# KIRTLAND AIR FORCE BASE
# ALBUQUERQUE, NEW MEXICO

# QUARTERLY REPORT – APRIL-JUNE 2016
# BULK FUELS FACILITY
# SOLID WASTE MANAGEMENT UNIT ST-106/SS-111
# KIRTLAND AIR FORCE BASE, NEW MEXICO

**September 2016**

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# Quarterly Report – April-June 2016
# Bulk Fuels Facility
# Solid Waste Management Unit ST-106/SS-111
# Kirtland Air Force Base, New Mexico

**September 2016**

**Prepared for**
U.S. Army Corps of Engineers
Albuquerque District
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# NOTICE

This report was prepared for the U.S. Army Corps of Engineers by EA Engineering, Science, and Technology, Inc., PBC for the purpose of documenting the progress of an Interim Action being implemented by the U.S. Air Force Environmental Restoration Program (ERP) at Kirtland Air Force Base. As the report relates to actual or possible releases of potentially hazardous substances, its release prior to a final decision on remedial action may be in the public's interest. The limited objectives of this report and the ongoing nature of the ERP, along with the evolving knowledge of site conditions and chemical effects on the environment and health, must be considered when evaluating this report, since subsequent facts may become known that may make this report premature or inaccurate.

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This Quarterly Report summarizes the activities performed from March 28 through June 30, 2016 as part of the Resource Conservation and Recovery Act interim measures for soil and groundwater remediation at Solid Waste Management Unit ST-106/SS-111, the Bulk Fuels Facility site, at Kirtland Air Force Base (AFB), New Mexico. Quarterly source area soil vapor, groundwater, drinking water at proximal water supply wells, and Groundwater Treatment System (GWTS) samples were collected and analyzed for contaminants of concern and other relevant field and laboratory parameters. The GWTS treated approximately 33,589,920 million gallons of extracted groundwater through a granular activated carbon filtration system and discharged the treated effluent to either the Kirtland AFB golf course main pond or to the aquifer via gravity-fed injection well KAFB-7. Concentrations in all treated effluent samples were below regulatory standards before discharge.

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Bulk Fuels Facility, Solid Waste Management Unit ST-106/SS-111, Interim Measures, Resource Conservation and Recovery Act, soil vapor, vadose zone, groundwater sampling, groundwater treatment system operation, granular activated carbon, ethylene dibromide

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# September 2016

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ERIC H. FROEHLICH, Colonel, U.S. Air Force
Commander, 377th Air Base Wing

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KIRTLAND AIR FORCE BASE
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# PREFACE

This Quarterly Report – April-June 2016 has been prepared by EA Engineering, Science, and Technology, Inc., PBC (EA) for the U.S. Army Corps of Engineers, under Contract Number W912DR-12-D-0006, Delivery Order DM01 and pertains to the Base Bulk Fuels Facility, Solid Waste Management Unit ST-106/SS 111, located in Albuquerque, New Mexico. This Report was prepared in accordance with 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 March 25 and May 20, 2016.

Quarterly monitoring of soil vapor, groundwater, and drinking water supply and operation of the groundwater treatment system were conducted from March 28 through June 30, 2016. Mr. Trent Simpler, PE, is the U.S. Army Corps of Engineers–Albuquerque District Project Manager. The Environmental Restoration Section Chief for this program is Mr. Ludie W. Bitner of Kirtland Air Force Base.
Ms. Devon Jercinovic is the EA Project Manager.

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# CONTENTS

**Section** **Page**

# APPENDICES (AS CITED)

# FIGURES

# FIGURES (CONTINUED)

# TABLES

# TABLES (CONTINUED)

# LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| °C | degrees Celsius |
| µg/L | microgram(s) per liter |
| $\mu g/m^3$ | microgram(s) per cubic meter |
| µS/cm | microsiemen(s) per centimeter |
| AFB | Air Force Base |
| BFF | Bulk Fuels Facility |
| bgs | below ground surface |
| BTEX | benzene, toluene, ethylbenzene, and total xylenes |
| CFR | Code of Federal Regulations |
| $CO_2$ | carbon dioxide |
| DO | dissolved oxygen |
| DoD | Department of Defense |
| EA | EA Engineering, Science, and Technology, Inc., PBC |
| EDB | ethylene dibromide |
| ELLE | Eurofins Lancaster Laboratories Environmental, LLC |
| EPA | U.S. Environmental Protection Agency |
| ERPIMS | Environmental Resources Program Information Management System |
| ft | foot (feet) |
| g/mol | gram(s) per mole |
| GAC | granular activated carbon |
| gpm | gallon(s) per minute |
| GWM | groundwater monitoring |
| GWTS | groundwater treatment system |
| HC | total hydrocarbon |
| HMI | human machine interface |
| Horiba | Horiba MEXA 584L auto emissions analyzer |
| HWB | Hazardous Waste Bureau |
| ID | identification |
| IDW | investigation-derived waste |
| K | Kelvin |
| LDC | Laboratory Data Consultants, Inc. |
| LNAPL | light non-aqueous phase liquid |
| MCL | maximum contaminant level |
| mg/L | milligram(s) per liter |
| MW | molecular weight |

# LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

| | |
|---|---|
| NMED | New Mexico Environment Department |
| NMWQCC | New Mexico Water Quality Control Commission |
| $O_2$ | oxygen |
| ORP | oxidation reduction potential |
| ppbv | parts per billion by volume |
| ppmv | parts per million by volume |
| PSL | project screening level |
| Q1 | first quarter of the year, 1 January through 31 March |
| Q2 | second quarter of the year, 1 April through 30 June |
| Q3 | third quarter of the year, 1 July through 30 September |
| Q4 | fourth quarter of the year, 1 October through 31 December |
| QAPjP | Quality Assurance Project Plan |
| QC | quality control |
| R | rejected |
| S.U. | standard unit |
| SVE | soil vapor extraction |
| SVM | soil vapor monitoring |
| SVMP | soil vapor monitoring point |
| SWMU | Solid Waste Management Unit |
| TPH | total petroleum hydrocarbons |
| USACE | U.S. Army Corps of Engineers |
| USAF | U.S. Air Force |
| VA | U.S. Department of Veterans Affairs |
| VOC | volatile organic compound |

# EXECUTIVE SUMMARY

Kirtland Air Force Base (AFB) Bulk Fuels Facility (BFF) is Solid Waste Management Unit (SWMU) ST-106/SS-111 and became a cleanup site in November 1999 after fuel was observed day-lighting from the ground surface near the BFF fuel off-loading rack. Subsequent pressure testing identified three leaks from lines that transferred aircraft fuel from the fuel off-loading rack to the Pump House at the BFF. The leaking lines were immediately taken offline and a temporary alternate off-loading rack was installed and used until construction of a new state-of-the-art BFF was brought online in April 2011. The ongoing investigation and cleanup activities of the BFF site began in 1999 by characterizing the extent of the contamination along with removing contaminated soil, vapors from the vadose zone, and contaminated groundwater. These cleanup efforts are ongoing.

This Executive Summary describes soil vapor monitoring (SVM), groundwater monitoring (GWM), and interim measure activities performed at the BFF between April and June 2016, which comprised the second quarter (Q2) of calendar year 2016 (herein referred to as Q2 2016). The activities included the following:

- Sampling the entire SVM network
- Sampling the entire GWM network
- Sampling the drinking water supply wells located in the vicinity of the dissolved benzene and ethylene dibromide (also known as 1,2-dibromoethane [EDB]) plumes
- Operation and maintenance of the EDB groundwater treatment system (GWTS).

## ES-1 Vadose Zone Monitoring

Soil vapor samples were collected from 56 SVM locations (comprised of a total of 284 individual SVM points [SVMPs]) for field parameter measurements and laboratory analyses. Each SVM location is comprised of up to six SVMPs. These monitoring points are screened at discrete intervals ranging from approximately 25 to 450 feet (ft) below ground surface (bgs). Each SVMP has a unique database identification (ID). Included in the database ID is the SVM location followed by a number identifying the approximate depth of the screened interval associated with an individual SVMP (example given, SVMW-04-250 is located at SVMW-04 and is screened at approximately 250 ft bgs).

SVM locations were separated into three areas of interest to evaluate soil vapor concentrations in Q2 2016. These areas include off-base SVM locations, on-base SVM locations outside of the source area, and on-base SVM locations inside of the source area. The source area is defined as a 100-ft buffer zone around the original jet fuel pipeline that was the source of the BFF releases. Within each area of interest, EDB, benzene, and total hydrocarbon (HC) concentrations were evaluated to determine areas of relative higher or lower contamination. Percent oxygen ($O_2$) at each SVMP was also evaluated.

The off-base SVM area of interest includes 28 SVMPs ranging in depth from approximately 25 to 450 ft bgs. All EDB, benzene, and HC concentrations in this area were below the comparison concentrations of 0.5, 1, and 1,000 parts per million by volume (ppmv), respectively. The Kirtland RCRA Permit does not specify cleanup values for soil vapor. The comparison concentrations used in this report were determined by historical maximum and minimum soil vapor concentrations to show which SVMPs had relatively high or low concentrations The highest concentration of EDB (0.0019 ppmv) in off-base wells was detected at KAFB-106028-450. The highest concentration of benzene (0.0027 ppmv) was detected in 106028-350. The highest HC concentration (7 ppmv) was detected at KAFB-106028-250.

There are 224 SVMPs in the on-base area of interest outside of the source area. Fifty-five percent of the SVMPs were non-detect for EDB in this area, 29 percent were non-detect for benzene, and 96 percent measured HC concentrations less than 1,000 ppmv. SVMPs with EDB concentrations greater than 0.5 ppmv, benzene concentrations greater than 1 ppmv, and HC concentrations greater than 1,000 ppmv were screened at depths ranging from approximately 100 to 450 ft bgs. The highest concentrations of EDB and HC (2 and 6,100 ppmv, respectively) were detected at KAFB-106128-450. The maximum detected concentration of benzene (110 ppmv) in wells on base outside the source area was at SVMW-06-252.

There are 32 SVMPs inside the source area. The source area had the highest EDB, benzene, and HC concentrations when compared to the other areas of interest. All SVMPs with EDB concentrations greater than 0.5 ppmv, benzene concentrations greater than 1 ppmv, or HC concentrations greater than 1,000 ppmv were at depths ranging from approximately 50 to 450 ft bgs. The highest detection of EDB within the source area was 31 ppmv at SVMW-10-050. The highest concentrations of benzene and HC (790 and 35,668 ppmv, respectively) within the source area were detected at SVMW-11-100.

At fuel release sites, microbial activity causes aerobic biodegradation of the fuel constituents, which consumes $O_2$ and produces carbon dioxide ($CO_2$). Field measured $O_2$ levels in SVMPs with HC concentrations greater than 1,000 ppmv ranged from 0.04 to 19.42 percent. The lowest $O_2$ level of 0.04 percent was measured in SVMW-03-050, located within the source area. Seventeen SVMPs had less than 5 percent $O_2$, which is considered less than optimal for aerobic microbial activity to degrade HC.

