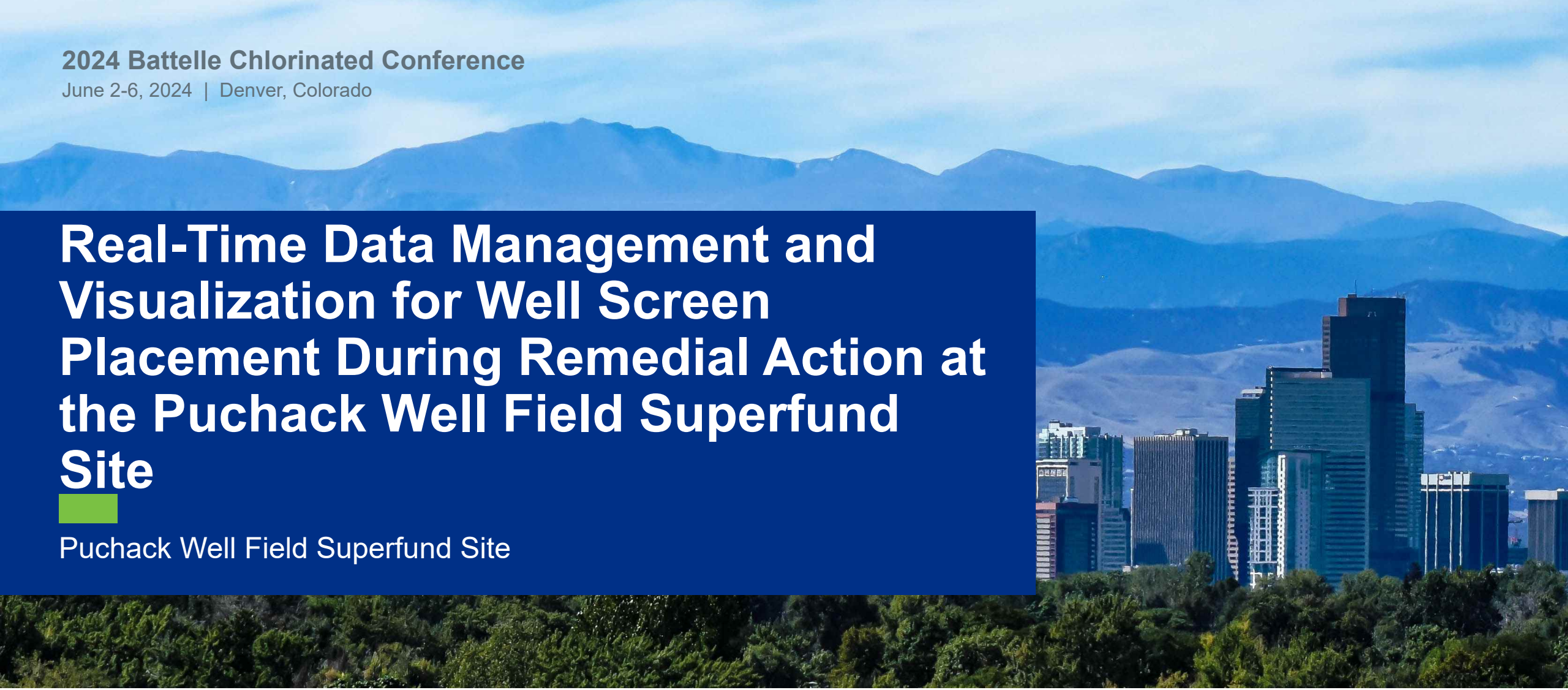
2024 Battelle Chlorinated Conference
June 2-6, 2024 | Denver, Colorado



Real-Time Data Management and Visualization for Well Screen Placement During Remedial Action at the Puchack Well Field Superfund Site

Puchack Well Field Superfund Site

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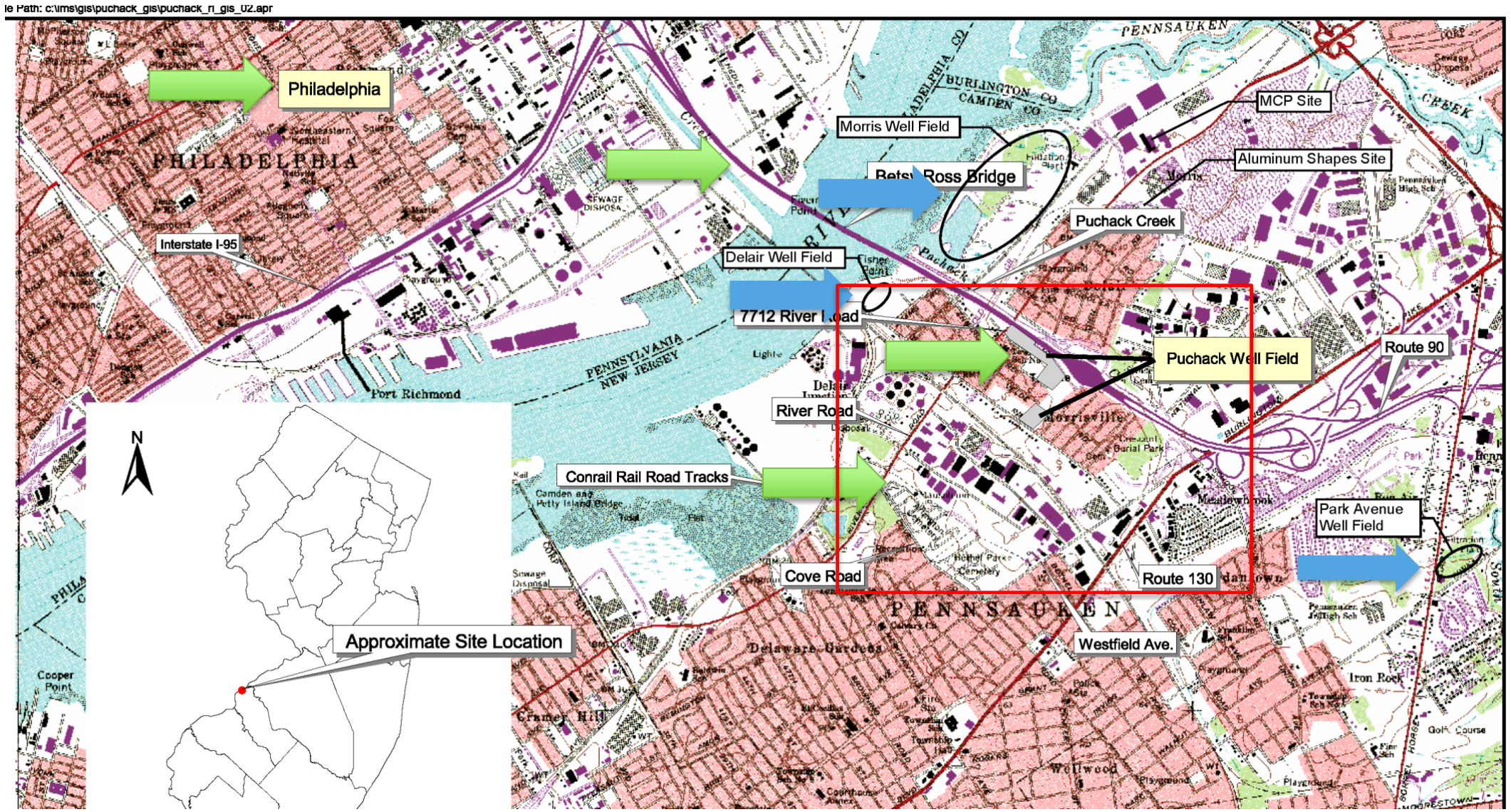
June 4, 2024

Presentation Overview

- Overview of the Puchack Well Field Superfund Site
- Site background
- Overview of Phase II Remedial Action
- The design requirement for real time data evaluation during drilling to finalize well screen placement.
- Real time data management workflow during drilling with up to 3 rigs
- Well package
- Time critical communications
- Next Steps

