KIRTLAND AIR FORCE BASE
ALBUQUERQUE, NEW MEXICO

Phase II Remediation Interim Measures Plan
Soil-Vapor Extraction Treatment System Design

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

December 2012

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SOIL-VAPOR EXTRACTION TREATMENT SYSTEM DESIGN

BULK FUELS FACILITY SPILL
SOLID WASTE MANAGEMENT UNITS ST-106 AND SS-111
KIRTLAND AIR FORCE BASE, NEW MEXICO

December 2012

Prepared for
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This Plan describes the Phase II interim measures remediation activities for the final design and operation of a catalytic oxidation soil vapor treatment system. Quarterly monitoring data from previous quarters were used to optimize the system design, and follow-on quarters of monitoring will be used to inform system operation and optimization. Additionally, data collected during the operation of this system will be used to inform any future remediation operations at the project site. The system will be installed in accordance with applicable state and local requirements and the approved engineering drawings included in this report.

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PREFACE

This Phase II Remediation Interim Measures Plan for Soil-Vapor Extraction Treatment System Design has been prepared by Shaw Environmental & Infrastructure, Inc. (Shaw) for the U.S. Army Corps of Engineers (USACE), under Contract W912DY-10-D-0014, Delivery Order 0002. It pertains to the Kirtland Air Force Base Bulk Fuels Facility Spill, Solid Waste Management Units ST-106 and SS-111, located in Albuquerque, New Mexico. This report was prepared in accordance with all applicable federal, state, and local laws and regulations, including the New Mexico Hazardous Waste Act, New Mexico Statutes Annotated 1978, New Mexico Hazardous Waste Management Regulations, Resource Conservation and Recovery Act, and regulatory correspondence between the New Mexico Environment Department Hazardous Waste Bureau and the U.S. Air Force, dated April 2, June 4, August 6, and December 10, 2010.

This work will be performed under the authority of USACE Contract No. W912DY-10-D-0014, Delivery Order 0002. Mr. Walter Migdal is the USACE Albuquerque District Project Manager; Mr. Wayne Bitner, Jr. is the Kirtland Air Force Base Restoration Section Chief; and Mr. Thomas Cooper is the Shaw Project Manager. This report was prepared by Diane Agnew.

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ACRONYMS AND ABBREVIATIONS

°F	degrees Fahrenheit
µg/L	microgram per liter
3D	three-dimensional
AFB	Air Force Base
AST	aboveground storage tank
AVGAS	aviation gasoline
BFF	Bulk Fuels Facility
bgs	below ground surface
CATOX	catalytic oxidizer
CME	Corrective Measures Evaluation
COC	constituent of concern
CQAP	Construction Quality Assurance Plan
EDB	1,2-dibromoethane/ethylene dibromide
EPA	U.S. Environmental Protection Agency
FFOR	Former Fuel Off-Loading Rack
GRO	gasoline range organic
GWM	groundwater monitoring
HWB	Hazardous Waste Bureau (NMED)
ICE	Internal Combustion Engine
JP-8	jet propellant-8 fuel
KAFB	Kirtland AFB
LEL	lower explosive limit
mg/kg	milligram per kilogram
NAPL	non-aqueous phase liquid
NMED	New Mexico Environment Department
PG	Professional Geologist
PMP	Project Management Professional
ppmv	parts per million by volume
Praxis	Praxis Environmental Technologies, Inc.
PSH	phase-separated hydrocarbons

ACRONYMS AND ABBREVIATIONS (concluded)

QA	quality assurance
QC	quality control
ROI	radius of influence
RSI	Remediation Service International
SCFM	standard cubic feet per minute
Shaw	Shaw Environmental & Infrastructure, Inc.
SM	Standard Method
SVE	soil-vapor extraction
SVEW	soil-vapor extraction well
SVMW	soil-vapor monitoring well
THC	total hydrocarbons
TMB	trimethylbenzene
TPH	total petroleum hydrocarbons
USACE	U.S. Army Corps of Engineers
USF	Upper Santa Fe
VFD	Variable Frequency Drive
VOC	volatile organic compound

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EXECUTIVE SUMMARY

This report details the Phase II Remediation Interim Measures Plan for the Soil-Vapor Extraction (SVE) System at Solid Waste Management Units ST-106 and SS-111, Bulk Fuels Facility (BFF) Spill site, Kirtland Air Force Base (AFB), New Mexico (U.S. Environmental Protection Agency Identification Number NM9570024423/HWB-KAFB-10-004).

The purpose of the Phase II Remediation Interim Measure is to replace the current internal combustion engine unit-based SVE action with a system designed for longer-term operation. The primary element of the Phase II Remediation Interim Measure is the installation of an SVE system to increase hydrocarbon removal from the BFF vadose zone soil. The SVE system includes two SVE wells (Kirtland AFB [KAFB]-106161 and KAFB-106160), an aboveground piping manifold that runs the vapors to a blower skid, and a catalytic oxidation unit to destroy the hydrocarbon vapors in the air extracted from the wells.

The Phase II Remediation Interim Measure system is not designed to complete remediation at the BFF. This system is designed to continue the interim measures remediation process and will then be incorporated into the corrective measures evaluation for the site, which will be submitted at a later date.

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1. INTRODUCTION

The Bulk Fuels Facility (BFF) Spill site is located within the western portion of Kirtland Air Force Base (AFB), New Mexico (Figure 1-1) and is comprised of two solid waste management units, designated as ST-106 and SS-111. The component of the BFF Spill project related to investigation and remediation of the vadose zone near the Former Fuel Off-Loading Rack (FFOR) is designated as ST-106. The phase-separated hydrocarbon (PSH)-impacted groundwater component of the project is designated as SS-111.

On April 2, 2010, regulatory control of the BFF Spill site was transferred from the New Mexico Environment Department (NMED) Ground Water Quality Bureau to the NMED-Hazardous Waste Bureau (HWB) (NMED, 2010b). Historically, semiannual reports have presented data regarding ongoing remediation of ST-106 vadose zone contamination associated with the FFOR, and ongoing characterization and interim remediation instituted to begin recovery of PSH in groundwater at SS-111. Activities and data related to ST-106 were conducted as the Stage 2 abatement action under the NMED-Ground Water Quality Bureau–approved *Stage 2 Abatement Plan for the Bulk Fuels Facility (ST-106)* (U.S. Air Force, 2002). This plan identified soil-vapor extraction (SVE) as the preferred abatement option to be implemented at ST-106 to attain abatement standards and requirements set forth in Section 4103 of Title 20, New Mexico Administrative Code, Chapter 6, Part 2. ST-106 remediation was initiated before the discovery of PSH impacts to groundwater. Following the discovery of SS-111, Kirtland AFB instituted PSH recovery directly from the aquifer surface at three well locations by using the same SVE technology approved for the Stage 2 abatement action for ST-106. These actions were conducted as interim measures while site characterization activities continued.

This report details the Phase II Remediation Interim Measures Plan for the SVE System at Solid Waste Management Units ST-106 and SS-111, BFF Spill site, Kirtland AFB, New Mexico (U.S. Environmental Protection Agency [EPA] Identification Number NM9570024423/HWB-KAFB-10-004).

1.1 Site Background

The BFF Spill site is located in the northwestern portion of Kirtland AFB (Figure 1-1). Historical aerial photography has revealed that the area was used for fuel storage and processing as early as 1951 (CH2M HILL, 2001). At that time, the fueling area was separated into a distinct tank-holding area where bulk shipments of fuel were received (near the location of existing well Kirtland AFB (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 north of the tank area.

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

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

At present, jet fuel is stored in two ASTs (1.7 million gallons each). The site currently has one temporary JP-8 off-loading rack located in the southwest corner of the facility, west of the fuel-loading structure at Building 2404. This rack was placed into service following the piping failure at the FFOR (ST-106). A second small off-loading rack (Building 2401) is used for the delivery of diesel and unleaded gasoline motor vehicle fuels.

Fuel delivered to the temporary JP-8 off-loading 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 aboveground for approximately 750 feet and runs belowground for approximately 300 feet.

1.1.1 Current Remediation Activities

There are currently four SVE and treatment systems in use at the BFF which consist of trailer-mounted units that include specialized on-board computer controllers, sensors, and a pair of 460-cubic-inch displacement Ford Model LSG-875 internal combustion engines (ICE). These ICEs have been modified and remanufactured to the specifications of Remediation Service International (RSI). Within each SVE system, the programmable logic controller (PLC) uses the engines as the vacuum pump to extract vapor from the vadose zone, and the internal combustion process along with the catalytic converters on each engine provide treatment of the hydrocarbon vapors.

The ST-106 FFOR SVE unit (RSI Unit 249) was installed in April 2003 (fully operational in July 2003), the KAFB-1065 unit (RSI Unit 335) was installed in August 2008, and the KAFB-1066 (RSI Unit 345) and KAFB-1068 (RSI Unit 344) units were installed in March 2009. Based on an evaluation of system performance during operations in 2011, the four units were re-located in order to increase system performance. During April 2012, RSI Unit 335 was moved to KAFB-106149-484, RSI Unit 344 was moved to KAFB-106161, and RSI Unit 345 was moved to KAFB-106160. The ST-106 unit is

connected through manifold piping to nine SVE wells (SVEWs), SVEW-01 through SVEW-09, shown on Figure 1-3.

The ST-106 SVE System (Unit 249) has extracted approximately 223,960 gallons of non-aqueous phase liquid (NAPL) from the vadose zone from July 2003 through June 2012. Based on the system computer PLC recorder, the KAFB-106149 SVE system (Unit 335) has extracted approximately 91,800 gallons of NAPL from the vadose zone from August 2008 through June 2012. The KAFB-106160 SVE system (Unit 345) has extracted approximately 66,300 gallons of NAPL from the vadose zone from March 2009 through June 2012. The KAFB-106161 SVE system (Unit 344) has extracted approximately 58,100 gallons of NAPL from the vadose zone from March 2009 through June 2012 (Shaw, 2012).

1.2 Previous Investigation Activities

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 off-loading rack (Building 2405) to the Pump House at the facility. Subsequent investigations were conducted, and the results are provided in the following reports:

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

The conclusions of these reports are summarized below. Soil data collected during the BFF Spill investigations are compared to the NMED total petroleum hydrocarbons (TPH) screening guidelines to aid in defining the extent of contamination (NMED, 2012a).

1.2.1 Stage 1 Abatement Plan Report

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

Site investigations conducted during 2000 also included soil characterization at depth, extending down to the water table at select locations. Contamination was identified in two deep soil borings (SB-25 and SB 26) installed during July 2000 by using hollow-stem auger drilling. These two borings were located on the eastern and western ends of the off-loading rack. The maximum concentration detected in soil from boring SB-25 was 81,000 parts per million by volume (ppmv) of TPH in the sample from 105 feet bgs, which is just below the Transition Zone between Upper Santa Fe (USF)-1 and USF-2. The maximum concentration detected in boring SB-26 was 114,000 ppmv of TPH in the sample from 270 feet bgs, which is just above the clay zone that divides the USF-2 hydrostratigraphic unit.

Additional borings were installed to determine the horizontal extent of the soil that had TPH concentrations greater than 100 milligrams per kilogram (mg/kg). Based on data from the additional borings, soil contaminated in excess of the NMED TPH Screening Guidelines (NMED, 2012a) is limited to within approximately 310 feet of the surface; and within the area 65 feet south (SB-29A), 280 feet north (SB-34), 400 feet east (SB-32), and 175 feet west (SB-33) of the FFOR. The total area of soil

affected by the petroleum hydrocarbon contamination is estimated to be 6.5 acres, with depths of contamination extending to 310 feet bgs (CH2M HILL, 2001).

1.2.2 Stage 2 Abatement Plan Report

Four additional soil borings were advanced in 2003 as part of a pilot test for SVE. All four soil-vapor monitoring wells included both soil and vapor sampling capabilities and were completed to a depth of approximately 450 feet bgs. In addition to the anticipated intervals of petroleum-related contamination, two locations were found to have detections at the shallowest sampling depth of 60 feet bgs (CH2M HILL, 2006a).

1.2.3 Stage 1 Abatement Plan Report, East Side of the Kirtland Air Force Base Bulk Fuels Facility

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

The investigation included excavating test pits (TP-07, TP-08, and TP-09) and advancing direct-push borehole (SB-04) to 50 feet bgs. Additionally, a temporary soil-vapor monitoring point was installed in the direct-push borehole and monitored for hydrocarbon concentrations with field-monitoring equipment for several quarters. Based on 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 feet bgs. The only area where the NMED TPH guideline (NMED, 2012a) 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-foot bgs sample. None of the detections suggested the area was a contributor to the soil-vapor profile at the BFF Spill (CH2M HILL, 2006b).

1.2.4 Semi-Annual Summary and Performance Report

In 2007, groundwater monitoring (GWM) 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 feet north of the storage tank area associated with the 1951 operations. Additionally, 15 GWM wells were installed between 2007 and 2008. These monitoring well installations are reported on the Semi-Annual Summary and Performance Reports (CH2M HILL, 2008). Soil sampling was conducted at 20-foot intervals during advancement of the KAFB-1066 borehole from 20 to 480 feet bgs. Soil sample results did not suggest the presence of a large surface release of fuel in this area. However, there were detections of limited petroleum hydrocarbon concentrations (less than 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 and 140 feet 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 (CH2M HILL, 2008).

1.2.5 Remediation and Site Investigation Report

In 2009, soil boring investigations were conducted, and four additional GWM wells were installed at the BFF Spill to further evaluate other potential source areas. Soil data were consistent with previous sampling results, and the effectiveness of the SVE system was indicated. NAPL was not detected in samples collected from any of the newly installed wells (CH2M HILL, 2009).

1.2.6 Current Investigation

1.2.6.1 Groundwater Monitoring Wells

During the first three quarters of 2011, GWM wells were completed by the subcontractor drilling companies, WDC Exploration and Wells (69 wells) and Yellow Jacket Drilling (9 wells). The GWM wells were installed at all 28 NMED-prescribed locations at depths specified for these locations in the Groundwater Investigation Work Plan (USACE, 2011a) and in accordance with Table 4 of the NMED-HWB August 6, 2010 letter (NMED, 2010c). A summary of well installation, as well as the soil boring logs and well construction diagrams, are included in the Quarterly Pre-Remedy Monitoring and Site Investigation Report for April – June 2012 (Shaw, 2012). The goal for the installation of the well clusters was to fully characterize the nature and extent of the jet fuel plume and its degradation constituents such as 1,2-dibromoethane/ethylene dibromide (EDB). The number and types of wells installed and surveyed are as follows:

- 22 water table wells – Shallow Zone
- 28 intermediate wells – Intermediate Zone (see discussion at end of this section)
- 28 deep wells – Deep Zone

An additional three monitoring well clusters were installed during August through October 2012 and will be included in the Fourth Quarter 2012 sampling event. These clusters were installed northeast of the previously installed wells to delineate the northern edge of the EDB plume. The monitoring well clusters and individual wells are shown on Figure 1-2; the wells associated with clusters are detailed in Table 1-1.

