

# Kirtland Air Force Base Fuel Spill Cleanup

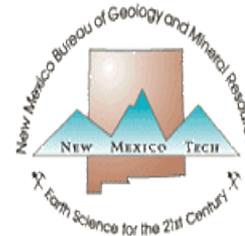
October 15, 2015



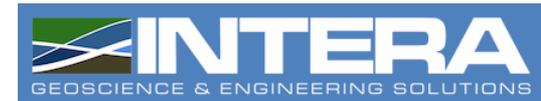
Prepared by  
**Dennis McQuillan, Geologist**  
and  
**Diane Agnew, Hydrogeologist**

# A Partnership for Success

A collaborative technical team is solving the complex hydrogeologic and engineering challenges posed by fuel spill



US Army Corps of Engineers



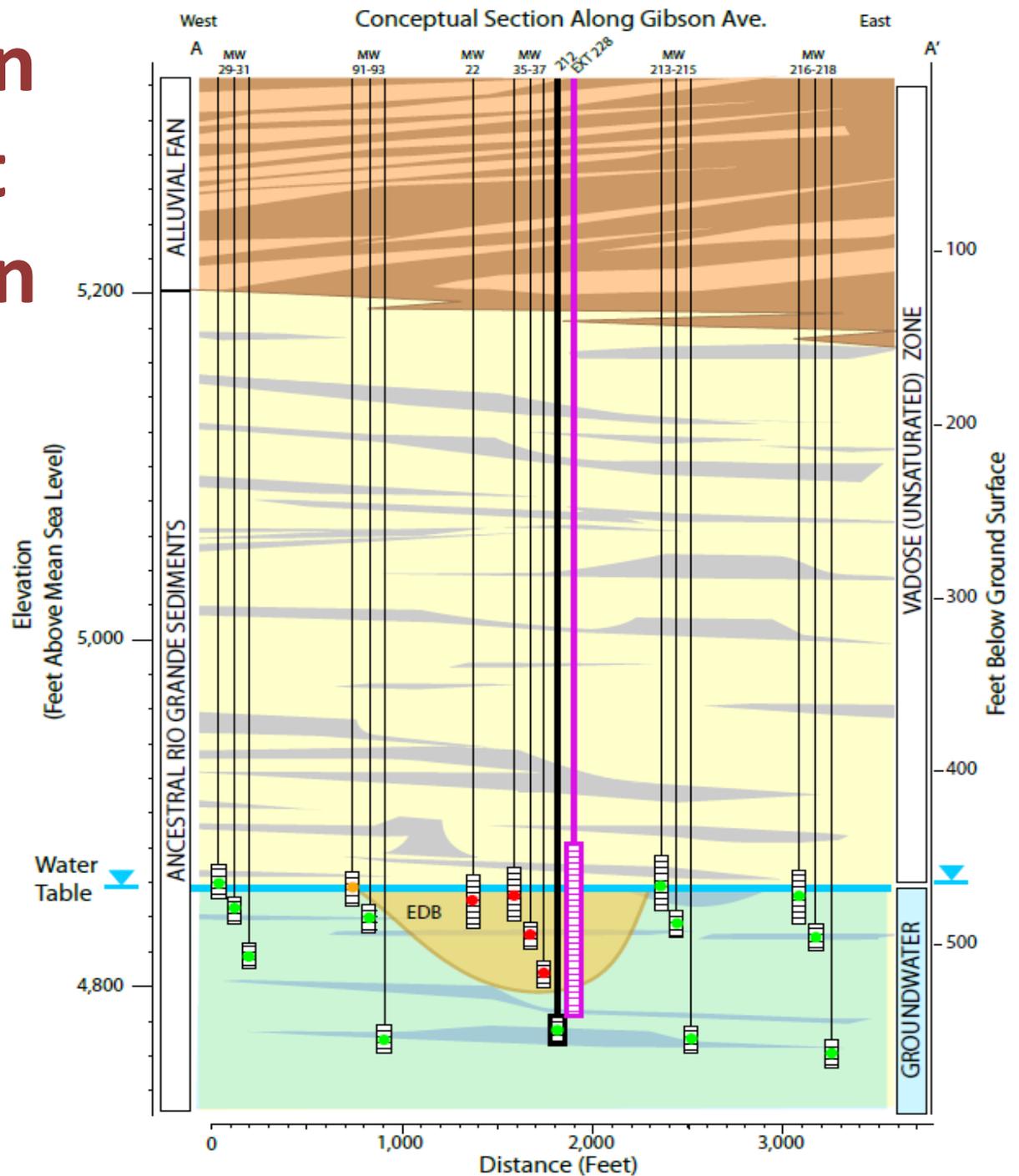
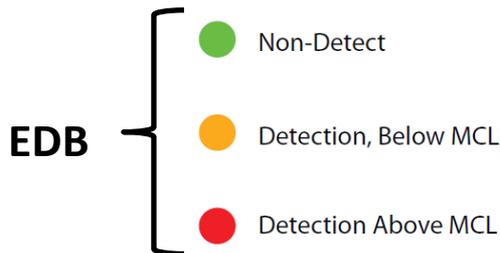
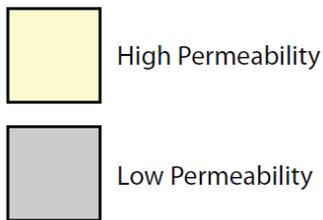


# Cross Section ~ West-East Along Gibson

## Alluvial Fan Sediments



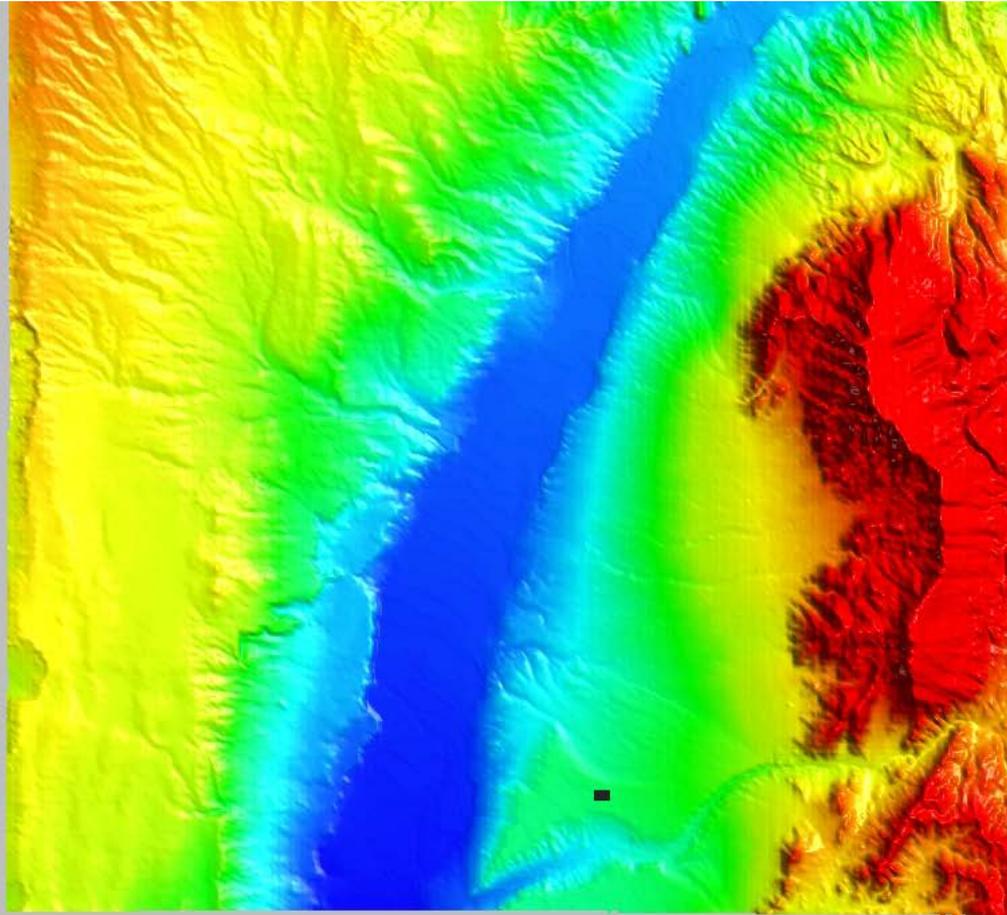
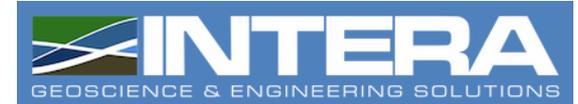
## Ancestral Rio Grande Sediments



