

GWQS Achieved in Fractured Bedrock at a TCE Release Site in the Passaic Formation

Bill Brab, PG, CPG

Senior Remediation Geologist

AST Environmental, Inc.



Slurry Application Techniques

- Direct Push (top-down)
 - Clay/silt/sand/gravel
- GeoTAP™ Method (top-down)
 - Sonic or auger → DPT
- Bedrock (bottom-up)
 - Straddle packer isolates fractures
- Soil mixing (trench or areal)



GeoTAP™ Technique

- Sites where DPT (alone) cannot be used due to refusal
 - e.g. gravel/cobble zones, glacial till, weathered bedrock, historic fill, etc.
- Pre-drill each location
 - Augers (HSA, SSA) or Sonic to the target/total depth
- Backfill borehole with engineered bentonite; hydrate; build in lifts
- Probe through bentonite using DPT
- High energy injection cuts through bentonite
- 50+ sites in various geologies/regions completed to date

Introducing RPI Group's **GeoTAP™** Pre-Drill Process

*Advancing the Science of
Optimized Injections*



GEOLOGICAL
TARGETED
ACCESS
POINT



Direct-Push Refusal

**PACKER
REQUIRED**

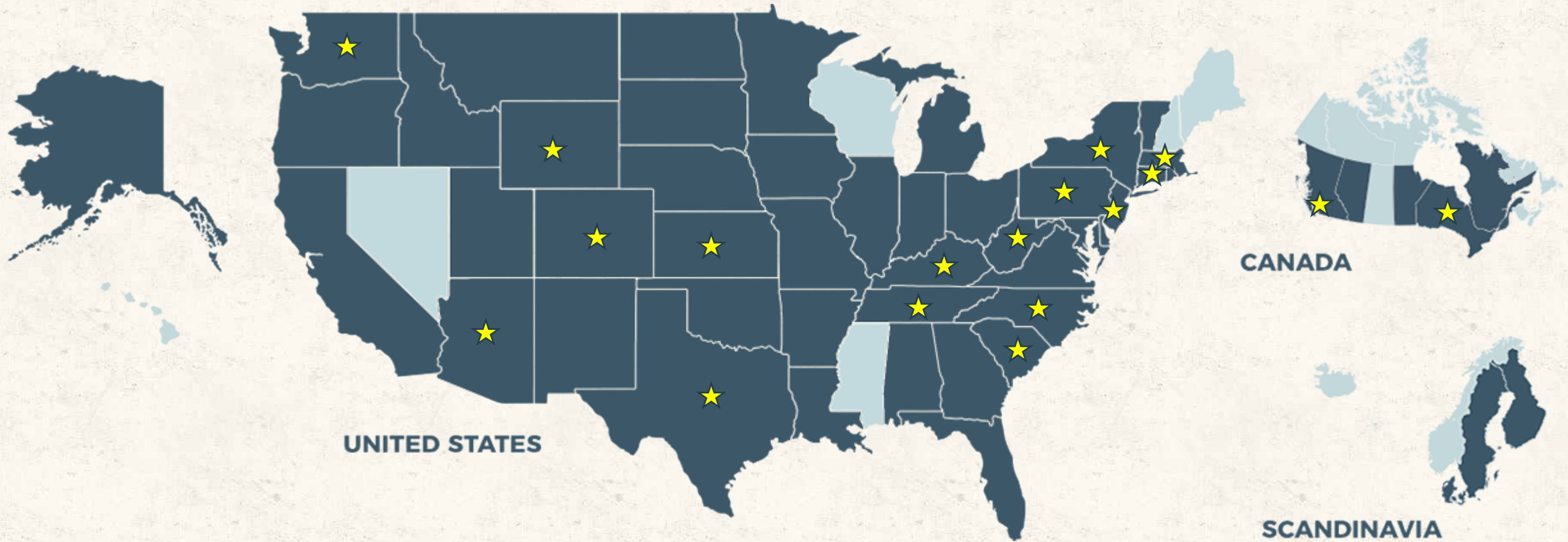
Competent Bedrock,
Fractured Rock

Cobble, Sandstone,
Caliche, Course Gravel,
Construction Debris

**DIRECT
PUSH
FRIENDLY**

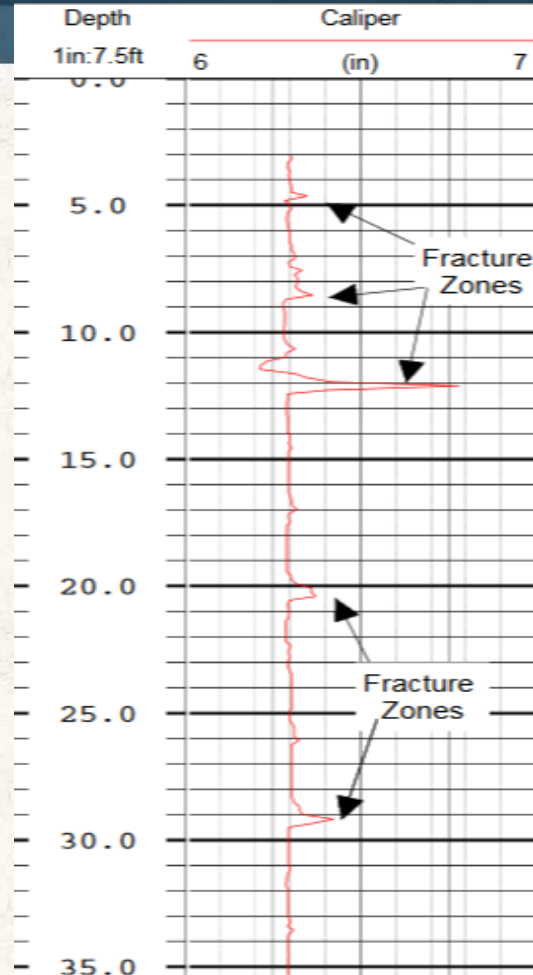
Silt, Sand, Clay

GeoTAP™ Applications



Bedrock Injection via Packers

- Straddle packers
 - 18" interval
 - Fracture isolation
 - Sampling
 - Injection
- High energy injection
 - Slurries
 - Distribution vs. ROI



