Training:
In Situ Remedial Action Design Considerations and Performance Monitoring

November 14, 2017

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SRWMP Training Committee
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Welcome

- In-Person Attendees
- Webinar Attendees

Continuing Education Credits (CECs)

Application has been made to the

SRP Professional Licensing Board to receive

1 Regulatory CEC and 1 Technical CEC

for this Training Class

Attendance Requirements:

- **In-Person Attendance**: Must sign-in / sign-out: May not miss more than 45 minutes of the training
- **Webinar participants**: must be logged-in for entire session and answer 3 out of 4 test questions (randomly inserted in the presentation)

Test Your Knowledge

Sky diving without a parachute may be hazardous to your health.

A. True

B. False

EXAMPLE WEBINAR QUIZ SLIDE

CECs: What's the Process?

- DEP compiles a list of "in-person" and "webinar" participants eligible for CECs
- Email will contain a "Link" to a LSRPA webpage, which will have instructions on how to access certificates
- Certificates are issued by the LSRPA - *$25 processing fee*

Case Study Training - Rutgers

Schedule for DEP provided training

Big Changes Planned

June 13, 2018

Case Study Training is a Prerequisite for the LSRP Exam

Important reminders

- Please mute cell phones
- Phone calls / conversations
  - Please take outside of the meeting room
- Question/Answers
  - At times specified during the presentation
  - Please wait for the microphone and introduce yourself
  - Webinar participants, wait for question period to “open up” and can then type in question

Remember!

Remember to sign in <u>and</u> out for credit

Please fill out Evaluation Form

NJDEP In Situ Remediation: Design Considerations and Performance Monitoring Technical Guidance Training

November 14, 2017


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36 Continuing Education Credits (CECs) over 3 year LSRP license renewal period

Minimum CECs must be satisfied in these categories:

- 3 CECs Ethics*
- 10 CECs Regulatory
- 14 CECs Technical
- 9 CECs Discretionary

LSRP Continuing Education Requirements

- The LSRPA offers, and will continue to offer, a 3 credit Ethics course ***six (6) times*** during each 3 year license period
- Twice a year - usually in March and September of each year
- Held throughout the state: 2x in Northern NJ, Central and Southern NJ
- The LSRPA offers the original, longest continuously running LSRP Ethics Course.

Ethics Continuing Education Requirements

- Next Ethics Courses will be on January 23, 2018 in New Brunswick at the LSRPA NJSRC.
- Registration is open on the LSRPA website: www.lsrpa.org/
- Ethics course will be offered again in September 2018 in Northern NJ.

Ethics Continuing Education Requirements

Public Service Announcement from the LSRP Licensing Board

- Carefully track CECs for each renewal cycle
- Most common issue is timing
- Renewal app is due 90 days prior to license expiration date
- CECs must be completed at time of application submission
- There are several on-line CEC options if time is tight - except for Ethics!!
- Pay renewal fees on time

Upcoming LSRPA Courses & Events

- **November 21, 2017 - LSRPA Member Breakfast (Blue Swan Diner, Oakhurst), (1.5 Reg. CECs)**
- **November 28, 2017 - Off-Site Source - Practical Implementation (Bressler, Amery & Ross, Florham Park, NJ), (.5 Reg. & 1.5 Tech. CECs)**
- **December 19, 2017 - LSRPA Member Breakfast (Ponzio's, Cherry Hill, NJ), (1.5 Reg. CECs)**
- **January 23, 2018--** Ethics, New Brunswick, **(3 Ethics CECs). Registration is open on the LSRPA website now!**

Visit LSRPA.org for details and registration

Recent LSRPA Initiatives

- **Jan 23 & 24, 2018: NJ Site Remediation Conference: Includes Ethics Course, 26 other Continuing Education Credits for LSRPs (15 are Tech. and 11 are Reg. CECs), the Annual Meeting, Networking, Entertainment, Speakers. Hyatt, New Brunswick, NJ - Registration open (lsrpa.org)!**
- **Member Breakfasts, held throughout the state: 11/21; 12/19. Check lsrpa.org for locations.**
- **Historic Fill Whitepaper for LSRPs – Now on the LSRPA website**
- **LSRPA CE Course Listing – List of upcoming LSRPA hosted/co-hosted events; LSRPA website > CE Tab.**
- **LSRPA just initiated a Sounding Board for local environmental commissions (ANJEC).**

Visit *LSRPA.org - Member Services* for details

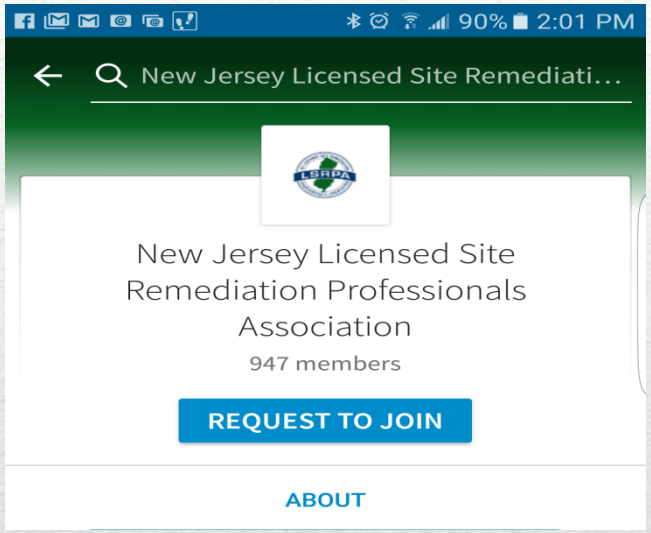
- **CE Tracking Spreadsheet Tool – Go to the CEC button on the LSRPA website - Plug in your classes as you go and it keeps track for you**

- **Dispute resolution - LSRPA listing of members willing to serve as a technical arbitrator/mediator in disputes between LSRPs / adversarial parties**

- **Sounding Board - Provides a forum for complex questions / concerns related to regulation or guidance; Responses based on collaborative input from the Sounding Board Subcommittee and are verbal / non-binding; Legal disclaimer agreement required and confidentiality is maintained**

Visit *LSRPA.org* - *Member Services* for details

Recent LSRPA Initiatives



@NJLSRPA

SOCIAL MEDIA IS NOT JUST FOR KIDS…

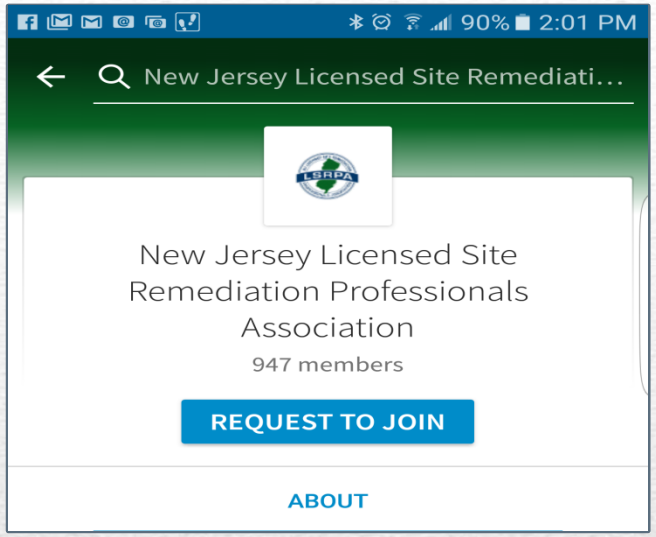
It is an important way to connect our membership with the community

JOIN THE CONVERSATION

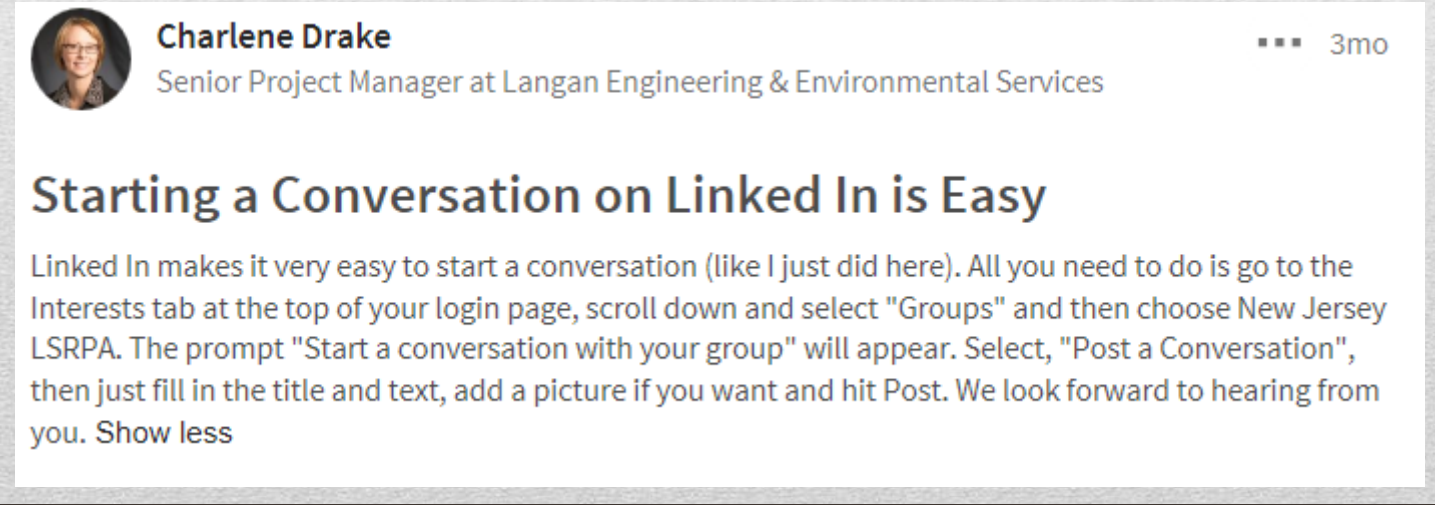
Be part of the LSRPA's LinkedIn Group

It's easy:

- Get out your phone (some of you never put it away)
- Go to www.LinkedIn.com or use the app
- Sign in with your user name and password
- Search: New Jersey Licensed Site Remediation Professionals Association
- When you arrive at our page, select REQUEST TO JOIN



You can like, share, comment or start a conversation



GET INVOLVED !

- **LSRPA Committees**

Governance (incl. Bylaws)
Continuing Education
Membership/Next Generation
Risk Management/Loss Prevention
Mentoring
Regulatory Outreach
Sponsorship
Sounding Board (NEW!)

Communications
College Outreach
Finance
Legal/Legislative
Nominating
SRRA 2.0

WANTED - VOLUNTEERS


NJ LICENSED SITE REMEDIATION
LSRPA
PROFESSIONALS ASSOCIATION

Thank You!

Introduction and Document Overview

Maria Van de Zilver, NJDEP
Bureau of Field Operations – Southern Section

In Situ Remediation: Design Considerations and Performance Monitoring Technical Guidance

NJDEP

- Joel Fradel, Co-Chair
- Maria Van de Zilver, Co-Chair
- Tracy Grabiak
- David Morrow
- Joe Nowak, Oversight Rep.

