Society of SAME American Military Engineers Omaha Post

WELCOME

VIRTUAL MEETING WILL BEGIN AT

11:30 AM Central

Society of American Military Engineers

Omaha Post

July 9th Meeting

Dedicated to National Security Since 1920

Omaha Post Meeting

Society of American Military Engineers

Omaha Post

July 9th, 2024 Meeting

Society of SAME American Military Engineers Omaha Post

Meeting Agenda

- Pledge of Allegiance
- New Member/ Guest Introductions
- Invocation
- Lunch
- Announcements
- Installation of Officers
- Awards
- Membership Spotlight
- Presentation
- Q&A
- Split Kitty Drawing
- Closing Remarks

Society of SAME American Military Engineers Omaha Post

Pledge of Allegiance

I pledge allegiance to the Flag of the United States of America, and to the Republic for which it stands, one Nation under God, indivisible, with liberty and justice for all.

Introductions

Introductions

- Welcome SAME Student Chapter Members
- Welcome New SAME Members
- Introduction of Guests

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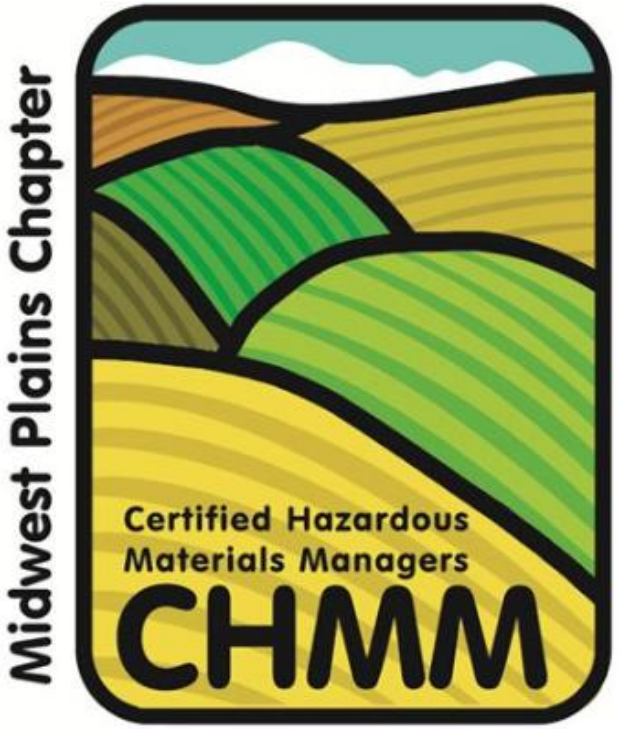
WELCOME!

Midwest Plains Chapter of Certified Hazardous Materials Managers (CHMM)



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Invocation

Please join us in the invocation before we dismiss for lunch

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Lunch

Dismiss by table

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Announcements

- **Veterans in Business Forum**
  - **Topic:** Nebraska Business Development Center
  - **Speaker:** Kiley Phelps, SBDC
  - **Event Date:** July 19, 2024, from 8:00am – 9:00am
  - **Location:**

    UNO, College of Business Administration

    Mammel Hall, Room 117

    6708 Pine Street

    Omaha, Nebraska 68182
  - **RSVP:** Michel Thornhill at info@littlemountainwebdesign.com
- **August - Monthly Omaha SAME Post Meeting**
  - **Event Date:** August 6th at Field Club of Omaha
  - **Topic:** Advances in Metal Roof Technology

Announcements

- **Veterans Outreach - 50 Mile March: Operation Noble Watchman 2024**
  - This year the Omaha Post's Veterans Outreach will be supporting the 50 Mile March Foundation and their ***mission to empower Veterans facing mental health challenges and homelessness by fostering a community of hope and relentless support.***
  - This year there is a **need for over 100 volunteers over August 24-25**
  - Please direct any questions regarding volunteer opportunities to Brianne Schuler at director@50milemarch.org or (402) 706-6470 or Leon Haith at leon.haith@50milemarch.org or (402) 669-3402.
- **Virtual Matchmaking Event**
  - Prime Connections: Bridging Opportunities, a premier virtual matchmaking event designed to connect prime contractors with small businesses.
  - Omaha Post is partnering with the Nebraska APEX Accelerator to host the virtual event
  - August 28th – More details to come!

Awards

Society of American Military Engineers

Omaha Post

Awards

Presented by Stephanie Heibel

Awards

Omaha Post Rising Star

Stephanie Ling, MCC

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Awards

Public Sector Partnering

Bobby Lingerfelt, USACE Omaha

Society of SAME American Military Engineers Omaha Post

Awards

Student Chapter Rising Star

Jacob Lang, UNL Student Chapter

Awards

Student Mentoring Program (SMP)

Ryan Garcia, Omaha Public Schools

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Awards

Omaha Post President

Chris Artz, Tetra Tech

Installation of Officers

Society of American Military Engineers

Omaha Post

Presiding Officer

SAME Regional Vice President Juila Pluff

Installation of Officers

President: Stephanie Heibel

Secretary: Chris Artz

Treasurer: Brian Schuele

Vice President for Service Members and Veterans: Rob Hufford

Vice President for IGE: Bobbi Jo Lang

Vice President for Resilience: Don Fucik

Vice President for Professional Development and Personal Growth: Kandi Srb

Vice President for Leadership and Mentoring: Tom Svoboda

Director for Communications: Jill Zehr

Director for Awards and Recognition: Christina McManis

Director for Young Members and Student Outreach: Stephanie Ling

Director for Fellows: Natasha Gromak

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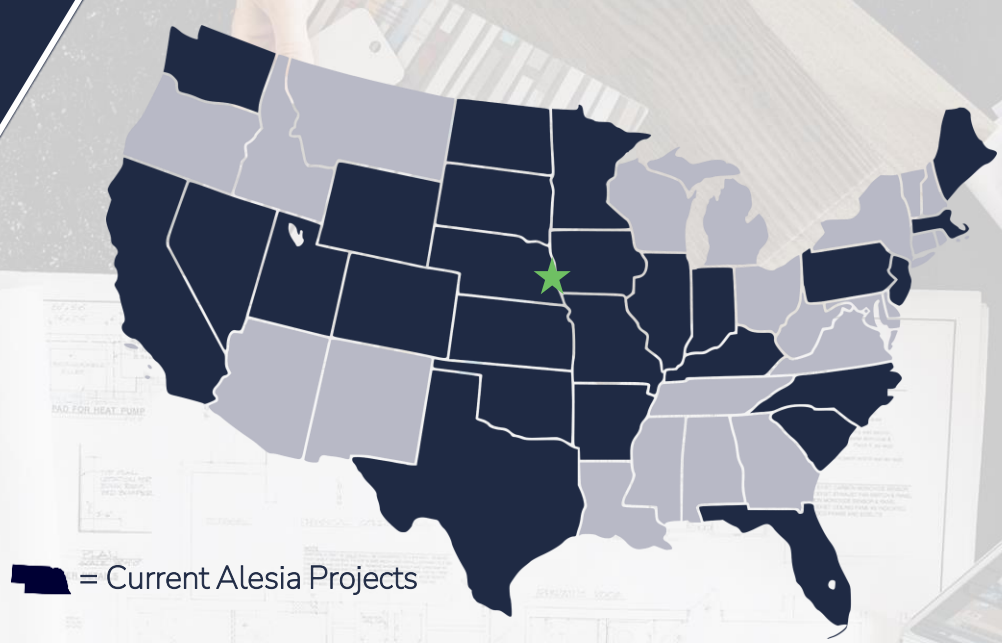
Membership Spotlight

ALESIA ARCHITECTURE

ALESIA
ARCHITECTURE

SBA
U.S. Small Business Administration
SERVICE-DISABLED VETERAN-OWNED CERTIFIED

- Architecture
- Project Management
- Interior Design
- Planning



Current IDIQs:

VISN 23 2019-2024
VISN 19 2021-2026
CFM National Region 2023-2028

ALESIA ARCHITECTURE

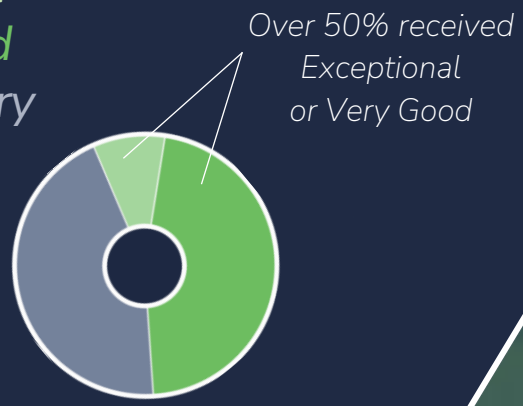
SBA U.S. Small Business Administration
SERVICE-DISABLED VETERAN-OWNED CERTIFIED

23 Person Team

6 Licensed Architects
2 Interior Designers
1 Engineering Project Manager
9 CAD (REVIT®) Technicians
5 Administrative Personal

CPARS - Quality

9% Exceptional
46% Very Good
45% Satisfactory



Key Markets

- *Healthcare*
- *Government*

Healthcare Project Highlights

Emergency Dept Design Guide
Urgent Care Design Guide
Radiology/Imaging
Sterile Processing
Mental Health/Behavioral
Outpatient Treatment Centers
PACT Clinics
Community Based Outpatient Clinics

ALESIA ARCHITECTURE

SBA U.S. Small Business Administration SERVICE-DISABLED VETERAN-OWNED CERTIFIED

What's New?

R. Brec Wilshusen, P.E., F.SAME – Engineering Project Manager

Military Experience: *Retired from Active Duty as a Major after serving 20 years in the Air Force*

Interest in Engineering: *Growing up on a farm, using water for irrigation and controlling erosion were essential elements to operating and improving assets*

Current Project: *Understand how the VA Sheridan WY makes their domestic water, and how we can improve the system*

One Core Value: *Service before Self - The investigation, design, and construction work we do have vast impacts upon society as a whole*

Other Interests: *An avid, if moderately successful, goat herder*

ALESIA ARCHITECTURE

SBA U.S. Small Business Administration SERVICE-DISABLED VETERAN-OWNED CERTIFIED

What's New?

Cort M. Johnson, M.Arch – Architectural Associate

Military Experience: *Early out after 4 years as an E-3*

Interest in Architecture: *Help make the human experience better through sustainable and equitable design*

Current Project: *VA Las Vegas Diagnostic Imaging Wing Expansion; more equitable and approachable for veterans*

One Core Value: *Freedom of expression through value in life experience…creating architecture which facilitates the freedom of the human-condition and existence*

Other Interests: *Avid adventurer and traveler, I am an alpinist/mountaineer, adventurer, diver of air and sea, sustainable hunter, designer, and veteran*

ALESIA ARCHITECTURE

SBA U.S. Small Business Administration SERVICE-DISABLED VETERAN-OWNED CERTIFIED

What's New?

Revitalizing our Core

Why?

As a certified Service-Disabled Veteran-Owned Small Business, we take pride in supporting our Veterans and their families through our work with the government.

Redesigning our Mission Statement and Core Values

We want to live those in our daily actions and ensure they are seen in our completed designs.

ALESIA ARCHITECTURE

SBA U.S. Small Business Administration
SERVICE-DISABLED VETERAN-OWNED CERTIFIED

Let's Work Together!

Email
ronken@alesiaarchitecture.com
lpfeffer@alesiaarchitecture.com

Visit
AlesiaArchitecture.com

Call
402-291-6941

LinkTree

Richard J. Onken
AIA, NCARB, EDAC, FHFI, Lt. Col. (Ret.)
President / CEO

Lindsey Pfeffer
MBA, SHRM-CP
Director Business Development
and Business Operations

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E-Redox® Technology Case Studies for Treating Contaminated Soils and Groundwater

Song Jin, PhD., CHMM
Advanced Environmental Technologies (AET)
Fort Collins, Colorado

E-Redox® Technology Case Studies for Treating Contaminated Soils and Groundwater

Song Jin, PhD., CHMM

Advanced Environmental Technologies (AET)
Fort Collins, Colorado

July 9, 2024

Acknowledgements and Outline

- Paul Fallgren, Joe Aiken, Nick Santiago, and Kylan Jin (UCLA) – AET
- Professor Jason Ren – Princeton University
- Michael Spievack - LANGAN

I. Case studies of E-Redox®-R for reductive remediation (e.g., chlorinated solvents, perchlorate, and PFAS)

II. Case studies of E-Redox®-O for oxidative remediation (e.g., petroleum hydrocarbons)

III. BioCook for solid organic wastes and PFAS media

IV. Mechanisms of E-Redox®-R and E-Redox®-O technologies

V. BioRemeter® for real-time and in-situ monitoring of biodegradation/NSZD/MNA

Advanced Environmental Technologies (AET)

- Mission: innovating sustainable remedial solutions
- Achievements: 70+ field applications across 14 states and 3 countries
- Key Technologies:
  - E-Redox for remediation (patents 11447429B2, 10647581, 10406572, 9045354B2, 7858243B2, 9545652B2)
    - E-redox-R for reductive degradation (e.g., USACE RFP for Fort Carlson and Offutt AFB
    - E-Redox-O for remediation (e.g, CO OPS remedial tool list)
  - BioRemeter (patent 11105766) for real-time monitoring of biodegradation activities
  - BioCook (MHTC) (patent 11725157 B2) for fast conversion of organic solid waste, potentially PFAS and the spent media and soil
- Team approach to provide comprehensive service

E-Redox®

Boosts bio(oxidative)degradation

Abiotic destruction and desorption of COC

E-Redox®-O(oxidation)

Typical Petroleum Hydrocarbons (e.g., BTEX)

Some PAHs

Other VOCs, SVOCs

Desorption of mass into water phase

E-Redox®-R(Reduction)

Certain Oxyanionic Metals (e.g., CrVI)

Chlorinated Solvents, Some PFAS

Nitrate/Nitrite, Perchlorate

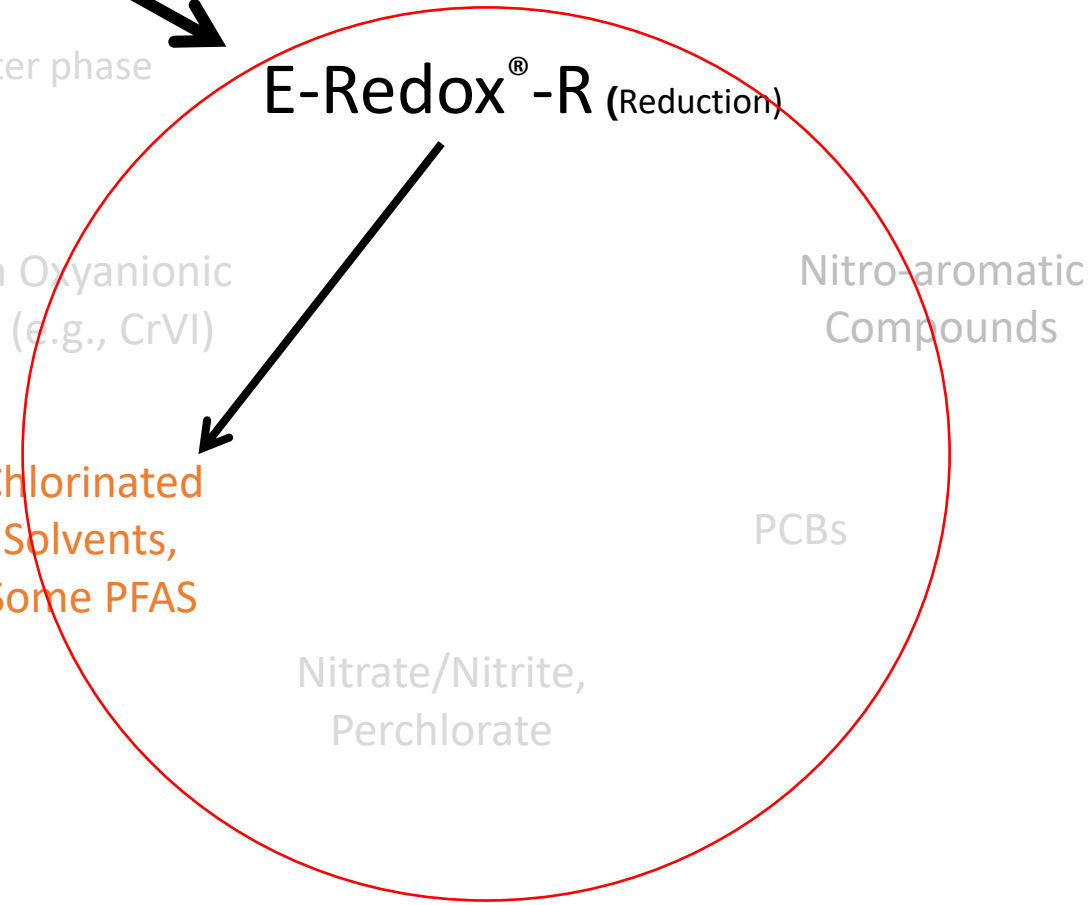
PCBs

Nitro-aromatic Compounds

Benefits: works in diverse matrices, no physical injection required

E-Redox®

- A low intensity "static" electrical field in the matrix and a perpetual source of electrons for (dominant) abiotic reductive degradation
- Desorption of contaminants
- Sets and maintains low redox conditions that also favors bio-dechlorination



-- Achieved NAD closures under CO Department of Public Health and Environment

E- remedies of different mechanisms

	Typical Linear Current Density	Typical Linear Voltage Density	Current Loading	Main Reactions
Electrolytic Destruction (ER)	50 mA/cm	5000 mV/cm		Electrode surface/interface reactions, reactive barrier applications
Electrokinetic Migration (Remediation)		500 mV/cm	0.123-0.615 mA/cm^2	Movements of soluble constituents in the matrix
E-Redox®-R	<2 mA/cm	<50 mV/cm	0.002-0.006 mA/cm^2	"Static" weak electrical field that charges soil particles as "micro-capacitors"; disturbing solid-water interface charges and configurations weakening surface adsorption

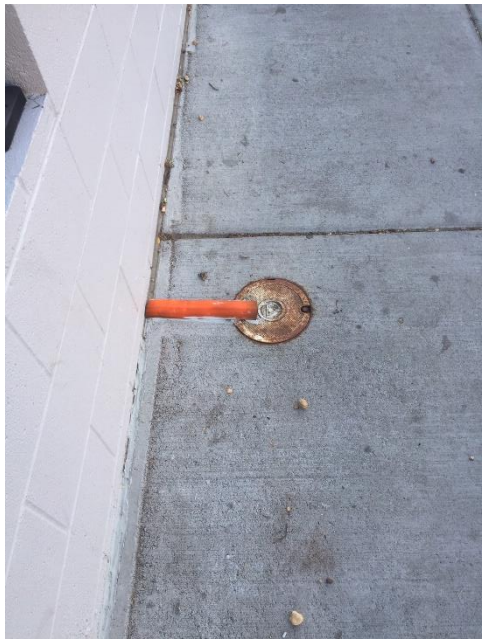
FORMER DRY CLEANER SITE ON EAST COLFAX AVENUE, DENVER, CO

