An Aqueous Method of Crude Oil Emulsification is Proving to be Effective at Remediating Tank Batteries and Other Hydrocarbon Releases

IPEC 2014

William Lundy Sr.

DeepEarth Technologies, Inc.

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The Traditional Solution

- **Type of Spill** (*Oil – Brine – Both*)
- **Location of Spill**, (*Proximity to Water, Sources, People, Buildings, Site Structures, Roads, etc.*
- **Type of Soil** (*Clay, Sand, Other*)
- **Time constraints** (*Odor, Public Perception, etc.*)
- **Regulatory Impacts** (*Notifications, etc.*)
- **Select Cleanup Method** (Generally Landfill)

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Typical Approaches to Spill Cleanup

- Site spill assessment
- Containment of the spill
- Collect “free” oil using mechanical means such as oil booms, skimmers or vacuum trucks.
- Excavate all contaminated material from the area.
- Dispose of contaminated material at a site accepting hazardous waste
- Haul in new soil and compact in place.

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The Proposed New Order

Reduce Waste Generation

- Controlled – In Plant
- Uncontrolled – Production Releases

Reuse

- On-site treatment
- Limit Excavations (Landfill Impact)

Recycle

- Use Treated Waste for Cover, etc.

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Chemical Oxidation & Bioremediation

- Chemical Oxidation can Completely (Carbon Dioxide) & Partially (Hydroxylate) Oxidize Hydrocarbons
- Partially Oxidized Hydrocarbons Are Highly Biodegradable
- *Cool-Ox*® - Oxidizes Hydrocarbons but, Does Not Kill Bugs
- Not Exothermal – No VOC volatilization
- Optimizes at Near Neutral pH (8.0)
- No Sodium (Na) or Potassium (K)! Thus – SAR is Reduced)
- No Corrosion – No Persulfate compounds
- Flammability – Static Discharge protected
- Long Term, On-Going Oxidation (90-120 days)

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What is Cool-Ox®?

- *Green* In-situ and Ex-situ Oxidation technology leaving no by-products
- Treats both soil and groundwater
- Uses food grade chemical oxidants
  - Clean Hydrogen peroxide, H_2O_2
- Most Important – Destroys Contaminants

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The Chemistry

(Produce Hydrogen Peroxide In-Situ)

$$CaO_2 + H_20 \rightarrow Ca^{+2} + OH^{-1} + H_2O_2 + O_2$$

(Chelates Activate Intrinsic Catalysts – Produces Radicals)

$$H_2O_2 + Fe^{+2} \rightarrow OH^{-1} + [OH]^{\bullet} + Fe^{+3}$$

$$H_2O_2 + Fe^{+3} \rightarrow OH^{-1} + [OOH]^{\bullet} + Fe^{+2}$$

(Radicals React with Contaminants – Oxidation By-products)

$$[OH]^{\bullet} \,\&\, [OOH]^{\bullet} + C_x \rightarrow C_x(OH)_y + CO_2$$

(Biodegradable By-products Used by Microbes)

$$C_x(OH)_y + O_2 \rightarrow CO_2$$ Totally Green

(Reductive Dechlorination)

$$_nC_2(Cl)_x + (OH)^- \rightarrow {}_nCO_2 + (Cl)^-$$

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What is a "Green" Process?

- Non-toxic
  - *Safe for the environment and people who handle the product*
- Renewable & Sustainable
  - *Product ingredients are derived from sources that do not deplete the environment*
  - *The product source(s) meet today's needs without compromising future supply*
- Commercial Viability
  - *The process works better than conventional technology for the intended purpose*
  - *The process makes sense economically*

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The Current Scene

- Increasing numbers of accidental oil spills requires effective remedial solutions.
- Excavation and disposal of contaminated soils is the traditional remedy but, is growing less acceptable.
- Proper application of chemical oxidation Coupled with Subsequent Bioremediation (*Cool-Ox* Technology) can provide a solution.

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Contact is Vital

Why is the method of delivery in the field so important?

- Contact Sport!
- The oxidant and contaminant must meet for a chemical reaction to occur.
- Proper application is vital to a successful remedial project.
- Nothing beats Know-How!

