connect the stuck tools directly to the feed mechanism of the drill. Do not use hydraulic leveling jacks for added pull to the hoist line or the feed mechanism of the drill.

- When attempting to pull out a mired down vehicle or drill rig carrier, only use a winch on the front or rear of the vehicle and stay as far away as possible from the wire rope. Do not attempt to use tool hoists to pull out a mired down vehicle or drill rig carrier.

- Minimize shock loading of a wire rope - apply loads smoothly and steadily.
- Avoid sudden loading in cold weather.
- Never use frozen ropes.
- Protect wire rope from sharp corners or edges.
- Replace faulty guides and rollers.
- Replace damaged safety latches on safety hooks before using.
- Know the safe working load of the equipment and tackle being used. Never exceed this limit.
- Inspect and test clutches and brakes of hoists periodically.
- Know and do not exceed the rated capacity of hooks, rings, links, swivels, shackles and other lifting aids.
- Always wear gloves when handling wire ropes.
- Do not guide wire rope on hoist drums with your hands.
- Following the installation of a new wire rope, first lift a light load to allow the wire rope to adjust.
- Never carry out any hoisting operations when the weather conditions are such that hazards to personnel, the public, or property are created.
- Never leave a load suspended in the air when the hoist is unattended.
- Keep your hands away from hoists, wire rope, hoisting hooks, sheaves and pinch points as slack is being taken up and when the load is being hoisted.
- Never hoist the load over the head, body or feet of any personnel.
- Never use a hoist line to "ride" up the mast (derrick) of a drill rig.
- Replacement wire ropes should conform to the drill rig manufacturer's specifications.

4.5.9.8 Safe Use of Cathead and Rope Hoists

The following safety procedures shall be employed when using a cathead hoist:

- Keep the cathead clean and free of rust and oil and/or grease. Clean the cathead with a wire brush if it becomes rusty.
- Check the cathead periodically, when the engine is not running, for rope wear grooves. Replace the cathead if a rope groove forms to a depth greater than 1/8 inch (3 mm).

- Always use a clean, dry, sound rope. A wet or oily rope may "grab" the cathead and cause drill tools or other items to be rapidly hoisted to the top of the mast.

- Should the rope "grab" the cathead or otherwise become tangled in the drum, release the rope and sound an appropriate alarm for all personnel to rapidly back away and stay clear. The operator shall also back away and stay clear. If the rope "grabs" the cathead, and tools are hoisted to the sheaves at the top of the mast, the rope will often break, releasing the tools. If the rope does not break, stay clear of the drill rig until the operator cautiously returns to turn off the drill rig engine and appropriate action is taken to release the tools. The operator shall keep careful watch on the suspended tools and shall quickly back away after turning off the engine.

- The rope shall always be protected from contact with all chemicals. Chemicals can cause deterioration of the rope that may not be visibly detectable.

- Never wrap the rope from the cathead (or any other rope, wire rope or cable on the drill rig) around a hand, wrist, arm, foot, ankle, leg or any other part of your body.

- Always maintain a minimum of 18 inches of clearance between the operating hand and the cathead drum when driving samplers, casing or other tools with the cathead and rope methods. Be aware that the rope advances toward the cathead with each hammer blow as the sampler or other drilling tool advances into the ground.

- Never operate a cathead (or perform any other task around a drill rig) with loose unbuttoned or otherwise unfastened clothing or when wearing gloves with large cuffs or loose straps or lacings.

- Do not use a rope that is any longer than necessary. A rope that is too long can form a ground loop or otherwise become entangled with the operator's legs.

- Do not use more rope wraps than are required to hoist a load.

- Do not leave a cathead unattended with the rope wrapped on the drum.

- Position all other hoist lines to prevent contact with the operating cathead rope.

- When using the cathead and rope for driving or back-driving, make sure that all threaded connections are tight and stay as far away as possible from the hammer impact point.

- The cathead operator must be able to operate the cathead standing on a level surface with good, firm footing conditions without distraction or disturbance.

4.5.9.9 Safe Use of Augers

The following general procedures shall be used when starting a boring with a continuous flight or hollow-stem augers:

- Prepare to start an auger boring with the drill rig level, the clutch or hydraulic rotation control disengaged, the transmission in low gear and the engine running at low revolutions per minute.

- Apply an adequate amount of down pressure prior to rotation to seat the auger head below the ground surface.

- Look at the auger head while slowly engaging the clutch or rotation control and starting rotation. Stay clear of the auger.

- Slowly rotate the auger and auger head while continuing to apply down pressure. Keep one hand on the clutch or the rotation control at all times until the auger has penetrated about one ft or more below ground surface.

- If the auger head slides out of alignment, disengage the clutch or hydraulic rotation control and repeat the hole starting process.

- An auger guide can facilitate the starting of a straight hole through hard ground or pavement.

- The operator and tool handler shall establish a system of responsibility for the various activities required for auger drilling, such as connecting and disconnecting auger sections, and inserting and removing the auger fork. The operator must assure that the tool handler is well away from the auger column and that the auger fork is removed before starting rotation.

- Only use the manufacturer's recommended method of securing the auger to the power coupling. Do not touch the coupling or the auger with your hands, a wrench or any other tools during rotation.

- Whenever possible, use tool hoists to handle auger sections.

- Never place hands or fingers under the bottom of an auger section when hoisting the auger over other auger sections or other hard surfaces such as the drill rig platform.

- Never allow feet to get under the auger section that is being hoisted.

- When rotating augers, stay clear of the rotating auger and other rotating components of the drill rig. Never reach behind or around a rotating auger for any reason whatsoever.

- Use a long-handled shovel to move auger cuttings away from the auger. Never use your hands or feet to move cuttings away from the auger.

- Do not attempt to remove earth from rotating augers. Augers should be cleaned only when the drill rig is in neutral and the augers are stopped from rotating.

4.5.9.10 Safety During Rotary and Core Drilling

Rotary drilling tools shall be safety checked prior to drilling:

- Lubricate and check water swivels and hoisting plugs for "frozen" bearings before use. Use only approved lubrication fluids.

- Check drill rod chuck jaws periodically and replace when necessary.

- Check the capacities of hoists and sheaves against the anticipated weight to the drill rod string plus other expected hoisting loads.

Special precautions for safe rotary or core drilling involve chucking, joint break, hoisting and lowering of drill rods:

- Only the operator of the drill rig shall brake or set a manual chuck so that rotation of the chuck will not occur prior to removing the wrench from the chuck.
- Do not brake drill rods during lowering into the hole with drill rod chuck jaws.
- Do not hold or lower drill rods into the hole with pipe wrenches.
- If a string of drill rods are accidentally or inadvertently released into the hole, do not attempt to grab the falling rods with your hands or a wrench.
- In the event of a plugged bit or other circulation blockage, relieve or bleed down the high pressure in the piping and hose between the pump and the obstruction before breaking the first tool joint.
- When drill rods are hoisted from the hole, they shall be cleaned for safe handling with a rubber or other suitable rod wiper. Do not use your hands to clean drilling fluids from drill rods.
- If work must progress over a portable drilling fluid (mud) pit, do not attempt to stand on narrow sides or cross members. The mud pit shall be equipped with rough surfaced, fitted cover panels of adequate strength to hold drill rig personnel.
- Do not lean unsecured drill rods against the mast. Either provide some method of securing the upper ends of the drill rod sections for safe vertical storage or lay the rods down.

4.5.9.11 Engines and Pumps

The following engine and pump stop devices are as follows:

- For an internal-combustion engine: an ignition or grounding switch.
- For a diesel engine: a quick-closing valve or equivalent device which will shut off the air to the air-intake manifold of the engine and prevent entry of gas-laden air, or a means of releasing the engine compression which will not produce an open flame or spark.
- For an electric motor: a suitable switch in the motor circuit, or a switch or stop button in the control circuit, approved for the location in which it is installed.
- Mud pumps shall be equipped with a pressure relieving device set to release within the limits of the safe working pressure of the pump. Such devices include direct spring-loaded safety valves, shear-pin safety valves, and rupture disks.
- There shall be no valve between the pump and its pressure-relieving device. The point of discharge from a pressure-relieving device shall be located where employees are not endangered by the discharge of fluids.
- Each pump shall be equipped with bleeder valves.

- All personnel involved in the operation of the rig shall know the exact location of each stop device.

4.5.9.12 Safety During Travel

The individual who transports a drill rig on and off a drilling site shall:

- Be properly licensed and shall only operate the vehicle according to federal, state and local regulations.
- Know the traveling height (overhead clearance), width, length and weight of the drill rig with carrier and know the highway and bridge load, width and overhead limits, making sure these limits are not exceeded and allowing an adequate margin of safety.
- Never move a drill rig unless the vehicle brakes are in sound working order.
- Allow for mast overhang when cornering or approaching other vehicles or structures.
- Be aware that the canopies of service stations and motels are often too low for a drill rig mast to clear with the mast in the travel position.
- Watch for low hanging electrical lines, particularly at the entrances to drilling sites or restaurants, motels or other commercial sites.
- Never travel on a street, road, highway with the mast (derrick) of the drill rig in the raised or partially raised position.
- Remove all ignition keys when a drill rig is left unattended.

4.5.9.13 Off-Road Movement

The following safety precautions relating to off-road movement shall be followed:

- Before moving a drill rig, first walk the route of travel, inspecting for depressions, stumps, gullies, ruts and similar obstacles.
- Always check the brakes of a drill rig carrier before traveling, particularly on rough, uneven or hilly ground.
- Check the complete drive train of a carrier at least weekly for loose or damaged bolts, nuts, studs, shafts and mountings.
- Discharge all passengers before moving a drill rig on rough or hilly terrain.
- Engage the front axle (for 4 x 4, 6 x 6, etc. vehicles or carriers) when traveling off highway on hilly terrain.
- Use caution when traveling a side hill. Conservatively evaluate side-hill capability of drill rigs, because the arbitrary addition of drilling tools may raise the center of gravity. When possible, travel directly uphill or downhill. Increase tire pressures before traveling in hilly terrain (do not exceed rated tire pressure).

- Attempt to cross obstacles such as small logs and small erosion channels or ditches squarely, not at an angle.

- Use the assistance of someone on the ground as a guide when lateral or overhead clearance is close.

- After the drill rig has been moved to a new drilling site, set all brakes and/or locks and block wheels.

