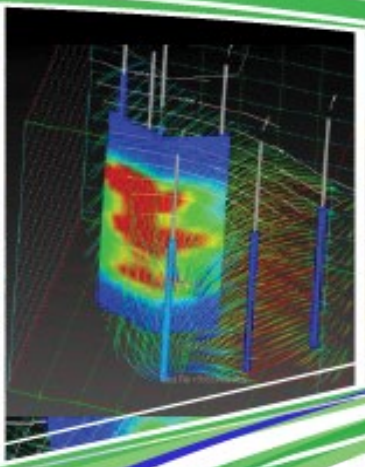




Using 3D Groundwater Visualization to Support Project Management

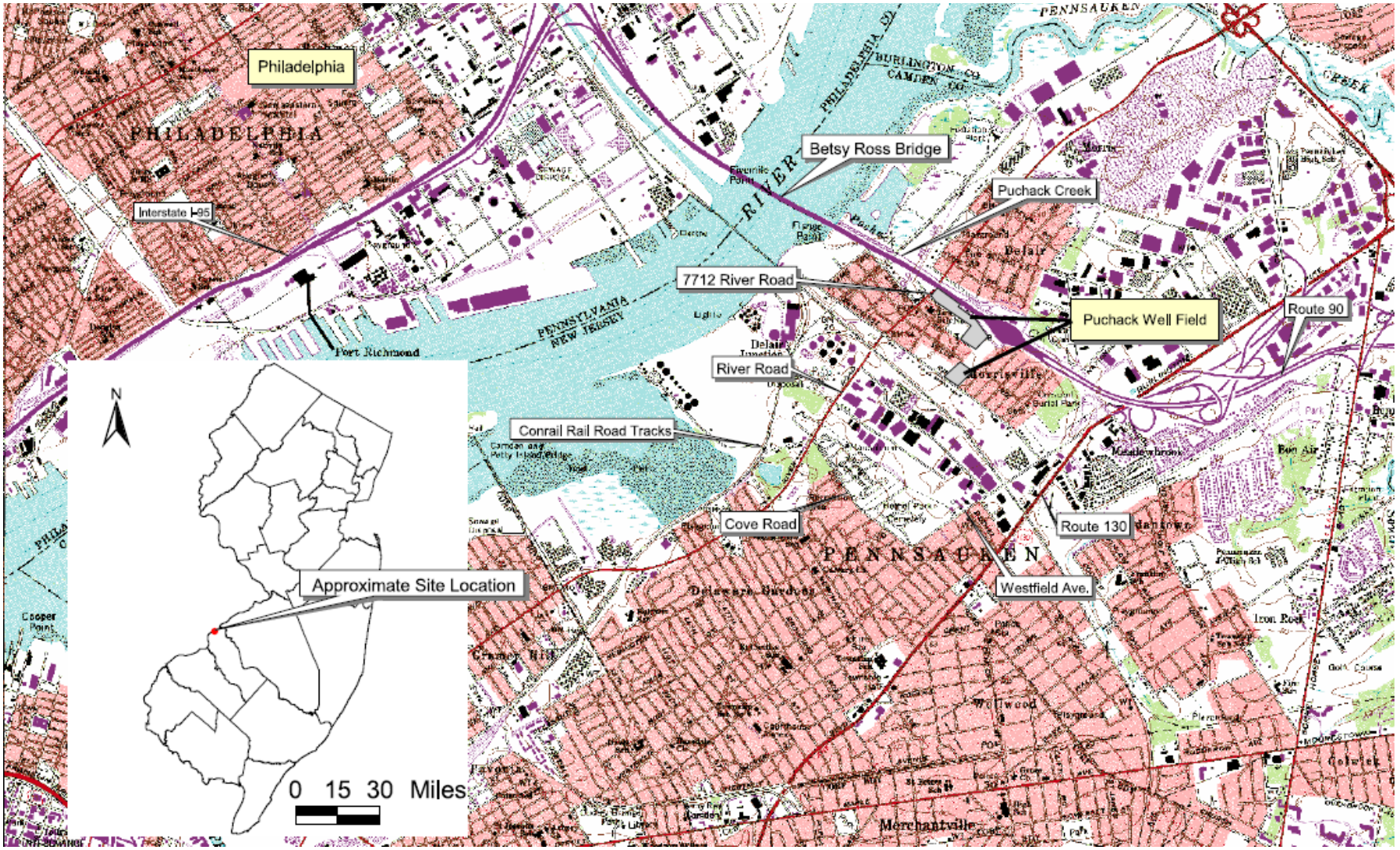
Application of Leapfrog Hydro at the Puchack Well Field Site.

Katie Mishkin and Jon Gorin

U.S. Environmental Protection Agency, Region 2

May 2, 2016

Site Location



Puchack Conceptual Site Model

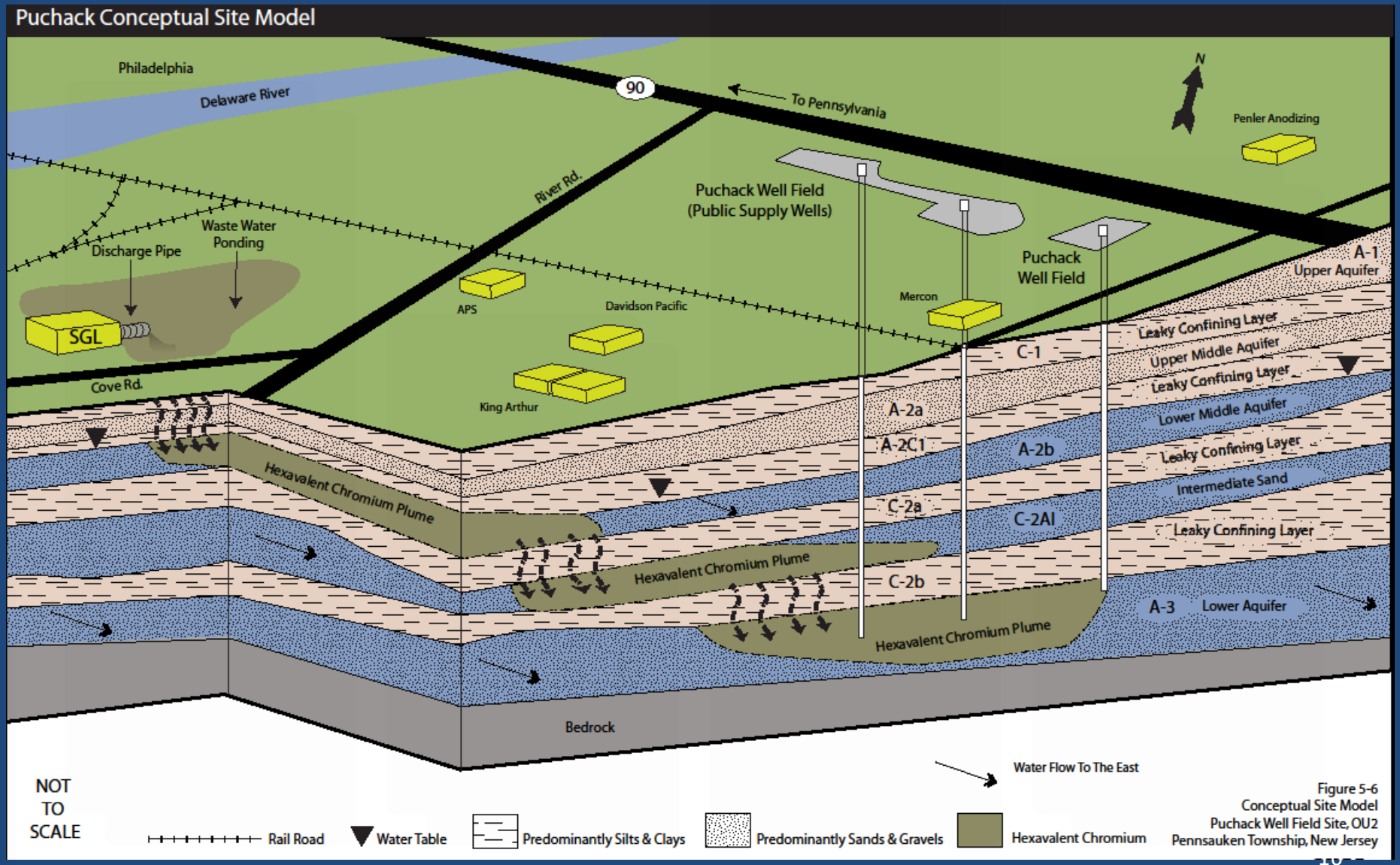


Figure 5-6
Conceptual Site Model
Puchack Well Field Site, OU2
Pennsauken Township, New Jersey

Record of Decision

- Goal: Reduce the level of chromium in the groundwater to meet New Jersey's Groundwater standard for *total* chromium (70 ug/l)

- Method: Reduce the Cr^{6+} to trivalent chromium (Cr^{3+}) through injection of an *unspecified* reducing agent into the areas of groundwater contamination

The PRPs Response
"We Didn't Do it"

- Financial records proved the company could not have purchased enough chromate to have caused the plume.
- There are other sources of CrVI in the area, including a sewer pipe and a landfill.
- EPA's data do not show a link between the middle aquifer and the lower aquifers.

