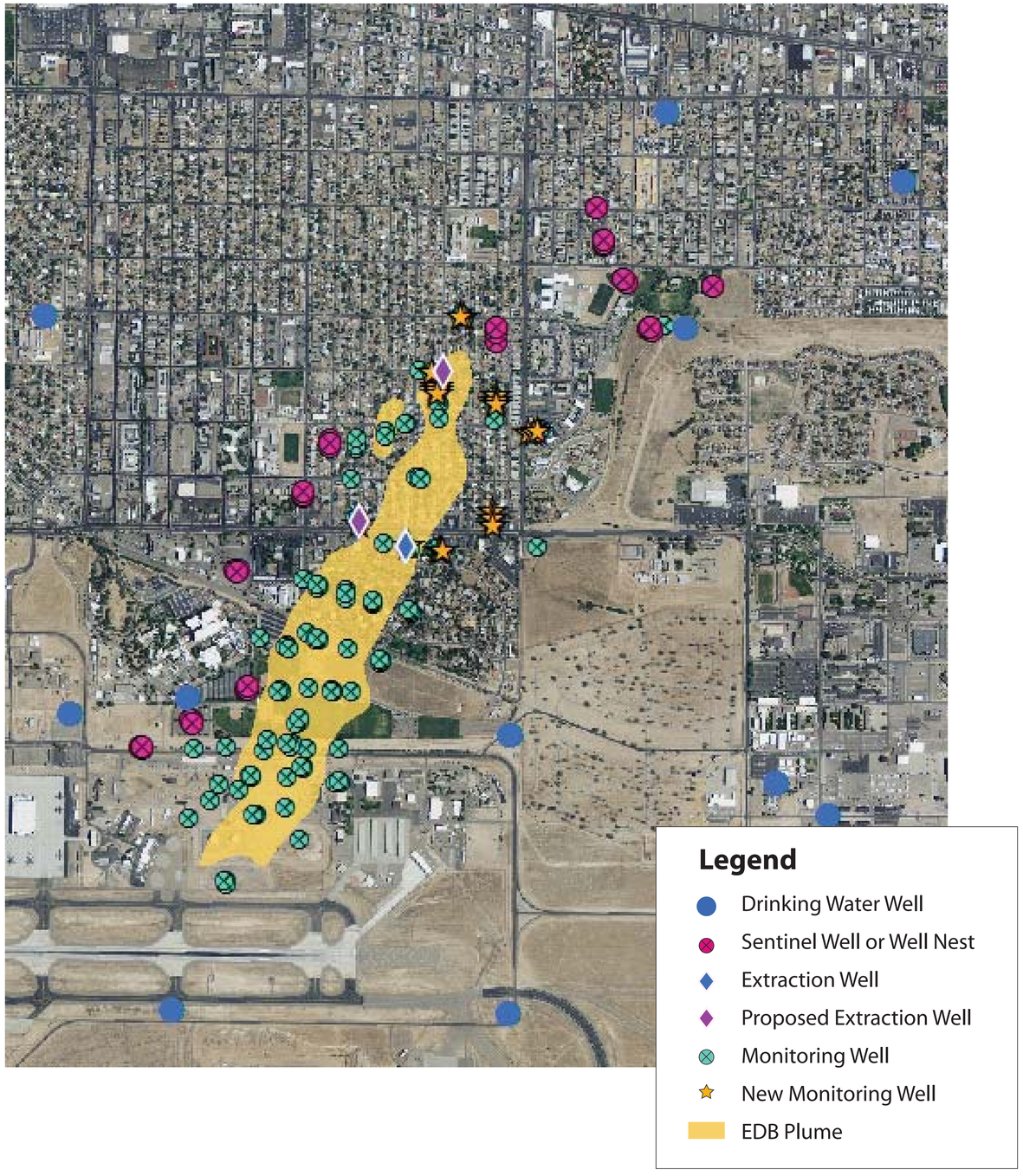
What is Ethylene Dibromide (EDB)?

- EDB is a synthetic chemical that has been used as a lead scavenger in aviation gas and leaded gasoline. EDB was also used as a fumigant in agriculture.
- EDB was in aviation gas that was used at Kirtland Air Force Base.
- Fuel leaked into the ground and contaminated groundwater.
- EDB is a known carcinogen and is regulated at 0.05 µg/L (parts per billion) by the U.S. Environmental Protection Agency and the New Mexico Environment Department.
- EDB has not been detected in Albuquerque drinking water supply wells.

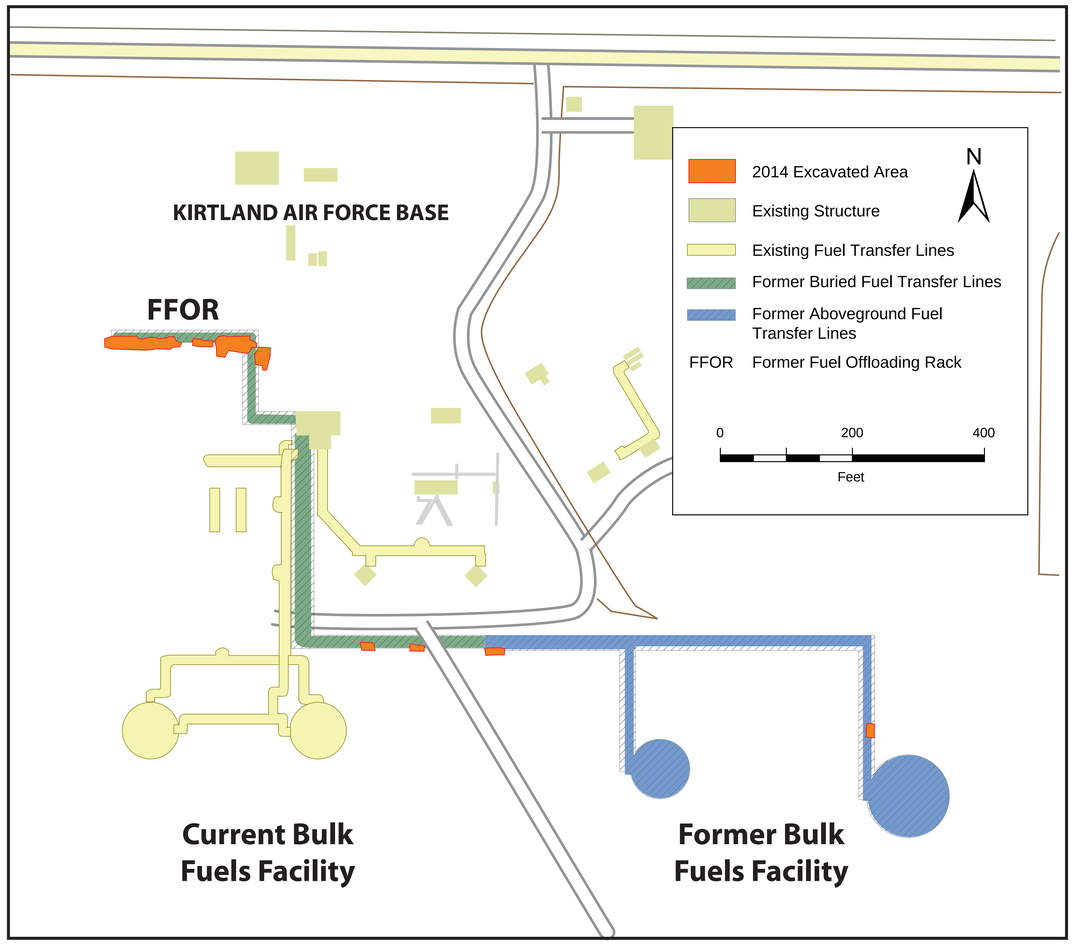


Source Excavations at the Former Fuel Offloading Rack

Excavation

- First Excavation after leak was detected in 2000, removed ~ 120 tons (76 yd^3).
- Second Excavation in 2010 removed 1,018 tons (611 yd^3) of contaminated soil. The former underground and aboveground fuel transfer lines were removed as part of this effort.
- Third Excavation in 2014 removed 3,684 tons (2,340 yd^3) of contaminated soil to meet NMED residential soil standards to a depth of 20 feet.

