PILOT TEST OF A DEEP HORIZONTAL INJECTION WELL TO TREAT HEXAVALENT CHROMIUM

THE PUCHACK WELL FIELD SUPERFUND SITE, PENNSAUKEN, NJ

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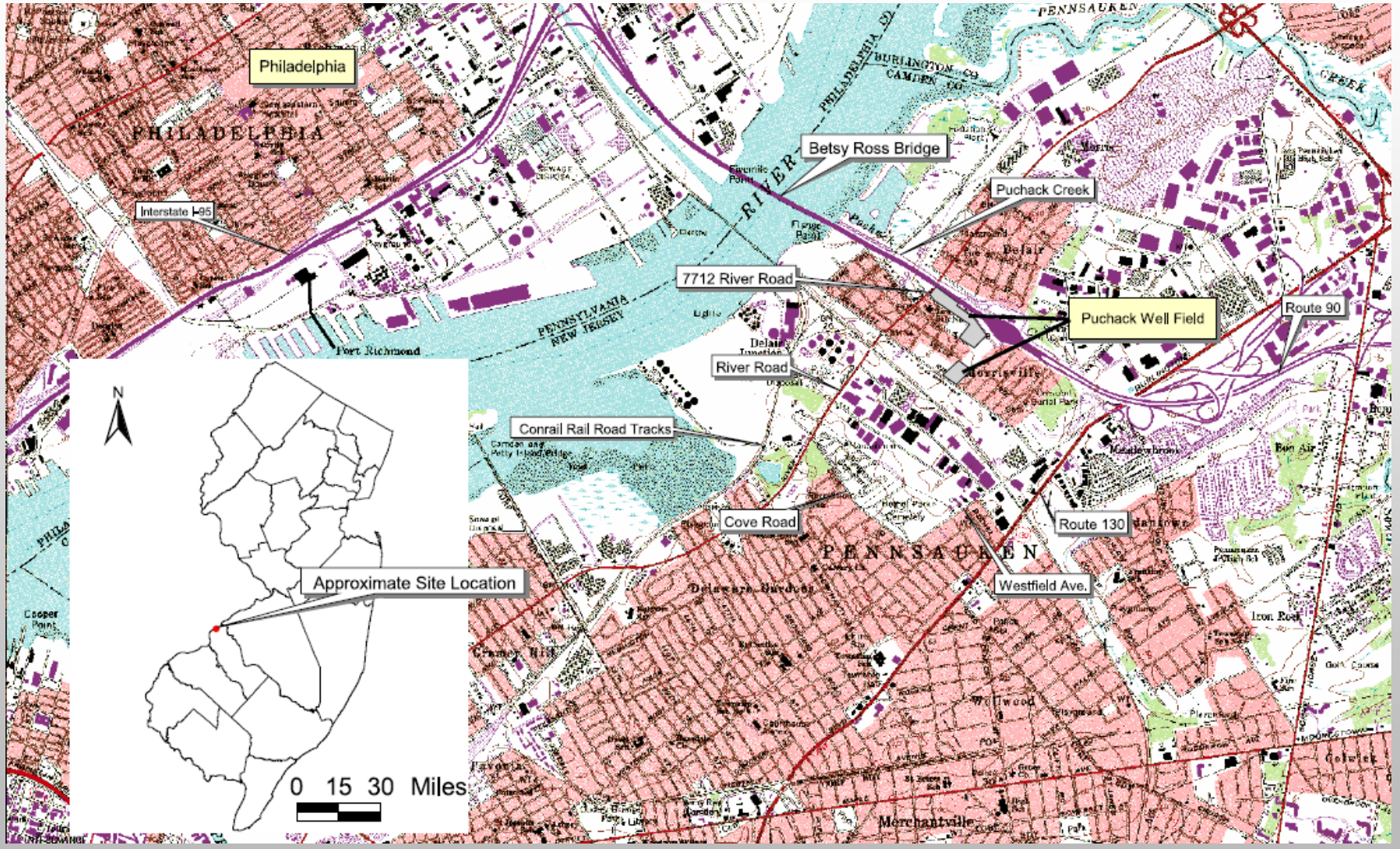
JON GORIN, RPM R2

NOVEMBER 27, 2018

SITE LOCATION



Puchack Conceptual Site Model

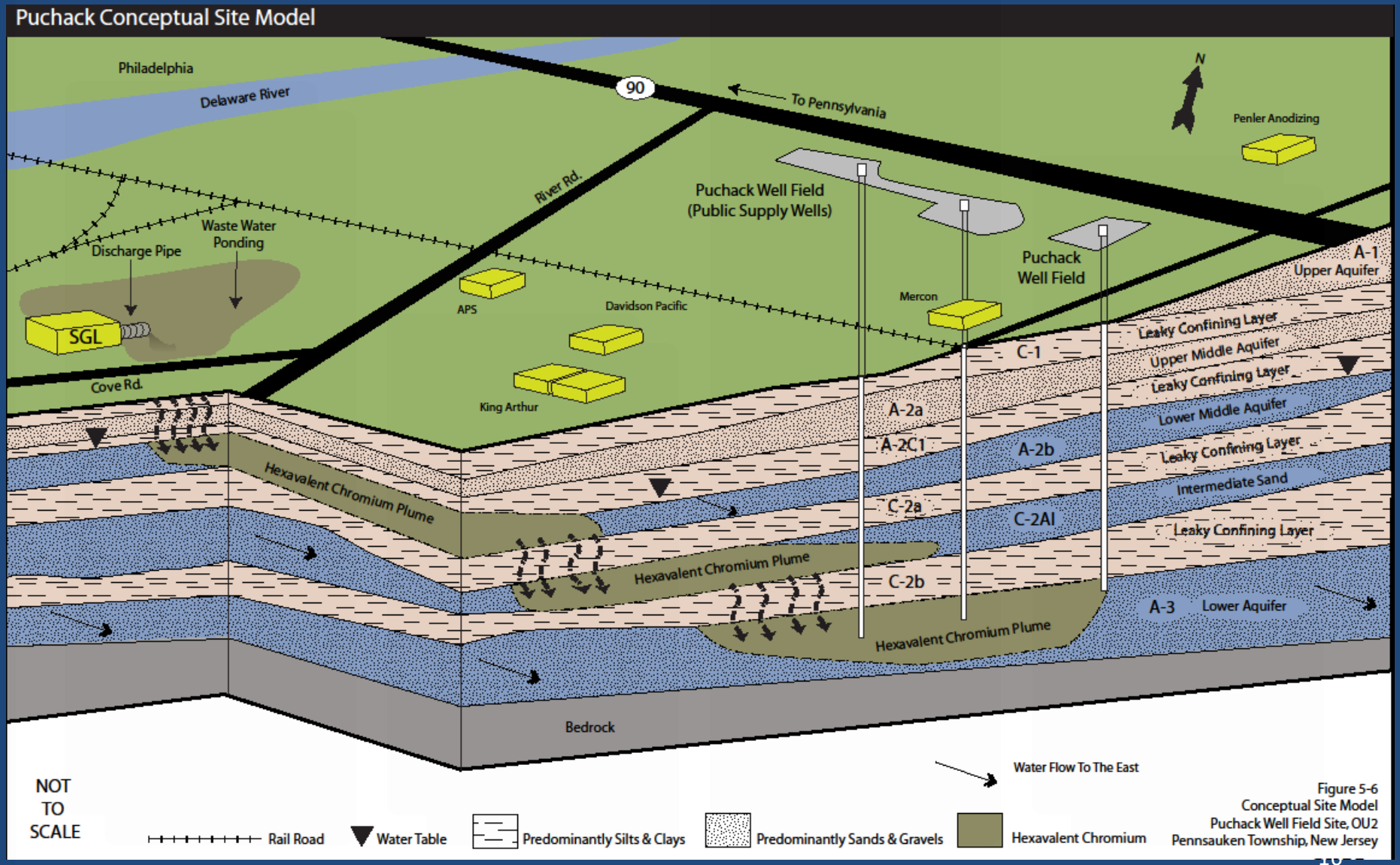


Figure 5-6
Conceptual Site Model
Puchack Well Field Site, OU2
Pennsauken Township, New Jersey