Puchack Conceptual Site Model

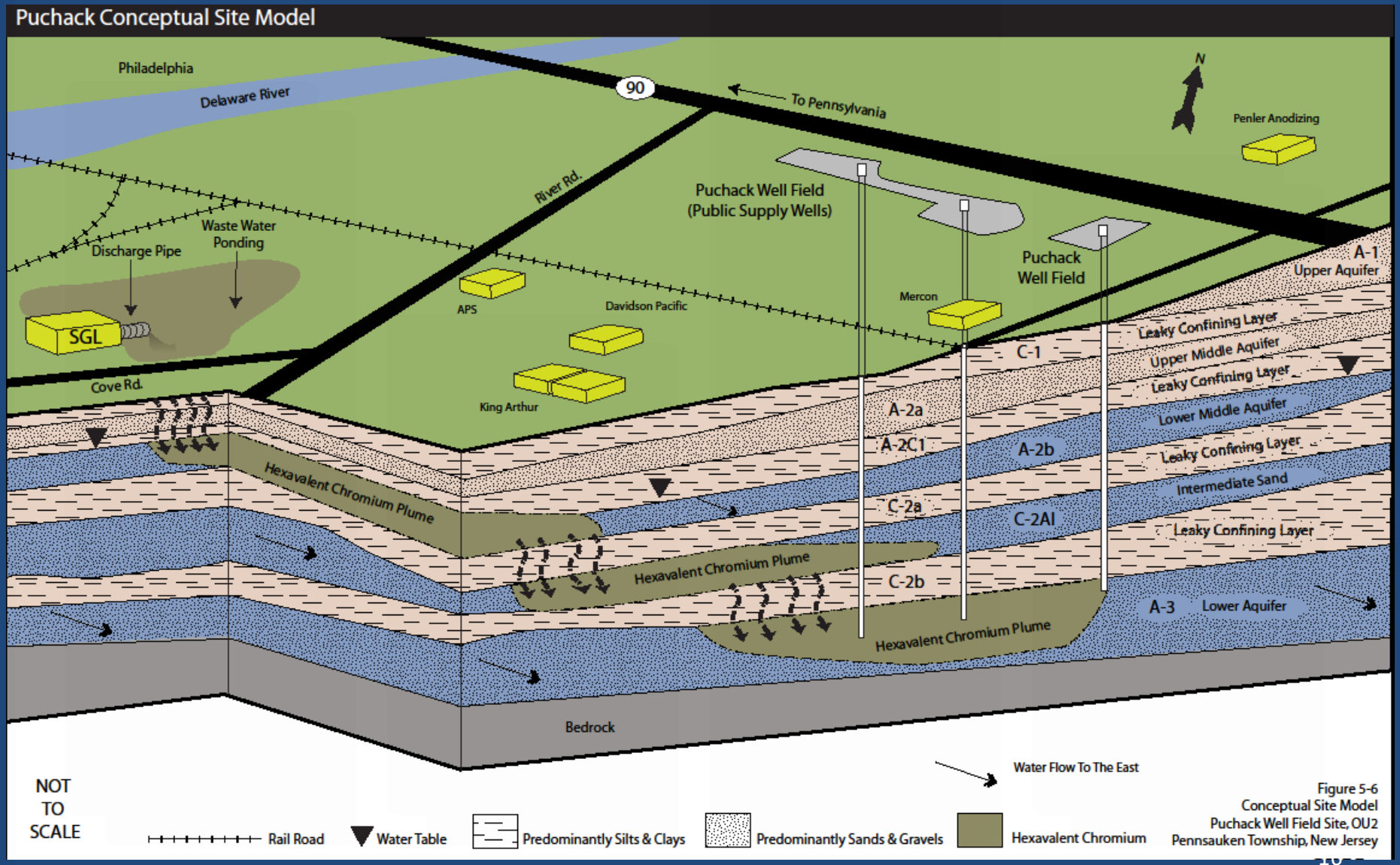
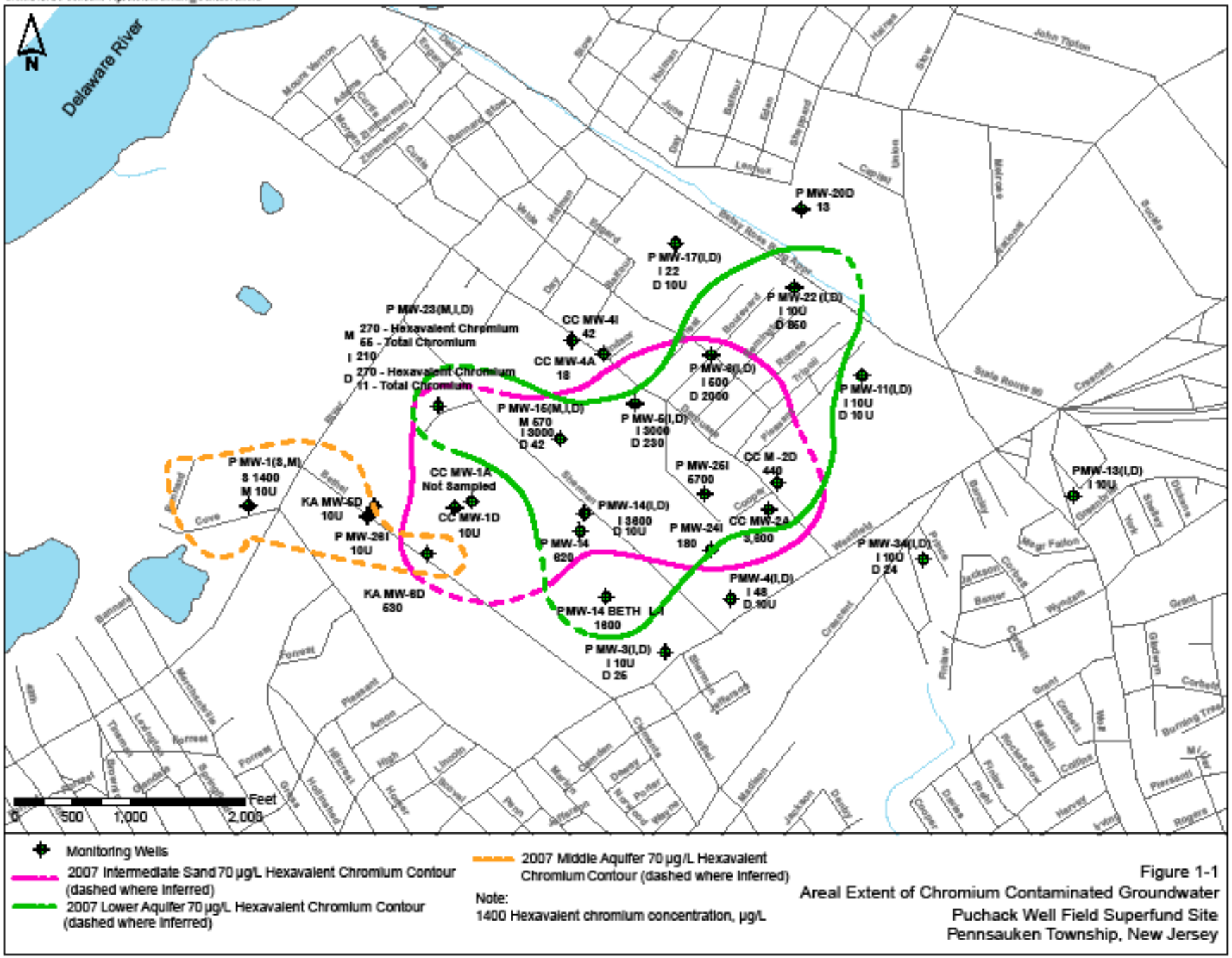


Figure 5-6
Conceptual Site Model
Puchack Well Field Site, OU2
Pennsauken Township, New Jersey



Monitoring Wells

2007 Intermediate Sand 70 µg/L Hexavalent Chromium Contour (dashed where Inferred)

2007 Lower Aquifer 70 µg/L Hexavalent Chromium Contour (dashed where Inferred)

2007 Middle Aquifer 70 µg/L Hexavalent Chromium Contour (dashed where Inferred)

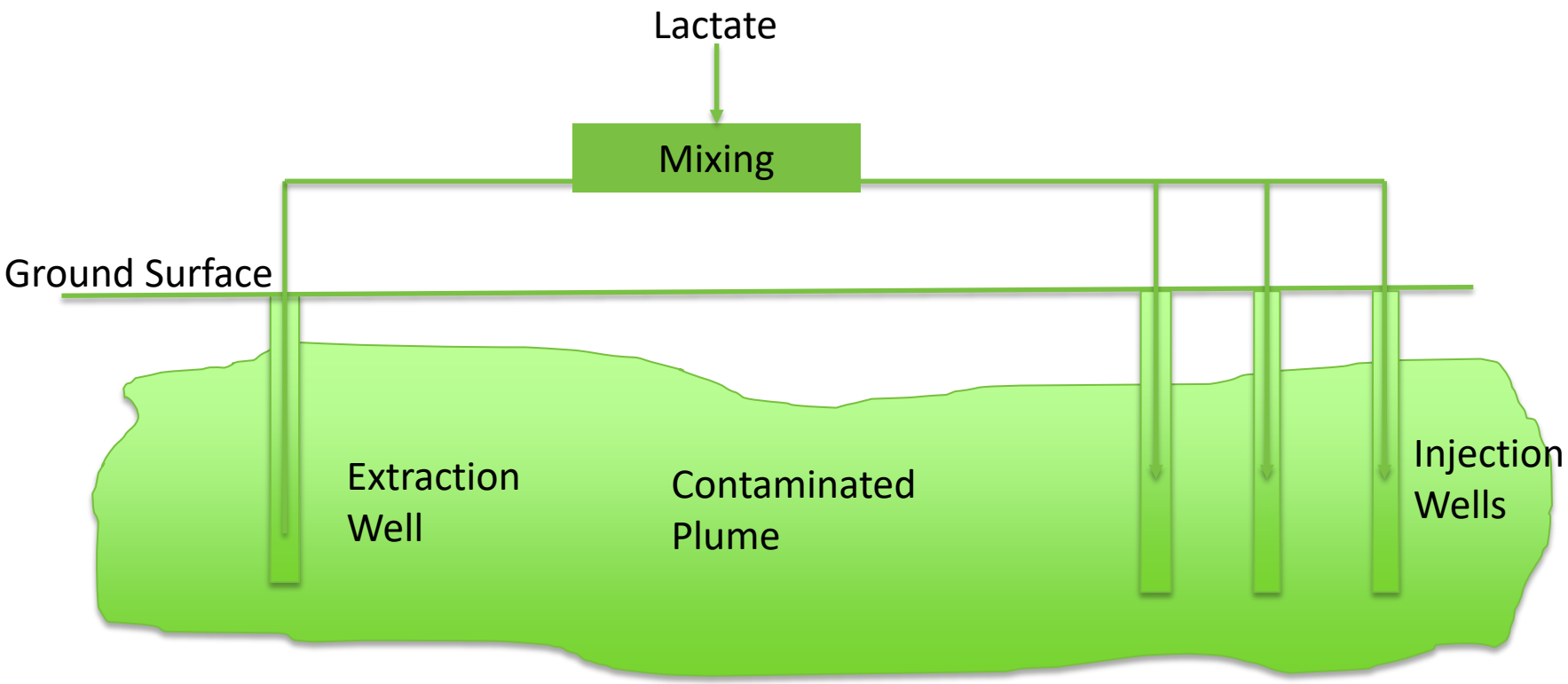
Note:
1400 Hexavalent chromium concentration, µg/L

Figure 1-1
Areal Extent of Chromium Contaminated Groundwater
Puchack Well Field Superfund Site
Pennsauken Township, New Jersey

Question #1

How could we have better shown the PRPs that there is a link between their property and the groundwater plumes?

General Design Approach



Full Scale Design/Implementation

Divided Groundwater Cleanup into Two Phases

- Phase 1, upgradient portion with higher Cr concentration
  - Underlies commercial properties.
- Phase 2, remaining portion
  - Underlies residential properties.

