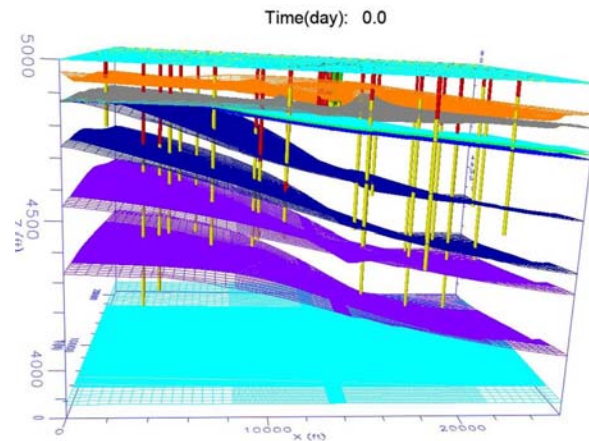




Kirtland Air Force Base – Groundwater Flow and EDB Plume Model



Deep Dive / Technical Session
July, 2016

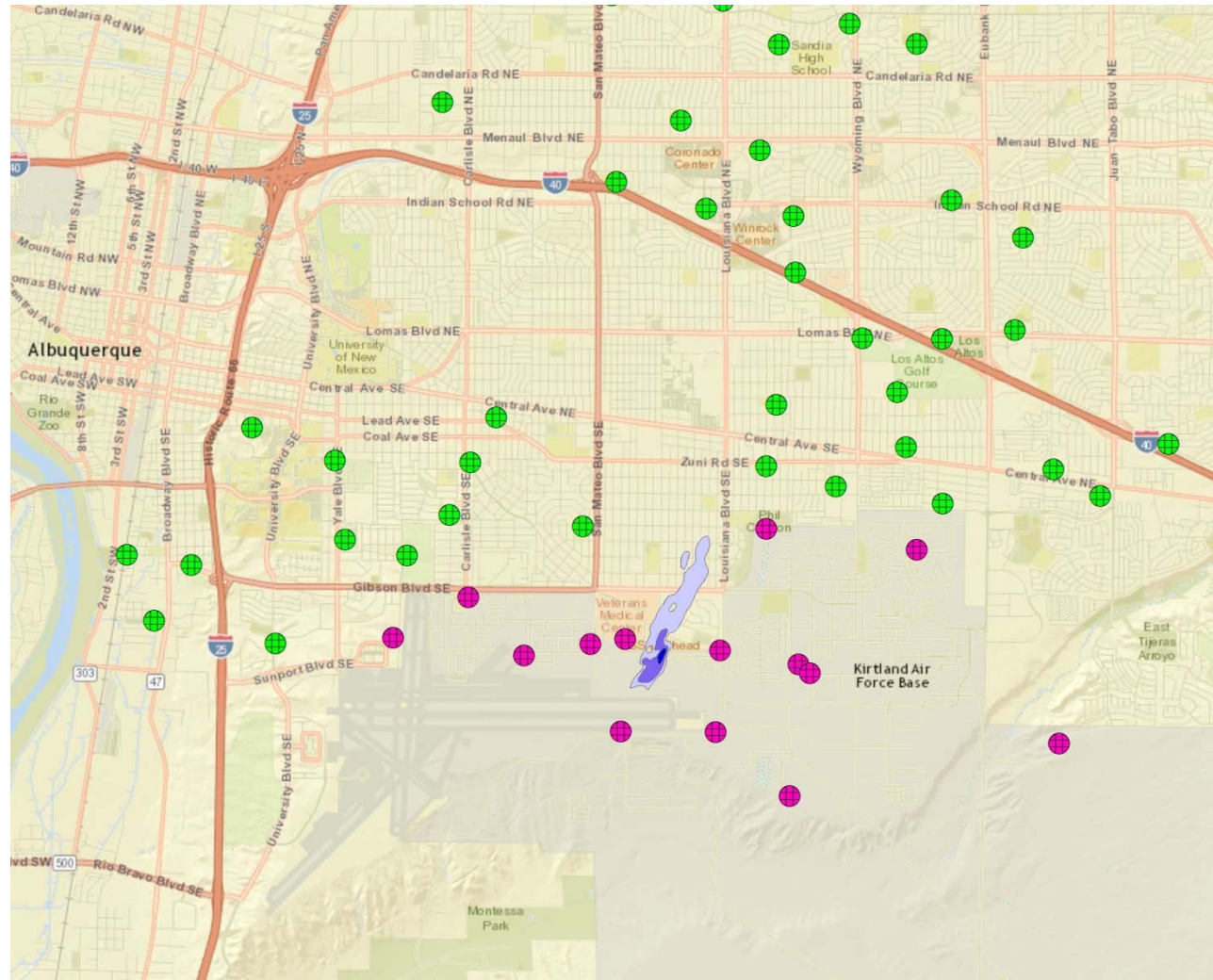


Modeling Background

- **Original Purpose:** Could EDB Impact Production Wells (i.e. Ridgecrest series)?
- **Models Created By Five Entities:**
 - New Mexico Environmental Department and EPA Region 6
 - US Army Corps of Engineers
 - ABC Water Utility Authority (CH2MHill and later Intera)
 - USGS
 - Air Force (CB&I)
- **Modeling Group Formed and Met Quarterly:**
 - Multiple stakeholders involved
 - Collaborative effort
 - Determined that EDB transport to production wells was not imminent, but would take upwards of 20+ years.
- **Revised Purpose:** Evaluate Interim Measures and EDB Plume Collapse
 - Intera (analytical element model)
 - EPA Region 6 / CB&I (numerical model)

EDB Model Discussion

- Groundwater Flow
- 3-D Model Setup
- Projected EDB Clean-up



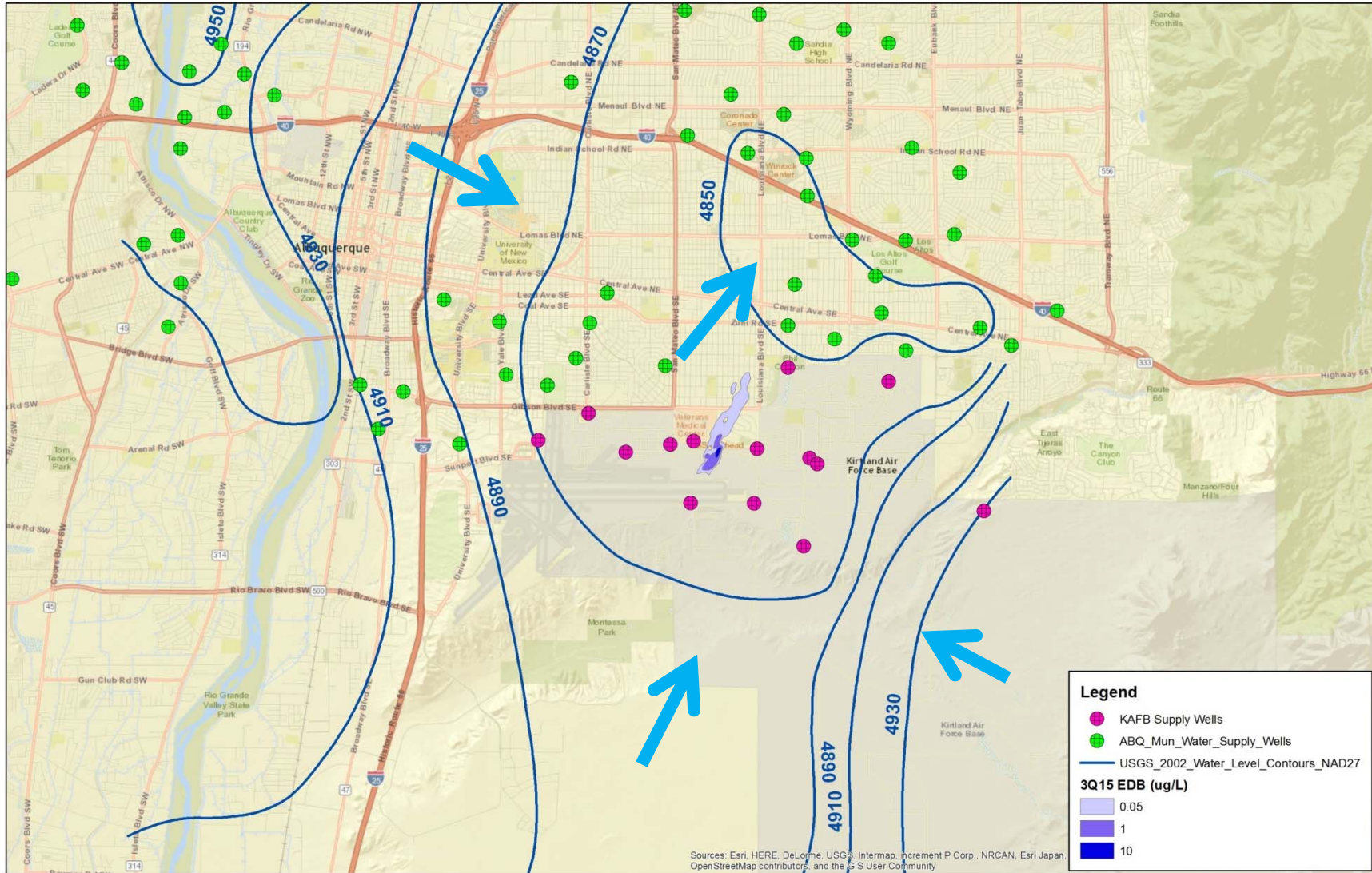
Albuquerque Basin (Northern Half)