Injection at Various Flow Rates

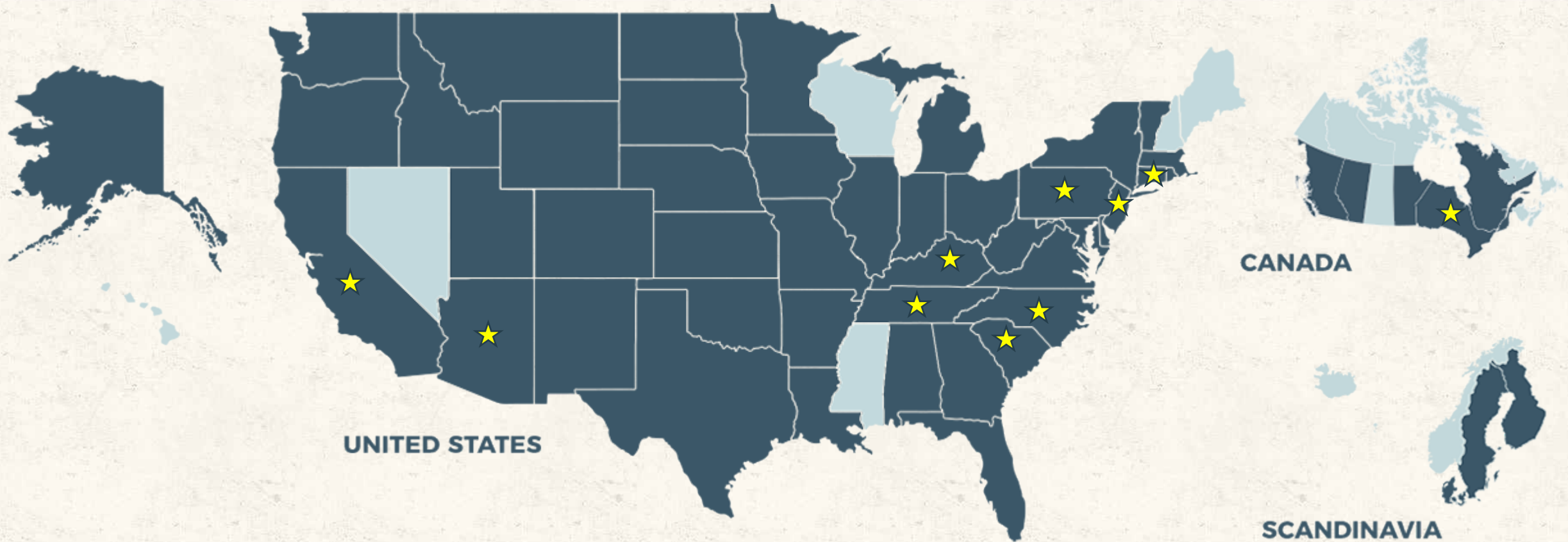


Various Flow Rates

25 gpm, 75 gpm

125 gpm, 250 gpm

Fractured Bedrock Applications



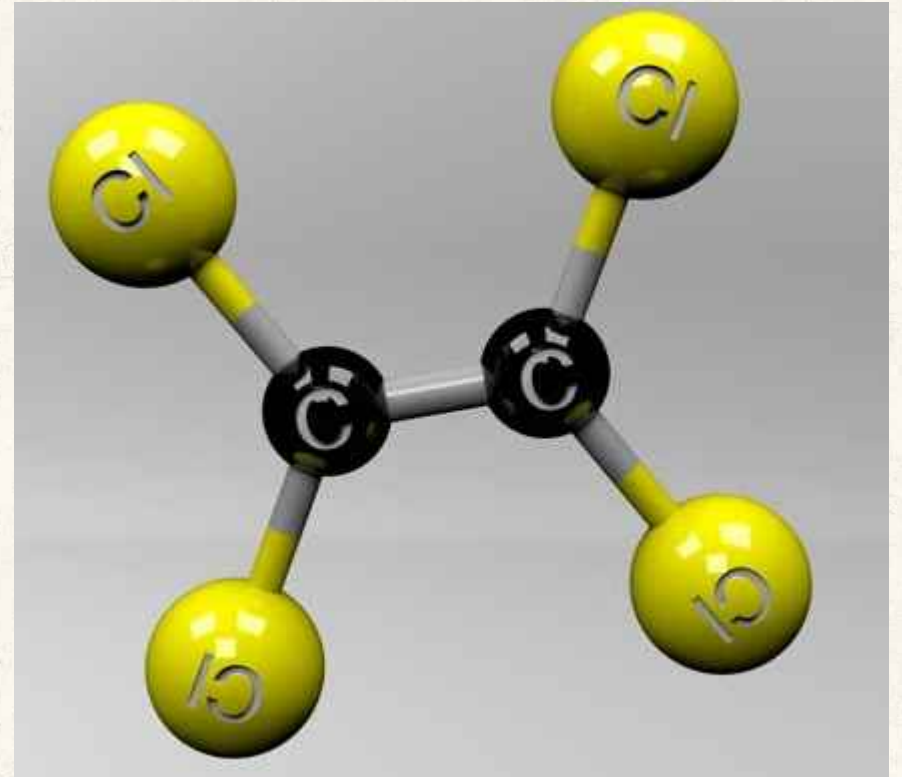
Dark Blue: Places we've worked

Other locations not shown- UK, France, Italy, South Africa, Australia, and Puerto Rico

Technology Selected – BOS 100®

BOS 100®

- Granular activated carbon impregnated with metallic iron
- Abiotic β -Pathway Elimination
- Treatment of chlorinated solvents