- Never travel off-road with the mast (derrick) of the drill rig in the raised or partially raised position.

4.5.9.14 Tires, Batteries and Fuel

Tires on the drill rig must be checked daily for safety and during extended travel for loss of air and they must be maintained and/or repaired in a safe manner. If tires are deflated to reduce ground pressure for movement on soft ground, the tires should be reinflated to normal pressures before movement on firm or hilly ground or on streets, roads and highways. Under inflated tires are not as stable on firm ground as properly inflated tires. Air pressures shall be maintained for travel on streets, roads and highways according to the manufacturer's recommendations. During air pressure checks, inspect for:

- Missing or loose wheel lugs

- Objects wedged between duals or embedded in the tire casing

- Damaged or poorly fitting rims or rim flanges

- Abnormal or uneven wear and cuts, breaks or tears in the casing.

- The repair of truck and off-highway tires shall only be made with required special tools following the recommendations of a tire manufacturer's repair manual. If they are split rim tires, repairs shall be performed using an appropriate tire cage device.

- Batteries contain strong acid. Use extreme caution when servicing batteries.

- Batteries shall only be serviced in a ventilated area while wearing safety glasses.

- When a battery is removed from a vehicle or service unit, disconnect the battery ground clamp first.

- When installing a battery, connect the battery ground clamp last.

- When charging a battery with a battery charger, turn off the power source to the battery before either connecting or disconnecting charger leads to the battery posts. Loosen cell caps prior to charging to permit the escape of gas.

- Spilled battery acid can burn your skin and damage your eyes. Spilled battery acid shall be immediately flushed off your skin with lots of water. Should battery acid get into someone's eyes, flush immediately with large amounts of water and see a medical physician at once.

- To avoid battery explosions, keep the cells filled with electrolyte, use a flashlight (not an open flame) to check electrolyte levels, and avoid creating sparks around the battery by shorting across a battery terminal. Keep lighted smoking materials and flames away from batteries.

- Special precautions must be taken for handling fuel and refueling the drill rig or carrier.

  — Only use the type and quality of fuel recommended by the engine manufacturer.

  — Refuel in a well-ventilated area.

  — Do not fill fuel tanks while the engine is running. Turn off all electrical switches.

  — Do not spill fuel on hot surfaces. Clean any spillage before starting an engine.

  — Wipe up spilled fuel with cotton rags or cloths - do not use wool or metallic cloth.

  — Keep open lights, lighted smoking materials and flames or sparking equipment well away from the fueling area.

  — Turn off heaters in carrier cabs when refueling the carrier or the drill rig.

  — To allow for expansion of the fuel during temperature changes, do not fill portable fuel containers completely full.

  — Keep the fuel nozzle in contact with the tank being filled to prevent static sparks from igniting the fuel.

  — Do not transport portable fuel containers in the vehicle or carrier cab with personnel.

  — Fuel containers and hoses shall remain in contact with a metal surface during travel to prevent the buildup of static charge.

4.5.9.15 Drill Rig Utilization and Alterations

Do not attempt to exceed manufacturer's ratings of speed, force, torque, pressure, flow, etc. Only use the drill rig and tools for the purposes which they are intended and designed.

Alterations to a drill rig or drilling tools shall only be made by qualified personnel and only after consultation with the manufacturer.

4.5.10 Overhead Electrical Hazards

Overhead power lines may present a hazard to equipment and personnel. To prevent equipment contact with power lines and to prevent arcing, adequate clearance must be maintained. For lines rated 50 kilovolt (kV) or below, the minimum clearance between the lines and any part of the crane or load will be 10 ft. For lines rated more than 50 kV, the minimum clearance between the lines and any part of the crane or load will be 10 ft plus 0.4 inch for each kV more than 50 kV.

4.5.11 Excavation Safety

Any excavation or trenching operation that is four ft or more in depth will be performed in accordance with 29 CFR 1926 Subpart P. A Contractor excavation permit must be completed by a competent person before excavation commences and at least each day thereafter. This permit requires daily inspections of the operation and adjacent areas. Specific situations addressed in these inspections are possible cave-ins, indications of failure of protective systems (benching, sloping, or shoring), hazardous atmospheres and other hazardous conditions. If the competent person finds evidence of any of these situations, exposed employees will be removed from the hazardous area until the necessary precautions have been taken to ensure their safety. Also, NMOC (505) 260-1990, must be notified before any excavation work begins regardless of depth. A dig permit from Kirtland AFB is required before any excavation begins regardless of the depth of the excavation (See Appendix H). Exploratory techniques, such as "pot-holing" will be performed to insure that any excavation near utilities can be performed safely. Dust suppression measures may include the use of a compound, which will make the soil less likely to dust or use water. However, work procedures as soil is moved and especially as it is lifted and loaded must be performed in such a way to minimize the generation of dust. For example, loaders dumping soil into a dump truck or a stockpile may have to lower the bucket as close as possible to the truck or stockpile before dumping to reduce the drop height of the soil and, thereby, reduce the amount of dust generated.

The following provides general requirements governing activities in and around excavation and trenches, as well as the requirements for the selection and use of protective systems.

- Surfaces surrounding open trenches and excavations shall have all surface hazards removed.

- All utilities shall be located and cleared prior to initiating digging. Public or facility utility groups shall be utilized where possible for this purpose. In the absence of either, the SHSS shall specify the procedures to be used to clear utilities in consultation with a Safety Professional and project manager. When the excavation is open, utilities shall be supported and protected from damage. Clearance and support methods shall be documented on the daily inspection checklist. EM 385-1-1, Section 25, requires the installation of perimeter protective systems for all open excavations. Class I perimeter protection is the most protective and requires installation of fences and barricades which would prevent members of the public (people other than workers) from entering or falling into the excavation. Consult the EM 385-1-1 for the types of protective system required for various situations.

- Where structural ramps are used for egress they shall be installed in accordance with 29 CFR 1926.651(c)(1).

- Stairways, ladders, or ramps shall be provided as means of egress in all trenches 4 ft or more in depth. Travel distance shall be no more than 25 ft between means of exit.

- Employees exposed to vehicular traffic shall wear traffic vests.

- No employee shall be permitted under loads being lifted or under loads being unloaded from vehicles.

- When vehicles and machinery are operating adjacent to excavations warning systems such as stop logs or barricades shall be utilized to prevent vehicles from entering the excavation or trench. In any case, vehicles, equipment, materials and supplies will never be placed closer than 2 ft from the edge of any excavation. A professional engineer may have to calculate the distances that heavier equipment may be placed from the edge so as to prevent collapse of the excavation wall caused by the weight of the equipment.

- Scaling or barricades shall be used to prevent rock and soils from falling on employees.
- Excavated and loose materials should be kept at least three ft from the edge of excavations, but at a minimum of two ft from the edge of the excavation in accordance with OSHA requirements.
- Walkways or bridges with standard railing shall be provided at points employees are to cross over excavations or trenches.
- Barriers shall be provided to prevent personnel from inadvertently falling into an excavation. Workers within two ft of the edge of the excavation must be protected by fall protection.

4.5.11.1 Hazardous Atmospheres

Where atmospheres containing less than 19.5 percent oxygen or other types of hazardous atmospheres may exist the following requirements shall be implemented.

- Atmospheric testing shall be done prior to employees entering excavations four ft or greater in depth.
- Testing methods shall be listed on the daily inspection checklist and results documented daily in field logs.
- Control measures such as ventilation and PPE shall be used to control employee exposure to hazardous atmospheres below published exposure limits.
- Ventilation shall be used to control flammable and combustible vapors to below 10 percent of their lower explosive limit.
- Testing shall be repeated as often as necessary to ensure safe levels of airborne contaminants.
- Emergency equipment shall be provided and attended when the potential for a hazardous atmosphere exists. This equipment shall include but not be limited to emergency breathing apparatus, harnesses, lifelines, and basket stretchers. Required equipment will be listed on the daily inspection checklist and reviewed daily.

4.5.11.2 Protection From Water Hazards

When water has collected or is collected in excavations and trenches the following requirements shall be applied.

- Employees shall not work in excavations in which water has, or is, accumulating without the use of additional protection such as special support systems or water removal.
- Water removal shall be monitored by a competent person.
- Barriers such as ditches and dikes shall be used to divert runoff from excavations and trenches.

- Trenches shall be reinspected prior to re-entry after water accumulation due to heavy rainfall or seepage.

4.5.11.3 Stability of Adjacent Structures

When excavating or trenching near an adjacent structure the following practices shall be implemented.

- Support systems such as shoring, bracing, or underpinning shall be provided where the stability of buildings, walls, or other structures is endangered by excavation.

- Excavation bases or footings of foundations shall be prohibited unless support systems are used, the excavation is in stable rock, a professional engineer has determined the structure is sufficiently removed from the site as to not pose a hazard, or the PE determines that the excavation shall not pose a hazard to employees due to the structure.

- Support systems shall be used when it is necessary to undermine sidewalks, pavements, and appurtenant structures.

- Surcharge load sources and adjacent encumbrances shall be listed with their evaluation date on the daily inspection checklist.

4.5.11.4 Daily Inspections

Inspections shall be performed daily on all excavations, adjacent areas, and protective systems before personnel enter the trench. A checklist will be used.

4.5.11.5 Soil Classification

To perform soil classification, the competent person shall use a thumb test, pocket penetrometer, or shear vane to determine the unconfined compressive strength of the soils being excavated. In soils with properties that change (i.e., one soil type mixed with another within a given area) several tests may be necessary. When different soil types are present the overall classification shall be that of the type with the lowest unconfined compressive strength. Classifications shall result in a soil rating of Stable Rock, Type A, Type B, or Type C in accordance with 29 CFR 1926.652. Soil classifications shall be listed on the daily inspection checklist. The soils analysis checklist will be used for soil classifications.

4.5.11.6 Sloping and Benching

All sloping and benching shall be done in accordance with 29 CFR 1926.652, Appendix B. Selection of the sloping method and evaluation of surface surcharge loads shall be made by a competent person familiar with the requirements contained therein. Sloping and benching methods and specifications shall be listed on the daily inspection checklist.