Overview of the Puchack Well Field Site



Lithostratigraphic CSM

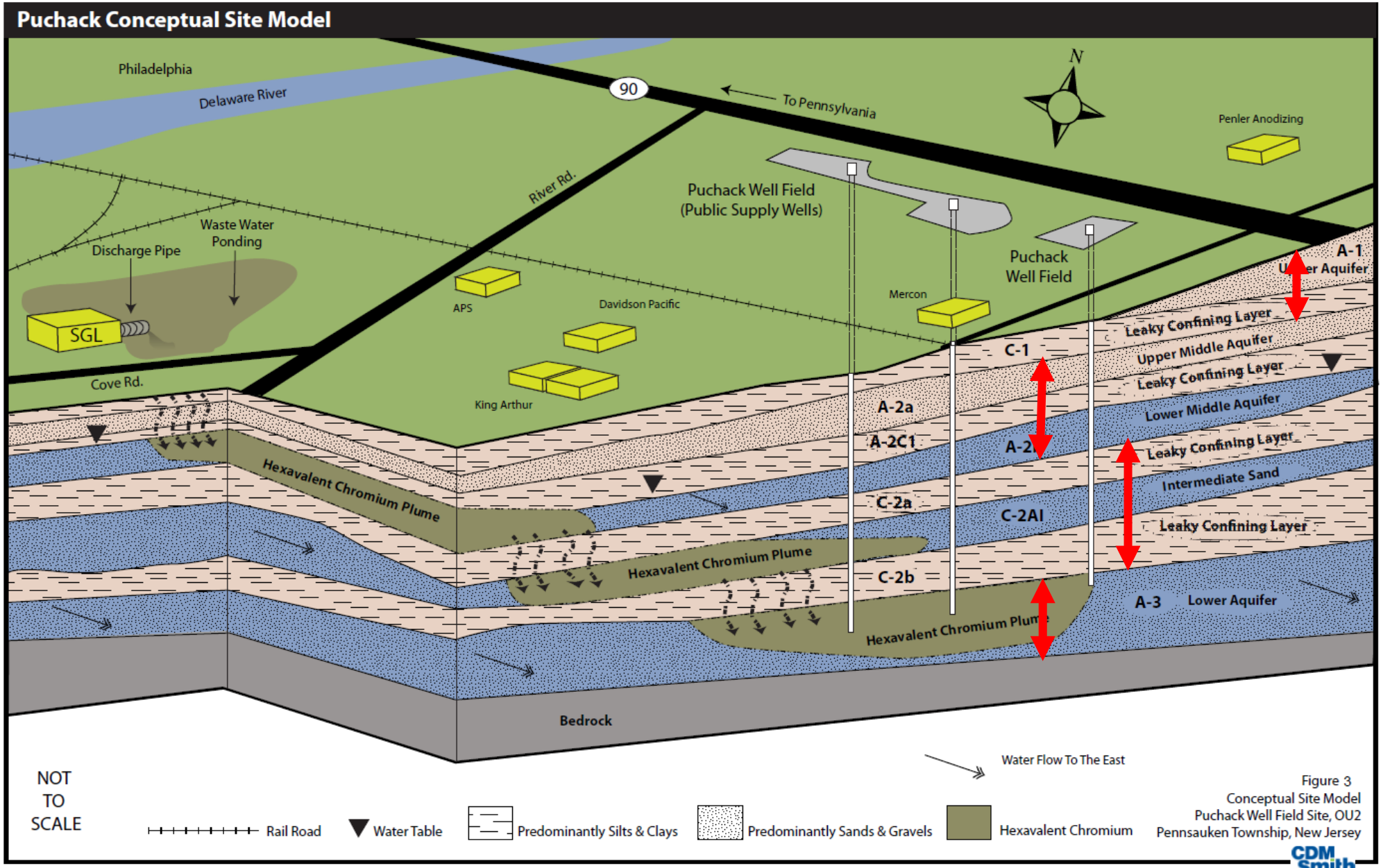


Figure 3
Conceptual Site Model
Puchack Well Field Site, OU2
Pennsauken Township, New Jersey

CDM Smith

Project Timeline

Phase I Remedial Action

- PDI: 2007
- Bench and Pilot Study: 2008
  - Sodium lactate selected as reducing
- RD Complete: 2010
- PRAI: 2011-12
- Remedial Action (RA) Construction: 2011-13
  - Monitoring completed 2016
  - **Borehole data stored in gINT but evaluated on paper**
- Expanded Series F: 2017
  - Monitoring through 2020

Phase II Remedial Action

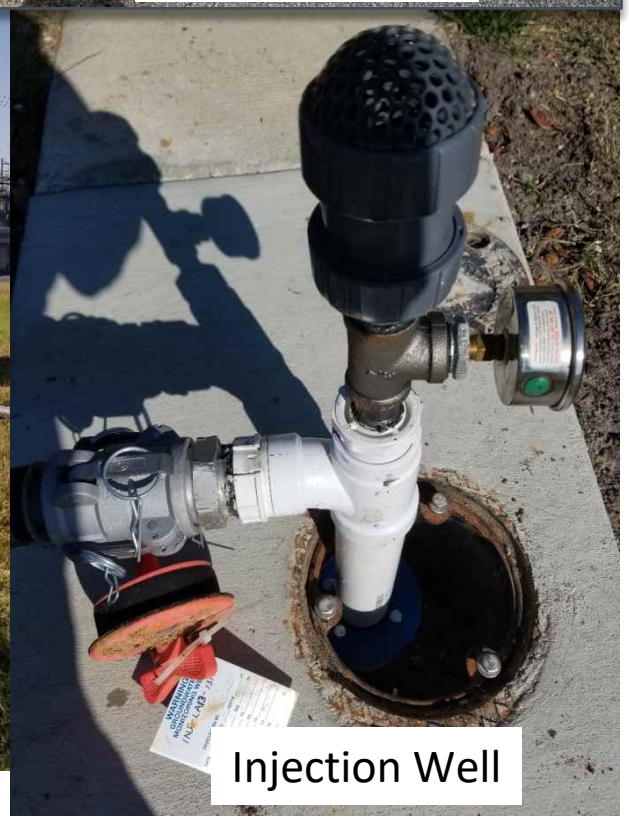
- PDI: 2014-15
- Pilot Study: 2015
  - Monitoring completed 2018
- **CSM in Leapfrog 2016**
  - Using data in gINT
- PRAI: 2017
  - **Pilot test of real time borehole data management using gINT**
- RD Complete: 2018
- RA Start: 2019 – ongoing
  - **RA Contractor implements borehole data management with gINT**

In Situ Treatment - Geochemical Fixation

- Create favorable conditions (low ORP) to reduce Cr^{+6} to Cr^{+3}, form iron/chromium precipitate
- Success of technology depends on:
  - **Proper screen placement to inject the reducing agent into the aquifer**
  - Ability of the reducing agent to reduce Cr^{+6} in groundwater to Cr^{+3}, and
  - Formation of immobile Cr^{+3} precipitate.
- Total chromium in system is not decreased, but the precipitate is fixed onto aquifer solids

Extraction Well

Injection Trailers: mix groundwater and sodium lactate



Injection Well

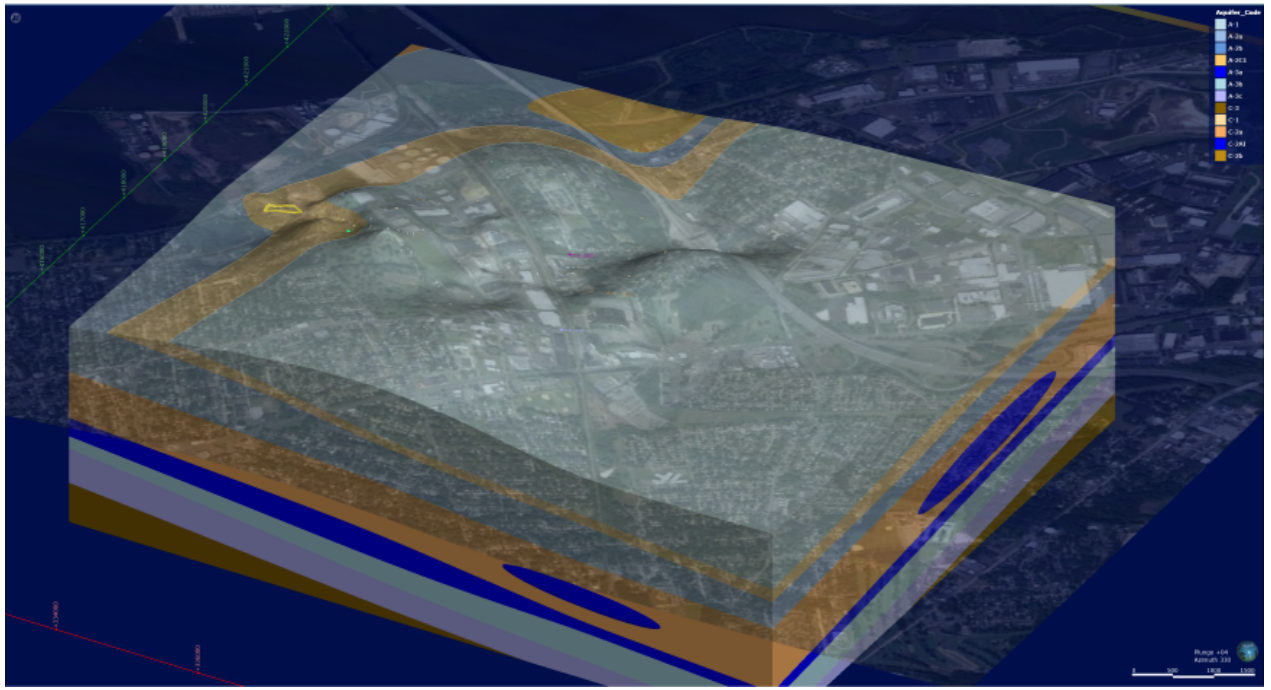
Development of Real Time Data Evaluation

