

First Application of PetroFix at Petrol Filling Station in Sweden



CASE STUDY

Integrated groundwater treatment strategy using RegenOx, ORC-Advanced and PetroFix yields a 98% reduction in groundwater contaminant concentrations

SUMMARY

RGS Nordic was asked by **Circle K** to remediate groundwater contaminated with gasoline at an active Petrol Filling Station (PFS) in Nykvarn, Sweden. During the site investigation, petroleum hydrocarbon contamination was identified within the fill material around the underground storage tank (UST) farm. RGS Nordic was required to deliver a remediation strategy which posed minimal disruption to the commercial operations of the PFS.

The chosen remediation strategy combined targeted excavation, in situ chemical oxidation (ISCO), in situ sorption and enhanced aerobic biodegradation using a range of complementary technologies: **RegenOx[®]**, **ORC-Advanced[®]** and **PetroFix[™]**.

A six-month groundwater validation program was completed after application. The analysis of the groundwater verified that all the remedial targets set for the site were achieved, yielding a **98% reduction** in contaminant concentrations.



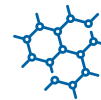
SITE TYPE

Petrol Filling Station



GEOLOGY

Silt / Clay



CONTAMINANTS

31,108 µg/L BTEX (Max)
8,043 µg/L TPH (Max)



PROJECT DRIVER

Liability Reduction



TREATMENT

In Situ Chemical Oxidation (ISCO)
In Situ Sorption and
Enhanced Natural Attenuation



TECHNOLOGIES

RegenOx[®], PetroFix[™],
ORC Advanced[®]

CASE HISTORY: UNKNOWN FUEL LOSS

In 2010, Circle K commissioned a site investigation to assess if there was any environmental liability associated with their PFS in Nykvarn, Sweden. The investigation showed there was significant total petroleum hydrocarbon (TPH) and BTEX contamination around the UST farm at the site. The USTs and pipework were integrity tested and found not to be leaking and so the contamination was thought to have occurred prior to the present UST installation. All free phase contamination was removed during remediation works in 2012-13 (by others), followed by a 4-year groundwater monitoring program. The monitoring data indicated that either residual contamination was still left in the ground, or that there was a new leak. Further integrity testing indicated a new leakage. However, further checks in 2019 proved that this indication was wrong. A second detailed site investigation was subsequently carried out to better understand the situation in the soil and groundwater, after which Circle K asked RGS Nordic to devise a minimal-dig remediation strategy which would achieve the stringent remedial target, while keeping the USTs in situ.

DESIGN APPROACH AND PLANNING

RGS Nordic had been tasked to deliver a remediation strategy which allowed for the underground infrastructure to remain in place, maintain the ongoing commercial operations at the PFS and achieve stringent groundwater remedial targets.

Where possible, RGS Nordic undertook **targeted excavation** to remove any potential secondary source from the unsaturated soils and during these works REGENESIS recommended that RGS Nordic install a series of injection wells to facilitate the application of reagents into the subsurface around and within the underground tank farm.

To protect the USTs and maintain treatment efficacy, RGS Nordic chose the **chemical oxidant** RegenOx to be applied into the subsurface. RegenOx is safe to use and will not corrode or damage USTs, pipes and cables.



Fig. 1 (top) Targeted excavation around UST
 Fig. 2 (right) Installation of injection wells by RGS Nordic