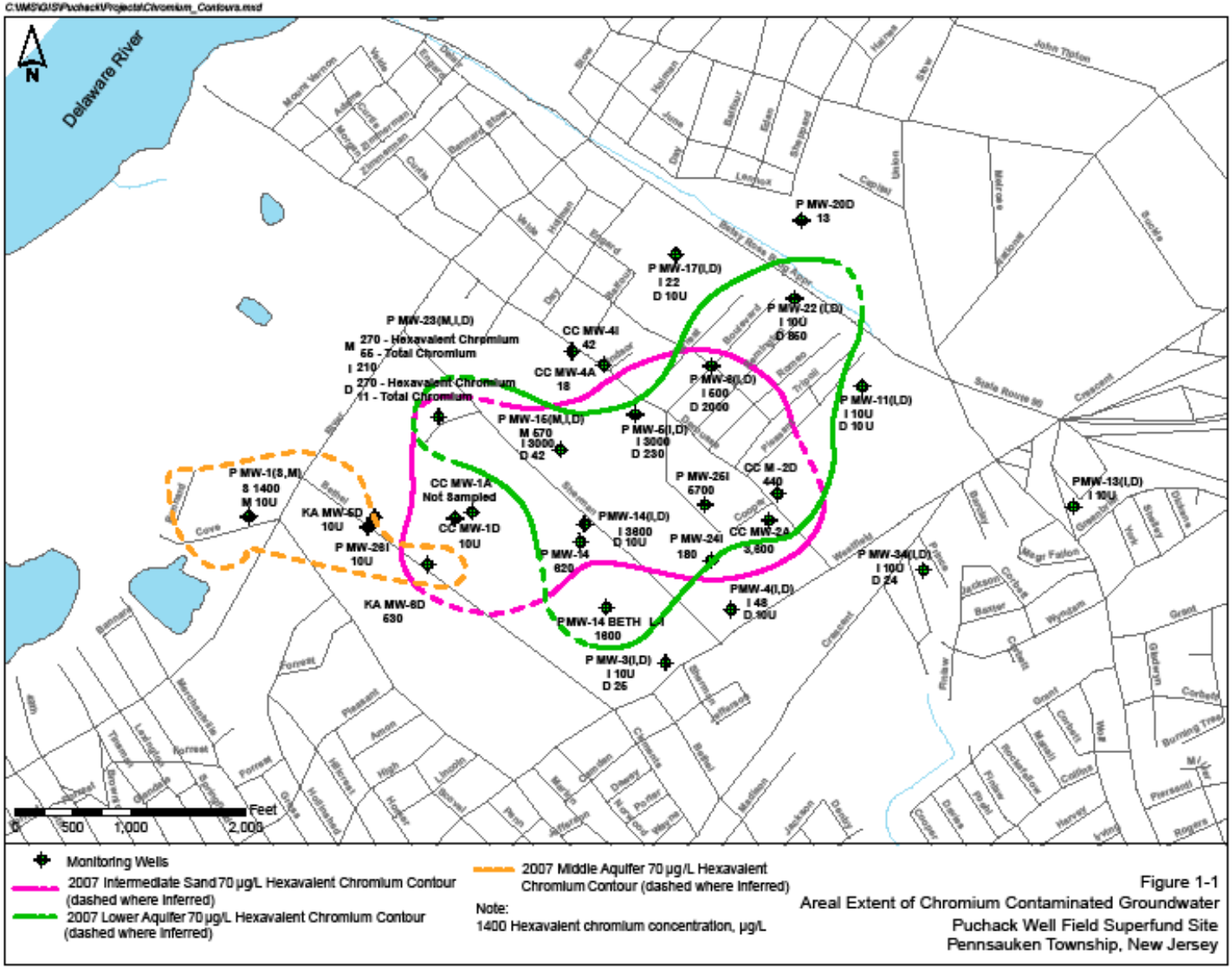


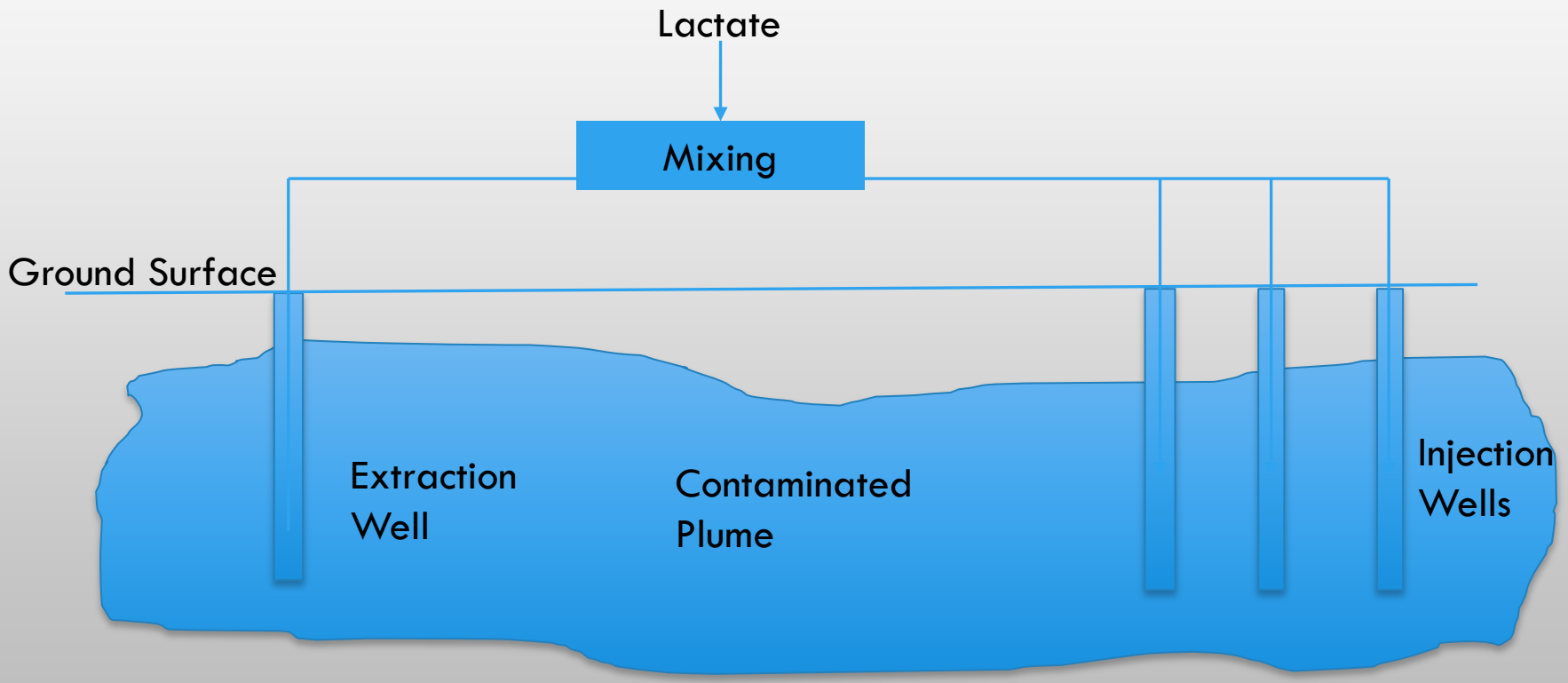
Figure 1-1
Areal Extent of Chromium Contaminated Groundwater
Puchack Well Field Superfund Site
Pennsauken Township, New Jersey

EPA 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

GENERAL DESIGN APPROACH

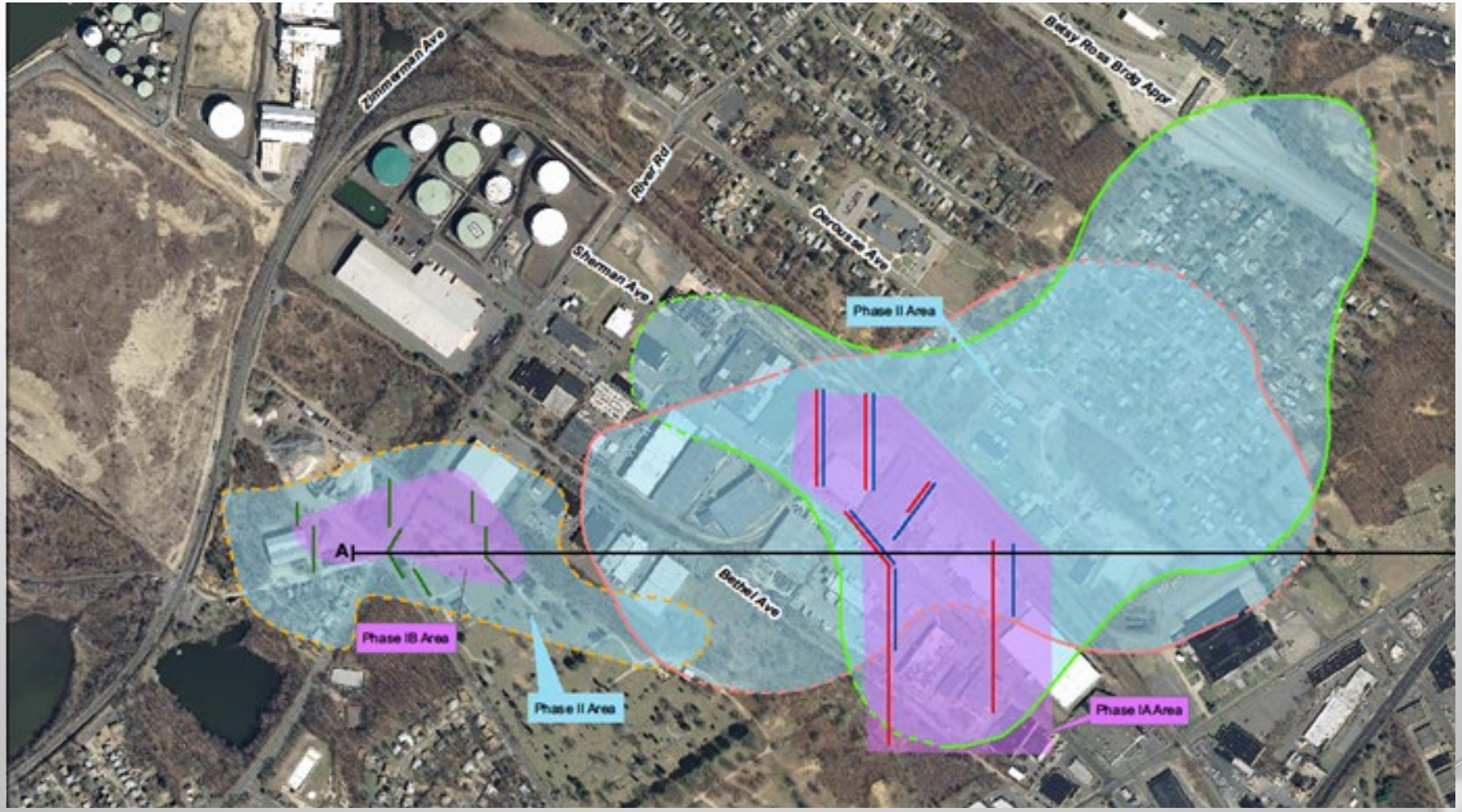


FULL SCALE DESIGN/IMPLEMENTATION

DIVIDED GROUNDWATER CLEANUP INTO TWO PHASES.

- PHASE 1, UPGRADIENT PORTION WITH HIGHER CR CONCENTRATION
  - UNDERLIES COMMERCIAL PROPERTIES.
- PHASE 2, REMAINING PORTION
  - UNDERLIES RESIDENTIAL PROPERTIES.