## ES-2 Groundwater Monitoring Network Gauging and Sampling

In Q2 2016, groundwater and light non-aqueous phase liquid (LNAPL) measurements were performed at 134 GWM wells. Field and laboratory analyses were performed on 132 GWM wells. The following are the findings of the field sampling event:

- Groundwater levels continued to rise across the GWM network resulting in one additional screen becoming submerged since first quarter (Q1) 2016.

- All 134 GWM wells were evaluated for floating fuel on the water table (i.e., LNAPL). Only three GWM wells (KAFB-106005, KAFB-106008, and KAFB-106076) had measurable LNAPL thicknesses of approximately 0.01, 0.05, and 0.01 ft, respectively.

- KAFB-106020 and KAFB-106026 were not sampled this quarter. KAFB-106020 has been moved to the third quarter (Q3) for sampling as well cleaning is scheduled for early July. KAFB-106026 could not be sampled due to safety concerns.

- Field parameters were measured for samples from all 132 GWM and ranged as follows: temperature from 18.1 to 23.1 degrees Celsius (°C), pH from 6.71 to 8.04 standard units (S.U.), conductivity from 226.3 to 2092 microsiemens per centimeter (µS/cm), dissolved oxygen (DO) from 0.06 to 9.97 milligrams per liter (mg/L), oxidation reduction potential (ORP) from -315.5 to 301.2 millivolts, and turbidity from 0.13 to 9.97 nephelometric turbidity units. DO and ORP measurements indicated aerobic conditions in most wells, while shallow wells associated with the source area generally had lower DO and ORP measurements.

- In addition to the standard GWM activities, a passive dual-membrane sampler evaluation was initiated on eight wells along the longitudinal axis of the EDB plume. The purpose of this evaluation is to assess if the quality of the analytical data for samples collected using dual-membrane passive diffusion samplers is comparable to that of analytical results for aliquots collected using Bennett sampling pumps. This evaluation will determine if dual-membrane samplers are a viable alternative to the failing Bennett sampling pump systems.

- Thirty sentinel wells (18 downgradient proximal wells, nine U.S. Department of Veterans Affairs [VA] proximal wells, and three signal wells) were sampled in Q2 2016. EDB was detected in two signal wells and one downgradient proximal well. EDB was detected in KAFB-106018 and KAFB-106205 at concentrations of 0.044 micrograms per liter (µg/L) and an estimated 0.017 µg/L, respectively, which were below the 0.05 µg/L project screening level (PSL) for EDB. Only the concentration in the sample from signal well KAFB-106017 exceeded the PSL for EDB with a concentration of 0.51 µg/L. Benzene, toluene, ethylbenzene, and total xylenes (BTEX) were not detected in VA proximal or signal wells.

- Samples from all 132 GWM wells were analyzed for EDB, and EDB was detected above the 0.05 µg/L PSL in 22 shallow, 6 intermediate, and 1 deep GWM wells.

- Samples from 57 GWM wells were analyzed for BTEX. Thirty-eight of the wells were scheduled for BTEX analyses in Q2 2016. In addition, benzene samples were collected from nineteen additional wells as part of the dual-membrane evaluation (8 wells) or the investigation into benzene detected in the intermediate zone well KAFB-106226 (11 wells). Benzene was detected above the 5 µg/L PSL in samples from 13 wells. All BTEX PSL exceedances occurred in source area wells. Benzene continued to be detected in well KAFB-106226 (3 µg/L), but the compound was not present in the shallow well (KAFB-106225) or the deeper well (KAFB-106227) in the cluster, nor in any surrounding wells sampled. The source of benzene in well KAFB-106226 has not been determined. Toluene was detected in six wells above the 750 µg/L PSL. Ethylbenzene was detected above the 700 µg/L PSL in two wells (KAFB-106010 and KAFB-106059), and xylenes were detected above the 620 µg/L PSL in two wells (KAFB-106010 and KAFB-106059).

- Samples from all 132 GWM wells were analyzed for select metals, anions, and alkalinity. Dissolved manganese exceeded the 0.2 mg/L PSL in 18 of 132 wells. Dissolved iron exceeded the 1.0 mg/L PSL in samples from six wells. Lead and arsenic concentrations were below their 0.015 and 0.01 mg/L PSLs, respectively, in all samples. Chloride exceeded the 250 mg/L PSL in KAFB-106009. Sulfate exceeded the 250 mg/L PSL in two wells (KAFB-106009 and KAFB-106012R). Nitrate/nitrite nitrogen exceeded the 10 mg/L PSL for nitrate in KAFB-106009 only. Total alkalinity as calcium carbonate ranged from 84.8 to 343 mg/L.

## ES-3 Drinking Water Supply Well Monitoring

Drinking water supply well samples were collected in April, May, and June 2016. A total of four drinking water supply wells are in the vicinity of the benzene and EDB plumes and are sampled monthly; however, KAFB-015 and KAFB-016 have not been sampled due to ongoing repairs. KAFB-003 and ST106-VA-2 were sampled for BTEX and EDB in Q2 2016. Both drinking water wells were non-detect for all organic compounds from the April, May, and June 2016 sampling events. KAFB-003 and ST106-VA-2 were also sampled for inorganic compound (anions, metals, and alkalinity) in Q2 2016. All detected concentrations of inorganic compounds were below PSLs.

## ES-4 Groundwater Treatment System Operation

During Q2 2016, the GWTS treated 33,589,920 gallons of groundwater. A total of 33,007,350 gallons was discharged to the Kirtland AFB golf course main pond and 582,570 gallons were discharged to gravity-fed injection well KAFB-7 under a temporary discharge permit. The GWTS was 99 percent operational from April 1 through April 11, 2016 and 92 percent operational from April 12 through June 30, 2016. With the exception of two estimated concentrations of dissolved manganese of 0.0012 and 0.0026 mg/L in the effluent samples collected on May 20 and June 21, 2016, respectively, all concentrations in effluent samples collected during Q2 were below their respective limits of detection. Consequently, all analytes were below the discharge limits (NMED, 2016a and c). The pump motor for extraction well KAFB-106228 was replaced and a sacrificial anode was added to the drop pipe. The predominant cause of frequent filter bag change out was determined to be annular filter pack from extraction well KAFB-106234, and residual drilling mud, formation sediments, and biological residuals from extraction well KAFB-106233. The filter pack was replenished at extraction well KAFB-106234. The upper layer of impacted granular activated carbon (GAC) was removed from the lead vessel via vacuuming, which decreased the pressure differential and prolong the GAC operational life.

## ES-5 Projected Activities

Planned activities for Q3 2016 include the following:

- Perform vadose zone monitoring of the entire SVMPs from July 11 through August 5, 2016
- Perform GWM from July 1 through September 30, 2016
- Continue passive sampling evaluation with dual-membrane samplers in a subset of GWM wells for data comparability with current low flow sampling method
- Initiate vertical profiling evaluation with passive diffusion bags in select wells in Q3 2016
- Perform monthly drinking water supply well monitoring for July, August, and September 2016
- Continue operating the GWTS and all three extraction wells (KAFB-106228, KAFB-106233, and KAFB-106234).

# 1. INTRODUCTION

This Quarterly Report for Q2 2016 summarizes the activities performed from March 28 through June 30, 2016 as part of the interim measures for soil and groundwater remediation at SWMU ST-106/SS-111, the BFF site, at Kirtland AFB, in accordance with the Hazardous Waste Treatment Facility Operating Permit (Number NM9570024423).

The BFF site is located within the northwestern portion of Kirtland AFB on the southern end of the City of Albuquerque as shown on site location map (Figure 1-1). Vadose zone and groundwater investigation and remediation activities are required to address the potential impact of fuels that were released from leaking pipelines at the Former Fuel Off-Loading Rack. As specified in the NMED–Hazardous Waste Bureau (HWB) letter to Kirtland AFB dated June 4, 2010 (NMED, 2010a) (Appendix A), quarterly reporting for both the vadose zone and groundwater impacted by dissolved fuel constituents is integrated for two reasons: (1) address the interrelation of the vadose zone and groundwater, and (2) avoid applying different data sets for characterization and remediation activities at the BFF site.

GWM, SVM, and interim measures for SWMU ST-106/SS-111 were conducted concurrently in compliance with NMED technical directives for performing interim measures for the BFF site (SWMU ST-106/SS-111). Monitoring was performed in accordance with multiple Work Plans for soil vapor (NMED, 2015a; U.S. Army Corps of Engineers [USACE], 2016b), groundwater (USACE, 2016a), and drinking water supply wells (USACE, 2016b). GWTS operations were performed in accordance with the Work Plan (USACE, 2016a), the temporary permission to discharge to KAFB-7 (NMED, 2016b), the monitoring and contingency plan (USACE, 2015b), and the Operations and Maintenance Plan (USACE, 2016d).

This Q2 2016 Report is prepared in accordance with NMED correspondence dated January 20, 2016 that approved the GWM Work Plan (USACE, 2016a). That correspondence stipulated that the quarterly reporting format include "...the compilation of a robust annual report with the annual sampling event in the Fourth Quarter (Q4) and non-cumulative data reports for each of the Q1, Q2, and Q3 sampling events." These revised Quarterly Report structure provides a streamlined, clear, and concise structure that focuses on the results of activities completed during the reporting period. This is the second Quarterly Report submitted under the new requirements.

# 2. VADOSE ZONE MONITORING

This section describes the field activities, analyses, and final results for the Q2 2016 monitoring of 56 SVM locations at Kirtland AFB (Figure 2-1). Quarterly soil vapor sampling is conducted to characterize and monitor contaminant concentrations in the vadose zone.

Each SVM location is comprised of up to six SVMPs, each screened at discrete intervals ranging from approximately 25 to 450 ft bgs. Each SVMP has a unique database ID; included in the database ID are the SVM location followed by a number identifying the approximate depth of the screened interval associated with an individual SVMP (example given, SVMW-04-250 is located at SVMW-04 and is at approximately 250 ft bgs). Table 2-1 lists each SVM location, its associated SVMPs, the screened intervals of each, and the pre-calculated purge volume.

Samples collected in Q2 2016 represent the vadose zone without the influence of induced air flow. All SVMPs are sealed to atmospheric air, which minimizes the exchange with the atmosphere during "inhalation" and "exhalation" cycles driven by barometric pressure fluctuations. In addition, there is no soil vapor extraction (SVE) system currently operational at SWMU ST-106/SS-111.

## 2.1 Field Vadose Zone Sampling Procedures and Analysis

Q2 2016 SVM was performed in accordance with Pilot SVE Shutdown Test Work Plan (USACE, 2015a), and SVM and Drinking Water Monitoring Work Plan with the Quality Assurance Project Plan (QAPjP) attached as an appendix (USACE, 2016b).

## 2.2 Vadose Zone Data Collection

Field parameters and soil vapor laboratory samples were collected from all SVMPs during Q2 2016. The condition of the vault and the pneumatic quick connect fittings at each SVMP was documented on the associated purge log (included in Appendix C-1) to ensure sample representativeness.

Well caps were replaced at eight SVMPs in Q2 2016 (SVEW-01 through -07 and SVEW-09). As discussed in the Q1 2016 report, the well cap at SVEW-08-260 had become loose and was replaced in Q1 2016. Because all SVE wells were constructed with similar materials, the well caps at the eight remaining SVMPs were proactively replaced with Fernco couplings following the Q2 sampling event to prevent the possibility of leaks occurring at the well caps. On May 6, 2016, Fernco couplings were installed on SVEW-01-260, SVEW-02-060, SVEW-03-160, SVEW-04-313, SVEW-05-460, SVEW-06-060, SVEW-07-160, and SVEW-09-460 to seal the pneumatic quick connects to the well casings in order to prevent atmospheric influence.