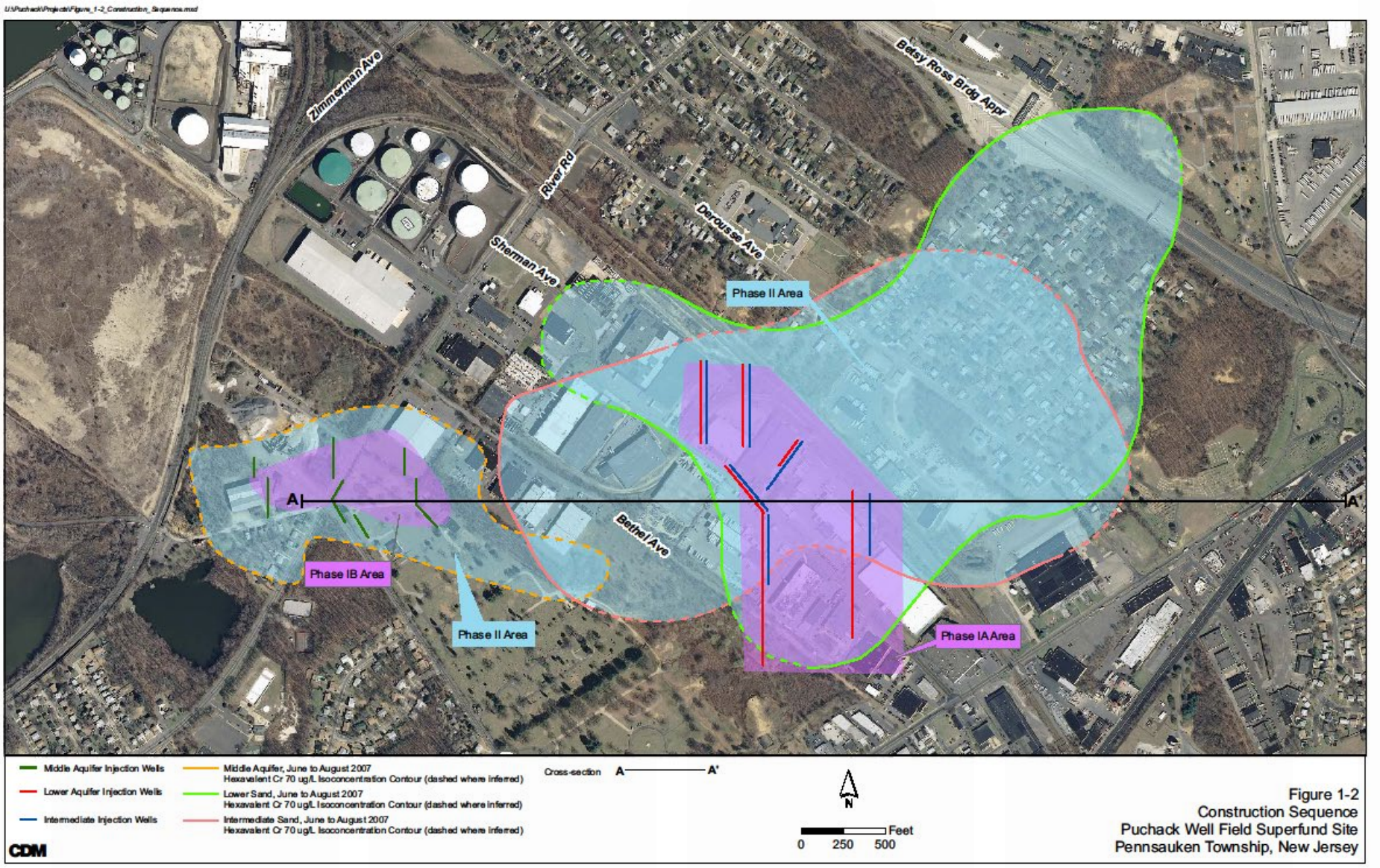
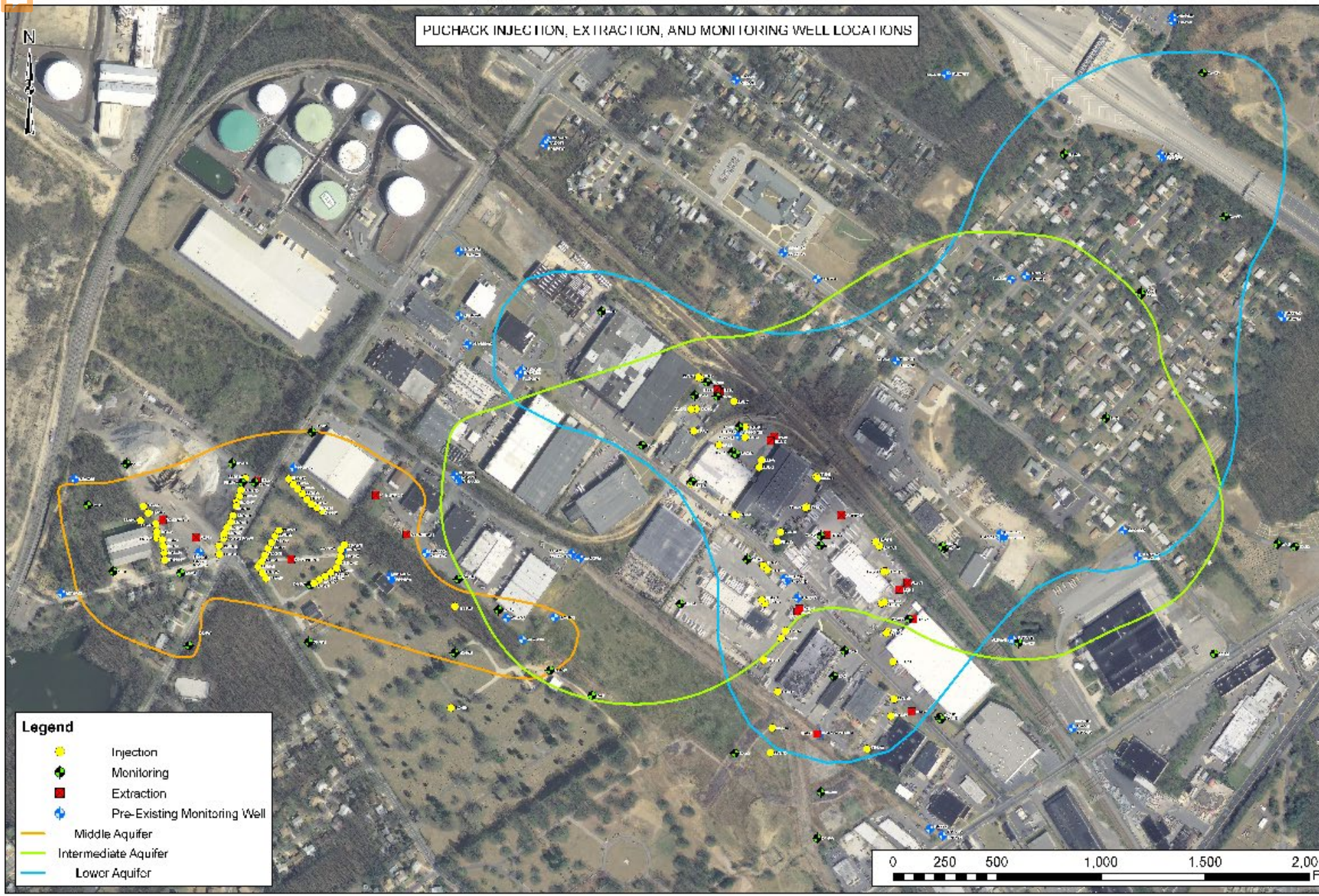
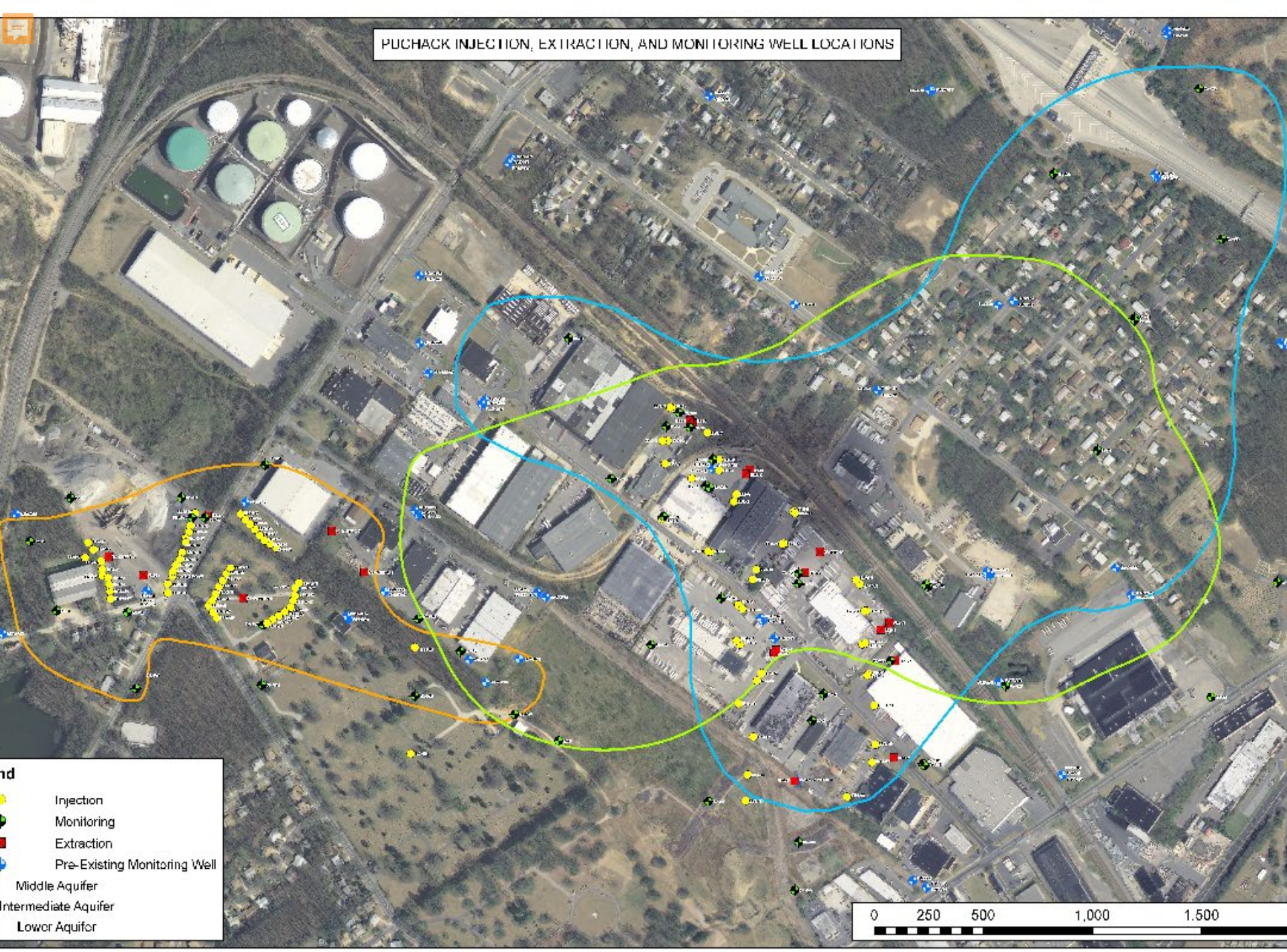


Figure 1-2
Construction Sequence
Puchack Well Field Superfund Site
Pennsauken Township, New Jersey


PUCHACK INJECTION, EXTRACTION, AND MONITORING WELL LOCATIONS
N
Legend
Injection
Monitoring
Extraction
Pre-Existing Monitoring Well
Middle Aquifer
Intermediate Aquifer
Lower Aquifer
0
250
500
1,000
1,500
2,00

Question #2

How can we demonstrate how well (or poorly) the remedy's first phase worked?

