The Kirtland Bulk Fuels Facility Leak: A Conceptual Model

N 0 250 500 1,000 Feet

Legend

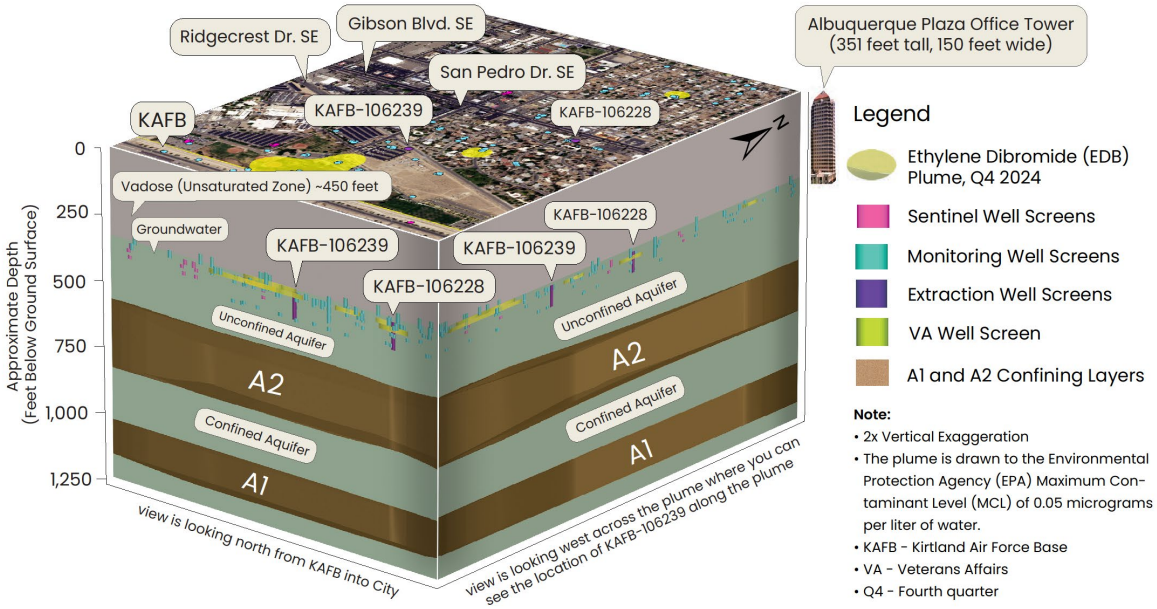
- Sentinel Wells
- Monitoring Wells
- Extraction Wells (KAFB-106239 & KAFB-106228)
- Ethylene Dibromide (EDB) Q4 2024 Plume (at reference elevation interval 4857)
- Kirtland AFB

Note:
- VA Well location not shown.
- The plume is drawn to the Environmental Protection Agency (EPA) Maximum Contaminant Level (MCL) of 0.05 micrograms per liter of water. Plume data from Q4 2024

Key Elements to Monitor and Protect Our Water Supply

- VA drinking water is sampled on a monthly basis since March 2006 to present. No EDB contamination has been detected in any monthly drinking water sample. All sample results have met drinking water standards.
- Sentinel wells, installed between 2014 – 2016, are located between the plume and the VA drinking water well to provide an "early warning system." No EDB contamination has been detected in any quarterly water sample. All sample results have met drinking water standards.
- Monitoring wells between the plume and the VA drinking water well are sampled multiple times each year and are used to identify horizontal and vertical plume boundaries.
- Groundwater flow is generally to the east, away from the VA drinking water well.
- A2 and A1 are "confining layers" of soil in deep groundwater. These layers provide a natural barrier for drinking water wells that are screened below these non-permeable layers.

Note: Block diagram (below) is represented in 2x exaggeration to help show plume thickness.

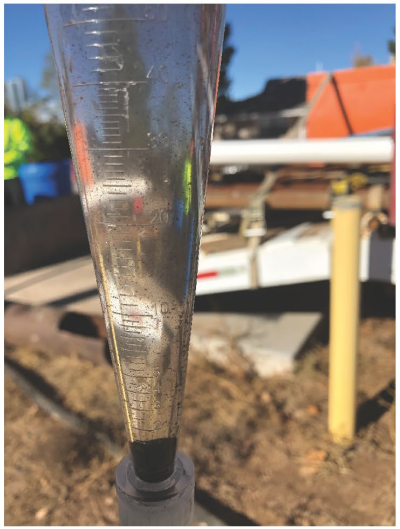


Note:
- 2x Vertical Exaggeration
- The plume is drawn to the Environmental Protection Agency (EPA) Maximum Contaminant Level (MCL) of 0.05 micrograms per liter of water.
- KAFB - Kirtland Air Force Base
- VA - Veterans Affairs
- Q4 - Fourth quarter

• Draft image will be finalized in the Q4 2024 Periodic Monitoring Report to be submitted no later than May 31, 2025.

Recent Field Work

Extraction well KAFB-106239 turbidity after initial three bails



Extraction well KAFB-106239 final turbidity

Passive samplers wedged in KAFB-106S2 (photo from downhole camera)