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The Deep-Shot™ Rig

Formulating – Mixing - Pumping

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Hydro-Dart™ Application

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Tank Battery

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Well Pumps

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Reactions

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Treatment at Well Head

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Crude Release

Pretreatment

Treated

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4 Weeks Post Treatment

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Large Spill

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Typical Old Release

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MGP Site

Tar well

Excavating
Look at the Bucket

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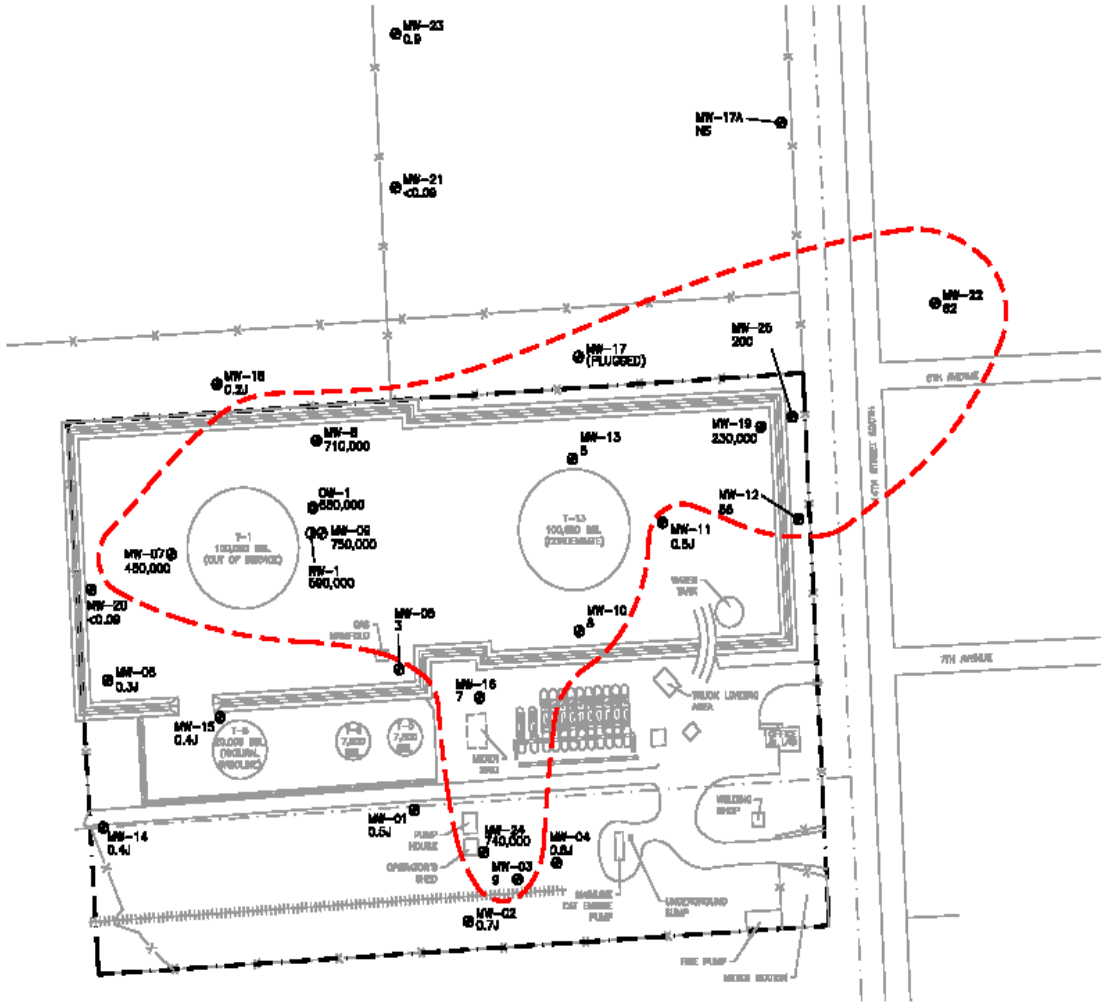
Groundwater Impact