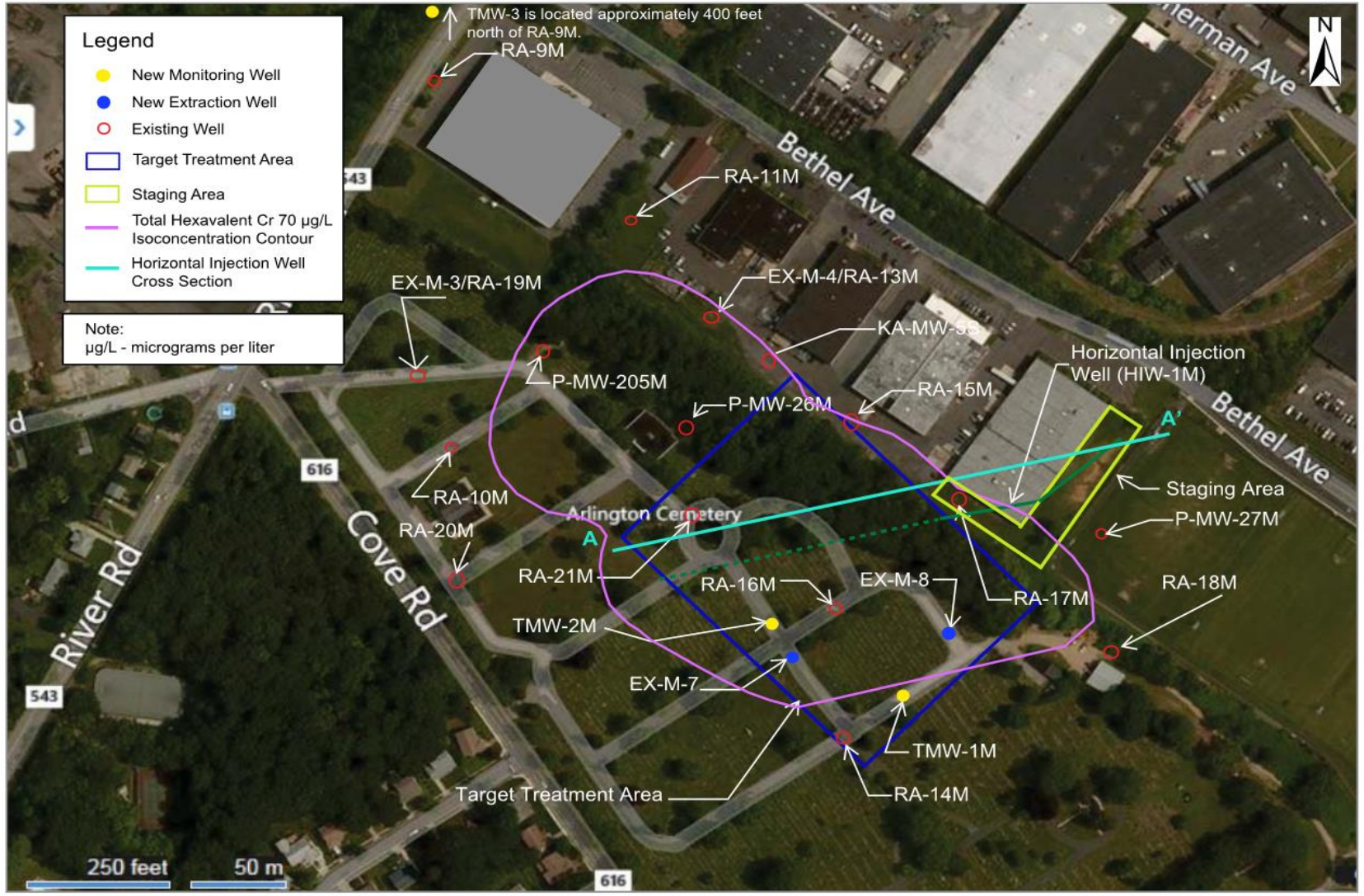

PUCHACK INJECTION, EXTRACTION, AND MONITORING WELL LOCATIONS
nd
Injection
Monitoring
Extraction
Pre-Existing Monitoring Well
Middle Aquifer
Intermediate Aquifer
Lower Aquifer
0
250
500
1,000
1,500


fesser

Phase 2 Pilot Study

Can horizontal well screens resolve our logistical issues?

- Need to properly locate the screens
- Lactate needs to discharge evenly over screen length



CDM Smith	Pilot Study Layout Aerial View Puchack Phase II Pilot Study Work Plan	Figure 4-1

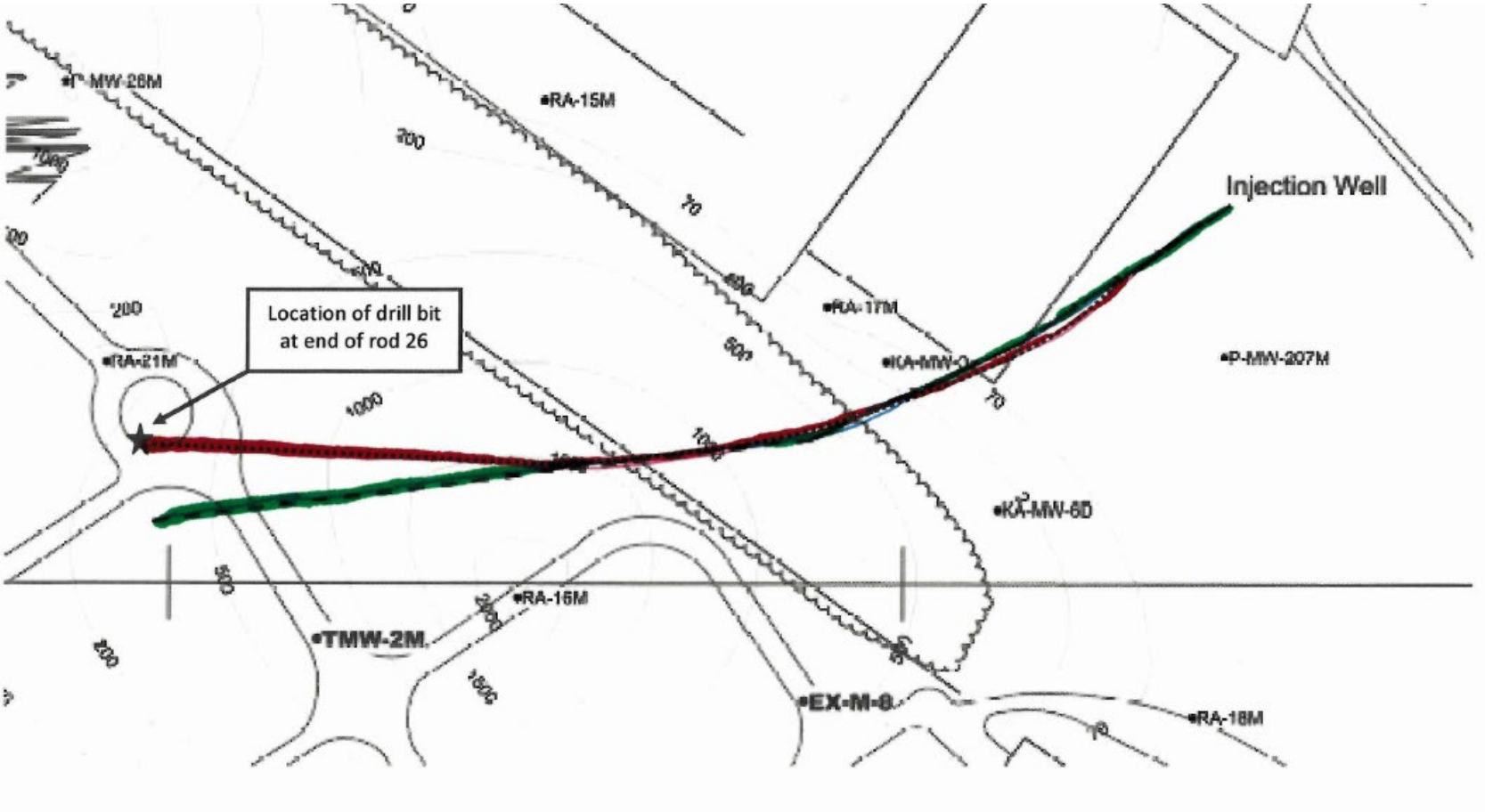
Well Installation "The Plan"

- Drill 850 foot pilot hole using a gyroscopic steering tool.
- Chase pilot hole using a "knock-off" drill bit and a large diameter drill rod – guidance through magnetic transmitter
- Well material inserted inside drill rod, bit sacrificed and drill rod removed.

Well Installation "The Reality"

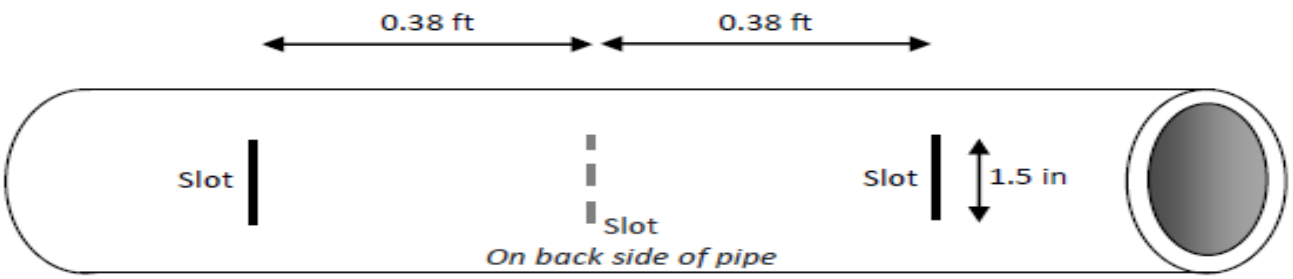
- The Gyroscopic steering tool (GST) was amazingly accurate
- Changes in formation material increased the risk of losing the GST; - switched to the knock-off bit/magnetic transmitter before completing the pilot hole
- The magnetic transmitter was at the maximum range of functionality - final screen off target area by about 50'

Planned Vs Actual Well Location



Variable Slotted Screen

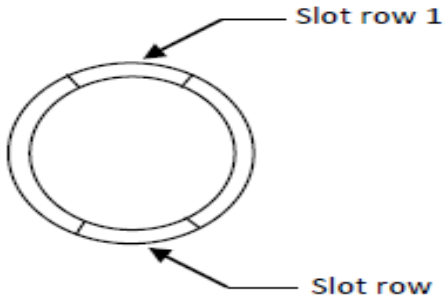
Well Screen
Isometric View



NOTES

1) Each slot 0.01” wide x 1.5” long (typical)
2) Slots are oriented across the pipe
3) Two rows of slots
4) Each row has slots spaced on 0.76 ft centers
5) Rows spaced 180 degrees apart in cross-section, with slots in opposite rows offset by 0.38 ft

Well Screen
End View



Figures Not Drawn To Scale


STANLEY
QC

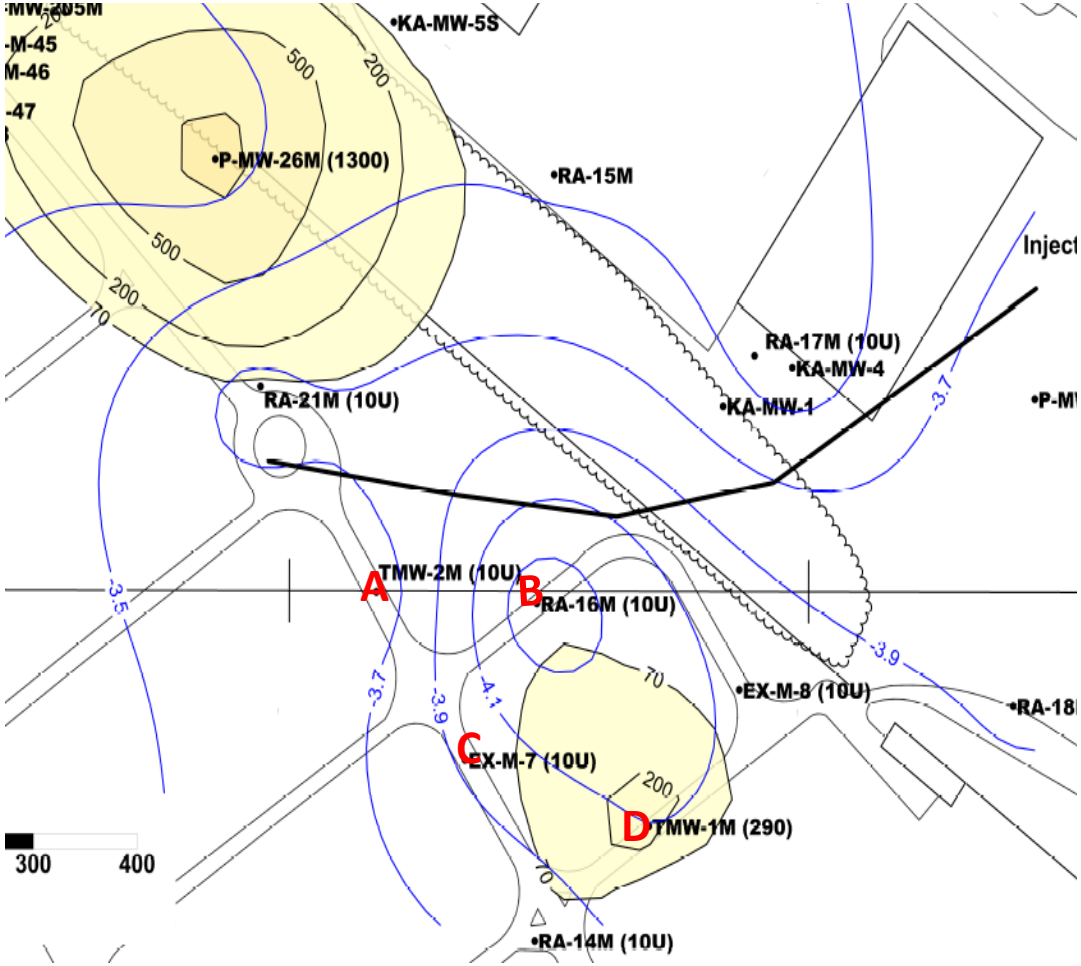
Phase 2 Pilot Study - Total Injection Quantities

Period of Injection	Total 60% Sodium Lactate Injected (gallons)	Total 60% Sodium Lactate Injected (pounds)
July 15, 2015 – August 5, 2015	22,132	246,329

Note: Density of 60% sodium lactate is 11.13 pounds per gallon.