Trench Box Installation

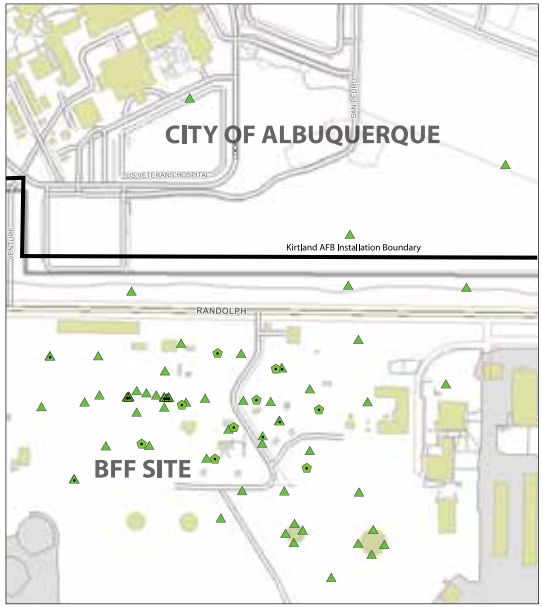


Confirmation Sampling

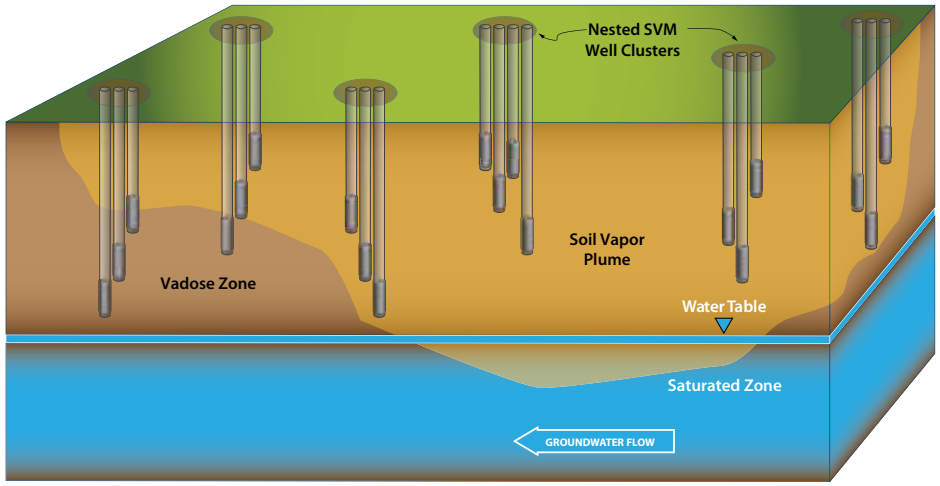
Compaction

Completed Excavation Site

How We Collect Data From the Vadose Zone



A network of Soil Vapor Monitoring (SVM) wells is used to measure and monitor vapor concentrations in the vadose zone.



Each SVM nested well cluster contains individual wells that are screened at different depths in the vadose zone. This allows data to be collected from a variety of depths at one geographic location.

Field analytical instruments, such as this air emissions analyzer, are used to measure concentrations of hydrocarbons, oxygen, and carbon dioxide in the subsurface.

Field and laboratory data are analyzed and interpreted to evaluate current remediation methods and determine future remediation methods for the vadose zone.

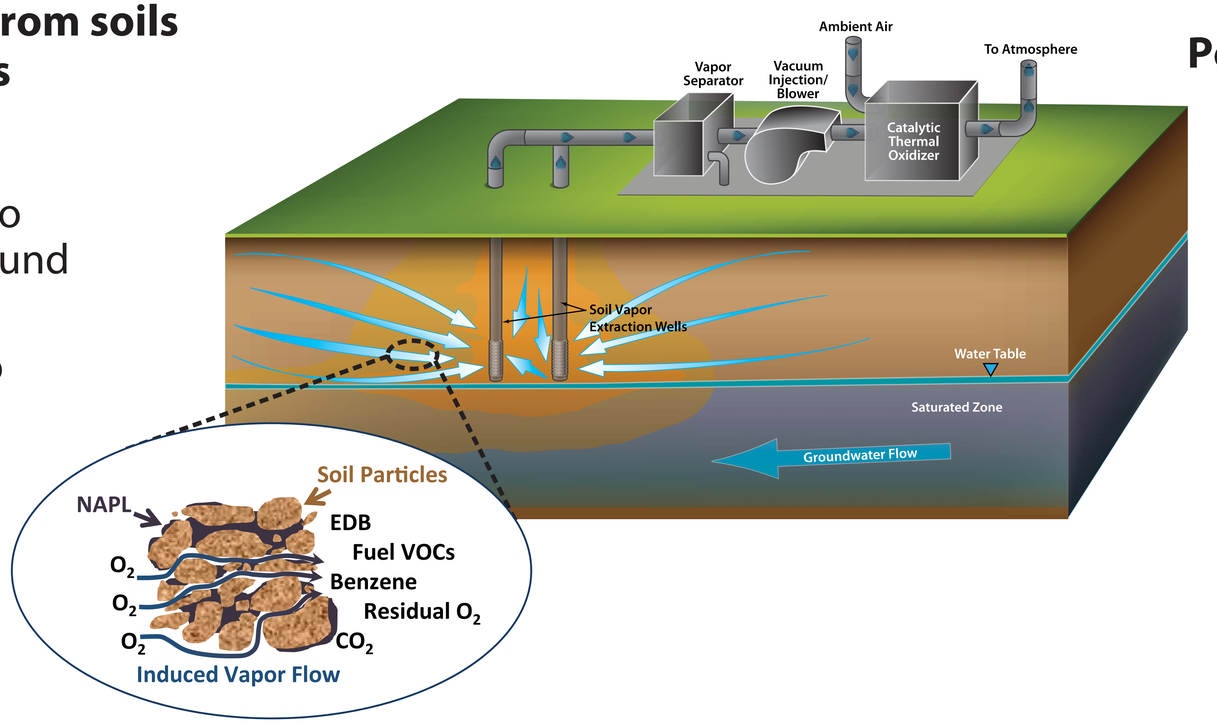
Nested SVM wells and soil vapor sampling system.

Soil vapor samples are collected for in-depth analyses of specific fuel hydrocarbon compounds by a certified laboratory.

Soil Vapor Extraction (SVE) Application and Performance

SVE is an energy intensive technology designed to quickly remove volatile contaminants from soils to disrupt potential exposure pathways

- Very effective at fuel-spill sites
- Uses vacuum and high vapor flowrates to transfer COCs from soil to above the ground surface
- Often requires off-gas treatment prior to discharge to atmosphere
- Promotes biodegradation
- Typically applied in conjunction with follow-up technologies
- Bioventing or monitored natural attenuation