Passive samplers successfully removed

Golf course main pond tumbleweed removal

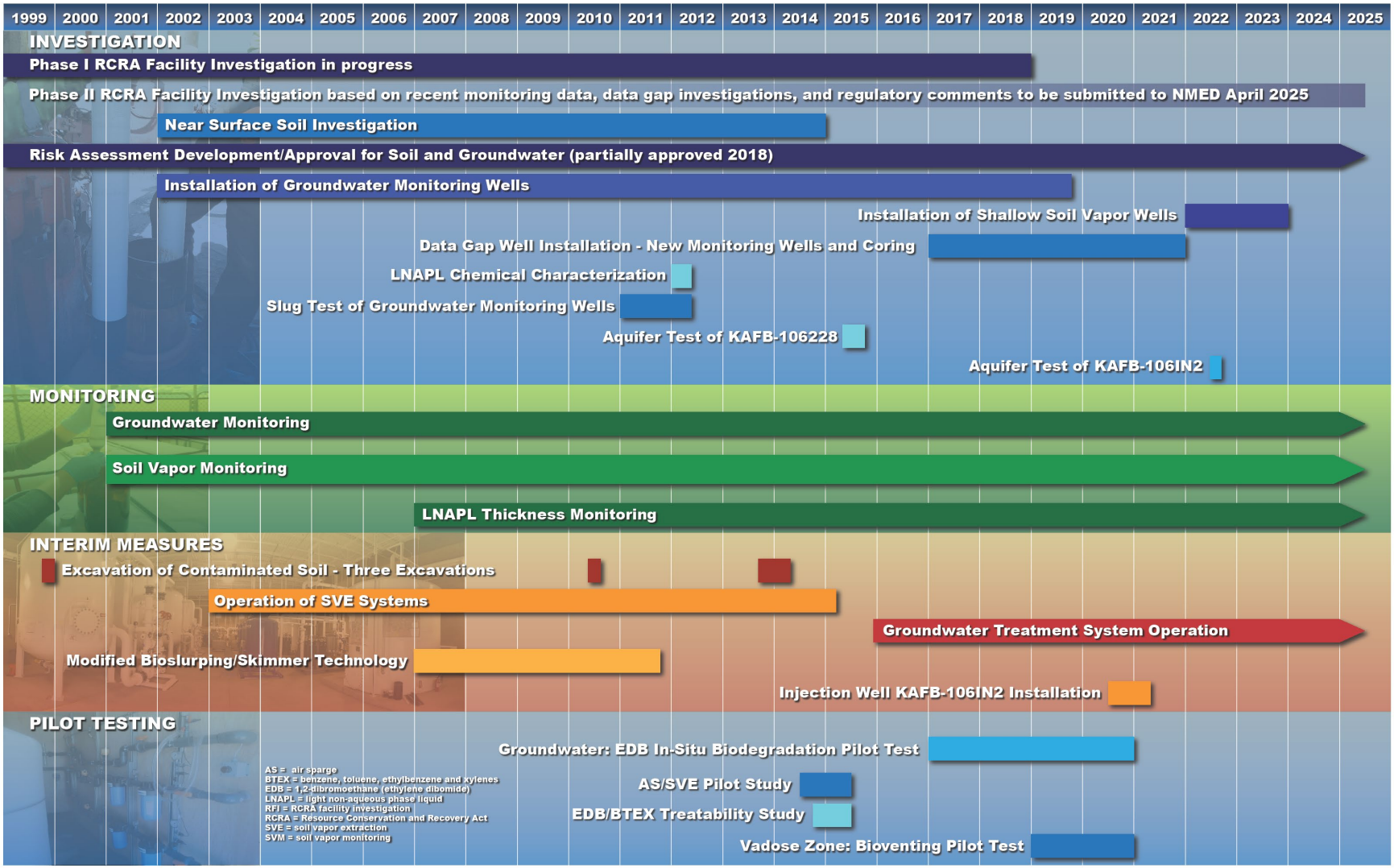
KAFB-106024 failed pump removal

Extraction well KAFB-106239 rehabilitation

Removing the failed pump in KAFB-106024

Q2 gauging well

Site Activity Timeline



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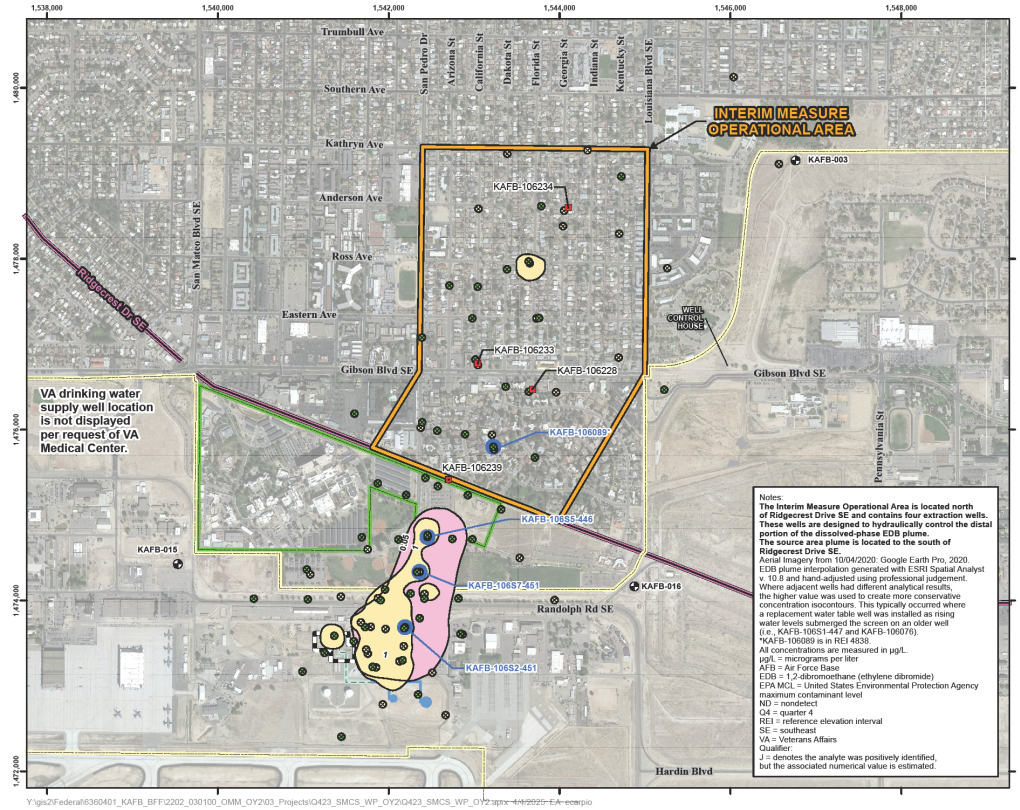
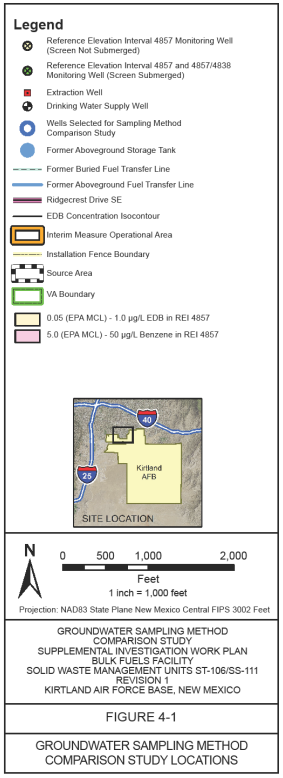
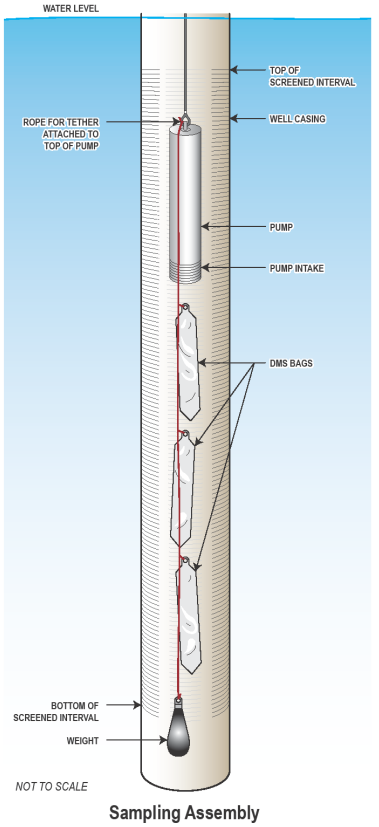
Sampling Comparison Study