Phase 2 Pilot Study
Performance Round 1 COD Concentrations

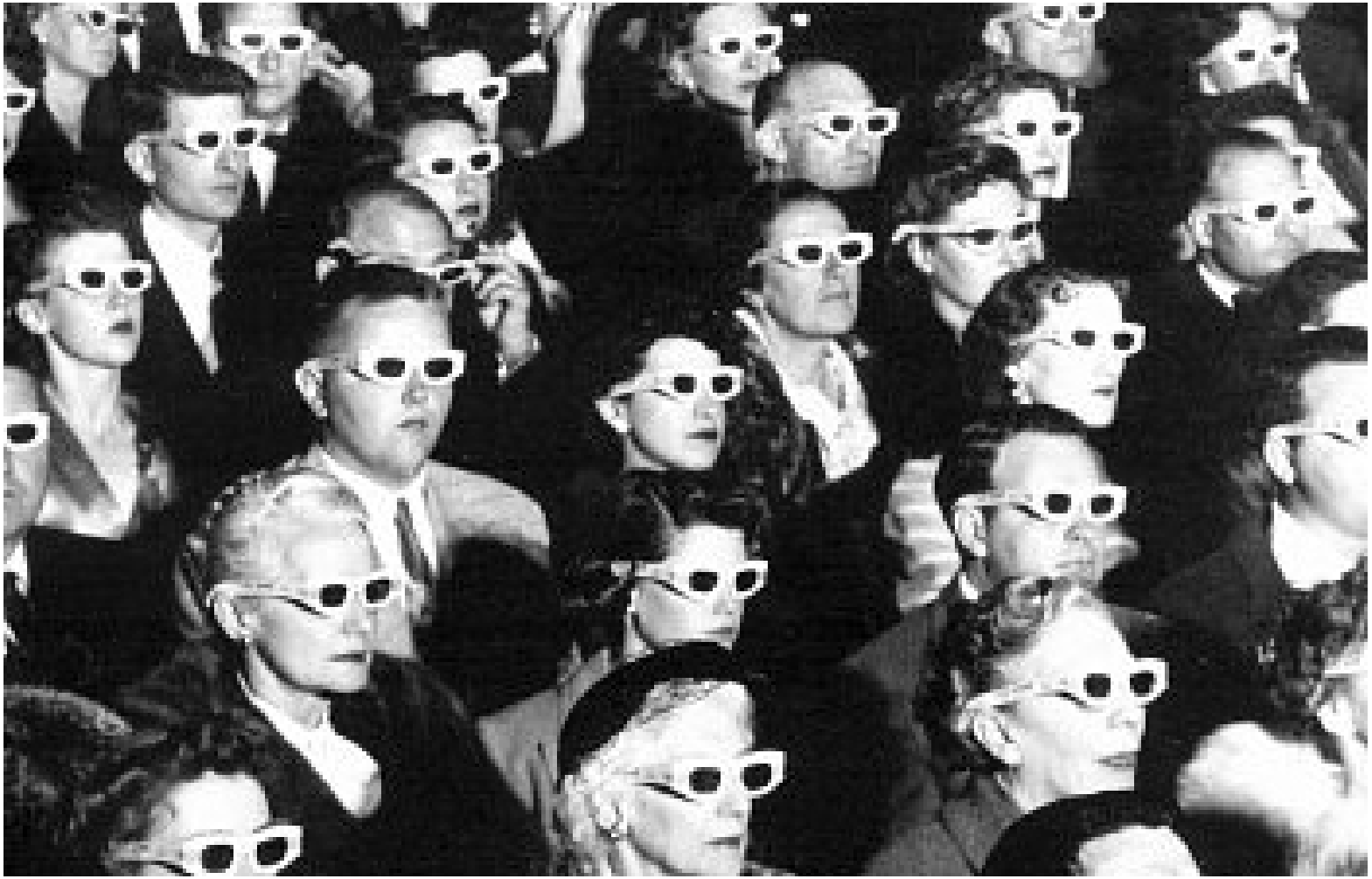
Well	Baseline COD (mg/L)	Round 1 COD (mg/L)
A	ND	580
B	810	4,800
C	ND	ND
D	ND	ND



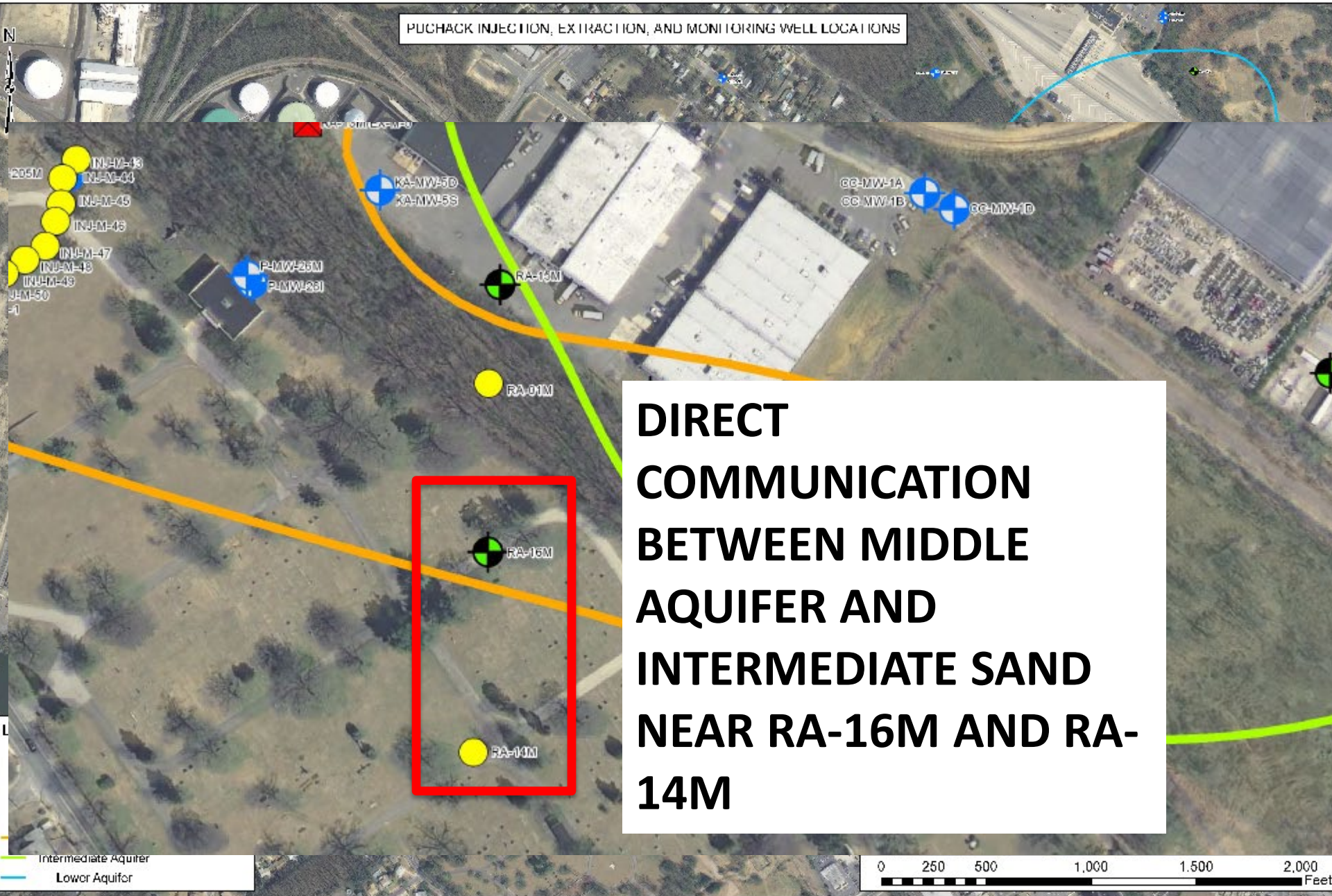
Question #3

How can we be confident we're installing the horizontal wells in the optimal locations?