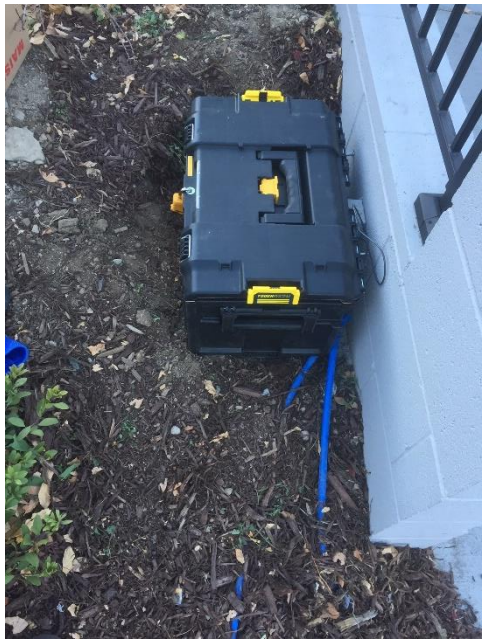
Location: Former dry cleaner in Denver, CO

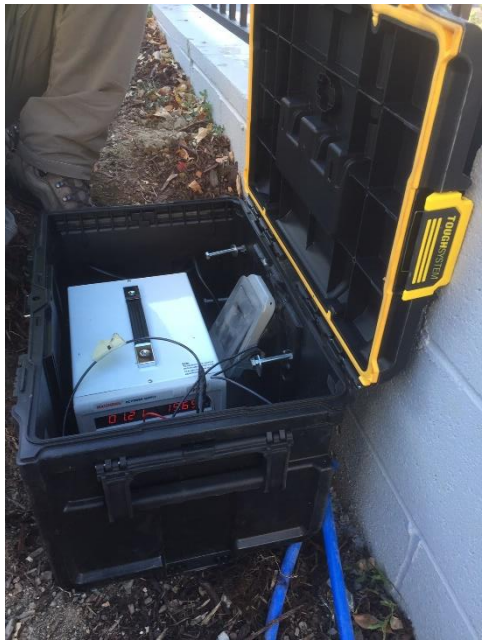
Contaminated Matrix: Saturated zone with clay

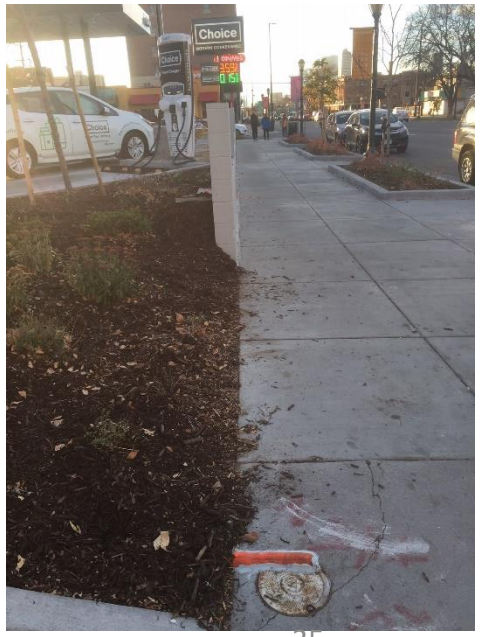
Primary Contaminants: Tetrachloroethene (PCE), trichloroethene (TCE) and 1,2-dichloroethenes (DCEs)

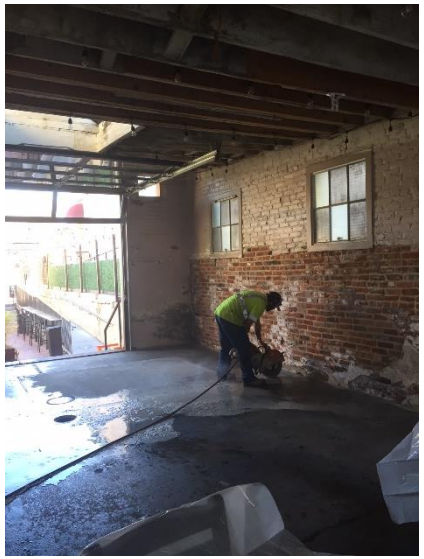

2200 E Colfax
Gaylord St
2220 E Colfax
Property
E Colfax Ave
40
Josephine St
RMW -1
RMW -2
RMW -3
RMW -4
Former Dry Cleaning Facility








Choice

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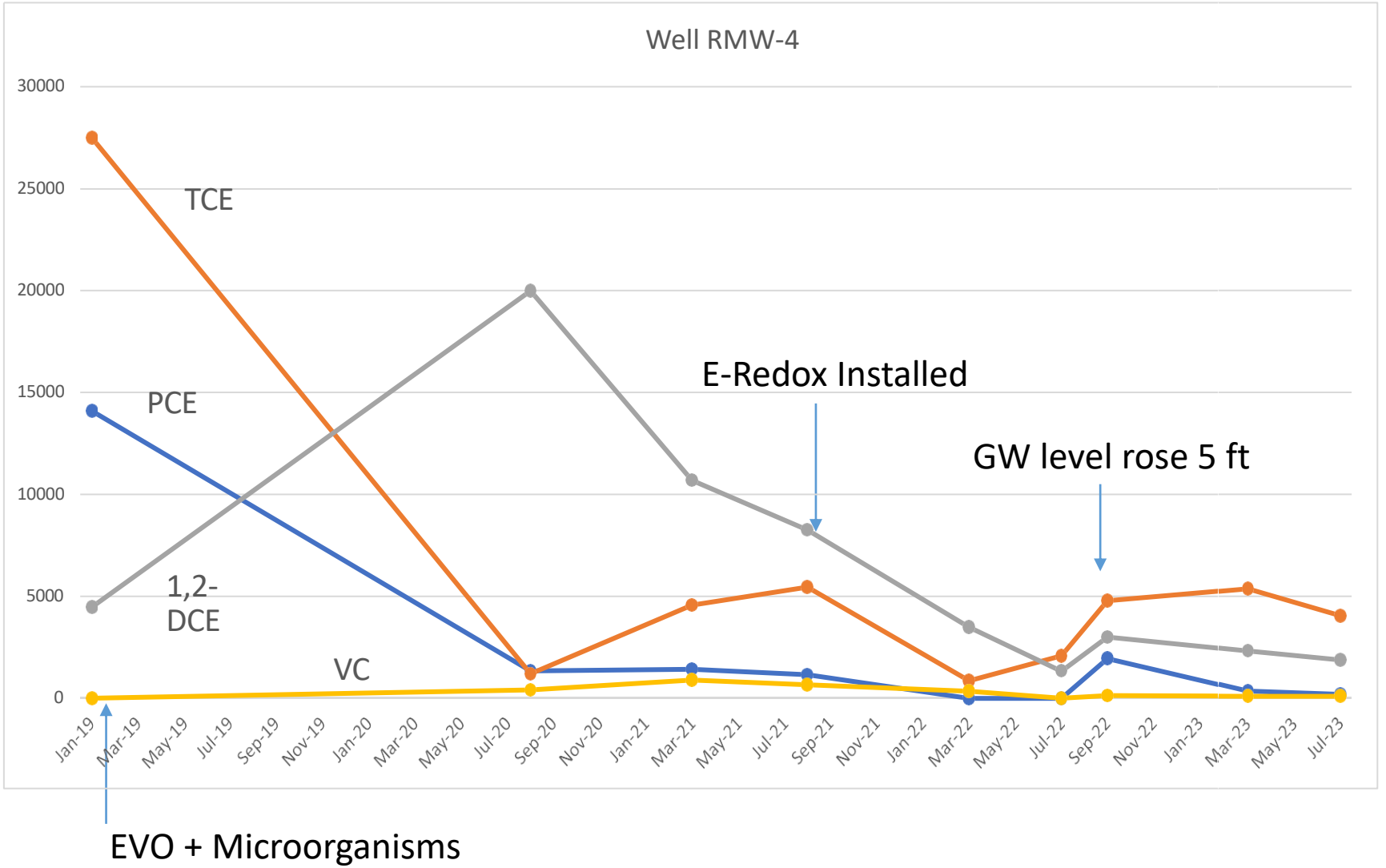
Well RMW-4
30000
25000
20000
15000
10000
5000
0
TCE
PCE
1,2-
DCE
VC
E-Redox Installed
GW level rose 5 ft
EVO + Microorganisms
Jan-19
Mar-19
May-19
Jul-19
Sep-19
Nov-19
Jan-20
Mar-20
May-20
Jul-20
Sep-20
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Sep-22
Nov-22
Jan-23
Mar-23
May-23
Jul-23

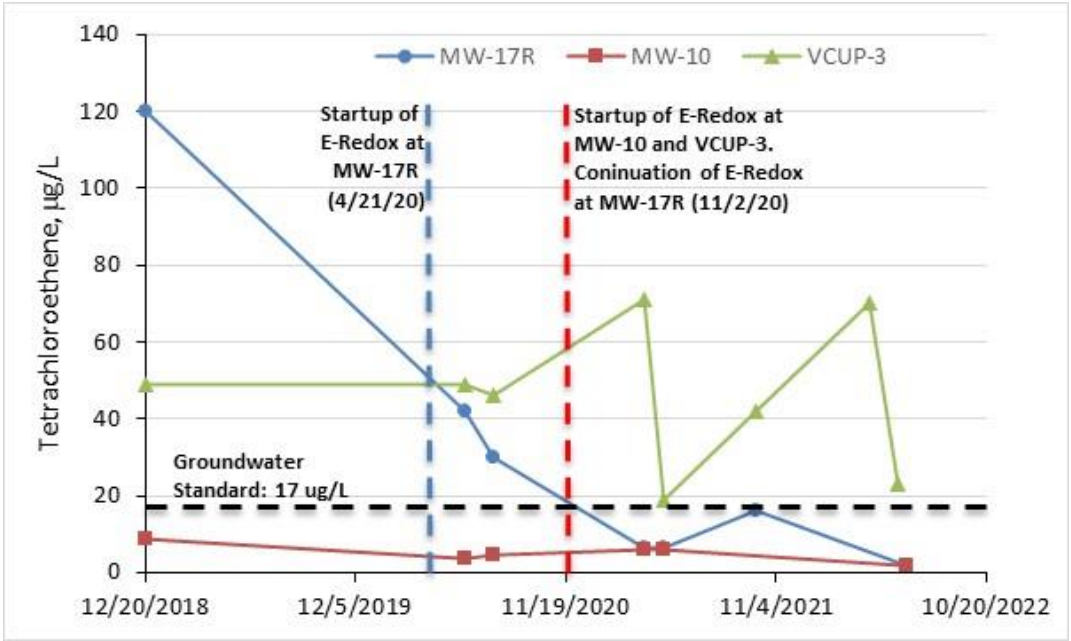

FORMER SHOPPING CENTER, NORTHGLENN, CO

Location: Former shopping center with dry cleaners in Northglenn, CO

Contaminated Matrix: Saturated zone (alluvial, clay, bedrock fractures)

Main Contaminant: PCE

Previous Remediation: ISCO injections



E-Redox®-R units were decommissioned after <1-yr operation. The site was closed with a No Action Determination (NAD) granted by the Colorado Department of Public Health and Environment in September 2022

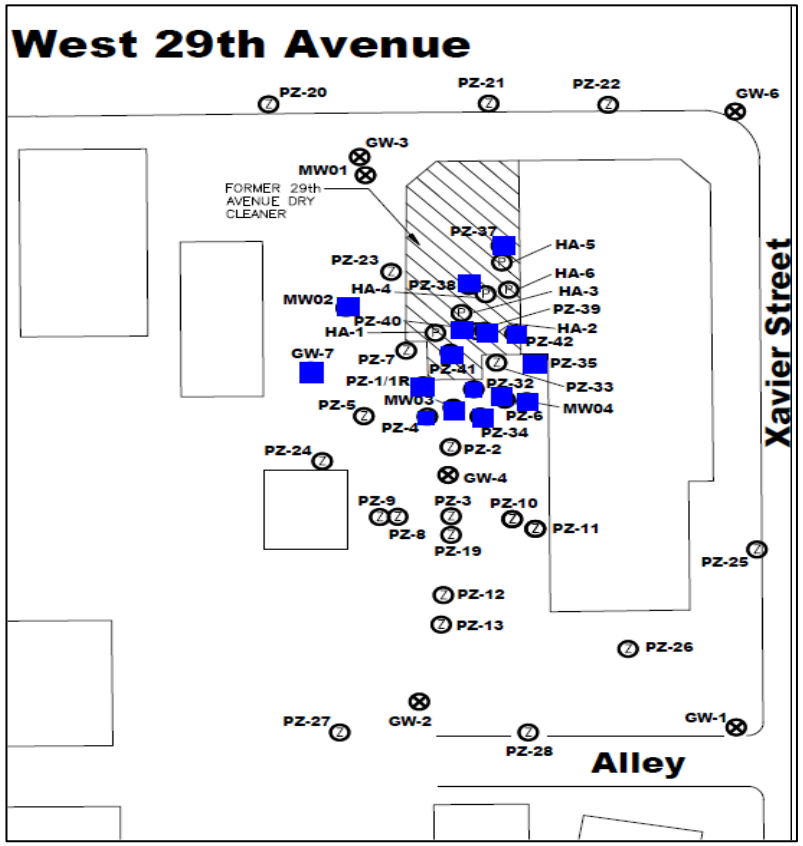
Location: Former dry cleaner in Denver, CO

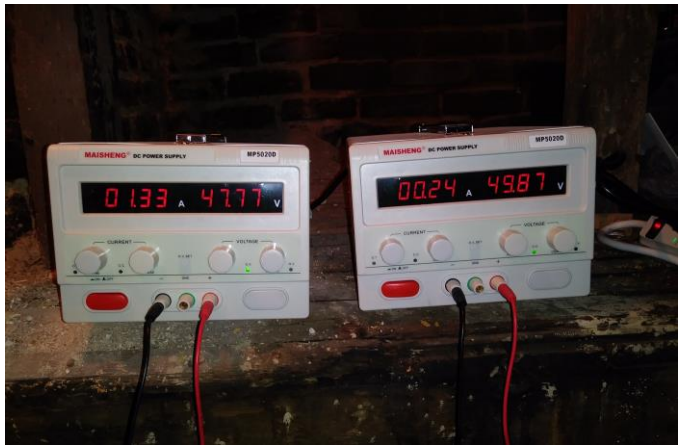
Contaminated Matrix: Saturated zone with clay

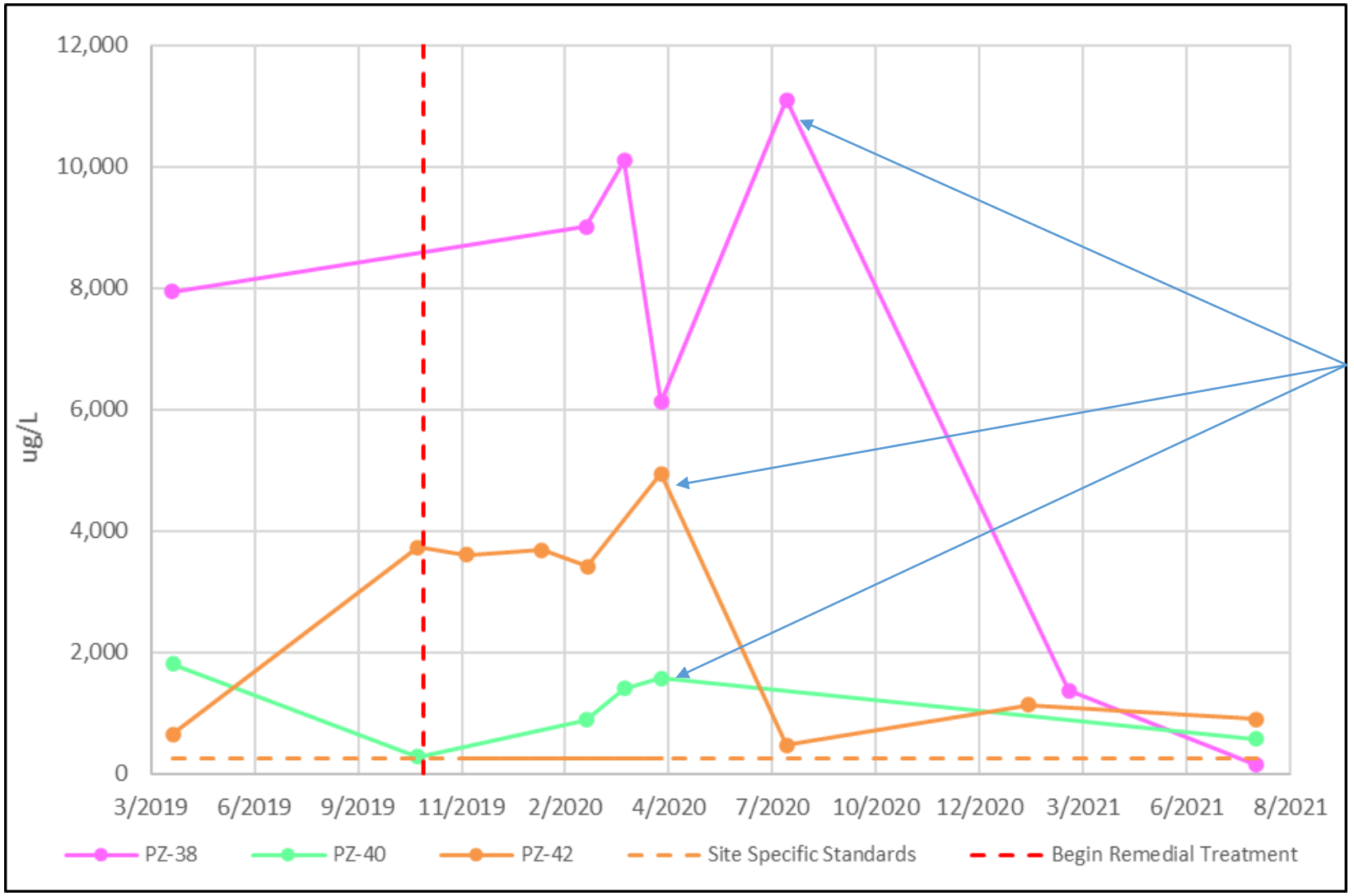
Primary Contaminants: PCE

Previous Remediation: ISCO injections

E-REDOX- R (REDUCTION) IMPLEMENTATION







PCE Concentration Profiles in Key Monitoring Wells

Polarity switches of the E-Redox-R units help desorbing PCE from solids into groundwater