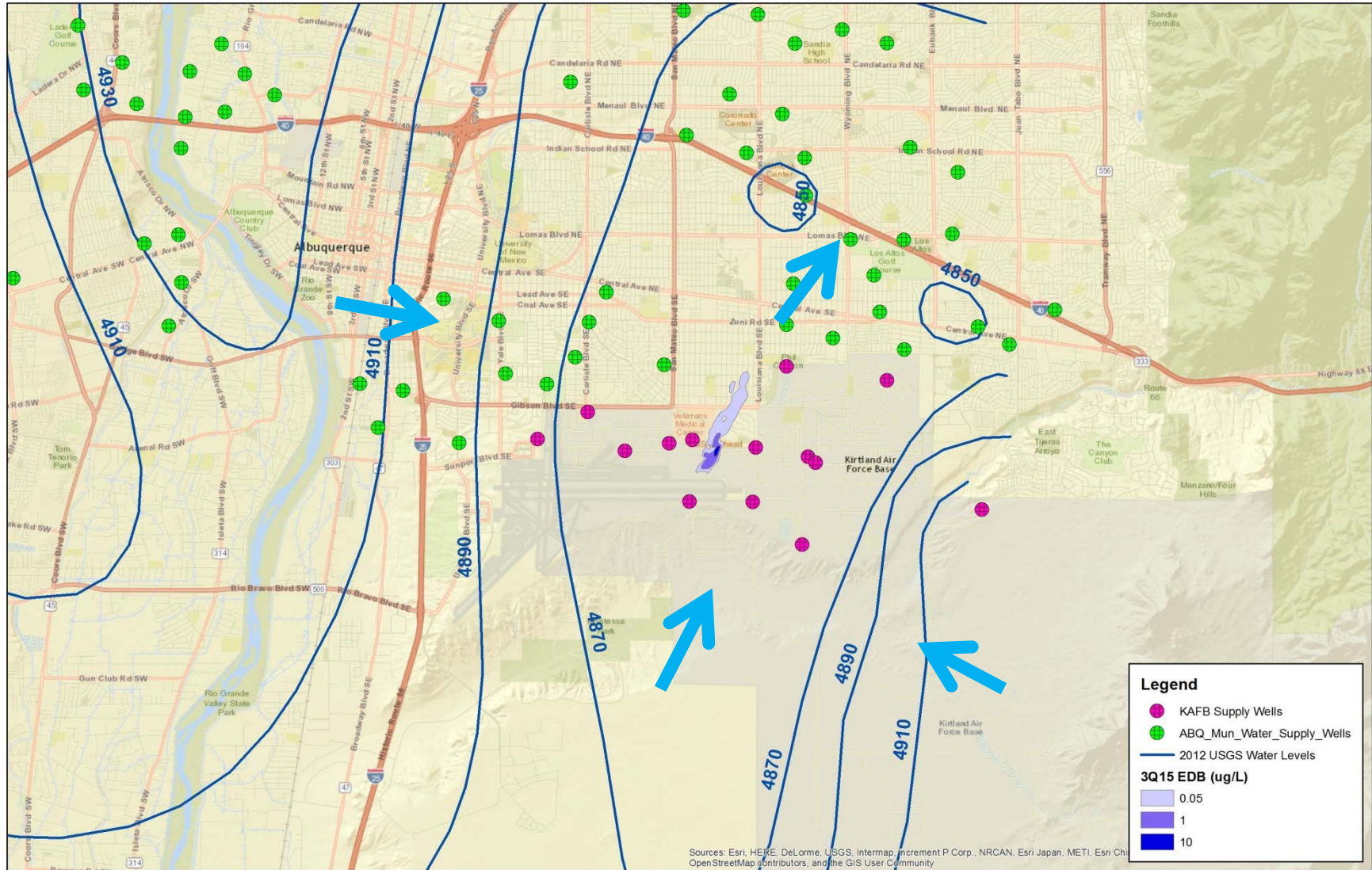
Figure from Connell and Love (2009)

