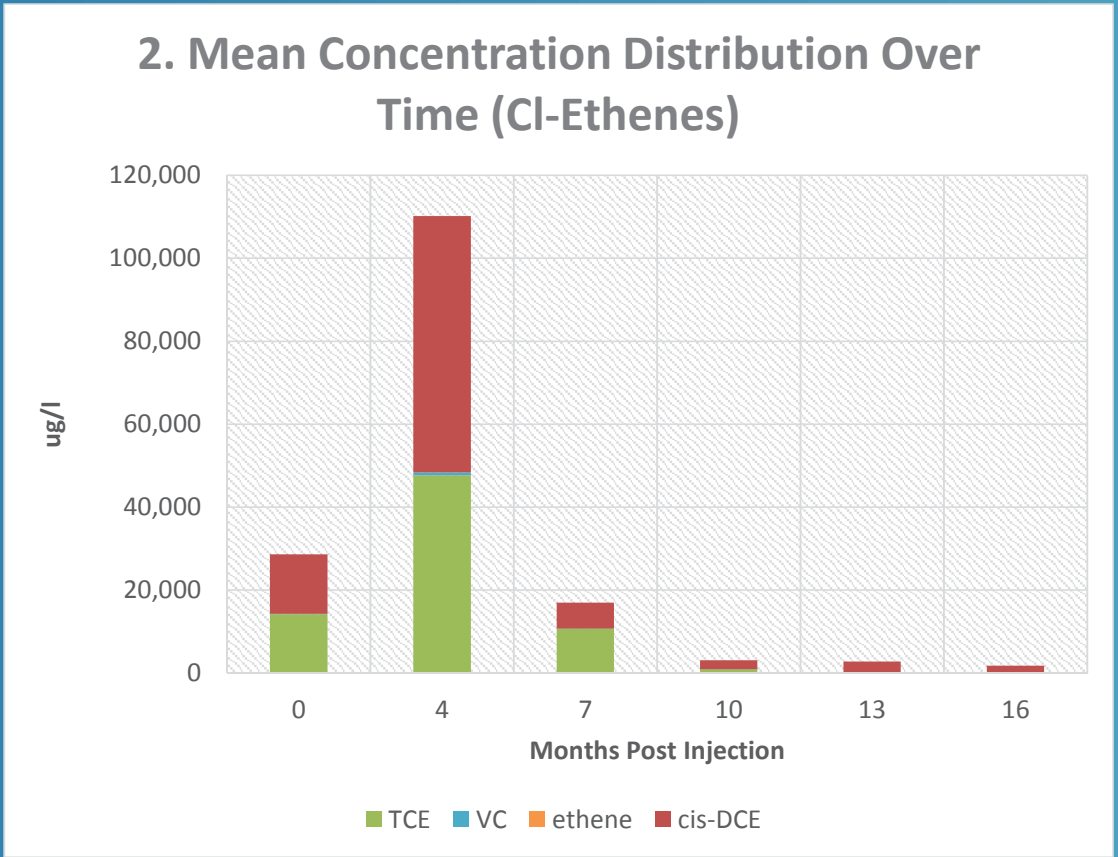
Successful full dechlorination of DNAPL comprising chlorinated ethenes and ethanes under a commercially active site.

Jack Shore
UK & Scandinavia District Manager
REGENESIS

What we will cover today

1. Introduction to Regenesis
2. Overview of Chlorinated Solvents – where they are found and the problems associated with them
3. Site Overview
4. Previous Remediation activity
5. The problems with back diffusion
6. The benefits of a pilot
7. The application of 3DMicroemulsion and BDI
8. Results and Conclusions



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CONTINUOUS DEVELOPMENT OF NEW TREATMENT TECHNOLOGIES

1994
ORC® Filter Socks

1995
ORC® Powder/Slurry

1999
HRC®

2000
HRC Primer

2001
HRC-X®

2002
MRC®

2004
Bio-Dechlor Inoculum® Plus

2005
ORC Advanced

2007
3-D Microemulsion®

2008
RegenOx®

2010
PetroCleanze™

2011
PersulfOx®

2011
ORC Advanced Pellets

2011
REGENESIS® Remediation Services

2012
CRS™

2014
PlumeStop® Liquid Activated Carbon™

2018
PetroFix™

2019
S-MicroZVI™

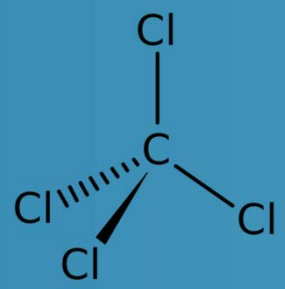
REGENESIS®

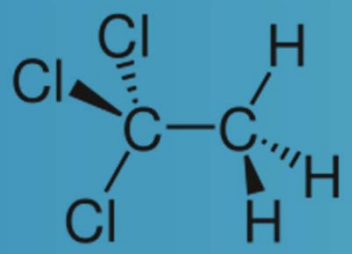
Chlorinated Solvents
Alkanes and Alkenes

Most commonly alkanes or alkenes (in terms of usage) with different degrees of chlorine substitution for hydrogen

Chlorinated alkanes

Chloromethanes (one carbon)
CT, TCM (chloroform), DCM, MC

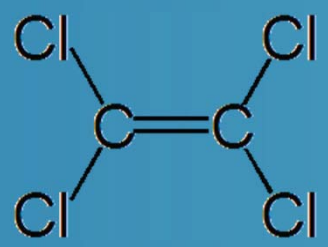


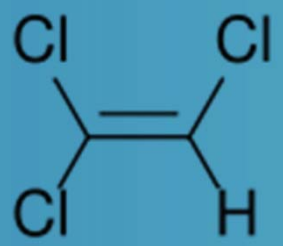


Chloroethanes (two carbons)
trichloroethane (TCA) (isomers), dicloroethane (isomers) and chloroethane

Chlorinated alkenes

Tetrachloroethene **(perchloroethene) (PCE)**
Trichloroethene (TCE)
Dichloroethene (isomers) (**DCE**)
Vinyl Chloride (**VC**)