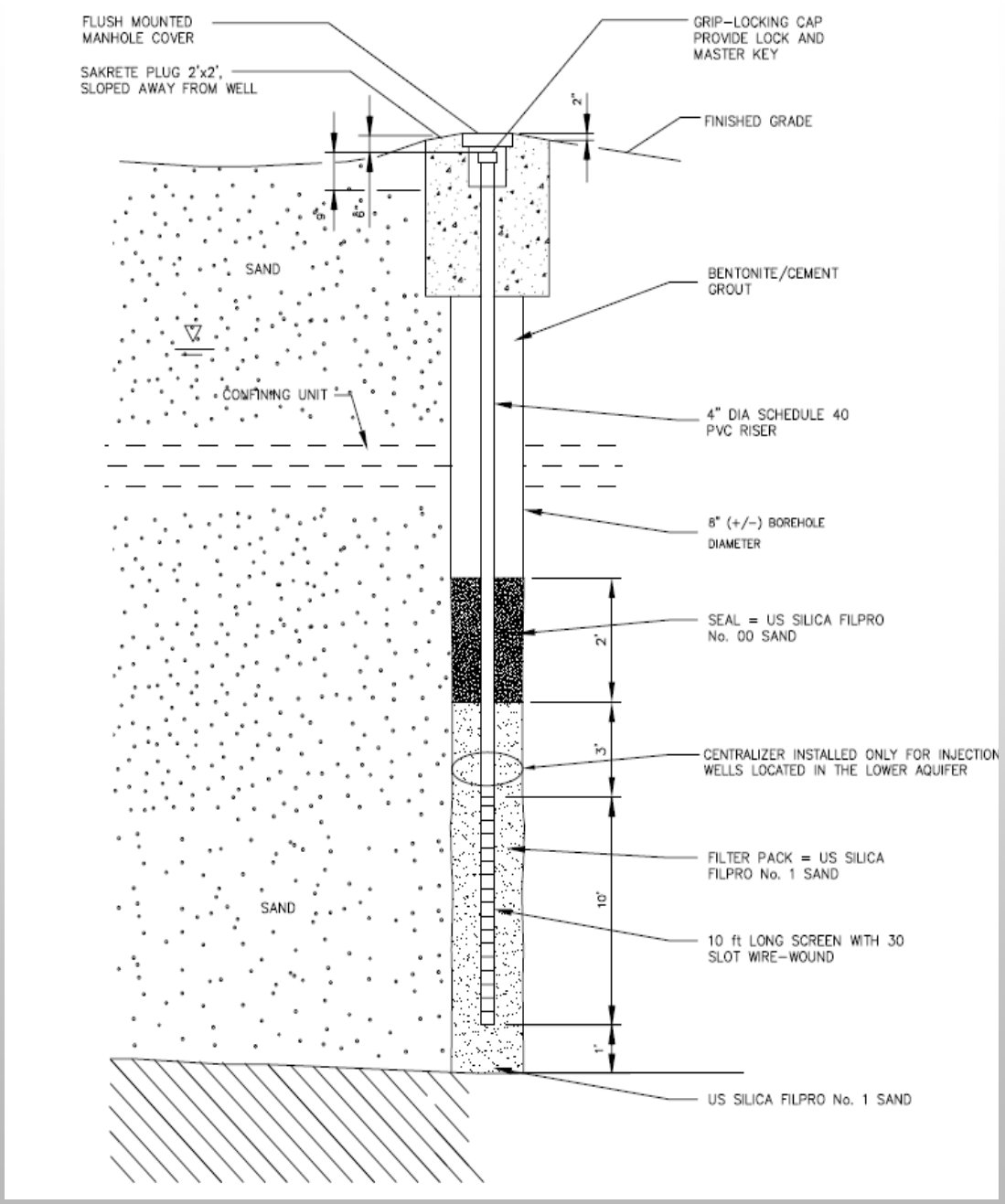
Phase I and Phase II Areas



PHASE I IMPLEMENTATION

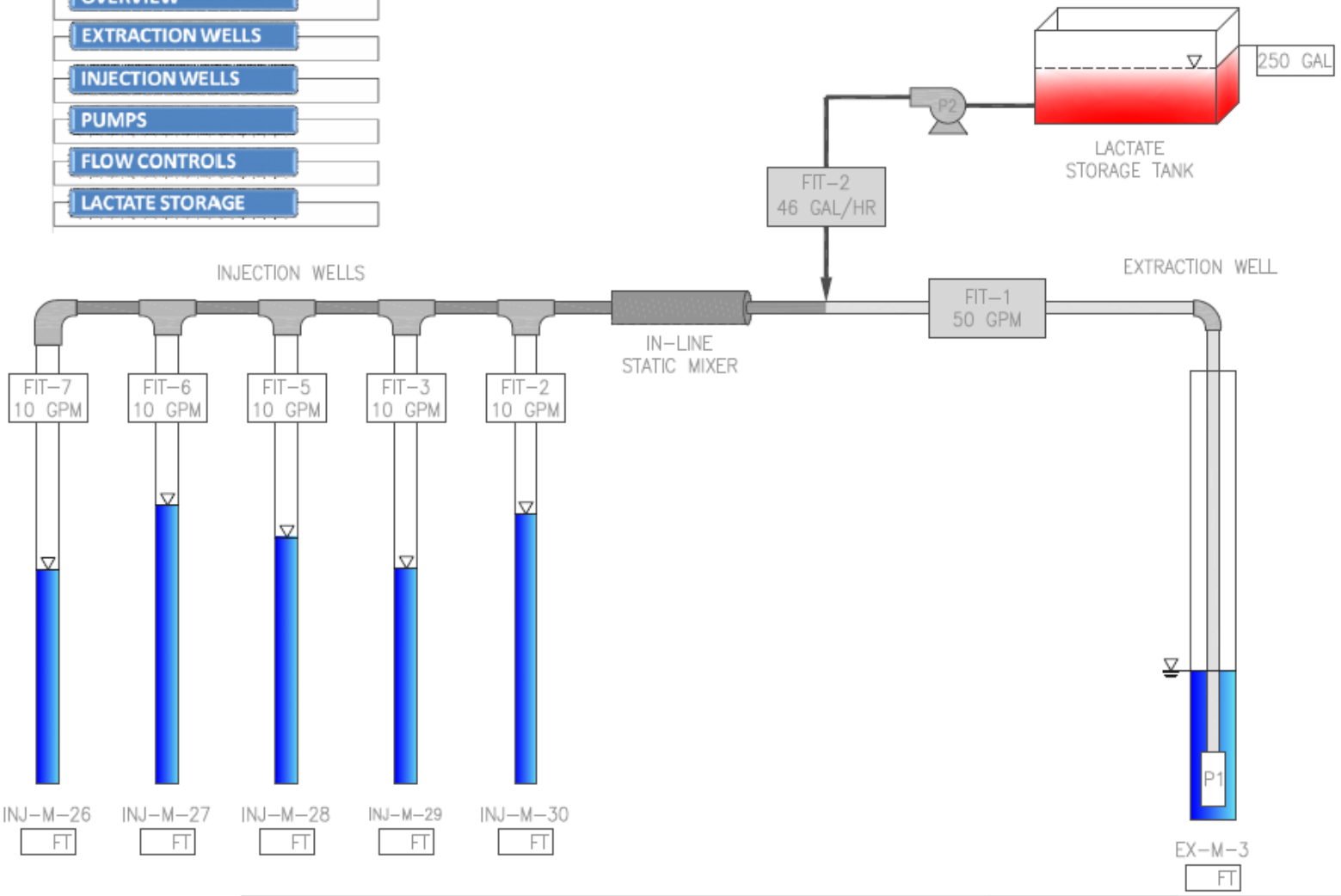
- USED SODIUM LACTATE
- DESIGNED AND CONSTRUCTED FOUR MOBILE TRAILERS TO MIX LACTATE/WATER. MIXTURE INJECTED INTO VERTICAL INJECTION WELLS.
- TOTAL 90 INJECTION WELLS, 20 EXTRACTION WELLS.
- INJECTIONS TAKE ~ TWENTY DAYS FOR DEEPER WELLS, ~ TEN DAYS FOR “MIDDLE AQUIFER” WELLS.

VERTICAL INJECTION WELL



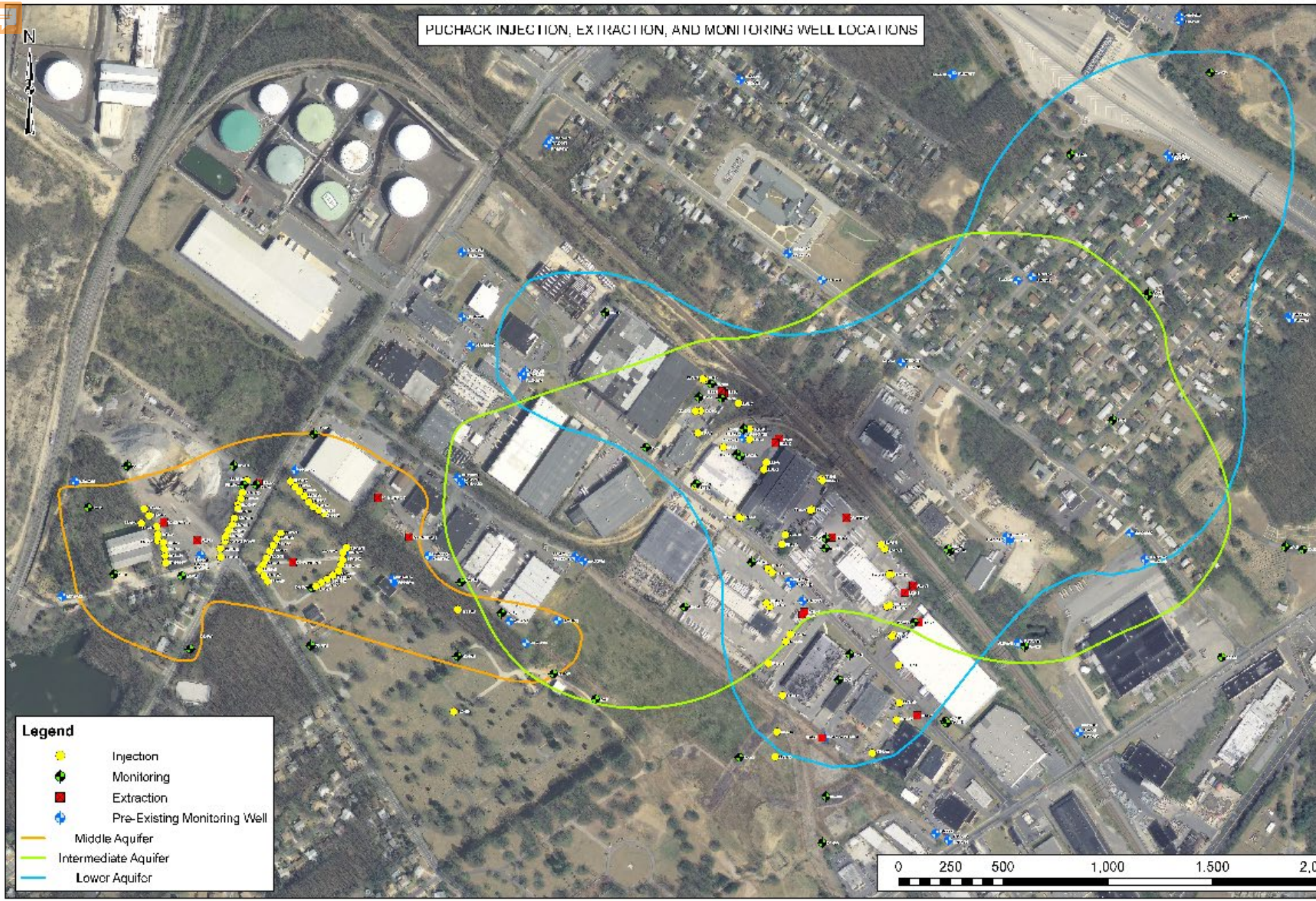
GEOCHEMICAL FIXATION INJECTION SYSTEM
PUCHACK WELLFIELD SUPERFUND SITE
CONTROL MODULE