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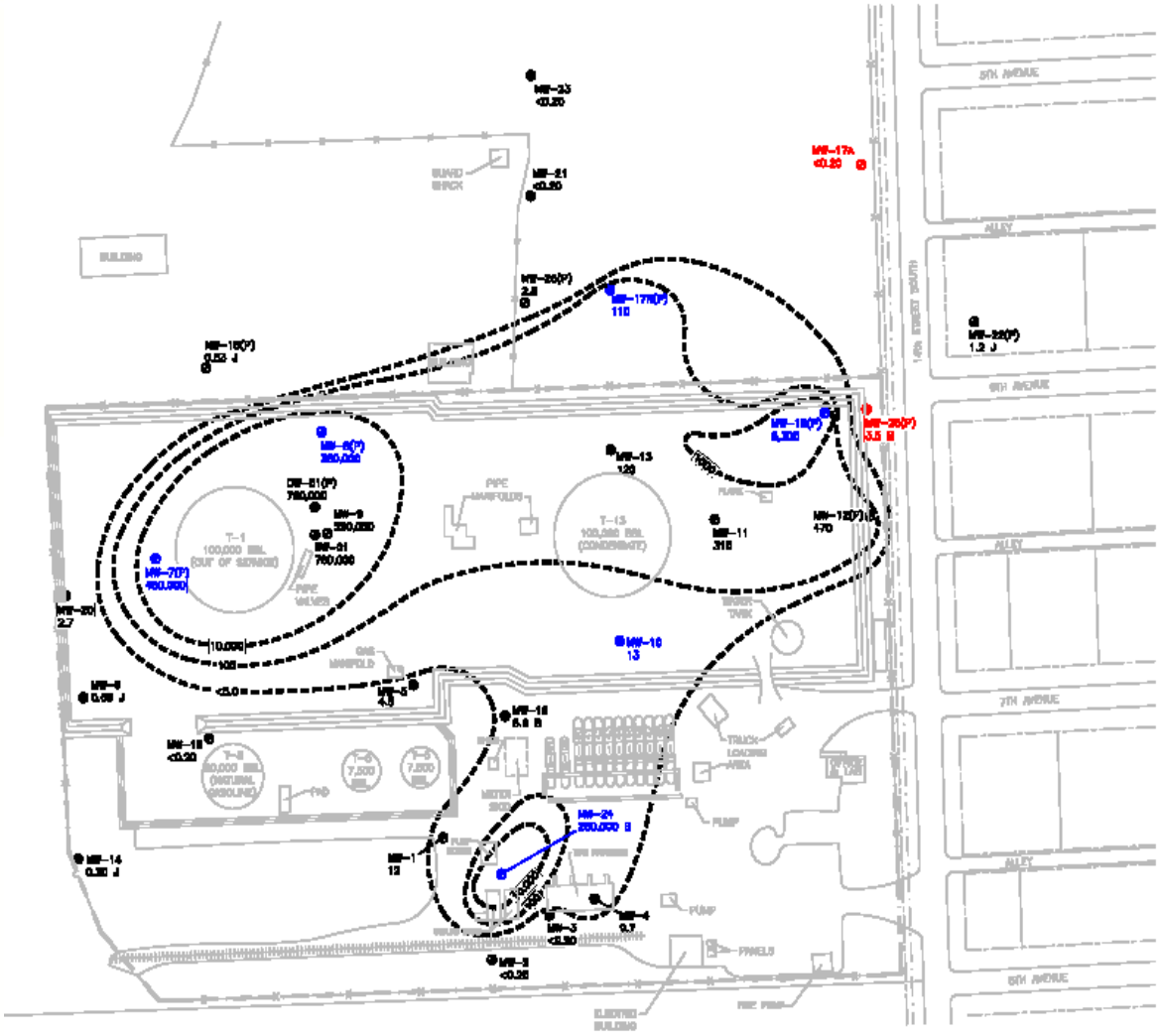
Post Injection– 2 Wks



LEGEND

MW-1	MONITORING WELL
OW-01	OBSERVATION WELL
RW-01	RECOVERY WELL
MW-13	POINT OF EXPOSURE (POE) WELL
MW-10	ATTENUATION MONITORING POINT (AMP) WELL
(P)	EXISTING MONITORING WELL TO BE USED AS PERFORMANCE MONITORING WELL
	ABOVEGROUND STORAGE TANK
	FENCE
	DITCH
	RIGHT OF WAY
	PROPERTY BOUNDARY
<5.0	BENZENE PCL EXCEEDENCE ZONE PCL = 5.0 ug/L
310	BENZENE CONCENTRATION IN ug/L
J	RESULT IS LESS THAN THE MDL BUT GREATER THAN OR EQUAL TO THE SQL AND THE CONCENTRATION IS AN ESTIMATED VALUE.

0 60 120
APPROXIMATE SCALE IN FEET

N

RSA Rosenquist, Smith & Associates, Inc.

