# Kirtland Air Force Base Fuel Spill Cleanup

October 23, 2014

# Welcome

**Col. Tony Haught**
**Commander**
**U.S. Air Force**
**377th Mission Support Group**

# Revised Public Meeting Format

**Greater opportunities for public involvement**

- **Poster sessions – talk to the experts**
- **Presentations – get updated on site actions and progress**
- **Facilitated discussion groups – make sure your voice is heard**

# Meeting Guidelines

- Hard copies of presentation are available near the sign-in sheet and will be posted online
- One question/comment per turn at the microphone
- Each question/comment will be allotted 3 minutes – please respect this time limit so others will have an opportunity to be heard
- In addition, comment cards have been made available
  - Return completed comment cards to Air Force staff
  - Questions will be answered at the end of the presentation
  - Questions will also be incorporated into the FAQ portion of the Kirtland AFB BFF Spill project website:

    www.kirtlandjetfuelremediation.com

# Kirtland Air Force Base
# Bulk Fuel Facility Site

## Site Conditions, Drinking Water Protection, & Soil and Groundwater Cleanup

**Adria Bodour, Ph.D., AFCEC Environmental Scientist**
**and**
**Dennis McQuillan, NMED Geologist**

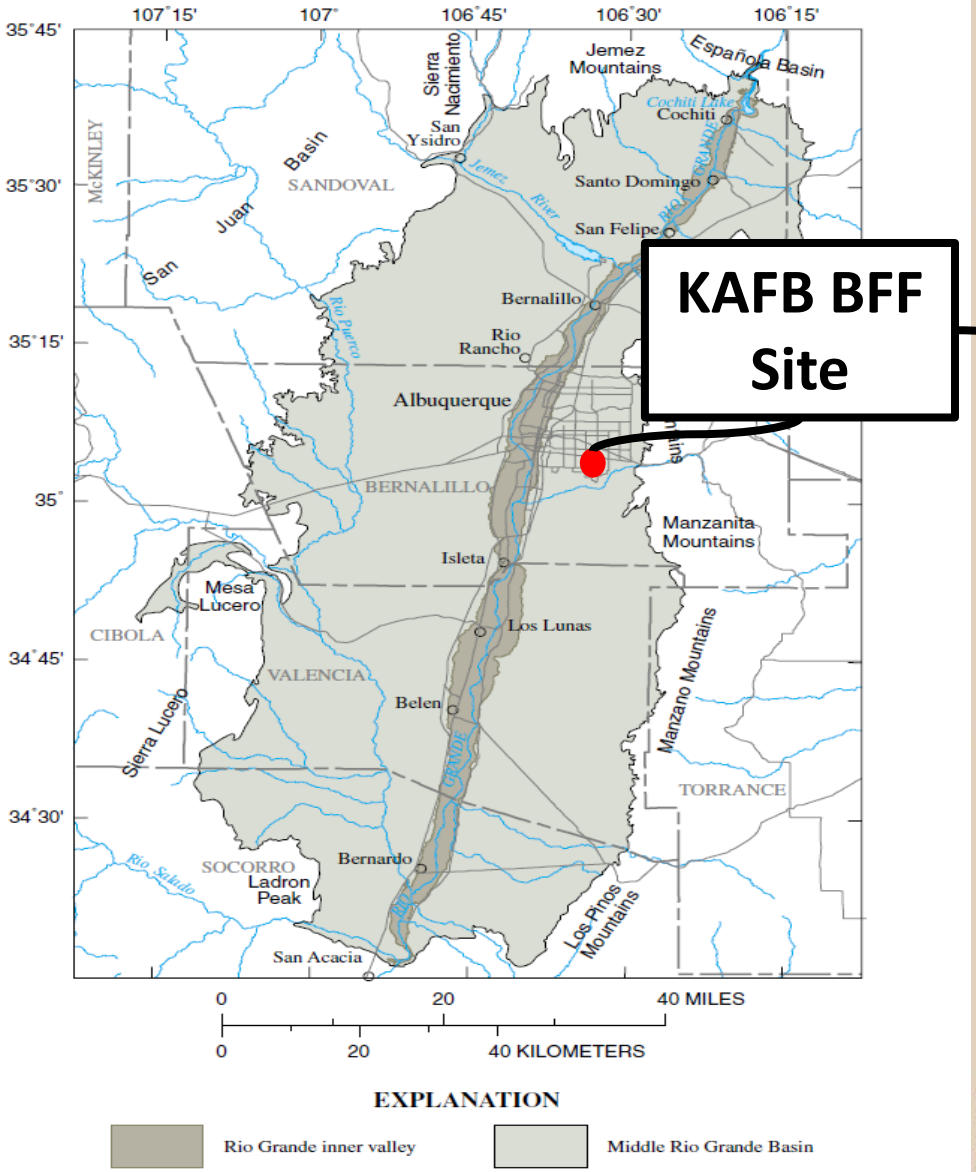
# Site History

- **1951-53** – Kirtland Air Force Base (KAFB) Bulk Fuels Facility (BFF) constructed
- **1975** – Handling of aviation gasoline containing EDB discontinued
- **1999** – KAFB notified NMED of soil contamination from underground piping and ceased use of piping
- **2001** – KAFB notified NMED of groundwater contamination with dissolved fuel constituents
- **2003** – Soil vapor extraction (SVE) technology began to remediate the contaminated soil in the vadose zone (i.e., unsaturated soil)
- **2007** – Fuel discovered floating on groundwater; attempted to skim fuel from water table with limited success
- **2009** – Water level rise begins to submerge LNAPL within aquifer
- **2014**
  - Excavated approximately 4020 tons of contaminated soil since 2000
  - 287 soil monitoring wells have been installed since 2000
  - 116 groundwater monitoring wells have been installed since 2000
  - SVE has recovered more than 500,000 gallons of fuel since 2003

# Executive Summary

- **Monthly testing of drinking water wells continues to show no evidence of contamination**
- **Physical, chemical, and biological processes influencing the contamination must be defined to identify and select remedies**
- **Critical data gaps are being filled with 16+ new monitoring wells**
- **Increasing robustness interim measures**
- **Proposal drafted to collapse the EDB plume**

# Albuquerque is in the Middle Rio Grande Basin, Calabacillas Subbasin - A Major Aquifer System




**KAFB BFF Site**

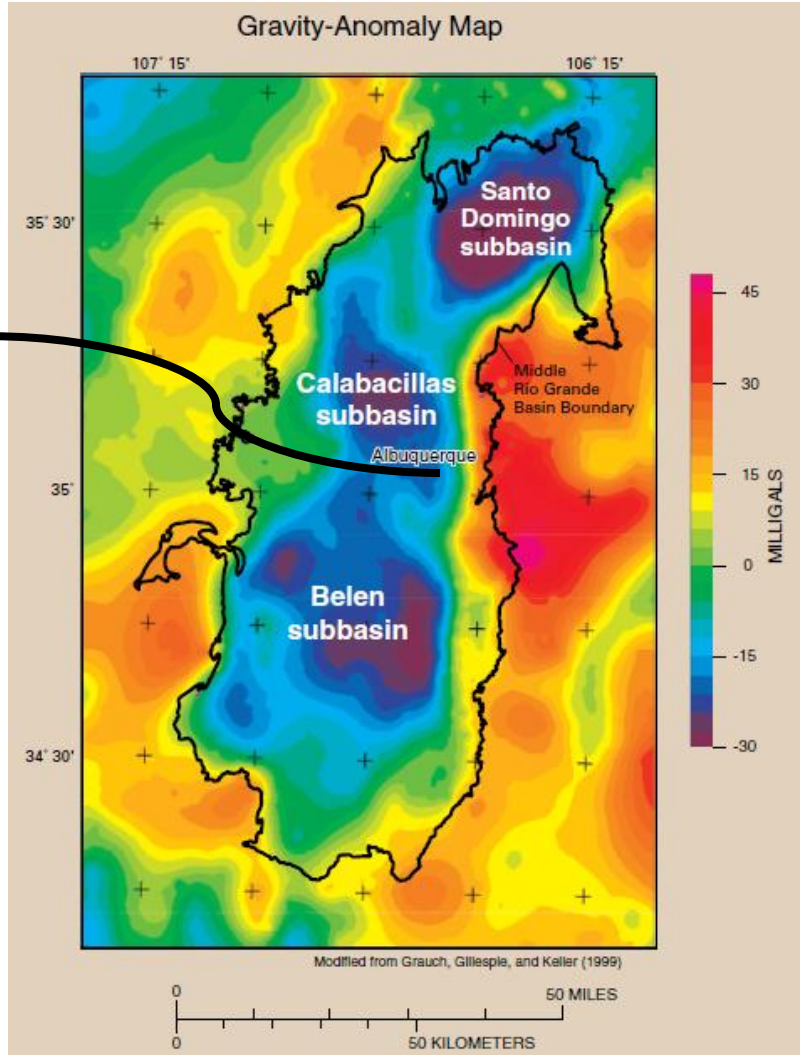



*Figure D.1.—Gravity data for the entire Middle Rio Grande Basin and surrounding area. The Santa Fe Group has much lower density than the surrounding bedrock, producing low values (shown in blue and purple) on the gravity-anomaly map .*