# Site Stratigraphy and Wells



John Sigda, Ph.D., Intera

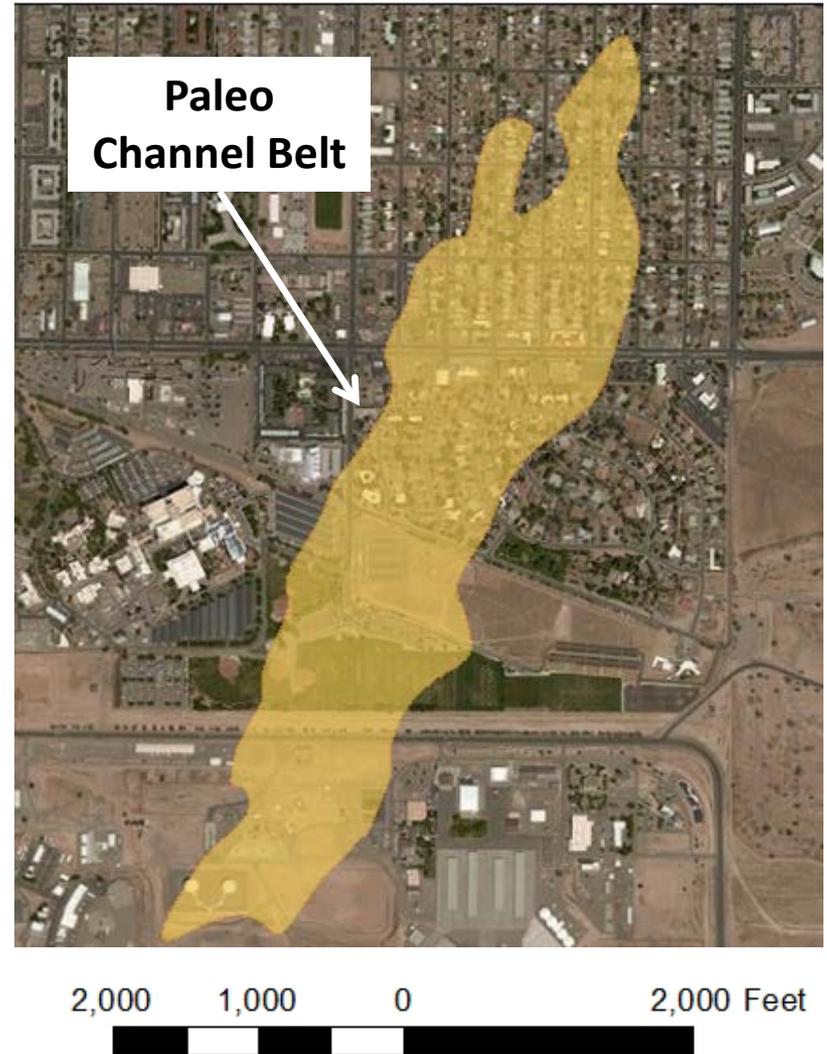


# Rio Grande Braided Stream Channel Belt

Rio Grande Braided Stream  
In Albuquerque South Valley



Shallow EDB Plume

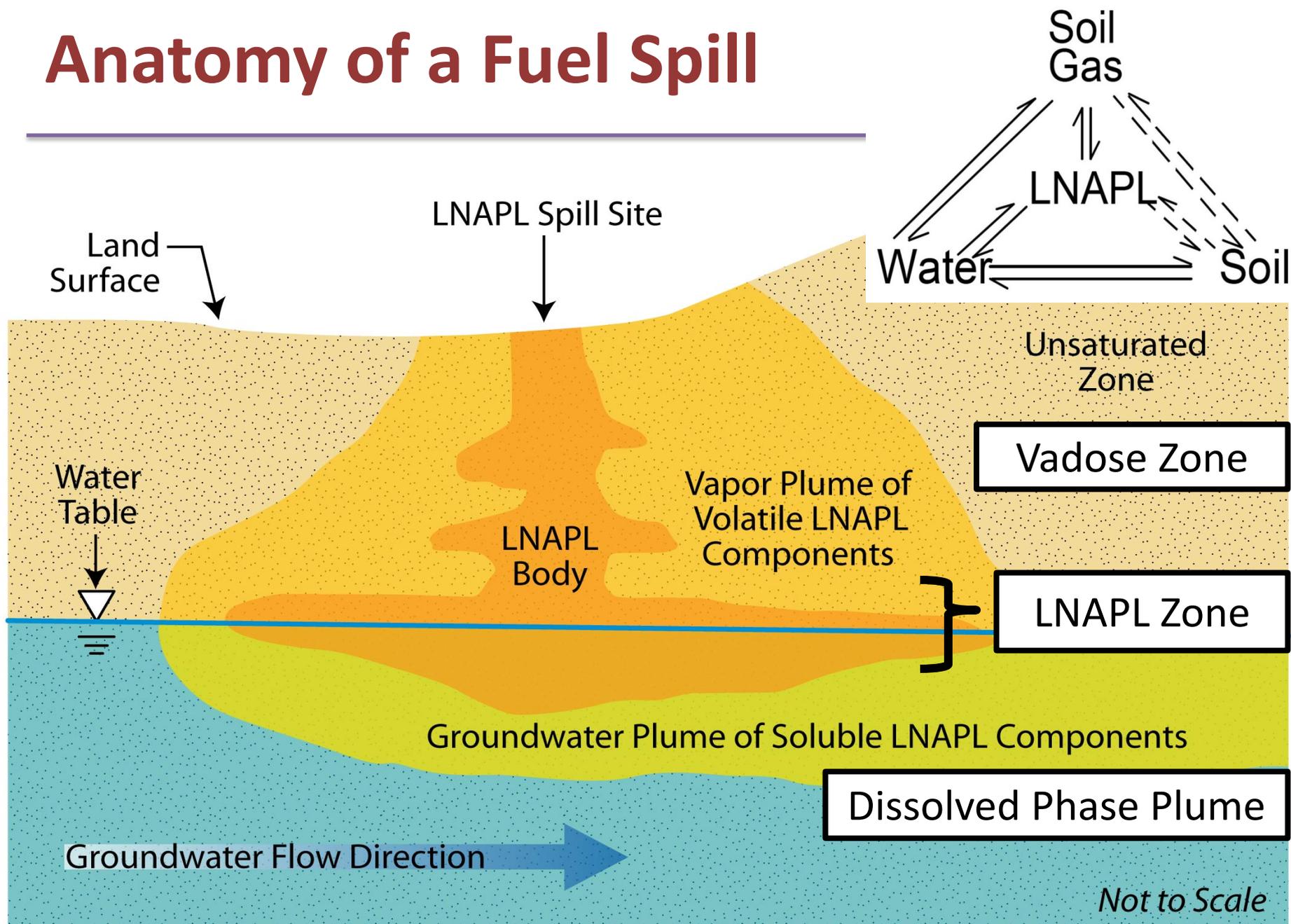


# KAFB Fuel Spill History

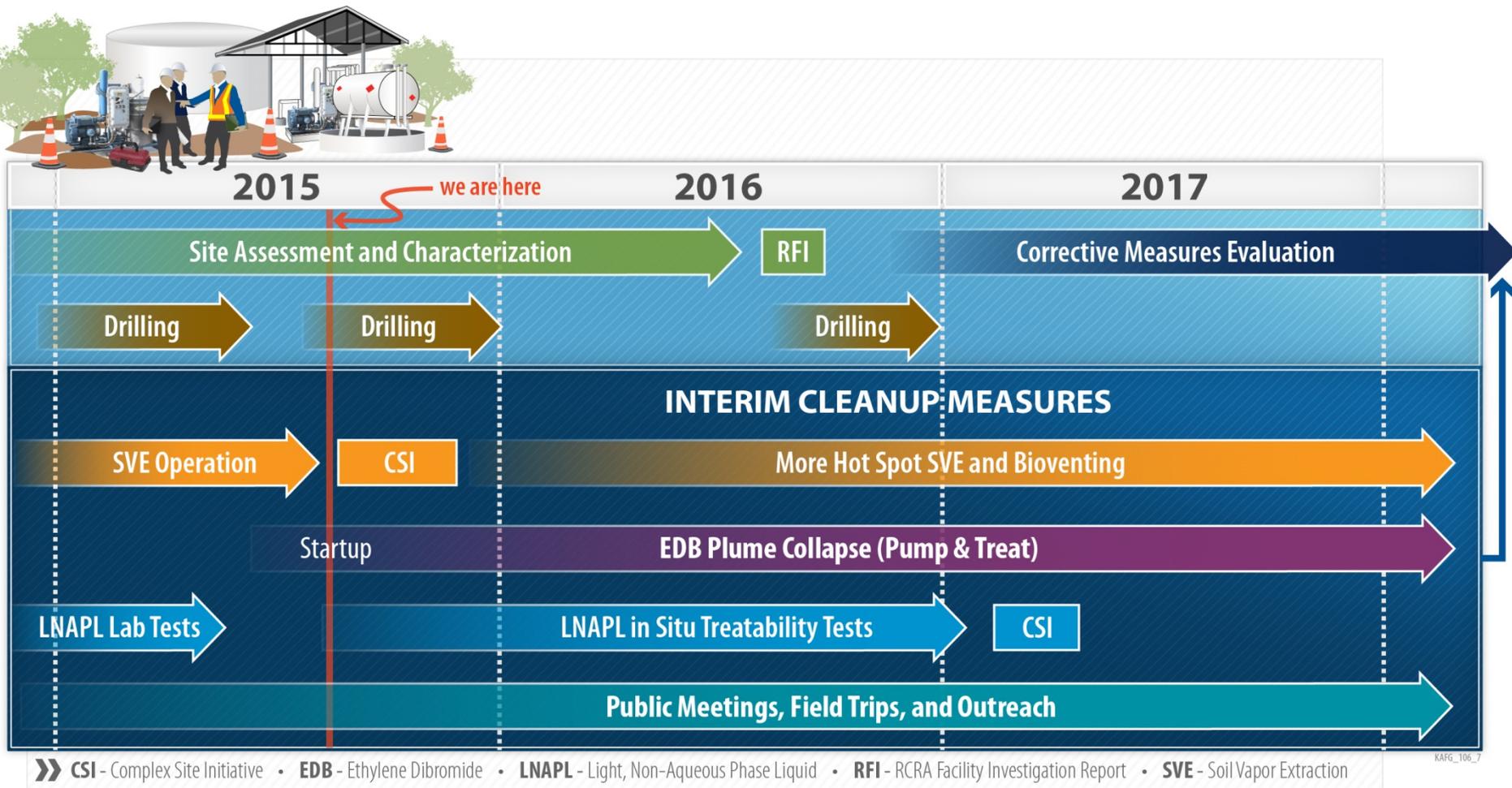
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- **1951-53** – Kirtland Air Force Base (KAFB) Bulk Fuels Facility (BFF) constructed
- **1975** – Handling of aviation gasoline containing the additive ethylene dibromide (EDB) discontinued
- **1999** – KAFB notified NMED of soil contamination from underground piping leak, and ceased use of piping
- **2001** – KAFB notified NMED of groundwater contamination with dissolved fuel constituents
- **2003** – Soil vapor extraction (SVE) begins to vacuum contaminants from soil
- **2007** – Fuel (light non-aqueous phase liquid, LNAPL) discovered floating on groundwater
- **2009** – Water level rise begins to submerge LNAPL within aquifer
- **2014-15** – Inter-agency partnership, additional interim measures
- **2015** – Groundwater cleanup begins

# Anatomy of a Fuel Spill



# RCRA Corrective Action Timeline 2015-17



KAFG\_106.7

# Regulatory Basis

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**The New Mexico Environment Department (NMED) has been granted primacy by the U.S. Environmental Protection Agency to administer:**

- The Safe Drinking Water Act (SDWA) program; and
- The Resource Conservation and Recovery Act (RCRA) program

**Public water systems, the ABC Water Utility Authority, Kirtland AFB and the VA Hospital, must deliver water to consumers that meets SDWA standards.**

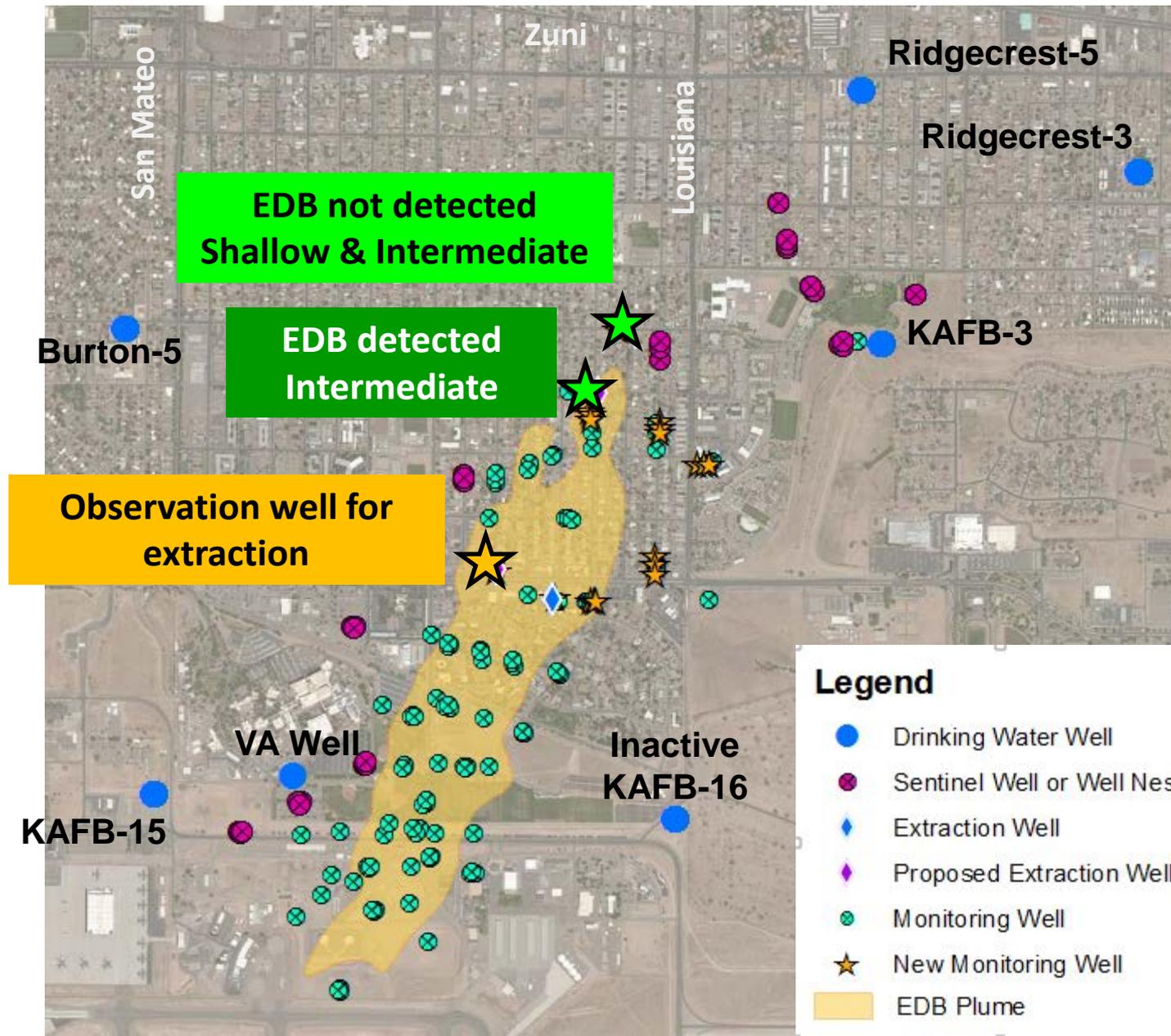
**Kirtland AFB must comply with their RCRA Hazardous Waste Permit, including the Corrective Action Process.**

# Monthly Wellhead Testing Shows No Drinking Water Contamination

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# Protecting Drinking Water Wells