Shaded Area Delineates Albuquerque Basin

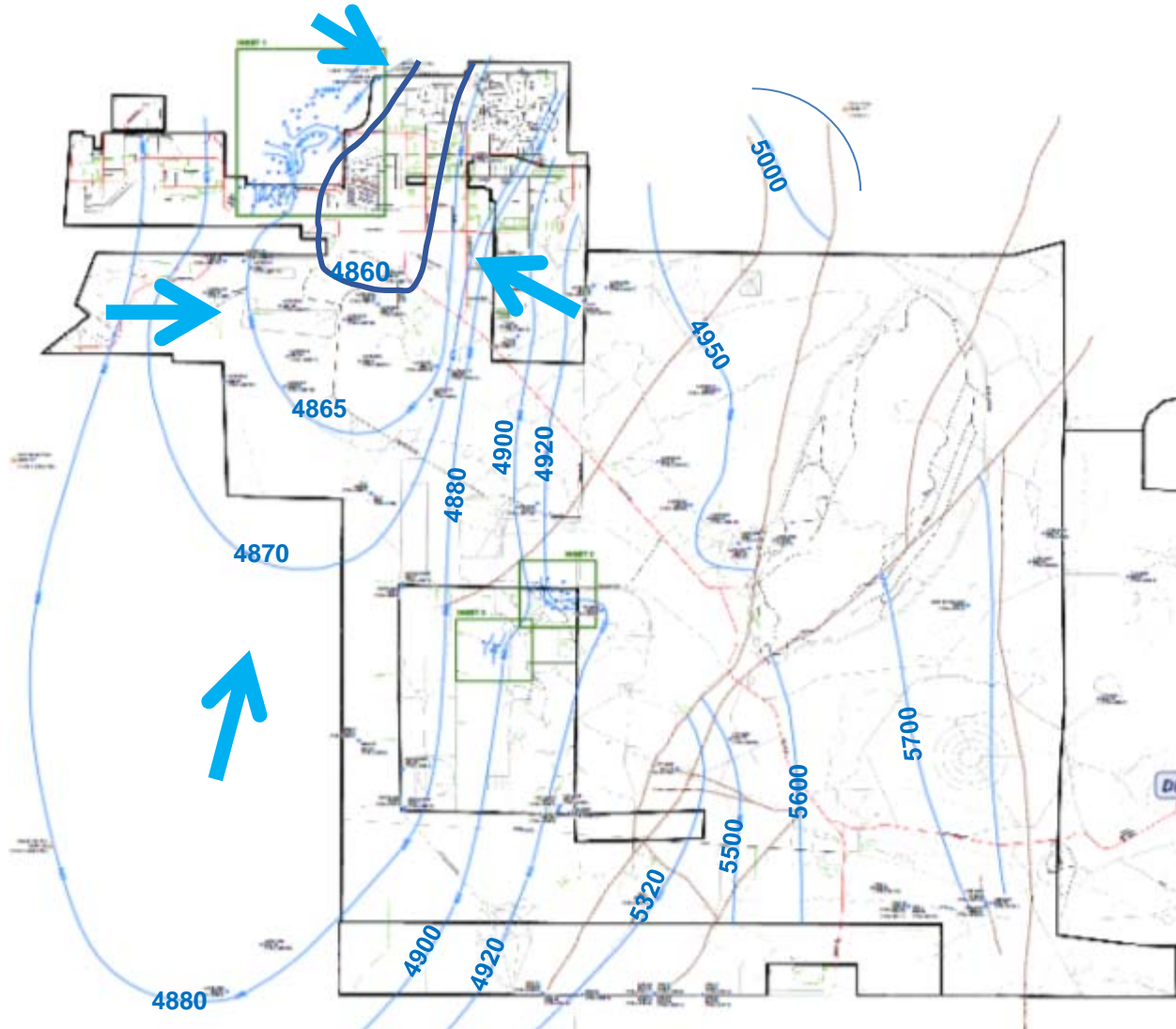
Groundwater Flow, 2002



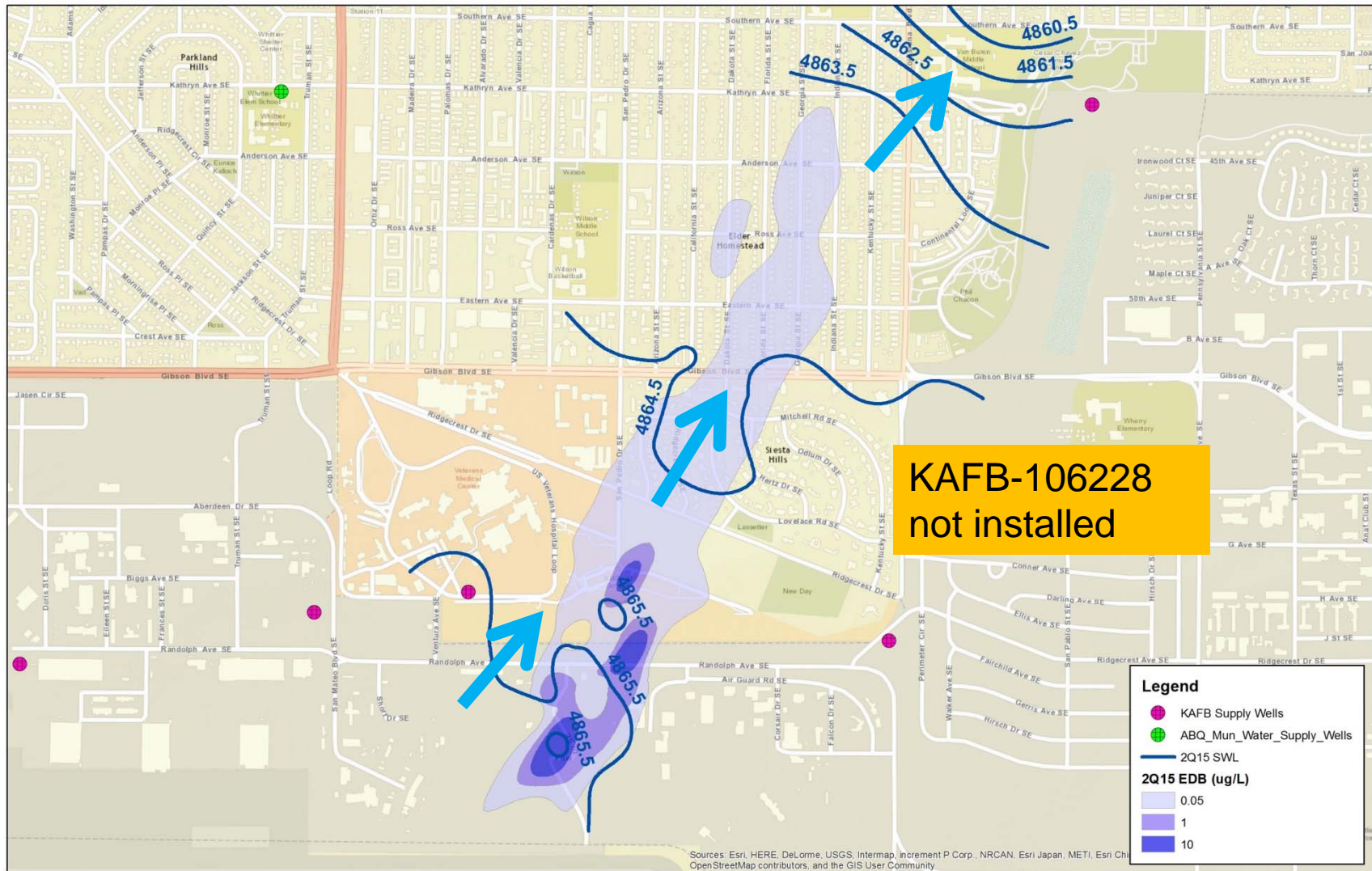
Groundwater Flow, 2012



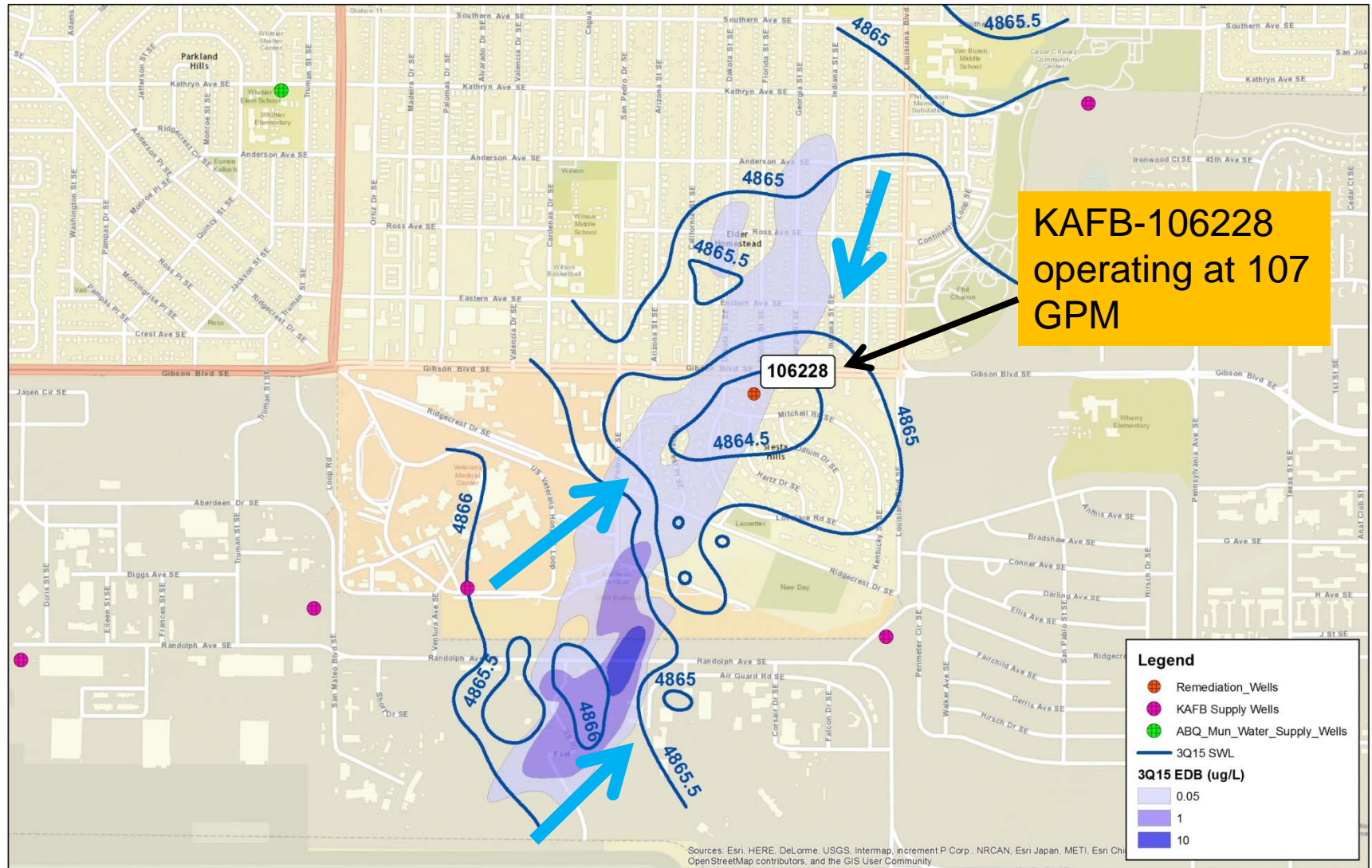
Groundwater Flow, July 2015



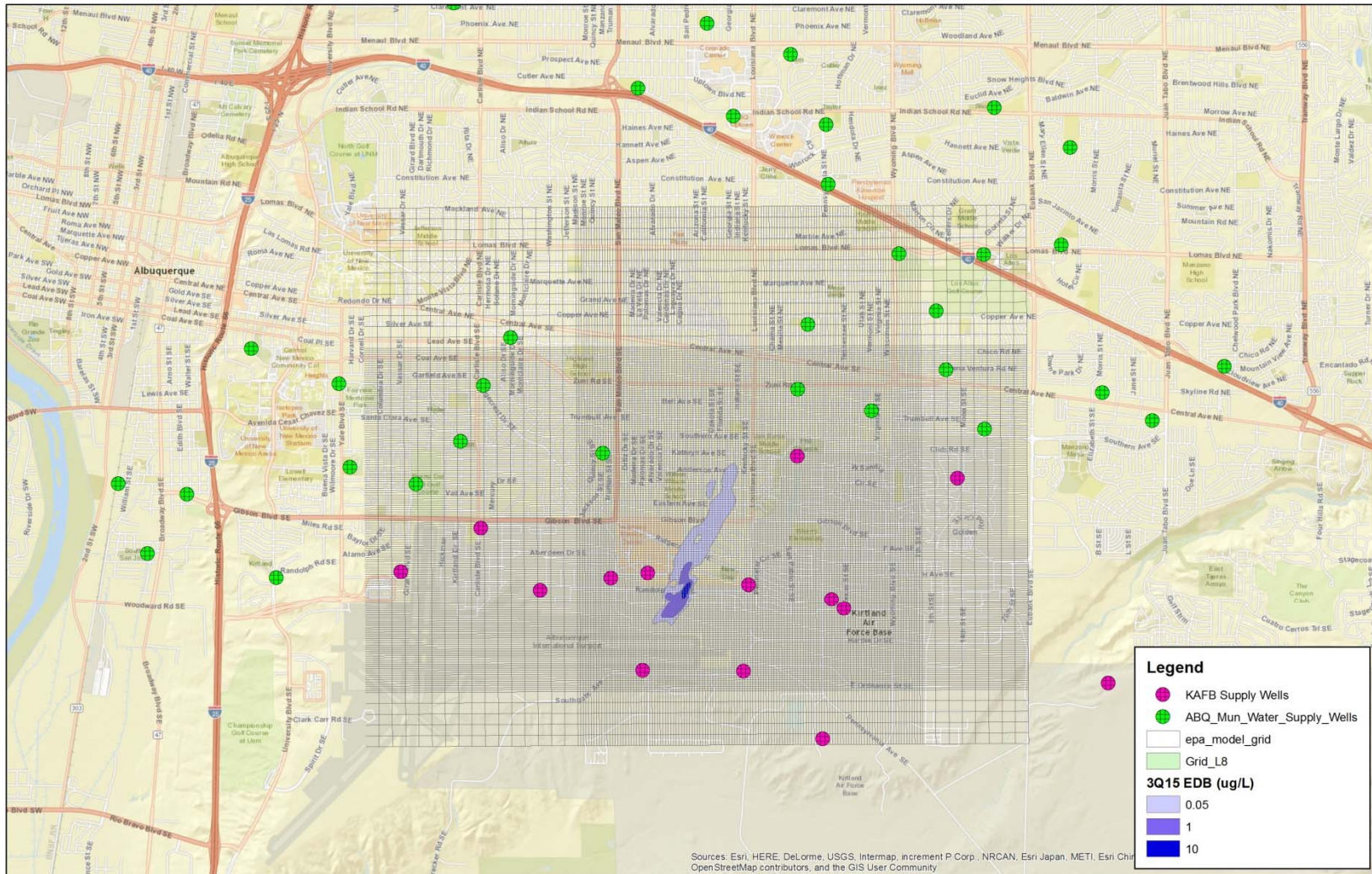
Groundwater Flow, BFF Area, April 2015



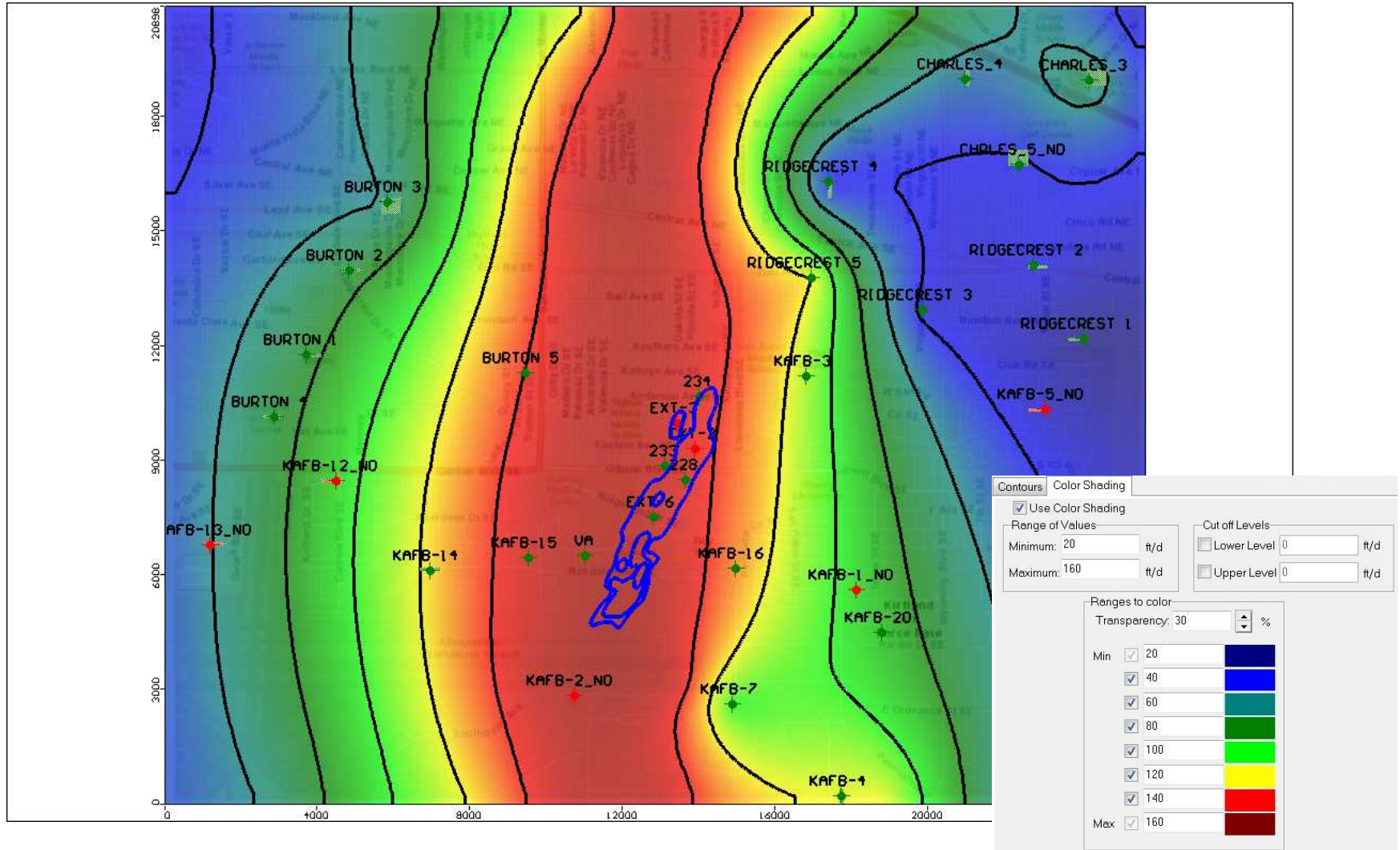
Groundwater Flow, BFF Area, July 2015



3-D Model Set-Up

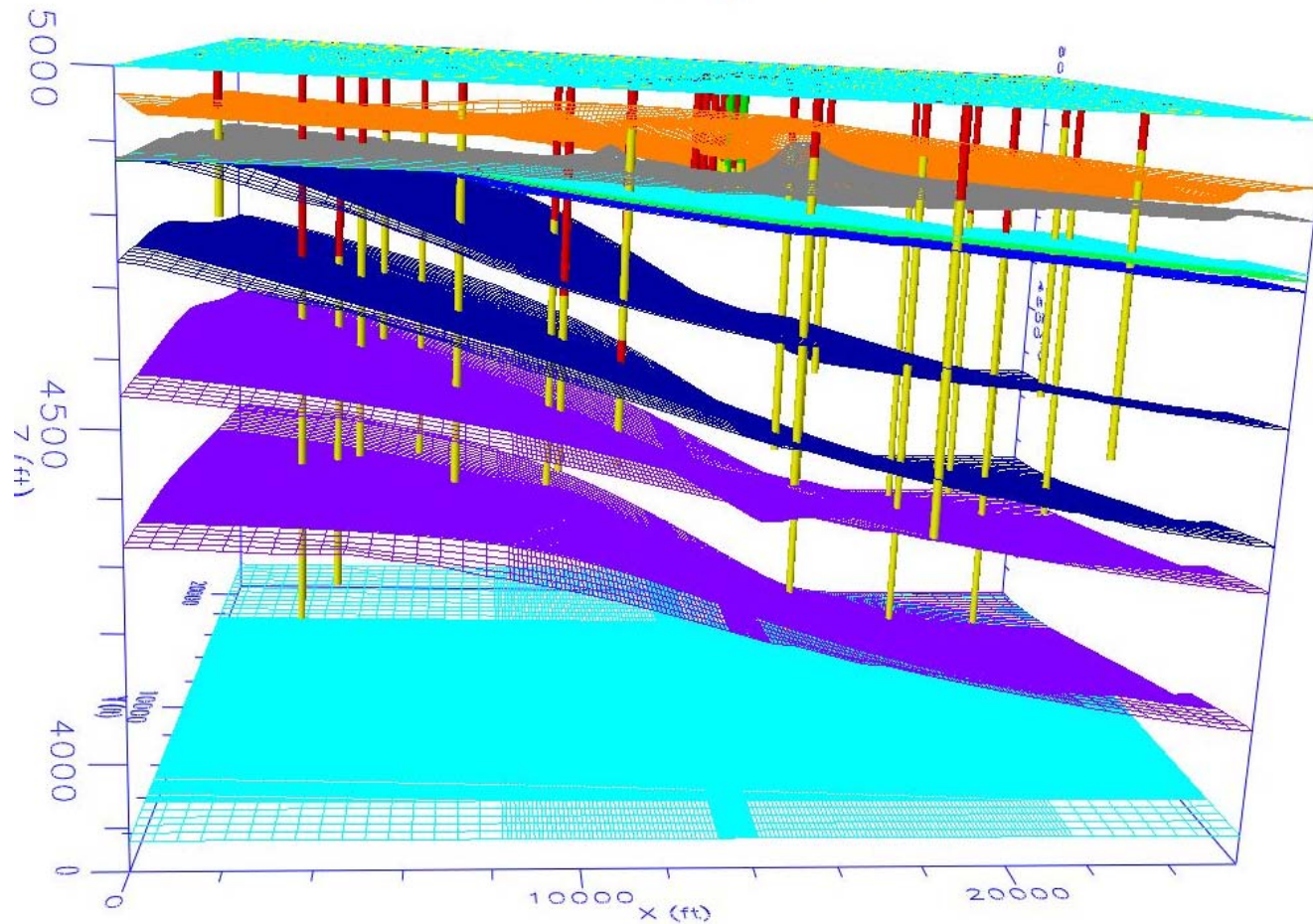