- In February 2024, NMED requested an additional study to compare the analytical data trends from samples collected using passive and low-flow sampling methods
- KAFB submitted Supplemental Investigation Workplan to NMED in March 2025
- Will be implemented to compare trends between passive and active groundwater sampling methodologies
- groundwater samples will be collected concurrently from KAFB-106S2-451, KAFB-106S5-446, KAFB-106S7-451, and KAFB-106089 using both low-flow and passive sampling methods
- ASTM International (ASTM) D7929-20 Standard Guide for the Selection of Passive Techniques for Sampling Groundwater Monitoring Wells provides recommendations on conducting a field comparison test
- The analytical data obtained from this sampling method comparison study will be used to confirm trends between passive and low-flow sampling methods at the BFF Site

ASTM D7929-20 Section X3.1.1 Procedure	Supplemental Investigation Work Plan Section 5.4 Procedure	Variation
Passive sampler and pump deployed	Passive sampler and pump deployed simultaneously	No difference.
Passive sampler is fully submerged and left in the well for the proper equilibration period prior to sampling	Passive sampler is fully submerged and left in the well for the proper equilibration period prior to sampling (at least 14 days)	No difference.
Samples collected from the same depth	Passive samples collected below the pump inlet depth	Due to the well casing diameter, the pump and passive samplers cannot be placed at the same depth at the same time. Passive samplers will be hung 0.2 feet below the pump, minimizing the difference in depth.
Avoid distubance to the water column when removing the passive sampler	Low-flow sample collected prior to passive sample to minimize disturbance to the water column	Due to the depth to groundwater at this site (approximately 450 ft bgs), it is difficult to install or remove equipment without significantly disturbing the water column. To eliminate the risk of disturbing the water column, the entire sampling assembly will be installed prior to the passive sampling equilibration time, and will not be removed until after low-flow sampling is complete.
Collect passive sample prior to pumped sample	Low-flow sample collected prior to passive sample	Because the passive samplers will be hung below the pump, they cannot be retrieved without also removing the pump. To minimize disturbance to the water column, low-flow samples will be collected first and then the entire sampling assembly will be retrieved to collect passive samples.







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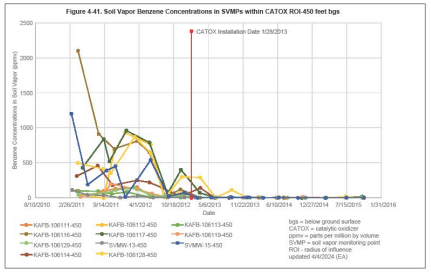
Soil Vapor Extraction (SVE) and Vadose Zone Interim Measure (IM) Summary

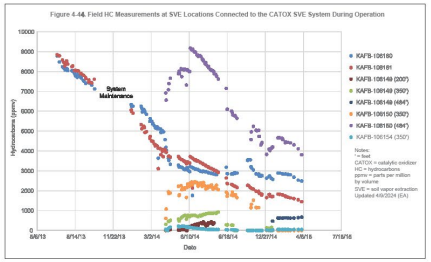
Several forms of IM performed between (2003-2015)

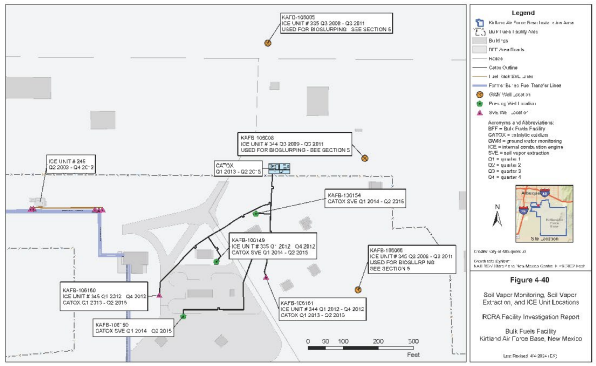
- Internal combustion engine (2003-2012; targeted where fuel was released)
- Skimmer pumps (2007-2008; following the first discovery of fuel at the water table in 2007; 280 gallons removed)
- Modified Bioslurping (2008-2011; targeted fuel at the water table)
- Catalytic oxidizer (2013-2015; utilized five SVE wells across vadose zone)
- 567,050 equivalent gallons of fuel removed from vadose zone through bioslurping and SVE
- 209,000 gallons of fuel biodegraded due to SVE operation
- On October 21, 2015, during a technical working group meeting attended by Air Force, NMED, and other stakeholders, it was decided to deactivate the CATOX SVE due to low vapor recovery and high supplemental fuel consumption
- Since SVE shutdown, semi-annual soil vapor monitoring has been conducted to define the nature and extent of soil vapor contamination under steady-state conditions
- SVE technologies will be evaluated in the CME Phase

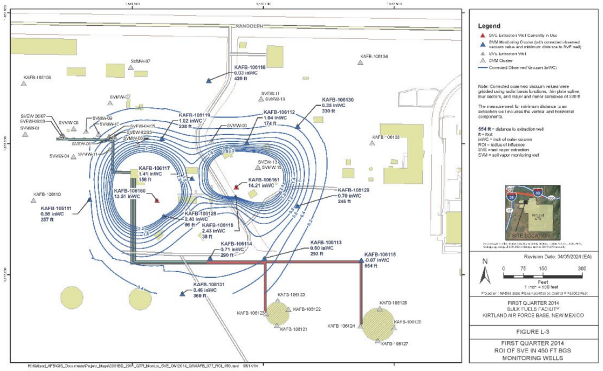
Approximately 775,000 equivalent gallons of fuel removed due to SVE, skimmer pump, and bioslurping.

The results of this interim measure will be evaluated during the corrective measures evaluation to determine the feasibility of this remedial technology for full scale implementation.