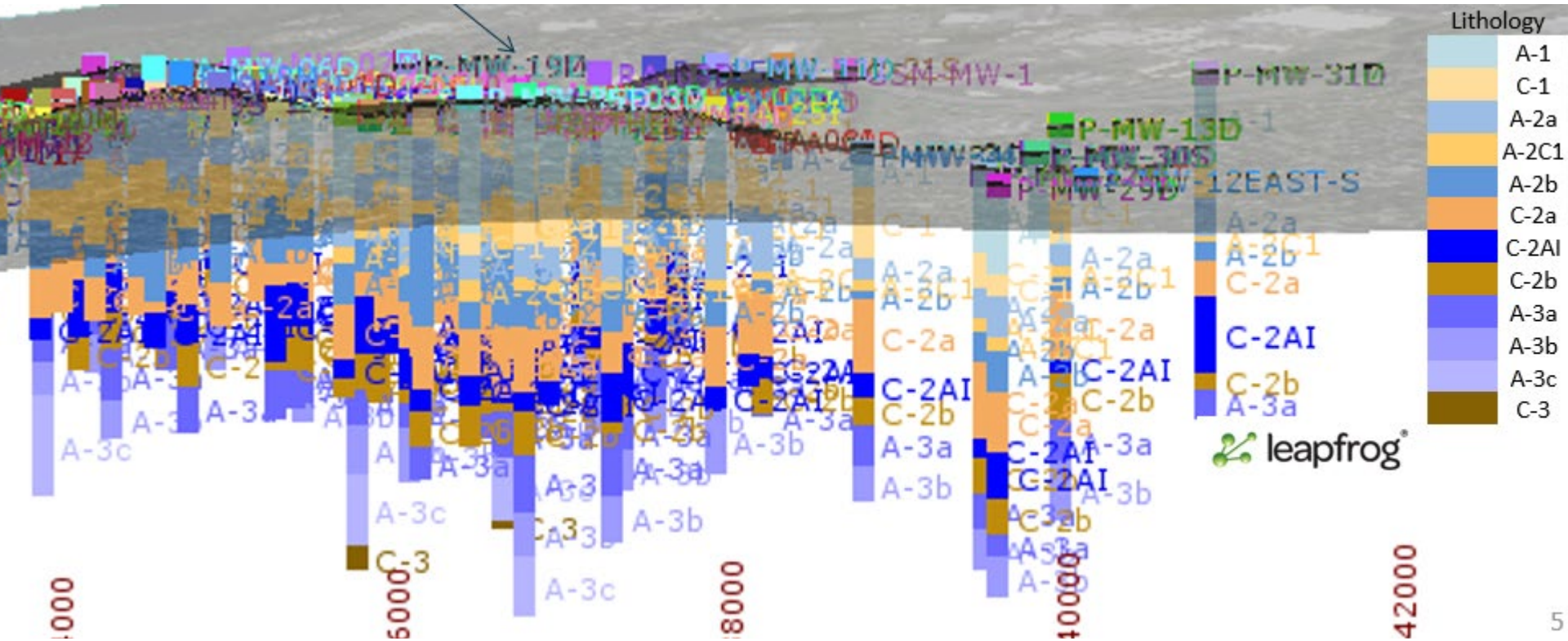
Seeing in 3D Might Help



Groundwater communication between aquifers



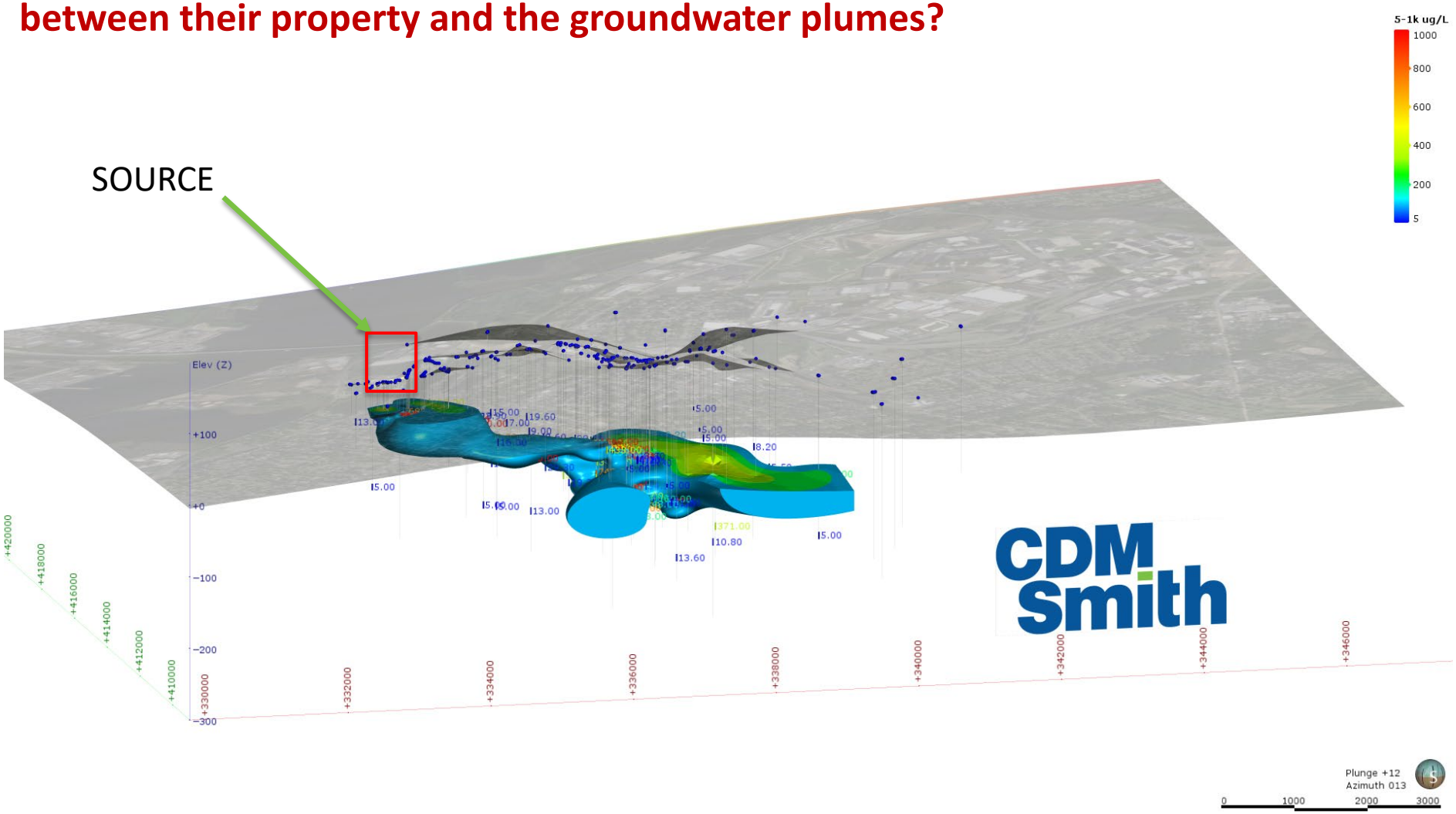
How could we have convinced the non-technical PRPs that there is a link between their property and the groundwater plumes?



Plunge +30
Azimuth 010

Topography and Chromium >70 µg/L

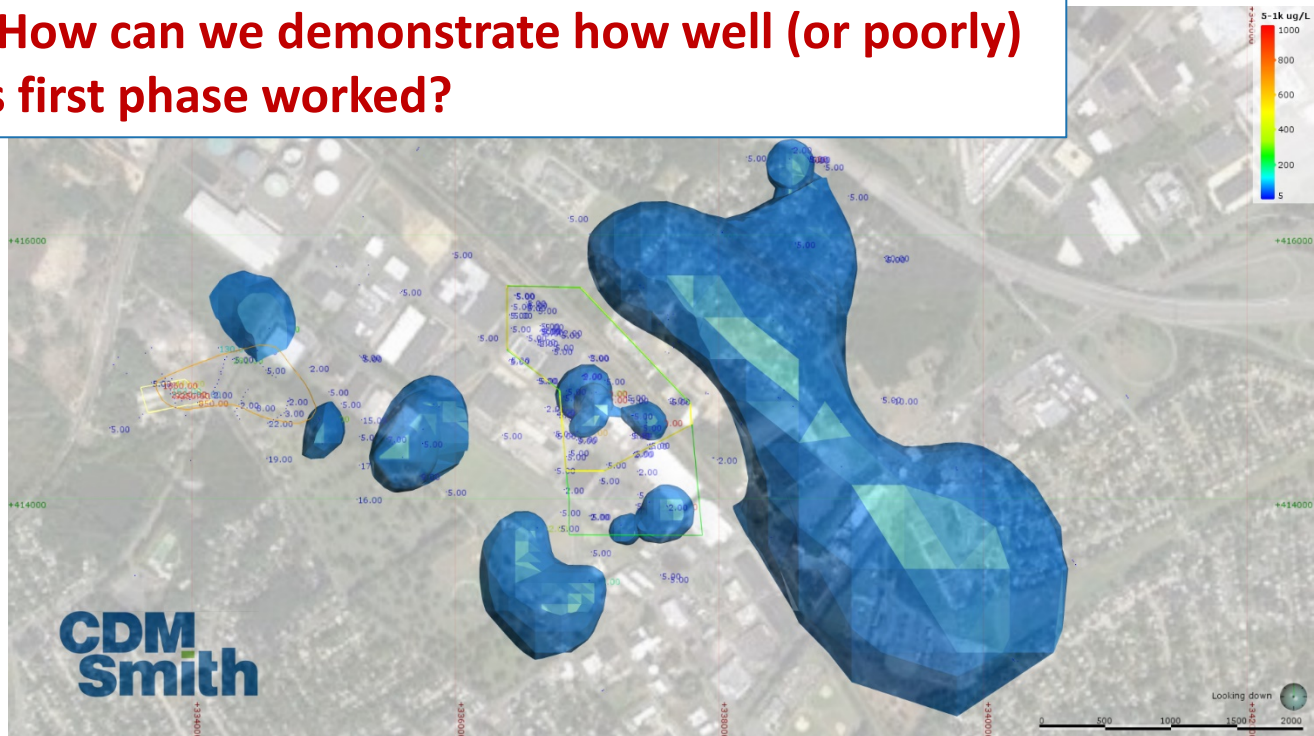
Question #1 How could we have better shown the PRPs that there is a link between their property and the groundwater plumes?

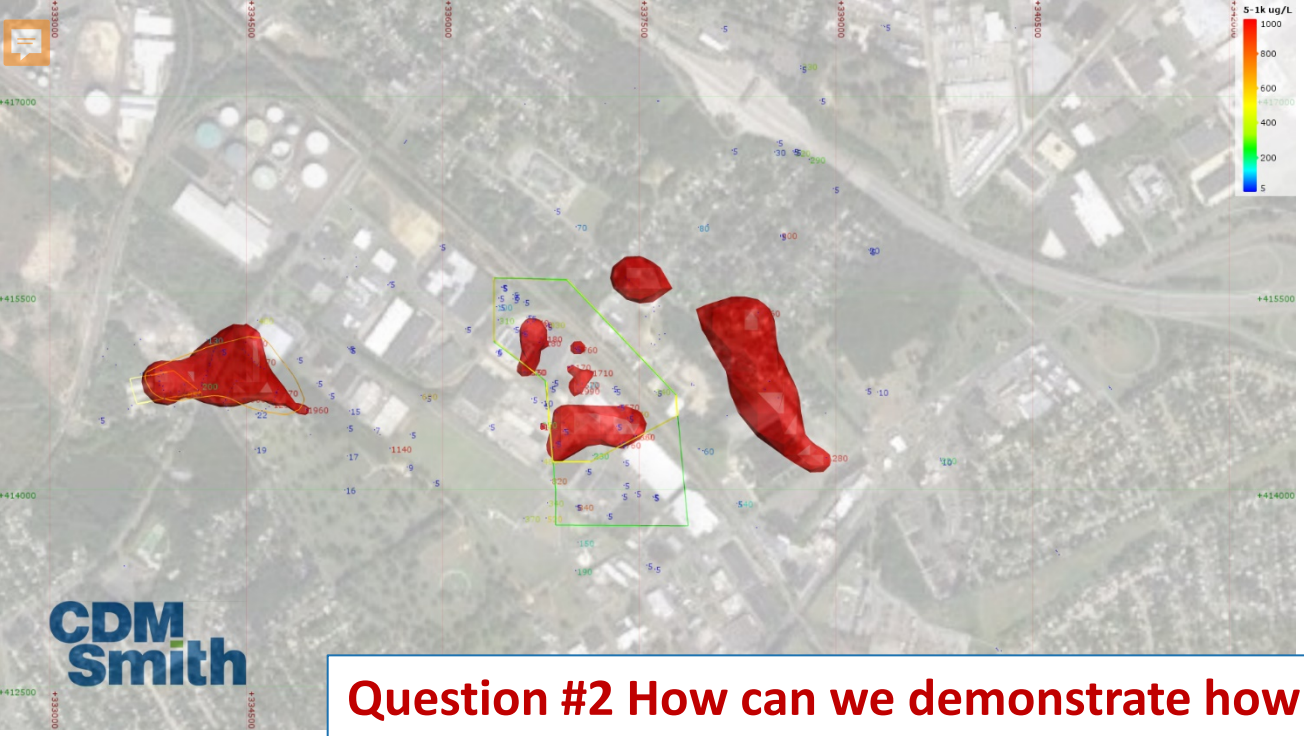


Pre-treatment
Cr $^{6+}$> 70 ug/L

Question #2 How can we demonstrate how well (or poorly) the remedy's first phase worked?