3-D Model Set-Up

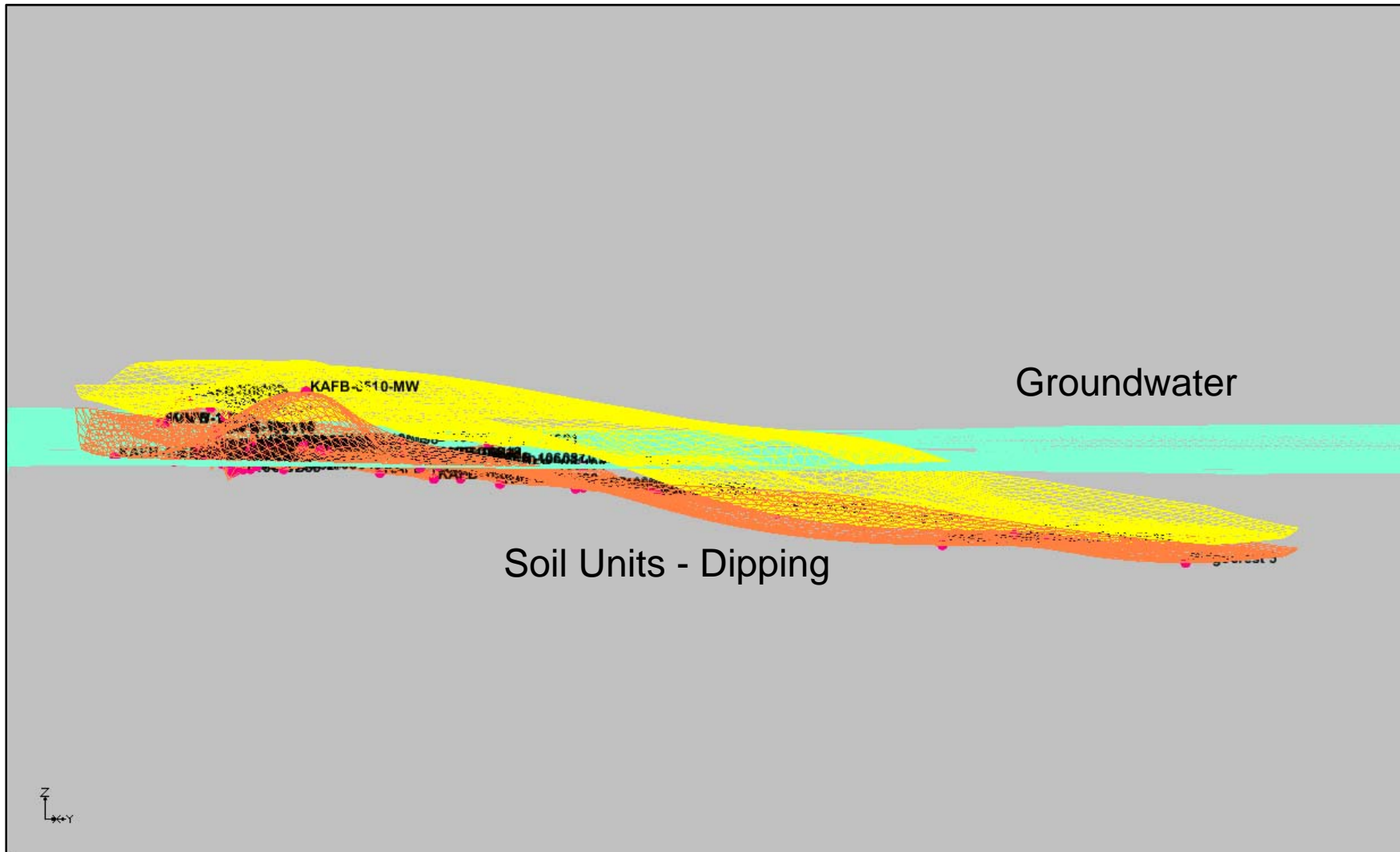


3-D Model Set-Up

Time(day): 0.0



3-D Model Set-Up



Transport Model Set Up

- Existing Extraction Wells (106228, 106233, 106234) + Possible New Wells (EXT-6 and EXT-2)
- Model Runs: Baseline + 3 remedy evaluations
- EDB (Initial Conditions + Constant Source Terms)
- **Min. Contour Shading = 0.05 $\mu\text{g}/\text{L}$ EDB**

Transport Model Set Up

- Model Runs: Baseline + 3 remedy evaluations