Other Contributors

- Mark Kluger, Dajak
- Timothy Maguire, NJDEP
- Helen Dudar, NJDEP

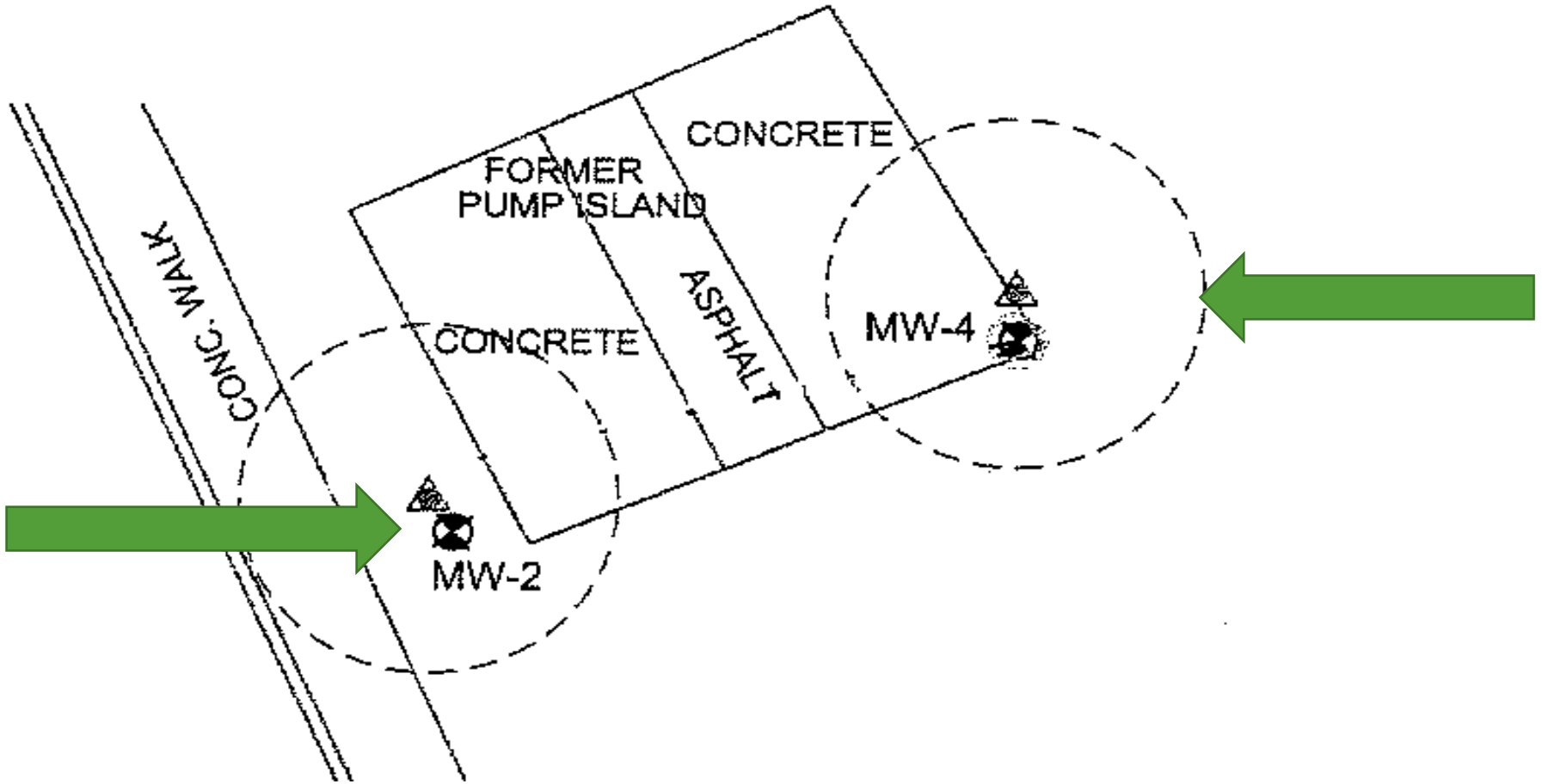
External Stakeholders

- Linda Caramichael, TRC Env. Corp
- Jeffery Fehr, The ELM Group
- Martin Hilfinger, Cumberland Gulf
- Jonathan Lisko, Lisko Env.
- Joseph Luty, AECOM
- Karnam Ramanand, Brown and Caldwell
- Kenneth Tyson, Langan

Why do we need this Technical Guidance?

- Provide guidance for design, implementation, and performance monitoring of in situ remedial action
- Provide guidance for improving submittals
  - Improper site characterization
  - Missing info such as well construction details, depth to water, analytical data, gw contour maps
  - Insufficient performance monitoring sampling points
  - Inappropriate sampling parameters
  - Appropriateness of sampling methodology
  - Questionable remedy

Questionable remedy



In Situ Remediation of a UHOT Site

- Improper site characterization
- Poor system design
- Over 10 year remedial duration

In Situ Remediation of a UHOT Site

In Situ Remediation of a UHOT Site

Reagents surfaced 40-50 feet downgradient of the source/injection area.

Purpose

- Section 2 & 3
  - Supplementing the Ground Water Technical Guidance: SI, RI, RA
  - Awareness to other regulatory hurdles and issues
  - Meant to be used in conjunction with other regulatory and technical guidance

Overview

- Section 3- Regulatory Basis for document
  - N.J.A.C. 7:26E – 5 Remedial Action
  - N.J.A.C. 7:14A – NJPDES
  - N.J.A.C. 7:26C – 7.5 Application for a Remedial Action Permit

Overview (cont.)

- Section 4 - Site Characterization & In Situ Remedial Design
  - Conceptual Site Model
  - Location of source area
  - Distribution of reagents and contact time with the contamination key
  - Holistic approach- not individual wells
  - DOES NOT tell you what technology to pick

Overview (cont.)

- Section 5- General Performance Monitoring Objectives
  - General guidance for developing remedial design
    - Remedial Goals and Performance Objectives
    - Performance Metrics
    - Designing an effective Performance Monitoring Plan

Overview (cont.)

- Section 6 Technology Specific Performance Monitoring
  - Biological Processes
    - Anaerobic and Aerobic
  - Physical and Chemical Processes
    - Solidification/stabilization
    - Soil Flushing
    - Soil Vapor Extraction/Air Sparge
    - Chemical Oxidation and Reduction
  - Thermal Processes
    - Electrical Resistance/Thermal Conduction/Steam Enhanced Heating

Overview (cont.)

- Section 7 Permitting
  - Overview of DGW Proposal Content
  - Specific Technical Guidance for DGW Proposal and Monitoring Plan
  - Avoiding Common pitfalls in DGW Proposal Preparation
  - Modifications to the DGW Proposal
  - Remedial Action Permit for Ground Water
- Section 8 Reporting

UHOT – Bureau of Field Operations Case Manager

Tables & Appendices

- Technology Specific Tables
- Appendix A – Parameters and Equations
- Appendix B – Field Parameters and Entries for Field Logs
- Appendix C – Monitoring for Common Reagent Products
    - Supplier
    - Injectant/Reagent Product
    - Technology
- Appendix D - Acronyms

Site Characterization, In Situ Remedial Design & General Performance Monitoring Objectives

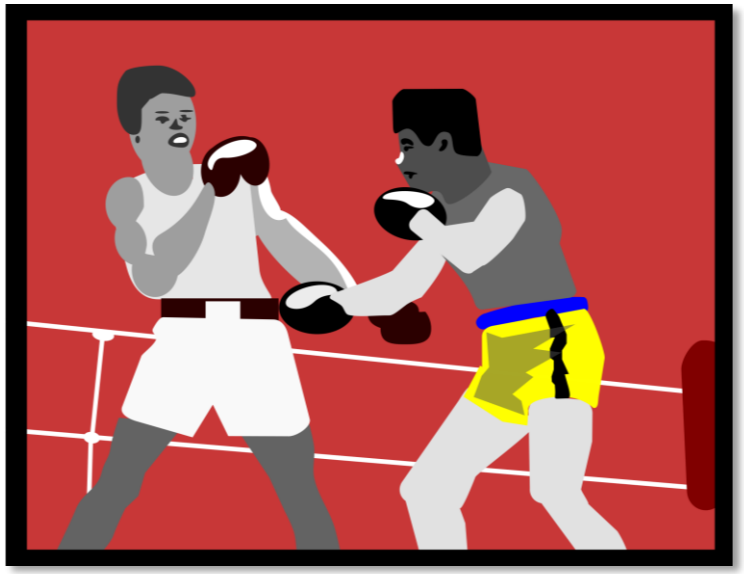
Sections 4 & 5 of Guidance

Joseph M. Luty, PE

Technical Services Director – Remediation, AECOM

Integrating Treatment Design with Performance Monitoring

- In situ remediation is a “contact sport”
  - Regardless of contaminant of concern (COC) and type of reagents
  - Design needs to ensure contact is achieved
  - Monitoring plan needs to confirm contact is occurring

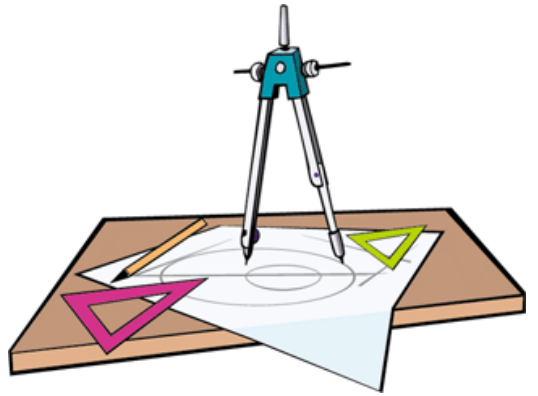


Site Characterization and Remedial Design

- Importance of the Conceptual Site Model (CSM)
  - Nature of contaminants of concern
  - Site geology and hydrogeology
  - Estimates of contaminant mass and distribution
  - Reference the Department's Technical Guidance for Preparation and Submission of a Conceptual Site Model

Site Characterization and Remedial Design

- Remedial action selection and general design considerations
  - Performance monitoring is governed by the type of remedial action selected
  - The ability to properly monitor the performance of the remedial action should be considered during the selection and design stages
  - “Radius” of influence
  - General implementation considerations
  - Technology-specific considerations



Integrating Treatment Design and Dosing with Performance Monitoring

- Injection wells vs. monitoring wells
  - Avoid injecting into monitoring wells
  - Proximity of injection wells to nearby monitoring wells
- Process monitoring vs. remedial effectiveness performance monitoring
- Site contaminants vs. competing reactants
  - Performance monitoring plan includes all constituents of interest
  - Contaminants, reagents, by-products

Pilot Tests / Design Studies

- What is a pilot test?
  - Remedial action conducted on a portion of the impacted area

- Benefits of pilot testing
  - Assess feasibility and effectiveness of technology
  - Provide design / scale up data
    - Radius of influence
    - Injection rates/volumes
    - Remedial cost estimates

Performance Monitoring Details

Overview of Performance Monitoring

- Process monitoring
  - Performed during treatment to optimize the process
- Remedial effectiveness performance monitoring
  - Performed to compare conditions before and after treatment
  - Various performance metrics to determine if remedial performance objectives have been met

Monitoring for the permit-by-rule (PBR) is not the same as monitoring for the Remedial Action Workplan (RAW)

Remedial Goals and Performance Objectives

- Based on the conditions identified in the CSM
- Interim goals vs. final goals
  - Ultimate / final goals typically based on achieving regulatory or statutory requirements
  - Remedial performance objectives may include site-specific and/or interim goals related to remedial milestones that are not necessarily specific rule requirements, but will further the attainment of final goals
  - Interim remedial measures (IRMs) are often an important step toward achieving success of the final remedy
- Included in the RAW and/or the Discharge to Ground Water (DGW) Proposal

Performance Metrics

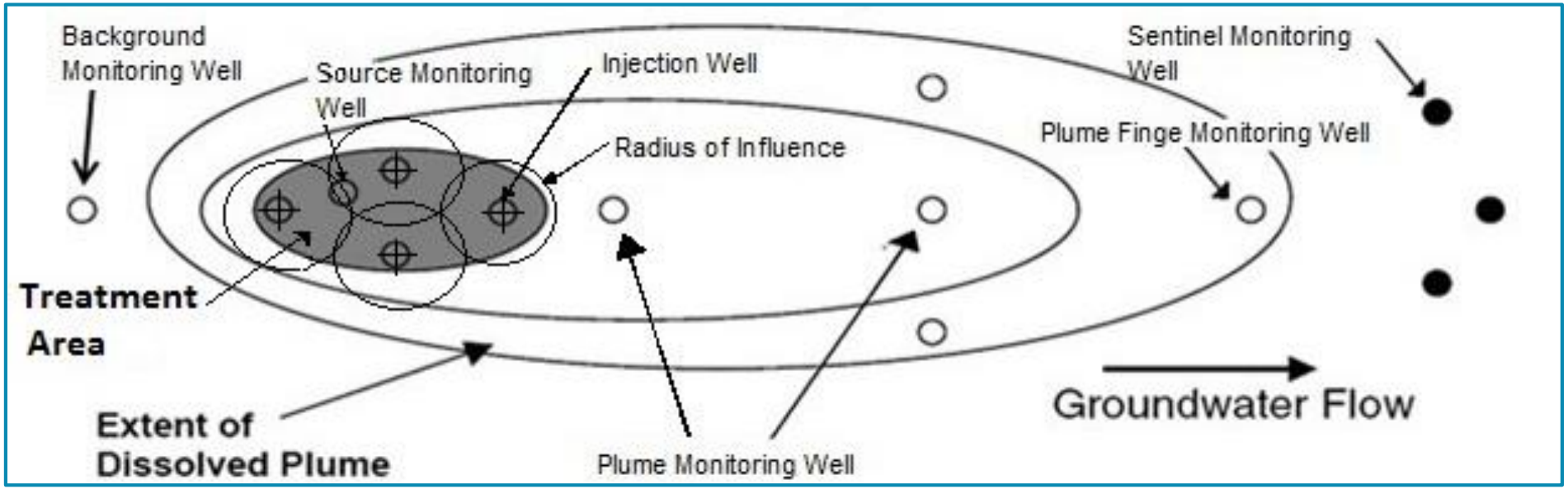
- One or more performance metrics for each remedial objective
- Technology-specific and site-specific
- Multiple lines of evidence
  - To confirm process monitoring and remedial effectiveness performance monitoring goals are being met
  - Ground water sampling, soil sampling, mass flux analysis, reduction in plume boundary or source material

Performance Monitoring Plans for Remedial Action

- Consider all media
  - Ground water, soil, surface water/sediments, and indoor air
- Key Factors
  - Location of the treatment area
  - Contaminant mass flux
  - Number/location of injection and monitoring wells
  - Timing/frequency of sampling
  - Composition of the remedial additive
  - Constituents to analyze (field/laboratory)
  - Unintended consequences – preferential pathways/impacts to receptors