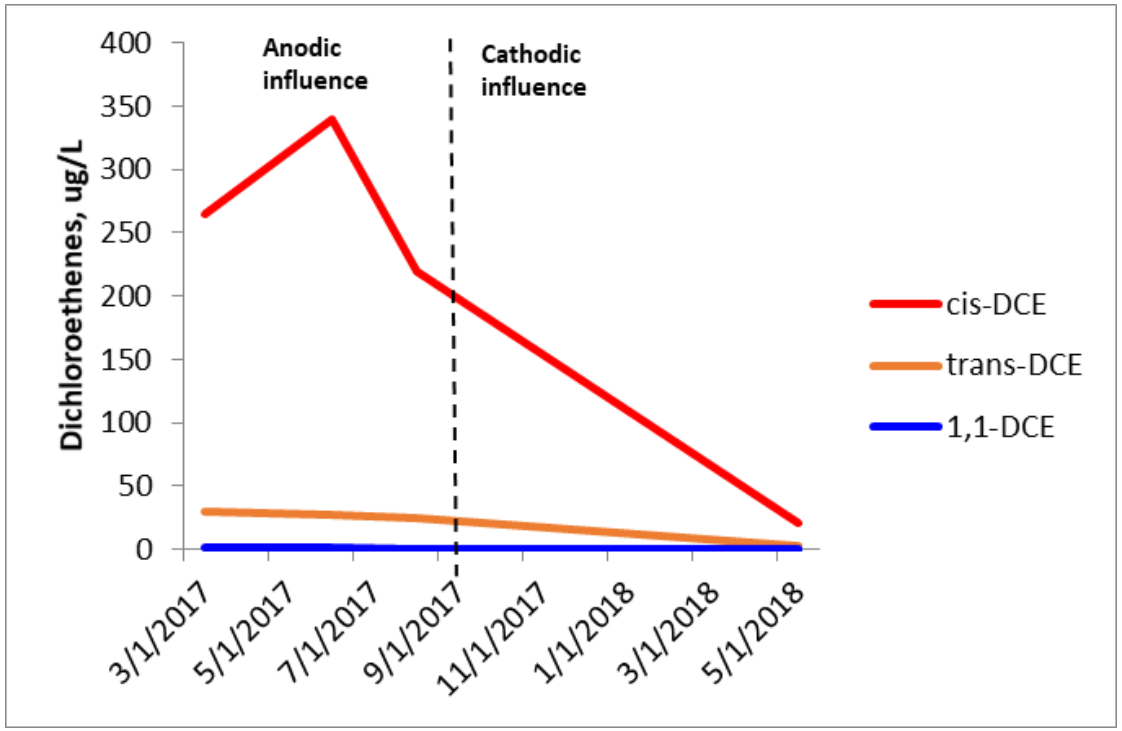
Alaska DOT Site
Fairbanks, Alaska

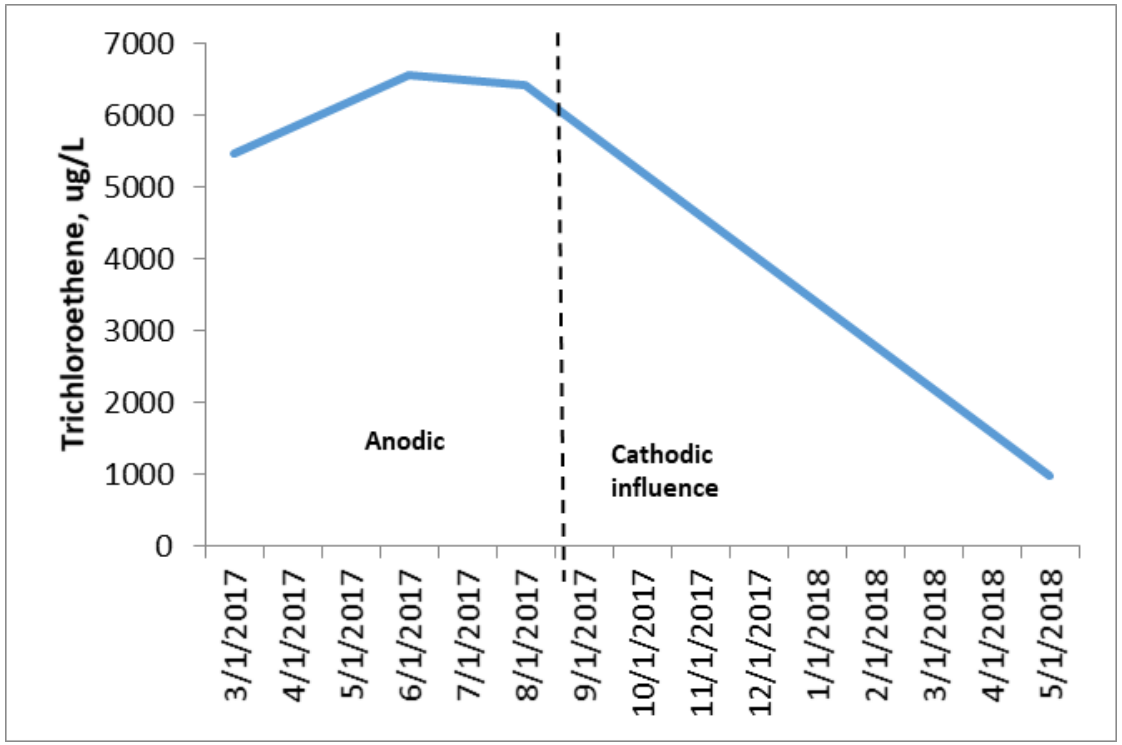
Location: DOT Service center, Fairbanks, AK

Contaminated Matrix: Groundwater (alluvial, clay)

Main Contaminant: TCE and DCEs

Previous Remediation: unknown


Dichloroethenes, ug/L
400
350
300
250
200
150
100
50
0
Anodic influence
Cathodic influence
3/1/2017
5/1/2017
7/1/2017
9/1/2017
11/1/2017
1/1/2018
3/1/2018
5/1/2018
cis-DCE
trans-DCE
1,1-DCE


Trichloroethene, ug/L
7000
6000
5000
4000
3000
2000
1000
0
Anodic
Cathodic influence
3/1/2017
4/1/2017
5/1/2017
6/1/2017
7/1/2017
8/1/2017
9/1/2017
10/1/2017
11/1/2017
12/1/2017
1/1/2018
2/1/2018
3/1/2018
4/1/2018
5/1/2018

Charleston, SC

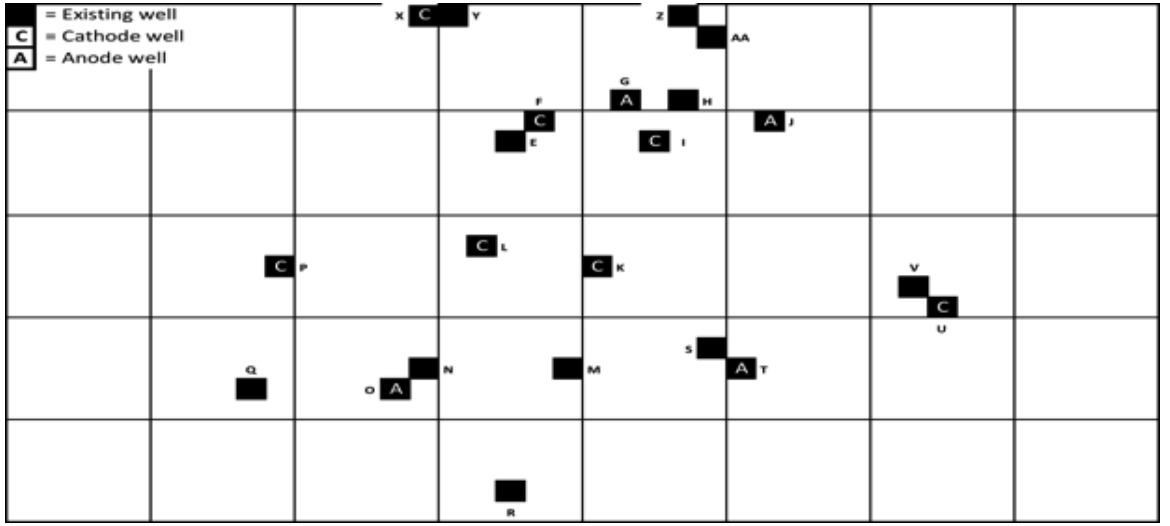
FORMER AHESIVES PRODUCTION PLANT
(under post-remedial monitoring)

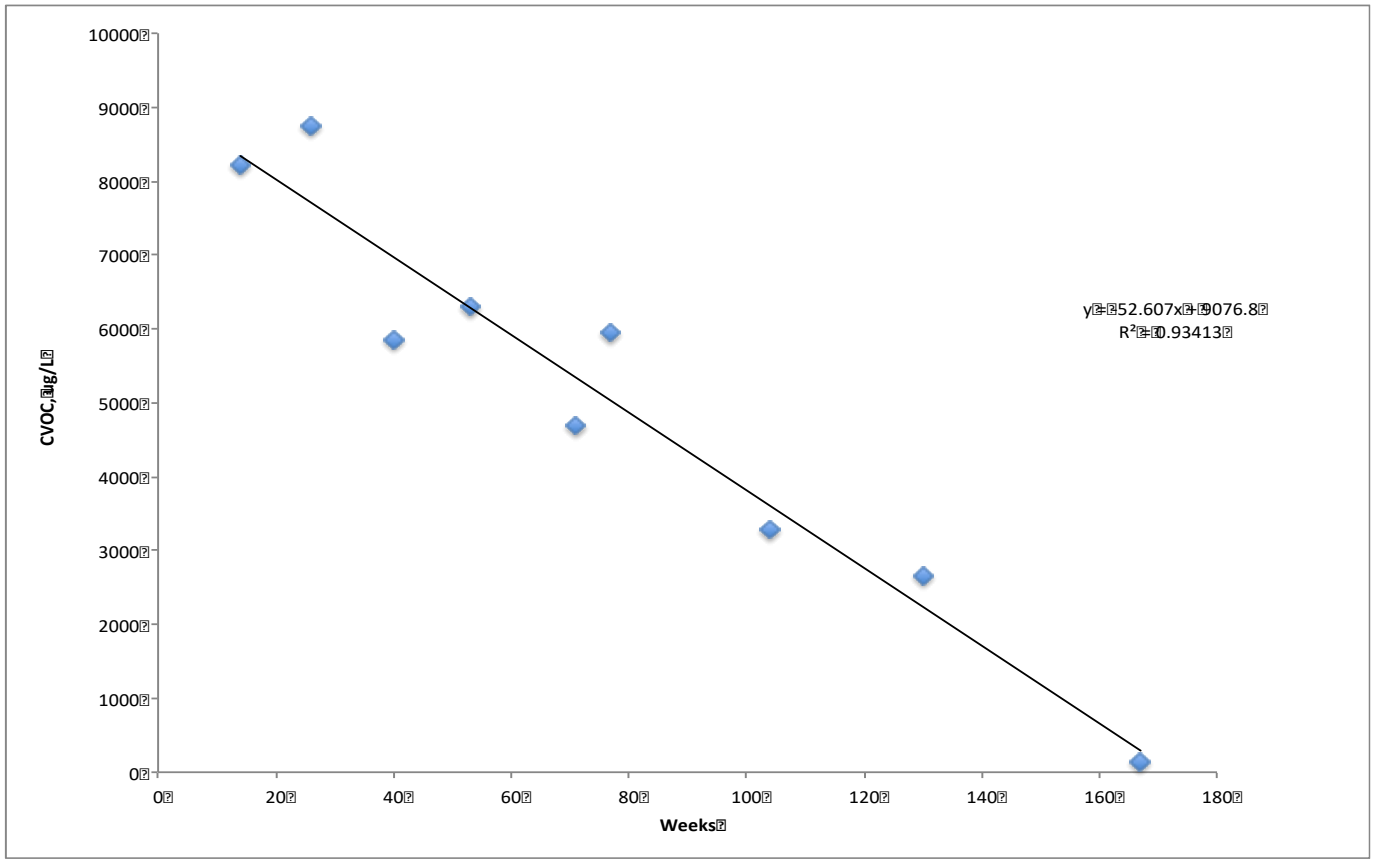
Location: Former adhesives production plant near Charleston, SC

Contaminated Matrix: Saturated zone (alluvial, clay)

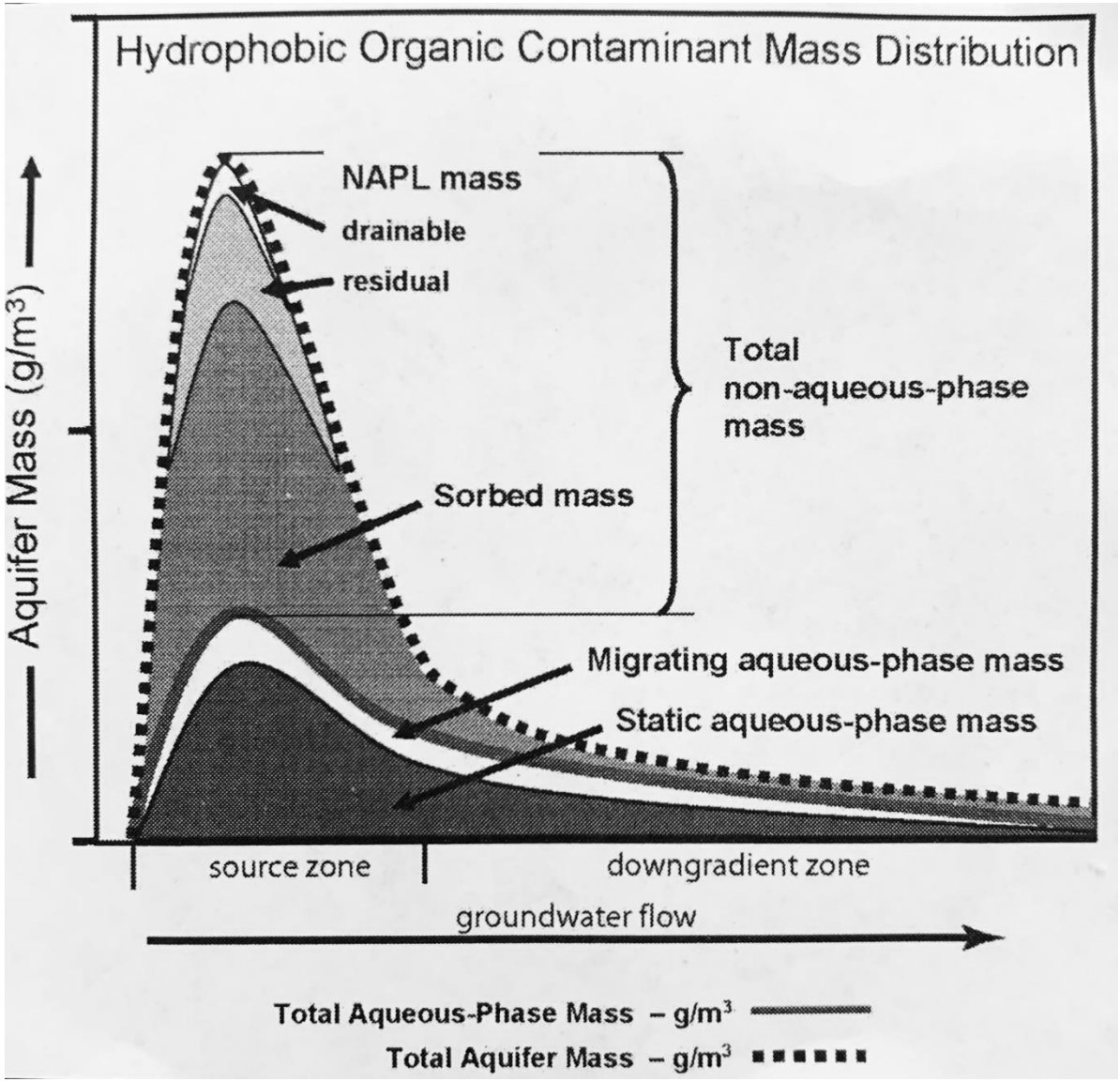
Main Contaminant: PCE, TCE and DCEs, and VC

Previous Remediation: injections of electron donors, ZVI, and DPE (ongoing)

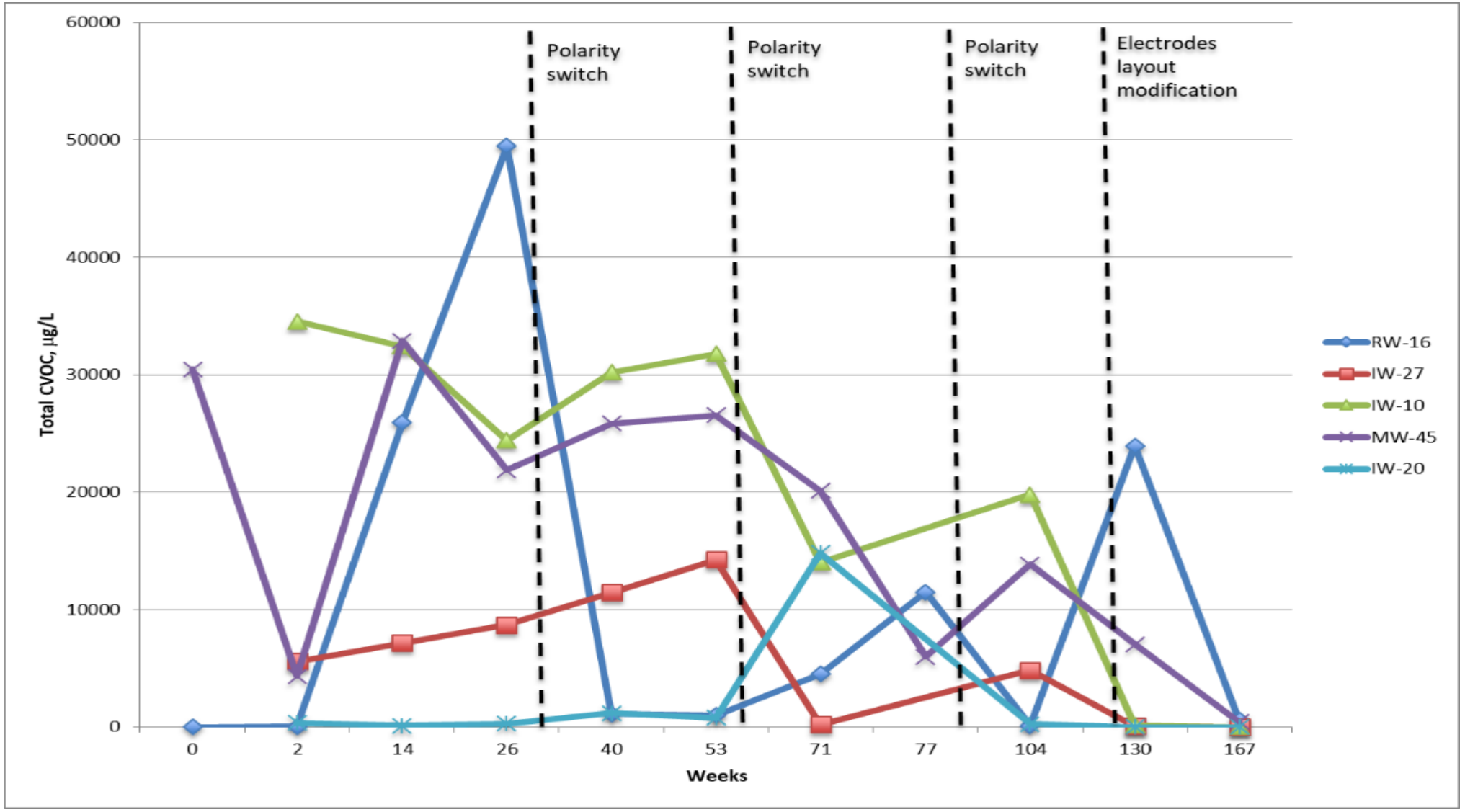




Total site-wide chlorinated volatile organic compounds (CVOC) concentrations



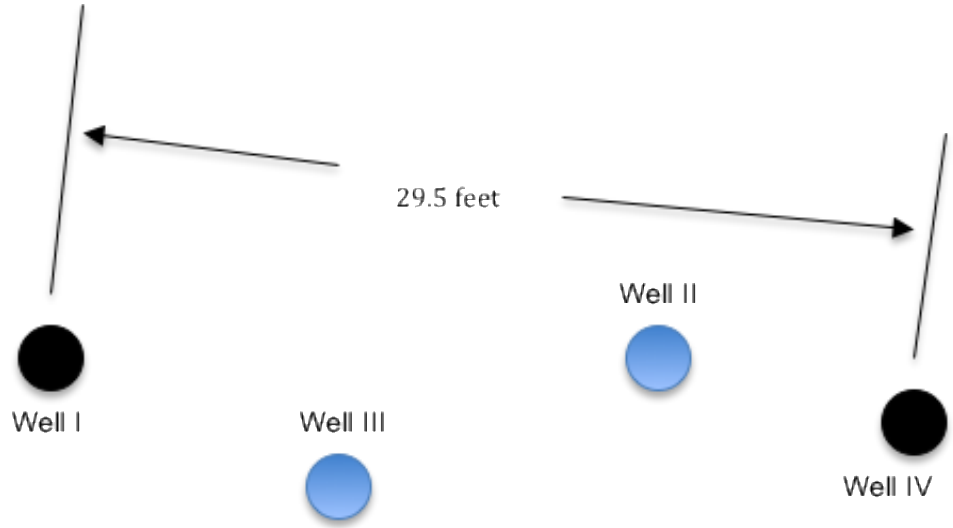
E-Redox®-I facilitated desorption-reduction for faster mass removal and degradation



