Cranston RCRA
Groundwater and Sediment

Review:

Characterization, gaps, path forward

12/01/2021

SEMS Doc ID 668986

Internal

Objectives

1 **Respond to EPA Comments on deliverables to date**

2 **Process basis for mass distribution**

3 **ID data gaps (discuss)**

4 **Fill gaps (discuss)**

GW Project Correspondence w/ EPA

WP

Implement

Review w/ Frank and Aaron

PRP design, installation and monitoring report

- 2019_0712 BASF Work Plan FINAL_07122019_pdf.msg
- 2019_0820 profile study.msg
- 2019_0828 Cranston RCRA_ PRB implementation.msg
- 2019_0829 Cranston RCRA_ PRB implementation.msg
- 2019_0830_ Cranston RCRA_ PRB implementation.msg
- 2019_0903 Cranston RCRA_ PRB implementation.msg
- 2019_0905 Cranston RCRA_ PRB implementation.msg
- 2019_0912_ Cranston RCRA_ PRB implementation.msg
- 2019_0922 Cranston PRB Drilling Plan.msg
- 2019_0927 photos.msg
- 2019_0930 Starting To Deploy KP Socks .msg
- 2020_1214 Ciba-Geigy.msg
- 2021_0104 Cranston RCRA GW PRB.msg
- 2021_1001_ BASF update.msg

Internal

Q&A

1. DNAPL source (e.g. conceptual site model wrt nature and extent of contamination), including:
   a) Has BASF characterized the vertical extent of this source?
   b) What frequency of monitoring data do you have to substantiate the upward hydraulic gradient/flow path ?
   c) NAPL versus DNAPL

2. What actions are BASF taking to control migration of the NAPL/DNAPL?
   a) What monitoring is in place?

   b) Does BASF have a plan to address the source?

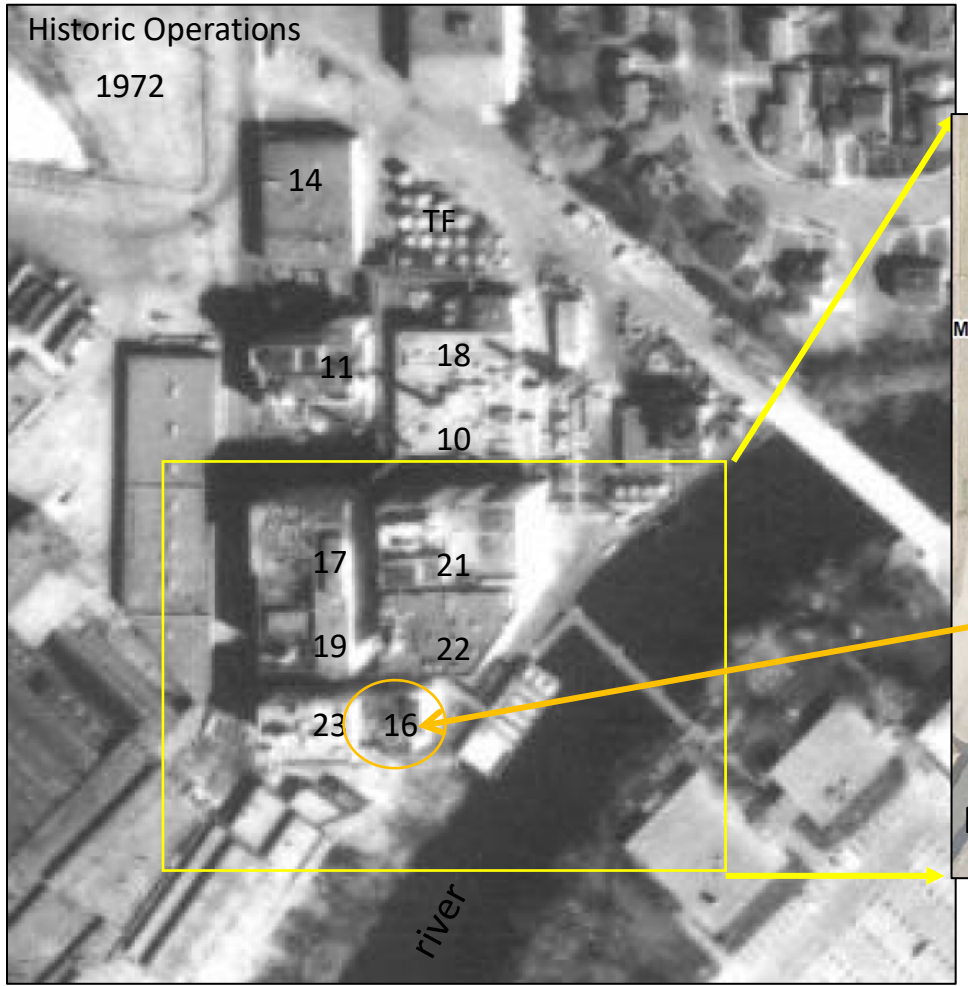
3. What is the next plan of action and associated timeline?

Internal

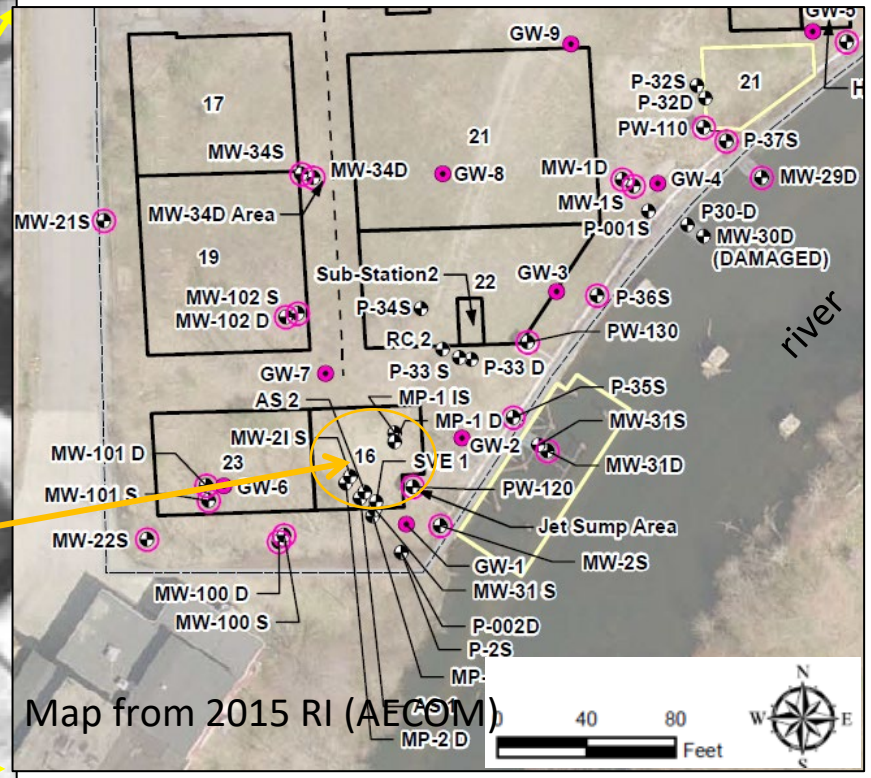
Develop Process-based CSM

Site History:

- Building 16 housed a condensate sump for solvent-laden steam (primarily mono- and di-chlorobenzenes with PCBs).
- Sump failed for an unknown period (persistent source).
- RCRA Site since 1990. Various RI and RA implemented over time



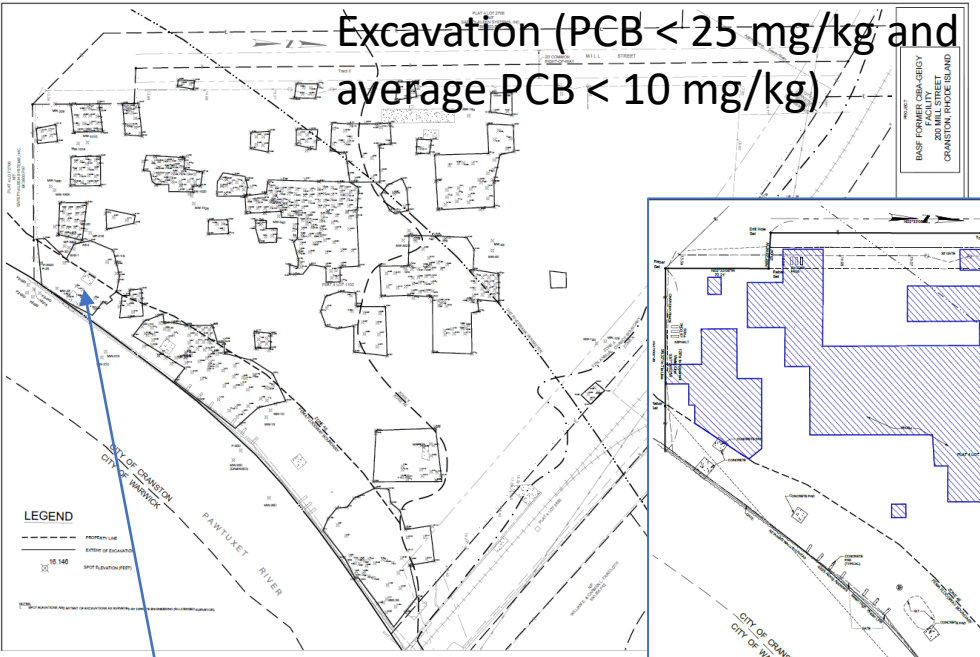
Several RI Phases



Map from 2015 RI (AECOM)

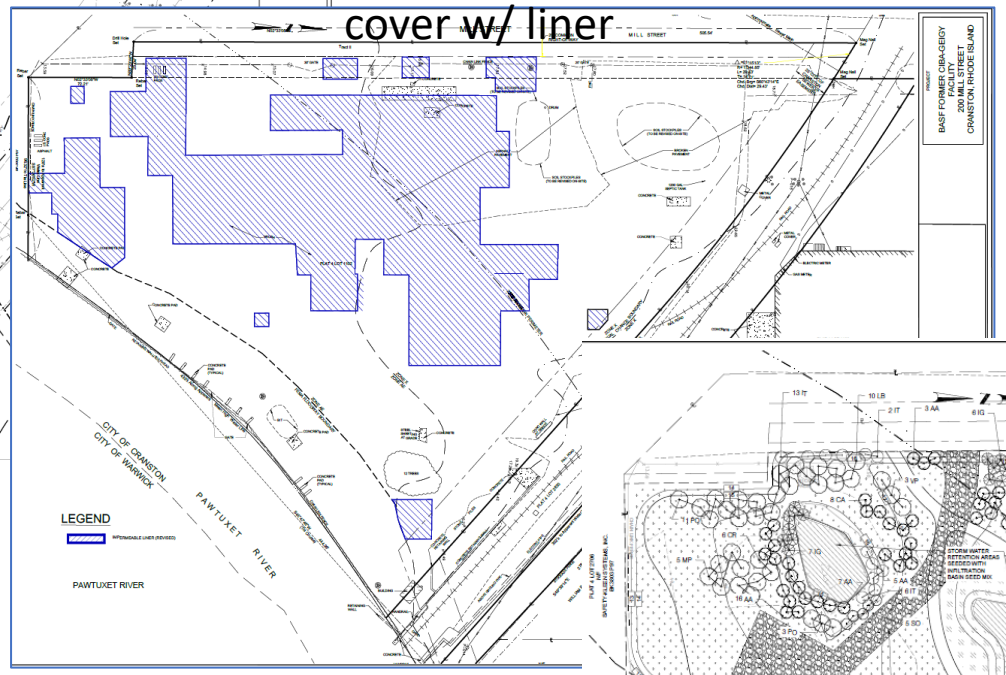
Former Plant (Lot 1102)

Excavation (PCB < 25 mg/kg and average PCB < 10 mg/kg)

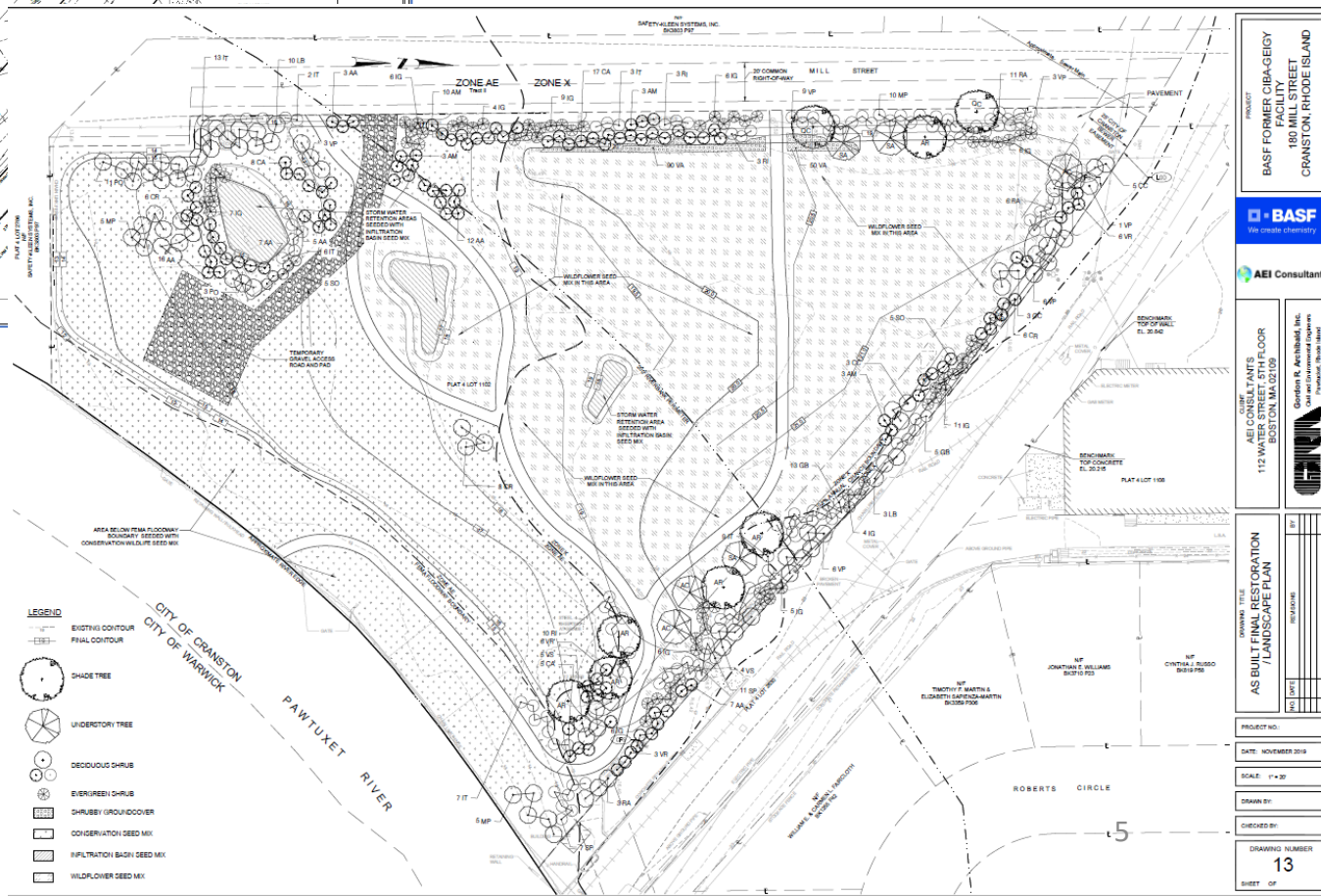


Test pit 5 area w/ high PCB levels

Where PCB >10 mg/kg remains, cover w/ liner



Install RIDEM soil cap where PCB > 1 mg/kg



January 24, 2020

CORRECTIVE MEASURES IMPLEMENTATION CLOSURE REPORT:
Soil Remedy for Former Production Area (Lot 1102)

Property Identification:
BASF Former Ciba-Geigy Facility
200 Mill Street
Cranston, Rhode Island
AEI Project No. 363655

Prepared for:
BASF Corporation
100 Park Avenue
Florham Park, New Jersey 07932

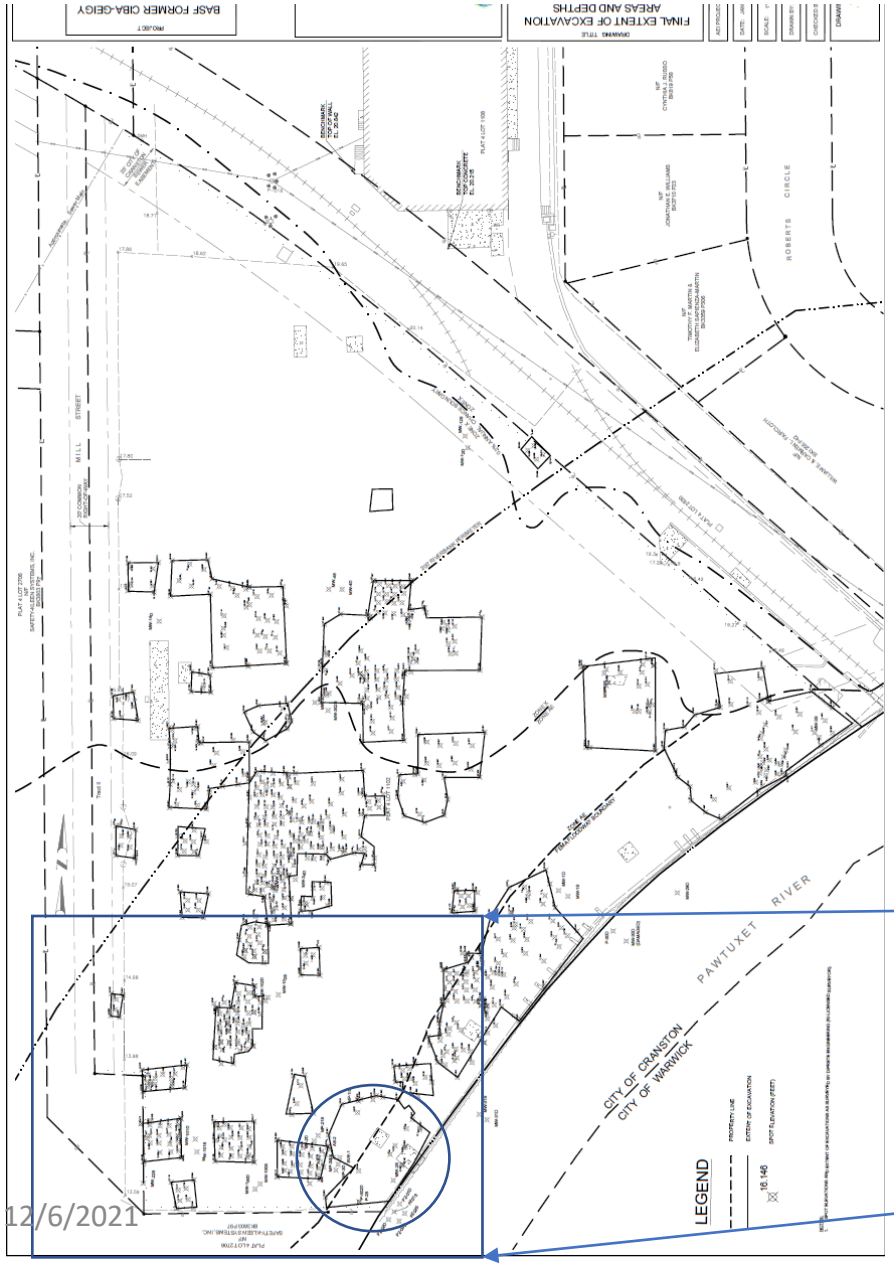
Prepared by:

AEI Consultants
112 Water Street, 5th Floor
Boston, Massachusetts 02109

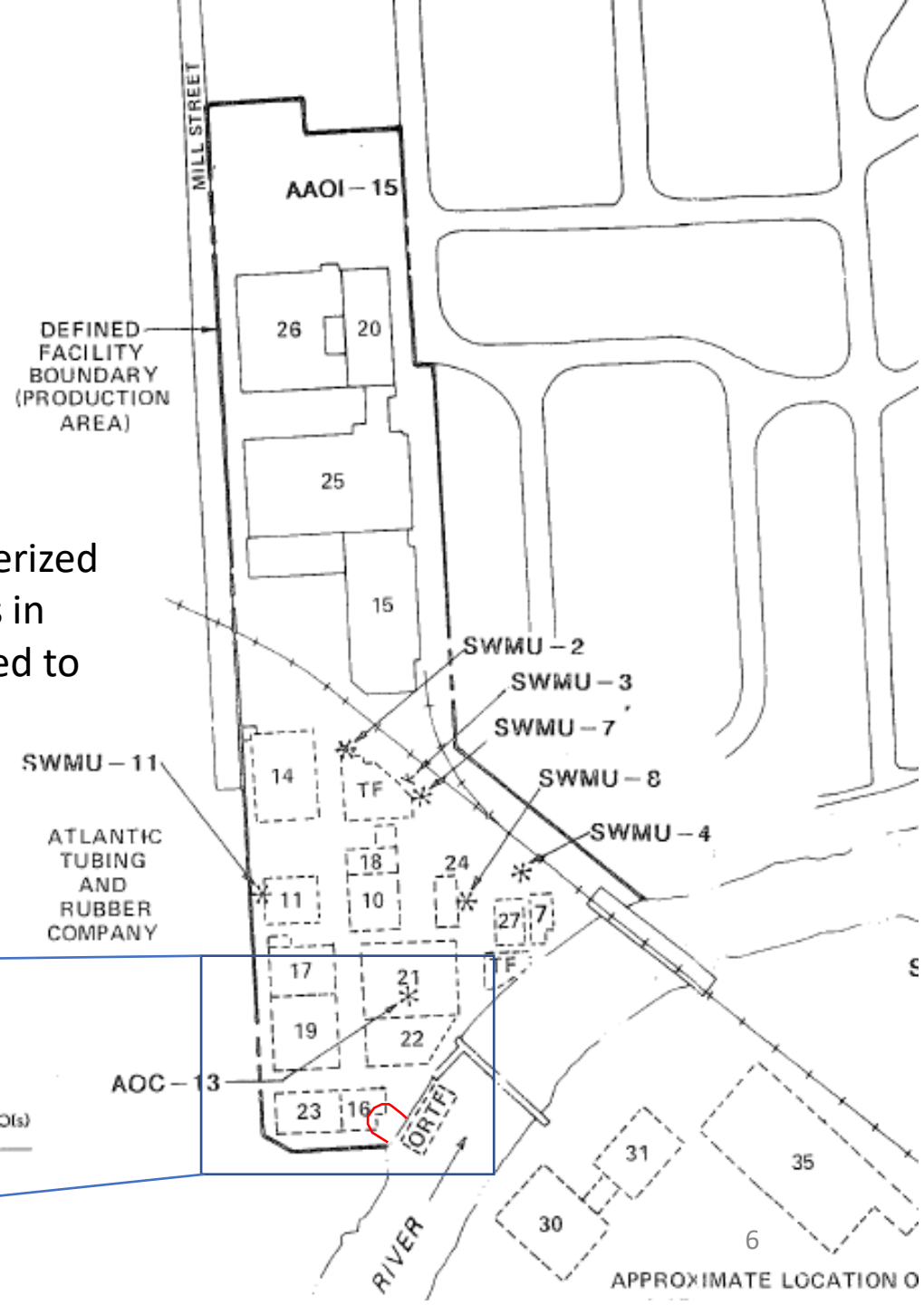
DRAFT

Remedy complete 9/30/19
Closure report 1/24/20

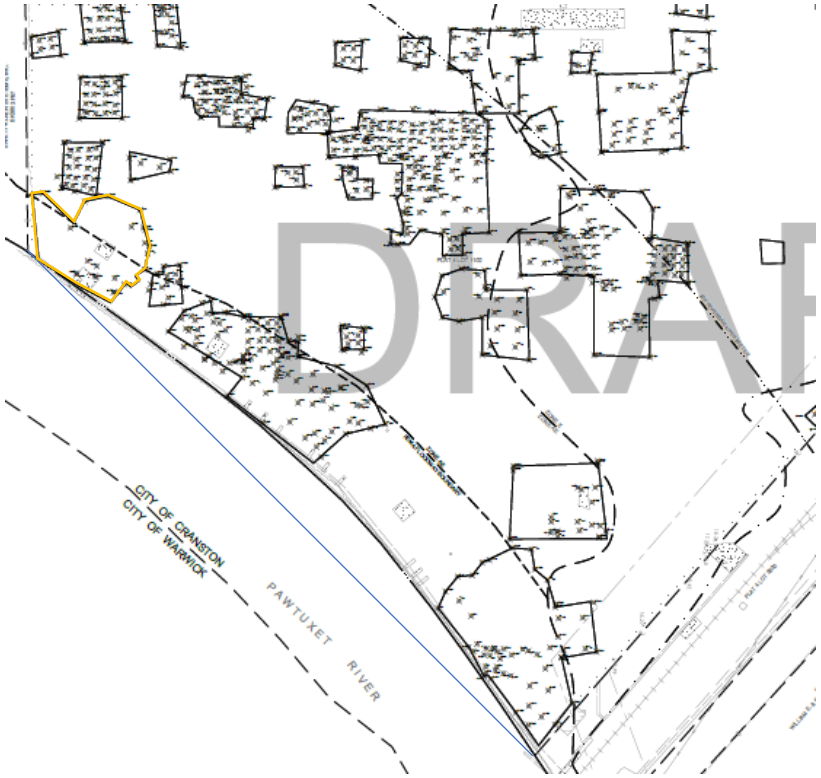
Area of impact implied by soil and GW data (historic and recent) = Jet sump release + halo.