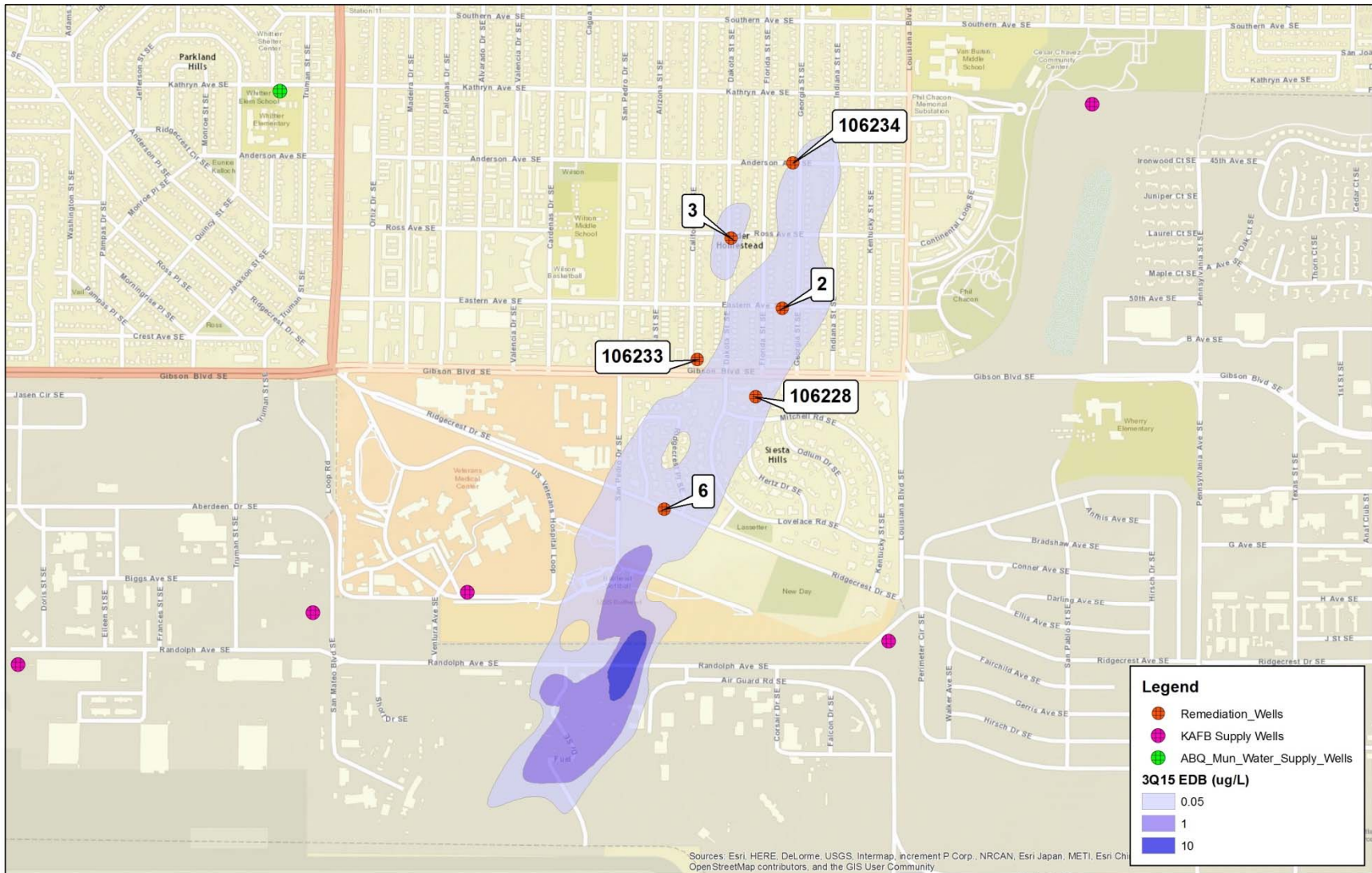
Well	Approximate Saturated Screen (ft)	Pumping Rate (gpm)			
		Baseline	Run 1	Run 2	Run 3
KAFB-106228	80	0	-150	-150	-150
KAFB-106233	80	0	-150	-150	-150
KAFB-106234	80	0	-150	-150	-200
EXT-2	80	0	-150	0	0
EXT-3	80	0	0	0	0
EXT-6	80	0	-75	-75	-75
KAFB-7	465	-300	675	525	575

ft - feet

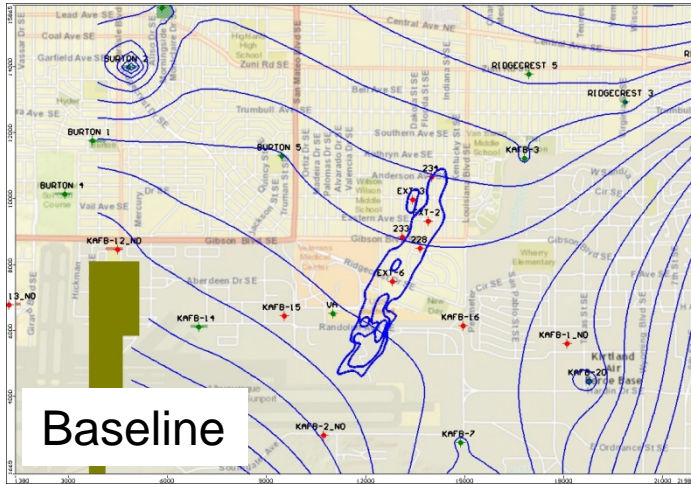
gpm - gallons per minute

Negative values indicate groundwater extraction. Positive values indicate treated water injection.