4.5.11.7 Protective Systems

Protective systems are required on all excavations over five ft in depth or in excavations less than five ft when examination of the ground by a competent person reveals conditions that may result in cave-ins. Selection and installation of protective systems shall be done in accordance with 29 CFR 1926.652, Appendices C & D, or manufacturers data for shoring and shielding systems. Selection of a protective system shall be made based upon soil classification and job requirements by a competent person. Protective systems and specifications shall be listed on the daily inspection checklist. Protective systems as discussed here refer to protective systems within the excavation itself and not to the perimeter protective systems as mentioned above,

4.5.11.8 Training

Competent persons shall have an adequate combination of experience and training to classify soil types and select protective systems as outlined in 29 CFR 1926.652. Training and experience pertaining to qualification as a competent person shall be documented and include the following:

- General safety practices related to working in or near open excavations;
- Inspection requirements and techniques;
- Classification of soils in accordance with 29 CFR 1926.652, Appendix A; and
- Uses, limitations, and specifications of protective systems in accordance with 29 CFR 1926.652.

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5. ACTIVITY HAZARD ANALYSES

Each SHSP will have a section that evaluates the risks and associated precautions for remediation activities associated with the site-specific activities. An Activity Hazard Analysis (AHA) is developed for each planned activity and operation occurring in each major phase of work. This AHA identifies the sequence of work, specific hazards anticipated, and the control measures to be implemented to minimize or eliminate each hazard. This AHA is used to augment daily safety meetings intended to heighten safety and hazard awareness on the job. This pre-task briefing will be documented and may be combined with the daily tailgate safety meeting. AHAs are the focal point for safe conduct of work on a project. Since each task is described and evaluated, workers should be better prepared to perform work safely.

The SHSS will discuss the risks and precautions associated with each task identified in the work plan. Daily "tailgate" safety meetings are held at the start of each shift. Prior to the day's remediation activity the safety meeting discusses the potential chemical, physical, and environmental hazards and preventive safety measures. During a workday, if there are any changes or new conditions, the SHSS will insure that the AHA is updated and that workers review the amended AHA. Attendance is mandatory for all employees involved in the specific work.

If there are changes required due to changing conditions or requirements, the SHSP may be modified by using the change form attached to the SHSP and by obtaining the approval of the PM or Project Superintendent, the Project SHSS, and the Safety Professional.

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6. PERSONAL PROTECTIVE EQUIPMENT

PPE for site workers will be selected and used based upon the existing and potential hazards anticipated and the requirements of 29 CFR, Part 1910.120. Different levels of personal protection will be provided to workers at the site depending on specific work tasks performed. The selection of PPE requires an evaluation of chemical contaminants, concentrations of these chemical contaminants, and physical hazards that may be encountered.

The initial PPE and action levels for each site activity will be established for each Project assignment based on available data and defined in the SHSP. As additional testing, monitoring, and background information become available, the SHSS may adjust the action levels and PPE accordingly. The Safety Professional will be consulted for approval to changes in the action levels. The decision to upgrade or downgrade the level of protection allowed in the field will be communicated as appropriate to all site personnel. The decision and justification for the change in level of protection will be recorded in the health and safety logbook.

The SHSP will comply with 29 CFR, Part 1910.132, which states that all PPE for eyes, face, head, and extremities, protective clothing, respiratory protection devices, and protective shields and barriers shall be provided, used, and maintained in a sanitary and reliable condition. PPE is required wherever it is necessary by reason of hazards from processes or environment, chemical hazards, or mechanical irritants encountered in a manner capable of causing injury or impairment in the function of any part of the body through absorption, inhalation, or physical contact.

Respiratory protection is of primary importance in the protection of employee health since inhalation of air contaminants is a potential major route of exposure. The Contractor respiratory protection program is administered pursuant to the requirements established by 29 CFR, Part 1910.134. The SHSS is assigned responsibility as the Respirator Program Administrator for the project. The SHSS may upgrade or downgrade the level of protection based on the hazard anticipated, evaluation of site monitoring data, and established action levels by the SHSP and with the concurrence of the Safety Professional.

The EPA Level categories are as follows:

***Level A*:** Used when the greatest level of skin, eye, and respiratory protection is needed and consists of a totally encapsulated suit with supplied breathing air.

***Level B*:** Used when the highest level of respiratory protection is needed but a lesser level (than Level A encapsulated suit) of skin protection is required.

***Level C*:** Used when criteria for using air-purifying respirators are met and a lesser level of skin protection is required.

***Level D*:** Used only as a work uniform and in an area without respiratory hazards.

Level D protection is used during site reconnaissance, mobilization, geophysical survey, base line surveying, and other activities that have no potential for exposure to chemical hazards. PPE for Level D includes:

- Coveralls, cotton and/or disposable
- Boots, leather or rubber, steel toe and shank, non-slip soles

- Rubber overboots or disposable booties (as required)
- Safety glasses or goggles, face shield when handling liquids
- Hard hat
- Gloves as required by task (e.g., leather work gloves)
- Hearing protection (as required)

Level C protection is used during Resource Conservation and Recovery Act (RCRA) and non-RCRA soil excavation, temporary storage, loading, backfilling and compaction, decontamination of equipment, and other activities where there is a potential for chemical exposure but where that exposure is below permissible exposure levels with the provided PPE. If air-monitoring information dictates that a higher degree of PPE is necessary, levels of protection are increased. PPE for Level C includes:

- Full face-piece air purifying respirator (APR)
- National Institute for Occupational Safety and Health (NIOSH)/Mine Safety and Health Administration-approved APR cartridges (approved for use with the specific types of contaminants)
- Emergency escape respirator (optional, depending on the potential for emergency conditions)
- Coveralls (inner), cotton
- Coveralls (outer), chemical-resistant, disposable (e.g., Tyvek)
- Gloves (outer), chemical-resistant (e.g., nitrile)
- Gloves (inner), cotton or nitrile
- Boots, chemical-resistant, rubber, with steel toe and shank, or leather, with steel toe and shank with chemically resistant rubber overboot, non-slip soles.
- Hard hat
- Hearing protection (optional or as required)

Level B protection is selected and implemented when it is determined through real time air monitoring and/or personnel sampling that the highest level of respiratory protection is necessary for site personnel. This level of protection is also used when the atmospheric contaminant(s) identified does not meet the selection criteria permitting the use of APR or when contaminants are unknown. There is a possibility that this may occur for some Project-specific work.

PPE for Level B includes:

- Pressure-demand, self-contained breathing apparatus (SCBA) or airline respirator (with attached 5-minute escape bottle)
- Coveralls (inner), cotton

- Coveralls (outer), chemical-resistant, disposable (e.g., Tyvek)
- Gloves (outer), chemical-resistant (e.g., nitrile)
- Gloves (inner), nitrile
- Boots, chemical-resistant, rubber, with steel toe and shank, or leather, with steel toe and shank with chemically resistant rubber overboot, non-slip soles
- Hard hat
- Hearing protection (optional or as required).

Subcontractors are responsible for supplying, maintaining, their own PPE according to the manufacturers' procedures and guidelines and their own policies and procedures, which must be at least as protective as required by regulations and those procedures described in this BWHSP.

Most projects usually require the use of either Level D or Level C protection. With each level of protection there is a degree of variability or modification dependent on the specific tasks and the nature and concentration of contaminants. For example, different tasks on the same site may require gloves of different materials, length, or thickness. Variations of a level of protection will be indicated by a qualifier (e.g., "Modified Level D") and specify the modification required. Level A protection, if ever required, will require specific discussion in the SHSP.

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7. AIR, NOISE, AND OTHER MONITORING

The SHSS will conduct monitoring to ensure that each site worker is adequately protected. Required monitoring will be defined in the SHSP. Site monitoring and sampling may include personal air sampling, real-time air monitoring, perimeter monitoring, radiation monitoring, noise monitoring, and heat stress monitoring.

The SHSS shall have experience using the required monitoring or sampling equipment. The Safety Professional shall ensure that each SHSS is qualified to operate all assigned instruments. The SHSS shall ensure that each piece of equipment is properly maintained and calibrated.

Personal sampling requirements will be defined in the SHSP, and will be based on potential airborne hazards and OSHA requirements. Personal sampling methods will be in accordance with NIOSH methods, OSHA instructions, or good industrial hygiene practice when established methods are not available or feasible. A laboratory accredited by the American Industrial Hygiene Association will conduct all laboratory analysis of industrial hygiene samples. Results will be compared to the ACGIH threshold values or OSHA-Permissible Exposure Limits, whichever is more stringent. Results will be communicated to employees in accordance with OSHA requirements. All exposure records will be kept in accordance with 29 CFR, Part 1910.20.

Real-time air monitoring will be used, as appropriate, to identify and quantify airborne levels of hazardous substances and safety and health hazards in order to determine the appropriate level of employee protection needed onsite. Real-time monitoring may be necessary for airborne hazards such as flammable vapors, specific target compounds, organic vapors, and dust. Real-time monitoring requirements will be documented in the SHSP and based on the probability of encountering potential contaminants at each site. The Safety Professional will establish action levels and the action required if levels should be reached or exceeded.

All instruments (both real-time and TWA) shall be calibrated according to the manufacturers' recommendations. All equipment shall be calibrated before and after use. A calibration log shall be kept to record all calibrations.

The SHSP may specify the use of colorimetric tubes for direct reading of specific contaminants. The details will be discussed and action levels established.

The need for radiation monitoring will be established in the SHSP. Radiation monitoring procedures, action levels, and record keeping will be in accordance with 10 CFR, Parts 20 and 29 CFR, Part 1910.1096.

Noise monitoring and hearing conservation requirements will be defined in the SHSP and implemented in accordance with 29 CFR, Part 1910.95.

Heat stress monitoring is used in estimating work loads and establishing work/rest times, based on:

- WBGT instrumentation and calculations,
- monitoring physiological conditions and adjusting work/rest periods, or
- using personnel heat stress monitors.

The SHSS will ensure that all data is documented in logs or logbooks including calibration, types of calibrants used, the manufacturer, model number of instruments used, the date and time of calibration and monitoring events, the area or personnel monitored, the atmospheric conditions and weather, unique site conditions, equipment operating in area, initials of individuals performing the monitoring, and any other information which affects the data or the actions taken based on the data.

8. SITE CONTROL

The PM, Project Superintendent, and the SHSS will implement site control measures at each site. These measures will consist of general site control and specific work location site control. Site control measures are specified in the SHSP for each Project.

General site control measures pertain to the overall site and may include the use of security guards, perimeter fencing, sirens, posting of warning signs, and illumination. These control measures are geared toward visitors and the general public. The Project Superintendent and the SHSS implement control measures as necessary.

