Final Report

Data Gap Monitoring Well Installation
Well No. WUABFFMW01

Kirtland Air Force Base Bulk Fuels Facility
Albuquerque, New Mexico

Prepared for:

Albuquerque Bernalillo County
Water Utility Authority

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EXECUTIVE SUMMARY

The Water Authority data gap groundwater monitoring well WUABFFMW01 was installed in Albuquerque, New Mexico (**Figure 1**) near the southeast corner of the intersection of Kathryn Avenue SE and Indiana Street SE (**Figure 2**) to investigate the distal end of the ethylene dibromide (EDB) groundwater plume emanating from the Kirtland Air Force Base Bulk Fuel Facility (BFF) jet fuel leak. Field construction activities were initiated on January 24, 2022 and were completed on April 14, 2022. A nominal 8-inch diameter boring was advanced to total depth (approximately 608 feet). The data gap monitoring well is constructed of 3-inch schedule 80 PVC with a total depth of approximately 597 feet bgs and a 20-feet screened interval of 0.02-inch slot within the interval of 572 feet to 592 feet bgs.

Push-ahead groundwater samples, collected during drilling, did not detect the presence of EDB. The location of thin, fine-grained layers therefore dictated where the well screen was placed (the INTERA Technical Memorandum identified an EDB extent data gap within the entire vertical interval of 508 to 592 ft bgs and for a well screen to be placed within a portion of this interval). The Water Authority data gap well was developed effectively in April 2022 and initially sampled in May 2022 (Quarter 2 2022) and again in August 2022 (Quarter 3 2022). Data gap groundwater monitoring well WUABFFMW01 ground water sample results were compared to Environmental Protection Agency (EPA) maximum contaminant levels (MCLs) and New Mexico Water Quality Control Commission (NMWQCC) standards (whichever level is more stringent). These are the same standards used by the Air Force in their BFF plume groundwater monitoring program. EDB was not detected in any of the May 2022 and August 2022 groundwater samples. May 2022 data gap groundwater monitoring well ground water sample results, passive and low-flow purge, identified low-level, estimated concentrations of toluene and benzene. Follow-up sampling of the data gap well in August 2022 did not identify benzene in the groundwater samples collected, but toluene was again identified at low-level, estimated concentrations in both the passive and low-flow purge samples collected. Subsequent investigation by INTERA found that the low-level, estimated concentrations of toluene and benzene in the May 2022 and August 2022 groundwater samples were likely attributable to sampling and/or laboratory analysis procedures, not from the groundwater environment and not related to the BFF plume. The sampling and analysis procedures have since been revised and the issue has been resolved.

Slug test results indicate a hydraulic conductivity of approximately 30 feet per day. Unfortunately, slug testing was only able to be conducted at the Water Authority data gap well, since nearby area BFF monitoring wells were not made available for slug testing by the Air Force.

INTERA recommends following the WUA directive for monitoring frequency of the newly installed data gap ground water monitoring well by collecting ground water samples at this location on a quarterly basis, beginning in December 2022. Quarterly monitoring frequency is consistent with the sampling frequency followed by the Air Force, allowing for more reliable data comparison across the BFF groundwater monitoring well network.

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ABBREVIATIONS AND ACRONYMS

%	percent
µS/cm	microSiemens per centimeter
°C	degrees Celsius
°F	degrees Fahrenheit
AES	Advanced Environmental Solutions
AOP	Advance On-Site Protection Security
ASTM	ASTM International
BFF	Bulk Fuels Facility
bgs	below ground surface
Cascade	Cascade Drilling
COC	constituent of concern
CPB	Construction Programs Bureau
DMS	dual membrane sampler
EDB	ethylene dibromide
ELAP	Environmental Laboratory Accreditation Program
EPA	United States Environmental Protection Agency
Eurofins TestAmerica	Eurofins
ft	feet *or* foot
gpm	gallons per minute
GR	gamma ray
HEAL	Hall Environmental Analysis Laboratory
IDW	investigation derived waste
INTERA	INTERA Incorporated
Jet West	Jet West Geophysical Services
KAFB	Kirtland Air Force Base
LNAPL	light non-aqueous phase liquid
MCL	maximum contaminant level
MDL	method detection limit
mg/L	milligrams per liter
ml	milliliter/milliliters

ms	milliseconds
NAD83	North American Datum of 1983
NAVD88	North American Vertical Datum of 1988
NMED	New Mexico Environmental Department
NTP	Notice to Proceed
NTU	nephelometric turbidity unit
NMWQCC	New Mexico Water Quality Control Commission
OSE	Office of the State Engineer
PDB	passive diffusion bag
PMP	Project Management Plan
psi	pounds per square inch
PVC	polyvinyl chloride
RL	Reporting Limit
RFP	Request for Proposal
Site	Kirtland Air Force Base Bulk Fuels Facility
S_S	specific storage
SSHASP	Site-Specific Health and Safety Plan
SVOC	semi-volatile organic compound
SWS	Southwest Safety Services
USCS	Unified Soil Classification System
VOC	volatile organic compound
Water Authority	Albuquerque Bernalillo County Water Utility Authority
Work Plan/SAP	Work Plan and Sampling and Analysis Plan

1.0 INTRODUCTION

INTERA Incorporated (INTERA), under contract with the Albuquerque Bernalillo County Water Utility Authority (Water Authority), was tasked to drill, install, test, and sample a data gap groundwater monitoring well associated with the Kirtland Air Force Base (KAFB) Bulk Fuels Facility (BFF) jet fuel leak (Site) located in Albuquerque, New Mexico (**Figure 1**). The well installation activities were conducted by INTERA according to the "Work Plan/Sampling Analysis Plan for Data Gap Monitoring Well Installation Well No. WUABFFMW01" (Work Plan/SAP) dated January 6, 2022 (INTERA, 2022a). The Work Plan/SAP was approved by the Water Authority and the New Mexico Environment Department (NMED) on January 10, 2022. A copy of the NMED Work Plan/SAP approval letter is included in **Appendix A.**

The purpose of Dap Gap Well No. WUABFFMW01 is to determine if ethylene dibromide (EDB) is present at depth in the northern extent of the plume, based on historical EDB concentrations measured in groundwater and the local geology, and to support Water Authority in its confidence in the safety of nearby water supply wells. WUABFFMW01 is located near the northern boundary of the EDB plume within Indiana Street SE, just south of Kathryn Avenue SE, Albuquerque, New Mexico (800 Indiana Street SE) (**Figure 2**).

1.1 Background

The Water Authority received New Mexico Capital Outlay funding through the NMED Construction Programs Bureau (CPB) to install, test, and sample a data gap groundwater monitoring well (WUABFFMW01) to address an outstanding data gap in the EDB groundwater contamination plume associated with the KAFB BFF project. The Water Authority issued a Request for Proposal (RFP) in July 2021 to select a contractor to install the data gap monitoring well and perform sampling events at the data gap well to determine the presence/absence of EDB and other fuel contaminants (Water Authority Solicitation No. 2022000002). INTERA was ultimately selected by the Water Authority to install the data gap well (Contract No. 2022000002/Contract Control No. 2020-0029/PO No. CE001306). The Water Authority issued INTERA a Notice to Proceed (NTP) on September 27, 2021.

The Water Authority requested that INTERA complete a review of geologic and hydrogeologic data and reports associated with the BFF Site. This evaluation included INTERA review of the characterization of the area hydrogeologic system and EDB migration to (1) confirm the final data gap well spatial location and (2) propose the data gap well screen interval. INTERA issued to the Water Authority a Technical Memorandum on November 19, 2021, which recommended the data gap well be located within Indiana Street, immediately south of Kathryn Avenue and a 20-foot (ft)

screen interval be installed at some point between the depths of 508 to 592 ft below ground surface (bgs) (INTERA, 2021a).

The Technical Memorandum also recommended that the data gap well be installed using sonic coring methods because this drilling method was likely to provide more detailed geologic data than Air Rotary Casing Hammer drilling methods to find interbedded fine-grained units that may compartmentalize the transport of EDB. The Water Authority and NMED CPB approved the sonic drilling approach and agreed that sonic drilling with "push-ahead" groundwater sampling once the water table was reached was the best option to attempt to find elevated concentrations of EDB in ground water potentially located between fine-grained units as the boring was advanced to total depth.

1.2 Scope of Work

To guide the field, laboratory, and data reporting efforts associated with this project, INTERA prepared a Work Plan/SAP (INTERA, 2022a). The Work Plan portion of the document provides the scope of work associated with the drilling, construction, and monitoring well completion activities. The SAP portion of the Work Plan/SAP outlines the sampling procedures that INTERA followed for all groundwater sampling and slug testing activities. The Work Plan/SAP included a Site-Specific Health and Safety Plan (SSHASP) as an attachment. The SAP (and the SSHASP) will also be followed for groundwater sampling activities associated with the low-flow purge groundwater sampling procedures during the long-term groundwater monitoring activities.

The Work Plan/SAP for the data gap monitoring well specified the following scope of work:

- Subcontracts and permitting;
- Soil boring drilling using sonic drilling methods and push-ahead groundwater sampling;
- Geophysical logging;
- Monitoring well installation and development;
- Monitoring well survey;
- Fluid level monitoring and groundwater sampling (passive and low-flow purge methods);
- Slug testing;
- Demobilization/Management of investigation-derived waste (IDW); and,
- Final Report including recommendations for next steps.

1.3 Work Plan/SAP Deviations

The following Work Deviations were noted:

1. IPS Security was not used as the security firm for overnight and weekend security during drilling and well development. Cascade elected to contract with Advance On-Site Protection (AOP) Security.

2. Daylighting of utilities used high pressure water rather than high pressure air as outlined in the Work Plan/SAP. Cascade opted to use high pressure water and INTERA approved because the ambient air temperature at the time of work was above 32°F.

3. Borehole diameter from the surface to a depth of approximately 300 feet was 10 inches and telescoped down to 8 inches nominally. The Work Plan/SAP indicates that the borehole would be approximately 8 inches in diameter, but in order to continue to advance Sonic core casing and retrieve an 8-inch casing at depth (a section of 8-inch sonic core casing became separated during drilling activities and a wash-over procedure was implemented to recover the 8-inch casing), 9-inch and 10-inch diameter Sonic core casing was used in the recovery.

4. The Slug testing procedure was modified in that only the data gap well (no offsite wells) was slug tested and slug testing was completed in one day (not multiple days as outlined in the Work Plan/SAP). The Water Authority was not granted access to KAFB BFF groundwater monitoring wells to allow INTERA to conduct slug tests in monitoring wells within close proximity to the newly installed data gap monitoring well.

5. INTERA did consider “skin effects” into the slug test analysis even though the Work Plan/SAP indicated this step would not be taken. INTERA decided that taking skin effects into consideration allowed for a more thorough analysis. Also, the slug testing evaluation did not calculate or provide anisotropy ratios (Ky/Kh) even though the Work Plan/SAP indicated that these calculations would be performed. INTERA did not feel this would significantly help the analysis.

1.4 Premobilization Activities and Permits

Following submittal and approval of the INTERA Technical Memorandum (INTERA, 2021a), INTERA submitted a Project Management Plan (PMP) to the Water Authority on December 10, 2021, and an updated and final PMP on December 17, 2021 (INTERA, 2021c). The PMP provided the general framework regarding how the project would be managed relative to the scope of work items. As per the PMP, INTERA executed technical service agreements with the following subcontractors:

- Cascade Drilling (Cascade): drilling contractor selected to drill, install, and develop WUABFFMW01 (New Mexico Well Drilling License No. WD-1664). Note: Traffic control (Southwest Safety – NM Contractor's License No. 82265) and Night/Weekend Security (AOP) subcontracted by Cascade;
- Hall Environmental Analytical Laboratory (HEAL) – analytical analysis of push-ahead groundwater samples and IDW samples; Eurofins TestAmerica (Eurofins, Environmental Laboratory Accreditation Program [ELAP] Certificate No. 2897, State of California) – off-site analytical laboratory selected for groundwater sample constituent of concern (COC) analysis (secured via a subcontract with HEAL);
- Jet West Geophysical Services (Jet West): geophysical logging of WUABFFMW01;
- High Mesa Consulting Group: elevation survey of WUABFFMW01; and,
- Advanced Environmental Solutions (AES): IDW storage, hauling, and disposal (NM Contractor's License No. 83422).

1.4.1 Permits

Prior to drilling activities, INTERA needed to secure the following permits:

- Excavation/Barricade Permit from the City of Albuquerque (Permit No. 2021044421EXC);
- Monitoring Well Installation Permit from the New Mexico Office of the State Engineer (OSE) (RG-A0195-POD1); and,
- Construction noise control permit from the City of Albuquerque (Permit No. 21-10).

The permit applications for the above permits were submitted in December 2021, and all permits were approved and in place prior to the initiation of drilling activities in January 2021. Copies of the above-referenced permit applications and subsequent agency approvals are included in **Appendix A.**

1.4.2 New Mexico 811

INTERA and Cascade contacted New Mexico One Call (811 notification) prior to drilling activities (INTERA Locate No. 22JA180705 and Cascade Locate No. 22JA180638). Copies of the confirmation emails from New Mexico One Call documenting the locate requests are included in **Appendix A.**

2.0 FIELD ACTIVITIES

Data gap monitoring well field activities included drilling, detailed lithologic logging, screening of groundwater for volatile organic compounds (VOCs), geophysical logging, monitoring well final design, monitoring well installation, well development, and well surveying. The activities followed the Work Plan/SAP (INTERA, 2022a) with certain modifications necessary to complete the scope under conditions encountered in the field, as discussed herein. Data gap monitoring well installation and well development field activities were initiated on January 24, 2022 and were completed on April 14, 2022.

2.1 Drilling Activities

As previously discussed, INTERA subcontracted with Cascade to provide drilling services for the Project. Rotosonic drilling technology (Truck-mounted Pro Sonic 600 Series) was used for all drilling and collection of continuous soil cores. Drilling activities included collection and analysis of soil samples, collection and analysis of push-ahead groundwater samples, and monitoring well construction activities. Drilling activities commenced on January 24, 2022 and were completed on April 5, 2022 (does not include well development time). Field notes are included as **Appendix B**.

2.1.1 Daylighting for Underground Utilities

As required by the approved Work Plan/SAP, Cascade was required to conduct "daylighting" or "potholing" to confirm that the data gap boring location was clear of subsurface utilities. Cascade worked with a rented Ditch Witch water jet/vacuum tank and hose to remove soil and daylight the boring to an approximate diameter of 8 inches and to a depth of 6 ft bgs. No subsurface utilities were encountered. The asphalt at the data gap well was then cut 24 inches x 24 inches square and the removed soil and asphalt was placed in roll-off container for disposal. Daylighting activities were observed by INTERA, and photographs of the daylighting work are included in the Photograph Log included as **Appendix C.**

2.1.2 Construction Area Set-Up

The soil boring location, drill rig location, location of sound panels, location of roll-off container, and the forklift parking area were set up as described/shown in the Work Plan/SAP (INTERA, 2022a). Sound panels were placed on either side of the drilling rig to mitigate noise to nearby residences and in accordance with the Construction Noise Permit (Permit No. 21-10) issued by the City of Albuquerque on December 17, 2021. Photographs of the construction area are included in the Photograph Log (**Appendix C**).