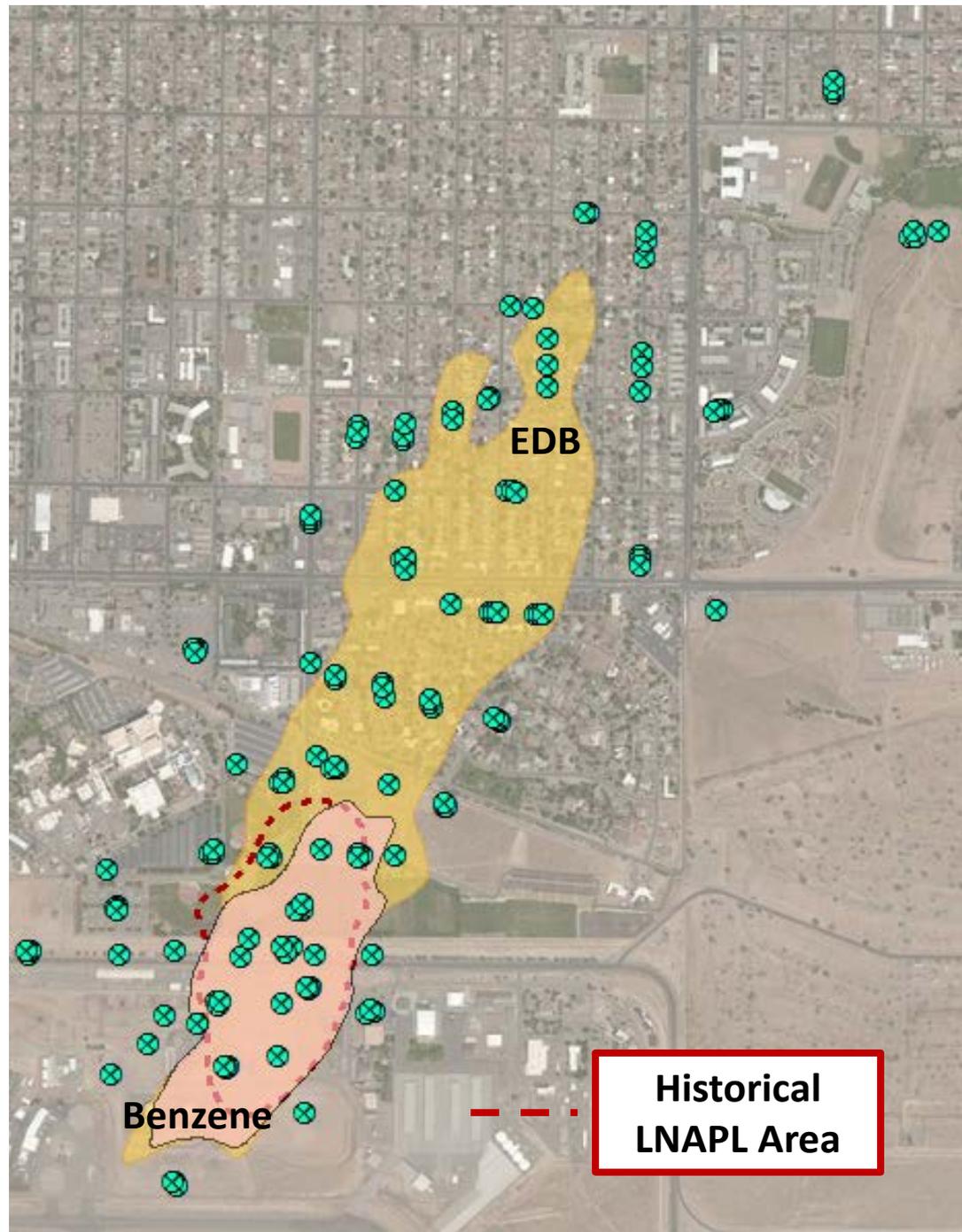


## EDB Plume

Biodegradation only  
in the area with  
dissolved  
hydrocarbons, EDB  
plume footprint is  
much larger than  
benzene footprint

## Benzene Plume

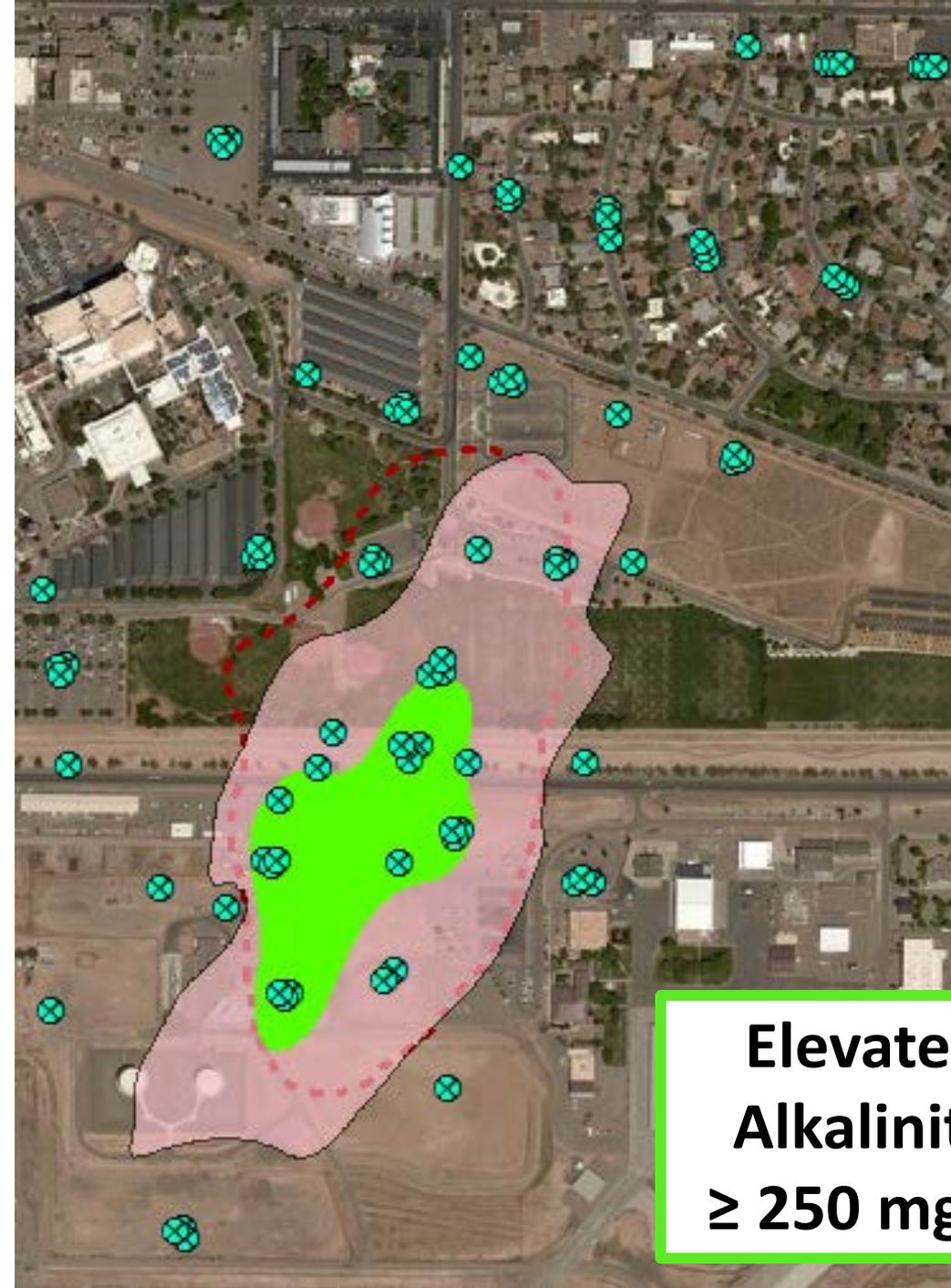
Hydrocarbons are being  
biodegraded by natural  
aquifer bacteria



# Natural Biodegradation

## Benzene Plume

Fuel hydrocarbons  
have undergone  
extensive  
biodegradation  
increasing alkalinity  
in groundwater