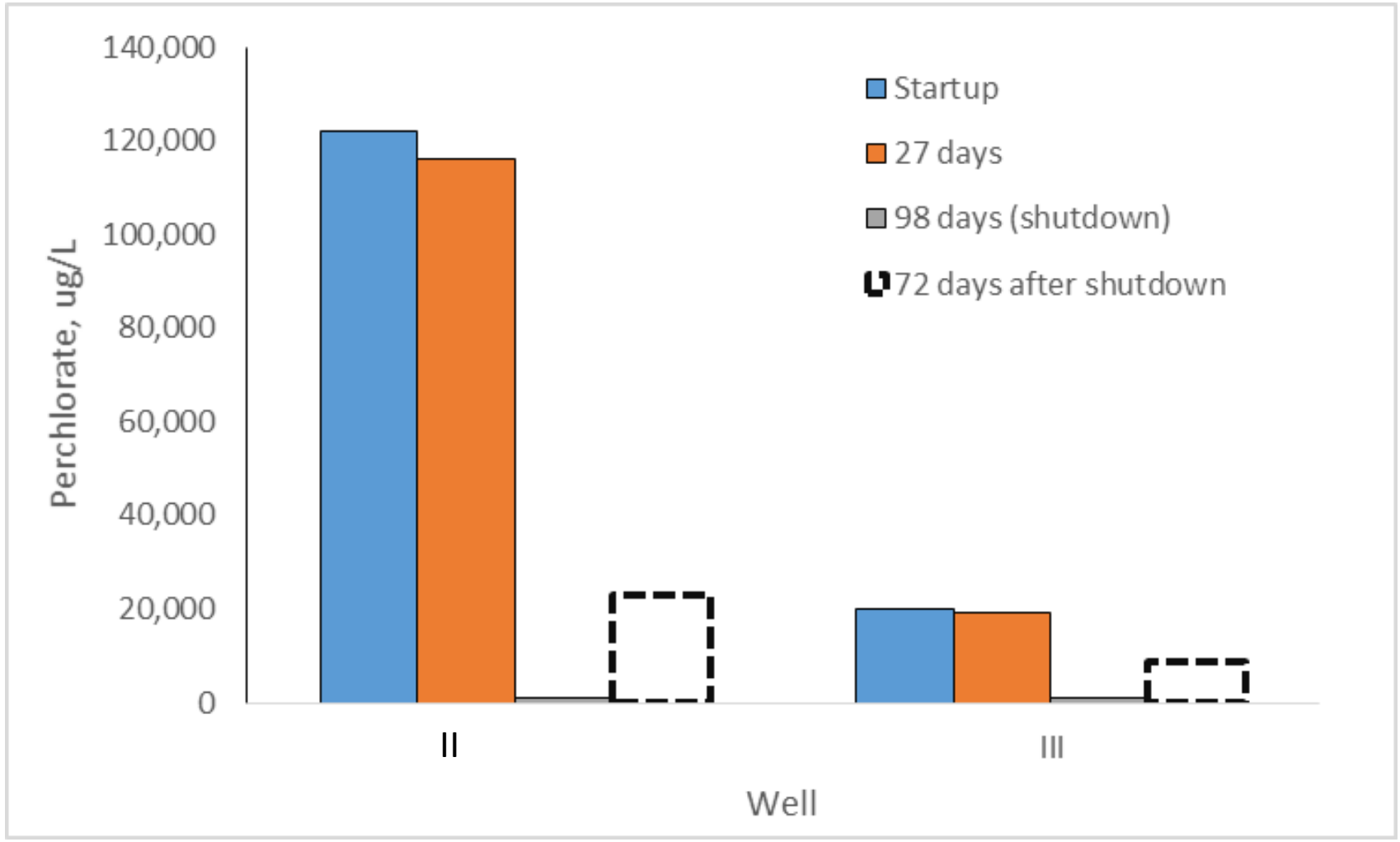
E-Redox®-I facilitated desorption-reduction for faster mass removal and degradation

Former Explosives Testing Site, San Bernardino, CA

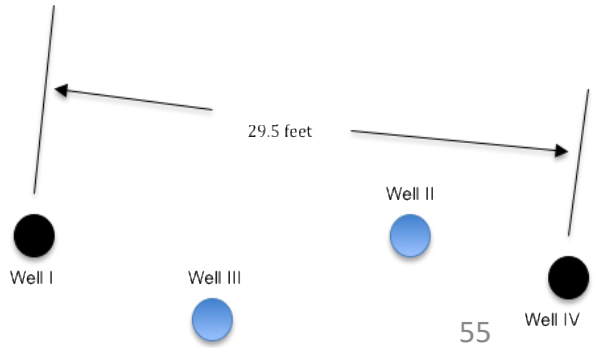
- Former explosives testing site in San Bernardino
- Contaminant: primarily perchlorate
- Past remediation efforts not effective due to low-permeability of aquifer material (clay and shale)
- No municipal power access; solar cells were used for establishing a low-intensity electric field

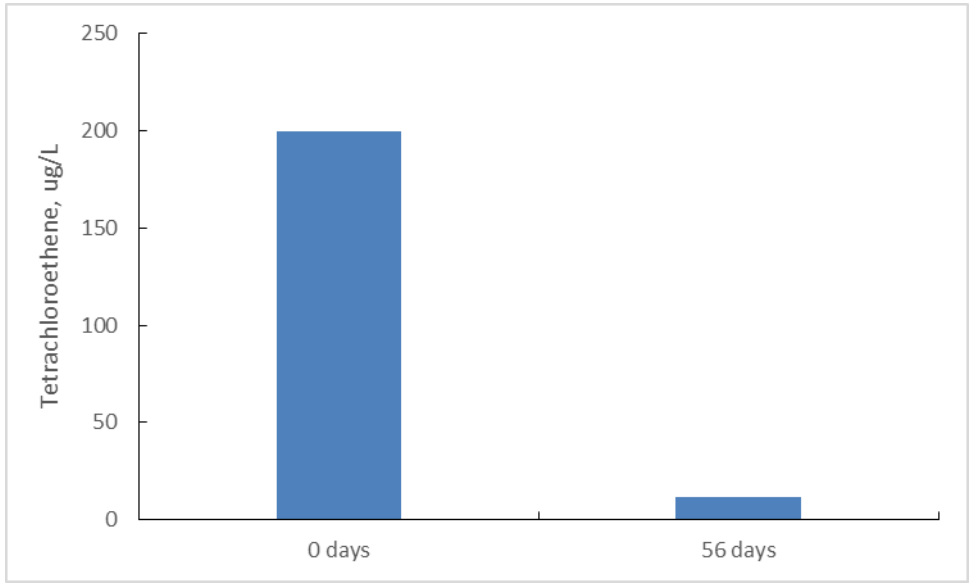


E-Redox® field test site layout

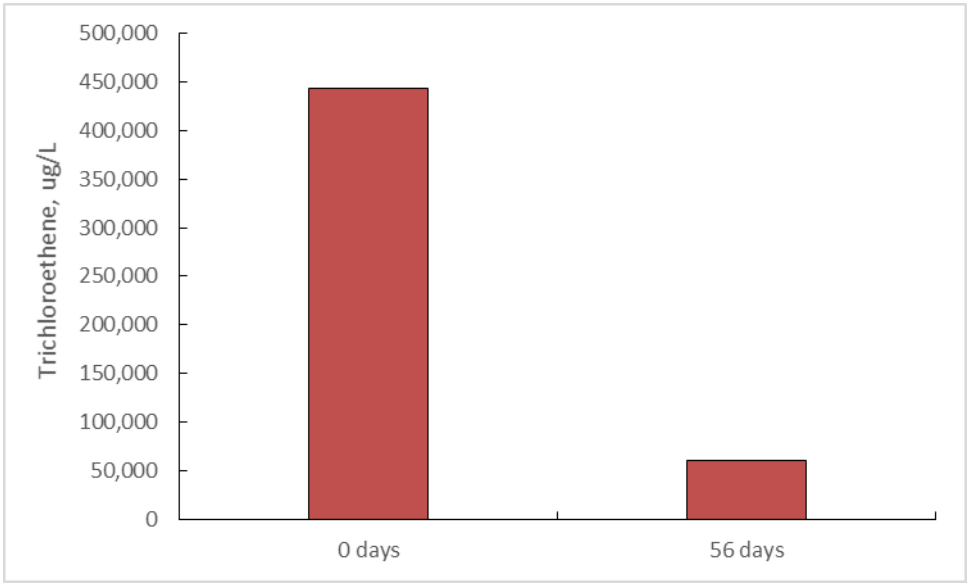


Perchlorate concentrations (98 days of field demonstration)

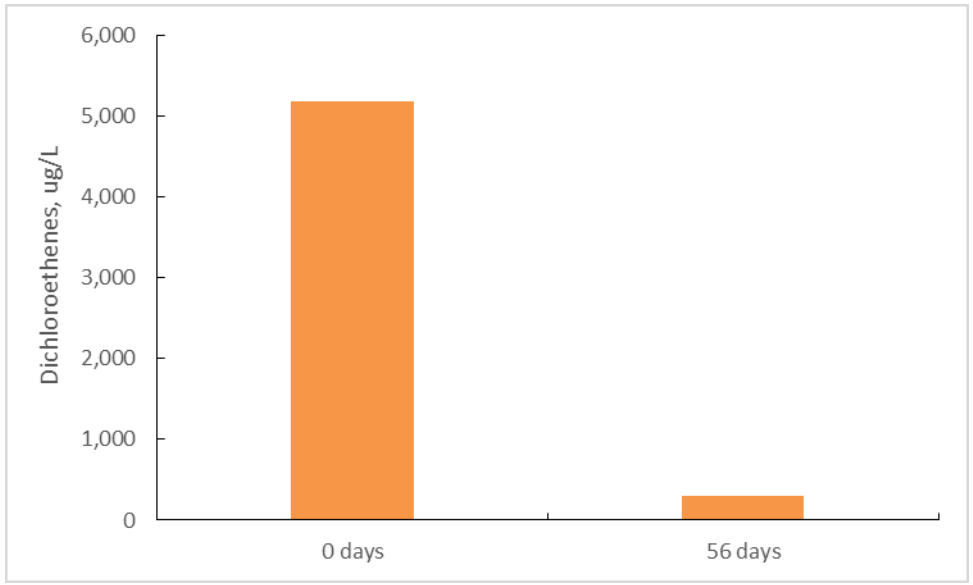




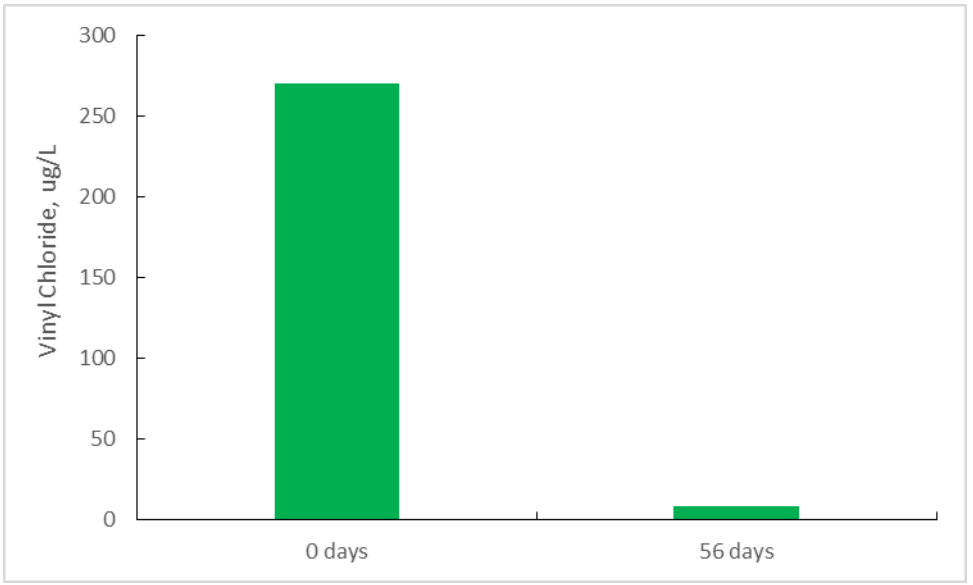
PCE (94% reduction)



TCE (86% reduction)



DCEs (94% reduction)



VC (97% reduction)

E-Redox®-R (Reduction) Highlights

- **IT WORKS IN CLAY as well; NO physical injection**
- Initiates and sustains both **abiotic and biological degradations (dechlorination of CVOC and defluorination of PFAS)**
- **Helps desorption** of COCs (CVOC and PFAS) into the water for enhanced mass removal and destruction
- **ROI of 25-50 ft** (500-2,000 sf/unit); consumes minimum energy, convenient O&M, fits remote sites
- Integrates with other remediation technologies:
  - ZVI rejuvenation
  - Extends electron donor longevity
  - Rapidly establishes **low redox potential** condition for reductive remedies

E-Redox®

Boosts bio(oxidative)degradation

Abiotic destruction and desorption of COC

E-Redox®-O(oxidation)

Typical Petroleum Hydrocarbons (e.g., BTEX)

Some PAHs

Other VOCs, SVOCs

Desorption of mass into water phase

E-Redox®-R(Reduction)

Certain Oxyanionic Metals (e.g., CrVI)

Chlorinated Solvents, Some PFAS

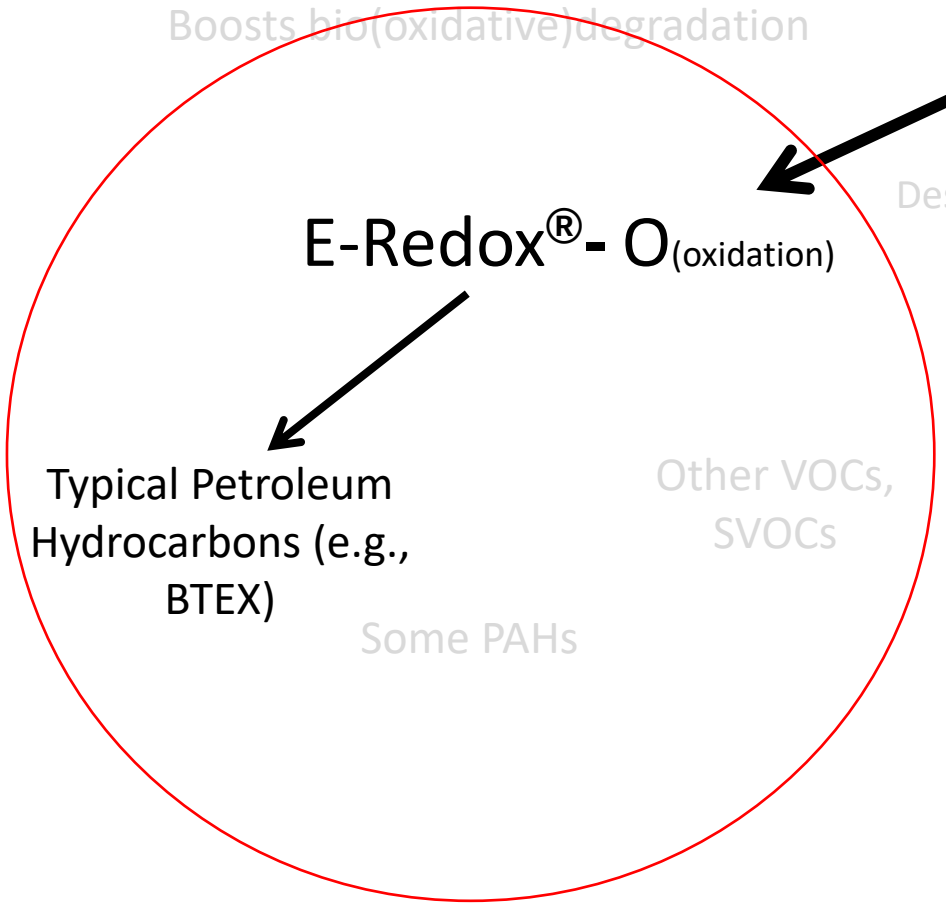
Nitrate/Nitrite, Perchlorate

PCBs

Nitro-aromatic Compounds

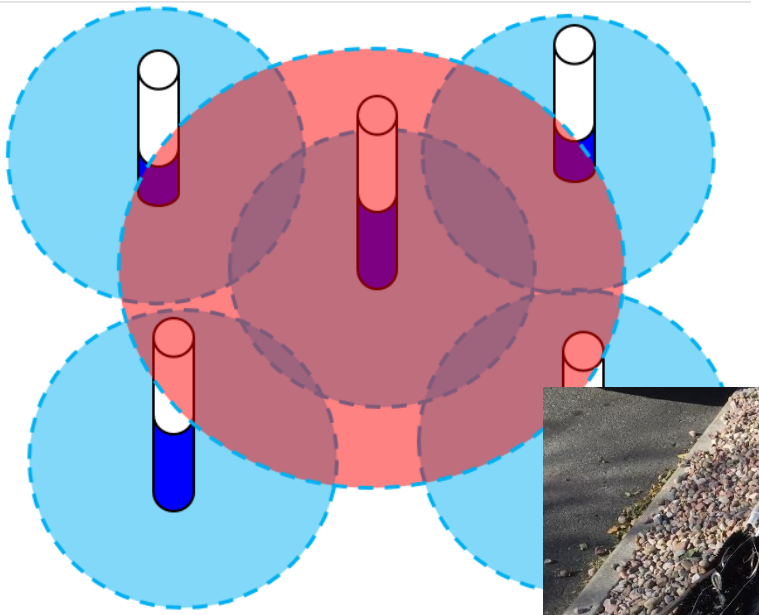
Benefits: works in diverse matrices, no physical injection required