# Albuquerque's Aquifer

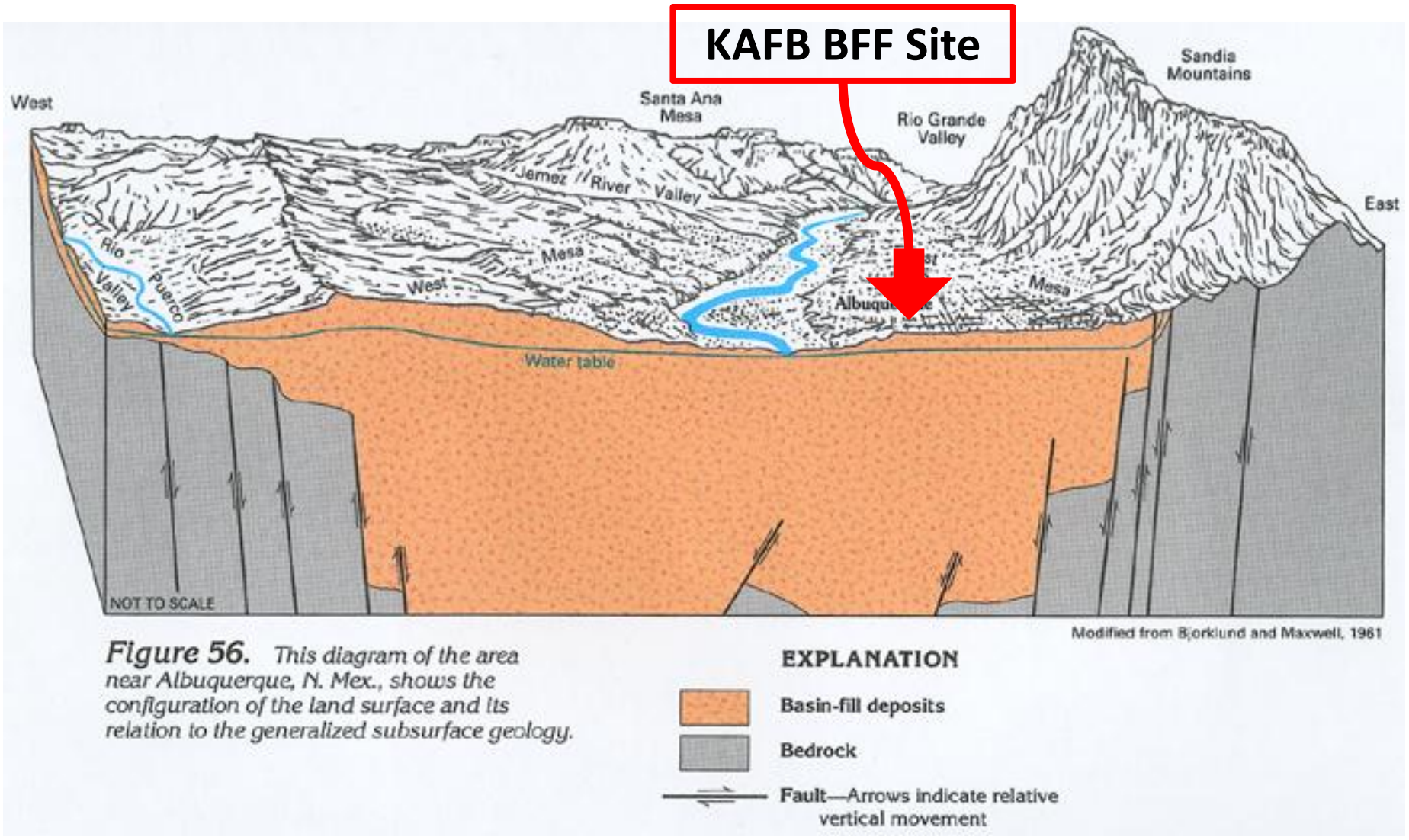
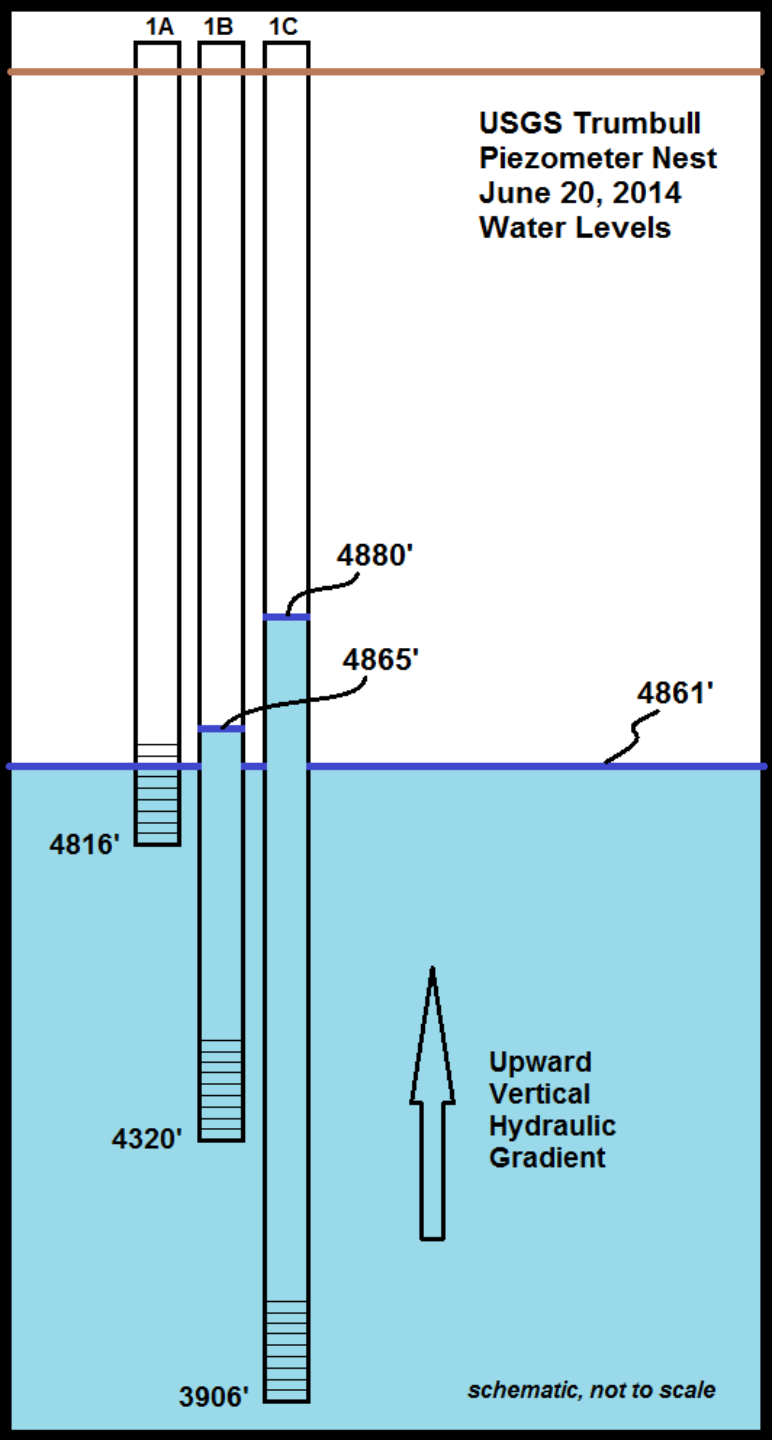



*Figure 56.* *This diagram of the area near Albuquerque, N. Mex., shows the configuration of the land surface and its relation to the generalized subsurface geology.*