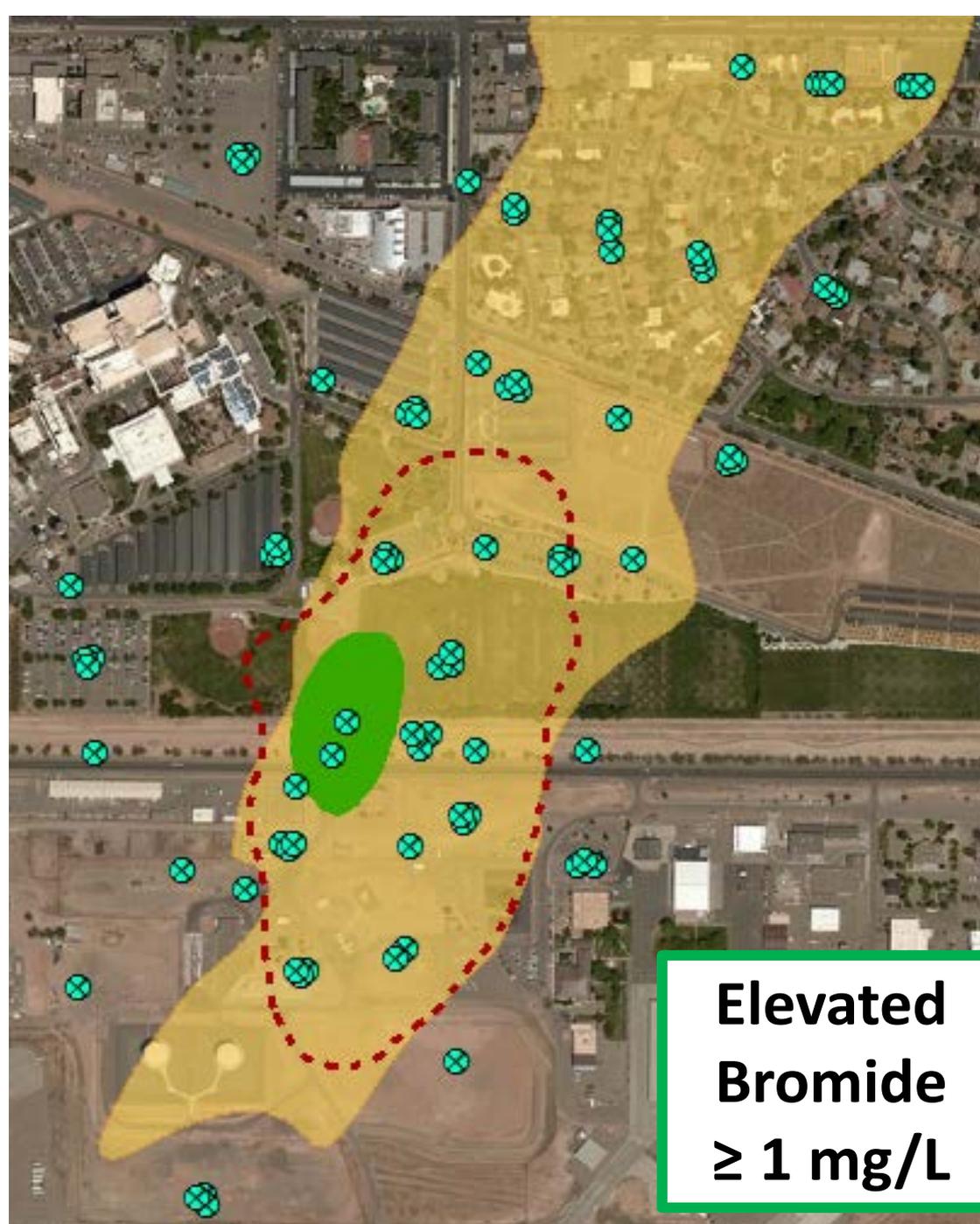
**Elevated  
Alkalinity  
≥ 250 mg/L**

# Natural Biodegradation

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## EDB Plume

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



**Elevated  
Bromide  
 $\geq 1$  mg/L**

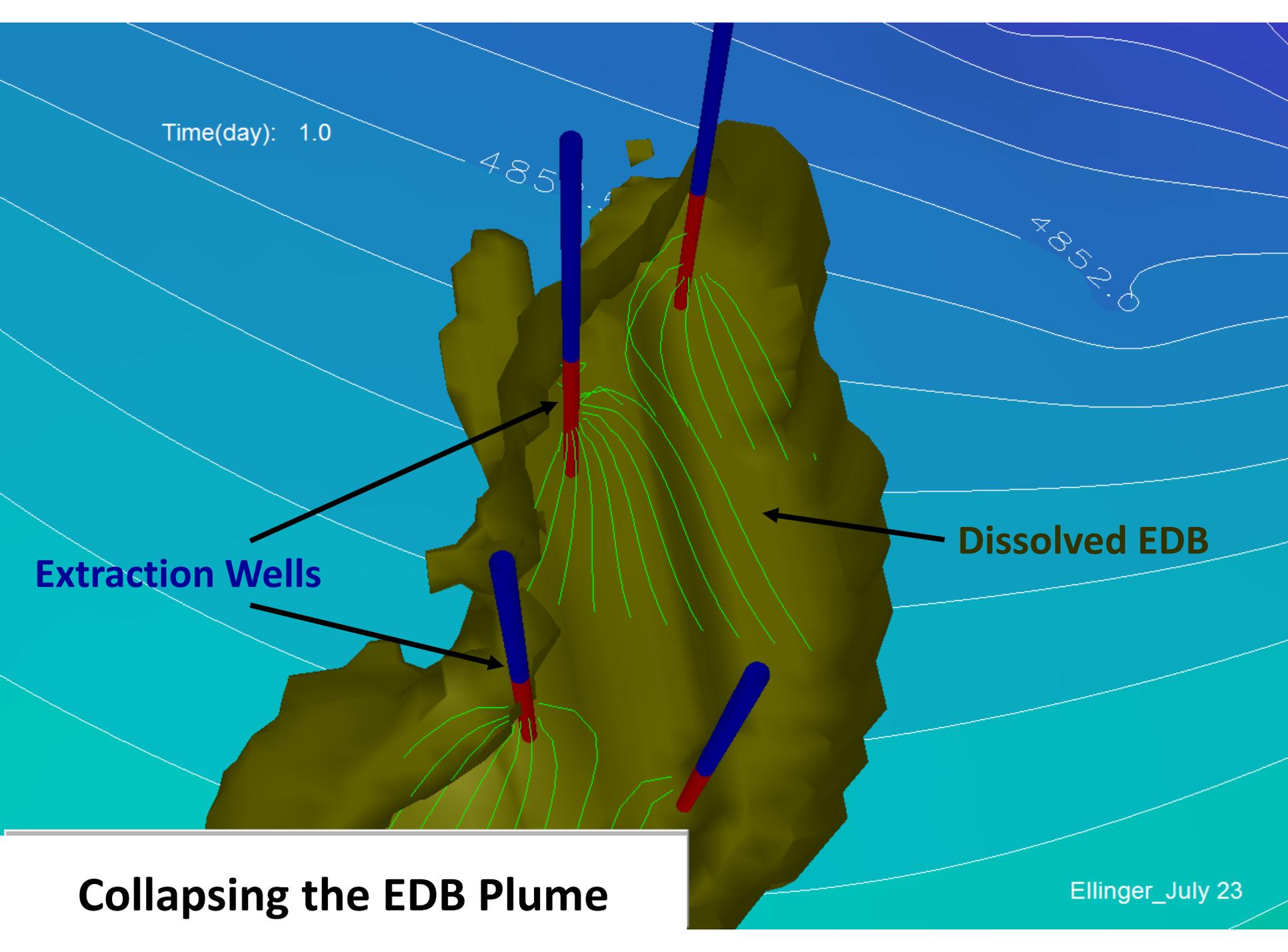
Time(day): 1.0

**Extraction Wells**

**Dissolved EDB**

**Collapsing the EDB Plume**

Ellinger\_July 23



# Collapsing the EDB Plume

2<sup>nd</sup> and 3<sup>rd</sup>  
Extraction  
Wells (2015)

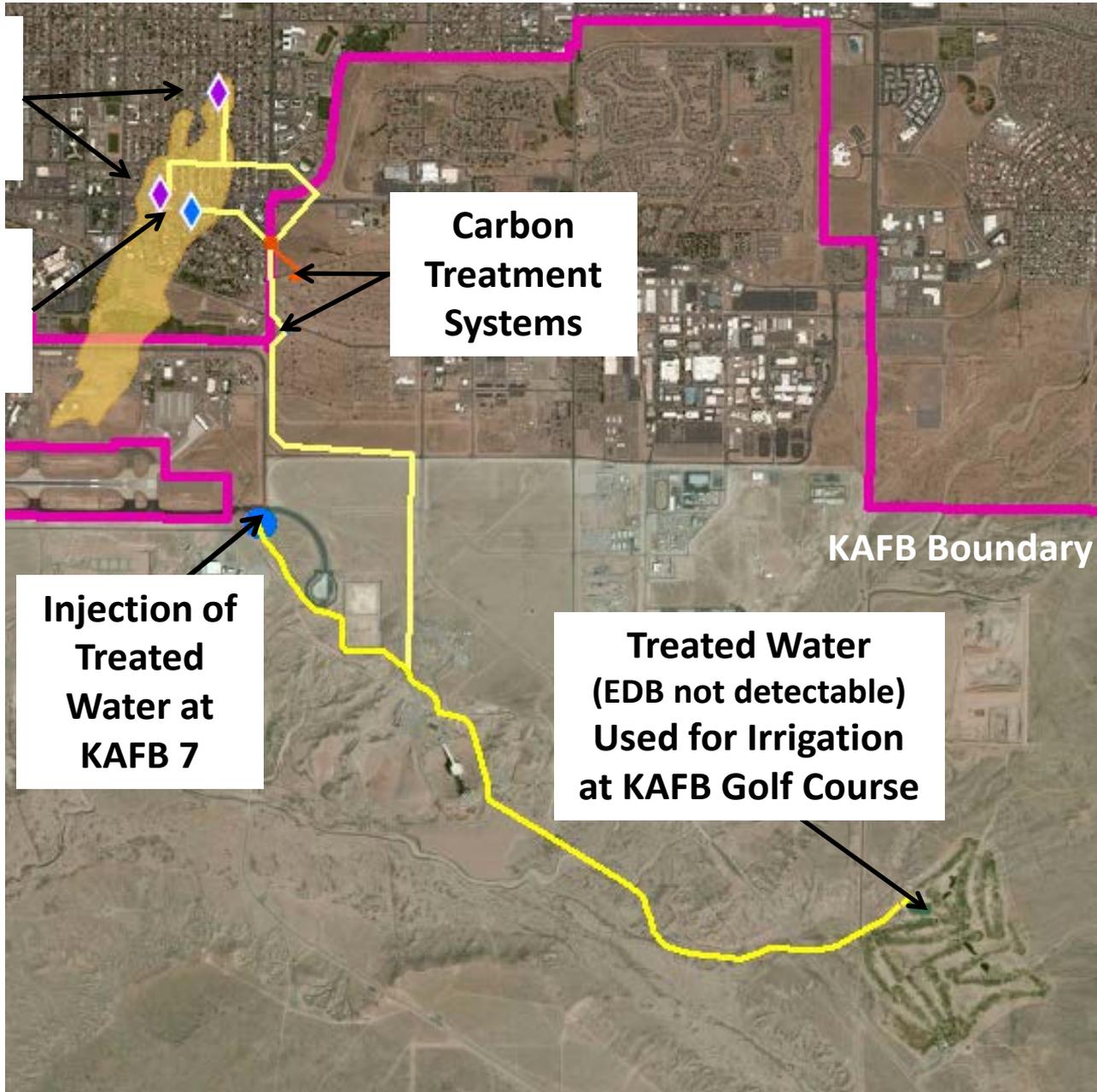
First  
Extraction  
Well

Carbon  
Treatment  
Systems

KAFB Boundary

Injection of  
Treated  
Water at  
KAFB 7

Treated Water  
(EDB not detectable)  
Used for Irrigation  
at KAFB Golf Course



# Groundwater Pump-and-Treat Full-Scale System



Excavation and leveling of building pad



Pouring of floor of building



GAC tanks and building walls

Pump on skid for full-scale treatment system

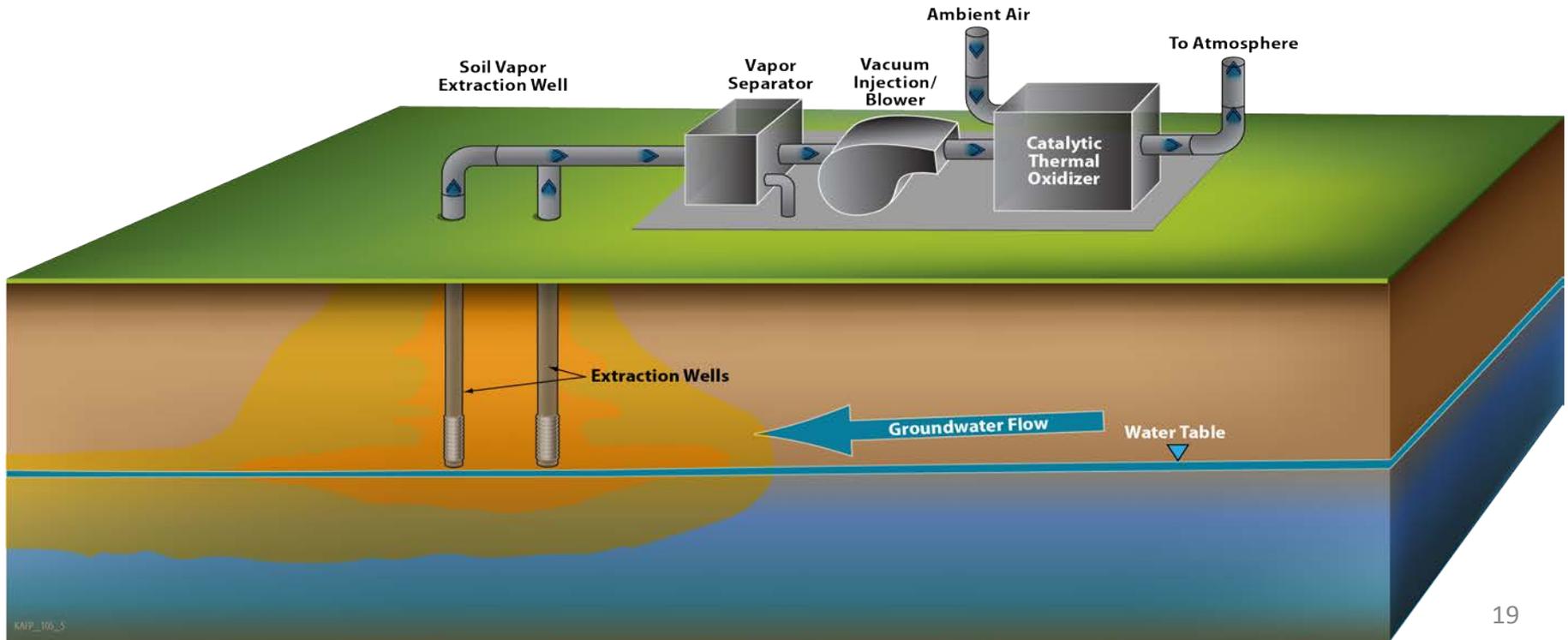


Discharge point at Tijeras Golf Course pond on Kirtland AFB



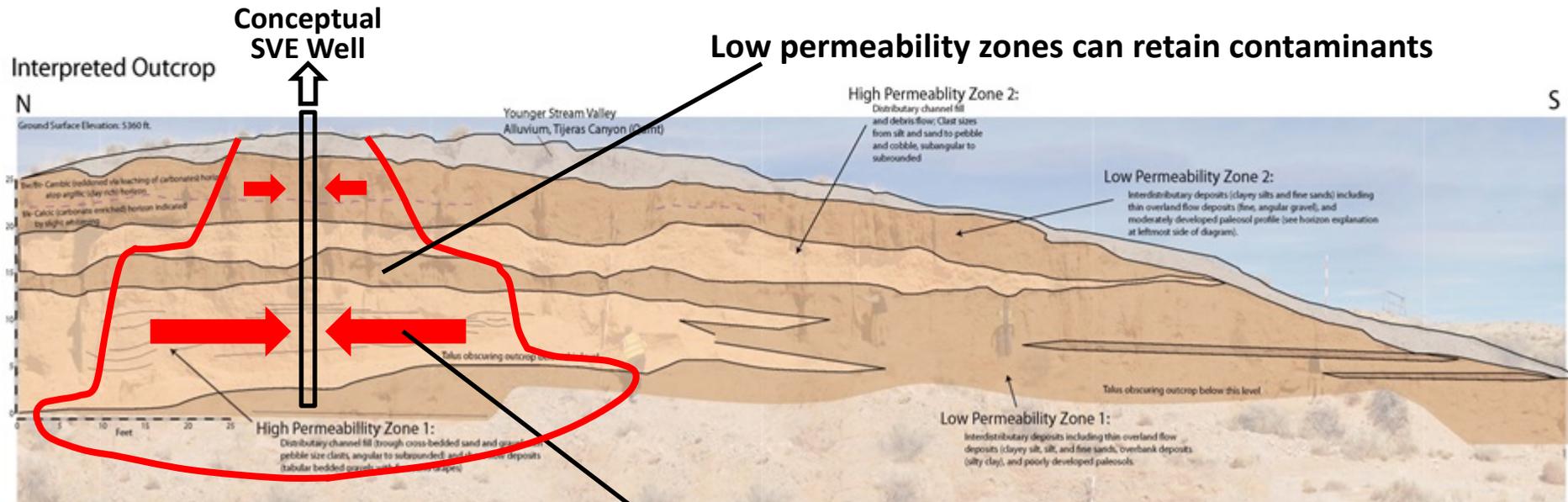
# Soil Vapor Extraction

- More than 600,000 gallons of fuel recovered by SVE
- After 12 years of SVE, soil vapor concentrations are decreasing
- Vapor is treated in accordance with City of Albuquerque Air Quality Permit requirements
- SVE rebound and bio-respiration testing completed in July 2015



# Alluvial Fan

Permeability differences control the migration of fuel and the recovery of fuel vapor by SVE