E-Redox®

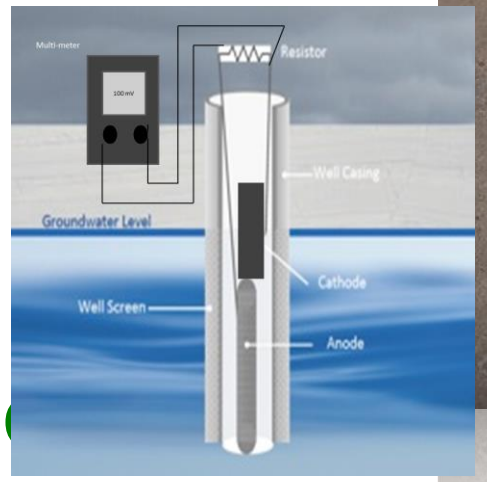


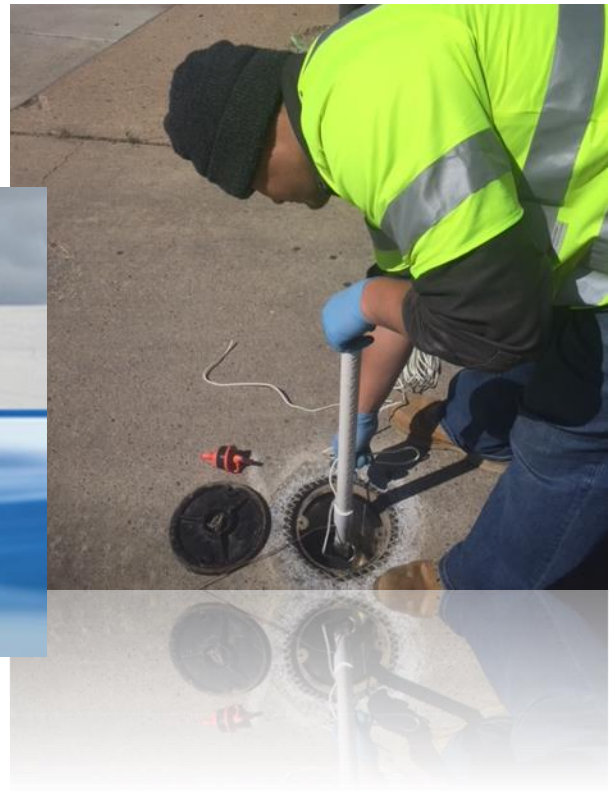
A respiratory "Snorkel" for microbes to support and expedite biodegradation in a matrix depleted of electron acceptors, without physical injection of any e-acceptors (air/oxygen/nitrate/sulfate)

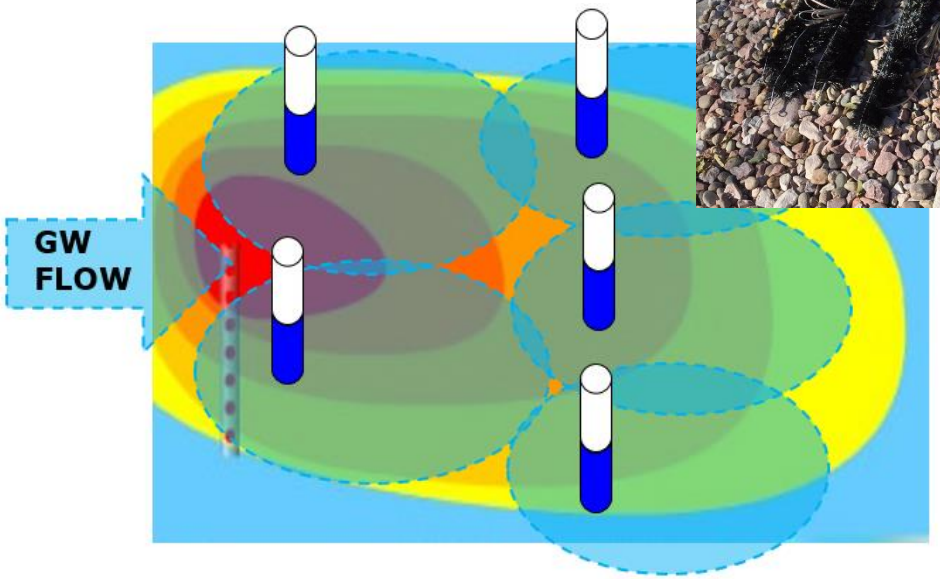
-- CO OPS listed remedial technology



E-Redox®-O for source and small plume treatment

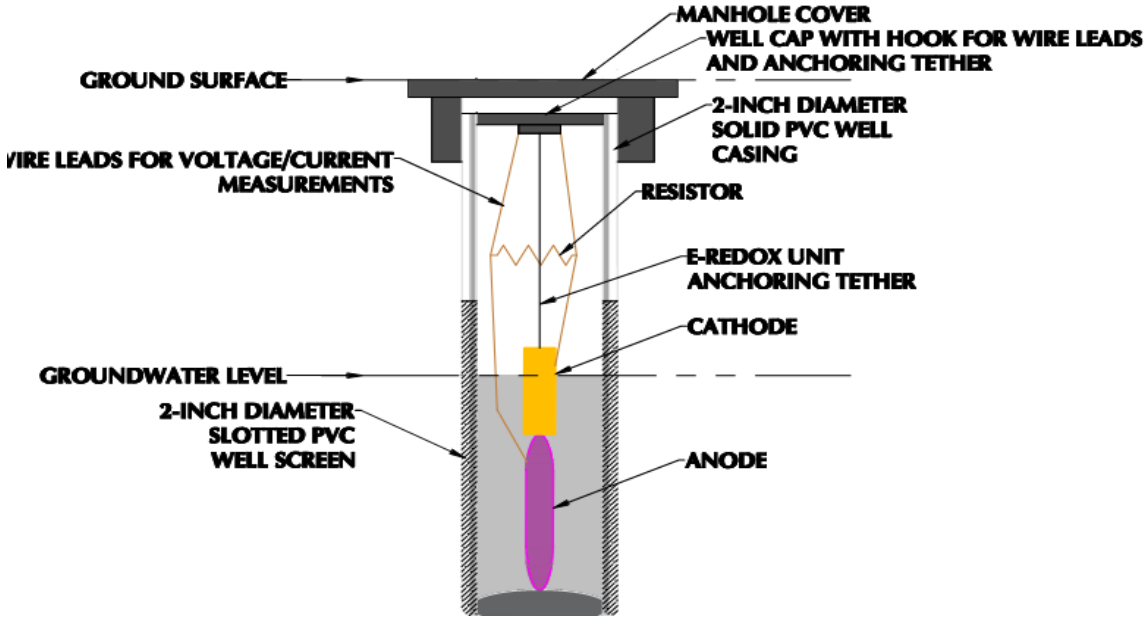




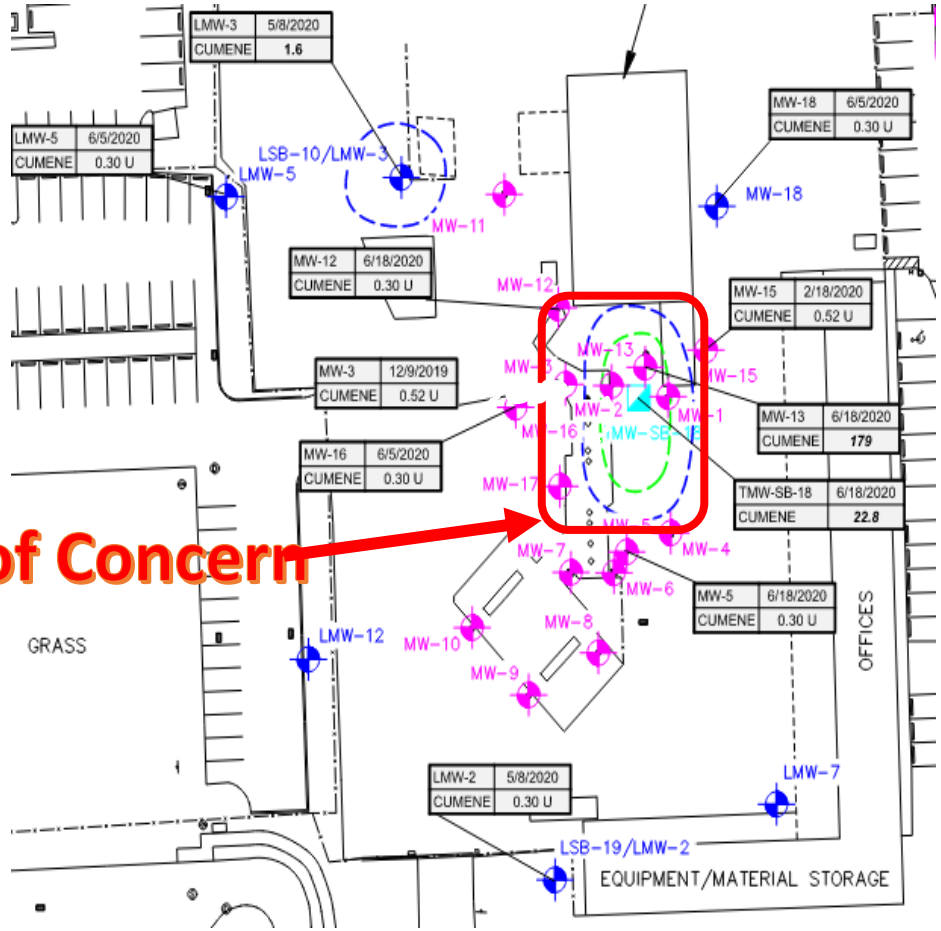


barrier for areal plume and edge treatment

E-Redox®-O for Petroleum Degradation


MANHOLE COVER
WELL CAP WITH HOOK FOR WIRE LEADS AND ANCHORING TETHER
GROUND SURFACE
2-INCH DIAMETER SOLID PVC WELL CASING
WIRE LEADS FOR VOLTAGE/CURRENT MEASUREMENTS
RESISTOR
E-REDOX UNIT ANCHORING TETHER
CATHODE
GROUNDWATER LEVEL
2-INCH DIAMETER SLOTTED PVC WELL SCREEN
ANODE

Site assessment findings – Oakland Park, FL



Area of Concern

Source:

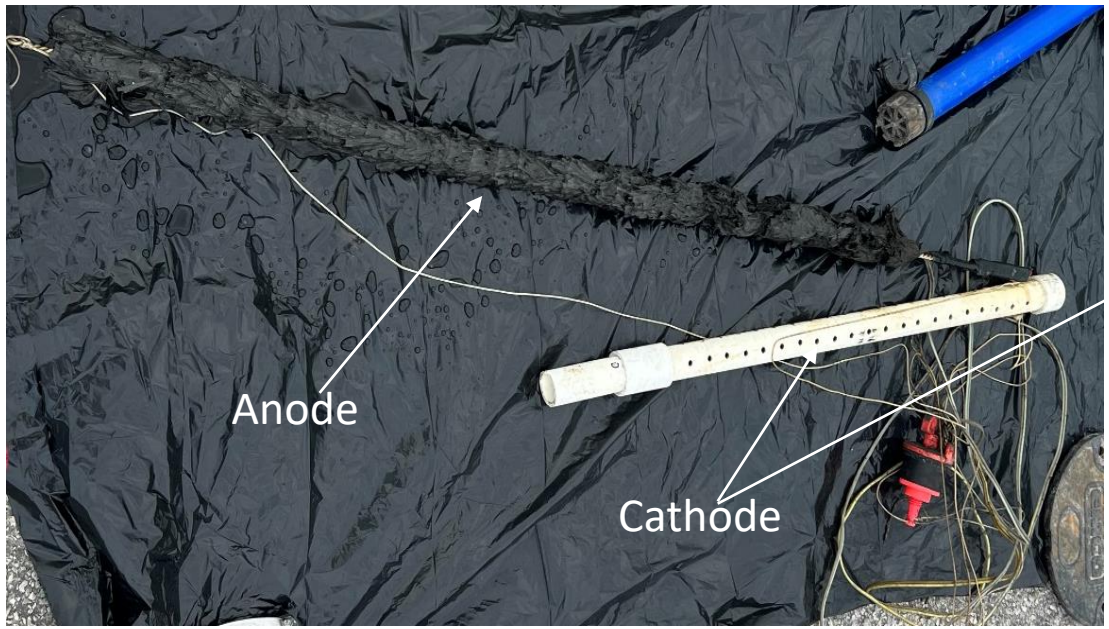
- 1987 Petroleum Discharge from Underground Storage Tanks

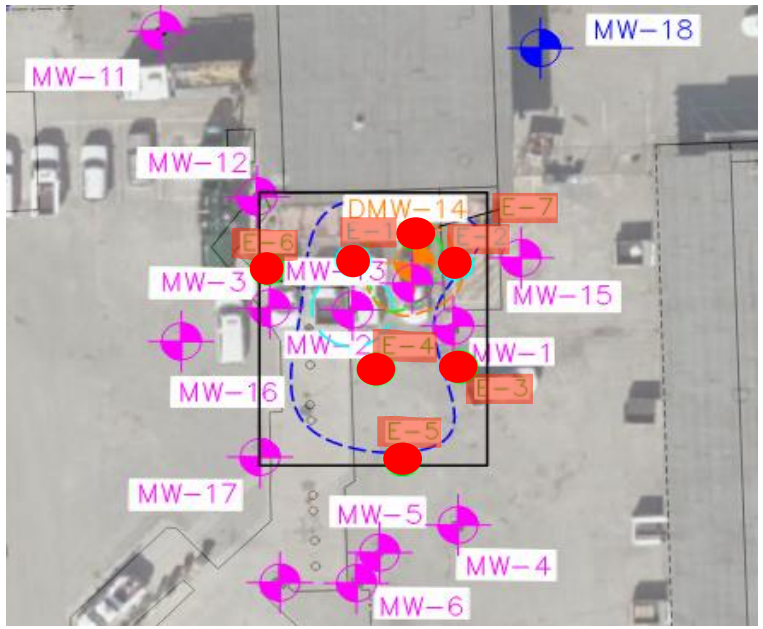
Contaminants:

- Benzene, Toluene, Ethylbenzene and Xylenes (BTEX), and cumene
- Polycyclic Aromatic Hydrocarbons (PAH) - Naphthalene and 1- and 2-methylnaphthalenes

E-RedoX® FULL SCALE IMPLEMENTATION

7 E-Redox® units installed with approximate spacing of 20 feet





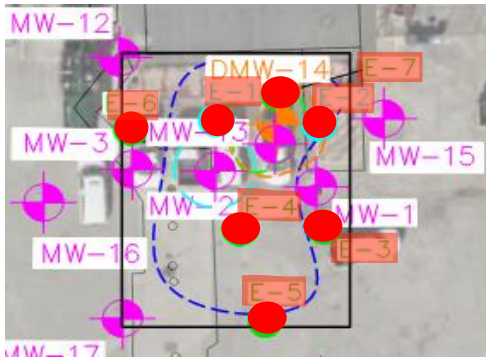
E-RedoX® FULL SCALE IMPLEMENTATION

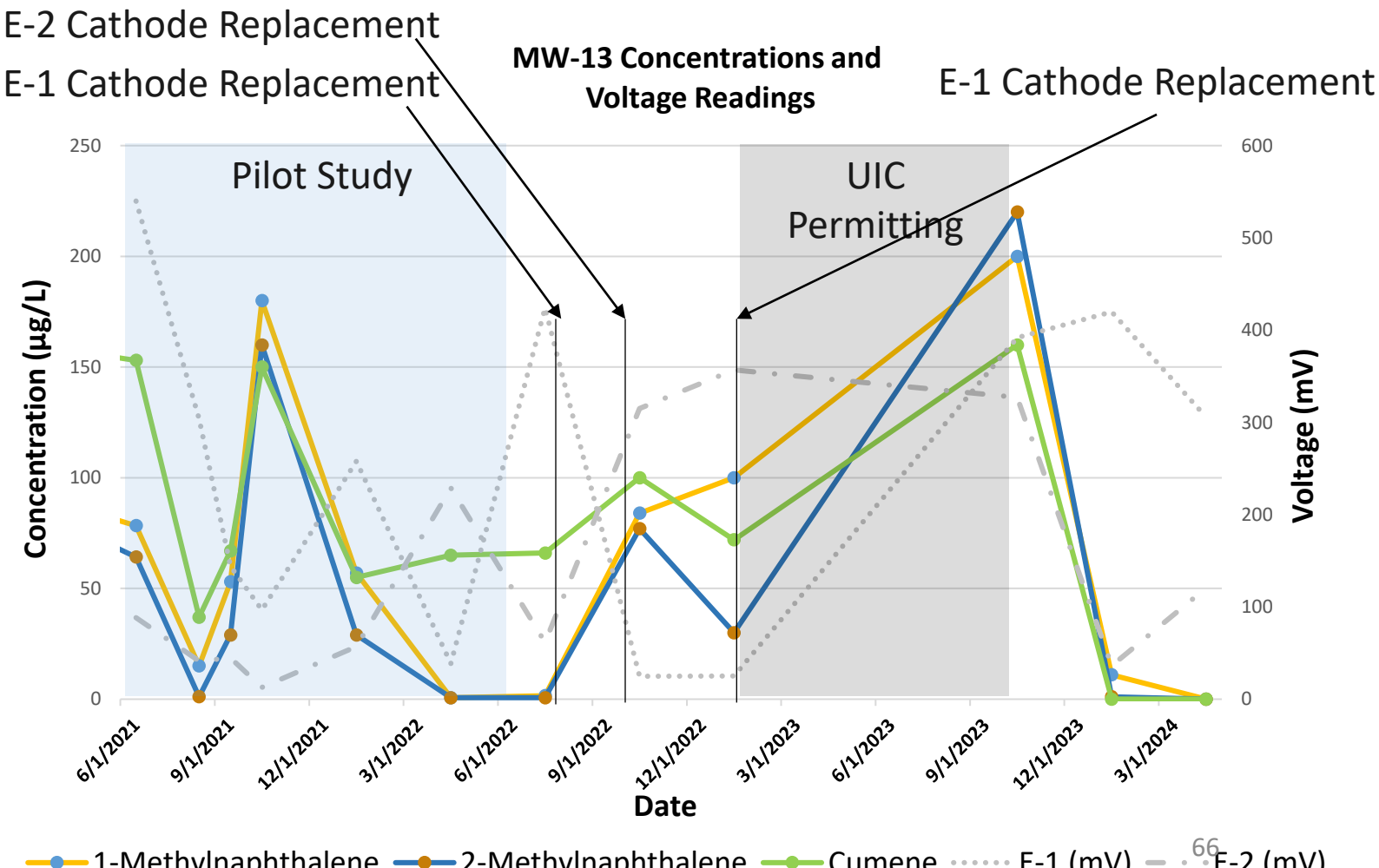
Challenge:

- Decrease in voltage and therefore effectiveness of the E-Redox® unit

Solution:

- Quarterly replacement of cathodes





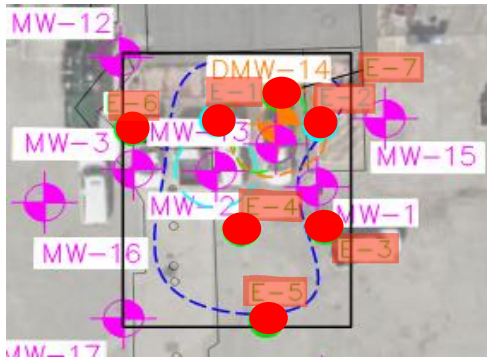
E-RedoX® FULL SCALE IMPLEMENTATION

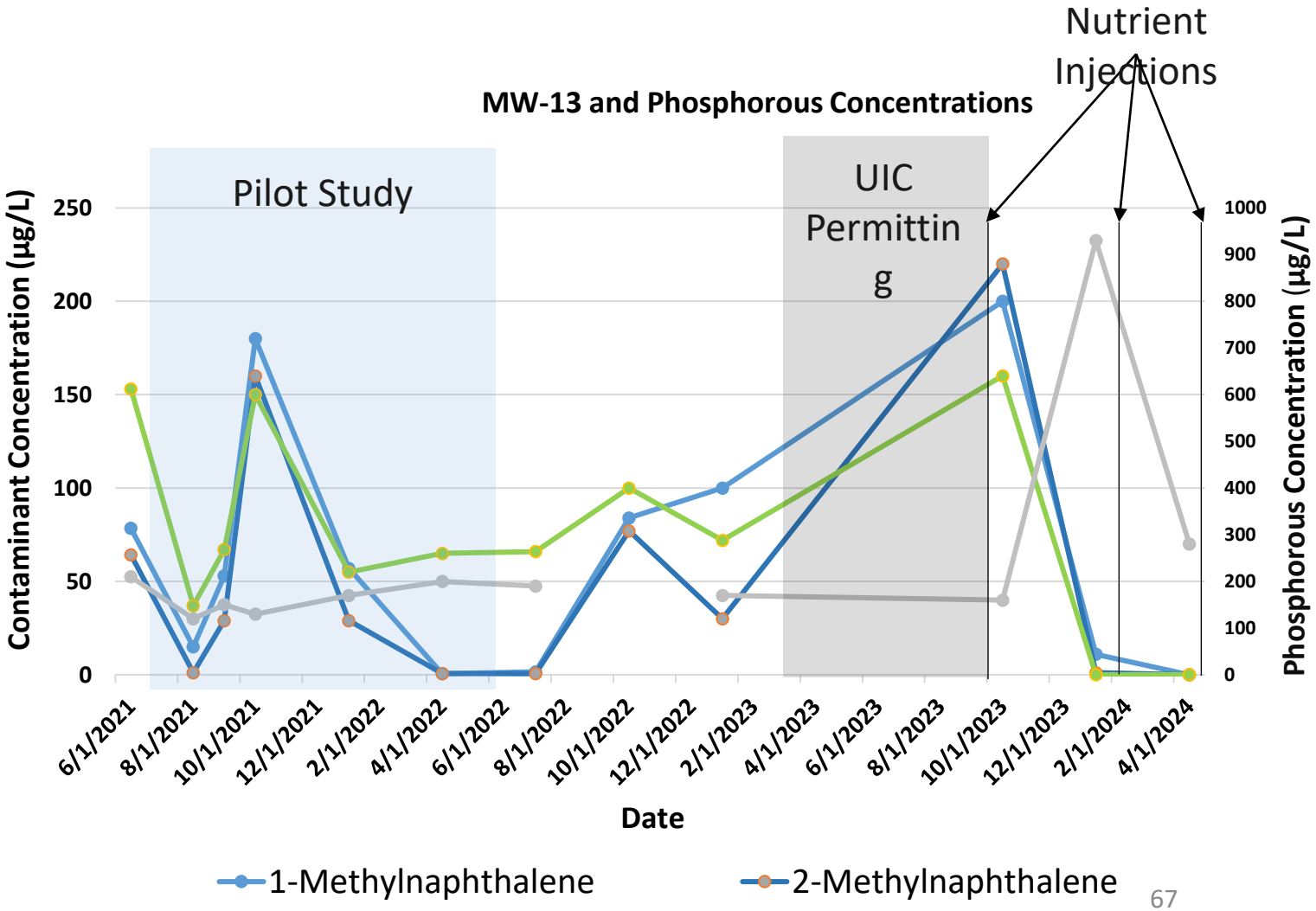
Challenge:

- Depletion of nutrients essential for biodegradation.

Solution:

- Addition of diammonium phosphate (DAP) and KCL to replenish macro nutrients in the treatment area





TOTAL CO_2 EMISSIONS

E-Redox®

- 1.07 metric tons, primarily from transportation

Chemical Oxidation

- 23.53 metric tons, primarily from equipment operation

Air Sparge & Soil Vapor Extraction

- 6,117 metric tons , primarily from equipment operation

E-Redox® in Remote Areas

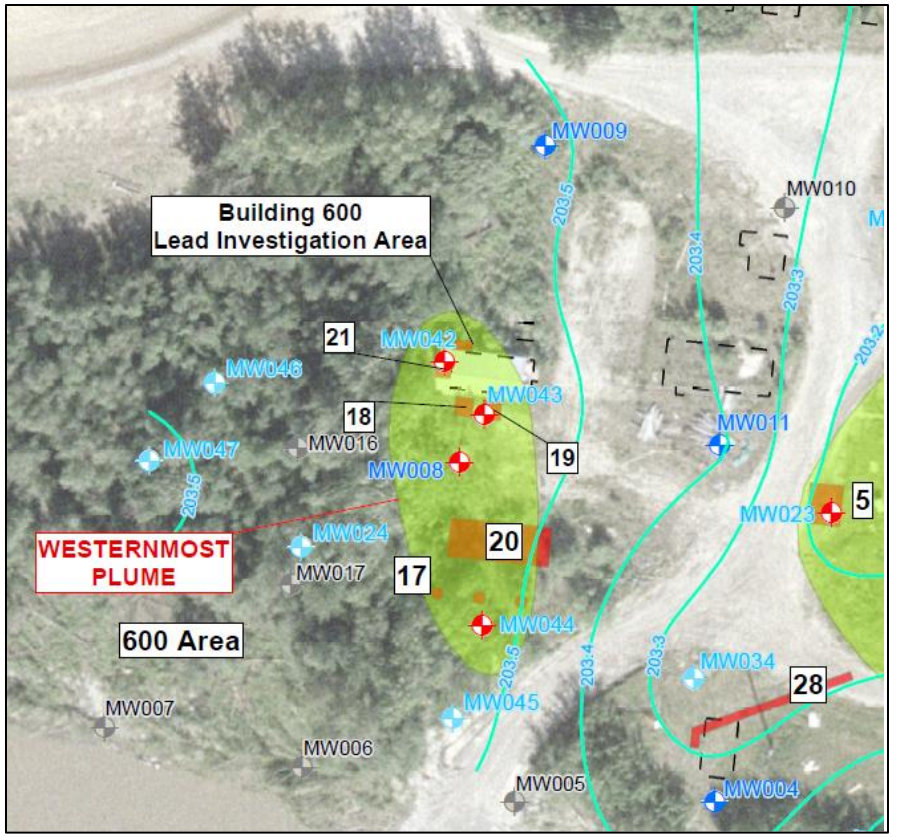
Location: Tanana, AK

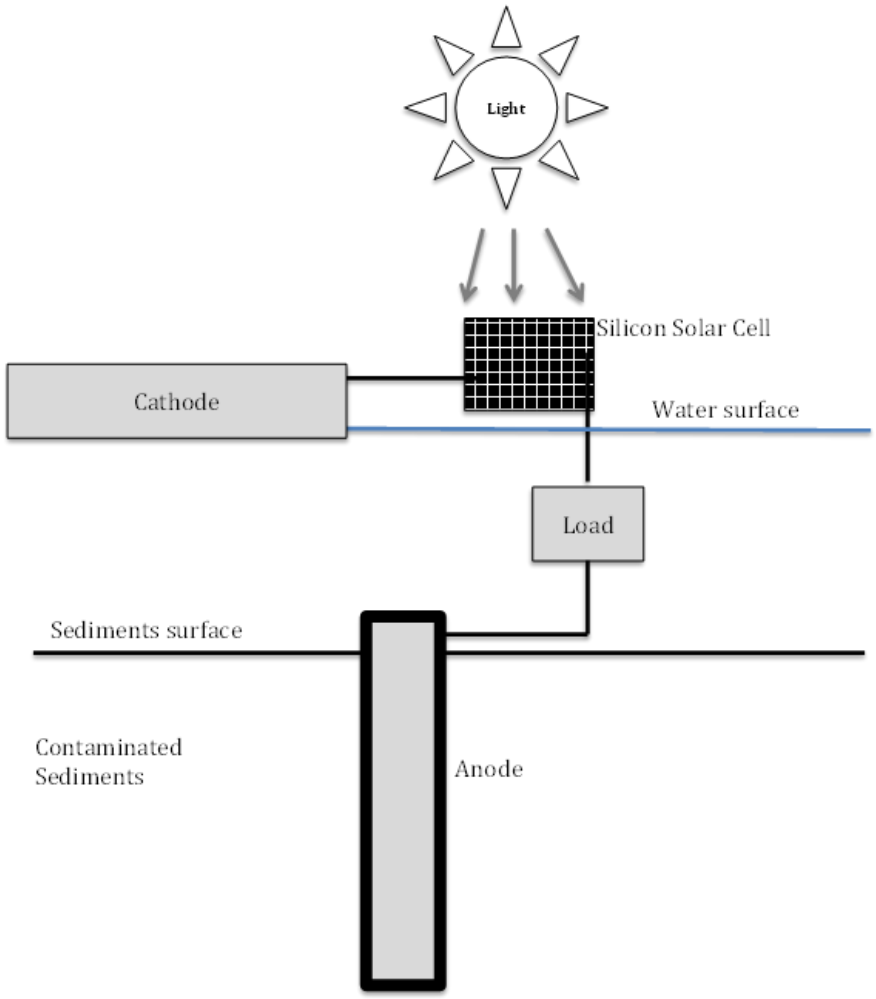
Contaminated Matrix: subsurface soil and groundwater

Primary Contaminants: DRO and TPH

Previous Remediation: NA

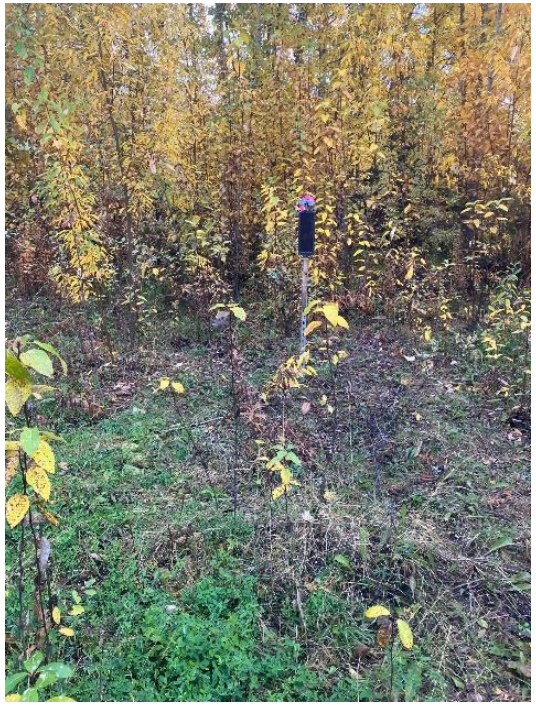
Challenges: Remote location; limited logistics; climate; lack of power source



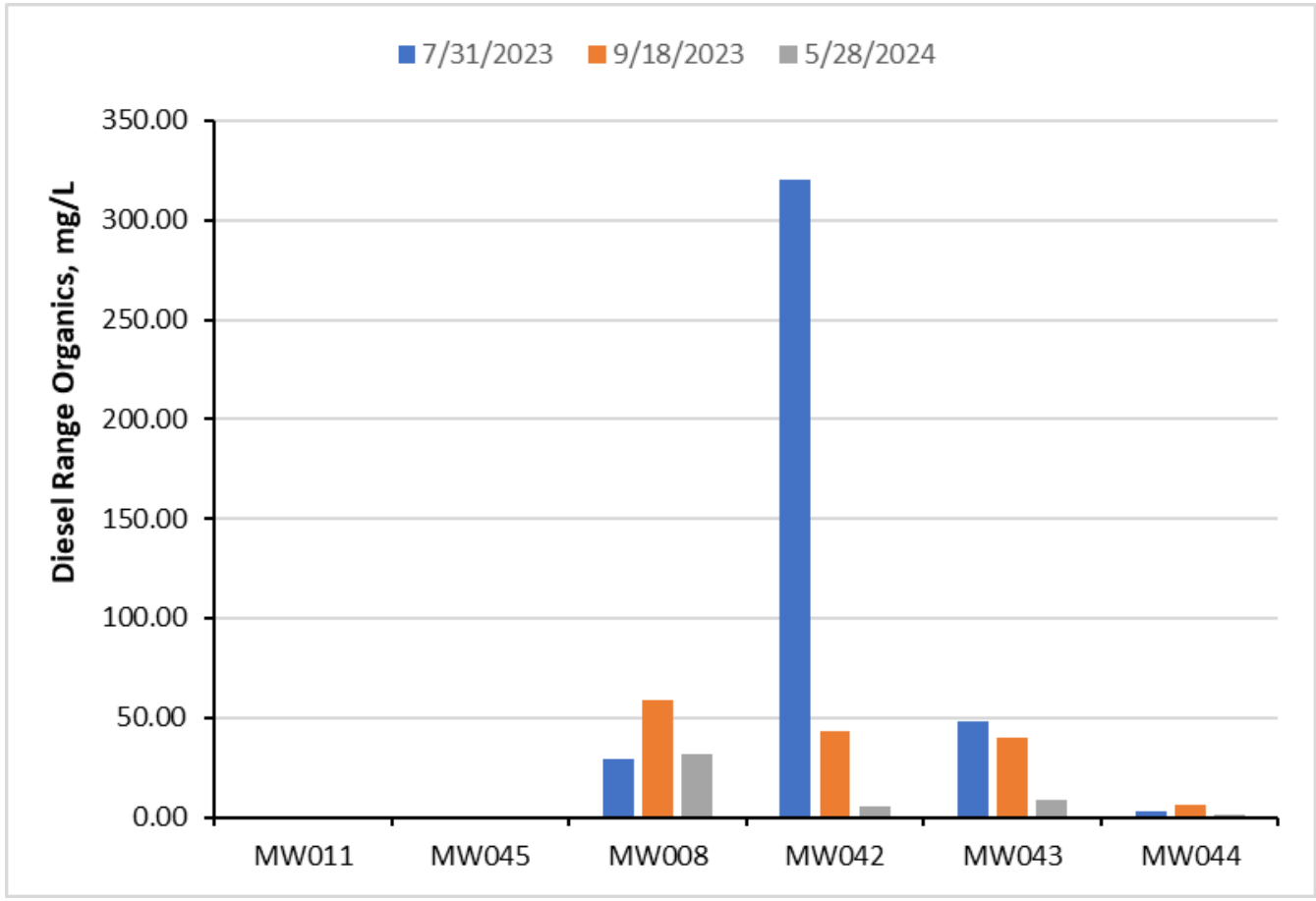


E-Redox® Plus applied for treating organic wastes in lake sediments, petroleum hydrocarbons at a former refinery, and DRO at a remote site in Alaska

E-Redox® Implementation in Remote Areas



E-Redox® Implementation in Remote Areas



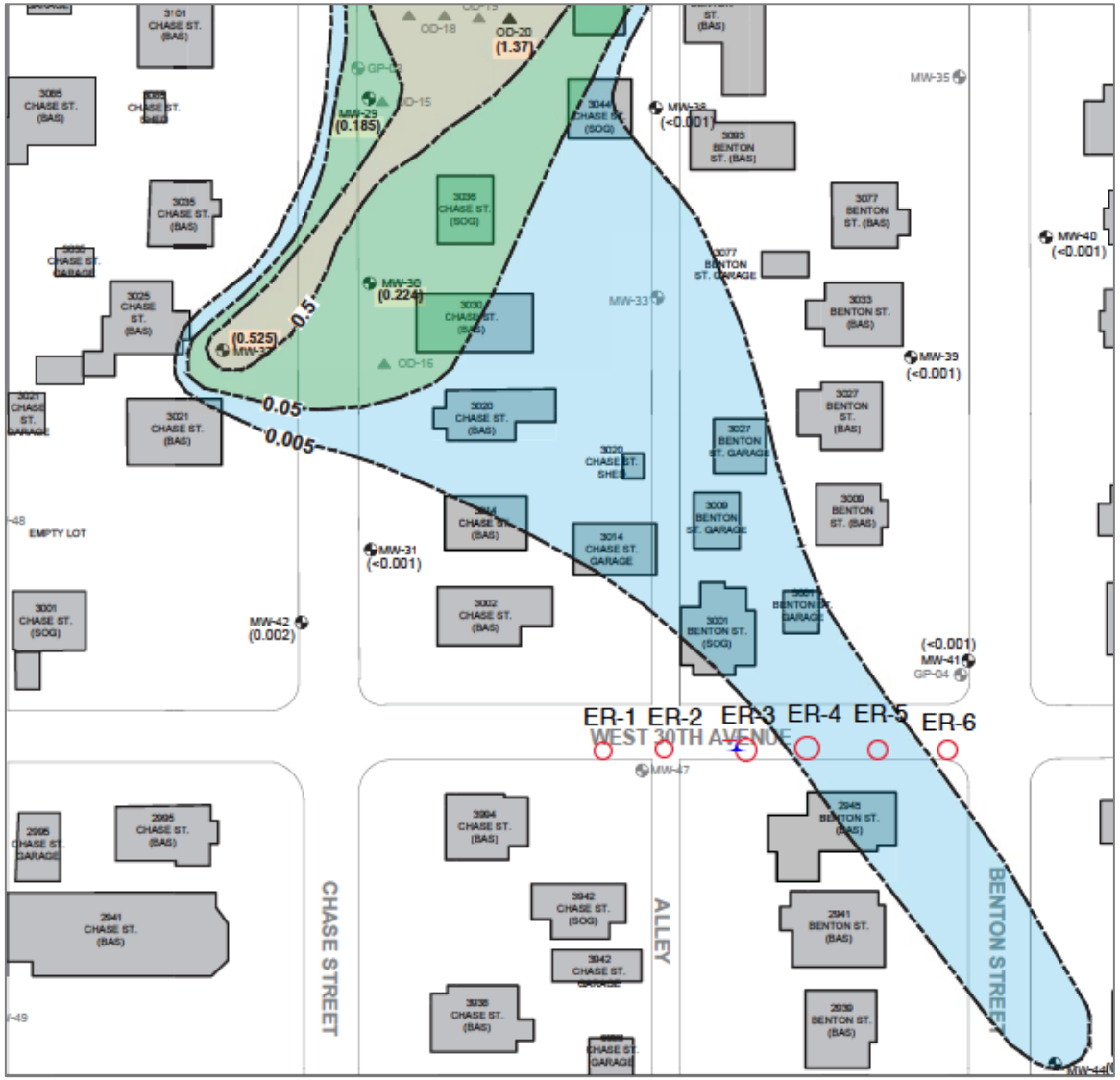
E-Redox® as a "Virtual Barrier"