### 2.2.1 Field Soil Vapor Data

Field parameters including HC concentration (in ppmv), percent $O_2$, and percent $CO_2$ were measured and recorded at each SVMP using a Horiba MEXA 584L auto emissions analyzer (Horiba). Differential air pressure (inches of water column) readings were measured and recorded for pre-purging and post-purging conditions of each well using an electric manometer. SVMP data were recorded on purge logs (Appendix C-1). Horiba calibration and sample system leak tests were performed. Daily quality control (QC) reports are included in Appendix C-2. Soil vapor field data are listed in Table 2-2.

### 2.2.2 Laboratory Soil Vapor Analytical Data

Q2 2016 soil vapor samples were collected between April 18 and May 13, 2016. All 284 SVMP samples, plus 29 field duplicates, were collected using certified pre-evacuated Bottle-Vac$^{TM}$ canisters fitted with a specialized female pneumatic connector that allowed only the vapor from the SVMP to enter the bottle. All samples were cataloged on sample collection logs included in Appendix C-1. Chain-of-custody forms are included in Appendix C-3. After collecting samples, each bottle was immediately placed into protective packaging, then shipped to ALS Environmental in Simi Valley, California, for analysis of the following soil vapor analytical suite:

- Volatile organic compounds (VOCs) by U.S. Environmental Protection Agency (EPA) Method TO-15
- Air-phase petroleum HCs by Method Massachusetts Department of Environmental Protection Air-Phase Petroleum Hydrocarbons 1.0
- Fixed gases (hydrogen, carbon monoxide, $CO_2$, nitrogen, methane, and $O_2$/argon by Method E3C)
- EDB by EPA Method California Air Resources Board 422.

Three trip blanks were analyzed for VOCs by EPA Method TO-15 to monitor and assess sample preservation, packing, shipping, and storage conditions. The Data Quality Summary Report is included in Appendix D-1. Analytical results are reported in the ALS Environmental report (Appendix D-2). Soil vapor analytical data were validated and given appropriate data qualifiers by Laboratory Data Consultants, Inc. (LDC), Carlsbad, CA. Data validation report data packets are included in Appendix D-2. Soil vapor analytical results are listed in Table 2-3.

## 2.3 Data Review and Usability

A third-party data-validation subcontractor, LDC, performed 100 percent Level III data validation of Q2 2016 soil vapor analytical data. All data were validated usable. The technical data completeness was 100 percent. The data met data quality objectives and were appropriate for use in project decision-making. The results of the QC parameter and data quality indicator (precision, bias [accuracy], representativeness, comparability, completeness, and sensitivity) evaluation are provided in the data validation reports included in Appendix D-2, and data quality assessment report included in Appendix D 1. Final validated soil vapor data are presented in Table 2-3.

## 2.4 Soil Vapor Data Evaluation

The Q2 2016 analytical results and field data from the 284 SVMPs were used to generate two-dimensional plan-view maps (Figures 2-2 through 2-8) that depict benzene, EDB, and HC concentrations at depths of 25, 50, 100, 150, 250, 350, 450 ft bgs.

The SVM locations have been categorized into three areas of interest: off-base SVM locations, on-base SVM locations outside of the source area, and on-base SVM locations inside of the source area. Soil vapor analytical data are discussed in relation to each area. The source area (delineated by the black and white line on Figures 2-1 through 2-8), is defined as a 100-ft buffer zone around the original jet fuel pipeline that was the source of the BFF releases. That pipeline has since been removed.

EDB and benzene were evaluated based on the laboratory results; HC concentrations and percent $O_2$ concentrations were evaluated based on field-measured data as discussed in Section 2.4.4. The Kirtland AFB Resource Conservation and Recovery Act Permit does not specify cleanup screening values for soil vapor. All EDB, benzene, and HC concentrations are compared to the comparison concentrations of 0.5, 1, and 1,000 ppmv, respectively. The comparison concentrations used in this report were determined by historical maximum and minimum soil vapor results to show which SVMPs had relatively high or low concentrations.

Of the three areas of interest identified to evaluate soil vapor concentrations from Q2 2016, the off-base SVMPs had the highest percentage of non-detects for EDB and benzene (22 of 28 SVMPs [79 percent] and 12 of 28 SVMPs [43 percent], respectively), and the lowest average EDB and benzene detected concentrations (0.00070 and 0.0010 ppmv, respectively). $O_2$ concentrations in these SVMPs were generally close to atmospheric levels (>15 percent), which suggests aerobic microbial activity is not limited and the native bacteria can degrade residual fuel constituents present. In the SVMPs located on-base but outside of the source area, EDB, benzene, and HC had average detected concentrations of 0.058, 2.8, and 194 ppmv, respectively. The areas with higher concentrations (EDB greater than 0.5 ppmv, benzene greater than 1 ppmv, and HC greater than 1,000 ppmv) were located at depths between approximately 100 and 450 ft bgs. The highest soil vapor EDB, benzene, and HC concentrations for Q2 2016 were within the source area, with maximums of 31, 790, and 35,668 ppmv for EDB, benzene, and HC, respectively. This area of interest also had the highest percentage of detections for EDB and benzene (30 of 32 SVMPs [94 percent]), and the highest average of detected concentrations of EDB and benzene of 4.0 and 161 ppmv, respectively. A total of 17 SVMPS had $O_2$ concentrations less than 5 percent, and these SVMPs suggest rate limiting aerobic microbial activity (i.e., native bacteria need more $O_2$ to degrade residual fuel constituents).

### 2.4.1 Off-Base Soil Vapor Monitoring Points

Figures 2-2 through 2-8 show the off-base SVMPs, which are all locations north of the Kirtland AFB installation boundary. There are five SVM locations off-base, with the furthest location approximately 1,200 ft north of Kirtland AFB. The off-base SVM locations consist of 28 SVMPs, which are screened at intervals from approximately 25 to 450 ft bgs.

Twenty-two of the 28 off-base (79 percent) SVMPs reported no EDB detection in Q2 2016. Of the six remaining SVMPs, five had J-flagged (estimated) detections. The one remaining SVMP with a detection was screened at approximately 450 ft bgs. The highest EDB concentration was 0.0019 ppmv at KAFB-106028-450.

Twelve of the 28 off-base (43 percent) SVMPS reported no benzene detections in Q2 2016. Of the remaining 16 SVMPs, 11 had J-flagged detections. The remaining five SVMPs with detections were all screened between approximately 25 and 450 ft. The highest benzene concentration was 0.0027 ppmv at KAFB-106028-350.

HC concentrations in the 28 off-base SVMPs ranged between 0 and 7 ppmv. $O_2$ levels were between 17.62 and 20.86 percent.

The monitoring of the off-base SVMPs demonstrated EDB concentrations below 0.0019 ppmv, benzene concentrations below 0.0027 ppmv, and HC concentrations below 10 ppmv in Q2 2016. Percent $O_2$ in the off-base SVMPs was close to atmospheric levels, which suggests aerobic microbial activity is not limited (i.e., native bacteria can degrade residual fuel constituents present).

### 2.4.2 On-Base Soil Vapor Monitoring Points Outside of Source Area

Figures 2-2 through 2-8 show the locations of the 224 SVMPs located on Kirtland AFB property, but outside of the source area boundary. Those SVMPs are screened at intervals from approximately 25 to 450 ft bgs. SVM location KAFB-106135 is the furthest away from the source area at approximately 1,400 ft to the northeast.

EDB was not detected in 123 of the 224 (55 percent) on-base outside of the source area SVMPs. EDB detections were J-flagged in 11 percent of SVMPs, and detected in 34 percent of SVMPs. Three SVMPs had an EDB concentration of greater than 0.5 ppmv. The highest detection was 2 ppmv at KAFB-106128-450, approximately 50 ft to the southeast of the source area.

Among the on-base outside the source area SVMPs, benzene was not detected in 67 of 224 (29 percent) SVMPs, J-flagged in 20 percent, and detected in 51 percent of SVMPs. Twenty-seven (12 percent) SVMPs had benzene concentrations greater than 1 ppmv. The highest detection, 110 ppmv, was measured at SVMW-06-252 located approximately 175 ft due east of the source area.

Two hundred and fifteen out of 224 (96 percent) of the on-base outside of the source area SVMPs had HC concentrations below 1,000 ppmv. The 9 SVMPs with concentrations greater than 1,000 ppmv are screened from approximately 100 to 450 ft bgs. The highest concentration of HC for these SVMPs was 6,100 ppmv at KAFB-106128-450, which is approximately 50 ft to the southeast of the source area.

Percent $O_2$ in the on-base outside of the source area SVMPs ranged from 4.57 to 21.47 percent. $O_2$ levels greater than 15 percent were measured in 213 out of 224 (95 percent) SVMPs. The lowest $O_2$ level was recorded at KAFB-106117-450, located approximately 100 ft away from the source area, which had an EDB concentration of 0.5 ppmv, a benzene concentration of 13 ppmv, and an HC concentration of 3,940 ppmv.

The high level EDB, benzene, and HC concentrations (EDB greater than 0.5 ppmv, benzene greater than 1 ppmv, or HC greater than 1,000 ppmv) were measured at on-base outside of the source area SVMPs located within 900 ft of the source area toward the southeast and the northeast. SVMP screened intervals showing these concentrations ranged in depths between approximately 100 and 450 ft bgs. $O_2$ levels below 15 percent in 11 SVMPs suggested that aerobic microbial activity is not limited and may be occurring. At KAFB-106117-450, oxygen levels were below five percent, which likely represented aerobic microbial activity rate limiting conditions at this SVMP.

### 2.4.3 Source Area Soil Vapor Monitoring Points

Figures 2-2 through 2-8 show the 32 source area SVMPs located within 100 ft of the original location of the underground jet fuel pipeline and screened from approximately 25 to 450 ft bgs.

EDB was non-detect in one out of 32 (3 percent) source area SVMPs, and there were no J-flagged detections. The highest EDB concentration was 31 ppmv at SVMW-10-050. Benzene was not detected in one out of 32 (3 percent) SVMPs and there were no J-flagged detections. The highest benzene concentration was 790 ppmv at SVMW-11-100. The higher concentrations (EDB greater than 0.5 ppmv or benzene greater than 1 ppmv) were all located at depths between approximately 50 and 450 ft bgs.

Seven out of 32 (22 percent) of the source area SVMPs had HC concentrations less than 1,000 ppmv. The highest concentration was 35,668 ppmv (analytical value; Section 2.4.4) at SVMW-11-100. HC concentrations above 1,000 ppmv were all located from approximately 50 to 300 ft bgs. Twenty-seven

SVMPs had percent $O_2$ below 15 percent; of those, 16 were measured with a percent $O_2$ less than five percent. The SVMPs with $O_2$ below 15 percent ranged from depths of approximately 50 to 300 ft bgs.

