

# Treatment of a Widespread Plume Beneath a Metropolitan Area in Italy

## PlumeStop provides rapid treatment of low concentration chlorinated solvent plume



Fig. 1, Overview of Bologna train station and surrounding urban area

### Introduction

A widespread plume of chlorinated solvents (CHC) has been monitored for more than a decade underneath the train station and extending out under the surrounding urban area of Bologna, Italy. One area has concentrations exceeding 1,000 µg/l, but most of the chlorinated solvent concentrations are low (100µg/l or less) yet persistent and with no effective natural attenuation occurring. The main contaminants are TCE and cis-1,2-DCE, which are present in two aquifers with different geological characteristics: The superficial aquifer has a thickness of 6 to 8 meters and consists of fine sands and silts. The deeper aquifer has a thickness of 2 to 4 meters and consists of higher permeable sand. This contamination had previously been considered as practically untreatable, due to its low concentrations, location and size.

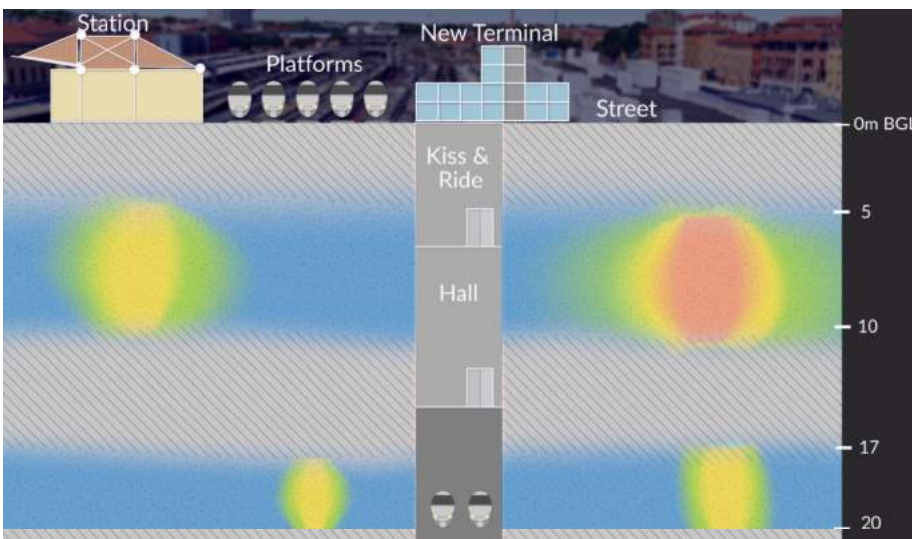


Fig. 2, Section illustration showing the superficial and deeper contaminated aquifers

The University of Rome “La Sapienza” had been commissioned to evaluate strategies for the remediation of this large urban site. Based on the results from site investigation, lab testing and microcosm studies, biological reductive dechlorination was recognized as a potential approach. However, biological degradation was considered impractical for treatment on the site, due to the potential inefficiencies at such low contaminant concentrations. However, with the creation of our new PlumeStop technology, another treatment approach became an option.

### Remediation Details

**Site Type:** Urban area

**Project Driver:**  
Regulatory Requirement

**Remediation Approach:**  
Enhanced adsorption and biological degradation

**Technologies:**  
PlumeStop® e HRC®

#### Geology

	Bedrock
	Gravel
X	Sand
X	Silt
	Clay

#### Medium

X	Groundwater
	Saturated Soil
	Vadose Zone

#### COC

	Petroleum Hydrocarbons
X	Chlorinated VOCs
	Free Phase
	Metals

#### COC Concentration Levels:

TCE (up to 100 µg/L)  
1,2DCE (in one area up to 1,000 µg/L)

**Treatment Level:** 2 Aquifers  
4-11 m BGL and 17-20 m BGL

**Treatment Area:**  
Hotspot treatment (400 m<sup>2</sup>)

**Injection Type:**  
Direct push in 2 areas;  
Injection into wells in 2 areas.

PlumeStop allows for the effective treatment of widespread, low concentration plumes, as it works by combining in situ adsorption and enhanced biological degradation. The technology provides a rapid and sustained treatment to very low concentration targets from a single, simple and safe injection into the subsurface. There is no need for mechanical plant installation and also no requirement for repeated applications, making it an ideal solution for this large, complex site. This minimised the activities on a site comprising a busy railway station, residential neighbourhood and ongoing redevelopment works.

The intention on this site was to treat all of the accessible 'hot spots' present within the plume, with the first area being used as a pilot test to confirm dose and distribution.

### Treatment

For the pilot test, REGENESIS installed 6 multi-level injection wells and applied specific doses of PlumeStop at the target depths. On-site works for the pilot test were completed in 3 weeks and included the execution of a range of tests in order to confirm the treatment effectiveness and create an accurate design for the full scale application.

Full scale treatment comprised injection into the four identified 'hot spot' areas (see figure 7). In Areas 1 and 2, multi-level injection wells were used, while in areas with restricted access: Area 3 (rail way station) and Area 4 (residential area) , a direct push approach has been employed.