2.1.3 Sonic Coring Activities

The sonic drilling method provided a way of obtaining undisturbed, continuous soil samples from the ground surface to the total depth of the boring. Core recovery was generally complete throughout the soil boring work. The sonic coring system advances the borehole and collects soil samples. The method employs a double-cased system with an inner core barrel and a larger override casing, which minimizes downhole sample mixing in the borehole. The ability to seal off shallower water-bearing zones proved especially beneficial during the collection of discrete depth groundwater samples (i.e., 'push-ahead' samples).

Sonic core samples were collected continuously by Cascade from the ground surface to the total depth of the boring (610 ft bgs) and provided to INTERA. INTERA described the samples using the Unified Soil Classification System (USCS) in accordance with ASTM Standard D 2488–17e1 Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) (ASTM, 2018). The sample descriptions were documented using an electronic data logging device and saved daily to the INTERA server and the data cloud. The daily log was then provided to Water Authority representatives via email each day following coring activities so the Water Authority could review. Representative samples were placed in labeled "chip trays" with individual compartments for each sample interval. These sample trays were delivered to the Water Authority upon completion of drilling operations. A complete copy of the soil boring log with lithologic descriptions is included in **Appendix D.**

2.1.4 Push-Ahead Groundwater Sampling Activities

Push-ahead groundwater sampling was conducted during drilling activities at six depths as follows:

1. 458-463 ft bgs;
2. 486.5- 488 ft bgs;
3. 516.5- 518 ft bgs;
4. 558.5- 560 ft bgs;
5. 582- 583.5 ft bgs; and
6. 601-602 ft bgs.

The first of these intervals was selected where groundwater was first encountered; the rest reflected areas of the aquifer where finer-grained sediments were observed in the zone immediately above the push-ahead sampling interval. The discrete samples were collected using a Push-Ahead™ groundwater profiler. The profiler is a heavy-gauge steel point that is attached to the base of the sonic drill rod and advanced ahead of the outer casing to the desired sample depth. When the

profiler is positioned at the target depth, the threaded portion between the profiler and drill stem is partially unthreaded, exposing ports that allow formation water to enter the profiler. Groundwater samples were collected from the profiler using a disposable bailer. The samples were collected by INTERA and submitted to HEAL and were analyzed for EDB by United States Environmental Protection Agency (EPA) Method 8011. Photos of the push-ahead sampler are included in the Photograph Log included in **Appendix C.**

Push-ahead sampling analytical results are discussed in Section 3.1.2 of this report.

2.2 Geophysical Logging

Once the total depth of the boring was reached, a geophysical log of the boring was conducted by Jet West on March 2, 2022. The geophysical logging equipment suite was conducted through the steel sonic casing and consisted of the following geophysical logging methods:

- Natural gamma ray (GR)log
- Caliper log
- Neutron log
- Omni-directional density log

Electric logs (i.e., dual induction) were not possible due to the presence of the steel casing in the borehole.

Cascade assisted the geophysical logging operation by making the area around the borehole accessible to Jet West. INTERA provided oversight of the geophysical logging operation to confirm that the geophysical logs provided the best possible data. The geophysical logging information was provided to the Water Authority, and the neutron and gamma data was incorporated on to the boring log/well construction diagram included in **Appendix D.**

2.2.1 Final Well Design

Following geophysical logging, INTERA prepared a final well design diagram for Water Authority and NMED CPB approval. The final well design diagram was submitted to the Water Authority and NMED CPB for approval on March 4, 2022, and was approved on March 7, 2022. A copy of the NMED well design approval letter is included in **Appendix D.**

The final well design was generally as outlined in the Work Plan/SAP. Since no EDB was detected in the push-ahead samples collected during drilling, the location of the well screen in the final design was based on lithology. The total depth of the soil boring was measured to be 608 ft bgs (the Work Plan/SAP estimated 605 ft bgs) and the recommended screen interval was designed at

572 ft bgs to 592 ft bgs (the Work Plan/SAP estimated the screen interval to be 580 ft bgs to 600 ft bgs). The screen interval was adjusted in order to screen between fine-grained units located at depths of 561 to 563.5 ft bgs and 594.5 ft bgs and 595 ft bgs as outlined on the well construction diagram included in **Appendix D.**

2.3 Well Installation

Monitoring Well WUABFFMW01 was installed in general accordance (Work Plan/SAP deviations are discussed in Section 1.3) with the INTERA Work Plan/SAP (INTERA, 2022a) and in accordance with the well design diagram approved by NMED CPD on March 7, 2022. Well construction activities were initiated by "cleaning" out the soil boring in order to have a nominal 8-inch diameter soil boring from the ground surface to the terminal depth of the soil boring. There were construction delays associated with equipment break-downs and down-hole challenges, but ultimately well casing installation began on April 2, 2022 and was completed on April 6, 2022 (final grout lift installed on April 5, 2022). Field notes from well installation activities are included in **Appendix B.**

Data gap monitoring well WUABFFMW01 was installed as follows:

1. *Depth:* Total Depth of boring: 608 ft bgs. The boring was backfilled to 597 ft bgs using bentonite pellets.
2. *Well Casing:* Nominal 3-inch, flush threaded Schedule 80 polyvinyl chloride (PVC). A 5-ft section of casing was attached below the bottom of the screen as a sump. A threaded stainless steel end cap without rivets, screws, or glued pieces was attached to the bottom of the sump casing. The well casing was pulled taught using the rig during annular backfilling activities, to ensure the well was plumb.
3. *Centralizers:* Stainless steel centralizers were installed at the base of the well and on the blank casing above the top of the screen.
4. *Screen:* 20-ft by nominal 3-inch schedule 80 PVC, 0.020-inch slot. Screen interval is 20 ft, set between 572 ft and 592 ft bgs.
5. *Sand Pack:* 10/20 silica sand (minimum siliceous material content 95%), installed from 569 ft bgs to 594 ft bgs.
6. *Casing Installation:* The well casing was "hung" in the boring above the total depth of the well; the well was not allowed to rest on the bottom of the boring.
7. *Bentonite Seal:* ¼-inch time-release coated bentonite pellets were placed by gravity fall from 559 ft bgs to 569 ft bgs. The seal was allowed to hydrate overnight prior to placement of additional annular materials.

8. *Grout to Surface:* A cement-bentonite grout was installed from the top of the bentonite seal to 2 ft bgs. To avoid damage to the well from heat of hydration, a minimum of 3 lifts with 8-hour curing time between lifts were required. Grout was placed by pumping through a tremie pipe.
9. *Surface completion:* The well was completed as a below-grade completion within a traffic-rated flush-mounted vault. The vault is 12-inches in diameter with a skirt length of 12 inches. A 2-ft square, 4-inch thick 3,000-pounds per square inch (psi) concrete pad was installed around the well vault. A locking J-plug was placed on the PVC casing and a lock added to secure the well.

Data gap monitoring well WUABFFMW01 construction details are outlined in **Table 1** and on the Boring Log/Geophysical Log/Monitoring Well Construction Diagram included as **Appendix D.**

2.4 Well Development

Well development activities were initiated on April 7, 2022 and were completed on April 13, 2022. Well development activities were completed in accordance with the INTERA Work Plan/SAP (INTERA, 2022a). Cascade provided a separate "development rig" to conduct the well development work. Development water was contained in 275 gallon "totes" transported to the Site by AES.

As described in the INTERA Work Plan/SAP, an Imhoff cone, provided by Cascade, was used to collect water from the first bailer run to evaluate the amount of silt and sediment in the water. This process was repeated after each cycle of surging development. The data gap groundwater monitoring well WUABFFMW01 was bailed until the discharge water contained less than 2 milliliters (ml) of sediment per 1 liter of water, as measured in the Imhoff cone. The initial reading was 280 ml of sediment per liter of water, the final reading was 1.0 ml of sediment per 1 liter of water.

Development was accomplished by surging and bailing to minimize fines in the filter pack and until a minimum of five casing volumes were removed. The bailer was fitted with a toggle valve and used to gently surge the well screen interval to remove any sand, silt, and debris accumulated in the well casing. Water quality was monitored during the process and temperature, pH, specific conductance, and turbidity were recorded on field forms. A total of approximately 4,345 gallons of development water was removed from the data gap well. The target amount of water to be removed during development was estimated to be 4,250 gallons. This total was calculated by determining the volume in the well (approximately 50 gallons) and per the Work Plan/SAP, removing 5 casing volumes (250 gallons). It was estimated by Cascade and INTERA that

approximately 4,000 gallons of water was added during drilling activities. The target of 4,250 gallons was exceeded during well development (the total volume of water removed during development was 4,345 gallons of water). All development water was contained in 275-gallon totes and transported by AES from the Site for waste disposal. Field notes from well development activities are included in **Appendix B.** Monitoring well development records are provided in **Appendix E**, and development water disposal manifests are provided in **Appendix K.**

2.5 Wellhead Survey

The wellhead survey was performed by High Mesa Consulting Group (Joseph Solomon, Jr., New Mexico licensed surveyor No. 15075). The survey was conducted on May 26, 2022, after well installation activities. High Mesa surveyed the horizontal and vertical coordinates of the top of each monitoring well casing and the ground surface elevation. Horizontal coordinates were measured relative to the New Mexico State Plane Coordinate System, Central Zone, North American Datum of 1983 (NAD83). Vertical coordinates were measured relative to the North American Vertical Datum of 1988 (NAVD88). Horizontal positions were measured to the nearest 0.1 ft, and vertical elevations were measured to the nearest 0.01 ft. A copy of the survey provided by High Mesa Consulting Group is included in **Appendix F.**

2.6 Groundwater Sampling

Data gap monitoring well WUABFFMW01 recovered for approximately 4 weeks following development prior to sampling. INTERA collected groundwater samples from data gap monitoring well WUABFFMW01 in May 2022 (Quarter 2 2022) and August 2022 (Quarter 3 2022). WUABFFMW01 was sampled using two sampling methods:

1. passive sampling using passive diffusion bag (PDB) samplers for VOC constituents and dual membrane passive diffusion samplers (DMS) for non-VOC constituents, and
2. a combination of low-flow sampling and purging three saturated well-casing volumes using a dedicated Bennett Pump.

WUABFFMW01 was sampled during two sampling events and was gauged, sampled, and analyzed in accordance with the approved Work Plan/SAP (INTERA, 2022a). The procedures are briefly described in the following sections.

2.6.1 Fluid Level Gauging and Pressure Transducer Installation

Depth to groundwater was measured prior to each sampling event. Light non-aqueous phase liquid (LNAPL) was not anticipated to be present in WUABFFMW01, but an electronic oil-water interface probe was used to confirm it was not present at the water surface prior to each sampling event. Upon retraction, the well gauging tape was thoroughly decontaminated according to

INTERA Standard Operating Procedure (SOP) No. 2 (INTERA, 2022a – Appendix C). Fluid level measurements, as measured in May 2022 and August 2022, are documented in **Table 2.**

A dedicated transducer was installed in data gap monitoring well WUABFFMW01 following well installation and the first sampling event as outlined in the approved Work Plan/SAP (INTERA, 2022a). The In-Situ pressure transducer (Level TROLL 700, 300 psi, with vented, twist-lock cable) will be used to monitor the static water level continuously and provides data that can be downloaded by the Water Authority to evaluate head level changes at the data gap well over time. INTERA downloaded the data from the transducer prior to the second sampling event in August 2022 and reinstalled the transducer on September 7, 2022 to continue data collection.

2.6.2 Passive Diffusion Bag and Dual Membrane Passive Diffusion Sampling

PDBs, DMSs, and accessories were ordered from Eon Products prior to each sampling event. The tethered line of PDB and DMS samplers was deployed for two sampling events, the first deployment occurred on April 27, 2022, and the second deployment occurred on August 9, 2022. The samplers were set in the screened interval from approximately 572 to 592 ft bgs and left in the well at this depth for 3 weeks prior to sample collection. The PDB and DMS samplers were retrieved for sample collection on May 24, 2022 and August 29, 2022 and split samples were collected by a representative from KAFB. Sampling results are described in Section 3.2.3 and a copy of the field logbook is provided in provided in **Appendix B**.

2.6.3 Low-Flow Purge Bennett Pump Sampling

After each PDB/DMS sampling event, the data gap monitoring well was sampled with low-flow purge methods in accordance with the Work Plan/SAP (INTERA, 2022a). The first low-flow purge sampling event occurred from May 25-27, 2022; and the second event occurred from August 29-31, 2022. During each event, the dedicated Bennett Pump, purchased specifically for the data gap monitoring well WUABFFMW01 sampling, was placed in the center of the well screen at a depth of approximately 582 ft bgs, and the flow rate was adjusted for minimal drawdown (<0.3 ft) using low-flow rates between 0.05 and 0.13 gallons per minute (gpm). During purging activities, groundwater quality parameters (specific conductivity, temperature, turbidity, and pH) were monitored for stabilization using a YSI Plus 1030 water quality meter and a separate turbidity meter. Stability was defined as a minimum of three consecutive measurements within 10 percent (%) of each other for specific conductivity and temperature, within 0.5 standard units for pH, and turbidity is either below 10 nephelometric turbidity units (NTUs) or measurements within 10% of each other. Purging was considered complete when the monitoring well had been purged a minimum of three saturated well-casing volumes and the groundwater quality parameters have

stabilized for three consecutive readings. Once purging was complete and stability achieved, a sample was collected. Samples were split with a representative from the KAFB.

All purge, water quality, and sample collection data were recorded on a field form, a copy of which is provided in **Appendix G.** A copy of the field logbook is provided in **Appendix B.** Purge water was containerized in a 275-gallon tote that was transported to the Site by INTERA, filled, and then transported back to AES by INTERA at the completion of low-flow purge sampling activities.

2.7 Slug Test Approach

A pneumatic slug test was performed at the data gap well WUABFFMW01 on June 10, 2022. The slug test was performed as outlined in the Work Plan/SAP (INTERA, 2022a) except as noted in the Work Plan Deviations (Section 1.3). Access to area monitoring wells was not provided by the Air Force so slug testing was limited to the data gap well only (five nearby KAFB monitoring wells were contemplated for slug testing in the Work Plan/SAP). Slug testing results are discussed in Section 3.0.

2.8 Waste Management, Handling, and Disposal

Management of IDW was performed in accordance with the approved Work Plan/SAP (INTERA, 2022a). The IDW produced during the project consisted of soil cuttings, drilling liquids, decontamination water, and well development water. Solid and liquid IDW was segregated and placed in roll-off bins or 275-gallon totes pending characterization. AES provided waste management support for this drilling and sampling program.