Location-specific control measures are designed to control contamination and worker entrance and exit from individual work areas. Prior to the commencement of any onsite work, controlled zones of activity will be established by the SHSS. No person will be allowed on the site without a briefing regarding the hazards of the site. This briefing must be documented and signed by the person receiving the briefing. This will reduce the spread of contamination to off-site areas and protect the health and safety of workers. The controlled zones will be included in one of the following categories:

- exclusion zone—where contamination does or could occur,
- contamination reduction zone—where decontamination will occur, and
- support zone—clean zone outside the contamination reduction zone.

Each work zone will be clearly identified and delineated by cones, rope, fences, signs, or barricades. The SHSS will maintain a site entry log for each site that documents each person entering a work zone . The logs will be kept in the project files.

8.1 Exclusion Zone

The exclusion zone may include all areas within the boundaries of a contaminated work area or merely the areas immediately surrounding the site of intrusive activity. Access points are provided to the exclusion zone. During activities where the possibility of airborne contaminants being carried outside the exclusion zone exists, the exclusion zone will be expanded to include areas of possible contamination. Only designated project team members and authorized government agency personnel shall be allowed in the exclusion zone. All personnel entering the exclusion zone must wear the appropriate level of protection designated for the work area. Personnel must also meet medical surveillance requirements, training requirements, and respirator fit test requirements. All personnel exiting the exclusion zone must be fully decontaminated in the contamination reduction zone.

8.2 Contamination Reduction Zone

All personnel and equipment that may have been contaminated in the exclusion zone will be subject to decontamination in the contamination reduction zone. Temporary or field decontamination stations for personnel and equipment will also be located in the contamination reduction zone as needed. The contamination reduction zone is intended to be a buffer between the exclusion zone and the support zone and will be designed to prevent the transfer of contaminants from the exclusion zone to the support zone and off site. Within this zone is usually located a Contamination Reduction Corridor (CRC). In the CRC, workers will find decontamination equipment, supplies, and stations.

8.2.1 Decontamination Procedures

Personal hygiene practices for field personnel will be described in the SHSP. At a minimum, site workers will be provided with adequate restroom and handwashing facilities and be required to wash exposed areas of the skin (i.e., hands and face) upon exiting potentially contaminated areas. Smoking, eating, or drinking will not be allowed in exclusion zone or contamination reduction zone work areas.

The SHSS is responsible for the functional activities of the decontamination facilities and shower trailer if one is required on the site. The SHSS will train site personnel in the steps used for decontamination. The SHSS will periodically inspect for compliance with decontamination procedures and correct any deficiencies.

Separate areas will be designated for equipment decontamination and personnel decontamination. These areas will be separated to minimize contamination of the personnel in the contamination reduction zone by overspray from equipment decontamination.

8.2.2 Personnel Decontamination

Personnel departing the exclusion zone are required to proceed through a decontamination line. The following decontamination procedure is an example and will be modified to meet site-specific requirements in the SHSP:

Facility 1—Segregated Equipment Drop: Drop equipment onto plastic liner or shelf.

Facility 2—Boot Cover Wash/Rinse and Removal: Wash and rinse outer boot covers with detergent and water. Remove boot covers and discard into proper container for disposal.

Facility 3—Boot Wash/Rinse, Outer Suit Wash/Rinse and Removal: Wash and rinse protective suits. Wash and rinse safety boots. Remove and discard outer suit and place into disposal containers.

Facility 4—Outer Glove Wash/Rinse and Removal: Wash and rinse outer gloves. Remove and discard into disposal container, leaving inner gloves on.

Facility 5—Respirator Removal: Decontaminate, remove, and sanitize respirator and backpack assembly. Place on the table.

Facility 6—Remove Boots and Inner Gloves: Remove boots, then inner gloves and discard inner gloves.

Facility 7—Field Wash: Wash hands and face with water. At shift's end, personnel are then required to enter the decontamination trailer and shower thoroughly (if a trailer and shower are required on the site).

In case of an emergency, gross decontamination procedures will be implemented and the person will be transported to the nearest medical facility immediately at the direction of the SHSS according to the Site Emergency Response Plan (reference Section 12.0). The medical facility will be informed that the injured person is on the way, and has not been fully decontaminated. The medical facilities will be notified of the potential chemicals present and of the exposure-prevention measures that can be used while treating the victim.

A commercial vendor may launder reusable protective clothing (cotton overalls). If the coveralls are contaminated with a hazardous waste, the vendor will be notified of the type of waste.

8.2.3 Equipment Decontamination

Heavy equipment, PPE, monitoring equipment, and sampling equipment may require decontamination. Procedures may be modified based on actual site conditions or Project requirements. Depending on the nature of the contaminant, seats and flooring of equipment and vehicles entering an exclusion zone may need to be covered with disposable plastic such as polyethylene.

Decontamination of heavy equipment (including under carriage, chassis, and cab) will be performed using a high-pressure washer sprayer, and/or steam cleaner and appropriate biodegradable solvents. All equipment will be decontaminated on a pre-constructed decontamination pad designed to collect and store washings. The equipment will first be sprayed and scrubbed with water (and a low-sudsing detergent as required). Secondly, the equipment will be rinsed with water. If persistent contamination exists after cleaning based on visual assessment, other cleaning methods may be necessary. Air filters on equipment used in the exclusion zone will be removed and disposed with the materials used for decontamination if warranted. Depending on the contaminants, a simple scraping and brushing off of the equipment may be acceptable.

Outer PPE (such as protective suits, boot covers, and outer gloves) will be washed and rinsed with trisodium phosphate and water. These items will all be discarded at the end of the day. If they have become grossly contaminated during work operations, they will be changed as necessary during the day. Respirators will be sanitized by rinsing in a germicidal rinse followed by a clean water rinse, then air drying in a clean area.

Each person will be responsible for the gross decontamination of their own respirators at the end of each shift. A thoroughly trained SHSS may perform respirator maintenance, however all repairs must meet manufacturers specifications.

Reasonable precautions will be taken to minimize monitoring equipment contamination. Decontamination will be accomplished using materials that will not damage the instrument(s). Delicate air monitoring and surveying equipment will be wiped off with alcohol or soap and water and protected from contamination when in use.

Sampling equipment used for chemical tests will be cleaned following procedures specified in the Field Sampling Plan (Appendix A) .

If decontamination pads are used, they will be constructed to facilitate containment and collection of all potentially contaminated water and decontamination fluids. The waste liquids will be transferred to appropriate drums, holding facilities, or waste systems. All PPE wastes generated will be bagged, labeled, and stored for offsite disposal or incorporation into other waste materials. The Contractor will store waste in a manner and in an area designated by the facility. In no case will storage exceed 90 days from the start date of accumulation of the waste. Some facilities require that storage not exceed a period of time less than 90 days (e.g., 45 days). Each project manager will ensure that the specific requirements of the facility are followed.

8.3 Support Zone

The support zone will be arranged considering accessibility, utility availability, wind direction, and line-of-sight to work. Included in this area will be the main office trailer, administration area, vehicle parking, security, toilets, water, electricity, and a break/lunch area. The support zone will be outside the contamination reduction zone and will be the area where support workers will provide assistance to workers inside the exclusion zone and contamination reduction zone. The support zone normally will begin at the exit from the decontamination line. Only clean or appropriately containerized equipment, material or personnel can enter the support zone from the contamination reduction zone.

9. MEDICAL SURVEILLANCE PROCEDURES

OSHA requires that site workers participate in a medical surveillance program that meets the requirements of 29 CFR, Part 1910.120(f). The medical surveillance program, shall be instituted for the following employees:

- All employees who are or may be exposed to hazardous substances or health hazards at or above the permissible exposure limits or, if there is no permissible exposure limit, above the published exposure levels for these substances, without regard to the use of respirators, for 30 days or more a year.

- All employees who wear a respirator for 30 days or more a year or as required by 29 CFR, Part 1910.134.

- All employees who are injured, become ill, or develop signs or symptoms due to possible overexposure involving hazardous substances or health hazards from an emergency response or hazardous waste operation.

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10. SAFETY CONSIDERATIONS

The following section presents Best Management Practices and Safety Considerations for site operations. The items specified should be followed and provide practices and rules which will assist in providing employees a safe workplace.

The following practices will be expressly forbidden during field operations:

- Entrance onto the site or into designated restricted area(s) without formal authorization, compliance with medical monitoring and training requirements, and/or compliance with this SHSP.

- Eating, drinking, chewing gum or tobacco, smoking, or any practice that increases the probability of hand-to-mouth transfer and ingestion of material in any area designated as contaminated.

- Approach or entry into areas or spaces where toxic or explosive concentrations of gases, vapors, or dusts exist without prior approval of the SHSS and/or utilization of proper protective equipment.

- Facial hair, which interferes with the satisfactory fit of the mask-to-face seal of respirators, is prohibited for personnel required to wear respiratory protection equipment.

- The use/wearing of personal stereo headphones. Their use may preclude reception of audible warning signals and/or hazard communication.

The following practices are required:

- Personnel and equipment in the contaminated area will be minimized, consistent with effective site operations.

- Equipment shall be bonded and grounded, spark-proof and explosion resistant, as appropriate to minimize or prevent the ignition or flammable materials in the work zone.

- A minimum of two employees, in constant communication (either visual or voice) with each other, will be required to perform any work within the exclusion zone.

10.1 Vehicle And Equipment Operations

Prior to the use of all vehicles and equipment, operators will conduct a safety inspection and record the findings in a Safety Inspection Equipment Checklist. Dust suppressants will be used to the extent possible for controlling airborne dust generation to the extent possible. In addition, vehicular traffic speed on non-paved roads will be restricted to 15 miles per hour. Motor vehicles and material handling equipment assigned to this site shall conform to the requirements of 29 CFR, Parts 1926.601, and 1926.602. Crews utilizing personnel transport vehicles to and from the work site shall use the vehicle's safety belts. Drivers of vehicles shall be responsible for passenger utilization of the safety belts. Personnel are not allowed to ride in the bed of pickup trucks unless there is an approved restraint system installed and used. The Project Superintendent is responsible for maintaining a clean job site free from hazards and for providing safe access and egress from the site. Traffic cones and/or high visibility barrier tape will be utilized, where appropriate, for traffic control into/out of hazardous or restricted. Personnel will wear reflective, orange safety vests whenever working in and around vehicles and on all roads.