- OVERVIEW
- EXTRACTION WELLS
- INJECTION WELLS
- PUMPS
- FLOW CONTROLS
- LACTATE STORAGE



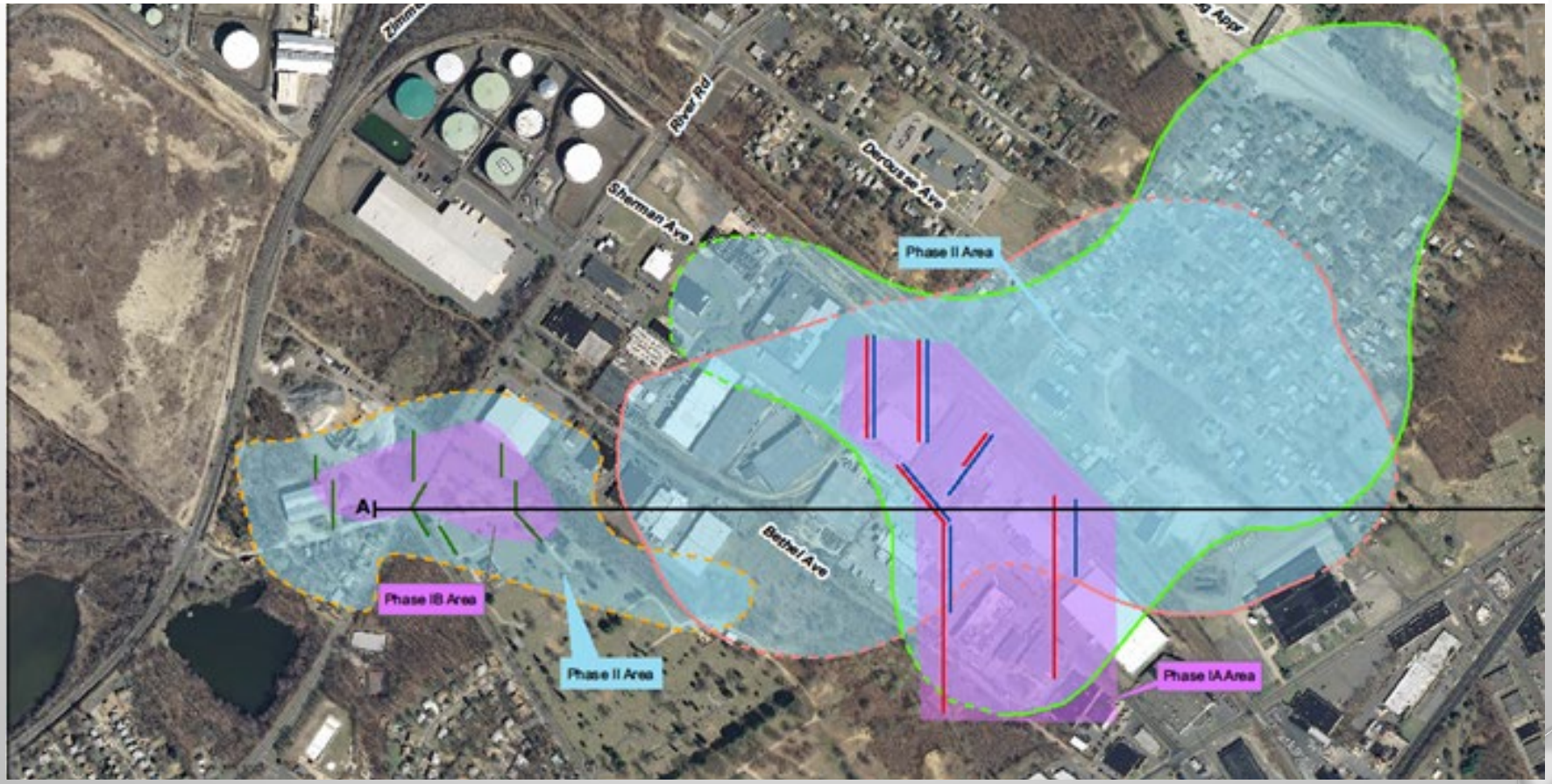
PREPARED BY: EA ENGINEERING, P.C. AND ITS AFFILIATE EA SCIENCE AND TECHNOLOGY				PUCHACK WELLFIELD SUPERFUND SITE EPA ID# NJD981084767 PENNSAUKEN TOWNSHIP, NEW JERSEY			TYPICAL GEOCHEMICAL FIXATION INJECTION SYSTEM CHEMICAL CONTROL MODULE
PROJECT MGR	DESIGNED BY	DRAWN BY	CHECKED BY	SCALE	DATE	PROJECT NO	FIGURE
EJL	DFC	SEF	DFC	NTS	JANUARY 2011	6239303	6-6

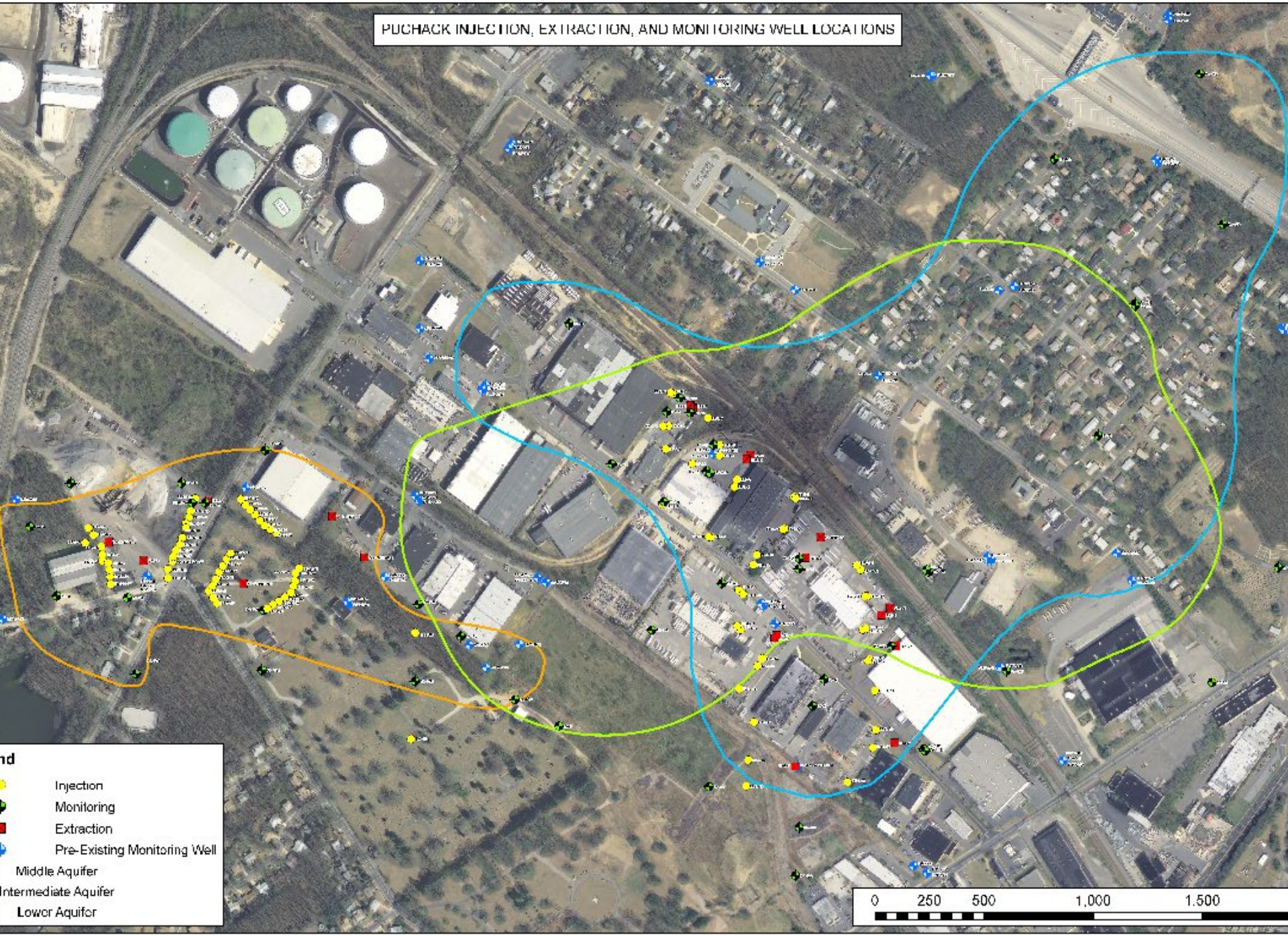

500
400
300
200
2


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

Total Chromium Summary:

	Avg Mass (kgs)			
	Middle Aquifer	Intermediate Sand	Lower Aquifer	Total Phase I Treatment Area
Pre Remedial Action (Baseline)	133	147	1,066	1,346
Post Remedial Action (Up to PR6)	1	12	92	105
Mass Reduction (%)	99%	92%	91%	92%




PUCHACK INJECTION, EXTRACTION, AND MONITORING WELL LOCATIONS
nd
Injection
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1,000
1,500


fesser

PHASE 2 PILOT STUDY

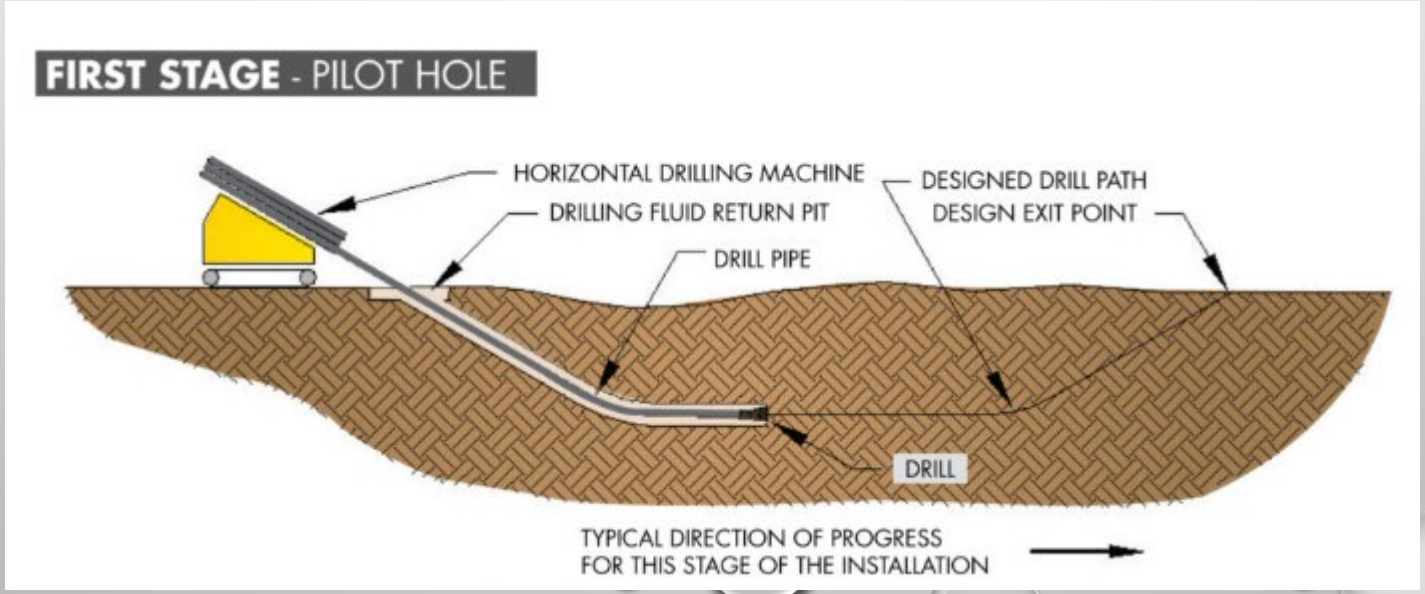
CAN HORIZONTAL WELL SCREENS RESOLVE OUR LOGISTICAL ISSUES?