2.8.1 Soil Investigation-Derived Waste

Soil was contained at the drill site in 20-cubic-yard roll-off bins and transported by AES to their facility in Belen, New Mexico, for characterization and temporary storage. One representative, five-point composite soil characterization sample was collected from each roll-off bin in accordance with the receiving waste facility requirements. The soil samples were analyzed by HEAL, and the IDW soil cuttings were determined to be non-hazardous waste. The soil generated during drilling was transported from the Site by AES for disposal at the Waste Management Landfill Facility in Valencia County, New Mexico. Approximately 21.72 tons of soil/soil core samples were disposed of by AES. Copies of the soil profile, soil laboratory analytical results, and soil disposal waste manifests are included in **Appendix K.**

2.8.2 Water Investigation-Derived Waste

All water generated during drilling, well development, decontamination, or during sampling events was 100% captured, contained, and analyzed for waste profiling before disposal as specified in the

Work Plan/SAP (INTERA, 2022a). The liquid IDW was characterized and deemed non-hazardous, so the liquid IDW containers were transported off-site by AES for disposal at their facility in Belen, New Mexico. A copy of the waste manifests is provided in **Appendix K.** IDW amounts of water disposed of during drilling/development/sampling equals approximately 5,285 gallons. Approximately 4,925 gallons of water was generated for disposal during drilling and well development (4,345 gallons from well development and 580 gallons generated by drilling activities associated with drill casing advancement and the 8-inch drill casing wash-over retrieval procedure). Approximately 175 gallons of purge water was generated during the May 2022 sampling event and approximately 185 gallons of purge water was generated during the August 2022 sampling event.

3.0 RESULTS

The following section outlines the results of the data gap well installation and sampling activities.

3.1 Drilling and Sampling

Data gap monitoring well installation and well development field activities were initiated on January 24, 2022 and were completed on April 14, 2022. A nominal 8-inch diameter boring was advanced to total depth (approximately 608 feet). The data gap monitoring well is constructed of 3-inch schedule 80 PVC with a total depth of approximately 597 feet bgs and a 20-feet screened interval of 0.02-inch slot within the interval of 572 feet to 592 feet bgs. The data gap monitoring well WUABFFMW01 was constructed as outlined in Section 2.3 and in **Appendix D.**

3.1.1 Site Stratigraphy

The geologic and hydrogeologic framework of the site vicinity and at the relevant depths for the Data Gap Well consist of braided ancestral Rio Grande axial-fluvial sediments of the Sierra Ladrones Formation of the Santa Fe Group, consisting of unconsolidated sand, silt, clay, and gravel layers, with medium- to coarse-grained sand being the dominant sediment type (INTERA, 2021a). **Figure 3** has been updated to include the stratigraphy observed during the drilling of the data gap well and also to show that a screened interval has been placed in the zone identified by the Water Authority and INTERA as the "data gap" (INTERA, 2021a). The screened interval of the data gap well targets a zone with fine-grained units immediately above and below the screen, and the screened interval is across a zone of relatively highly permeable, well-graded and poorly-graded sand, with gravel and cobbles present (**Appendix D**).

3.1.2 Push-Ahead Groundwater Sampling and Analysis

The approved Work Plan/SAP objective that five push-ahead sample be collected was achieved. The grab/push-ahead ground water data should be considered a screening technique and not necessarily a definitive sample result because they are not collected from a fully developed monitoring well. Grab/push-ahead groundwater samples were collected during drilling activities at six depths: (1) where groundwater was first encountered, 458-463 ft bgs; (2) 486.5- 488 ft bgs; (3) 516.5- 518 ft bgs; (4) 558.5- 560 ft bgs; (5) 582- 583.5 ft bgs; and (6) 601-602 ft bgs. The samples were submitted to HEAL and were analyzed for EDB by EPA Method 8011.

EDB results for the groundwater samples are outlined below:

1. Grab Groundwater Sample at water table – 458 to 463 feet bgs – EDB Result - <0.0091 ug/L
2. Push Ahead No. 1 Groundwater Sample – 486.5 to 488 feet bgs – EDB Result - <0.0093 ug/L

3. Push Ahead No. 2 Groundwater Sample – 516.5 to 518 feet bgs – EDB Result - <0.0094 ug/L
4. Push Ahead No. 3 Groundwater Sample – 558.5 to 560 feet bgs – EDB Result - <0.0095 ug/L
5. Push Ahead No. 4 Groundwater Sample – 582 to 583.5 feet bgs – EDB Results - <0.0094 ug/L
6. Push Ahead No. 5 Groundwater Sample – 601 to 602 feet bgs – EDB Result - <0.0095 ug/L

EDB was not detected in any of the ground water samples collected during data gap borehole advancement. The sample results are illustrated on the well completion diagram presented in **Appendix D** and copies of the push-ahead groundwater laboratory analytical reports are provided in **Appendix H.**

3.2 Groundwater Sampling

Groundwater samples were collected from data gap monitoring well WUABFFMW01 in May 2022 (Quarter 2 2022) and August 2022 (Quarter 3 2022). The groundwater monitoring results are discussed below:

3.2.1 Fluid Levels

LNAPL of measurable thickness (greater than 0.01 ft) was not observed in WUABFFMW01 during the sampling events. Static groundwater level measurements were collected before each sampling event, slug test, or deployment of the pressure transducer. Depth to groundwater ranged from 452.75 ft below top of casing (btoc) to 456.01 ft btoc between April 27, 2022 and September 7, 2022. The corresponding potentiometric surface elevation range was from a maximum of 4875.79 ft NAVD88 to a minimum of 4872.53 ft NAVD88. The measurements collected are summarized in **Table 2.** A current potentiometric surface map is included as **Figure 4**, which shows that August 2022 measurements from WUABFFMW01 were consistent with measurements from nearby KAFB monitoring wells**.** INTERA downloaded the data from the transducer prior to the second sampling event in August 2022 and transferred the electronic file to the Water Authority via email.

3.2.2 Groundwater Quality Parameters

Groundwater quality parameters were measured from the water collected from the PDB/DMS samplers and measured and recorded during well purging until parameters stabilized for three consecutive readings. Groundwater quality parameter values were recorded on groundwater sampling forms presented in **Appendix G**, and stabilized/final groundwater quality parameters are summarized in **Table 3.**

3.2.3 Groundwater Sample Analytical Results

Eurofins provided the required fixed-laboratory analytical services for the Project. Groundwater samples were collected, labeled, packaged, and submitted to HEAL for overnight delivery to Eurofins and analyzed for the following:

- VOCs via EPA Method 8260.
- Semi-volatile organic compounds (SVOCs) via EPA Method 8270.
- Metals via EPA Method 6010.
- Anions via EPA Method E300.0.
- EDB via EPA Method 8011.
- Alkalinity via Standard Method SM2320B.

It should be noted that HEAL was used as the receiving/shipping laboratory because of their location in Albuquerque and their close working relationship with Eurofins. HEAL and Eurofins have an existing contractual agreement and sample turn-around time is reduced by using HEAL to ship samples/receive laboratory data reports. Analytical results are summarized in **Table 4**, and results for each sampling event are discussed in the following sections.

Passive Diffusion Bag/Dual Membrane Bag Sampling – May 2022 Event

The initial passive ground water sample collected from data gap monitoring well WUABFFMW01 identified benzene and toluene at estimated concentrations of 0.094J µg/L and 0.26J µg/L, respectively[1]; EDB was not detected above a method detection limit (MDL) of 0.0037 µg/L. Subsequent investigation by INTERA found that the low-level, estimated concentrations of toluene and benzene in the May 2022 and August 2022 groundwater samples were likely attributable to sampling and/or laboratory analysis procedures, not from the groundwater environment and not related to the BFF plume. The sampling and analysis procedures have since been revised and the issue has been resolved. Other organic compounds identified at estimated concentrations were 2-butanone (0.47J µg/L) and bis(2-ethylhexyl) phthalate (1.3J µg/L); both of these compounds are commonly detected at low levels as a result of laboratory contamination (which was determined to be the source of their presence in the sample).

Anions, cations, and metals identified include bromide (0.18J milligrams per liter [mg/L]), chloride (12 mg/L), sulfate (26 mg/L), calcium (33 mg/L), magnesium (4.4 mg/L), potassium (2.8 mg/L), sodium (25 mg/L), dissolved iron (0.13 mg/L), and dissolved manganese (0.17 mg/L). Total alkalinity was identified at a concentration of 120 mg/L. Positive results were compared to

[1] The "J" qualifier means that the concentration identified is estimated (the result is less than the Reporting Limit [RL] but greater than or equal to the MDL used by the laboratory). The estimated concentrations indicate that benzene and toluene are present in the sample, but the concentrations are estimated because the analytes were identified below the laboratory reporting limit.

their respective EPA MCLs and NMWQCC Standards (whichever was more stringent), and no exceedances were identified.

A copy of the laboratory report is provided in **Appendix I**.

Bennett Pump Sampling – May 2022 Event

The ground water sample collected from data gap well WUABFFMW01 using low-flow purge sampling methods identified an estimated concentration of toluene at 0.47J µg/L (also likely attributable to sampling and/or laboratory analysis procedures, since resolved). EDB was not detected above the MDL of 0.0037 µg/L, and no other organics analyzed except toluene were detected.

Anions, cations, and metals detected at either estimated or reported concentrations include bromide (0.18J mg/L), chloride (11 mg/L), sulfate (34 mg/L), calcium (32 mg/L), magnesium (4.2 mg/L), potassium (2.7 mg/L), sodium (27 mg/L), dissolved iron (0.16 mg/L) and dissolved manganese (0.28 mg/L). Total alkalinity was identified at a concentration of 120 mg/L. The laboratory analytical results were compared to their respective EPA MCLs and NMWQCC Standards (whichever was more stringent), and no exceedances were identified with the exception of manganese (NMWQCC Standard for manganese is 0.2 mg/L).

A copy of the laboratory report is provided in **Appendix I**.

Updated area plume maps for concentrations of EDB, benzene, and toluene in the shallow, intermediate, and deep zones, including the passive and low-flow purge sampling results from the data gap well (deep zone) are included as **Figures 5a, 5b, 5c, 6a, 6b, 6c, 7a, 7b, and 7c.** Monitoring data from KAFB wells from the fourth quarter of 2021 reported by EA (2022) are used to determine plume contours for wells with tops of screens less than or equal to 10 ft below the water table (the definition of the shallow zone for purposes herein), wells with tops of screens between 10 and 40 ft below the water table (intermediate), and for wells with screens greater than 40 ft below the water table (deep). The Quarter 4 2021 KAFB BFF data was used because this was the most recent final quarterly report available at the time the figures were prepared.

Passive Diffusion Bag/Dual Membrane Bag Sampling – August 2022 Event

The second sampling event using PDB/DMS methods identified an estimated concentration of toluene at 0.19J µg/L (also likely attributable to sampling and/or laboratory analysis procedures, since resolved). EDB was not detected above an MDL of 0.015 µg/L. Bis(2-ethylhexyl) phthalate (1.6J µg/L), a plasticizer and common contaminant in sampling and laboratory materials (which

was determined to be the source of its presence in the sample), was the only other organic compound identified.

Anions, cations, and metals identified at estimated or reported concentrations include bromide (0.24J mg/L), chloride (17 mg/L), sulfate (35 mg/L), calcium (28 mg/L), magnesium (3.8 mg/L), potassium (2.8 mg/L), sodium (36 mg/L), dissolved iron (0.032J mg/L) and dissolved manganese (0.53 mg/L). Total alkalinity was identified at a concentration of 130H mg/L with an "H" qualifier indicating the sample was analyzed beyond the specified method holding time. The laboratory analytical results were compared to their respective EPA MCLs and NMWQCC Standards (whichever was more stringent), and no exceedances were identified with the exception of manganese (NMWQCC Standard for manganese is 0.2 mg/L).

A copy of the laboratory report is provided in **Appendix I.**

Bennett Pump Sampling – August 2022 Event

The second sampling event using low-flow purge sampling methods identified an estimated concentration of toluene 0.099J µg/L (also likely attributable to sampling and/or laboratory analysis procedures, since resolved). EDB was not detected above an MDL of 0.015 µg/L, and no other organics analyzed except toluene were detected.

Anions, cations, and metals identified at estimated or reported concentrations include bromide (0.18J mg/L), chloride (9.7 mg/L), sulfate (29 mg/L), calcium (29 mg/L), magnesium (3.9 mg/L), potassium (2.7 mg/L), sodium (28 mg/L), dissolved iron (0.12 mg/L) and dissolved manganese (0.43 mg/L). Total alkalinity was identified at a concentration of 120H mg/L with an "H" qualifier indicating the sample was analyzed beyond the specified method holding time. The laboratory analytical results were compared to their respective EPA MCLs and NMWQCC Standards (whichever was more stringent), and no exceedances were identified with the exception of manganese (NMWQCC Standard for manganese is 0.2 mg/L).

A copy of the laboratory report is provided in **Appendix I.**

QA/QC Samples

Trip Blanks were analyzed for VOCs during each sampling event (with the exception of the May 2022 Bennett Pump Sampling Event, because a trip blank was not provided by the contract laboratory). VOCs were not identified in any of the Trip Blanks analyzed.

One equipment rinsate (blank) sample (designated "EQP-01") was collected on August 31, 2022 after the primary sample was collected by the Bennett pump and the Bennett pump and tubing

were decontaminated using the process discussed in Section 5.8 of the Work Plan Addendum (INTERA, 2022b), with one exception. The exception was that distilled water provided by Culligan was used for the final rinse of the Bennett Pump and tubing and as the source of water for the equipment rinsate sample (i.e., EQP-01) instead of ASTM International (ASTM) Type II reagent grade water (ASTM, 2011), which is specified in the INTERA SOP (INTERA, 2022a). "EQP-01" was analyzed for the presence of VOCs by EPA Method 8260B. VOC analytes identified were bromodichloromethane (0.78 µg/L), chloroform (3.7 µg/L), dibromochloromethane (0.72 µg/L), 1,2-dichloroethane (0.74 µg/L) and 1,2,4-trichlorobenzene (0.48J µg/L); Eurofins stated that the presence of 1,2-dichloroethane (EDC) and 1,2,4-trichlorobenzene was possibly instrument carryover from previous analytical runs of contaminated samples. None of these analytes were detected in the primary sample and therefore did not affect the primary sample results.

Data Usability

Data validation found that non-detections of EDB in the May 2022 and August 2022 sampling events were reliable, as were all analytical results, but that some detections of organic compounds can be attributed to laboratory contamination, as described above.

