Components Cleaning Facility (CCF), East

Construction Completion and Operations, Maintenance, and Monitoring ADP

SWMU 030

September 2016

Acronyms

bls	below land surface
CCF	Components Cleaning Facility
cDCE	cis-1,2-dichloroethene
COC	constituent of concern
DPT	direct push technology
EE	Engineering Evaluation
ERH	electrical resistance heating
EVS	Environmental Visualization System
HS	hot spot
IM	interim measure
in. w.c.	inches of water column
IWP	Implementation Work Plan
KSC	Kennedy Space Center
KSCRT	Kennedy Space Center Remediation Team
kV	kilovolt
kW	kilowatt
lb	pound
LDA	large-diameter auger
LPGAC	liquid-phase granular activated carbon
MNA	monitored natural attenuation
NADC	Natural Attenuation Default Concentration
PCU	power control unit
PID	photo-ionization detector
ppmv	parts per million, by volume
SCADA	supervisory control and data acquisition
scfm	standard cubic feet per minute
SMWU	Solid Waste Management Unit
SSHP	Site-Specific Health and Safety Plan
SVE	soil vapor extraction
TCE	trichloroethene
TMP	temperature monitoring probe
TOC	total organic carbon
TWA	time-weighted average
V	volt
VC	vinyl chloride
VE	vapor extraction
VMP	vapor monitoring point
VPGAC	vapor-phase granular activated carbon
ZVI	zero-valent iron

Presentation Content

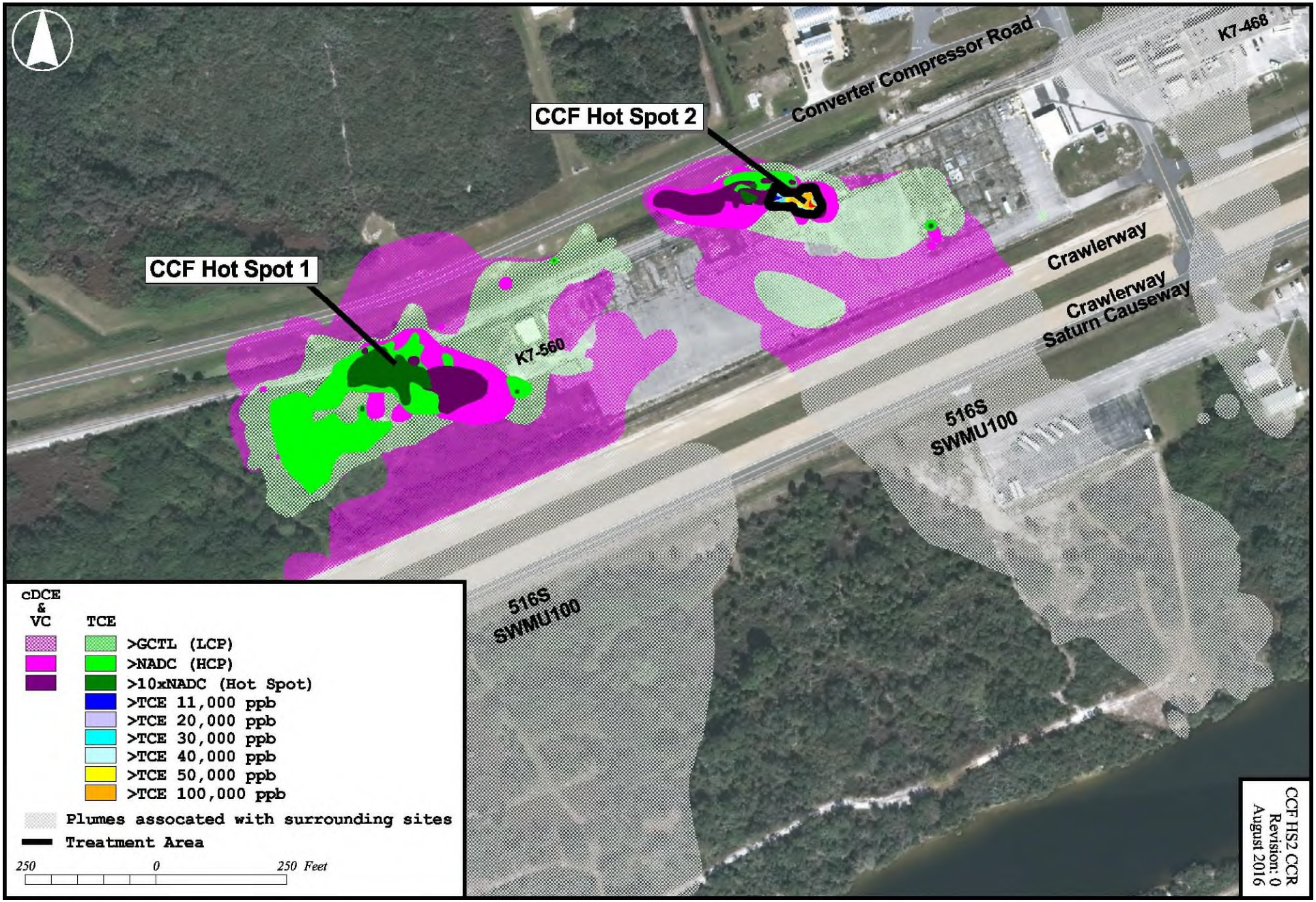
- Site information
- Site characterization
- Remedial selection
- Interim measure (IM) components
- IM installation
- IM commissioning, startup, and operations
- Performance monitoring
- Lessons learned
- Path forward

Site Information

- Area developed in 1962 for cleaning and refurbishment of hardware and an associated analytical laboratory
- Designated Solid Waste Management Unit 030
- Currently site is vacant (buildings demolished ~2006)
- Groundwater plume co-mingled with Area South of K7-0526, SMWU 100
- Located northeast of intersection of Crawler Parkway and Fluid Servicing Road