# Vertical Hydraulic Gradient

**In the area of the fuel spill, groundwater is under artesian pressure at depth**

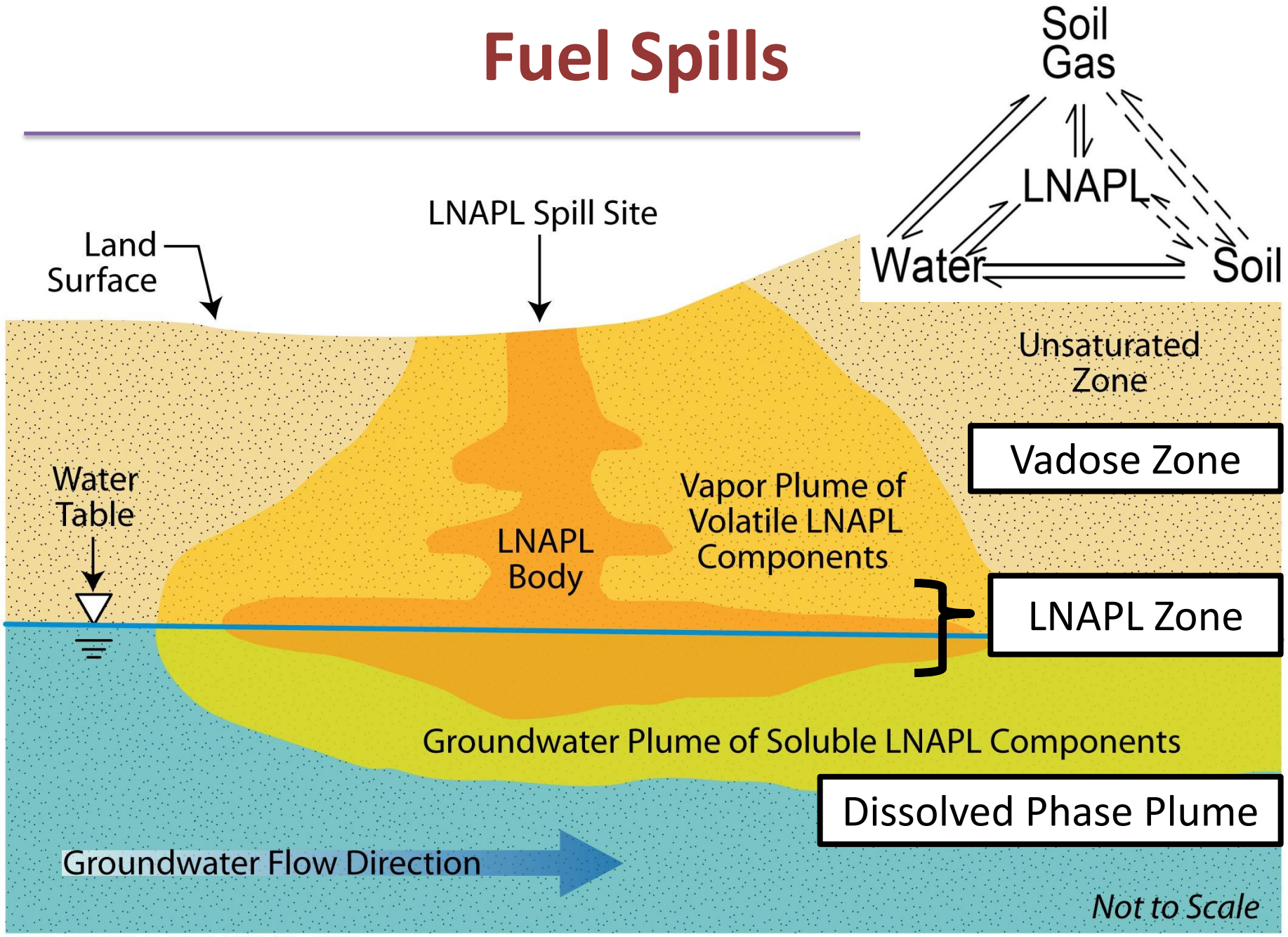
**Vertical migration of groundwater and any contaminants will tend to be upward, rather than downward**

**This upward hydraulic gradient works in favor of protecting deep water supply wells from fuel contamination in the shallow zone**

# Hydrogeology Take Away

- **Albuquerque sits on top of the Middle Rio Grande Basin, a deep alluvial aquifer system that is a highly productive and high-quality source of drinking water for the metropolitan area**
- **Small portion of the uppermost aquifer has been contaminated**
- **Several important drinking water wells are in the immediate vicinity of the plume area but not contaminated**
- **KAFB BFF contamination plume does not threaten water supply wells in other areas of the basin, such as in Corrales or the West Mesa**

# Fuel Spills



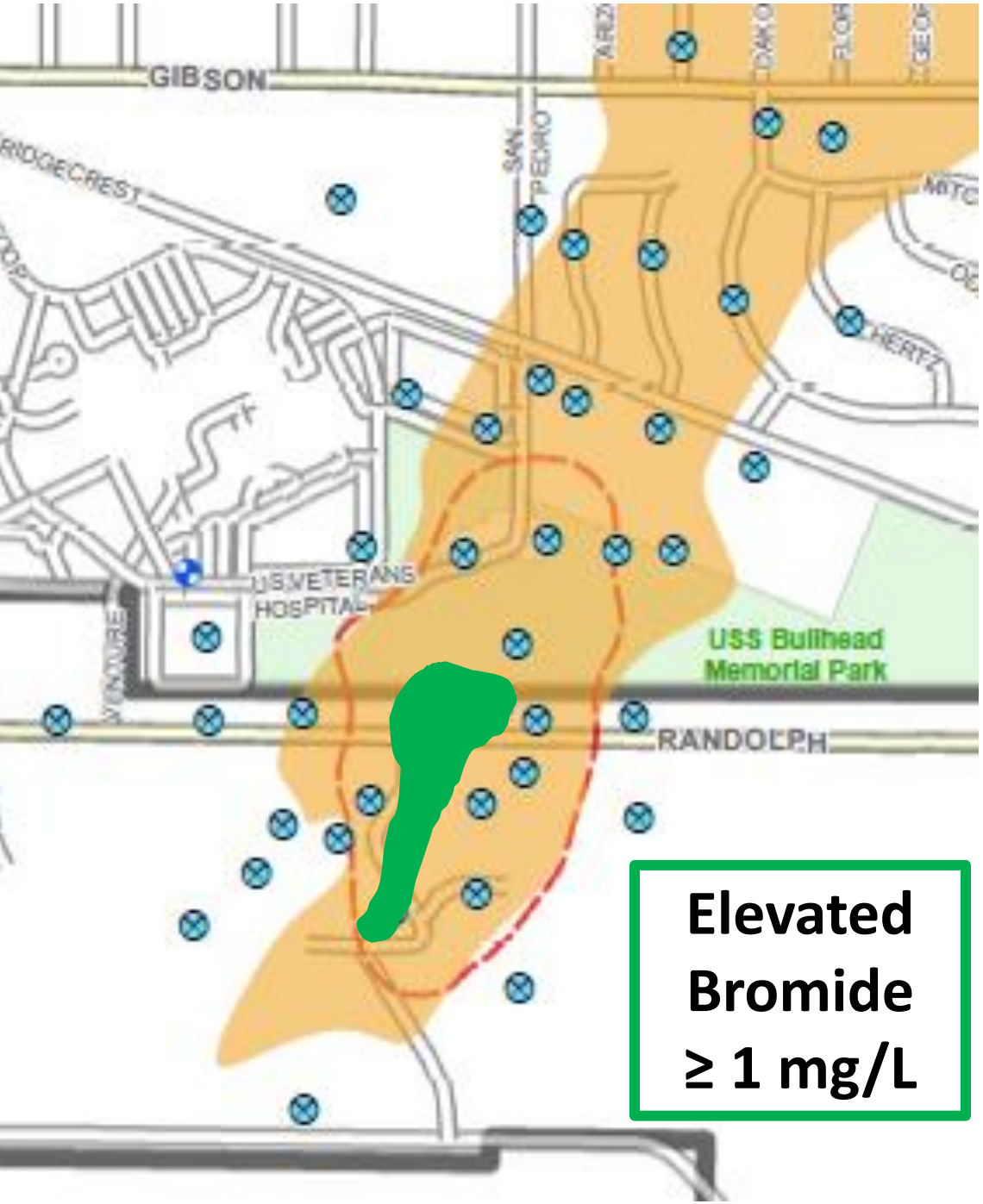

Adapted from Delin et al., 1998, USGS Fact Sheet FS-084-98

# Natural Biodegradation


## Benzene Plume

Fuel hydrocarbons have undergone extensive biodegradation increasing alkalinity in groundwater

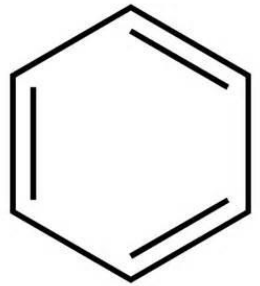
# Natural Biodegradation




## EDB Plume

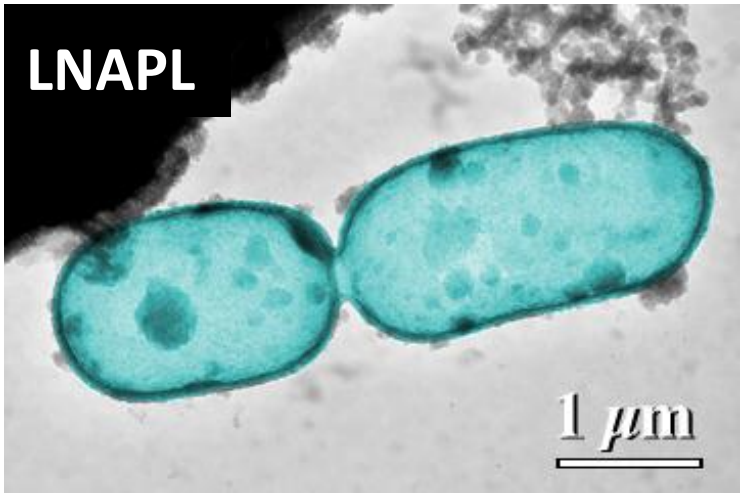
EDB has undergone degradation in the anaerobic plume core increasing groundwater bromide

# Natural Biodegradation Take Away



Benzene

- **Hydrocarbons and EDB have degraded to some extent**
- **Natural biodegradation will not adequately clean up the contamination**
- **Stimulate aquifer bacteria to do a better job**