Phase I Remedial Action

- Data management and evaluation was done on paper.
- Difficult to incorporate information from adjacent wells because you could not create cross sections as needed

Conceptual Site Model Development

- The gINT database of about 500 boring and wells and the USGS framework were used in Leapfrog to prepare a geologic model
- Surfaces exported for use in gINT
- Last updated in 2016



Development of Real Time Data Evaluation

- PRAI: 2017
  - Planned well locations and screens were input into gINT
  - Cross section used to predict depths to key units, e.g., C-2a
  - Field geologist transmitted data via text or scan to geologist off site
  - Data input into gINT
  - Feedback to the field geologist in real time for screening sample collection and screen placement

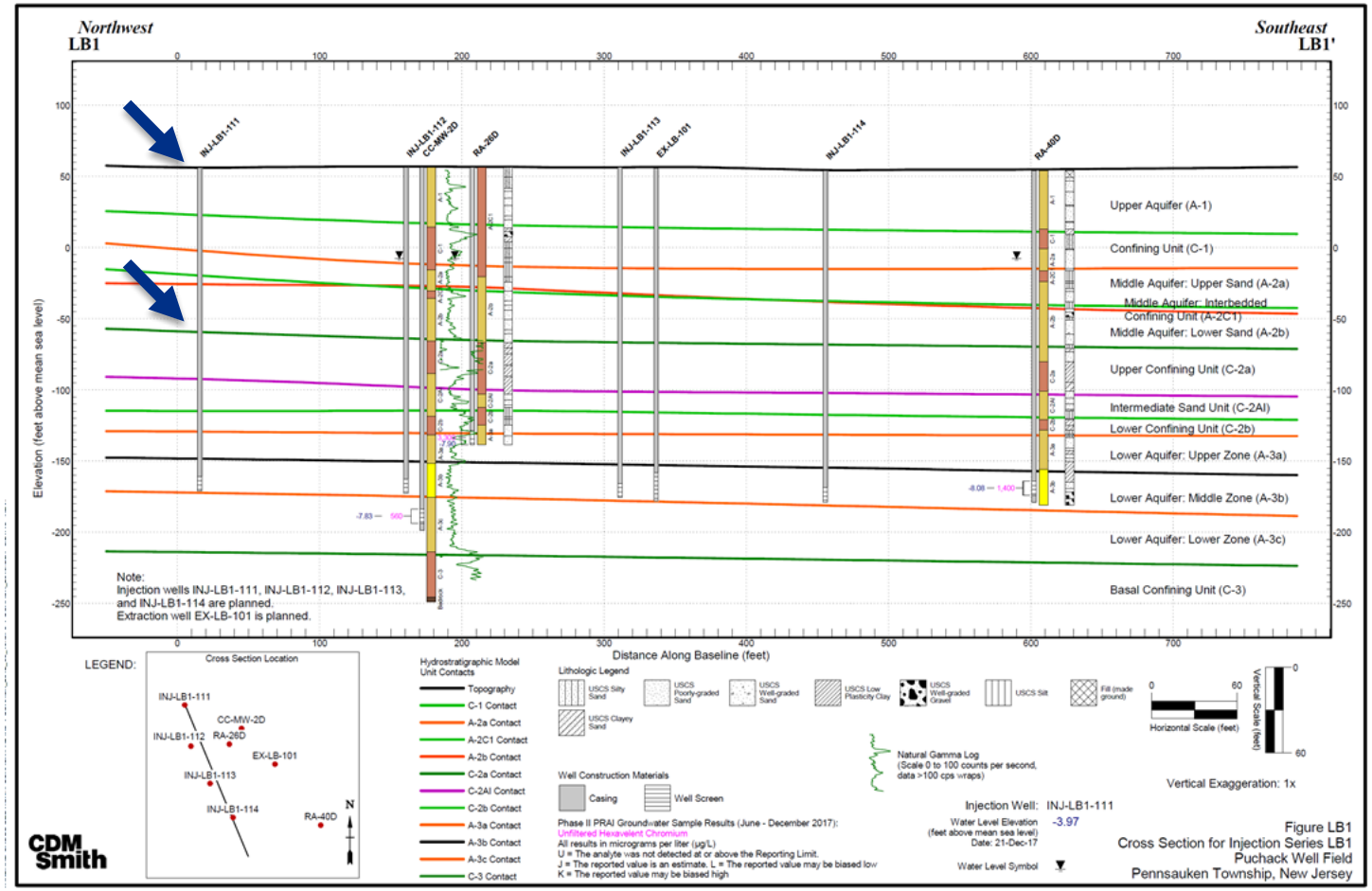


Figure LB1
Cross Section for Injection Series LB1
Puchack Well Field
Pennsauken Township, New Jersey

Phase II Remedial Action Design

- Design wells were input into gINT and shown in cross section in the design with existing data
  - x, y, and z estimated
  - Staked and surveyed during mobilization
- 9 injection series in the Middle Aquifer (50 feet deep),
- 15 injection series for the Lower Aquifer (200 to 250 feet deep)
- Over 100 planned monitoring, injection, and extraction wells

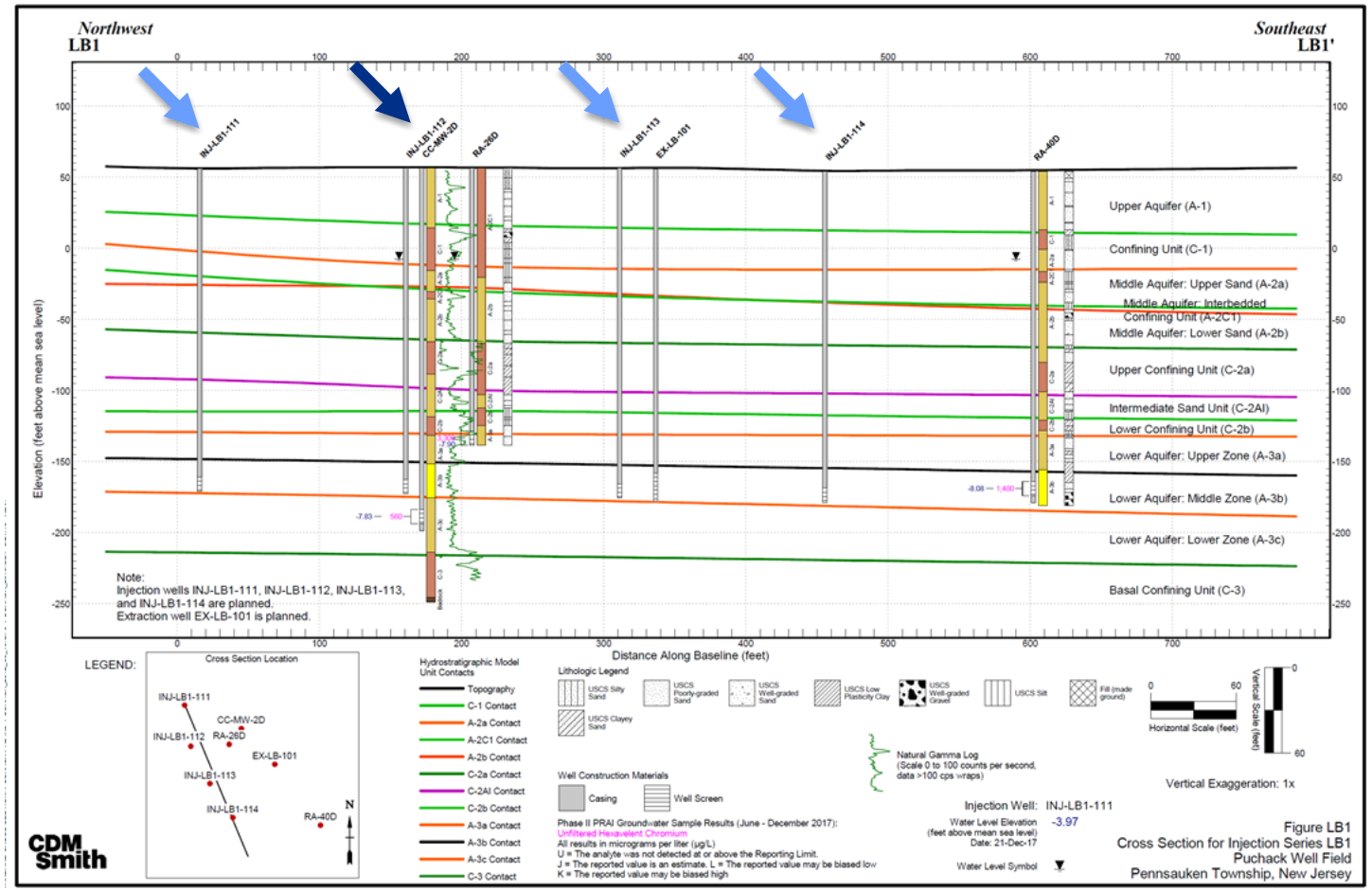


Figure LB1
Cross Section for Injection Series LB1
Puchack Well Field
Pennsauken Township, New Jersey