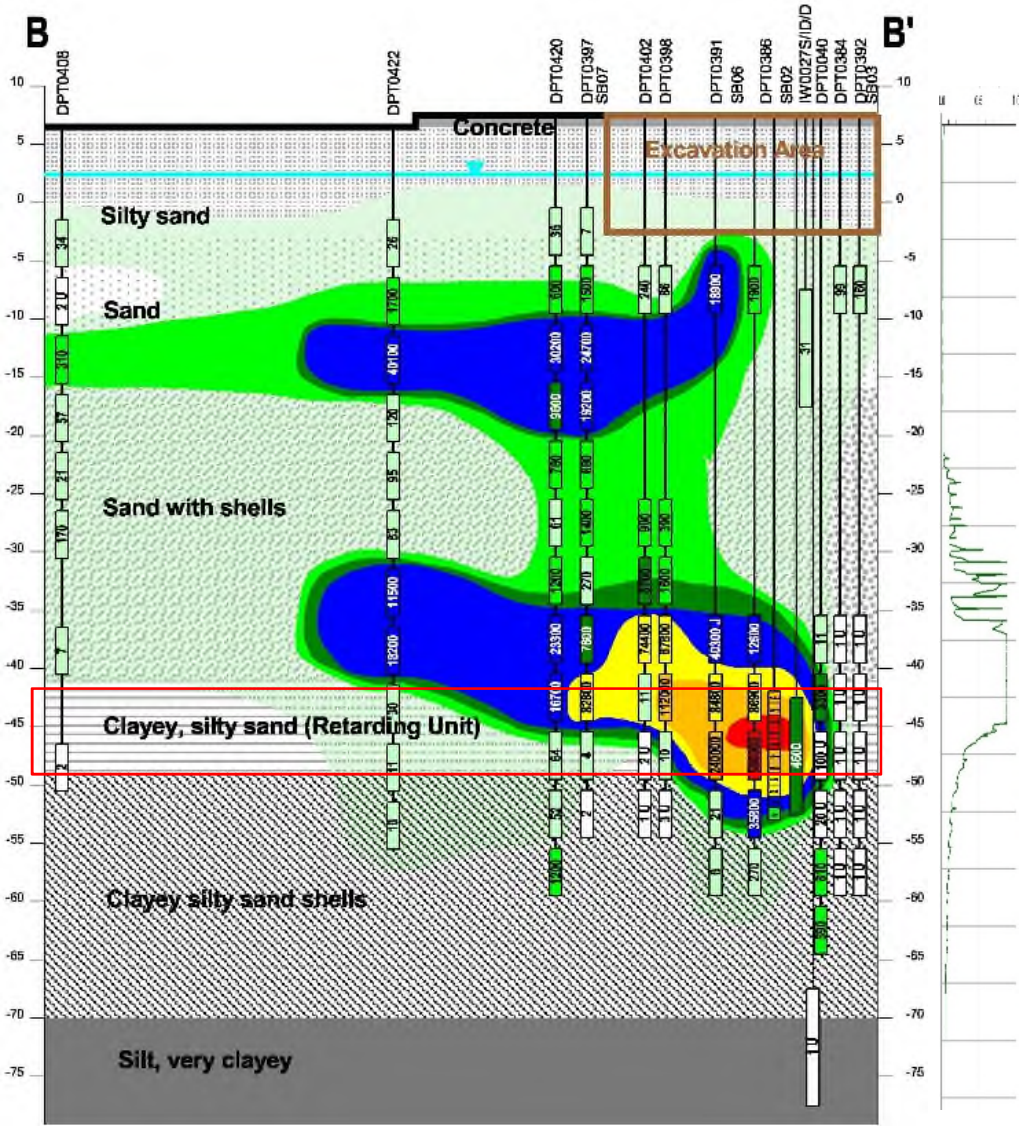
TETRA TECH

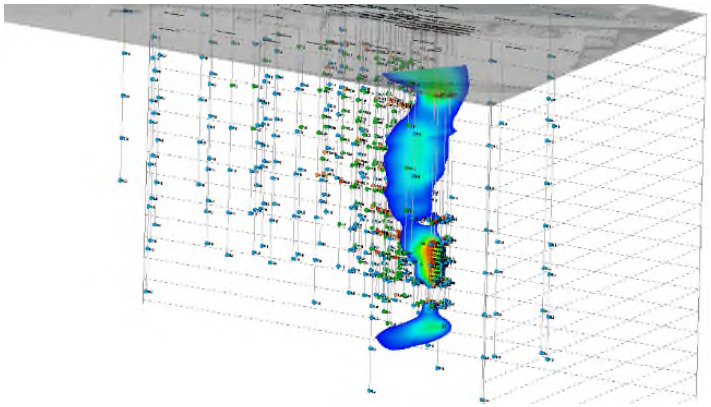
Components Cleaning Facility (1990)