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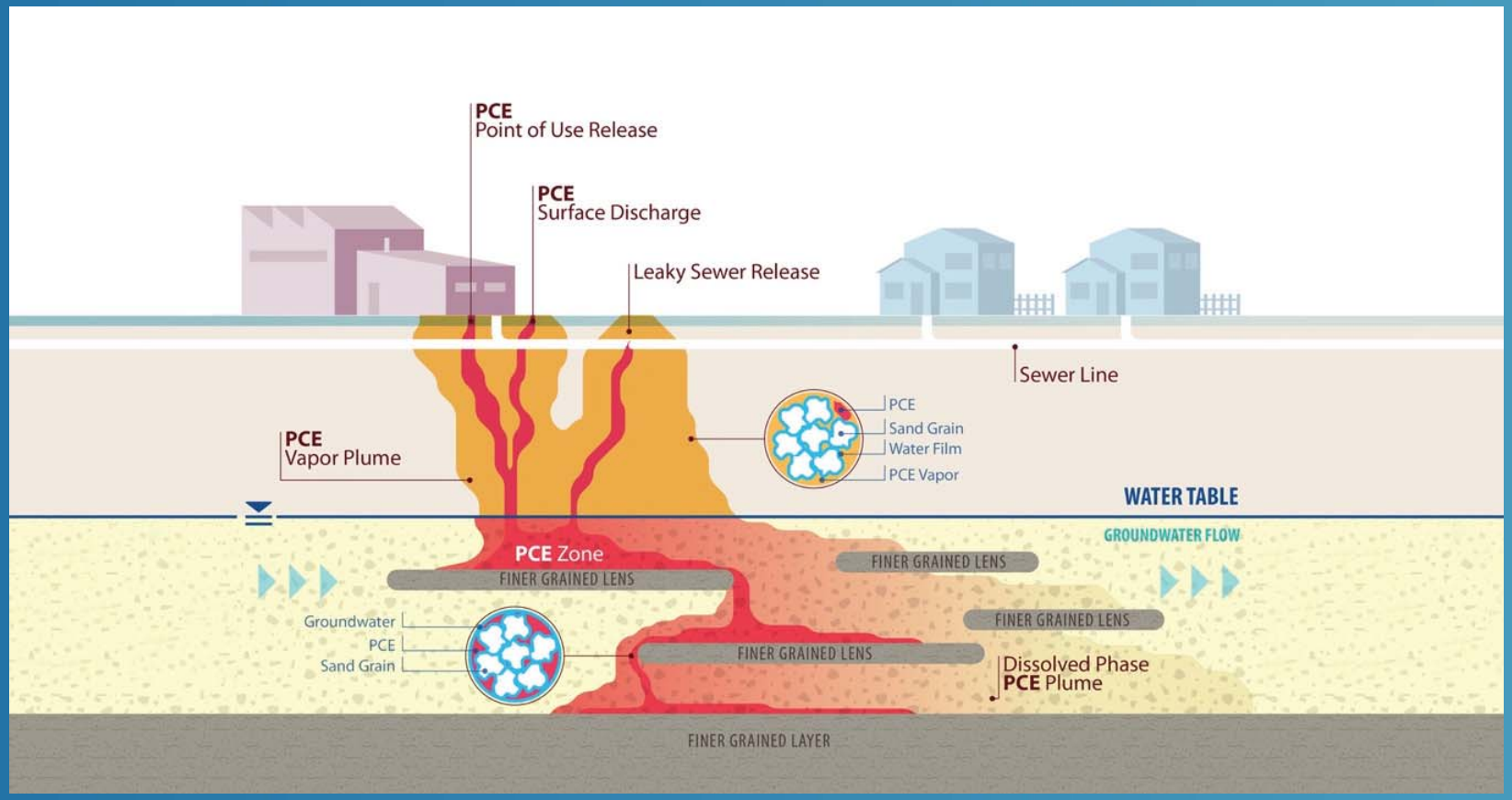
Chlorinated Solvents

Dense Non-aqueous phase liquids (DNAPLs)



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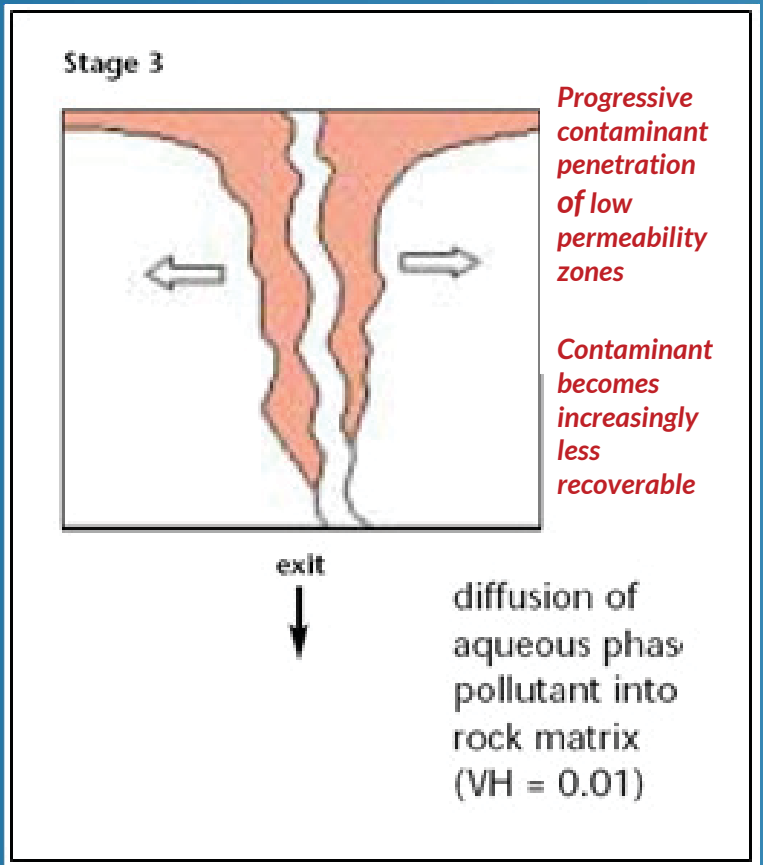
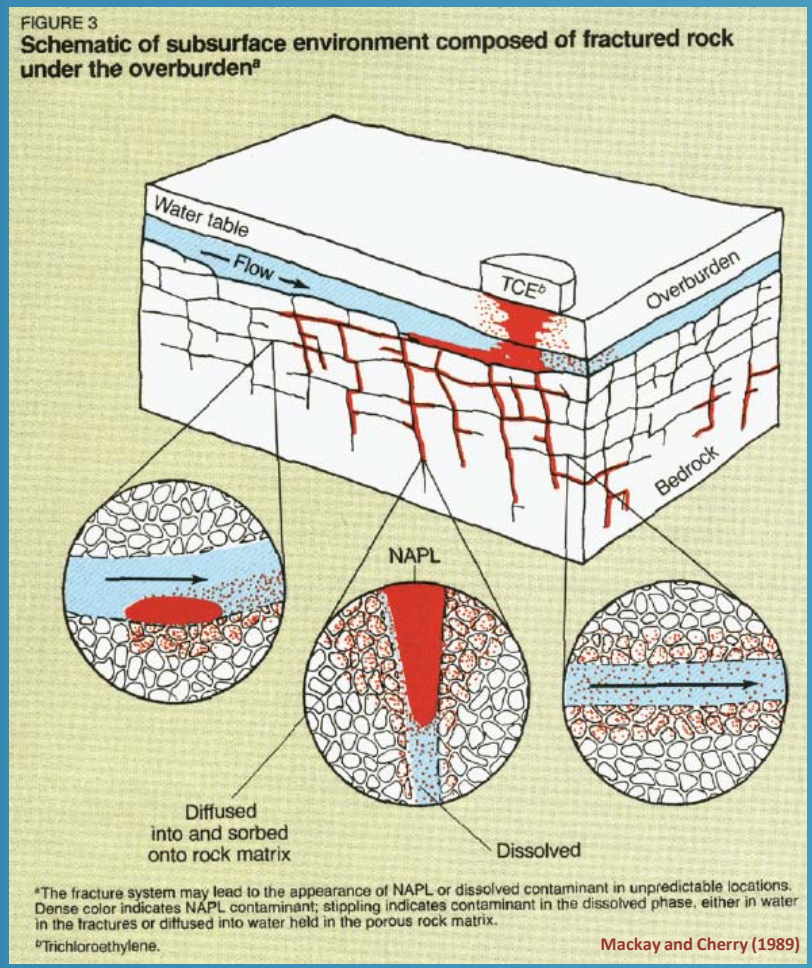
Chlorinated Solvents
Permeation



Progressive contaminant penetration of low permeability zones

Contaminant becomes increasingly less recoverable



Mackay and Cherry (1989)