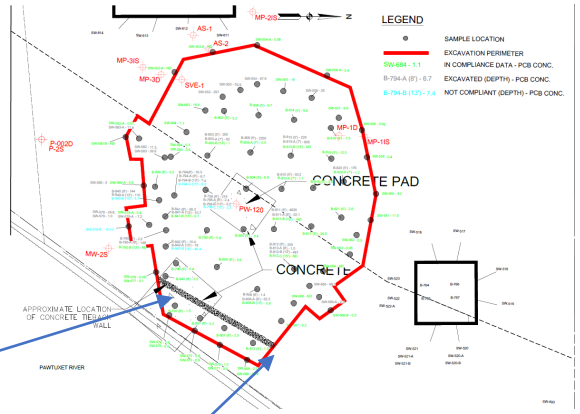
TP-5 area characterized by high PCB levels in soil. Area excavated to up to 15’ bgs

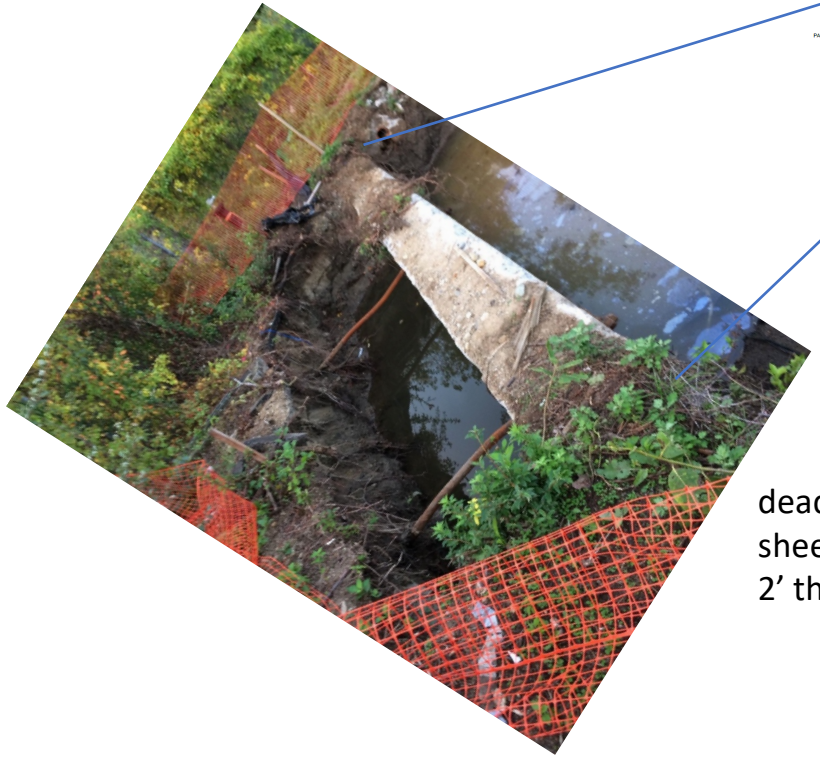


TP-5 area characterized by high PCB levels in soil. Area excavated to up to 15’ bgs



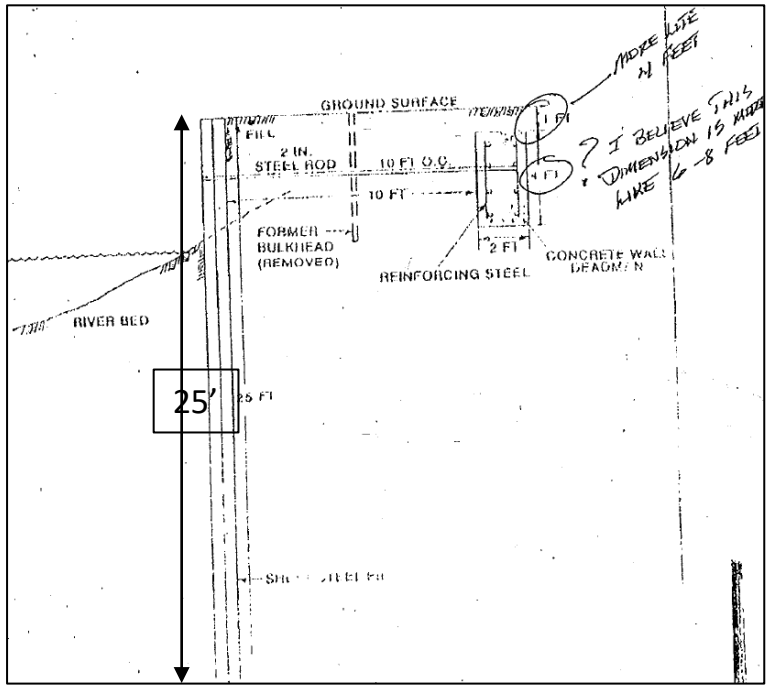
TP-5 area excavated to up to 15’ bgs





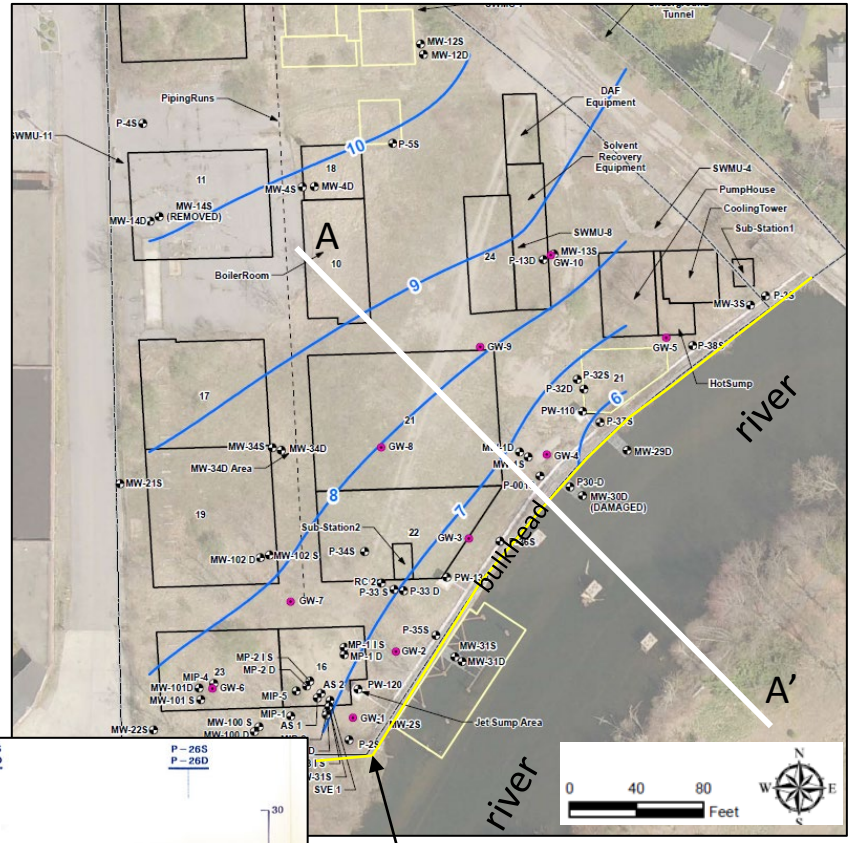
dead-man 10’ from
sheetpile and rods 10’ OC.
2’ thick, from 4’ to ~12’ BGS

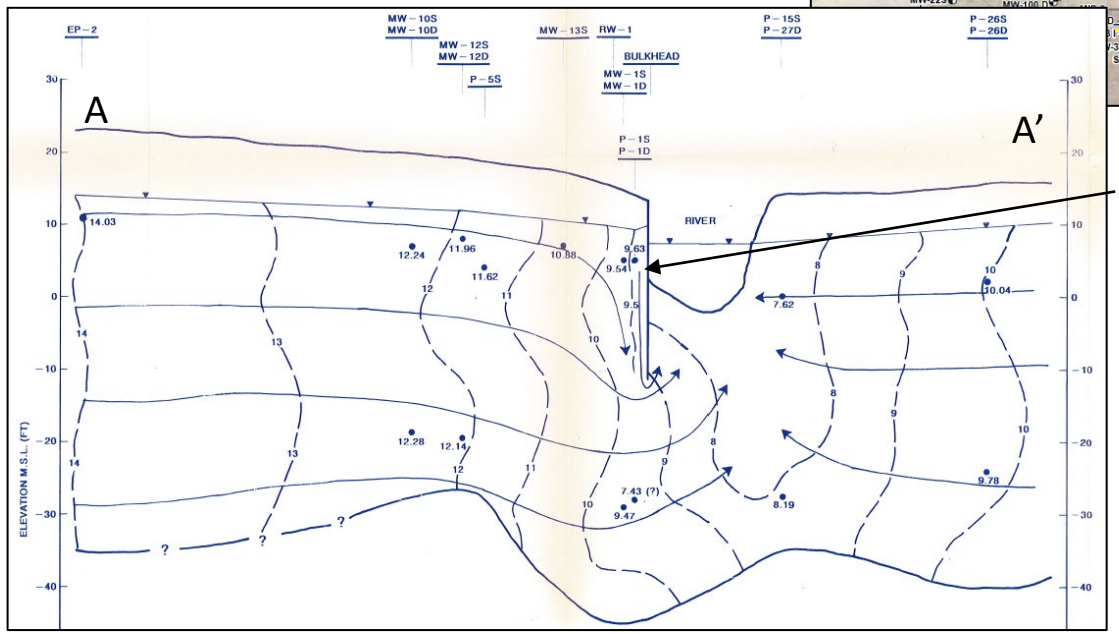
Buklhead as-built



Hydrogeology

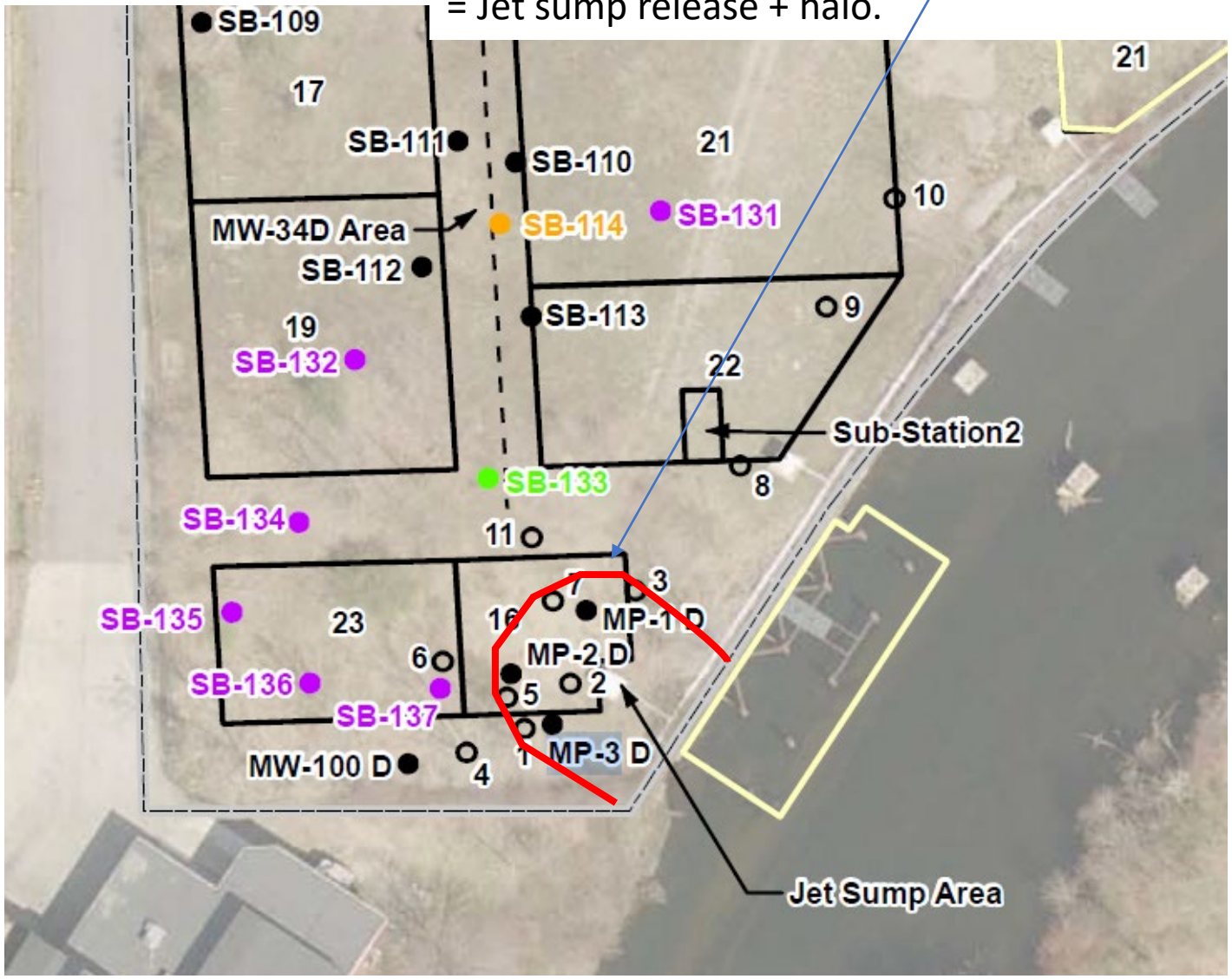
- Unconsolidated fine grain granular glacial and alluvial sediments.
- Groundwater flows from upland to a gaining river (hydraulic divide).
- Sheet-pile bulkhead alters groundwater flow path.

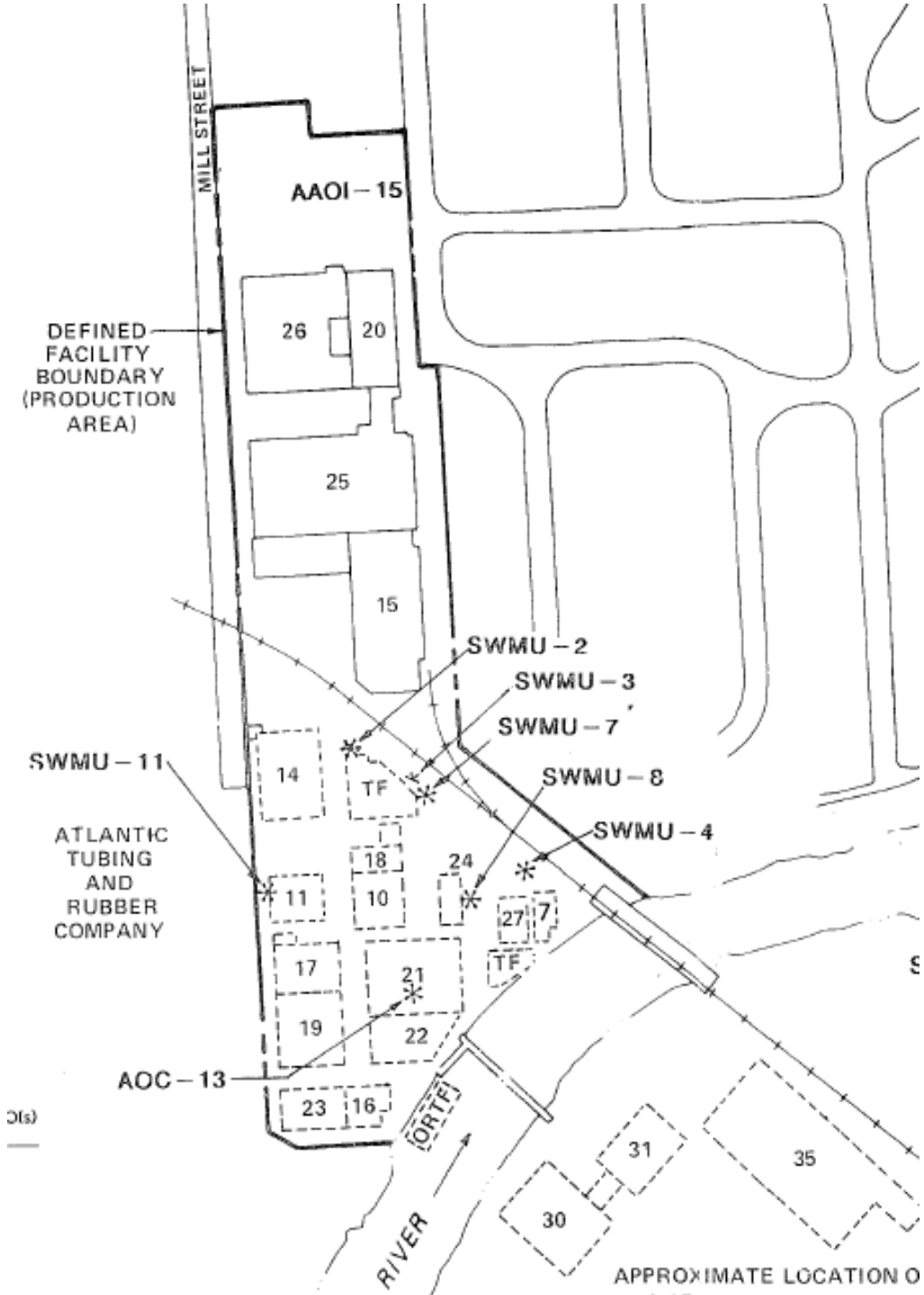




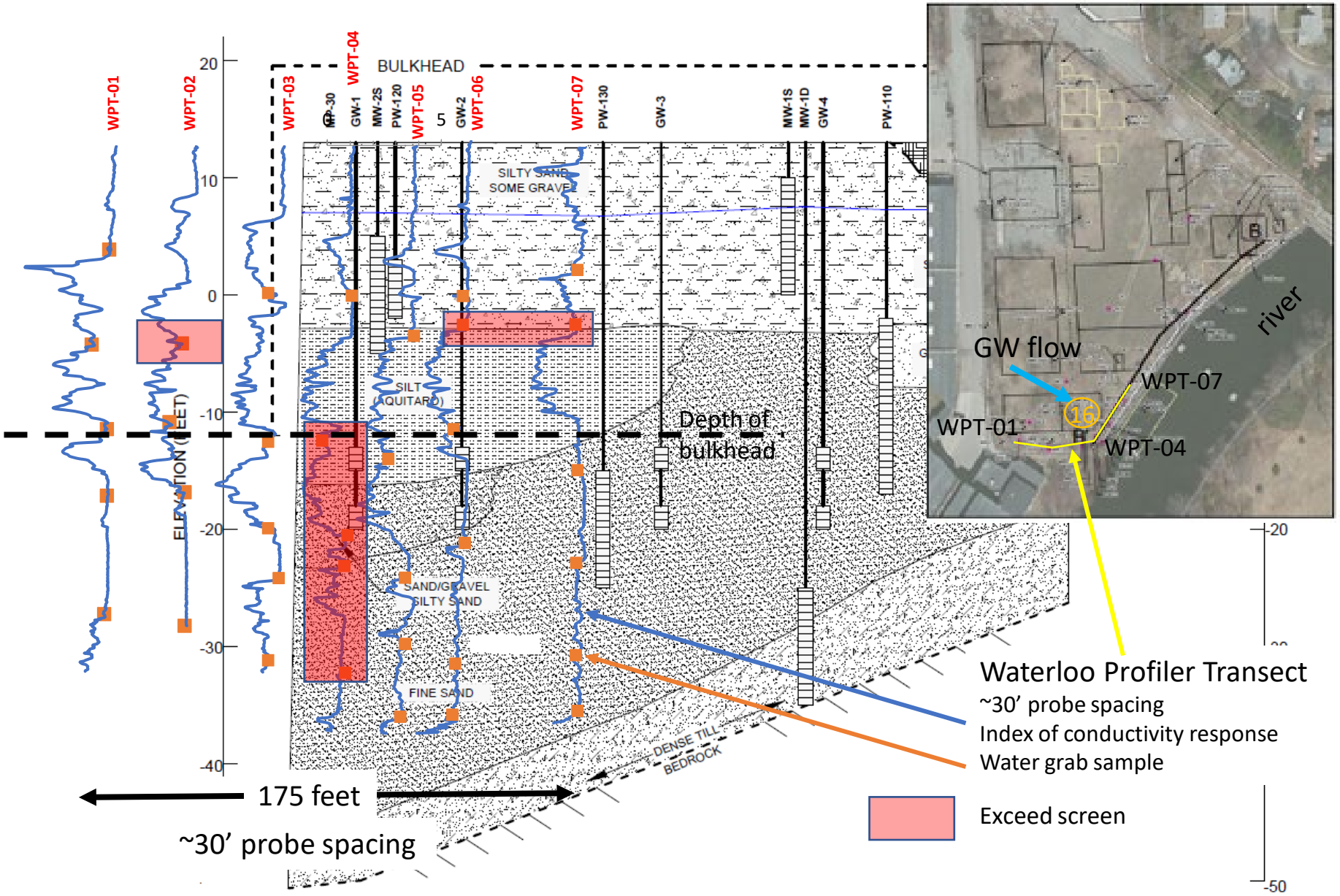
Sheet-pile bulkhead to 25' BGS

Area of impact implied by RI soil and GW data = Jet sump release + halo.





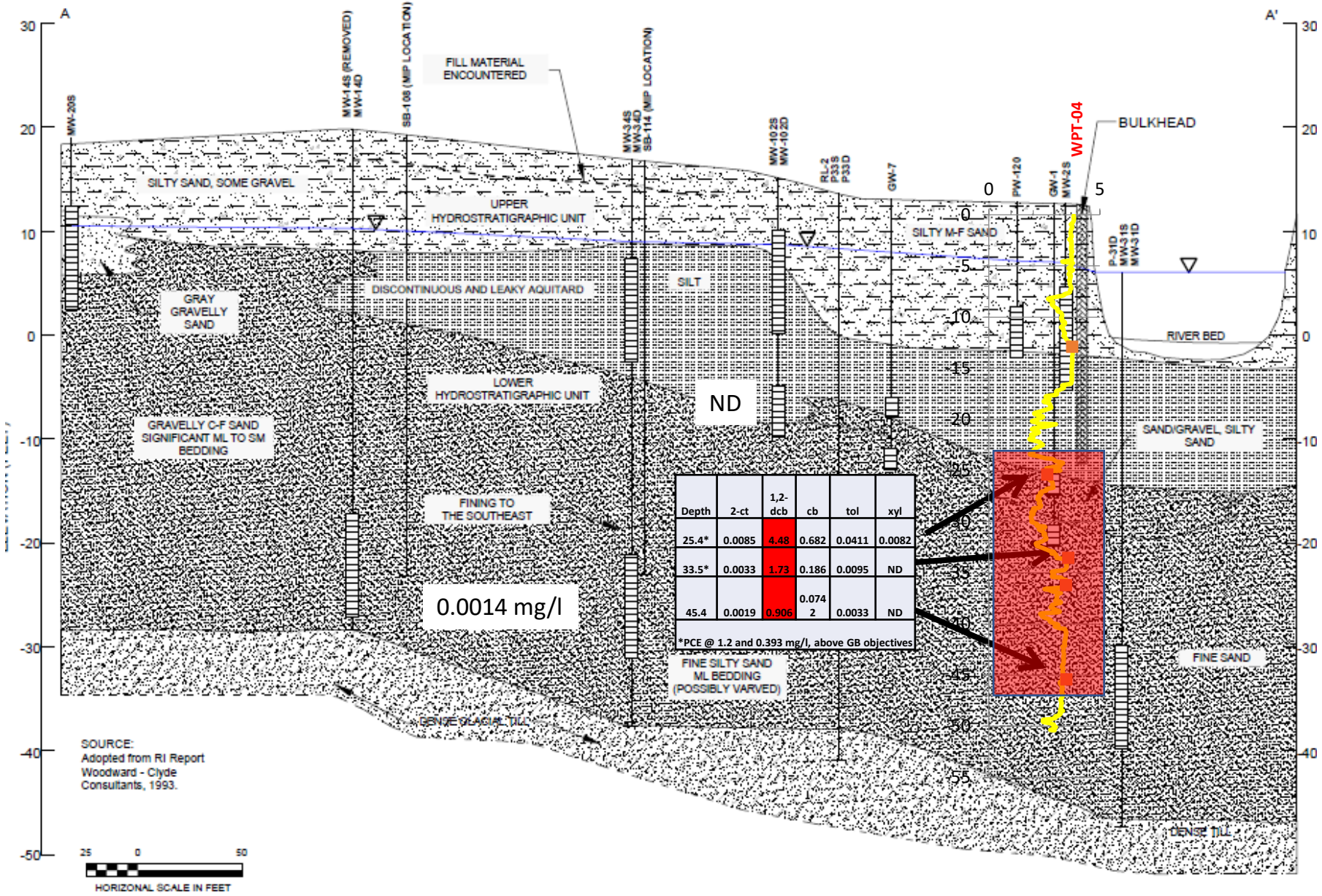
HRSC via Waterloo Profiler



AECOM

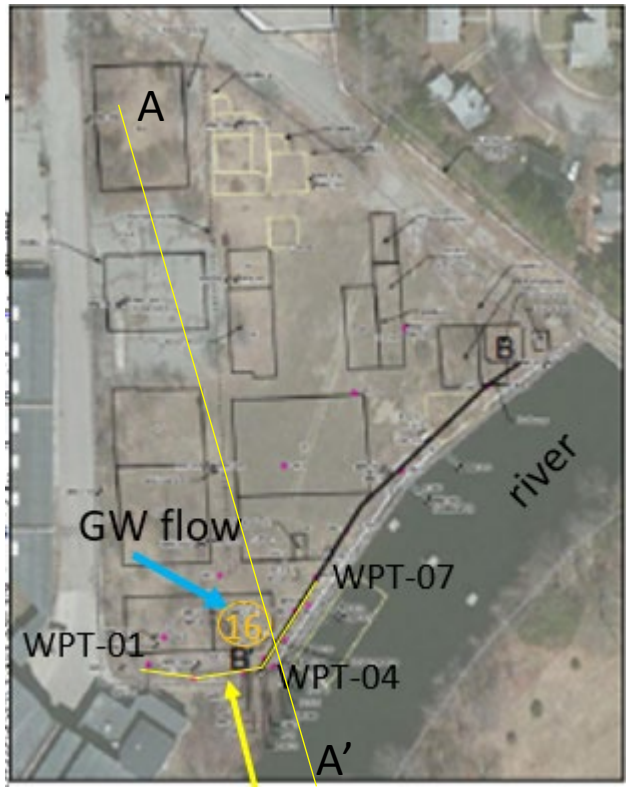
Figure 5: Waterloo Profiling Preliminary Results – Preliminary Transect A-A' – 1,2-Dichlorobenzene

