

CENSUS qPCR

Evaluating Biostimulation to Overcome DCE Stall

PROJECT SUMMARY



- Site managers were concerned that cis-DCE was accumulating at a chlorinated solvent site.
- CENSUS qPCR quantification of *Dehalococcoides* and functional genes was performed to evaluate the potential for complete reductive dechlorination to ethene and to assess enhanced bioremediation strategies.
- Based on CENSUS qPCR results, bioaugmentation was not necessary, saving money, and biostimulation by electron donor injection was selected as the remedy.
- After electron donor injection, substantial increases in *Dehalococcoides* and functional gene concentrations demonstrated the effectiveness of biostimulation as a treatment strategy.

PROJECT CHALLENGE



The study site is a former manufacturing facility in upstate New York where a shallow aquifer was impacted by tetrachloroethene (PCE) and trichloroethene (TCE). Historical groundwater monitoring indicated that reductive dechlorination was occurring at least to a limited degree. With vinyl chloride and ethene concentrations remaining low in most monitoring wells however, site managers were concerned that cis-1,2-dichloroethene (cis-DCE) was accumulating and that complete reductive dechlorination to ethene was unlikely under existing site conditions.

REMEDY SELECTION



Dehalococcoides are the only known bacterial group capable of complete reductive dechlorination of PCE and TCE to non-toxic ethene. Therefore, CENSUS qPCR quantification of *Dehalococcoides* and functional genes (TCE, BVC, and VCR) was performed with samples from selected monitoring wells within the source area and dissolved plume to answer the following questions:

1. Is complete reductive dechlorination to ethene likely or will cis-DCE accumulate?
2. Is electron donor injection (biostimulation) needed to enhance biodegradation?
3. Is bioaugmentation needed or an unnecessary expense?

REMEDY SELECTION (CONT.)



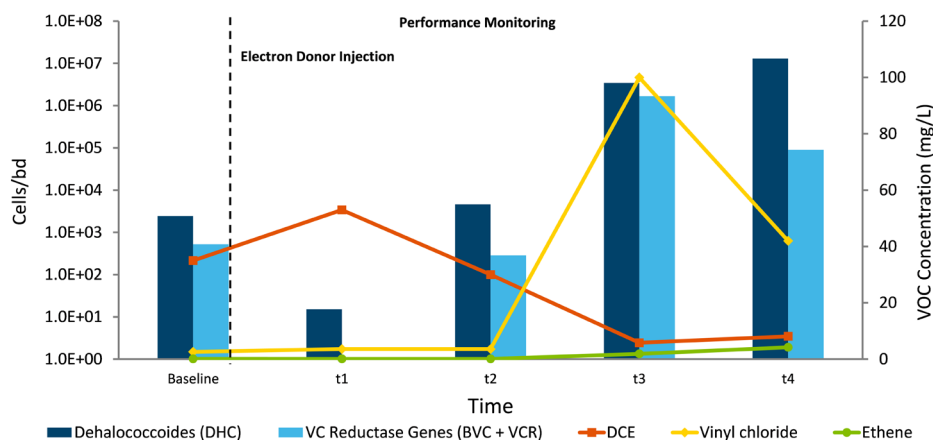
Dehalococcoides and vinyl chloride reductase genes were detected within the dissolved plume. However, *Dehalococcoides* concentrations were below the 10^4 cells/mL threshold for generally effective rates of reductive dechlorination.

Decision: Biostimulation was selected as the remediation strategy. With *Dehalococcoides* detected at least at low concentrations at each sampling location, bioaugmentation was not needed.

PERFORMANCE MONITORING



An electron donor injection was performed in the source area. CENSUS qPCR quantification of *Dehalococcoides* and functional genes was performed to evaluate the effectiveness of biostimulation and monitor remedy performance.



- Following electron donor injection (times **t1** and **t2**), a lag period was initially observed in which *Dehalococcoides* concentrations remained low. By **t3** however, the *Dehalococcoides* population had increased to $10^6 - 10^7$ cells/bd with a corresponding decrease in DCE.
- Due to enhanced reductive dechlorination of DCE, the vinyl chloride concentration was higher at **t3**. However, CENSUS qPCR results revealing vinyl chloride reductase genes (BVC, VCR) on the order of 10^6 cells/bd demonstrated that *Dehalococcoides* capable of reductive dechlorination of vinyl chloride were not just present but abundant.
- Consistent with the high concentrations of *Dehalococcoides* and vinyl chloride genes, the observed increase in vinyl chloride concentrations at time **t3** was temporary and by time **t4** had decreased substantially with a concurrent increase in ethene.

Decision: Substantial increases in the concentrations of *Dehalococcoides* and functional genes after electron donor injection demonstrated that biostimulation was successful.

KEY BENEFITS



Throughout the project, CENSUS qPCR quantification of *Dehalococcoides* and functional genes was a critical line of evidence that directly impacted site management decisions.

- **Actionable:** A deciding factor in selecting biostimulation as the treatment strategy.
- **Saved Money:** Indicated that bioaugmentation was not necessary.
- **Increased Confidence:** High concentrations of vinyl chloride reductase genes confirmed potential for complete reductive dechlorination to ethene.
- **Conclusive:** Substantial increases of *Dehalococcoides* and vinyl chloride reductase genes following electron donor addition demonstrated that biostimulation was successful.

LAB LOCATIONS



Microbial Insights, Inc. USA

10515 Research Drive, Knoxville, TN 37932 USA

Microbial Insights Canada, c/o EBPI

735 Griffith Court, Burlington Ontario, L7L 5R9

Microbial Insights (Australia) Pty Ltd, c/o AGRF Ltd

Plant Genomics Centre, Hartley Grove, Urrbrae SA 5064, Australia

Microbial Insights Europe, c/o Avecom

Industrieweg 122P, B-9032 Wondelgem, Belgium

Microbial Insights Europe (Germany), c/o Sensatec

Tempelhofer Weg 8, 12099 Berlin Germany

Microbial Insights China, Xiuying Li (cell# 13204027102)

Institute of Applied Ecology, Chinese Academy of Sciences
72 Yunong Road, Shenyang, Liaoning, 110164 China