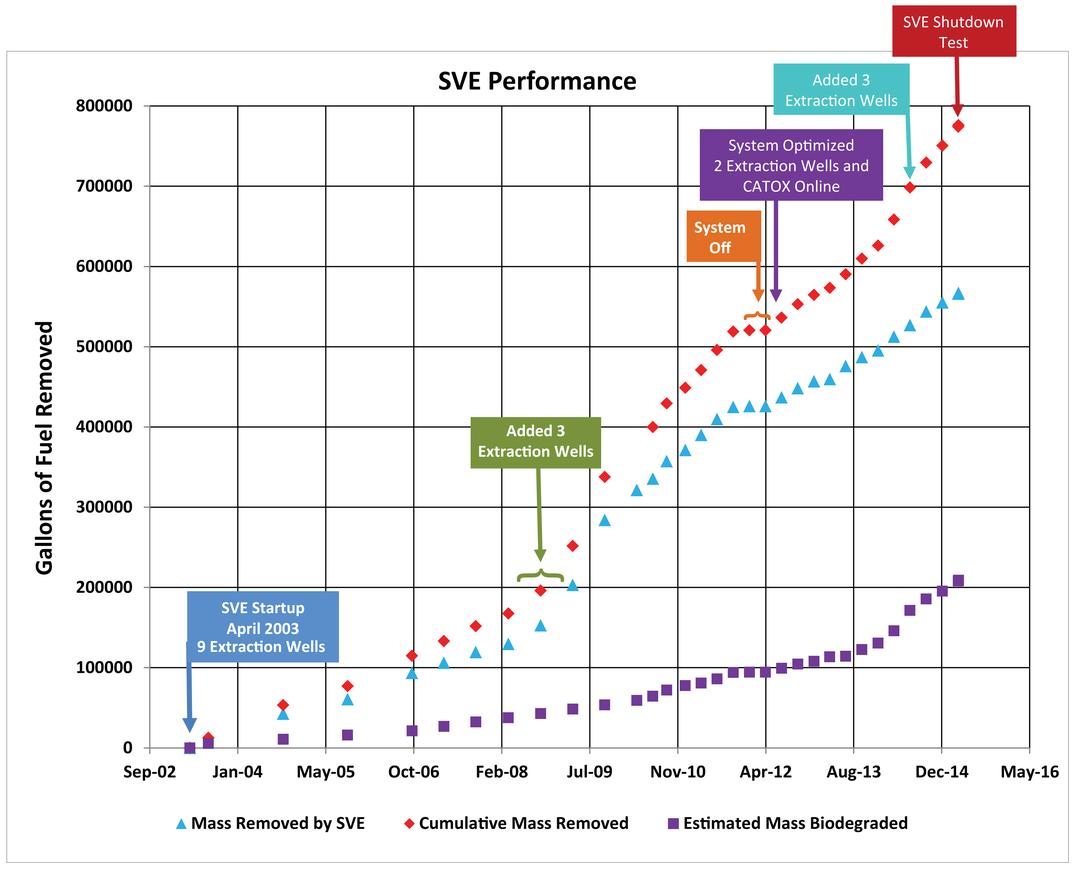


Performance Highlights

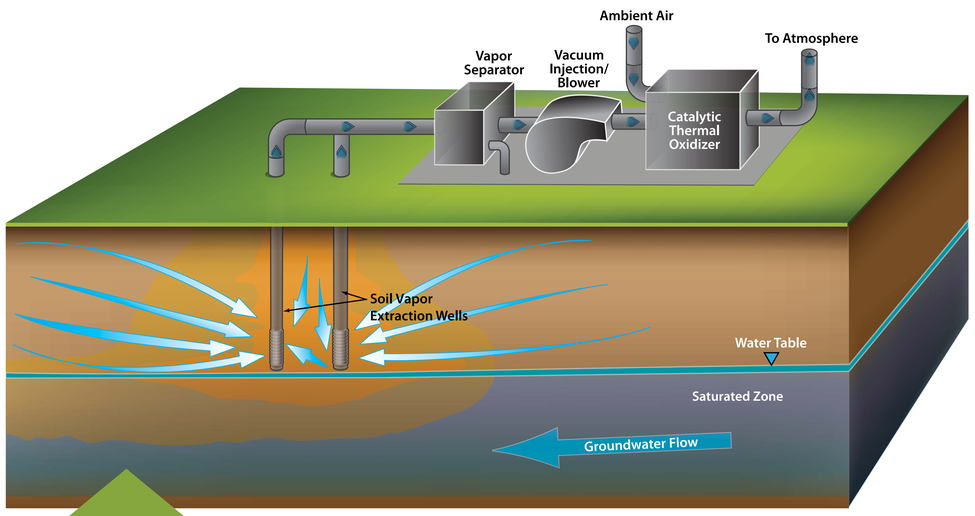
- Total of 774,000 gallons of fuel removed
- 566,000 gallons extracted
- 208,000 gallons biodegraded
- Numbers are conservative

SVE Operated for 12 Years

- Original SVE unit installed in 2003 containing 9 soil-vapor extraction wells
  - Off-gas treatment with two internal combustion engines (ICE) units
- Three additional extraction wells brought online in 2008/2009
- Off-gas treatment with individual ICE units
- ICE Units moved to optimized locations in 2012
- New SVE system brought online in January 2013 containing two vapor extraction wells
  - Off-gas treatment with catalytic oxidizer
- Three extraction wells added in 2014

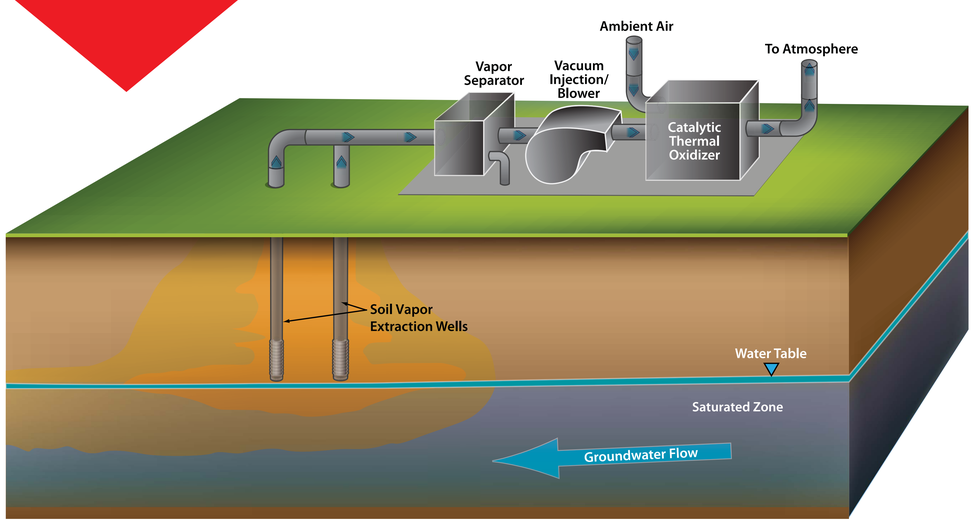


SVE System Shutdown Test

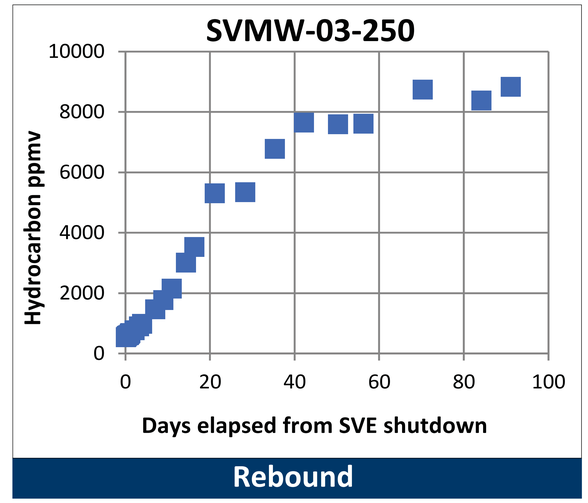


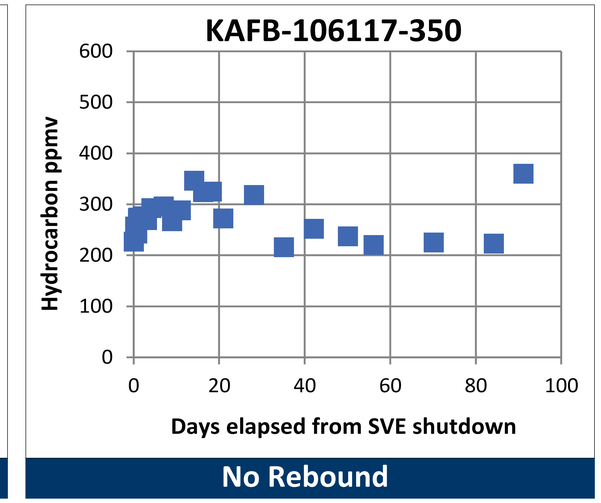
During SVE operation, many vapor-flow pathways are established as soil-gas is pulled through the vadose zone to extraction well screens.