Treatment Area and Well Network

Generalized Monitoring Well Network *(Section 5.4, Figure 1)*



Key Monitoring Points

- Source area vs. plume/plume fringe area wells
- Sentinel wells
- Background wells

Performance Monitoring Parameter Tables

- Six tables in Section 6 (Tables 1, 2, 5, 6, 7, 8)
  - Field parameters
  - Lab parameters for ground water and soil
  - Type of Analysis
    1. Required analysis for DGW permits if a COC is related to a direct or indirect impact to ground water
    2. Recommended analysis
    3. Conditional analysis
    4. Analysis not applicable

Performance Monitoring Parameter Tables

Table 1. Performance monitoring parameters for bio-anaerobic technologies

Sampling Media / Parameters	Anaerobic Biostimulation / Bioaugmentation	Permeable Reactive Biobarrier			Anaerobic Co-metabolism
		Organic Carbon	Organic Carbon / Iron	Organic Carbon / Sulfate/Iron	
Field Parameters*					
pH*	*	*	*	*	*
Dissolved oxygen*	*	*	*	*	*
Oxidation-reduction potential*	*	*	*	*	*
Temperature*	*	*	*	*	*
Conductivity*	*	*	*	*	*
Ferrous iron	2	2	2	2	2
Hydrogen Sulfide	2	2	2	2	2
Depth to water*	*	*	*	*	*
Depth of soil*	*	*	*	*	*
Lab Parameters - Ground Water					
Volatile organic compounds (VOCs)	1, 2	1, 2	1, 2	1, 2	1, 2
Alkalinity	2	2	2	2	2
Nitrate-nitrite nitrogen	2	2	2	2	2
Ammonia nitrogen	3	3	3	3	3
Total Phosphorus	3	3	3	3	3
Total iron	1, 2	1, 2	1, 2	1, 2	1, 2
Dissolved iron	2	2	2	2	2
Total manganese	1, 2	1, 2	1, 2	1, 2	1, 2
Dissolved manganese	2	2	2	2	2
Total arsenic	2	2	2	2	2
Sulfate	1, 2	1, 2	1, 2	1, 2	1, 2
Dissolved carbon dioxide	3	3	3	3	3
Dissolved ethene, ethane, and methane	2	2	2	2	2
Dissolved acetylene	4	4	3	3	4
Total organic carbon	2	2	2	2	2
Volatile fatty acids	3	3	3	3	3
Chloride	1, 2	1, 2	1, 2	1, 2	1, 2
Bromide (or other tracer) (a)	3	3	3	3	3
Major cations (b)	3	3	3	3	3
Molecular biology assays (c)	3	3	3	3	3
Compound specific isotopic analysis	3	3	3	3	3
Lab Parameters - Soil					
Contaminants and breakdown products	3	3	3	3	3
Fraction organic carbon	3	3	3	2	3
Total iron	3	3	3	2	3
Acid volatile sulfide (AVS)	4	4	3	2	4
Chromium extractable sulfide (CES)	4	4	4	3	4
Weak acid soluble ferrous and ferric iron (WAS-Fe)	4	4	4	3	4
Strong acid soluble ferrous and ferric iron (SAS-Fe)	4	4	4	3	3
X-Ray Diffraction	4	4	4	3	4
Scanning Electron Microscopy	4	4	4	3	4

Notes: See Section 5.4 for a detailed discussion of notes 1, 2, and 3 below.
+ - For Field Parameters see Appendix B
* - Standard field parameters for all ground water sampling events
1 – Required parameter for DGW permits if a COC or related to a direct or indirect impact of DGW.
2 - Recommended analysis.
3 - Conditional analysis.
4 - Analysis not applicable.
(a) Injectant indicators and tracers vary by technology. These may include field colorimetric indicators and/or shake testing (see Appendix B) for soil flushing agents, field and/or laboratory analysis of helium for air sparge helium tracers, laboratory analysis of indicators for soil flushing agents, etc.
(b) Includes calcium, magnesium, sodium, and potassium.
(c) Includes Phospholipid Fatty Acids (PLFA), CENSES, and QuantArray.

Sampling Media / Parameters	Anaerobic Biostimulation / Bioaugmentation	Permeable Reactive Biobarrier			Anaerobic Co-metabolism
		Organic Carbon	Organic Carbon / Iron	Organic Carbon / Sulfate/Iron	
Lab Parameters - Ground Water					
Volatile organic compounds (VOCs)	1, 2	1, 2	1, 2	1, 2	1, 2
Total organic carbon	2	2	2	2	2
Volatile fatty acids	3	3	3	3	3
Chloride	1, 2	1, 2	1, 2	1, 2	1, 2
Bromide (or other tracer) (a)	3	3	3	3	3

Commonly Used Reagent Products Reference

- Appendix C
  - Biological/Physical/Chemical
  - References back to performance monitoring tables in Section 6
  - Suppliers/Trade Names/Additional Info
  - Not an endorsement, not all inclusive

Supplier	Injectant / reagent product	Notes/Additional Information	Table Number
Terra Systems, Inc. or RNAS Remediation	Emulsified vegetable oil (EVO)	Anaerobic and Reduction Technology	1 & 7
various	Molasses – Bulk	Anaerobic Technology	1
various	Oxygen –releasing substances	Aerobic Technology	2
various	Microorganisms	Anaerobic Technology	1

Summary

- Performance monitoring should be considered during the remedial action selection and design stage
- Integrate with details of CSM
- Benefits of pilot testing – performance monitoring details
- Process monitoring vs. remedial effectiveness performance monitoring
- Interim goals vs. final goals
- Multiple lines of evidence
- Use the resources in the guidance document to develop effective performance monitoring plans

Questions?

Case Study – Zero Valent Iron Injection for Treatment of PCE and TCE in Groundwater

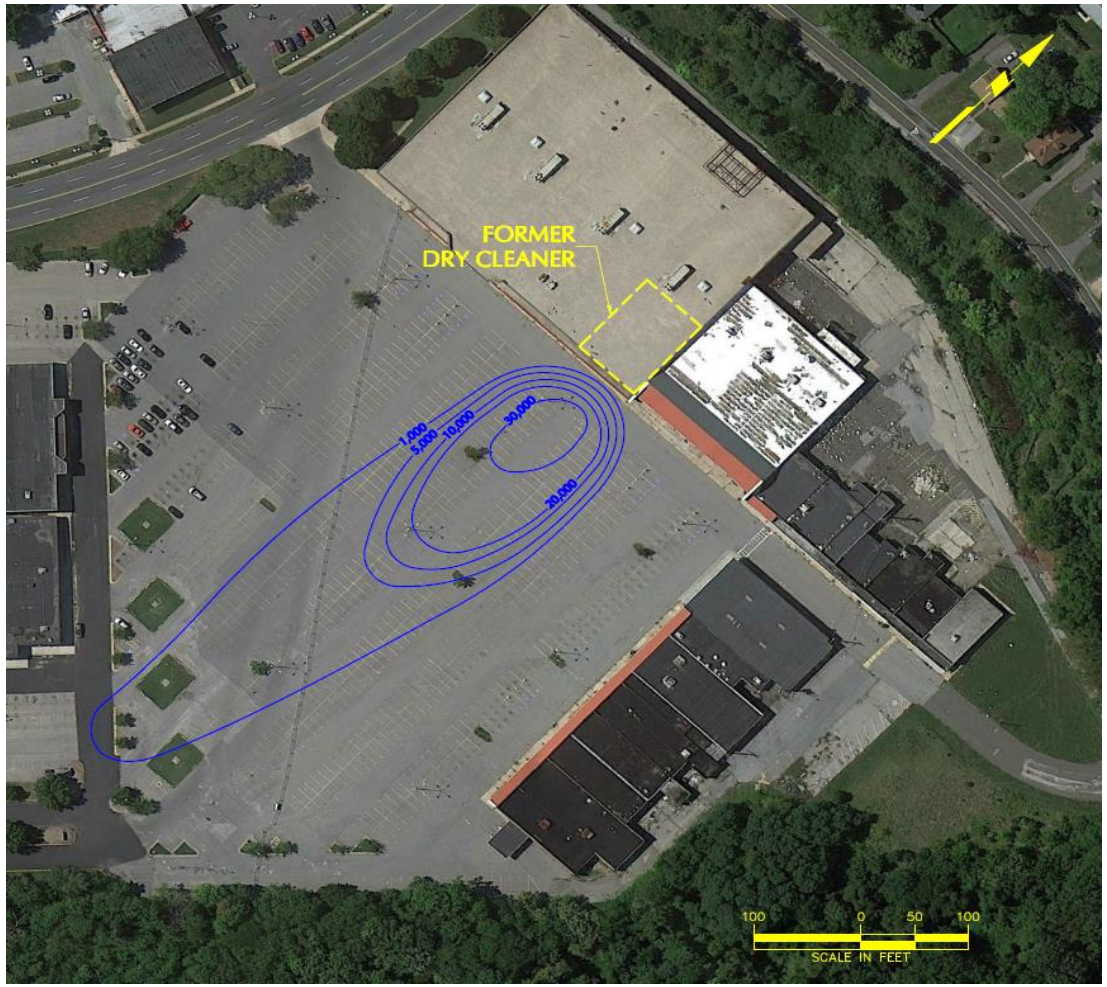
Kenneth C. Tyson, P.G., L.S.R.P.
Senior Project Manager – Langan Engineering and Environmental Services, Inc.

Case Study – Zero Valent Iron (ZVI) Injection for Treatment of PCE and TCE in Ground Water

- Site Background
- Remedial Approach
- Field Implementation
- Results

Site Background

- Former Dry Cleaner
- Commercial Brownfield Redevelopment
- Conducted multiple investigations to fully delineate extent of impact

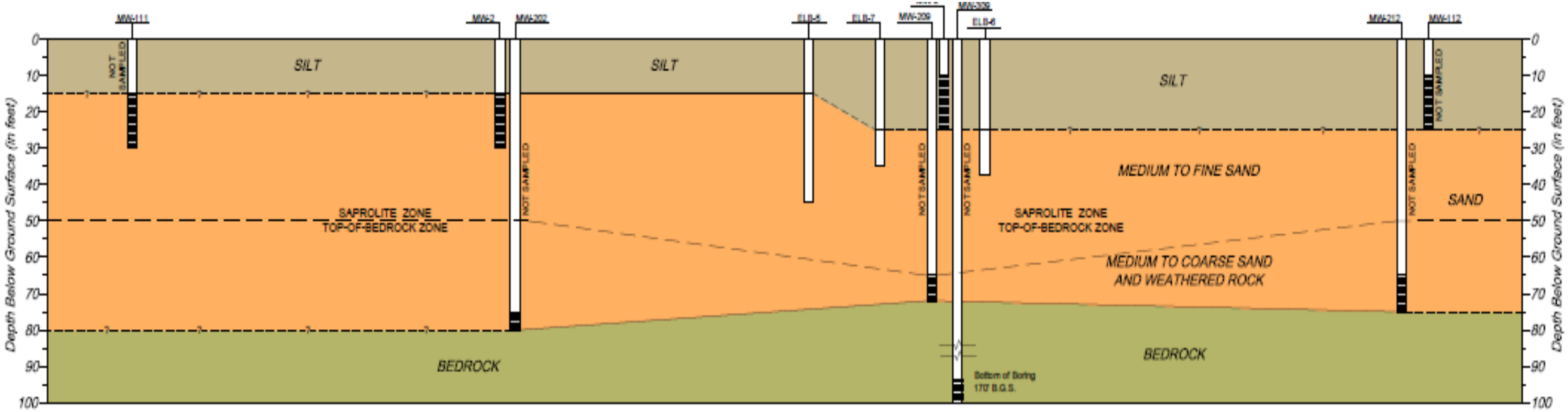


Site Constraints and Treatment Goals

- Very limited treatment timeframe
- Very limited operational area during injection
- No significant above-grade operations allowed after construction
- Must achieve significant mass reductions in core of plume, with MNA for remaining low concentration areas

Site Geology and Conceptual Site Model

- Shallow “Saprolite” Zone
- Intermediate “Top-of-Bedrock” Zone
- Deep “Bedrock” Zone



Remedial Action Selection Process

- Evaluated multiple technologies, including pump & treat, AS/SVE, etc.
- Determined that existing microbial population was insufficient to promote biodegradation
- Given site constraints, ZVI treatment of source zone selected
- Conducted treatability study using site soil and groundwater to confirm effectiveness of technology
- Given the short time frame, there was no time for a formal pilot study. An informal pilot study was done during the initial stages of the injections