In all treatment areas, PlumeStop has been co-injected with REGENESIS electron donors HRC® and HRC Primer®, to provide initial biostimulation and promote continual in situ bio-regeneration of the Liquid Activated Carbon.



Fig. 3, Soil testing during the pilot phase



Fig. 4, Drilling wells prior to injection in Area 2



Fig. 5, Injection of PlumeStop on the platform of the railway station, in Area 3



Fig. 6, Direct push injections in the road at Area 4

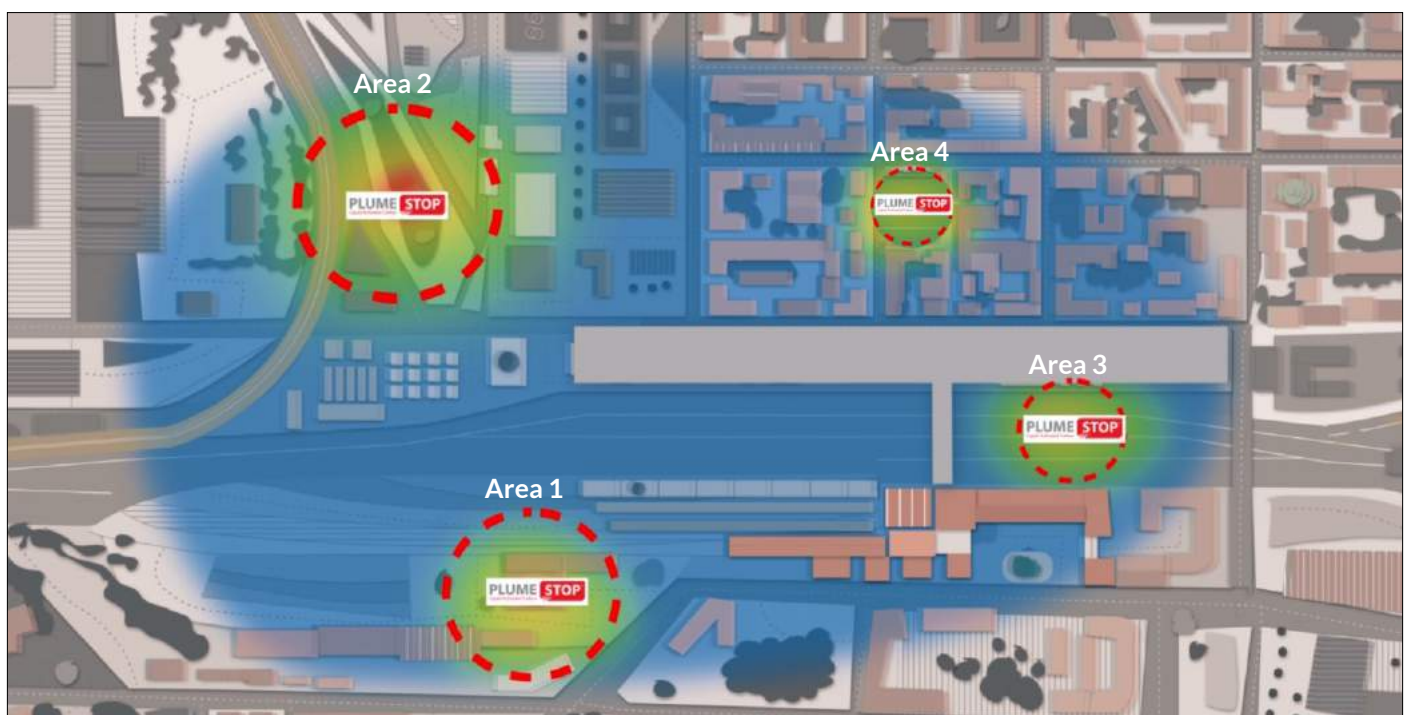
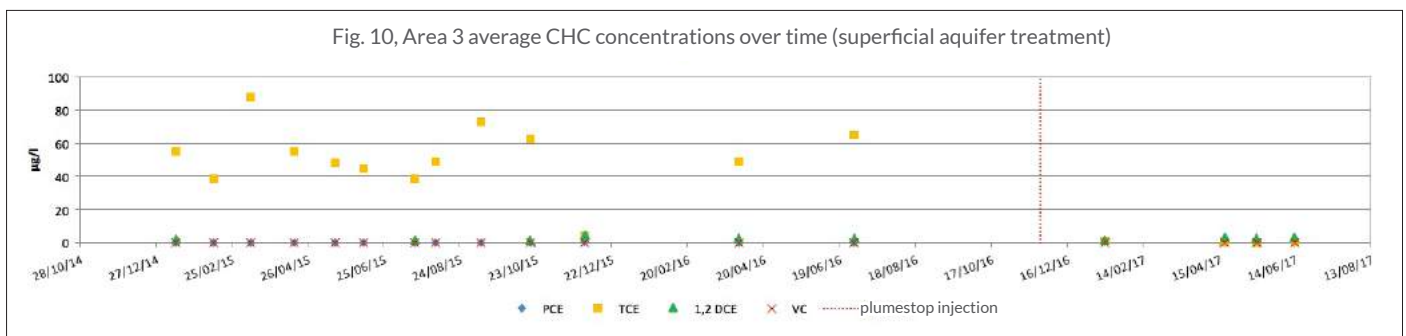
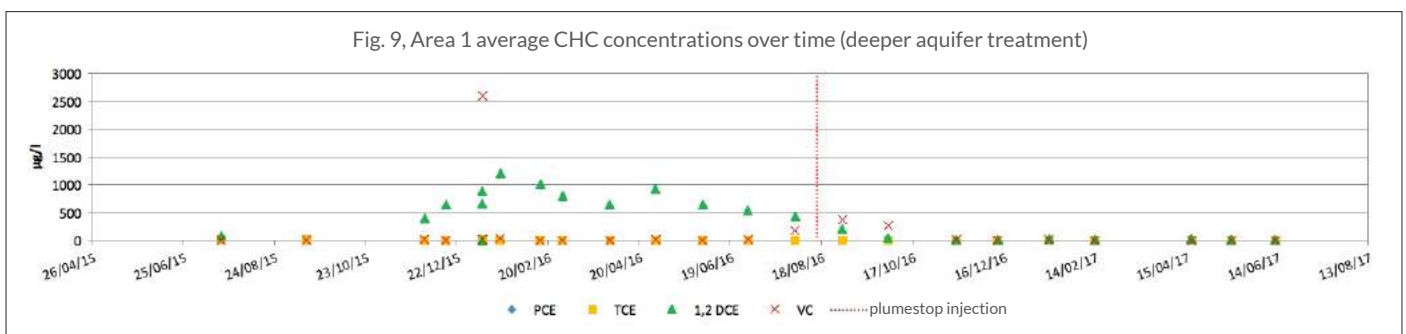
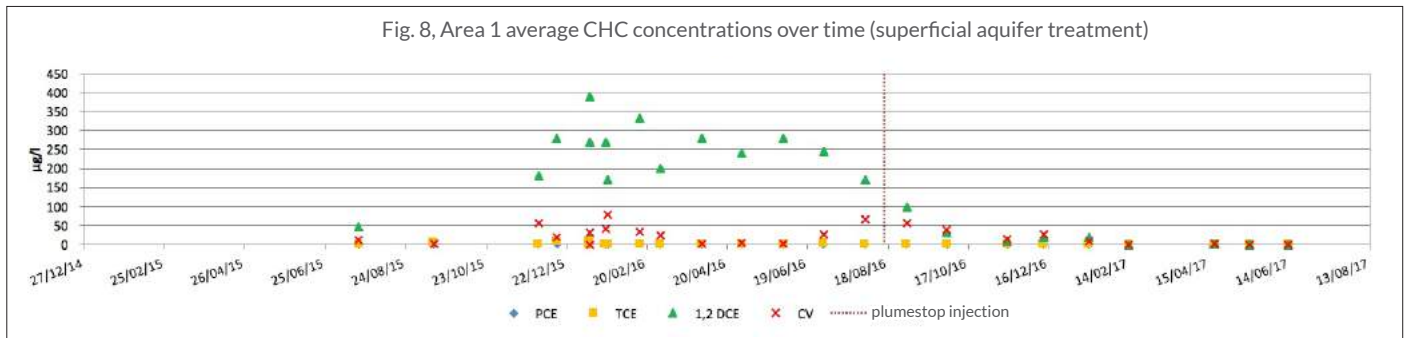