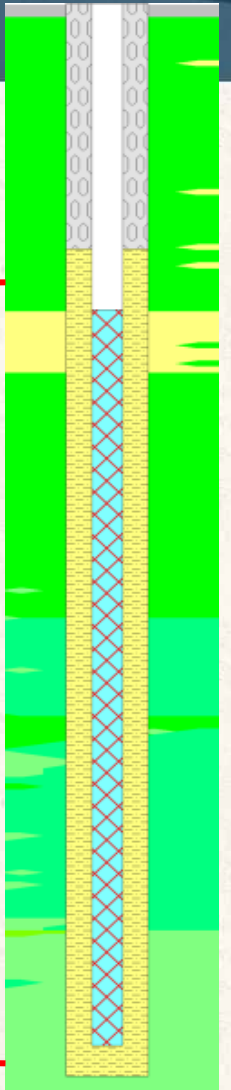
Existing Issues w/CSM and Infrastructure

Concerns

- Long well screens; cross bedrock interface; multiple zones
- Cased wells with constructed filterpack
- No groundwater characterization data
- Lithology logged from chips expelled during air rotary → need rock cores

Preliminary Designs and Estimates Based Upon:

- No differentiation of high/low concentration intervals
- Estimated porosities and hydraulic gradients
- Homogeneous stratigraphy
- Groundwater mass only

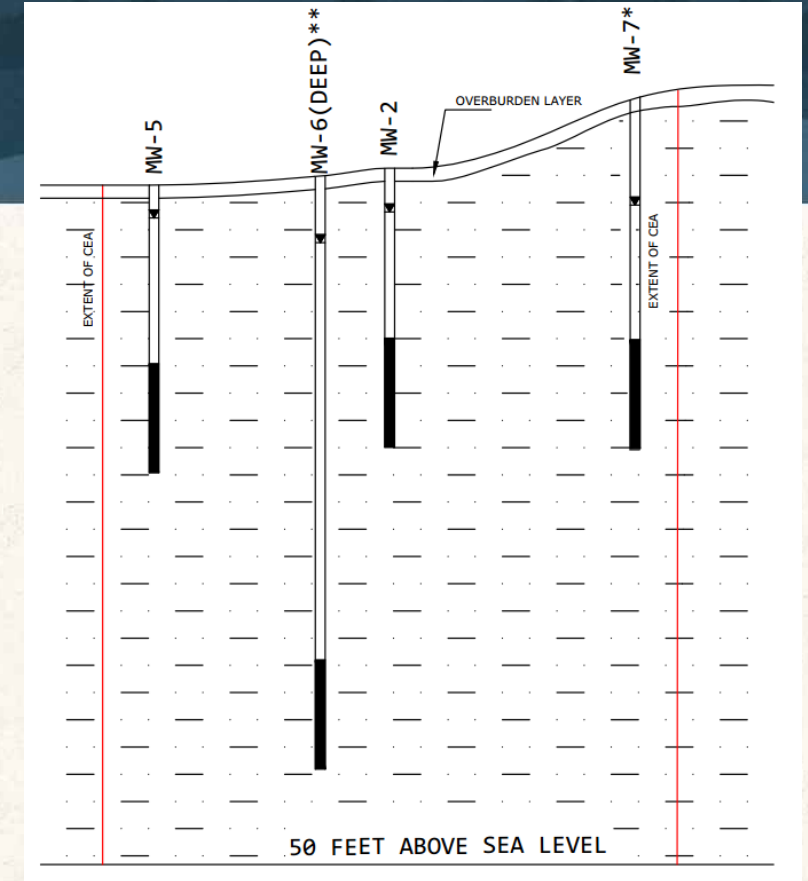


Key Project Dates

- 1992 – Unknown TCE discharge discovered in groundwater
- 2011 – Former catch basin and soils removed
- 2016 – Remedial Investigation Report (RIR)
- 2018 – RDC/BOS 100 injections
- 2020 – No Further Action Granted