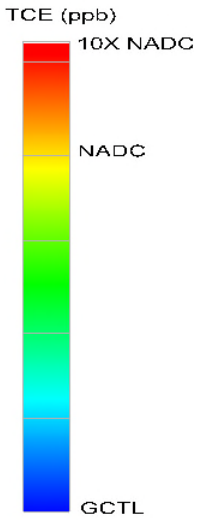
CCF Plume Overview

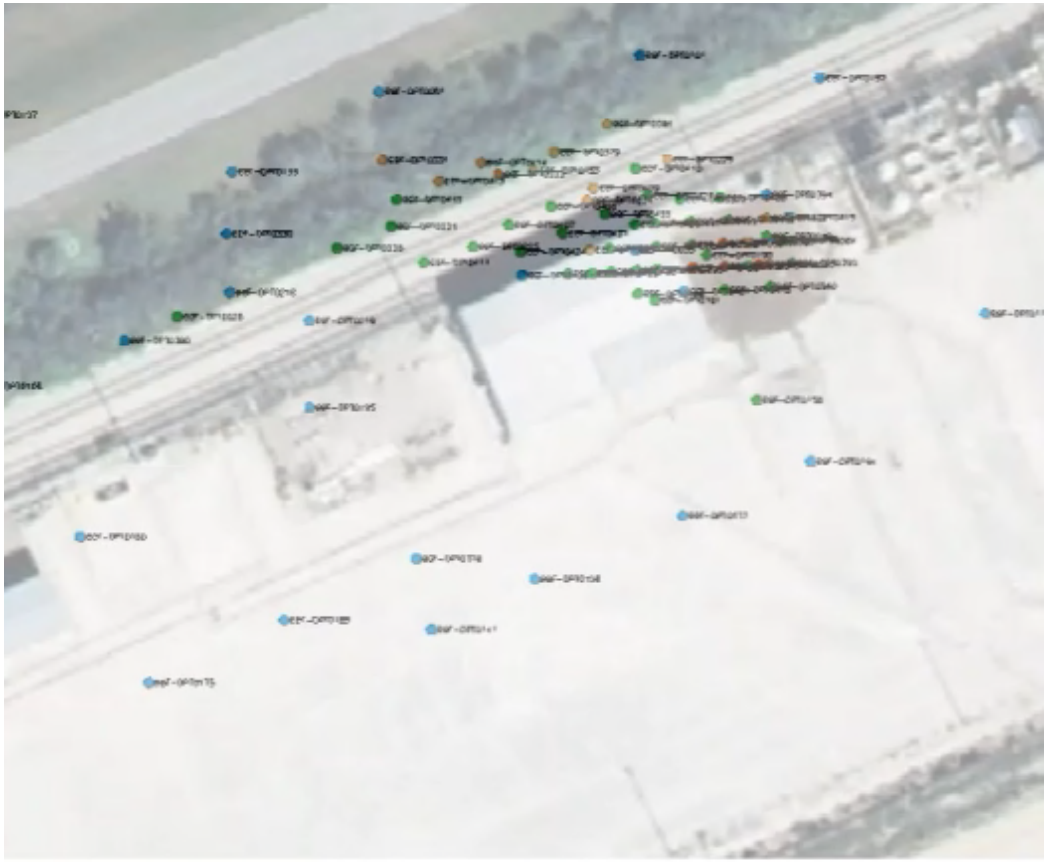
Hot Spot 2 Site Characterization





CCF East Characterization (EVS, TCE)