ZVI Reductive Reactions

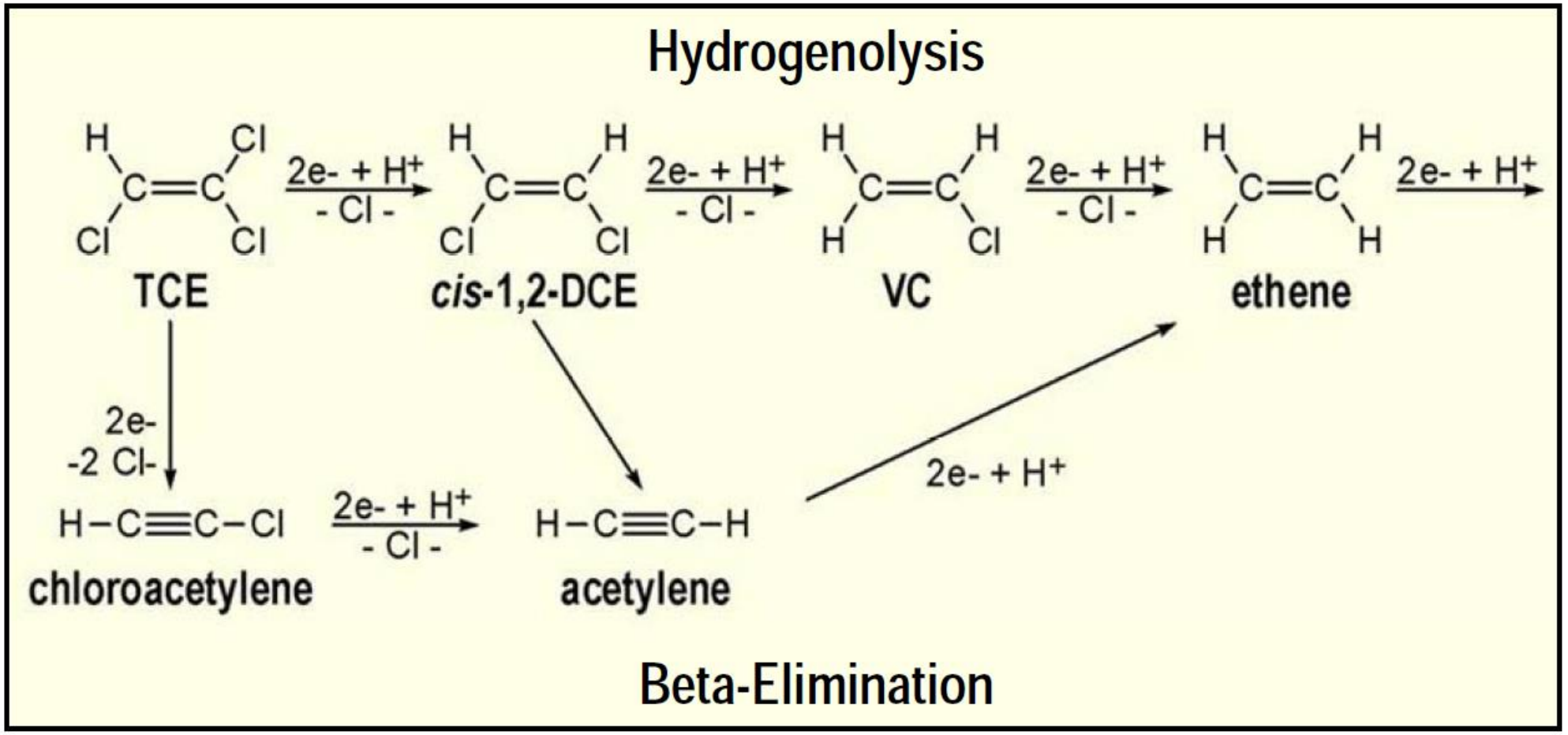
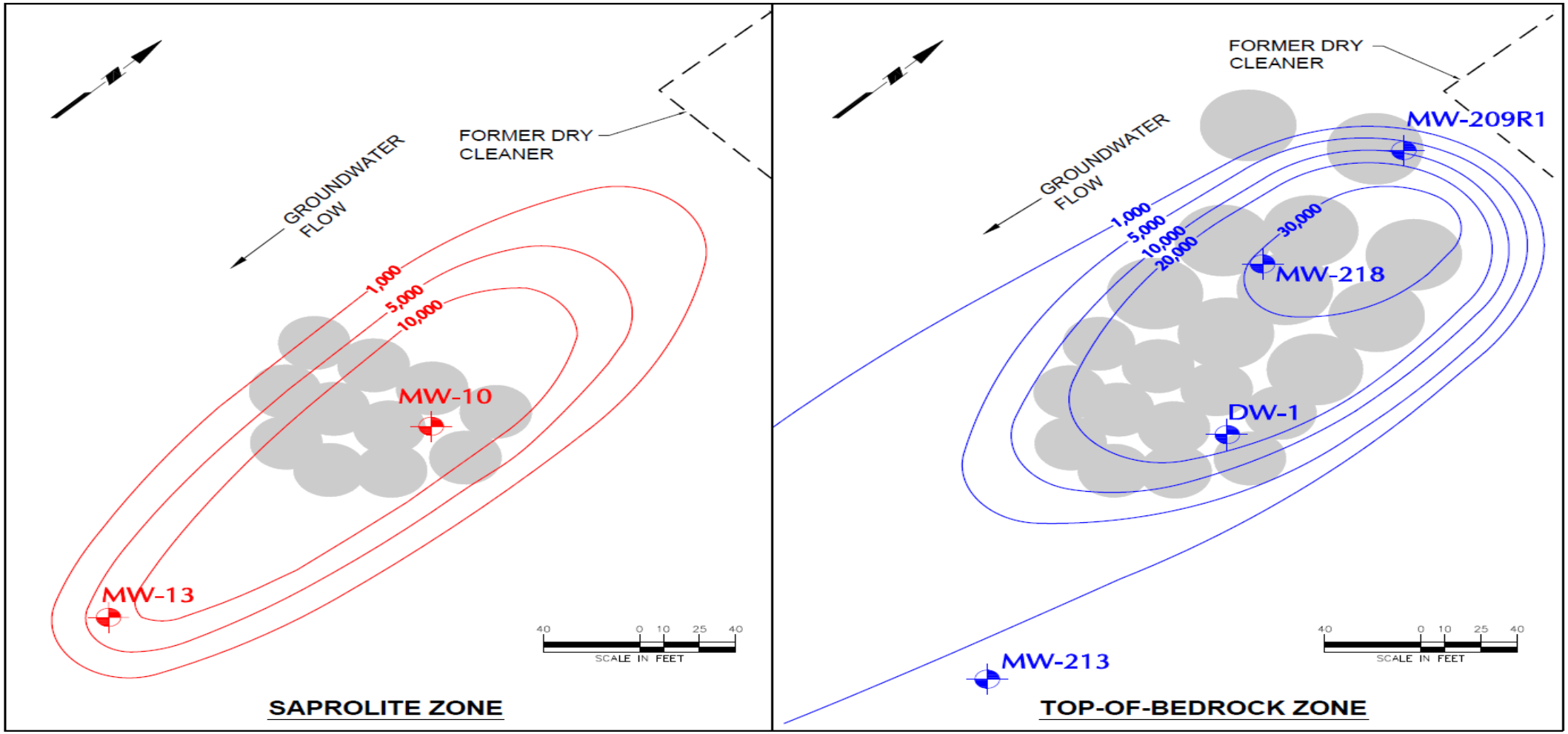
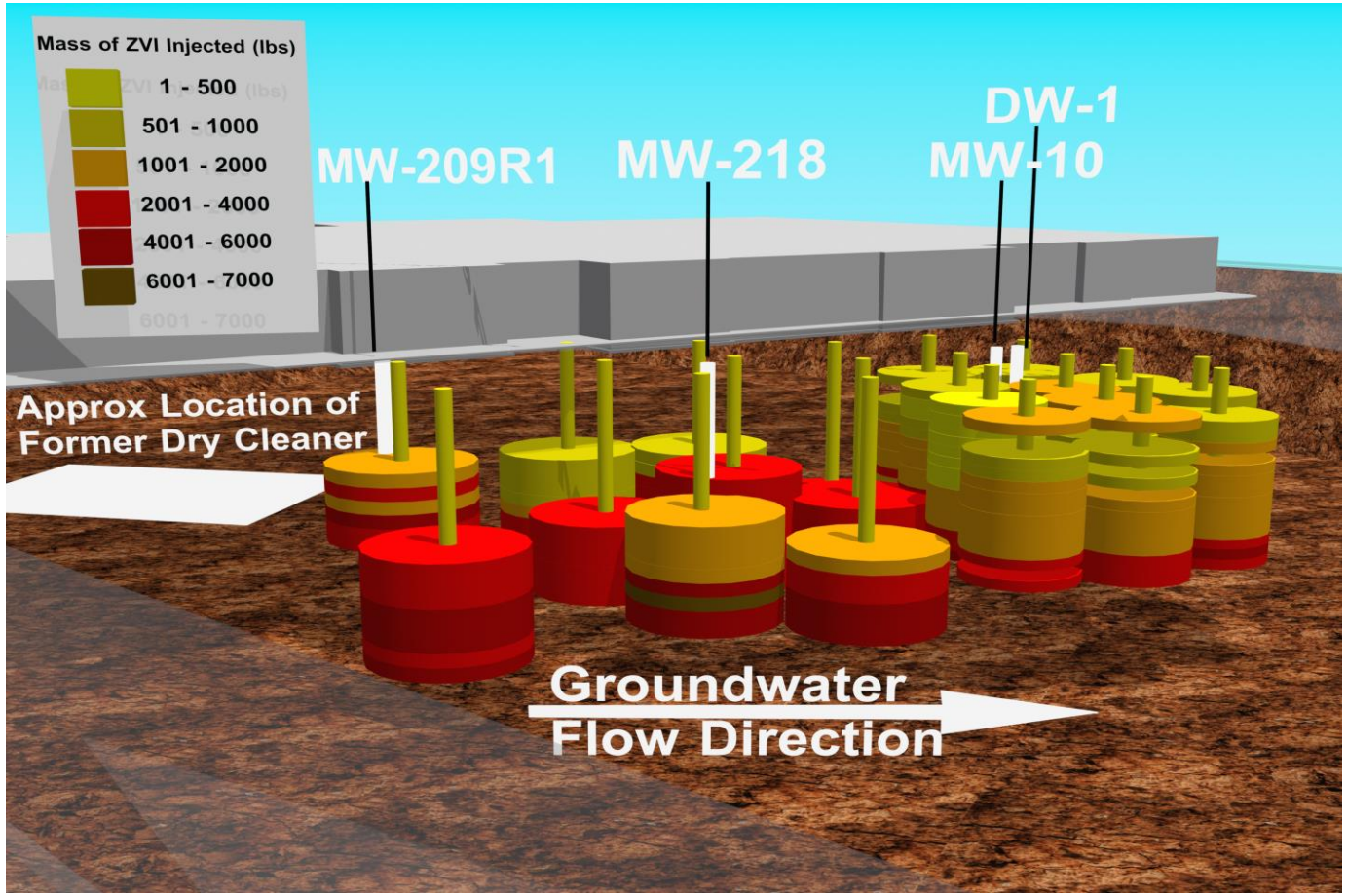


Figure 1-1. Abiotic Reduction of TCE by ZVI

Treatment Area

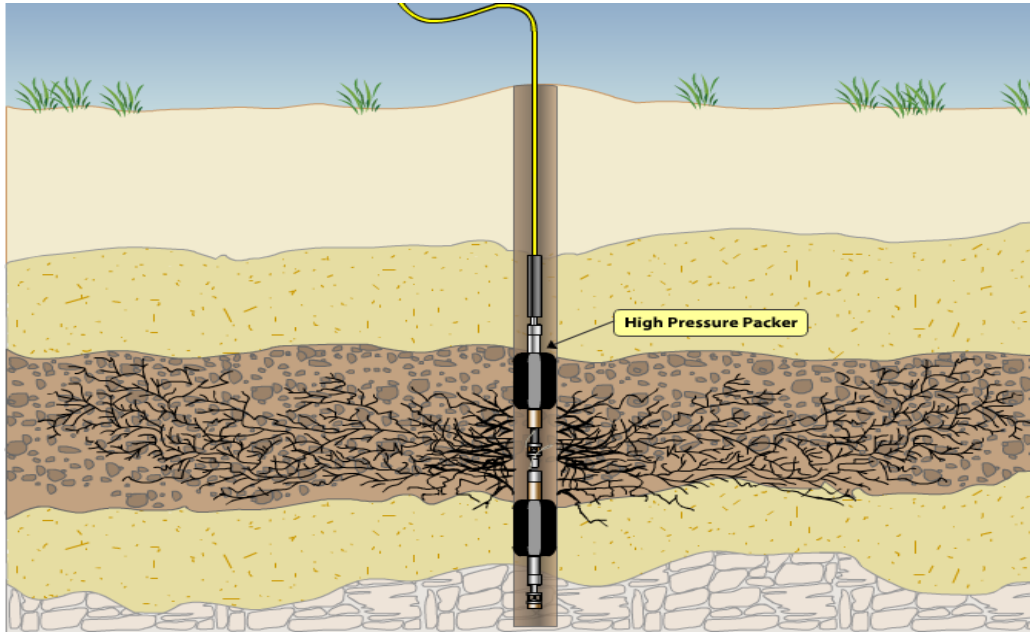


Final Injection Configuration



Remedial Approach

- Selected approach:
  - Microscale Zero-Valent Iron (Ferox™)
    - Dosage determined by treatability study
    - Roughly 0.5%
  - Pneumatic fracturing