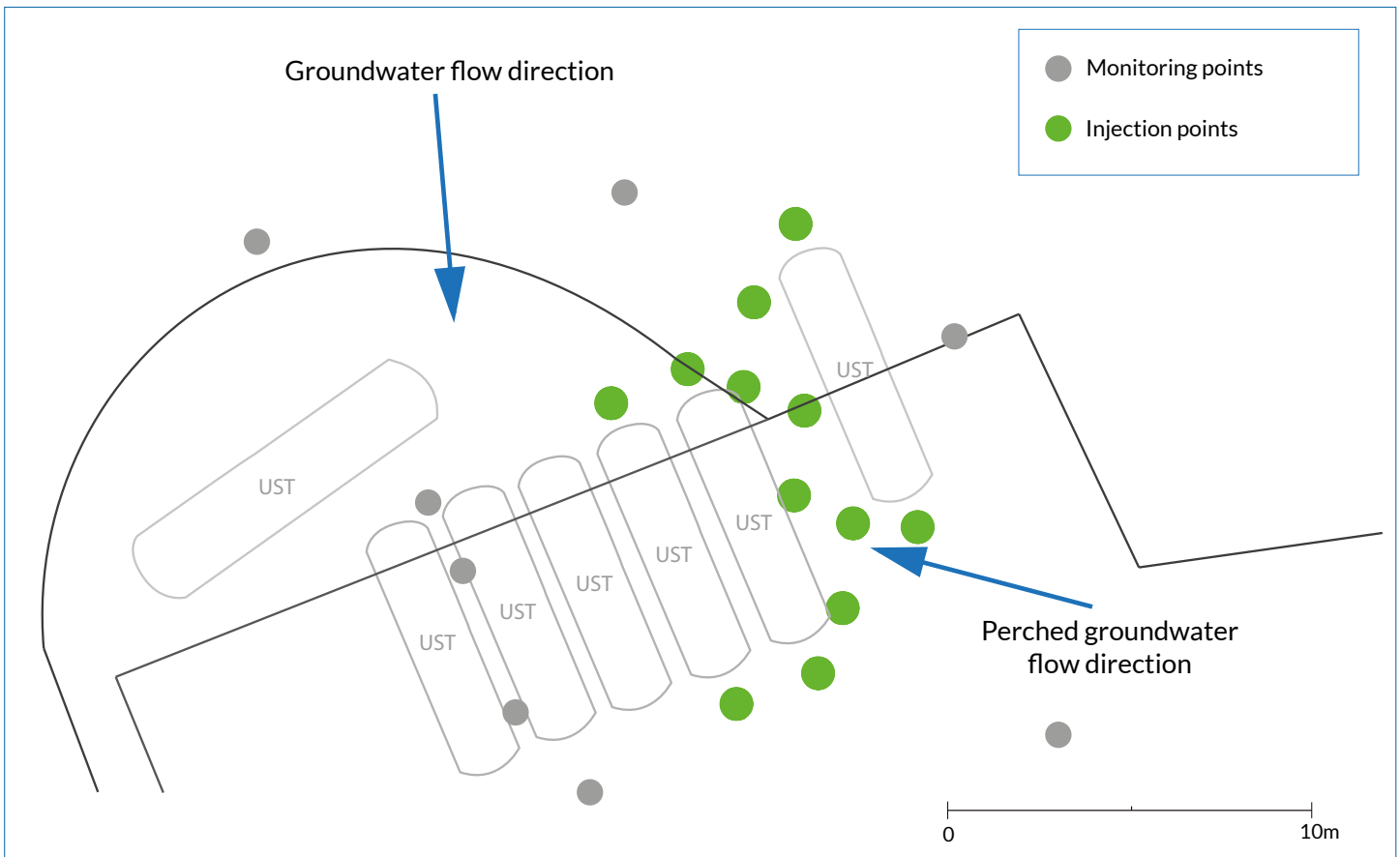


Fig 3. Treatment area with tank farm and monitoring wells

Once RegenOx had reduced the contaminant mass to levels amenable to **bioremediation**, a combined treatment of ORC-Advanced and PetroFix could then be applied.

ORC-Advanced expedites the reduction of the high BTEX recorded in the subsurface via **enhanced aerobic biodegradation**. ORC-Advanced provides a controlled release of oxygen for up to 12 months from a single injection, stimulating and maintaining the growth of aerobic biomass, which will accelerate the biological degradation of the target contamination.

Soon after, PetroFix was injected across the site to **rapidly adsorb and enhance the biodegradation** of the residual TPH and BTEX to accelerate the closeout of the site. PetroFix comprises 1-2µm particles of activated carbon held in a colloidal suspension, which when injected, coats the subsurface with a thin layer of activated carbon.

At this particular site, the drainage runs and tank bedding were probably the conduits facilitating the transport of contamination. By coating these conduits with PetroFix the contamination can be rapidly sorbed – preventing further migration – after which it is biologically degraded.



TREATMENT

An initial application of RegenOx was applied into the bases of the remedial excavations. Once the excavations were backfilled and reinstated, injection wells were installed inside and around the UST farm. Subsequently RegenOx, ORC Advanced and PetroFix were applied spread over four injection campaigns.