The highest EDB, benzene, and HC concentrations (EDB greater than 0.5 ppmv, benzene greater than 1 ppmv, and HC greater than 1,000 ppmv) at source area SVMPs were measured at depths ranging from approximately 50 and 450 ft bgs. Generally, reduced $O_2$ concentrations corresponded with higher EDB, benzene, and HC concentrations (Table 2-2), suggesting that microbial degradation of fuel compounds may be taking place. Some SVMPs showed low percent $O_2$ corresponding with low EDB, benzene, and HC concentrations; however, the SVMP above or below those SVMPs at the same SVM location had higher VOC concentrations. Percent $O_2$ was less than five percent at 16 SVMPs ranging in depth from approximately 50 to 300 ft bgs. Aerobic microbial activity was likely rate limited at these locations due to the lack of $O_2$ available to degrade HC.

### 2.4.4 Comparison of Field Parameters with Laboratory Analytical

The field-measured percent $O_2$ (listed on Table 2-2) was compared with the fixed-gas laboratory analyses for percent $O_2$. The comparison showed that the laboratory results were on average 0.96 percent greater than the field-measured $O_2$. Laboratory percent $O_2$ was higher than atmospheric percent $O_2$ (21 percent) in 120 samples. These factors suggest the field-measured $O_2$ concentrations are a better representation of vadose zone conditions than laboratory analysis of percent $O_2$.

HC data were used to assess total VOCs in Q2 2016. An evaluation of HC concentrations in comparison to laboratory total petroleum hydrocarbon (TPH) concentrations was performed in the *Quarterly Pre-Remedy Monitoring and Site Investigation Report for October-December 2015 and Annual Report for 2015* (USACE, 2016c). That evaluation determined that HC data were biased higher in comparison to laboratory TPH data, and represented a more conservative estimate of total VOCs in soil vapor.
A comparison of the Q2 2016 data supported this conclusion. As a result, laboratory TPH data were used in this report to assess total VOC concentrations when laboratory TPH data exceeded the Horiba's saturation limit of 32,760 ppmv. This was only required at SVMW-11-100.

Laboratory TPH concentrations were calculated as follows. The aliphatic and aromatic carbon-range analytical results were converted from units of $\mu g/m^3$ as reported by the analytical laboratory to parts per billion by volume (ppbv) using the following equation:

$$CRppbv = CR\mu g/m^3 \cdot \frac{0.080205 \cdot T}{CRMW} \quad \text{Equation 1}$$

where:

CRppbv = Carbon-range hydrocarbon concentration in ppbv in air.
$CR\mu g/m^3$ = Carbon-range hydrocarbon concentration in $\mu g/m^3$ in air.
0.080205 = Universal gas constant in atm•liter/mole• Kelvin (K).
T = Temperature in K.
CRMW = Average carbon-range molecular weight (MW) in grams per mole (g/mol).

Average MWs assigned to the carbon ranges were: 93 g/mol for $C_5$-$C_8$ aliphatic hydrocarbon compounds, 149 g/mol for $C_9$-$C_{12}$ aliphatic hydrocarbon compounds, and 120 g/mol for $C_9$-$C_{10}$ aromatic hydrocarbon compounds. These MWs were published in, *Characterizing Risks Posed by Petroleum Contaminated Sites* (Massachusetts Department of Environmental Protection, 2002). These values were confirmed by ALS to be appropriate values for the TPH analytical method used. An average temperature of 293.15 K was used. The total VOC concentrations were calculated by totaling the TPH fractions (aliphatic and aromatic).

As a result of the conversion from $\mu g/m^3$ to ppbv using average MW, total VOC data by the laboratory method should be considered an estimated value representing the total volatile contaminant present in soil vapor. The average MWs assigned were representative weights for the three TPH fractions. The use of these weights allows all vapor data to be compared in units of ppbv or ppmv.

## 2.5 Vapor Concentrations over Time (Q4 Annual Report Only)

To be provided in the Q4 2016 Annual Report.

# 3. GROUNDWATER MONITORING NETWORK GAUGING AND SAMPLING

Quarterly GWM was conducted as part of the interim measures implemented at the BFF to assess system performance of the GWTS and determine contaminant plume changes over time. As of Q2 2016, the BFF GWM well network was comprised of the 134 GWM wells. GWM includes measuring depths to groundwater, gauging LNAPL thickness, and collecting groundwater samples for field measurements and laboratory analyses.

To characterize the distribution of the dissolved-phase contaminants in the shallow, intermediate, and deep groundwater zones, the BFF monitoring wells are classified into those three categories based on their screened intervals. No GWM wells installed in the regional aquifer zone are included in this GWM network; however regional wells have been installed and are monitored by the U.S. Geological Survey. The groundwater zones and well screen intervals for the entire GWM network, if applicable, are summarized below.

- ***Shallow Aquifer,*** as defined in this report, extends from the water table to 200 ft below the water table. GWM of this shallow aquifer is performed in the following zones based on monitoring well screened intervals.
    - ***Shallow Zone*** is monitored by GWM wells with screens that extended from the water table to 15 ft below the water table measured at the time of well installation. Sixty GWM wells are installed in this zone. These wells were designed as water table wells with screens that were partially submerged; however, only 15 shallow zone wells remain with partially submerged screens due to rising groundwater elevations.
    - ***Intermediate Zone*** is monitored by GWM wells with screens that extend from 15 to 30 ft below the water table measured at the time of well installation. Thirty-seven GWM wells are installed in this zone.
    - ***Deep Zone*** is monitored by GWM wells with screens that extended from 30 to 130 ft below the water table measured at the time of well installation. Thirty-seven GWM wells are installed in this zone. Deep zone GWM wells installed starting in the Q2 2011 were screened from 45 to 60 ft, from 85 to 100 ft, or from 115 to 130 ft below the water table measured at the time of well installation.
- ***Regional Aquifer*** contains most of the drinking water supply wells that are screened within this aquifer with screens 500 ft or more below the current water table. This aquifer does not contain any wells included in this GWM network.

## 3.1 New Groundwater Monitoring Activities

GWM for Q2 2016 GWM was performed in accordance with Expansion of the Dissolved-Phase Plume GWTS Design Work Plan (USACE, 2016a); sample analyses were performed according to the requirements specified in the QAPjP, which is Appendix D to the Work Plan. The second GWM well optimization was included in this Work Plan (USACE, 2016a) and is described below (Section 3.2).

In addition to the standard GWM activities, a passive dual-membrane sampler evaluation was initiated on eight wells selected along the longitudinal axis of the EDB plume as well as a background well. The purpose of this evaluation is to assess if the quality of the analytical data for samples collected using dual-membrane passive diffusion samplers is comparable to that of analytical results for aliquots collected using Bennett sampling pumps. This evaluation will determine if dual-membrane diffusion samplers are a viable alternative to replace the failing Bennett sampling pump systems. The evaluation plan is provided in Appendix E-1.

Additional benzene samples were collected from eleven wells in the vicinity of KAFB-106226 to investigate low-level benzene detections in this intermediate zone well.

The entire GWM well network was resurveyed for top-of-casing elevations with controlled benchmarks by the U.S. Geological Survey. The resurveyed elevations will be utilized for calculating groundwater elevations for the network as soon as they are made available.

## 3.2 Groundwater Monitoring Network Optimization

Q2 2016 is the second quarter in which the optimized monitoring program was implemented (USAF, 2015a and b; NMED, 2015b and 2016b). Table 3-1 lists the network GWM wells and their optimized sampling and analysis requirements. In addition to quarterly sampling of select wells, water levels and LNAPL measurements are performed across the entire GWM network on a quarterly basis. The activities performed are described on the Daily QC Reports for groundwater sampling (Appendix E-2). The following sections describe Q2 2016 field GWM well monitoring activities and present the analytical data for the samples collected.

## 3.3 Groundwater and Light Non-Aqueous Phase Liquid Level Measurement

Depths to LNAPL and groundwater were measured in all 134 wells between March 28 and March 30, 2016 to calculate groundwater elevations and LNAPL thicknesses, with the groundwater elevation in the three wells that contained measurable LNAPL corrected to account for the presence of the LNAPL on the water surface in the well. The measurement dates, measured depths to LNAPL and groundwater, LNAPL thicknesses, and groundwater elevations are provided in Table 3-2. Forms used to record the depth to groundwater and LNAPL measurements are provided in Appendix E-3. Potentiometric surface maps for the shallow, intermediate, and deep zones of the aquifer are provided on Figures 3-2, 3-3, and 3-4, respectively.

Solinst Model 122 oil-water interface probes were used to measure the depth to LNAPL and depth to groundwater at all locations. Prior to each use, the probes were checked for proper operation and cable integrity. Depth to LNAPL and groundwater measurements were recorded in the field on Well Gauging Forms, which are provided in Appendix E-3. The probes were decontaminated between wells.

Out of the 60 shallow wells gauged in Q2 2016, the water level in only 15 wells was present within the screened intervals (Table 3-3); since Q1 2016, the screen in well KAFB-106201 has become submerged. This is due to continued rise of the water table as a result of ongoing water conservation practices in the Albuquerque area.

As shown in Table 3-2, LNAPL was detected in shallow source area GWM wells KAFB-106005 (0.01 ft), KAFB-106008 (0.05 ft), and KAFB-106076 (0.01 ft). These wells are located in the source area and had historically exhibited elevated concentrations of EDB and BTEX. LNAPL thickness decreased by 0.09 ft in well KAFB-106005 since Q1 2016 and by 0.01 ft in well KAFB-106076 since Q4 2015; however, no LNAPL was present in KAFB-106008 during the last available gauging in Q4 2015 (Table 3-3).

### 3.3.1 Quarterly Groundwater Sampling

Quarterly groundwater sampling was conducted at 132 GWM wells between March 28 and May 25, 2016; Table 3-4 presents the GWM wells sampled in Q2 2016 and their respective groundwater zones. Well locations are shown on Figure 3-1. Wells KAFB-106020 and KAFB-106026 could not be sampled in Q2 2016. Well KAFB-106020 required cleaning following the loss of the dedicated sampling pump down well. The pump was retrieved on March 17, 2016, and the well is scheduled for cleaning in early July 2016. Well KAFB-106026 could not be sampled due to safety concerns.

GWM well sampling was performed using either dedicated or portable Bennett sampling pumps as indicated in Table 3-4. Portable Bennett sampling systems were decontaminated prior to deployment in each well. For portable Bennett sampling pumps, new polyethylene tubing was purchased and measured for dedication to each well specific to the screen depth for wells not sampled in Q1 2016. A minimum of one well volume was purged from each well prior to sample collection; the purge rate ranged from 1.2 to 4.9 liters per minute. The depth to water was monitored the entire time of the purge to ensure that the drawdown was within the specifications. During purging, the following water-quality parameters were measured and recorded on the field forms (Appendix E-4): temperature, pH, dissolved DO, turbidity, ORP, conductivity, and specific conductivity. After reaching stabilization of the water-quality parameters and removal of at least one well volume, the purge rate was reduced to approximately 1.0 liter per minute to collect aliquots for the required analyses.

Prior to sample collection, the field parameter measurements ranged as follows: temperature from 18.1 to 23.1 °C, pH from 6.71 to 8.04 S.U., specific conductivity from 226.0 to 2092 µS/cm, DO from 0.06 to 9.97 mg/L, ORP from -315.5 to 301.2 millivolts, and turbidity from 0.13 to 9.97 nephelometric turbidity units. DO and ORP measurements indicated aerobic conditions in most wells except shallow wells associated with the source area, which generally had lower DO and ORPs. The field parameters measured prior to sample collection are summarized in Table 3-5.