ZVI Injection Setup

ZVI Injection Setup

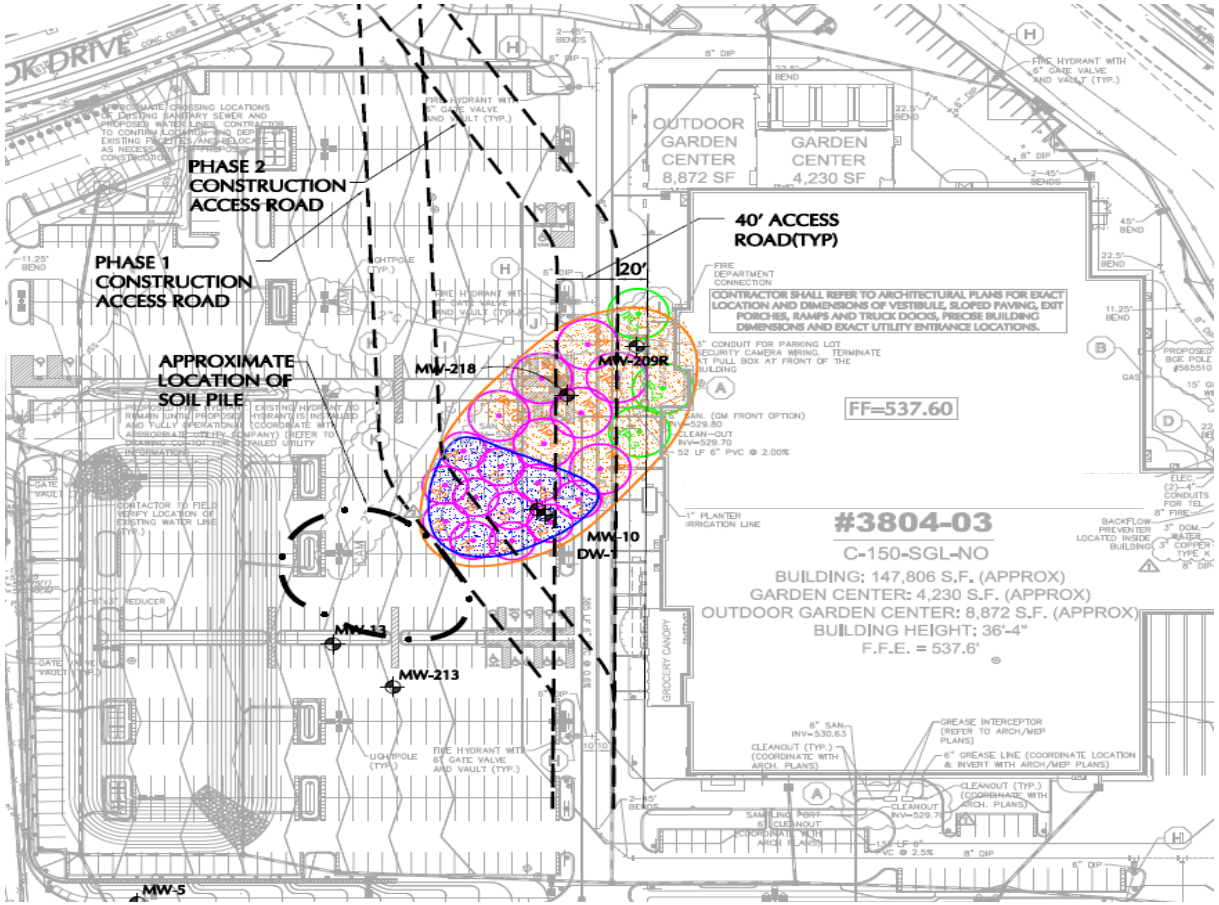
Confirming Radius of Influence

- Tilt meters and transit levels to observe surface heave
- Design ROI confirmed

ZVI Daylighting

- This was significant field issue.
- Real-time modifications to injection strategy.

Site Logistics



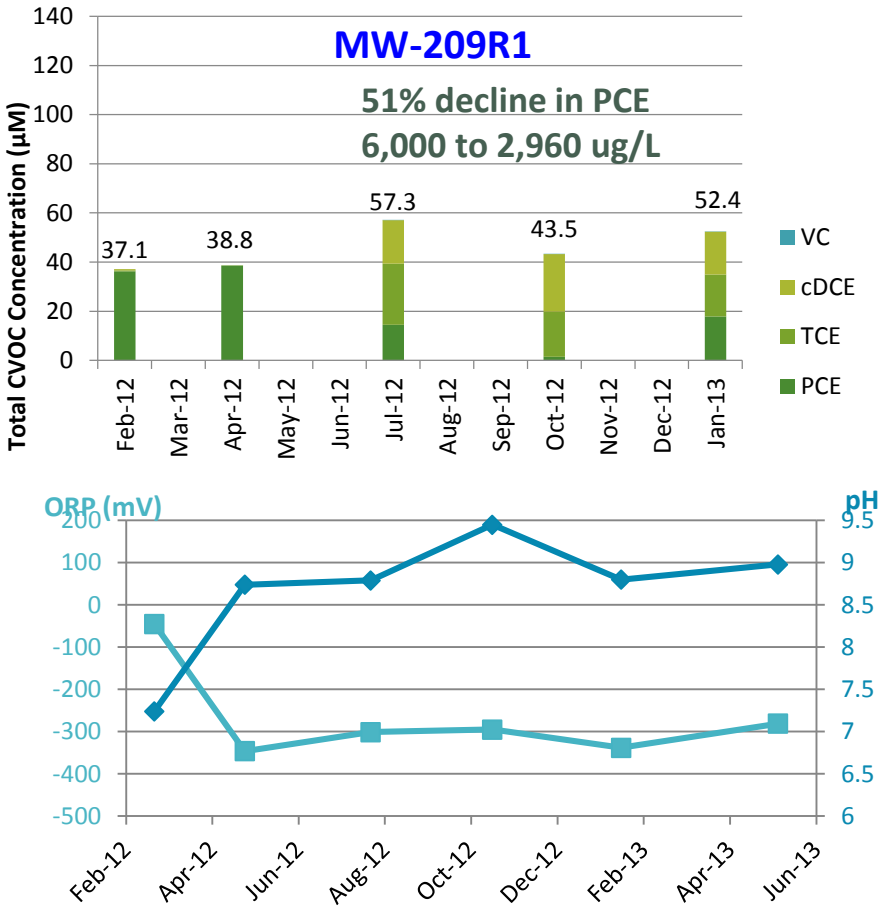
Injection by the Numbers

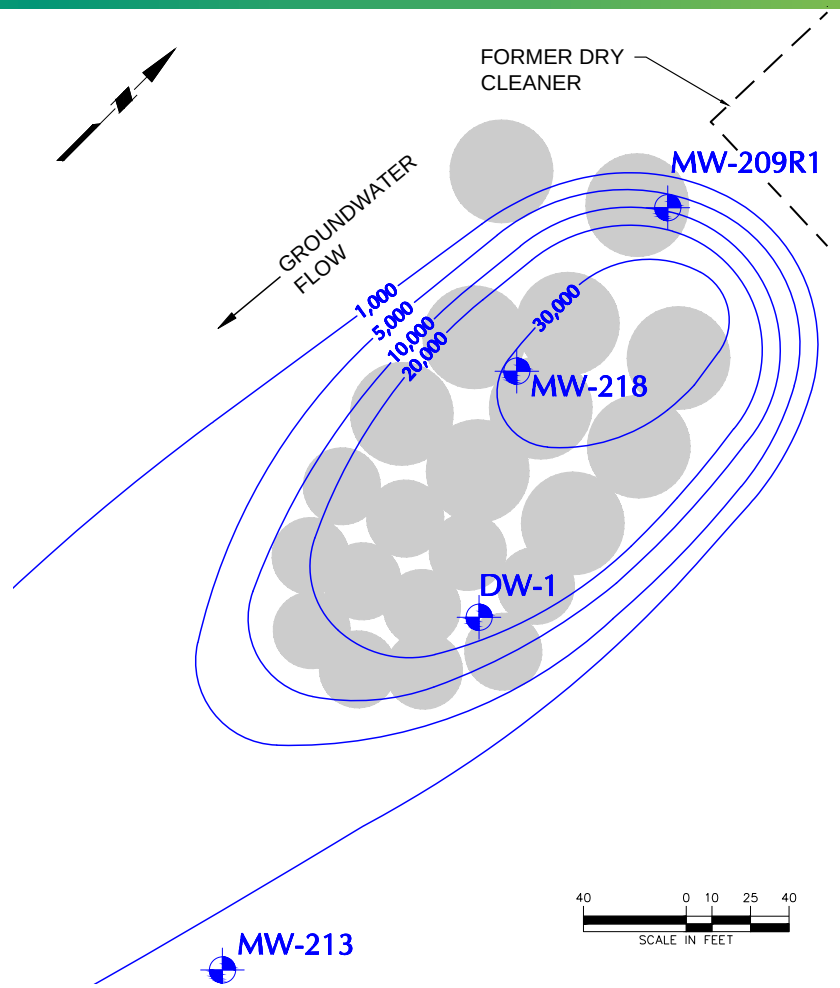
- 21 injection points
- 401,310 lbs (182 metric tons) ZVI injected
- 179,360 gallons of water used
- 29 days of injection
  - February 24 through March 26

Performance Monitoring

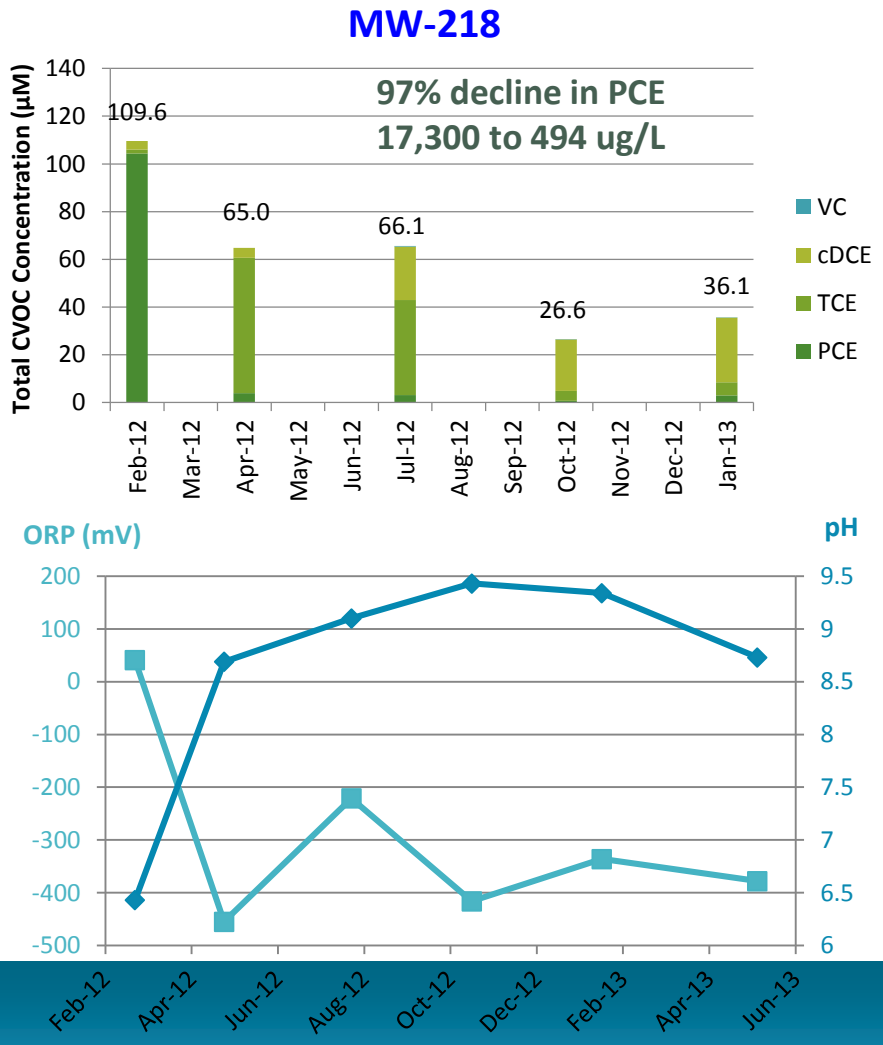
- Recommended performance monitoring parameters, locations, frequency, and duration provided in Table 7 of guidance.
- Two years of quarterly monitoring at selected source zone and down-gradient wells in both saprolite zone and top of bedrock zone wells
- Field parameters included temperature, pH, dissolved oxygen (DO), specific conductivity (SpC), and oxidation-reduction potential (ORP)
- Lab parameters included Chlorinated Volatile Organic Compounds (CVOCs)