# Priorities

1) Protect Drinking Water Supply Wells

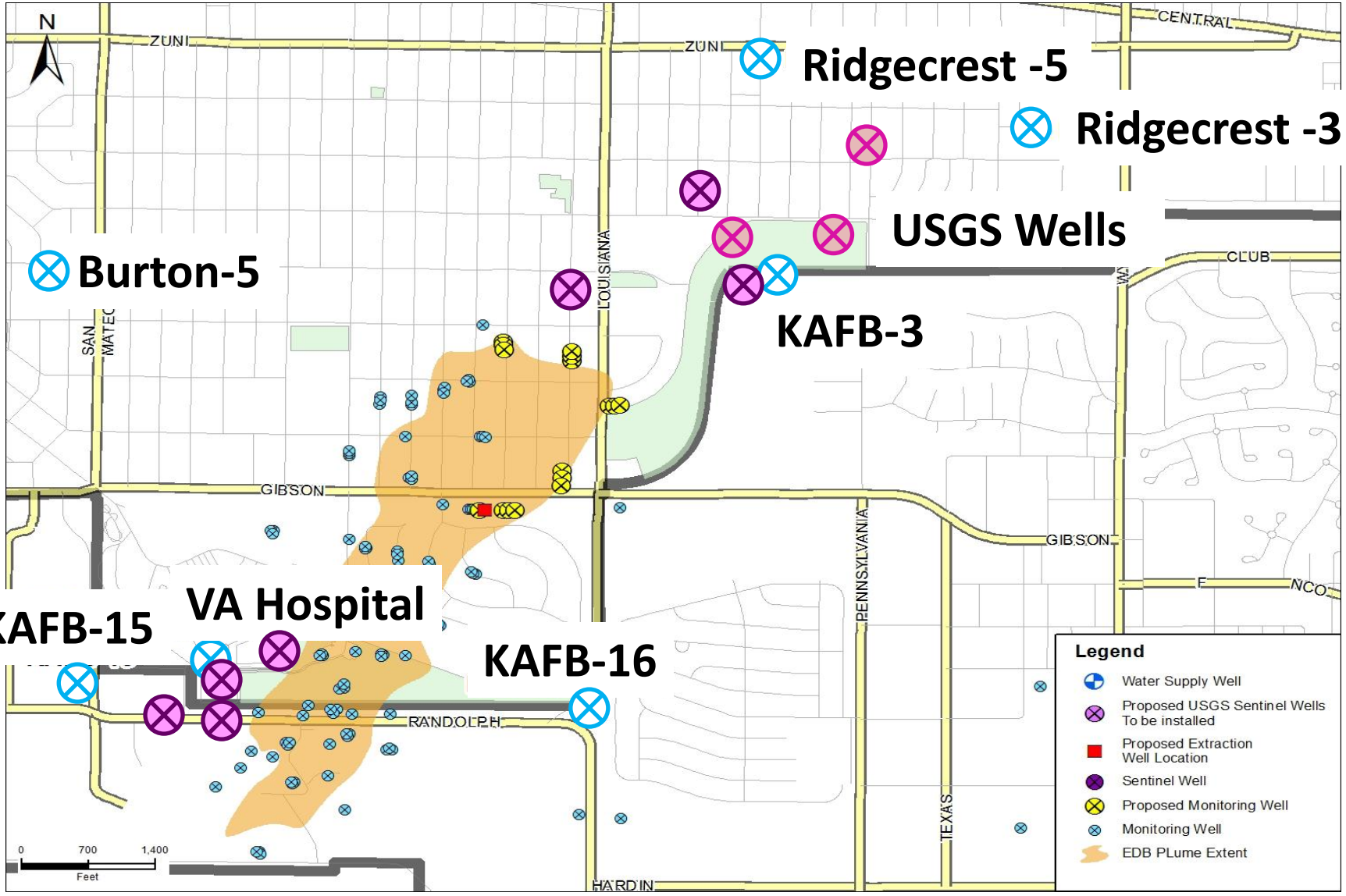
2) Collapse the EDB Plume

3) Remediate LNAPL

4) Soil Vapor Extraction in the Source Area

**Interim Measures are Underway to Cleanup the KAFB BFF Site.**

# Protecting Drinking Water Supply Wells



# Drinking Water Protection Take Away

| EDB Drinking Water Standards | |
|---|---|
| **U.S. EPA** | **0.05 µg/L** |
| **State of New Mexico** | **0.05 µg/L** |

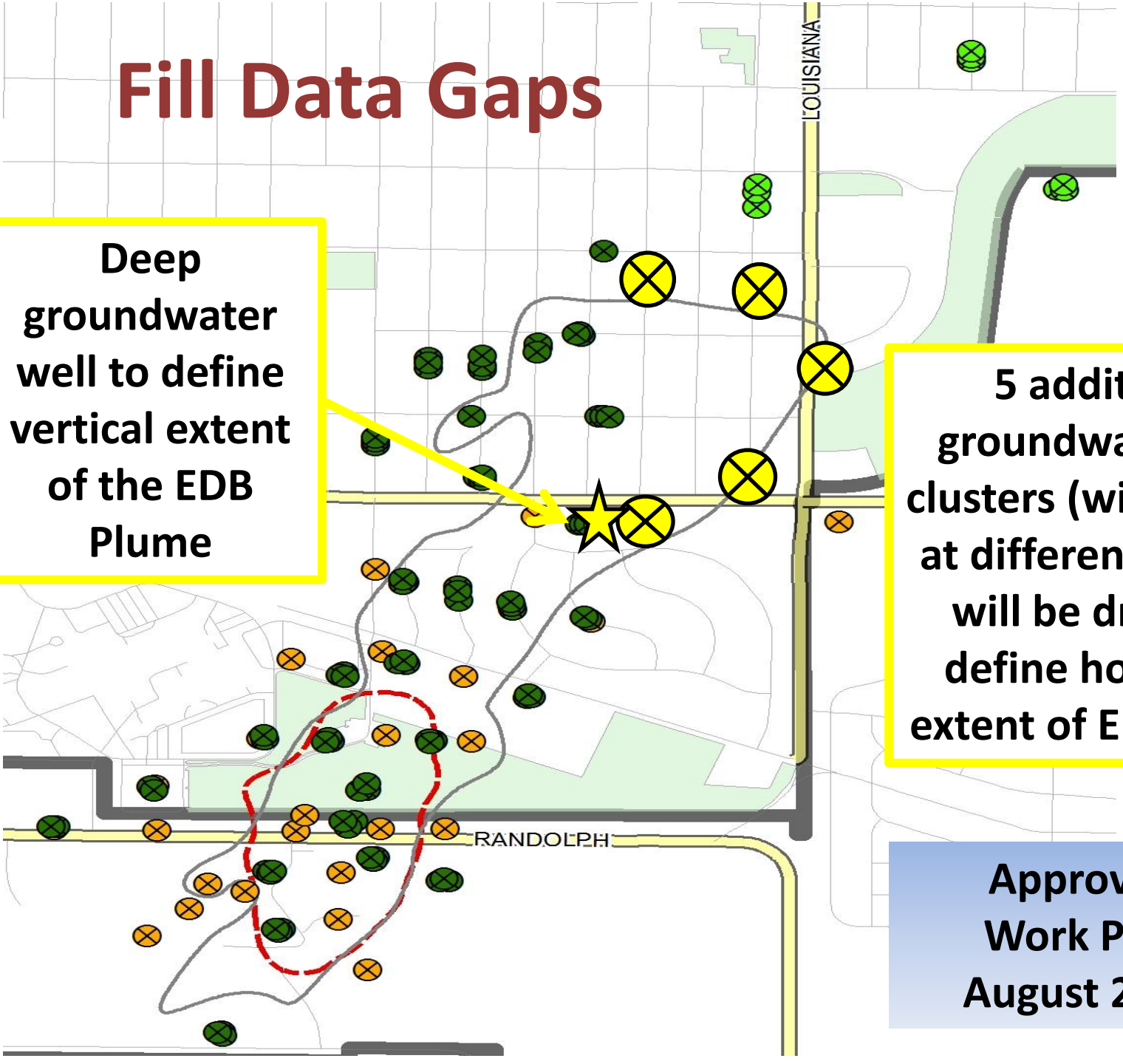
- Federal law requires testing once every 3 years for EDB and benzene; sampling increases to quarterly if contaminants are detected
- Drinking water supply wells in the area are being tested monthly
- No detections of any fuel contaminants in any production well
- EDB regulatory detection limit = 0.01 µg/L for public water systems
- Sentinel wells have been installed to provide early detection of any plume migration in the direction of the water supply wells

**Dissolved EDB will not be allowed to impact any drinking water supply system at detectable concentrations**

# Collapse the EDB Plume Plan

- **Phase 1** – Interim measure P&T of EDB plume in the vicinity of well KAFB-106035 & additional characterization of the lateral & vertical extent was needed
  - Fill data gaps with 16 groundwater monitoring wells
  - Install initial well/P&T system to treat approximately 100 gpm
- **Phase 2** - Design and construct an expanded P&T system to collapse the EDB plume
  - Install up to 7 additional extraction wells; total pumping rate of 600-800 gpm
- **Phase 3** - System operation and maintenance along with optimization to stop potential migration and continue collapsing the EDB plume