BASF Mill Street Site

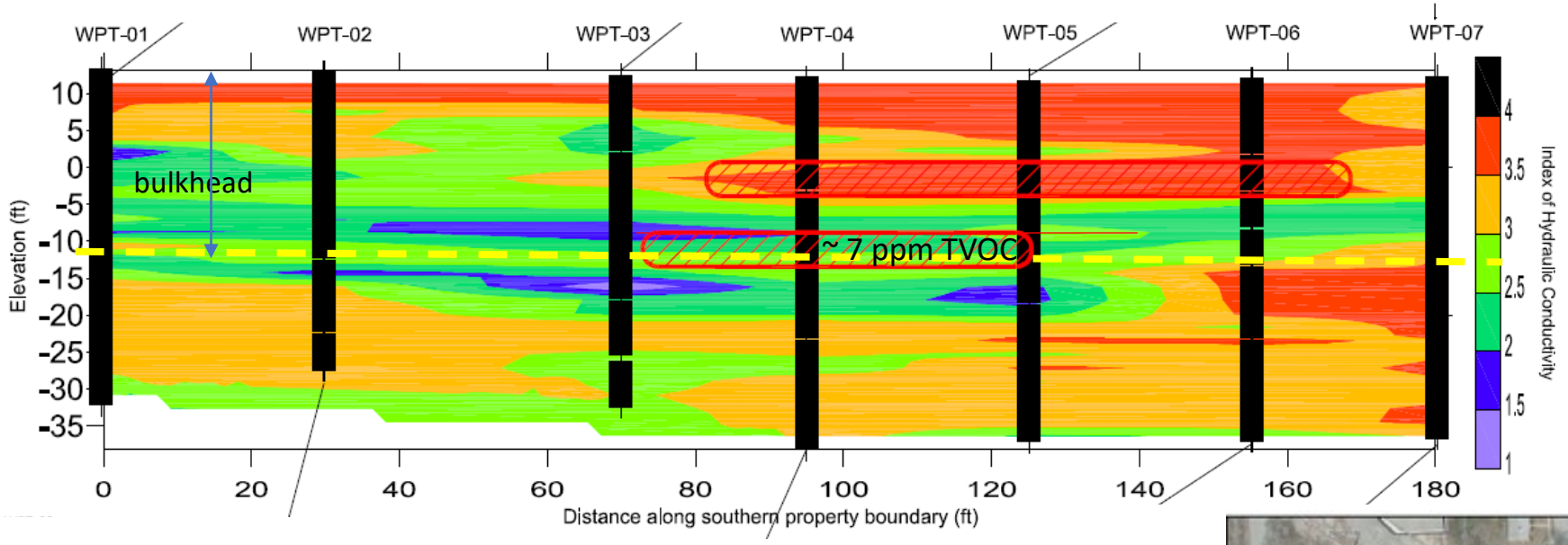


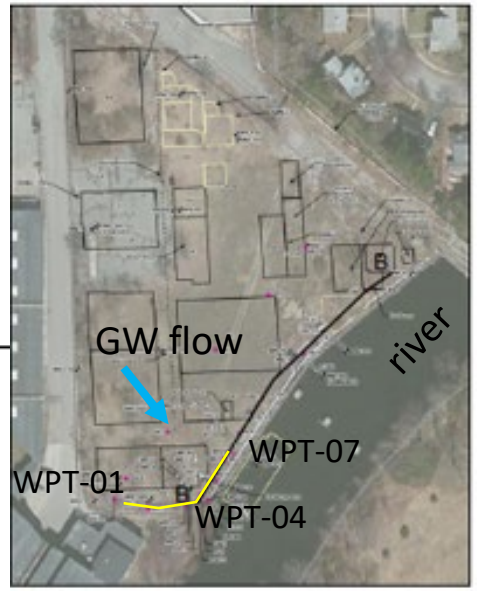
Depth	2-ct	1,2-dcb	cb	tol	xyl
25.4*	0.0085	4.48	0.682	0.0411	0.0082
33.5*	0.0033	1.73	0.186	0.0095	ND
45.4	0.0019	0.906	0.0742	0.0033	ND

*PCE @ 1.2 and 0.393 mg/l, above GB objectives

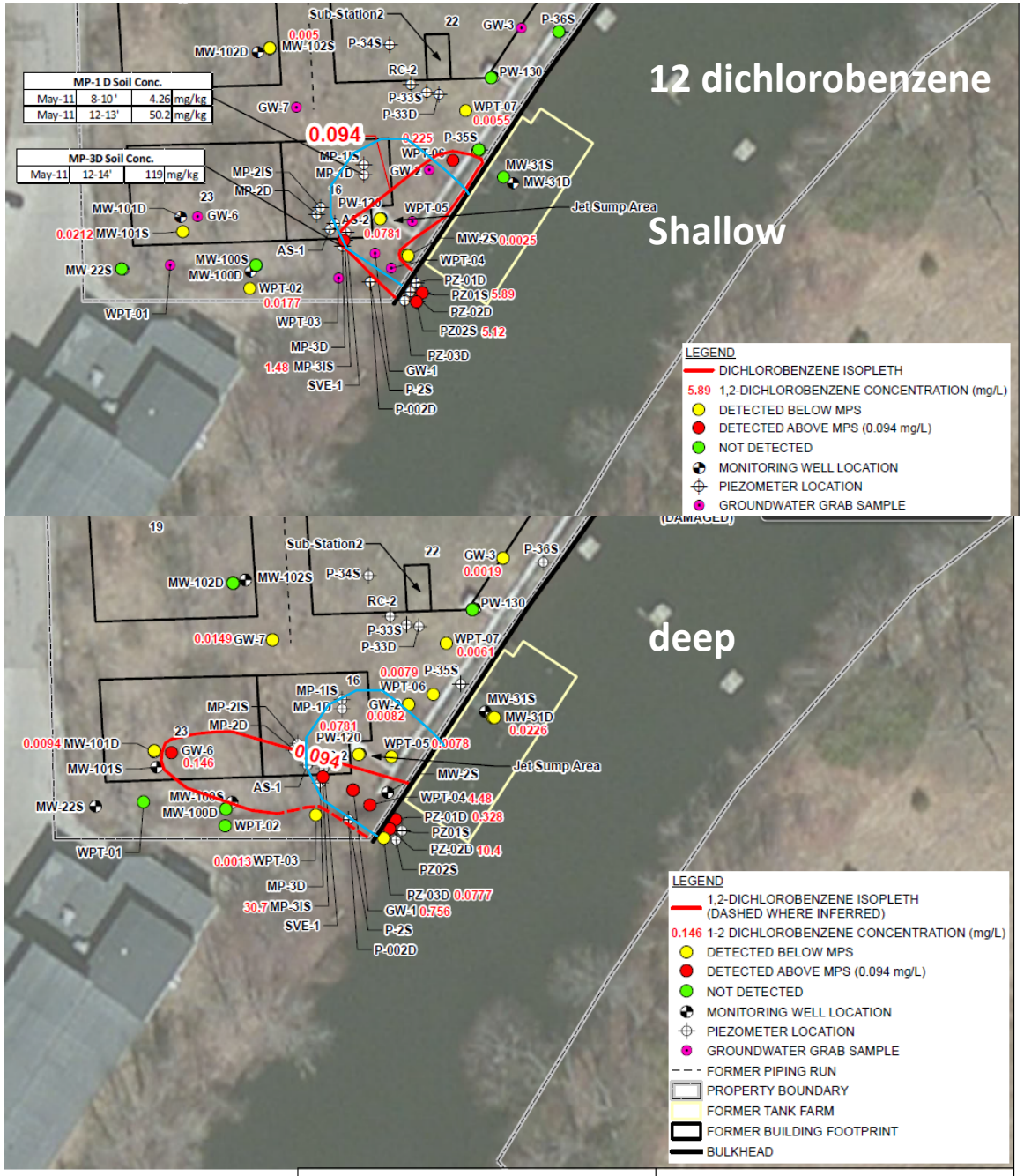


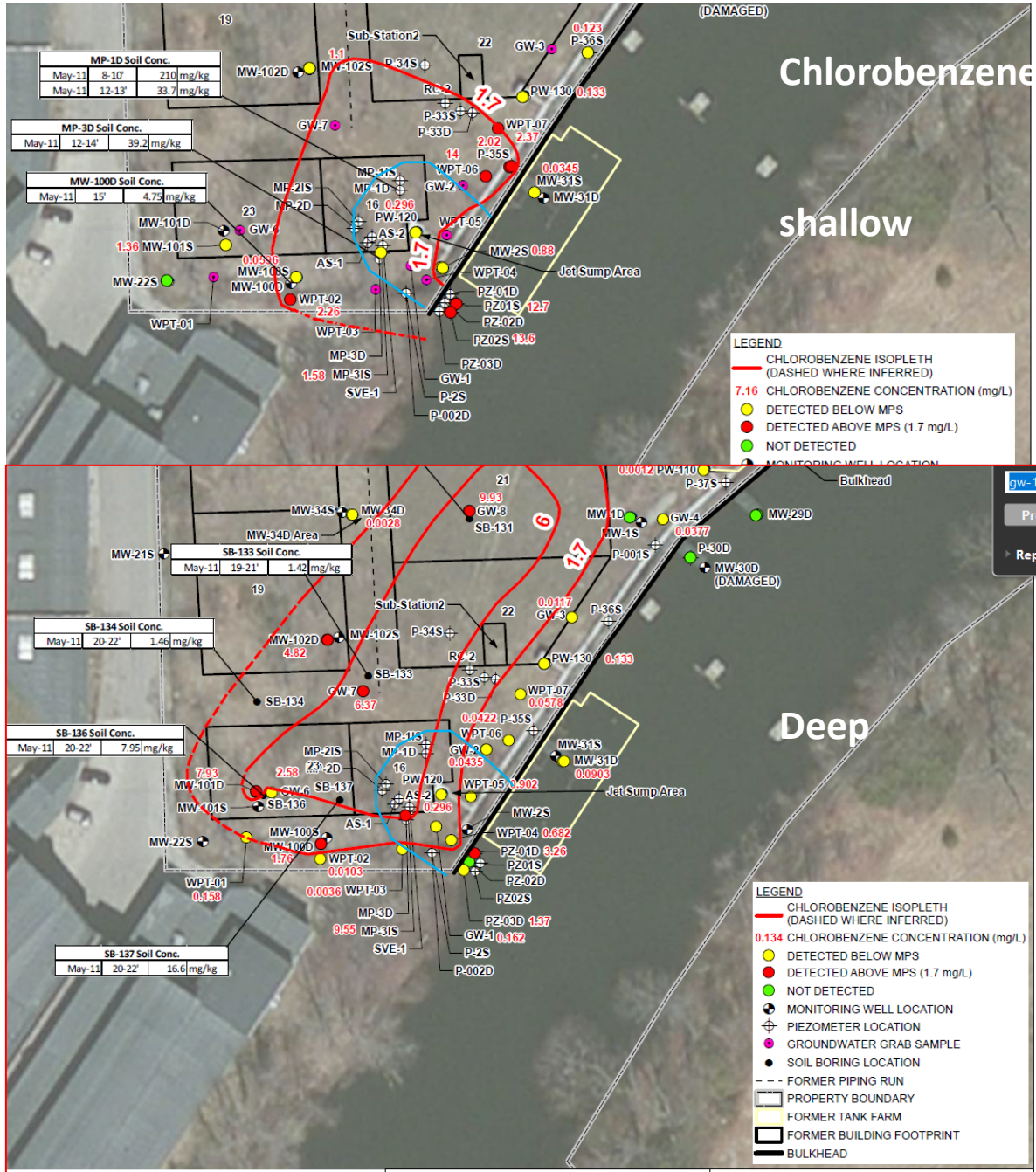
Waterloo Profile Index of Conductivity (red = high, blue = low)
Interpreted high mass flux zones shown (2XMPS).





From SRI





12/6/2021

FORMER CIBA-GEIGY
CRANSTON, RI
60297249.1200

DEEP MONITORING WELLS (>20 FT BGS)
1,2-DICHLOROBENZENE
SUPPLEMENTAL RI

DATE: 05/20/2014 DRWN: J.E.B. FIGURE 4-2

AECOM

FORMER CIBA-GEIGY
CRANSTON, RI
60297249.1200

DEEP MONITORING WELLS (>20 FT BGS)
CHLOROBENZENE
SUPPLEMENTAL RI

DATE: 08/01/2014 DRWN: J.E.B. FIGURE 4-1

2017 Sample groundwater for PCBs.

2017 Groundwater Sampling

Samples were collected from twelve existing groundwater monitoring wells (MW-12S, MW-2S, MW-302D, MW-31D, MW-31S, MP-3I, MP-3S, MW-102D, MW-102S, MW-302S, MW-34D, and MW-34S) for analysis of PCB Aroclors. Five of the 12 wells were also sampled for PCB congeners. Three of these wells (MW-2S, MP-3S, and MP-3I) were selected due to their location near TP-5 where high concentrations of PCBs were detected in shallow soil.

PCB Aroclors were detected in only 1 of the 12 monitoring wells sampled at a concentration greater than the EPA MCL of 0.5 µg/L. The sole exception was well MP-3S, which exhibited 9 µg/L. However, a deeper well in this same location (MP-3I) had only 0.33 µg/L.

MEMORANDUM

TO: Frank Battaglia, Kim Tisa, Kelly Owens.

FROM: BASF

SUBJECT: Cranston RCRA Closure Project: Former Production Area Remediation

DATE: July 13, 2017

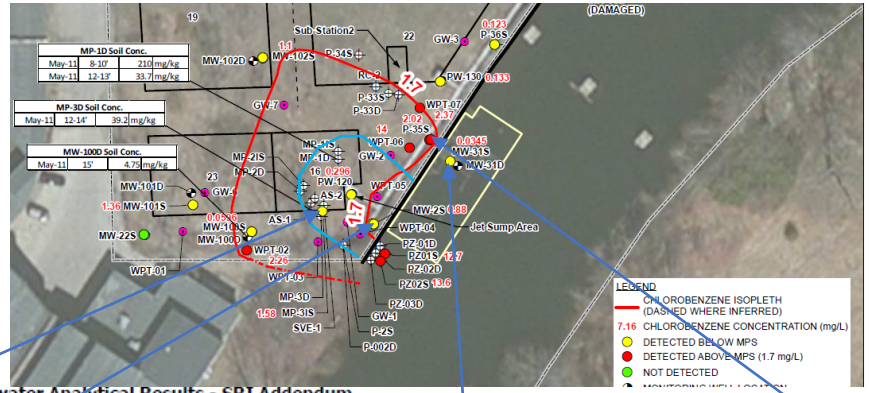


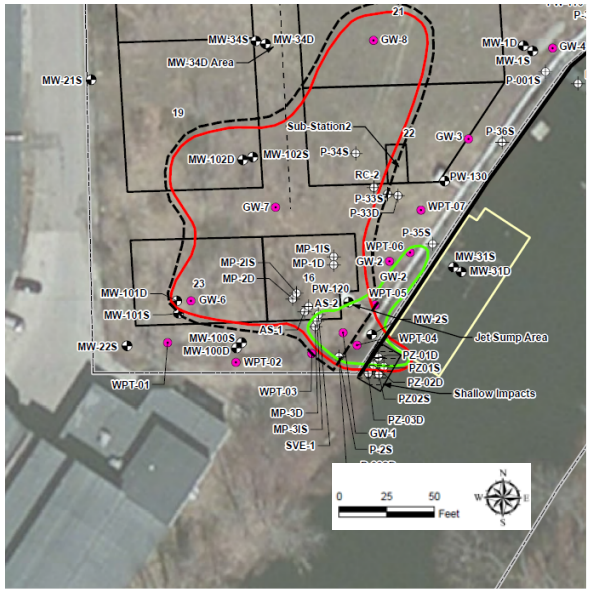
Table 6 - Summary of Groundwater Analytical Results - SRI Addendum
BASF
180 Mill Street
Cranston, RI

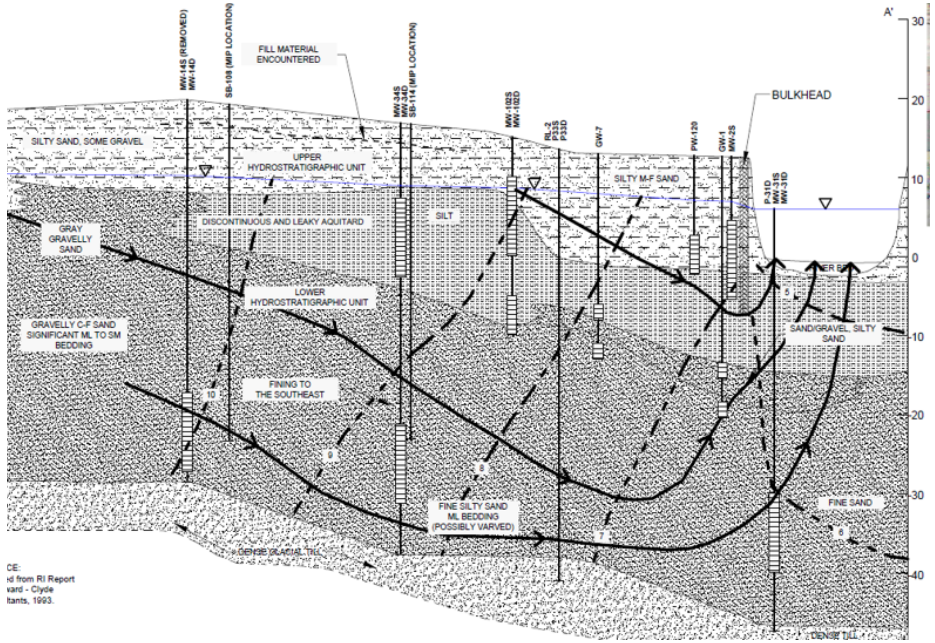
		Sample Designation	MP-3I	MP-3S	MW-002S	MW-021S	MW-029D	MW-031D	MW-031S	MW-034D	MW-102D	P-030D	P-035S
		Date Collected	7/24/2013	7/26/2013	7/26/2013	7/26/2013	7/26/2013	7/25/2013	7/25/2013	7/24/2013	7/24/2013	7/26/2013	7/25/2013
		Sample Code	N	N	FD	N	N	N	N	N	N	N	N
		Sample Depth	18 - 22 ft	5 - 13 ft	8 - 18 ft	6 - 16 ft	34 - 44 ft	36 - 46 ft	NA	38 - 48 ft	20 - 25 ft	35 - 38 ft	10 - 15 ft
Parameter	**EPA Maximum Contaminant Level (MCL)**	**Units**											
AROCLOR-1016	N/A	mg/l	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U
AROCLOR-1221	N/A	mg/l	**0.00904 D**	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	0.00019	< 0.00009 U	< 0.00009 U	< 0.00009 U
AROCLOR-1232	N/A	mg/l	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U
AROCLOR-1242	N/A	mg/l	< 0.00009 U	**0.0141 D**	0.00046	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U
AROCLOR-1248	N/A	mg/l	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U
AROCLOR-1254	N/A	mg/l	< 0.00009 U	< 0.00009 U	< 0.00009 U	0.00027	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U
AROCLOR-1260	N/A	mg/l	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U
AROCLOR-1262	N/A	mg/l	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U
AROCLOR-1268	N/A	mg/l	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U	< 0.00009 U
Total PCBs	0.0005	mg/l	**0.00904 D**	**0.0141 D**	0.00046	0.00027	< 0.00009 U	< 0.00009 U	< 0.00009 U	0.00019	< 0.00009 U	< 0.00009 U	< 0.00009 U

Notes:
U = not detected above detection limits
D = Dilution
Numbers in **Bold** exceed the MCL
< indicates not detected above detection limits

Process-based CSM:

- <u>Source:</u> failed jet sump
- <u>Groundwater flow</u>: discharge to river under sheet pile bulkhead.
- <u>Primary contaminants</u> are mono and di-chlorobenzene.

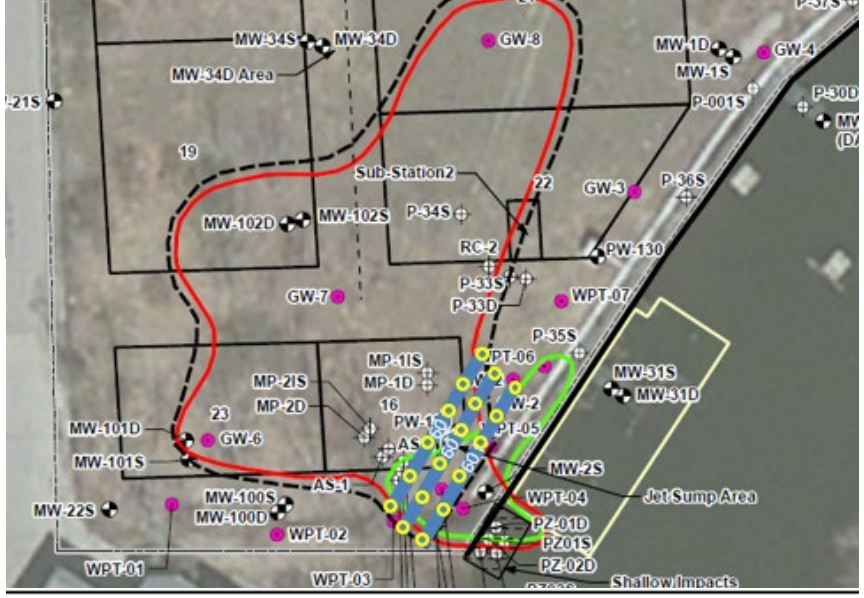


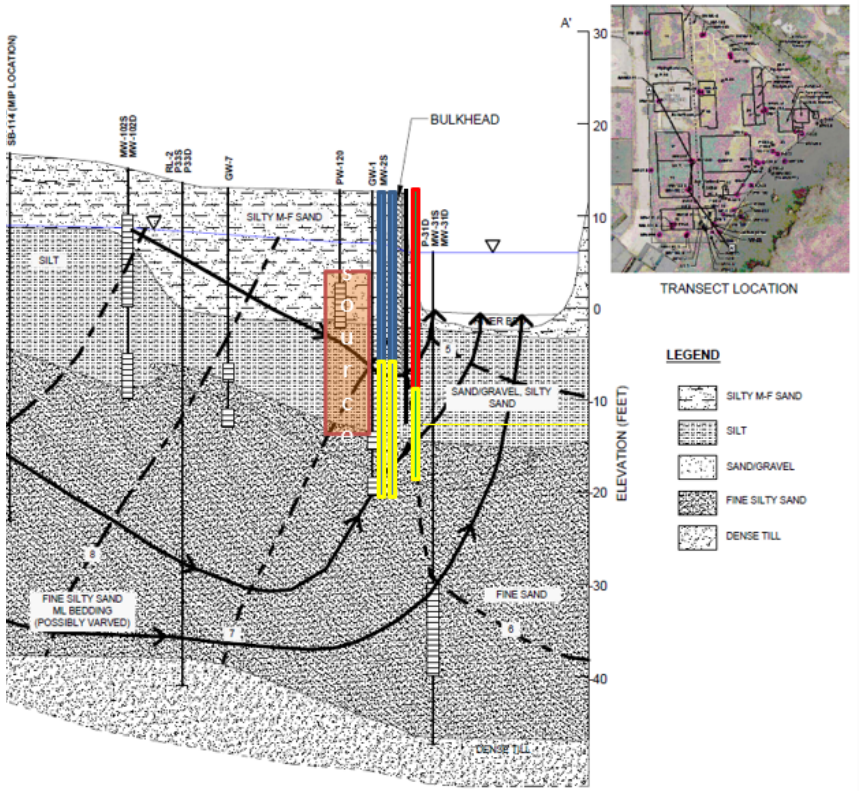


Remedy Concept

- **Purpose**: treat impacted groundwater to meet site-specific discharge standards. Address dissolved phase VOCs and PCBs.
  - Mass flux control technology
- Method: Passive ISCO.
  - **Install an array of wells** screened across the bottom of the bulkhead and fitted with oxidant-loaded socks (activated potassium persulfate)
  - Downward gradients w/ well sand pack will transport the oxidant where it is needed
  - OMM plan
    - Define protocol for sock maintenance
    - Define performance monitoring

- **Site well array using HRSC:**
- Intercept primary flow tubes
- Spacing a function of GW seepage velocity
- Length a function of dissolved phase mobile fraction and magnitude.