BENZENE GROUNDWATER CONCENTRATION MAP
MARCH 2008

DRAWN BY: TTO | PROJECT NO. –

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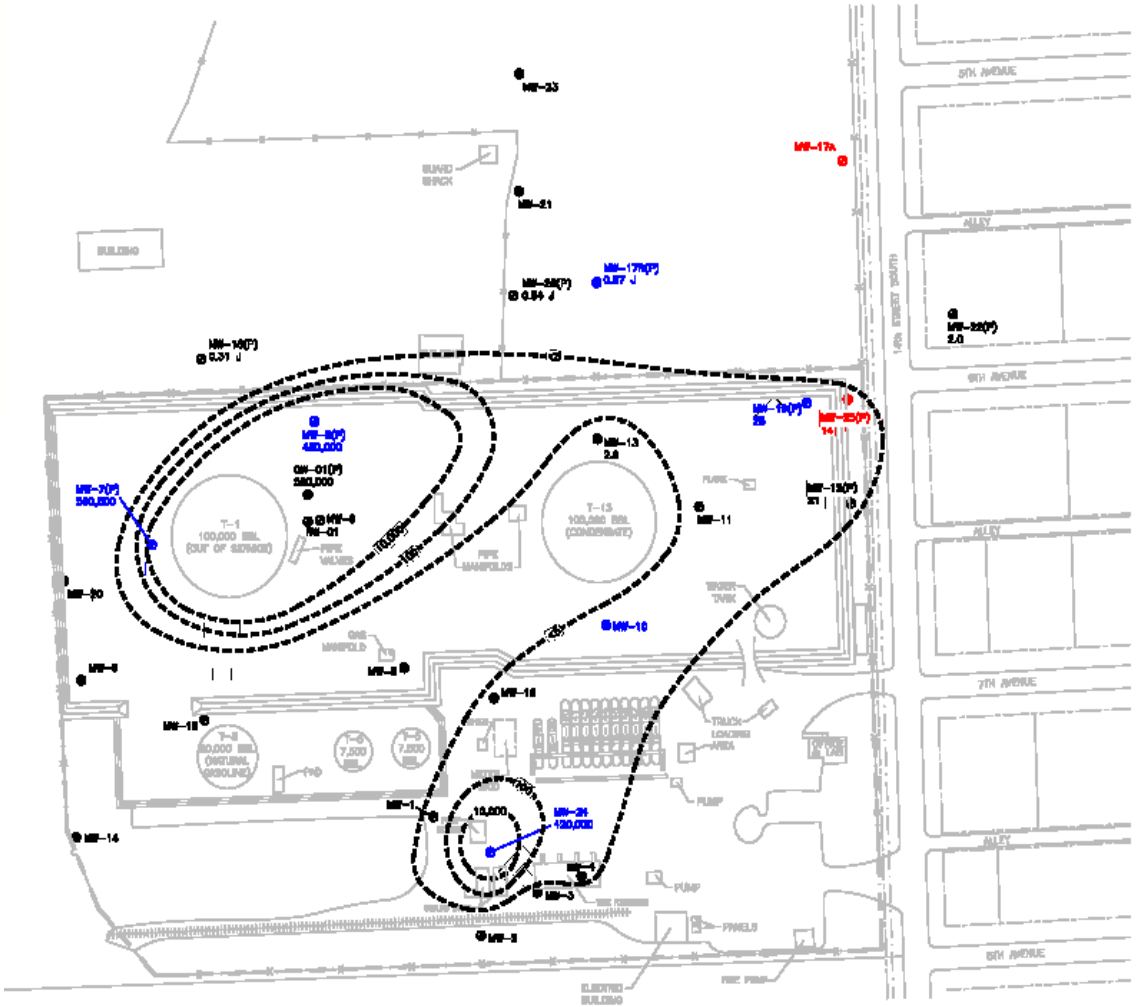
Post Injection– 3 Mos



LEGEND

MW-1 ⊕	MONITORING WELL
OW-01 ⊕	OBSERVATION WELL
RW-01 ⊕	RECOVERY WELL
MW-13 ⊕	POINT OF EXPOSURE (POE) WELL
MW-19 ⊕	ATTENUATION MONITORING POINT (AMP) WELL
(P)	EXISTING MONITORING WELL TO BE USED AS PERFORMANCE MONITORING WELL
◯	ABOVEGROUND STORAGE TANK
	FENCE
	DITCH
	RIGHT OF WAY
	PROPERTY BOUNDARY
<5.0	BENZENE PCL EXCEEDENCE ZONE PCL = 5.0 µg/L
310	BENZENE CONCENTRATIONS IN µg/L

NOTES:
1.) BENZENE PCLE ZONE ESTIMATED USING MARCH & JUNE 2008 DATA.
2.) MW-13 & MW-24 ADDED TO PERFORMANCE SAMPLING FOR THE JUNE 2008 EVENT.

N

0 60 120
APPROXIMATE SCALE IN FEET

RSA Risenhoover, Smith & Associates, Inc.