# Fill Data Gaps

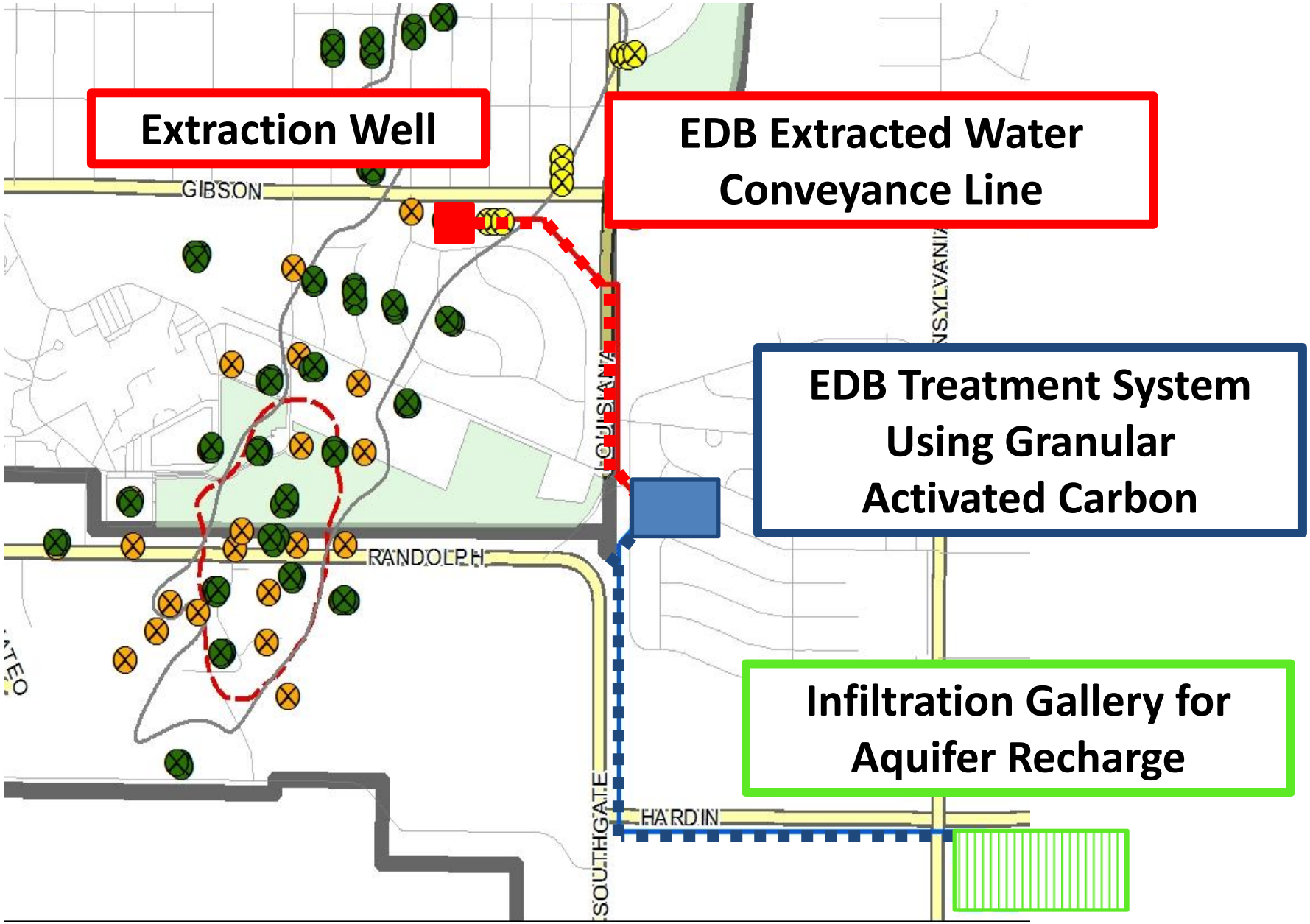



**Deep groundwater well to define vertical extent of the EDB Plume**

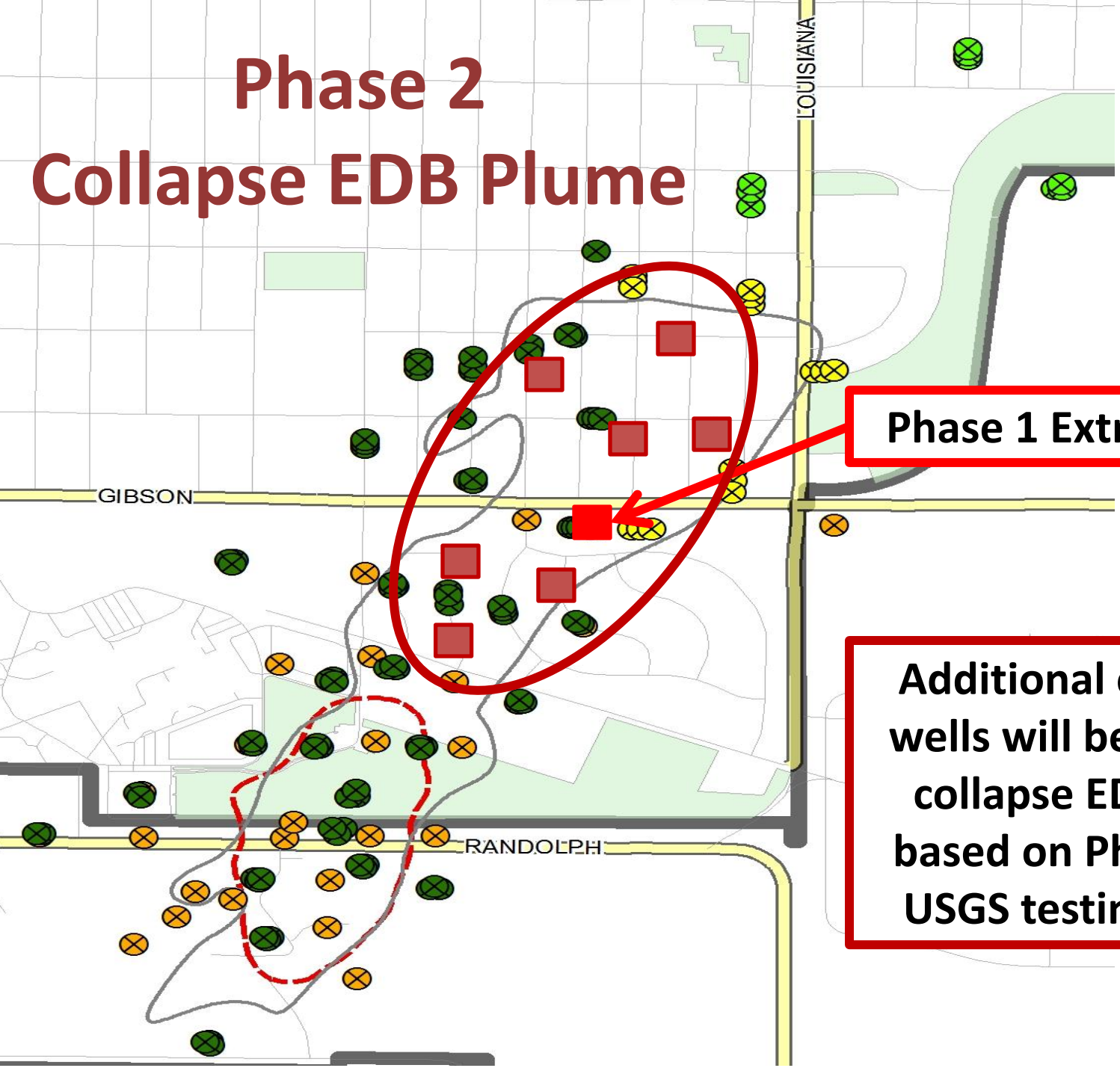
**5 additional groundwater well clusters (with 3 wells at different depths) will be drilled to define horizontal extent of EDB plume**