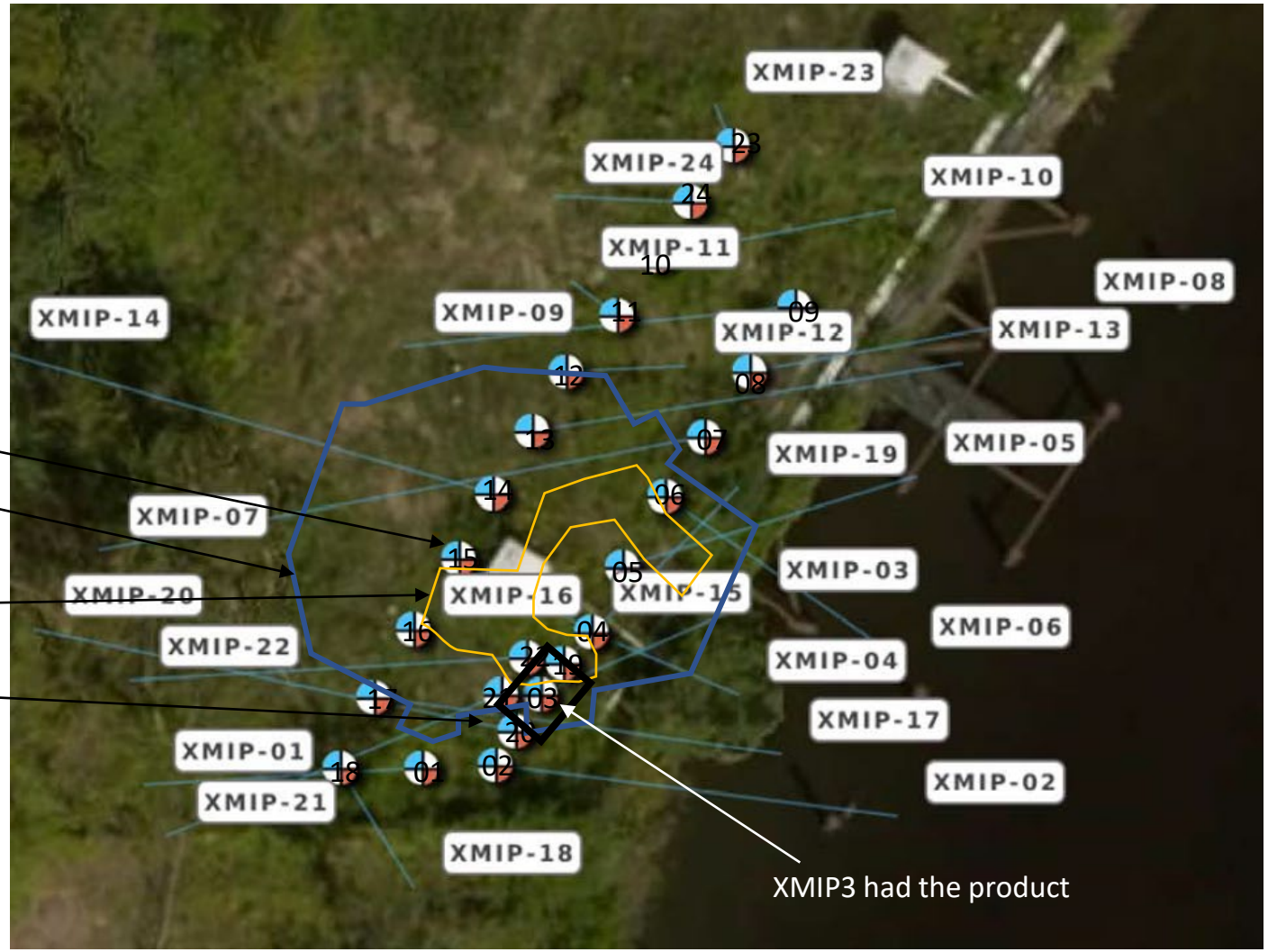
6/2013
1995
2018
MIP/HPT transects (5' to 10' OC
10'
15'
Bulkhead (sheetpile to 25' bgs)
Area of soil impact
below water table
PCB soil excavation
2' to 15' BGS
PRB (5' OC, screened
22 to 32' bgs)
Performance monitoring
Proposed initial PRB infrastructure

Design PRB Well Array

- Method: HRSC using Membrane Interface Probe w/ Hydraulic Profile Tool (MiHpt)

  Operated by COLUMBIA TECHNOLOGIES

  - **Sensors used to detect various classes of VOCs**
    - **Photo Ionization Detector (PID)**
    - **Flame Ionization Detector (FID)**
    - **Halogen Specific Detector (XSD)**
  - **Sensors used to estimate hydrogeology**
    - **Electrical Conductivity (EC)**
    - **Hydraulic Profile Tool (HPT)**
  - **Field application**
    - Direct push installation of MiHpt tool
    - Real-time data compilation and visualization
    - Step-outs as warranted
    - Follow with coring for soil and groundwater grabs to correlate MiHpt data.



MIP location

Soil excavation <8’

Soil excavation <15’

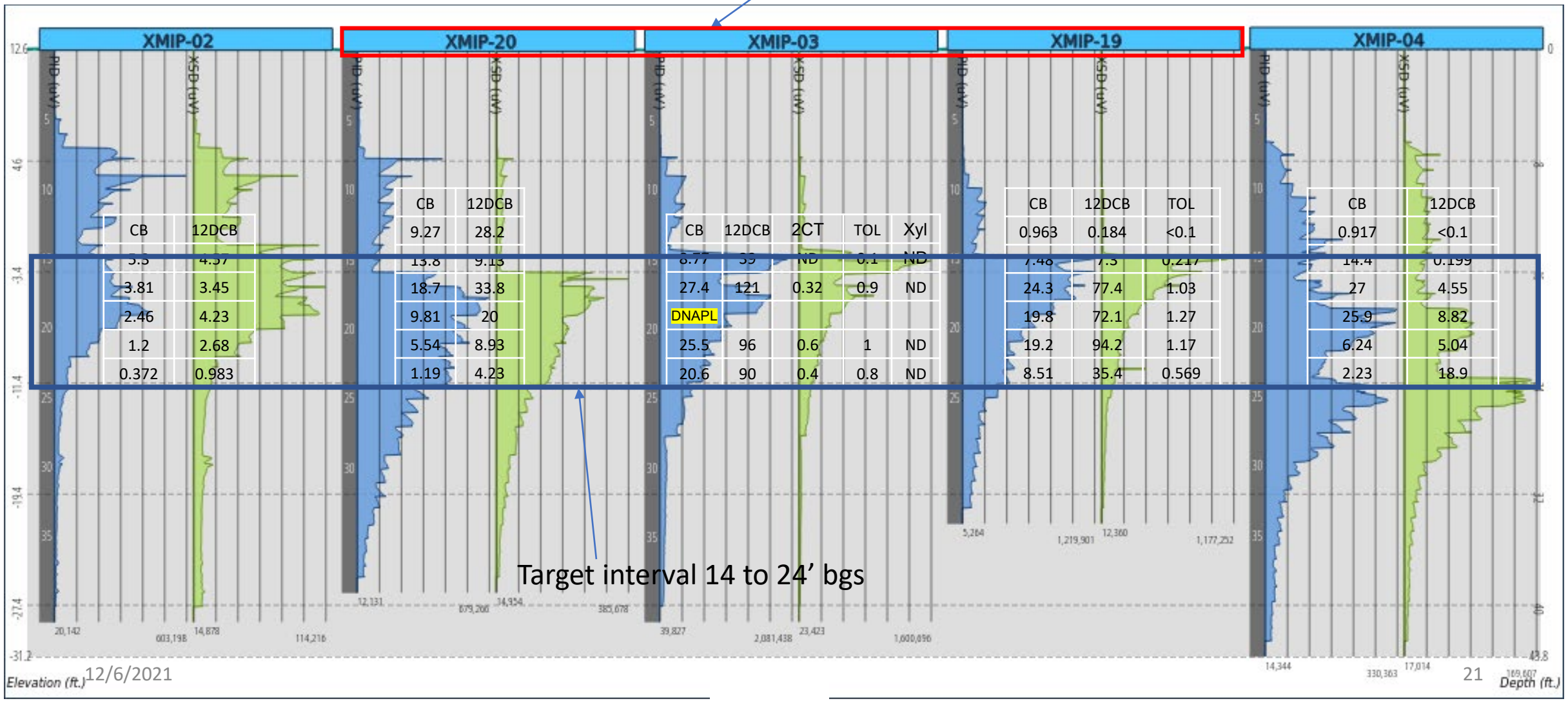
Hot spot

Transect MIP locations 2, 20, 3, 19 and 4

CB, 12DCB, 2CT and TOL, Xyl data [mg/L]

RCRA soil remedy, top 13 – 15’ Excavated

Chemical Mass sampling intervals and locations



XMIP-02 CB	XMIP-02 12DCB
3.3	4.57
3.81	3.45
2.46	4.23
1.2	2.68
0.372	0.983

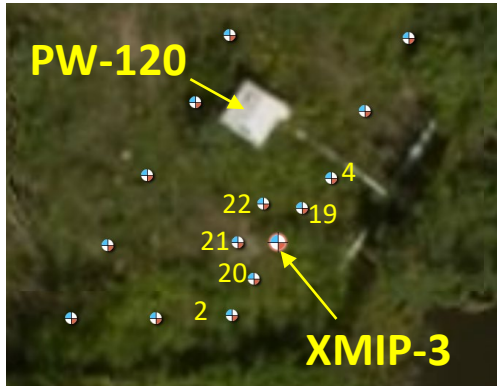
XMIP-20 CB	XMIP-20 12DCB
9.27	28.2
13.8	9.13
18.7	33.8
9.81	20
5.54	8.93
1.19	4.23

XMIP-03 CB	XMIP-03 12DCB	XMIP-03 2CT	XMIP-03 TOL	XMIP-03 Xyl
8.77	33	ND	0.1	ND
27.4	121	0.32	0.9	ND
DNAPL				
25.5	96	0.6	1	ND
20.6	90	0.4	0.8	ND

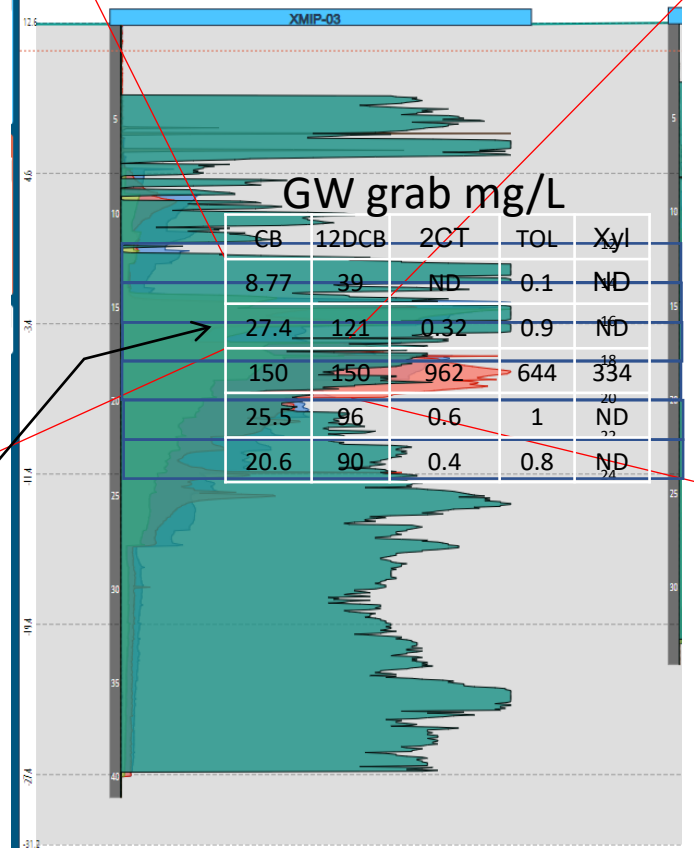
XMIP-19 CB	XMIP-19 12DCB	XMIP-19 TOL
0.963	0.184	<0.1
7.48	7.3	0.217
24.3	77.4	1.03
19.8	72.1	1.27
19.2	94.2	1.17
8.51	35.4	0.569

XMIP-04 CB	XMIP-04 12DCB
0.917	<0.1
14.4	0.199
27	4.55
25.9	8.82
6.24	5.04
2.23	18.9

XMIP-3 Core – NAPL encountered @ base of granular unit 18 – 20’ bgs



Granular unit uniformly stained black (high carbon content)



GW grab mg/L

CB	12DCB	2CT	TOL	Xyl
8.77	39	ND	0.1	ND
27.4	121	0.32	0.9	ND
150	150	962	644	334
25.5	96	0.6	1	ND
20.6	90	0.4	0.8	ND

Soil sample [mg/kg]

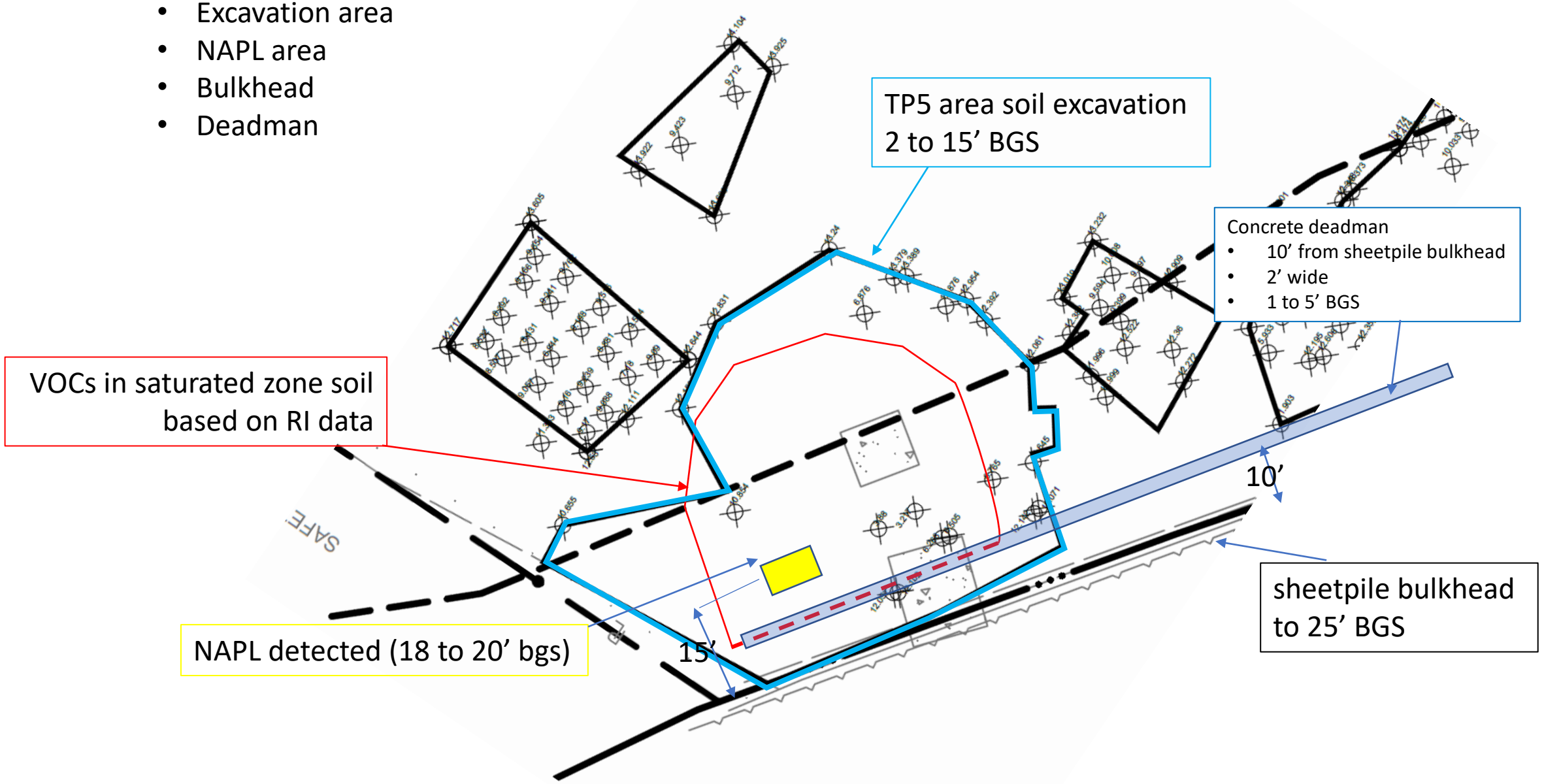
Compound	XMIP-3 (15-18 feet bgs)
1,2-Dichlorobenzene	3,200
2-Chlorotoluene	16
Chlorobenzene	130
Total Xylene	4.5 U
Toluene	3
PCB total	980

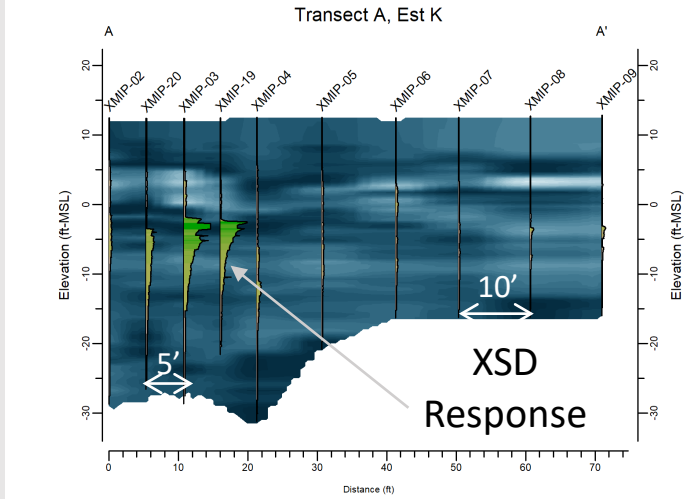
interface

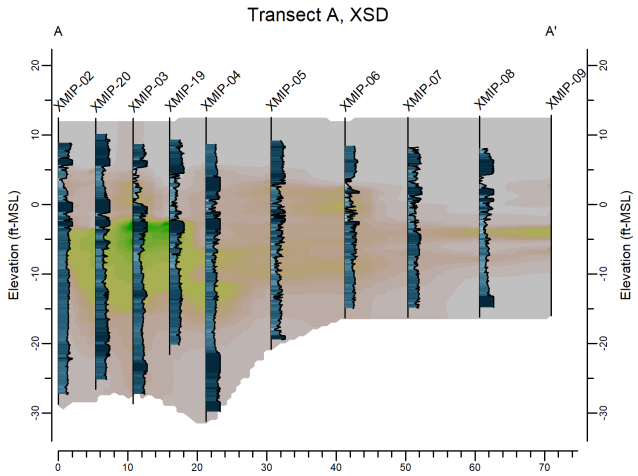
Internal

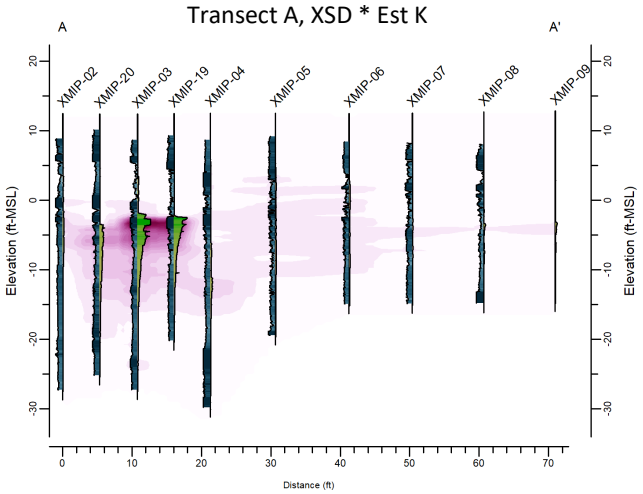
Site attributes:

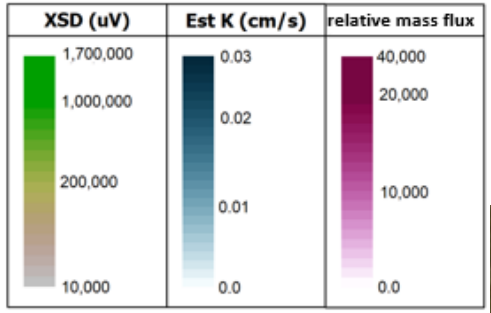
- Excavation area
- NAPL area
- Bulkhead
- Deadman

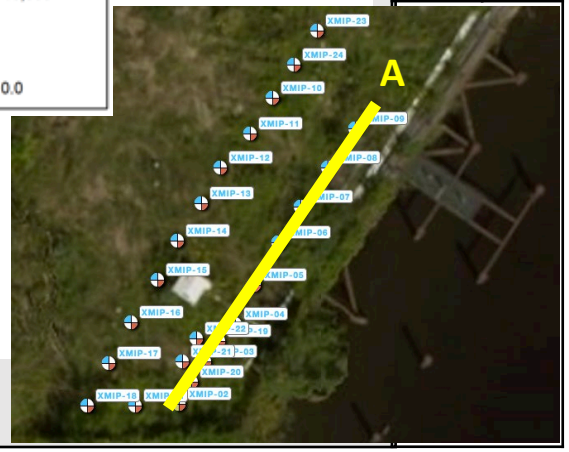










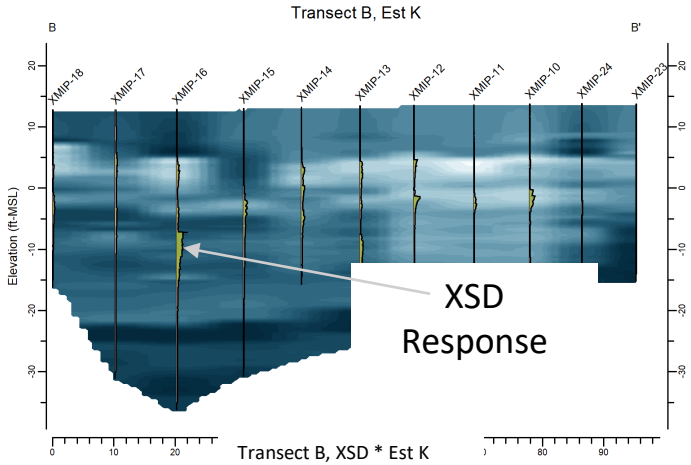


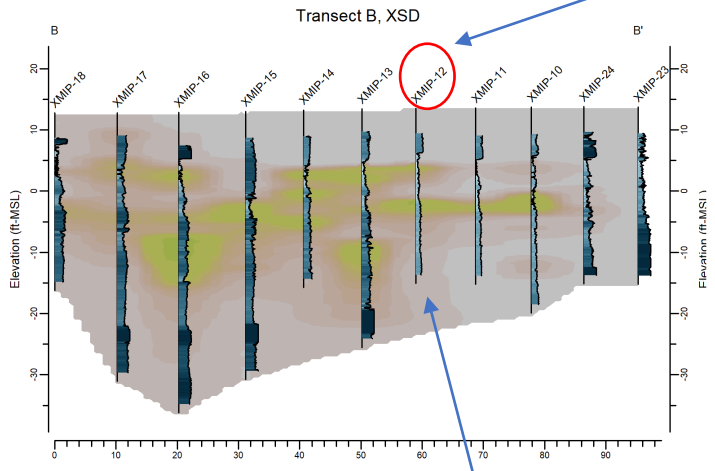
Transect A MiHpt Profile - XSD

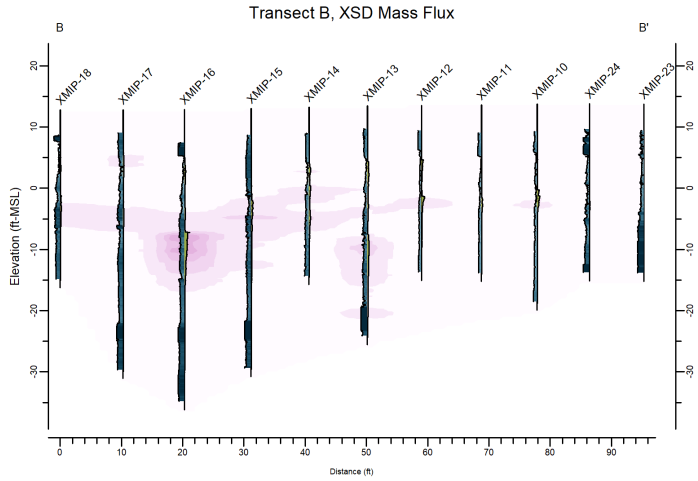
Figure 5

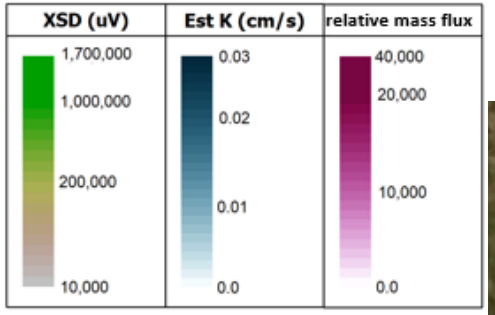
COLUMBIA TECHNOLOGIES

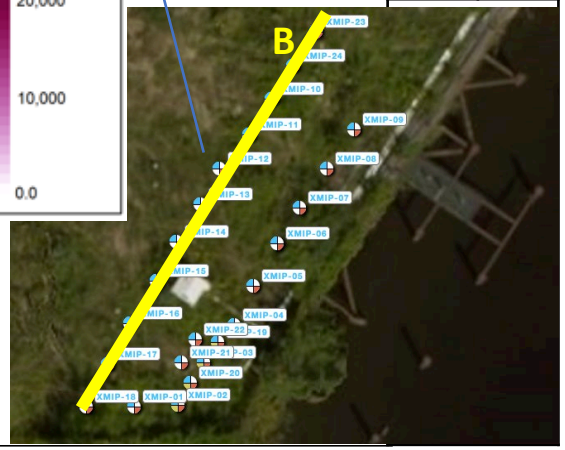
This is a representation of XSD Response * Est K