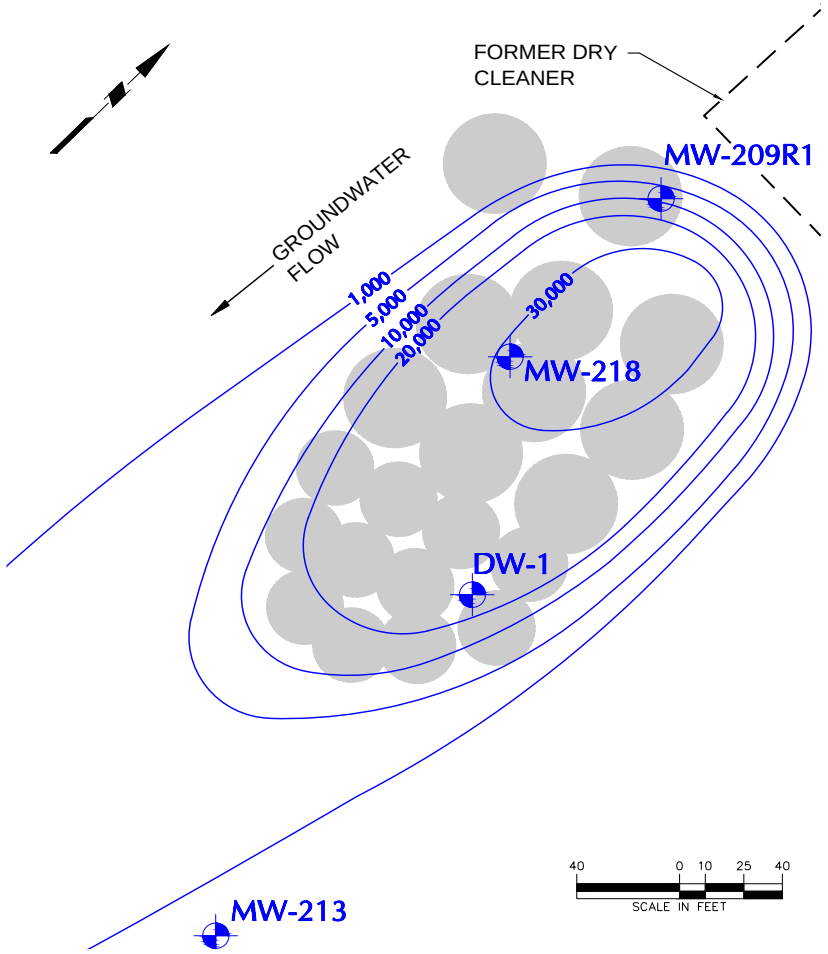
Top-of-Bedrock Zone Results



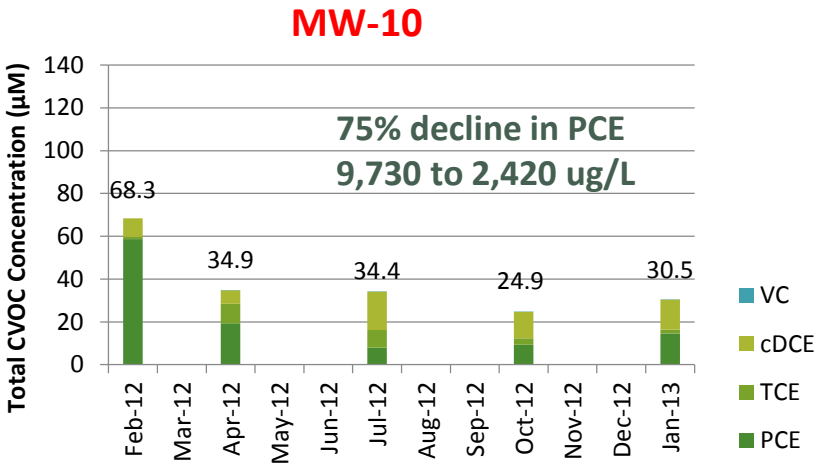


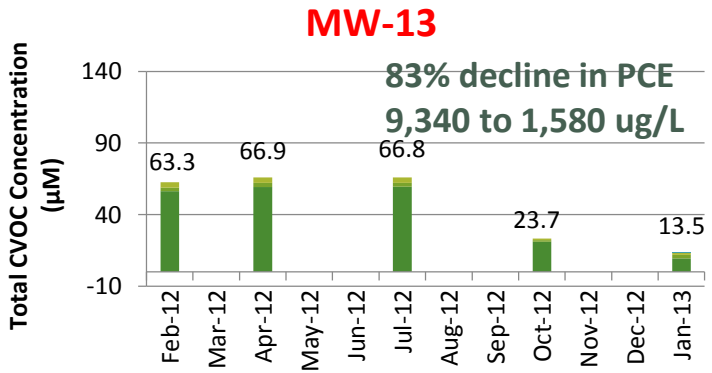
Top-of-Bedrock Zone Results

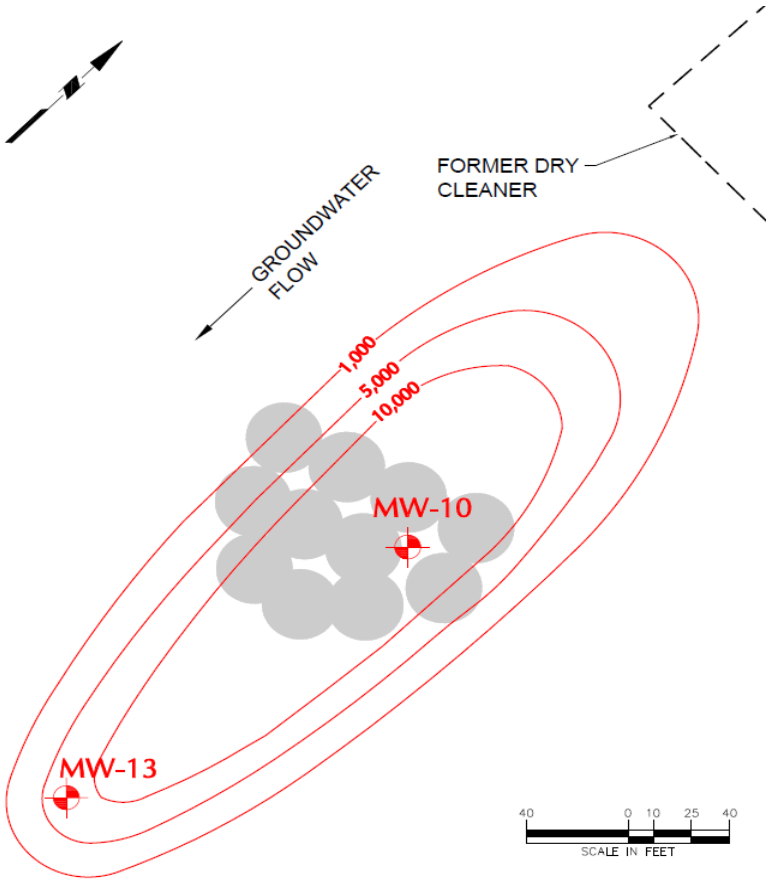




Saprolite Zone Results







Conclusions

- ZVI dosage of 0.4% iron-to-soil mass ratio was sufficient to treat 20,000 µg/L of PCE in less than one year
- Pneumatic fracturing can be effectively used to create an interconnected fracture network in residual soils and weathered bedrock
- The effective treatment area extends at least 110 feet beyond the injection area

Questions?

Discharge to Ground Water (DGW) Proposals, Permit-by-Rule and Other Approvals or Permits (Section 7)

Tracy Grabiak

Bureau of Ground Water Pollution Abatement

DGW Permit By Rule (PBR) Regulations

- New Jersey Pollutant Discharge Elimination System (NJPDES)
  - N.J.A.C. 7:14A-7 - Requirements for Discharges to Ground Water (DGW)
  - N.J.A.C. 7:14A-8 – Underground Injection Control (UIC) Program

- Technical Requirements for Site Remediation (Tech. Rules)
  - N.J.A.C. 7:26E-1.5 and 5 – General Remediation & Remedial Action

DGW Permit-by-Rule 101

- When and why do I need a NJPDES permit?
  - To conduct most injections & all pollutant discharges onto or into the ground
  - To monitor the DGW and protect receptors

- What is a Permit-by-RULE?
  - A type of NJPDES permit you are deemed to have by complying with specified requirements in the NJPDES and Tech. Rules
  - PBR provisions developed specifically for SRP
    - Discharges part of any remediation
    - Discharges associated with dewatering

The specified PBR requirements?

- For most DGW
  - Submit a DGW proposal to NJDEP
  - Obtain NJDEP written approval of it

- For purge water & related DGW
  - Follow Tech. Rules – 1.5(b) and 1.5(h)
  - Field Sampling Procedures Manual - Sections 2.4.5.6 and 2.4.5.7

Examples of DGW	Is a permit needed?	Does PBR require a DGW proposal and written approval?
Air sparging using clean air/oxygen	No	NA
Purge Water to ground surface	Yes	No
Purge Water injected	Yes	Yes
Injection of liquid oxidants or ozone	Yes	Yes
DGW of recovered ground water (GW) from a contaminated area	Yes	Yes

NJDEP Guidance - PBRs Section 7.1 and…

- Instructions for DGW PBR Authorization Request Form
  www.nj.gov/dep/srp/srra/forms/

- NJPDES DGW Technical Manual for SRP
  www.nj.gov/dep/srp/guidance/njpdes/
  - 2013 Webpage includes updated information

- Field Sampling Procedures Manual
  - www.nj.gov/dep/srp/guidance/fspm/

Starting Approval Process & Timing

- Submit to BCAIN:
  - Completed DGW PBR Authorization Request Form
  - $350 fee
  - DGW Proposal

- NJDEP's average turnaround time is 4 weeks for a complete submittal

NJPDES Permit and Discharge Duration

- Authorization to discharge starts as of the date of the NJDEP's approval letter
  - Permit duration is limited to 5 years
- Discharge duration is the timeframe between when the discharge to ground water starts and when it is completed
  - Discharge duration should only be as long as necessary
  - If more than 180 days, do public notice (UHOTs exempt)

Overview of DGW Proposal Content

- Refer to N.J.A.C. 7:26E-5.6(b)1 thru 8

Components of a proposal (Section 7.1.1)

1. Detailed RI Summary
2. Type of Discharge
   - For in situ treatment or recovered GW
3. Chemical content and/or contaminants in GW
   - Percent reagent & H_2O mixture
   - Attach Safety Data Sheets
   - Effluent data from ex-situ treatment system

Overview of DGW Proposal Content (cont.)

4. Discharge method/facility (see form instructions)
   - UIC - injection wells, direct push, laterals
   - Non UIC- into temporary excavation

5. Design, number & locations of discharge unit, area or injection points/events, radius of influence, injection depth intervals

6. Total discharge duration

7. Total volume of discharge (in gal.)
   - Volume per injection point & per event

Overview of DGW Proposal Content (cont.)

8. Describe potential effects on all receptors
   - GW, SW, VI pathway or nearby structures

9. Comply with GWQS & SWQS Rules
   - CEA, antidegradation policies

10. Detailed monitoring plan
   - All constituents & breakdown products

11. Schedule for reporting

More DGW Proposal Monitoring Plan Guidance

- Purpose - monitor for negative impacts and document receptor protection
- Baseline GW conditions
  - Get pre-injection/discharge GW data
- Process monitoring
  - Impacts on any receptors during DGW
- Post-injection/DGW monitoring
  - Negative impacts after DGW complete

More DGW Proposal, Monitoring Plan and PBR Guidance

- Monitoring plan design - Sections 5.4 and 6
  - media to monitor, sampling methods
- PBR specific guidance - Section 7.1.2
  - monitoring duration, contingency sampling
- Permit-related CEA - Section 7.1.3
- PBR reporting, compliance and modifications - Sections 7.1.5 and 7.1.6

Common Pitfalls

- See Section 7.1.4 - Avoid pitfalls that delay the NJDEP approval of DGW proposals
- Missing fee
- Missing information (no RI summary, no duration, no total volume)
- Inappropriate or deficient monitoring plan
- No schedule for monitoring or reporting

Other Approvals or Permits

- Section 7.2
  - Well permits – N.J.A.C. 7:9D
  - Air Pollution Control Permits - N.J.A.C. 7:27
  - Pinelands - N.J.A.C. 7:50
  - Highlands - N.J.A.C. 7:38
  - Security Considerations
- Section 7.3
  - Interaction of PBR and Ground Water Remedial Action Permit (GW RAP)

Contacts for DGW Proposal/PBR Info

- Tracy Grabiak, Section Chief, BGWPA, (609) 292-1176
- Joel Fradel, Section Chief, BGWPA, (609) 777-0125
- MaryAnne Kuserk, Bureau Chief, BGWPA, (609) 292-8427

Questions?