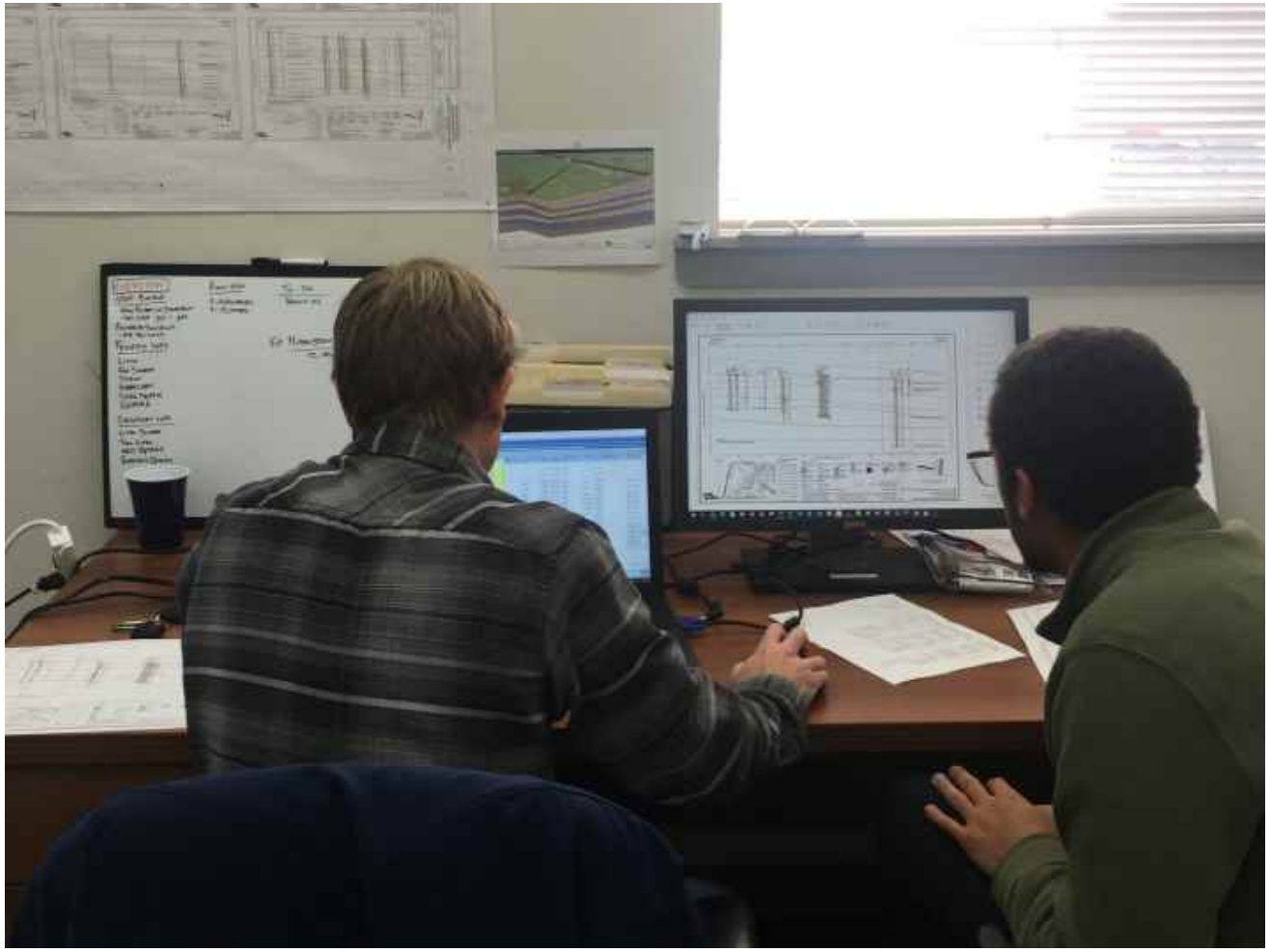
How to Meet the Requirements for Real Time Data Evaluation During Drilling?

- Up to three rigs running simultaneously
- Case off the C-2a confining unit separating the Middle and Lower Aquifers
  - **What is the depth to depth to the C-2a?**
- Collect screening samples
  - 10-foot intervals
  - From the Middle Aquifer and the Lower Aquifer (A-3a, A3b, and A3c) up to 250 feet deep
  - **Where do we collect samples?**
- Well screen placement must consider:
  - Screening sample data
  - Lithologic data
  - Natural gamma log
  - Data from nearby borings
  - Site hydrostratigraphic model
  - Review with the Contracting Officer to finalize screen placement
  - **What depth should we screen?**

How do we do this?

How to Meet Requirements During Drilling?

- Share the gINT project file and library with the RA contractor EA Science and Engineering (EA)
- EA implement the approach developed during the PRAI
- CDM Smith worked with EA staff for one week to train and transition
- EA senior geologist experienced with gINT trained junior geologist site for about 2 weeks



Workflow: Lower Aquifer Well

- Expected depths to top or each HSU and total depth determined from cross section/design table
- C-2a: case off temporarily
- Top of Lower Aquifer: collect screening samples