Transect B MiHpt Profile - XSD

Figure 6

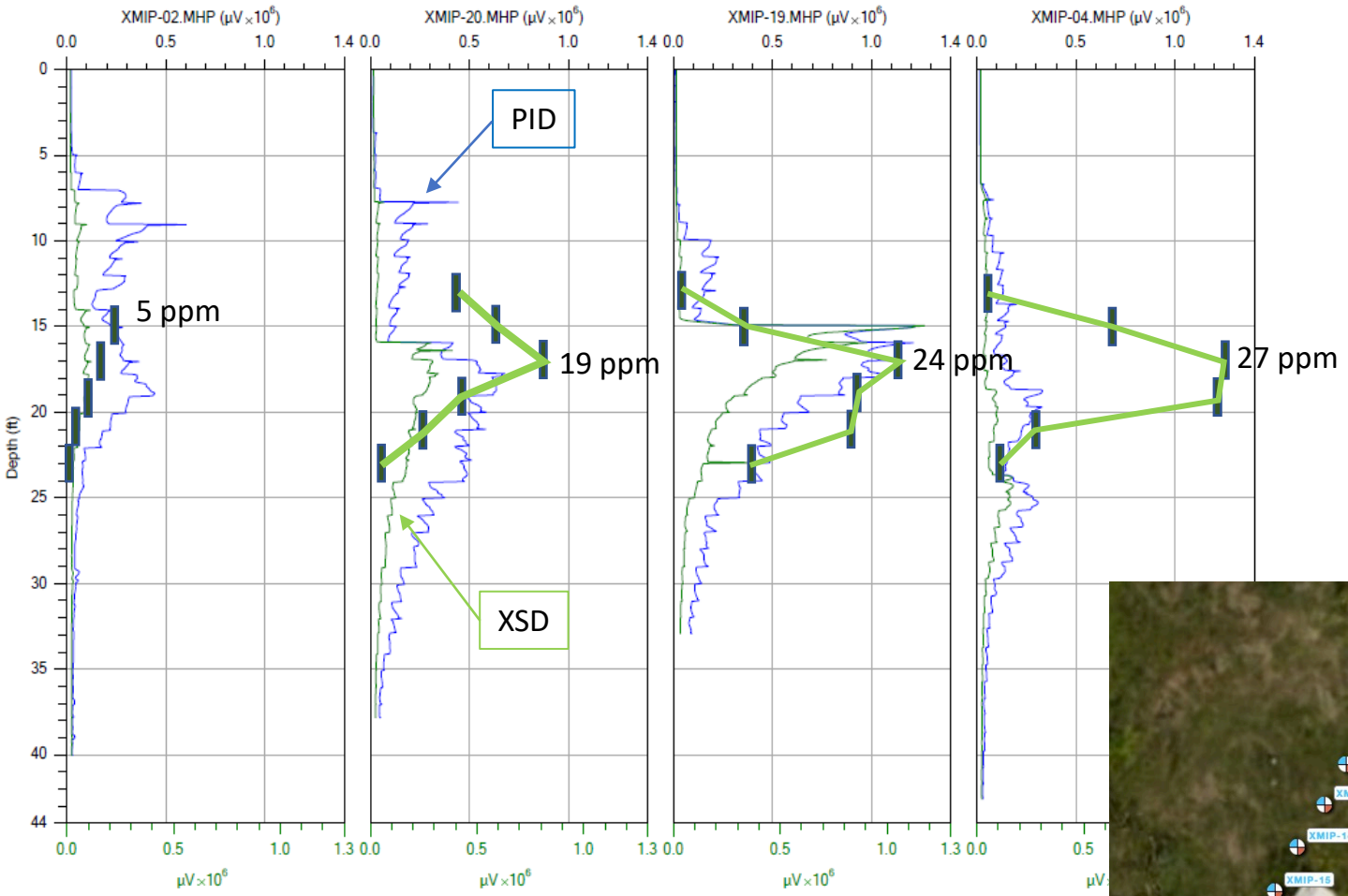
COLUMBIA TECHNOLOGIES

Soil sample [mg/kg]

Compound	XMIP-12 (9 to 12 feet bgs)
1,2-Dichlorobenzene	11
2-Chlorotoluene	0.13
Chlorobenzene	91
Total Xylene	0.85
Toluene	0.44
PCB total	2.3

PID and XSD response to **chlorobenzene**

Relative to 2’ grab samples



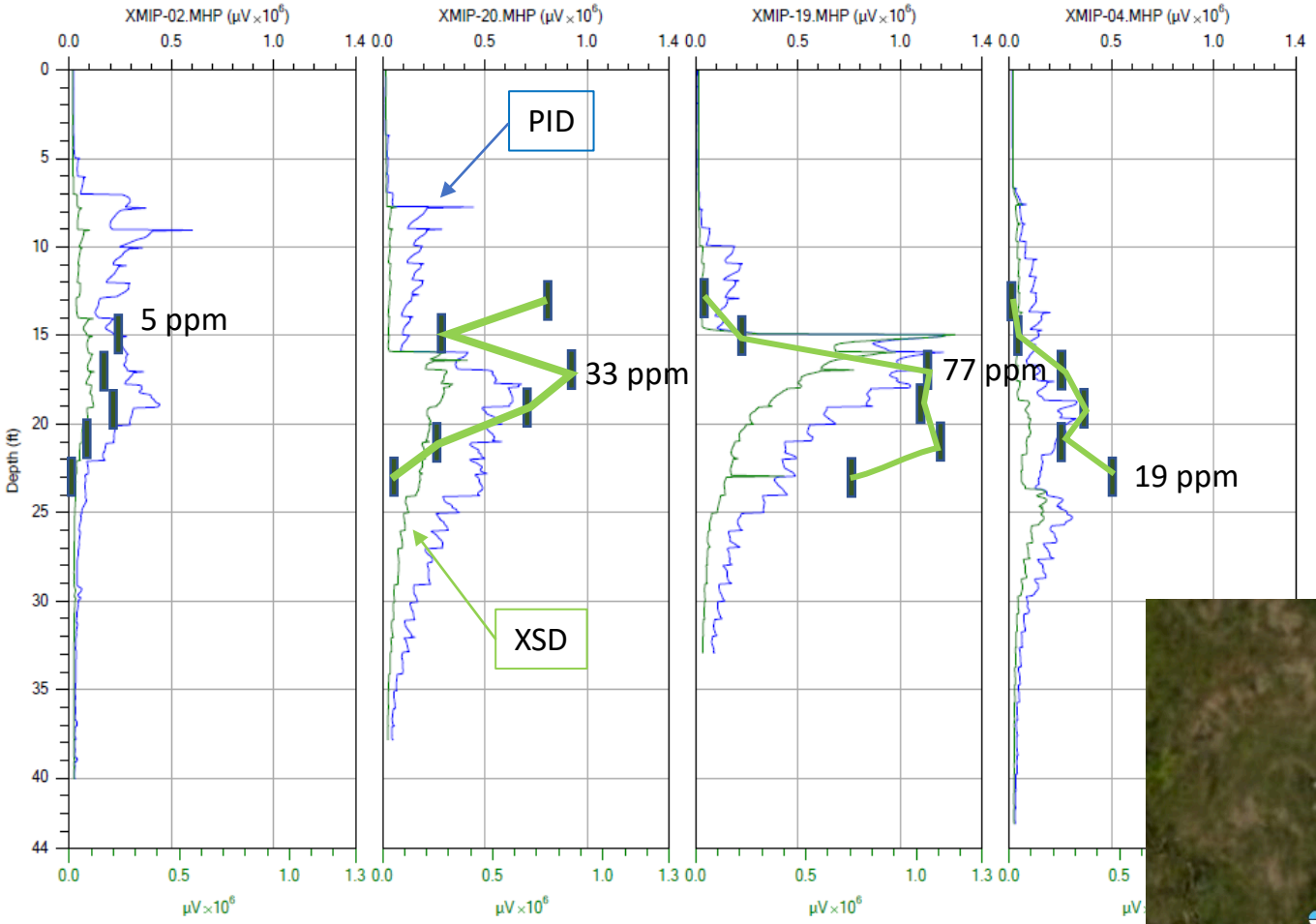
COLUMBIA TECHNOLOGIES

PID Max / XSD Max

Company: Columbia Technologies	Operator: Scott
Project ID: BASF	Client: CEC

PID and XSD response to **1,2-dichlorobenzene**

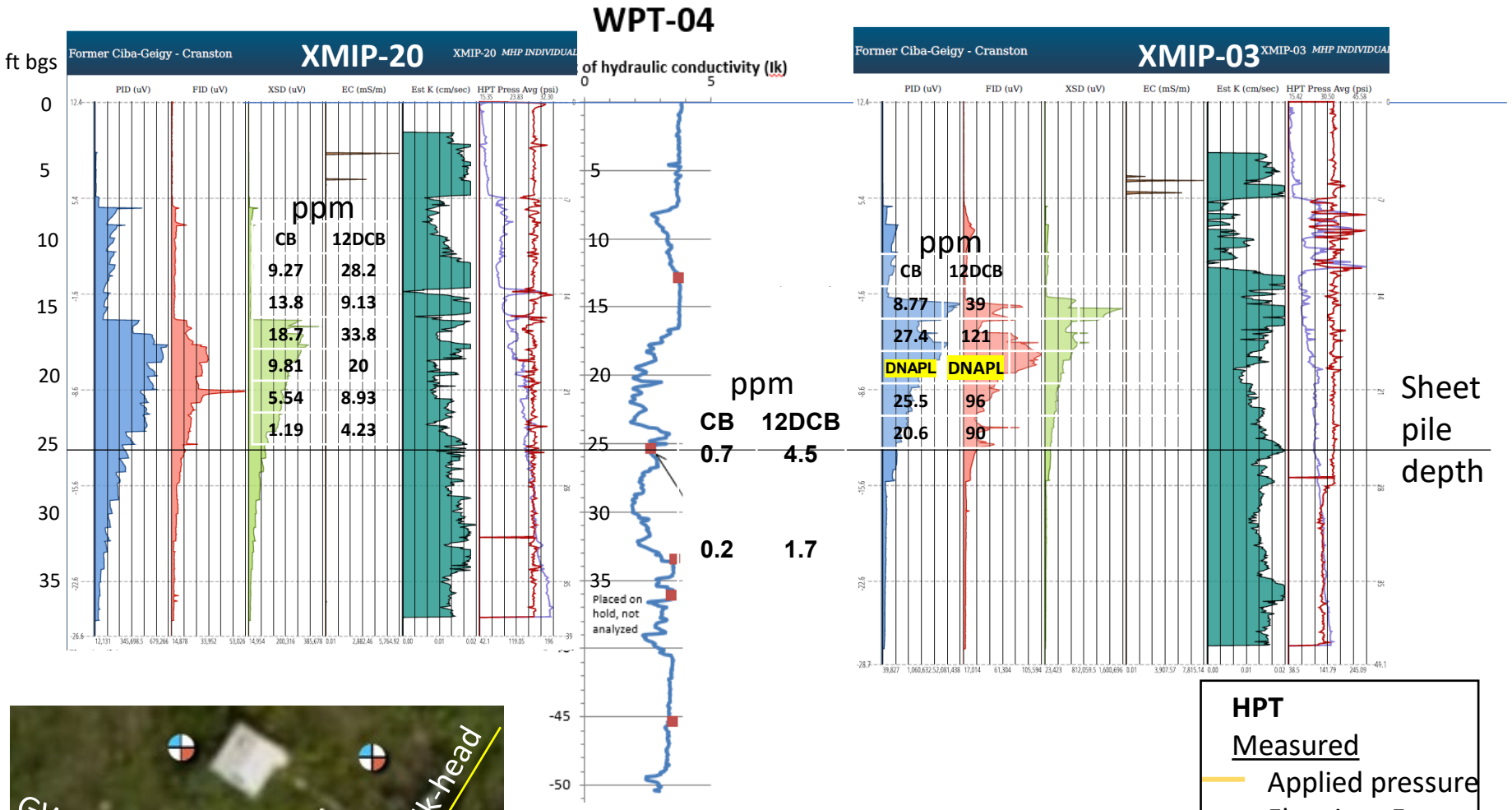
Relative to 2' grab samples

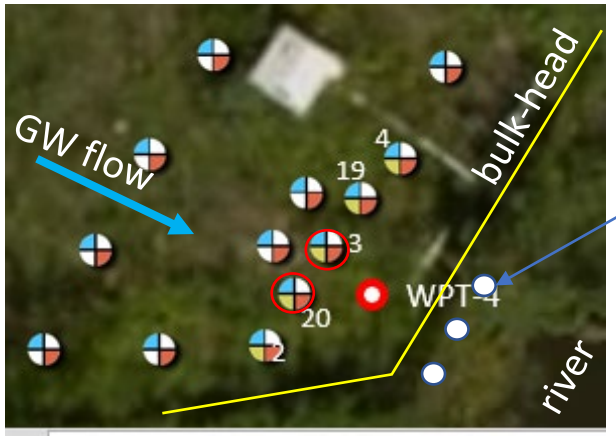


COLUMBIA TECHNOLOGIES

PID Max / XSD Max

Company: Columbia Technologies	Operator: Scott
Project ID: BASF	Client: CEC





River piezometers

CB	12DCB	
0.5	4.5	ppm

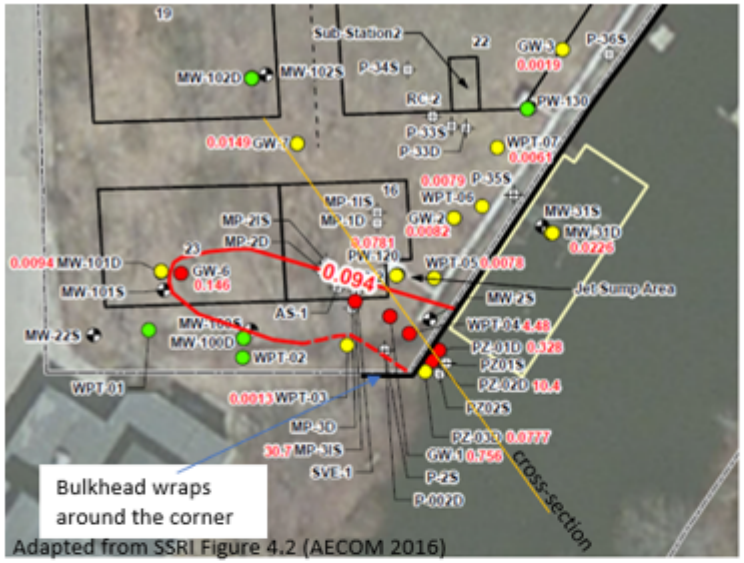
HPT

Measured

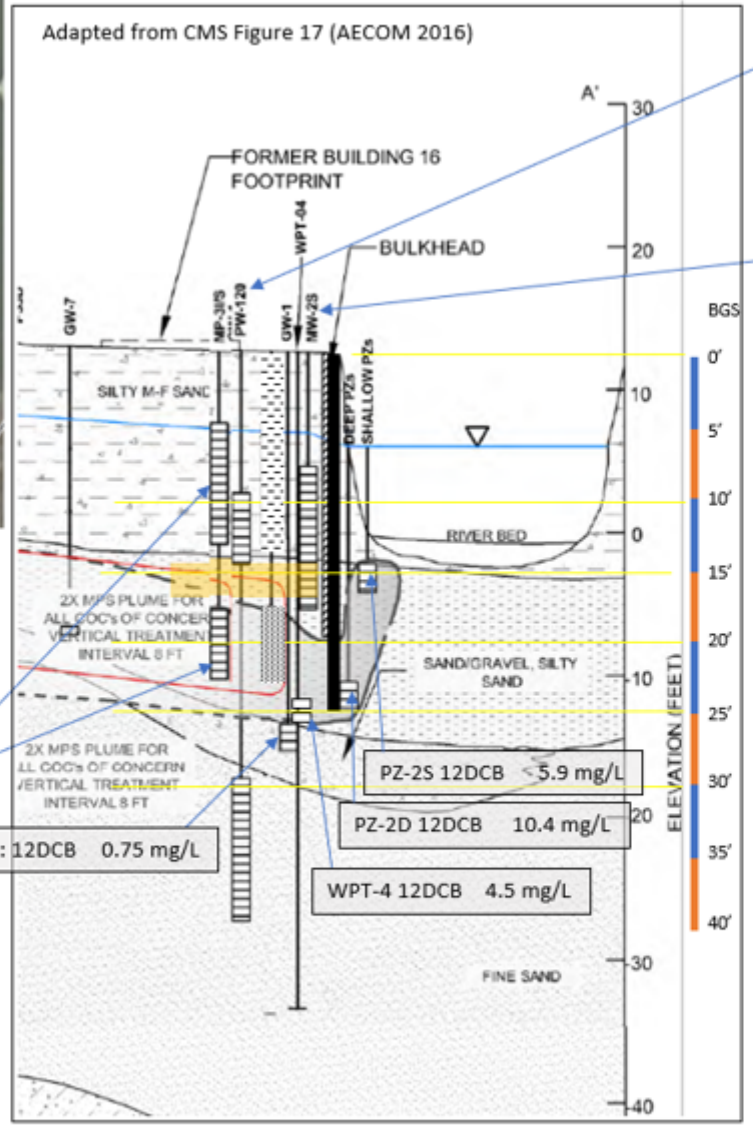
- Applied pressure
- Flow into Fm.

Calculated

- K



Granular layer over silty clay



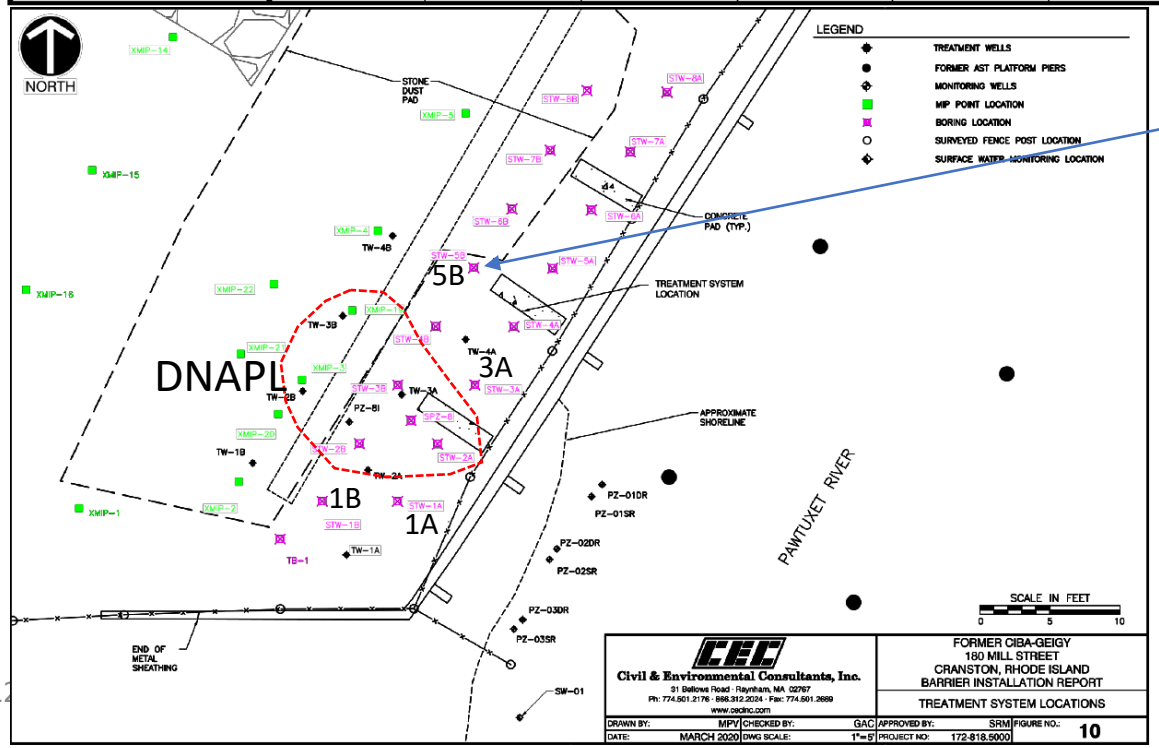
SSRI (AECOM, 2016)

PW-120	6/2012 [ppb]
CB	296
12DCB	78
2CT	5.6
Tol	ND
Xyl	ND

MW-2S	7/2013 [ug/L]
CB	502
12DCB	2.4
2CT	2.6
Tol	16
Xyl	ND
Total PCB	0.46

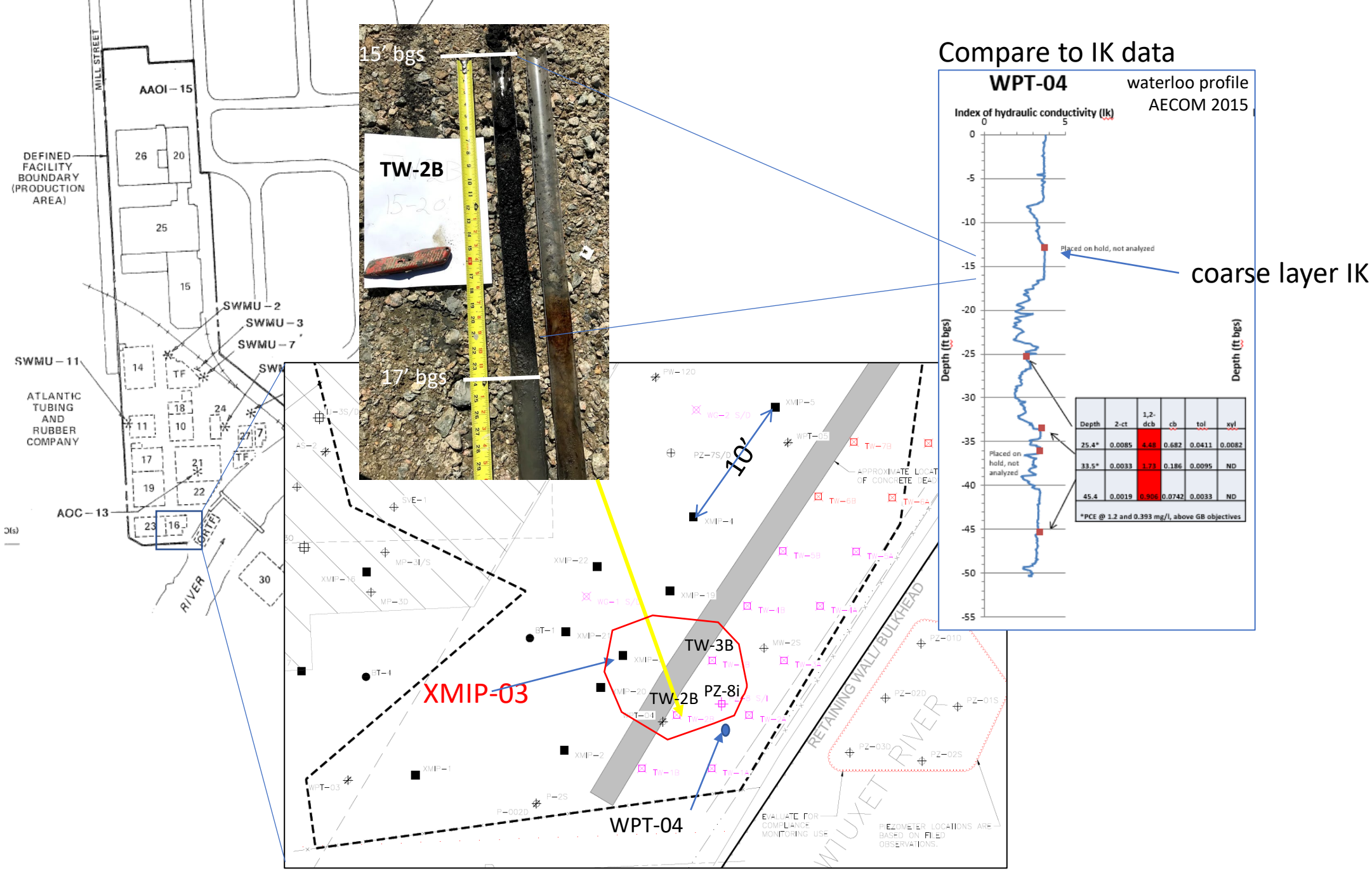
CSM cross-section adapted from CMS Figure 17 (AECOM 2016b). Graphic shows dissolved phase 12DCB migration from the apparent source area (jet sump) towards the river (discharging groundwater). The presence of the bulkhead deflects groundwater vertically to >25' bgs before it discharges to the river hydrological system.