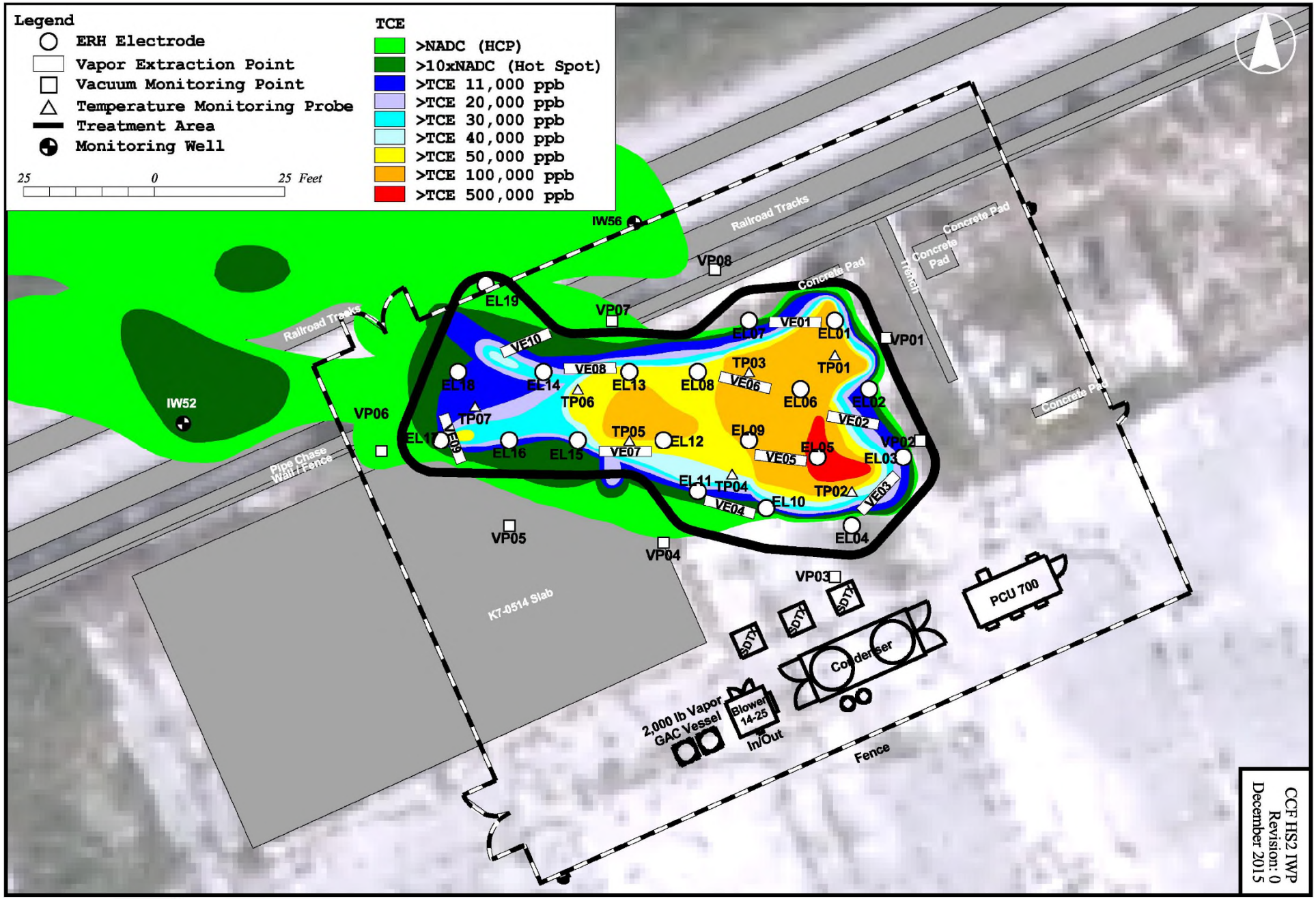




TCE Depth (feet): -8

Remedy Selection

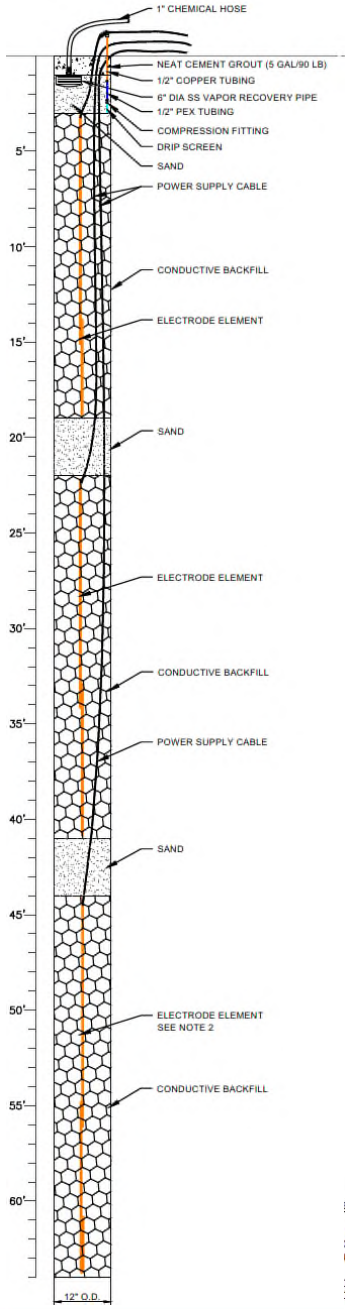
- ERH selected under following rationale:
  - Cost efficient removal of contaminant mass
  - Treatment operations continued until treatment objective reached
  - Flexible/highly optimizable technology
  - Risk management (only technology with treatment performance guarantee)
- IM objective/exit strategy: Reduce concentrations within TCE >3,000 µg/L contour to support transition to MNA (i.e. treat source zone to <NADCs)


Legend
ERH Electrode
Vapor Extraction Point
Vacuum Monitoring Point
Temperature Monitoring Probe
Treatment Area
Monitoring Well
25 0 25 Feet
TCE
>NADC (HCP)
>10xNADC (Hot Spot)
>TCE 11,000 ppb
>TCE 20,000 ppb
>TCE 30,000 ppb
>TCE 40,000 ppb
>TCE 50,000 ppb
>TCE 100,000 ppb
>TCE 500,000 ppb
IW56
IW52
VP08
VP07
VP06
VP05
VP04
VP03
VP02
VP01
EL19
EL18
EL17
EL16
EL15
EL14
EL13
EL12
EL11
EL10
EL09
EL08
EL07
EL06
EL05
EL04
EL03
EL02
EL01
VE10
VE08
VE07
VE06
VE05
VE04
VE03
VE02
VE01
TP07
TP06
TP05
TP04
TP03
TP02
TP01
Railroad Tracks
Railroad Tracks
Concrete Pad
Concrete Pad
Concrete Pad
Trench
Pipe Chase Wall / Fence
K7-0514 Slab
SDTH
SDTH
SDTH
Condenser
PCU 700
2,000 lb Vapor GAC Vessel
Blower 14-25 In/Out
Fence
CCF HS2 IWP
Revision: 0
December 2015

ERH Layout

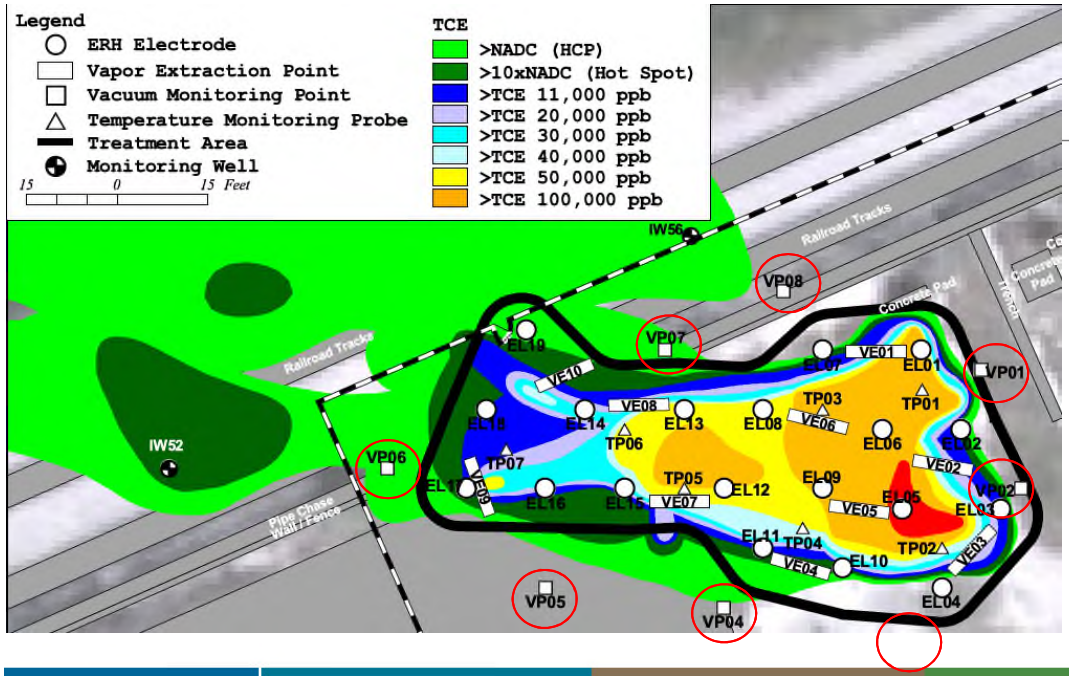
Electrode Installation

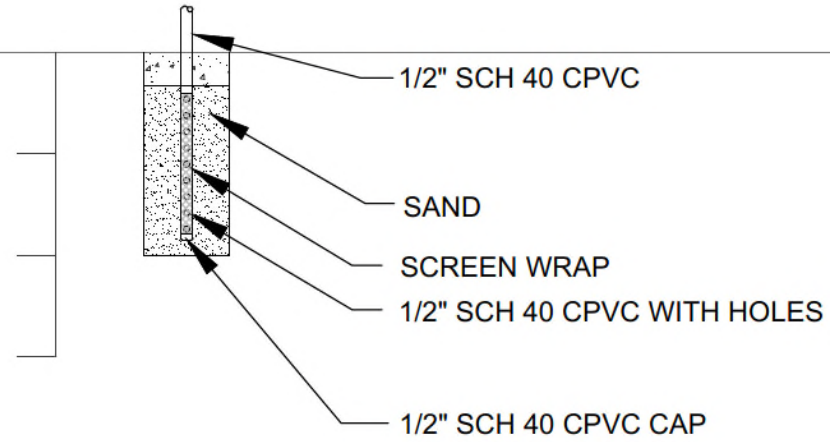
- 19 electrodes (12” sonic boring)
- Three elements per electrode (57 elements total)
  - Element 1: 3 to 19 feet bls (16-foot element)
  - Element 2: 22 to 41 feet bls (19-foot element)
  - Element 3: 44 to 64 feet bls (20-foot element)
- Elements installed in graphite and steel shot conductive material
- 3-foot fine sand layer installed between elements
- 6” diameter vapor extraction screens installed 1 feet bls
- Drip tubing screens placed at 3 feet bls
- One boring continuously cored
  - Conducted at electrode H4
  - Lithologic logging
  - PID screening
  - TOC samples collected (every 5’)