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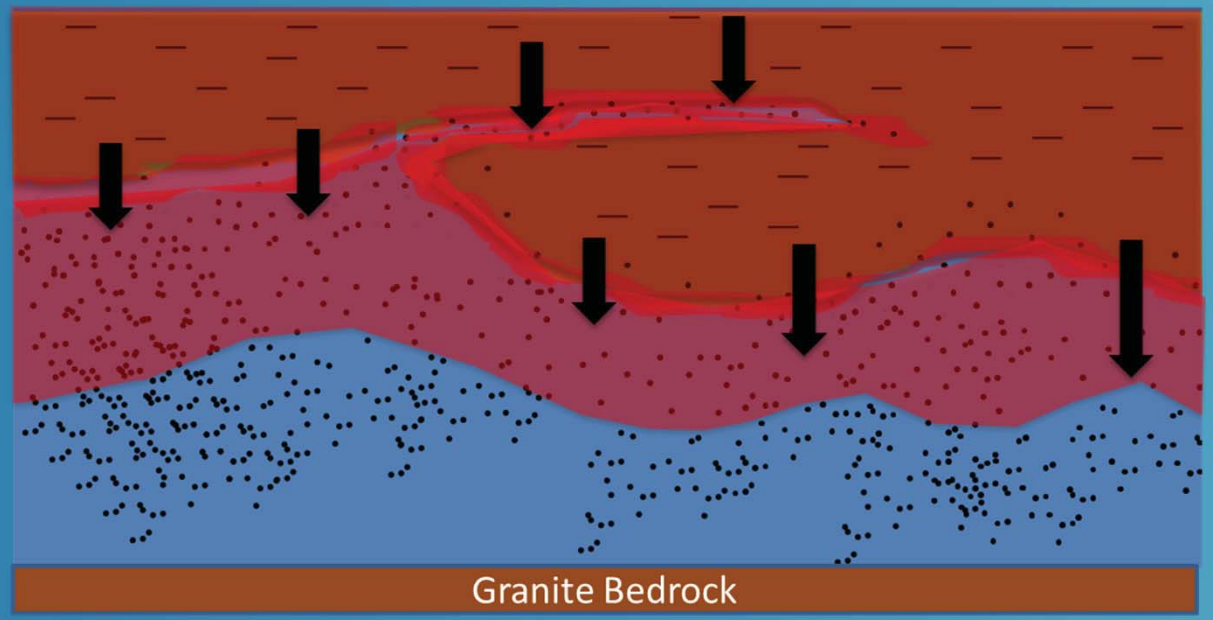
Metal Works– United Kingdom
Groundwater Impacted with DNAPL TCE/TCA

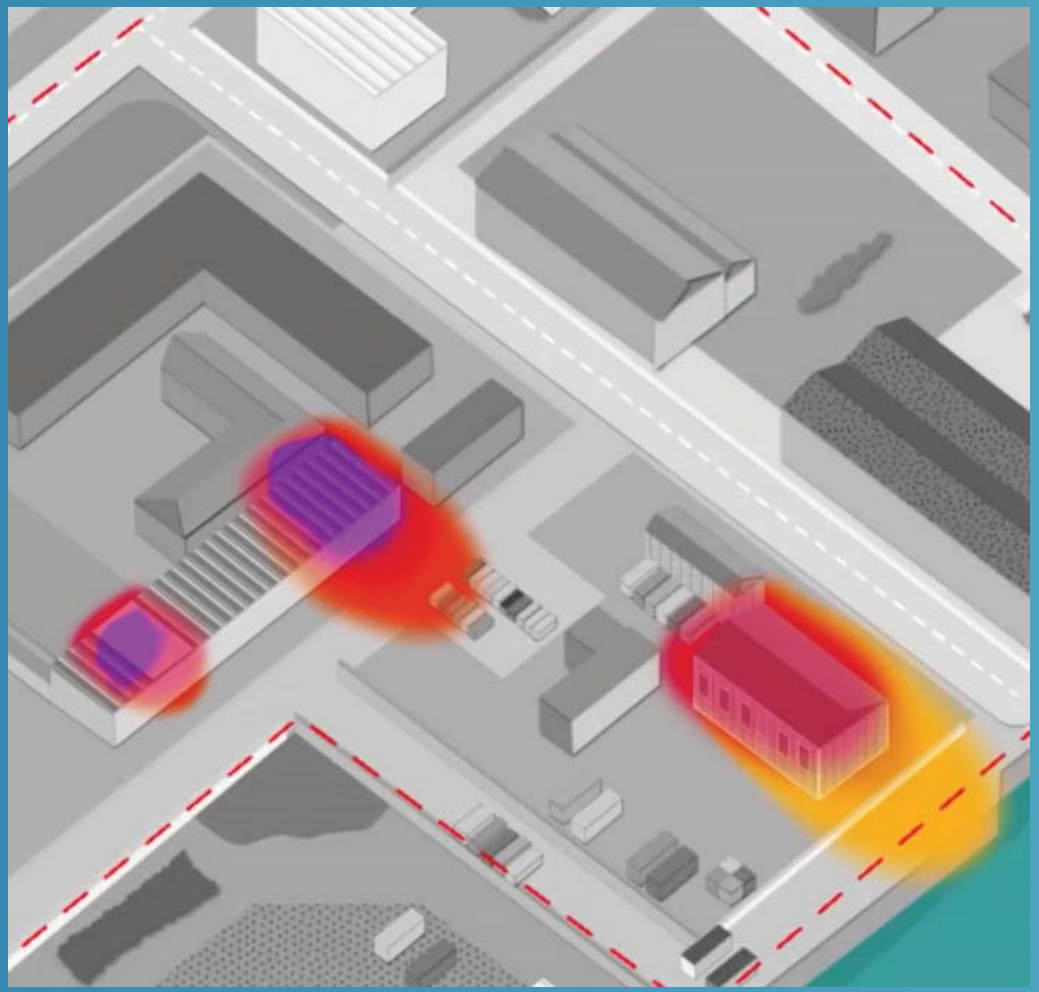
Site investigation

- Identified a 1,500m^2 area Impacted with TCE and TCA
- Up to 20 mg/L of TCA and 33 mg/L TCE identified across the area
- Average total CHC concentrations 11 mg/L
- Impacted thickness 1 – 9m BGL
- Groundwater at 2.5m BGL
- Geology identified as glacial till/ clay underlain by coarse sands and granite bedrock