Toluene was identified in groundwater samples collected from the data gap monitoring well (both passive and low-flow purge samples) at concentrations below the laboratory reporting limit (i.e., values were "J" flagged") as summarized in **Table 4.** Similar concentrations were detected in an equipment blank subsequently collected to investigate the source of these toluene detections. EPA guidance indicates that when this occurs during a project, the primary sample results should be qualified by the users of the data (EPA, 2020). Since the blank result was less than the reporting limit, and the primary sample toluene results are also all less than the reporting limit, the primary sample results should be qualified as "U" or "not detected" above the laboratory reporting or quantification limit, which, in this case is 0.50 µg/L. INTERA has reported the concentrations as <0.50 µg/L on **Figure 7c.**

3.3 Slug Test Results

Slug testing was conducted at the data gap well on June 10, 2022. The data gap well recovered very quickly and INTERA was able to run multiple tests within a few hours. The first three tests were slugs of air dropping the water level approximately 50 inches. The last two slug tests were slightly larger, consisting of approximately 60-inch slugs. Results did not vary between the different slug sizes to a significant degree.

The initial test was run with the transducer at a 1 second interval, but because of the high hydraulic conductivity, the data gap well recovered within a few seconds, so all further tests were run at the

fastest possible transducer time of 250 milliseconds (ms) datapoints. This helped significantly with giving additional data during the very fast recovery time. The recovery curves also displayed a secondary variation at the point the air pressure was released, generating a slight surging effect before the curve smoothed. INTERA does not know what caused this secondary vibration in the data, but one possible explanation is how the pressurized air is interacting with the smaller casing volume and the slug test manifold. The manifold itself has a simple large diameter ball valve to release the air pressure of the slug, and opening this valve consistently and as quickly as possible was difficult.

Because the data at the spike of the slug pressure curve is rather noisy, all curve-matching for hydraulic measurements was applied as the pressure noise faded into a smoother curve. This gave repeatable results by using the top half to top third of the recovery curves.

- The slug tests conducted yielded repeatable hydraulic conductivity measurements, all within the same order of magnitude, with an average of approximately 30 ft/day.
- The calculated Specific Storage (S_S) is variable, between $1x10^{-4}$ and $1x10^{-8}$ (1/ft) but tending towards the smaller number ($1x10^{-8}$).
- Skin effects are well constrained with a small average skin radius (<2 inches), skin S_S between $1x10^{-6}$ and $1x10^{-8}$ (1/ft), and skin K values of ~$1x10^{-5}$ ft/day.

Copies of the data gap well slug test results are provided in **Appendix J.**

4.0 CONCLUSIONS AND RECOMMENDATIONS

Water Authority data gap well WUABFFMW01 provides valuable additional stratigraphic, groundwater potentiometric surface elevation, and groundwater quality data at the BFF site. The Water Authority area of interest and the identified data gap for EDB in the aquifer in the vertical zone between 572 feet and 592 feet bgs can now be monitored by the Water Authority as a sentinel location for its downgradient water supply wells.

The groundwater flow direction is generally to the north, northeast (with a complex flow pattern near the capture zone of the KAFB interim measure extraction wells) as shown on the potentiometric surface map in **Figure 4**. The Water Authority data gap well WUABFFMW01 is in the appropriate location and screened at the appropriate depth to monitor deep zone concentrations of volatile organics downgradient of the BFF plume.

EDB, benzene, and toluene concentration contour maps (**Figures 5, 6,** and **7**) provide a snapshot of current plume conditions in the aquifer's shallow, intermediate, and deep zones as defined in **Section 3.2.3.** It should be noted that these are the "monitored" portions of the aquifer in the area of interest and not the aquifer as a whole. EDB has not been detected in groundwater samples collected from Water Authority data gap well WUABFFMW01 to date. Benzene and toluene have been detected at concentrations less than the laboratory quantification limits. The toluene results have been further qualified as non-detect due to the presence of toluene in an equipment blank. Subsequent investigation by INTERA found that the low-level, estimated concentrations of toluene and benzene in the May 2022 and August 2022 groundwater samples were likely attributable to sampling and/or laboratory analysis procedures, not from the groundwater environment and not related to the BFF plume. The sampling and analysis procedures have since been revised and the issue has been resolved. INTERA recommends following the WUA directive for monitoring frequency of the newly installed data gap ground water monitoring well by collecting ground water samples at this location on a quarterly basis, beginning in December 2022.

5.0 REFERENCES

ASTM International (ASTM). 2011. Standard Specification for Reagent Water. D1193-06 (Reapproved 2011).

_____. 2018. Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), Designation: D2488 – 17, West Conshohocken, PA 19428-2959. American Society for Testing and Materials. March.

EA Engineering, Science, and Technology, Inc., PBC (EA), 2022. Periodic Monitoring Report – October–December 2021 and Annual Report for 2021 Bulk Fuels Facility Solid Waste Management Units ST-106/SS-111, Kirtland Air Force Base, New Mexico. Prepared for Kirtland Air Force Base by EA, Albuquerque, New Mexico. May 24.

Environmental Protection Agency (EPA). 2020. National Functional Guidelines for Organic Superfund Methods Data Review. Office of Superfund Remediation and Technology Innovation (OSTRI). Document No. OLEM 9240.0-51, EPA 540-R-20-005. November.

INTERA Incorporated (INTERA). 2021a. Proposal for Kirtland Airforce Base Bulk Fuel Facility Water Authority Data Gap Well. Submitted to the Albuquerque Bernalillo County Water Authority. August 13.

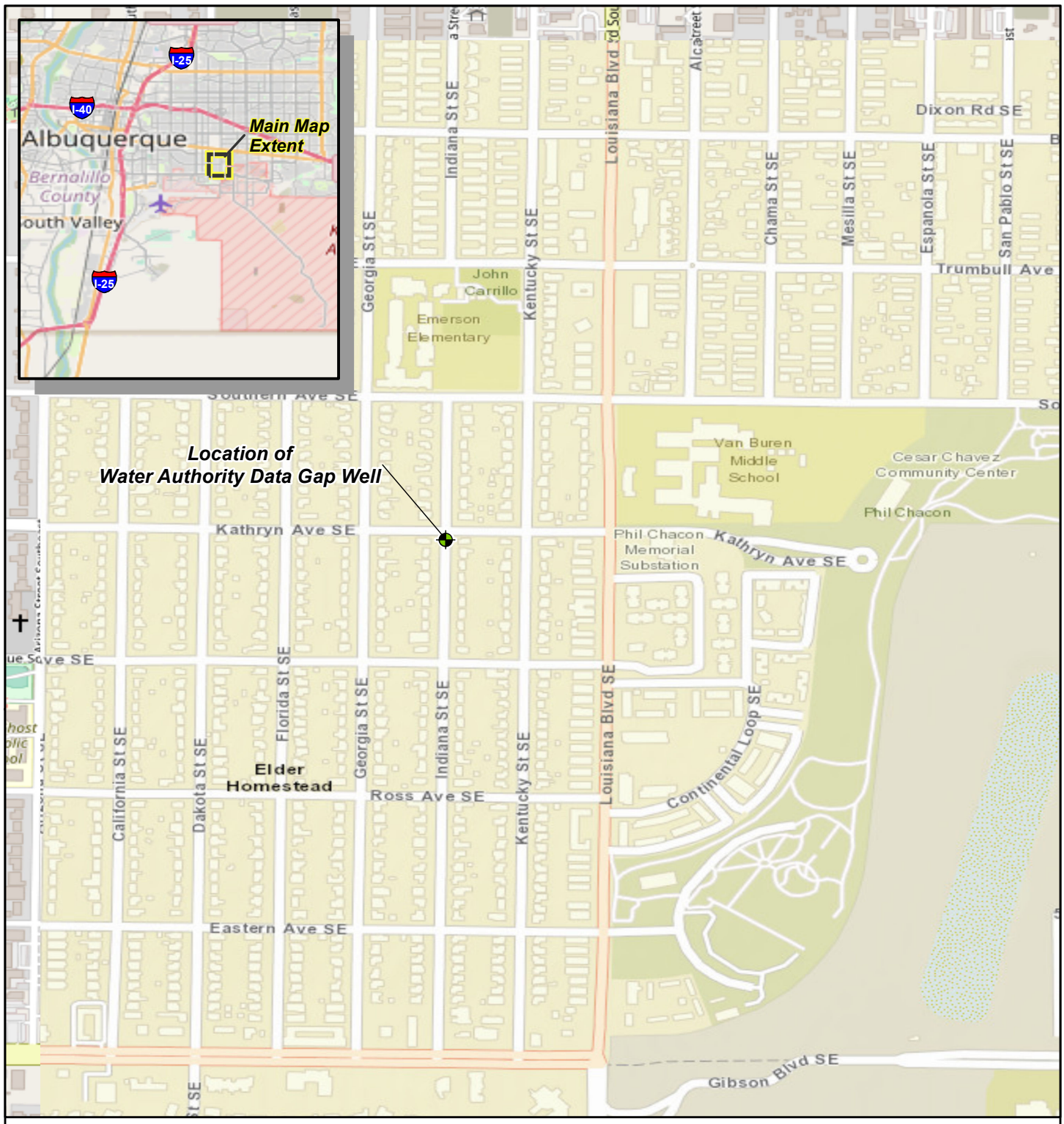
_____. 2021b. Technical Memorandum: Proposed Monitoring Well Location and Screened Interval for the Water Authority Data Gap Well. November 19.

_____. 2021c. Project Management Plan, Bulk Fuel Facility Water Authority Data Gap Well. Submitted to the Albuquerque Bernalillo County Water Authority. December 17.

_____. 2022a. Work Plan/Sampling Analysis Plan for Data Gap Monitoring Well Installation Well No. WUABFFMW01. Prepared for Albuquerque Bernalillo County Water Utility Authority. January 6.

_____. 2022b. Work Plan/Sampling Analysis Plan for Data Gap Monitoring Well Installation Well No. WUABFFMW01. Addendum No. 1. Prepared for Albuquerque Bernalillo County Water Utility Authority. November 15.

Figures



Source(s):Street map – ESRI online GIS

Figure 1
Data Gap Well Location
Albuquerque Bernalillo County Water Utility Authority Data Gap Well WUABFFMW-01 – 2022 Final Report
Bernalillo County, New Mexico, USA

FILE: S:\ABQ\ABWUA.C009.KAFB\Data_Gap_Well\Graphics\GIS\Map_Docs\2022_FinalReport\01_SiteLocation.mxd Date: 10/4/2022

Water Authority Data Gap Well

Utility Line

Gas

Sewer

Water

N

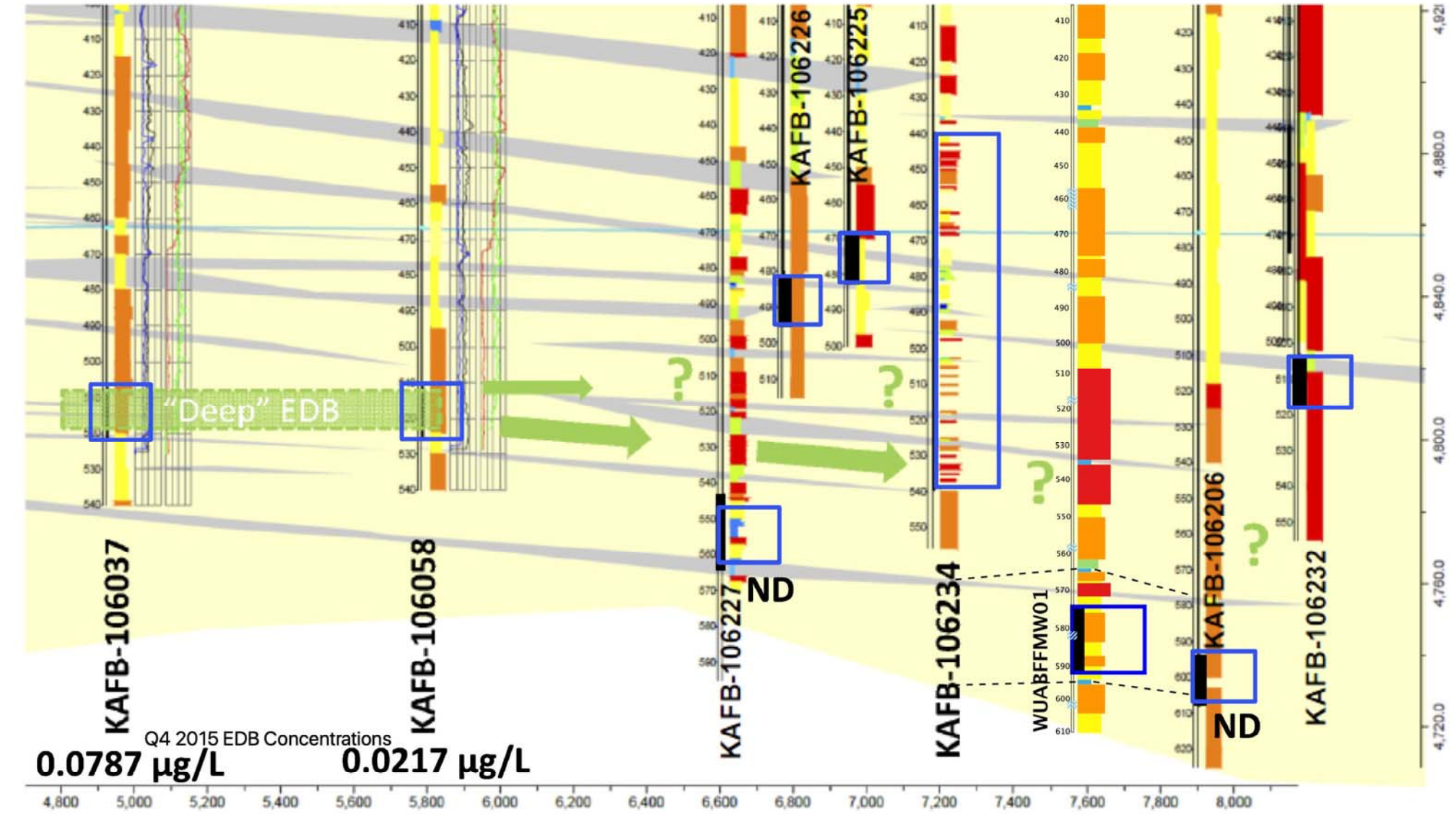
20 0 20

Feet

Source(s): Aerial – BERNCO website, dated 2020

Figure 2
Site Plan
Albuquerque Bernalillo County Water Utility Authority Data Gap Well WUABFFMW-01 – 2022 Final Report
Bernalillo County, New Mexico, USA

FILE: S:\ABQ\ABWUA.C009.KAFB\Data_Gap_Well\Graphics\GIS\Map_Docs\2022_FinalReport\02_SitePlan.mxd Date: 10/4/2022



Summarized Grain-Size Log Index

- Clay; Clay with Sand; Clayey Sand
- Silt; Silt with Sand
- Sandy Silt; Silty Sand
- Sand, Silt, or Clay with fine- or medium-grained Gravel
- Sand, Silt, or Clay with coarse-grained Gravel