VMP Installation

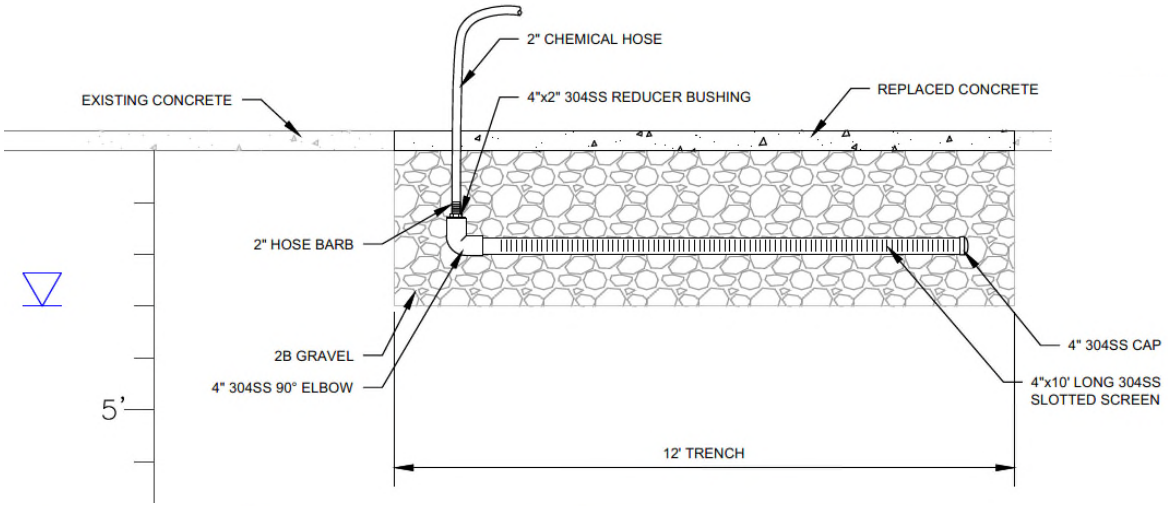
- 8x vapor monitoring probes (VMPs)
- Installed along perimeter to monitor vacuum capture
- Vacuum readings measured with a magnehelic gauge





VE Installation

- 10x horizontal VE screens
- 10 ft long, 4 inch diam., 20 slot screens
- Installed to maximize vapor capture in treatment area with thin vadose zone
- Operated in addition to electrode VE points



Electrode field prepped for cabling and piping.

Installing VE piping and cabling.

Temperature Monitoring Probe surface completion.

Electrode surface completion (3x cables, electrode drip, VE)

Completed electrode field (facing southwest).

Completed electrode field (facing northwest).

Power control unit and step down transformers.

Condenser/cooling tower skid and liquid-phase GAC.

Cooling tower (middle) and vapor-phase GAC (right).

3x 3,000 lb vapor-phase GAC vessels.

ERH Equipment Installation

Security camera (facing western gated entrance)

Security camera (overviewing electrode field).

Hazard signage (50’ intervals along fenceline)

Motion sensor (in right foreground).

Vapor Extraction Commissioning

- Conducted to verify vapor capture before energizing electrodes
- Blower set with variable frequency drive for condenser skid inlet vacuum of 15 inches of water column at 415 scfm
- Magnehelic readings at VMPs >0.5 in. w.c. around perimeter of electrode field
- Based on vacuum readings, VE system deemed to have adequate capture of vadose zone to commence with ERH commissioning
- VE system operational through ERH commissioning, startup, and full-scale operation

Step and Touch Voltage Survey

- Conducted to survey site for stray surface voltages
- Tested locations of potential receptor surface contact
- Conducted in voltage steps of 200V, 375V, 600V (max voltage)
  - Readings multiplied by voltage scaling factors based on step voltage
  - For example, 200V survey readings were multiplied by 3x
- Voltage survey thresholds (OSHA standard – 50V at surface):
  - 5V in unrestricted area (outside ERH perimeter fence)
  - 10V in restricted area (in ERH perimeter fence)

Step and Touch Voltage Mitigation

Surface voltages identified above thresholds at:

- Existing fenceline to the west of ERH perimeter fence
  - Mitigation: remove top rail, over-sleeve with PVC, coat vertical rail brackets with insulating surface cover
- Western-most ERH step-down transformer
  - Mitigation: install voltage isolation mat bonded to transformer
- Hose bib for potable water service connection
  - Mitigation: Coat metallic parts with insulating surface cover
- Stainless steel valve and piping from former operations
  - Mitigation: Piping excavated and removed sub-grade
- Following mitigation, surface voltage re-measured and confirmed below thresholds

Surface voltage survey (at PCU entrance).

Surface voltage survey (at step-down transformers).

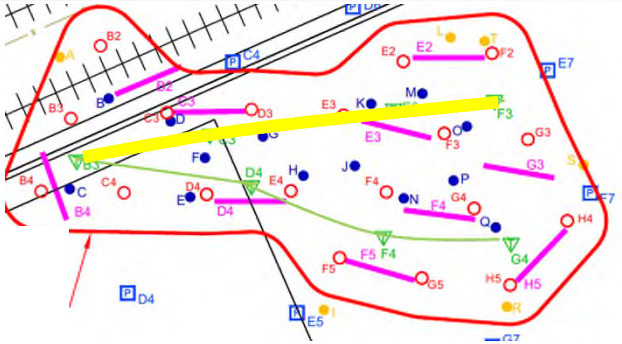
Surface voltage mitigation along western fenceline.

Surface voltage mitigation at western step-down transformer.