**Approved Work Plan August 2014**

# Phase 1 - Collapse the EDB Plume



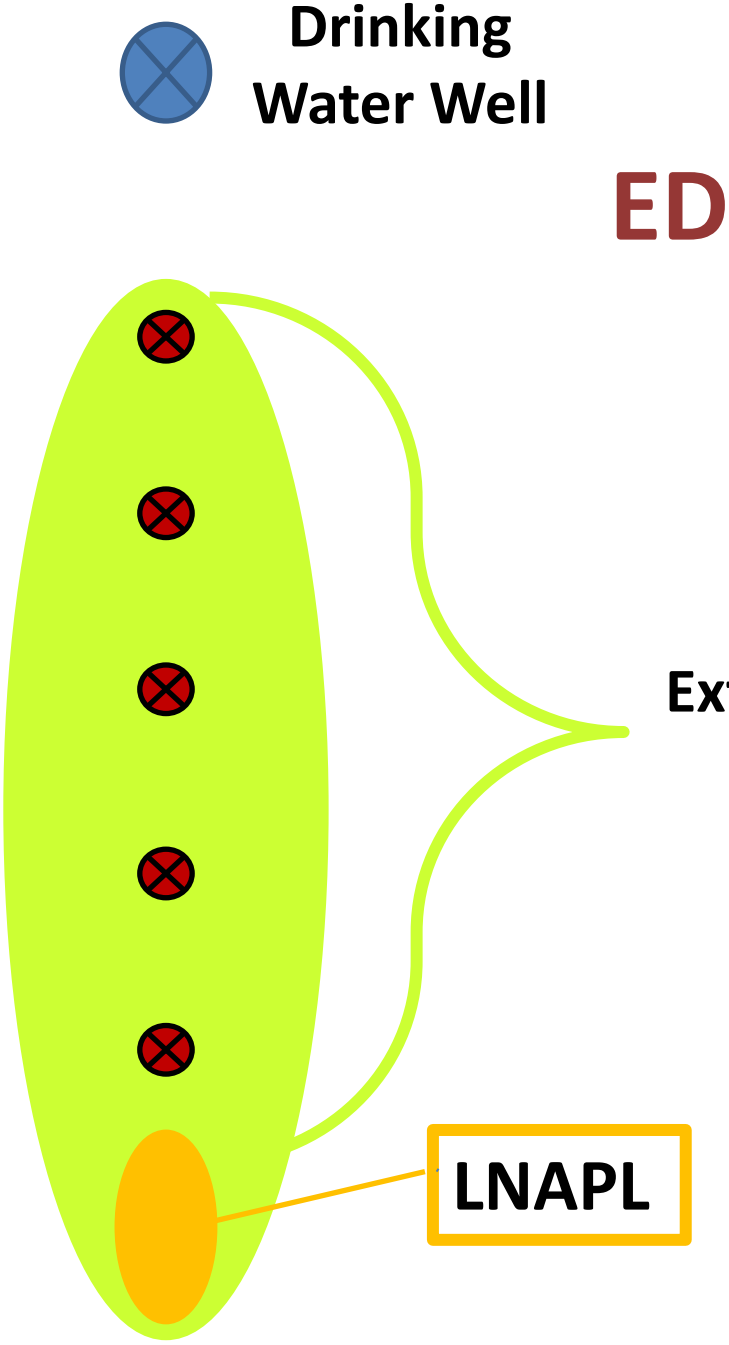
# Phase 2
# Collapse EDB Plume




**Phase 1 Extraction Well**

**Additional extraction wells will be placed to collapse EDB plume based on Phase 1 and USGS testing results.**

# Collapsing the EDB Plume Take Away



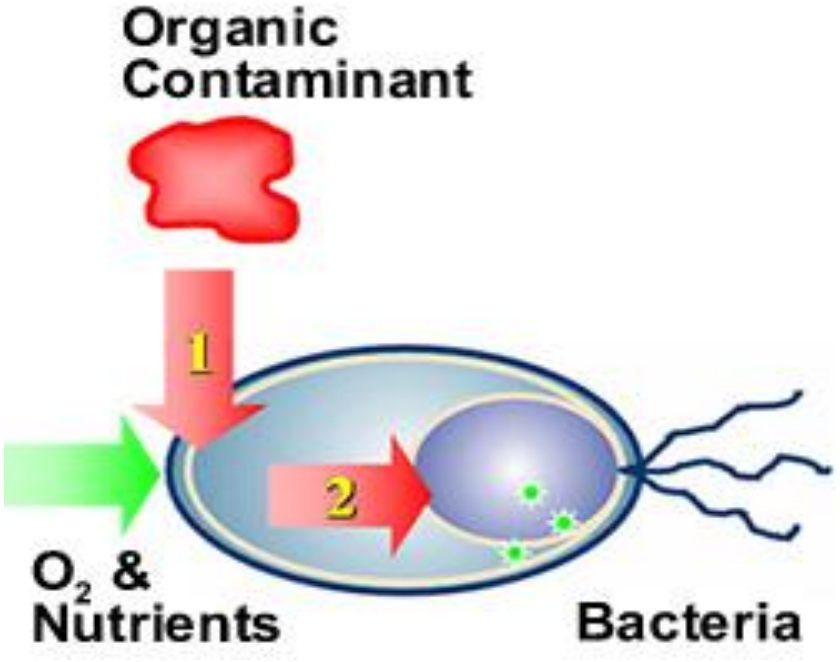

**Extracted groundwater will be treated to 0.05 µg/L or better, and put to beneficial use.**

**Options being considered:**

- Aquifer recharge
- Non-potable industrial use (irrigation, dust control)

# Remediate LNAPL

- **Naturally occurring processes that degrade LNAPL components (i.e., fuel hydrocarbons and EDB)**
  - Biological processes (biotic)
  - Non-biological processes (abiotic)
- **Effective remedial approaches take advantage of these processes**




# Biotic Degradation Processes

**Biotic processes - Natural bacteria living in the aquifer are biodegrading the fuel hydrocarbons and destroying some of the EDB under aerobic and anaerobic conditions.**

- Bacteria can utilize fuel hydrocarbons as a food source

$$C_6H_6 \text{ (benzene)} + O_2 \rightarrow CO_2 + H_2O + \text{cell mass}$$

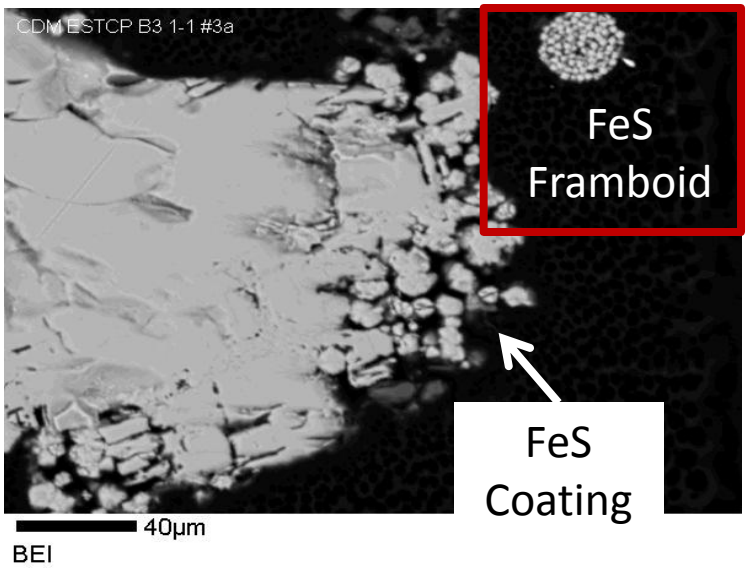
- Bacteria can utilize EDB like people use oxygen to breathe during the degradation of fuel hydrocarbons under anaerobic conditions

$$C_2H_4Br_2 \text{ (EDB)} + 2\ e^- \rightarrow C_2H_4 \text{ (ethylene)} + 2\ Br^-$$

Called Reductive Debromination

- Some bacteria can utilize fuel hydrocarbons as a food source and cometabolize EDB
  - Enzymes that degrade fuel hydrocarbons also degrade EDB without benefit to the bacteria