Other requirements include the following:

- Whenever the operator leaves the operator's position, the equipment will be turned off, unless the equipment must be kept running to perform required maintenance or safety inspection. (In which case, the operator will assure that the equipment cannot move by placing equipment in "park', by setting the emergency brake or another type of brake, or by placing blades or pans to the ground or any other manufacturer recommended method to keep the vehicle from moving.)
- Blades and buckets on heavy equipment will be lowered during transport. Blades and buckets will be placed on the ground whenever the operator leaves the machine.
- Construction equipment (heavy equipment) has the right-of-way in field activities.
- All heavy equipment will have a reverse signal alarm (90 dBA) that operates automatically with backward movement.
- All equipment will have brakes and brake lights. Equipment operated in hours of darkness must have operating headlights.
- Personnel will not ride on or be on any equipment while it is in motion unless there is a seat or stand designed for a person to occupy and which has restraints such as approved seatbelts.
- Seatbelts and restraints will be used at all times when any equipment is in motion.

10.2 Additional Safety Considerations

The following is a list of precautions to minimize the possibility of injury-related accidents from occurring during field operations.

10.2.1 General Information

- Be aware of your surroundings. Consider what you do in terms of the hazard it may create for others.
- Ask the SHSS if you do not know how or are in doubt as to the safe way of doing your job.
- No running at any time, except in extreme emergencies.
- Throwing of any object at personnel or equipment is prohibited.
- Minimum requirements on construction sites and in shop are long pants, a shirt with the shoulders covered, and good work shoes. Torn, ragged, or frayed items should not be worn because they can catch on obstructions or machine parts, or otherwise cause you to trip or fall.
- Know where emergency exits are, and how to get to them. Do not block them with material or equipment.

10.2.2 Housekeeping

- Clean work areas and storage areas encourage better incident prevention, and make the work easier to do.
- Dispose of trash and scrap in proper containers. This includes lunch papers, soft drink cans, banding straps, wood, rags, paper cups, etc.
- Keep tools, material, and equipment stored in an orderly manner, and in their proper places. This prevents unnecessary damage, and helps you to find them when you need them.
- Keep stored material, scrap, and other tripping hazards out of roads and walkways and away from emergency equipment. If it's in a walkway and it's not moving, it does not belong there.
- Cords, cables, and hoses crossing roads or walkways are to be covered to prevent tripping or damage, or are to be supported overhead, at least 7 ft above walkways, 14 ft above roads.

10.2.3 Fire Prevention

- Control "open flame" tools and equipment.
- Protect nearby combustible materials from heat, flames, sparks, and slag by moving or covering them.
- Keep flammables in closed containers. Use safety cans.
- All site workers will have training on the use of portable fire extinguishers.

10.2.4 Personal Protective Equipment

Head

Hard hats are required at all times on construction sites. They are also required at other locations where overhead hazards exist. Bump hats are not permitted.

Eyes and Face

Spectacle type safety glasses are required when hitting steel on steel, grinding, drilling, sawing, vibrating concrete, etc., or when working near someone else who is creating flying particles.

Boots

At a minimum, workers will wear steel-toe boots (not shoes, boots must be at least up to ankle, with steel shank and non-slip soles. They must be constructed or leather or other chemically resistive material. Suede and cloth is not acceptable.

Safety vests

For the protection of workers, and to make workers more visible, most safety plans require that workers wear brightly colored safety vests. Workers working near roads or other places where there is vehicular traffic must wear safety orange or lime green vests as required by code. During hours of darkness these vests must have reflective tape.

Fall Protection

Safety harnesses and a fall restraint system, such as lanyards, attached to an approved support point are required when working from any support or surface where possibility of falls exist, or where guardrails are not installed.

Tie off to a solid, approved support. Tie off as short as possible allowing no more than a 36 inches for fall.

10.2.5 Hand Tools

- Every tool is designed for a specific use. Do not misuse. Inspect daily for defects.
- Keep tools in proper working condition - clean, sharp, oiled, dressed, and adjusted.
- Mushroomed chisels, drills, etc. cause dangerous flying objects. Keep them dressed.
- Never hit hardened steel with hardened steel, such as hitting a hatchet with a hammer.
- Do not use "cheaters" to increase capacity. Get a bigger sized tool.
- Carry tools in proper sheath, belt bag, or box. Points down.
- Do not carry pointed or sharp tools in any pockets.
- Eye protection is required for protection from flying particles.
- Do not use damaged tools—mark them and tag them as out of service. Give those tools to the Project Superintendent or SHSS.

10.2.6 Power Tools

- Know how to shut it off before turning it on. No locked "on" switches on hand held power tools.
- Eye protection is required for protection from flying particles.
- Power activated tools shall be inspected daily before use for proper operation of their safety devices. You must be authorized by your foreman to operate this equipment.
- All power tools designed to accommodate guards will have guards installed and functioning prior to use.
- Power supply must be properly attached to tool, and to source. Electric tools must be grounded (or "double insulated").
- Check area for other people before starting tool. Warn people nearby.
- Be prepared for jamming of rotating tools. Have good footing, good balance, and watch out for nearby obstructions. Check yourself for loose clothing.

- Shut off and bleed down air hose before disconnecting air tools. Never point an air hose toward another person or yourself.
- Power tools must be GFCI-protected or double-insulated.
- Avoid using power tools in wet locations (air powered tools may be used).
- Protect all cords and plugs from damage. Assure that the power cord is well away from the operating portion of the power tool.
- All power tools must be turned off before disconnecting from power source. If a circuit breaker is tripped or the tool stops operating turn off the power switch before disconnecting the power source.
- Disconnect power cords from source before coiling.
- Refer to Section 4.3.5 regarding the use of extension cords.
- Unplug electric cords.
- Store in safe place when not in use. Protect from weather, dirt, and water.

10.2.7 Material Hoists

- Not to be used for hoisting people.
- Secure material to prevent it from shifting.
- Use tag lines
- Assure that rigging is performed by a person competent in rigging techniques.
- Inspect all rigging before use.

10.2.8 Crane

General

- Know the crane capacity and the weight to be lifted before lifting.
- Be sure air space and walkway are clear before moving bridge or trolley.
- Inspect all rigging before use.
- A competent person must inspect all rigging and the crane before use and certify that crane is safe and positioned properly.
- A positive acting device will be used to prevent contact between the load block or overhaul ball and the boom tip (anti-two blocking device), or a system will be used that deactivates the hoisting action before damage occurs in the event of a two-blocking situation.

Mobile

- Solid footing. Use outriggers with rubber-tired cranes.
- Barricade area of swing of counterweight.
- Keep boom, lines, and loads at least 15 ft away from electric power lines. Minimum distance increases above 50,000 volts. Power lines must be de-energized to work closer than the minimum distance.
- The operator shall avoid swinging loads over workmen's heads. Only one signalman at any one time.
- Equipment shall be inspected before each use and all deficiencies corrected before further use.

10.2.9 Forklifts

- You must be authorized by your supervisor before operating this equipment.
- Keep forks spread as far apart as possible. Check stability of load before moving it.
- Look in direction of travel before moving and during moving. Watch out for overhead hazards.
- Back downgrades when carrying a load.
- No riders, unless a passenger seat is provided.
- Forks are not to be used as an elevator or as a work platform.
- Lower forks all the way down before leaving the equipment.
- Do not drive along the edge of raised docks, platforms, or ramps.

10.2.10 Mechanical Material Handling

- Know the weight of the load to be moved.
- Know the capacity of the equipment to be used to move the load.
- Use tag lines to control the load. Keep tag line free of your body, and free of obstructions during movement of the load.

10.2.11 Manual Material Handling

- Leg muscles are stronger than back muscles. Lift with your legs not your back. Bend knees, keep back straight, tighten abdomen, using legs, make a smooth controlled lift.
- Plan before you lift—consider weight, size, shape, path of travel, and set down location. Get help if necessary.

- Protect your hands and fingers from rough edges, sharp corners, metal straps. Keep hands and fingers out of pinch points between the load and other objects.

10.2.12 Overhead Work

- No one is to be unprotected under overhead work.
- Erect barricades, signs, or other devices to warn people of the work overhead. Respect the barricades or signs put up by others.
- Covered walkways are needed where people must pass under overhead work.

10.2.13 Portable Ladders

General - All Portable Ladders

- Inspect for defects. When defects are found, the ladder is to be withdrawn immediately from use. Set ladder feet on solid foundation.
- Only one person is allowed on a ladder at one time.
- Use ladders for climbing—not for material skids, walkways, or workbenches.
- Face the ladder while climbing up or down, and while working from it. Use safety harness or fall protection when falls are possible.
- Both hands are needed for climbing. Use a hand line for material.
- No metal ladders are to be used.
- Store safely to prevent damage from vehicles, materials, etc.
- Straight and Extension Ladders
- Correct slope of ladder is 1:4.
- Secure ladder from slipping. Non-slip feet on bottom, and tie off with rope at top.
- Extend ladder three ft above top landing where ladder is to be used for access to the landing.
- Extension ladders cannot exceed 30 ft.
- Do not take extension ladders apart to get two ladders.
- Keep hands off rungs while extending or lowering extension section. Be sure latches are in place before climbing.

Stepladders

- Open fully. Lock spreaders. Do not use as a straight ladder.
- Do not stand or step on top platform.

- Keep loose tools off steps and top platform.
- Tie off stepladder if longer than 12 ft.
- Step ladders cannot exceed 20 ft in height.

10.2.14 Compressed Gas Cylinders

- Always keep cylinders upright. Tie off vertically with strong wire, rope or chain, or keep chained in cylinder cart.
- Do not drop or roll the cylinders.
- Use a rack for lifting cylinders to and from upper elevations. Never lift a cylinder by the control valve or a valve cover.
- Always replace valve covers when gauges are removed. Valve covers must be placed on all cylinders before they are moved.
- Store oxygen cylinders 20 ft away from other cylinders, or separate by a solid approved divider. Do not store any cylinders inside a building.
- Keep oil and grease away from oxygen valves.
- Cylinders are to be kept at a safe distance or shielded from welding and cutting operations. They are not to be placed where they can contact an electric circuit.
- Acetylene cylinders must always be stored upright.
- Use only regulators specifically approved for the type of gas in the cylinder (read the front of the gauges for this information). Never modify regulators or use adapters.