Purging and sampling conformed to the requirements, with minor exceptions (USACE, 2016a).

- Tubing used to connect the wellhead discharge line to the inline field instruments at four wells with dedicated sampling pumps was decontaminated and reused rather than replaced. The wells impacted by this modification were KAFB-106051, KAFB-106050, KAFB-106222, and KAFB-106223. A comparison of the data collected this quarter to data collected in previous quarters revealed that this modification was not detrimental to the data quality for the associated wells.

- Four wells did not achieve stabilization of all water-quality parameters prior to being sampled. KAFB-106017 and KAFB-106022 could not achieve stabilization as the concentrations of ORP and DO, respectively, were close enough to zero that the 10 percent stabilization window was too small to obtain three consecutive readings within the window in a reasonable amount of time. KAFB-106058 and KAFB-106212 were not stabilized for specific conductivity and DO, respectively, and was an unintentional variance by field staff. All other parameters were stabilized in all four situations and a comparison of the analytical results to previous quarterly data reveal that the data are consistent with previous findings. These factors indicate that the lack of a single field parameter stabilization did not have an impact on the data quality for the samples.

- Calibration verification of turbidity meters did not occur during the week of April 11. These instruments are typically calibrated once per quarter and calibration is verified weekly. The week following this deviation, these instruments were operating within tolerable limits. This deviation was not considered detrimental to the data quality objectives for the associated monitoring wells

(Table 3-5) as the instruments have historically held their calibration consistently throughout the quarter and none of the readings collected from these five wells were above 5 nephelometric turbidity units, which is consistent with historical turbidity data for the affected wells.

- Only the initial water-level measurement was made at wells KAFB-106001, KAFB-106010, KAFB-106017, KAFB-106019, KAFB-106023, KAFB-106037, and KAFB-106087, as identified on the individual field forms in Appendix E-4. However, the fact that the maintenance of the water level within the established criteria was not checked during purging is not considered detrimental to the data quality objectives because, historically, recharge of the water column matched the drawdown.

Groundwater samples were analyzed by Eurofins Lancaster Laboratories Environmental, LLC (ELLE) in Lancaster, Pennsylvania (see Table 3-4 for analytical suites). ELLE maintains current Department of Defense (DoD) Environmental Laboratory Accreditation Program certification. The Groundwater Purge and Sampling Forms are provided in Appendix E-4 and the chain-of-custody forms are provided in Appendix E-5.

## 3.4 Data Review and Usability Results

The Q2 2016 groundwater analytical data underwent EPA Stage 3 data validation by an independent third-party subcontractor. Subsequent to validation, data qualifiers were uploaded to the EQuIS® project database. Data were further assessed for accuracy, precision, representativeness, comparability, completeness, and sensitivity and determined to achieve project data quality objectives and usable for their intended purpose. No Q2 2016 project data were rejected (R-qualified). All groundwater data presented and discussed in this Report are final validated data. The Environmental Resources Program Information Management System (ERPIMS) submittal is scheduled for submittal on August 13, 2016. The Data Quality Evaluation Report for groundwater samples collected in Q2 2016 is provided in Appendix F-1 and the final laboratory data reports are included in Appendix F-2.

## 3.5 Project Screening Levels

The PSLs were selected to satisfy the requirements of Kirtland AFB Hazardous Waste Permit No. NM9570024423 (NMED, 2010b) as the lowest of:

1. New Mexico Water Quality Control Commission (NMWQCC) standards per the New Mexico Administrative Code, Title 20.6.2.3101A, Standards for Ground Water of 10,000 mg/L Total Dissolved Solids Concentration or Less (New Mexico Administrative Code, 2004). For metals, the NMWQCC standard applies to dissolved metals and total mercury.

2. EPA National Primary Drinking Water Regulations; Maximum Contaminant Levels (MCLs) and Secondary MCLs; and Title 40 Code of Federal Regulations (CFR) Part 141, 143 (EPA, 2015).

If no MCL or NMWQCC standard existed for any analyte, the PSL was the EPA Tapwater Regional Screening Level (EPA, 2015).

The analytical method utilized to analyze for total nitrate/nitrite nitrogen concentrations cannot identify individual nitrate and nitrite concentrations without modification. Typically in highly oxidizing and near neutral aquifers, nitrate is the primary nitrogen species found in groundwater (Langmuir, 1997) and previous studies in the Albuquerque Basin have used total nitrate/nitrate nitrogen concentrations as equivalent to nitrate nitrogen concentrations (Longmire, 2016 and Anderholm et al., 1995). The total nitrate/nitrite nitrogen concentrations are compared to both MCLs for nitrate and nitrite in this text.

PSLs for groundwater samples are provided in all groundwater data tables included in this report.

## 3.6 Groundwater Quality Data

Samples collected in Q2 2016 were analyzed for EDB, total metals (arsenic, lead, calcium, magnesium, potassium, and sodium), dissolved metals (iron, manganese), anions (ammonia nitrogen, bromide, chloride, sulfate, nitrate/nitrite nitrogen, sulfide), and alkalinity. A subset of the samples was also analyzed for BTEX and naphthalene (Table 3-4). Contaminant concentrations were compared to their respective PSLs, and the results of this comparison are discussed in the sections below. Of note, the analytical results for field duplicate samples are presented in the tables, figures (when greater than the normal sample), and are used to assess field and laboratory analytical precision. Duplicate samples are not discussed in this text for comparison unless otherwise noted, but results for the duplicates are included in the Data Quality Evaluation Report in Appendix F-1.

Analytical results for EDB from the shallow, intermediate, and deep zones are presented on Figures 3-5, 3-6, and 3-7, respectively. Concentrations for the following analytes are depicted on figures only for the shallow zone aquifer, as follows:

- Benzene on Figure 3-8
- Toluene on Figure 3-9
- Ethylbenzene on Figure 3-10
- Total xylenes on Figure 3-11
- Total alkalinity on Figure 3-12
- Nitrate/nitrite nitrogen on Figure 3-13
- Sulfate on Figure 3-14
- Bromide on Figure 3-15
- Dissolved iron on Figure 3-16
- Dissolved manganese on Figure 3 17

Field parameters are also depicted on figures for the shallow zone aquifer:

- DO on Figure 3-18
- ORP on Figure 3-19

Groundwater data-quality variograms are provided in Appendix E-6.

### 3.6.1 Sample Results for Sentinel Wells

The purpose of sampling the 30 sentinel wells (nine VA and 18 downgradient proximal and three signal GWM wells) is to ensure protectiveness of downgradient drinking water supply wells. Data from these wells serve to trigger actions in the event that constituents exceed pre-determined concentrations (MCLs). Q2 2016 analytical results for the signal wells are provided in Table 3-6, for VA proximal wells in Table 3-7, and for downgradient proximal wells in Table 3-8. The sampling results are discussed in the following sections.

#### *3.6.1.1 Organic Compounds Analytical Results*

Samples from all sentinel GWM wells were analyzed for EDB. In addition, the 12 samples from the VA proximal and signal GWM wells were also analyzed for BTEX and the three samples from the signal wells were analyzed for naphthalene. EDB was the only organic compound detected in the samples. The only exceedance of the PSL occurred in shallow signal well KAFB-106017 at 0.51 µg/L, an order of magnitude greater than the 0.05 µg/L EDB PSL (Figure 3-5). The only other EDB detections were 0.017J µg/L in shallow well KAFB-106205 (Figure 3-6) and 0.044 µg/L in shallow signal well KAFB-106018 (Figure 3-5).

#### *3.6.1.2 Inorganic Analytical Results*

Inorganic analytes consisted of total and dissolved metals, anions, and alkalinity and were detected in most samples collected from sentinel GWM wells. PSL exceedances were noted as follows:

- Dissolved manganese in shallow signal well KAFB-106018 was reported at 0.861 mg/L, exceeding the 0.2 mg/L PSL (Figure 3-17).

- Nitrite/nitrate nitrogen in shallow signal well KAFB-106038 (Figure 3-13) and shallow, intermediate, and deep downgradient proximal wells except KAFB-106030, KAFB-106203, KAFB-106205, and KAFB-106209 exceeded the 1.0 mg/L PSL established for nitrite but not the 10 mg/L MCL for nitrate. The highest concentration (3.8 mg/L) was measured in the sample from KAFB-106201.

### 3.6.2 Sample Results for Newly-installed Wells

NMED requires four quarterly sampling events for newly-installed monitoring wells prior to implementing the approved optimized monitoring program. Three newly-installed wells are currently in this quarterly program (Table 3-9). Groundwater analytical results from Q2 2016 for the newly-installed wells are provided in Table 3-10. Of note, BTEX analysis was added to the three newly-installed wells in addition to the analyses required in the optimization program to determine the extent of benzene in the area surrounding KAFB-106226. The aquifer zone where the wells are screened is also shown in Table 3-10.

#### *3.6.2.1 Organic Compounds Analytical Results*

EDB was estimated in the sample from KAFB-106230 at a concentration of 0.011 µg/L (below the 0.05 µg/L PSL).

#### *3.6.2.2 Inorganic Analytical Results*

Inorganic analytes including metals, anions, and alkalinity were detected in most samples collected from newly-installed wells. PSL exceedances were noted as follows:

- Nitrate/nitrite nitrogen in samples from KAFB-106231 (Figure 3-13) and KAFB-106232 exceeded the 1.0 mg/L PSL but not the 10 mg/L MCL for nitrate with concentrations of 2.4 and 1.5 mg/L, respectively.

### 3.6.3 Sample Results for Source Area Wells

All 26 GWM wells located in the source area (Figure 3-1) were sampled during Q2 2016 and sample analytical results are provided in Table 3-11 and summarized below.

#### *3.6.3.1 Organic Compounds Analytical Results*

Organic compounds, including EDB and BTEX compounds, were detected in samples collected from source area GWM wells except in KAFB-106012R, KAFB-106060, KAFB-106061, KAFB-106062, KAFB-106066, KAFB-106068, KAFB-106077, KAFB-106078, and KAFB-106081. PSL exceedances were noted as follows:

- EDB was detected at concentrations higher than the 0.05 µg/L PSL in samples from 12 of the 26 source area wells with the highest concentration of 17 µg/L in wells KAFB-106028 and KAFB-106064 (Figures 3-5, 3-6, and 3-7).

- Benzene was detected above the 5.0 µg/L PSL in samples from 13 of the 26 wells with the highest concentration of 16,000 µg/L in the sample from well KAFB-106059 (Figure 3-8).

- Toluene exceeded the 750 µg/L PSL in samples collected from six of 26 wells with the highest concentration of 20,000 µg/L in the sample from well KAFB-106059 (Figure 3-9).

- Ethylbenzene was detected above the 700 µg/L PSL in the samples collected from wells KAFB-106010 and KAFB-106059 (Figure 3-10). The highest ethylbenzene concentration was reported in the sample from KAFB-106010 at 1,400 µg/L.

- Total xylenes were detected above the 620 µg/L PSL in the samples collected from KAFB-106010 and KAFB-106059 (Figure 3-11). The highest total xylenes concentration was measured in the sample from KAFB-106059 at 4,000 µg/L.