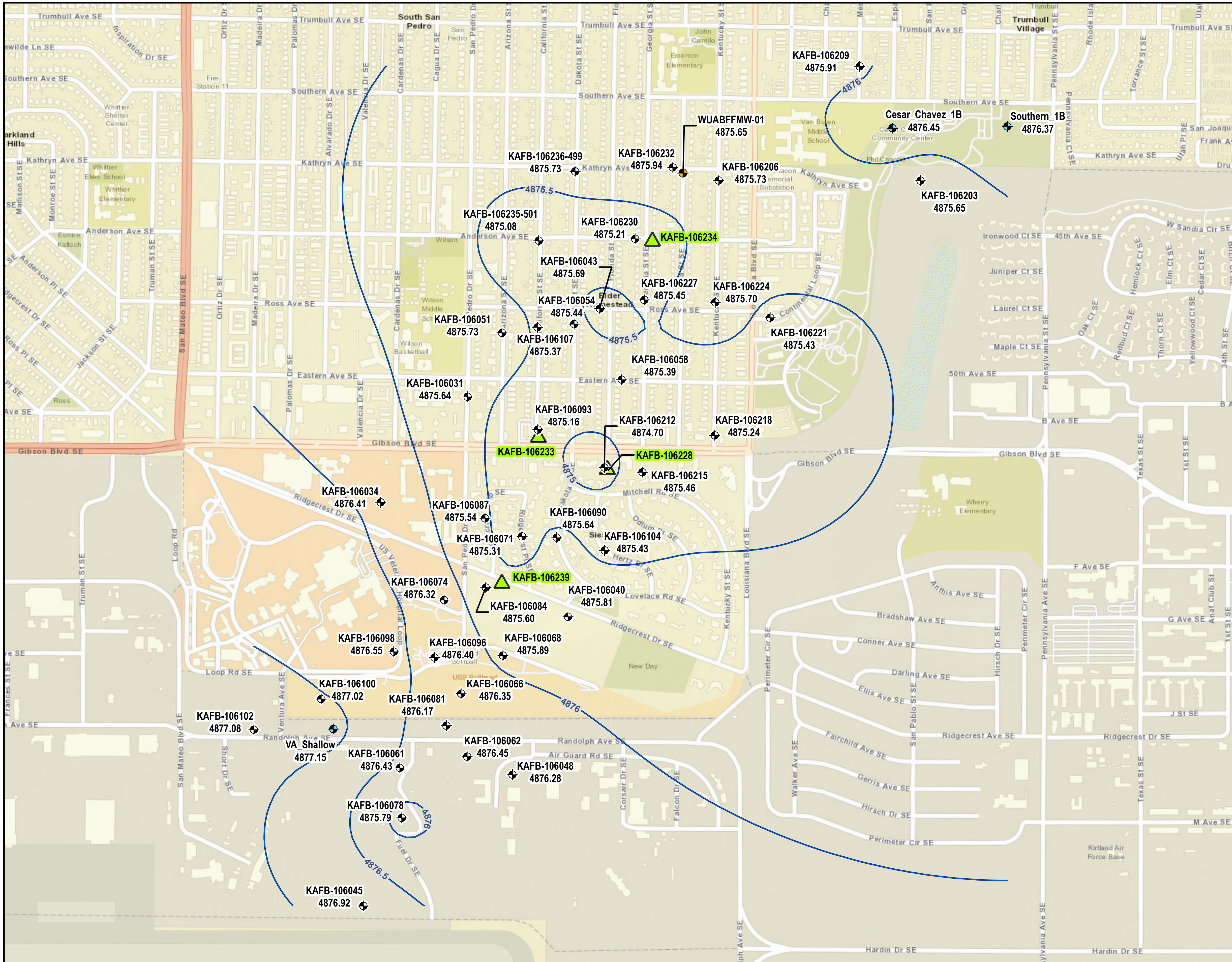
---- Fine Grain Layer Interpretation by INTERA

Push ahead sample in WUABFFMW01

Screened Interval

INTERA

Figure 3
Geologic Cross-Section (updated from AECOM 2015 A – A')
Albuquerque Bernalillo County Water Utility Authority Data Gap Well WUABFFMW-01 – 2022 Final Report
Bernalillo County, New Mexico, USA



INTERA

N

900 0 900

Feet

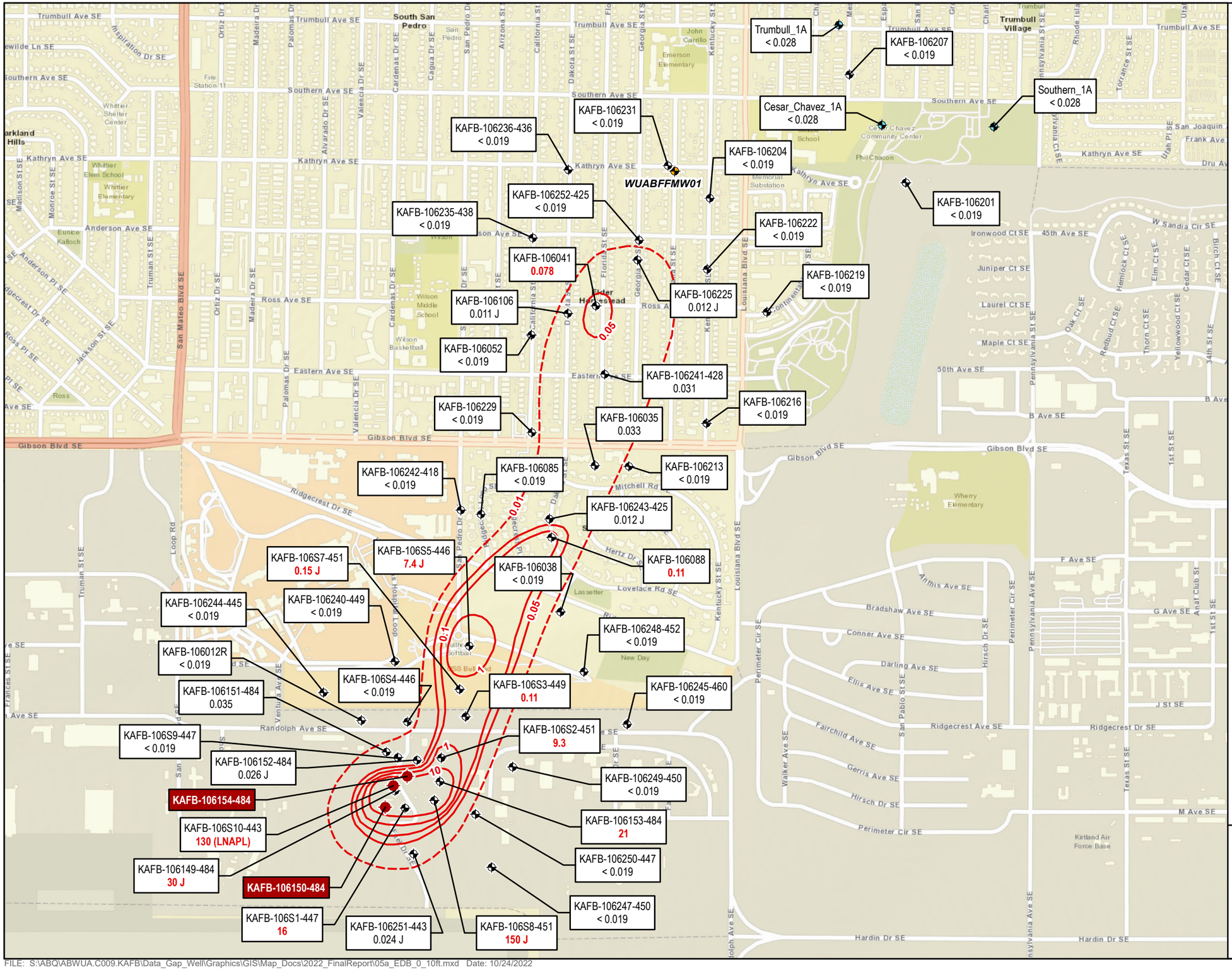
Source(s):
Street Map – ESRI online;
Wells – BFF database transmitted by ABCWUA, 2/13/23, and USGS wells from NWIS database, queried 9/29/22.

- Monitoring Well
- USGS Sentinel Well
- Water Authority Data Gap Well
- Interim Measure Extraction Well
- Potentiometric Surface Elevation (ft)

Note(s):
1. 2022 Q2 measurements are plotted from Kirtland Air Force Base monitoring wells at "Reference Elevation Interval 4814," the Water Authority Data Gap Well, and similarly screened USGS Sentinel Wells.
2. No measurable thickness of light non-aqueous phase liquid (LNAPL) was detected in this group of measurements.

Figure 4
Potentiometric Surface
Albuquerque Bernalillo County Water Utility Authority Data Gap Well WUABFFMW-01 – 2022 Final Report
Bernalillo County, New Mexico, USA

FILE: S:\ABQ\ABWUA.C009.KAFB\Data_Gap_Well\Graphics\GIS\Map_Docs\2022_FinalReport\2023_UPDATE\04_PotenSurface.mxd Date: 3/7/2023



Source(s):
Street Map – ESRI online;
Wells – BFF database transmitted by ABCWUA, 9/15/22.and USGS wells from NWIS database, queried 9/29/22

- Monitoring Well
- USGS Sentinel Well
- Well with Measurable LNAPL in 2021 Q4
- Water Authority Data Gap Well
- EDB Concentration Contour in µg/L (dashed where inferred)

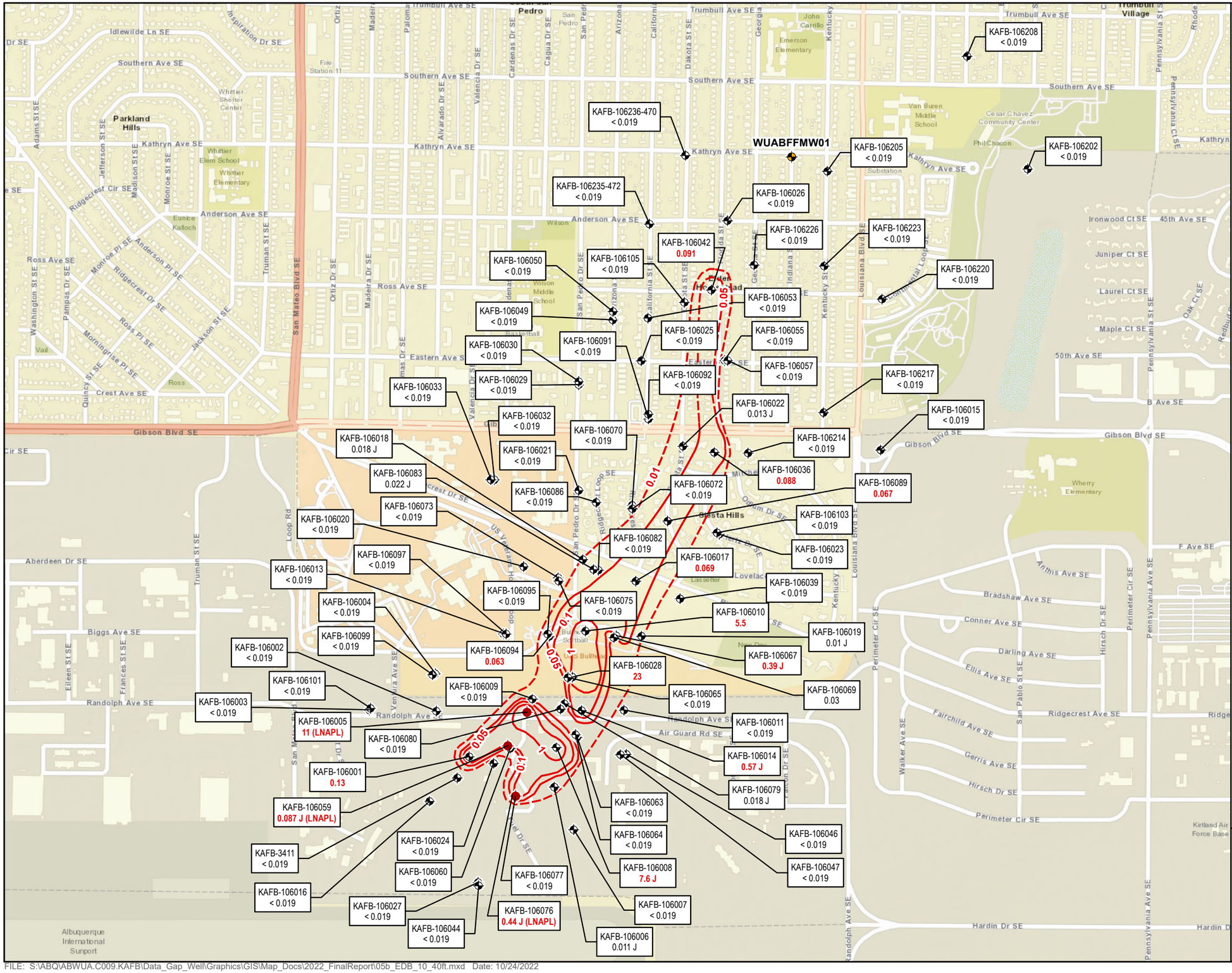
Well ID
EDB in µg/L

RED/BOLD indicates values or RLs in excess of NMWQCC Standard for EDB (0.05 ug/L)

Note(s):
J = Result is less that the Reporting Limit (RL) but greater than or equal to the method detection limit (MDL) and the concentration is an approximate value.
LNAPL = light non-aqueous phase liquid.
Data shown are from 4th quarter 2021 KAFB groundwater monitoring event samples from wells with tops of screens <= 10 ft below water table at that time. The maximum detection or minimum reporting limit is shown from EPA Method 8011 or EPA Method 8260 analyses or from duplicate samples as applicable.