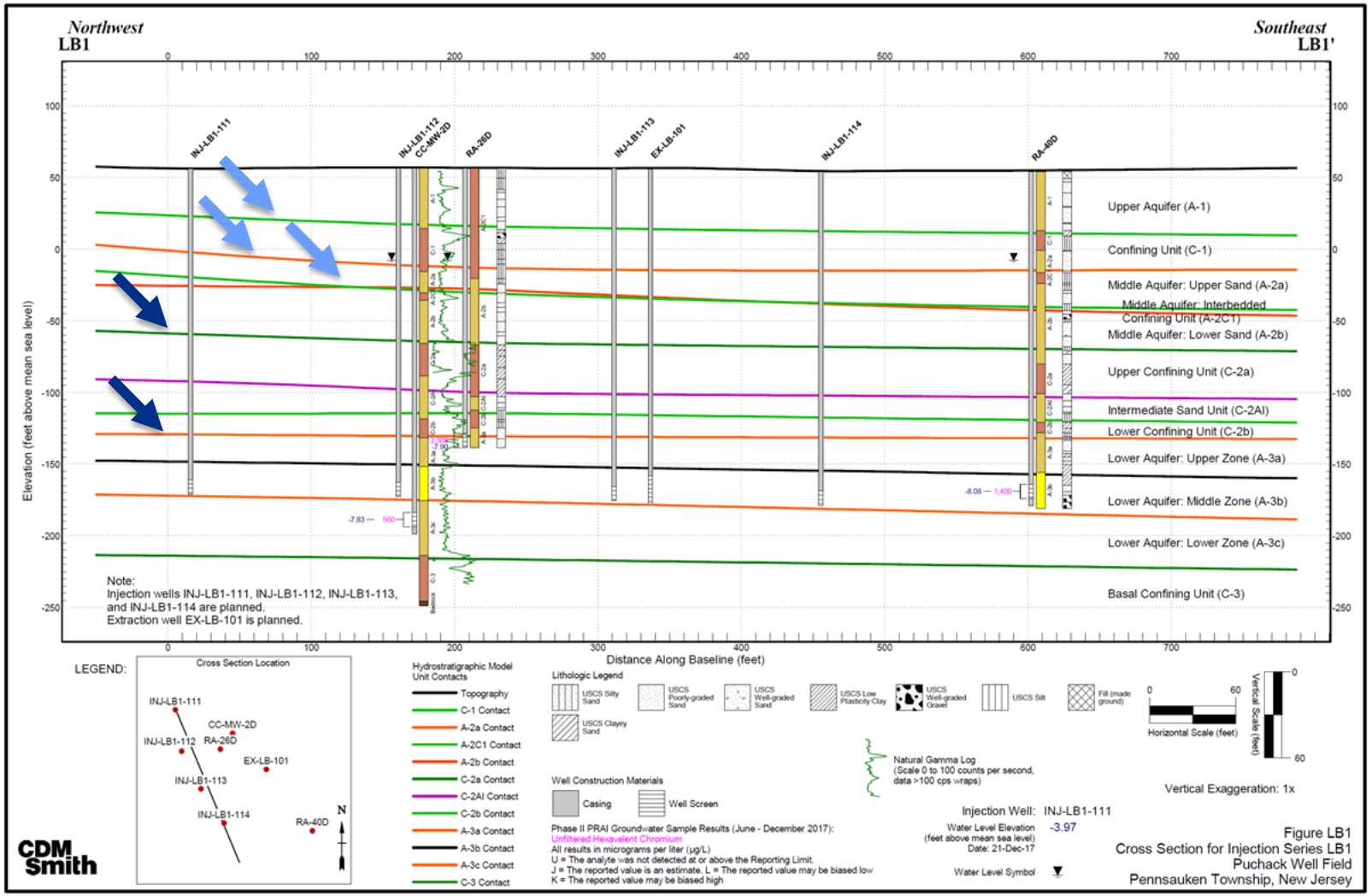
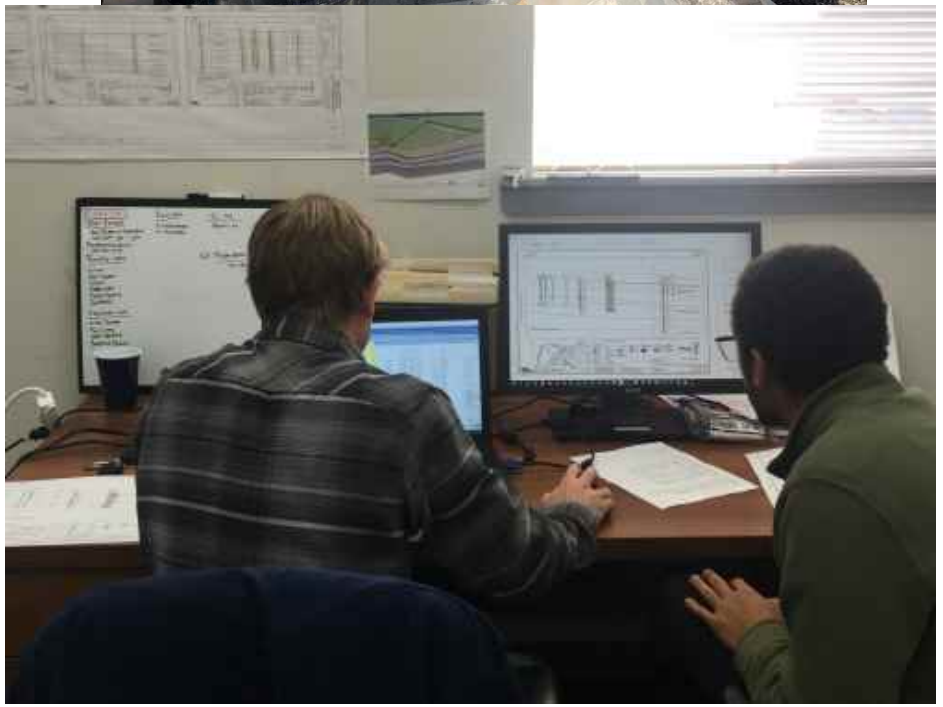


Figure LB1
Cross Section for Injection Series LB1
Puchack Well Field
Pennsauken Township, New Jersey

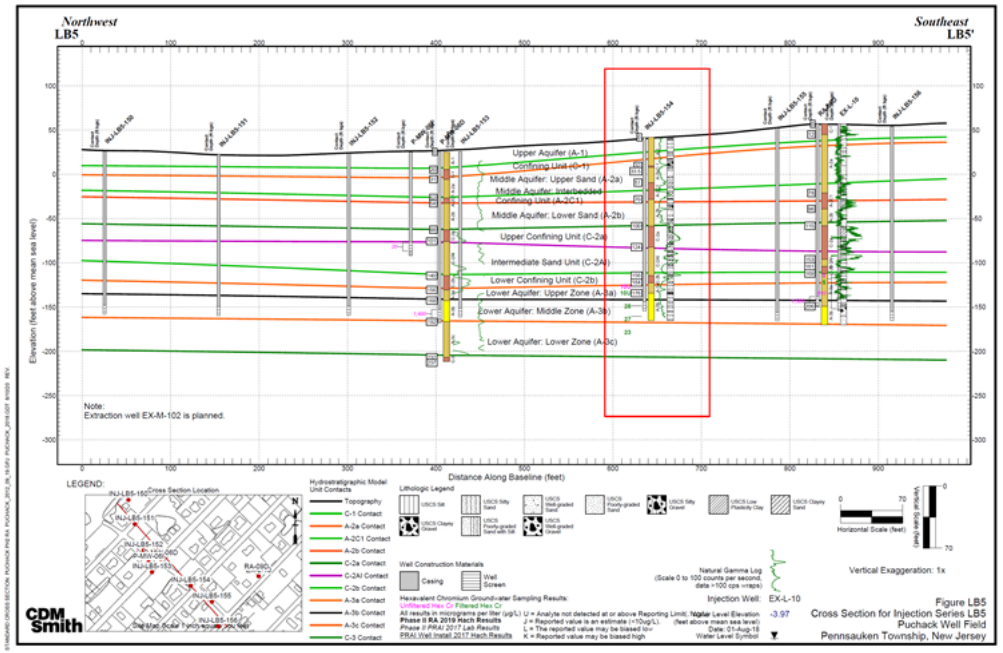
Workflow

- Expected depths to tops of HSUs shared with field geologist
- Field geologist prepares lithologic log at the rig
- Transmits log to gINT geologist every 20 to 30 feet via text or email
  - gINT geologist was onsite to input data into gINT for much of the project especially when 3 rigs running at the same time
- Input lithologic data into gINT
- QC lithologic data
- Add screening sample data and natural gamma log



Workflow

- When the C-2a unit was reached then assign hydrostratigraphic units to the lithologic data
- The data were evaluated in cross section to select screening sample depths



PREVIOUSLY DESCRIBED FRAMEWORK	FRAMEWORK USED IN THIS STUDY
UPPER AQUIFER	AQUIFER (A-1)
UPPER/MIDDLE CONFINING UNIT	CONFINING UNIT (C-1)
MIDDLE AQUIFER	UPPER SAND (A-2a)
	INTERBEDDED CONFINING UNIT (A-2C1)
	LOWER SAND (A-2b)
MIDDLE/LOWER CONFINING UNIT	UPPER CONFINING UNIT (C-2a)
	INTERMEDIATE SAND (C-2AI)
	LOWER CONFINING UNIT (C-2b)
LOWER AQUIFER	UPPER ZONE (A-3a)
	MIDDLE ZONE (A-3b)
	LOWER ZONE (A-3c)
LOWER CONFINING UNIT	CLAY OR BEDROCK BASAL CONFINING UNIT (C-3)

Workflow

- Once the borehole was at depth a natural gamma log was run at some locations
- The data was QC'd by the senior EA geologist who reviewed the planned well in cross section and selected a screened interval

Well Package:
Well Construction Diagram

PROPOSED WELL INTERVAL

EA Engineering, Science, and Technology, Inc.

Project Name/ Project No.: Puchack/6304306

Approvals:
USACE: _____
EA:

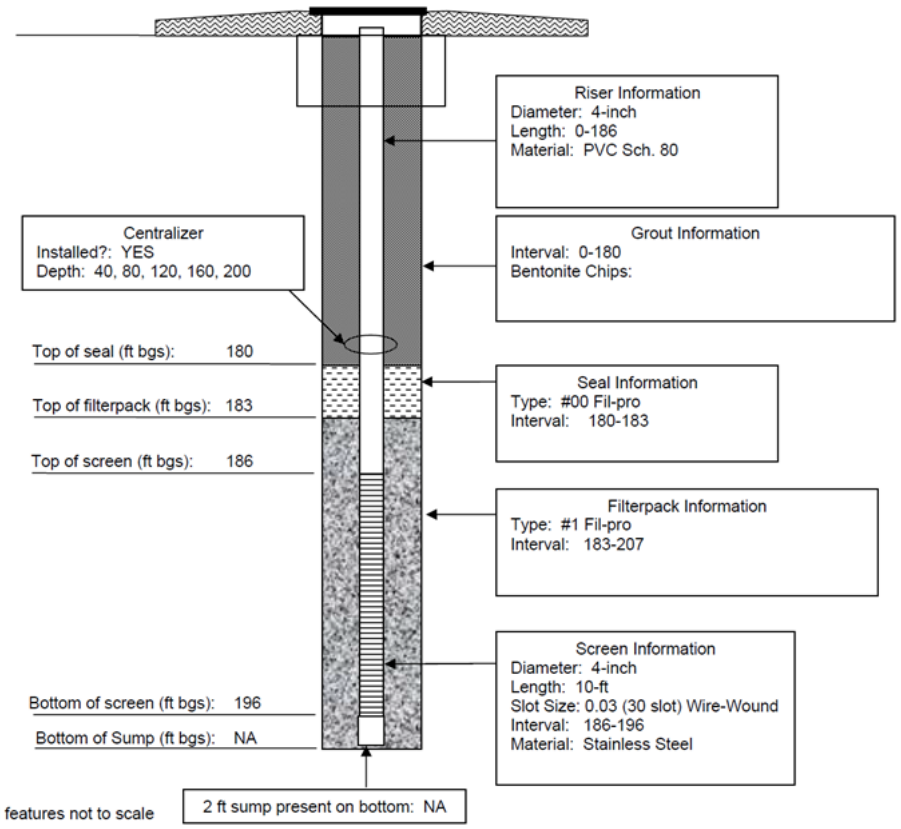
Location: 7245 WESTFIELD AVE

Well ID No.:

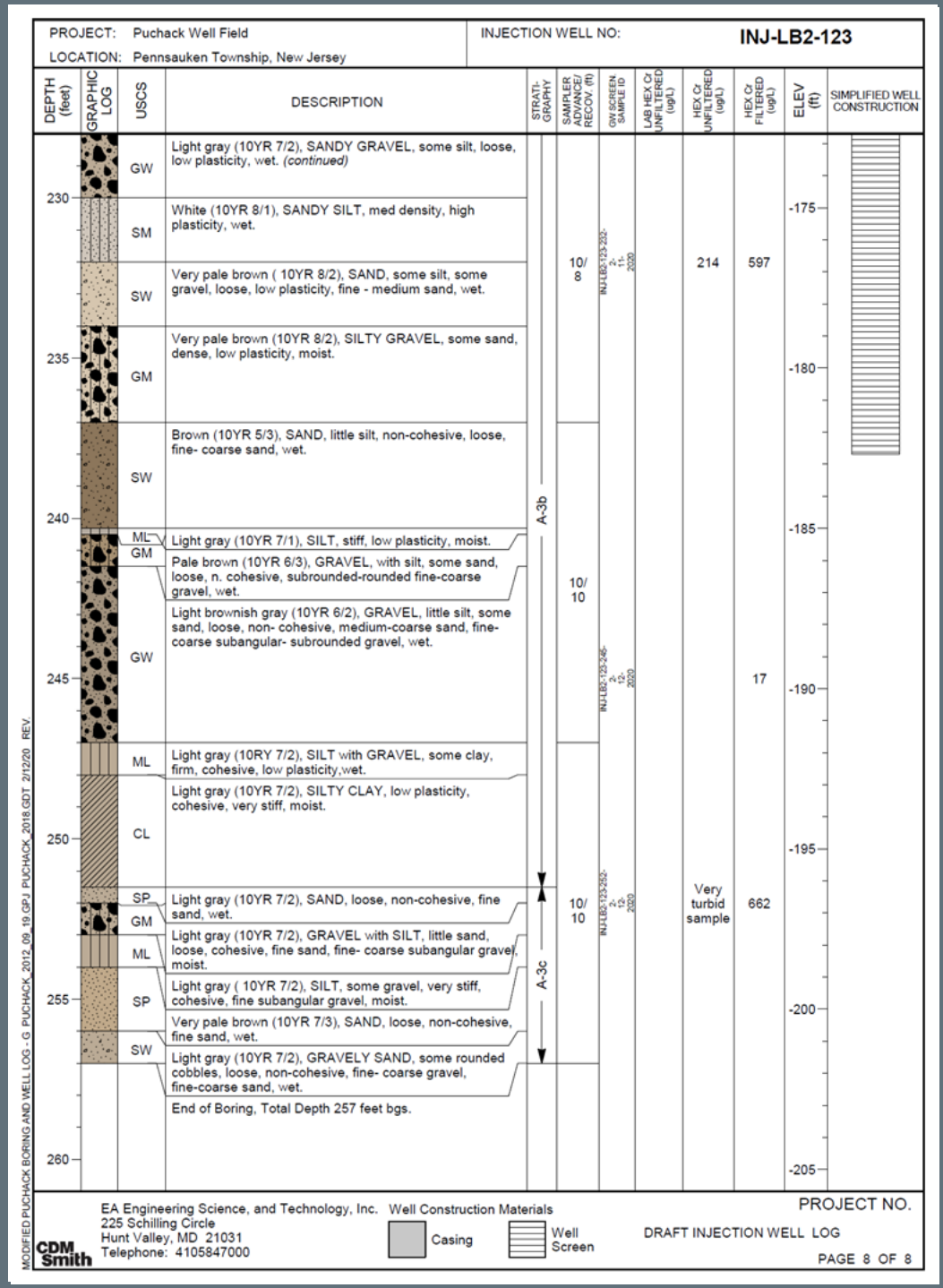
INJ-LB5-154
(415865.40 N, 338195.78 E NAD27)
TOC Elevation: 41.61 ft NAVD88

Top of A-3B Lower Aquifer:
176
Bottom of Borehole:
207

EA recommends installing well at locations indicated on this form with the stratigraphy as shown. Well to be constructed in accordance with the approved specification unless otherwise noted. All footages indicated are below ground surface (bgs).



Well Package:
Boring Log, Natural Gamma Log,
Screened Interval


PROJECT: Puchack Well Field
LOCATION: Pennsauken Township, New Jersey
INJECTION WELL NO: INJ-LB2-123

DEPTH (feet)	USCS	DESCRIPTION	STRATI-GRAPHY	SAMPLER ADVANCE/ RECOV. (ft)	HEX Cr UNFILTERED (ug/L)	HEX Cr FILTERED (ug/L)	ELEV (ft)
230	GW	Light gray (10YR 7/2), SANDY GRAVEL, some silt, loose, low plasticity, wet. *(continued)*					-175
	SM	White (10YR 8/1), SANDY SILT, med density, high plasticity, wet.					
	SW	Very pale brown (10YR 8/2), SAND, some silt, some gravel, loose, low plasticity, fine - medium sand, wet.		10/ 8	214	597	
235	GM	Very pale brown (10YR 8/2), SILTY GRAVEL, some sand, dense, low plasticity, moist.					-180
	SW	Brown (10YR 5/3), SAND, little silt, non-cohesive, loose, fine- coarse sand, wet.	A-3b				
240	ML	Light gray (10YR 7/1), SILT, stiff, low plasticity, moist.					-185
	GM	Pale brown (10YR 6/3), GRAVEL, with silt, some sand, loose, n. cohesive, subrounded-rounded fine-coarse gravel, wet.		10/ 10			
245	GW	Light brownish gray (10YR 6/2), GRAVEL, little silt, some sand, loose, non- cohesive, medium-coarse sand, fine-coarse subangular- subrounded gravel, wet.				17	-190
	ML	Light gray (10RY 7/2), SILT with GRAVEL, some clay, firm, cohesive, low plasticity,wet.					
250	CL	Light gray (10YR 7/2), SILTY CLAY, low plasticity, cohesive, very stiff, moist.					-195
	SP	Light gray (10YR 7/2), SAND, loose, non-cohesive, fine sand, wet.		10/ 10	Very turbid sample	662	
	GM	Light gray (10YR 7/2), GRAVEL with SILT, little sand, loose, cohesive, fine sand, fine- coarse subangular gravel, moist.					
	ML	Light gray (10YR 7/2), SILT, some gravel, very stiff, cohesive, fine subangular gravel, moist.	A-3c				
255	SP	Very pale brown (10YR 7/3), SAND, loose, non-cohesive, fine sand, wet.					-200
	SW	Light gray (10YR 7/2), GRAVELY SAND, some rounded cobbles, loose, non-cohesive, fine- coarse gravel, fine-coarse sand, wet.					
260		End of Boring, Total Depth 257 feet bgs.					-205

GW SCREEN SAMPLE ID: INJ-LB2-123-252-2-11-2020; INJ-LB2-123-246-2-11-2020; INJ-LB2-123-252-2-11-2020

SIMPLIFIED WELL CONSTRUCTION

MODIFIED PUCHACK BORING AND WELL LOG - G PUCHACK_2012_09_19.GPJ PUCHACK_2018.GDT 2/12/20 REV.

EA Engineering Science, and Technology, Inc.
225 Schilling Circle
Hunt Valley, MD 21031
Telephone: 4105847000

CDM Smith

Well Construction Materials: Casing; Well Screen

PROJECT NO.