- CAN WE INSTALL THE HORIZONTAL WELL (SCREEN) IN THE PROPER LOCATION?

- WILL LACTATE BE DISTRIBUTED EVENLY ACROSS THE 450 FT SCREEN?

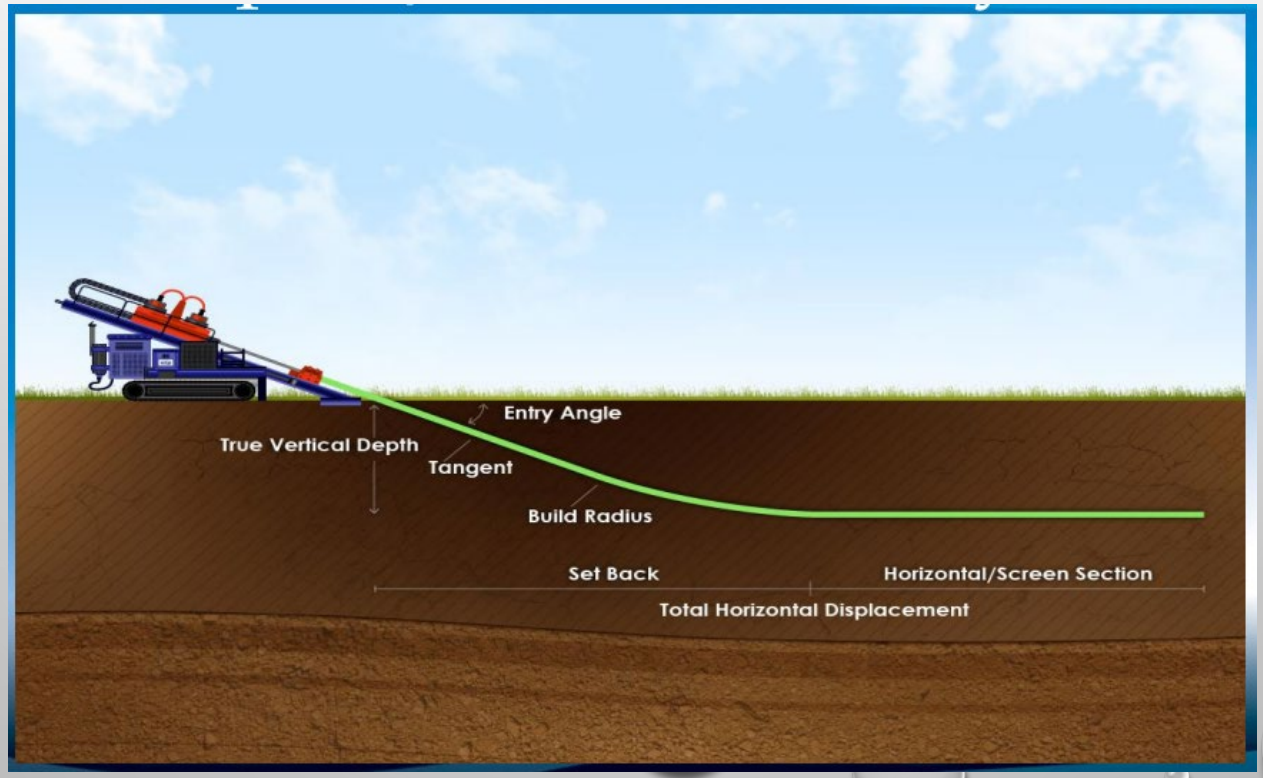
CONTINUOUS COMPLETION

- TWO ACCESS POINTS (ENTRY/EXIT)
- WELL DEPTHS >200 FT
- WELL LENGTHS > 2,850 FT
- SCREEN AND CASING PULLED INTO BOREHOLE
- REQUIRES ACCESS TO EXIT POINT



BLIND COMPLETION

- ONE ACCESS POINT
- WELL DEPTHS >200 FT
- WELL LENGTHS > 1500 FT
- SCREEN AND CASING PUSHED INTO OPEN BOREHOLE



QUESTION 1:

CAN WE INSTALL THE HORIZONTAL WELL IN THE PROPER LOCATION?

LOCATING TECHNOLOGIES

- SEVERAL OPTIONS AVAILABLE:

  - **WALKOVER**

  - INDUCED MAGNETIC FIELD

  - EARTH'S MAGNETIC FIELD AND GRAVITATIONAL FORCE

  - **GYROSCOPIC STEERING TOOL**

- SELECTION BASED ON BORE PATH, INTERFERENCE RISK, FORMATION, DEPTH, AND COST

GYROSCOPIC STEERING TOOL

- NO DEPTH RESTRICTION
- MOST ACCURATE & EXPENSIVE
- REQUIRES PLANNED BORE PATH; CAD DRAWING WITH COORDINATES
- PROVIDES X, Y, Z COORDINATES IN SUBSURFACE
- SENDS INFORMATION TO SURFACE VIA A WIRELINE THAT RUNS THROUGH THE CENTER OF THE DRILL STRING

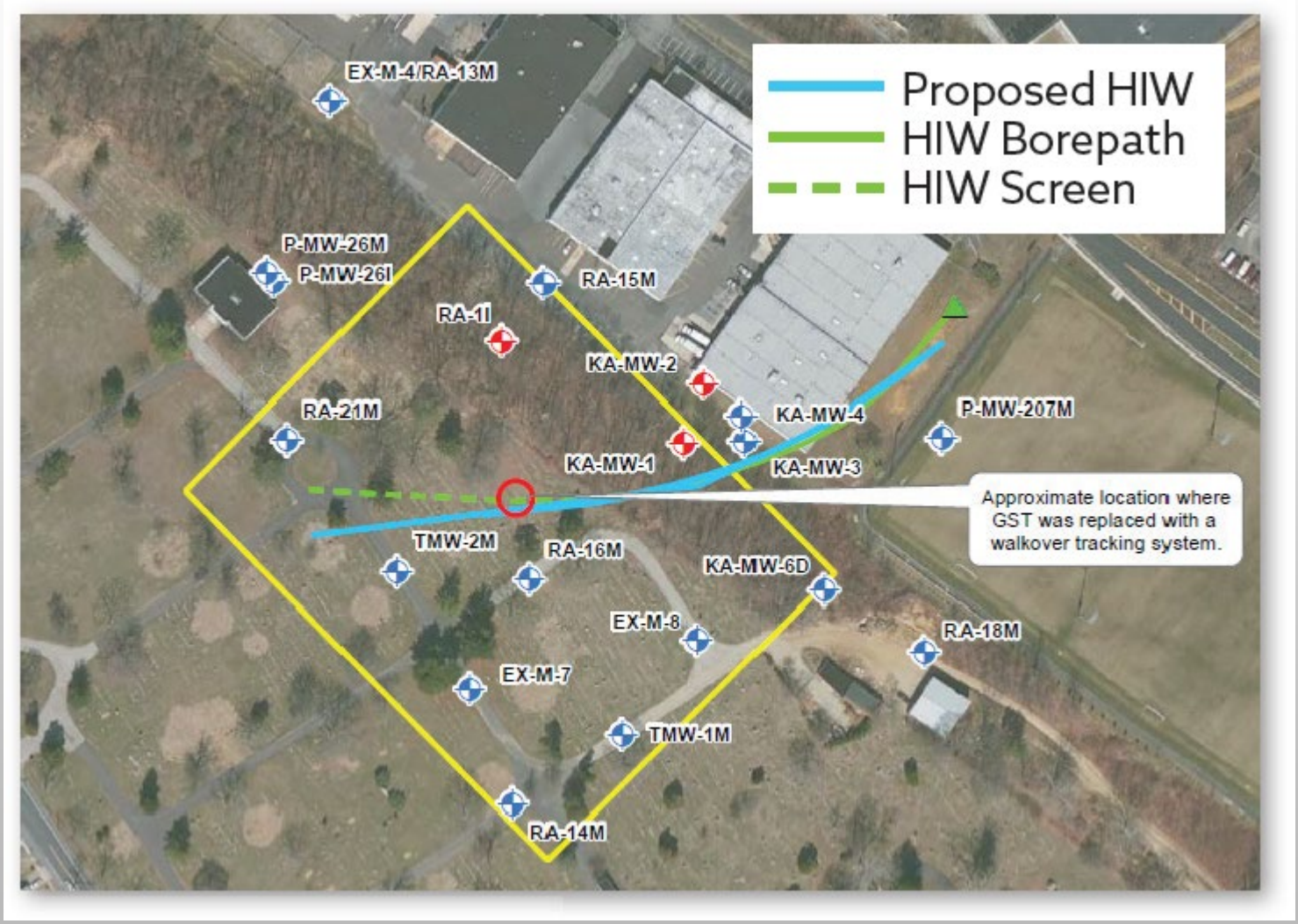
WELL INSTALLATION "THE PLAN"