Commissioning and Startup

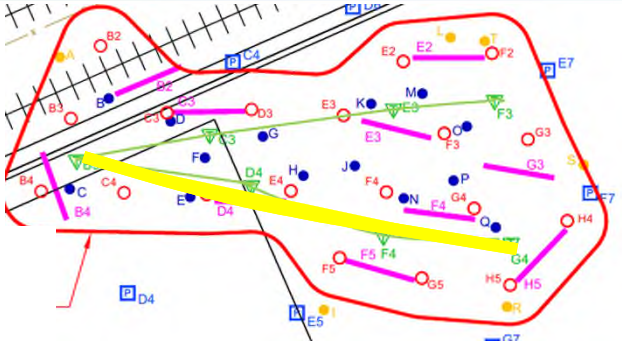
- Full scale operations began on 5/5/2016
- Daily PID and ambient air monitoring (8-hr TWA summa canisters; TO-15)
- Daily influent sampling (grab summa samples; TO-15)
- PID process monitoring (PID at influent, VPGAC midfluent/effluent)
- Routine process logging (manual and SCADA logging)
- Daily amperage surveys at each element cable (57 elements)
  - Adjusted voltage by cable position changes on stepdown transformers
- Startup completed without any notable issues

Temperature Monitoring Data

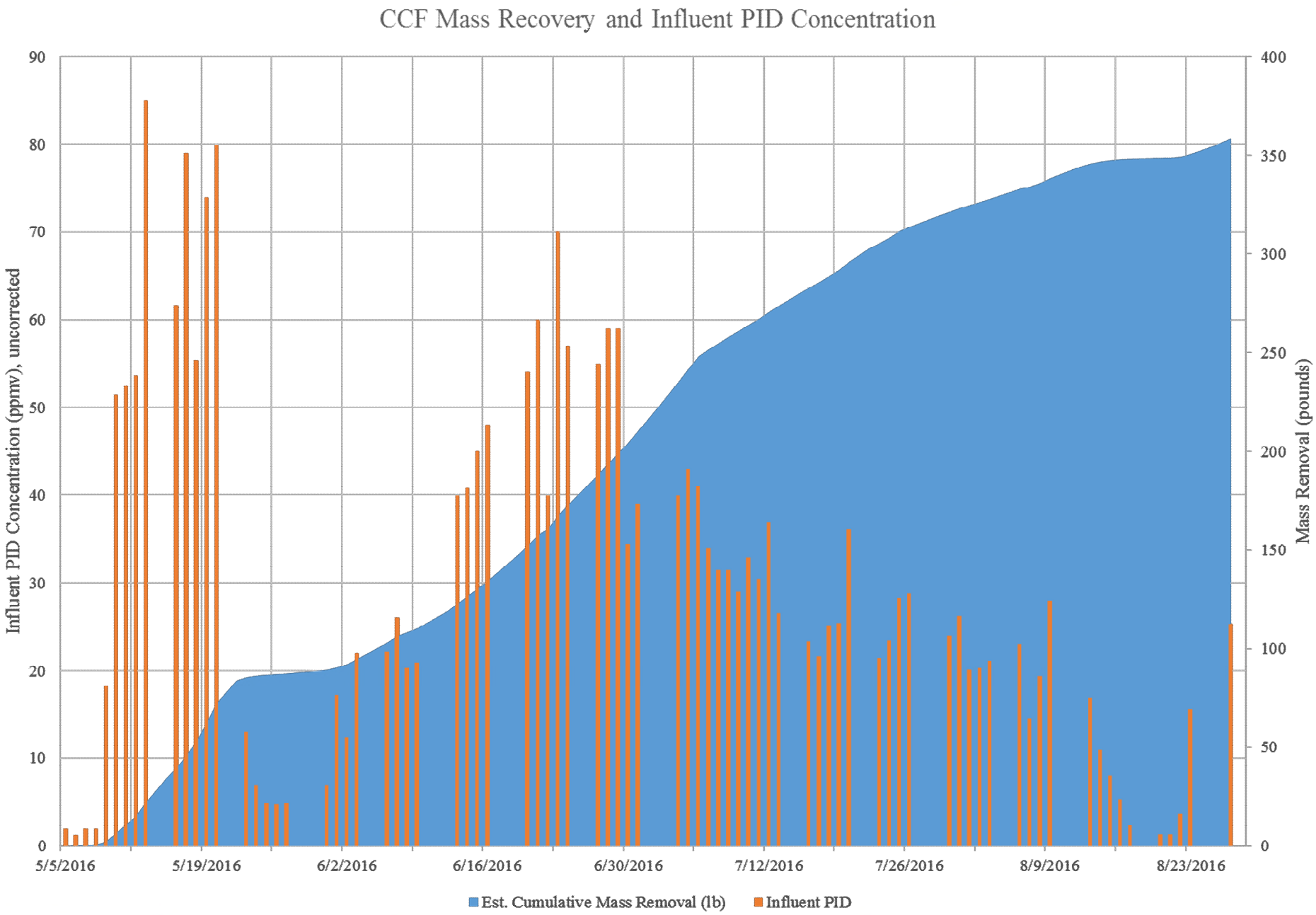


Note: Horizontal TMP distances not scaled.