#### *3.6.3.2 Inorganic Analytical Results*

Inorganic analytes including metals, anions, and alkalinity were detected in most samples collected from source area GWM wells. PSL exceedances were noted as follows:

- Dissolved iron exceeded the 1.0 mg/L PSL in samples from six of 26 wells, with the highest concentration of 4.37 mg/L measured in the sample from well KAFB-106059 (Figure 3-16).

- Dissolved manganese in samples from 15 of 26 wells exceeded the 0.2 mg/L PSL, with 5.11 mg/L the highest concentration measured in the sample from KAFB-106079 (Figure 3-17).

- Nitrate/nitrite nitrogen in two samples from wells (KAFB-106005 and KAFB-106009) exceeded the 1.0 mg/L PSL established for nitrite. The highest concentration (25.3 mg/L) was measured in the sample from KAFB-106009 and was the only detection above the 10 mg/L PSL established for nitrate (Figure 3-13).

- Sulfate in samples from KAFB-106009 and KAFB-106012R exceeded the 250 mg/L PSL. The highest concentration was 423 mg/L, measured in the sample from KAFB-106009 (Figure 3-14).

- Chloride in one sample from KAFB-106009 was measured at 336 mg/L, which exceeded the 250 mg/L PSL.

## 3.6.4 Sample Results for Groundwater Monitoring Network Wells

All GWM wells were sampled during Q2 2016 with the exception of KAFB-106020 and KAFB-106026; the sample analytical results are provided in Table 3-12. As noted in Section 3.1, samples from six network wells (KAFB-106015, KAFB-106021, KAFB-106082, KAFB-106083, KAFB-106084, and KAFB-106105) were also analyzed for BTEX to assist with a passive dual-membrane sampler evaluation. In addition, due to historical detections of benzene in samples collected from intermediate well KAFB-106226, BTEX analyses were also performed on groundwater from 11 wells from the GWM network located in its proximity and screened in various aquifer zones: KAFB-106055, KAFB-106057, KAFB-106058, KAFB-106106, KAFB-106107, and KAFB-106222 through KAFB-106227.

### *3.6.4.1 Organic Compounds Analytical Results*

The only organic compound analyzed for in all samples collected in Q2 from the GWM network wells was EDB, and was detected at concentrations higher than the 0.05 µg/L PSL in 16 of the 73 samples (Figures 3-5 through 3-7) with the highest concentration of 0.52 µg/L being detected in the sample from KAFB-106226.

Benzene and xylenes were detected in KAFB-106226 at concentrations of 3.0 and 1.0 µg/L, respectively. However, the additional BTEX analyses performed in surrounding wells did not yield any detections (Figure 3-20). Benzene and xylenes detected in KAFB-106226 are exclusive to that well and it is indeterminate at this time as to why these compounds are being detected in the groundwater samples from this screened interval. This well will be included in a vertical profiling evaluation with passive diffusion bags in Q3 2016.

### *3.6.4.2 Inorganic Analytical Results*

Inorganic analytes, including metals, anions, and alkalinity, were detected in most samples collected from source area GWM wells. Exceedances of PSLs were noted as follows:

- Dissolved manganese in samples from eight of 73 wells exceeded the 0.2 mg/L PSL, with 0.965 mg/L the highest concentration measured in the sample from KAFB-106075 (Figure 3-17).

- Nitrite/nitrate nitrogen in samples from 11 wells exceeded the 1.0 mg/L PSL established for nitrite but none exceeded the 10 mg/L MCL for nitrate. The highest concentration (3.6 mg/L) was measured in the sample from KAFB-106222 (Figure 3-13).

## 3.6.5 Groundwater Trends of the Analysis Performed

Aerobic microorganisms require the presence of DO to effectively break down organic compounds found in the environment. Decreased DO and ORP can be indicators of microbial degradation in a subsurface environment as increased microbial activity can result in anaerobic conditions. These conditions are often associated with microbial growth and the subsequent degradation of organic compounds in an environment. Field measurements for DO (Figure 3-18) and ORP (Figure 3-19) appeared to be higher outside of the distal EDB plume area and lower close to and just downgradient of the source area. This indicates that microbial degradation is occurring in the vicinity of the benzene and EDB plumes.

Higher alkalinity and dissolved-metals concentrations can often be associated with microbial activity as increased microbial activity can cause the dissolution of minerals found in the saturated subsurface. The dissolution of minerals is associated with excess respiration of $CO_2$ and subsequent drop in pH caused by high rates of microbial activity. The highest total alkalinity measurements are present within the benzene plume with the highest detection in KAFB-106079. Wells situated outside of the benzene plume have similar concentrations of total alkalinity (shallow zone shown in Figure 3-12). The 19 PSL exceedances for dissolved manganese and the six exceedances for dissolved iron in the shallow aquifer zone were detected in samples collected in the vicinity of the benzene plume (Figures 3-16 and 3-17). The combination of elevated alkalinity and dissolved metals concentrations is likely associated with increased microbial degradation of organics in the benzene plume and the anaerobic conditions.

Decreased concentrations of nitrate/nitrite nitrogen and sulfate are often associated with microbial activity. Nitrogen is incorporated into microbial biomass and sulfate can be used as an energy source by some microorganisms. The highest nitrate/nitrite nitrogen and sulfate concentrations occurred in source area well KAFB-106009 (Figures 3-13 and 3-14). Elevated nitrate/nitrite nitrogen and sulfate concentrations occur in similar wells but are not consistent with the benzene plume. Additionally, the only exceedance of the chloride PSL was found in the sample from KAFB-106009. These findings are consistent with an extraneous source of nitrate/nitrite nitrogen and sulfate in the vicinity of KAFB-106009 such as a leaking sewer line. Investigation of over 1,000 feet of newer sewer line located in Randolph Street was initiated by the USAF in December 2015 with camera surveys and indicated sewer line was intact. Additional investigations are on-going into the manholes and other possible sources of leakage.

Degradation of EDB can result in elevated concentrations of bromide in the subsurface as bromide ions can be liberated from EDB during decomposition. The highest bromide concentration was detected in the sample from KAFB-106009 (Figure 3-15). The elevated concentrations of bromide coincide with the EDB plume except for the detection in KAFB-106222.

### 3.6.6 Dual-Membrane Sampler Evaluation

A passive sampling evaluation utilizing dual-membrane samplers is being conducted on eight wells selected along the longitudinal axis of the EDB plume as well as a background well (Figure 3-22). The purpose of this evaluation is to assess if the quality of the analytical data for samples collected using passive dual-membrane samplers is comparable to that of analytical results for aliquots collected using dedicated or portable Bennett sampling pumps (Appendix E-1). This evaluation will determine if dual-membrane samplers are a viable alternative to replace the failing Bennett sampling pump systems. KAFB-106015, KAFB-106021, KAFB-106082, KAFB-106083, KAFB-106084, and KAFB-106105. The first of two rounds of evaluation samples were collected in Q2 2016 and analyzed for EDB, BTEX, total metals (arsenic, lead, calcium, magnesium, potassium, and sodium), dissolved metals (iron, manganese), anions (ammonia nitrogen, bromide, chloride, sulfate, nitrate/nitrite nitrogen, sulfide), and alkalinity. (Table 3-14). In wells with shorter screened intervals where only six of the eight DMS could be deployed, the ammonia aliquot was not collected.

The majority of the organic and inorganic analytical results from samples collected in the Bennett sampling pumps and dual-membrane samplers were very similar, with Relative Percent Differences (RPD) generally less than 20 percent (Table 3-14). The QAPjP acceptable RPD for duplicate groundwater samples is 35 percent (USACE 2016a). RPD is calculated as follows:

$$RPD = \left( \frac{R_B - R_D}{\left[ \frac{R_B + R_D}{2} \right]} \right) * 100$$

where:

$R_B$ = Result from sample obtained using active sampling equipment.
$R_D$ = Result from sample obtained using passive sampling equipment.

The RPDs comparing results exceeded 35% in only a few cases. For EDB, in particular, the RPD exceedance in two cases was related to EDB analyses collected from the dual-membrane sampler resulting in an EDB concentration higher than the Bennett sampling pump EDB concentration. In the third RPD exceedance for EBD, the dual-membrane sampler resulted in a lower reported concentration of EDB. Six DMS field duplicate samples were collected and four of these were analyzed for EDB. EDB was reported at 0.064 µg/L and 0.065 µg/L in the KAFB-106009 DMS and the DMS duplicate, respectively. EDB was not detected in DMS duplicate samples from the other wells.

Since the dual-membrane samplers utilized for EDB collection in the first round of sampling were located at the highest level of the screen, a decision was made to deploy passive diffusion bags (volatile organic compound diffusion only) in the top position in Q3 2016 for EDB collection, in lieu of a dual-membrane sampler to determine if we can achieve lower RPDs. No recommendations will be submitted until the second evaluation round is completed in Q3 2016.

## 3.7 Time-Series Analysis of Groundwater Elevations and Light Non-Aqueous Phase Liquid Thicknesses (Q4 Annual Report Only)

This section will be provided in the Q4 2016 Annual Report.

## 3.8 Time-Series Analysis of Concentrations in Groundwater (Q4 Annual Report Only)

This section will be provided in the Q4 2016 Annual Report.

## 3.9 Groundwater Monitoring Well Network Operation and Maintenance

The surface flush-mount vaults for GWM wells were inspected, cleaned of debris, and the protective cover bolts and seals were serviced to ensure they were operating properly between May 13 and June 24, 2016. This work was performed to ensure that the condition of all vaults and wellheads meets the intended requirements for performance and security. Security bolts were replaced on all flush-mounted wells. Aboveground completions will be inspected in Q3 2016.

Dedicated sampling systems were removed Q2 2016 from the following wells: KAFB-106025, KAFB-106033, KAFB-106037, KAFB-106039, KAFB-106040, KAFB-106045, KAFB-106069, KAFB-106072, KAFB-106107, and KAFB-106209 (Figure 3-23). These wells have been converted to use portable sampling equipment in future quarters as their dedicated sampling systems underwent failure or near-failure in Q2 2016.

# 4. DRINKING WATER SUPPLY WELL MONITORING

Monthly organic compound sampling, and analyses were performed during Q2 2016 at drinking water supply wells KAFB-003 and ST106-VA-2 as part of the monitoring associated with the BFF site. These wells were sampled monthly for EDB and BTEX due to their proximity to the dissolved-phase EDB and benzene plumes. Sampling for inorganic compounds is performed semi-annually and was performed in Q2 2016.

Four drinking water supply wells (KAFB-003, KAFB-015, KAFB-016, and ST106-VA-2) provide drinking water to Kirtland AFB employees and tenants, and VA Medical Center patients, employees, and visitors. In Q2 2016, Kirtland AFB wells KAFB-015 and KAFB-016 were not operational due to ongoing maintenance. As such, only wells ST106-VA-2 and KAFB-003 were sampled for organic compounds in April, May, and June 2016. Inorganic parameter sampling was performed at these two wells in April 2016. Results of sampling activities are summarized below.