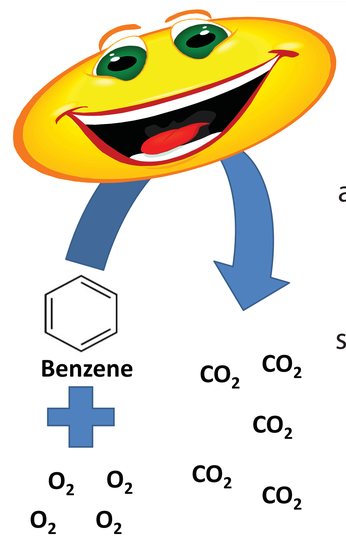
After shutdown, artificial flow patterns are replaced by natural flow patterns as the vadose zone returns to "equilibrium".



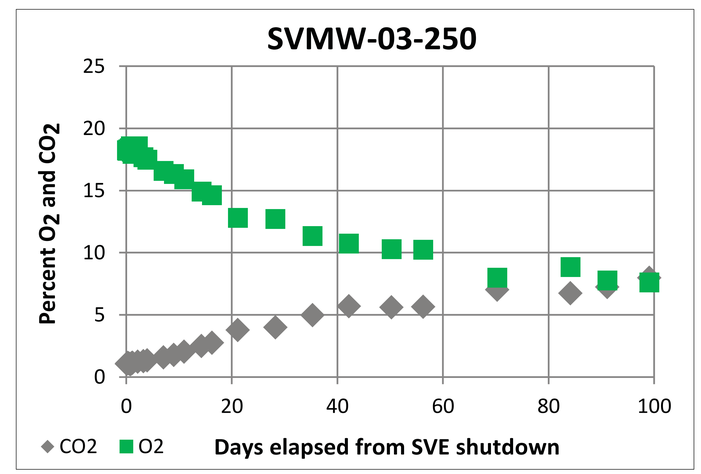
After SVE shutdown, hydrocarbon concentration trends at soil-vapor monitoring points are evaluated to determine areas of residual contamination.



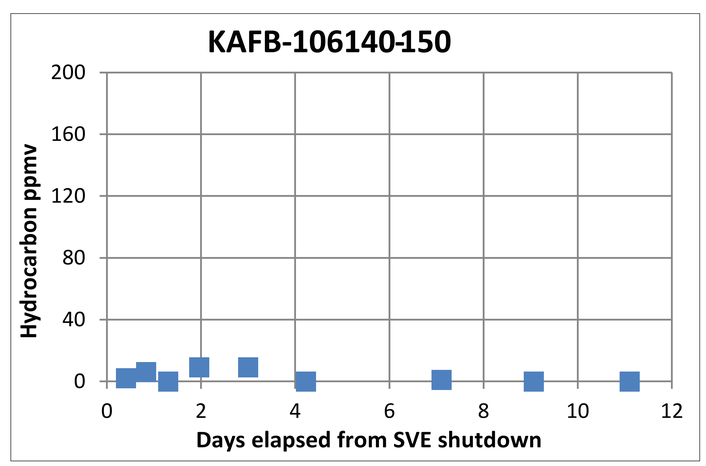


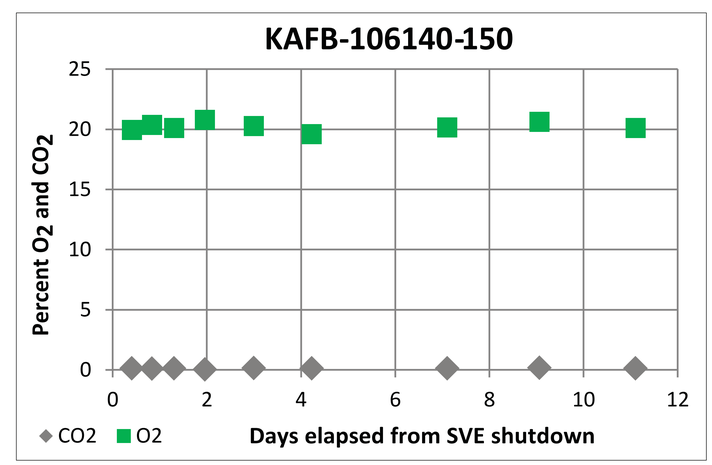


Naturally occurring bacteria in the vadose zone consume benzene and other hydrocarbons. This activity is observed through bacterial respiration when O_2 in soil-vapor samples drops and CO_2 rises. Respiration is a direct result of hydrocarbon degradation.



Many parts of the vadose zone at the BFF site have been treated and are now "clean". These locations can be identified by their very-low hydrocarbon concentrations and sustained atmospheric O_2 and CO_2 signatures.