TECHNOLOGY SPECIFIC PERFORMANCE MONITORING (Section 6)

In-Situ Biotreatment of Chlorinated Ethenes: A Case Study

Karnam Ramanand
Brown and Caldwell

Topics

- Site Background
- Remedial Standards and Remedial Goals
- Pilot-Scale Test
  - Permitting
  - Design and Implementation
  - Monitoring parameters
  - Results
- Full-Scale Treatment
  - Design and Implementation
  - Monitoring parameters
  - Results (in progress)

Site Background

- Historic printing business operations at the Site was the primary source of chlorinated solvents contamination.

- Sanitary and industrial wastewater was discharged into two wastewater removal systems on Site leading up to contamination near former wastewater removal systems.

- Impacts were observed in the overburden and bedrock:
  - Overburden is made up of glacial till and peat with glacial till consisting of fine sand, silt/clayey silt, and gravel.
  - Bedrock lithology is sedimentary comprising of siltstone and sandstone.

Site Ground Water Conditions

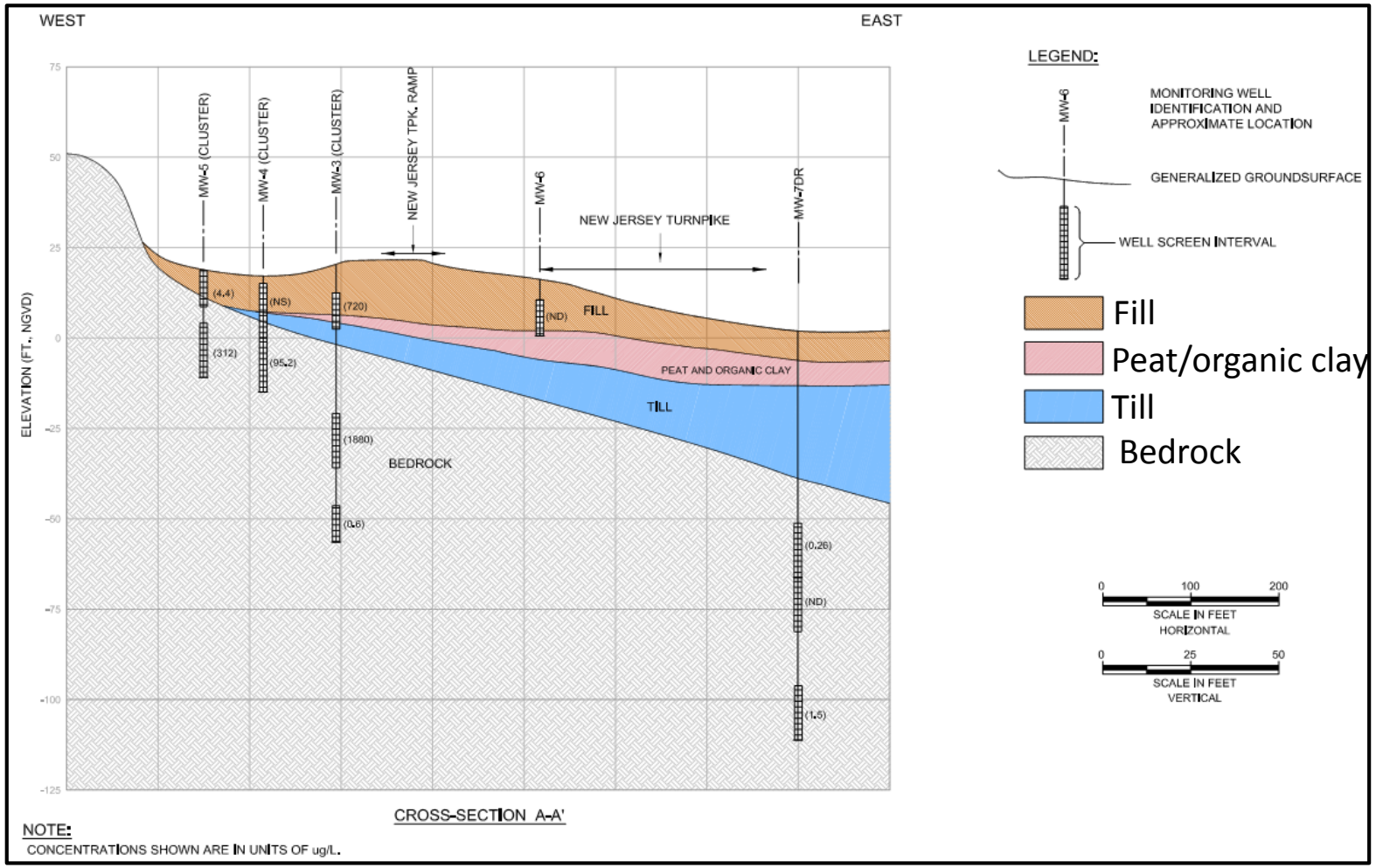
- Chlorinated ethenes (PCE and TCE) and associated breakdown products (cis-1,2-DCE and VC) were detected in ground water near the former wastewater removal system
- Evidence of natural attenuation of PCE and TCE
- Groundwater contaminants migrated in the bedrock with an eastward flow direction

Site Features

Source

Ground water flow direction

Site Cross-Section



Remedial Standards and Objectives

- Applicable remedial standards for the ground water at the Site are NJ GWQS for Class II-A aquifers (N.J.A.C. 7: 9C)

- Objective of the pilot test: Determine if the remedial technology selected can reduce contamination and eventually achieve Class II-A standards through active treatment and monitored natural attenuation (MNA)

Permits Required to Conduct Pilot Test

- A Permit-by-Rule for the injection of the reagents

- Drilling and well installation permits for the construction of injection wells must be obtained from the NJDEP Bureau of Water Allocation.

Pilot Test

- Enhanced anaerobic dechlorination was determined to be the most appropriate remedial technology for treatment of the chlorinated ethenes (Section 6.2.1- Anaerobic Processes)
- Conducted in the source area and targeted overburden and bedrock
- Organic carbon substrate used was 3-D MicroemulsionTM (3DMeTM)
- Results will be used to determine if enhanced reductive dechlorination is effective

Pilot Test Injection Design

- The reagent injections into subsurface were conducted in two rows:
  - 10 injections points in two rows
  - Seven of the 10 points were direct push points to inject into the overburden
  - Three of the 10 points were injection wells to inject into the bedrock

- The reagent injection rate was determined using vendor's software and site-specific data

Pilot Test Performance Monitoring Parameters – (Table 1)

- VOCs (PCE, TCE)
  - By-products cis-1,2-DCE, vinyl chloride
- Electron donors
  - Total Organic Carbon (TOC)
- Inorganic parameters
  - Nitrate, manganese, sulfate, iron, alkalinity, chloride, and bromide (tracer)
- Final degradation products
  - Dissolved gases (ethene, ethane, and methane)
  - Sulfide
  - Ferrous iron
- Field parameters
  - pH, dissolved oxygen, ORP, temperature, conductivity

Pilot Test Performance Monitoring Parameters – (Table 1)

- VOCs (PCE, TCE)
  - By-products cis-1,2-DCE, vinyl chloride
- Electron donors
  - Total Organic Carbon (TOC)
- Inorganic par
  - Nitrate, ma
- Final degrada
  - Dissolved g
  - Sulfide
  - Ferrous iro
- Field parameters
  - pH, dissolved oxygen, ORP, temperature, conductivity

Depth to water	
Depth of well*	*
Lab Parameters - Ground Water	
Volatile organic compounds (VOCs)	1, 2
Alkalinity	2
Nitrate-nitrite nitrogen	2
Ammonia nitrogen	3

Pilot Test Performance Monitoring Parameters – (Table 1)

- VOCs (PCE, TCE)
  - By-products cis-1,2-DCE, vinyl chloride
- Electron donors
  - Total Organic Carbon (TOC)
- Inorganic parameters
  - Nitrate, r
- Final degra
  - Dissolve
  - Sulfide
  - Ferrous i
- Field parameters
  - pH, dissolved oxygen, ORP, temperature, conductivity

Dissolved ethene, ethane, and methane	2
Dissolved acetylene	4
Total organic carbon	2
Volatile fatty acids	3
Chloride	1, 2

Pilot Test Performance Monitoring Parameters – (Table 1)

- VOCs (PCE, TCE)
  - By-products cis-1,2-DCE
- Electron donors
  - Total Organic Carbon (TC
- Inorganic parameters
  - Nitrate, manganese, sul
- Final degradation produ
  - Dissolved gases (ethene
  - Sulfide
  - Ferrous iron
- Field parameters
  - pH, dissolved oxygen, O

Lab Parameters - Ground Water	
Volatile organic compounds (VOCs)	1, 2
Alkalinity	2
Nitrate-nitrite nitrogen	2
Ammonia nitrogen	3
Total Phosphorus	3
Total iron	1, 2
Dissolved iron	2
Total manganese	1, 2
Dissolved manganese	2
Total arsenic	2
Sulfate	1, 2
Dissolved carbon dioxide	3
Dissolved ethene, ethane, and methane	2
Dissolved acetylene	4
Total organic carbon	2
Volatile fatty acids	3
Chloride	1, 2
Bromide (or other tracer) (a)	3

Pilot Test Performance Monitoring Parameters – (Table 1)

Conductivity*	*
Ferrous iron	2
Hydrogen Sulfide	2
Depth to water*	*

- VOCs (PCE, TC
  - By-products
- Electron donors

Dissolved carbon dioxide	3
Dissolved ethene, ethane, and methane	2
Dissolved acetylene	4

er)

- Final degradation products
  - Dissolved gases (ethene, ethane, and methane)
  - Sulfide
  - Ferrous iron
- Field parameters
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Pilot Test Performance Monitoring Parameters – (Table 1)

- VOCs (PCE, TCE)
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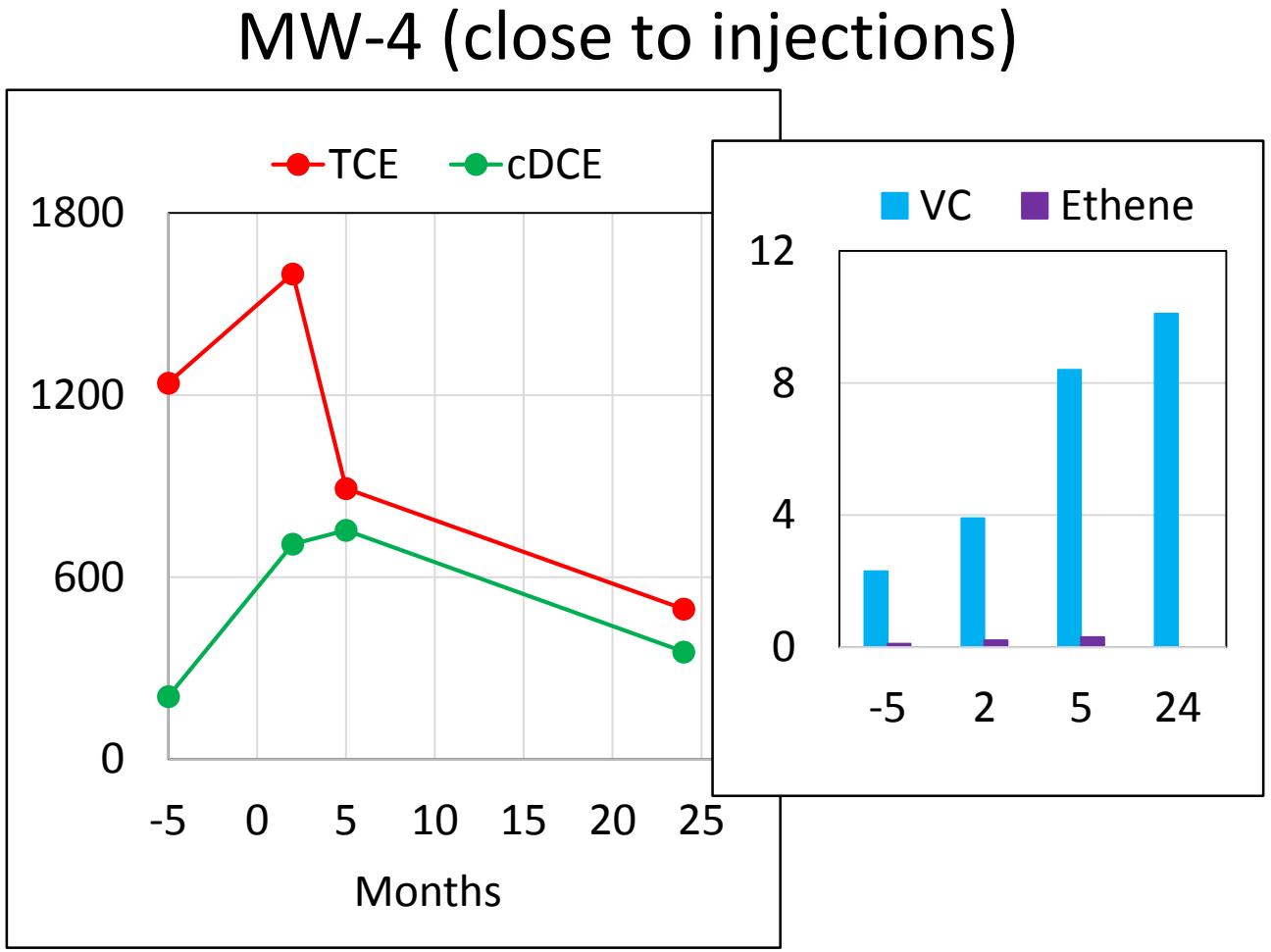
- Inorganic
  - Nitrate,
- Final degradation products
  - Dissolved gases (ethene, ethane, and methane)
  - Sulfide
  - Ferrous iron
- Field parameters
  - pH, dissolved oxygen, ORP, temperature, conductivity

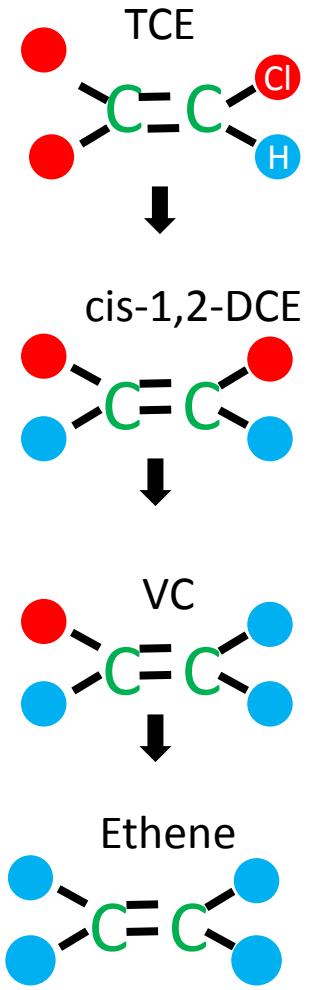
Field Parameters[+]	
pH*	*
Dissolved oxygen*	*
Oxidation-reduction potential*	*
Temperature*	*
Conductivity*	*
Ferrous iron	?