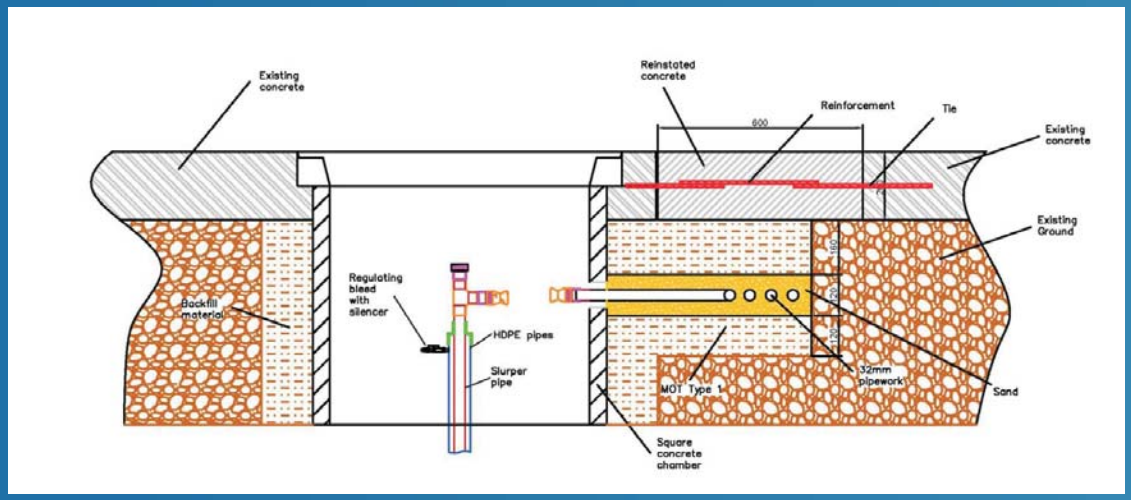


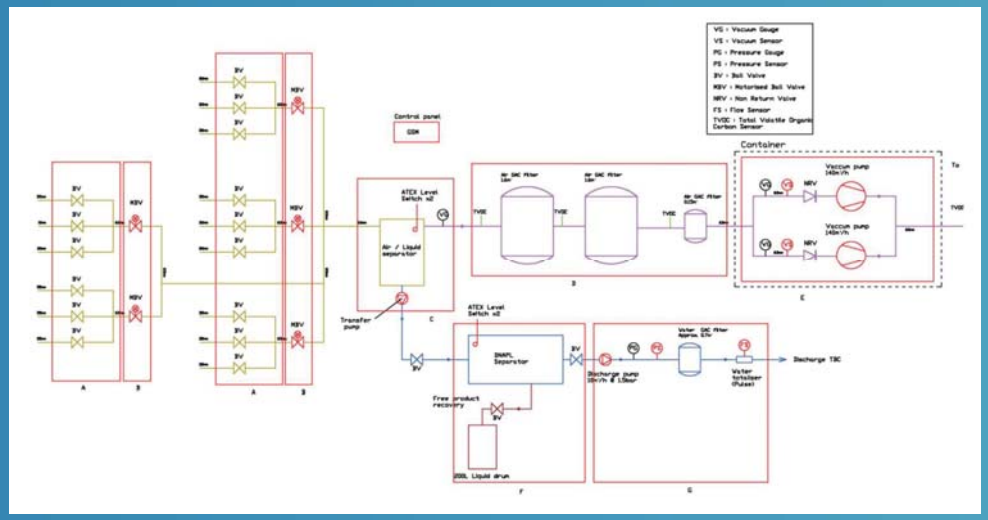
Remediation driver – contractual

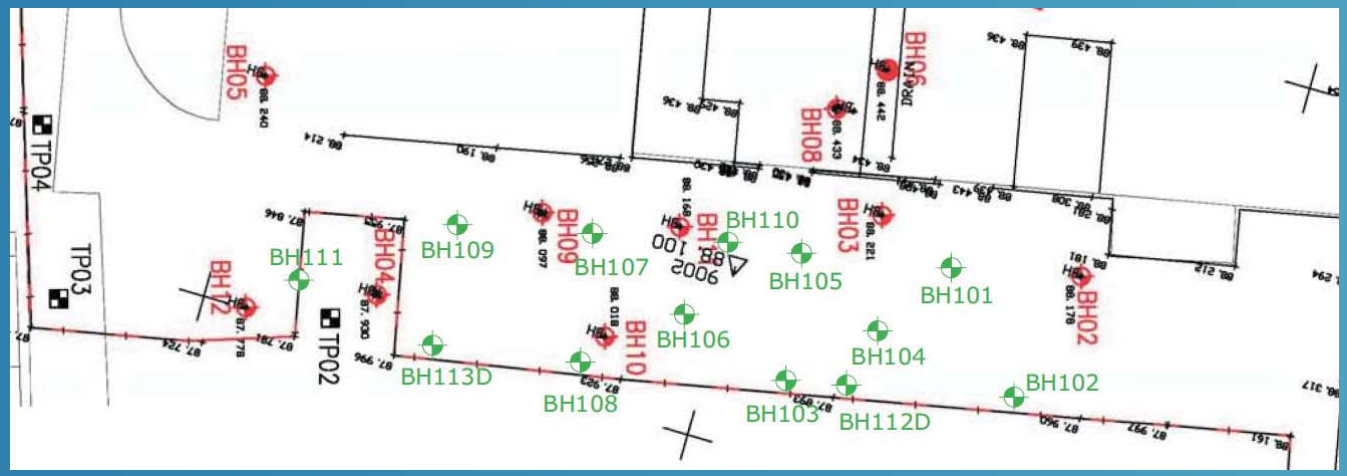
Challenges to overcome…



Before REGENESIS: Initial Remediation Strategy – Dual / Multi Phase Vacuum Extraction

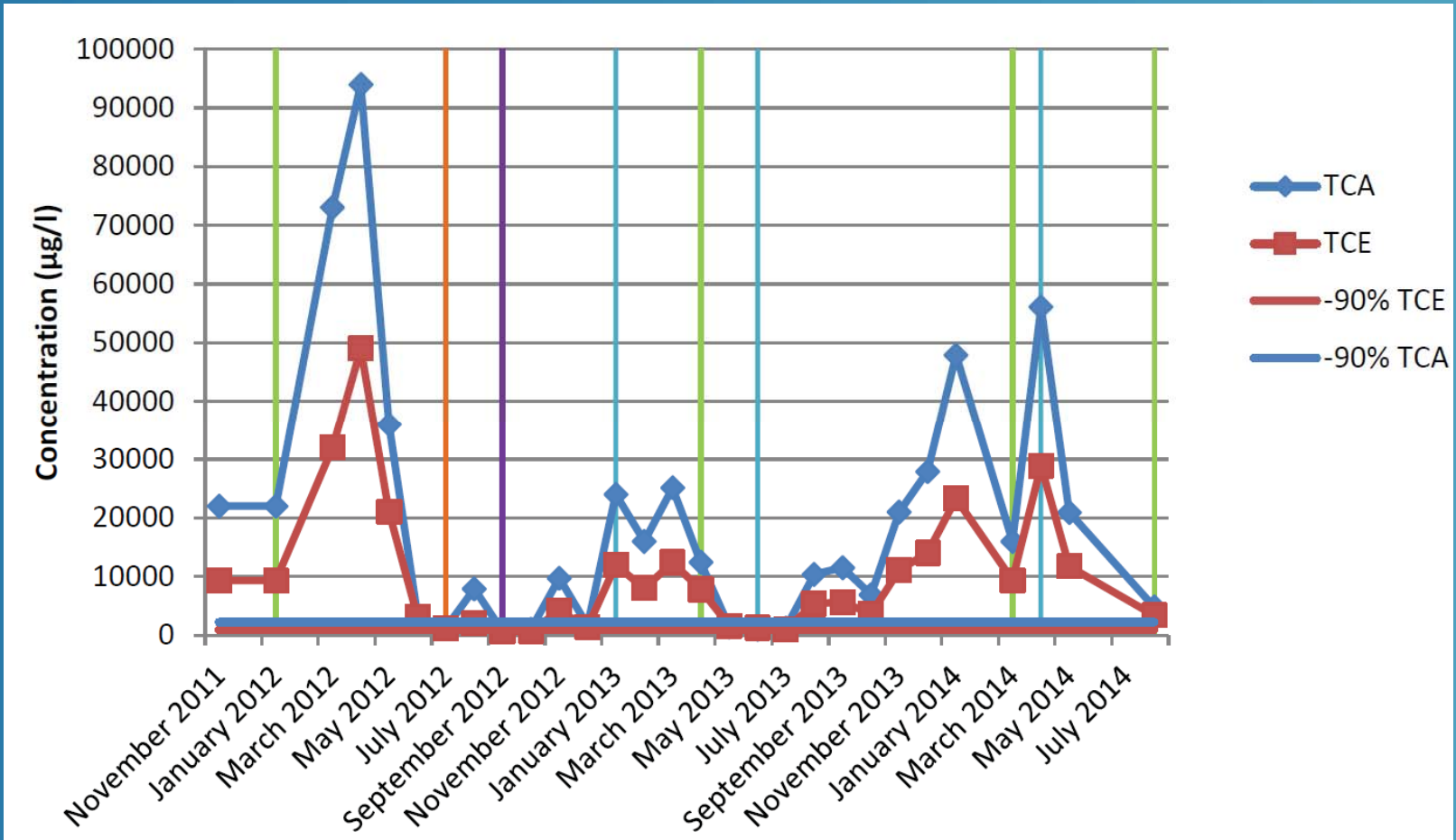






Dual / Multi Phase Vacuum Extraction – Results

- 75% Reduction not achieved
- Significant rebound when the system was switched off
- 3 yrs of physical treatment
- Targets not met
- Further investigation required