BENZENE GROUNDWATER CONCENTRATION MAP
JUNE 2008

DRAWN BY: TTD | PROJECT NO. –
CHECKED BY: DM | DATE: 07/24/08

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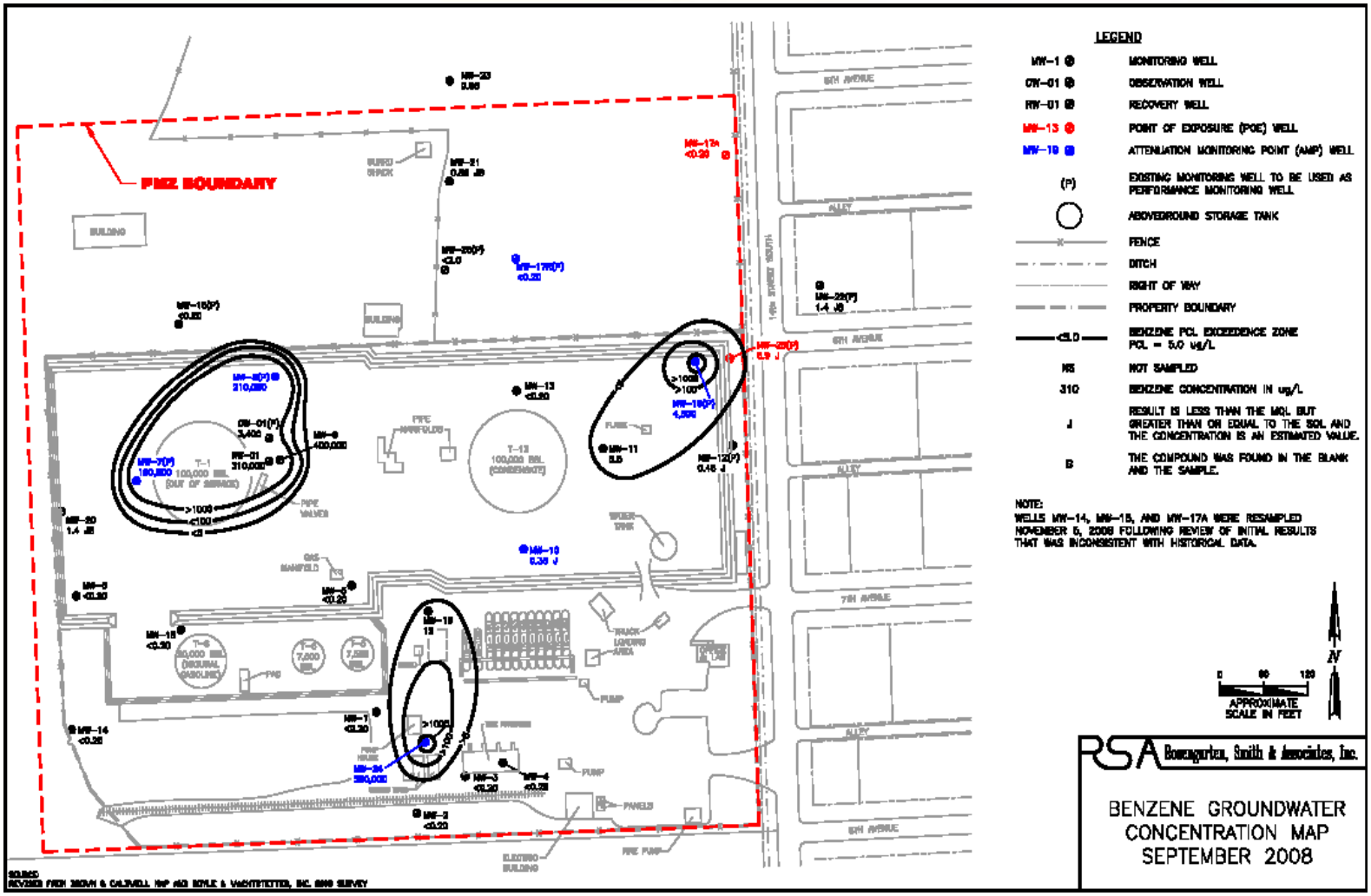
Post Injection – 6Mos