Post-treatment
Cr $^{6+}$> 70 ug/L

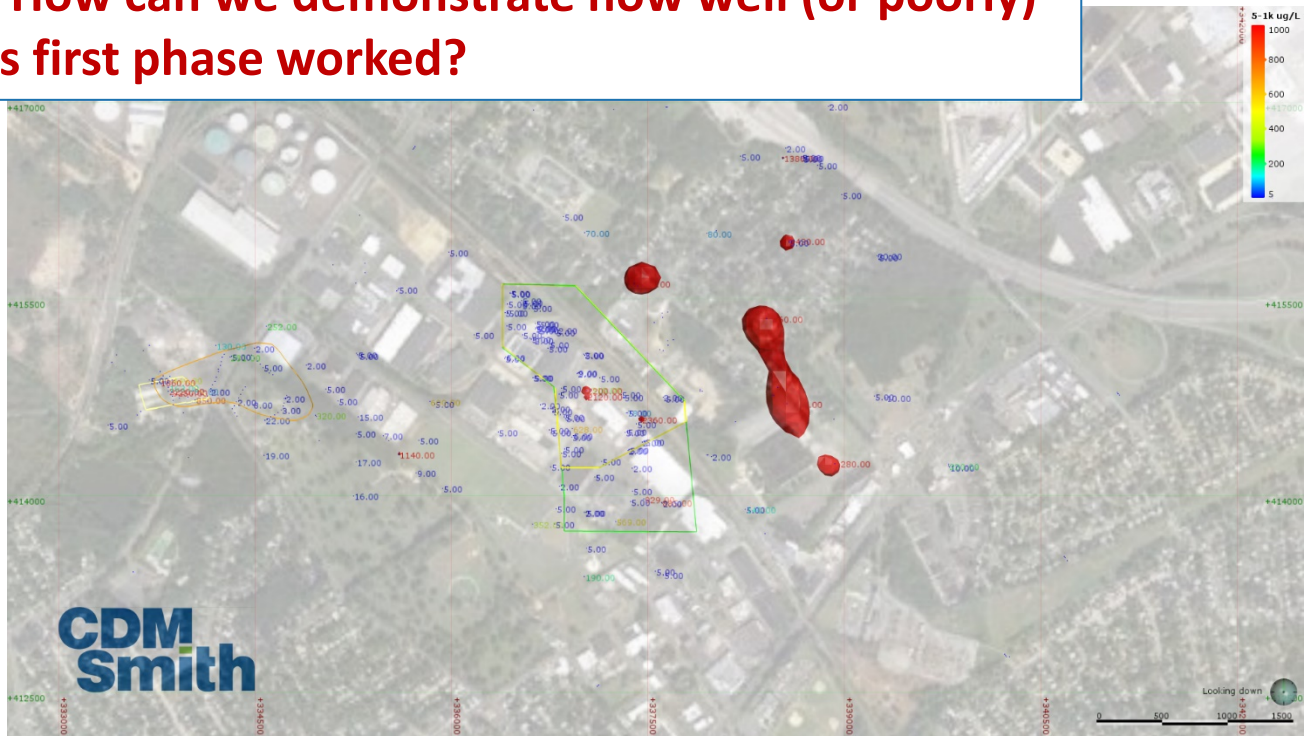


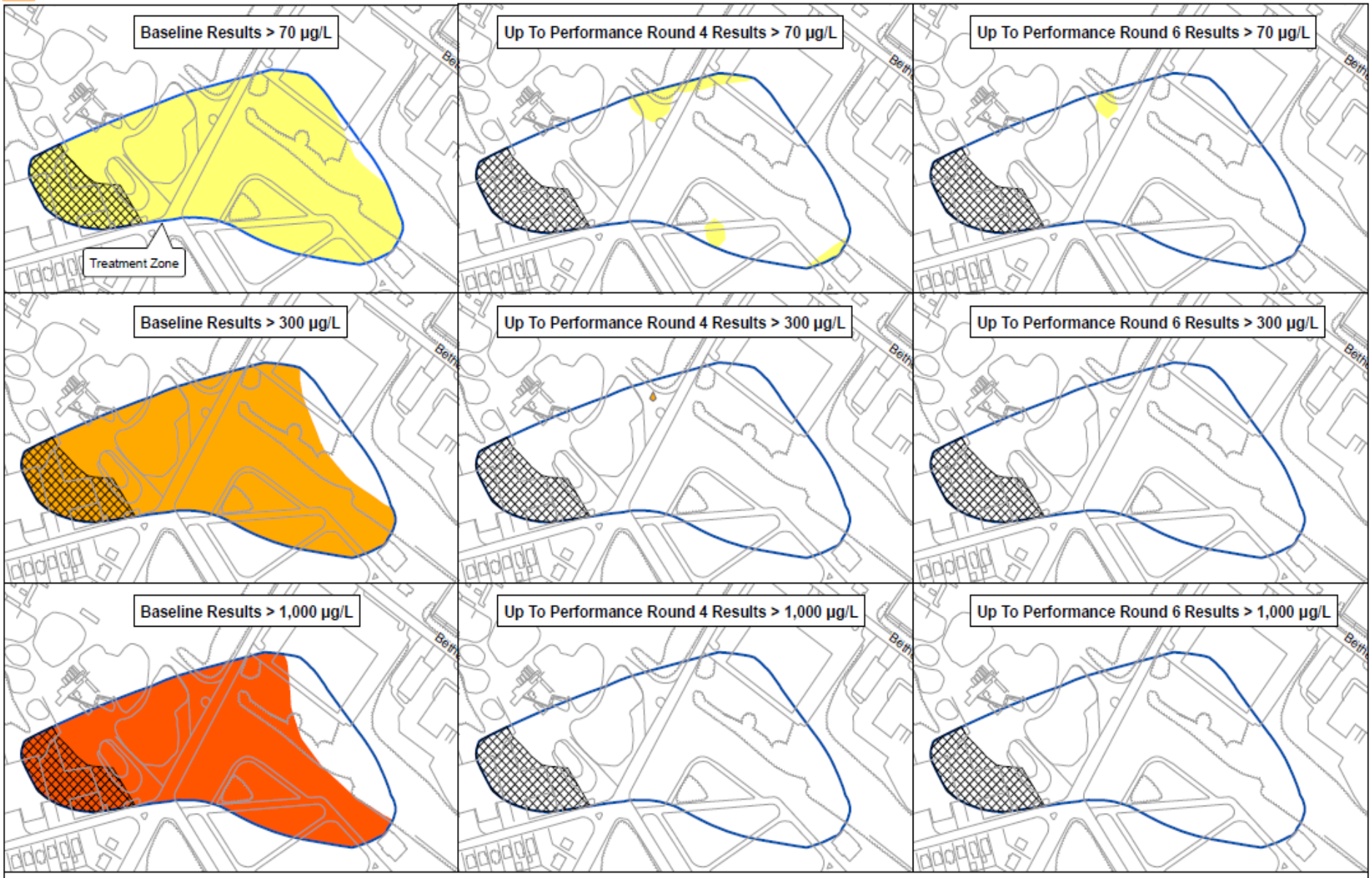


Pre-treatment
Cr $^{6+}$> 1000 ug/L

Question #2 How can we demonstrate how well (or poorly) the remedy's first phase worked?

Post-treatment
Cr $^{6+}$> 1000 ug/L





Notes:
1. Series A wells sample results are not included.
2. Leapfrog Hydro was used to interpolate hexavalent chromium plumes pre- and post-treatment.
3. µg/L - micrograms per liter
4. > - greater than

Legend

- Hexavalent Chromium > 70 µg/L
- Hexavalent Chromium > 300 µg/L
- Hexavalent Chromium > 1,000 µg/L
- Phase I Middle Aquifer Treatment Zone
- Middle Aquifer Series A (not evaluated)

N W E S

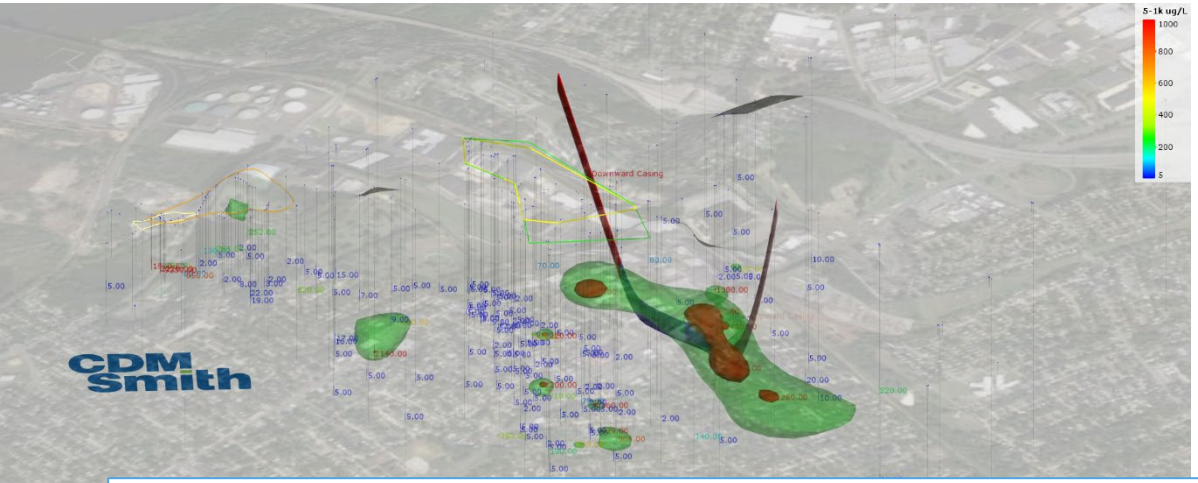
0 150 300 600 Feet

CDM Smith

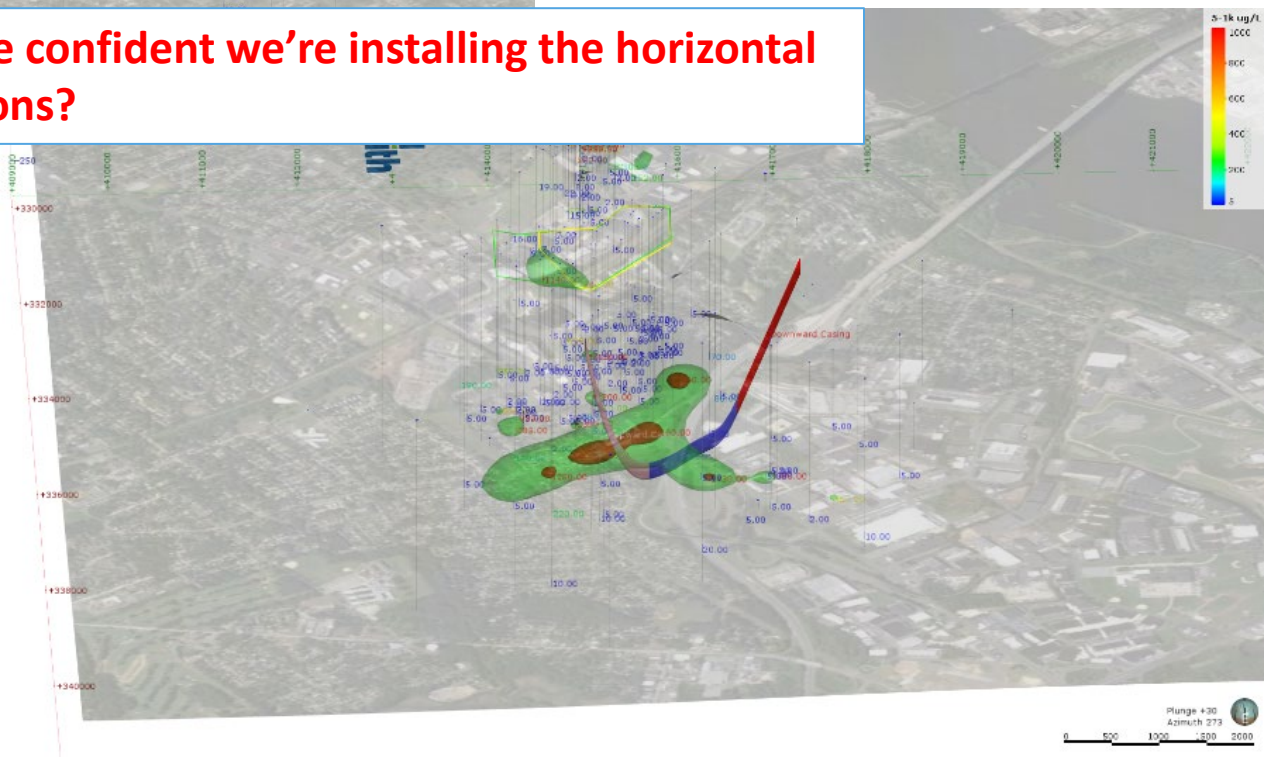
Document Path: F:\Puchack\GIS\ArcGIS_Projects\Phase 1 Treatment\Middle Aq Crtl Interpolated Vol.mxd