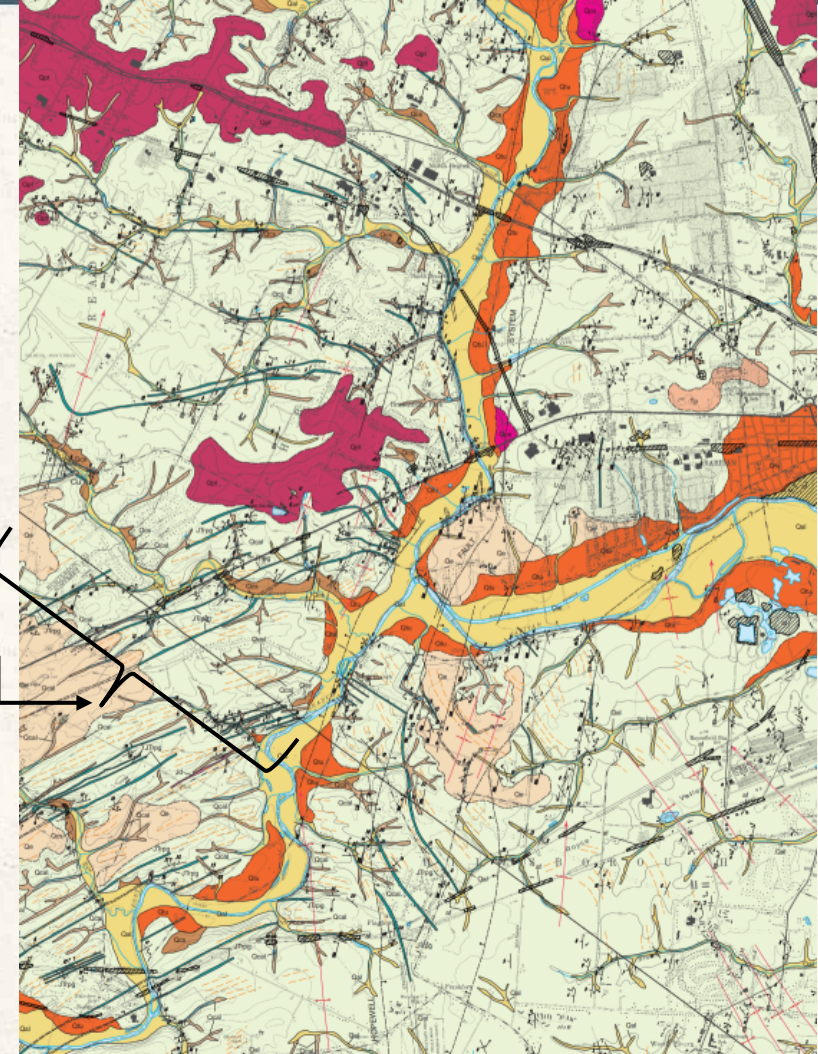
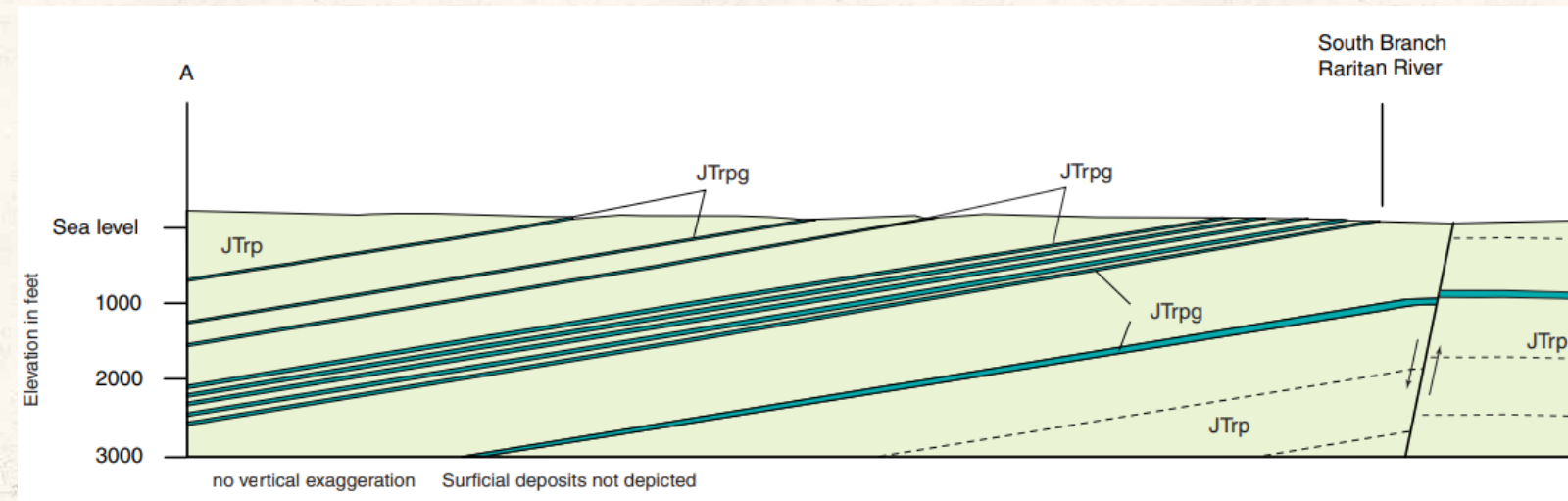
Site Information