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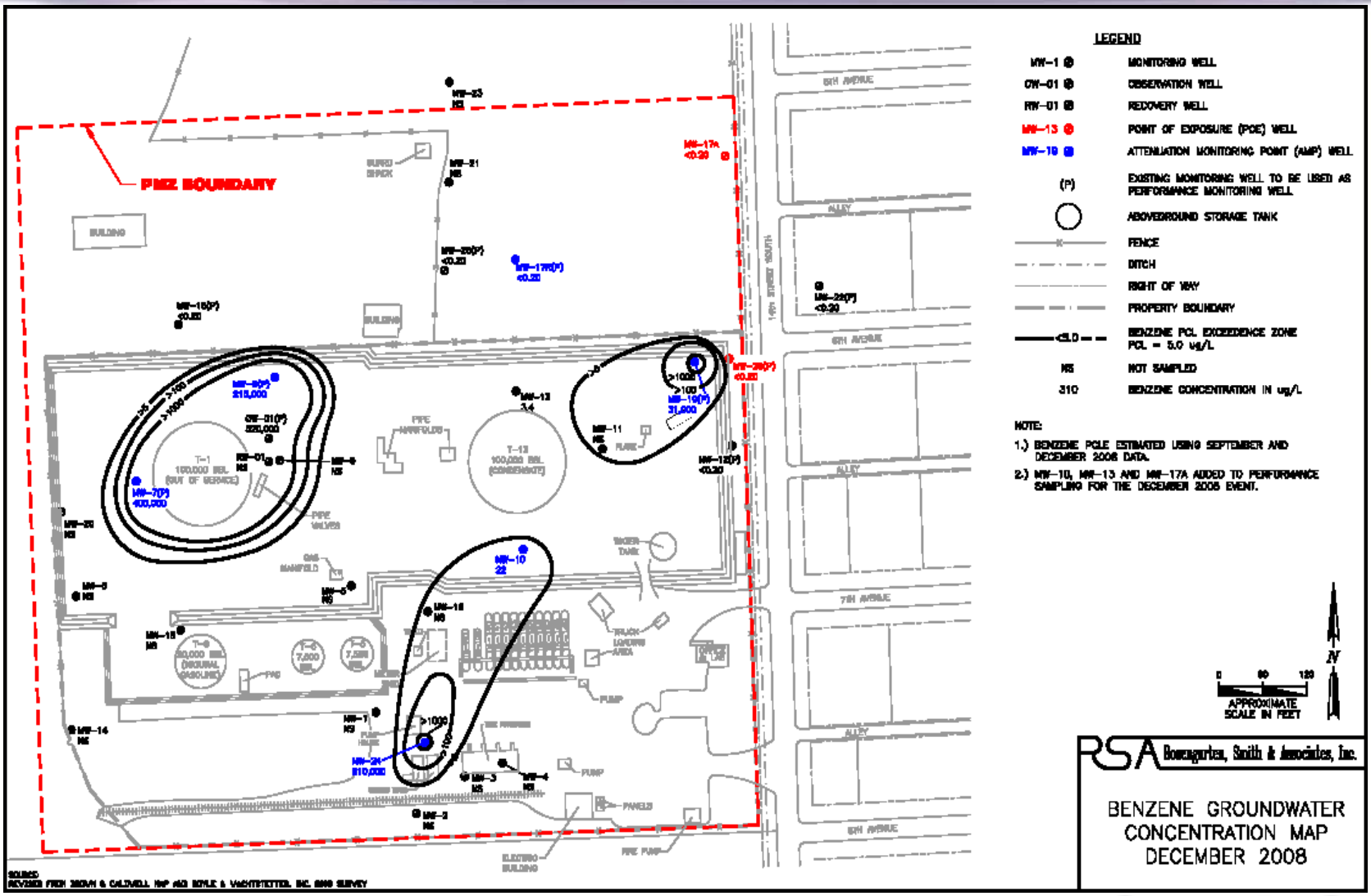
Post Injection– 9 Mos