Figure 5a
Distribution of EDB in Groundwater (Shallow)
Albuquerque Bernalillo County Water Utility Authority Data Gap Well WUABFFMW-01 – 2022 Final Report
Bernalillo County, New Mexico, USA

FILE: S:\ABQ\ABWUA.C009.KAFB\Data_Gap_Well\Graphics\GIS\Map_Docs\2022_FinalReport\05a_EDB_0_10ft.mxd Date: 10/24/2022



Source(s):
Street Map – ESRI online;
Wells – BFF database transmitted by ABCWUA, 9/15/22.and USGS wells from NWIS database, queried 9/29/22

- Monitoring Well
- Well with Measurable LNAPL in 2021 Q4
- Water Authority Data Gap Well
- EDB Concentration Contour in µg/L (dashed where inferred)

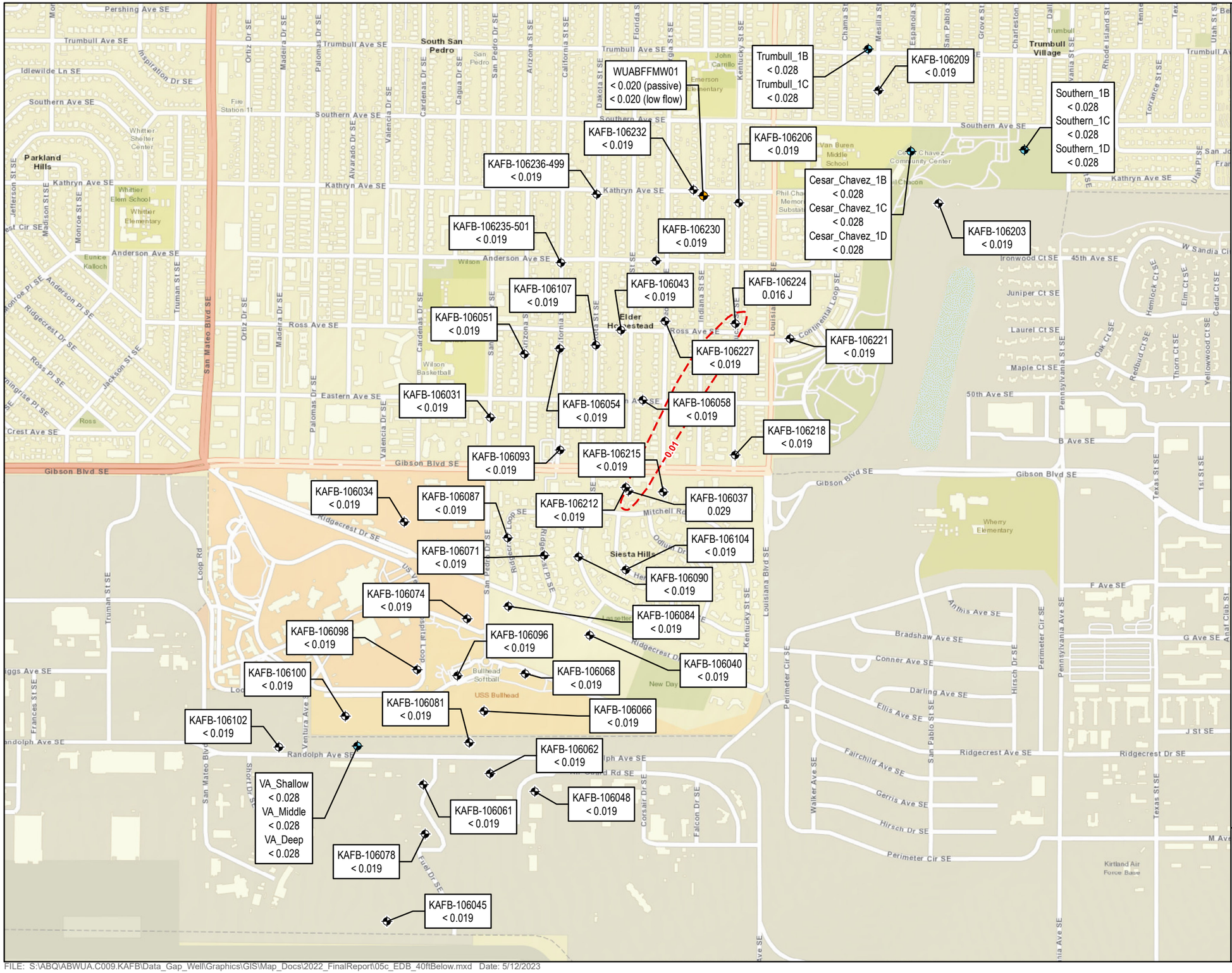
Well ID
EDB in µg/L

RED/BOLD indicates values or RLs in excess of NMWQCC Standard for EDB (0.05 ug/L)

Note(s):
J = Result is less that the Reporting Limit (RL) but greater than or equal to the method detection limit (MDL) and the concentration is an approximate value.
LNAPL = light non-aqueous phase liquid.
Data shown are from 4th quarter 2021 KAFB groundwater monitoring event samples wells with tops of screens >10 ft and <40 ft below water table at that time. The maximum detection or minimum reporting limit is shown from EPA Method 8011 or EPA Method 8260 analyses or from duplicate samples as applicable.

Figure 5b
Distribution of EDB in Groundwater (Intermediate)
Albuquerque Bernalillo County Water Utility Authority Data Gap Well WUABFFMW-01 – 2022 Final Report
Bernalillo County, New Mexico, USA

FILE: S:\ABQ\ABWUA.C009.KAFB\Data_Gap_Well\Graphics\GIS\Map_Docs\2022_FinalReport\05b_EDB_10_40ft.mxd Date: 10/24/2022



Source(s):
Street Map – ESRI online;
Wells – BFF database transmitted by ABCWUA, 9/15/22.and USGS wells from NWIS database, queried 9/29/22

- Monitoring Well
- USGS Sentinel Well
- Water Authority Data Gap Well
- EDB Concentration Contour in µg/L (dashed where inferred)

Well ID
EDB in µg/L

RED/BOLD indicates values or RLs in excess of NMWQCC Standard for EDB (0.05 ug/L)

Note(s):
J - Result is less that the Reporting Limit (RL) but greater than or equal to the method detection limit (MDL) and the concentration is an approximate value.
Except for WUABFFMW01 samples from May 2022 collected by INTERA for ABCWUA, data shown are from 4th quarter 2021 KAFB groundwater monitoring event samples from wells with tops of screens >40 ft below water table at that time. The maximum detection or minimum reporting limit is shown from EPA Method 8011 or EPA Method 8260 analyses or from duplicate samples as applicable.

Figure 5c
Distribution of EDB in Groundwater (Deep)
Albuquerque Bernalillo County Water Utility Authority Data Gap Well WUABFFMW-01 – 2022 Final Report
Bernalillo County, New Mexico, USA

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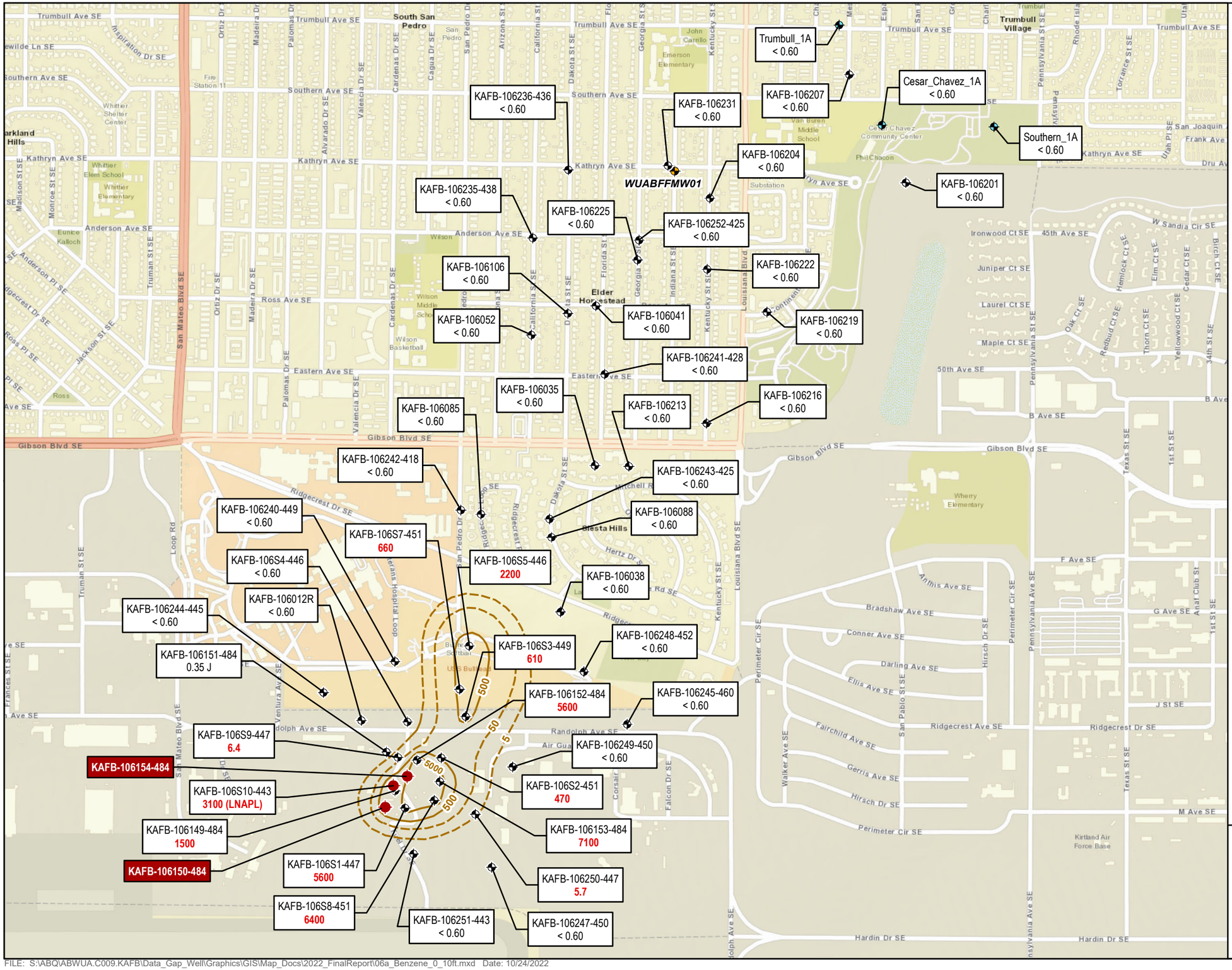


INTERA

N

900 0 900

Feet

Source(s):
Street Map – ESRI online;
Wells – BFF database transmitted by ABCWUA, 9/15/22.and USGS wells from NWIS database, queried 9/29/22

- Monitoring Well
- USGS Sentinel Well
- Well with Measurable LNAPL in 2021 Q4
- Water Authority Data Gap Well
- Benzene Concentration Contour µg/L (dashed where inferred)

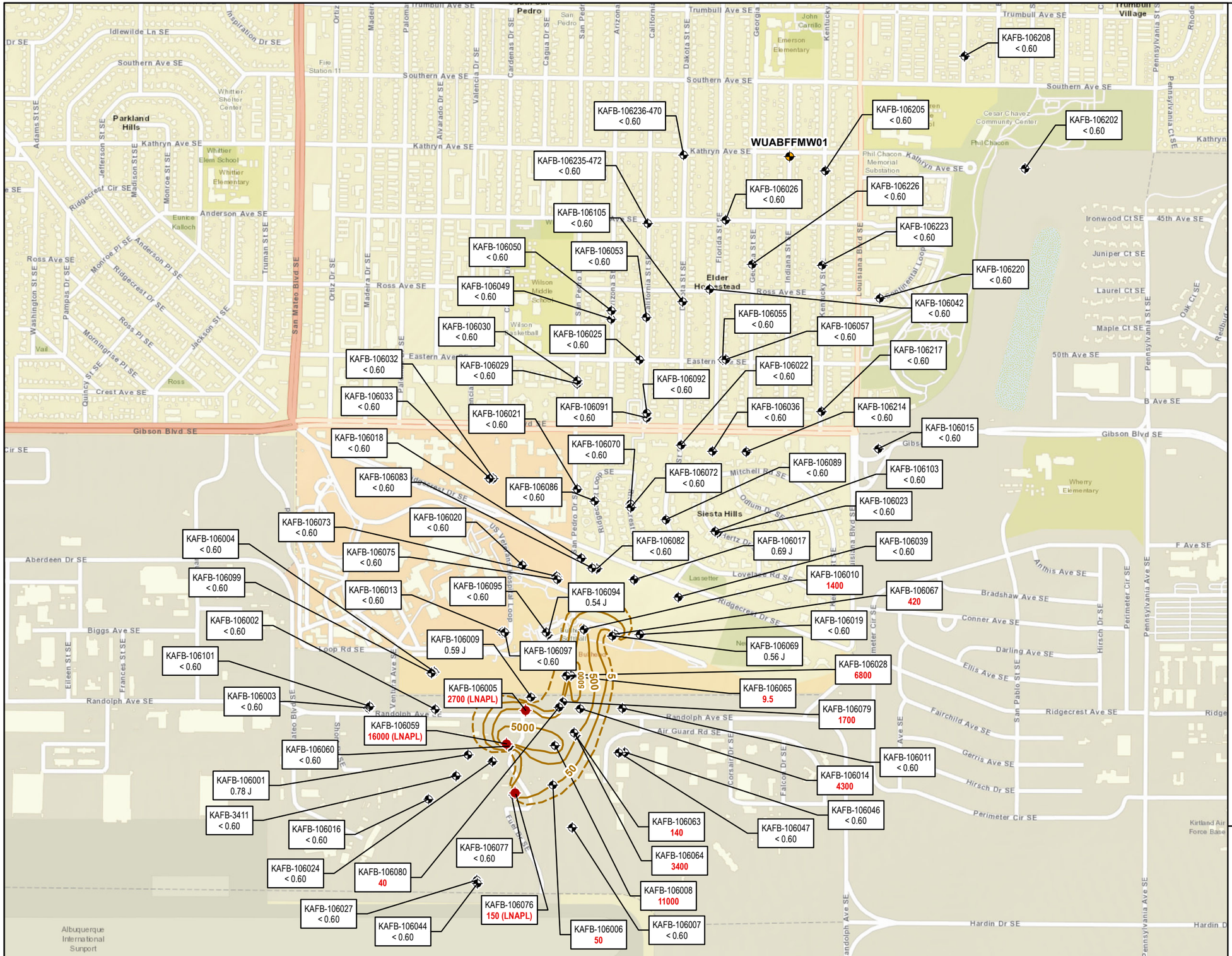
Well ID
Benzene in µg/L

RED/BOLD indicates values or RLs in excess of NMWQCC Standard for Benzene (5 ug/L)

Note(s):
J = Result is less that the Reporting Limit (RL) but greater than or equal to the method detection limit (MDL) and the concentration is an approximate value.
LNAPL = light non-aqueous phase liquid.
Data shown are from 4th quarter 2021 KAFB groundwater monitoring event samples from wells with tops of screens <= 10 ft below water table at that time. The maximum detection or minimum reporting limit is shown from duplicate samples as applicable.