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CCH

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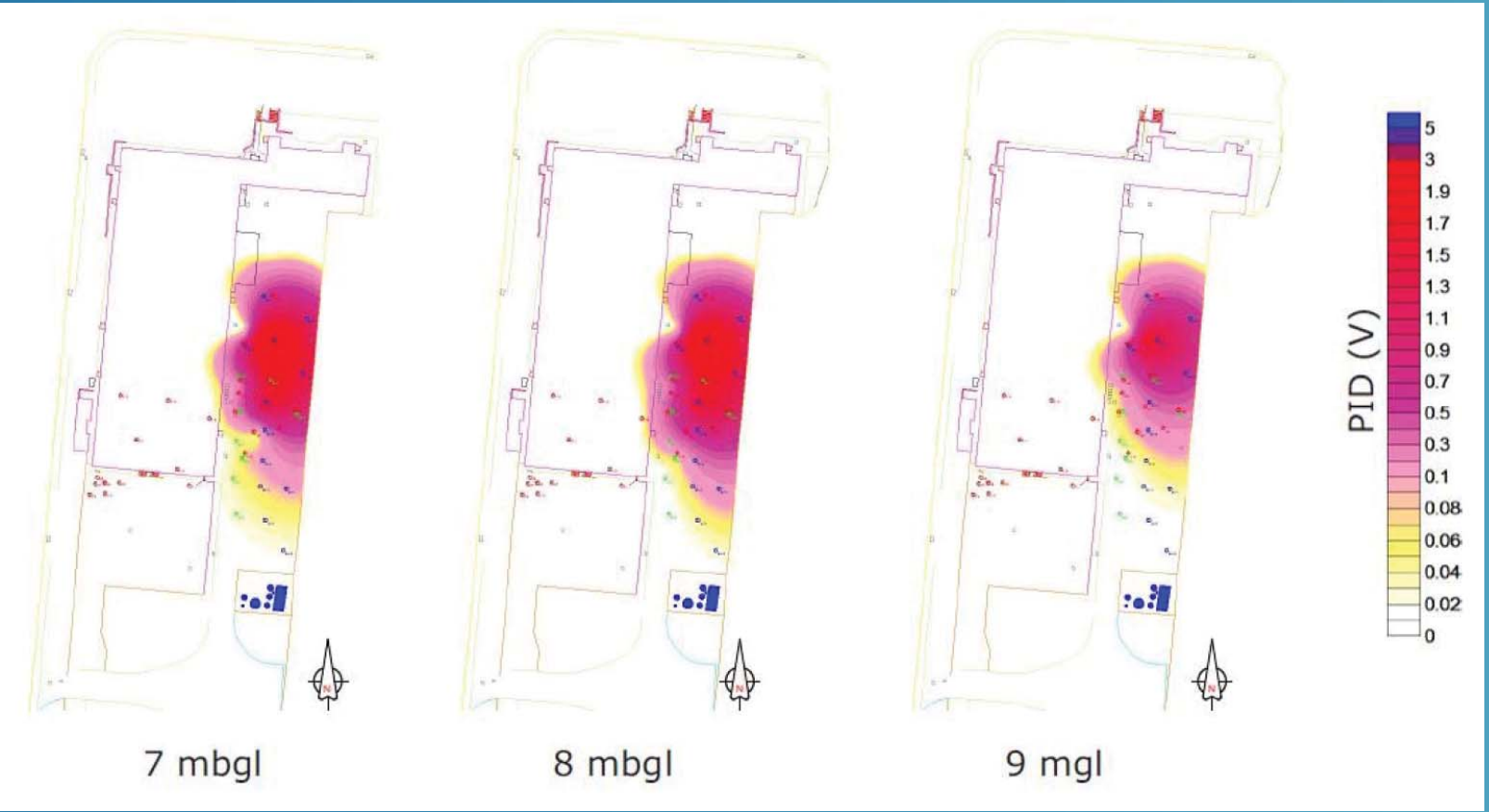
MIP Survey Results – Post SVE

Objectives:

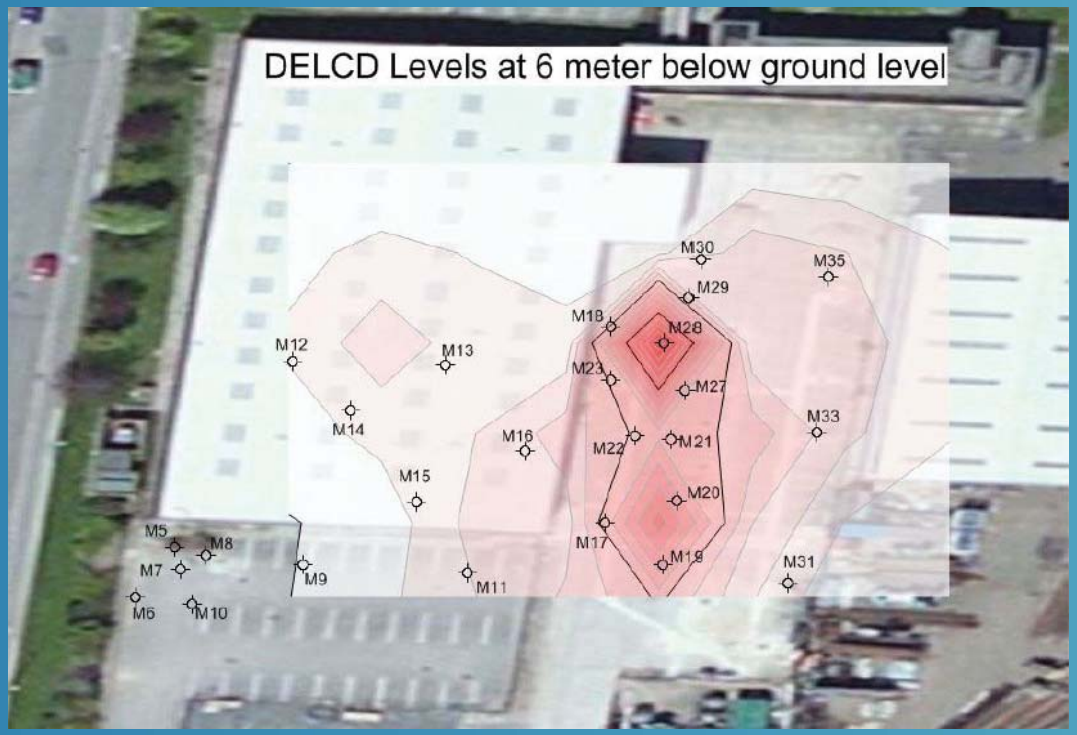
- Assess residual mass
- Understand vertical plume profile
- Inform remedial strategy
- Evaluate risk