1.2.6.2 Soil Vapor Monitoring Wells

A total of 35 soil-vapor monitoring well (SVMW) clusters has been installed during the current investigation; previous contractors installed 41 individual soil vapor monitoring wells. All SVMW locations are shown on Figure 1-3. Each nested well location consists of six individual (one 3-inch-diameter and five 3/4-inch-diameter), Schedule 80, polyvinyl chloride SVMWs that were installed in the

same borehole. Nested wells included a 10-foot length of machine-slotted (0.050-inch) screen. Planned depths for the bottom of the nested well screens were 25, 50, 150, 250, 350, and 450 feet bgs. In some cases, the screened intervals were adjusted based on lithology observed during borehole advancement (e.g., screens were placed in transmissive zones). If proposed vapor-monitoring screened intervals were observed to be within fine-grained lithologic intervals (clay or silt), screened intervals were adjusted up or down to the nearest coarser-grained unit. Screens separated by 100 feet (150, 250, 350, and 450 feet bgs) were adjusted by no more than 25 feet, and screens separated by 25 feet (25 and 50 feet bgs) were adjusted by no more than 5 feet. The soil classification logs and completion diagrams for these wells can be found in the Quarterly Pre-Remedy Monitoring and Site Investigation Report for April – June 2012 (Shaw, 2012).

1.2.6.3 PneuLog® Wells

Nine PneuLog® well clusters have been installed as part of the current investigation. All PneuLog® well clusters are shown on Figure 1-3. Each well cluster consists of three "nested" 3-inch-diameter well casings with three screened intervals at approximately 500 to 355, 350 to 205, and 200 to 25 feet bgs. All nine well clusters were surveyed during Fourth Quarter 2011. The soil classification logs and completion diagrams for these wells can be found in the Quarterly Pre-Remedy Monitoring and Site Investigation Report for April – June 2012 (Shaw, 2012).

1.3 Remediation Design Data-Gathering Activities

The following activities were performed in a effort to characterize the different plumes as well as optimize the design for the remediation system.

- PneuLog® Testing
- SVE Radius of Influence (ROI) Testing
- Contaminant Fate and Transport Conceptual Modeling for the vadose zone and groundwater

The results of these activities are presented in greater detail in the Interim Measures Work Plan (Shaw, 2011a).

1.3.1 PneuLog® Testing

During Second Quarter 2012, PneuLog® wells KAFB-106148, KAFB-106149, and KAFB-106150 were analyzed using PneuLog® technology developed by Praxis Environmental Technologies, Inc. (Praxis). Praxis' technology utilizes pneumatic well logging to measure the vertical air permeability and chemical concentration profiles in wells screened for SVE. Down-hole instruments simultaneously measure cumulative air flow and chemical vapor concentrations along the depth of the well screen.
Praxis personnel performed the testing with oversight provided by on-site Shaw Environmental & Infrastructure, Inc. (Shaw) personnel.

The PneuLog® vadose zone testing generated distinctive permeability and vapor concentration profiles that will be used in the design of the overall vadose zone remediation system. In general, the permeability increases with depth, which is consistent with the lithologic data where the upper 250 feet of the vadose zone is finer-grained than the deeper intervals. In addition, the results for two of the three PneuLog® tests (KAFB-106149 and KAFB-106150) show increasing vapor hydrocarbon concentrations with depth, which is consistent with the conceptual model in terms of a declining water table creating a large NAPL "smear" zone extending from 250 feet bgs to the top of the current water table. The concentration profile for well KAFB-106148 shows higher concentrations in the upper 350 feet compared to the bottom 100 feet. This profile is consistent with the location of this well, which is closer to the initial FFOR release locations than the other two wells. Results of the PneuLog® testing are below, and a full description and report for the testing are presented in the Quarterly Pre-Remedy Monitoring and Site Investigation Report for April – June 2012 (Shaw, 2012).

1.3.2 SVE Radius of Influence Testing

The following sections summarize the SVE ROI testing conducted during Fourth Quarter 2011 and describe the data analysis that took place during First and Second Quarters 2012. SVE ROI testing commenced on November 2, 2011, and was completed on December 16, 2011. Five single-well tests and three 5-day tests were performed to provide detailed, site-specific information to aid in the quantitative assessment and modeling of SVE vadose zone remediation and subsequent optimization of the existing system. Extraction and monitoring wells used for each 5 day ROI test are presented in Figure 1-4. The five single-well tests were conducted to determine the extraction wells for the three 5-day tests. The 5-day tests were conducted to determine the extent of the area impacted by SVE at the BFF. Following the analysis of the 5-day tests, it was clear that additional data was needed to clarify the ROI of SVE at the BFF. Consequently, when the RSI SVE engines resumed operation on April 30, 2012, an SVE monitoring program began and is ongoing.

Data were collected to be incorporated into the three-dimensional (3D) analysis of remediation prospects for the vadose zone contamination using existing SVE wells and RSI SVE units. This analysis involves vapor concentration distribution, lithology, and 3D numerical modeling of vapor flow. The ongoing quarterly field and analytical vapor concentration monitoring data for existing SVMWs and soil-vapor extraction wells (SVEWs) are used as chemical data input for the analysis. Results of the ROI testing are described below, and a full description and report for the testing are presented in the Quarterly Pre-Remedy Monitoring and Site Investigation Report for April – June 2012 (Shaw, 2012). Full details for operations of the RSI SVE units are presented in the Soil-Vapor Extraction Optimization Plan (Shaw, 2011b), and the Pre-Remedy Monitoring and Soil-Vapor Extraction

System Operation and Maintenance Work Plan (Shaw, 2011c).

1.3.2.1 Procedure

Monitoring wells were selected for each 5 day test (Figure 1-4). Each period during which vacuum pressure on all monitoring wells was obtained once is referred to as a monitoring round. On the first day of tests 5DTKAFB106121-450 and 5DTSVEW-05, monitoring rounds were conducted hourly. On the first day of test 5DTKAFB-106149-484 monitoring rounds were conducted approximately every 90 minutes, as there were more wells than could be monitored in an hour. On the second and third days, monitoring rounds were conducted twice daily, and on the fourth and fifth days, monitoring round were conducted once daily.

The ongoing SVE monitoring program at the BFF includes measuring vacuum pressure on all depths at all 9 PneuLog® wells. Since April 30, 2012, SVE is occurring at wells KAFB-106149-484, KAFB-106160, KAFB-106161, and SVEW-01. SVE was also occurring at SVEW-05 from April 30, 2012 through October 23, 2012. The results below include data taken through September 30, 2012 and consequently assume extraction from SVEW-05. Initially, an attempt was made to have both engines running on each SVE unit. However, several units frequently had at least one engine down for repairs. At the end of June 2012, a decision was made to run only one engine on each RSI SVE unit for consistency.

1.3.2.2 Results

Results from the two of the three 5-day ROI tests were useful for establishing a horizontal ROI for the individual extraction wells, while results from the SVE monitoring were useful for establishing a 3D ROI in the BFF as a whole.

Because vacuum pressure at the BFF is strongly influenced by changes in barometric pressure, the difference between vacuum pressures measured at each well and vacuum pressure at a selected

background monitoring well was calculated. This effectively removes the influence of barometric pressure from the data.

Test 1 - Test 5DTKAFB106121-450 Results

ROI test 5DTKAFB106121-450 used well KAFB-106121-450, screened from 430 to 440 ft bgs, as the extraction well. RSI SVE Unit 335, running both engines, was used to extract soil vapor from KAFB-106121-450. Well KAFB-106131-450, which is 381 ft from the extraction well, was used as the background monitoring well, as it was the most distant well monitored during the test.

Only the data from wells screened in the same interval as the extraction well were used for analysis. Three monitoring wells, KAFB-106120-450, KAFB-106122-450, and KAFB-106123-450, are screened from approximately 430 to 440 ft bgs, while two monitoring wells, KAFB-106113-450 and KAFB-106114-450, are screened from 440 to 450 ft bgs. Data from these 5 wells were used in the analysis of this test.

Based on the results, only wells KAFB-106123-450 and KAFB-106122-450, located respectively 61 and 75 ft from the extraction well, show an observable response to SVE. This indicates that the ROI for this five-day test is at least 75 ft but, most likely, is less than 95 ft, as the results for well KAFB-106120-450, located 95 ft from the extraction well, show no observable response to the SVE (Figure 1-4).

Test 2 - Test 5DTSVEW-05 Results

ROI test 5DTSVEW-05 used well SVEW-05, screened from 445 to 460 ft bgs, as the extraction well. RSI SVE Unit 249, running both engines, was used to extract soil vapor from SVEW-05. Well KAFB-106121-450, located 964 ft from the extraction well, was used as the background monitoring well. KAFB-106121-450 was monitored only once per day during this test. Consequently, only the first monitoring round per day was used in this analysis.

Only data for wells screened in the same portion of the vadose zone as the extraction well were used in this analysis. KAFB-106148-484 is screened from 354 to 484 ft bgs; SVEW-09 is screened from 445 to 460 ft bgs; and KAFB-106119-450 is screened from 440 to 450 ft bgs (Figure 1-4). Data from these 3 wells were used in the analysis of this test.

Because data from only the first monitoring round per day was used and only data from wells screened in the same portion of the vadose zone as the extraction well were used, there was very little usable data available for analysis. No meaningful conclusions about the ROI for extraction well SVEW-05 could be determined based on the analysis of data from only 5 monitoring rounds and 3 monitoring wells.

Test 3 - Test 5DTKAFB106149-484 Results

ROI test 5DTKAFB106149-484 used well KAFB-106149-484, screened from 354 to 484 ft bgs, as the extraction well. RSI SVE Unit 335, running both engines, was used to extract soil vapor from KAFB-106149-484. Well KAFB-106121-450, located 643 ft from the extraction well, was used as the background monitoring well.

Only data for wells screened within the same interval as the extraction well were used in this analysis. Nine monitoring wells, KAFB-106111-450, KAFB-106112-450, KAFB-106113-450, KAFB-106114-450, KAFB-106116-450, KAFB-106117-450, KAFB-106119-450, KAFB-106128-450, and KAFB-106129-450 are screened from 440 to 450 ft bgs, and SVMW-15 is screened from 450 to 452.5 ft bgs. Data from these 10 monitoring wells was used in the analysis of this test.

Wells KAFB-106117-450, located 29 ft from the extraction well, KAFB-106116-450, located 161 ft from the extraction well, KAFB-106119-450, located 201 ft from the extraction well, KAFB-106128-450, located 205 ft from the extraction well, and SVMW-15, located 227 ft from the extraction well, all showed an observable response to SVE (Figure 1-4). Vacuum pressure for KAFB-106112-450, located

221 ft from the extraction well, was greater than average for approximately half of the monitoring rounds. It was, however, greater than average for four of the six monitoring rounds that occurred after the first day, indicating that it may have been weakly experiencing the effects of SVE.

Wells SVMW-15 and KAFB-106112-450 are located at very similar distances from the extraction well, though on different radii extending from the extraction well, with SVMW-15 being only 6 ft farther away. SVMW-15 shows a definite response to SVE, while KAFB-106112-450 possibly shows a weak response, indicating that these two wells are on the edge of the ROI for SVE from KAFB-106149-484. This places the horizontal ROI at approximately 220 to 230 ft for a five-day period of extraction. Vacuum pressure for KAFB-106114-450 was greater than average on the last two days of testing, which could be a result of the ROI extending over 300 ft after four days of extraction. However, additional data would be necessary to make a conclusive statement.

SVE Monitoring Results

On April 30, 2012 RSI SVE units began extracting from wells KAFB-106149-484, KAFB-106160, KAFB-106161, SVEW-01 and SVEW-05. Because results from ROI tests were not sufficient to determine the 3D ROI at the BFF, it was determined that vacuum pressure across the BFF should be monitored during SVE and the data used to clarify the 3D ROI at the BFF. All wells in each of the 9 PneuLog® clusters were selected as the monitoring wells. Each cluster contains wells screened across three intervals: approximately 354 to 484, 205 to 350, and 25 to 200 ft bgs. Data for all depth intervals were used in this analysis to help determine the 3D ROI of the system. Well KAFB-106121-450 is used as the background monitoring well for the 484-ft bgs PneuLog® wells; KAFB-106121-350 is used as the background monitoring well for the 350-ft bgs PneuLog® wells; and KAFB-106121-145 is used as the background monitoring well for the 200-ft bgs PneuLog® wells.

484-ft bgs Wells

Wells KAFB-106154-484, located 176 ft from the nearest extraction well (KAFB-106149-484), KAFB106150-484, located 68 ft from the nearest extraction well (KAFB-106160) and KAFB-106148-484, located 96 ft from the nearest extraction well (SVEW-05) all show an observable response to SVE. These wells are also the three closest to an extraction well; the next closest, KAFB-106151-484, located 205 ft from the nearest extraction well (KAFB-106160), does not show an observable response to SVE. This indicates that the horizontal ROI for the RSI SVE units running one engine at the Kirtland AFB BFF Spill site is at least 176 ft, but less than 205 ft.

350-ft bgs Wells

Wells KAFB-106150-350, located 79 ft from the nearest extraction well (KAFB-106160), KAFB-106149-349, located 5 ft from the nearest extraction well (KAFB-106149-484), KAFB-106148-349, located 84 ft from the nearest extraction well (SVEW-01) and KAFB-106154-350, located 176 ft from the nearest extraction well (KAFB-106149-484) all show an observable response to SVE, though the responses of wells KAFB-106148-349 and KAFB-106154-350 are not as strong as those for the 484-ft bgs wells in the same clusters. These wells are also the four closest to an extraction well; the next closest, KAFB-106151-350, located 209 ft from the closest extraction well (KAFB-106160) does not show an observable response to SVE. This indicates that the ROI for RSI SVE units running one engine is between 176 and 209 ft, which is consistent with the results for the 484-ft bgs wells.

200-ft bgs Wells

Well KAFB-106148-194, located 98 ft from the closest extraction well (SVEW-01), shows an observable response to SVE. Well KAFB-106149-194, located 205 ft above the nearest extraction well (KAFB-106149-484), may be showing a slight response to SVE. These results indicate that the vertical ROI for RSI SVE units running one engine at the Kirtland AFB BFF Spill site is approximately 200 ft, which is consistent with the horizontal ROI shown in the response of the 484-ft bgs monitoring wells.

Based on the data gathered thus far, it appears that the ROI for RSI SVE units running one engine at the Kirtland AFB BFF Spill site is isotropic and between 176 and 205 ft in all directions. Data obtained during the ROI testing indicate that the ROI may extend up to an additional 100 ft when RSI SVE units are running both engines.

1.3.3 Contaminant Fate and Transport Conceptual Model

Conceptual site models were developed for both the vadose zone and for groundwater. The results of these models are explained below. Full details of the conceptual site models are presented in the Quarterly Pre-Remedy Monitoring and Site Investigation Report for April – June 2012 (Shaw, 2012).