DRAFT INJECTION WELL LOG

PAGE 8 OF 8

Well Package: *Cross Section*

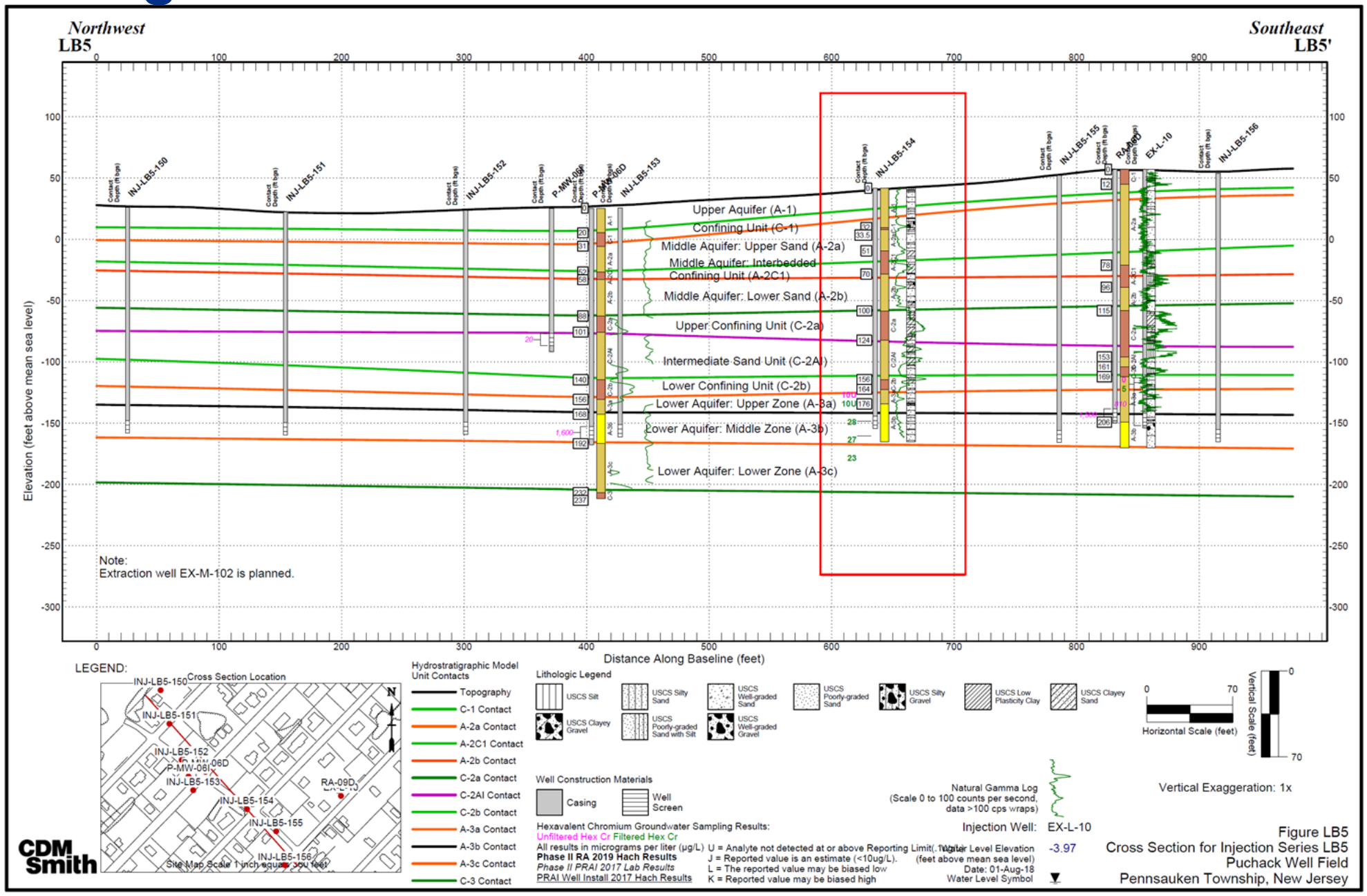
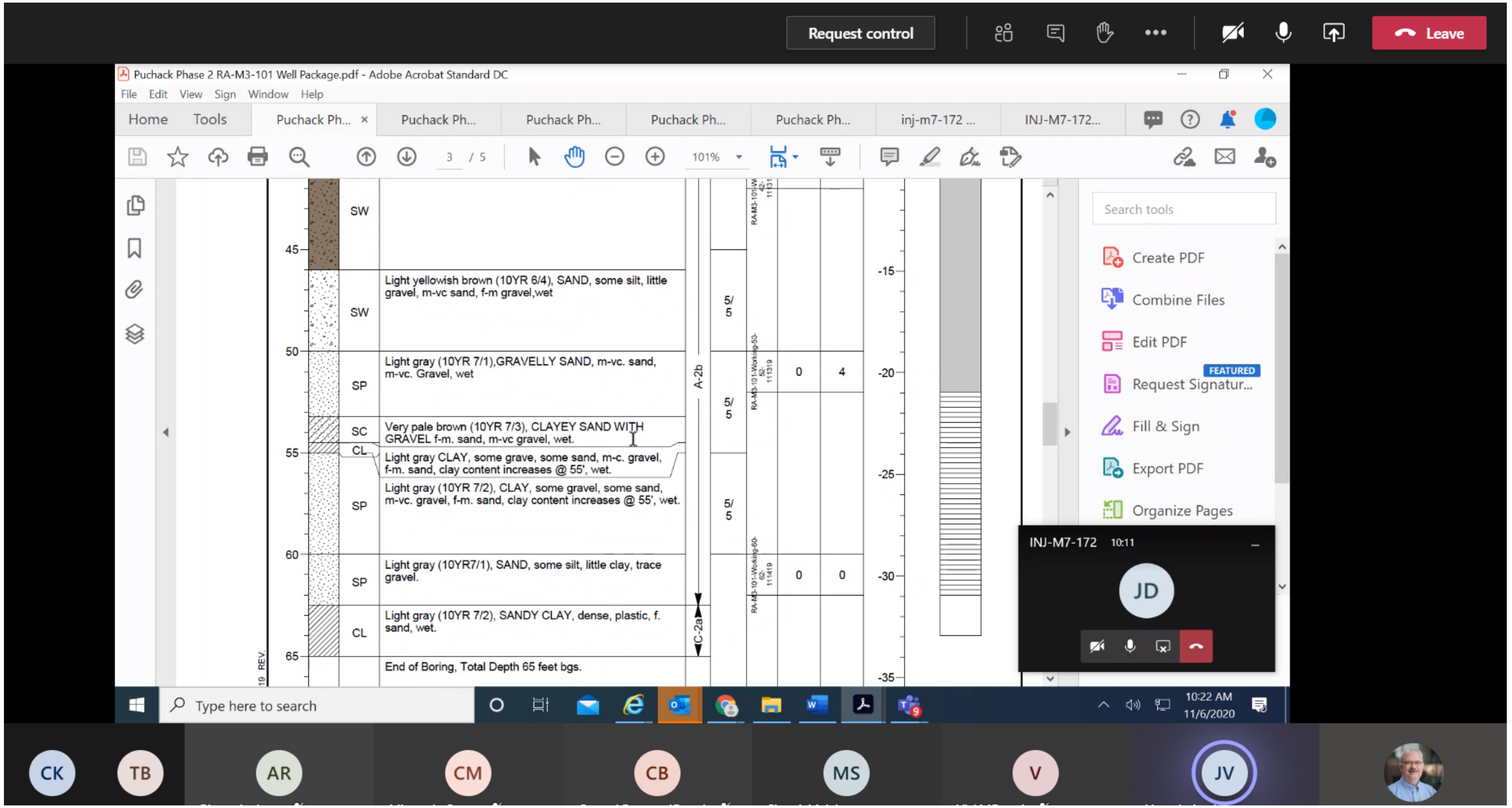


