

# Plume Remediation at an Active Manufacturing Site near Orléans, France

## Effective source zone treatment of a 1km chlorinated solvent plume



Fig. 1 3DMe mixing area onsite

### Summary

Historic leakage and spillages of chlorinated hydrocarbons (CHCs) at an active manufacturing facility, had lead to high levels of contamination acting as a secondary source in the aquifer, under the building. Dual Phase Vacuum Extraction (DPVE) had effectively reduced the contaminant mass in the source area, however a 1km dissolved phase plume was found to be still migrating from the site. It was thought that residual contamination in the low permeability zones were feeding the plume via back diffusion. It was therefore determined that further remedial works would be undertaken to address the residual secondary source and reduce the mass flux within the downgradient plume.

### Design & Application

REGENESIS worked with AECOM to create a remedial strategy using 3-D Microemulsion (3DMe) to biologically degrade the CHC contamination through Enhanced Reductive Dechlorination (ERD). The 3DMe was injected into the subsurface using three direct push rigs working simultaneously, in order to minimise the time onsite and disturbance to the busy factory; completing the application in just 15 days.

In the source area, 3DMe was injected on a grid pattern. 3DMe has the unique ability to self-distribute in the subsurface following injection, maximising the radius of influence (ROI) from each injection point. This ensures that the ROI from each injection point interlocks to provide treatment throughout the target volume. Residual contamination was located in the low permeability zones in the target areas, which was back-diffusing into the groundwater. As 3DMe provides a controlled electron donor release for approximately 4-5 years, a single injection is able to diffuse active ingredient into the low permeability zones and degrade contamination back-diffusing over a long period. This therefore remediates the contamination in the permeable and impermeable zones and prevents rebound due to back-diffusion.