## 4.1 Drinking Water Supply Well Sampling and Analysis Procedures

All field measurements, sample collection, packaging, shipping, and analyses were performed in accordance with the SVM and Drinking Water Monitoring Work Plan with the QAPjP attached as an appendix (USACE, 2016b). The Q2 2016 inorganic compound field sampling and analyses were performed in accordance with the Work Plan (USACE, 2016a).

Field DO, pH, ORP, conductivity, turbidity, and temperature measurements were made using a Yellow Springs Instrument 556 multi-probe system. Instrument calibration was performed daily to ensure accurate readings. The sample port at each drinking water wellhead was opened for 30 seconds prior to sampling to purge any entrained sediment. Volatile organic analysis samples were collected first. Upon filling, the sample containers were immediately sealed, labeled, and put into a cooler. Daily field activity logs and calibration logs are included in Appendix G-1. Completed sample collection logs and chain-of-custody forms are included in Appendix G-2.

Drinking water supply samples were collected for the following analyses:

- EDB using EPA Method 504.1
- BTEX using EPA Method 524.2.

Samples were submitted to ALS Environmental in Kelso, Washington, for analytical testing. Analytical results were validated by LDC. The Data Quality Evaluation Report is included in Appendix H-1. ALS Environmental analytical reports for April, May, and June 2016 are included in Appendix H-2.

In addition, semiannual water samples were collected in April 2016 and analyzed for the following inorganic parameters:

- Total metals (calcium, magnesium, potassium, sodium) using EPA Method 6010C
- Dissolved metals (iron, manganese) using EPA Method 6010C
- Total metals (arsenic, lead) using EPA Method 6020A
- Anions (bromide, chloride, sulfate) using EPA Method 300.0A
- Anions (nitrate/nitrite nitrogen) using EPA Method 353.2
- Ammonia nitrogen using Standard Method SM4500NH3B/C
- Sulfide using Standard Method SM4500S2CF

- Alkalinity-bicarbonate/carbonate using Standard Method SM2320B.

Inorganic parameter samples collected in Q2 2016 were submitted to ELLE for analytical testing. The Data Quality Evaluation Report and Data Packages are included in Appendices F-1 and F-2, respectively.

## 4.2 Data Review and Usability

A third-party data-validation subcontractor, LDC, performed a 100 percent Stage 3 data validation for Q2 2016 organic compound analytical data. Inorganic analytical data underwent EPA Stage 3 data validation by an independent third-party subcontractor. The data met data quality objectives and were appropriate for use in project decision-making. The QC parameter and data-quality indicators (precision, bias [accuracy], representativeness, comparability, completeness, and sensitivity) evaluation results are provided in the Data Quality Evaluation Report included in Appendix H-1 for organic compounds and Appendix F-1 for inorganic parameters. Final validated data are presented in Table 4-1.

## 4.3 Drinking Water Supply Well Water Quality

Analytical results for April, May, and June 2016 are presented in Table 4-1 and Appendix H-2, and depicted in Figure 4-1. Project screening levels for drinking water supply wells were the lower of either the EPA or NMWQCC screening levels, as discussed in Section 3.6. All inorganic compounds detected in drinking water supply wells KAFB-003 and ST106-VA-2 were below PSLs. There were no EDB and BTEX detections above the limit of detection in both drinking water supply wells sampled in April, May, and June 2016. This indicates that both wells had no detectable concentrations of EDB and BTEX and there were no inorganic compounds that exceeded PSLs in the drinking water that is supplied to Kirtland AFB employees and tenants, and VA Medical Center patients, employees, and visitors.

# 5. GROUNDWATER CAPTURE AND TREATMENT SYSTEM OPERATION

The GWTS was operated during Q2 2016 in order to treat the distal EDB plume. During Q2 2016, the GWTS treated 33,589,920 gallons of groundwater. A total of 33,007,350 gallons was discharged to the Kirtland AFB golf course main pond and 582,570 gallons was discharged to gravity-fed injection well KAFB-7. Table 5-1 provides a summary of groundwater quantities extracted, treated and discharged. The sections below provide capture evaluation, system evaluation metrics, and issues encountered throughout Q2 2016. New Mexico 811 line location tickets are located in Appendix I-1.

## 5.1 Plume Capture and Reduction

The shallow zone aquifer groundwater potentiometric surface map (Figure 3-2) in conjunction with the shallow EDB contour map (Figure 3-5) indicate the initial capture of the distal EDB plume. Comparisons of plume capture and metrics of plume reduction are not provided in this Report as this is the first quarter of entire network gauging and plume characterization coincident with extraction well pumping. Future quarterly monitoring will provide data to more thoroughly evaluate plume capture and reduction.

## 5.2 Groundwater Treatment System Operation

The performance of the GWTS is monitored by metrics for system run time, extraction well performance, and analytical results. Comparisons of these metrics are not provided in this Report as this is the baseline quarter for GWTS performance.

### 5.2.1 System Operation and Percentage Run Time

From April 1 through April 11, 2016, the GWTS was operational 99 percent of the time. From April 12 through June 30, 2016 the GWTS was in operation for 92 percent of the time. Operation is defined as pumping water from at least one extraction well and water being treated and discharged.

### 5.2.2 Well Performance Metrics

#### *5.2.2.1 Extraction Rates*

Water was extracted from KAFB-106228 from April 1 through April 18, 2016 at an average of 89.6 gallons per minute (gpm). The pump in well KAFB-106233 was operational and averaged 163.4 gpm from April 1 through May 2, 2016; May 18 through 19, 2016; and June 1 through June 10, 2016. The pump in well KAFB-106233 was also functional from April 1 through May 2, 2016 and from May 20 through June 30, 2016, and averaged 165.5 gpm. Table 5-2 provides a summary of monthly extraction well performance.

#### *5.2.2.2 Specific Capacity*

The specific capacity for KAFB-106228 appeared fairly constant for the 18 days that it pumped during Q2, although the Q1 data seemed to indicate a slight trend toward reduced specific capacity. Historical data are provided in the Q1 2016 Report. The specific capacity for KAFB-106233 appeared to show a slight downward trend for the days that it was pumped from April 1 through May 24, 2016. When operated from May 24 through June 10, 2016 (at a higher pumping rate), the specific capacity appeared fairly constant. The specific capacity for well KAFB-106234 showed a slightly increasing trend, indicating that the well was undergoing development. Specific capacity over time was plotted and is included in Appendix I-1.

### 5.2.3 Analytical Metrics and EDB Removal

Samples were collected from the GWTS monthly from the untreated influent, post-GAC 1, and from the treated effluent (post-GAC 2). GWTS performance sample collection logs are located in Appendix I-3. Samples were analyzed for EDB, BTEX, and dissolved metals (iron and manganese). GWTS effluent discharge limits are as follows (NMED, 2016a and c).

| | |
|---|---|
| EDB | 0.05 µg/L |
| benzene | 5 µg/L |
| ethylbenzene | 700 µg/L |
| toluene | 750 µg/L |
| total xylenes | 620 µg/L |
| dissolved iron | 1 mg/L |
| dissolved manganese | 0.2 mg/L |

With the exception of two estimated values (0.0012 and 0.0026 mg/L) for dissolved manganese in the effluent samples collected on May 20 and June 21, 2016, all concentrations for effluent samples collected during Q2 were below their respective limits of detection (Table 5-3). The two estimated concentrations of dissolved manganese were below discharge limits (NMED, 2016a and c).

The Q2 2016 GWTS analytical data underwent EPA Stage 3 data validation by an independent third-party subcontractor in accordance with the requirements in the QAPjP. Data were further assessed for accuracy, precision, representativeness, comparability, completeness, and sensitivity in accordance with the QAPjP and determined to achieve project data quality objectives and usable for their intended purpose. No Q2 2016 GWTS data were rejected (R-qualified). All GWTS data presented and discussed in this report are final validated data. The results of the validation are included in the Data Quality Evaluation Report provided in Appendix F-1 and the final laboratory data reports are included in Appendix F-2.

From April 1 through June 30, 2016, an estimated 8,216 milligrams of ethylene dibromide was captured in the GAC vessels. This value was calculated based on the monthly influent concentrations and total flow per month (Table 5-4). Due to the frequency of flow measurements, the estimate was adjusted to remove dates occurring outside of the reporting period.

## 5.3 Groundwater Treatment System Maintenance

### 5.3.1 Routine Maintenance Activities

The bag filters were changed out frequently during Q2 2016. While extraction well KAFB-106233 was in operation, influent bag filters were changed out approximately every three days. KAFB-106233 was taken offline on June 17, 2016, and since that time, the bag filters have not been changed out and differential pressures have not shown a measurable increase by the end of June. The lead GAC vessel required maintenance due to increased differential pressure in June 2016 as discussed in Section 5.3.4.2 below.

The GWTS routine maintenance schedule is provided in Table 5-5. During the Q2 2016 GWTS operation, the system encountered operational issues which are discussed in Section 5.3.3

### 5.3.2 Conveyance Line Security and Administrative Controls

Kirtland AFB is registered as a line-owner with New Mexico 811 for the off-base portion of the conveyance lines and requires permits for all excavation projects on-base. In Q2 2016, Kirtland AFB responded to five off-base tickets requested through New Mexico 811 (Appendix I-2)

### 5.3.3 Non-Routine Maintenance Activities

#### *5.3.3.1 Extraction Well KAFB-106228 Pump Motor Failure*

Extraction well KAFB-106228 was shut down on April 19, 2016 and remained inoperable during the remainder of the quarter. Extraction well KAFB-106228 automatically shut down on April 19, 2016, in response to a power loss alert received by the human machine interface (HMI). Review of the alarm summaries indicated that the power loss occurred after the HMI showed a low current alert. Attempts to restart the pump were not successful. Programming support personnel arrived at the KAFB-106228 wellhead within a few hours, inspected one of the electrical panels, and determined that the system was shutting down due to a high current and that the pump would need to be removed, inspected, and possibly serviced. On May 23, 2016, the pump and drop pipe were retrieved and the pump and motor assembly were sent to the TP Pump facility in Albuquerque, New Mexico. During equipment removal, it was observed that the portion of the drop pipe that was set below the water was coated in what appeared to be an iron oxide coating (photograph provided in Appendix I-1). A representative from TP Pump determined that the pump motor was damaged and would require repair or replacement.

#### *5.3.3.2 Operational Issues*

The GWTS utilizes two bag filter vessels to remove solids from influent water prior to the GAC vessels. At the beginning of Q2 2016, the frequency of bag filter change outs had increased to approximately every two to three days. The bag filters exhibited a slimy texture with sediment. A representative of the firm providing the filter skid warranty was present during a bag filter change out and speculated that the slimy texture was related to biological residuals. The sediment that was inspected consisted of both filter pack and formation material. Field tests were performed to determine the source of biological and formation material by operating individual wells and inspecting the bag filters after a set amount of time. However, due to programming limitations, the wells could not initially be isolated as the reduced flow rate resulted in a system shutdown.

Extraction Well KAFB-106234 Operational Issues

As part of the well isolation to determine sources of sediment and biological residuals, only KAFB-106234 groundwater was pumped and treated from May 13 through 15, 2016. Only sediment accumulated in the filter bags was observed. The filter pack height in well KAFB-106234 was measured on May 5, 2016 through a dedicated filter pack drop tube and determined that the filter pack had dropped 2 feet below the top of the screen and additional filter pack was added. During the measurement, the weighted end and a short length of the measuring tape were lost down hole and could not be retrieved and were abandoned in the filter pack. A scissor lift was used to inspect the interior of the influent feed tank from a top manway to determine if sediment was accumulating in this tank; a small amount of sediment was observed in the influent feed tank.