- New Jersey
- Lithology
 - Reddish-brown argillaceous shale
 - Localized sandstone/siltstone interbedding
 - PWR 3 to 20 ft.
 - Competent Bedrock 20 ft.+
- Depth to Water: 10 ft-bgs.
- Contaminants: TCE and 1,1-DCE
 - Not above limits for overburden soils (previous removal efforts)
 - Focus on treating groundwater in PWR and bedrock → mass
 - 86.9 µg/L to 98.9 µg/L TCE in the groundwater



Passaic Formation (Lower Jurassic and Upper Triassic)

- Strike NE-SW
- Dip NW average $\sim 10^\circ$



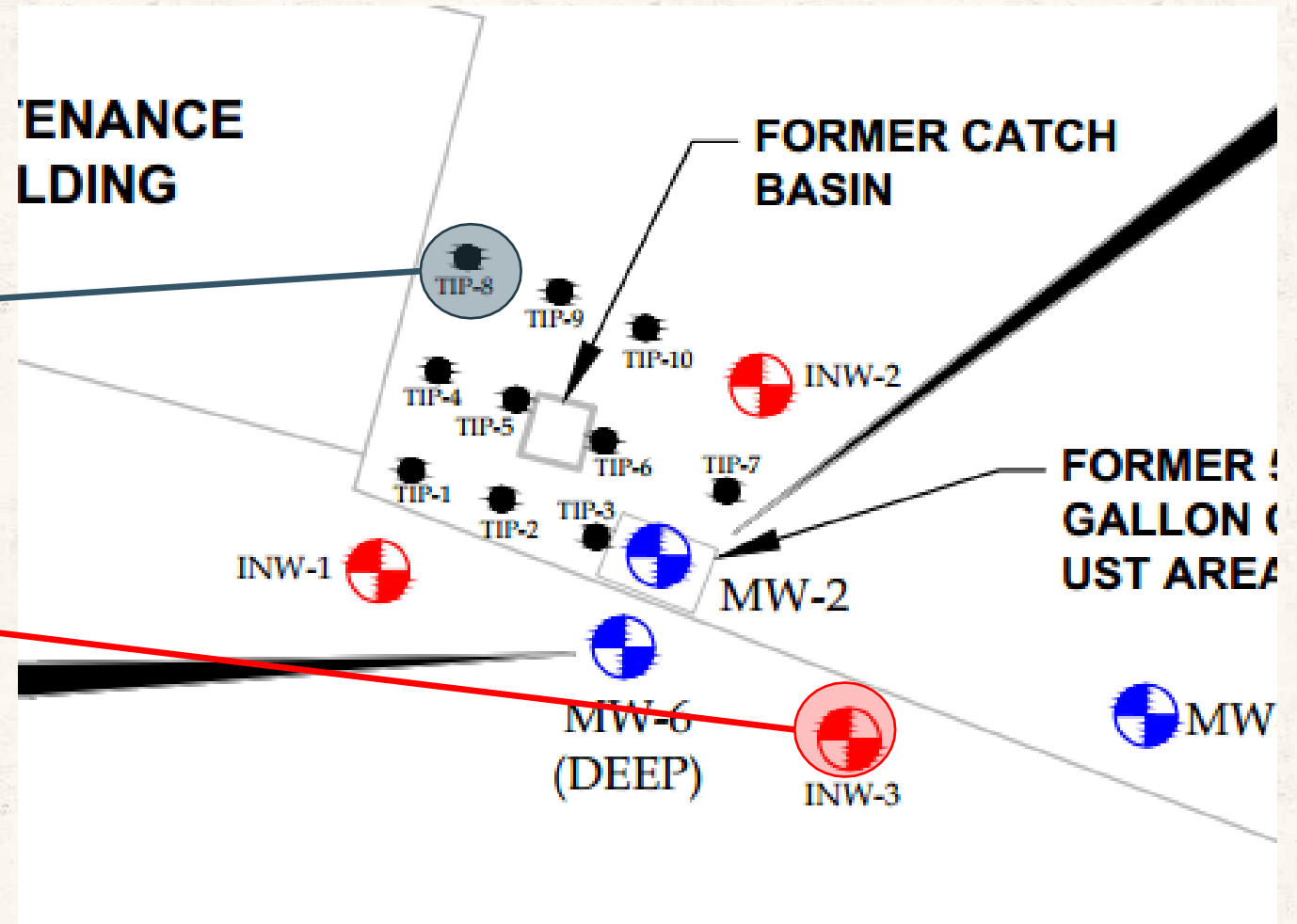
Passaic Formation (cont.)