1.3.3.1 Vadose Zone

Based on the 3D distribution of soil and vapor concentration data in the vadose zone, a relatively simple vadose zone NAPL and vapor migration model becomes apparent:

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

- The definitive indicators that NAPL did not spread out substantially as it migrated through the vadose zone until it encountered the historical capillary fringe and water table, where it spread out in horizontal directions, includes the following: 1) the low TPH and benzene soil concentrations, 2) the constant contaminant footprint at elevations of 5,000 feet above mean sea level (350 feet bgs) and above, and 3) the expansion of the aerial extent and increase in concentrations at the elevation of 4,900 feet above mean sea level (450 feet bgs). If the vertical NAPL migration occurred over a widespread area or had spread out along vadose zone capillary barriers, it would be expected that higher soil and vapor concentrations would be observed at shallower elevations.

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

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

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

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

- Based on the 3D distribution of soil and vapor concentrations, the majority of the vadose zone contaminant mass is located within 100 to 150 feet above the present-day water table at depths of 350 to 500 feet bgs (Figure 1-5).

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

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

1.3.3.2 Groundwater

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

- Current groundwater flow directions are toward the Ridgecrest water supply wells (Ridgecrest-5 and Ridgecrest-3) with average groundwater velocity of 95 feet/year and a range of 18 to over 300 feet/year to the northeast at a direction of North 25° to 35° East. Overall, vertical groundwater flow direction is down - a downward flow velocity has not been determined at this time. As previously discussed in the Fourth Quarter 2011 report (USACE, 2012c), EDB and TPH-gasoline range organic (GRO) plume maps confirm this plume migration direction and general velocity. The EDB plume is moving at least 50 feet/year to the northeast simply based on plume extent (Figure 1-6).

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

- Concentrations for KAFB-1065 (the contaminated well with the longest data record) and the NAPL chemical composition, i.e., the NAPL on top of and below the water table, will act as a persistent source of groundwater contamination for the indefinite future.

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

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

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

  - Intermediate Zone—EDB, benzene, ethylbenzene, iron, manganese, and naphthalene.

  - Deep Zone—EDB, bis (2-ethylhexyl) phthalate, and manganese.

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

- EDB has migrated the full length of the monitoring network and was detected above the EPA maximum contaminant level (0.05 µg/L) in samples from 30 of 51 shallow wells, 11 of 27 intermediate wells, and 3 of 28 deep wells during the Second Quarter 2012 monitoring event. EDB is the one compound that was detected in the Shallow, Intermediate, and Deep Zones in the farthest downgradient well cluster (GWM 10; KAFB-106055, KAFB-106057, and KAFB-106058) for the last three quarters (Figure 1-6).

- The concentration patterns of both EDB and TPH-GRO indicate two release periods of NAPL containing EDB. EDB concentrations (Shallow Zone) in the immediate vicinity of the NAPL plume mostly range from 1 to 10 µg/L, with hot spots of up to 320 µg/L (Figure 1-6). Approximately 500 feet downgradient of the northern edge of the NAPL plume, the concentrations decline to less than 1 µg/L, followed by concentration increases to greater than 1 µg/L at the downgradient edge of the monitoring well network. TPH-GRO (Intermediate Zone) has a similar pattern with high concentrations in the NAPL area, a low concentration area approximately 500 feet downgradient of the northern edge of the NAPL plume, and higher concentrations in the downgradient monitoring wells.

- The extent of EDB groundwater contamination is not defined at this time.

2. REMEDIATION SYSTEM DESIGN AND INSTALLATION

2.1 Phase II Remediation Interim Measure

The purpose of the Phase II Remediation Interim Measure is to replace the current ICE unit-based SVE action with a system designed for longer-term operation. The primary element of the Phase II Remediation Interim Measure is the installation of a SVE system to increase hydrocarbon removal from the BFF vadose zone soil. The increased hydrocarbon removal will not only increase treatment of contaminated soil in the vadose zone, but will also allow additional ROI and other tests to be performed. As the SVE system operates, data gathered from the system and the surrounding monitoring wells will provide more information for characterization and evaluation of the contamination, which will provide feedback for the Corrective Measures Evaluation (CME) final remediation system design.

The SVE system includes two SVE wells (KAFB-106161 and KAFB-106160), an aboveground piping manifold that transports the vapors to a blower skid, and a catalytic oxidation unit to destroy the hydrocarbon vapors in the extracted well gas. The SVE system is designed to extract up to 1600 standard cubic feet per minute (SCFM) of air, containing up to 3450 ppmv total hydrocarbons (THC) from the two SVE wells; which results in removal of over 2200 lb/day of hydrocarbon from the soil. Initially the well gas is expected to contain roughly 6800 ppmv THC and the flow rate of the well gas will be reduced to around 800 SCFM. This is necessary to limit the hydrocarbon mass removal rate to the catalytic oxidizer (CATOX) design capacity of 2200 lb/day. Over time the THC in the well gas is expected to decrease and the flow rate will be increased to maximize hydrocarbon removal.

The SVE wells are installed at locations with the highest measured and estimated concentrations of COCs to maximize remediation potential. The aboveground manifold is roughly 200 feet of 8-inch-diameter and 600 feet of 6-inch-diameter polyethylene pipe mounted on sleepers. The SVE blower skid includes a knock-out pot for removing and collecting entrained NAPL and condensate, and a positive displacement

blower fitted with silencers and inlet filters. The CATOX is a natural gas-fired unit designed for 98 percent minimum destruction of hydrocarbons. It includes an inlet system fan burner and burner control systems, a catalyst bed, a heat-recovery exchanger, and an exhaust stack. With the high hydrocarbon content of the SVE well gas and the heat recovery exchanger, the CATOX will require very little natural gas until THC concentrations in the SVE well gas drop below 1500 ppmv. Condensate generated from system operation will be collected in a standard, aboveground fuel storage tank that is equipped with gages and alarms that are tied into the system control panel. The tank will be maintained in accordance with Resource Conservation and Recovery Act and NMED requirements, specifically 40 CFR parts 264 and 265 (U.S. EPA, 2012), and NMAC 20.5 (NMED, 2012b). Figure 2-2 shows the layout of the system, Figure 2-3 provides a closer detail of the system at the pad, and Figure 2-4 details the flow process.

2.2 Monitoring Well Network

Monitoring wells for the remediation system will include all of the groundwater, soil vapor, and PneuLog® wells that have been installed as part of the current and past investigations (Figures 1-2 and 1-3). These wells will be monitored on a quarterly basis, and their results will be presented in the Quarterly Pre-Remedy Monitoring and Site Investigation Report. Monitoring well sample procedure and details are presented in the Pre-Remedy Monitoring and Soil-Vapor Extraction System Operation and Maintenance Work Plan (Shaw, 2011c).

2.3 System Friction Loss Estimates

The piping network for the vapor extraction pipeline was modeled to determine frictional head losses. Using the vacuum blower performance data and pipeline friction losses, an evaluation was conducted to determine the available vacuum for the system. For a normal operating case at low vacuum, the piping manifold provides an absolute pressure at the wells of 10.7 pounds per square inch absolute pressure (2.8 inches of mercury vacuum, relative to normal atmospheric pressure in Albuquerque). This will be sufficient for vapor extraction to the treatment system. A detailed calculation is provided in Appendix F.

2.4 Remediation System Installation

2.4.1 Permitting

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

- Albuquerque Environmental Health Department Air Quality Authority-To-Construct Permit #1984
  - This Permit will be modified to include the planned SVE system's catalytic oxidation exhaust. A full description of the system's specifications and exhaust will be included in the permit modification.
- Kirtland AFB Dig Permit
  - This Permit clears or marks all AFB utilities at the proposed SVE system and associated utility locations.
- Kirtland AFB Request for Environmental Impact Analysis
  - This form has been submitted and approved. This form gives approval for the installation of natural gas and electrical lines that supply the SVE system.
  - This form also provides a checklist that ensures that all other necessary forms and permits have been or will be obtained for operating the system.

2.4.2 System Installation

The SVE system will be installed and operated at the BFF and will run off of two wells that have been previously installed, as shown in red on Figure 2-1. Soil Classification Logs and Well Construction Diagrams for the two wells are presented in Appendix A. The well casing is 6-inch, stainless steel with stainless steel centralizers. The well screen is 6-inch, 0.050-slot wire-wrapped stainless steel set in a 50-foot section and a 40-foot section separated by 10 feet of casing. From the bottom of the 40-foot section of the 6-inch, 0.050-slot screen, a 6-inch, 0.030-slot wire-wrapped stainless steel screen is continued to 525 feet bgs. The bottom of the sump is set at 530 feet bgs and is 5 feet in length. The SVEW design was constructed for multi-purpose applications and, as such, was screened across the water table to provide an option to adapt the well for future groundwater extraction if required.

The SVE blower and CATOX skids will be installed and anchored on a 50-foot by 18-foot concrete pad, and the steel stack will be placed on a 6-foot by 6-foot concrete pad adjoining the larger pad. The entire system will be surrounded by a secured fence. The complete system layout is presented on Figure 2-2, with further detail presented in Appendix B.

Piping will run from the individual vacuum recovery wellheads and will join into a single high-density polyethylene pipe that will run to the SVE system. The SVE process is designed to maximize the volatilization of low-molecular weight compounds by pulling air from the vadose zone of the soil layer. The air is extracted using a motor-driven vacuum blower built by Global Technologies, which creates vacuum on the influent lines, and at low pressure, discharges the air to the treatment system. Upstream of the vacuum blower, a demister system is installed that separates entrained water in the system. A knock-out tank and demister filter condense water, which can then be collected and pumped to a collection/treatment system. Inlet filters to the vacuum blower reduce particulate in the blower, while also lowering sound levels created by suction. Silencers are installed at the discharge of the blower to reduce sound output of the unit. Vapor will then move from the blower skid to the Aguil Model 20 CATOX adjoined to the 30-foot steel stack. A CATOX was chosen for the system because of the close proximity to the BFF, and in order to comply with regulations dictating the lower explosive limit (LEL) on Kirtland AFB. A detailed description of both the blower skid and CATOX are presented in Appendix B. The units will be constructed off site and delivered to the BFF after the concrete pad has been poured and set.

Approved and licensed electrical and plumbing contractors will be employed for the installation of the SVE remediation system. The construction quality assurance (QA)/quality control (QC) program will use testing and inspection methods that are standard to the specific electrical or plumbing work. The QA/QC requirements will be detailed in the engineering specification and drawings/details. The Site Construction Manager, at a minimum, will be present on site for critical junctures in the system installation such as

groundbreaking, piping assembly and leak testing, natural gas installation and connection, electrical wiring, and system start-up.

The site property and vegetation will be restored after completion of the installation. An as-built report will also be prepared and submitted, and it will document any changes and modifications to the drawings and specifications that may occur during installation of the remediation system. Photo documentation of the SVE remediation system will be included in the as-built report. The as-built report will be reviewed, signed, and stamped by a Professional Engineer licensed and registered in the State of New Mexico.

2.4.3 Key Personnel

An identification and description of the qualifications of key persons, consultants, and contractors that will be implementing the SVE system installation is presented in Appendix C.

2.4.4 Construction Quality Assurance Plan

The purpose of the Construction Quality Assurance Plan (CQAP) is to define the methodology and practices to control construction work quality during the performance of work. The CQAP provides the description of the general construction work QC measures to be implemented for SVE system installation. The CQAP provides the framework and criteria to plan, monitor, verify, and assess quality-related services to assure construction and related tasks are of the highest standard. The CQAP is presented in Appendix D.

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3. PHASE V: OPERATION, MAINTENANCE, AND MONITORING

3.1 SVE Operational Approach

The SVE system will be operated 24 hours a day, 7 days a week. The primary goals of system operation are to maximize the removal of THC from the vadose zone soil and to aid in data gathering activities to further characterize and evaluate the contamination. Data gathered from operation of the SVE system will contribute to the CME and final remedy design. The amount of hydrocarbon in the soils should be high enough that the SVE system is expected to operate at near maximum capacity. Procedures for system startup and normal operation are found in the O&M manual in Appendix E.

The thermal capacity of the CATOX unit is limited to a mass removal rate of approximately 2,200 pounds of hydrocarbons per day. This is based on the design capacity of 1,600 SCFM of air at 3,450 ppmv of hydrocarbon (25 percent of LEL). In order to achieve this mass removal rate for hydrocarbons, the inlet air flow to the CATOX unit should be close to 2,500 SCFM, and the inlet hydrocarbon should be close to 2,100 ppmv (as measured by the instruments on the CATOX unit). These conditions mean that the CATOX unit is running at near maximum thermal capacity and maximum hydrocarbon removal from the vadose zone soil.

To maintain these conditions the system operators will have to periodically optimize the flows of well gas from the two wells and the dilution air. This requires manually adjusting the SVE blower speed (using the Variable Frequency Drive [VFD]) and the position of the dilution air valves at the blower inlet and at the two well heads. As the hydrocarbon content of the well gas changes, the operating settings will have to be adjusted. During the first 8 weeks of operation, the system should be optimized on a weekly basis. After several weeks of operation, the rate of change in THC concentrations in the wells should decrease and the system will require less frequent optimization. Optimizing the system flows will require a tradeoff between maximizing hydrocarbon removal (high well gas flow and high THC concentrations)

and preventing CATOX unit shutdown due to high catalyst outlet temperature caused by hydrocarbon removal rates over the designed limit.

Figure 2-4 illustrates the process flow diagram for the SVE system and expected operation based on current conditions where the soil gas from both wells contains 6,800 ppmv hydrocarbons. Typically after starting the SVE system, the hydrocarbon content of the soil gas will decline, and the operators will cut back on the dilution air flow to pull higher volume of air from the wells. The dilution air that is let into the system at the wellheads helps reduce water condensation in the SVE manifold during the colder months and therefore, it is preferable to first cut back on the dilution air let in to the inlet of the SVE blower. If the hydrocarbon content of one of the SVE wells is consistently higher than the other, the operators may increase the amount of air extracted from that well by adjusting the position of the wellhead valves (partially closing the low-hydrocarbon well to restrict flow). Routine optimization of flow rates between the two wells will be conducted using the Horiba instruments or equivalent.

3.2 Performance Based Criteria

The SVE system is expected to operate at near maximum capacity while being monitored and optimized until such time as the CME final remedy is put in place. Data collected from the system and surrounding monitoring wells during SVE system operation will aid in creating performance based criteria. The performance based criteria will be addressed in the CME to be submitted at a later date.

3.3 System Maintenance and Monitoring

Maintenance for the SVE and thermal CATOX system will include preventative maintenance, corrective maintenance, and shut-down inspection and maintenance. The systems will be inspected and maintained monthly, quarterly, and annually. Activities will include observance, documentation, servicing, repair, or replacement (if necessary). Any defects will be reported as soon as possible to Shaw environmental, health, and safety personnel. The air/water knock-out pump, SVE vacuum blower, filters, CATOX fan,

burner, catalyst, and instruments will be inspected regularly to ensure proper operation. Appendix E contains the Operations and Maintenance manuals for the SVE blower skid and the CATOX unit. These manuals describe the preventative maintenance and periodic inspection practices for the SVE System.