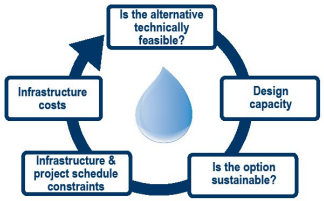
Treated Effluent Disposition Locations

Treated effluent quantities discharged as of 3/25/2025:

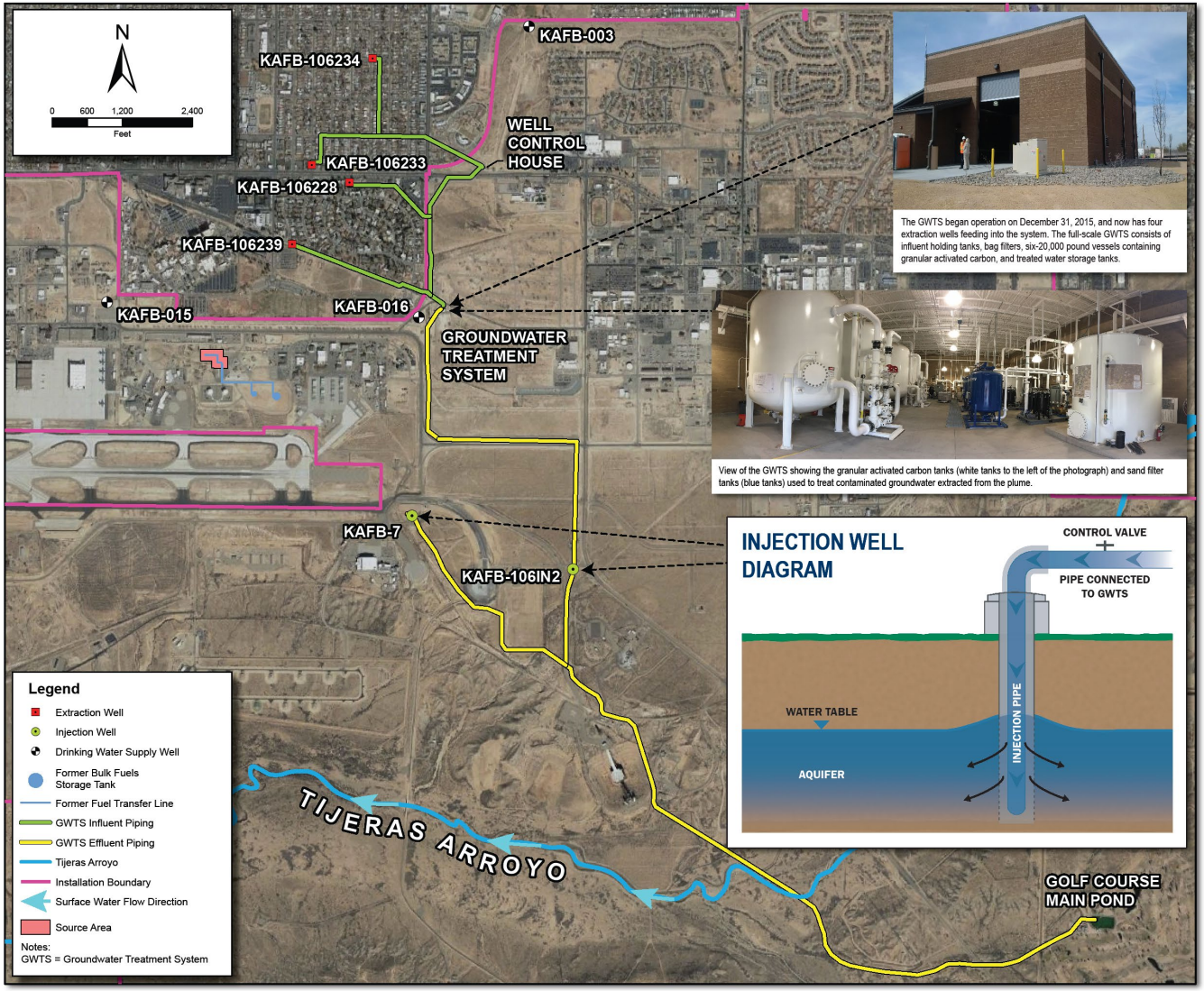
- 2,184,377,600 total gallons treated
- 1,228,939,464 treated gallons discharged to Golf Course Main Pond
- 621,325,035 treated gallons discharged to KAFB-007
- 334,113,100 treated gallons discharged to KAFB-106IN2

BENEFICIAL USE OF TREATED WATER

Different options (e.g., infiltration galleries, surface application such as irrigation, retention ponds, injection, etc.) were considered for discharging water treated from the full-scale groundwater treatment facility. These options were evaluated using the beneficial reuse criteria below.