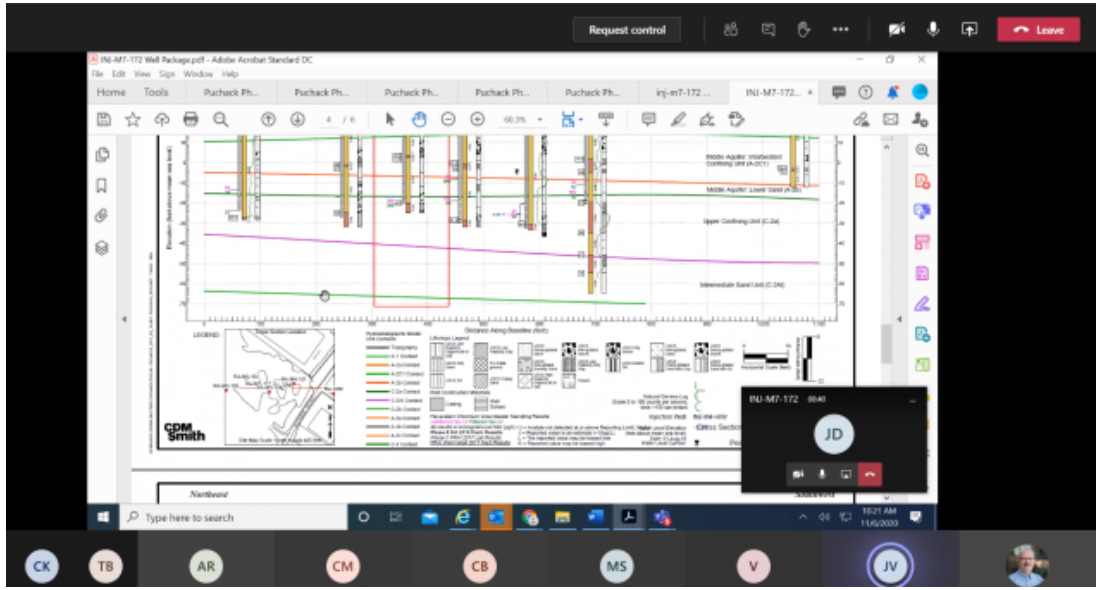
Figure LB5
Cross Section for Injection Series LB5
Puchack Well Field
Pennsauken Township, New Jersey

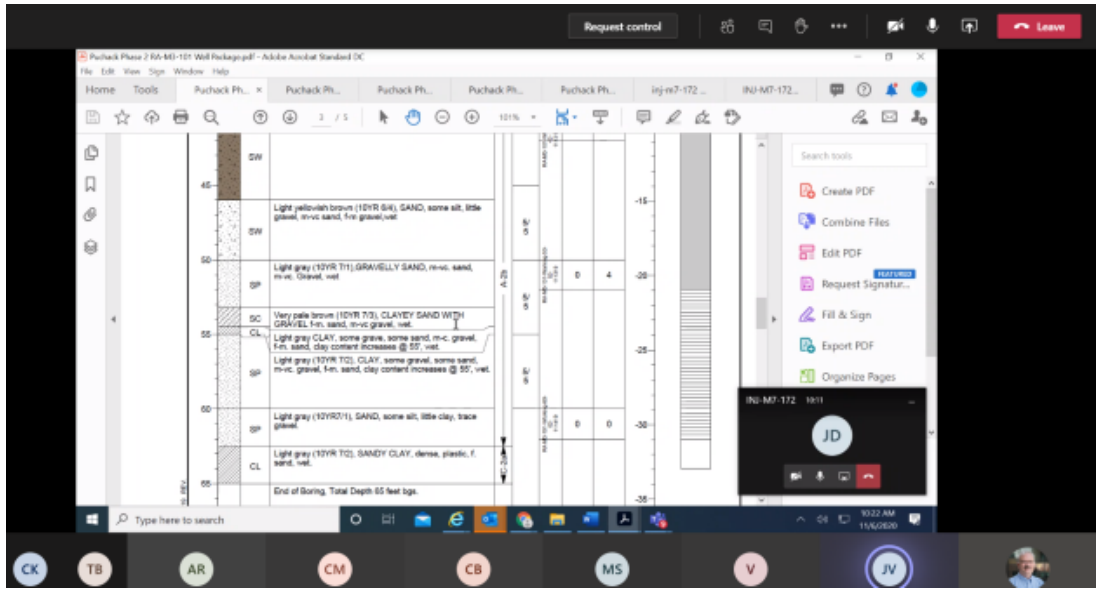
Review Screen Placement by Project Team



Project Team Conference Call to Finalize Screen Placement

- Borehole is at depth and the rig is on the borehole waiting for a final well design
- The well package was finalized and QC'd by the EA PM and senior geologist then sent to the project team
- Project team: EPA, KC Corps, Philly Corps, EA, and CDM Smith met via Teams
- Reviewed well package, adjusted the screen position if necessary and approved the design
- Typical calls lasted 10 minutes
- Driller completed the well construction





Conclusions

- This process was developed by CDM Smith during the PRAI in 2017
- Transferred to the RA contractor to implement the Phase II RA drilling (October 2019 through January 2021)
- This process can be scaled to any size site

Aquifer	Monitoring Wells	Injection Wells	Extraction Wells	Total
Middle	12	29	2	43
Intermediate Sand	2	0	0	2
Lower Aquifer A-3a Unit	10	39	4	53
Lower Aquifer A-3b/c Unit	2	20	3	25
Total	**26**	**88**	**9**	**123**

Next Steps

- The gINT project file now contains data from 667 borings stretching back to 2000
- Update the site conceptual model in Leapfrog and to apply ESS to support remediation of the Intermediate Sand unit
- The workflow detailed here will be used to guide well installation

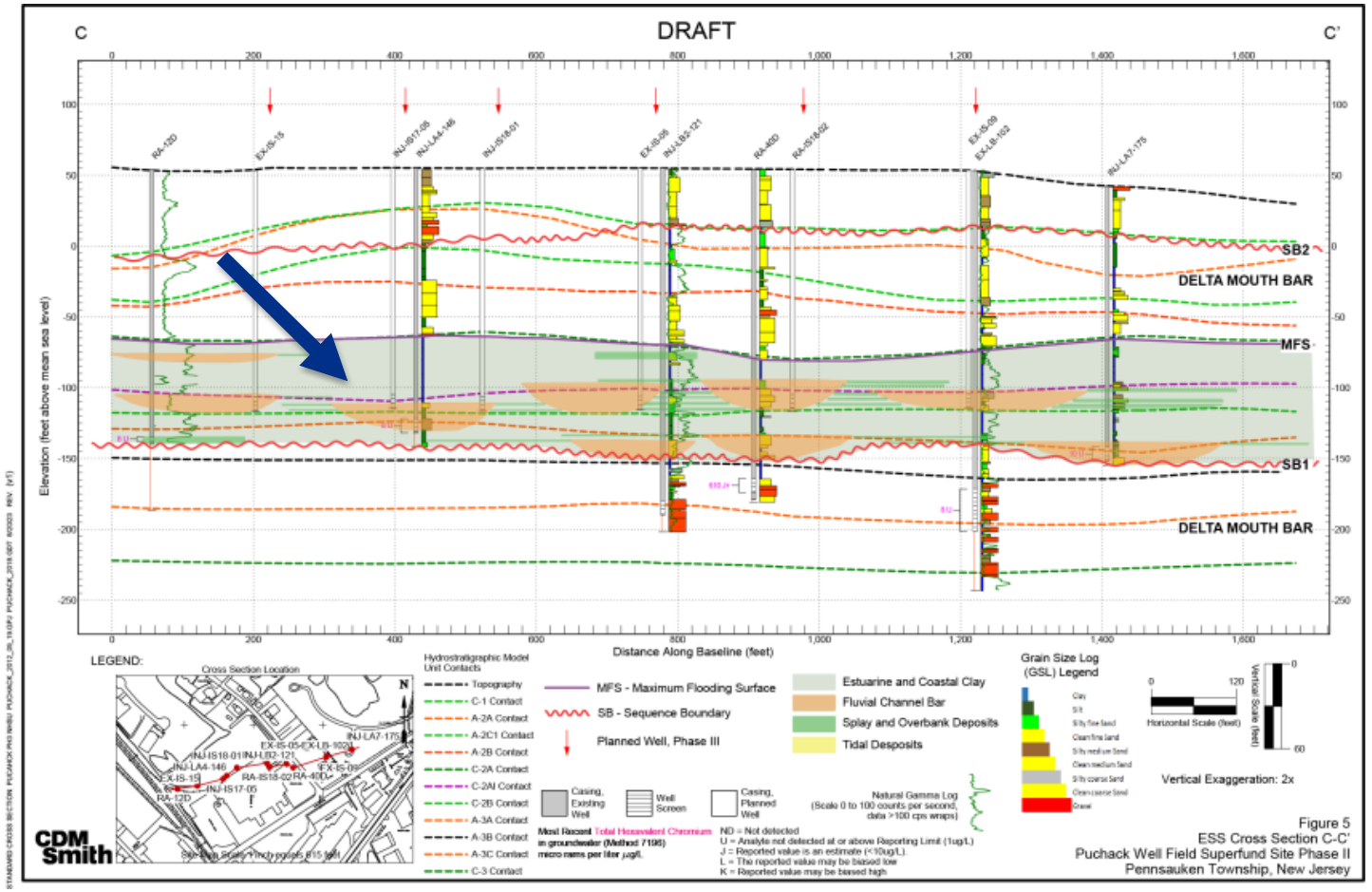


Figure 5
ESS Cross Section C-C'
Puchack Well Field Superfund Site Phase II
Pennsauken Township, New Jersey

Thank you!

To learn more, contact:

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CDM Smith
DoughertyJN@cdmsmith.com