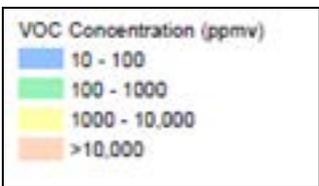
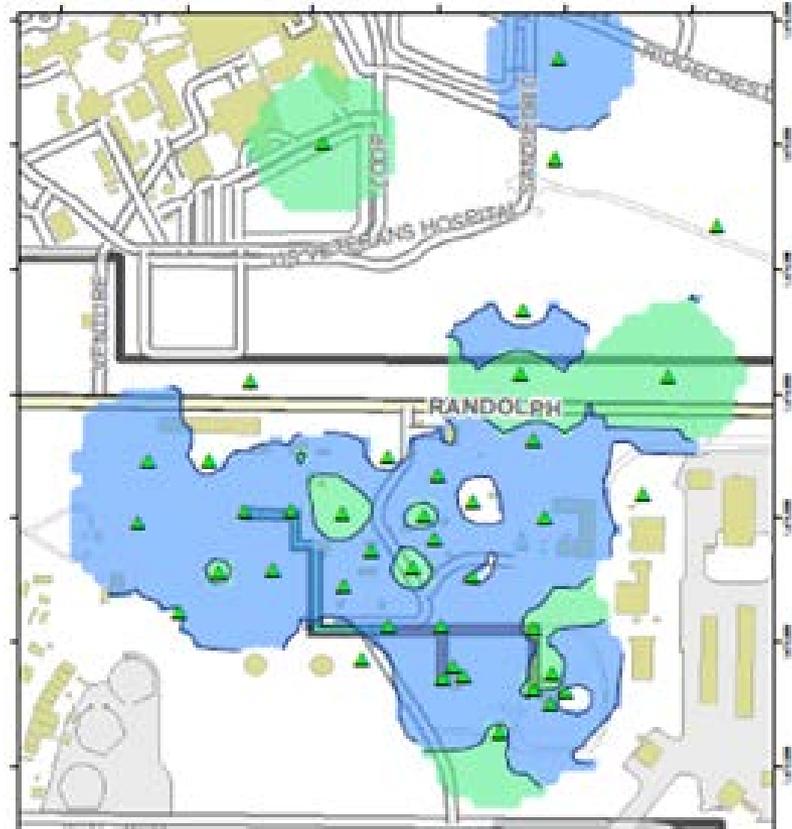


SVE vapor flow greater in high permeability zones

# Reduction in Soil Vapor Contamination

Q4-2011

Q4-2014



450 feet below ground surface

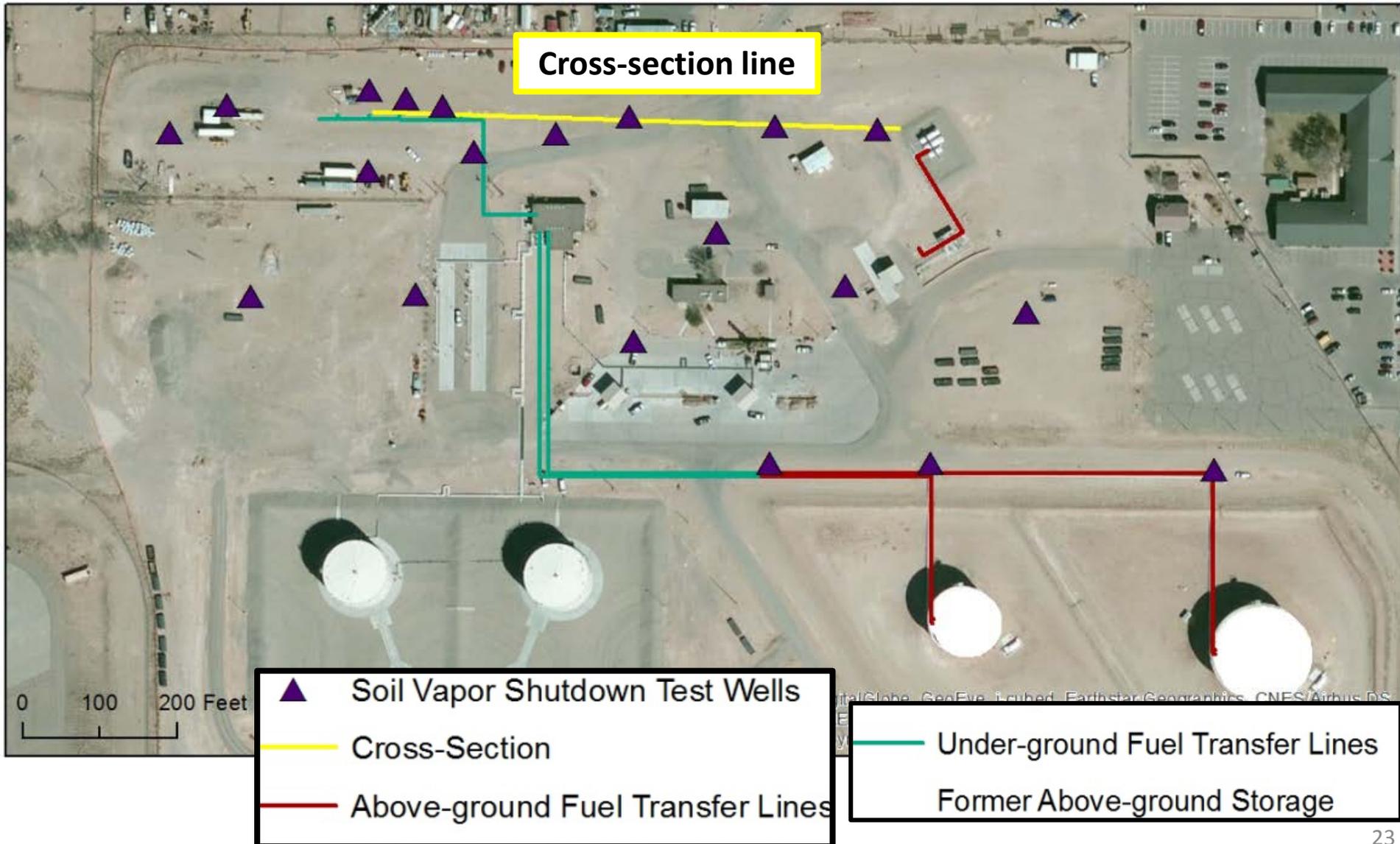
# In Situ Respiration Testing

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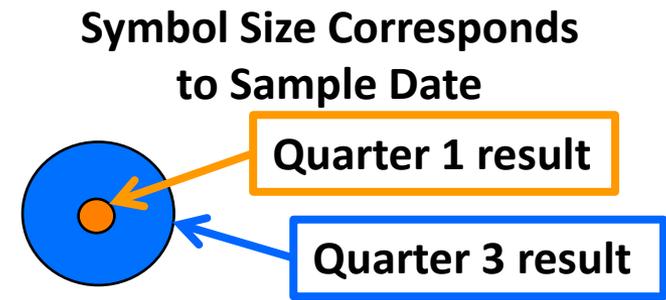
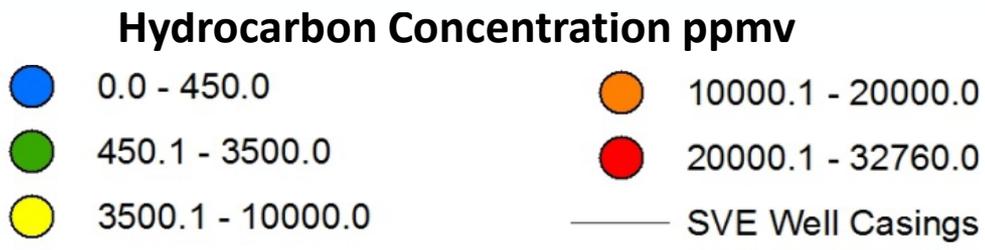
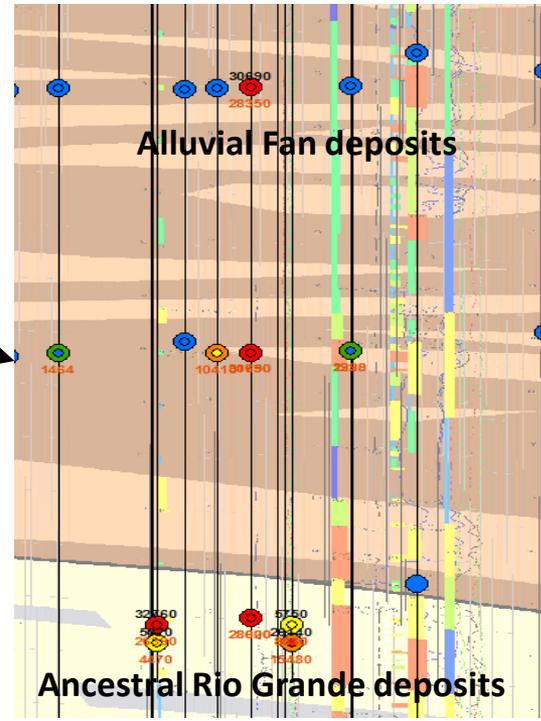
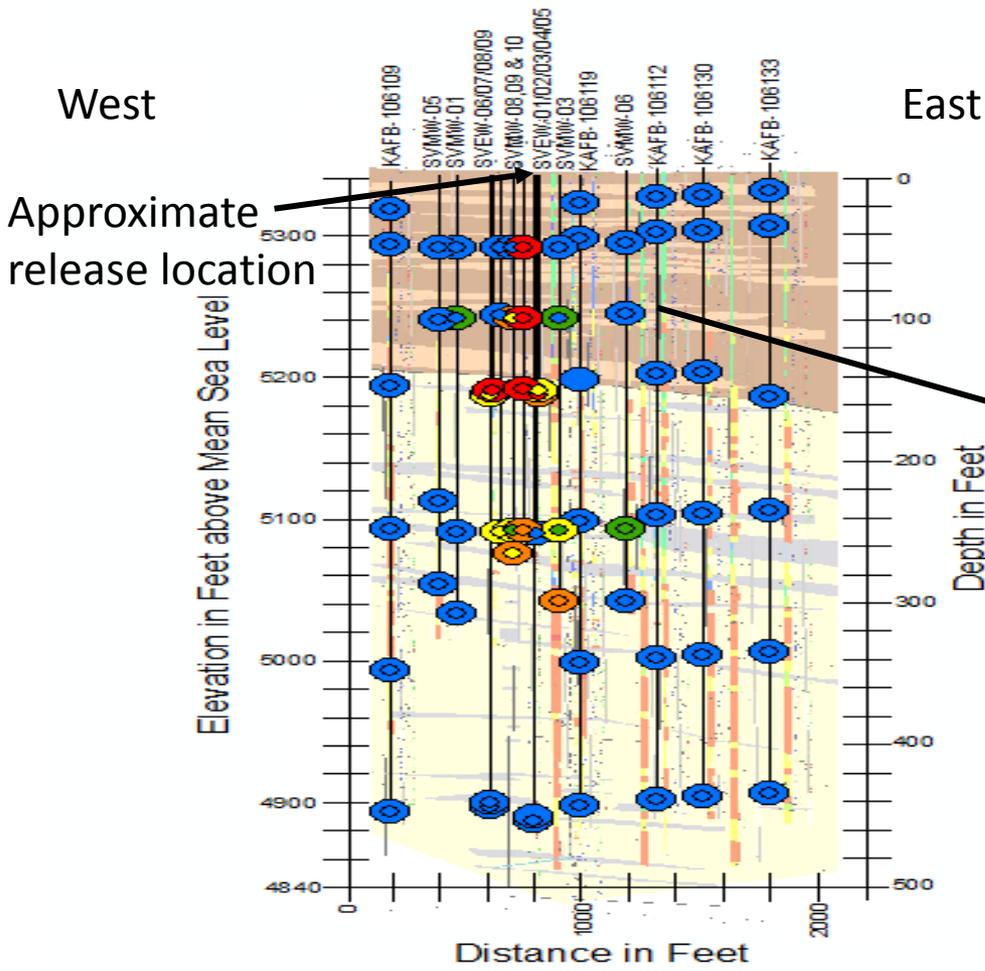
- **Soil bacteria consume hydrocarbons with oxygen and emit carbon dioxide**
- **Measured oxygen, carbon dioxide, and hydrocarbon vapor will help identify:**
  - **Areas for continued SVE**
  - **Areas where treatment should switch from SVE to bioventing**
  - **Areas that need no further treatment**

**Find the sweet spot for biodegradation and enhance it.**

# SVE Temporary Shutdown Test



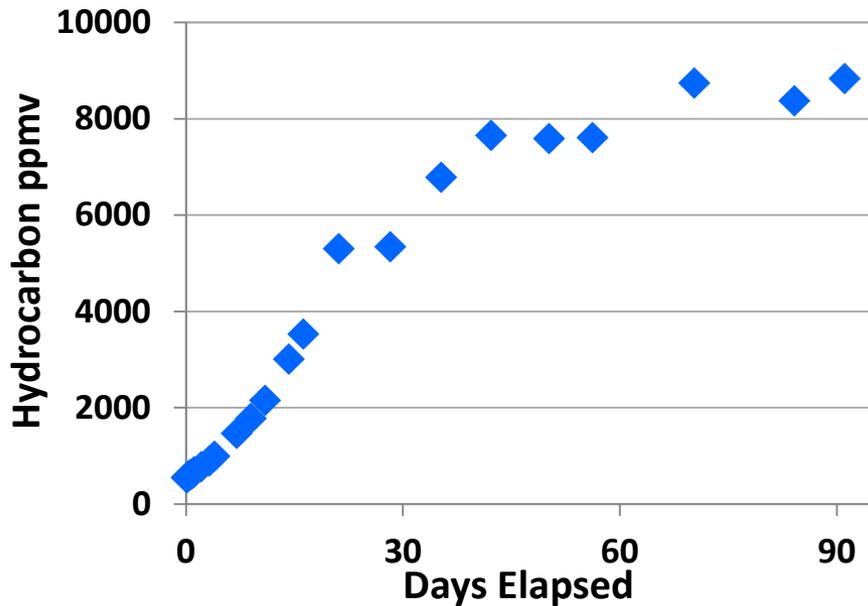
# Cross Section West-East In Source Area