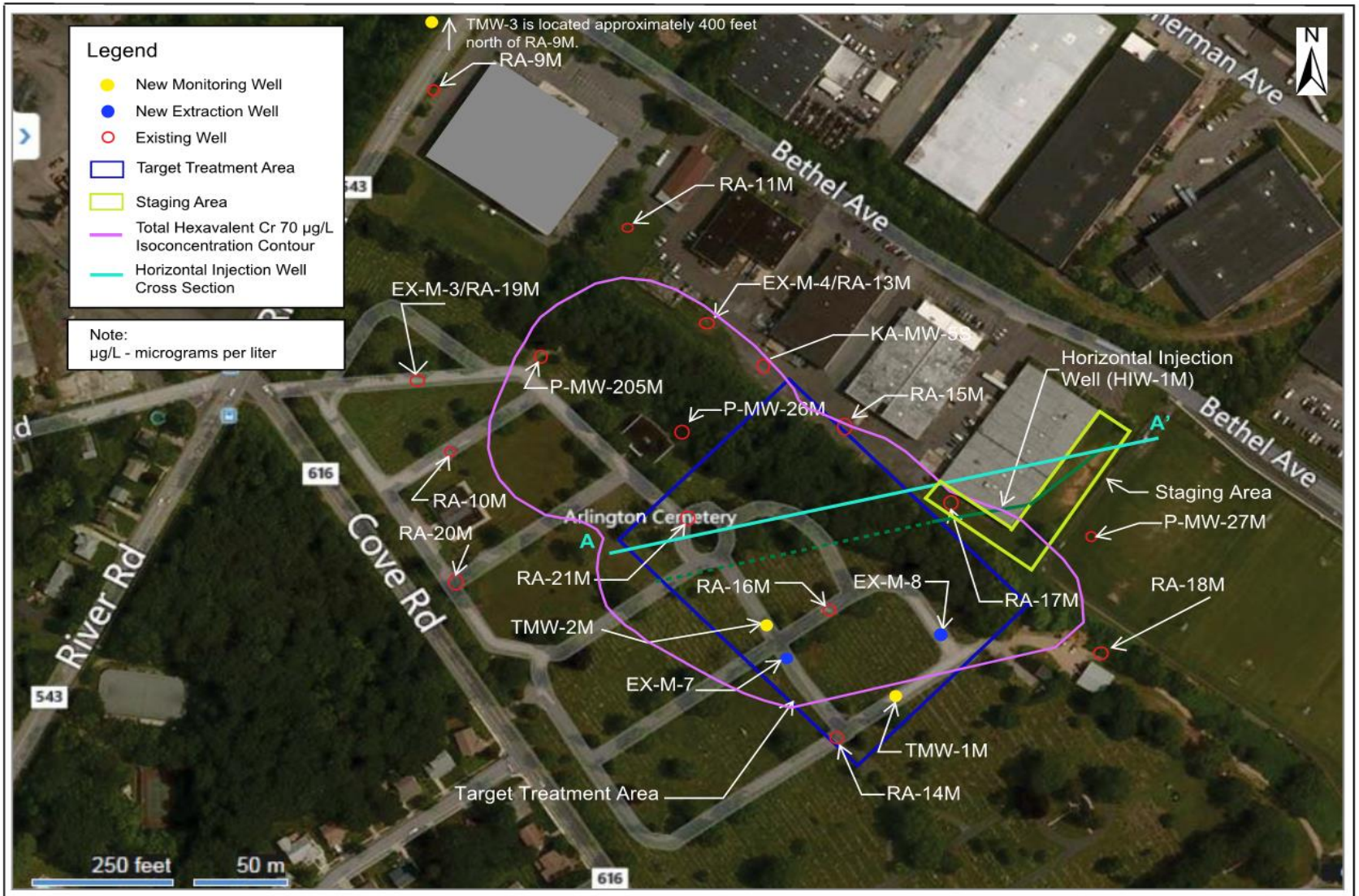
- DRILL 850 FOOT PILOT HOLE USING A GYROSCOPIC STEERING TOOL.
- GST IN DRILL PIPE BEHIND TOOTHED BIT – NAVIGATED ALONG PRE-DETERMINED PATH
- CHASE PILOT HOLE USING AN ASSYMETRIC "KNOCK-OFF" DRILL BIT AND A LARGE DIAMETER DRILL ROD – GUIDANCE THROUGH MAGNETIC TRANSMITTER
- WELL MATERIAL INSERTED INSIDE 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; PULLED WIRE AND GST OUT AND SWITCHED TO THE KNOCK-OFF BIT/WALKOVER BEFORE COMPLETING THE PILOT HOLE
- THE TRANSMITTER WAS AT THE MAXIMUM RANGE OF FUNCTIONALITY - FINAL SCREEN OFF TARGET AREA BY ABOUT 50'

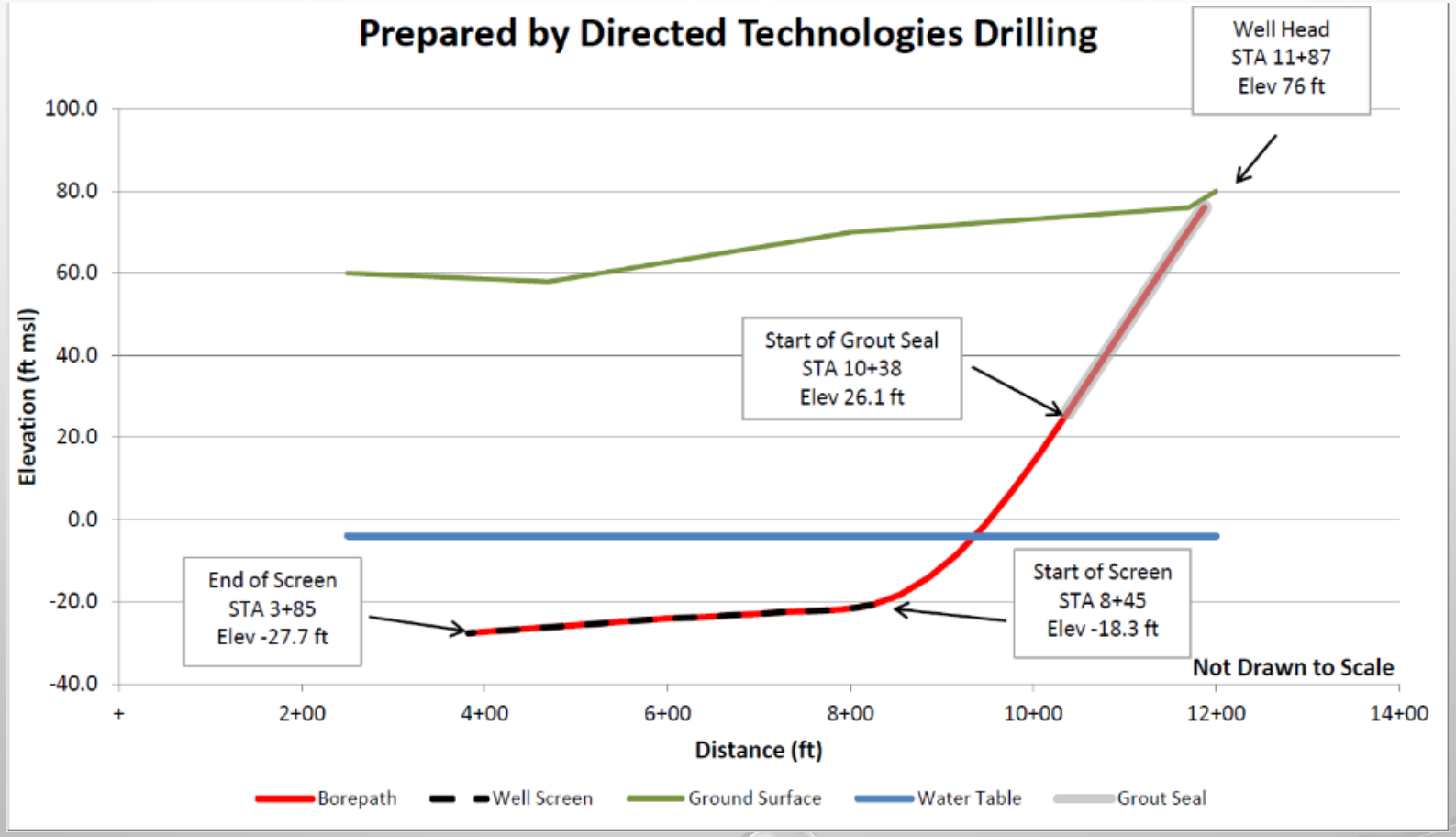
PLANNED VS ACTUAL WELL LOCATION





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

PHASE II PILOT STUDY – AS-BUILT

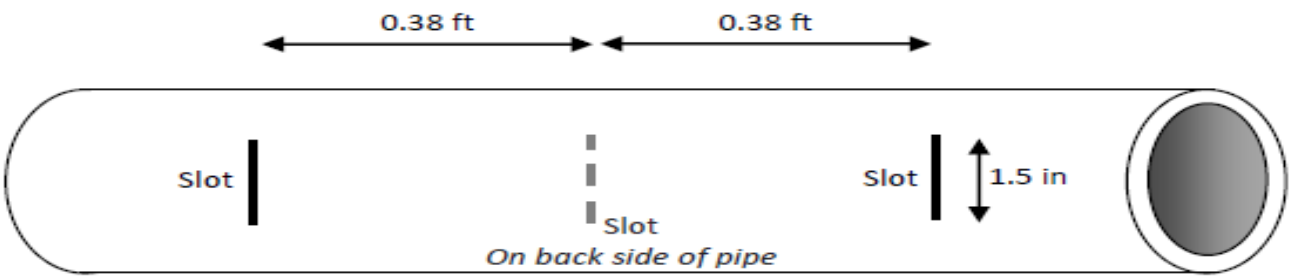


QUESTION 2:

CAN LACTATE BE DISTRIBUTED EVENLY ACROSS THE 450 FOOT HORIZONTAL SCREEN?