10.2.15 Welding and Burning

Electric

- Proper eye protection with shading will be worn.
- Keep leads out of walkways.
- Shield arcs to protect others from direct arc rays.
- Remove rod from electrode holder before laying it down. Put rod butts in a container, not on the floor.
- Proper grounding from work to machine is a must.
- Turn off machine at end of shift.

Gas

- Proper eye protection with shading will be worn.

- Keep hoses out of walkways.
- Check area-sides and below for possible fire hazards.
- Remove gauges at end of shift and replace cap on cylinder. Toolboxes used to store hose and gauges are to be ventilated.
- Use soapy water when checking for leaks.
- Before using fuel gas cylinders:
- Always crack cylinder valve before connecting gauges to clear dirt.
- Open cylinder valve slowly and leave wrench in position while cylinder is in use.
- A regulator shall always be used on fuel gas cylinders.
- The cylinder valve shall always be closed before removing regulator.
- When fuel gas cylinders connected to gauges have a leak it will be repaired or removed from service and stored away from the work area.

10.2.16 Electricity

Refer to Section 4.3.5 for additional details on electrical safety.

- All electrical work will be performed by qualified persons familiar with the NEC and other applicable codes.
- Temporary lighting circuits require guards over the bulbs. Metal guards must be grounded.
- Keep extension cords out of water, and at least seven ft above walkways.
- Disconnect switches must be labeled to show the equipment or service they feed. Check before operating.
- Always shut down electrical equipment before servicing, repairing, or investigating questionable function.

10.2.17 Decontamination

Personnel

- Do not walk through areas of obvious or known contamination.
- Do not handle or touch contaminated materials directly.
- Make sure all personal protective equipment has no cuts or tears prior to donning.
- Fasten all closures on suits, covering with tape, if necessary.

- Particular care should be taken to protect any skin injuries.

- Do not carry cigarettes, gum, etc., into contaminated areas.

Heavy Equipment

- Take care to limit the amount of contamination that comes in contact with heavy equipment.

- If contaminated tools are to be placed on non-contaminated equipment for transport to the decontamination pad, use plastic to keep the equipment clean.

10.2.18 Illumination

All work onsite, when performed outdoors, must be performed during daylight hours only (½ hour after sunrise to ½ hour before sunset). If work must be performed during hours of darkness or inside buildings, the project will insure that additional lighting is provided to meet the requirements of 29 CFR, Part 1910.120.

10.3 Ergonomic Considerations

Routine activities at the project may involve tasks that, by their nature, may subject personnel to unexpected ergonomic stresses. Examples of ergonomic stresses include:

- Muscular sprains and strains.

- Musculo-skeletal trauma from impacts or vibrations.

- Fatigue due to extended work schedules.

Caution and workload awareness should be exercised by all site personnel during project activities. Tasks which involve manual manipulation of sampling devices, chemical storage drums, shoveling, and/or prolonged exposure to vibrating mechanical equipment should be monitored by the individuals involved with them to preclude the adverse effects of ergonomic stress. The SHSS should evaluate ergonomic stress and establish control methods, such as tool selection, PPE, and task rotations.

11. DISPOSAL PROCEDURES

A Waste Management Plan usually describes the handling of wastes from the project site and the management of all decontamination liquids and disposable clothing and supplies that have come in contact with contaminated materials. Refer to Appendix E, The IDW Management Plan for detailed disposal procedures. The Contractor will arrange for the proper disposal of all decontamination fluids, contaminated debris, soil and other waste per contract requirements. In no case will accumulation be allowed to exceed 90 days from the date that the accumulation started. If a separate waste management plan is not prepared the SHSS will include a detailed discussion on how each waste stream is managed.

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12. EMERGENCY RESPONSE PLAN

There are numerous emergency services nearby in the civilian community. This plan describes response activities as they apply to Kirtland AFB. Site-specific response procedures, if any different, will be discussed in the SHSP. Certain information will always be repeated in every SHSP to ensure that the information is readily available and "on top." For example, every SHSP will have a table that lists all the emergency contact numbers and the map to the nearest medical facilities.

12.1 Responsibilities

The Project Superintendent or PM, is the primary emergency coordinator for the project. In the absence of either or both the Project Superintendent and the PM, the SHSS is the emergency coordinator. The emergency coordinator will take charge and determine, direct and delegate personnel and resources to manage the emergency. Key responsibilities of the emergency coordinator are to:

- Initiate evacuation, if needed.
- Initiate emergency response agency notification.
- Evaluate and assess emergency situation to insure that response activities are commensurate with the level of the emergency and as discussed in this plan are implemented.
- Interface and coordinate with outside agencies responding to onsite emergencies.

12.2 Communications

Personnel shall maintain verbal communication with each other. The following communications systems will be available during site activities:

- Cellular telephone or access to a land phone for emergency purposes.
- Hand held radios, as needed.
- Compressed air horn (signals emergency evacuation only) at the site.
- Hand signals, if used, will be diagrammed and posted.
- Posted location of evacuation assembly area(s).
- Posted route to the nearest hospital for the project site.
- Posted emergency phone numbers.

12.3 Accident/Incident Report

After the emergency event is over or during the course of the emergency when possible, the SHSS will notify the Safety Professional by telephone. Should an accident or incident occur, the Project Superintendent or PM and the SHSS will immediately investigate the cause, notify the Safety Professional, and promptly complete any contractually-required incident report and investigation forms.

Any recommended additional hazard control measures must be discussed with the Project Superintendent, the SHSS, and the Safety Professional and meet their approval, prior to implementation. Any occupational injuries and illnesses will be recorded, if applicable, on an OSHA Form No. 300. The SHSS shall report immediately by telephone or telegraph to the nearest OSHA office. Any serious injury or illness resulting in the hospitalization of 3 or more employees, or the death of an employee occurring in a place of employment, or in connection with any employment. Immediately means as soon as practically possible but not longer than 8 hours. Records of all site accidents and first aid treatments will be maintained by the SHSS.

12.4 Pre-Emergency Planning

Prior to performing any work the Project Superintendent or PM and the SHSS will verify all emergency action plans by insuring that planned support facilities are available and that emergency contact numbers are valid. As work proceeds the SHSS will continue to insure that plans specified in this section can be implemented at all times. Furthermore, the SHSS will constantly insure that plans are modified as necessary to accommodate changes. The SHSS will coordinate all changes with the Safety Professional. Upon arrival at the site, the Project Superintendent will ensure that all personnel know the system for communication of emergency situations and how to use a radio or nearby phone to summon emergency assistance. A vehicle must be available to transport personnel to safe locations or to hospitals. All personnel on this project will know how to use a portable fire extinguisher. All personnel will know the location of all emergency equipment and supplies. The SHSS will assure that emergency equipment is available in the work areas as specified by site specific plans and that the equipment is inspected as required by regulations and Contractor policies:

- Fire extinguishers—monthly, annual refill and servicing, seven-year hydrotest
- First aid kits—monthly
- Eyewashes—weekly, if preservative is used eyewash water may be changed every four months, otherwise, water must be changed weekly. Only potable water may be used for eyewashes.

12.5 Emergency Medical Treatment

The following procedures should be observed if an accident with injury occurs:

12.5.1 First Aid

Only qualified personnel shall provide first aid and stabilize an individual needing assistance. Life support techniques such as cardiopulmonary resuscitation (CPR) and treatment of life threatening problems such as airway obstruction and shock will be given top priority. The SHSS will be current in First Aid and CPR. Professional medical assistance shall be obtained at the earliest possible opportunity. The nearest hospital to the project site shall be shown on a map that is part of every SHSP.

12.5.2 Minor Injury

- Contact a supervisor or "buddy."
- Have qualified first aid personnel treat injury.
- Record injury and include name of injured person, nature of injury, and treatment given.

12.5.3 Medical Emergency

In the event of a medical emergency when actual or suspected serious injury occurs, the following procedures shall be implemented:

- Survey scene and evaluate whether the area is safe for entry.
- Remove the exposed or injured person(s) from immediate danger.
- Render first aid if necessary. Decontaminate affected personnel after critical first aid is given.
- Obtain paramedic services or ambulance transport to local hospital. This procedure shall be followed even if there is no visible injury.
- Call 911 from phones on Kirtland AFB. Call 853-9111 from cell phones.
- Identify location by number of nearest building, request medical assistance, provide name and telephone number.
- Request assistance from emergency medical service and/or additional assistance.

  Other personnel in the work area shall be evacuated to a safe distance until the Project Superintendent determines that it is safe for work to resume. If there is any doubt regarding the condition of the area, work shall not commence until all hazard control issues are resolved.

- Notify Kirtland AFB RPM, PM, and Safety Professional of incident and fill out accident reporting forms and associated documents, per contractual requirements.

12.5.4 Fatal Injury

If a fatal injury occurs, the following additional steps will be followed:

- Notify the Project Superintendent immediately.
- Notify Safety Professional who will initiate contact with OSHA and other appropriate agencies.
- Notify Kirtland AFB RPM and PM
- All work activities on the project must be stopped on the project for 24 hours.

12.6 Decontamination During Medical Emergencies

Any personnel requiring emergency medical attention shall be evacuated immediately from exclusion and contamination-reduction zones. Personnel shall not enter the area to attempt a rescue if their own lives would be threatened. The decision whether or not to decontaminate a victim prior to evacuation is based on the type and severity of the illness or injury and the nature of the contaminant.

For some emergency victims, immediate decontamination may be an essential part of life saving first aid. For others, decontamination may aggravate the injury or delay life saving treatment. If decontamination does not interfere with essential treatment, it should be performed.

- If decontamination can be performed:
- Wash external clothing and cut it away.
- Wrap victim in clean blanket or towel if necessary.
- If decontamination cannot be performed:
- Wrap the victim in blankets or plastic to reduce contamination of other personnel.
- Alert emergency and off-site medical personnel to potential contamination; instruct them about specific decontamination procedures.
- Send along site personnel familiar with the incident.