### Remediation Details

#### Site Type:

Active factory

#### Project Driver:

Regulatory compliance

#### Remediation Approach:

Enhanced Reductive Dechlorination

#### Technologies:

3-D Microemulsion®

### Geology

	Bedrock
	Gravel
X	Sand
X	Silt lenses
	Clay

### Medium

X	Groundwater
	Saturated Soil
	Vadose Zone

### COC

	Petro HCs
	Petro LNAPL
X	Chlorinated VOCs
	Metals

#### COC Concentration Levels:

5,000µg/L TCE  
20,000µg/L DCE  
1,000µg/L VC

Treatment Depth: 2m-16m BGL

Injection Points: 85

Area Treated: 3,500m<sup>2</sup>

Remediation Cost: €430k

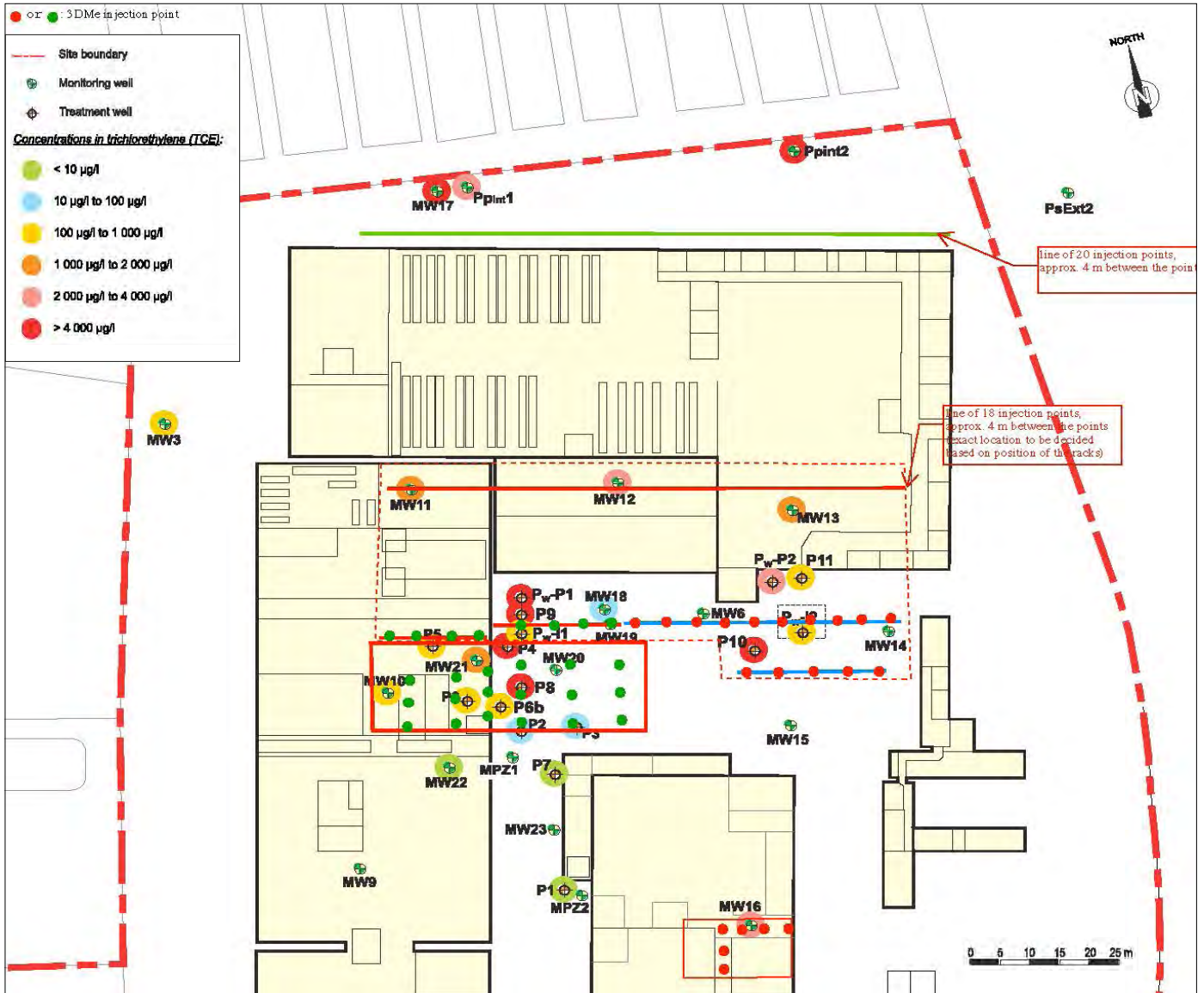


Fig. 2 Plan showing injection spacing in grid and barrier formation

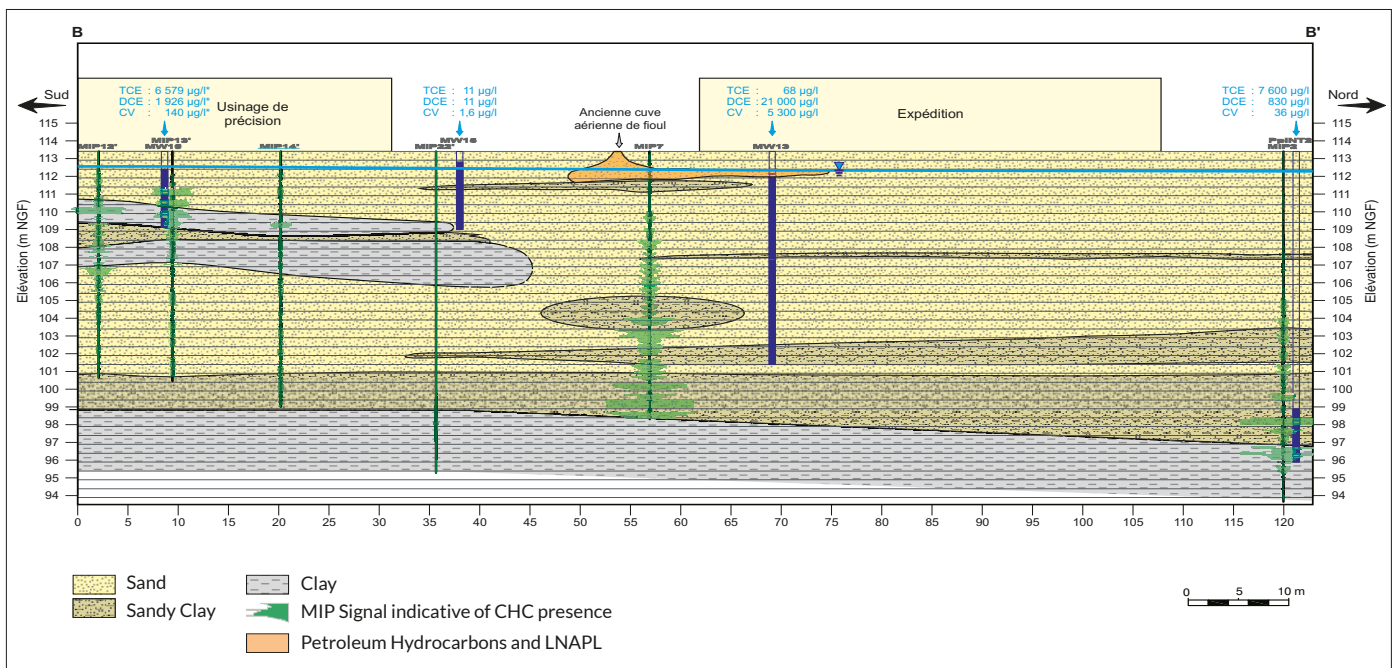


Fig. 3 North-south section showing CHC contaminant levels

In the downgradient plume, the 3Dme was installed in a series of rows, which act as barriers to the contamination flux. This is achieved by the 3Dme creating and maintaining an anaerobic treatment zone, through which the groundwater continues to flow, while the contamination influx is degraded. Because 3Dme lasts for 4-5 years, the barriers are capable of degrading contaminant influx over an extended period, allowing time for the secondary source to be degraded and preventing the residual plume migrating offsite during treatment of the residual source.



Fig. 4 Injection into downgradient plume in barrier formation, inside the factory building

**Results**

Following application in the source area, the parent compound (TCE) has been reduced to very low concentrations. It is expected that back diffusion is providing an influx into the treatment zone, but the ideal degradation conditions maintained by the 3Dme ensure that the TCE is immediately degraded as it diffuses into the mobile porosity. This is evidenced by the sequential creation and degradation of the breakdown products, with full reductive dechlorination being achieved.