DEPTH (feet)	REC- OVERY (%)	LAB I.D.	PID READING (ppm)	TCE (soil) (µg/kg)	DESCRIPTION NAME (USCS): color, sorting, plasticity, moisture, sorting, grain size, packing	WELL CONSTRUCTION DETAILS AND/OR DRILLING REMARKS
0	100				Geologic logging not performed 0'-20'	
20						
22					Red, coarse sand and gravelly clay, moderate plasticity, soft, wet	
24						
26	100	BCIP-03 (26')	0.2	1	GC. Large, rounded cobble, coarse white grained matrix, w/in gravelly clay, trace grey mottling, damp,	
28		BCIP-03 (28')	0.8	<0.5	Dense till, gravel and weathered siltstone, brittle, grey mottling, dry	
30		BCIP-03 (30')	1.5	20	Gravelly/sandy clay, wet	
32		BCIP-03 (31')		37		
34	80	BCIP-03 (33')		170	6"-7" cores of solid red/grey siltstone, angular cobbles	
36		BCIP-03 (35')		500	Jrp. Red/grey, angular cobbles, 2 solid 3" cores	
38	40	BCIP-03 (37.5')		380	1' long rock core w/ mineralized vugs	
40		BCIP-03 (39.5')		850	Rock core with vertical fractures, red/grey gravel @ 39' 5" core, 2" weathered core @ 39.5, 4" core @ 40'	
					Boring Terminated	



Treatment Area Information

- Area: 1,100 sf
- Total Zone: 10-55 ft-bgs.
- Transition Zone
 - GeoTAP
 - 10-25 ft-bgs.
- Bedrock Zone
 - Straddle Packer
 - 20-55 ft-bgs.



Bedrock RDC, Findings, and Remedial Approach

- 3 open boreholes to 85 ft-bgs.
- 10 GeoTAP points to 25 ft-bgs.
- Downhole Geophysics
- Aquifer Characterization
 - Straddle packer pump test
 - Discrete interval sampling
 - Transducer data logging
- Low CVOC impacts in borehole fractures (~10% MW-2 impacts)
- Sorbed mass in PWR = persistent source for dissolved impacts