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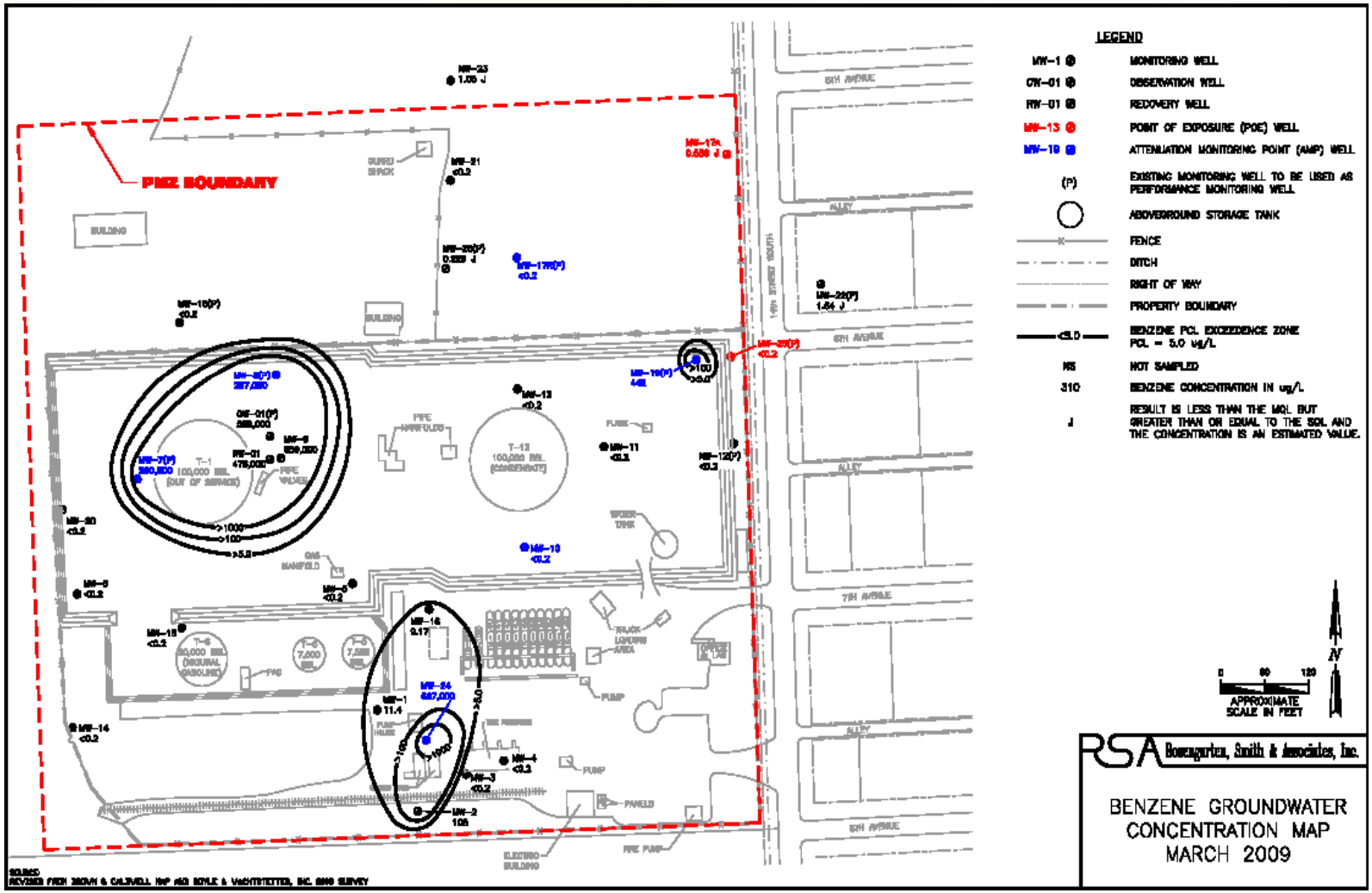
Post Injection– 12 Mos



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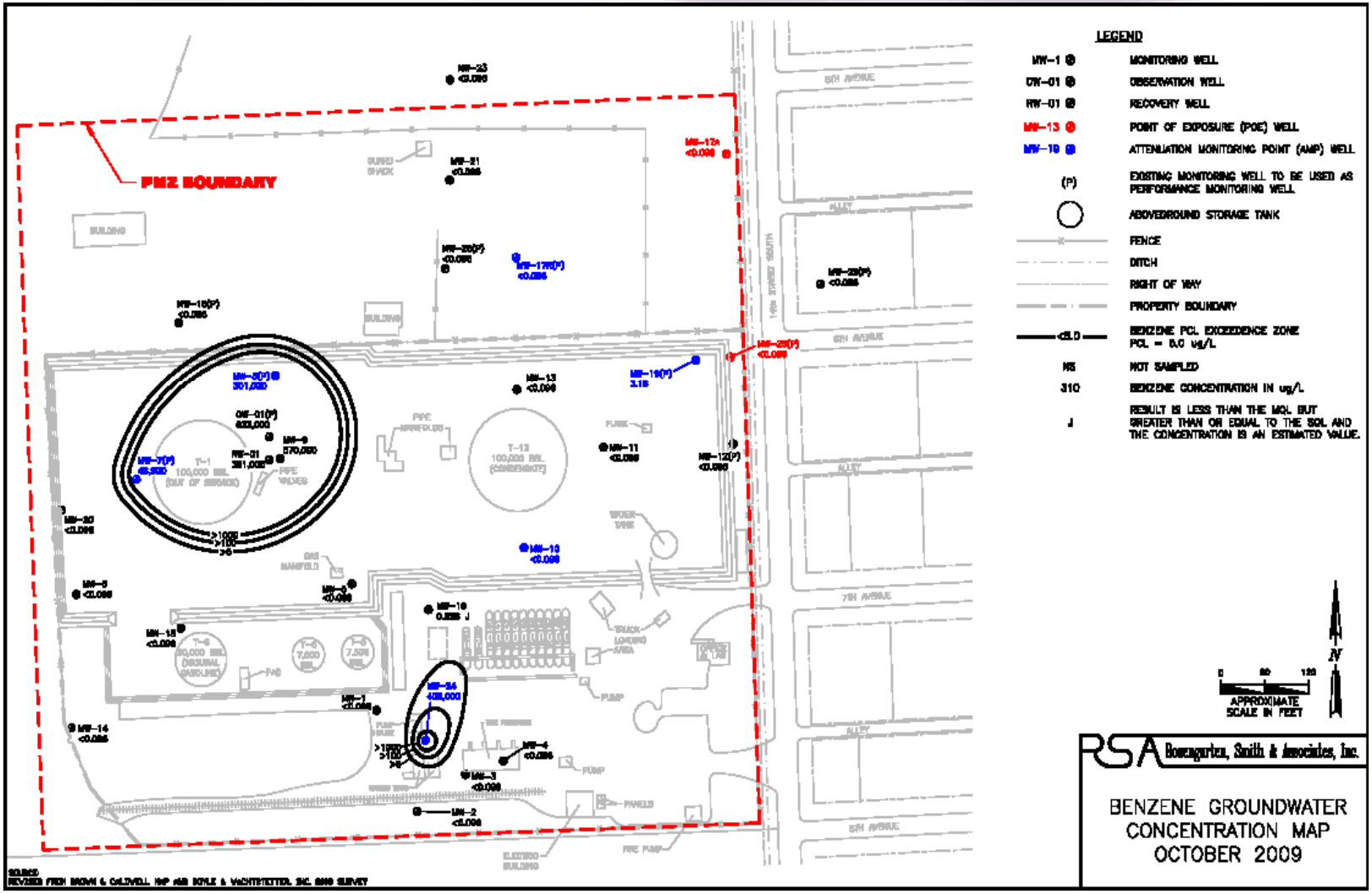
Post Injection– 18 Mos