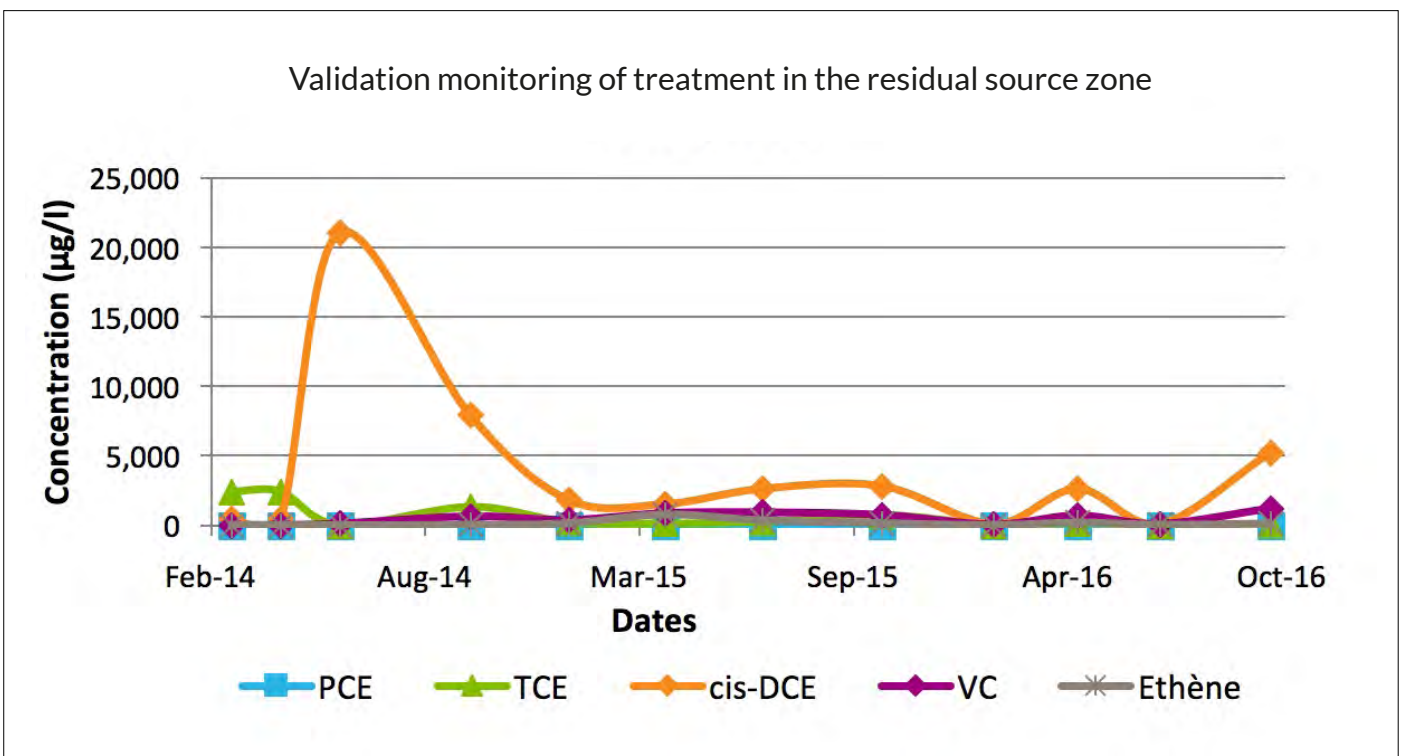


Fig. 5 Long term monitoring results for well P6, located in the source zone

Validation monitoring downgradient of the barriers, show that the total chlorinated solvent mass flux has been reduced, with full reductive dechlorination occurring.