For routine weekly optimization of the SVE system for THC removal, Shaw will use the Horiba THC monitors or equivalent. In addition, Shaw will collect SUMMA canister samples to monitor, track, and report mass removal of benzene, toluene, ethylbenzene, xylenes and EDB every quarter. Shaw will also measure pressure and take vapor samples in the SVE monitoring wells on a quarterly basis, and their results will be presented in the Quarterly report. SVE monitoring wells for the remediation system will include all of the groundwater, soil vapor and PneuLog® wells that have been installed as part of the current and past investigations (Figures 1-2 and 1-3).

The PLC in the CATOX unit will record flow rate and THC so that data can be used to calculate gross THC removal. The PLC also records temperature to ensure that the system is operating at conditions that result in 98% organic destruction. The flow, pressure, and temperature of air entering the SVE system will be measured and recorded to calculate removal rates from vapor recovery wells and to indicate the efficiency of the system. Vapor samples will be taken from sample ports throughout the system using vacuum or SUMMA canisters. Laboratory tests will be conducted from the extracted vapors before and after the treatment process to determine volatile organic compound (VOC) concentrations. This will allow the system to be optimized to increase the overall effectiveness. An air emission monitoring report will be prepared for the client. The report will present the progress of the system from start-up, and will consist of maintenance and monitoring descriptions, system effectiveness, lessons learned, emission data, calculations of volume of contaminants removed, and analytical laboratory certificates of analysis. The report will also describe any system problems and reasons for down time.

3.4 Quarterly Groundwater Monitoring

Quarterly groundwater monitoring is currently being performed according to the Pre-Remedy Monitoring and Soil-Vapor Extraction System Operation and Maintenance Work Plan (Shaw, 2011c) and results are presented in the Quarterly Pre-Remedy Monitoring and Site Investigation Report for April – June 2012 (Shaw, 2012). Groundwater monitoring consists of collecting liquid level groundwater elevation and light nonaqueous phase liquid measurement data quarterly, and performing quarterly groundwater sampling for field chemical parameters and off-site laboratory analysis. In the following discussions, the aquifer beneath the Kirtland AFB BFF Spill site has been classified into the following four zones for purposes of data analysis:

- **Shallow Zone—**This is the monitored zone that intersects the water table and extends 5 to 15 feet below the 2011 measured water table. As the water table has continued to rise, a number of these wells have become flooded to where the water level is now above the top of the screens. Based on ongoing water conservation practices in the Albuquerque area, additional wells will become flooded over the next several years.
- **Intermediate Zone—**This is the aquifer zone that is monitored by wells that extend 15 to 30 feet below the 2011 measured water table elevation. As the water table continues to rise, this zone will become deeper in the aquifer.
- **Deep Zone—**This is the aquifer zone that is monitored by wells that extend 30 to 100 feet below the 2011 measured water table elevation. As the water table continues to rise, this zone will become deeper in the aquifer.
- **Regional Aquifer—**This is the aquifer zone where most of the water supply wells in the area are completed. Generally, these wells are completed 500 feet or more below the 2009 water table elevation (typically greater than 1,000 feet bgs).

3.4.1 Quarterly Pre-Remedy Groundwater Monitoring

The groundwater investigation and monitoring program currently includes collecting quarterly groundwater elevation and light nonaqueous phase liquid measurement data, and conducting quarterly groundwater sampling at BFF Spill site monitoring wells and nearby production wells. This data will also be used to evaluate the success and production of the SVE system.

Groundwater sampling includes purging one well boring volume and monitoring field parameters for stabilization of temperature, pH, and specific conductance to within an estimated 10 percent prior to collecting water quality measurements. Field parameters that were recorded prior to collecting groundwater samples for laboratory analysis were pH, conductivity, temperature, alkalinity, dissolved oxygen, turbidity, oxidation-reduction potential, and alkalinity.

After collection of water quality measurements, the wells will be purged at an approximate rate of 1.0 liter per minute. Prior to sample collection, the Kirtland AFB production wells and the Veterans Affairs Medical Center groundwater production well will be purged by flushing the dedicated sample line and then collecting the samples. Samples will be collected through non-chlorinated taps from the production wells. Groundwater samples collected will be analyzed for the following list of parameters:

- VOCs – EPA SW8026B
- EDB – EPA SW8011
- Semivolatile organic compounds – EPA SW8270C
- TPH-GRO and TPH-diesel range organics – EPA SW8015B
- Polycyclic aromatic hydrocarbons – EPA SW8270C low-level method (VA-2 well only)
- Lead and major cations – EPA SW6010C
- Dissolved iron and manganese – EPA SW6010C
- Anions (chloride and sulfate) – EPA 300.0
- Nitrate/nitrite as nitrogen – EPA 353.2
- Ammonia nitrogen – Standard Method (SM) 4500NHB
- Total sulfide – SM 4500 S-2CF
- Carbonate/bicarbonate alkalinity – SM 2320B

Field QC samples will be collected in accordance with the BFF Spill Quality Assurance Project Plan (USACE, 2011g), and will include trip and ambient field blanks for VOCs, field duplicate and equipment rinse blank samples, and extra sample volume collected and submitted for laboratory matrix spike and matrix spike duplicate QC measurements.

Groundwater analytical data are validated for precision, accuracy, representativeness, comparability, and completeness in accordance with the BFF Spill Quality Assurance Project Plan (USACE, 2011g), and appropriate data qualifiers are appended to the analytical data in the project database.

3.5 Status and Quarterly Reporting

All data and summaries for the SVE system will be included in the current Quarterly Pre-Remedy Monitoring and Site Investigation Report. The SVE system section of the report will include results of system monitoring along with field activities for that quarter. The following information will also be included in the quarterly report:

- Charts and tables of the remediation system operation monitoring parameters, including flow rate, vapor screening results, analytical laboratory results for air, and a summary of operating conditions
- The volume of extracted hydrocarbons, recovery rate, and effective radius and efficiency for vapor treatment
- Graphic representation of photoionization detector vapor screening concentrations, VOC vapor extraction removal rates, and system electrical and natural gas consumption
- The modeled horizontal and vertical extent and magnitude of contamination
- Maps illustrating the extent and concentration of contamination

Groundwater sampling results with plume maps and tables of historic and recent analytical results and gauging are already included in the Quarterly Pre-Remedy Monitoring and Site Investigation Reports.

3.6 Completion of Remediation

The Phase II Remediation Interim Measure system is not designed to complete remediation at the BFF; this system is designed to continue the interim measures remediation process and will then be incorporated into CME for the project site, which will be submitted at a later date.

4. SCHEDULE

Appendix G contains the project schedule for system permitting and construction. The schedule contains major milestones and work elements related to construction and initiation of system operation. The project schedule is specific to this phase of work and does not include contract milestones.

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5. WASTE MANAGEMENT

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

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

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REFERENCES

CH2M HILL. 2001. *Stage 1 Abatement Plan Report for the Bulk Fuels Facility (ST-106)*. Kirtland Air Force Base, New Mexico. May 21.

CH2M HILL. 2006a. *Stage 2 Abatement Plan Report for the Soil Vapor Extraction and Treatment System, Bulk Fuels Facility (ST-106)*. Kirtland Air Force Base, New Mexico. January.

CH2M HILL. 2006b. *Stage 1 Abatement Plan Report, East Side of the Kirtland AFB Bulk Fuels Facility*. Kirtland Air Force Base, New Mexico. February.

CH2M HILL. 2008. *Semi-Annual Summary and Performance Report, October 2007 through March 2008, Bulk Fuels Facility*. Kirtland Air Force Base, New Mexico. May.

CH2M HILL. 2009. *Remediation and Site Investigation Report for the Bulk Fuels Facility, April 2009 through September 2009*. Kirtland Air Force Base, New Mexico. December.

NMED. 2012a. *Risk Assessment Guidance for Site Investigation and Remediation, Volume I, Tier 1: Soil Screening Guidance Technical Background Document,* Hazardous Waste Bureau and Ground Water Quality Bureau Voluntary Remediation Program, New Mexico Environment Department, Santa Fe, New Mexico, February.

NMED. 2012b. *New Mexico Administrative Code, Title 20 Environmental Protection, Chapter 5 Petroleum Storage Tanks,* New Mexico Environment Department, Santa Fe, New Mexico, March.

NMED. 2010b. April 2, 2010 correspondence from Mr. James P. Bearzi, Chief, NMED-HWB, to Colonel Michael S. Duvall, Base Commander, 377 ABW/CC, Kirtland AFB, NM, and Mr. John Pike, Director, Environmental Management Section, 377 MSG/CEANR, Kirtland AFB, NM, re: SWMUs ST-106 and SS-111, Bulk Fuels Facility, Kirtland AFB, EPA ID# NM9570024423, HWB-KAFB-10-004.

NMED. 2010c. August 6, 2010 correspondence from Mr. James P. Bearzi, Chief, NMED-HWB, to Colonel Robert L. Maness, Base Commander, 377 ABW/CC, Kirtland AFB, NM, and Mr. John Pike, Director, Environmental Management Section, 377 MSG/CEANR, Kirtland AFB, NM, re: Bulk Fuels Facility, SWMUs ST-106 and SS-111, Directive for Conducting Interim Measures and Notice of Disapproval, Interim Measures Work Plan, June 2010; Vadose Zone Work Plan, June 2010; and Groundwater Investigation Work Plan, June 2010; Kirtland AFB, EPA ID# NM9570024423, HWB-KAFB-10-015, HWB-KAFB-10-16, and HWB-KAFB-10-019.

Shaw. 2011a. *Interim Measures Work Plan, Bulk Fuels Facility Spill, Solid Waste Management Units ST-106 and SS-111, Kirtland Air Force Base, Albuquerque, New Mexico*. March.

Shaw. 2011b. *Soil-Vapor Extraction Optimization Plan, Bulk Fuels Facility Spill, Solid Waste Management Units ST-106 and SS-111, Kirtland Air Force Base, Albuquerque, New Mexico*. September.

Shaw. 2011c. *Pre-Remedy Monitoring and Soil-Vapor Extraction System Operation and Maintenance Work Plan, Bulk Fuels Facility Spill, Solid Waste Management Units ST-106 and SS-111, Kirtland Air Force Base, Albuquerque, New Mexico.* February.

Shaw. 2012. *Quarterly Pre-Remedy Monitoring and Site Investigation Report for April – June 2012, Bulk Fuels Facility Spill, Solid Waste Management Units ST-106 and SS-111, Kirtland Air Force Base, Albuquerque, New Mexico*. October.

USACE. 2011g. *Quality Assurance Project Plan, Bulk Fuels Facility (BFF) Spill, Solid Waste Management Units ST-106 and SS-111, Kirtland Air Force Base, Albuquerque, New Mexico.* Prepared by Shaw Environmental & Infrastructure, Inc. for the USACE Albuquerque District under USACE Contract No. W912DY-10-D-0014, Delivery Order 0002. April.

U.S. Air Force. 2002. *Stage 2 Abatement Plan for the Bulk Fuels Facility (ST-106).* U.S. Air Force, Kirtland AFB. February.

U.S. EPA. 2012. *Title 40, Code of Federal Regulations Parts 264 and 265*. U.S. Environmental Protection Agency. November.

FIGURES

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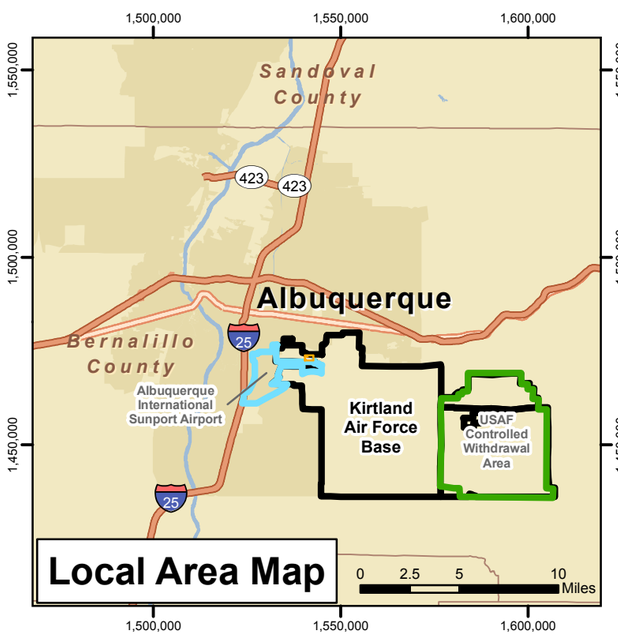