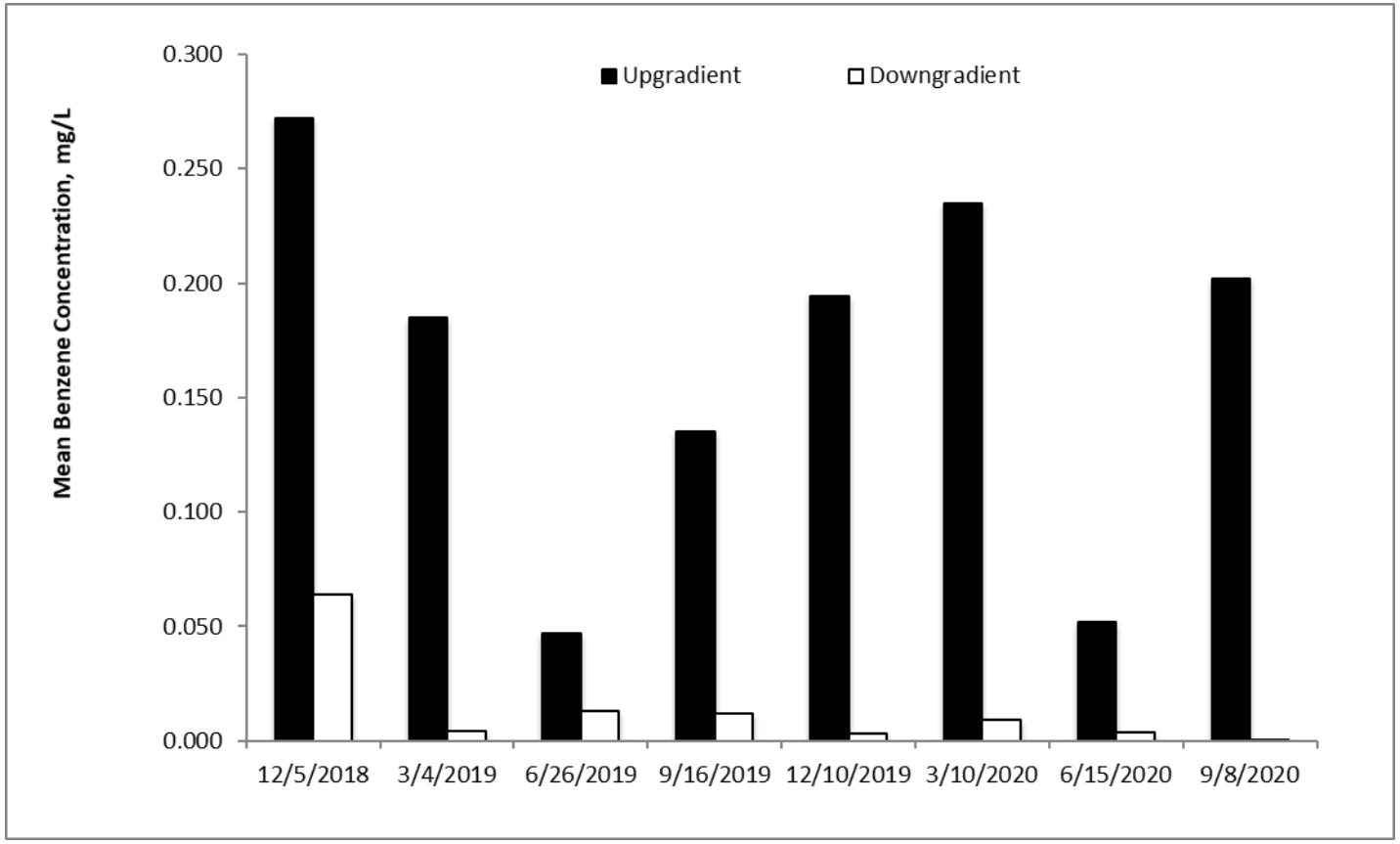
Location: Residential area downgradient from a former auto-repair shop and retail fuel station in Wheat Ridge, CO

Contaminated Matrix: Groundwater

Primary Contaminants: Benzene

Previous Remediation: Bioaugmentation




Mean Benzene Concentration, mg/L
0.300
0.250
0.200
0.150
0.100
0.050
0.000
Upgradient
Downgradient
12/5/2018
3/4/2019
6/26/2019
9/16/2019
12/10/2019
3/10/2020
6/15/2020
9/8/2020

E-Redox®-O (oxidation) Highlights

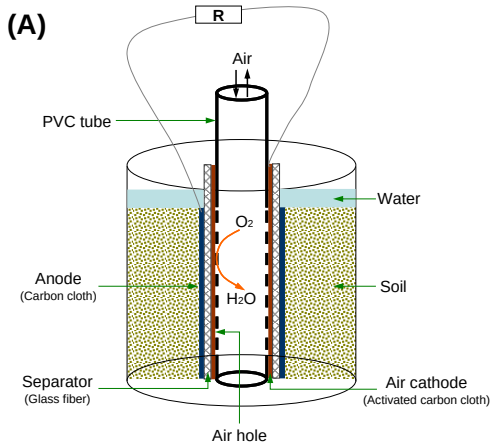
- ✓ **E-Redox®**-O technology is a **"passive" active** treatment for petroleum hydrocarbons by providing a perpetual terminal electron acceptor and expediting electron transfer for microbes
- ✓ E-Redox® favors sites with good matrix electrical conductivity (most sites). **IT WORKS IN CLAY as well; and No injection**
- ✓ Voltage profiles in the E-Redox® device as a tool for **in-situ real-time monitoring** of biodegradation and potential deficiencies – **BioRemeter ™**
- ✓ Modular, sustainable, **zero energy input**, minimum maintenance
- ✓ E-Redox® can be a stand-alone remedy or synergistically used with other remedial technologies (e.g., nutrients addition, bioaugmentation, carbon-based trapping materials, chemOx, SVE, etc.)

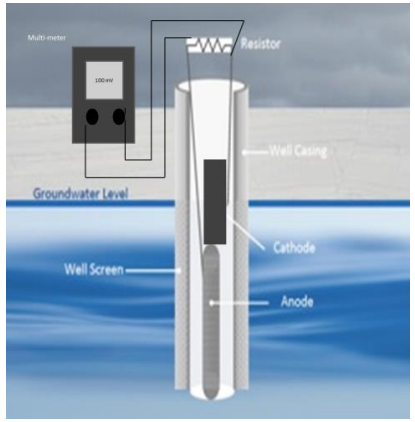
BioCook ®

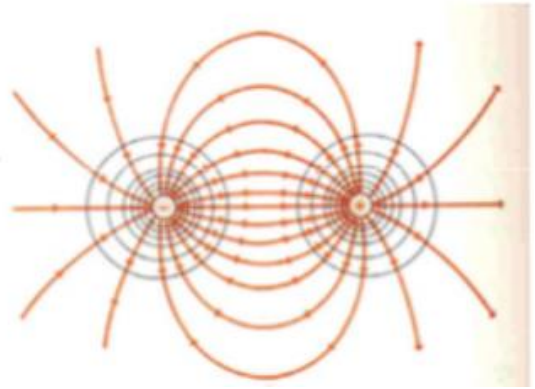
An innovative waste treatment solution with potential for PFAS impacted solids

Proof of Concept Test in Water

Catalytic Reaction	PFOA (ug/L)	PFOS (ug/L)	pH
1-C	5.43	48.74	3.18
1-T	0.14	36.01	3.33
2-C	4.82	46.37	2.4
2-T	0.15	4.31	2.36







Microbial-Electro-Chemistry Redox Technology

1

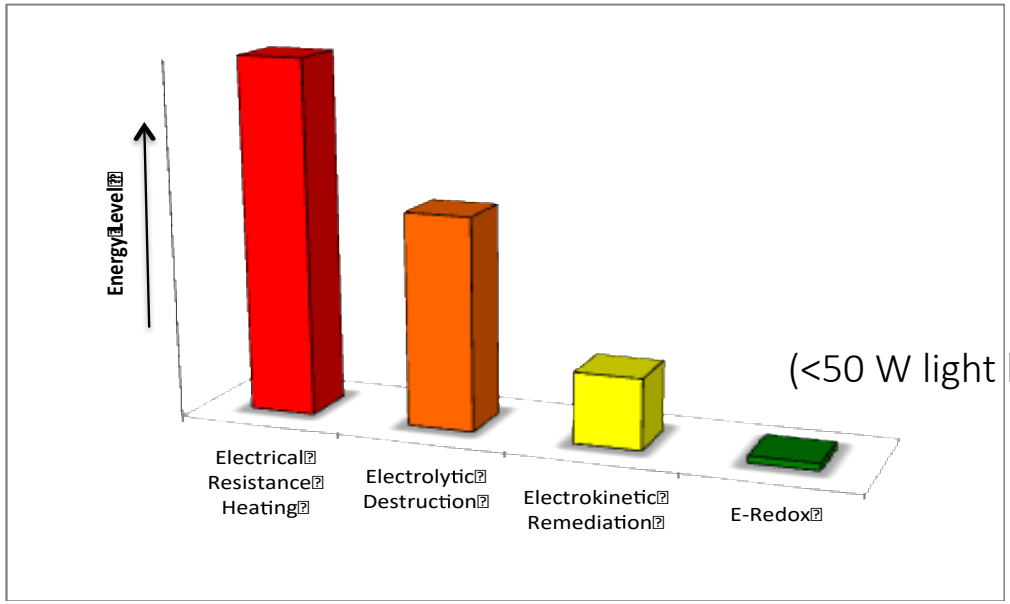
Reactions via electron transport and shifts of matrix particle/water interface charges and configurations

2

Friendly for fine-grained lithology with higher electrical conductivities: silts & clays

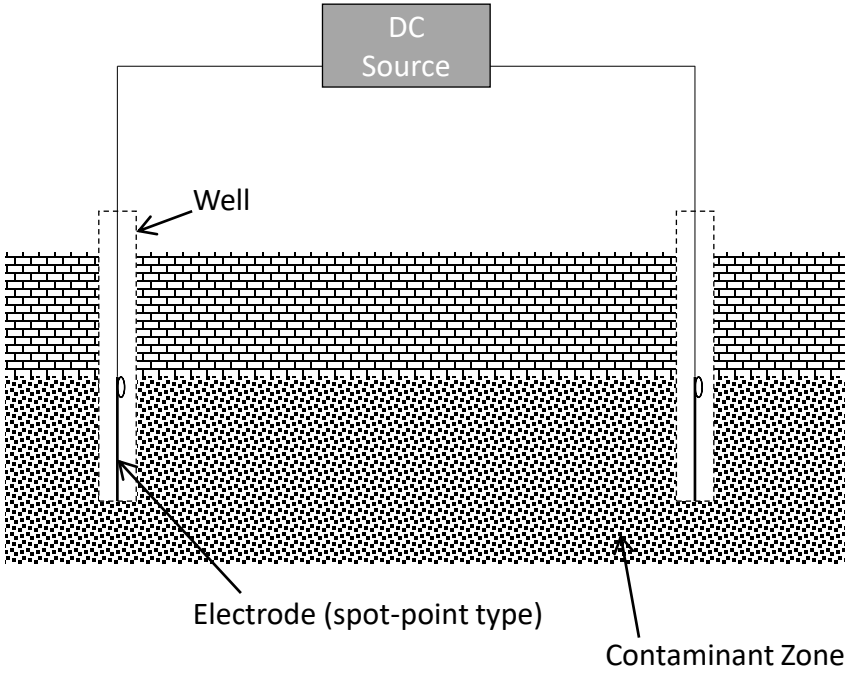
E-Redox®-R (reduction and localized oxidation)

- Establishes a low-voltage/low-amperage static electric field in the contaminated matrix.
- Promotes reductive destruction and desorption of source compounds from soil into water



(<50 W light bulb/module)

Relative Electrical Energy Requirement



Patented by AET, 1st Field Application 2014
Jin et al., 2008. Chem Eng J, 140:642
Jin and Fallgren 2009, J Haz Mat, 153:127
Luo et al., 2010. Chem Eng J, 160:185

E-Redox®-R: “micro-conductor”, “micro-capacitor” mechanism for redox reactions and mass desorption

- Soil particles in the influenced matrix act as micro-conductors, become polarized, and act as “micro-capacitors”* with constant charging and discharging cycles:
  - Abiotic reductive destruction of chlorinated solvents and oxyanions
  - Beneficial to biological dechlorination
  - Localized redox reactions destruct PFAS compounds

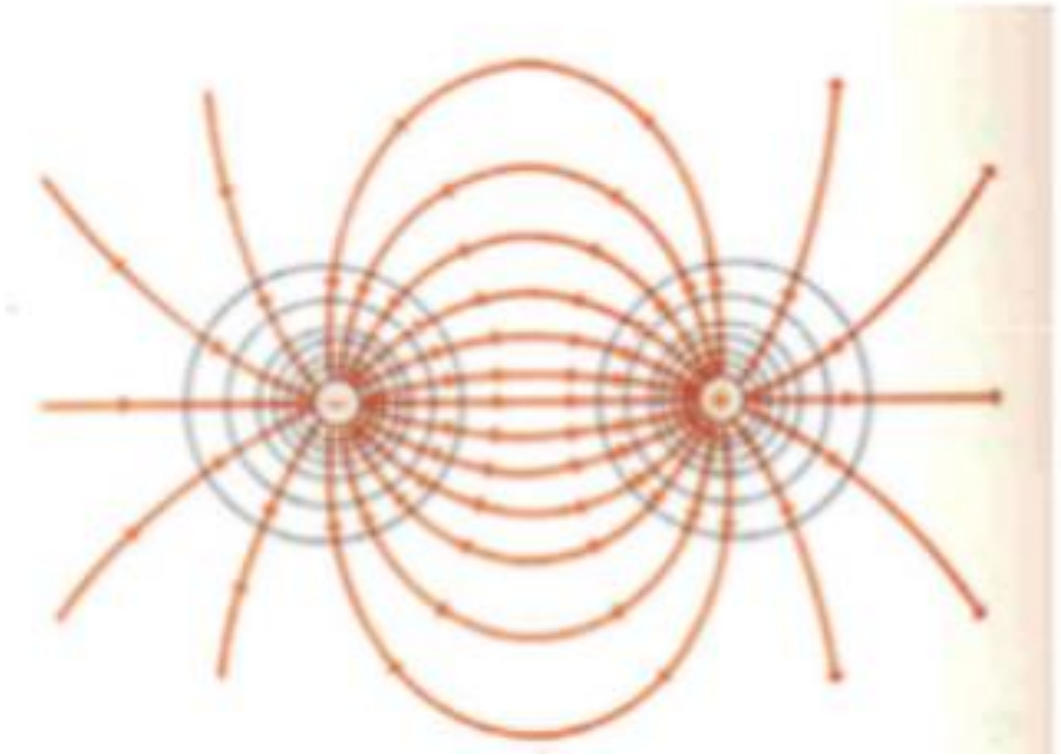
- Constant shifts of surface charge causes electrostatic and hydration repulsion, disturbs the “water cage” configuration and results in:
  - Desorption of contaminants from soil/solids into water
  - Elimination of “rebounds”

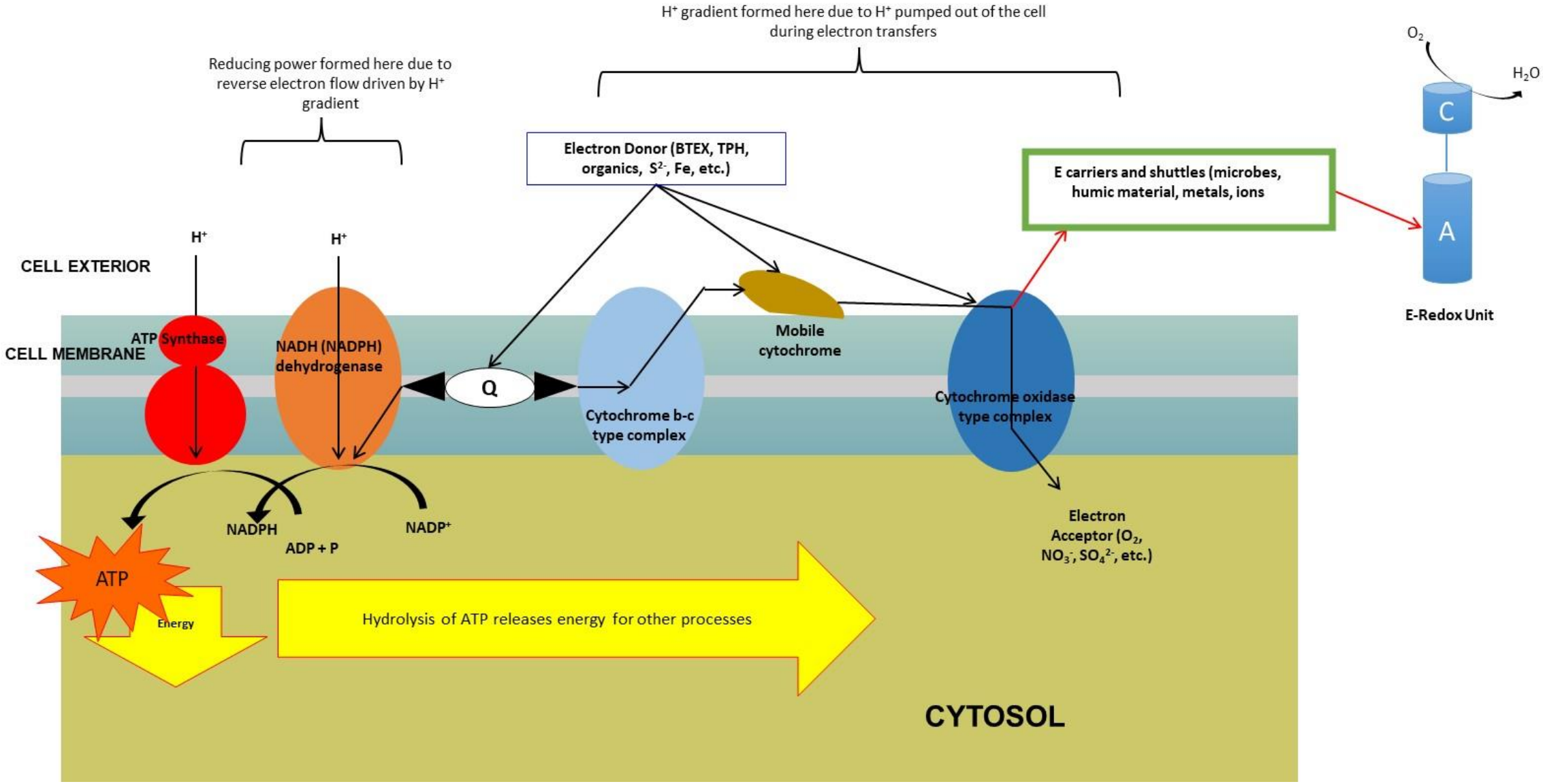
** Dietmar Rahner, Dresden U of Technology, 2002*