12.7 Emergency Site Evacuation Procedures

In the event of an emergency situation such as fire or explosion, the SHSS or a supervisor will activate an air horn for approximately 15 seconds indicating the initiation of evacuation procedures. All personnel in both the restricted and non-restricted areas will evacuate and assemble near the support zone or other safe area as identified by the SHSS. Prior to start of work at any project site the SHSS will identify and mark the location of an evacuation assembly area for that project site. The location should be upwind of the site as determined by the wind direction. For efficient and safe site evacuation and assessment of the emergency situation, the Project Superintendent or SHSS will have authority to initiate proper action if outside services are required. Under no circumstances will incoming personnel or visitors be allowed to proceed into the area once the emergency signal has been given. The SHSS must ensure that access for emergency equipment is provided and that all equipment that may cause combustion has been shut down once the alarm has been sounded. As soon as possible, and while the safety of all personnel is confirmed emergency agency notification will commence. The SHSS will brief site personnel each day as to the location of the evacuation assembly area.

Prior to the start of each project work site the SHSS will establish safe egress routes from the site to the evacuation assembly area. The SHSS will prepare a drawing or map that diagrams these safe egress routes. The SHSS will use this same map to diagram egress from the evacuation assembly area to the facility gate to be used as an exit. From this point, the map showing the route to the nearest clinic and the nearest hospital will be used if medical services are required.

12.8 Fire Prevention And Protection

Fire prevention and protection measures require pre-planning. At least one 20-pound dry chemical ABC fire extinguisher will be located at each project site. A mounted fire extinguisher is required in every vehicle including heavy equipment. Extinguishers mounted on heavy equipment will be a minimum 5-pound ABC dry chemical fire extinguisher. Fire extinguishers inside the cab of pickup trucks will be 2½ -pound dry chemical ABC. Fire extinguishers in the cabs of all vehicles must be mounted or secured. Employees will follow safe work practices to include proper storage of flammable and combustible liquids. Smoking is permitted only in those areas designated specifically by the project manager, Project Superintendent or SHSS. Personnel will follow hot work procedures to insure that work is performed in a safe environment. In the event of a fire or explosion, summon the Fire Department immediately, take a head count and implement evacuation procedures.

12.9 Spill Control And Response

All spills, leaks, and fires involving oil or hazardous substances at Kirtland AFB must be reported to the to the Kirtland AFB RPM and the Safety Professional. The person reporting the leak, spill, etc. is required to provide the following information:

- His/her name
- Location of spill and facility number, if known
- Number of injured personnel and nature of injuries, if known
- Substance spilled
- Amount spilled (estimate)
- Extent of spill
- Rate that substance is currently being released (estimate)
- Time spill occurred (estimate)
- Any other pertinent information

The Kirtland AFB RPM in coordination with the PM will manage notifications to regulatory agencies. Project personnel will not report spills directly to any agency unless specifically requested by the Kirtland AFB RPM or Contracting Officer.

A minor spill would involve no immediate threat to human health or the environment, minimal property damage, and does not exceed the reportable quantity for that material. In the event of a minor spill, the appropriate response action is for the responsible person to notify the Kirtland AFB RPM and the PM and supply the responders with as much information as possible. In the case of a spill of contaminated or hazardous materials, the following procedures shall be followed:

- Notify the Project Superintendent
- Identify protective clothing or equipment required to respond
- Contain the spill
- Neutralize and/or solidify any product
- Transfer material into 55-gallon drums
- Document incident

Release Prevention and Minimization Measures

In addition to training, the following procedures will be implemented to prevent and minimize releases of hazardous materials:

Do not conduct hazardous materials operation when the weather could cause significant risk to surrounding area if a spill should occur.

Transfer all materials in or over a bermed or "protected" area. A protected area is one that is covered with an impermeable material, such as polyethylene.

Dike temporary storage tanks containing hazardous wastes or potentially hazardous wastes to contain potential releases.

Maintain a supply of basic spill response materials and protective equipment onsite to include:

- Absorbent sheets, pillows, booms or absorbent material
- Open top 55-gallon drums or other containers with lids
- Booms, shovels, and other tools, such as squeegees

12.10 Significant Vapor Release

Any project activity which releases significant amounts of vapor must be reported immediately as described in the spill release procedure. Every attempt to mitigate the release must be taken if it can be safely performed. For example, during excavations vapor releases may be controlled by simply replacing cover on the excavation. Down-wind evacuation procedures may be required. These will be initiated through coordination with Kirtland AFB emergency coordinators.

12.11 Emergency Equipment

The following emergency equipment will be brought onto the site or will be stationed near each work area:

- Fire extinguisher, minimum one 20-pound dry chemical ABC type in the CRC at the edge of exclusion zone.
- Industrial first aid kit, in the CRC, at the edge of the support zone.
- Portable eye wash, capable of supplying 15 minutes of water and protected from direct sunlight in the support area, at the edge of the support zone.
- Air horn at the support area, at the edge of the support zone.
- Spill control material consisting of absorbent pillows or absorbent material and shovels, plastic sheeting, and 55-gallon drum(s) in the support zone by the CRC entrance.

The following equipment will be available at the support trailer for use in an emergency situation:

- Industrial first aid kit
- Blanket

Each SHSP may specify additional emergency equipment consistent with the hazards associated with the Project. For example, some projects may require that SCBAs be available for work on projects where exposure to contaminants may require their use.

12.12 Postings

Emergency contact names and phone numbers will be posted at every project site. A map showing egress routes, evacuation assembly areas, and the route to the clinic and the hospital will also be posted. At some remote locations, posting may not be practical. In this case, the contact names, phone numbers and maps will be placed on the dashboard of every vehicle. These postings and maps are prepared for each SHSP.

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13. TRAINING

In accordance with 29 CFR, Part 1910.120, hazardous waste site workers shall, at the time of job assignment, have received a minimum of 40 hours of initial health and safety training for hazardous waste site operations unless excepted by the above reference. As a minimum, the training shall have consisted of instruction in the topics outlined in the above reference. Personnel who have not met the requirements for initial training shall not be allowed to work in any site activities that may expose them to chemical or physical hazards.

An employee's prior experience and/or training for equivalency may be considered to meet the training described above. The Safety Professional will make the determination if previous experience and/or training meet the initial training requirements.

In addition to the required initial training, each employee shall have received three days of directly supervised on-the-job training at a hazardous waste site. This training shall have addressed the duties the employees are expected to perform and be properly documented. The Contractors Project Superintendent has the responsibility for ensuring that personnel assigned to field sites comply with these requirements.

13.1 Manager/Supervisor Training

In accordance with 29 CFR, Part 1910.120, onsite managers and supervisors directly responsible for, or who supervise employees engaged in hazardous waste operations, shall receive training as required above and at least 8 additional hours of specialized training on managing such operations by the time of job assignment.

13.2 Annual 8-Hour Refresher Training

Annual 8-hour refresher training will be required of all hazardous waste site field personnel to maintain their qualifications for fieldwork. The following topics will be reviewed: toxicology, respiratory protection—including air purifying devices and SCBA—medical surveillance, decontamination procedures, and personal protective clothing. In addition, topics deemed necessary by the SHSS or Safety Professional may be added to the above list.

13.3 Site-Specific Training

Prior to commencement of field activities, the SHSS will provide site-specific training to all personnel assigned to the site; this training will specifically address the activities, procedures, monitoring, and equipment for the site operations. Training will include site and facility layout, hazards, and emergency services at the site, hazard communication, and will highlight all provisions contained within the SHSP. This training will also allow field workers to clarify anything they do not understand and to reinforce their responsibilities regarding safety and health for their particular activity. Additional training, if required for completion of field tasks during the site work, will be identified and provided for personnel as the work progresses.

13.4 Onsite Safety Briefings

Project personnel and visitors will be given daily onsite health and safety briefings by the SHSS, or designee, to assist site personnel in safely conducting their work activities. This training will be conducted prior to the start of new work activities using AHAs. The briefings will include information on new operations to be conducted, changes in work practices, or changes in the site's environmental conditions. The briefings will also provide a forum to facilitate conformance with safety requirements, and identify performance deficiencies related to safety during daily activities or as a result of safety inspections.

13.5 First Aid and CPR

The SHSS will identify those individuals requiring first aid and CPR training. At a minimum, the SHSS will have received first aid and CPR training.

14. LOGS, REPORTS, AND RECORDKEEPING

The following is a summary of health and safety required record keeping.

14.1 Medical And Training Records

Full medical and training records are normally kept by the employer. Proof of the most recent training and medical qualification must be provided to the SHSS by the employee. The SHSS will keep a file containing appropriate training and medical qualifications for site workers. Medical records will be maintained in accordance with 29 CFR, Part 1910.20.

14.2 Exposure Records

Any personal monitoring results, laboratory reports, calculations, and air sampling data sheets are part of an employee exposure record. These records will be kept in accordance with 29 CFR, Part 1910.20.

14.3 OSHA Form 300

An OSHA Form 300 (Log of Occupational Injuries and Illnesses) will be kept at the project site. All recordable injuries or illnesses will be recorded on this form. At the end of the project, the original will be sent to the Contractor records coordinator for maintenance. Subcontractor employers must also meet the requirements of maintaining an OSHA 300 form. The Contractor accident/incident report meets the requirements of the OSHA Form 301 (Supplemental Record) and must be maintained with the OSHA Form 300 for all recordable injuries or illnesses. Every year from March 1 through April 30, a contractor must post an OSHA Form 300A (Summary of Work Related Injuries and Illnesses).

14.4 Material Safety Data Sheets

MSDS will be obtained and kept on file at the project site for each hazardous chemical brought to, used, or stored at the site. An MSDS for each contaminant will also be maintained. The MSDS will be kept on file by the SHSS at the project site.

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15. FIELD PERSONNEL REVIEW

All personnel are required to be trained in this BWHSP and the SHSP. Upon completion of this training and review, all project personnel will acknowledge this training by signing a SHSP review form.

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16. REFERENCES

Occupational Safety and Health Guidance for Hazardous Waste Site Activities, U.S. Department of Health

10 CFR, Part 20, Nuclear Regulatory Commission.

Threshold Limit Values (TLVs) for Chemical Substances and Physical Agents and Biological Exposure Indices, American Conference of Governmental Industrial Hygienists (ACGIH), most current publication.

29 Code of Federal Regulations (CFR), Part 1910, Occupational Safety and Health Standards, General Industry.

29 CFR, Part 1926, Occupational Safety and Health Standards, Construction Industry.

U.S. Army USACE of Engineers (USACE) Safety and Health Requirements Manual, EM 385-1-1, 3 September 1996.