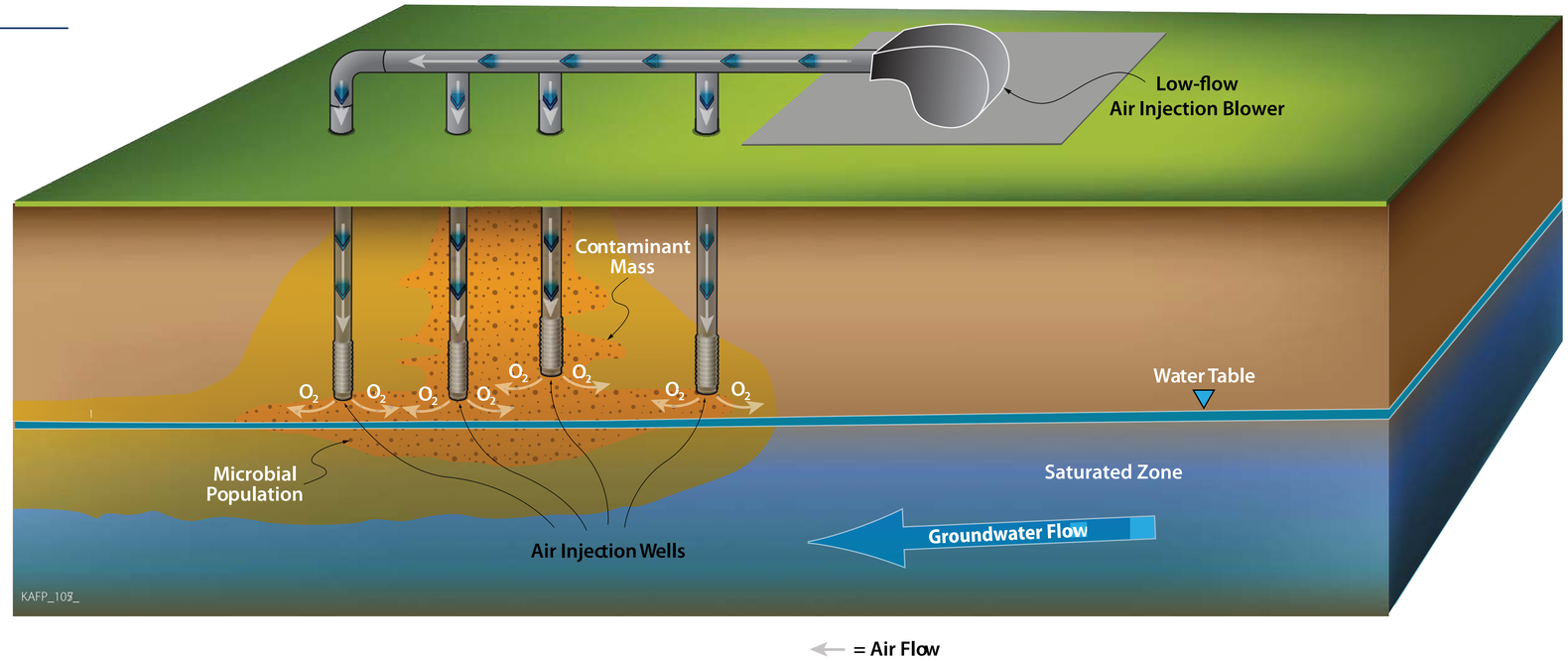


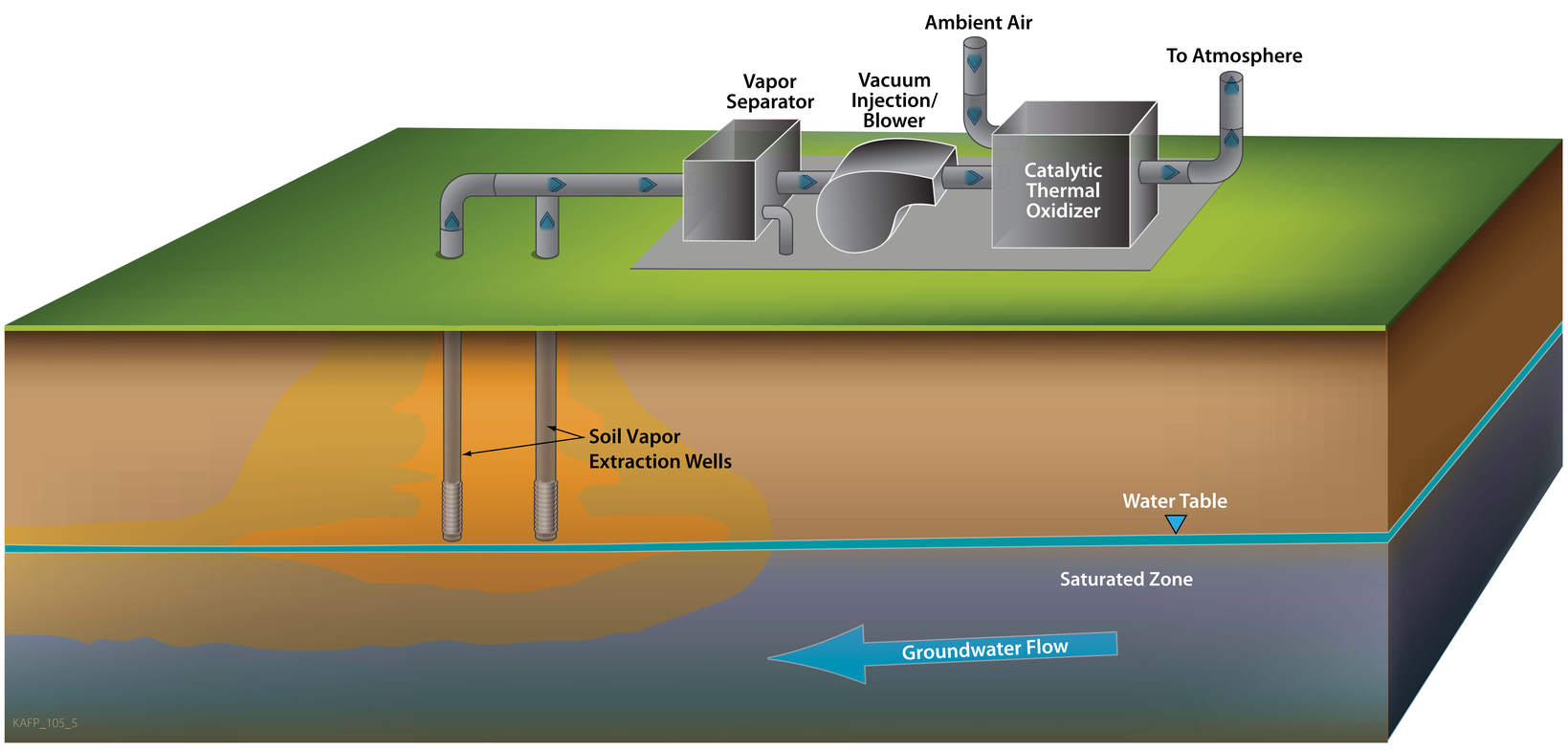


Vadose Zone Remediation Technologies

Bioventing

Bioventing works by injecting oxygen into the vadose zone to increase bacterial growth and biodegradation rates, leading to faster degradation of fuel contaminants. Some types of bioventing may also use nutrients or moisture to enhance biodegradation.



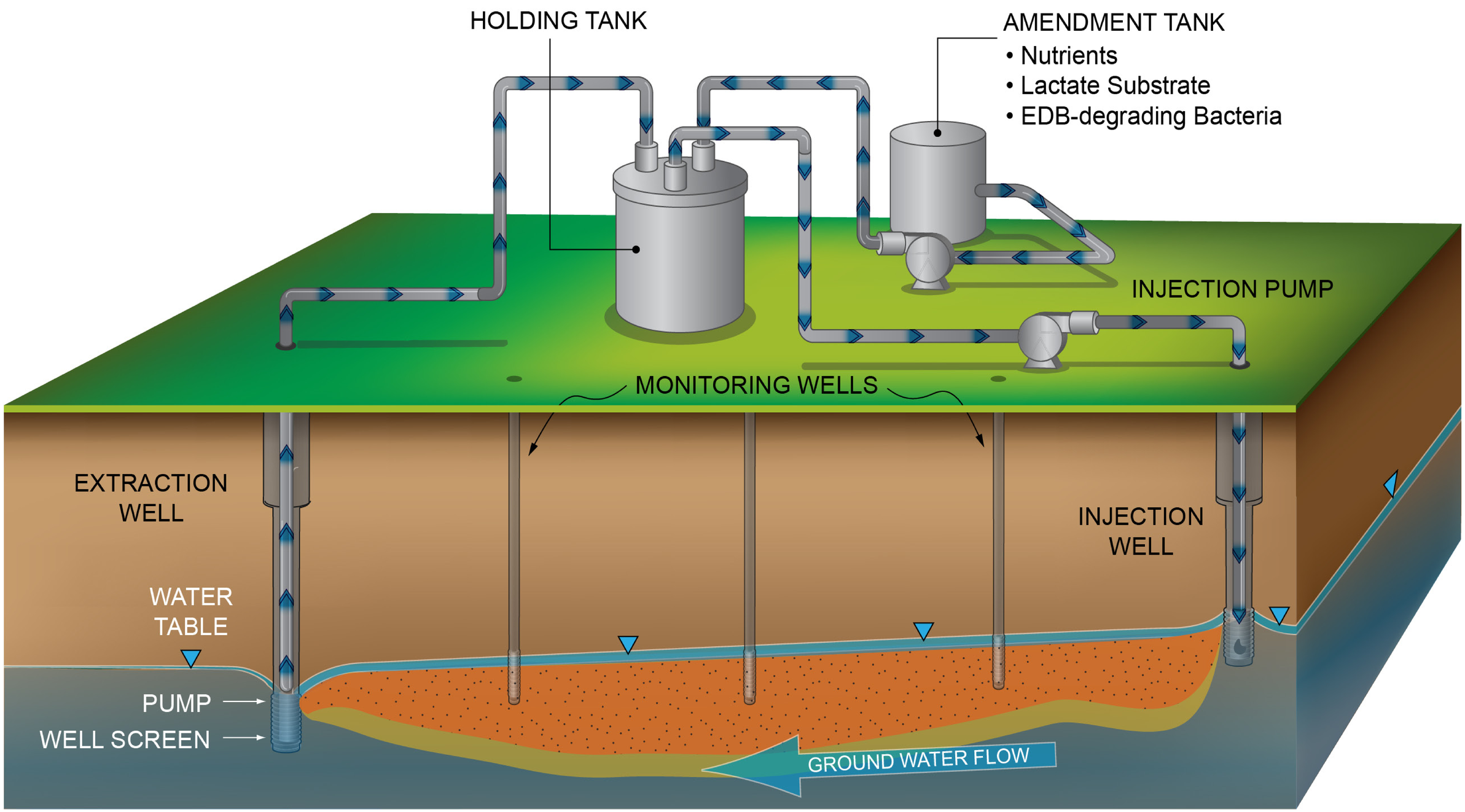


Soil Vapor Extraction (SVE)