Fig. 7, Full-scale treatment locations: targeting the 4 'hot spots' within the widespread, low concentration chlorinated solvent plume



## Results

Results available to date show a rapid reduction in CHC concentrations inside the treatment areas (see examples in figures 8, 9 and 10). In the majority of monitoring wells concentrations of all chlorinated compounds are below stringent regulatory standards ('CSC') and in many cases also below the detection limit. In most groundwater monitoring results, daughter products, cis-1,2-DCE and VC, show a decreasing trend from the start of treatment, rather than a sequential increase and then decrease in concentration, as would be expected in a typical ERD approach. This is due to full reductive dechlorination occurring on the surface of the PlumeStop biomatrix, rather than in the groundwater itself. It is expected that the concentrations will be maintained at low levels without any rebound effect, due to the continuous regeneration of the activated carbon provided by the biodegradation process.



## Conclusion

- Successful remediation has been achieved with a single application in two porous media aquifers at the same time.
- PlumeStop Liquid Activated Carbon has proven to be an in situ technology with unprecedented capabilities; able to rapidly remove contaminants from the groundwater and degrade them within a few months.
- It had previously been considered impossible to treat this site due to the low starting concentration, the stringent remediation targets, the widespread plume and its location under a city centre. PlumeStop has made the treatment simple and cost-effective.
- Due to the self-regenerating capability of the biomatrix, there is no requirement for re-application, providing long term ongoing treatment.

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

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