Sample Name	STW-1A	STW-1A	STW-1B	STW-1B	STW-3A	STW-3A	STW-4A	STW-4B	STW-5A	STW-5B	STW-6A	STW-7A	STW-8A
Sample Depth (feet)	15-17	20-25	15-17	20-25	15-17	19-20	16-18	15-17	14-16	14-16	14-16	14-16	14-16
Sample Date	08/30/2019	08/30/2019	08/30/2019	08/30/2019	09/03/2019	09/03/2019	09/03/2019	09/03/2019	09/03/2019	09/03/2019	09/03/2019	09/04/2019	09/04/2019
PID Reading (ppmv):	0.9	0.0	1.4	0.0	6.9	12.1	23.7	14.2	50.3	151	10.4	NT	21.1
Laboratory Sample ID:	19I0275-01	19I0275-02	19I0275-03	19I0275-04	19I0275-05	19I0275-06	19I0275-09	19I0275-11	19I0275-10	19I0275-08	19I0275-07	19I0275-12	19I0275-13
VOCs (mg/kg)													
1,2-Dichlorobenzene	0.0415 J	0.0492 J	0.245	0.0723 J	0.100 J	12.6	3.66	0.286	11.1	47.2	0.535	1.88	0.422
2-Chlorotoluene	0.159 U	0.182 U	0.0237 J	0.185 U	0.0197 J	0.021 J	0.264	0.644	5.74	3.14	0.53	0.115 U	0.130 U
Chlorobenzene	0.872	0.182 U	2.43	0.386	2.39	24.4	6.68	11.7	61.5	83.6	24.2	2.84	2.67
Toluene	0.159 U	0.182 U	0.0947 J	0.0334 J	0.064 J	0.175 U	0.086 J	0.144 U	0.0445 J	0.249	0.138 U	0.315	0.229
Xylene O	0.159 U	0.182 U	0.158 U	0.185 U	0.164 U	0.0246 J	0.0422 J	0.0231 J	0.164 J	0.136 J	0.176	0.559	0.155
Xylene P,M	0.319 U	0.365 U	0.0331 J	0.371 U	0.328 U	0.351 U	0.0688 J	0.289 U	0.556 U	0.105 J	0.242 J	1.06	0.307
Total Xylene	0.319 U	0.365 U	0.0331 J	0.371 U	0.328 U	0.0246 J	0.0688 J	0.0231 J	0.164 J	0.241 J	0.418 J	1.619	0.462
PCBs (mg/kg)													
Aroclor 1016	0.06 U	-	0.06 U	-	0.06 U	-	0.06 U	0.06 U	0.07 U	12.60 U	0.06 U	0.05 U	0.06 U
Aroclor 1221	0.06 U	-	0.06 U	-	0.06 U	-	0.06 U	0.06 U	0.07 U	12.60 U	0.06 U	0.05 U	0.06 U
Aroclor 1232	0.06 U	-	0.06 U	-	0.06 U	-	0.06 U	0.06 U	0.07 U	12.60 U	0.06 U	0.05 U	0.06 U
Aroclor 1242	0.06 U	-	0.06 U	-	0.06 U	-	0.06 U	0.06 U	0.07 U	12.60 U	1.8 U	1.7	0.06 U
Aroclor 1248	0.06 U	-	1.6	-	0.4	-	0.6	3.8	0.8	203	0.06	0.05 U	3.4
Aroclor 1254	0.06 U	-	0.06 U	-	0.06 U	-	0.06 U	0.06 U	0.07 U	12.60 U	0.06 U	0.05 U	0.06 U
Aroclor 1260	0.06 U	-	0.06 U	-	0.06 U	-	0.06 U	0.06 U	0.07 U	12.60 U	0.06 U	0.05 U	0.06 U
Aroclor 1262	0.06 U	-	0.06 U	-	0.06 U	-	0.06 U	0.06 U	0.07 U	12.60 U	0.06 U	0.05 U	0.06 U
Aroclor 1268	0.06 U	-	0.06 U	-	0.06 U	-	0.06 U	0.06 U	0.07 U	12.60 U	0.06 U	0.05 U	0.06 U

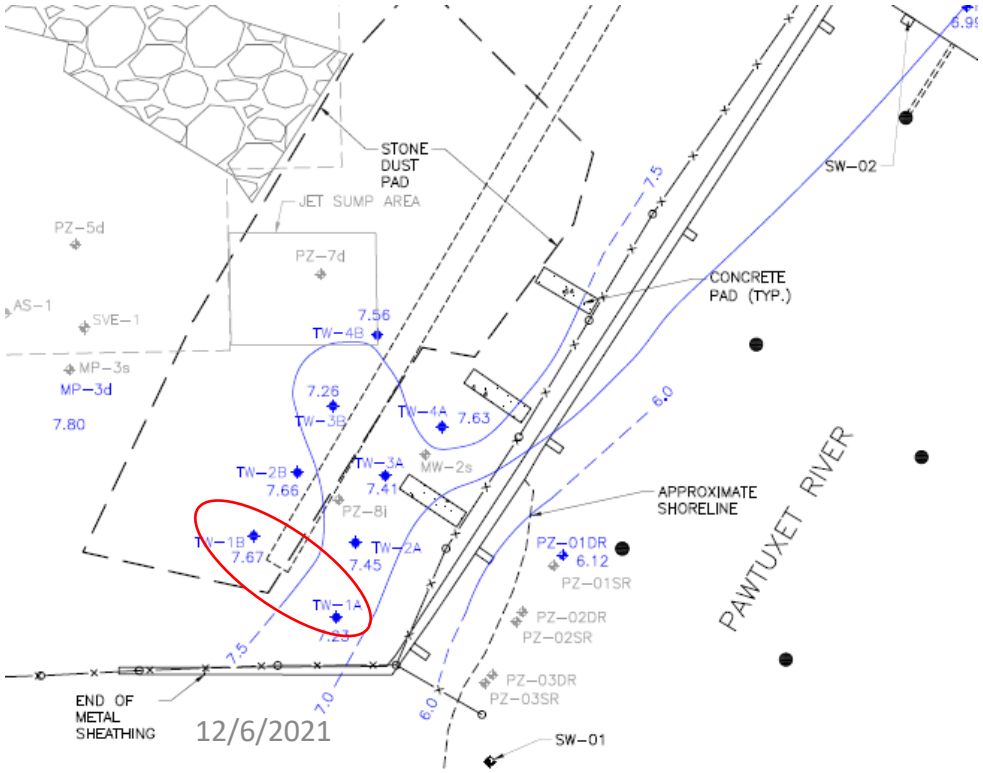


Pre-PRB well borings (soil mg/kg).

Compare to IK data



Boring log for TW-1A (TW-1B same)

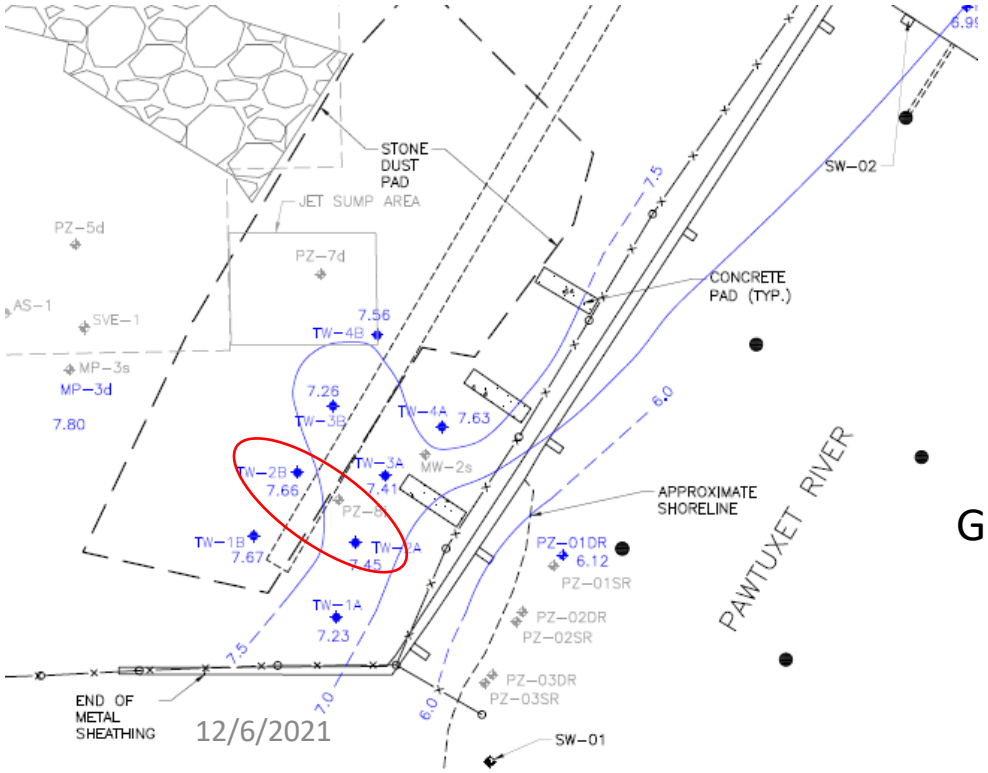


Gravel layer

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	RECOVERY % (RQD)	BLOWS COUNTS (N VALUES)	PID (PPM)
0		Discrete Sampling (started collecting samples at 15'BSG)			
5					
10					
15	15.0	Black, GRAVEL, Little Fine Sand, Wet			0.9
	17.0	Gray, Fine Grained, SAND, and Silt, Wet	100	–	2.8
					1.9
20	20.0				
	20.5	Dark Gray and Black, Fine Grained, SAND, and Silt, Wet			
		Gray, Fine Grained, SAND, and Silt, Wet			0.0
			60	–	
25	25.0				
		Gray, Fine Grained, SAND, and Silt, Saturated			0.0
			100	–	0.0
30	30.0				0.0
		End of boring at 30.0 feet			

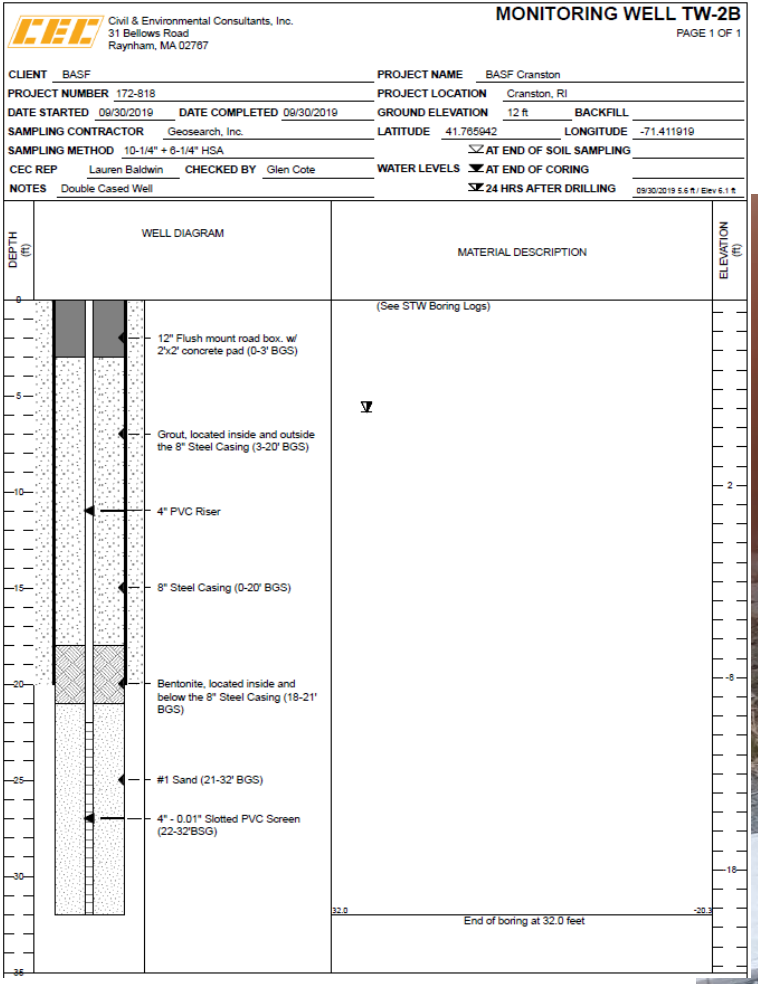
Interr

Boring logs 2A, 2B, 8i
(same description, different PID)



Gravel layer

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	RECOVERY % (RQD)	BLOWS COUNTS (N VALUES)	PID (PPM) 2B	PID (PPM) 8i	PID (PPM) 2A
0		Discrete Sampling (started collecting samples at 15' BSG)					
5							
10							
15							
15.0		Black, GRAVEL, Some Fine Sand, Wet, (OUTWASH)			350.0	21.2	26.9
17.0		Gray, Fine Grained, SAND AND SILT, Wet, Heavy Sheen	92	–	105.0	9.6	6.9
20					30.0	0.3	
20.0		End of boring at 20.0 feet					



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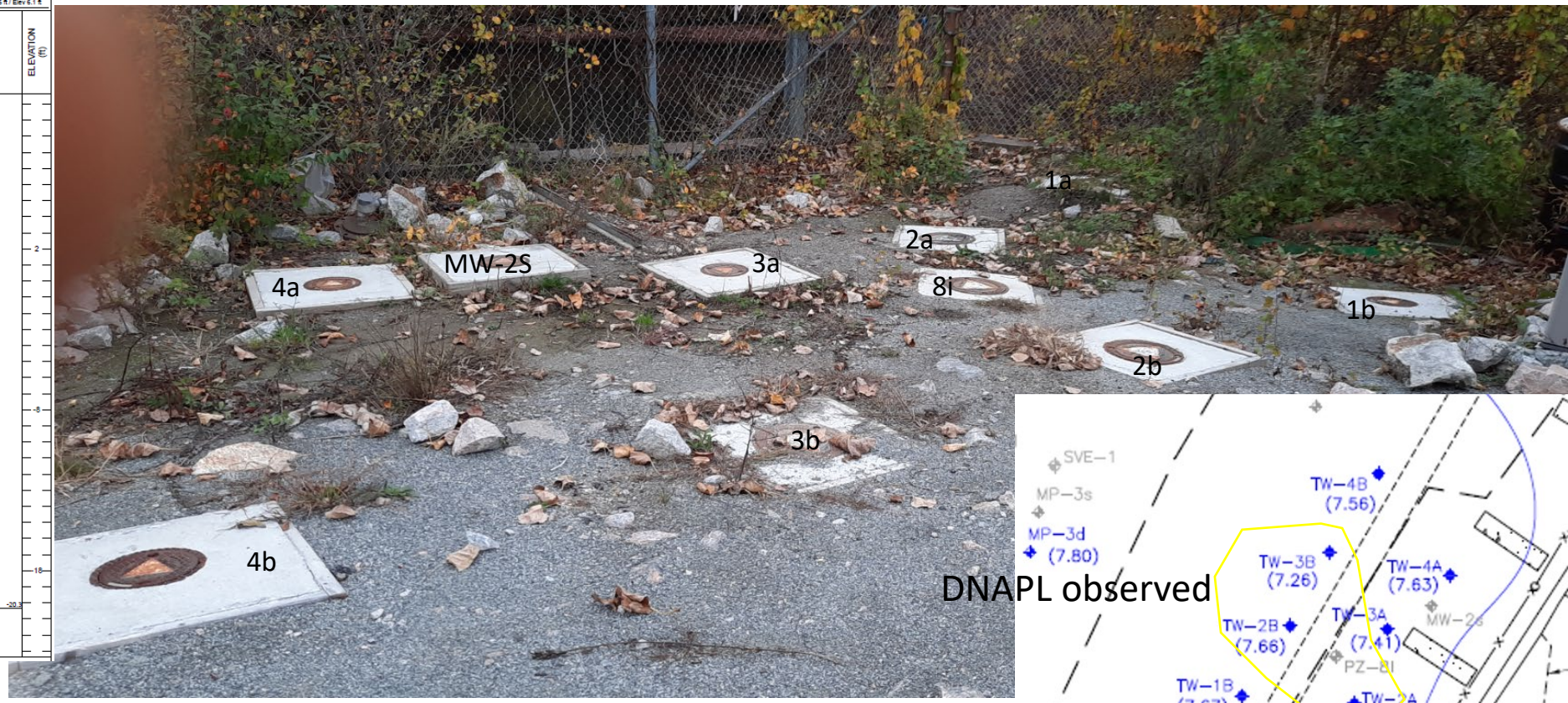
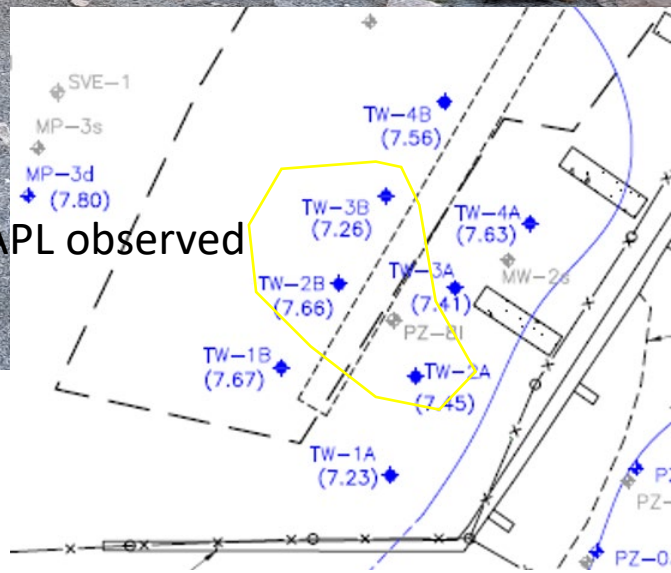
Raynham, MA 02767

MONITORING WELL TW-2B

PAGE 1 OF 1

CLIENT	BASF	PROJECT NAME	BASF Cranston
PROJECT NUMBER	172-818	PROJECT LOCATION	Cranston, RI
DATE STARTED	09/30/2019	DATE COMPLETED	09/30/2019
GROUND ELEVATION	12 ft	BACKFILL	
SAMPLING CONTRACTOR	Geosearch, Inc.	LATITUDE	41.765942
LONGITUDE	-71.411919		
SAMPLING METHOD	10-1/4" + 6-1/4" HSA	WATER LEVELS	AT END OF SOIL SAMPLING
CEC REP	Lauren Baldwin	CHECKED BY	Glen Cote
			AT END OF CORING
NOTES	Double Cased Well		24 HRS AFTER DRILLING 09/30/2019 5.6 ft / Elev 6.1 ft





Wells 2A, 2B, 3B, 8i cased to 20’ to address potential for DNAPL migration

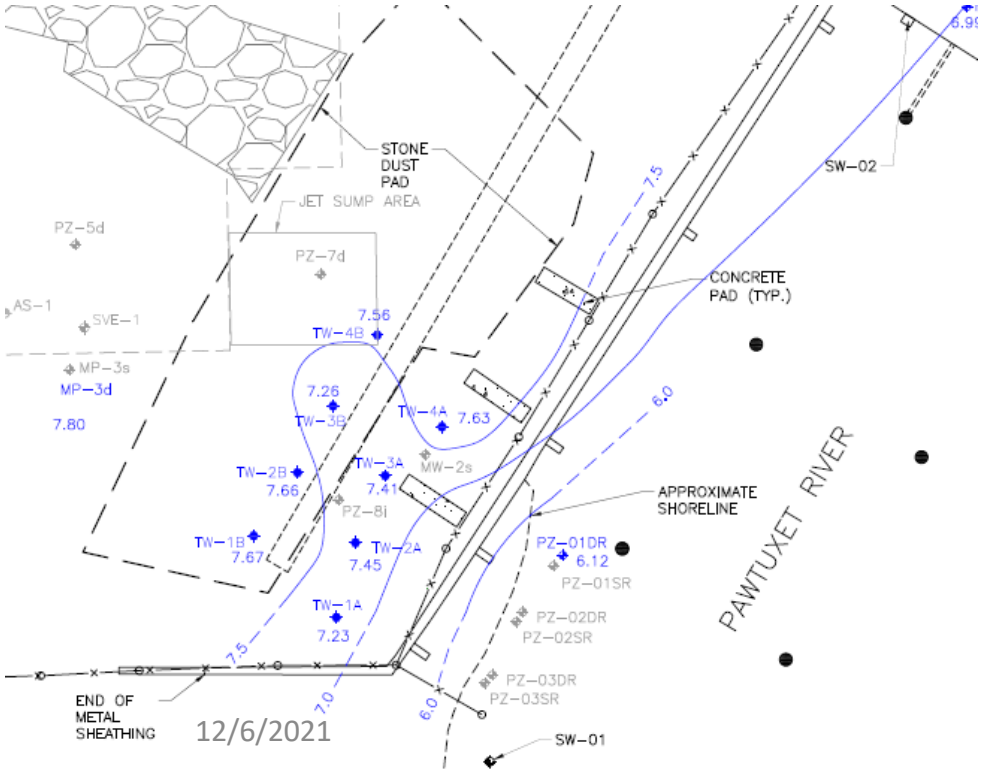
After all 9 well were installed, DNAPL detected in wells

- 2B (until 9/2020),
- 3B (until (3/2021) and
- 8i (until 12/2020)

Use absorbent at bottom of well to control head.

Install 8 PRB wells (TW-series) (22 to 32’ bgs)
Install upland monitoring well PZ-8i (22 – 32’ bgs)
Install river piezometers
shallow (7 – 9’ bsb)
deep(11 – 13’ bsb)

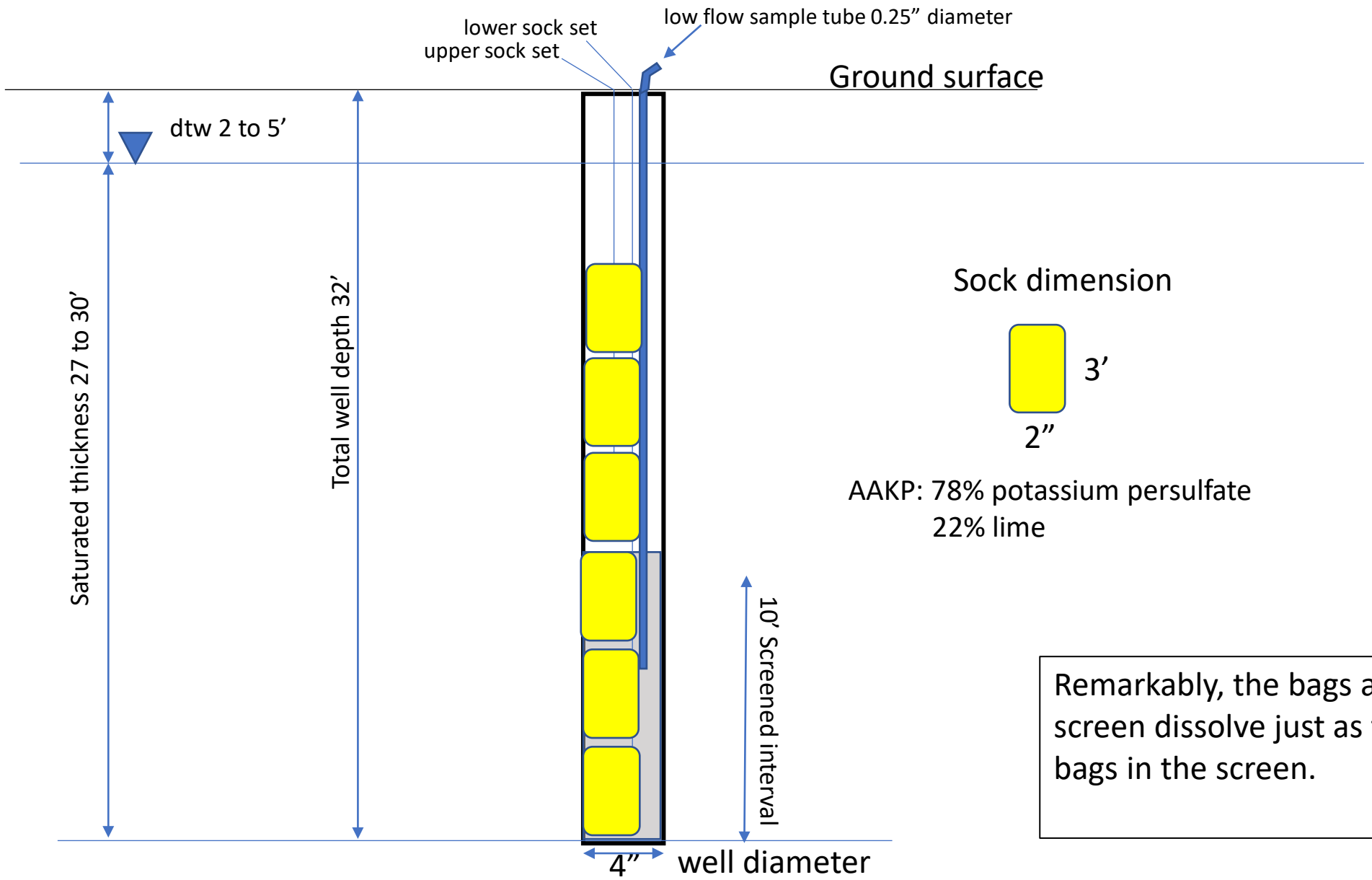
Initial Conditions.