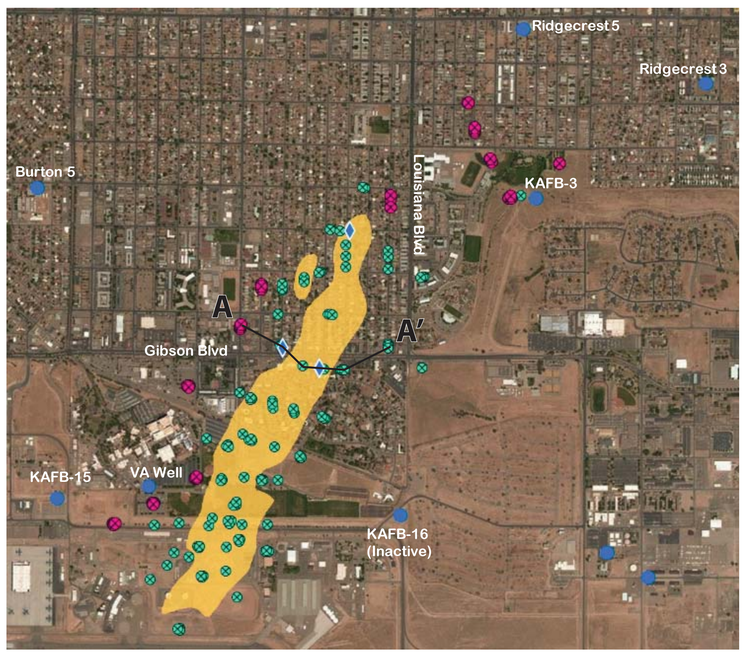
The SVE system pulls contaminated vapor from the ground and uses high temperatures to "burn off" contaminants. Treated air is tested to ensure it is clean and then released to the atmosphere. SVE is most effective for treating moderately high levels of hydrocarbon vapor.

Bioremediation

Natural groundwater bacteria readily biodegrade hydrocarbons with no human intervention. Different kinds of amendments can be added to enhance the microbial populations and increase biodegradation rates, leading to more rapid degradation of fuel contaminants. This remediation can be done either aerobically or anaerobically. The below example is a recirculation bioremediation system.



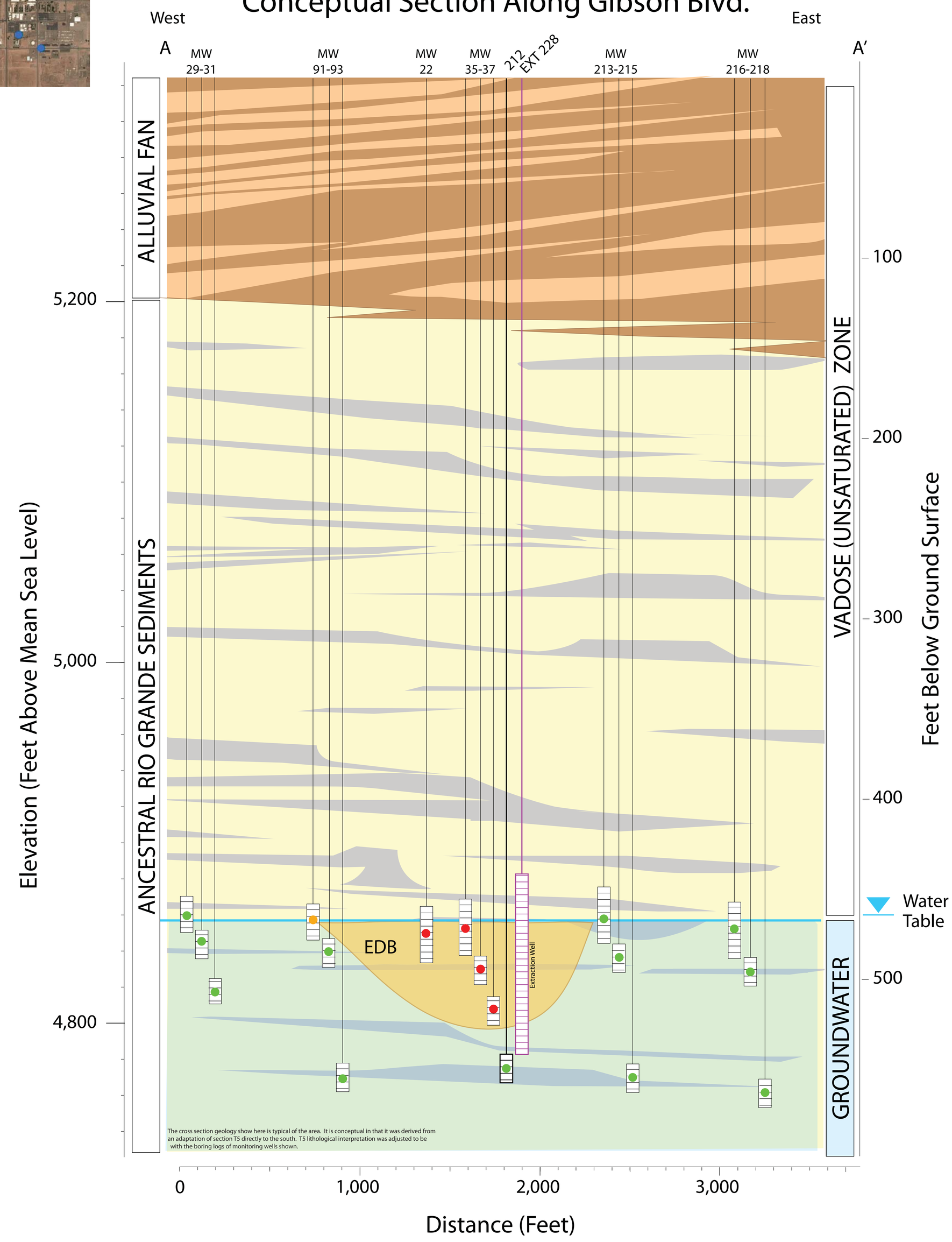
Progress In Plume Definition and Contaminant Extraction



Legend

- Drinking Water Well
- Sentinel Well or Well Nest
- Extraction Well
- Groundwater Monitoring Well
- EDB Plume

Conceptual Section Along Gibson Blvd.



Conceptual Cross Section Key

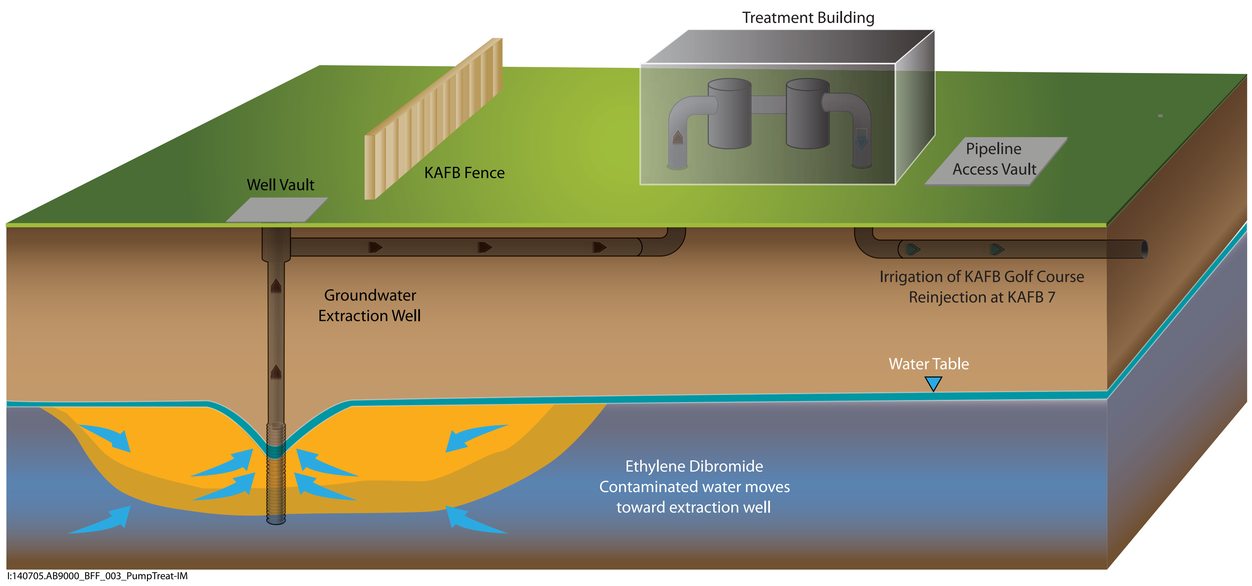
Alluvial Fan Sediments
- High Permeability
- Low Permeability