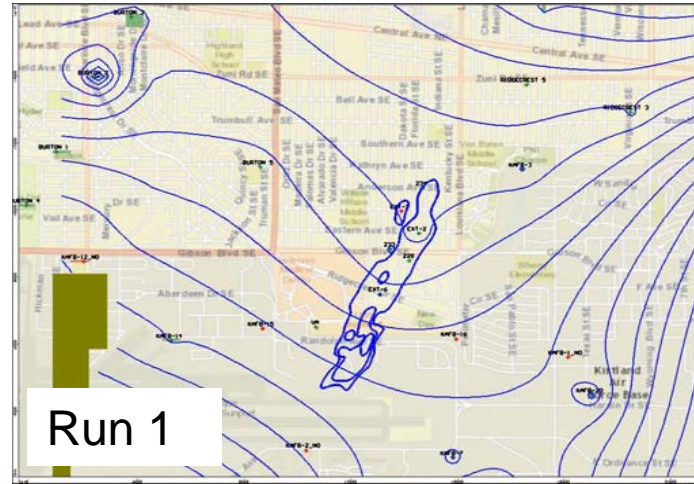
Well Location Map



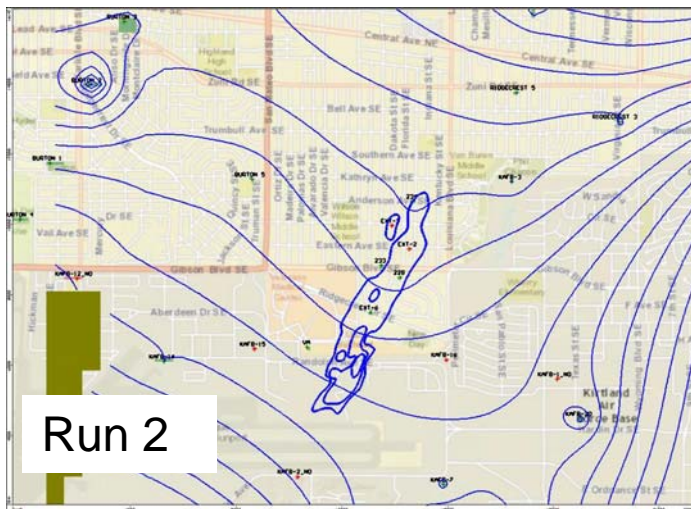
Baseline + Remedy Evaluation – Well Locations/Potentiometric Heads



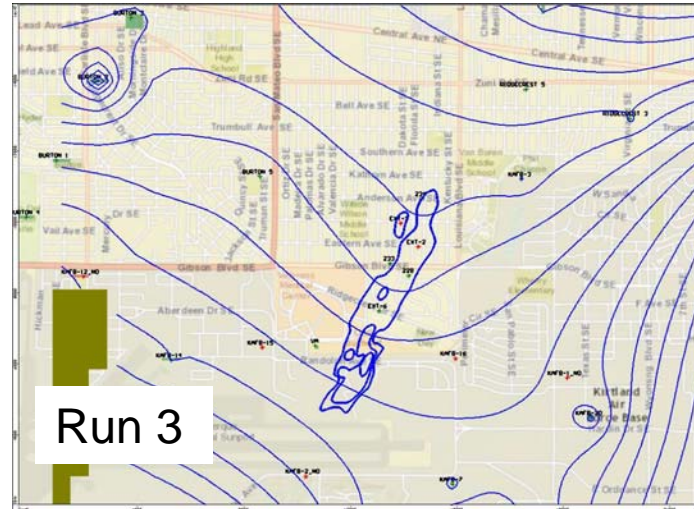
Baseline



Run 1



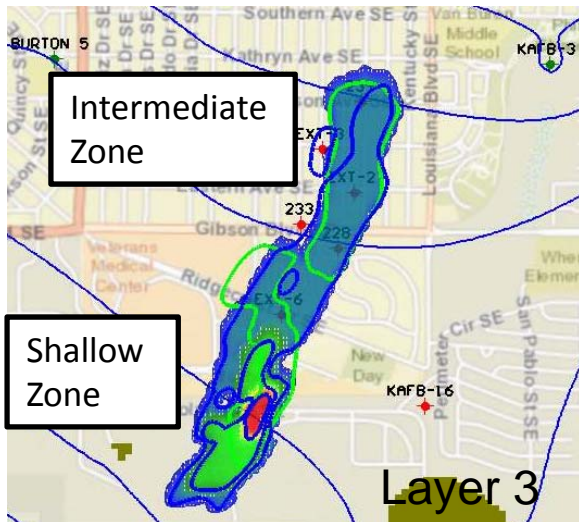
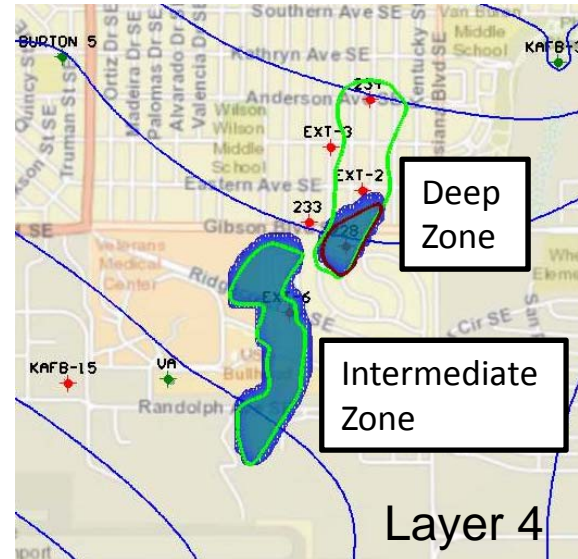
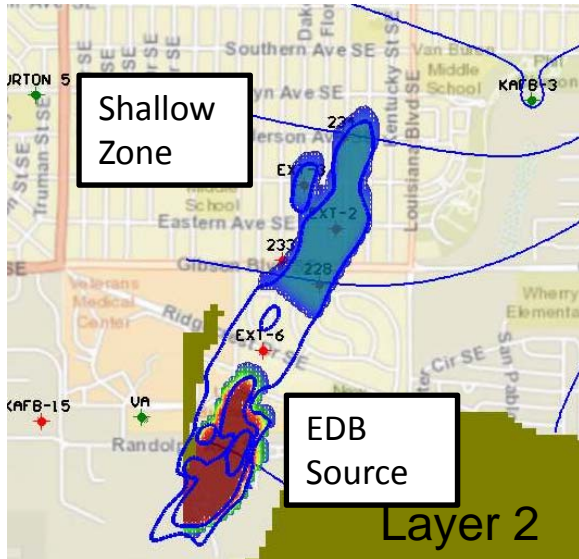
Run 2



Run 3

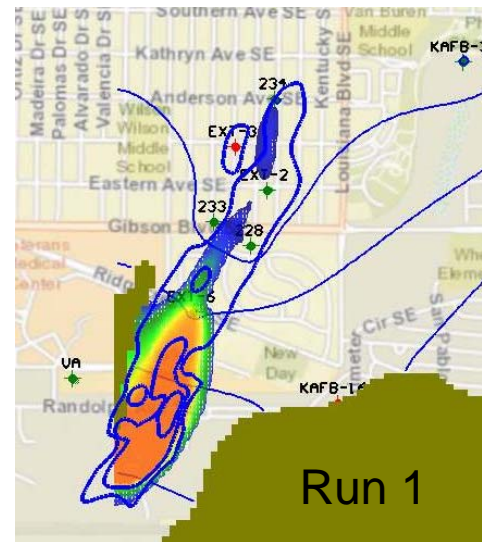
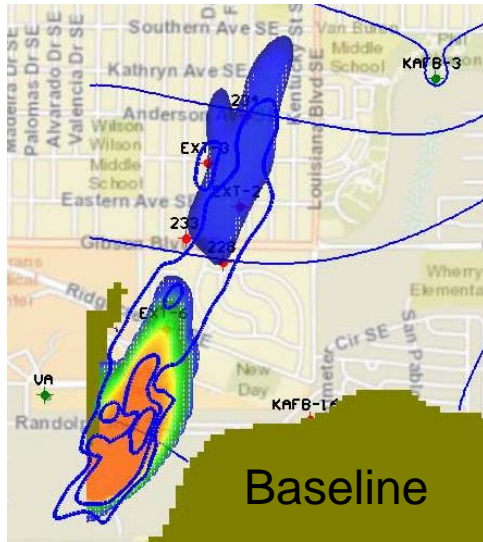
Simulated Transport – Initial Conditions

EDB Initial Conditions

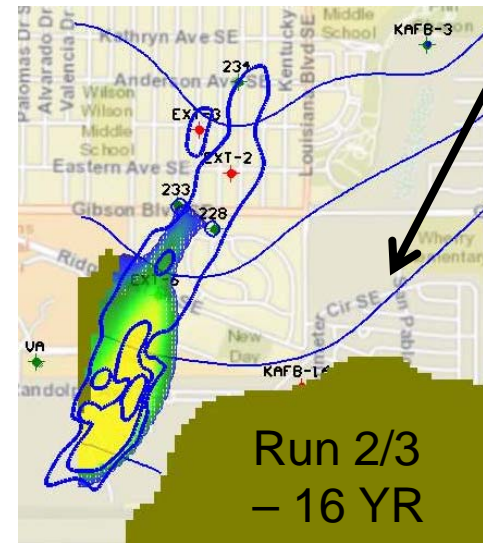
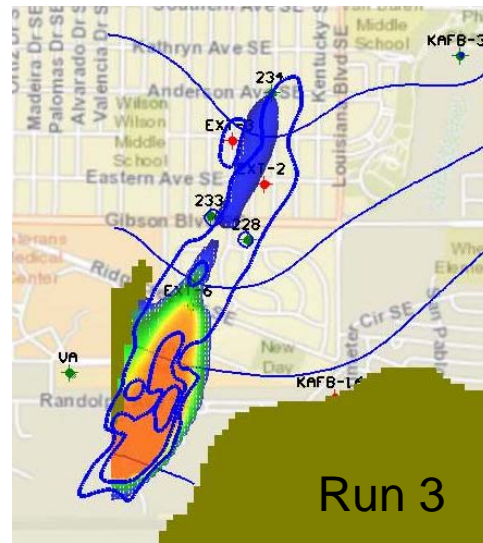


- Initial Conditions Based on July 2015 Plume Data
- Constant Source Term in Layer 2
- Constant Source Term Decreases 10% Each Year. Starts at 50 $\mu\text{g/L}$.