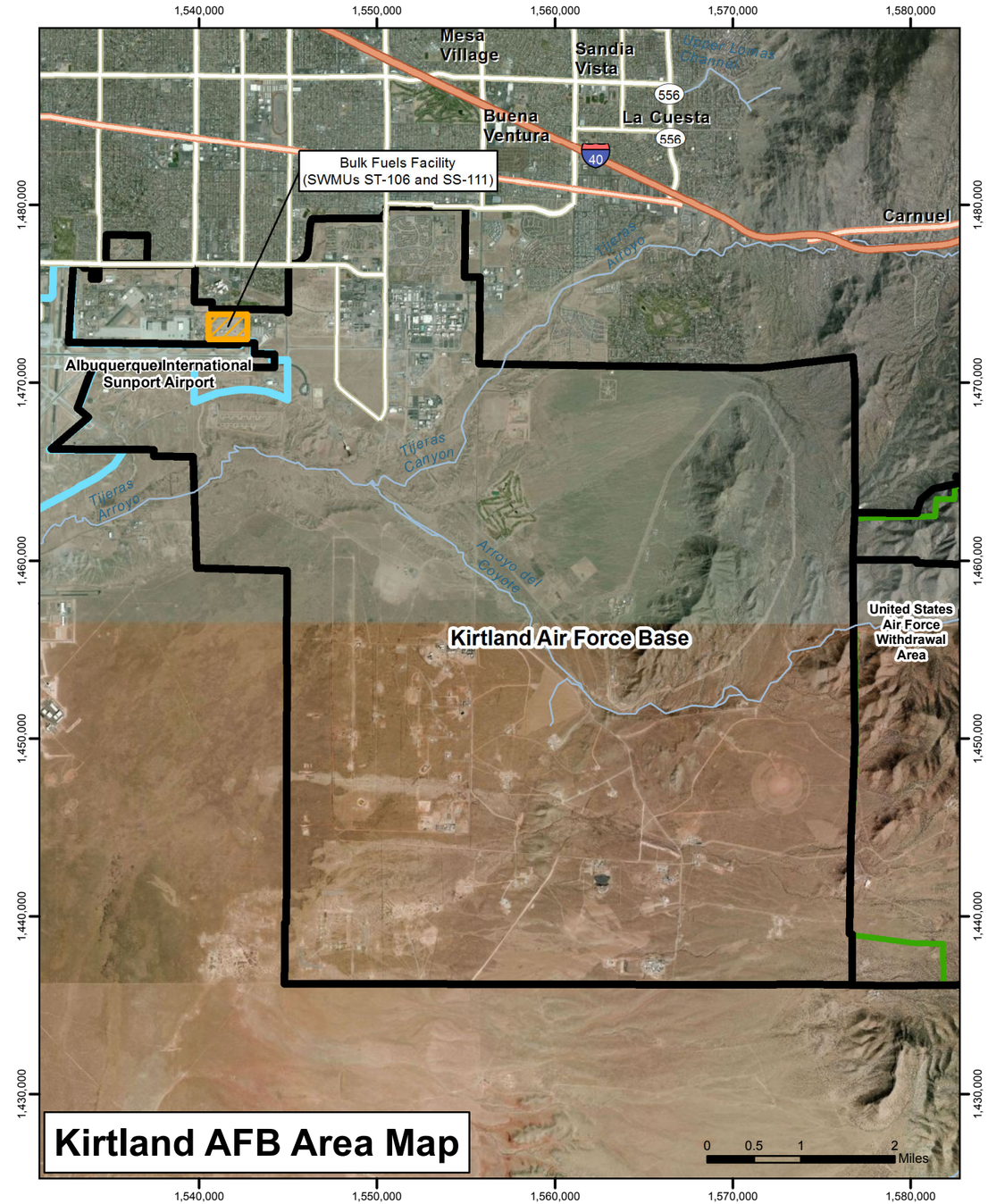

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Legend

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

N

Revision Date: 11/02/12

Projection : NAD83 State Plane New Mexico Central FIPS3002 Feet

PHASE II REMEDIATION INTERIM MEASURES PLAN
BULK FUELS FACILITY
KIRTLAND AIR FORCE BASE, NEW MEXICO

FIGURE 1-1

SITE LOCATION MAP

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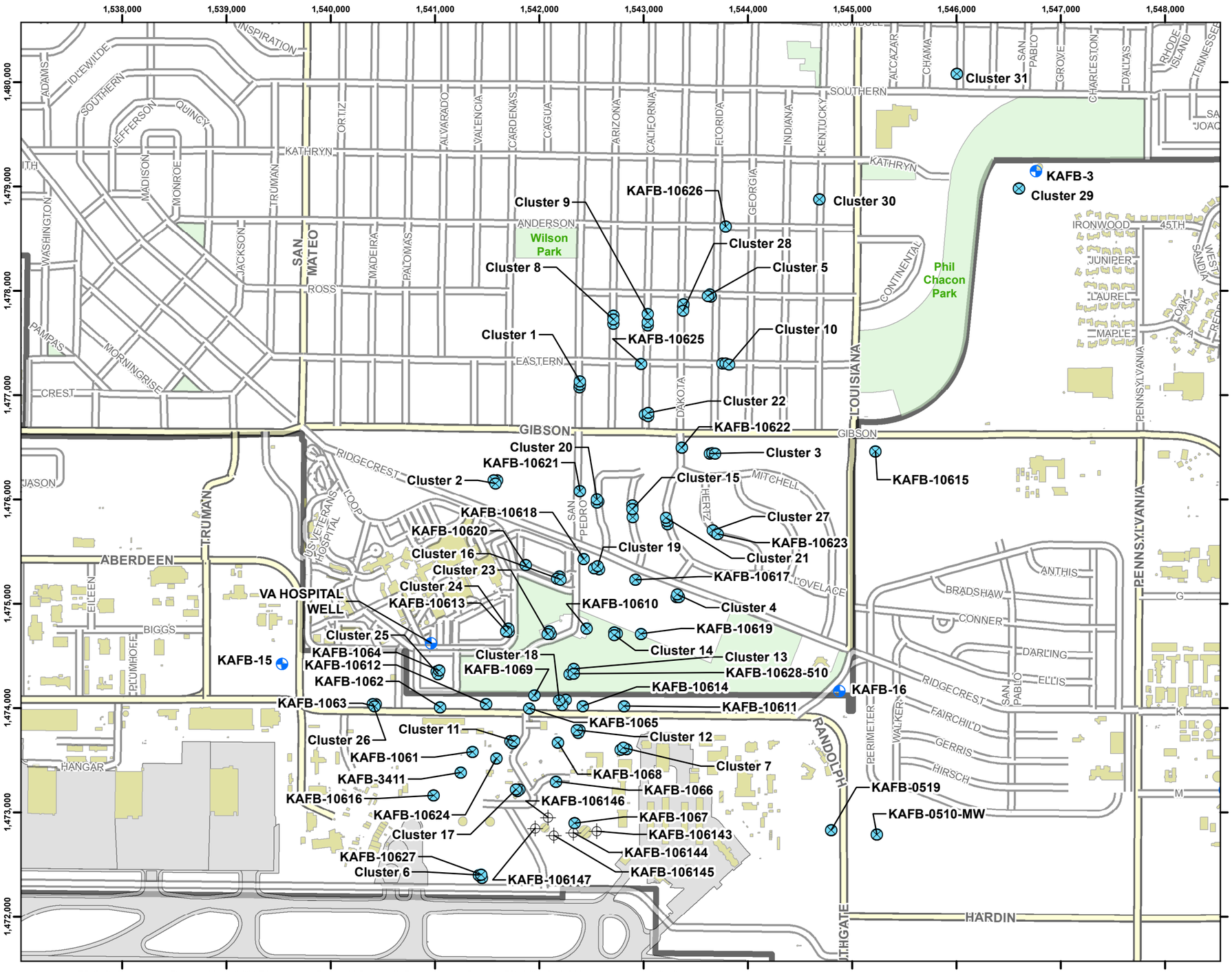

PHASE II REMEDIATION INTERIM MEASURES PLAN
BULK FUELS FACILITY
KIRTLAND AIR FORCE BASE, NEW MEXICO

FIGURE 1-2

GROUNDWATER MONITORING WELL AND SOIL BORING LOCATIONS

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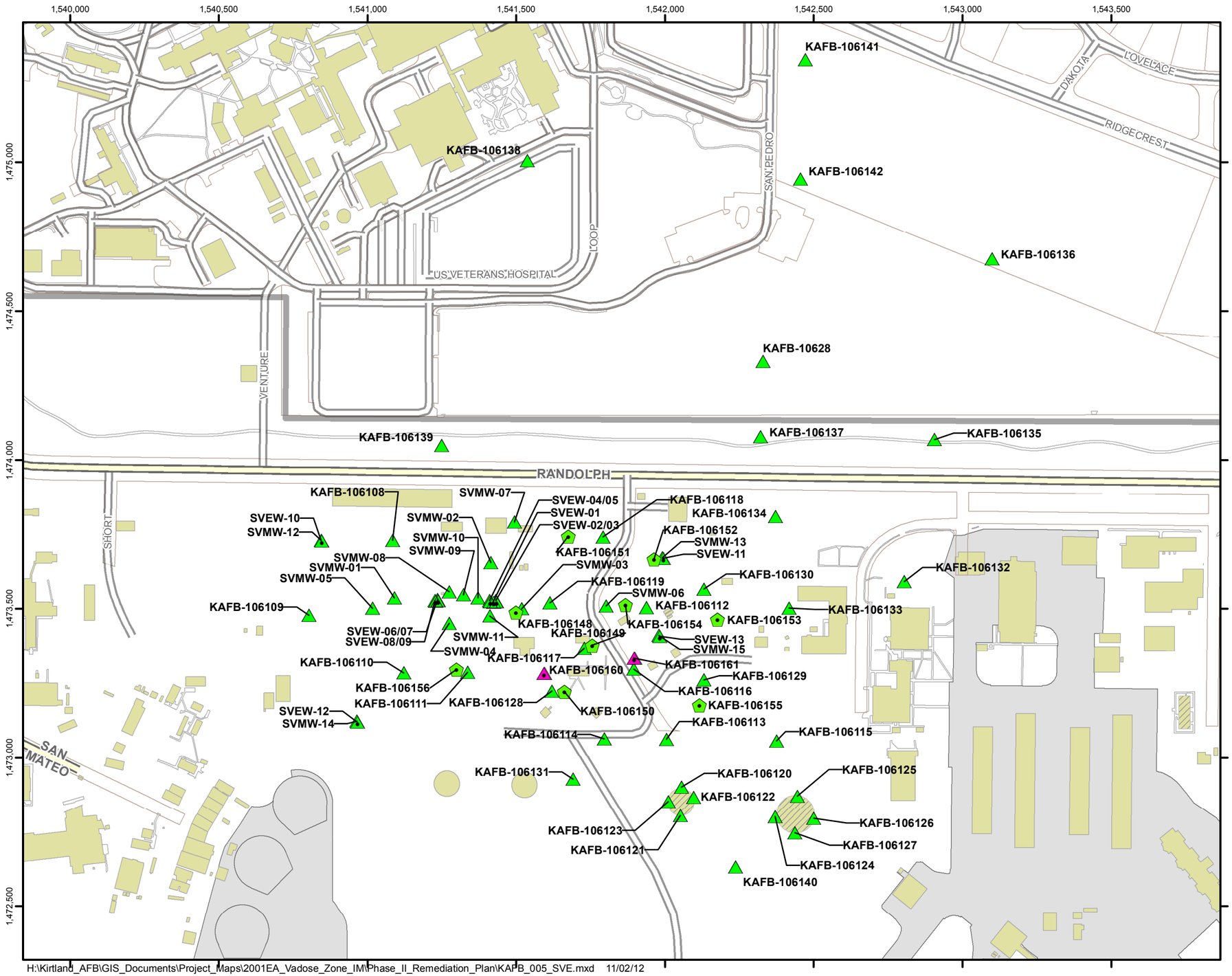

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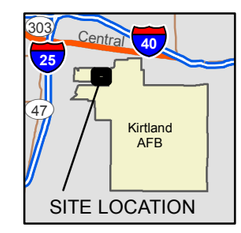
Legend

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



Revision Date: 11/02/12

N

0 175 350 700

Feet

1 inch = 350 feet

Projection : NAD83 State Plane New Mexico Central FIPS3002 Feet

PHASE II REMEDIATION INTERIM MEASURES PLAN
BULK FUELS FACILITY
KIRTLAND AIR FORCE BASE, NEW MEXICO

FIGURE 1-3

SOIL VAPOR MONITORING LOCATIONS

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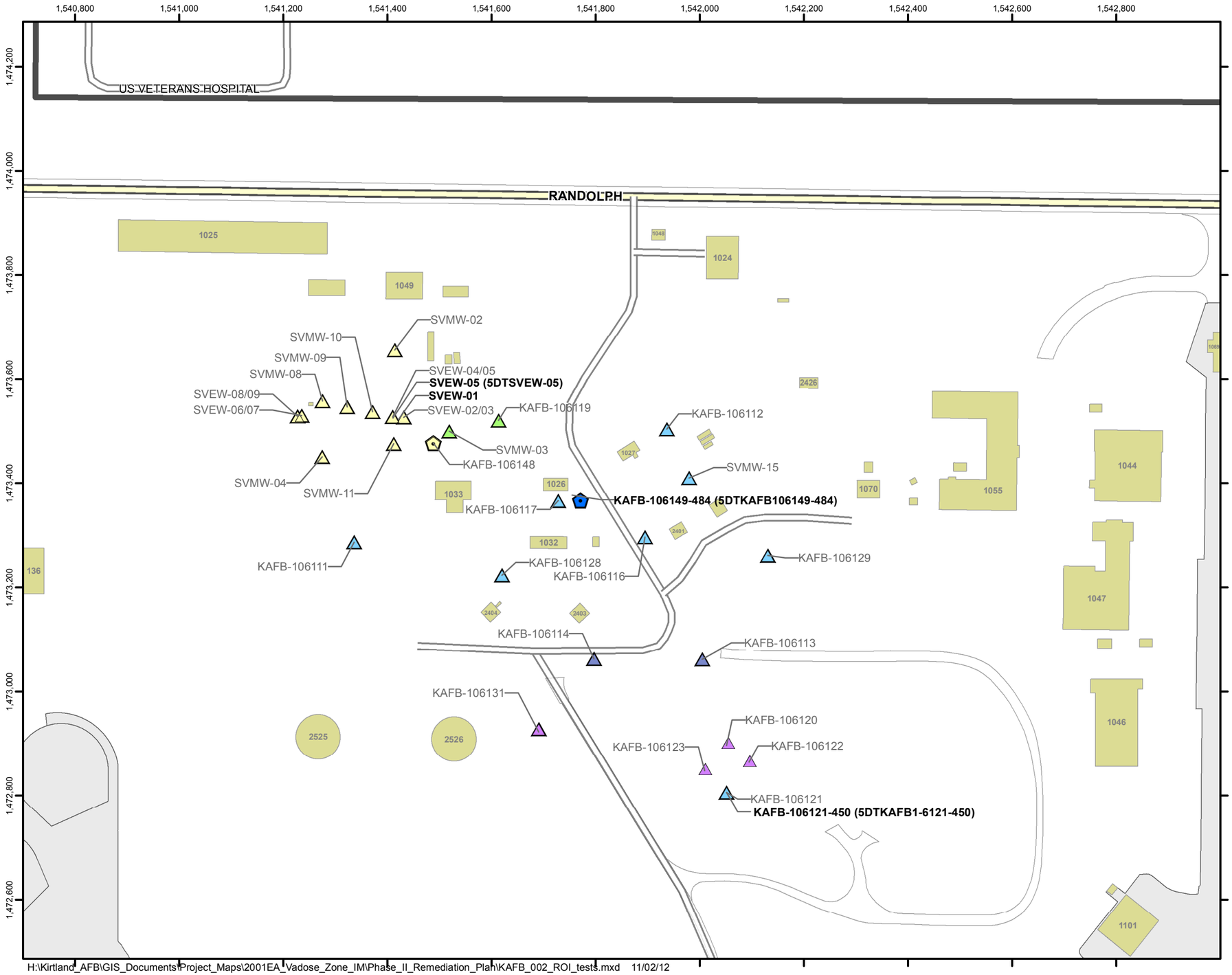

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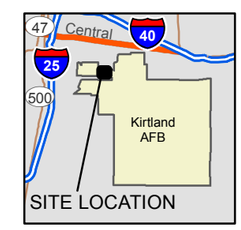
Legend

- Observation Well Cluster for ROI Test 1
- Extraction Well for ROI Test 1
- Observation Well Cluster for ROI Tests 1 and 3
- Observation Well Cluster for ROI Tests 2 and 3
- Extraction Well and Alternative for ROI Test 2
- Observation Pneulog Well for ROI Test 2
- Observation Well for ROI Test 2
- Extraction Well for ROI Test 3
- Observation Well Cluster for ROI Test 3
- Interstate
- Major Road
- Road
- Existing Structure
- Runway
- Installation Boundary

Note:
Extraction wells for tests are labeled in **bold** font.
Observation wells for tests are labeled in regular font.