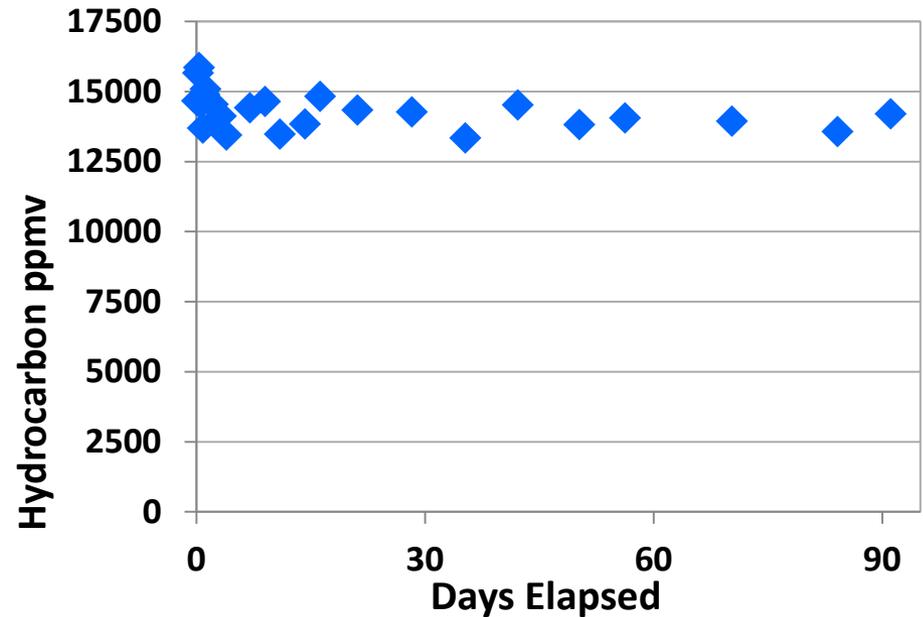
# SVE Shutdown Rebounding Testing

**SVMW-03 at  
250 ft below ground surface**



**Hydrocarbon concentrations  
increased (rebounded)**

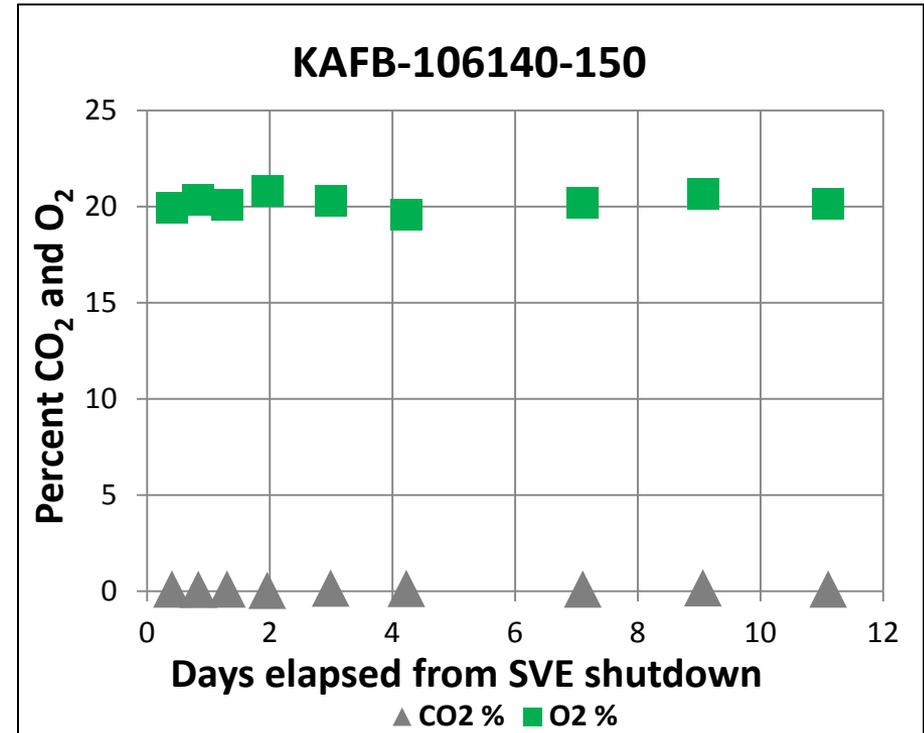
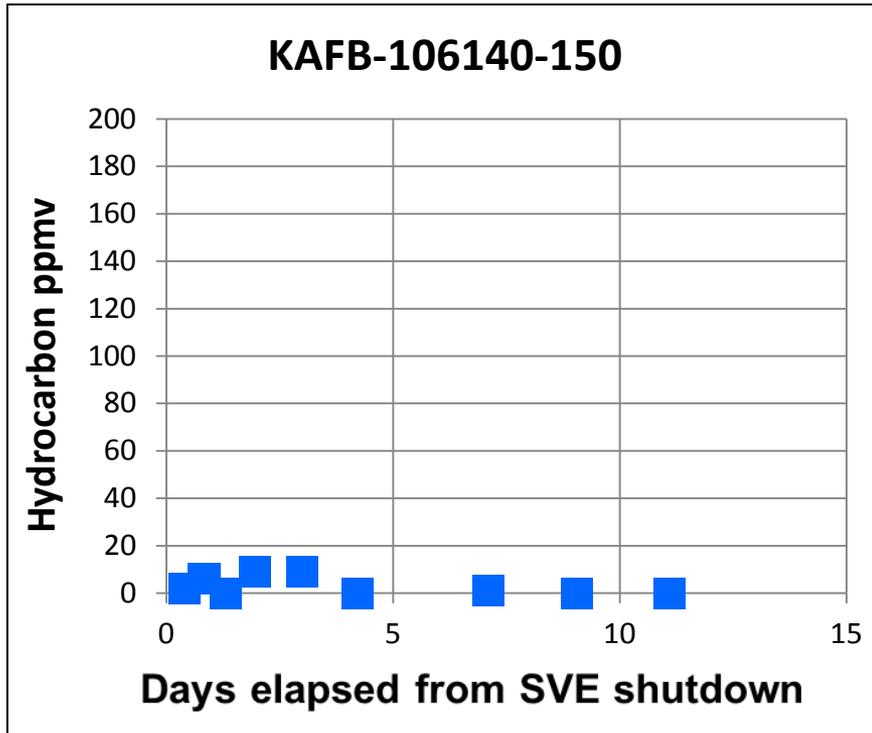
**SVMW-03 at  
300 ft below ground surface**



**Hydrocarbon concentrations  
remained stable**

# Preliminary Respiration Results

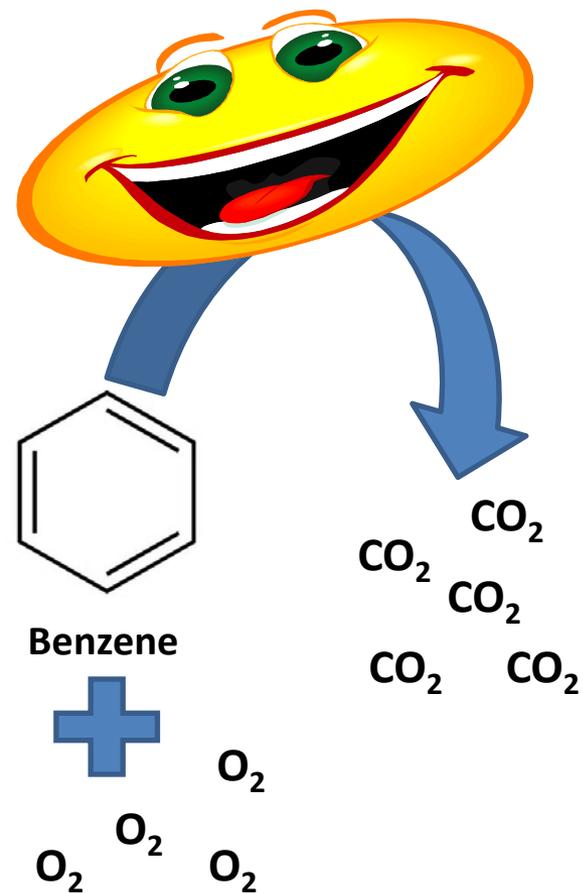
- Background SVMPs with little or no hydrocarbon contamination have very low bio-respiration rates
- O<sub>2</sub> and CO<sub>2</sub> signatures at these wells show near atmospheric conditions
- These locations indicate clean vadose zone and require no remediation



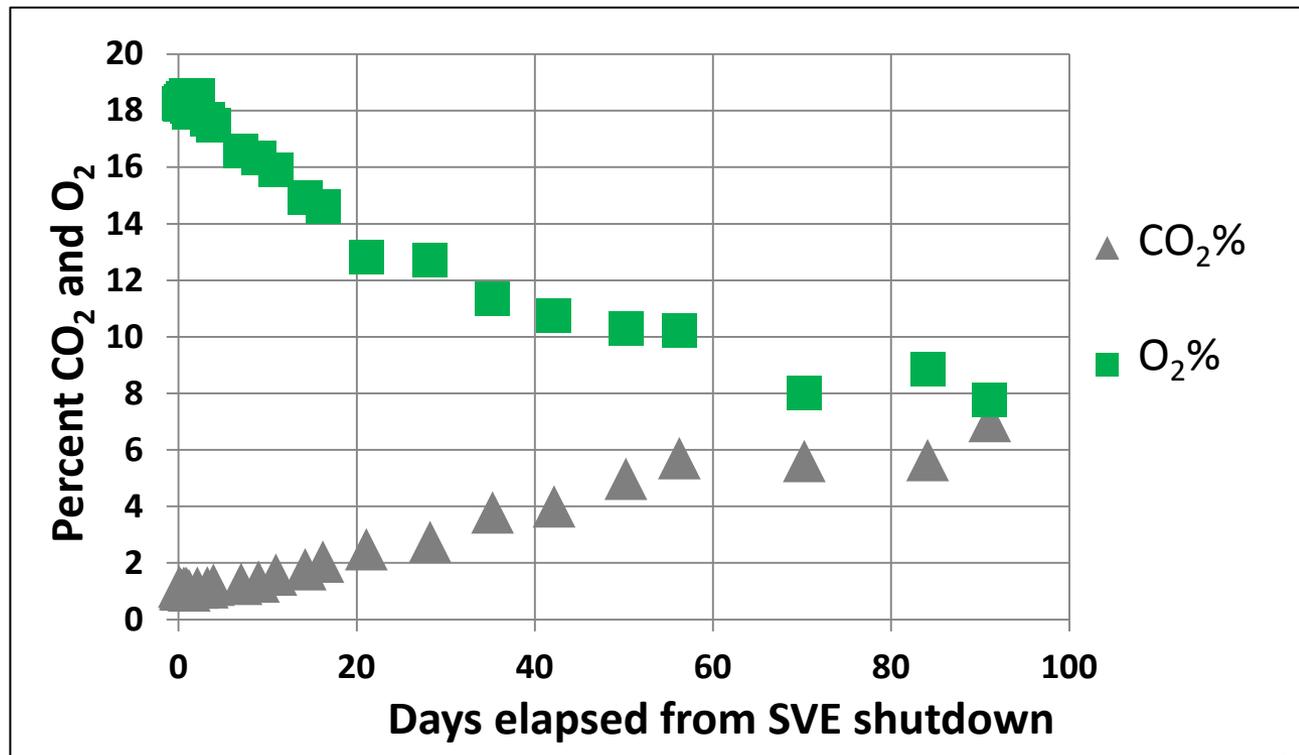
**Background Respiration Example**

# Soil Bio-Respiration Testing

Naturally occurring vadose zone bacteria consume  $O_2$  and produce  $CO_2$  as they biodegrade hydrocarbons