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Conclusions in the Midstream Production

Analytical Results of Samples Collected from Garfield County, Colorado Natural Gas Production Facilities (Treated with *Cool-Ox*™)

Sample #	Description	Reactor Time	pH	EC	SAR	Benzene	Toluene	EB	Xylene	TRPH
#1	From Drill Pit									
		Day "0"	7.4	14160	76.6	68.5	154	ND	291	58.7
		Day 28	7.5	35490	4.7	ND	ND	ND	87.3	11.7
						100%	100%		70%	80%
#2	Seperator Sludge									
		Day "0"	9.2	11640	57.3	ND	ND	ND	151	2,530
		Day 28	10.6	6000	5	ND	ND	ND	ND	804
									100%	68.20%
#3	Land Farm Native Soil									
		Day "0"	8.8	3852	23.3	ND	ND	ND	ND	ND
		Day 28	8.3	13680	1.4	ND	ND	ND	ND	ND
#4	Land Farm Frac Sand									
		Day "0"	8.9	48840	91.2	577	2,580	228	159,000	83,600
		Day 28	8.4	18930	6.7	ND	594	49	87,000	36,500
						100%	77%	78.50%	45.3%	56.30%
#5	Pit Cuttings									
		Day "0"	8.5	10740	10.9	161	226	ND	264	48,800
		Day 28	6.5	8550	2.2	ND	ND	ND	36.3	121
						100%	100%		86.3%	99.8%
#6	Frac Sand									
		Day "0"	8.8	969	2.1	2,340	90,200	9,550	576,000	344
		Day 28	9.6	7920	0.8	ND	2,580	1,320	75,400	121
						100%	97.3%	86.2%	86.9%	64.8%
#7	Production Waste									
		Day "0"	8.5	1290	4	ND	ND	ND	ND	796
		Day 28	12.1	8880	0.6	ND	ND	ND	ND	376
										52.8%
#8	Frac Sand (Ten-150 Yard Piles)									
		Day "0"	9	19140	78	ND	121	ND	1,510	3,330
		Day 28	11.2	7620	2.5	ND	ND	ND	ND	1,580
							100%		100%	52.6%

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Another Large Site

- *2,072 injection points*
- *10,284 injected feet*
- *154,260 gallons of Cool-Ox®*
- *9,020 safe work hours during the coldest 5 months that Philadelphia has seen in a long time (63 inches of Snow – Av 13 inches)*
- *6” DNAPL Halogens (DDT, CE, CB, DCE, DCA, HC)*
- *69% Mass Reductions – one appl.*

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Thank You !

William Lundy Sr.

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Remember Total Green

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Deep or Highly Weathered Contamination

- ***Highly weathered hydrocarbon***
  - High fractions of heavy hydrocarbons & high TPH at bioremediation endpoint
- ***Deep contamination***
  - Excavation?
  - Cost of excavation increases with depth & volume of contaminated soil
  - Risks of exposure increase
- ***The need for speed***
  - Small spills
  - Immediate threat to environmental receptor
  - High evaporation rates (VOCs) and odor issues

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Site Locations

LEGEND

STATES TREATED WITH COOL-OX TECHNOLOGY

DEEPEARTH TECHNOLOGIES INC. SITE CLOSURES - AND PENDING CLOSURE

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