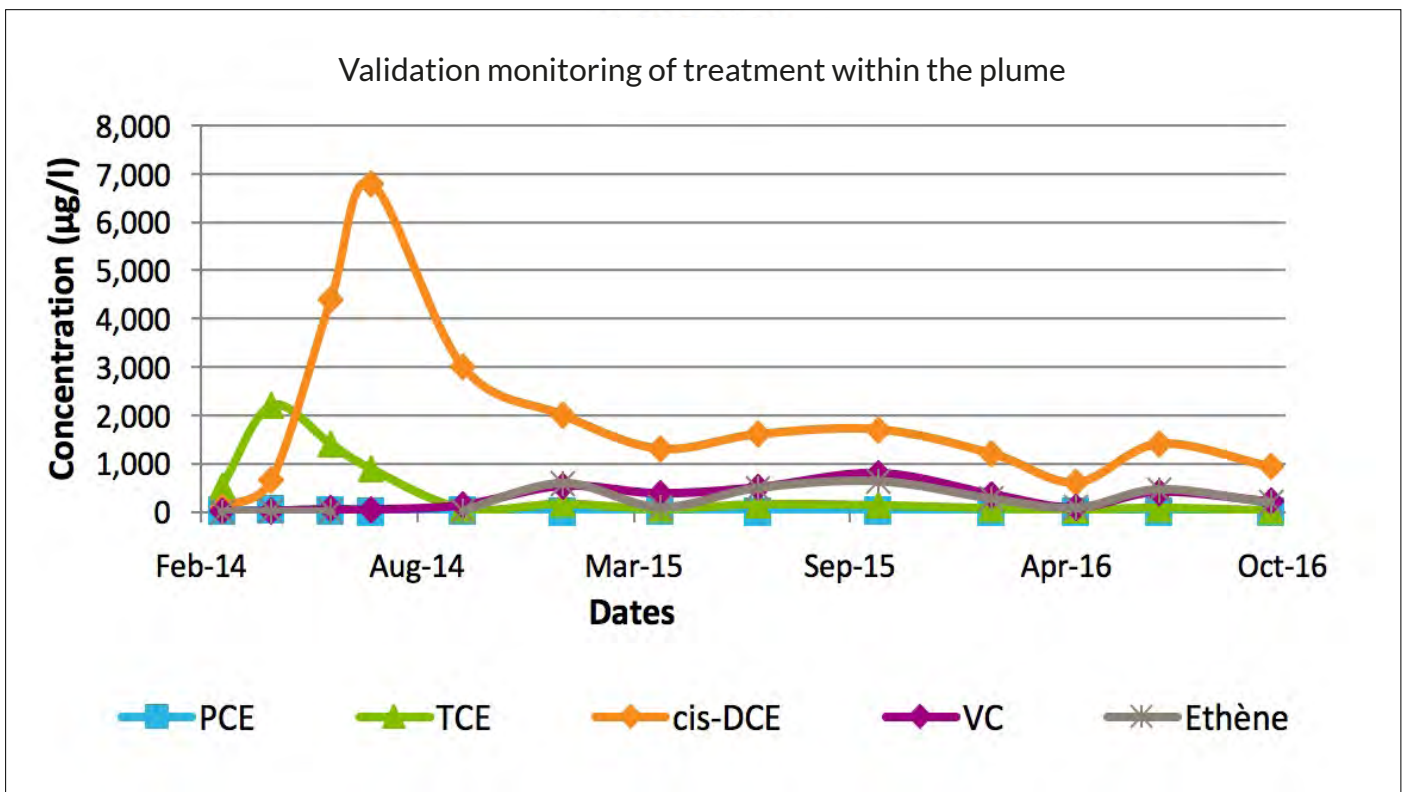


Fig. 6 Long term monitoring results for well MW12, located in the barrier (plume area)

### Conclusion

- REGENESIS completed the application works on a fixed-price basis for AECOM in order to provide the end user with surety of cost and programme length.
- The application was completed in difficult working conditions, i.e. in a busy delivery yard, inside an active factory, warehousing areas and even pedestrian corridors. By using direct push injection, the works were completed without disruption to any site activities.
- Due to 3DMe providing a long term controlled release of electron donors, only a single application was required, minimising the time onsite, while remediation continues to occur underneath the active facility.
- Due to the ability of 3DMe to self-distribute in the subsurface following application, the injection point spacing was maximised, minimising the number of locations and therefore minimising cost and time onsite.
- 3DMe has a very wide ROI, allowing the treatment to target contamination beneath areas inaccessible from the surface due to structures or services.
- Residual contamination in the source area was located in low permeability lenses and was providing a secondary source of groundwater contamination through back diffusion. The 3 donor construction of the 3DMe technology allows it to rapidly create the ideal conditions for ERD of the contamination and then maintain these conditions for 4-5 years in order to address any contamination back-diffusing into the mobile porosity.

For more information or to discuss your project, please contact:

Kris Maerten  
REGENESIS  
Technical Manager, Europe

kmaerten@regenesisis.com  
+32 (0)57 35 97 28

Contact Reference:

Richard Sumner  
AECOM  
Associate Director - Investigation & Remediation

richard.sumner@aecom.com  
+33 (0)155692001