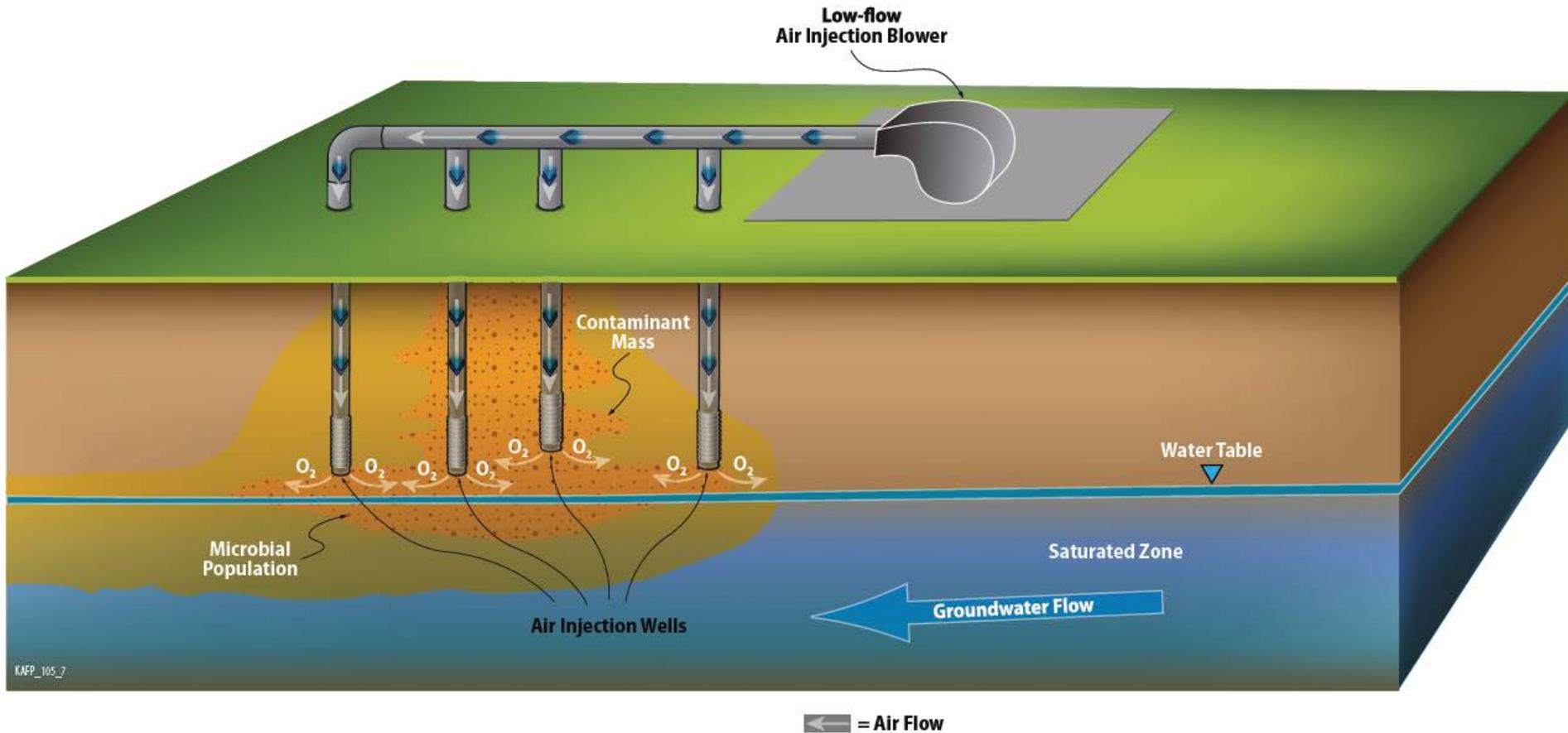


SVMW-03 at 250 ft below ground surface

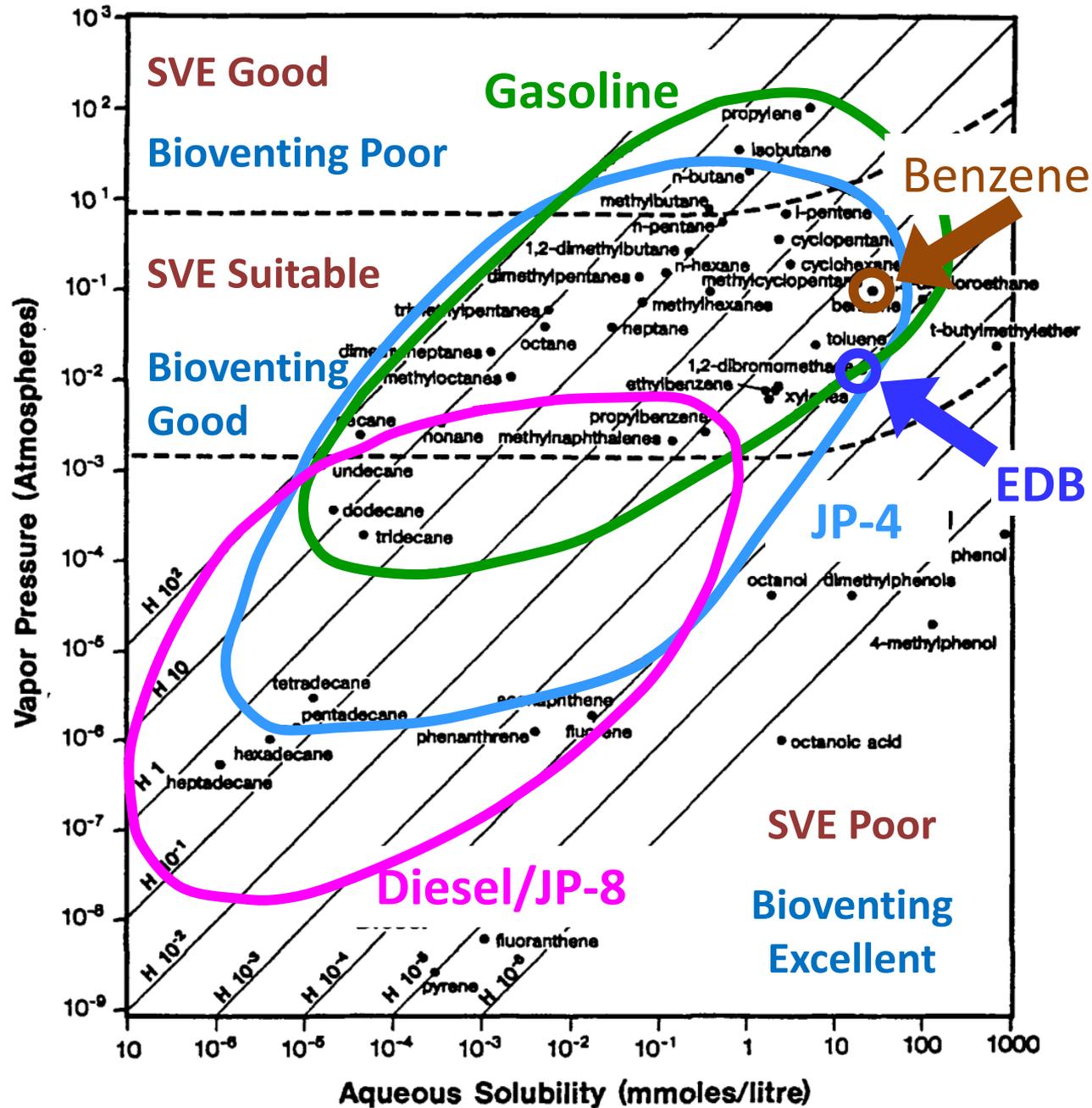


# Bio-Venting

- Air is injected into the vadose zone to deliver oxygen to soil bacteria to help them biodegrade contaminants