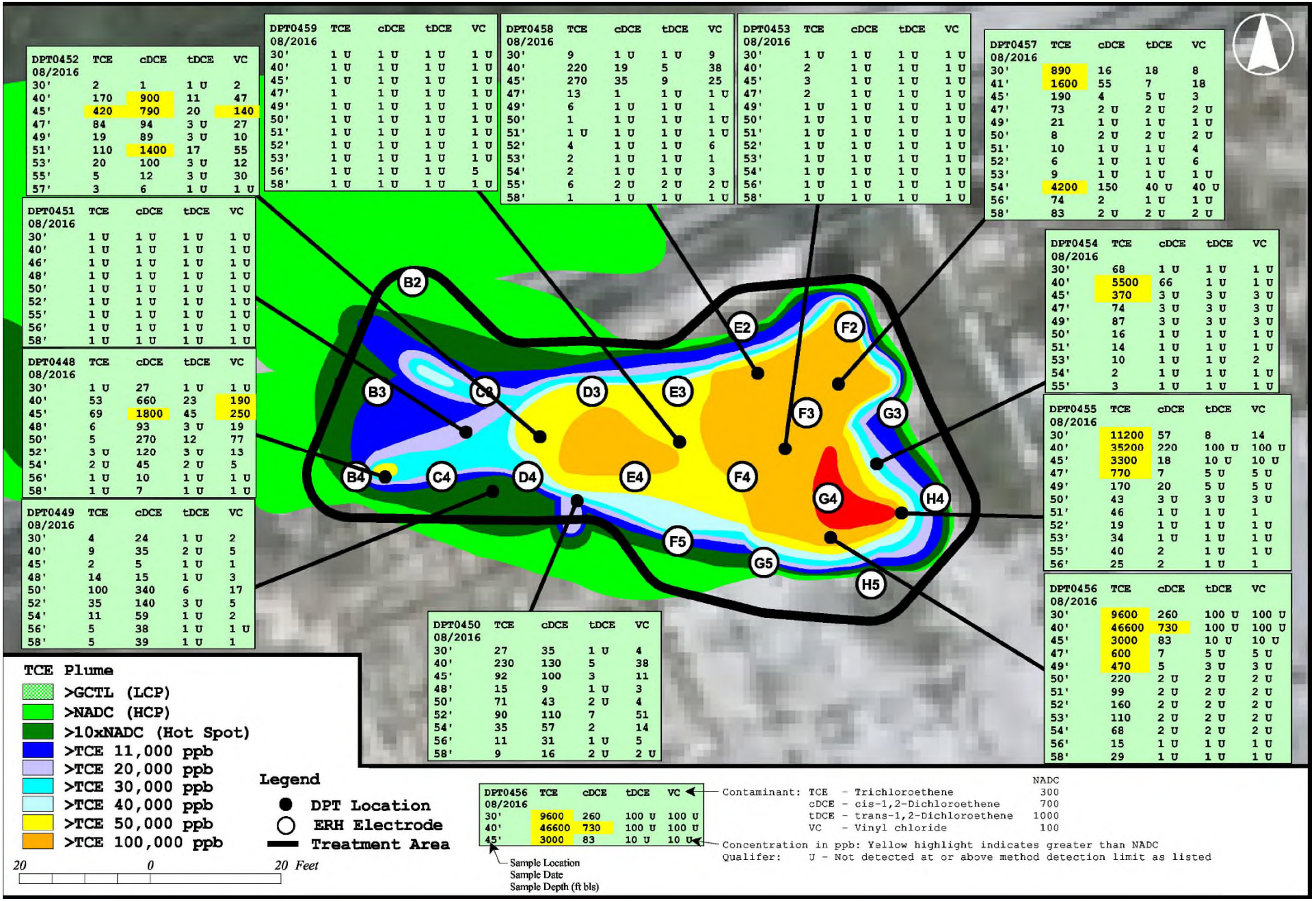
Temperature Monitoring Data



Note: Horizontal TMP distances not scaled.



Influent Concentrations and Mass Removal


DPT0452 TCE cDCE tDCE VC
08/2016
30' 2 1 1 U 2
40' 170 900 11 47
45' 420 790 20 140
47' 84 94 3 U 27
49' 19 89 3 U 10
51' 110 1400 17 55
53' 20 100 3 U 12
55' 5 12 3 U 30
57' 3 6 1 U 1 U
DPT0459 TCE cDCE tDCE VC
08/2016
30' 1 U 1 U 1 U 1 U
40' 1 U 1 U 1 U 1 U
45' 1 U 1 U 1 U 1 U
47' 1 1 U 1 U 1 U
49' 1 U 1 U 1 U 1 U
50' 1 U 1 U 1 U 1 U
51' 1 U 1 U 1 U 1 U
52' 1 U 1 U 1 U 1 U
53' 1 U 1 U 1 U 1 U
56' 1 U 1 U 1 U 5
58' 1 U 1 U 1 U 1 U
DPT0458 TCE cDCE tDCE VC
08/2016
30' 9 1 U 1 U 9
40' 220 19 5 38
45' 270 35 9 25
47' 13 1 1 U 1 U
49' 6 1 U 1 U 1
50' 1 1 U 1 U 1 U
51' 1 U 1 U 1 U 1 U
52' 4 1 U 1 U 6
53' 2 1 U 1 U 1
54' 2 1 U 1 U 3
55' 6 2 U 2 U 2 U
58' 1 1 U 1 U 1 U
DPT0453 TCE cDCE tDCE VC
08/2016
30' 1 U 1 U 1 U 1 U
40' 2 1 U 1 U 1 U
45' 3 1 U 1 U 1 U
47' 2 1 U 1 U 1 U
49' 1 U 1 U 1 U 1 U
50' 1 U 1 U 1 U 1 U
51' 1 U 1 U 1 U 1 U
52' 1 U 1 U 1 U 1 U
53' 1 U 1 U 1 U 1 U
54' 1 U 1 U 1 U 1 U
56' 1 U 1 U 1 U 1 U
58' 1 U 1 U 1 U 1 U
DPT0457 TCE cDCE tDCE VC
08/2016
30' 890 16 18 8
41' 1600 55 7 18
45' 190 4 5 U 3
47' 73 2 U 2 U 2 U
49' 21 1 U 1 U 1 U
50' 8 2 U 2 U 2 U
51' 10 1 U 1 U 4
52' 6 1 U 1 U 6
53' 9 1 U 1 U 1 U
54' 4200 150 40 U 40 U
56' 74 2 1 U 1 U
58' 83 2 U 2 U 2 U
DPT0451 TCE cDCE tDCE VC
08/2016
30' 1 U 1 U 1 U 1 U
40' 1 U 1 U 1 U 1 U
46' 1 U 1 U 1 U 1 U
48' 1 U 1 U 1 U 1 U
50' 1 U 1 U 1 U 1 U
52' 1 U 1 U 1 U 1 U
55' 1 U 1 U 1 U 1 U
56' 1 U 1 U 1 U 1 U
58' 1 U 1 U 1 U 1 U
DPT0454 TCE cDCE tDCE VC
08/2016
30' 68 1 U 1 U 1 U
40' 5500 66 1 U 1 U
45' 370 3 U 3 U 3 U
47' 74 3 U 3 U 3 U
49' 87 3 U 3 U 3 U
50' 16 1 U 1 U 1 U
51' 14 1 U 1 U 1 U
53' 10 1 U 1 U 2
54' 2 1 U 1 U 1 U
55' 3 1 U 1 U 1 U
DPT0448 TCE cDCE tDCE VC
08/2016
30' 1 U 27 1 U 1 U
40' 53 660 23 190
45' 69 1800 45 250
48' 6 93 3 U 19
50' 5 270 12 77
52' 3 U 120 3 U 13
54' 2 U 45 2 U 5
56' 1 U 10 1 U 1 U
58' 1 U 7 1 U 1 U
DPT0455 TCE cDCE tDCE VC
08/2016
30' 11200 57 8 14
40' 35200 220 100 U 100 U
45' 3300 18 10 U 10 U
47' 770 7 5 U 5 U
49' 170 20 5 U 5 U
50' 43 3 U 3 U 3 U
51' 46 1 U 1 U 1
52' 19 1 U 1 U 1 U
53' 34 1 U 1 U 1 U
55' 40 2 1 U 1 U
56' 25 2 1 U 1
DPT0449 TCE cDCE tDCE VC
08/2016
30' 4 24 1 U 2
40' 9 35 2 U 5
45' 2 5 1 U 1
48' 14 15 1 U 3
50' 100 340 6 17
52' 35 140 3 U 5
54' 11 59 1 U 2
56' 5 38 1 U 1 U
58' 5 39 1 U 1
DPT0456 TCE cDCE tDCE VC
08/2016
30' 9600 260 100 U 100 U
40' 46600 730 100 U 100 U
45' 3000 83 10 U 10 U
47' 600 7 5 U 5 U
49' 470 5 3 U 3 U
50' 220 2 U 2 U 2 U
51' 99 2 U 2 U 2 U
52' 160 2 U 2 U 2 U
53' 110 2 U 2 U 2 U
54' 68 2 U 2 U 2 U
56' 15 1 U 1 U 1 U
58' 29 1 U 1 U 1 U
DPT0450 TCE cDCE tDCE VC
08/2016
30' 27 35 1 U 4
40' 230 130 5 38
45' 92 100 3 11
48' 15 9 1 U 3
50' 71 43 2 U 4
52' 90 110 7 51
54' 35 57 2 14
56' 11 31 1 U 5
58' 9 16 2 U 2 U
B2
B3
C3
D3
E3
E2
F2
F3
G3
B4
C4
D4
E4
F4
G4
H4
F5
G5
H5
TCE Plume
>GCTL (LCP)
>NADC (HCP)
>10xNADC (Hot Spot)
>TCE 11,000 ppb
>TCE 20,000 ppb
>TCE 30,000 ppb
>TCE 40,000 ppb
>TCE 50,000 ppb
>TCE 100,000 ppb
Legend
DPT Location
ERH Electrode
Treatment Area
20 0 20 Feet
DPT0456 TCE cDCE tDCE VC
08/2016
30' 9600 260 100 U 100 U
40' 46600 730 100 U 100 U
45' 3000 83 10 U 10 U
Sample Location
Sample Date
Sample Depth (ft bls)
Contaminant: TCE - Trichloroethene NADC 300
cDCE - cis-1,2-Dichloroethene 700
tDCE - trans-1,2-Dichloroethene 1000
VC - Vinyl chloride 100
Concentration in ppb: Yellow highlight indicates greater than NADC
Qualifer: J - Not detected at or above method detection limit as listed