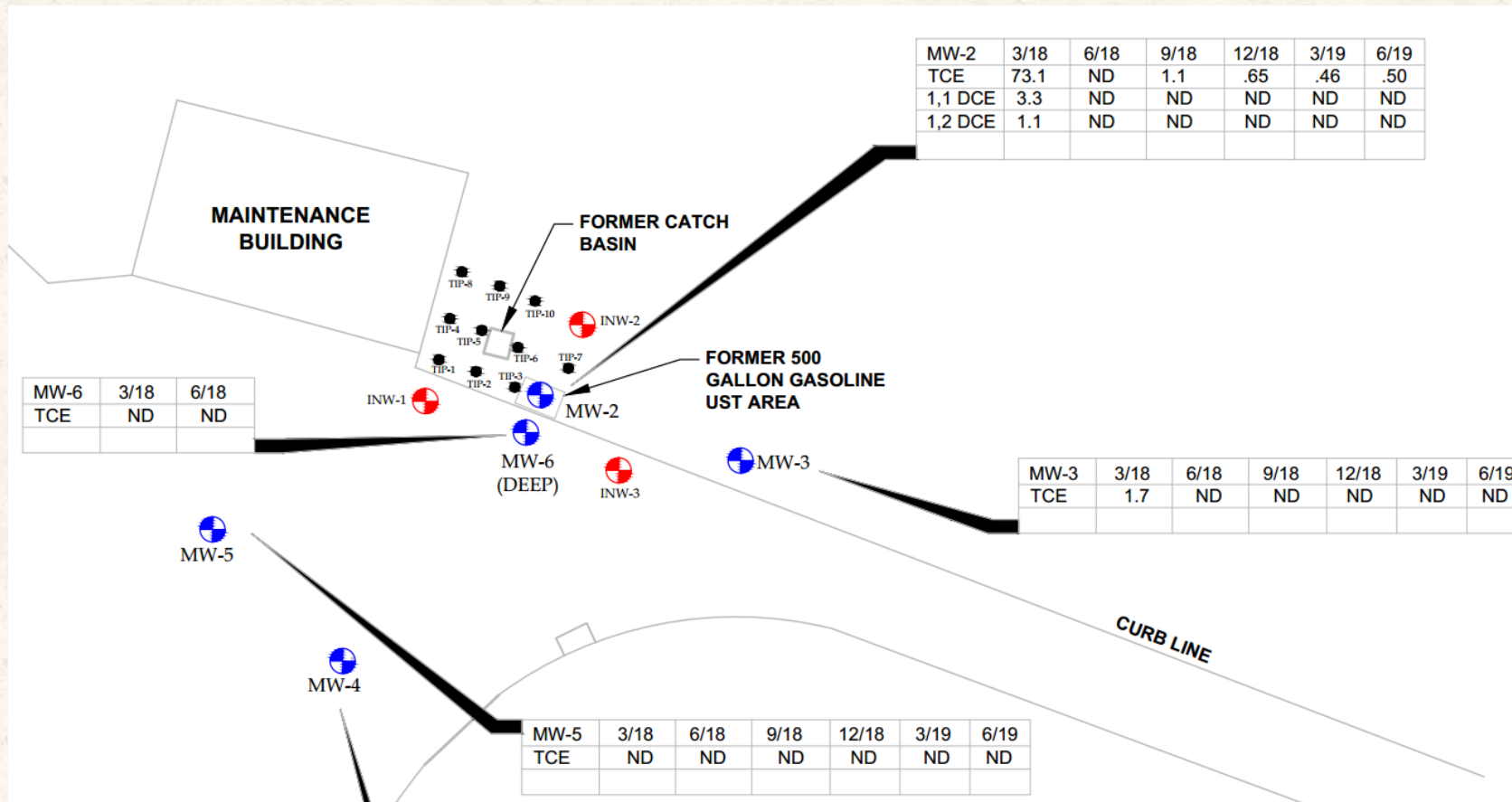


Remedial Approach

- BOS 100 slurry was applied in both geologic units
- Fracture Network Injections
 - AST bedrock truck unit
 - High flow rates through a narrow (18") straddle packer system.
- Transition Zone Injections
 - Conducted using the AST bedrock truck unit
 - High flow rates
 - 2.25" direct-push rods + custom ported injection tip
- Injection flow rates of 70 to 100 gpm

Results

- All MWs (4) achieved 1 ug/l for TCE and 1,1-DCE in less than 6 months
- GeoTAP + Straddle Packers – widely implemented



Thank You For Joining Me



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Bill Brab, PG, CPG

bbrab@astenv.com