VARIABLE SLOTTED SCREEN

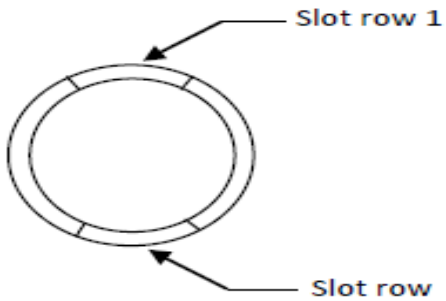
Well Screen
Isometric View



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

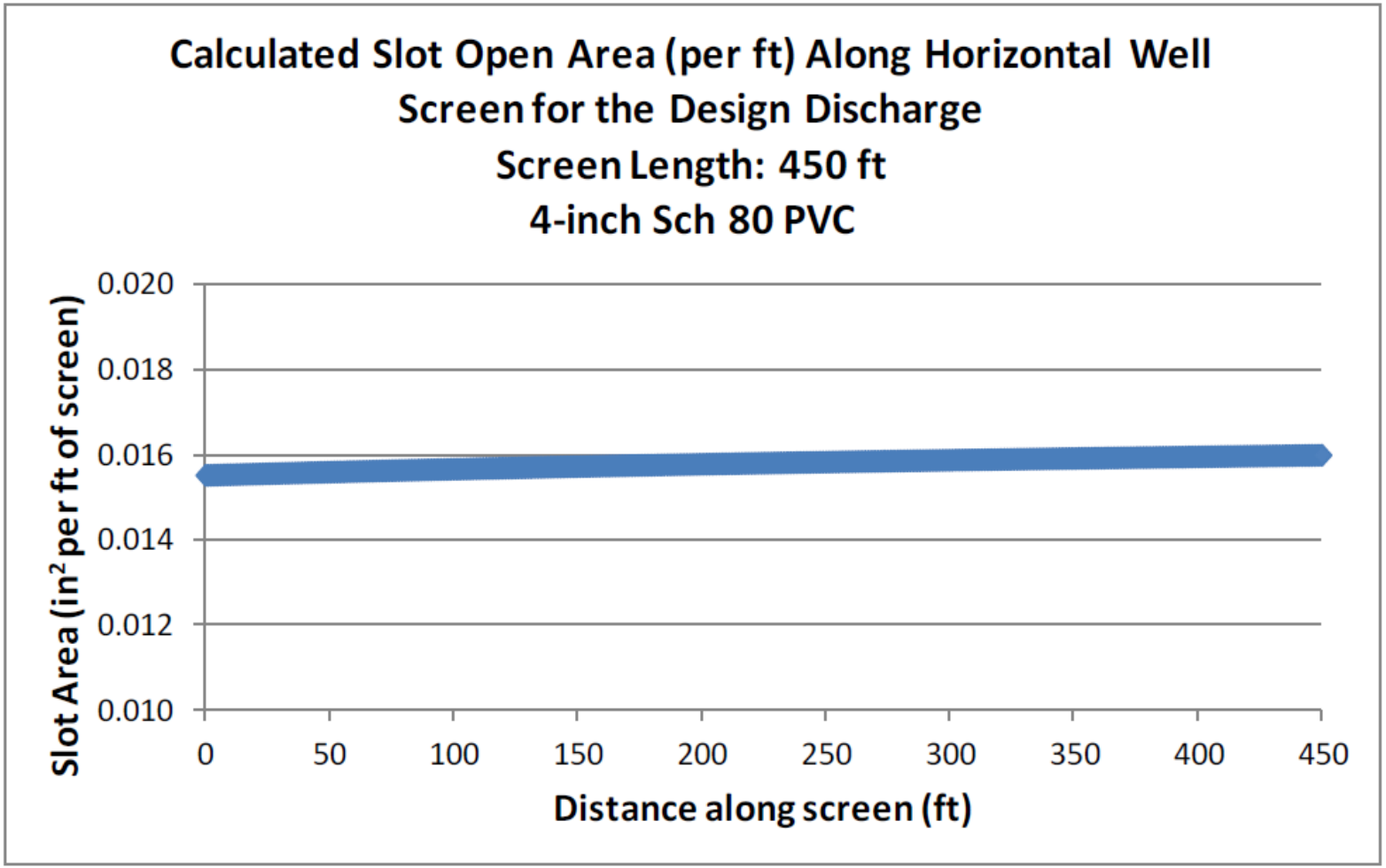


Figure 2: Calculated slot area (per foot) along the screen to achieve the incremental design flow rate of 0.333 gpm/ft.

STANLEY
1
2
3
4
5
6
7
8
9
10

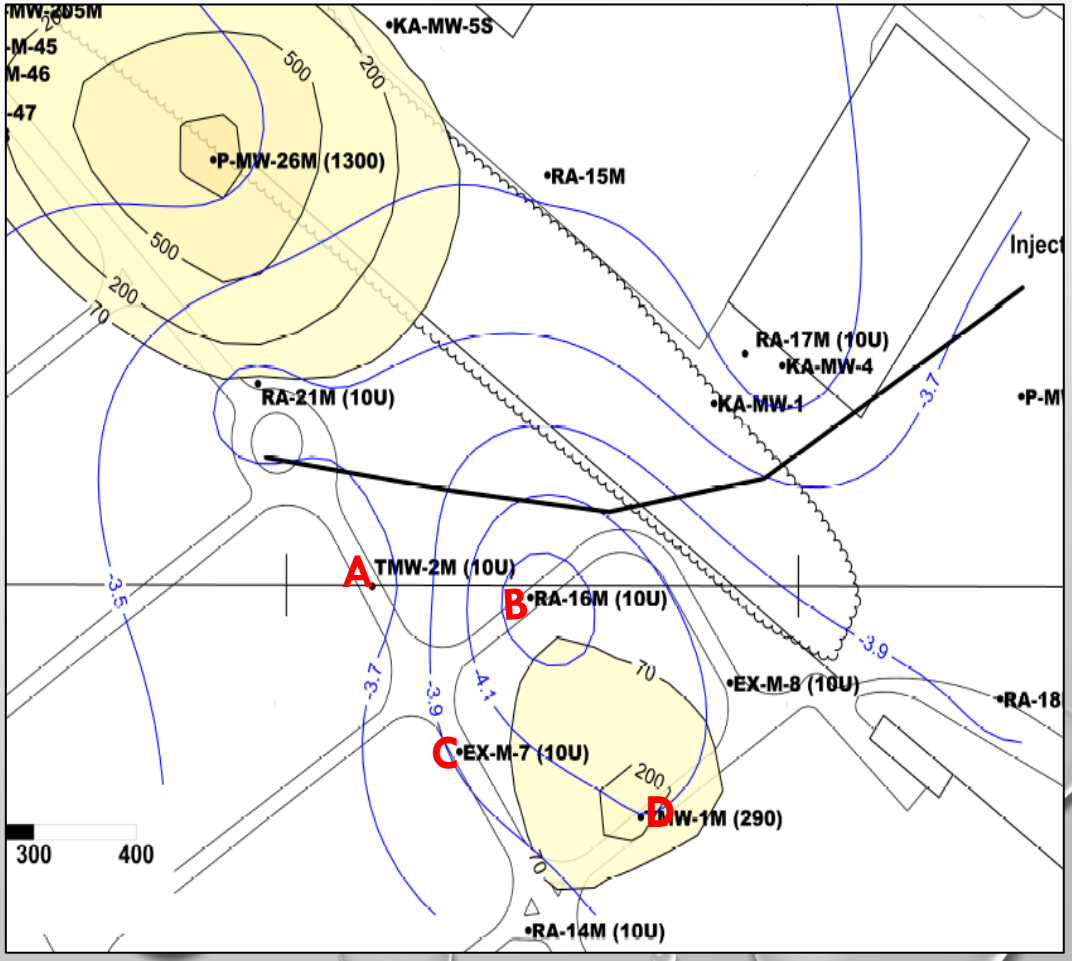
PHASE 2 PILOT STUDY - TOTAL INJECTION QUANTITIES

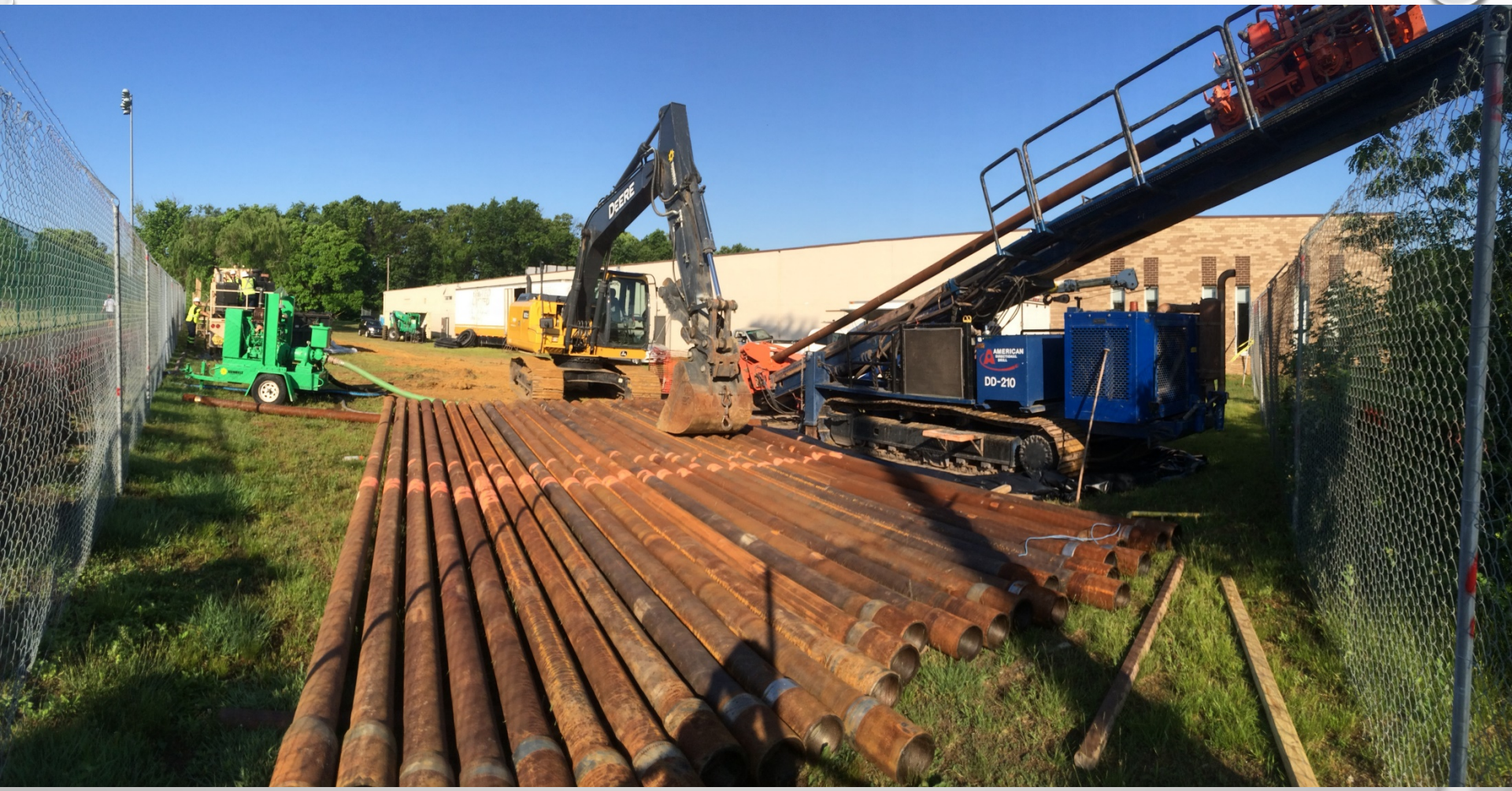
Period of Injection	Total 60% Sodium Lactate Injected (gallons)	Total 60% Sodium Lactate Injected (pounds)
July 15, 2015 – August 5, 2015	22,132	246,329

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

CHEMICAL OXYGEN DEMAND (LACTATE) CONCENTRATIONS

Well	Baseline COD (mg/L)	Round 1 COD (mg/L)	Round 2	Round 3
A	ND	580	55	15
B	810	4,800	5,000	4,900
C	ND	ND	ND	ND
D	ND	ND	750	590




DEERE
AMERICAN
DD-210


609323
4"

- Blue box: Drill rig 70 ft long)
- Small white box: drill cab.
- Green box: rod trailer – 48 ft long.
- Black box: entry pit.
- Brown box: mud system
- Red boxes: water tight waste roll-off boxes.
- Yellow: excavator
- Large white box: tool trailer

FEATURING HORIZONTAL DRILLING

REMAINING PLUME AREAS – MIDDLE AND LOWER UNITS

(INTERMEDIATE SAND NOT SHOWN)

