USE OF PERMEABLE REACTIVE BARRIER TO BIOREMEDIATE A PETROLEUM HYDROCARBON GROUNDWATER PLUME

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Site Background



- 1980s Gasoline Release
- Soil and Groundwater Impacts
- LNAPL Historically
 Observed in Source and
 Downgradient MWs
- MWs Adjacent to Downgradient Wetland Area Contain Dissolved Volatile Petroleum Hydrocarbons

Remedial Response Actions Time Line

- Soil Vapor Extraction (SVE) System Installation (1991 1996)
- Groundwater Recovery and Treatment System (1992 1996)
- Air Sparge/SVE (2004 2007)
- ISCO Injection Pilot Test (2009 2010)
- Interceptor Trench and Recirculation System (2011 Present)
- BOS 200[®] PRB Pilot Test (June 2015)
- BOS 200[®] Full Scale PRB (November 2015)
- BOS 200[®] PRB Extension (February 2017)

BOS 200[®] Product Description

- Remediation Products Inc. (RPI), located in Golden Colorado
- Trap & Treat[®] in-situ technology
- Complete system that accelerates biodegradation of various organic compounds on an activated carbon platform that includes:
 - Micro and macro nutrients
 - Time release electron acceptors
 - Blend of facultative organisms => key to efficiency
- "Trap" Carbon Adsorption "Treat" Biodegradation
- Flourish in aerobic and anaerobic conditions
- Mixed with water to create a slurry
- PRBs constructed by injection using tight grid pattern or trenching

Difficult Site Conditions Required Injection



- Large Throughput Fueling Facility (Safety!)
- ~25 to 30 feet of Fill Material Overlying Saturated Zone

BOS 200[®] PRB Design



- ~150 feet long
- 88 Injection Points
- 4 rows of injection points ~7.5 ft spacing
- Vertical Interval 26' to competent bedrock (34' to 57' bgs)
- ~45,000 lbs of BOS 200[®] & 28,500 lbs food grade

gypsum

PRB Construction (Unique Injection Technique)

- Due to rubble and blast rock, injection points were pre-drilled using roto-sonic to bedrock interface (ranging from 34 to 57 feet)
- The pre-cleared holes were backfilled with hydrated bentonite to maintain and seal the boreholes
- ~Injections were completed using direct push to drive 2.25 inch rods through backfilled hydrated bentonite; injections were completed top down.
- Formation Injection Pressures ranged from 50 to 400 psi
- Injection flow ~55 gpm
- 40 gallons of slurry per injection

Predrilled Injection Points



Injections Operations







Results



Compound Specific Isotope Analysis (CSIA)

- June 26 and 27, 2017 groundwater samples collected from MWs located on transect through the BOS 200[®] PRB
- Pace Analytical performed isotope analysis
- Isotope enrichment as compared to MW-204 was observed for npropylbenzene, ethylbenzene, m,p- xylenes, and 1,2,4-trimethylbenzene.
- Isotope enrichment was not observed for o-xylene.
- Enrichment (indicating biodegradation) is apparently occurring within the PRB, as demonstrated by the change in 3¹³C for each compound, except o-xylene.
- Biodegradation continues 80' to 100' downgradient from MW-204

CSIA Evaluation

Table 2. Difference in ¹³C as compared to MW-204. Positive numbers indicate enrichment.

		Difference to MW-204				
ID	Downgradient distance from MW-204 (ft)	¹³ C nPB	¹³ C EB	¹³ C <u>mpXy</u>	¹³ C oXy	¹³ C 124TMB
MW-204	0	0	0	0	0	0
MW-206	39.2	2.23	0.13	1.04	-1.16	-0.12
IW-7	76.8	2.82	0.71	1.22	-2.03	0.32
MW-102	91.8	0.56	1.11	1.47	-1.04	0.44
MW-103	171.6		0.53			-0.03

Applicable Site Conditions for Unique Technique



Direct Push Not Possible (Refusal) and Open Boreholes (Collapse) Not Appropriate

- Construction Debris
- Glacial Outwash
- Limestone Epikarst
- Mudstone
- Saprolite Transition Zone

Thank You! Questions?