Metal Works– United Kingdom
Groundwater Impacted with DNAPL TCE/TCA

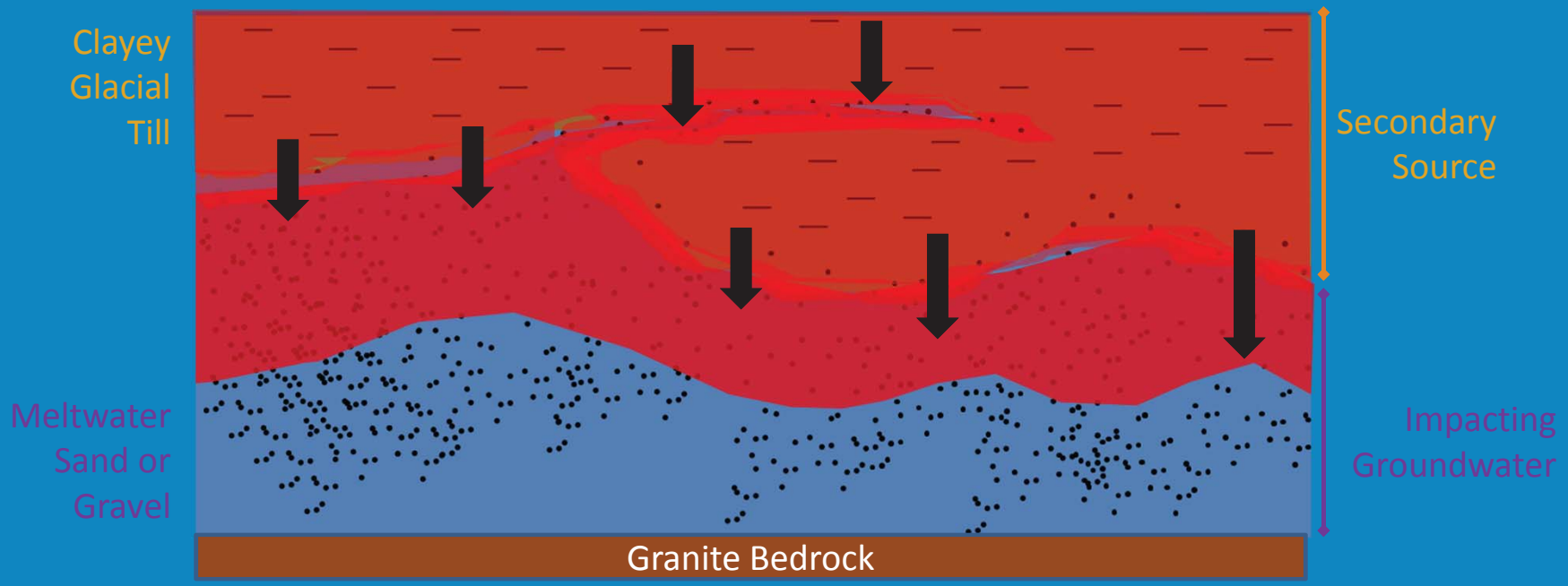
The Challenge

- Active Metal Plaiting Works
- Multiple TCE spills over decades
- Into made ground, underlying clays with sand layers. To 9mBGL.
- Considerable DNAPL onsite
- Limited signs of reductive dechlorination
- DPVE System reached asymptomatic conditions



Metal Plating Works – United Kingdom

Upon Flushing and Removal of Adsorbed Mass "Back Diffusion" Continues



3-D MICROEMULSION

PRODUCTS

3-D® MICROEMULSION

Enhanced Anaerobic Biodegradation (Reductive Dechlorination)

WHAT IT DOES

Making **enhanced reductive dechlorination** (ERD) process possible for *in situ* remediation projects.

HOW IT WORKS

Problematic chlorinated solvents such as tetrachloroethylene (PCE) and trichloroethene (TCE), dichloroethene (DCE) and vinyl chloride (VC) in groundwater are biologically transformed into less harmful end products such as ethene.

ADVANTAGES

- **Propagates widely within the subsurface**
- **Treats wide areas around one injection point saving time and money**
- **Immediate, mid-range and long-term, controlled-release supply of organic acids**

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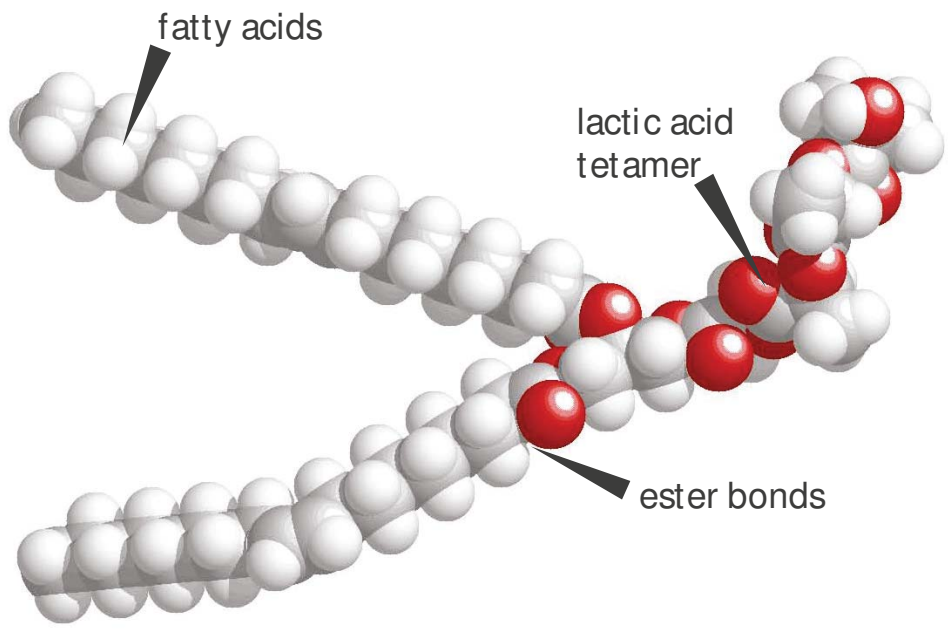
3DMicroemulsion