Revision Date: 11/01/12

N

0 100 200 400

Feet
1 inch = 200 feet

Projection : NAD83 State Plane New Mexico Central FIPS3002 Feet

PHASE II REMEDIATION INTERIM MEASURES PLAN
BULK FUELS FACILITY
KIRTLAND AIR FORCE BASE, NEW MEXICO

FIGURE 1-4

RADIUS OF INFLUENCE TEST WELLS

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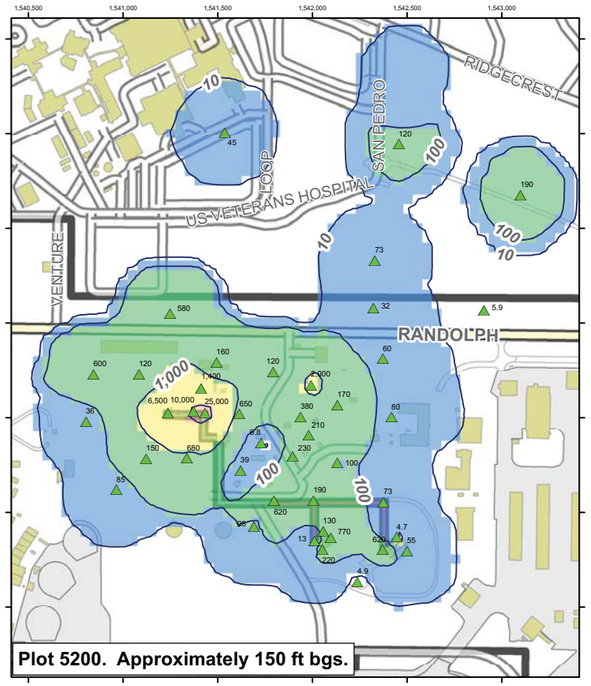
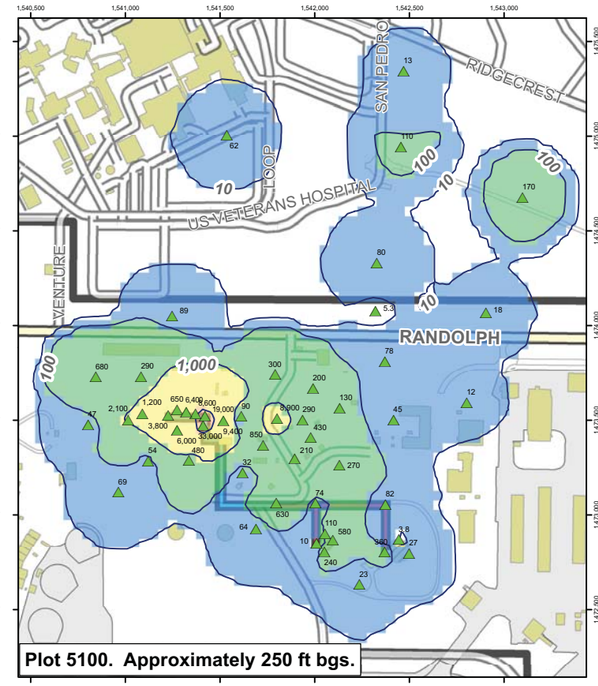
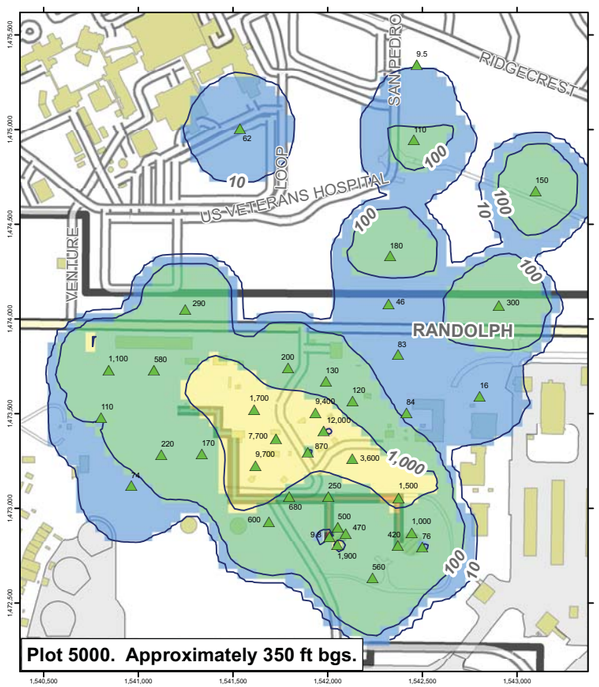
Plot 5300. Approximately 50 ft bgs.



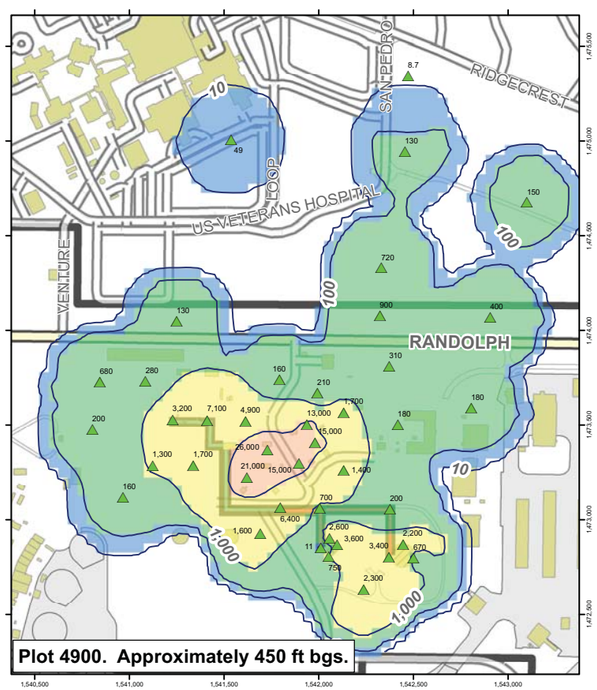
Plot 5200. Approximately 150 ft bgs.



Plot 5100. Approximately 250 ft bgs.



Plot 5000. Approximately 350 ft bgs.



Plot 4900. Approximately 450 ft bgs.

Note:
The vadose zone VOC plume was gridded in three dimensions using inverse distance weighting in RockWorks and then concentration plan-view maps were "cut" at respective elevations. Ground elevations range from 5314 to 5364 ft above mean sea level across the ST-106/SS-111 investigation area.

SVE well locations are presented with the total vapor VOC concentration in ppmv for each elevation. Sample results within 25 ft of the elevation are posted. For example, plot 5000 includes sample results within the 5025 to 4075 ft interval. Locations are not shown at elevations where there is no sample result for the elevation interval.

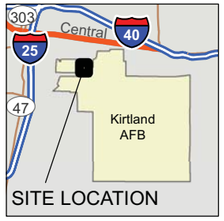
See Figure 4-2 for SVE well locations with ID numbers.

Legend

- SVE/SVM Well with Vapor VOC Concentration (ppmv)
- VOC Concentration Contours (ppmv)

VOC Concentration (ppmv)

- 1 - 10
- 11 - 100
- 110 - 1,000
- 1,100 - 10,000
- 11,000 - 41,000



Revision Date: 11/02/12

N

0 400 800 1,600

Feet

1 inch = 400 feet

Projection : NAD83 State Plane New Mexico Central FIPS3002 Feet

PHASE II REMEDIATION INTERIM MEASURES PLAN
BULK FUELS FACILITY
KIRTLAND AIR FORCE BASE, NEW MEXICO

FIGURE 1-5

TOTAL VOC VAPOR PLUME FOOTPRINTS BY ELEVATION
JUNE 2012

H:\Kirtland_AFB\GIS_Documents\Project_Maps\2001EA_Vadose_Zone_IM\Phase_II_Remediation_Plan\KAFB_008_Lab_VOC_plan_Dsize.mxd 11/02/12

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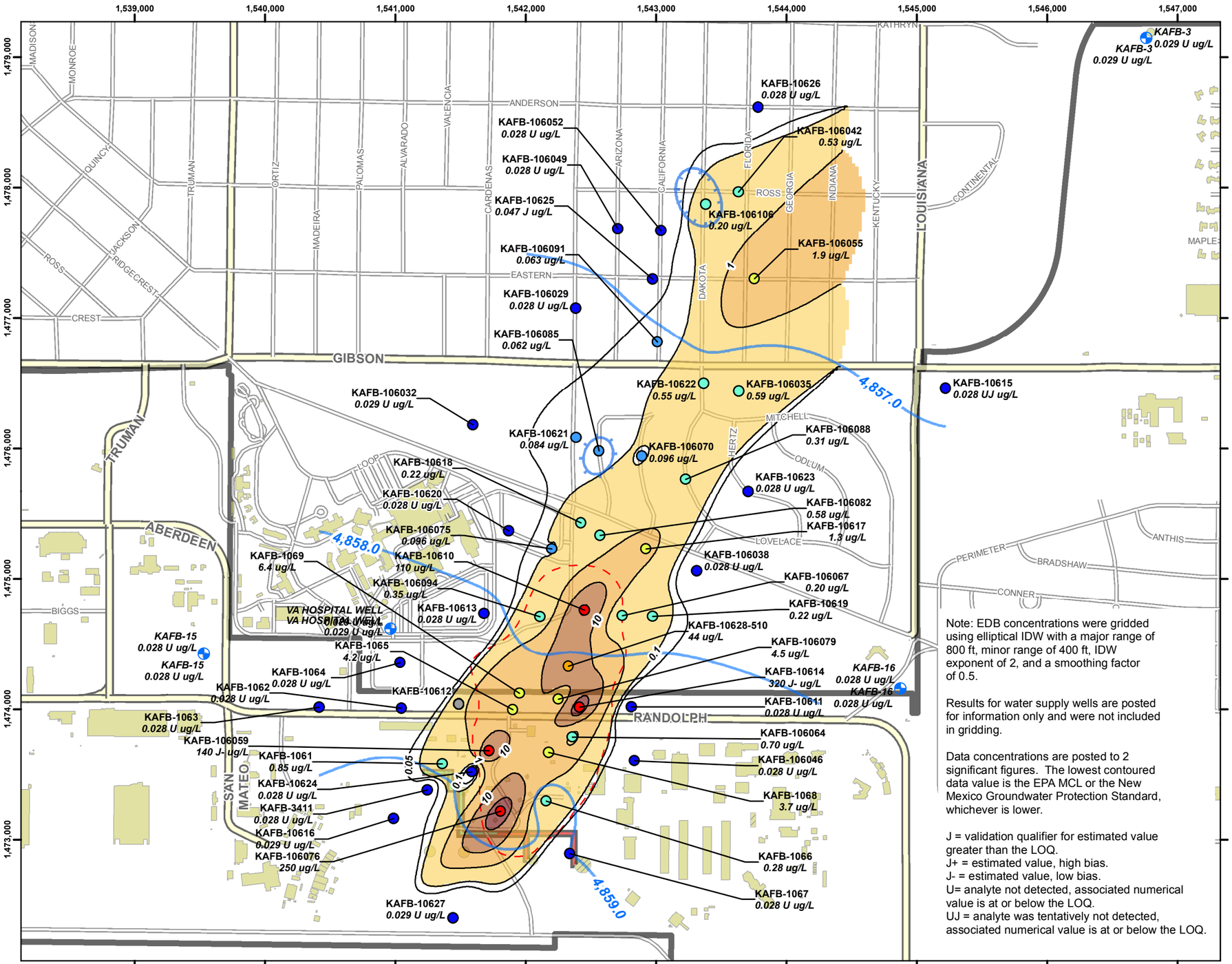


Note: EDB concentrations were gridded using elliptical IDW with a major range of 800 ft, minor range of 400 ft, IDW exponent of 2, and a smoothing factor of 0.5.

Results for water supply wells are posted for information only and were not included in gridding.

Data concentrations are posted to 2 significant figures. The lowest contoured data value is the EPA MCL or the New Mexico Groundwater Protection Standard, whichever is lower.

J = validation qualifier for estimated value greater than the LOQ.
J+ = estimated value, high bias.
J- = estimated value, low bias.
U= analyte not detected, associated numerical value is at or below the LOQ.
UJ = analyte was tentatively not detected, associated numerical value is at or below the LOQ.

Legend

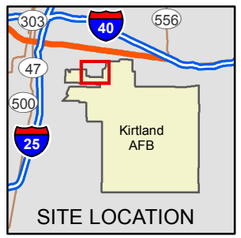
- Water Supply Well

EDB Result (ug/L)

- 0.028 - 0.050
- 0.051 - 0.10
- 0.11 - 1.0
- 1.1 - 10
- 11 - 100
- 110 - 320
- Not Sampled
- Groundwater Level Contour (ft msl)
- Groundwater High
- Groundwater Depression
- EDB Concentration Contour (ug/L)

EDB Concentration (ug/L)

- 0.014 - 0.1
- 0.11 - 1
- 1.1 - 10
- 11 - 100
- 110 - 310
- Historical Area of Observed NAPL (July 2009)



Revision Date: 11/02/12

N

0 400 800 1,600

Feet
1 inch = 800 feet

Projection : NAD83 State Plane New Mexico Central FIPS3002 Feet

PHASE II REMEDIATION INTERIM MEASURES PLAN
BULK FUELS FACILITY
KIRTLAND AIR FORCE BASE, NEW MEXICO

FIGURE 1-6

1,2-DIBROMOETHANE (EDB) CONCENTRATIONS IN SHALLOW GROUNDWATER

H:\Kirtland_AFB\GIS_Documents\Project_Maps\2001EA_Vadose_Zone_IM\Phase_II_Remediation_Plan\KAFB_007_GW_EDB_shallow.mxd 11/02/12