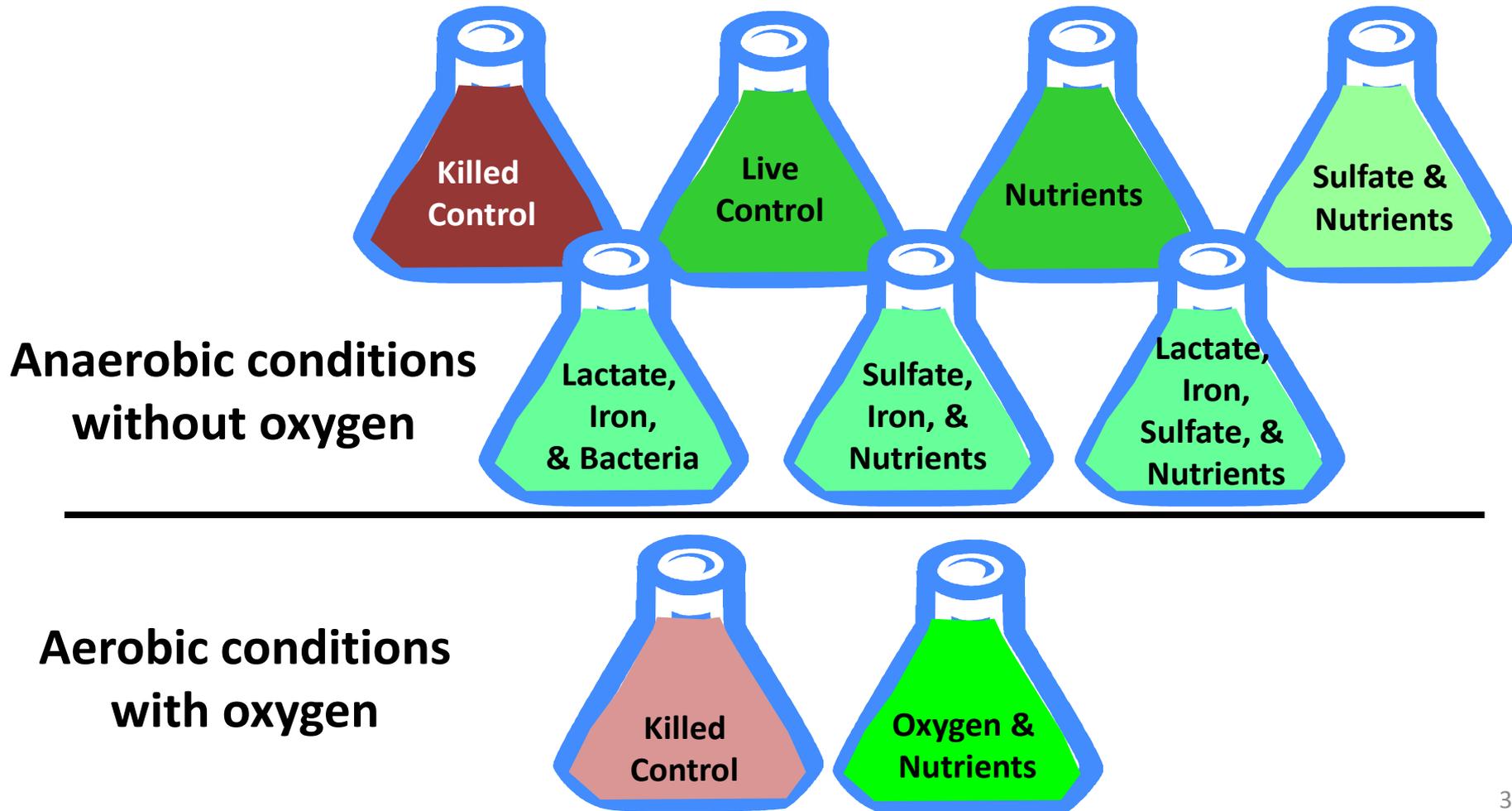


# Suitability Ranges for SVE and Bioventing

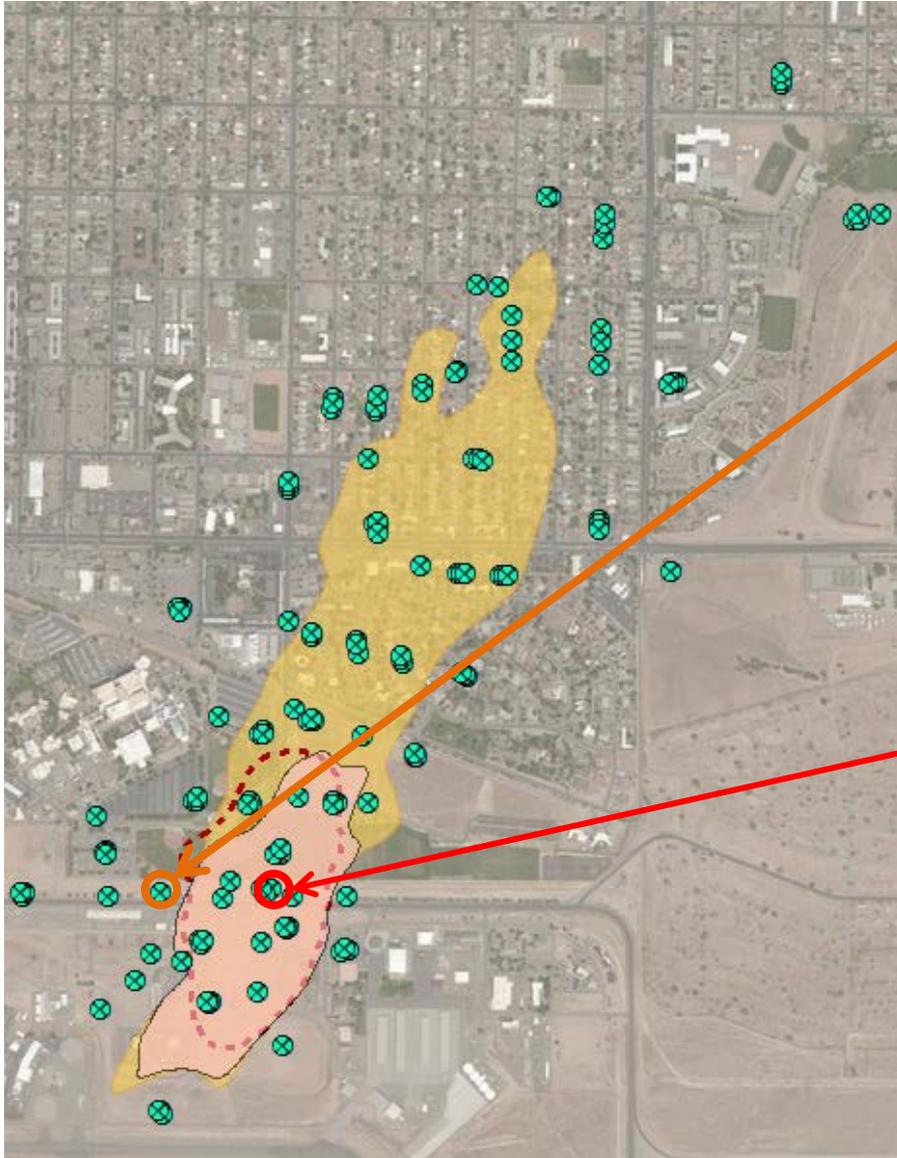


# Laboratory Microcosm Testing

Identify potential technologies to biodegrade EDB



# Laboratory Microcosm Testing



Two areas were cored and sampled for use in the microcosm study:

## Side gradient:

- Collected core from 489 to 498 feet bgs during drilling of groundwater monitoring well KAFB-10612-R
- Collected groundwater from the same well

## Source Area (NAPL):

- Collected core from 487 to 501 feet bgs during drilling of well KAFB-106201
- Collected groundwater from the same well

# Microcosm Summary

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## Source Area: Aerobic

- Complete BTEX and partial EDB degradation

## Source Area: Anerobic

- Complete EDB Degradation when *Dehalococcoides* added
  - Minimal EDB degradation with added lactate, sulfate, Fe, and/or nutrients
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## Side Gradient: Aerobic

- Complete BTEX and nearly complete EDB degradation

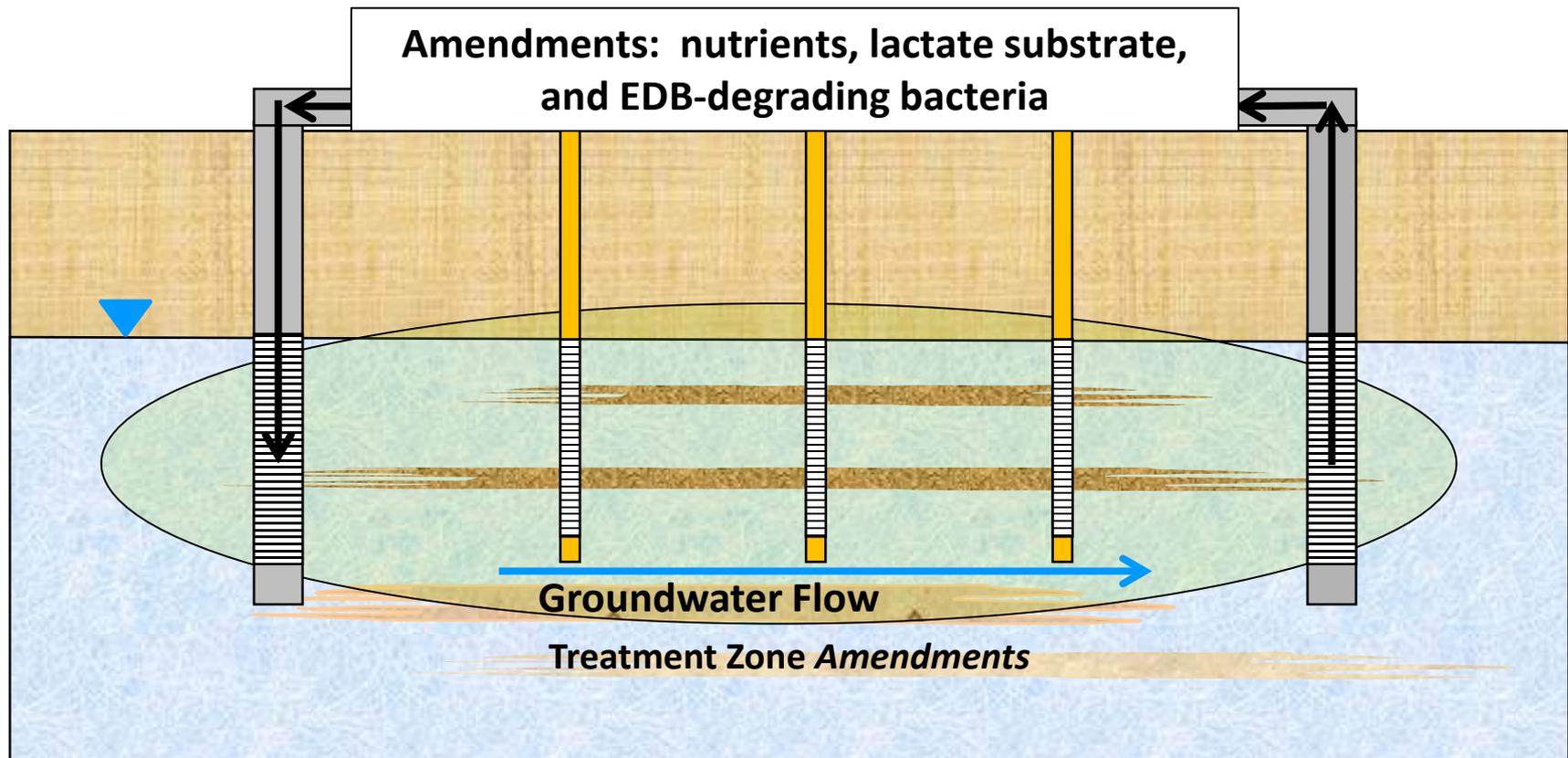
## Side Gradient: Anaerobic

- Complete EDB degradation when *Dehalococcoides* added
- Minimal EDB degradation with added lactate, sulfate, Fe, and/or nutrients
- Toluene and m,p-xylene degradation and less degradation of ethylbenzene or o-xylene

# Anaerobic Biodegradation Pilot Test

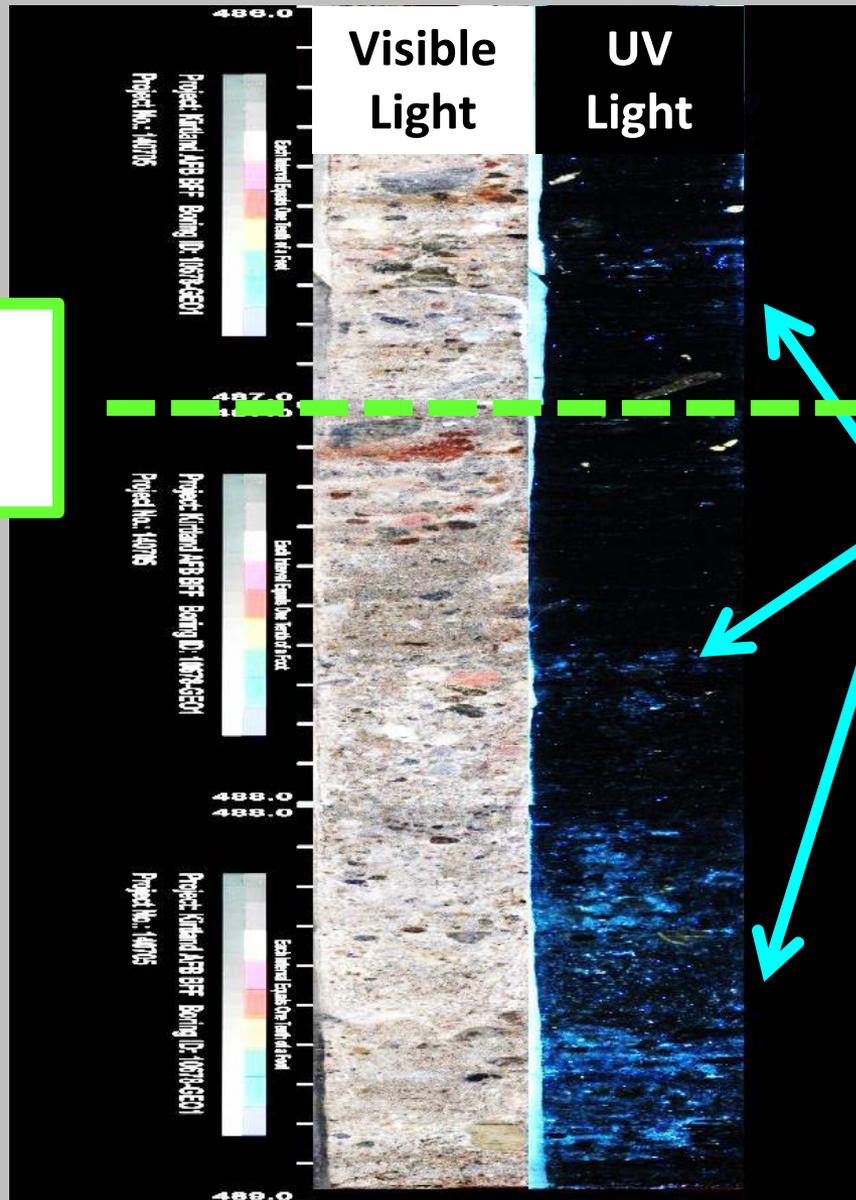
## Groundwater Recirculation

- Pump groundwater - Add amendments
- Inject amended water up-gradient to create recirculation cell to support anaerobic biodegradation EDB



# Drowned LNAPL – Soil Cores

**Groundwater Table**



**LNAPL Under UV Light Fluoresces Blue**

# LNAPL Clean Up

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- **Technically challenging due to groundwater depth and submerged LNAPL from rising water table**
- **Screening potential technologies for interim measures**
- **Conduct laboratory and field scale pilot tests for potentially suitable technologies**
- **Collect continuous core samples from the source area to determine evaluate presence and nature of LNAPL at the site**

# 2015 Site Status

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- **4020 tons of contaminated soil excavated since 2000**
- **287 soil monitoring wells installed since 2000**
- **More than 600,000 gallons of fuel recovered by SVE since 2003; soil vapor levels are decreasing**
- **135 groundwater monitoring wells installed since 2000**
- **Water table continues to rise**
- **Groundwater plumes are relatively stable**
- **Monthly testing of drinking water wells continues to show no evidence of contamination**
- **No contaminant detects in any sentinel wells**
- **First of up to 8 extraction wells to collapse EDB plume began operation in June 2015 with an additional two online by end of the year**

# NMED Strategic Plan Summary

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**Goal: *Protect Albuquerque's aquifer and the drinking water supply wells in the area of the fuel spill***

**Strategies to Achieve the Goal:**

- 1) Continue robust groundwater and wellhead monitoring**
- 2) Collapse the dissolved EDB Plume away from the Albuquerque Bernalillo County Water Utility Aquifer Wells**
- 3) Clean up soil in the spill area**
- 4) Remediate Light Non-Aqueous Phase Liquid (LNAPL) and associated dissolved phases in the LNAPL area**
- 5) Meet or exceed all requirements for providing public information and involvement**

# Thank You Neighborhoods!

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**The Air Force, NMED, and all the collaborating organizations sincerely thank the neighborhoods for putting up with the temporary road blocks and noise from the well drilling rigs**

# Upcoming Events

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- **Public Field Trip – October 24, 2015**
- **Public Meeting – November 17, 2015**



# How do I get more information?

## Contact NMED:

Dennis McQuillan,  
KAFB project technical lead  
[dennis.mcquillan@state.nm.us](mailto:dennis.mcquillan@state.nm.us)  
505-827-2140

Jill Turner,  
KAFB project communications lead  
[jill.turner@state.nm.us](mailto:jill.turner@state.nm.us)  
505-222-9548

NMED Website and Listserv: <http://www.nmenv.state.nm.us/>

## Contact the Air Force:

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 or (866) 725-7617  
Email: [afcec.pa@us.af.mil](mailto:afcec.pa@us.af.mil)

Air Force BFF-specific spill website: [www.kirtlandjetfuelremediation.com](http://www.kirtlandjetfuelremediation.com)

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