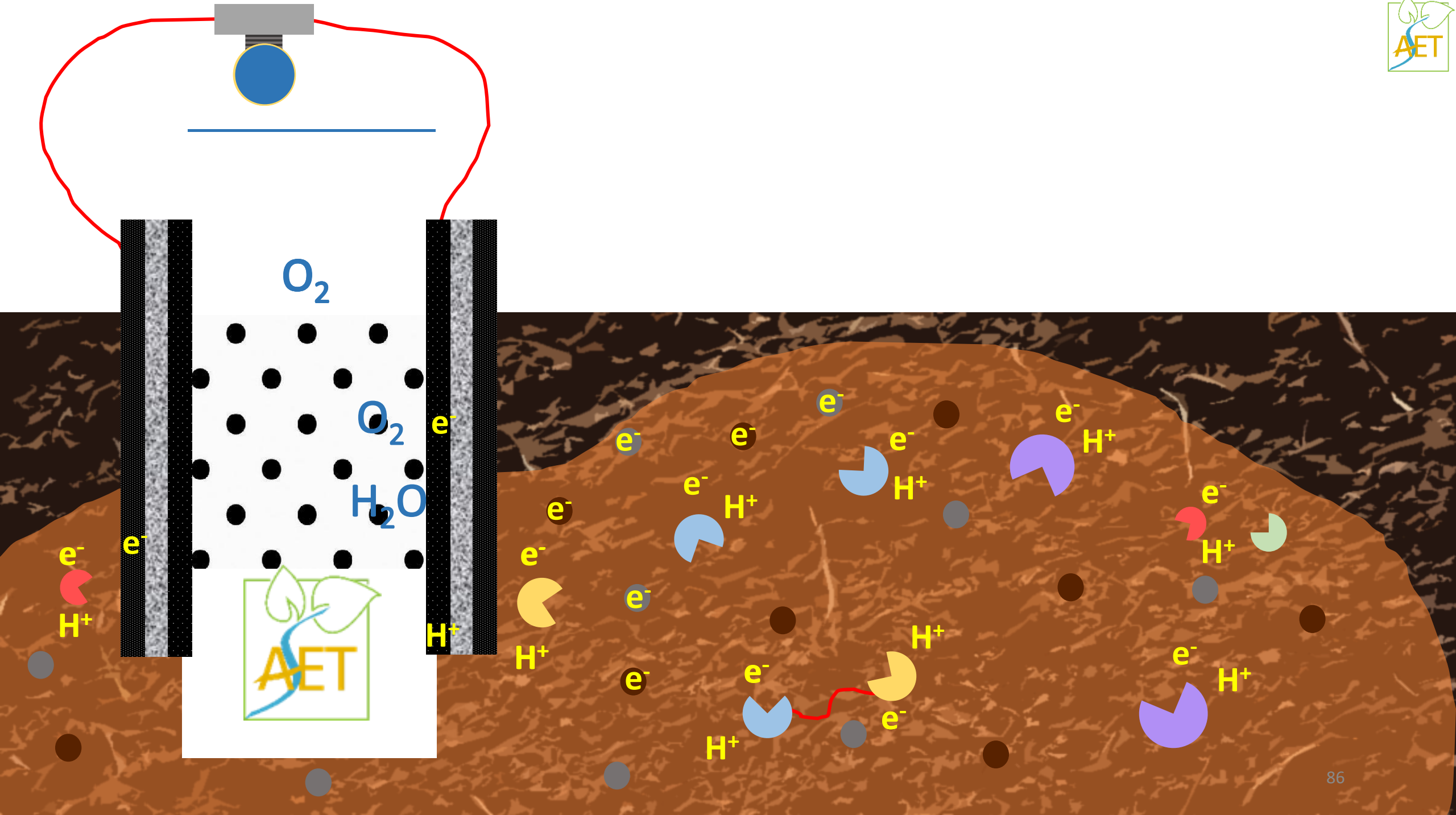
Static Electric Field

- Field data indicate a radius of influence (ROI) of ~25-30 ft in clay and silts; >50 ft for matrices with injection history of carbon, ZVI, or other conductive compounds

- Electrodes spacing: ~25 ft for mixed saturated and unsaturated matrices




H⁺ gradient formed here due to H⁺ pumped out of the cell during electron transfers
Reducing power formed here due to reverse electron flow driven by H⁺ gradient
Electron Donor (BTEX, TPH, organics, S²⁻, Fe, etc.)
E carriers and shuttles (microbes, humic material, metals, ions
O₂
H₂O
C
A
E-Redox Unit
H⁺
H⁺
CELL EXTERIOR
CELL MEMBRANE
ATP Synthase
NADH (NADPH) dehydrogenase
Q
Cytochrome b-c type complex
Mobile cytochrome
Cytochrome oxidase type complex
NADPH
ADP + P
NADP⁺
ATP
Energy
Hydrolysis of ATP releases energy for other processes
Electron Acceptor (O₂, NO₃⁻, SO₄²⁻, etc.)
CYTOSOL


O_2
O_2
H_2O
e⁻
H⁺


RadioShack
T-RMS DIGITAL MULTIMETER
AUTO
HOLD
REL Δ
RANGE
SELECT
Duty
Hz
EF
OFF
mA/A
μA/A
V
OFF
10A MAX
UNFUSED
500V MAX

SUMMARY

- E-Redox® (R and O) technologies are applicable to diverse matrices including CLAY and other tight matrices. No injection is involved
- E-Redox®-R (reduction) is mainly an abiotic pathway; E-Redox®-O (oxidation) is mainly a biodegradation pathway
- E-Redox® facilitates desorption of COCs into the water, benefiting mass removal and destruction
- E-Redox® is compatible and synergistic to other remediation tools
- BioCook® can treat organic solids and potentially PFAS impacted media

E-Redox®

Song Jin PhD., CHMM
E: songjin@aetecs.com
T: 970.889.8410

Supplemental Slides

E-Redox®

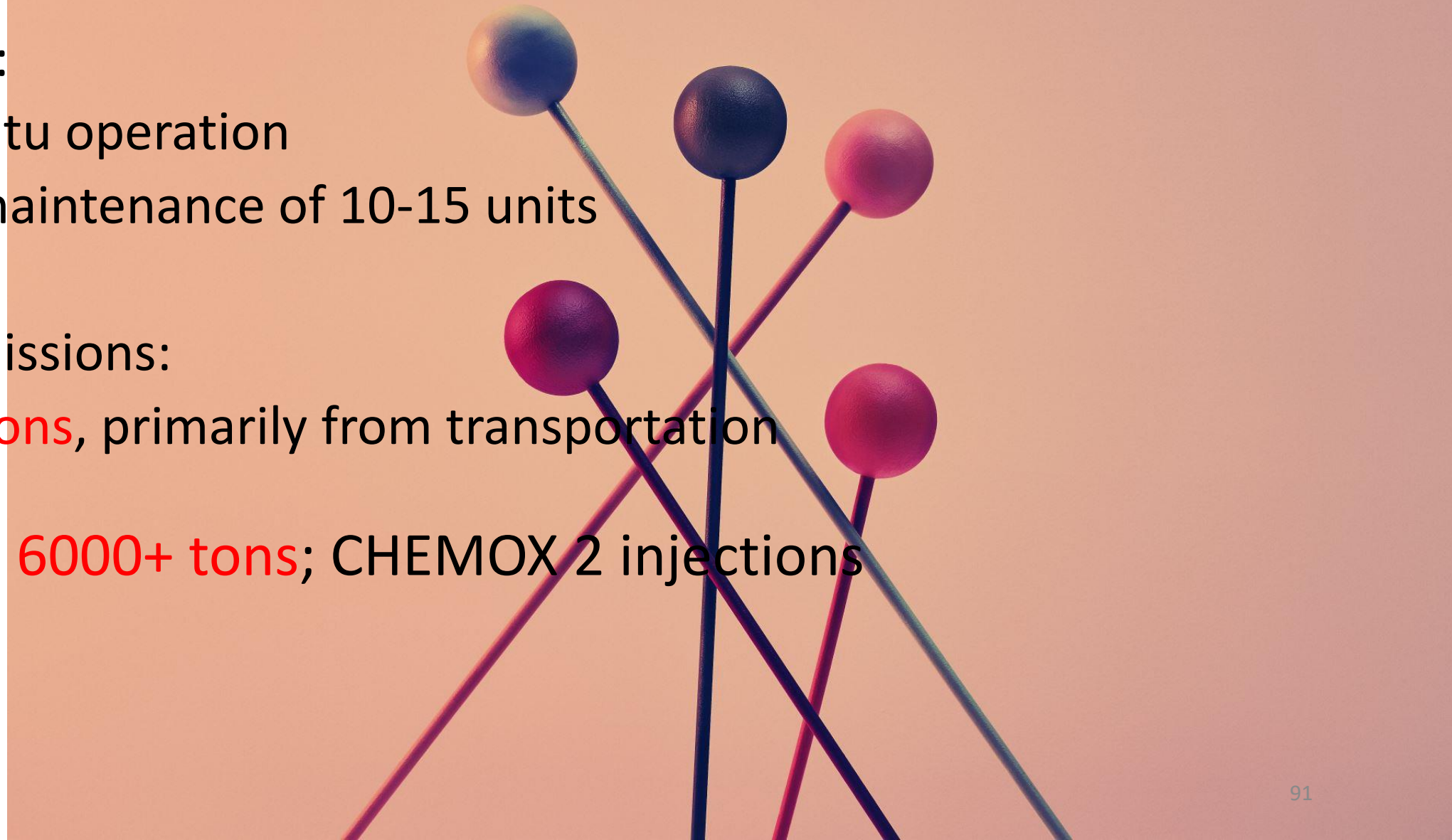
Assumptions:

- 2 years in-situ operation
- Quarterly maintenance of 10-15 units

Total CO_2 Emissions:

1.07 metric tons, primarily from transportation

- Vs. AS/SVE 6000+ tons; CHEMOX 2 injections 50+ tons



E-Redox®-O (oxidation)

Environmental Science & Technology
Article
pubs.acs.org/est

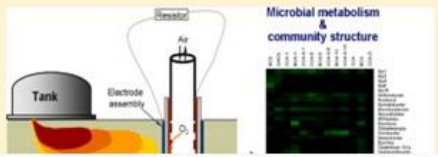
Microbial Metabolism and Community Structure in Response to Bioelectrochemically Enhanced Remediation of Petroleum Hydrocarbon-Contaminated Soil

Lu Lu,[†] Tyler Huggins,[†] Song Jin,[‡] Yi Zuo,[§] and Zhiyong Jason Ren*[,†]

[†]Department of Civil, Environmental, and Architectural Engineering, University of Colorado Boulder, Boulder, Colorado 80309, United States
[‡]Department of Civil and Architectural Engineering, University of Wyoming, Laramie, Wyoming 82071, United States
[§]Chevron Energy Technology Company, San Ramon, California 94583, United States

Supporting Information

ABSTRACT: This study demonstrates that electrodes in a bioelectrochemical system (BES) can potentially serve as a nonexhaustible electron acceptor for *in situ* bioremediation of hydrocarbon contaminated soil. The deployment of BES not only eliminates aeration or supplement of electron acceptors as in contemporary bioremediation but also significantly shortens the remediation period and produces sustainable electricity. More in... and ce... bioelect... with ca...



Environmental Science & Technology
pubs.acs.org/est
Article

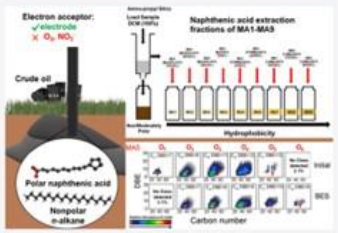
Molecular Transformation of Crude Oil Contaminated Soil after Bioelectrochemical Degradation Revealed by FT-ICR Mass Spectrometry

Huan Wang, Lu Lu, Huan Chen, Amy M. McKenna, Jie Lu, Song Jin, Yi Zuo, Fernando L. Rosario-Ortiz, and Zhiyong Jason Ren*

Cite This: *Environ. Sci. Technol.* 2020, 54, 2500−2509 | Read Online

ACCESS | Metrics & More | Article Recommendations | Supporting Information

ABSTRACT: Bioremediation is a low-cost approach for crude oil spill remediation, but it is often limited by electron acceptor availability. In addition, the biodegradation products of crude oil contaminants are complex, and transformation pathways are difficult to decipher. This study demonstrates that bioelectrochemical systems (BESs) can be effective in crude oil degradation by integrating biological and electrochemical pathways, and more importantly, it provides the first understanding on the daughter products of bioelectrochemical hydrocarbon degradation. Using electrospray ionization (ESI) Fourier transform ion cyclotron resonance mass spectrometry (FT-ICR MS) and two-dimensional gas chromatography (GC × GC), the results showed that the active BES reactor improved the total petroleum hydrocarbon (TPH) degradation by ~70% than open circuit control reactors. After separating the daughter products into nine fractions (MA1−MA9)



Journal of Hazardous Materials
Volume 274, 15 June 2014, Pages 8-15

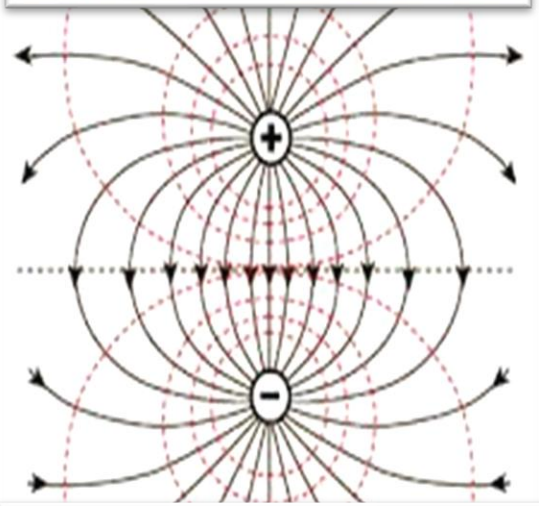
Enhanced bioremediation of hydrocarbon-contaminated soil using pilot-scale bioelectrochemical systems

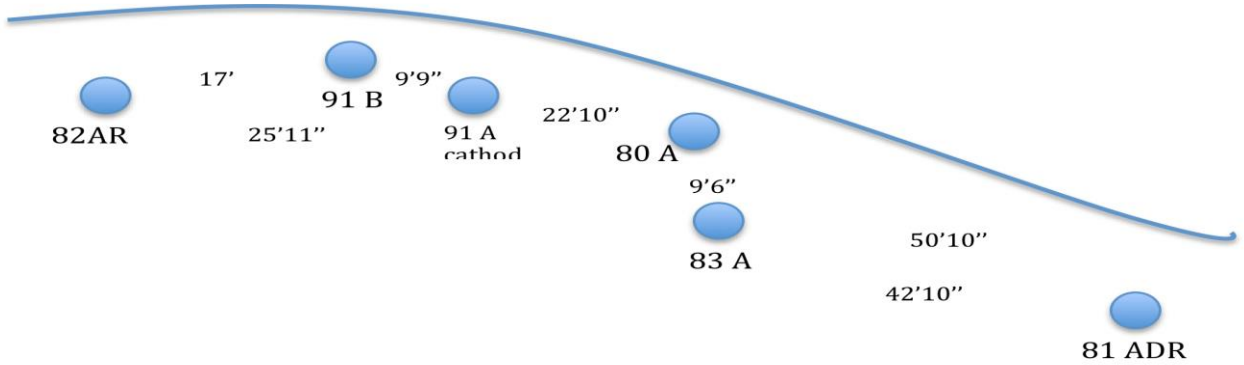
Lu Lu [a], Hadi Yazdi [a], Song Jin [b], Yi Zuo [c], Paul H. Fallgren [d], Zhiyong Jason Ren [a, d]

Chemosphere
Volume 235, November 2019, Pages 776-784

Dominance of electroactive microbiomes in bioelectrochemical remediation of hydrocarbon-contaminated soils with different textures

Huan Wang [a, b], Lu Lu [a, b], Deqiang Mao [c], Zhe Huang [b], Yixiao Cui [b], Song Jin [d], Yi Zuo [e], Zhiyong Jason Ren [a, b]





ORP decreased >115 mV after 30 min and continued to decrease in the area with continued E-Redox-I operating

During the testing period of 4 hr, E-Redox-I system has a measurable ROI of >26 feet from either electrode outward

**Fallgren, P.H., Eisenbeis, J.J., Jin, S. 2018. J. Environ. Sci. Health Part A 53:517-523.*

Benzene Degradation Rates from Laboratory Studies

- E-Redox-O: 585 ug/L/day
- Aerobic: 400 ug/L/day
- Denitrifying: 251 ug/L/day
- Sulfidogenic: 189 ug/L/day
- Methanogenic: lowest to negligible

Chemical Oxidation

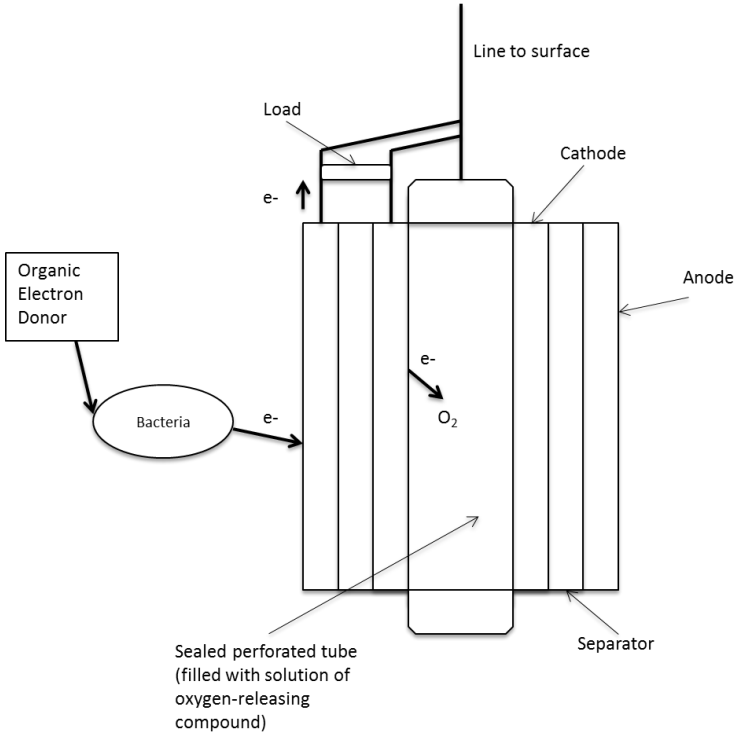
Assumptions:

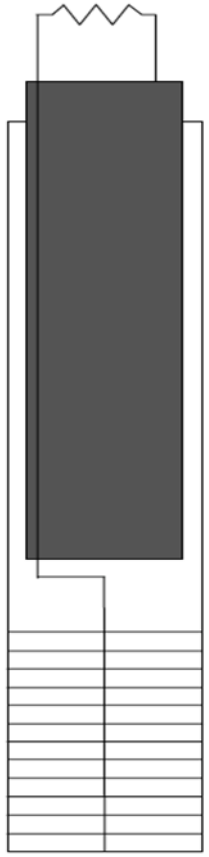
- 20 injection wells, 2 rounds of injections
- 55 gallons/persulfate, per injection
- 1000 HP engine to drive injections
- 500 gallons hydrocarbons released

Total CO_2 Emissions:

23.53 metric tons, primarily from equipment operation

BioRemeter™





Project student intern won 2018 President's Environmental Youth Award

BioRemeter™ Survey Vs. CO2 Measurements for Biodegradation

CO_2% by gas tube	Microbial activity scale	BioRemeter	Improved microbial activity scale
0%	None	12.9 mV	Lower
0.1%	None to very low	16.9 mV	Low
0.3%	Very low	19.2 mV	Low to Moderate
1.0%	Very low	20.5 mV	Low to Moderate
5%	Low	21.4 mV	Low to Moderate
9%	Moderate	51.8 mV	Moderate to High

If we assume 10% of TPH is 10% of TOC:

Upper limit: y = 0.0253V (g/d)
Lower limit: y = 0.0077V (g/d)

y = TPH degradation rate (g/day)
x = E-Redox voltage (mV)

Meeting Close

- Split Kitty Drawing
- PDHs available from the Omaha Post Website
  - https://www.same.org/omaha/resources/