An appropriately soluble controlled release electron donor



The molecular structure of 3-D Microemulsion®

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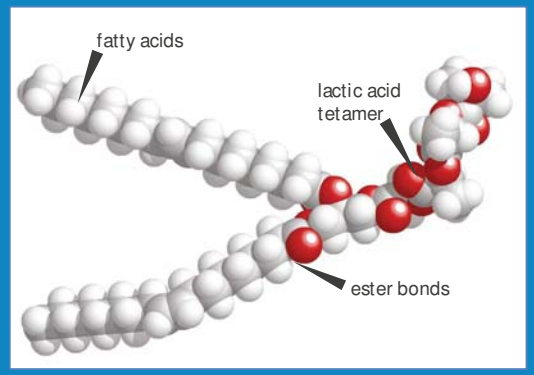
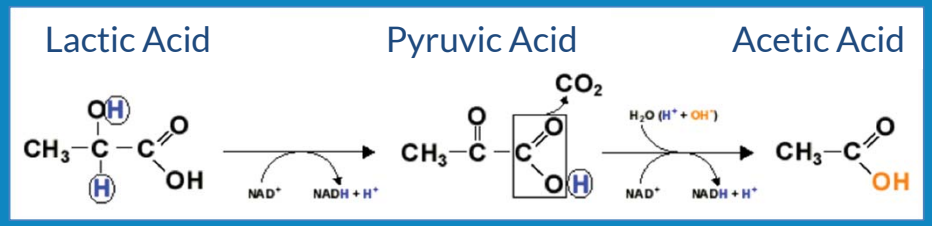
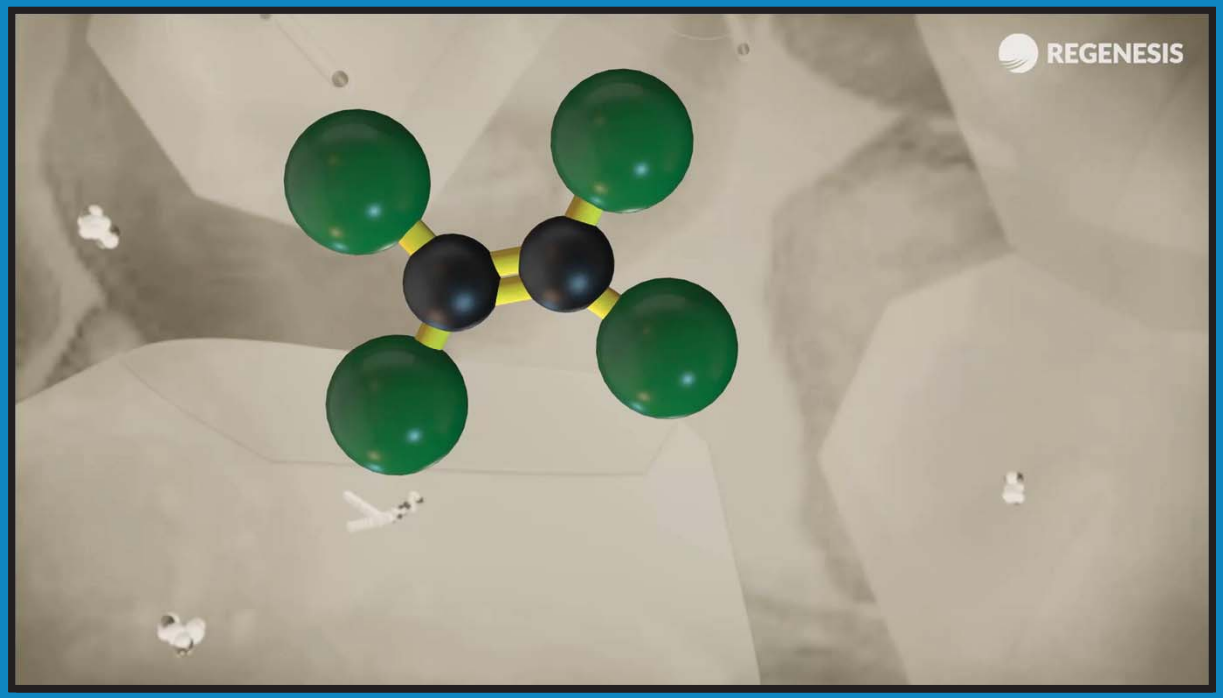
3DMicroemulsion - Controlled Release of Hydrogen for up to 5 years



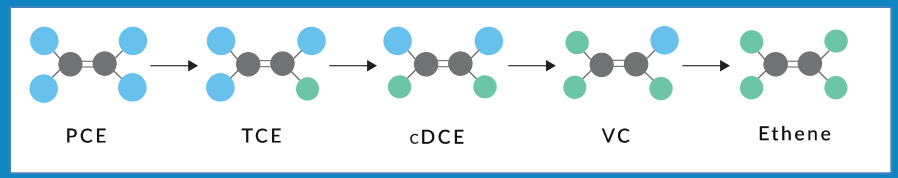
Dissolution

Fermentation





Enhanced Reductive Dechlorination



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PRODUCTS

BIO-DECHLOR INOCULUM

Bioaugmentation

WHAT IT DOES

Rapidly dechlorinate contaminants during *in situ* bioremediation processes.

HOW IT WORKS

Bio-Dechlor INOCULUM stimulates the rapid and complete dechlorination of compounds such as tetrachloroethene (PCE), trichloroethene (TCE), dichloroethene (DCE), and vinyl chloride (VC).

ADVANTAGES

+ Contains microbes capable of dehalogenating halomethanes (e.g. carbon tetrachloride and chloroform**) and haloethanes** (e.g. 1,1,1 TCA and 1,1, DCA**) as well as mixtures of these halogenated contaminants.**

+ Fast acting

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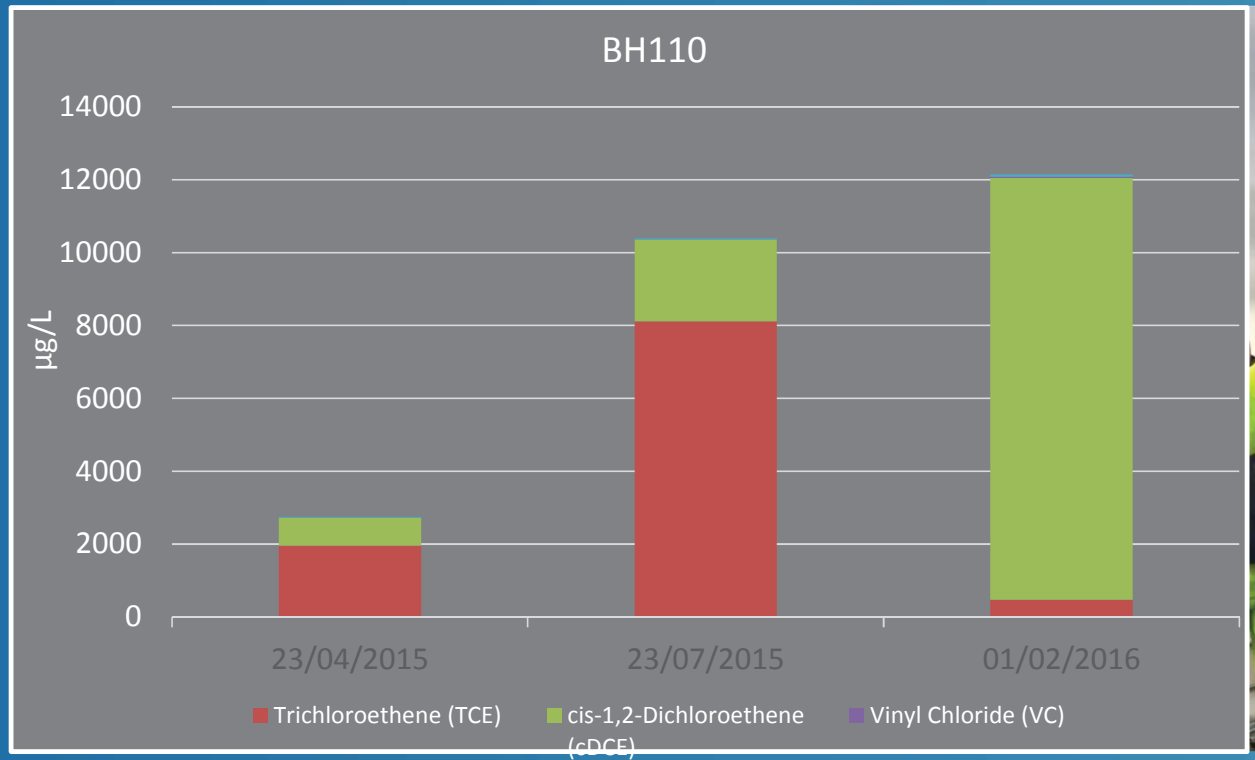
Initial Pilot Trial