On June 17, 2016, sediment was collected from the bag filters using a plastic card to scrape the sediment off of the bag surfaces with influent only from KAFB-106234. The sediment was analyzed for particle size by wet sieve and hydrometer by method ASTM D422. Results of the analysis are provided in Appendix I-1. The grain-size analysis indicated a fine sand with silt and clay indicating that KAFB-106234 was the source of the sediment.

Extraction Well KAFB-106233 Operational Issues

On May 30 and June 2, 2016, staff from the USACE Engineer Research and Development Center (ERDC) collected samples from the bag filters and water samples from various locations throughout the treatment system to characterize the system fouling including corrosion, biologic communities, and sediment characteristics. The preliminary investigation indicated that extraction well KAFB-106233 was contributing residual drilling mud, formation sediments, and biological residuals. The well was shut down on June 10, 2016 to prevent further operational issues with the downstream treatment system.

The differential pressure across the GAC vessels increased to between 10 and 15 psi early in June 2016. On June 10, 2016, USACE ERDC staff collected additional carbon media samples from the from the lead GAC vessel. The carbon sample was collected through the access port at the top of the vessel. A disposable bailer was modified to form a tube, which was used to push through the carbon and collect a core. However, when the tube was inserted, it was observed that the only the carbon at the surface (top few inches) was coated with a sticky, rusty-brown-colored crust (photograph provided in Appendix I-1). A plan was devised to remove the coated material from the lead GAC vessel with a vacuum. On June 17, 2016, after draining the water below the level of the impacted carbon, the top of the GAC media was accessed via the top manway and vacuumed to remove the affected material into a 55-gallon drum. The seal on the manway was replaced and the vessel was closed and refilled with water. After bleeding out the trapped air, the GAC differential pressure dropped to approximately 1 psi and remained stable at this pressure differential for the remainder of Q2. The USACE ERDC provided preliminary sampling results that are included as Appendix I-1. A final report is expected in Q3 2016.

# 6. INVESTIGATION-DERIVED WASTE

During Q2 2016, investigation-derived waste (IDW) was generated during operations at the BFF site consisting of liquid and non-liquid IDW. IDW generated during Q1 was held for disposal in Q2. Liquid IDW was associated with groundwater sampling and equipment decontamination activities. Solid IDW consisted of passive sampling equipment, impacted GAC, bag filters, and dedicated sampling system equipment.

## 6.1 Liquid Investigation-Derived Waste

Liquid IDW generated during Q2 2016 consisted of purge water associated with GWM well sampling, and decontamination water generated from cleaning non-dedicated sampling equipment. Disposal of liquid IDW to the GWTS was evaluated by comparing historical data to the discharge limits outlined in the temporary permission to discharge (NMED, 2016d). Liquid IDW was not to be discharged if it would cause the GWTS effluent to exceed the following concentration limits: 0.05 µg/L EDB; 5 µg/L benzene; 750 µg/L toluene; 700 µg/L ethylbenzene; 620 µg/L total xylenes; 1 mg/L dissolved iron; and 0.2 mg/L dissolved manganese.

The distinction between hazardous and non-hazardous liquid IDW was made prior to sampling the GWM network in Q2 by considering historical data available for each GWM well and identifying the liquid IDW originating from each well as hazardous if the concentration of benzene exceeded 500 µg/L in any of the previous four quarters. Decontamination water was considered non-hazardous due to the low potential of it carrying residual contamination from the GWM water; however, the decontamination water was characterized to ensure that it met treatment requirements for discharge to the GWTS.

### 6.1.1 Non-Hazardous Liquid Investigation-Derived Waste

Liquid IDW was collected in 55-gallon plastic drums that were sealed with plastic covers with locking-ring steel collars and 275-gallon plastic totes with threaded caps. Liquid IDW from individual wells was segregated into separate drums and totes, which were labeled with vinyl non-hazardous waste labels, and transferred to the designated IDW storage yard located on Kirtland AFB.

A total of 107 drums containing 5,050 gallons of non-hazardous liquid IDW generated during Q1 2016 was batched through the GWTS between May 24 and June 1, 2016. Five gallons of liquid IDW from Q1 was combined with 275 gallons from Q2 associated with dedicated equipment decontamination in and characterized to ensure that it meets the treatment requirements for discharge to the GWTS. A summary of all non-hazardous water management and disposal is provided in Appendix J-1.

A total of 250 drums and four totes containing 11,303 gallons of non-hazardous purge water were generated during Q2 2016. Table J-1-1 (Appendix J-1) provides well-specific purge water details. Non-hazardous purge water with concentrations of dissolved iron and manganese less than permit discharge limits was batched through the GWTS between April 13 and June 23, 2016. All GWTS effluent exhibited concentrations of dissolved iron and manganese below permit discharge limits. A summary of all non-hazardous water management and disposal is provided in Table J-1-1.

A total of 20 drums and one tote of liquid IDW from Q1 and Q2 containing 855 gallons of non-hazardous liquid IDW with elevated or unknown concentrations of metals are being held in the pending analysis yard until the appropriate means for disposal is determined. Table J-1-2 (Appendix J-1) provides well-specific purge water details.

### 6.1.2 Hazardous Liquid Investigation-Derived Waste

Purge water from KAFB-106005 contained benzene concentrations above the characteristic hazardous waste toxicity criteria (40 CFR Part 261.24). Purging this well during Q1 2016 generated two drums and approximately 90 gallons of hazardous (DO018) liquid IDW. This waste was removed from the 90-day accumulation area on April 19, 2016 by Advance Chemical Transport for disposal, as summarized in Table J-2-1 and the manifest is provided in Appendix J-2.

During the Q2 2016 sampling event, purge water was stored from eight GWM wells known historically to have contained benzene concentrations above the characteristic hazardous waste toxicity criteria (40 CFR Part 261.24). Purging these wells generated 15 drums and approximately 625 gallons of hazardous (DO18) liquid IDW. The drums were labeled as hazardous waste (DO018) and placed in the Kirtland AFB 90-day accumulation area pending analytical results, as summarized in Appendix J-2.

## 6.2 Non-Liquid Investigation-Derived Waste

Two drums containing non-liquid waste are being held in the IDW pending analysis yard prior to offsite disposal. One drum contains GAC that was removed from the lead GAC vessel of the GWTS on June 17, 2016. The second drum contains equipment solid waste associated with passive sampling of eight wells during Q2 2016. Table J-1-2 (Appendix J-1) provides specific details on the solid waste being held in the pending analysis yard.

# 7. PROJECTED ACTIVITIES

Q3 2016 will comprise the period between July 1 and September 30, 2016. A corresponding Quarterly Report will be prepared that details the activities conducted during the quarter, presents the data obtained from all of the sampling, and provides a similar level of interpretation to this Report. Planned Q3 2016 activities are summarized as follows.

### *Vadose Zone Monitoring*

- Vadose zone monitoring will be performed between July11 and August 5, 2016.

### *Groundwater Monitoring*

- GWM will be performed between July 1 and early August, 2016.
- The passive dual-membrane sampler evaluation will be continued.
- The vertical profiling evaluation will be initiated with passive diffusion bags.

### *Drinking Water Supply Well Monitoring*

- Drinking water supply well monitoring will be performed monthly organic compound analysis.

### *Groundwater Treatment System Operation*

- GWTS operation will continue with expansion scheduled to begin in late September 2016.

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# FIGURES

# TABLES

# APPENDICES

# LIST OF APPENDICES

# LIST OF APPENDICES (CONCLUDED)

# APPENDIX A

# REGULATORY CORRESPONDENCE

# APPENDIX C

# SOIL VAPOR FIELD SAMPLING RECORDS

# APPENDIX C-1

# SOIL VAPOR SAMPLING PURGE LOGS

# APPENDIX C-2

# SOIL VAPOR FIELD ACTIVITY LOGS

# APPENDIX C-3

# SOIL VAPOR SAMPLE CHAIN-OF-CUSTODY

# APPENDIX D

# SOIL VAPOR DATA QUALITY EVALUATION REPORTS AND DATA PACKAGES

# APPENDIX D-1

# DATA QUALITY EVALUATION REPORT – SOIL VAPOR SAMPLES

# APPENDIX D-2

# DATA PACKAGES
# – SOIL VAPOR SAMPLES

# APPENDIX E

# GROUNDWATER MONITORING NETWORK FIELD SAMPLING DATA AND RECORDS

# APPENDIX E-1

# PASSIVE SAMPLING EVALUATION

# APPENDIX E-2

# DATA QUALITY CONTROL REPORTS – GROUNDWATER SAMPLING

# APPENDIX E-3

# GROUNDWATER MEASUREMENTS

# APPENDIX E-4

# GROUNDWATER PURGE LOGS AND SAMPLE COLLECTION LOGS

# APPENDIX E-5

# GROUNDWATER SAMPLE CHAIN-OF-CUSTODY FORMS APPENDIX

# APPENDIX E-6

# GROUNDWATER QUALITY DATA VARIOGRAMS

# APPENDIX F

# GROUNDWATER MONITORING NETWORK SAMPLE DATA QUALITY EVALUATION REPORTS AND DATA PACKAGES

# APPENDIX F-1

# DATA QUALITY EVALUATION REPORT – GROUNDWATER SAMPLES

# APPENDIX F-2

# DATA PACKAGES
– GROUNDWATER SAMPLES

# APPENDIX G

# DRINKING WATER SUPPLY WELL SAMPLING DOCUMENTATION

# APPENDIX G-1

# DAILY QUALITY CONTROL REPORTS – DRINKING WATER SUPPLY WELL SAMPLING

# APPENDIX G-2

## DRINKING WATER SAMPLE COLLECTION LOGS

# APPENDIX H

# DRINKING WATER SUPPLY WELL DATA QUALITY EVALUATION REPORTS AND DATA PACKAGES

# APPENDIX H-1

# DATA QUALITY EVALUATION REPORT – DRINKING WATER SUPPLY WELL SAMPLES

# APPENDIX H-2

# DATA PACKAGES
# – DRINKING WATER SUPPLY WELL SAMPLES

# APPENDIX I

# GROUNDWATER TREATMENT SYSTEM PERFORMANCE SAMPLING

# APPENDIX I-1

# NEW MEXICO 811 LINE LOCATE TICKETS

# APPENDIX I-2

# GROUNDWATER TREATMENT SYSTEM PLANT OPERATION AND MAINTENANCE DOCUMENTATION

# APPENDIX I-3

# GROUNDWATER TREATMENT SYSTEM PERFORMANCE SAMPLE COLLECTION LOGS

# APPENDIX J

# WASTE DISPOSAL DOCUMENTATION

# APPENDIX J-1

# NON-HAZARDOUS WATER INVESTIGATION-DERIVED WASTE PROFILING AND DISPOSAL DOCUMENTATION

# APPENDIX J-2

# HAZARDOUS WATER INVESTIGATION-DERIVED WASTE PROFILING AND DISPOSAL DOCUMENTATION