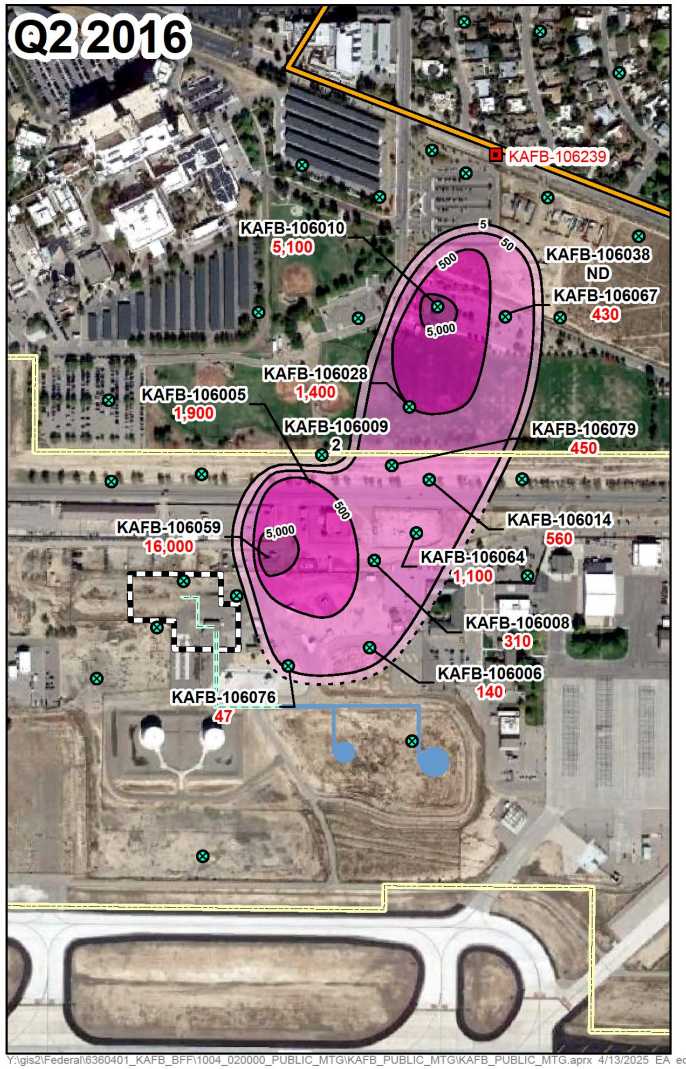


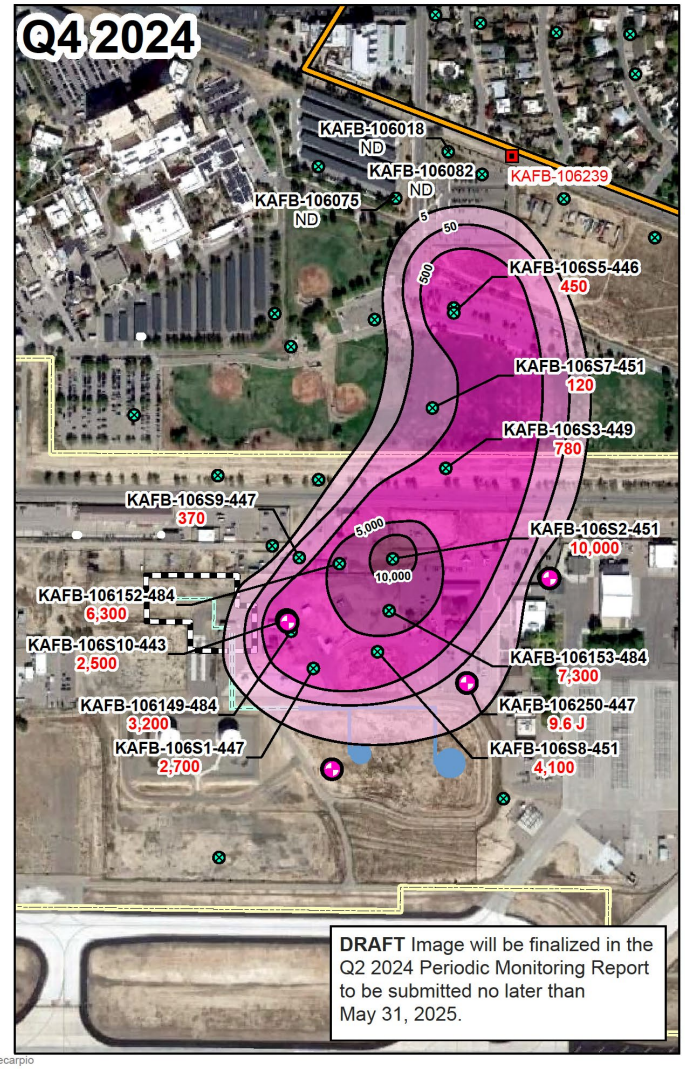
Based on evaluation, which included an understanding of how water moves through soil, two options were identified as viable methods for discharging treated water: 1.) use of the Kirtland AFB Golf Course pond to hold water for irrigation use on the golf course and 2.) use of a gravity-fed well to inject water into the aquifer.



Benzene Plume Footprint (over time)

Comparison of Benzene in the Interim Measure Operational Area Between Q2 2015 and Q4 2024





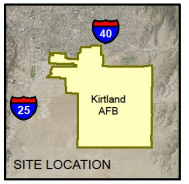
Legend

- Groundwater Monitoring Well (174 wells total)
- Extraction Well
- Newly Installed Well
- Former Aboveground Storage Tank
- Former Buried Fuel Transfer Line
- Former Aboveground Fuel Transfer Line
- Benzene Concentration Isocontour (µg/L) (dashed where inferred)
- Interim Measure Operational Area
- Installation Fence Boundary
- Source Area

Measured Benzene Concentration Range

- 5.0 (EPA MCL) - 50 µg/L
- 50 - 500 µg/L
- 500 - 5,000 µg/L
- 5,000 - 10,000 µg/L
- > 10,000 µg/L

Notes:
Bold and red = reported concentrations exceed the project screening level (benzene > 5.0 µg/L).
Bold = analyte was detected at this location.
Plumes depicted are at the water table, not REI.
* Well is no longer at water table.
Unlabeled wells are non-detect for benzene.
J = denotes the analyte was positively identified, but the associated numerical value is estimated.
Acronyms:
µg/L = micrograms per liter
EPA MCL = United States Environmental Protection Agency maximum contaminant level
ft = foot/feet
NA = not analyzed
ND = nondetect
Q2 = quarter 2
Q4 = quarter 4
REI = reference elevation interval