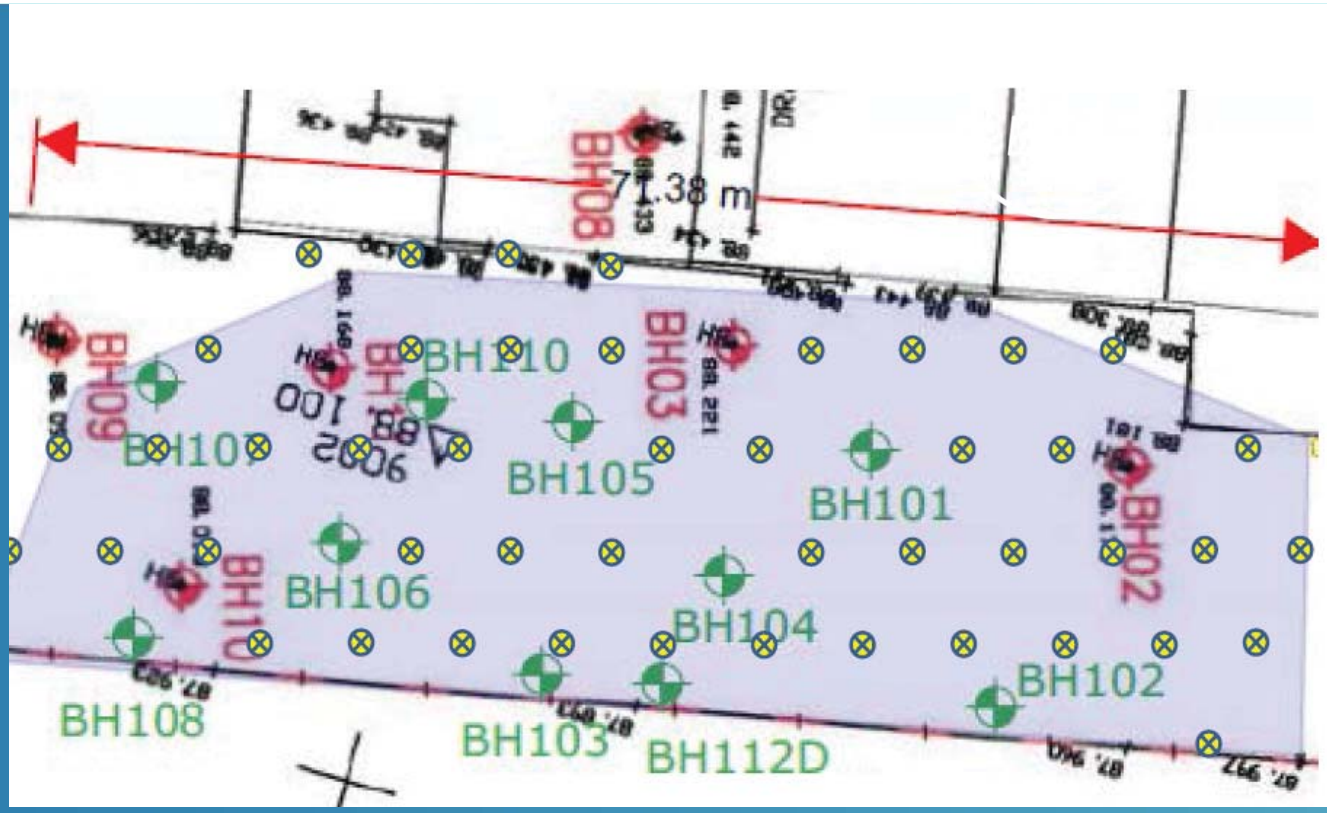
Concern about the efficacy of direct push injection

MIP Injection proved difficult on site

All parties concerned that direct push injection not possible to 9mBGL

✓ Successfully reached 9m BGL



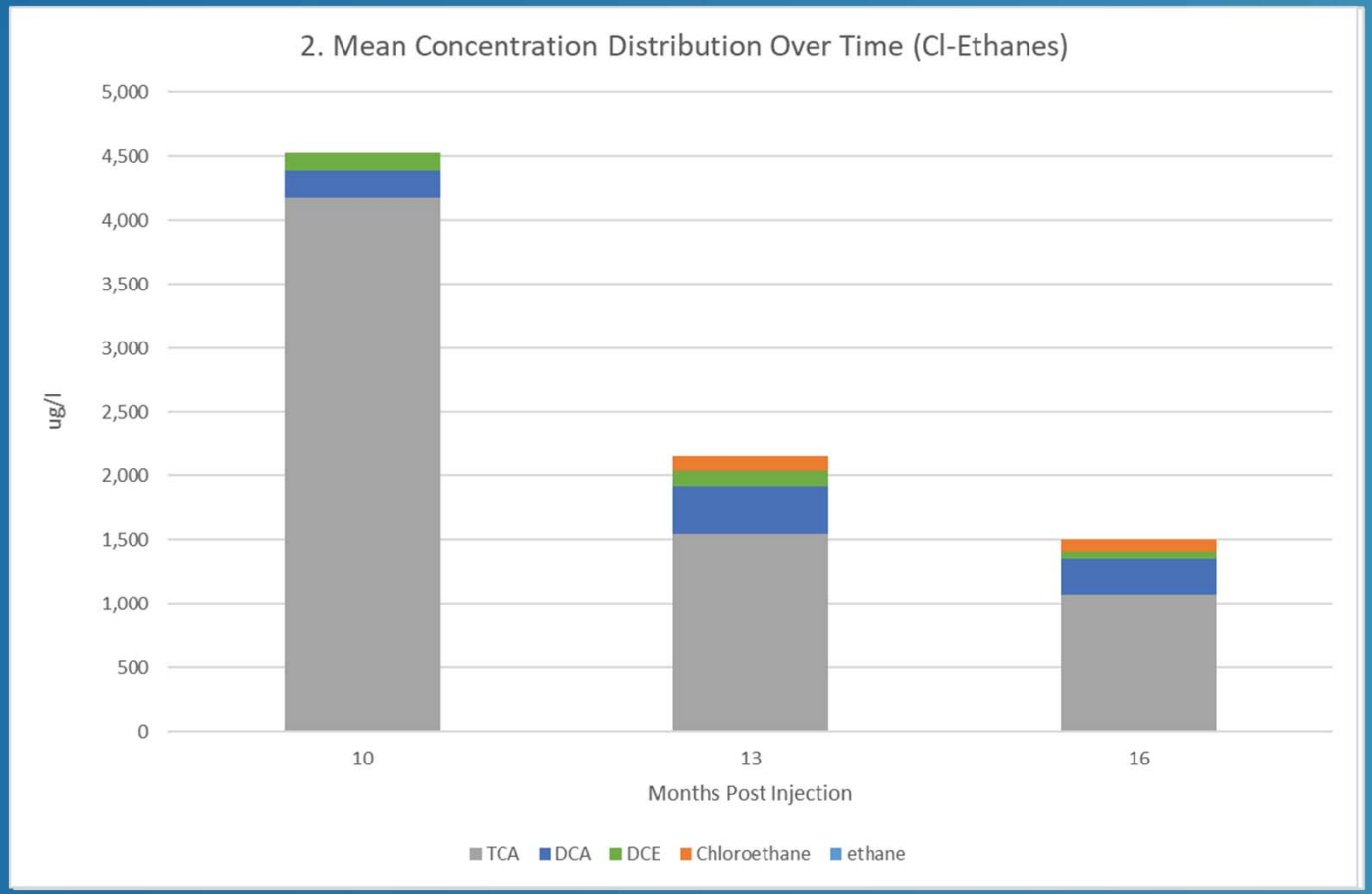


Full-scale application works

Direct Push Injection of HRC and 3DMe across 60 Points

Full-scale application works

16 Months Post Monitoring.. Chlorinated Ethenes



- Following the injection works, quarterly validation monitoring was completed.
- Post injection monitoring showed no inhibition of parent compound degradation due to the mixed halogenated compound plume.
- 98% and 99% reduction in mean concentration of TCA and TCE respectively.

Remediation across occupied sites
Is often possible and cost effective with minimal disruption

- Just because a site is occupied does not mean remediation cannot take place
- Communicating occupants expectations to the remediation contractor/ designer is key
- Continual stakeholder engagement is key to ensuring that the occupier knows what to expect and that REGENESIS understands commercial and technical limitations to the site.

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