

## In-situ pilot remediation of gasworks impacted groundwater, Stockholm, Sweden

### Targeted treatment of a wide range of contaminant concentrations in challenging geology



#### Introduction

In the north-east of Central Stockholm, a historical industrial site was earmarked for redevelopment. Part of the site comprised a former gasworks, where historical operations have caused a complex mix of contaminants to impact the surrounding soil, groundwater and shoreline sediments.

The large site is due to be redeveloped in a series of parcels including a road, industrial park, residential homes and schools. Remediation is required to ensure the human health risk is removed as part of the restoration of the site. The impacted groundwater also represents an environmental risk and requires treatment.

Risk assessments were used to determine that remediation was required to a depth of 20m BGL. The geology of the site is heterogeneous, comprising a shallow made ground, a clay layer and underlying coarse sands. The sands are highly impacted with a range of gas works contamination included creosote NAPLs and high levels of benzene. The saturated clays are also impacted with dissolved phase contamination. Due to contaminants, concentrations and superficial geologies, a range of remedial methods would be required to ensure the most appropriate was used in each scenario. Therefore, RGS Nordic engaged REGENESIS to design a series of pilot tests utilising several in-situ methods. The results from these trials would then be used to shape the full-scale remediation strategy for the entire gasworks site area.

#### Combined In-Situ Remediation Approach and Planning

REGENESIS proposed a pilot-scale combined remediation approach comprising:

- Enhanced desorption using PetroCleanze to target high concentrations of soil-bound contaminants of concern (COC's) in the sands,
- In-Situ Chemical Oxidation (ISCO) using both RegenOx and PersulfOx to target medium to high dissolved phase and soil-bound PAHs in the sandy soil, and
- Enhanced aerobic degradation using ORC-Advanced to target the low dissolved phase benzene and naphthalene concentrations in the clay.

#### Remediation Details

##### Site Type:

Former gasworks

##### Project Driver:

Redevelopment

##### Remediation Approach:

Enhanced Desorption,  
In-Situ Chemical Oxidation,  
Enhanced Aerobic Degradation

##### Technologies:

PetroCleanze®, RegenOx®,  
PersulfOx®, ORC-Advanced®

#### Geology

	Bedrock
	Gravel
X	Sand
	Silt
X	Clay

#### Medium

X	Groundwater
X	Saturated Soil
X	Vadose Zone

#### COC

X	Petro HCs
	Chlorinated VOCs
	Metals

##### COC Concentration Levels:

Benzene up to 140,000 µg/L,  
PAH up to 4,000 µg/L

##### Treatment Depth & Thickness:

PetroCleanze 2.0m-4.5m BGL,  
RegenOx 2.0m-6.0m BGL,  
PersulfOx 11.0-20.0m BGL,  
ORC Advanced 3.0-7.0m BGL -  
(overall 2.0-20.0m BGL)

## Results

Groundwater samples were collected 3-4 months after the application of REGENESIS remediation products, see graphs 1 to 3.

### Enhanced Desorption using PetroCleanze

>95% reduction in dissolved phase benzene was achieved with the addition of PetroCleanze. The treatment for PAHs was found to be less effective, primarily due to the low baseline PAH concentrations which were below the optimum treatment concentration range for PetroCleanze.

### ISCO using RegenOx and PersulfOx

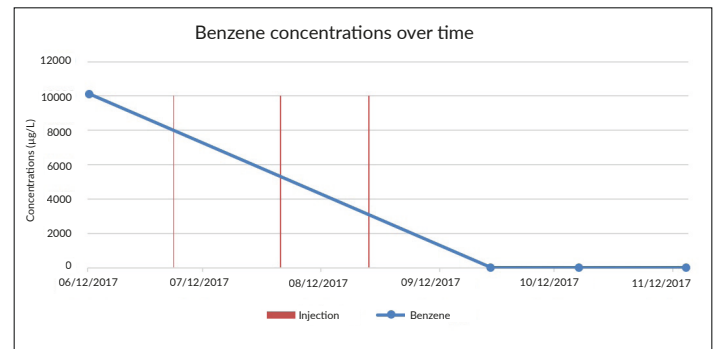
>90% reduction in dissolved phase benzene and PAHs was observed using PersulfOx. In the RegenOx trial, dissolved benzene concentrations were found to decrease by 80%, while PAH levels increased slightly, potentially due to large volumes of desorbed COCs being released into groundwater post-treatment.

### Enhanced Aerobic Biodegradation using ORC-Advanced

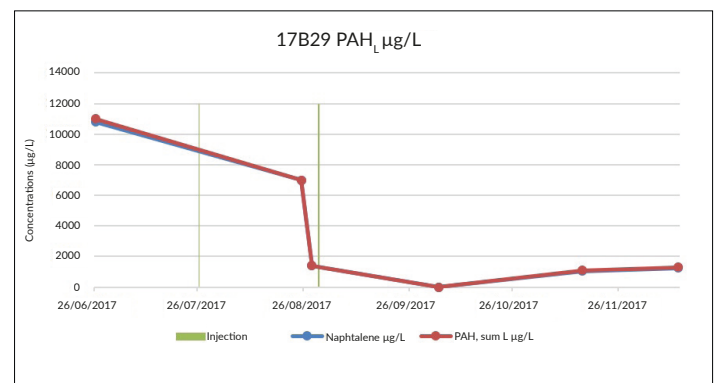
A sustained reduction in Naphthalene and benzene (despite suspected influx into the test area) was achieved using ORC-Advanced in the saturated clay.

## Conclusion

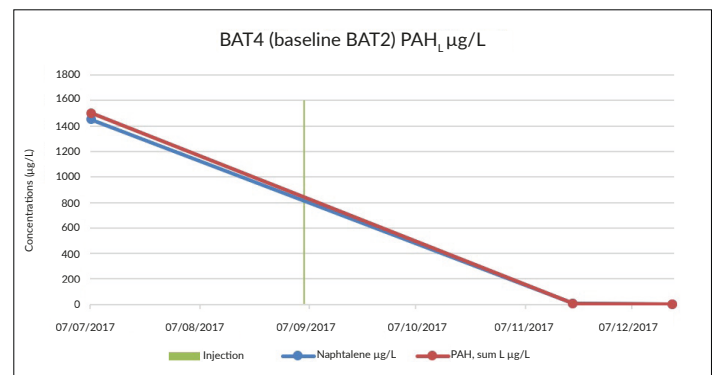
- A wide range of contaminant concentrations were treated effectively using a combined in-situ remediation approach.
- Substantial reductions in COC concentrations were achieved despite the challenging geological setting.
- The results from the pilot tests show that all areas of the gasworks site can be successfully remediated in-situ using REGENESIS remediation products, providing significant cost savings when compared with conventional techniques.



Graph 1- Effect of PetroCleanze application on dissolved Benzene concentrations



Graph 2- Effect of PersulfOx application on PAH concentrations



Graph 3- Effect of ORC-A application on PAH concentrations

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

Jack Shore  
 REGENESIS  
 District Manager UK & Scandinavia  
 jshore@regenesisis.com  
 +44 (0) 1225 61 81 60

Contact reference:

Helena Nord  
 RGS Nordic  
 hnor@rgsnordic.com  
 +46 (0) 70332 5280