Figure 6a
Distribution of Benzene in Groundwater (Shallow)
Albuquerque Bernalillo County Water Utility Authority Data Gap Well WUABFFMW-01 – 2022 Final Report
Bernalillo County, New Mexico, USA

FILE: S:\ABQ\ABWUA.C009.KAFB\Data_Gap_Well\Graphics\GIS\Map_Docs\2022_FinalReport\06a_Benzene_0_10ft.mxd Date: 10/24/2022



N

900 0 900

Feet

Source(s):
Street Map – ESRI online;
Wells – BFF database transmitted by ABCWUA, 9/15/22.and USGS wells from NWIS database, queried 9/29/22

- Monitoring Well
- Well with Measurable LNAPL in 2021 Q4
- Water Authority Data Gap Well
- Benzene Concentration Contour in µg/L (dashed where inferred)

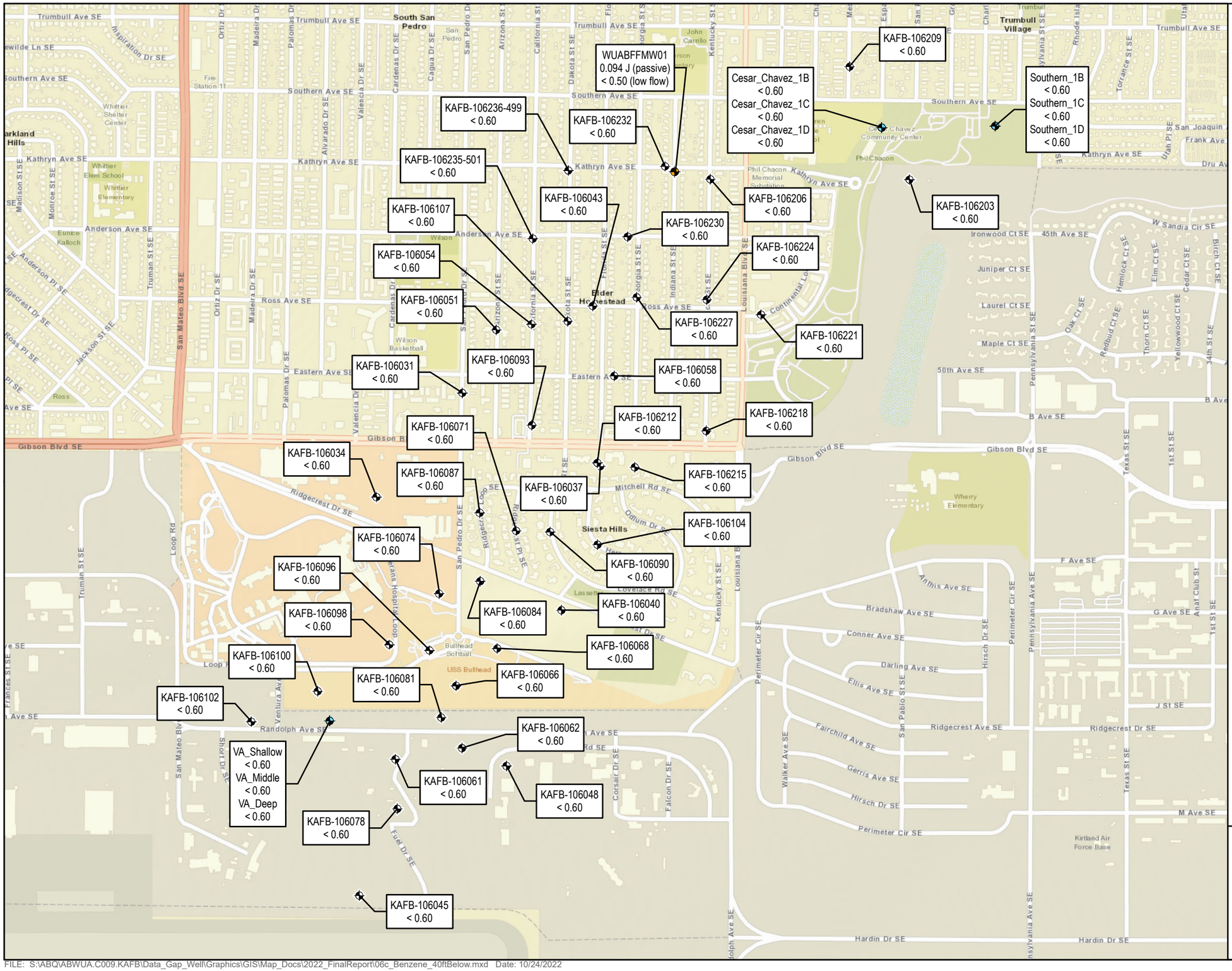
Well ID
Benzene in µg/L

RED/BOLD indicates values or RLs in excess of NMWQCC Standard for Benzene (5 ug/L)

Note(s):
J = Result is less that the Reporting Limit (RL) but greater than or equal to the method detection limit (MDL) and the concentration is an approximate value.
LNAPL = light non-aqueous phase liquid.
Data shown are from 4th quarter 2021 KAFB groundwater monitoring event samples from wells with tops of screens >10 ft and <40 ft below water table at that time. The maximum detection or minimum reporting limit is shown from duplicate samples as applicable.

Figure 6b
Distribution of Benzene in Groundwater (Intermediate)
Albuquerque Bernalillo County Water Utility Authority Data Gap Well WUABFFMW-01 – 2022 Final Report
Bernalillo County, New Mexico, USA

FILE: S:\ABQ\ABWUA.C009.KAFB\Data_Gap_Well\Graphics\GIS\Map_Docs\2022_FinalReport\06b_Benzene_10_40ft.mxd Date: 10/24/2022



Source(s):
Street Map – ESRI online;
Wells – BFF database transmitted by ABCWUA, 9/15/22.and USGS wells from NWIS database, queried 9/29/22

- Monitoring Well
- USGS Sentinel Well
- Water Authority Data Gap Well

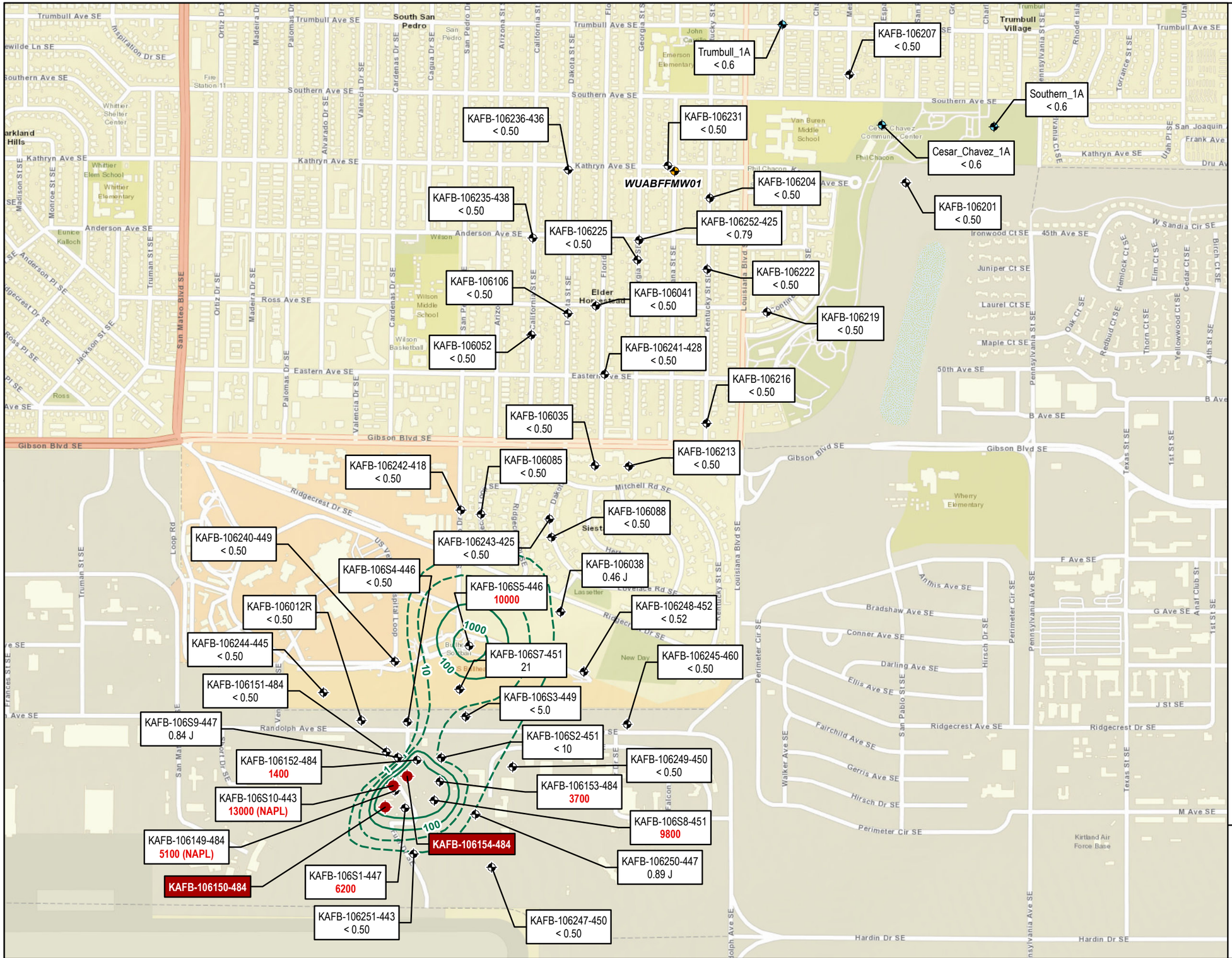
Well ID
Benzene in µg/L

RED/BOLD indicates values or RLs in excess of NMWQCC Standard for Benzene (5 ug/L)

Note(s):
J - Result is less that the Reporting Limit (RL) but greater than or equal to the method detection limit (MDL) and the concentration is an approximate value.
Except for WUABFFMW01 samples from May 2022 collected by INTERA for ABCWUA, data shown are from 4th quarter 2021 KAFB groundwater monitoring event samples from wells with tops of screens >40 ft below water table at that time. The maximum detection or minimum reporting limit is shown from duplicate samples as applicable.

Figure 6c
Distribution of Benzene in Groundwater (Deep)
Albuquerque Bernalillo County Water Utility Authority Data Gap Well WUABFFMW-01 – 2022 Final Report
Bernalillo County, New Mexico, USA

FILE: S:\ABQ\ABWUA.C009.KAFB\Data_Gap_Well\Graphics\GIS\Map_Docs\2022_FinalReport\06c_Benzene_40ftBelow.mxd Date: 10/24/2022



Source(s):
Street Map – ESRI online;
Wells – BFF database transmitted by ABCWUA, 9/15/22.and USGS wells from NWIS database, queried 9/29/22

- Monitoring Well
- USGS Sentinel Well
- Well with Measurable LNAPL in 2021 Q4
- Water Authority Data Gap Well
- Toluene Concentration Contour µg/L (dashed where inferred)

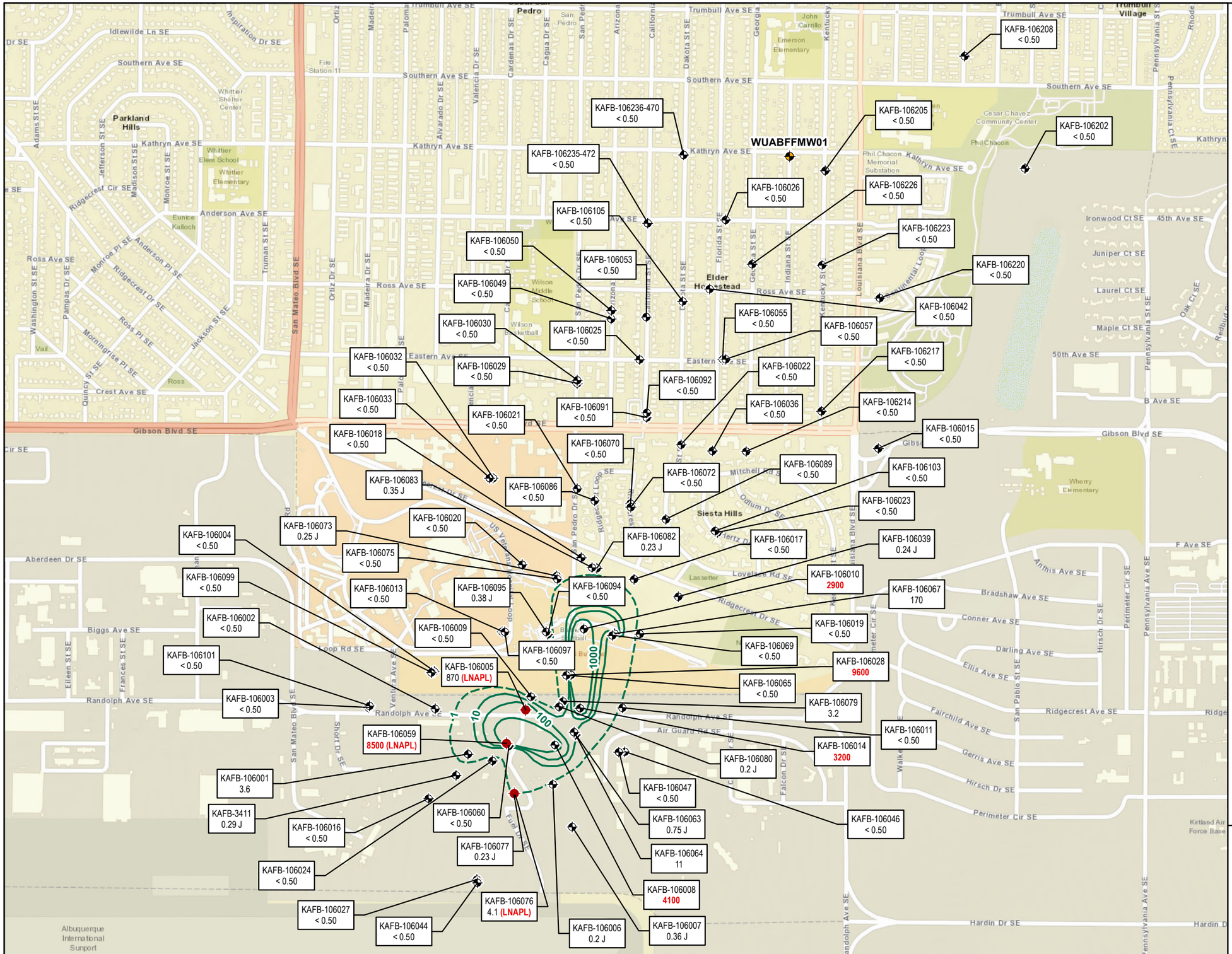
Well ID
Toluene in µg/L

RED/BOLD indicates values or RLs in excess of NMWQCC Standard for toluene (1,000 ug/L)

Note(s):
J = Result is less that the Reporting Limit (RL) but greater than or equal to the method detection limit (MDL) and the concentration is an approximate value.
LNAPL = light non-aqueous phase liquid.
Data shown are from 4th quarter 2021 KAFB groundwater monitoring event samples from wells with tops of screens <= 10 ft below water table at that time. The maximum detection or minimum reporting limit is shown from duplicate samples as applicable.