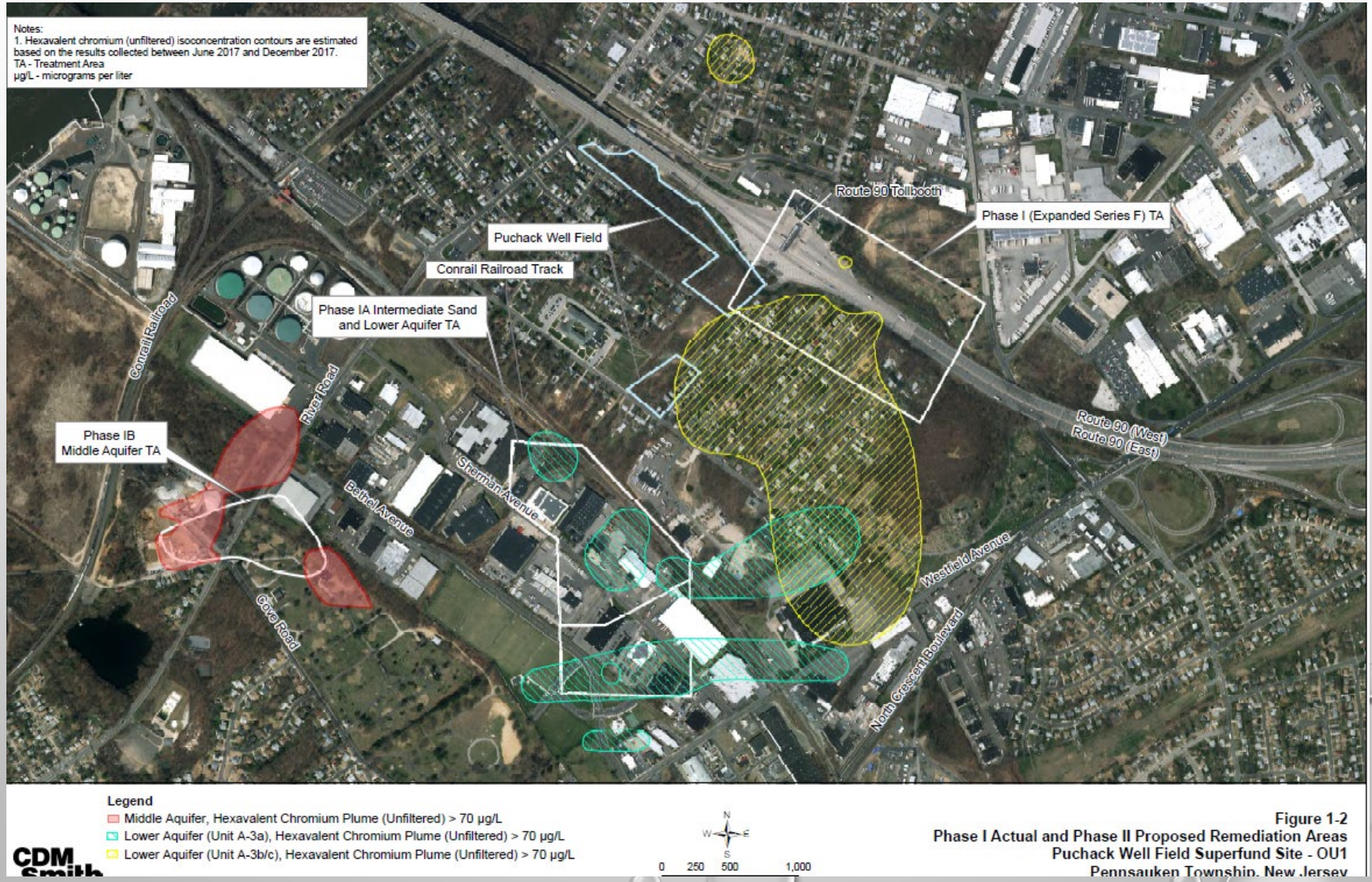
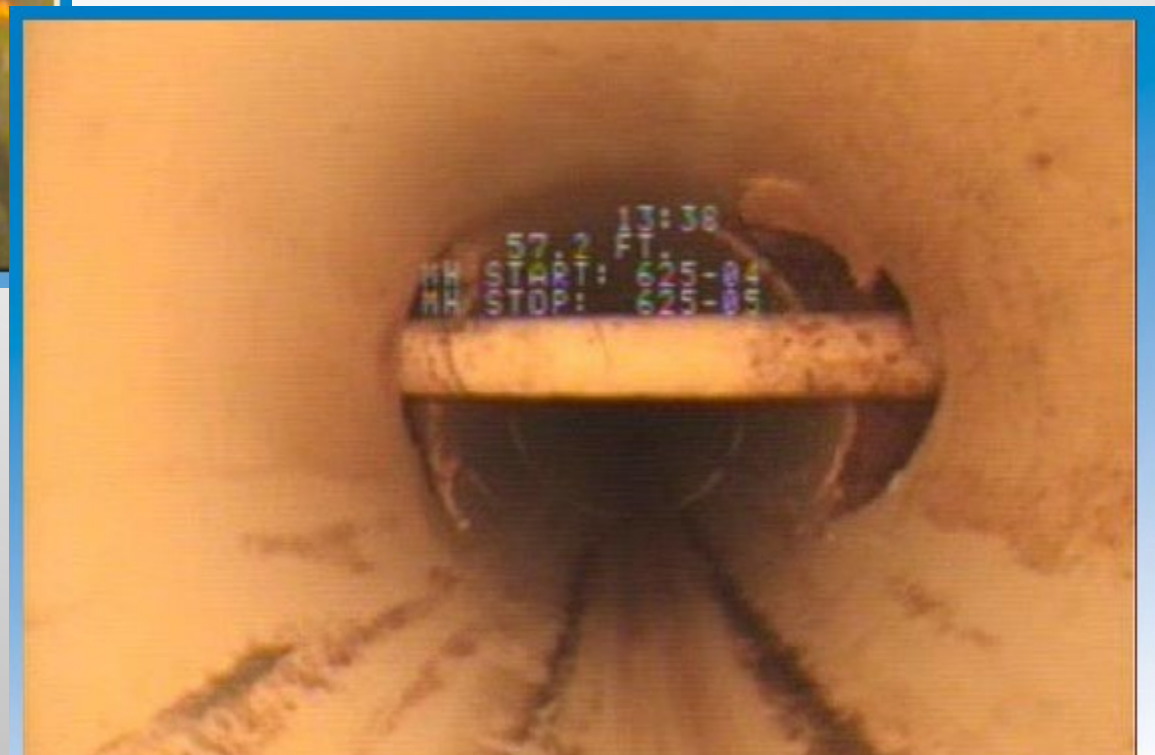


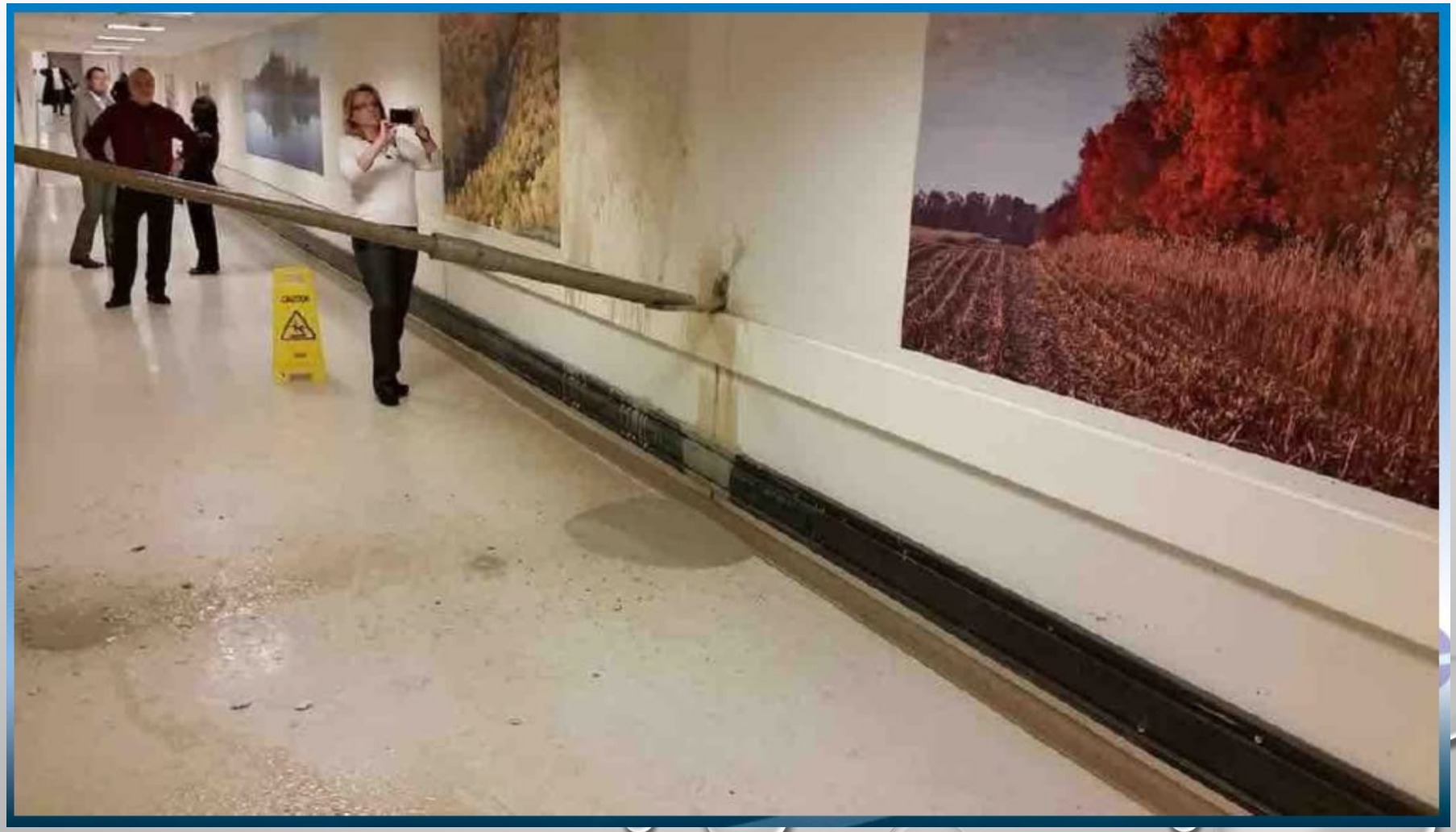
Figure 1-2
Phase I Actual and Phase II Proposed Remediation Areas
Puchack Well Field Superfund Site - OU1
Pennsauken Township, New Jersey

HORIZONTAL WELLS PHASE 2

LOOK OUT FOR UTILITIES



…AND PUBLIC SPACES



BAD PLACE TO PARK

Regulatory Agencies:

- US Environmental Protection Agency, Region 2

- NJ Department of Environmental Protection

Design and Implementation:

- U. S. Army Corps of Engineers, Kansas City District
  Environmental Programs Branch

- CDM Smith
  New York, NY
  http://cdmsmith.com/

Implementation:

- U.S. Army Corps of Engineers, Philadelphia District
  Environmental Programs Branch

- EA Engineering, Science, and Technology, Inc., PBC
  Abingdon, MD
  www.eaest.com

Horizontal Drilling:

Directed Technologies Drilling
Bellefonte, PA
http://www.horizontaldrill.com/

Questions?

END