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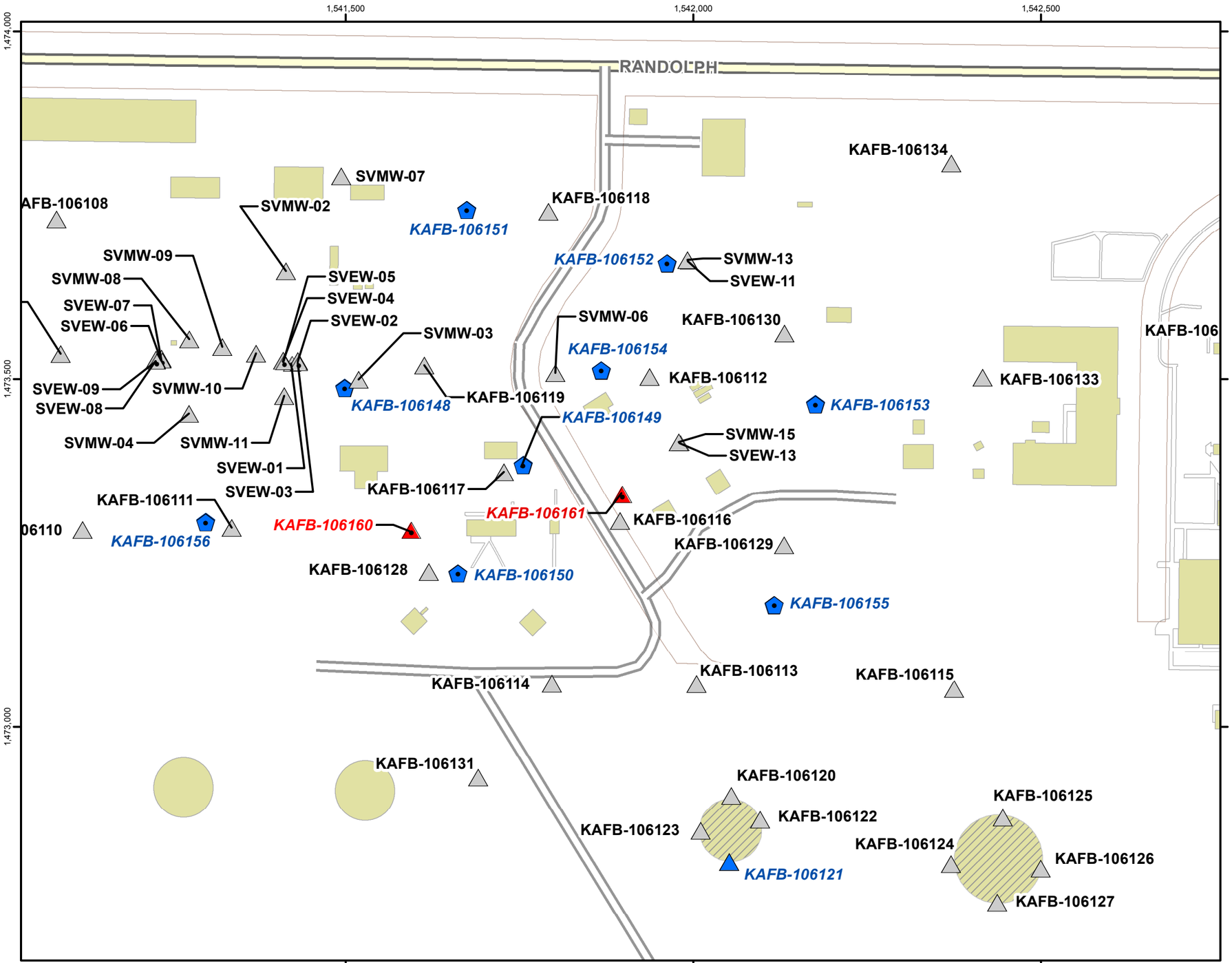

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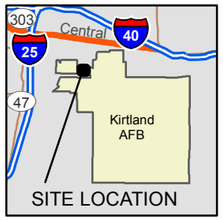
Legend

- Active SVE Extraction Well
- Primary SVM Cluster
- Pneu Log
- SVE Extraction Well
- SVM Cluster
- Removed Fuel Storage Tanks



Revision Date: 11/02/12

N

0 75 150 300

Feet

1 inch = 150 feet

Projection : NAD83 State Plane New Mexico Central FIPS3002 Feet

PHASE II REMEDIATION INTERIM MEASURES PLAN
BULK FUELS FACILITY
KIRTLAND AIR FORCE BASE, NEW MEXICO

FIGURE 2-1

SVE REMEDIATION
MONITORING SYSTEM

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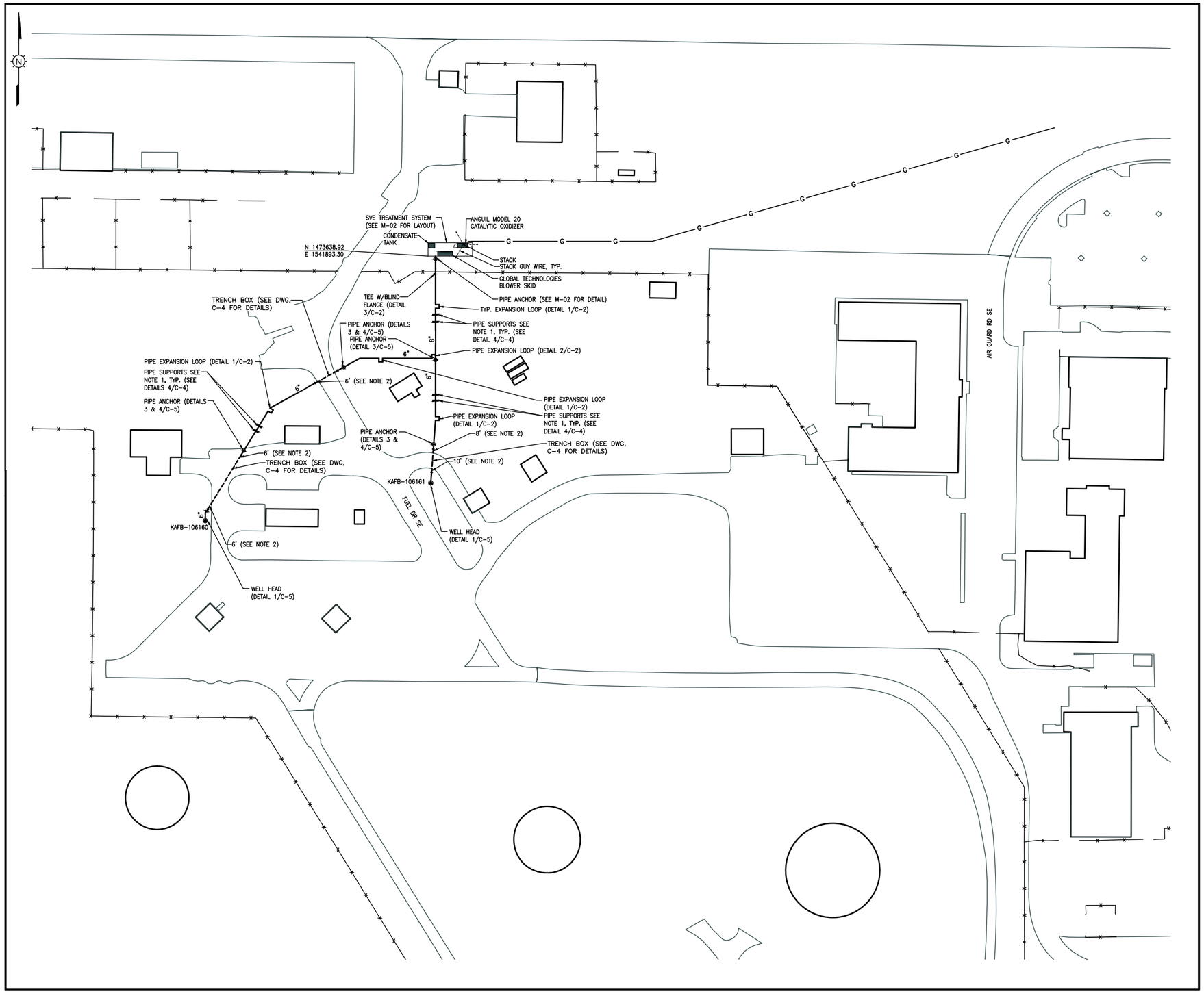


LEGEND:

EXISTING

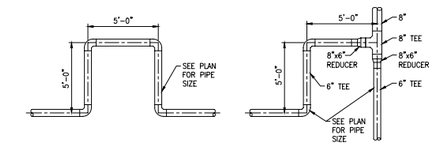
- BUILDING
- ROAD
- FENCE
- 5350 MAJOR CONTOURS
- MINOR CONTOUR
- G_x GAS LINE
- ST STORM SEWER
- WW WASTE WATER LINE
- W_x WATER LINE
- E_x ELECTRICAL CABLE
- F FUEL LINE
- (F) FORMER FUEL LINE
- IW INDUSTRIAL WASTE LINE
- T1049 (3)-25 kVA TRANSFORMER
- LIGHT POLE
- POWER POLE

NEW

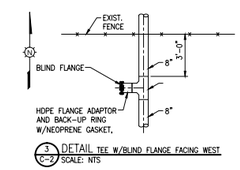
- SVE TREATMENT SYSTEM
- KAFB-106161 EXTRACTION WELLS
- EXTRACTION WELL PIPING IN TRENCH BOX
- EXTRACTION WELL ABOVE GRADE PIPING
- G GAS LINE
- PIPE SUPPORTS
- PIPE ANCHOR
- OR EXPANSION LOOP

NOTES:

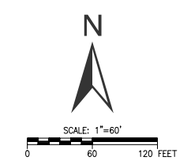
1. VACUUM PIPING WILL BE SUPPORTED BY 4"x4" PRESSURE TREATED POSTS LAID HORIZONTALLY ON GRADE EXCEPT WHERE NOTED BY PIPE ANCHORS. 6"ø PIPING SHALL BE SUPPORTED EVERY 8'-0" OC. 8"ø PIPING SHALL BE SUPPORTED EVERY 10'-0" OC.
2. MINIMUM DISTANCE REQUIRED FROM EDGE OF PAVED ROAD TO OUTSIDE DIAMETER OF PIPE.

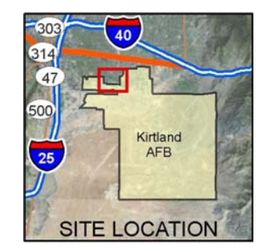


2 C-2 DETAIL PIPE EXPANSION LOOP
SCALE: NTS



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





PHASE II REMEDIATION INTERIM MEASURES PLAN
BULK FUELS FACILITY
KIRTLAND AIR FORCE BASE, NEW MEXICO

FIGURE 2-2

SOIL VAPOR EXTRACTION AND THERMAL TREATMENT SYSTEM SITE PLAN

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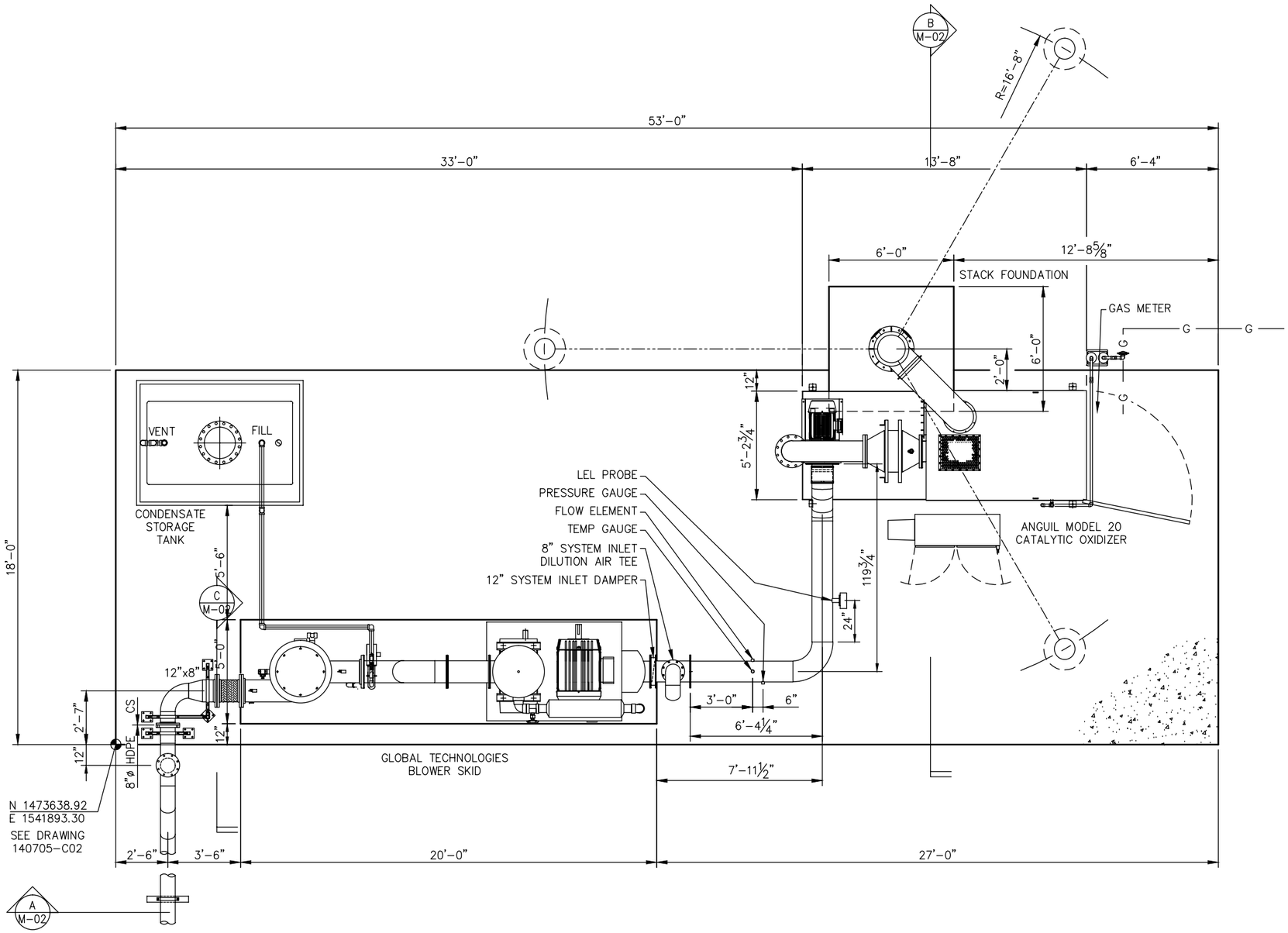