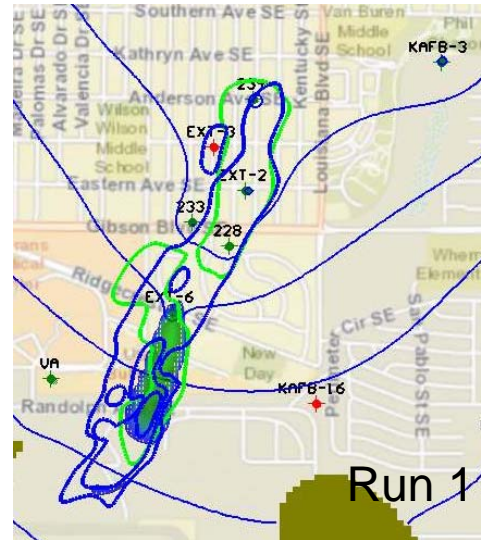
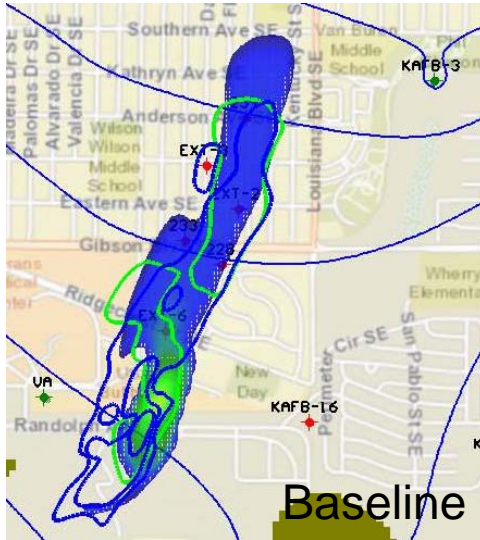
Projected EDB Clean-Up Layer 2 – 10 YR



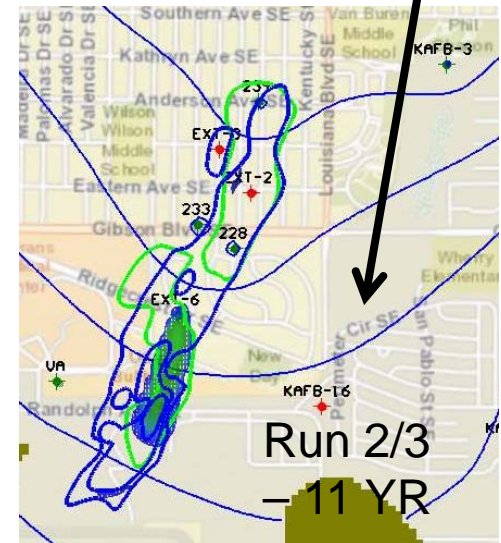
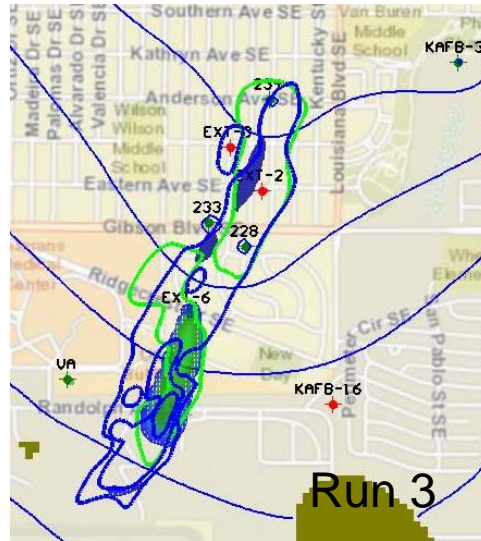
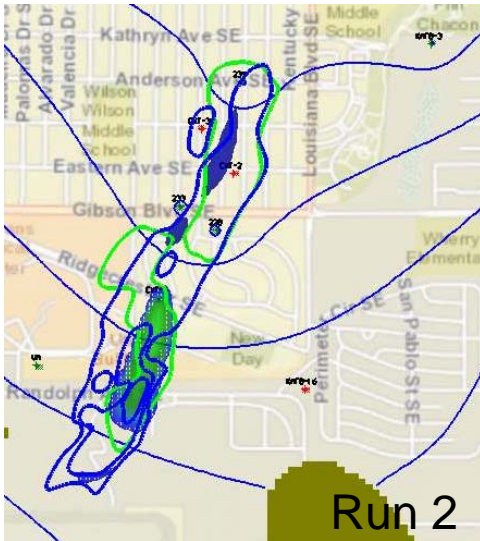
Max. time to clean up EDB north of Gibson.



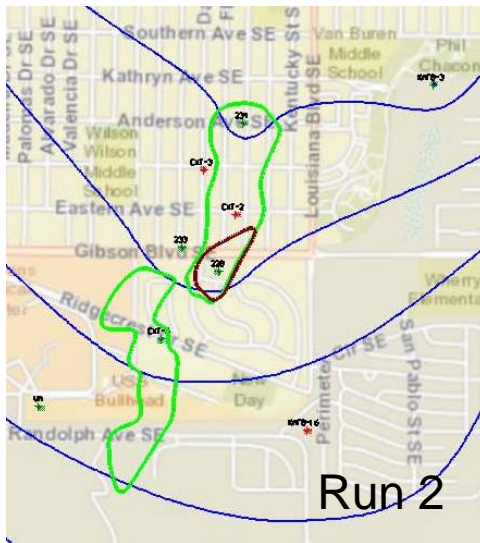
Projected EDB Clean-Up Layer 3 – 10 YR



Max. time to clean up EDB north of Gibson.

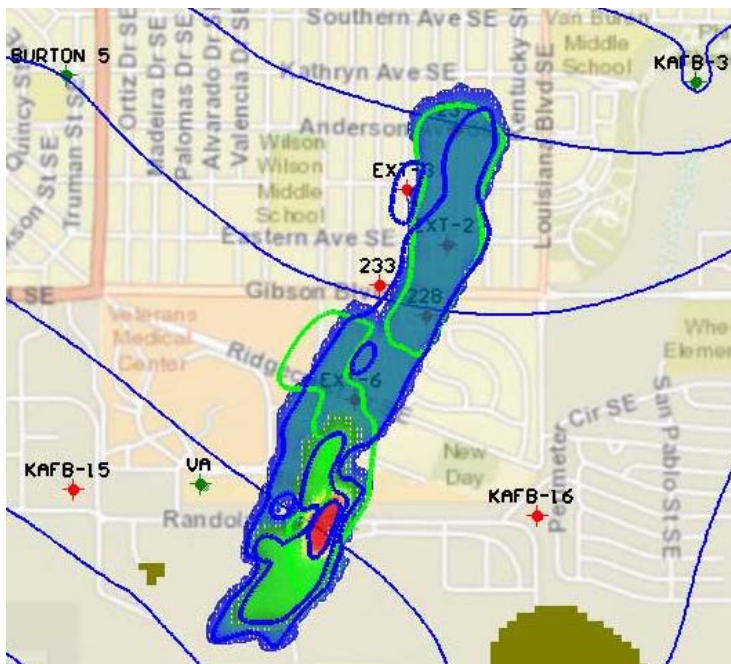


Projected EDB Clean-Up Layer 4 – 10 yr



Summary

- Installed and running remediation wells 106228, 106233, 106234
- Install and run remediation well EXT-6 in 2016
- Run full system for 2 years and assess EDB plume clean-up
- After re-assessment, determine next steps



Baseline



Run 2/3: 11 years

Thoughts / Questions?