Figure 7a
Distribution of Toluene in Groundwater (Shallow)
Albuquerque Bernalillo County Water Utility Authority Data Gap Well WUABFFMW-01 – 2022 Final Report
Bernalillo County, New Mexico, USA

FILE: S:\ABQ\ABWUA.C009.KAFB\Data_Gap_Well\Graphics\GIS\Map_Docs\2022_FinalReport\07a_Toluene_0_10ft.mxd Date: 10/24/2022



FILE: S:\ABQ\ABWUA.C009.KAFB\Data_Gap_Well\Graphics\GIS\Map_Docs\2022_FinalReport\07b_Toluene_10_40ft.mxd Date: 10/24/2022

INTERA

N

900 0 900

Feet

Source(s):
Street Map – ESRI online;
Wells – BFF database transmitted by ABCWUA, 9/15/22.and USGS wells from NWIS database, queried 9/29/22

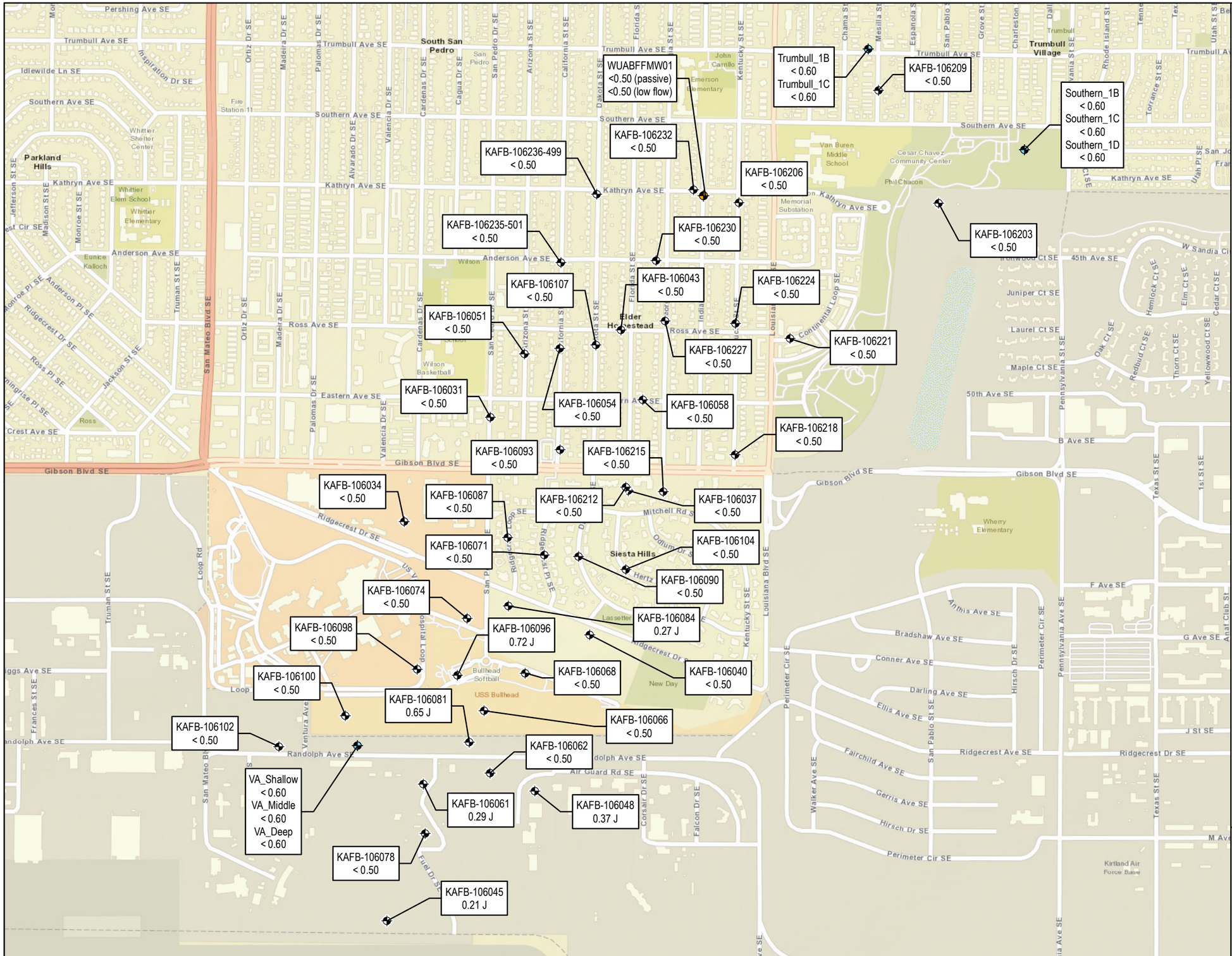
- Monitoring Well
- Well with Measurable LNAPL in 2021 Q4
- Water Authority Data Gap Well
- Toluene Concentration Contour (2021 Q4) µg/L (dashed where inferred)

Well ID
Toluene in µg/L

RED/BOLD indicates values or RLs in excess of NMWQCC Standard for Toluene (1,000 ug/L)

Note(s):
J = Result is less that the Reporting Limit (RL) but greater than or equal to the method detection limit (MDL) and the concentration is an approximate value.
LNAPL = light non-aqueous phase liquid.
Data shown are from 4th quarter 2021 KAFB groundwater monitoring event samples from wells with tops of screens >10 ft and <40 ft below water table at that time. The maximum detection or minimum reporting limit is shown from duplicate samples as applicable.

Figure 7b
Distribution of Toluene in Groundwater (Intermediate)
Albuquerque Bernalillo County Water Utility Authority Data Gap Well WUABFFMW-01 – 2022 Final Report
Bernalillo County, New Mexico, USA



Source(s):
Street Map – ESRI online;
Wells – BFF database transmitted by ABCWUA, 9/15/22.and USGS wells from NWIS database, queried 9/29/22

- Monitoring Well
- USGS Sentinel Well
- Water Authority Data Gap Well

Well ID
Toluene in µg/L

RED/BOLD indicates values or RLs in excess of NMWQCC Standard for Toluene (1,000 ug/L)

Note(s):
J = Result is less that the Reporting Limit (RL) but greater than or equal to the method detection limit (MDL) and the concentration is an approximate value.
Except for WUABFFMW01 samples from May 2022 collected by INTERA for ABCWUA, data shown are from 4th quarter 2021 KAFB groundwater monitoring event samples from wells with tops of screens >40 ft below water tableat that time. The maximum detection or minimum reporting limit is shown from duplicate samples as applicable.
WUABFFMW01 May 2022 toluene results shown as <0.50 based on third-party data validator qualification of reported low detections due to equipment blank detections.

Figure 7c
Distribution of Toluene in Groundwater (Deep)
Albuquerque Bernalillo County Water Utility Authority Data Gap Well WUABFFMW-01 – 2022 Final Report
Bernalillo County, New Mexico, USA

FILE: S:\ABQ\ABWUA.C009.KAFB\Data_Gap_Well\Graphics\GIS\Map_Docs\2022_FinalReport\07c_Toluene_40ftBelow.mxd Date: 5/12/2023

Tables

TABLE 1
Well Construction Details
Final Report for Data Gap Well WUABFFMW01
ABCWUA
Kirtland Air Force Base Bulk Fuels Facility
Albuquerque, New Mexico

Monitoring Well ID	Top of Casing Elevation[1] (ft NAVD88)	Diameter (inches)	Screen Interval (ft bgs)	Total Depth (ft bgs)	Comments
WUABFFMW01	5328.542	3	572-592	597.10	Flush-mount completion. SW Corner of Intersection of Kathryn Avenue and Indiana Street. SCH 80 PVC/Slot Size 0.020-inch/Locking Cap/In-Situ Level TROLL 700 transducer in place. Installed using SONIC Coring methods.

Notes:

bgs = below ground surface.

ft = feet.

NAVD88 = North American Vertical Datum of 1988.

[1]= The well was surveyed on May 26, 2022, by High Mesa Consulting Group.

TABLE 2
Fluid Level Measurements
Final Report for Data Gap Well WUABFFMW01
ABCWUA
Kirtland Air Force Base Bulk Fuels Facility
Albuquerque, New Mexico

Well ID	Date	Screen Interval (ft bgs)	Top of Casing Elevation (ft NAVD88)	Depth to Product (ft btoc)	Depth to Water (ft btoc)	Product Thickness (ft)	Total Depth (ft btoc)	Water Column Height (ft)	Potentiometric Surface Elevation (ft NAVD88)[1]
WUABFFMW01	4/27/2022	572-592	5328.54	NP	453.03	0.00	597.10	144.07	4875.51
	5/25/2022	572-592	5328.54	NP	452.89	0.00	597.10	144.21	4875.65
	6/10/2022	572-592	5328.54	NP	452.75	0.00	597.10	144.35	4875.79
	7/8/2022	572-592	5328.54	NP	453.81	0.00	597.10	143.29	4874.73
	8/9/2022	572-592	5328.54	NP	455.21	0.00	597.10	141.89	4873.33
	8/29/2022	572-592	5328.54	NP	455.63	0.00	597.10	141.47	4872.91
	9/7/2022	572-592	5328.54	NP	456.01	0.00	597.10	141.09	4872.53

Notes:

Manual measurements shown; pressure transducer data provided separately.

[1] = Value calculated from: Potentiometric Surface Elevation = (Top of Casing Elevation - Depth to Water).

bgs = below ground surface.

btoc = below top of casing.

ft = feet.

NAVD88 = North American Vertical Datum of 1988.

NP = none present (no measureable thickness >0.01 ft).

TABLE 3
Groundwater Quality Parameters
Final Report for Data Gap Well WUABFFMW01
ABCWUA
Kirtland Air Force Base Bulk Fuels Facility
Albuquerque, New Mexico

Well ID	Date	Temperature		Specific Conductivity (µS/cm)	pH	Turbidity (NTU)
		°C	°F			
WUABFFMW01	5/24/2022*	17.8	64.0	327.2	7.64	-
	5/27/2022**	23.0	73.4	307.0	7.85	0.72
	8/29/2022*	30.4	86.7	358.9	7.61	-
	8/31/2022**	21.9	71.4	324.7	7.76	0.48

Notes:

*Passive Diffusion Bag Sampling Event.

**Bennett Pump Low-Flow Purge Sampling Event.
°C = degrees Celsius.

°F = degrees Fahrenheit.

µS/cm = microSiemens per centimeter.

NTU= nephelometric turbidity unit.

"-" = Not collected.

TABLE 4
Laboratory Analytical Results - Groundwater
Final Report for Data Gap Well WUABFFMW01
ABCWUA
Kirtland Air Force Base Bulk Fuels Facility
Albuquerque, New Mexico

Sample ID	Date	Organics[1,2,3,4]								Inorganics[5,6]								Dissolved Metals[6]	
		1,2-Dibromoethane (EDB)[1]	Benzene[2]	Toluene[2]	Ethylbenzene[2]	Total Xylenes[2]	BTEX[3]	2-Butanone (MEK)[2]	Bis(2-ethylhexyl) phthalate (DEHP)[4]	Bromide[5]	Chloride[5]	Sulfate[5]	Total Alkalinity[5]	Calcium[6]	Magnesium[6]	Potassium[6]	Sodium[6]	Iron[6]	Manganese[6]
Units		µg/L								mg/L									
EPA MCL		**0.05**	**5**	**1000**	**700**	**10,000**	**NS**	**NS**	**6**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
EPA RSL		**0.075**	**4.6**	**1100**	**15**	**190**	**NS**	**5600**	**5.6**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**14**	**0.43**
NMWQCC Standard		**0.05**	**5**	**1000**	**700**	**620**	**NS**	**NS**	**NS**	**NS**	**250**	**600**	**NS**	**NS**	**NS**	**NS**	**NS**	**1.0**	**0.2**
KAFB BFF PSL		**0.05**	**5**	**1000**	**700**	**620**	**NS**	**5600**	**6**	**NS**	**250**	**600**	**NS**	**NS**	**NS**	**NS**	**NS**	**1.0**	**0.2**
WUABFFMW01	5/24/2022*	<0.0037	0.094 J	0.26 J U*	<0.084	<0.27	0.354 J	0.47 J U*	1.3 J	0.18 J	12	26	120	33	4.4	2.8	25 B	0.13	0.17
	5/27/2022**	<0.0037	<0.24	0.47 J U*	<0.30	<0.49	0.47 J	<4.5	<1.1	0.18 J	11	34	120	32	4.2	2.7	27 B	0.16	**0.28**
	8/29/2022*	<0.015	<0.080	0.19 J U*	<0.084	<0.27	0.19 J	<0.33	1.6 J	0.24 J	17	35	130 H	28	3.8	2.8	36	0.032 J	**0.53**
	8/31/2022**	<0.015	<0.080	0.099 J U*	<0.084	<0.27	0.099 J	<0.33	<1.0	0.18 J	9.7	29	120 H	29	3.9	2.7	28	0.12	**0.43**

Notes:

Bolding indicates values or RLs in excess of KAFB BFF PSLs = more stringent of EPA MCL or NMWQCC Standard, or EPA RSL if analyte has no MCL or NMWQCC Standard.

NS = No standard/screening level.

Selected analytes listed include EDB, BTEX compounds, and analytes detected in at least one environmental sample. See laboratory report for all non-detected analytes.

[1] = EDB analyzed by U.S. Environmental Protection Agency (EPA) Method 8011.

[2] = Volatile organic compounds analyzed by EPA Method 8260B.

[3] = BTEX includes sum of benzene, toluene, ethylbenzene, and total xylenes detections (non-detections < method detection limit [MDL] are assumed to be 0) or sum of MDLs when no individual analytes are detected.

[4] = Semivolatile organic compounds analyzed by EPA Method 8270C.

[5] = Anions analyzed by EPA Method 300.0 and total alkalinity analyzed by Standard Method 2320B.

[6] = Cations/dissolved metals analyzed by EPA Method 6010B.

*Passive Diffusion Bag Sampling Event.

**Bennett Pump Low-Flow Purge Sampling Event.

µg/L = microgram(s) per liter.

mg/L= milligram(s) per liter.

B - The analyte was detected in the associated method blank and the concentration is an approximate value.

J - Result is less than the Reporting Limit (RL) but greater than or equal to the method detection limit (MDL) and the concentration is an approximate value.

H - Sample was prepped or analyzed beyond the specified holding time.

U* - Detections reported by the laboratory were qualified as non-detections below reporting limits (<0.50 µg/L for toluene and <2.0 µg/L for 2-butanone) based on data validation.

BTEX = benzene, toluene, ethylbenzene, and total xylenes.

EDB = 1,2-dibromoethane, also known as ethylene dibromide.

EPA MCL = maximum contaminant level as defined by the EPA.

EPA RSL = regional screening levels as defined by the EPA.

NMWQCC Standard = Groundwater Standards as defined by the State of New Mexico Water Quality Control Commission (NMWQCC, December 2018).

KAFB BFF PSL = Kirtland Air Force Base Bulk Fuel Facility Project Screening Level