DPT # (DPT-0)	90% DPT Performance Monitoring Event (August 15-22, 2016) TCE Results (µg/L)															Max TCE Result, 90% PM	Max TCE Result, Pre-IM		% Reduction, TCE
	30'	40'	45'	47'	48'	49'	50'	51'	52'	53'	54'	55'	56'	57'	58'		Result	(DPT-0)	
DPT-0448	1 U	53	69		6		5		3		2 U		1 U		1 U	69	68,000	431	**99.899%**
DPT-0449	4	9	2		14		100		35		11		5		5	100	8,600	443	**98.837%**
DPT-0450	27	230	92		15		71		90		35		11		9	230	104,000	389	**99.779%**
DPT-0451	1 U	1 U	1 U		1 U		1 U		1 U		1 U		1 U		1 U	*0.5*	13,700	432	**99.996%**
DPT-0452	2	170	**420**	84		19		110		20		6		3		420	68,800	442	**99.390%**
DPT-0453	1 U	2	3	2	1 U	1 U	1 U	1 U	1 U	1 U	1 U		1 U		1 U	3	383,000	435	**99.999%**
DPT-0454	68	**5500**	**370**	74		87	16	14		10	2	3				5,500	655,000	386	**99.160%**
DPT-0455	**11200**	**35200**	**3300**	**770**		170	43	46	19	34		40	25			35,200	862,000	385	**95.916%**
DPT-0456	**9600**	**46600**	**3000**	**600**		**470**	220	99	160	110	68		15		29	46,600	1,430,000	436	**96.741%**
DPT-0457	**890**	**1600**	19	73		21	8	10	6	9	**4200**		74		83	4,200	383,000	435	**98.903%**
DPT-0458	9	220	270	13		6	1	1 U	4	2	2		6		1	270	459,000	434	**99.941%**
DPT-0459	1 U	1 U	1 U	1		1 U	1 U	1 U	1 U	1 U	1 U		1 U		1 U	1	112,000	398	**99.999%**

Notes: TCE >NADC results bolded

Average of % Reduction: 99.047%

Daughter products not included in evaluation; reference tag map for daughter product results.

Lessons Learned

- Suggest team collect foc/TOC soil data during investigations
  - Site-specific data can refine mass by orders of magnitude
- Site conditions can change between design and installation. Ensure the installation is appropriate for site conditions
  - DPT baseline sampling is encouraged prior to IM implementations
- Sonic electrode installation significantly reduced waste
  - Minimal drilling spoils and liquid IDW treated onsite with mobile air stripper
  - Sonic drillers with 12-inch boring capabilities are limited – prepare in advance
- Incorporate sufficient time for electrical review and procurement
  - Larger transformers have 3 to 6 month lead-time from specification approval
- Subsurface at CCF/KSC is amenable to ERH
- Effective communication with support stakeholders is paramount (e.g., KSC/ISC electrical support, railway manager, excavation permit inspectors)
- Continuous data review and subcontractor interaction an important aspect of efficiently optimizing ERH remedy performance

Path Forward

- IM is constructed and operating as designed
- Conduct milestone DPT performance monitoring (via hot sampling):
  - Event 1 – at 90% estimated reduction: Complete
  - Event 2 – at 100% estimated reduction: week of September 12, 2016
  - Event 3 – post-shutdown monitoring: TBD
- Discontinue operations based on multiple lines of evidence (groundwater concentrations, temperatures, VE influent concentrations, etc.)

*