	TW-1A	TW-2A	TW-3A	TW-4A	TW-1B	TW-2B	TW-3B	TW-4B	PZ-8i
1,2-DCB	3.5	**1,260**	42.8	5.0	65.3	NS	**3,280**	35.9	**2,290**
CB	49.9	274	572	6.7	92.3	NS	796	35.7	314
2-CT	< 1.0	2.1	<1.0	<1.0	<1.0	NS	5.7	<1.0	6.8
Tol	<1.0	5.7	73.6	<1.0	1.5	NS	37.7	<1.0	13.5
Xyl	<3.0	<3.3	11.4	<3.0	<3.0	NS	7.4	<3.0	3.6
PCBs	<0.09	<0.09	<0.09	<0.09	<0.09	NS	<0.10	<0.09	**2.72**
pH	6.80	10.06	7.88	6.95	7.44	NS	7.42	6.64	6.76
Sulfate	16.8	34.0	18.8	8.7	7.9	NS	24.0	6.6	22.0
DO	0.14	0.36	0.08	0.19	0.13	NS	0.90	0.24	0.14
ORP	-14.8	-239.5	-151.5	-87.5	-104.9	NS	-147.6	-109.6	-97.6

	PZ-01SR	PZ-02SR	PZ-03SR	PZ-01DR	PZ-02DR	PZ-03DR
1,2-DCB	**336**	**98**	**656**	**4,480**	<1.0	28.2
CB	**9,070**	**4,680**	**2,380**	233	26.3	559
2-CT	60.5	34.2	7.7	6.4	<1.0	9.2
Tol	37.5	8.6	1.2	3.5	<1.0	1.5
Xyl	45.7	14.3	<3.4	9.5	<2.0	4.6
PCBs	**1.84**	**1.81**	**1.0**	<0.1	0.16	0.41
pH	6.85	7.14	6.83	6.99	6.85	7.14
Sulfate	36.5	37.5	<5.0	<5.0	26.4	13.0
DO	0.40	0.33	0.39	0.31	1.22	0.37
ORP	183.4	145.9	154.7	135.3	195.8	161.9

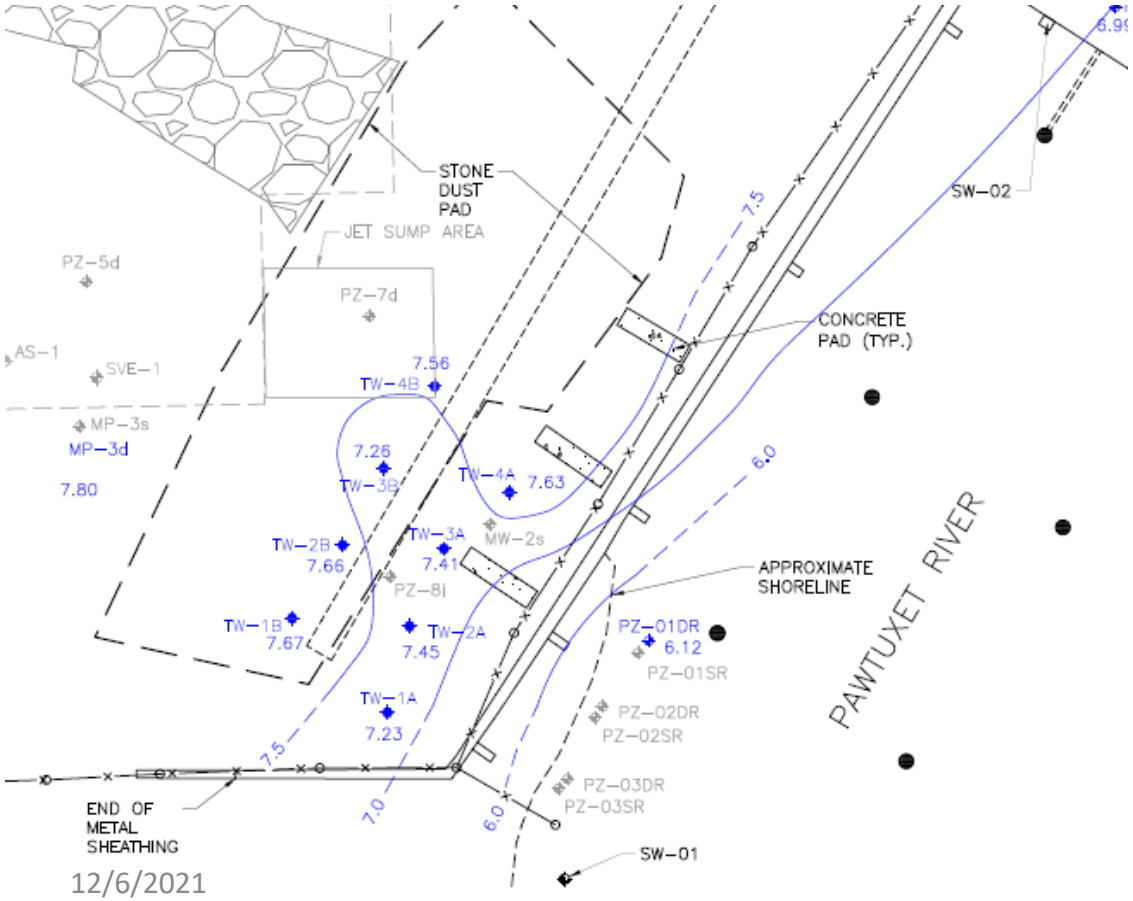
Hang socks on 2 separate tethers w/ 3 socks per tether.



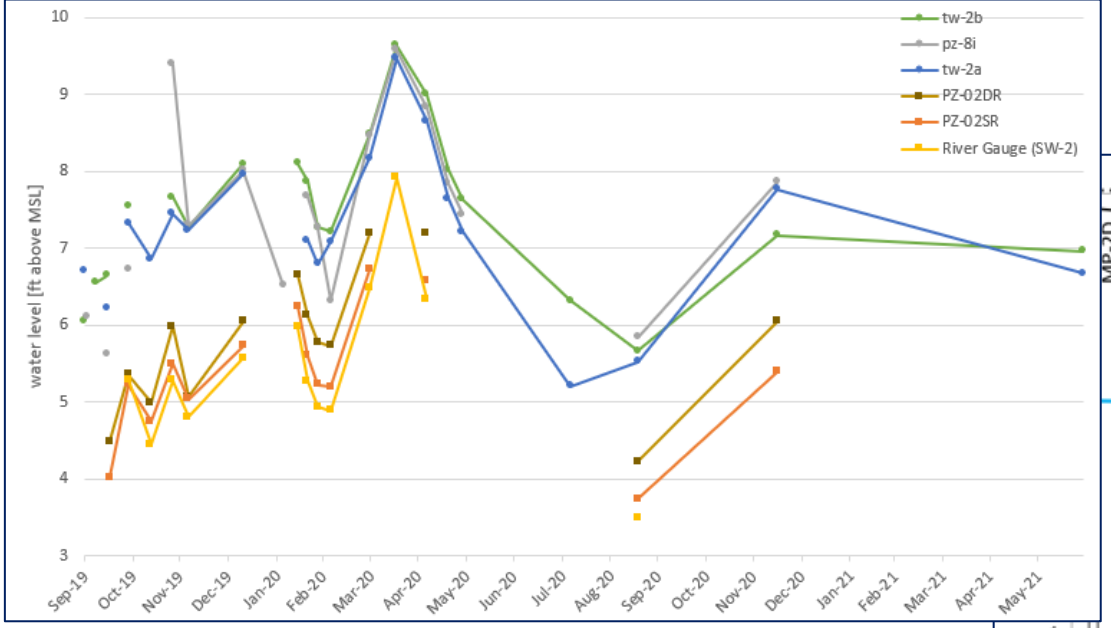
AAKP: 78% potassium persulfate
22% lime

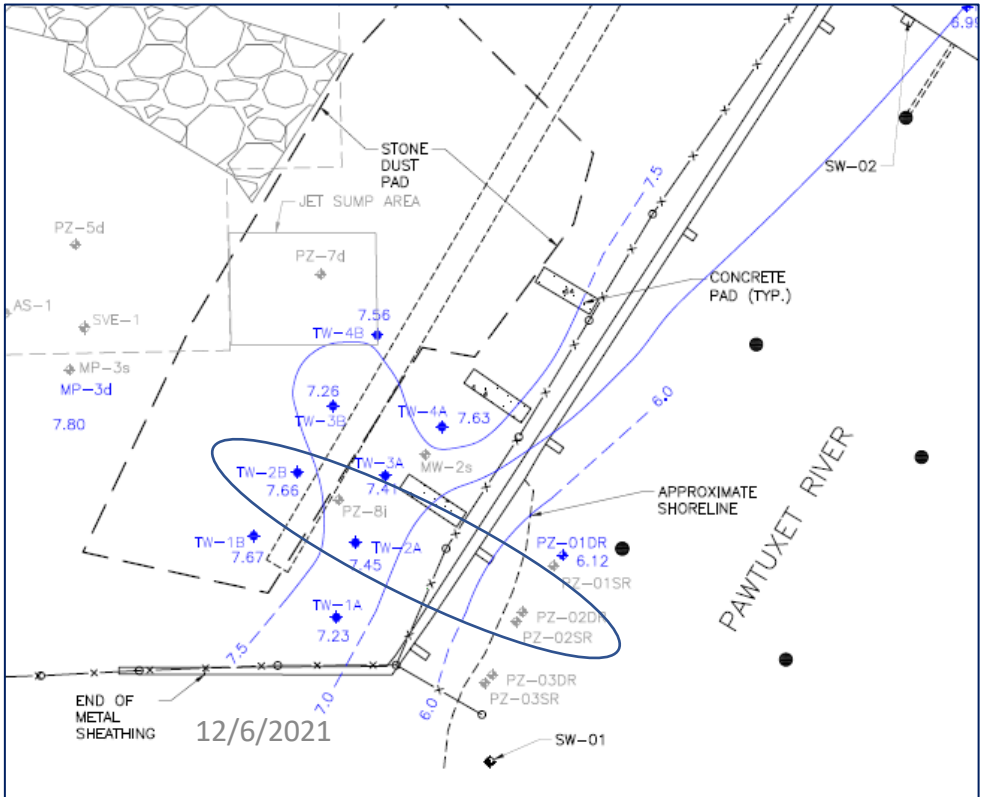
Remarkably, the bags above the screen dissolve just as fast as the bags in the screen.

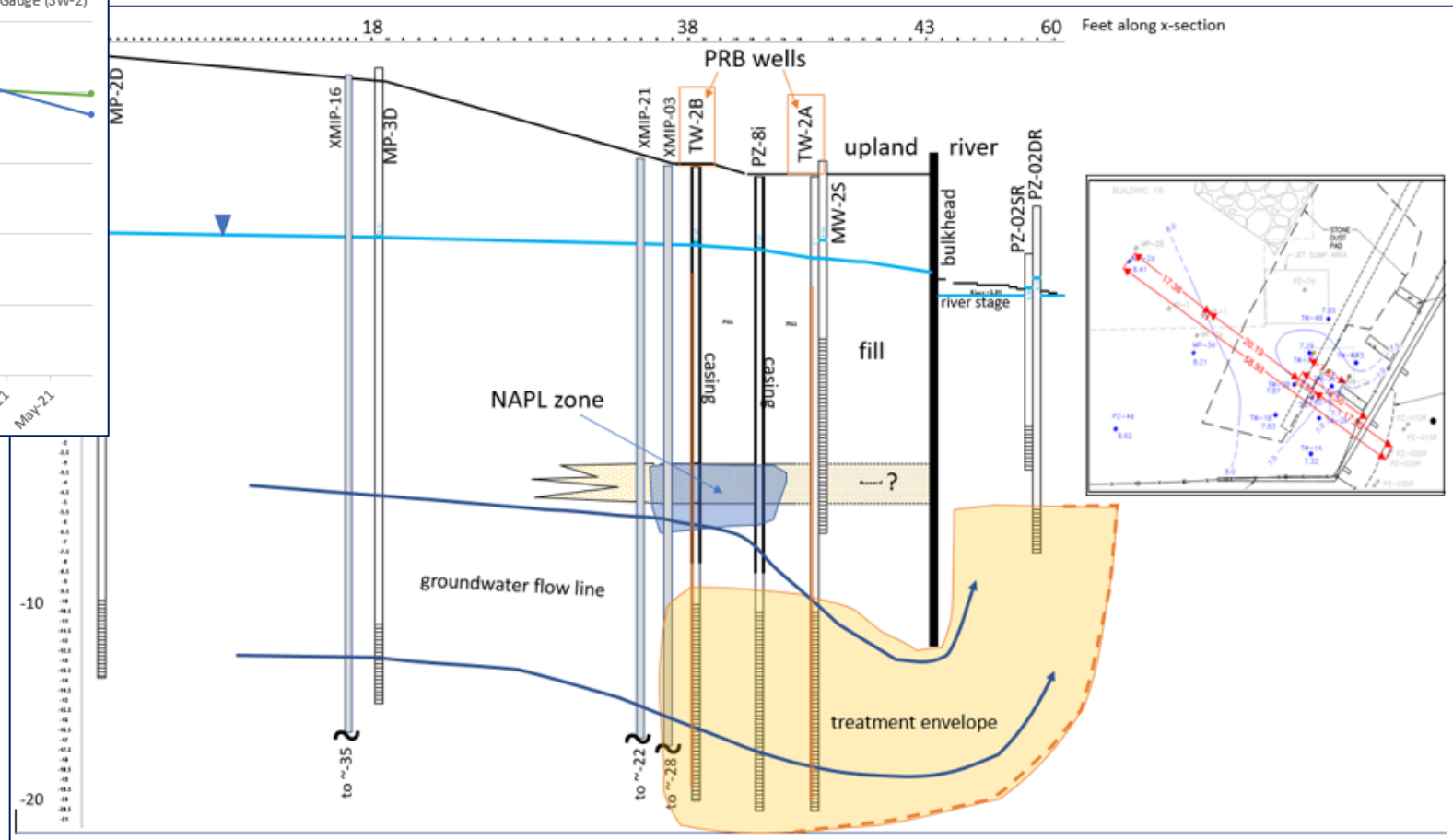
Performance monitoring plan (extend to present)



	TW-1A	TW-1B	TW-2A	TW-2B	TW-3A	TW-3B	TW-4A	TW-4B	PZ-8i	PZ-01DR	PZ-01SR	PZ-02DR	PZ-02SR	PZ-03DR	PZ-03SR	SW-01	SW-02
Week 1 (October 7, 2019)																	
Persulfate	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
pH	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sulfate									X	X	X	X	X	X	X	X	X
Week 2 (October 14, 2019)																	
Persulfate	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
pH	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sulfate									X	X	X	X	X	X	X	X	X
Week 4 (October 28, 2019)																	
VOCs									X	X	X	X	X	X	X		
PCBs									X	X	X	X	X	X	X		
Persulfate	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
pH	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sulfate									X	X	X	X	X	X	X	X	X
Week 6 (November 11, 2019)																	
Persulfate	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
pH	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sulfate									X	X	X	X	X	X	X	X	X
Week 9 (December 5, 2019)																	
Persulfate	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
pH	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sulfate									X	X	X	X	X	X	X	X	X
Week 12 (January 9, 2020)																	
VOCs									X	X	X	X	X	X	X		
PCBs									X	X	X	X	X	X	X		
Persulfate	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
pH	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sulfate										X	X	X	X	X	X	X	X
Week 18 (February 19, 2020)																	
VOCs																	
PCBs																	
Persulfate	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
pH	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sulfate	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Week 24 (March 30, 2020)																	
VOCs									X	X	X	X	X	X	X		
PCBs									X	X	X	X	X	X	X		
Persulfate	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
pH	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sulfate									X	X	X	X	X	X	X	X	X
Week 48																	
VOCs									X	X	X	X	X	X	X		
PCBs									X	X	X	X	X	X	X		
Persulfate	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
pH	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sulfate									X	X	X	X	X	X	X	X	X







Cross section through the PRB showing MIP locations, well placements, NAPL zone, water levels (2/19/20 event) and implied flow lines and treatment envelope. The hydraulic gradient between TW-2A and PZ-02DR is ~0.04.

PRB Monitoring Program: River pore water. (2020 PRB Report)

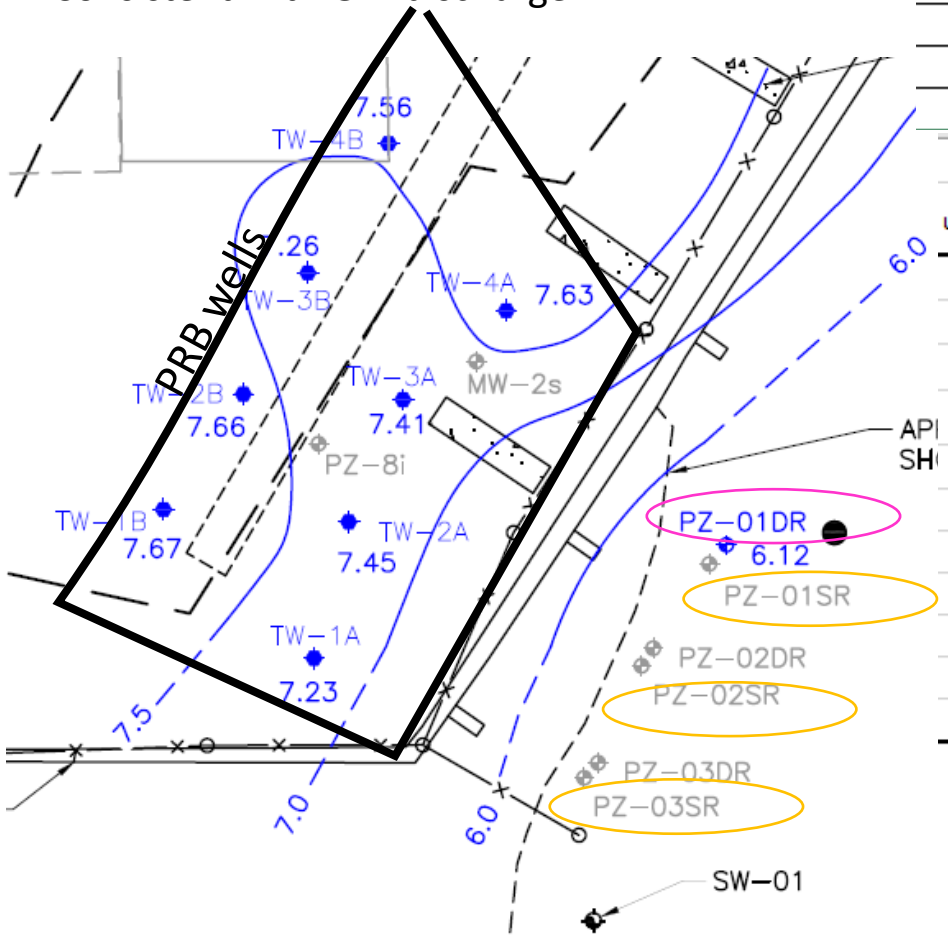
River Piezometer Monitoring

Shallow composition (CB and PCB)

- Consistent with known river sediment impacts

Deep composition (DCB)

- Consistent with GW discharge



	PZ-01SR			7 to 9'	PZ-02SR			7 to 9'	PZ-03SR			7 to 9'
COC [ug/L]	10/16/19 (baseline)	10/28/19	1/9/20	3/30/20	10/16/19 (baseline)	10/28/19	1/9/20	3/30/20	10/16/19 (baseline)	10/28/19	1/9/20	3/30/20
1,2-DCB	**336**	7.4	**428**	**690**	**98**	27.8	83	82	**656**	**322**	**204**	**308**
CB	**9,070**	220	**3,520**	**5,050**	**4,680**	254	**1,900**	**2,160**	**2,380**	673	523	884
2-CT	60.5	2.5	23.7	25.5	34.2	2.3	7.6	2.7	7.7	2.1	< 1	< 1
Tol	37.5	1.4	2.9	1.3	8.6	1.3	1.5	1	1.2	1.3	< 1	1
Xyl	45.7	<3	7.9	7	14.3	<3	<4	2	<3.4	< 3	<3	< 2
PCB	**1.84**	<0.09	0.38	0.5	**1.81**	**8.77**	**4.34**	0.18	**1**	<0.09	**0.97**	<0.09
Persulfate	0	0	0	0	0	0	0	0	0	0	0	0
Sulfate	36.5	25.9	12.9	20.8	37.5	34	17.1	21.1	<5.0	<5.0	<5.0	6.5
pH	6.85	6.78	7.37	6.75	7.14	6.81	6.71	6.46	6.83	6.88	6.57	6.65
DO	0.4	0.24	9.43	2.69	0.33	1.61	10.86	2.90	0.39	0.12	10.55	3.28
ORP	183.4	-306	12.3	-41.4	145.9	-192	33	-40.4	154.7	-388.5	21.3	-101.2

	PZ-01DR			12 to 14'	PZ-02DR			11 to 13'	PZ-03DR			10 to 12'
ug/L	10/16/19 (baseline)	10/28/19	1/9/20	3/30/20	10/16/19 (baseline)	10/28/19	1/9/20	3/30/20	10/16/19 (baseline)	10/28/19	1/9/20	3/30/20
1,2-DCB	**4,480**	**4,510**	**4,580**	**5,240**	<1	2.4	<1	<1	28.2	12.9	26.9	18.2
CB	233	57.9	36.4	50	26.3	38.4	11.3	3.2	559	144	219	250
2-CT	6.4	1.1	<1	< 1	<1	1.3	<1	<1	9.2	3.2	<1	<1
Tol	3.5	2.1	1.4	1.6	<1	1.4	<1	<1	1.5	<1.0	<1	<1
Xyl	9.5	5.1	4.5	4.65	<2	<3	<3	<2	4.6	<3	<3	2
PCB	<0.10	< 0.11	<0.11	<0.11	0.16	0.23	< 0.11	< 0.11	0.41	<0.10	0.18	<0.09
KP	0	0	0	0	0	0	0	0	0	0	0	0
Sulfate	<5.0	5.2	<5.0	<5.0	26.4	26.3	< 5.0	< 5.0	13	15.4	<5.0	<5.0
pH	6.99	6.96	8.52	7.54	6.85	7.35	7.59	9.60	7.14	7.01	6.43	6.55
DO	0.31	0.03	9.67	1.07	1.22	0.02	9.4	1.16	0.37	0.03	10.16	1.93
ORP	135.3	-450.3	-26.9	-196.7	195.8	-503.2	24.1	-97.3	161.9	-472.2	10.9	-69.4

PRB WELL PARAMETERS w/ TIME

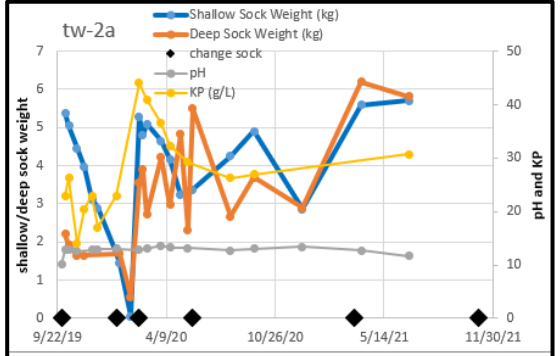
- 8 wells (1A/B to 4A/B)
- Sock weight
- Sock changeout time
- pH
- KP concentration