N

0 250 500 1,000
Feet

1:6,000

Projection: NAD83 State Plane New Mexico Central FIPS3002 Feet

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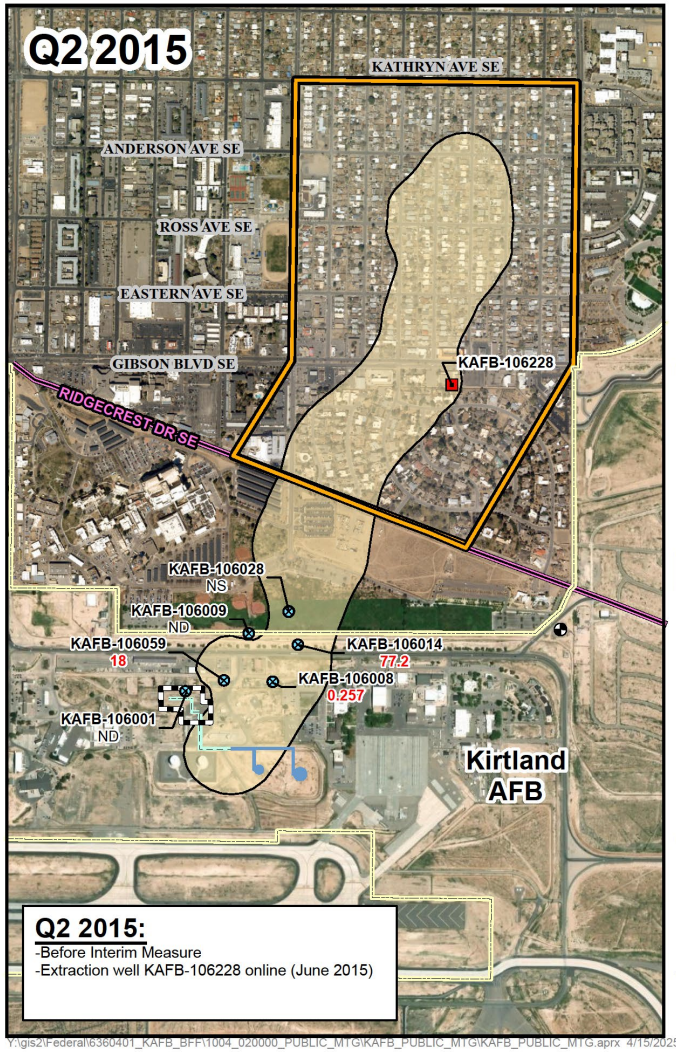
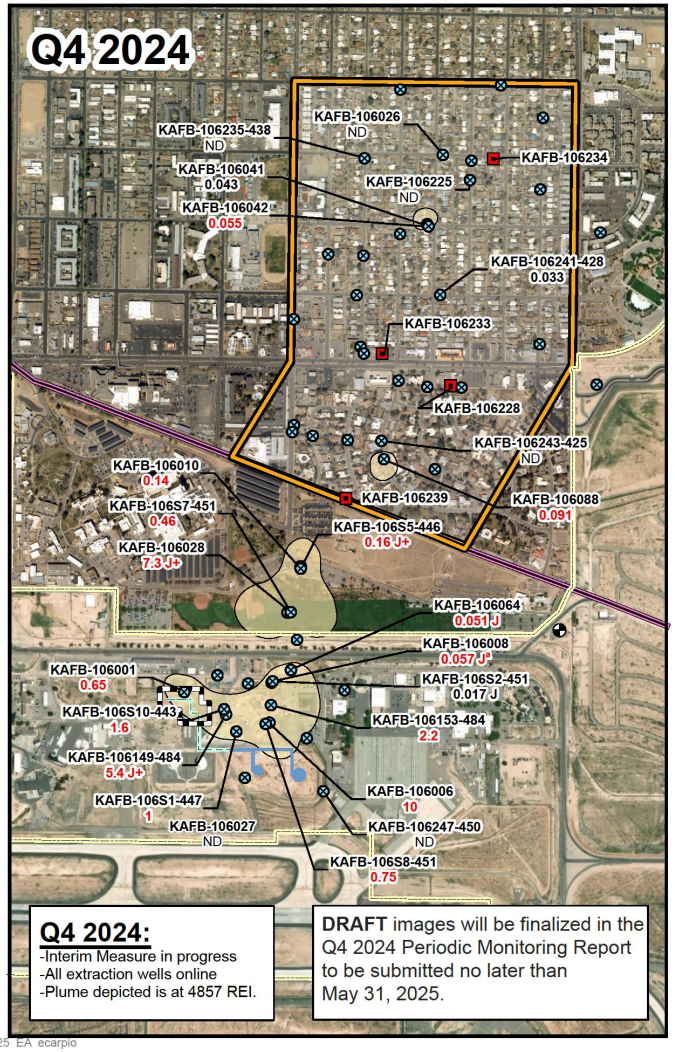
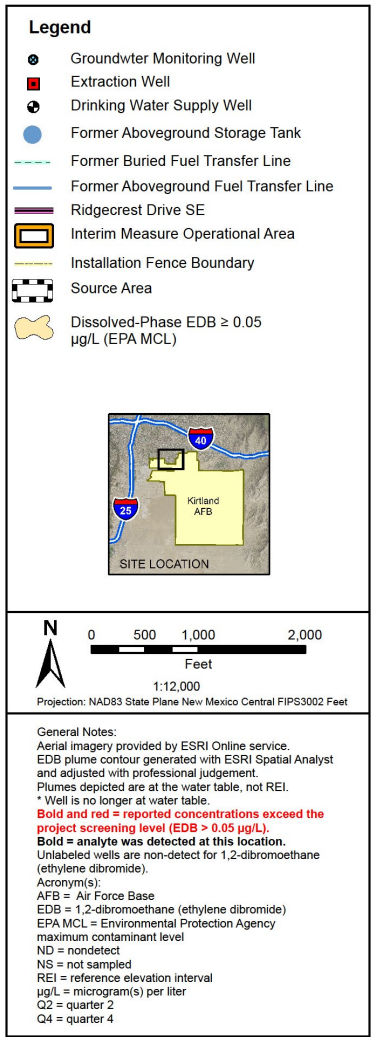
EDB Plume Footprint (over time)

Comparison of Dissolved-Phase EDB in the Interim Measure Operational Area Between Q2 2015 and Q4 2024







General Notes:
Aerial imagery provided by ESRI Online service.
EDB plume contour generated with ESRI Spatial Analyst and adjusted with professional judgement.
Plumes depicted are at the water table, not REI.
* Well is no longer at water table.
Bold and red = reported concentrations exceed the project screening level (EDB > 0.05 µg/L).
Bold = analyte was detected at this location.
Unlabeled wells are non-detect for 1,2-dibromoethane (ethylene dibromide).
Acronym(s):
AFB = Air Force Base
EDB = 1,2-dibromoethane (ethylene dibromide)
EPA MCL = Environmental Protection Agency maximum contaminant level
ND = nondetect
NS = not sampled
REI = reference elevation interval
µg/L = microgram(s) per liter
Q2 = quarter 2
Q4 = quarter 4

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Groundwater Standards for clean-up at the Bulk Fuels Facility Project

New Mexico Environment Department (NMED) Promulgated Standard for Groundwater Cleanup

- NMED regulates groundwater at Kirtland AFB with the Resource Conservation and Recovery Act Permit:
- The Permit requires the cleanup levels for groundwater shall be the New Mexico Water Quality Control Commission (WQCC) water quality standards and the drinking water Maximum Contaminant Levels (MCLs) adopted by Environmental Protection Agency (EPA) under the Federal Safe Drinking Water Act.
- If both a WQCC standard and a MCL have been established for a contaminant, then the most stringent of the two levels shall be the cleanup level for that contaminant."

Uses of the Safe Drinking Water Act standard (MCLs)

- Drinking water, including bottled water, may reasonably be expected to contain at least small amounts of some contaminants. Thus, MCLs are used locally and nationally to ensure that tap water is safe to drink. MCLs limit the amount of certain contaminants in water provided by public water systems.
- MCL uses for restoration (clean-up) activities
  - Delineate the groundwater contamination: show the entire area of groundwater that is at or above the Safe Drinking Water Act Standard
  - Objectively quantify risk to drinking water supply
  - Target contamination above these standards with remedial technologies
  - Demonstrate if a site can be clean closed or requires additional corrective actions

Phase II Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) Report to be Submitted to NMED on April 30, 2025

PHASE II RFI REPORT OBJECTIVES

- Conclude the investigation phase by refining the nature and extent of contaminants of potential concern (COPCs) to the degree necessary to evaluate remedies in a Corrective Measures Evaluation (CME).
- Address the two data gaps detailed in the Phase I RFI Report (2018):
  - *Light non-aqueous phase liquid (LNAPL): Due to the rising groundwater levels, it is unclear how much and where the LNAPL remains vertically smeared beneath the water table, how weathered the existing LNAPL is, and how that may be contributing to the dissolved contamination in the groundwater.*
  - *Groundwater: Changes in dissolved-phase concentrations and apparent configuration could be influenced by the rising water table...*