Figure 1f
Hexavalent Chromium Plume Interpolations Pre- and Post-Treatment, Middle Aquifer
Puchack Well Field Superfund Site - OU1
Pennsauken Township, New Jersey

Cross-sectional view of remaining Cr^{6+} plume



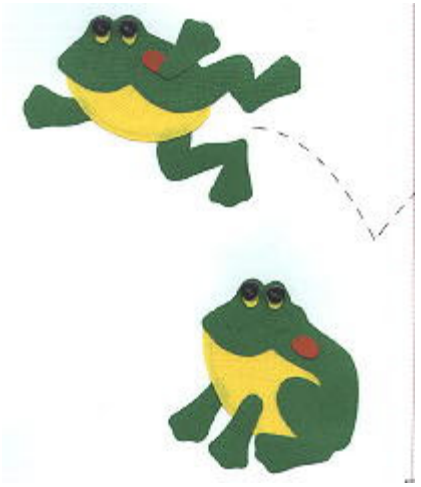
Question 3: How can we be confident we're installing the horizontal wells in the optimal locations?



Considering 3D visualization?

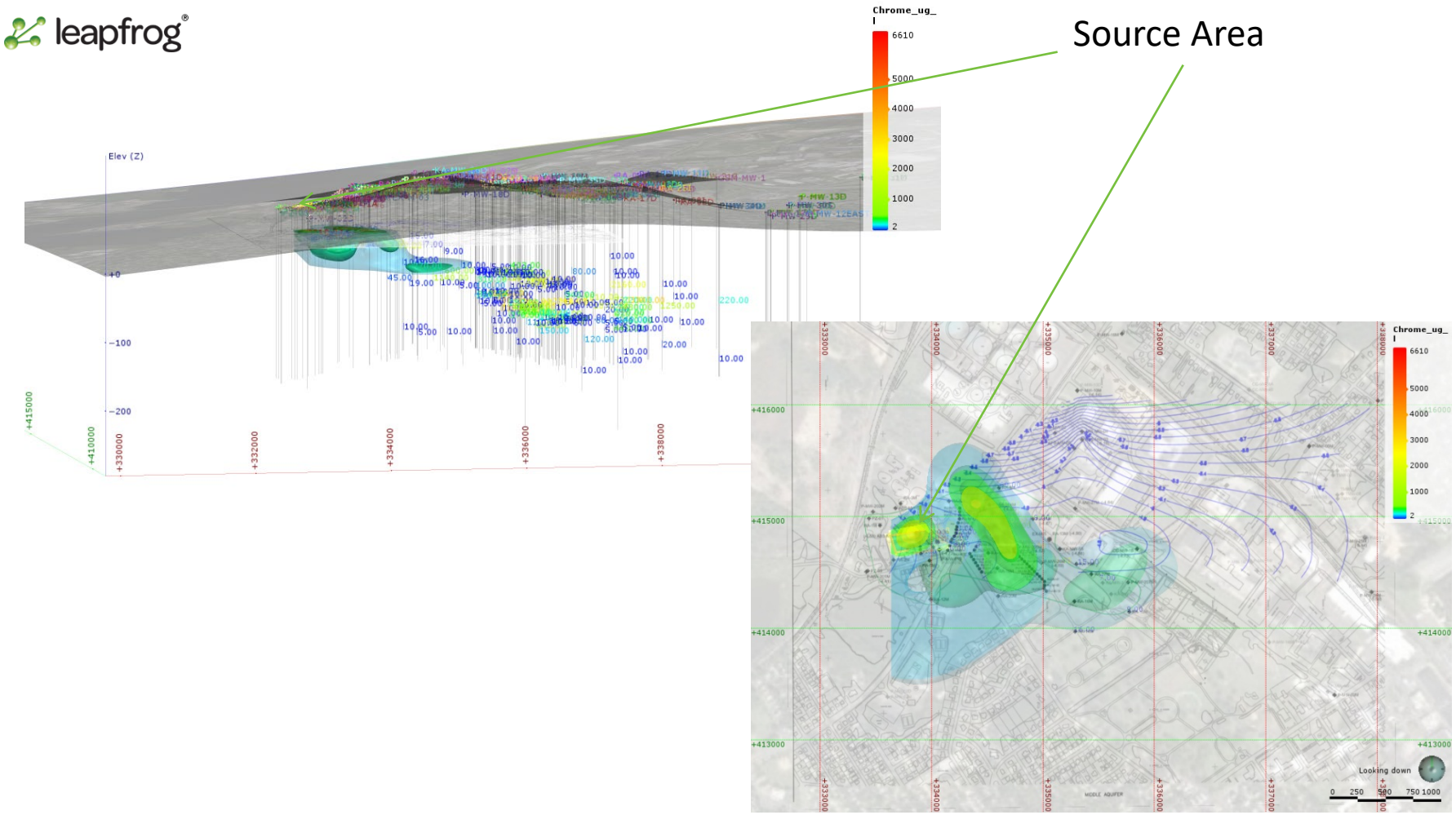
- Best to consider when…
  - Robust dataset
  - Sufficient hydrogeologic information from well logs
  - Complicated aquifer system (e.g. multiple aquifers, fractured bedrock)
  - Multiple/co-mingled contaminant plumes

Leapfrog Hydro Viewer

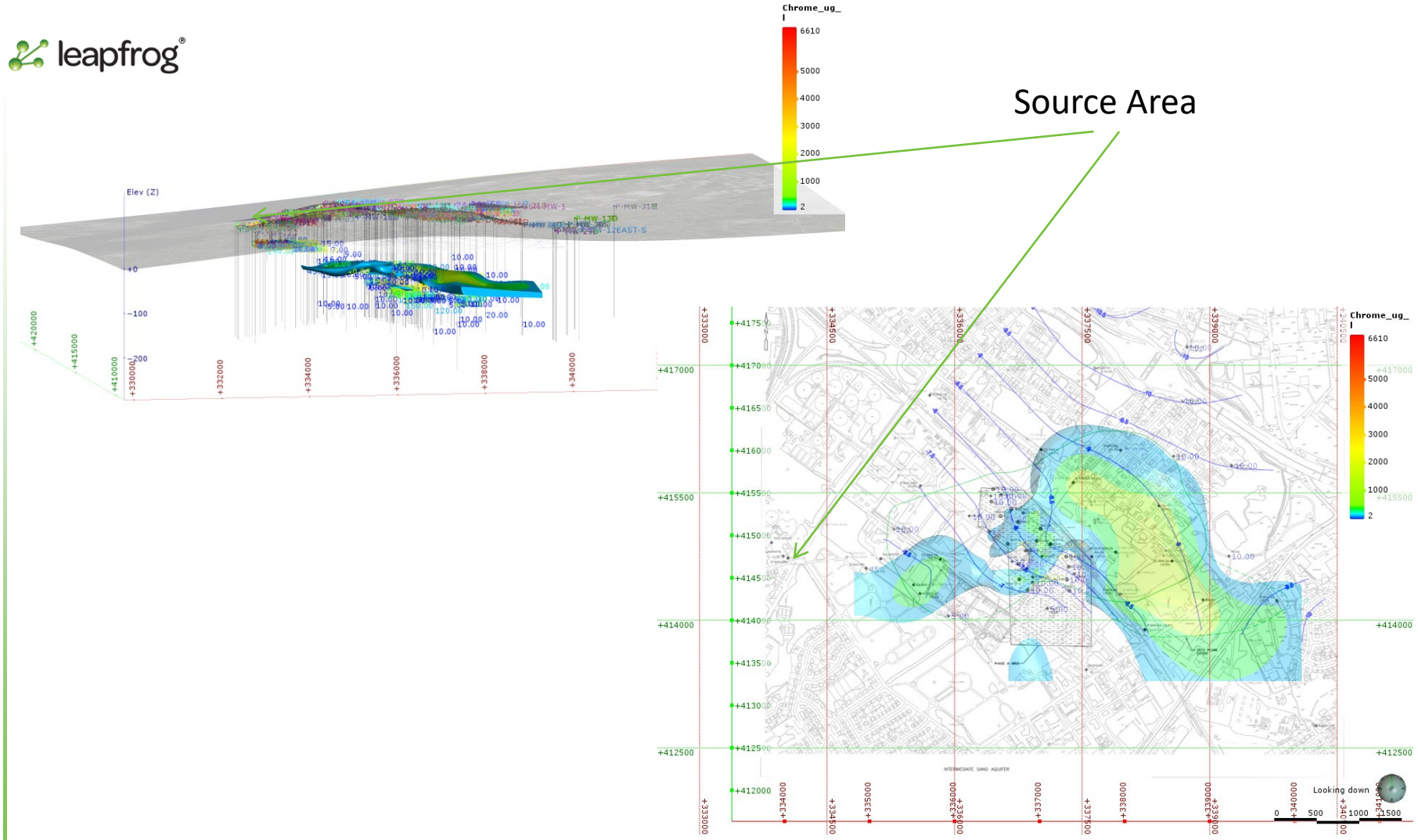


Extras

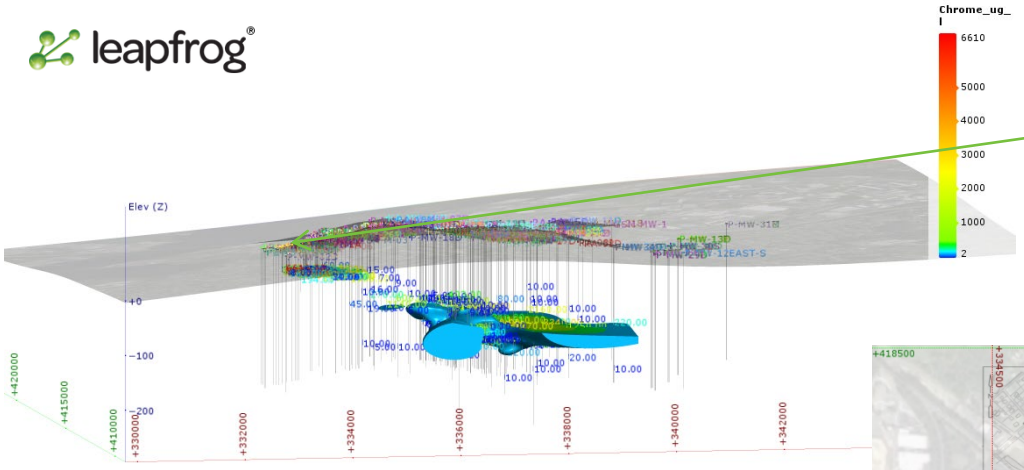
Extent of CR^{+6} >70 µg/L for Middle Aquifer with Middle Potentiometric Surface Map



Extent of CR^{+6} >70 µg/L for Intermediate Sand with Intermediate Potentiometric Surface Map



Extent of CR^{+6} >70 µg/L for Lower Aquifer with Lower Potentiometric Surface Map



Source Area