Ancestral Rio Grande Sediments
- High Permeability
- Low Permeability

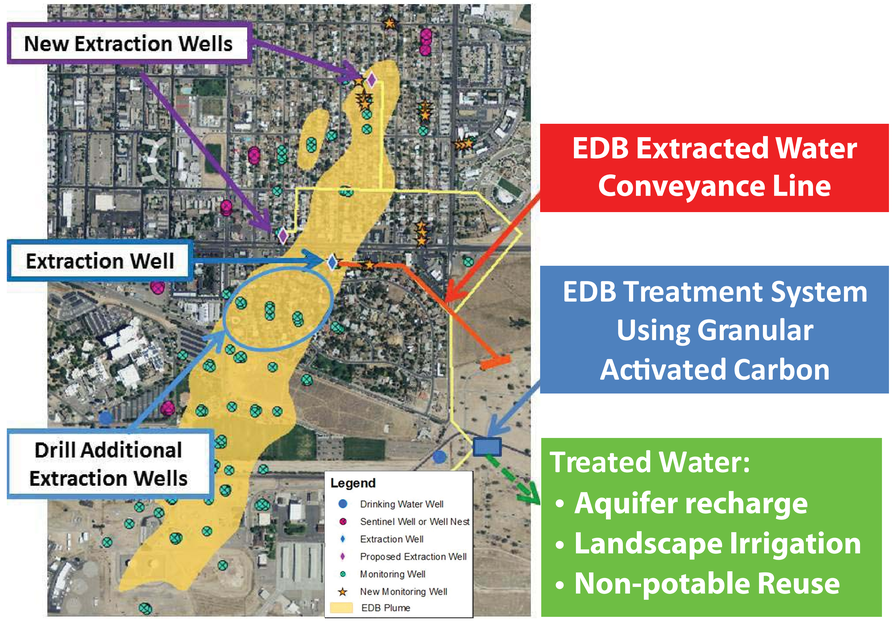
EDB Plume

Groundwater Treatment System

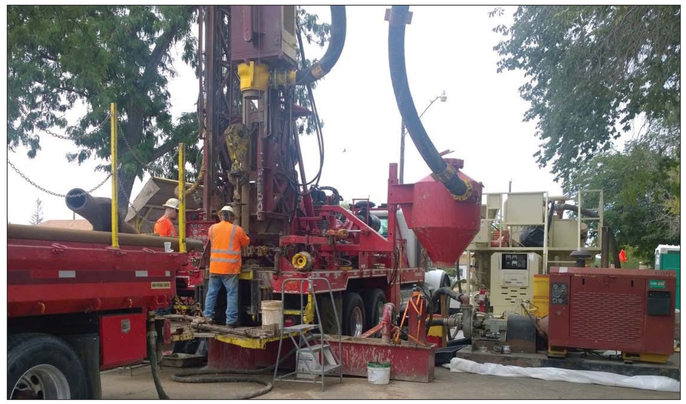
Example of a Pump & Treat System



Collapsing the Dissolved EDB Plume



Well 234 Driller inserting bit into well



Well 234 Drilling well in mud mode

Looking at split spoon for lithologic description

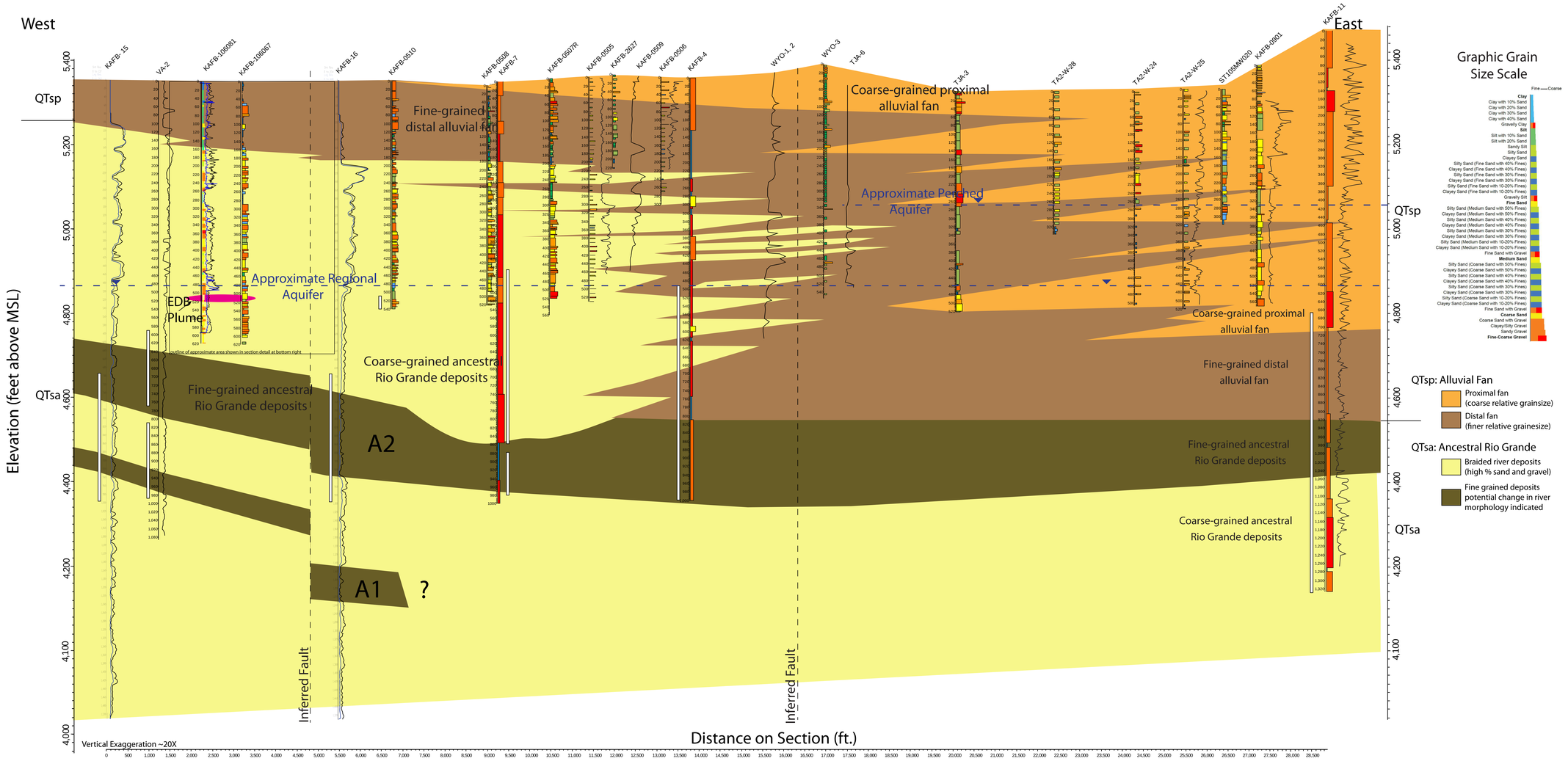
Directional drilling for installation of underground HDPE piping from extraction well KAFB-106228 to Kirtland AFB.

Holding tanks with carbon vessels and associated bag filters at the temporary treatment system. Holding tanks store treated water and are used for system balancing.