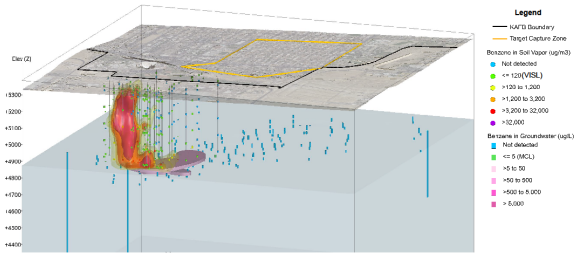
PHASE II RFI REPORT CONCLUSIONS

- Phase I RFI Data Gaps Addressed:
  - LNAPL addressed with eight years of soil vapor monitoring (SVM), and groundwater monitoring (GWM), results of 10 soil corings in source area, and 32 LNAPL gauging events
  - Shallow Groundwater: addressed with 22 shallow groundwater monitoring wells installed; continued refinement with 2 additional proposed monitoring wells
- Phase II RFI supports the Phase I RFI evaluations/conclusions. Nature and extent of groundwater and soil vapor COPCs were refined since the Phase I RFI Report with:
  - 23 newly installed nested groundwater monitoring wells (GWMWs)
  - 11 newly installed nested soil vapor monitoring wells (SVMWs)
  - 32 GWM events and 18 SVM events were conducted and presented in the Phase II RFI Report
- Phase II RFI updated conceptual site model and is consistent with Phase I RFI conceptual site model

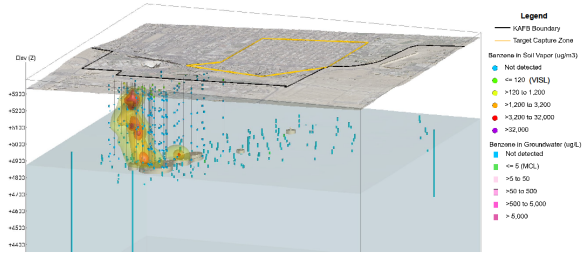
PHASE II RFI REPORT RECOMMENDATIONS

1. Continue GWM and SVM and the groundwater treatment system interim measure to control the migration of the dissolved-phase contaminant plume.
2. Collect and analyze additional LNAPL samples when sufficient quantities are present.
3. Install additional step-out wells as needed in the future due to changing groundwater gradients, the rising water table, or other changes to site conditions throughout the corrective action process. These additional step-out wells will not impact the evaluation of remedies.
4. Upon NMED's anticipated concurrence that the data presented defines the nature and extent of contamination to the degree necessary to inform the CME, conclude the investigation phase and begin the corrective measure evaluation phase.

Quarter 4 2023 Benzene
Soil Vapor and Groundwater Plumes

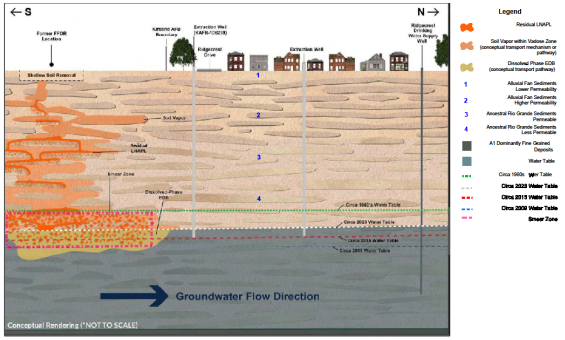


Quarter 4 2023 1,2-Dibromoethane (EDB)
Soil Vapor and Groundwater Plumes

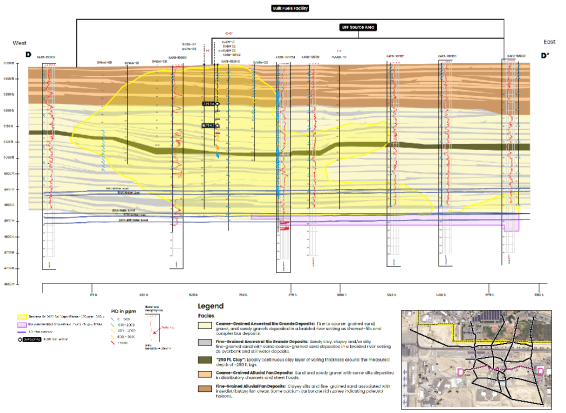


Draft images will be finalized in the Phase II RFI Report to be submitted no later than April 30, 2025