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APPENDIX G

Construction Quality Assurance/Quality Control Plan

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CONTENTS

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1. INTRODUCTION TO CONSTRUCTION QUALITY ASSURANCE/QUALITY CONTROL PLAN

This Base-Wide Construction Quality Assurance/Quality Control (QA/QC) plan has been prepared as part of the Kirtland Air Force Base (AFB) Base-Wide Plan (BWP) required to support environmental restoration activities at Kirtland AFB in Albuquerque, New Mexico. Environmental Restoration activities include Resource Conservation and Recovery Act (RCRA) interim corrective measures, voluntary corrective measures, and corrective measures implementation.

This Plan combines the U.S. Army Corps of Engineers, Omaha District, Construction Quality Assurance Plan with the Air Force Center for Environmental Excellence Construction Quality Assurance and Quality Control system requirements to form a set of common requirements commensurate with the scope and nature of services planned for individual projects.

The Construction QA/QC Plan shall be prepared in accordance with the requirements and guidelines established by the USAF in conjunction with contractor working for the USACE and AFCEE. Minimum components of the Plan shall include:

- Project Scope
- Responsibility and authority of project personnel.
- Construction quality assurance personnel qualifications
- Inspection activities
- Monitoring tests and observations
- Sampling requirements
- Any required submittals or documentation

2. SUBMITTALS

Required submittals may consist of the following types:

Data—Submittals that provide calculations, descriptions, or documentation of the work.

Drawing—Submittals that graphically show the relationship of various components of the work: schematic diagrams of systems and details of fabrication layouts of particular elements, connections, and other relational aspects of the work.

Instruction—Preprinted material that describes the installation of a product, system, or material, including special notices and material safety data sheets concerning impedances, hazards and safety precautions.

Schedule—Tabular lists showing the location, features, or other pertinent information regarding products, materials, equipment, or components to be used in the work.

Statement—A required document that confirms the quality or orderly progression of a portion of the work by documenting procedures, acceptability of methods or personnel, qualifications or other verifications of quality.

Report—Reports of inspections or tests, each property identified, and an interpretation of results that includes a description of test methods and all results.

Certificate—Statement signed by an official authorized to certify on behalf of the manufacturer of a product, system, or material, attesting that the product, system, or material meets specified requirements. The statement must be dated after the award of this contract, must state the contractor's name and address, must name the project and location, and must list the specific requirements that are being certified.

Sample—Samples, including both fabricated and unfabricated physical examples of materials, products, and units of work as complete units or as portions of units of work.

Record—Documentation to record compliance with technical or administrative requirements.

Plans—Work Plans, Construction QC Plans that document work practices to be performed during the construction activities.

Submittal requirements shall be in accordance with the technical specifications and Project Specific Work Plan. The following requirements apply to all submittals:

- Units of weights and measures will match those used in the technical specifications.

- Proposed deviation from the technical specifications will be clearly identified.

APPENDIX H

Permitting Plan

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CONTENTS

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1. PERMIT CONSIDERATIONS

The purpose of this section is to identify standard environmental regulatory permit requirements that apply to typical contractor environmental investigation and remediation activities at Kirtland AFB. A table of various permit requirements from the Federal, state, local, and base-specific level is provided in this section to be used as a guide for identifying applicable or relevant and appropriate permits for various contractor activities conducted at Kirtland AFB (See Table 1). The table is set-up to provide the permit requirements for certain environmental actions along with a description as to when they apply. Table 1 also provides a Kirtland AFB and regulatory agency point-of-contact that can give further information relating to the specific permit requirements for the referenced activity.

It is noted that certain actions conducted under the Environmental Restoration Program (ERP) at the base, which was initially managed under the United States Air Force (USAF) ERP, may not require administratively securing the requisite permit. However, the substantive aspects of the permit conditions would need to be met. The ERP was subsequently integrated with the United States Environmental Protection Agency's (EPA) Resource Conservation and Recovery Act (RCRA) corrective action program. Many sites are included under the base's ERP as Solid Waste Management Units. ERP activities are implemented in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and response procedures consistent with the National Contingency Plan.

Under CERCLA, Executive Order 12580, and the Defense Restoration Program (10 United States Code Section 2701, et seq.), the Department of Defense has delegated USAF "lead agency" in responding to hazardous substance and other pollutant and contaminant releases. Because these projects are under the ERP, there is certain flexibility regarding permitting requirements. Specifically, no federal, state, or local permits are required for onsite response actions conducted pursuant to CERCLA. The term "onsite" means the areal extent of contamination and all suitable areas in very close proximity to the contamination necessary for implementation of the response action. Nevertheless, on a site specific basis, the Kirtland AFB project manager should be consulted to determine whether a proposed action is to be conducted under the permit exemption or whether it necessitates filing for and/or obtaining the appropriate permit as identified in Table 1. Sometimes, it takes applying for and securing a permit to accurately identify all of the substantive permit requirements and conditions to be met.

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Permit Type	Agency Contact	KAFB Contact	Comments	Project Type
Special Bulk Storage User Permit State of New Mexico Taxation and Revenue Department, Special Tax Programs and Services Section	Elaine Rodriguez (505) 827-0725		For storage of bulk fuel onsite to be used only for non-highway vehicles/equipment	Remediation/Construction
EPA Storm Water Construction NPDES General Permit	Brent Larsen (EPA) (214) 665-7523	Pat Montaño (505) 846-8577	For construction activities disturbing >1 acre. Will require preparation of a Storm Water Pollution Prevention Plan (SWPPP), filing a Notice of Intent (NOI) at least 48 hours prior to commencing construction, and filing a Notice of Termination (NOT) when the project is complete.	Remediation/Construction
NPDES Discharge Permit	NMED - Water and Waste Management Division, Surface Water Quality Bureau (505) 827-0187	Pat Montaño (505) 846-8577	For discharge of effluent to creek, stream, arroyo, or other surface water body	Remediation/Construction
Bernalillo County Surface Disturbance Permit	Charles Aragon Albuquerque Environmental Health Department - Air Quality Division (505) 768-1951	Bob Flint / Matt Nida (505) 846-2808/853-3098	For construction activities disturbing site > 3/4 acre. Cost of the permit is $100 per acre. Permit must be applied for at least 10-days prior to construction.	Remediation/Construction and Investigation
Liquid Waste Permit	Larry Gutierrez NMED - Field Operations Division (505) 841-9450	Bob Flint / Matt Nida (505) 846-2808/853-3098	For in-ground septic tanks, new installations or modification(s) to existing systems.	Remediation/Construction
Holding Tank Permits		Bob Flint / Matt Nida (505) 846-2808/853-3098	In lieu of installation of septic tank	Remediation/Construction
Section 404 Permit from USACE	Steve Purdy, PE (USACE)		For wetlands impacts (dredging or filling)	Remediation/Construction
RCRA TSDF Part B Permit for treatment, storage or disposal of Hazardous Waste		CEVR Project Manager	For copy of existing permit.	Remediation/Construction

Permit Type	Agency Contact	KAFB Contact	Comments	Project Type
Spill Prevention Control and Countermeasure (SPCC) Plan		Pat Montaño (505) 846-8577	For storage of fuel hydrocarbons in excess of 1,320 gallons at one location. Will require preparation of an SPCC Plan.	Remediation/Construction
Air Emissions Permit (Source Registration, Permit-to-Construct, General Operating Permits)	Albuquerque Environmental Health Department - Air Quality Division (505) 768-1930	Jackie Carns (505) 846-8781	Source registration is required for remediation systems with air emissions (e.g. air strippers, SVE units, etc.) of more than 2,000 pounds per year of any air contaminant or emissions of any amount of a hazardous air pollutant. Authority-to-Construct permits have different emission threshold requirements depending on the constituents being emitted.	Remediation/Construction
Industrial Waste Discharge Permit		Pat Montaño (505) 846-8577	For discharge of wastewater to POTW	Remediation/Construction and Investigation
KAFB Dig Permit (AF Form 103)	New Mexico One Call (505) 260-1990	Ray Perez (Chugach Management Services) (505) 846-9091	Covers Kirtland AFB utilities, pavements, environmental, etc. Required from Kirtland AFB Civil Engineering prior to commencement of excavation or grading activities. Allow 2 to 3 days for completion. Must also call New Mexico One call	Remediation/Construction and Investigation
NEPA Permits / Cultural Resource Permits (AF Form 332)		Valerie Butler (505) 846-8840	Submit with Form 103 (Dig Permit)	Remediation/Construction and Investigation
Sandia National Laboratories Dig Permit	Mike Jamael (505) 844-9390 Troy Hart, Facilities Environmental Support (505) 845-0836		Generally only required for certain areas of Kirtland AFB although it is recommended obtaining SNL clearance for all areas when boundaries are questionable.	Remediation/Construction and Investigation
Petroleum Storage Tank Permitting, installation or removal	NMED Petroleum Storage Tank Bureau (505) 984-1741	Pat Montaño (505) 846-8577	For projects involving the installation or removal of petroleum storage tanks.	Remediation/Construction and Investigation
Discharge to Albuquerque Sanitary Sewers		Bob Flint / Matt Nida (505) 846-2808/853-3098	e.g. Discharge of monitoring well purge water to sanitary sewer	Remediation/Construction and Investigation

Permit Type	Agency Contact	KAFB Contact	Comments	Project Type
Hot Work Permit (AF Form 592)	Kirtland AFB Fire Department, (Inspectors) Gabe Moreno (505) 853-6699		For any site activities involving welding, cutting and brazing.	Remediation/Construction and Investigation
Authority to Construct Permits (Air Quality)		Jackie Carns (505) 846-8781	For portable generators	Remediation/Construction
Pollution Control Groundwater Well Permits	New Mexico Office of the State Engineer – Water Rights Unit – District 1, Albuquerque (505) 764-3888		For wells employed in pollution control (e.g. pump and treat wells). Permit is also required from Water Rights Unit District 1 for reinjection of treated groundwater.	Remediation/Construction
Title V Air Permits		Jackie Carns (505) 846-8781		Remediation/Construction

NOTES:

EPA - Environmental Protection Agency
AFB - Air Force Base
NMED - New Mexico Environmental Department
NPDES - National Pollutant Discharge Elimination System
SPCC – Spill Pollution Control and Countermeasures
SWPPP – Stormwater Pollution Prevention Plan
USACE - United States Army Corp of Engineers

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APPENDIX I

Community Relations Plan

(To be provided at a later date)

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APPENDIX J

Land Use Plan

(To be provided at a later date)

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APPENDIX K

Document Content and Style Guide

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