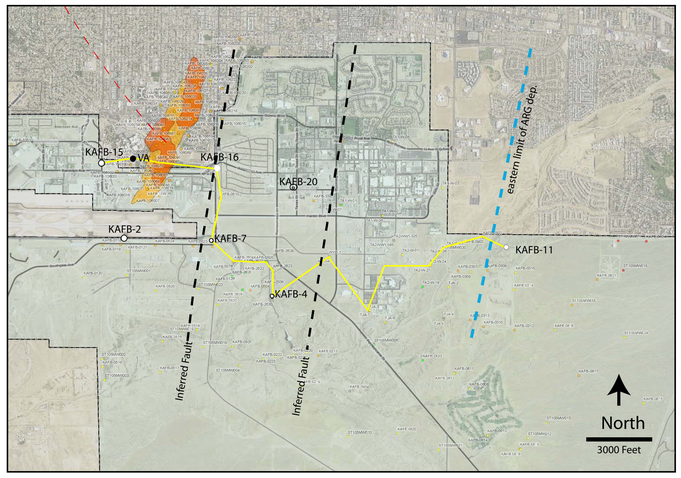
Fusing of the HDPE influent piping. This piping is being installed beneath the ground surface and connects the existing valve vault to the full-scale treatment building.

Skid containing the pump that will be used to operate of the full-scale treatment system.

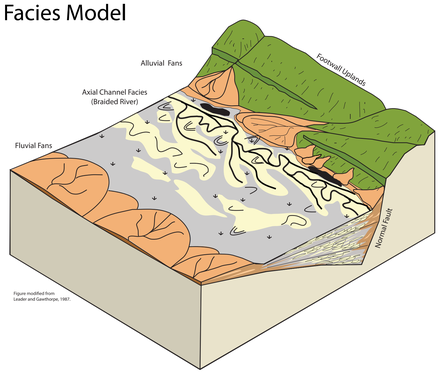
Regional Stratigraphy



Regional Cross Section Location



Facies Model



LithoFacies Key (Model and Inset Section)

High Transmissivity Facies (High Permeability Sediments)

Alluvial fan distributary channel fills and sheet flood deposits: Angular and subangular gravel and sand mixtures that correspond to piedmont member of Sierra Ladrones Formation in east, potentially the Ceja formation in the west.

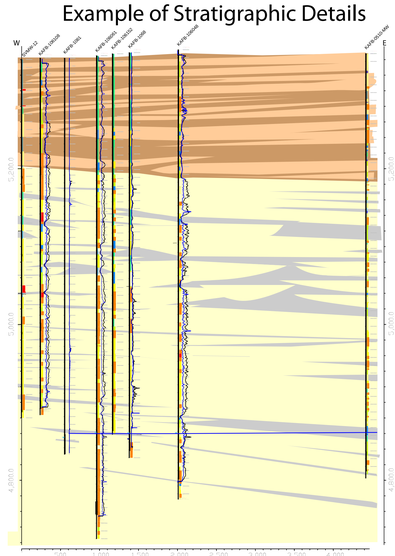
Braided River Deposits: Rounded and subrounded gravel and sand mixtures deposited as channel fills, lenticular bars, and splay (coarse overbank) deposits. Thick zones (>20ft) likely consist of discrete, closely stacked fining upward packages of sediment. Sediments correspond to the axial-fluvial member of the Sierra Ladrones Formation.

Low Transmissivity Facies (Low Permeability Sediments)

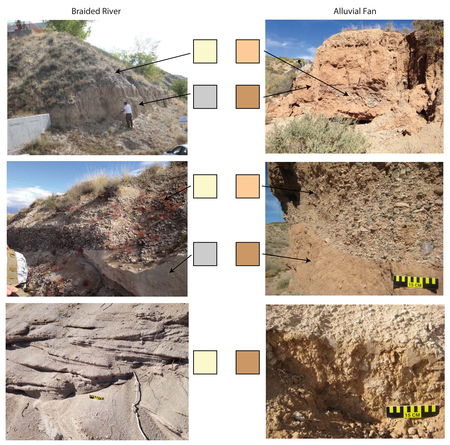
Alluvial fan distal deposits and interdistributary fill: Fine grained fan material consisting of silts and silty, sandy clay.

Braided River Deposits: Overbank , chute fill, and backwater deposits consisting of silty sands, silts, and clays.

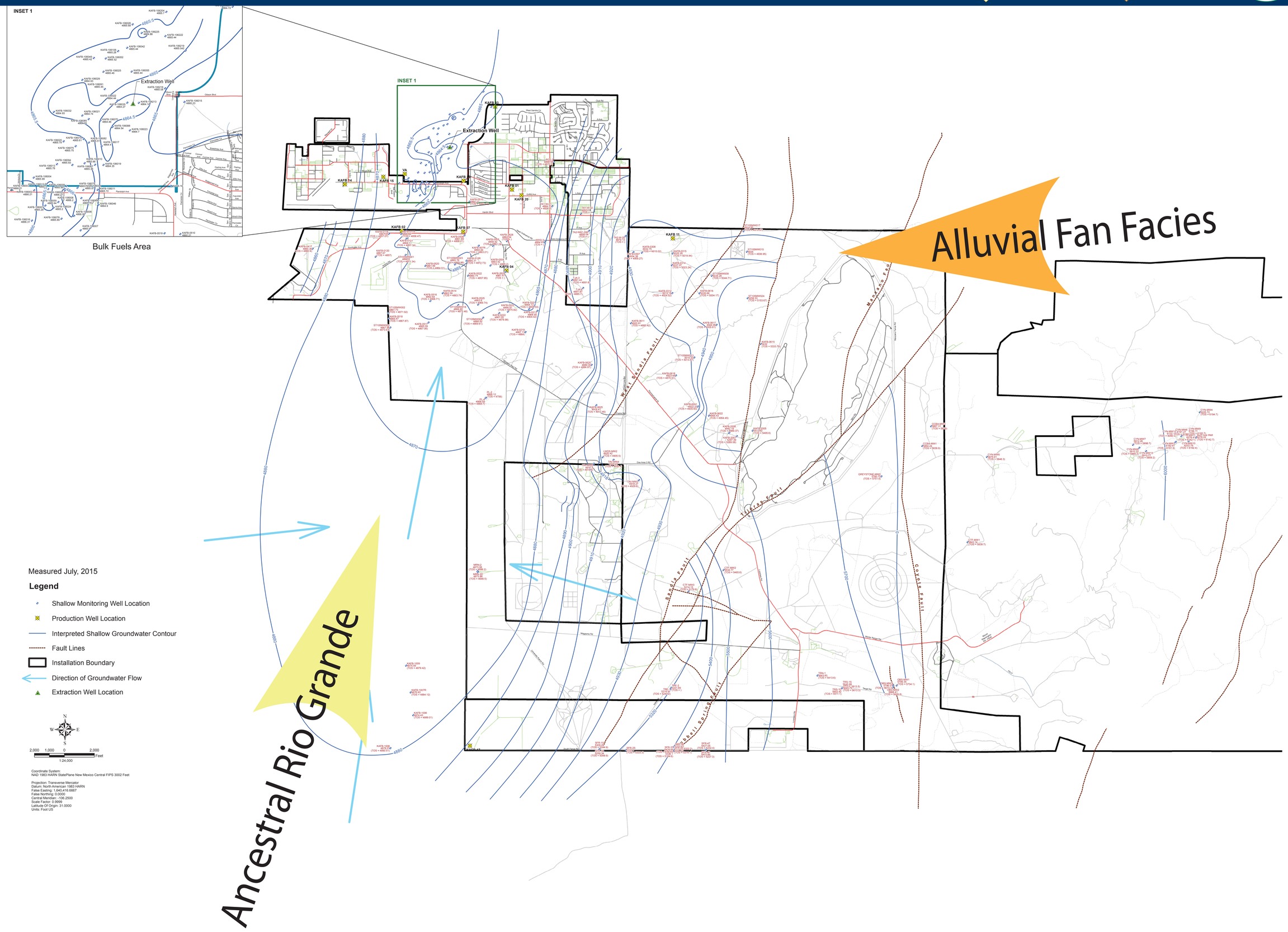
Example of Stratigraphic Details



Outcrop Examples Of Facies Types



Regional Aquifer Water Table Map



Document Path: L:\Projects\60308494\900-CAD-GIS\Kirtland AFB\Maps\KAFB Shallow GW Layout_E_3444L.mxd