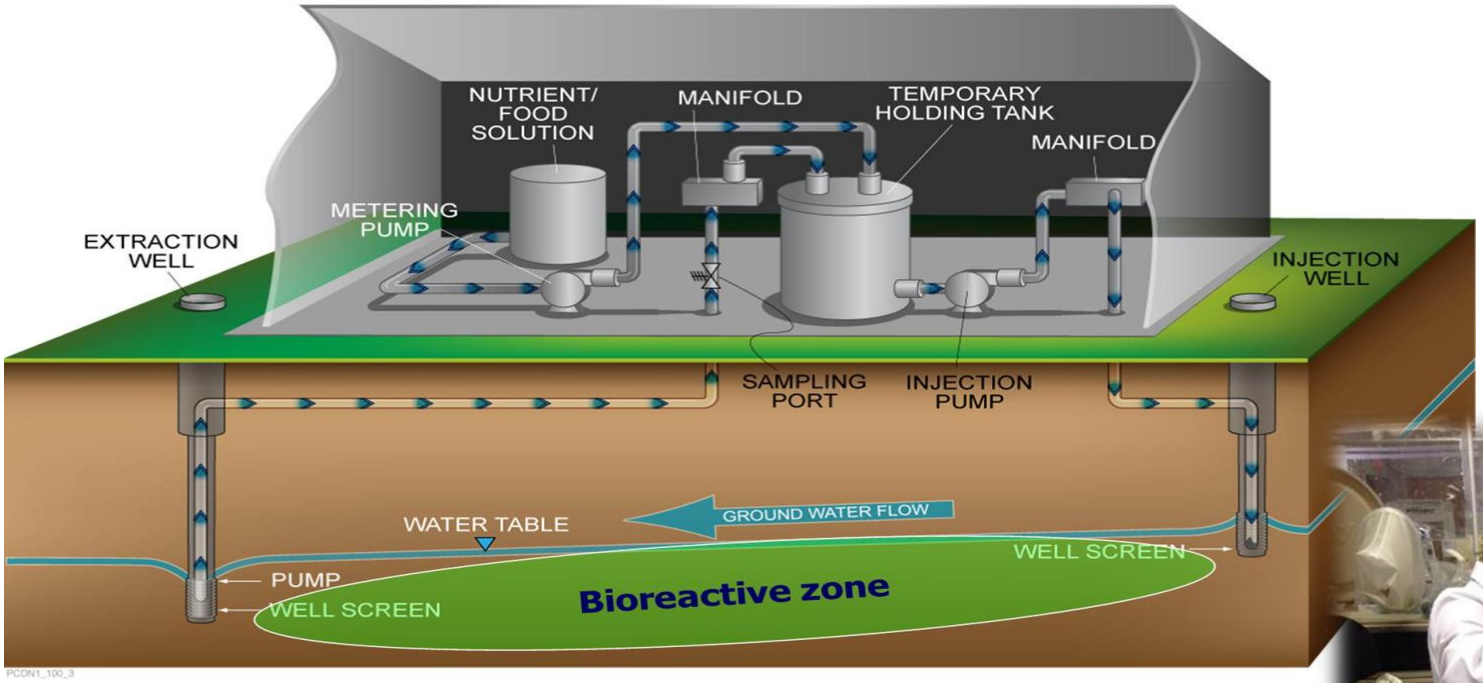
# Abiotic Degradation Processes

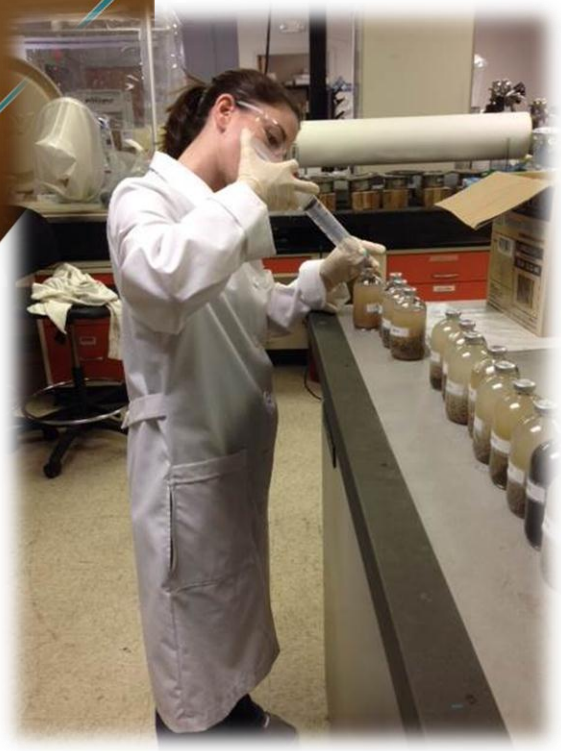



- **Reactive minerals can remove bromide from the EDB**
  - Similar to reductive debromination the result is bromide and ethylene

- **Hydrolysis (i.e., reaction with water)**
  - Half lives can be up to 18 years
  - In the presence of sulfide or at elevated temperatures half lives can be on the order of hours
  - The end product is bromide and ethylene glycol, which degrades readily under aerobic and anaerobic conditions

# Bioremediation Option

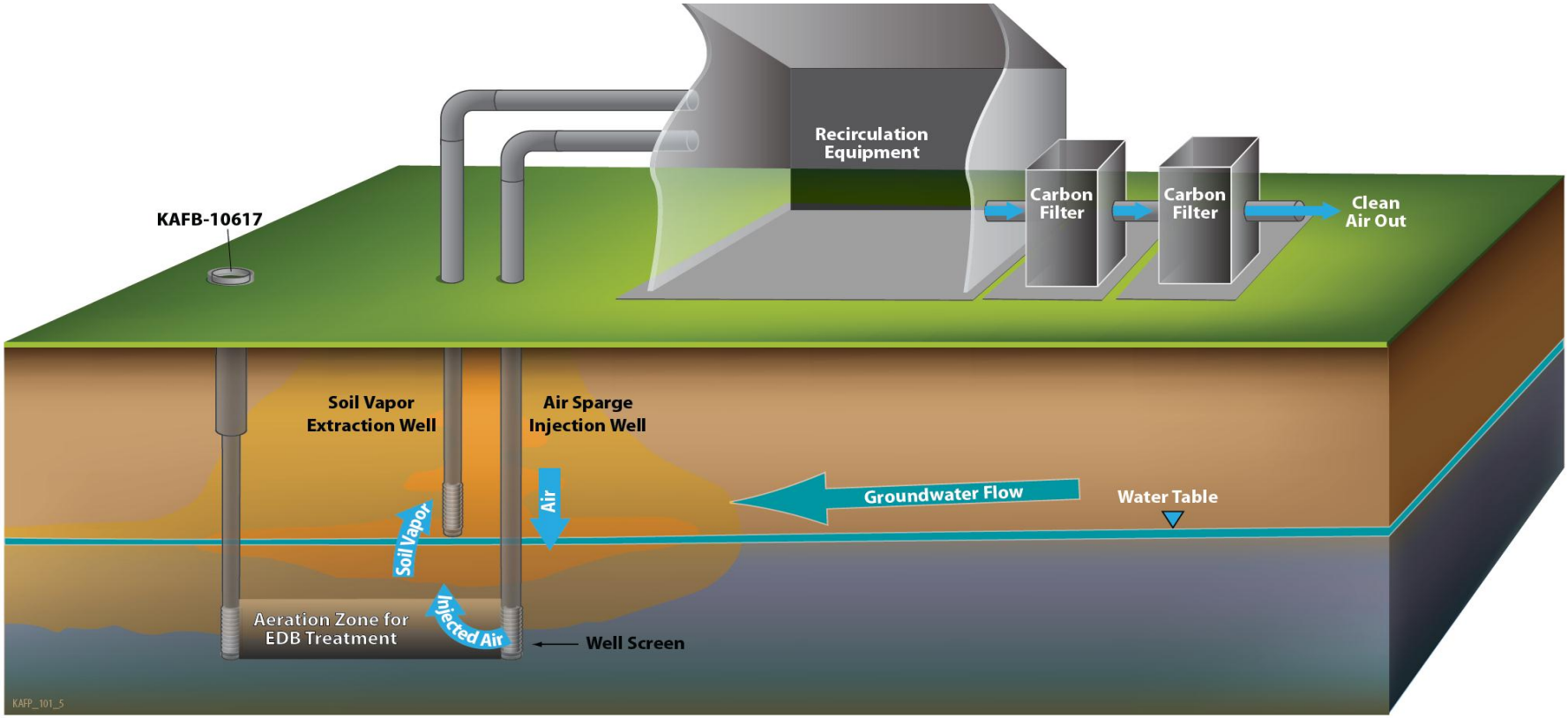


- **Laboratory studies are evaluating abiotic and biotic degradation including aerobic and anaerobic conditions**
  - Results expected early 2015
  - Ramping up for in situ bioremediation pilot test based on the results obtained

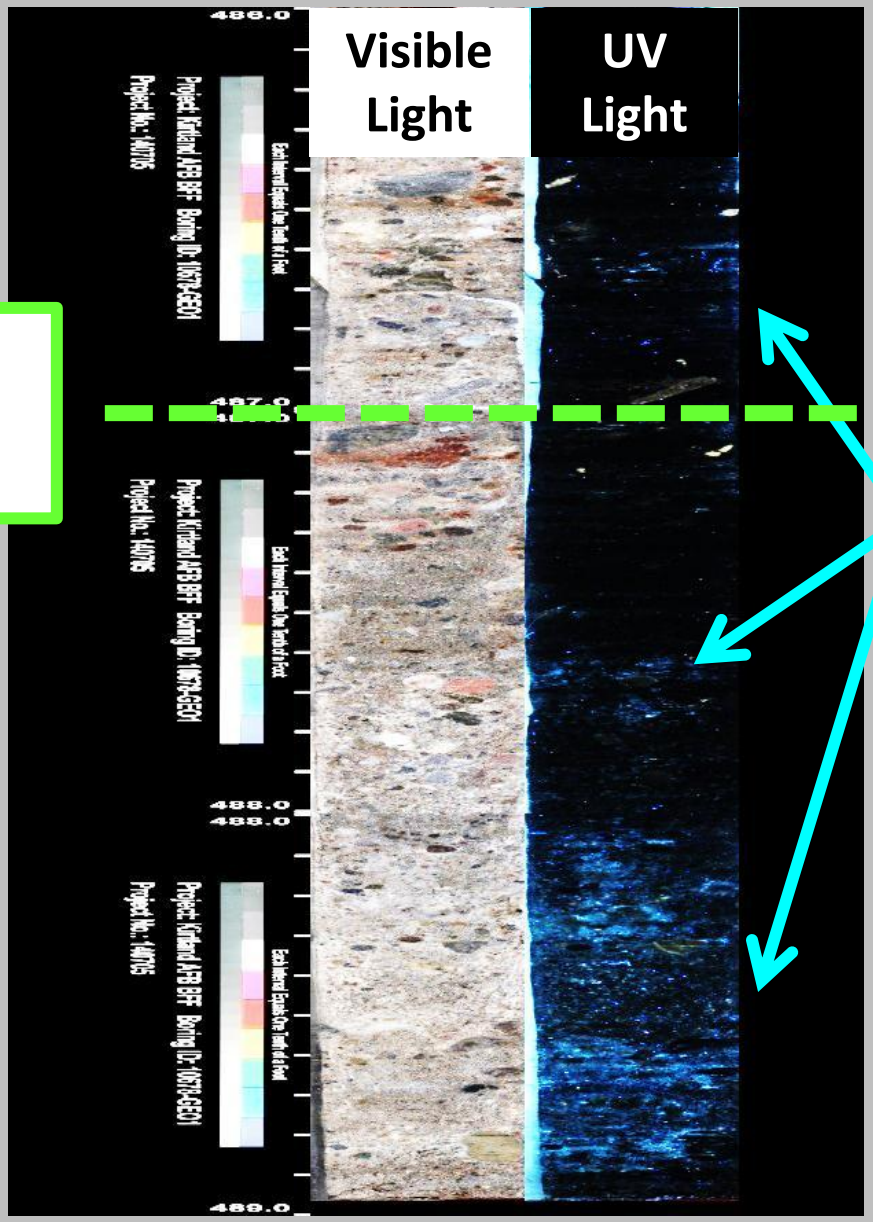
# Air Sparging Option

- **Air sparging pilot currently operating and results are expected in late 2014/early 2015**
- **Ramping up for pilot study of three air sparging wells to target both dissolved-phase and LNAPL zone**