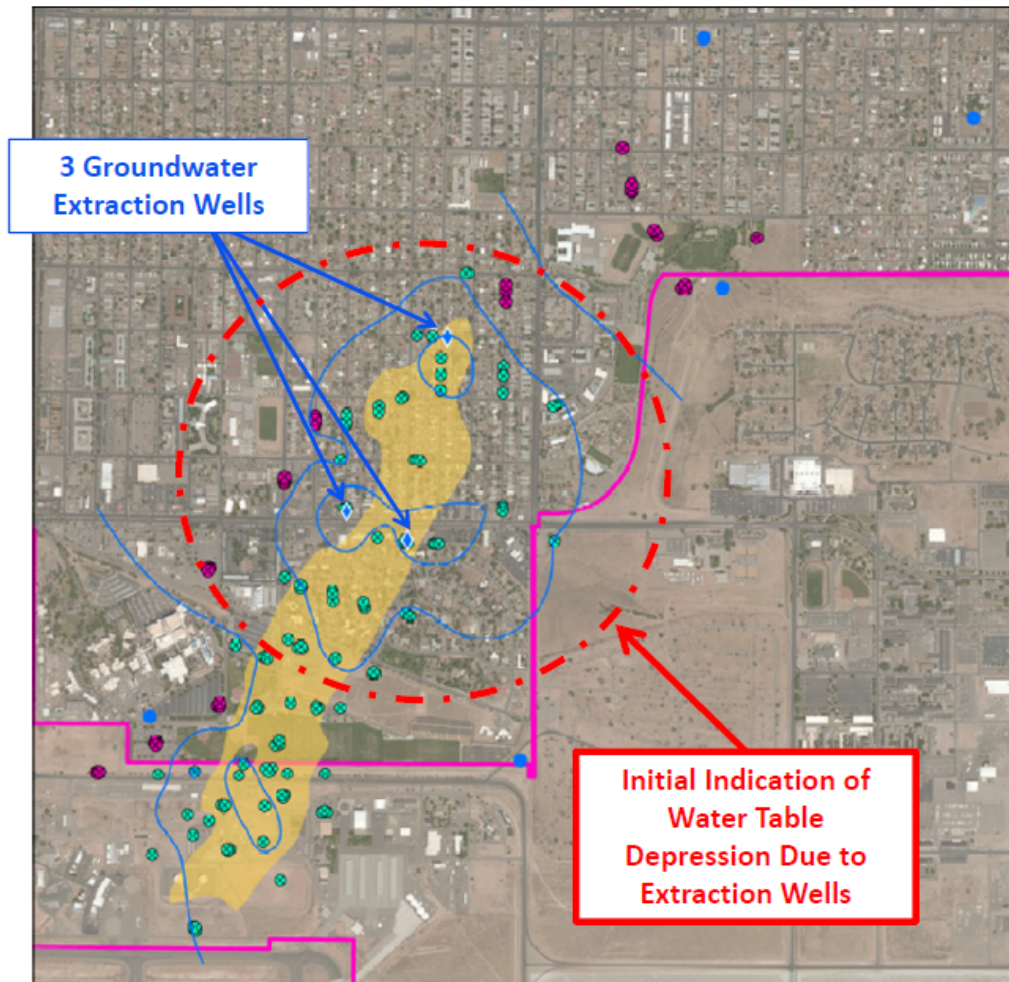




Extra Slides

2nd Quarter 2016 Groundwater Levels

Evidence of Success



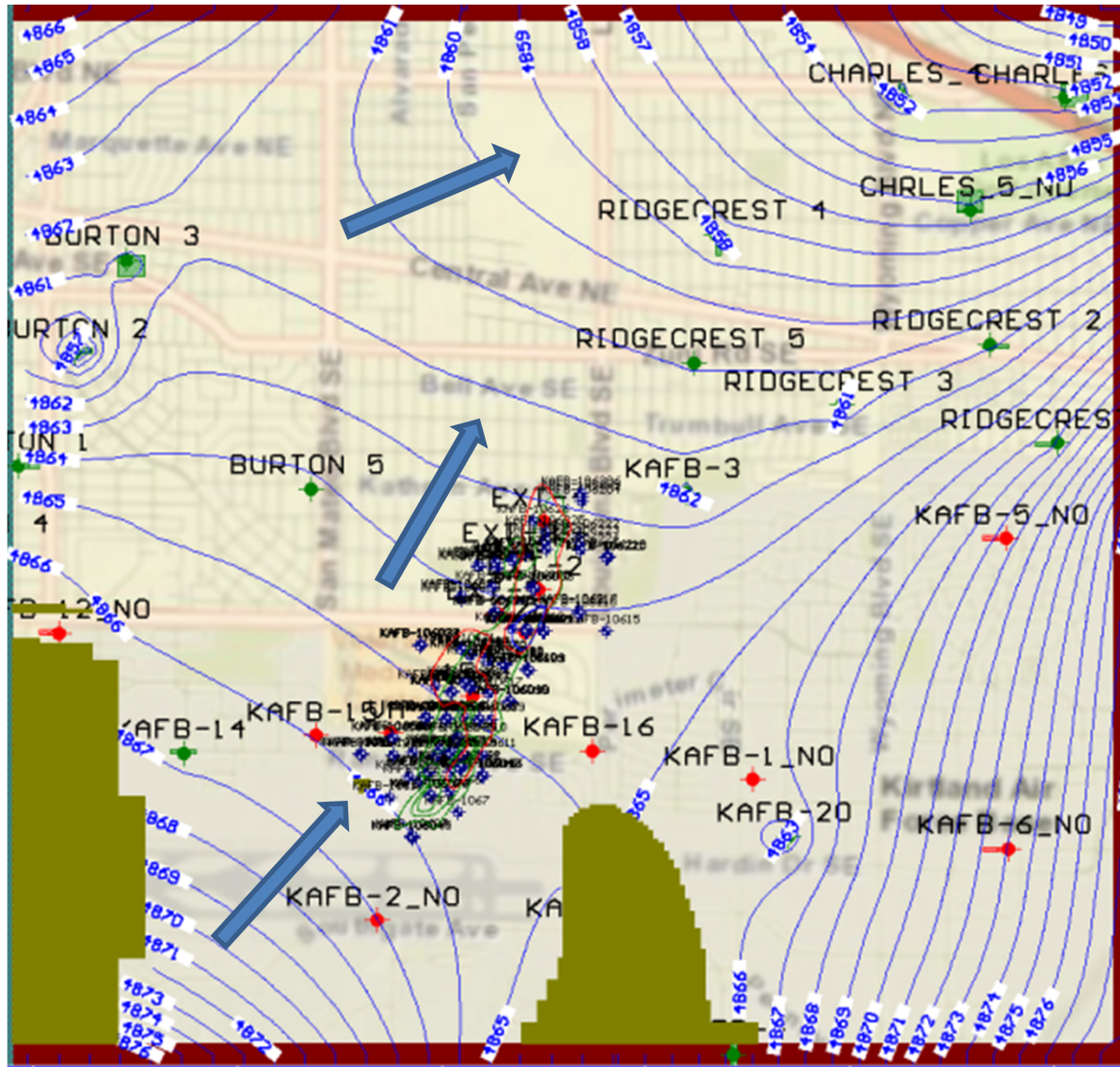
- The “cone of depression” from the first three extraction wells indicates successful removal of EDB-contaminated groundwater
- Plume collapse will be confirmed with EDB concentration trends

Legend

- ◆ Extraction Well
- Groundwater Monitoring Well
- Sentinel Well or Well Nest
- Drinking Water Well
- Q2 2016 Shallow GW Contours (04-20-16)
- Q4 2015 EDB Plume
- KAFB Base Boundary

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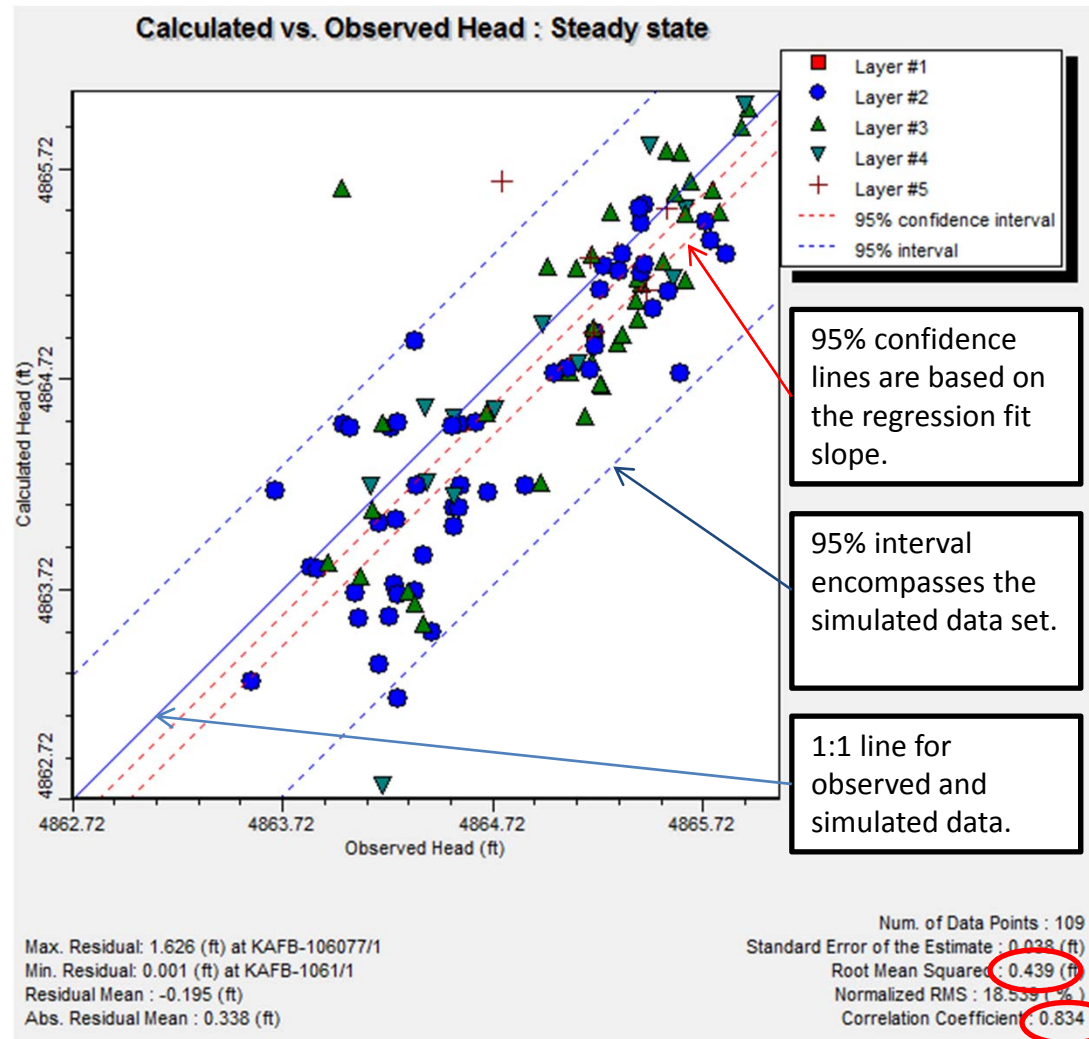
Calibrated Model Potentiometric Surface Contours



Model Calibration Scatter Plot

Notes:

1. It is likely that water level elevations vary by several tenths of a foot due to barometric pressure changes and possible measuring tape variance.
2. Model calibrated heads at **106 out 109 calibration target wells** had an **absolute error of less than 0.5 feet**
3. Only one of the calibration targets had an error exceeding 1 foot
4. The even spread across the diagonal indicates lack of bias in the model prediction errors



Transport Parameters	
Model	EDB
Kd (L/μg)	4E-11
1/2 Life (1/day)	0.0004
Field and Published	EDB
FOC (Kirtland Geo. Mean)	0.002
KOC	28.2 ^a
Calculated Kd (L/Kg)	0.0564
Calculated Kd (L/μg)	5.64E-11

a New York State Department of Environmental Conservation, January 1997. *Interim Procedures for Inactivation of Petroleum Impacted Sites*. Table O-2