Updated Conceptual Site Model 2023



Cross Section D-D' with Benzene Soil Vapor and Groundwater Plume Shells



RCRA Corrective Action Process

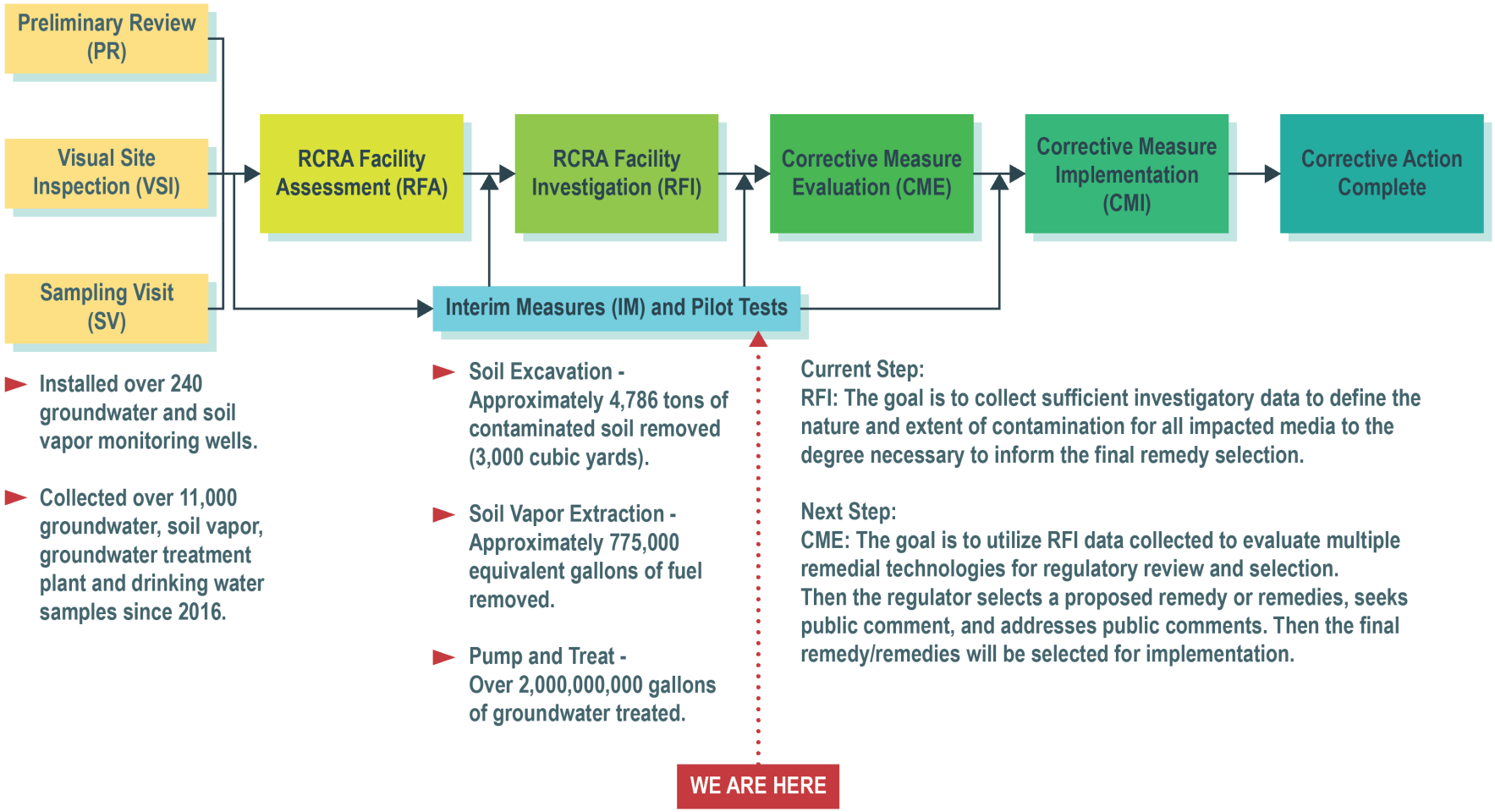
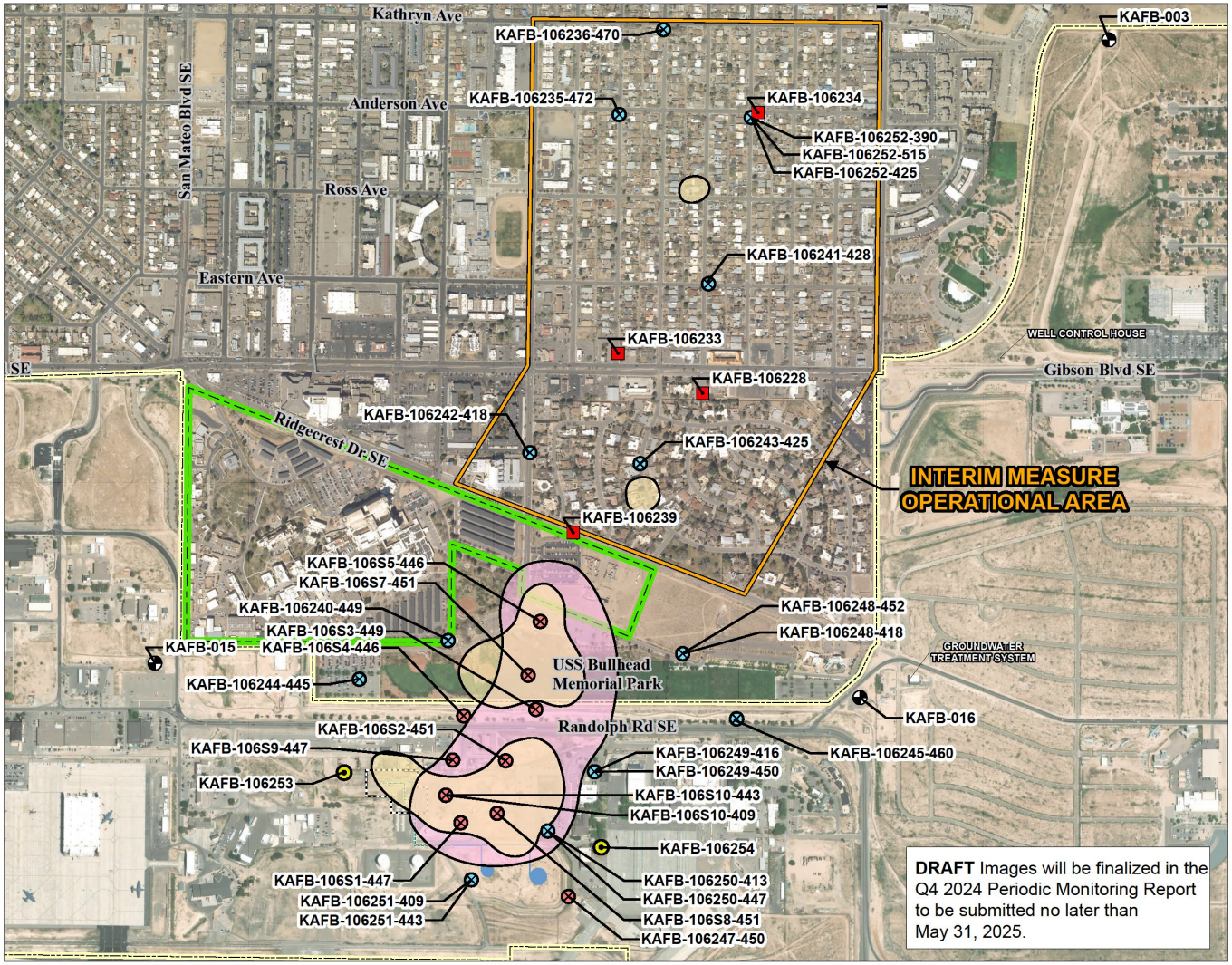


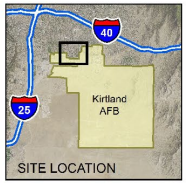
*Image adapted from California Department of Toxic Substances Control (https://dtsc-topock.com/resource-conservation-and-recovery-act)

Recent and Proposed Groundwater Monitoring Wells



Legend

- Rising Water Table Data Gap Groundwater Monitoring Well
- Source Zone Characterization Monitoring Well
- Proposed Groundwater Monitoring Well
- Extraction Well
- Drinking Water Supply Well
- Former Aboveground Storage Tank
- Former Buried Fuel Transfer Line
- Former Aboveground Fuel Transfer Line
- Installation Fence Boundary
- Interim Measure Operational Area
- Source Area
- VA Boundary
- EDB Plume Q4 2024 (> 0.05 µg/L) depicted at REI 4857
- Benzene Plume Q4 2024 (> 5.0 µg/L) depicted at the Water Table



N

0 300 600 1,200

Feet

1 inch = 300 feet

Projection: NAD83 State Plane New Mexico Central FIPS 3002 Feet

Notes:
The Interim Measure Operational Area consists of the distal portion of the EDB plume north of Ridgecrest Drive Southeast.
The source area plume is located to the south of Ridgecrest Drive Southeast.
Aerial Imagery from 10/04/2020: Google Earth Pro, 2020.
Drinking water supply well ST106VA2 is not shown on this figure per request of the medical center.
ID = identification
REI = reference elevation interval
VA = Veterans Affairs

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