# Drowned LNAPL – BFF Soil Cores

Groundwater Table

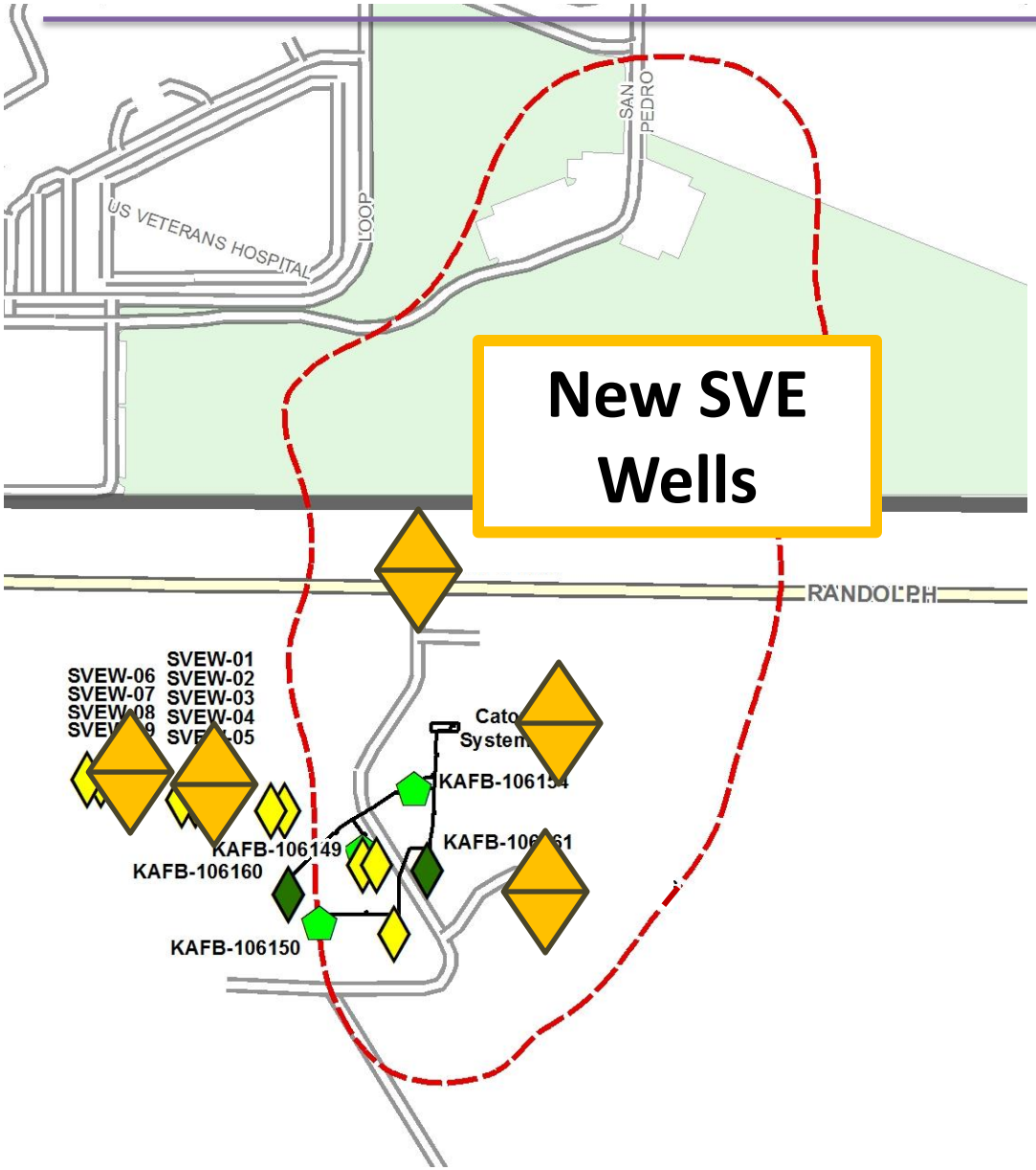



LNAPL Under UV Light Fluoresces Blue

# LNAPL Take Away

- **LNAPL submerged by a rising water table exists in a 44 acre area and is a long-term source of dissolved-phase contamination**
- **Exploring physical and biological options to cleanup the LNAPL zone**
  - In situ bioremediation
  - Air sparging
- **Natural aquifer bacteria have biodegraded the fuel hydrocarbons**
  - EDB has undergone biodegradation in the anaerobic portion of the plume
  - Engineered bioremediation should accelerate cleanup at the BFF site by stimulating the natural aquifer bacteria to do a better job

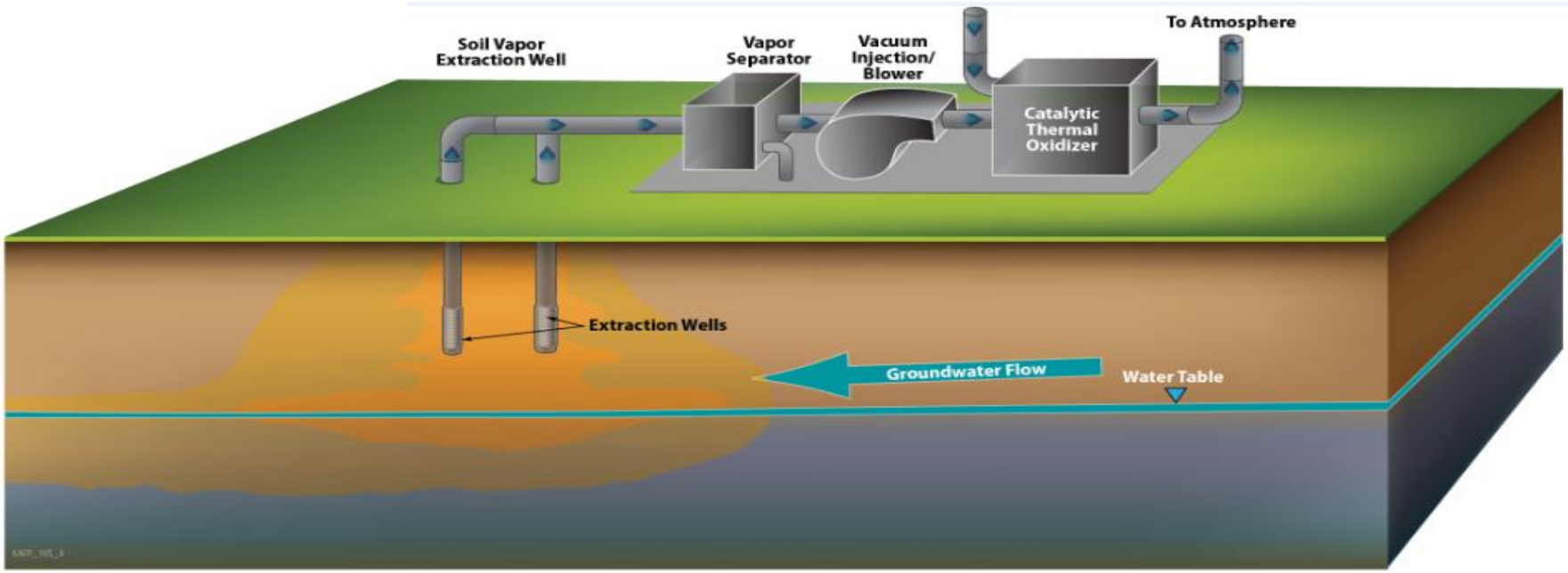
# Soil Vapor Extraction




- **Expand the SVE footprint by installing 5 SVE well clusters in hot spot areas**
- **Collect and evaluate SVE soil cores using state of the art techniques**
- **Perform SVE pilot testing to inform vapor extraction rates and the size of the SVE destruction system**

# SVE Take Away

- More than 500,000 gallons (3.5M pounds) of fuel recovered by SVE
- SVE capacity will be increased from 90 up to as much as 1500 pounds per hour
- Vapor will be treated in accordance with City of Albuquerque Air Quality Permit requirements



# Recap

- **Protect Drinking Water Supply Wells**
  - Sentinel wells for early detection
  - Monthly testing of drinking water wells
- **Collapse the EDB Plume**
  - Fill data gaps
  - Extract dissolved EDB and pull EDB away from drinking water wells
- **Remediate LNAPL**
  - Pilot tests underway
- **Soil Vapor Extraction in the Source Area**
  - Expand vacuum footprint
  - Expand and increase capacity

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# Questions?

# How do I get up to date information on the BFF spill?

Project updates

BFF-specific spill website:
www.kirtlandjetfuelremediation.com

## Contact us:

**Air Force Civil Engineer Center**
Office of Public Affairs
2261 Hughes Ave, Ste 155
Joint Base San Antonio-Lackland TX 78236-9853
(210) 925-0956
Phone #: (866) 725-7617
Email: afcec.pa@us.af.mil

Interested community members may review Air Force Environmental Restoration Program documents at the Kirtland AFB Information Repository located at the Central New Mexico (CNM) Community College-Montoya Campus Library, 4700 Morris NE, (505) 224-5721

or

by visiting the Kirtland AFB website at http://www.kirtland.af.mil in the Environmental Issues section for Public Records.