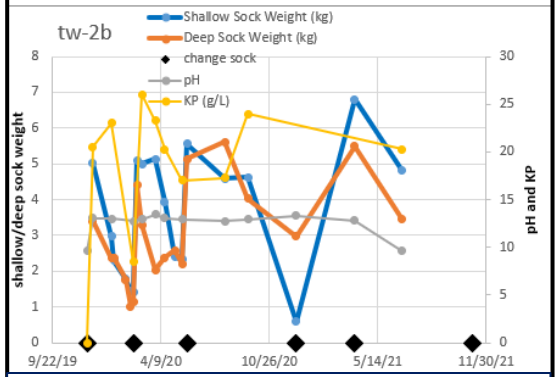
AAKP recipe

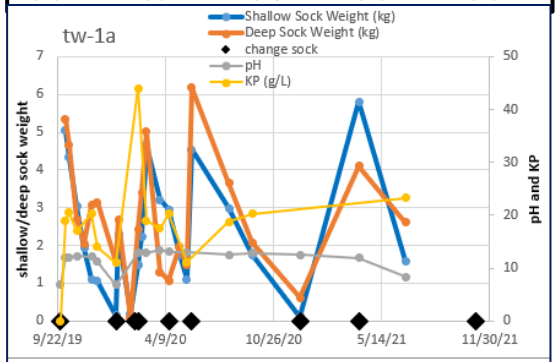
9/2019 to 3/2021 77% KP:22% lime

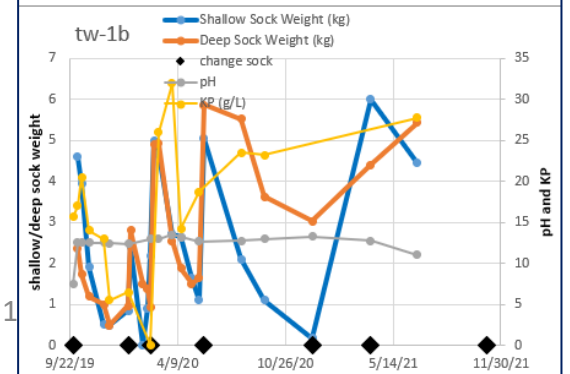
3/21 to 11/21 85% KP: 15% lime

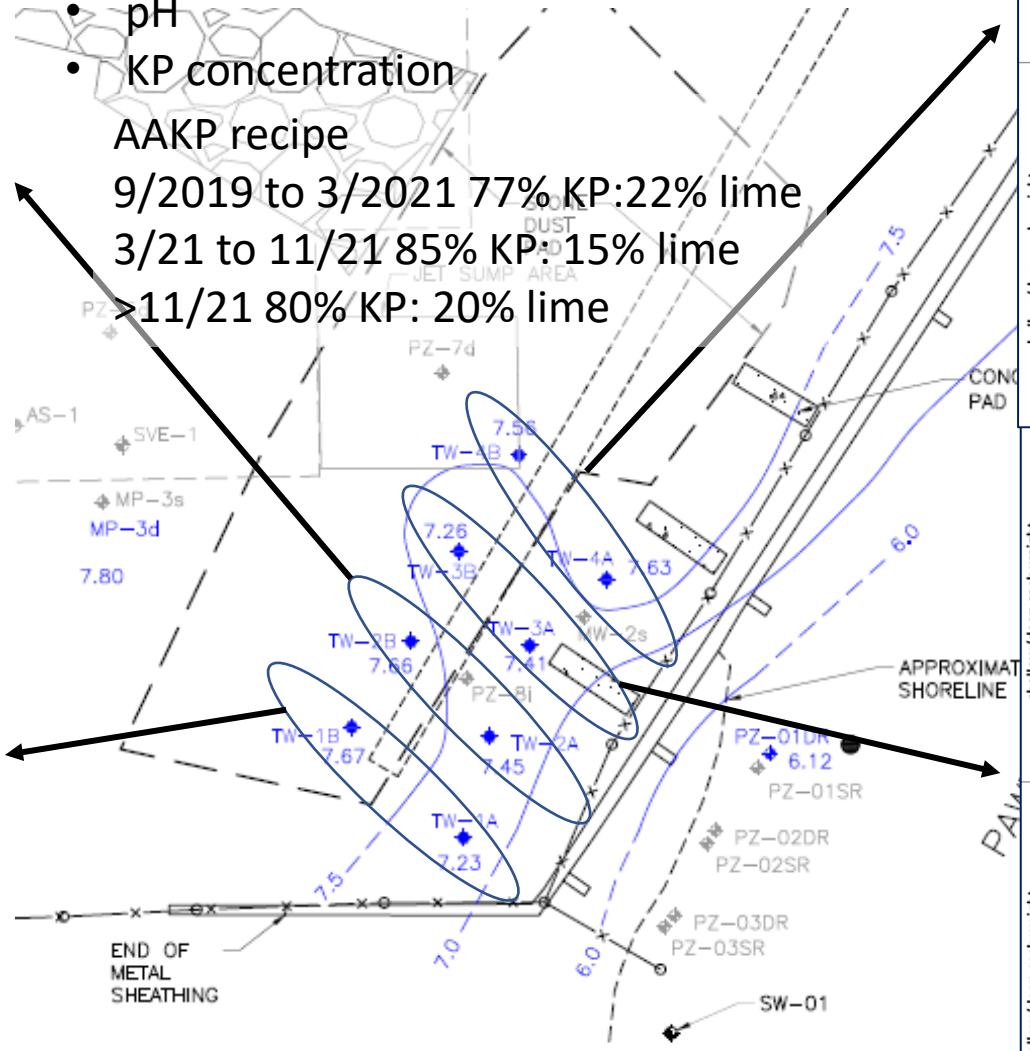
>11/21 80% KP: 20% lime

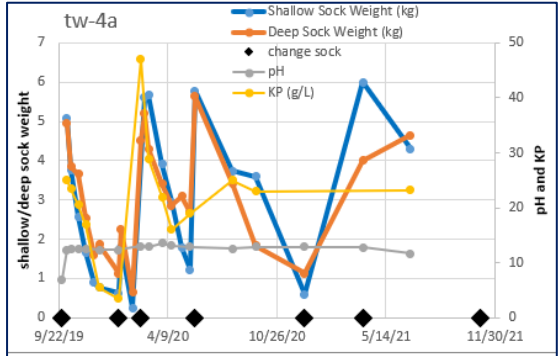


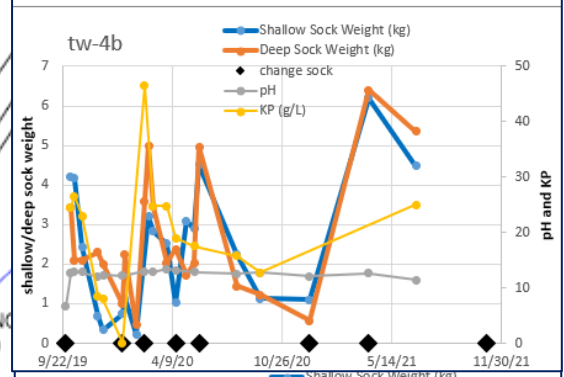


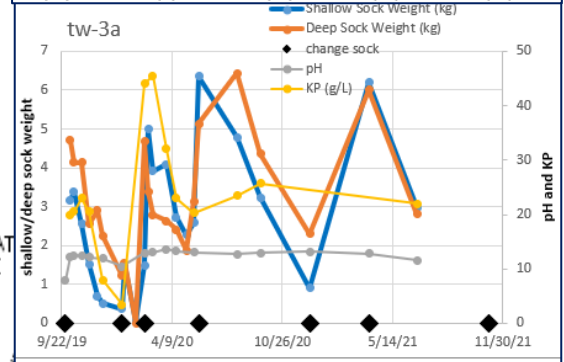


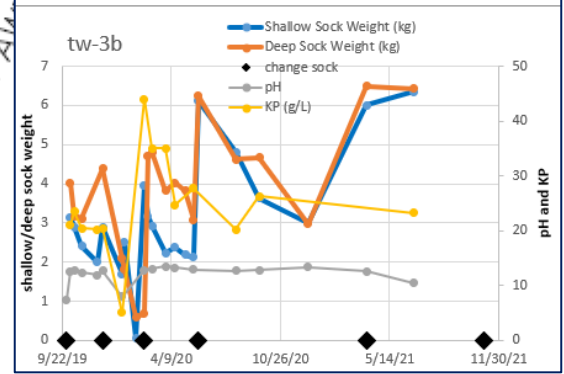








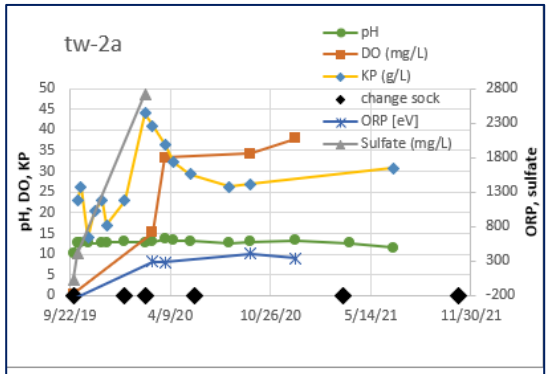


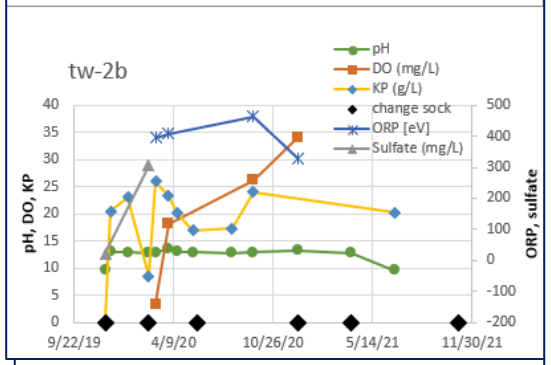


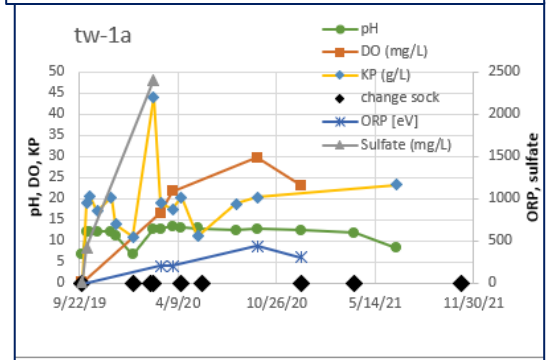
Internal

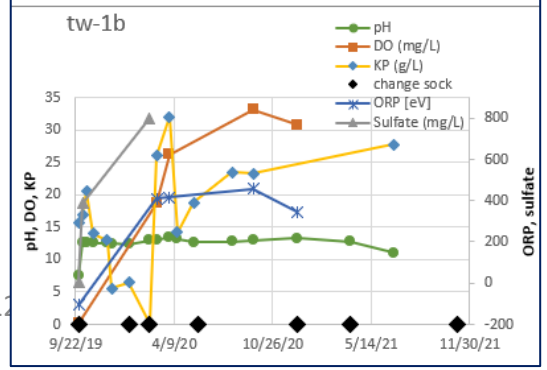
PRB WELL PARAMETERS w/ TIME

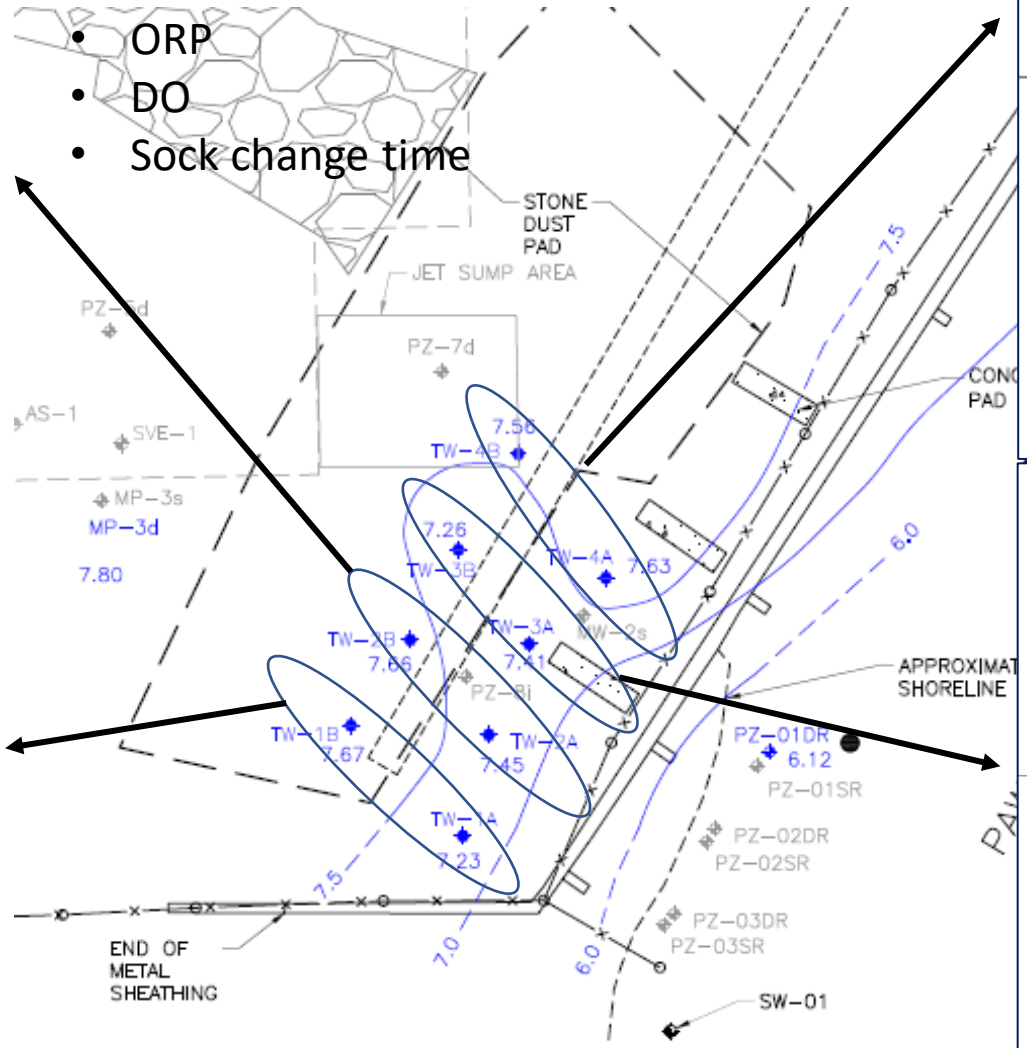
- 8 wells (1A/B to 4A/B)
- pH
- KP concentration
- Sulfate concentration
- ORP
- DO
- Sock change time

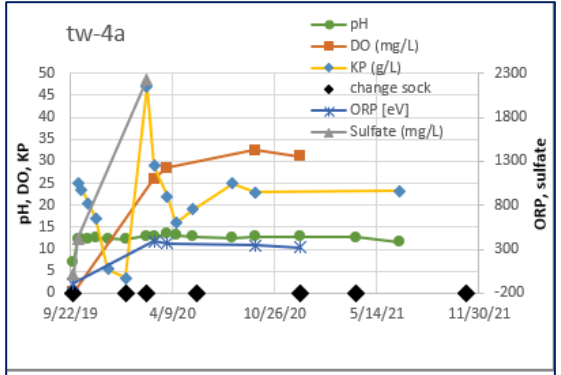


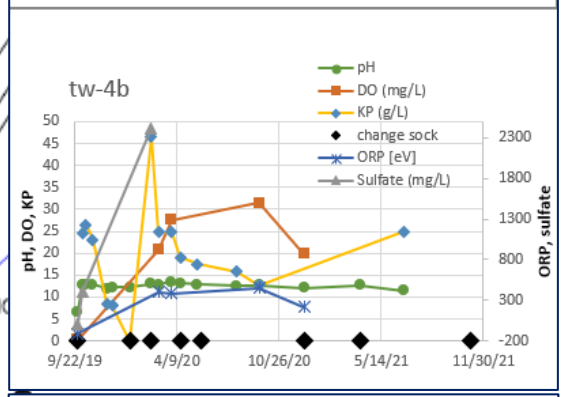


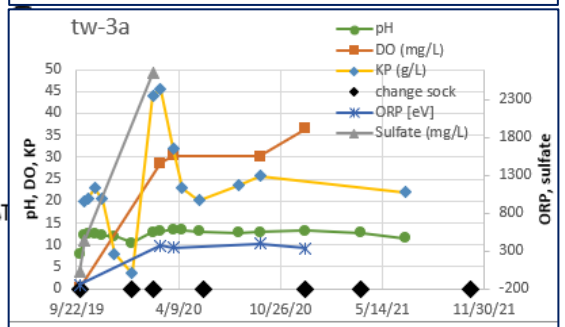


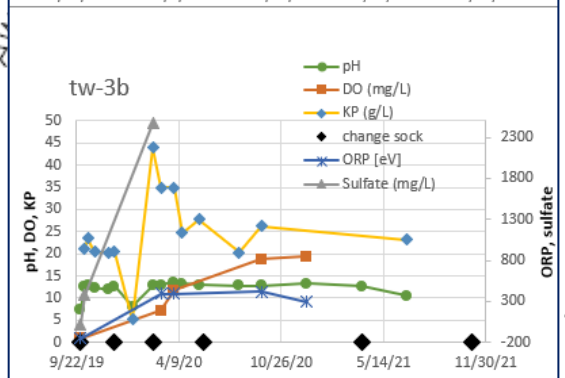








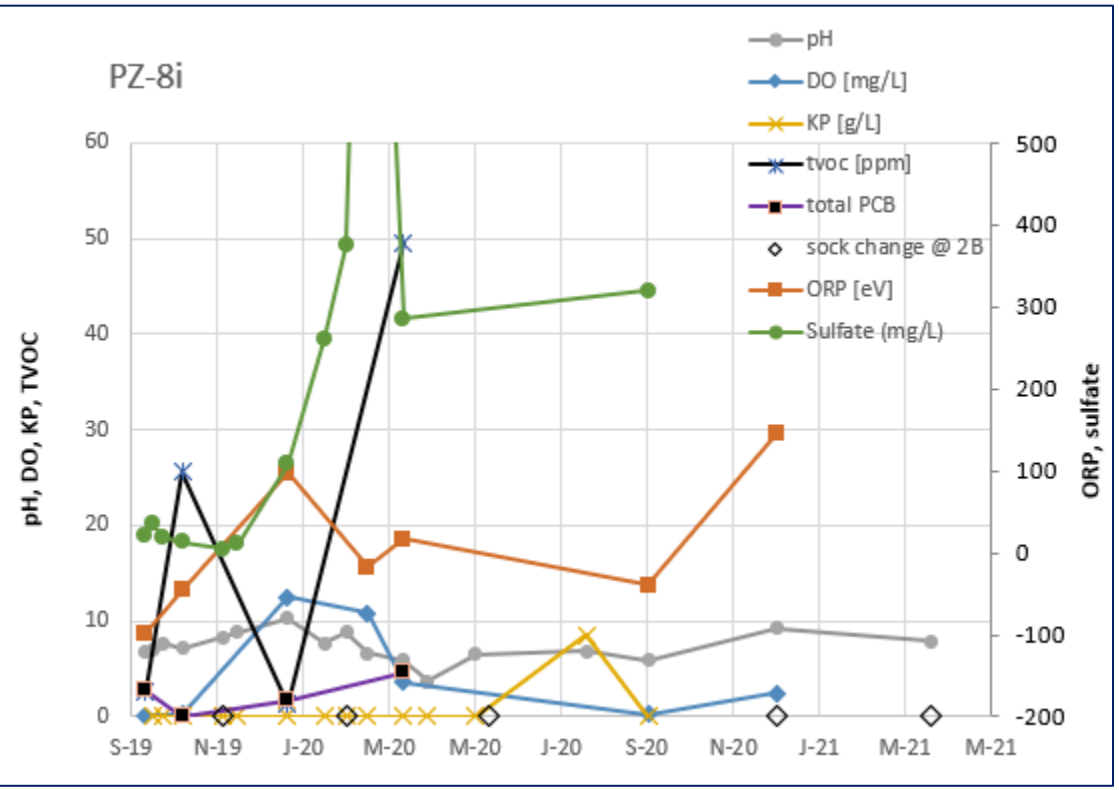




Internal

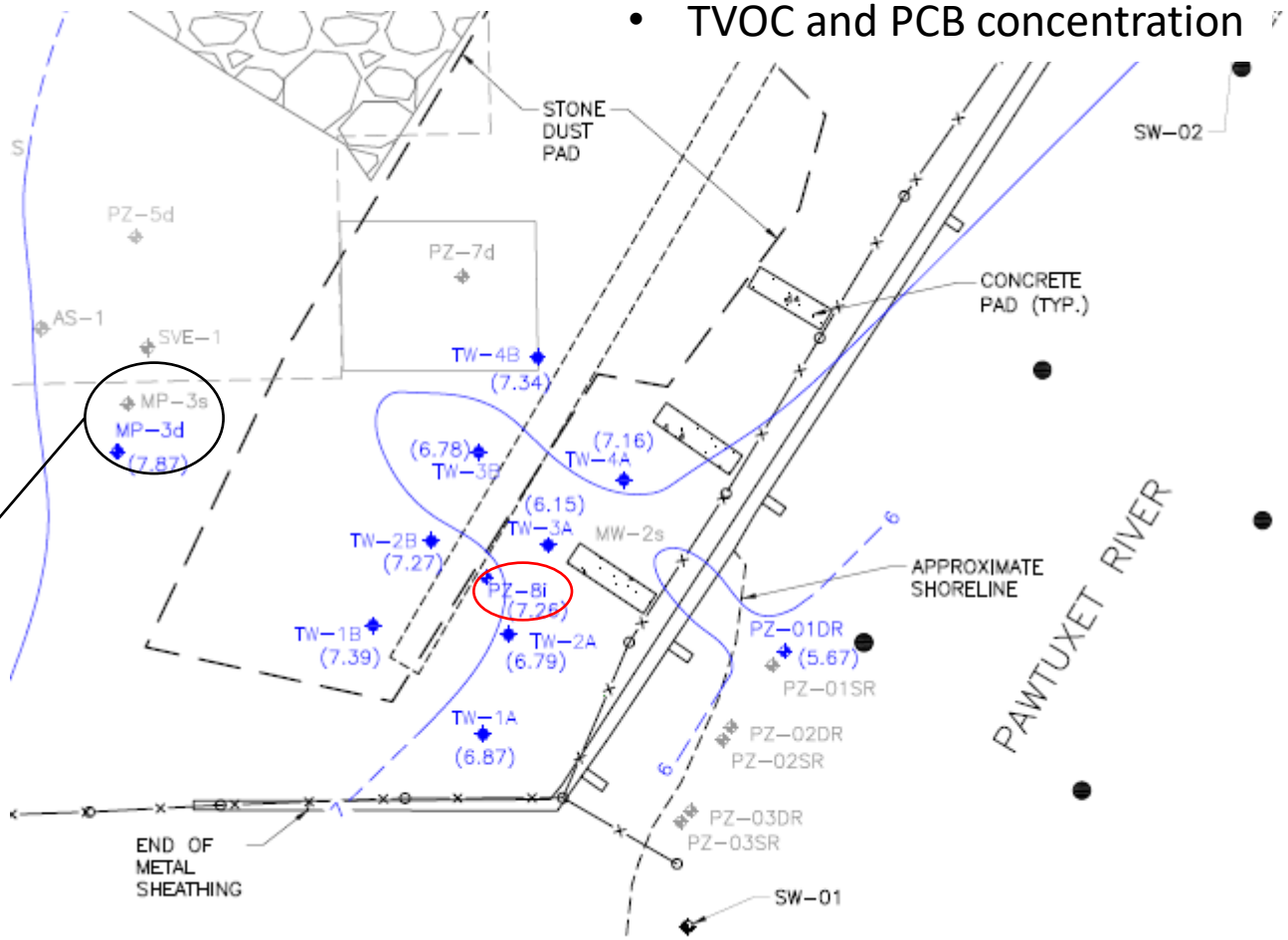
PRB PERFORMANCE MW (8i)

- pH
- DO
- ORP
- KP concentration
- Sulfate concentration
- TVOC and PCB concentration



Field –Scale Treatability Test Slug Test Summary
Ciba-Geigy RCRA Closure Project

Monitoring Well	Slug Test Type	Conductivity (cm/sec) [ft/d]
MP-3s	Rising Head	3.57×10^{-3} [10]
MP-3i	Falling Head	4.53×10^{-4} [1.3]
MP-3i	Rising Head	7.72×10^{-4} [2.2]
PZ-8i	rising/falling	1.0×10^{-4} [0.28]



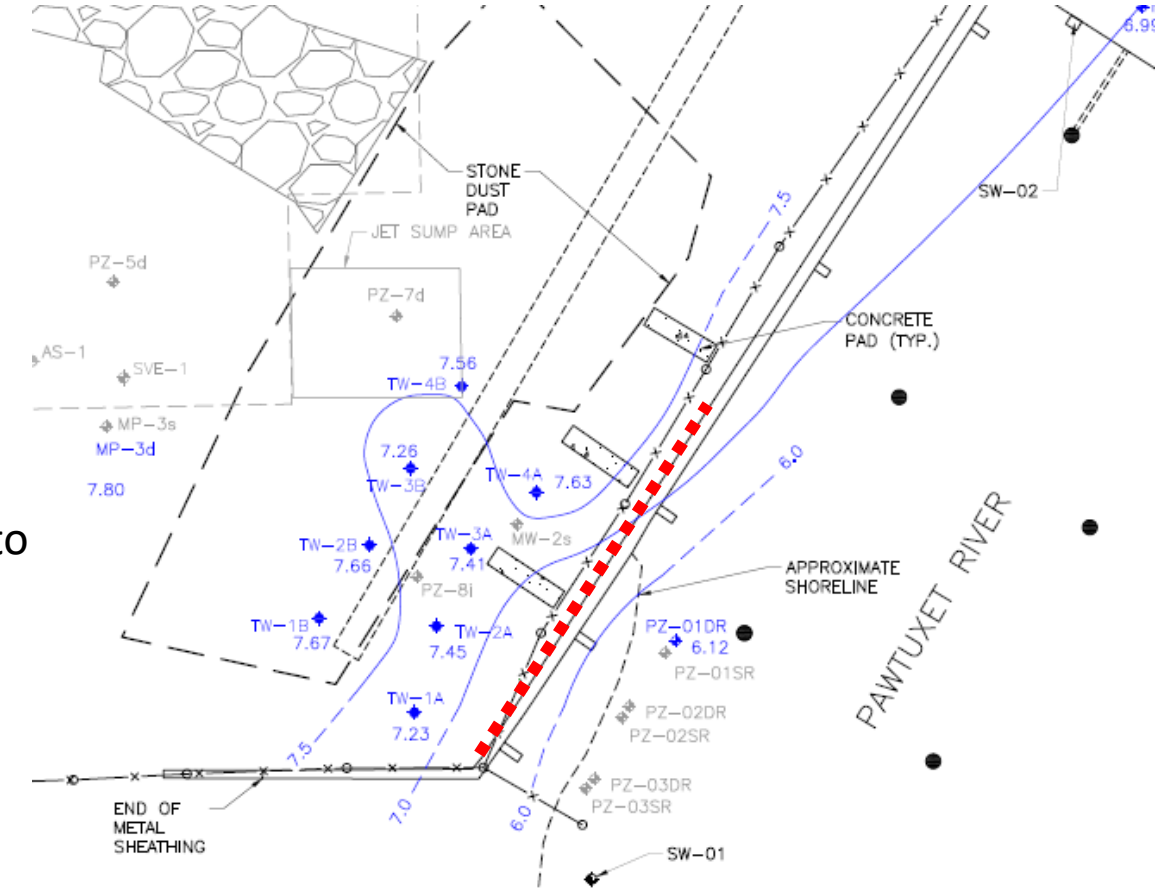
Internal

Summary

- RCRA Closure CD TBC
- Soil: EPA review of Closure and M&M plan
- PRB installed 9/30/19
- DNAPL (DCB and CB w/ PCB) detected in granular layer 18 to 20’ bgs.
- Remedy monitored and maintained for >2 years.
- AAKP is dissolving and disassociating under favorable pH (>10.5).
- No indication of significant reagent transport away from PRB wells.
- River-side impact appears to be from 2 sources: shallow associated with known surface discharge to sediment, deep from GW discharge.
- Data gaps: resolve mass flux flow path to river to refine treatment area and monitoring of same.

Recommendations

- Continue maintaining PRB
- Field work
  - Hydraulics of PRB wells (slug tests)
  - Profile study
    - Adjacent to sheet-pile from 20 to 35’
  - Based on result:
    - Install MWs on upland side, adjacent to and spanning across the depth of the sheet-pile bulkhead.
    - Extend river PZ transect further downgradient.



Q&A

1. Can you elaborate on BASF's understanding of the newly identified DNAPL source (e.g. conceptual site model wrt nature and extent of contamination), including:
   a) Has BASF characterized the vertical extent of this source? Yes, confined to a gravel layer and below 15' to 18' bgs
   b) If DNAPL, what is preventing further migration downward? The DNAPL appears to be limited to a 2' layer of granular media underlain by fine silt. The basis for this conclusion is:
      a) As a non-wetting phase in a NAPL-water fluid system, NAPL tends to occupy relatively large pore spaces based on concepts of capillarity (the imbibition pressure exponentially increases as the pore size decreases).
   c) What frequency of monitoring data do you have to substantiate the upward hydraulic gradient/flow path from upland to river? See slide 38.
   d) Refer to NAPL as opposed to DNAPL? Consider DNAPL and LNAPL to be specific subsets of NAPL. The dominance of 1,2-dichlorobenzene make it a DNAPL.
2. What actions are BASF taking to control migration of the NAPL/DNAPL?
   a) What monitoring is in place? Case wells into confining layer. Use DNAPL absorbents in wells.
   b) Does BASF have a plan to address the source?
      - BASF entered into this remedy with the concept that the PRB would act as an equivalent to a P&T to eliminate discharge from the upland to the river, where treatment takes place in-situ.
      - While there is significant mass in the subsurface, the mass flux appears to be low due to fine grain media.
      - Additional data are required to fully characterize transport across the bulkhead.
      - A more significant river sediment impact is due to direct discharge, not upwelling.
3. What is the next plan of action and associated timeline?
   What are EPA requirements for WPs?
   BASF will hire a contractor to develop and implement a definitive plan.

Internal