Pilot Test Monitoring Well Network (Section 5.4.1)

- **Upgradient of the Treatment Area:** Monitoring wells MW-5 and MW-5D
- **Treatment Area:** Monitoring wells MW-4 and MW-4D
- **Downgradient of the Treatment Area:** Monitoring wells MW-3, MW-3D, and MW-3DR

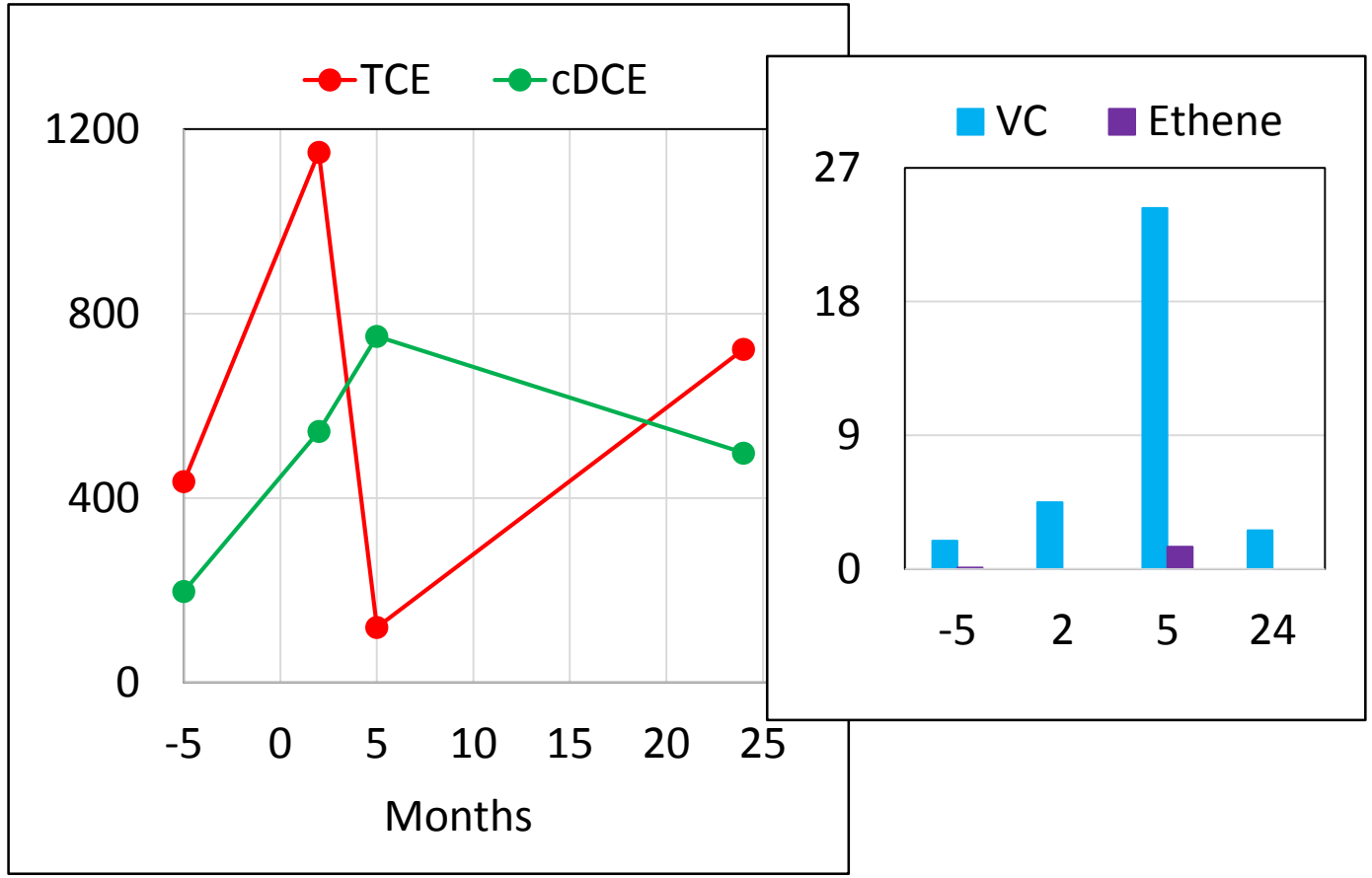
Pilot Test Results (Concentrations [µg/L] vs. Months)





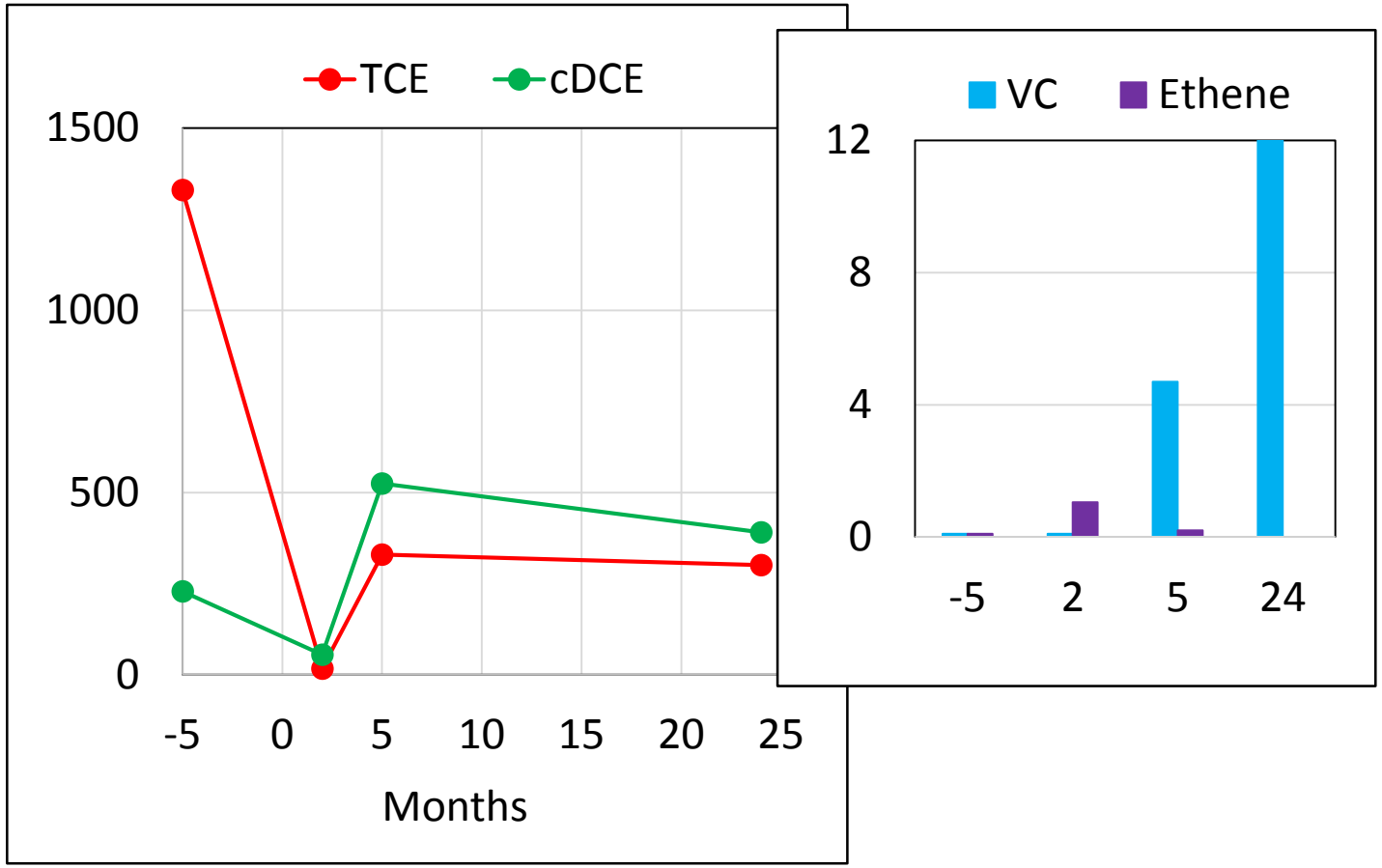
Pilot Test Results (Concentrations [µg/L] vs. Months)

MW-3 (downgradient of injections)



Pilot Test Results (Concentrations [µg/L] vs. Months)

MW-4D (close to injections)



Pilot Test Results:
Changes in Ground Water Geochemistry

	MW-4D	
Geochemistry	Pre-Injection	Post-Injection
TOC (mg/L)	1.7	up to 8.9
Sulfate (mg/L)	100	up to 20
Dissolved methane (mg/L)	0.042	up to 2.85
Bromide (mg/L)	not analyzed	up to 1.9

Full Scale Remedial Action Implementation

- Activities associated with the full scale remedial action implementation included:
- Permitting
- Bedrock injection well installation
- Baseline ground water sampling
- Remedial action injection design and implementation
- Post-injection ground water monitoring

Full Scale Reagents Injection Design

- Overburden:
  - Ten direct push injection points as transects upgradient of MW-3 and MW-4
- Bedrock:
  - Eight injection wells in the vicinity of the former source area and downgradient plume
- Dehalococcoides sp. bacteria was injected along with the organic carbon

Full-Scale Treatment Performance Monitoring Parameters (Table 1)

Additional Parameters Included:

- CENSUS bacteria
  - Dehalococcoides sp. (DHC)
  - BAV1 Vinyl Chloride Reductase (BVC)
  - Vinyl Chloride Reductase (VCR)
- Compound Specific Isotope Analysis:
  - Carbon isotopes
- Ground water sampling will be performed before the reagents injection (baseline) and at 4, 8, and 12 months following the injections

Full-Scale Treatment Performance Monitoring Parameters (Table 1)

Additional parameters included:

- CENSUS bacteria
  - Dehalococcoides sp. (DHC)
  - BAV1 Vinyl Chloride Reductase (BVC)
  - Vinyl Chloride Reductase (VCR)
- Compou
  - Carbo
- Ground
  injection
  injections

Bromide (or other tracer) (a)	3
Major cations (b)	3
Molecular biology assays (c)	3
Compound specific isotopic analysis	3
Lab Parameters - Soil	

Full-Scale Treatment Performance Monitoring Parameters (Table 1)

Major cations (b)	3
Molecular biology assays (c)	3
Compound specific isotopic analysis	3
Lab Parameters - Soil	
Contaminants and breakdown products	3

- Additio
  - CENS
  - Deha
  - BAV1
  - Vinyl Chloride Reductase (VCR)
- Compound Specific Isotope Analysis:
  - Carbon isotopes
- Ground water sampling will be performed before the reagents injection (baseline) and at 4, 8, and 12 months following the injections

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Summary

- Enhanced anaerobic dechlorination was the technology selected for the treatment of PCE and TCE in overburden and bedrock groundwater
- A pilot test was conducted as a proof-of-concept
- DGW permit to inject reagents was procured for both pilot test and full-scale treatment
- Pilot test results revealed complete TCE dechlorination leading up to full-scale design and treatment
- Monitoring parameters listed in the guidance were analyzed to measure performance of the in-situ anaerobic treatment
- Full-scale treatment is in progress

Questions?