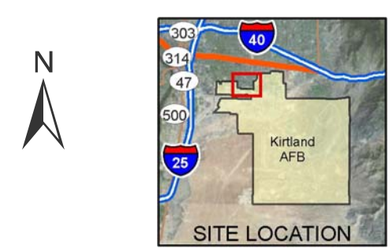

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FIGURE 2-3

SOIL VAPOR EXTRACTION AND THERMAL TREATMENT SYSTEM MECHANICAL - GENERAL ARRANGEMENT

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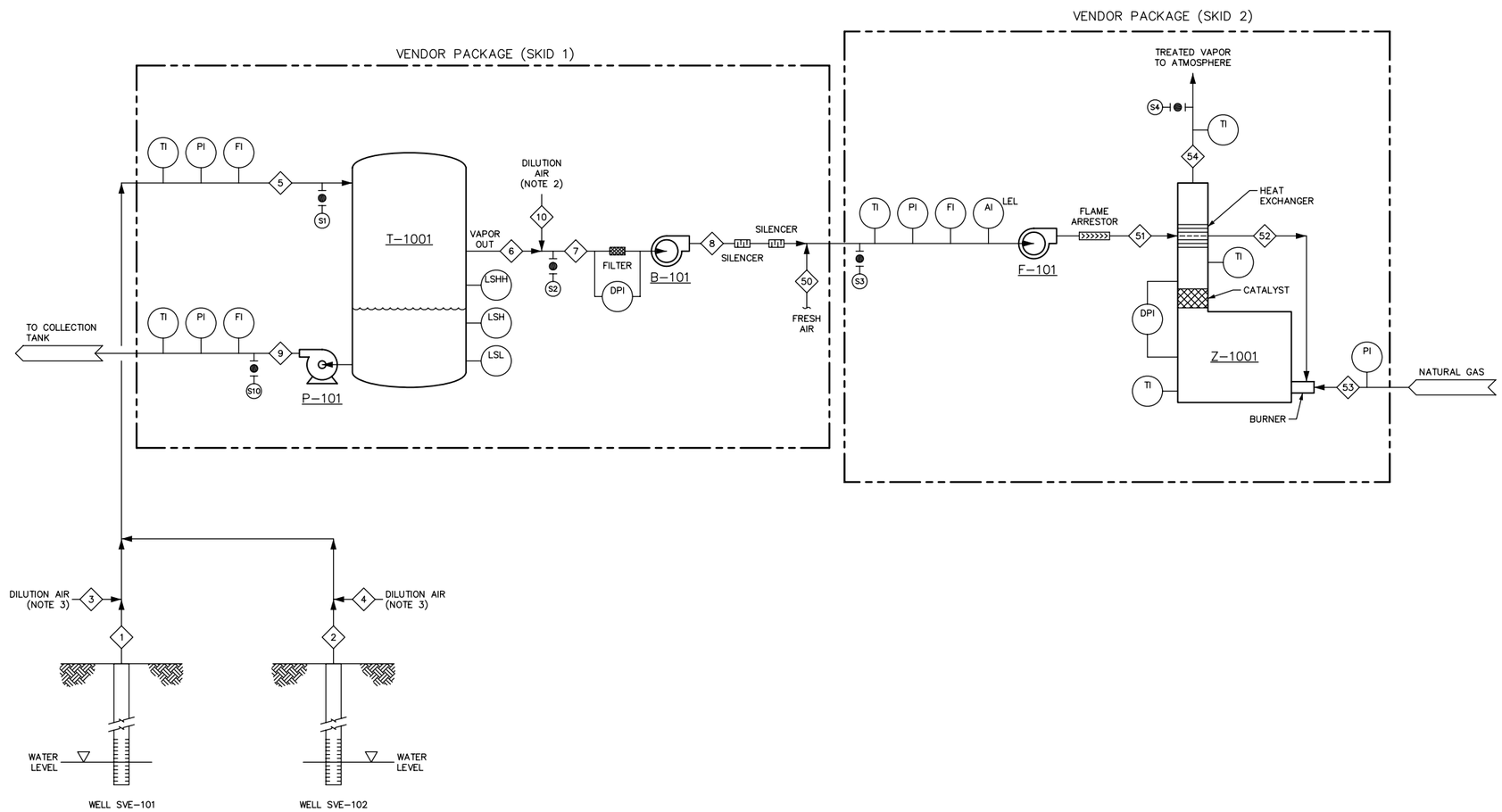


B-101
SVE-1 VACUUM/BLOWER SYSTEM
1,200 SCFM
-12" Hg VACUUM
125 HP

F-101
SYSTEM FAN
2,500 SCFM

P-101
SVE-1 LIQUID PUMP
5 GPM

T-1001
SVE-1 AIR/WATER SEPARATOR
600 GALLON
48" DIA x 6' H

Z-1001
THERMAL CATALYTIC OXIDIZER

STREAM NO. / COMPONENT		1 AIR FLOW FROM SVE-101	2 AIR FLOW FROM SVE-102	3 DILUTION AIR FROM SVE-101	4 DILUTION AIR FROM SVE-102	5 VAPOR FROM WELLS	6 SEPARATOR VAPOR	7 DILUTED INLET VAPOR	8 BLOWER VAPOR	9 CONDENSATE	10 DILUTION AIR	50 FRESH AIR	51 EXTRACTED VAPOR	52 COMBUSTION AIR	53 NATURAL GAS	54 STACK GAS
WATER FLOW (average)	lb/hr															
AIR FLOW (average)	lb/hr	1,800	1,800	900	900	5,400	5,400	7,200	7,200	(NOTE 4)	1,800	4,050	11,250	11,250		11,340
LIQUID FLOW (maximum)	gpm															
LIQUID FLOW (average)	gpm															
AIR FLOW	acfm	529	529			1,633	1,633	2,177	2,105		479	1,078	3,104	5,529		6,153
AIR FLOW	scfm	400	400	200	200	1,200	1,200	1,600	1,600		400	900	2,500	2,500		2,520
TOTAL HYDROCARBONS	lb/hr	45	45			90	90	90	90				90	90		1.8
TOTAL HYDROCARBONS	ppmv	6,800	6,800			4,533	4,533	3,400	3,400				2,176	2,176		44
GAS FLOW	lb/hr (scfh)														6 (162)	
TEMPERATURE	°F	50	50	60	60	60	60	60	111	60	60	60	95	500		600
PRESSURE	psia	10.7	10.7	10.7	10.7	10.6	10.6	10.6	12.04		12.04	12.04	12.40	12.04		12.04
AIR DENSITY (AT 70°F)	lb/ft^3	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075		0.075	0.075	0.075	0.075		0.075
WATER DENSITY	lb/gal									8.340						

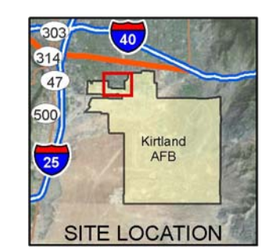
NOTES:

1. VENDOR TO SUPPLY ITEMS MARK WITH AN ASTERICK (*).
2. DILUTION AIR MANUALLY ADJUSTED TO LIMIT LEL IN VAPORS TO THERMAL TREATMENT SYSTEM.
3. DILUTION AIR TO REDUCE CONDENSATION IN PIPELINE.
4. CONDENSATE RATE WILL DEPEND ON OUTSIDE TEMPERATURE. DURING WINTER UP TO 112 GALLONS PER DAY OF CONDENSATE CAN BE PRODUCED.

LEGEND:

LEL – LOWER EXPLOSION LIMIT
S2 – SAMPLE PORT

N



PHASE II REMEDIATION INTERIM MEASURES PLAN
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FIGURE 2-4

SOIL VAPOR EXTRACTION (SVE) SYSTEM PROCESS FLOW DIAGRAM

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TABLES

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Table 1-1. Groundwater Monitoring Well Clusters and Associated Wells

NMED Cluster	Location
Cluster 1	KAFB-106029
	KAFB-106030
	KAFB-106031
Cluster 2	KAFB-106032
	KAFB-106033
	KAFB-106034
Cluster 3	KAFB-106035
	KAFB-106036
	KAFB-106037
Cluster 4	KAFB-106038
	KAFB-106039
	KAFB-106040
Cluster 5	KAFB-106041
	KAFB-106042
	KAFB-106043
Cluster 6	KAFB-106044
	KAFB-106045
Cluster 7	KAFB-106046
	KAFB-106047
	KAFB-106048
Cluster 8	KAFB-106049
	KAFB-106050
	KAFB-106051
Cluster 9	KAFB-106052
	KAFB-106053
	KAFB-106054
Cluster 10	KAFB-106055
	KAFB-106057
	KAFB-106058
Cluster 11	KAFB-106059
	KAFB-106060
	KAFB-106061
Cluster 12	KAFB-106062
	KAFB-106063
	KAFB-106064
Cluster 13	KAFB-106065
	KAFB-106066
Cluster 14	KAFB-106067
	KAFB-106068
	KAFB-106069
Cluster 15	KAFB-106070
	KAFB-106071
	KAFB-106072
Cluster 16	KAFB-106073
	KAFB-106074
	KAFB-106075
Cluster 17	KAFB-106076
	KAFB-106077
	KAFB-106078
Cluster 18	KAFB-106079
	KAFB-106080
	KAFB-106081

Table 1-1. Groundwater Monitoring Well Clusters and Associated Wells (concluded)

NMED Cluster	Location
Cluster 19	KAFB-106082
	KAFB-106083
	KAFB-106084
Cluster 20	KAFB-106085
	KAFB-106086
	KAFB-106087
Cluster 21	KAFB-106088
	KAFB-106089
	KAFB-106090
Cluster 22	KAFB-106091
	KAFB-106092
	KAFB-106093
Cluster 23	KAFB-106094
	KAFB-106095
	KAFB-106096
Cluster 24	KAFB-106097
	KAFB-106098
Cluster 25	KAFB-106099
	KAFB-106100
Cluster 26	KAFB-106101
	KAFB-106102
Cluster 27	KAFB-106103
	KAFB-106104
Cluster 28	KAFB-106105
	KAFB-106106
	KAFB-106107

NMED New Mexico Environment Department

APPENDIX A

Soil Classification Logs and Well Construction Diagrams

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APPENDIX B

Project Specifications and Drawings

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Normal Operation of SVE System

A detailed layout of the SVE blower skid and CATOX system is presented on Figure 2-3, and the process flow diagram for the system is shown on Figure 2-4.

SVE is the process of pulling fresh air through the subsurface soil to volatilize THC. The air/water knock-out tank will separate entrained water that is in the air stream. A lobed vacuum blower pulls the vapors from the individual recovery wells through the knock-out tank and to the blower, and then discharges at low pressure. The air will then be pushed through the CATOX for treatment. THC-laden air is drawn into the CATOX's fan and is discharged into the system's heat exchanger. The air passes through the tube side of the heat exchanger and into the burner, where the contaminated air is raised to the catalyst operating temperature of 600 degrees Fahrenheit (°F) (Figure 2-4). When the THC-laden air passes through the catalyst, an exothermic reaction takes place. The THC in the air stream are converted to carbon dioxide and water vapor. The unit is designed for 98 percent destruction of hydrocarbons.

On initial start-up and after any shutdown, the oxidizer must be started and heated up using an air stream of fresh air only because the oxidizer cannot destroy the THC until it reaches adequate temperatures, thus, the process stream cannot be passed through the unit during heat-up. The fresh air inlet is maintained open as a default position, and is always open during start-up. Moreover, during startup, there is a system valve at the inlet of the SVE blower (during the heatup cycle, this valve is shut), that isolates the CATOX unit from the SVE manifold and contaminated soil gas. During on-line operation, the system valve is opened, and the fresh air (dilution air) inlet is open to a greater or lesser degree depending on operating conditions.

The vacuum blower system can be started to pull vacuum from the wells. Upon start-up, all dilution air valves will be open, and using the VFD, the blower will be set at about 80 percent of maximum speed. SVE wells will be brought on-line by opening the valve for that well. Once preliminary readings of LEL

are attained, dilution air at the SVE can be reduced. As new wells are brought on-line, the dilution valves at wellheads can be closed slightly without risking production of excessive liquid. The VFD on the blower motor can be used to adjust the vacuum applied to the well field. Higher speeds will increase the vacuum if all valve positions remain the same. Based on the expected initial conditions for the SVE wells, a blower speed of 80 percent of the maximum should give adequate flow and vacuum to the wells. The vacuum blower is interlocked with the high-high temperature on the discharge side of the vacuum blower. The blower system also will have a pumping oiler system. If the oil level reaches a low condition, it will shut down the vacuum blower.

As hydrocarbon loadings increase in the CATOX, the temperature of the air stream exiting the catalyst rises. The fresh air inlet, in turn, opens proportionally to dilute the THC level in the process stream to keep the catalyst outlet temperature from climbing to the safety shut-down point of 1,000 °F. As THC loadings decrease, the fresh air inlet, conversely, proportionally closes to lessen the amount of dilution to help maintain operating efficiency.

The CATOX system fan, with associated drive mechanism and controls, induces a negative pressure upstream of the oxidizer to serve as the major source of air into the system. It is sized to provide suitable flow through the system under all design conditions.

The oxidizer is equipped with an air heat-type burner that delivers up to 1,000,000-British Thermal Units-per-hour output from a natural gas source. Pilot gas feeds from the same ports as main gas to immediately merge, thus forming a common fire envelope.

The burner and its associated controls combust a fuel air mixture to provide the initial driving heat to the system. The controls include a modulating firing rate valve and temperature loop controller to modulate the volume of fuel going to the burner and the dilution air coming in through the system fan. The reactor

vessel holding the catalyst modules has an inner liner constructed entirely of stainless steel. The inner liner is covered with 6 inches of high-temperature mineral wool insulation. It has an outer cabinet of 14-gauge, aluminized steel with a structural framework. The temperature set point for heating the process stream to catalyzing temperature is achieved by a loop control that governs the burner firing rate by sending a 4-20 milliamp control signal to the actuator, which modulates the gas inlet to the burner. It receives a thermo-couple input signal from the catalyst inlet area.

When the catalyst inlet temperature tends to decrease below the field-adjustable set point, the temperature-control loop drives the firing rate valve open to deliver more fuel to the burner to maintain the set point. Once the burner is lit, if at any time during burner operation the flame controller senses the lack of a flame or an unacceptably weak flame, the controller automatically and immediately closes the main fuel valves, thus turning off the burner. The control then locks out, thus requiring a manual reset before further burner operation is allowed. This safety feature prevents a buildup in the combustion chamber of uncombusted fuel.

As the THC pass through the catalyst, heat is given off, and a portion of this heat is passed to the inlet stream via the heat exchanger. If high THC loadings are present, the amount of heat given off by oxidation of the THC may alone be enough to maintain the catalyst inlet set point. Under this condition, the temperature-control loop moves the firing rate actuator to fully closed, since no additional heat is required. If the catalyst outlet temperature continues to rise, a separate controller begins opening the fresh air valve in order to keep this temperature below 1,000 °F.

The catalyst within the CATOX oxidizes the THC if the catalyst is at the minimum oxidizing temperature. The primary function of the control system of the catalyst is to bring it up to and maintain it at proper oxidizing temperature. This will limit the heat the catalyst receives to avoid damage to the catalyst, and to recover, to a certain extent, the heat given off by the catalytic reaction for use in

maintaining catalyst operating temperature. The catalyst is a noble metal type; it is a class of precious metal catalyst consisting of special-purpose compositions of highly dispersed platinum and rhodium for performance and durability in catalyzed reactions. The catalyst breaks down the hydrocarbons into carbon dioxide and water in a range of 500 °F to 1,000 °F.

During normal operation, the liquid-transfer pump from the air/water knock-out drum should cycle on and off as liquids collect in the knock-out tank. During automatic operation, the transfer pump will start when water level in the knock-out tank rises above the high level. The pump will continue to operate until the water level in the knock-out tank drops below the low-level set point. If water level reaches high-high level in the knock-out tank, an interlock will trigger automatic shutdown of the vacuum blower. The vacuum blower cannot be started until the liquid level in the knock-out tank is reduced by pumping out.

APPENDIX C

Key Personnel

(to be submitted at a later date)

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APPENDIX D

Construction Quality Assurance Plan

(to be submitted at a later date)

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APPENDIX E

System Operations and Maintenance Manual

(to be submitted at a later date)

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APPENDIX F

System Friction Loss Calculations

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APPENDIX G

Project Schedule

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