REMEDIATION TIME LINE





Fig. 4 PetroFix, prior to being mixed and injected onsite

INJECTION GRID

3x3m

INJECTION POINTS

12

TREATMENT AREA

50m²

REMEDIATION COST

€ 33k

RESULTS

Monitoring was completed over a **12-month period**. During the first six months, groundwater contaminant concentrations were recorded as each of the remediation phases were completed. This enable RGS Nordic to adapt the remediation strategy as the groundwater conditions changed. Months 6 to 12 represent the validation and verification phases. These results show a **>99% reduction** in contaminant concentrations within the source area (See figure 7) with a reduction in dissolved phase contaminant mass of **98%** across the entire treatment area (See figures 5 and 6).

Fig. 5 Total contaminant concentrations (11 monitoring wells)

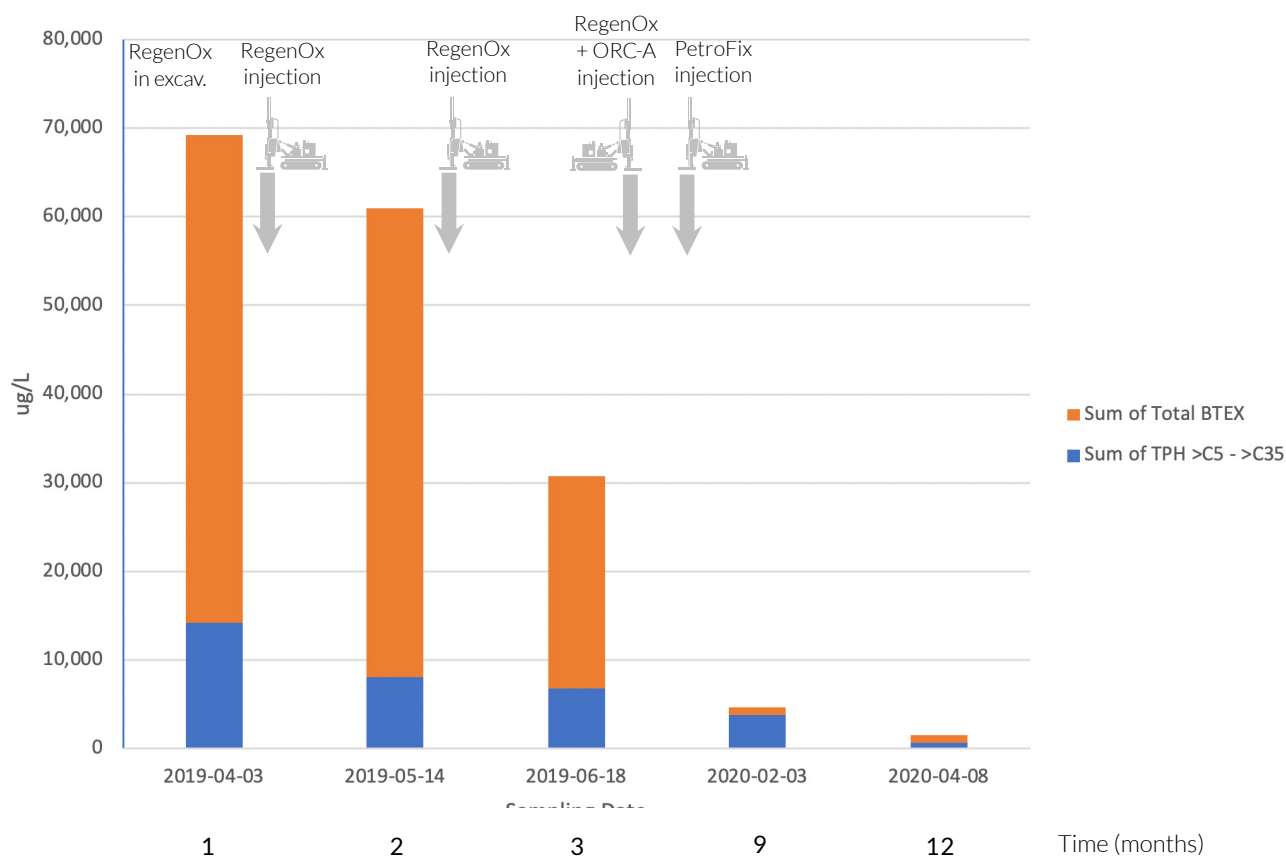


Fig. 6 Average contaminant concentrations across the site

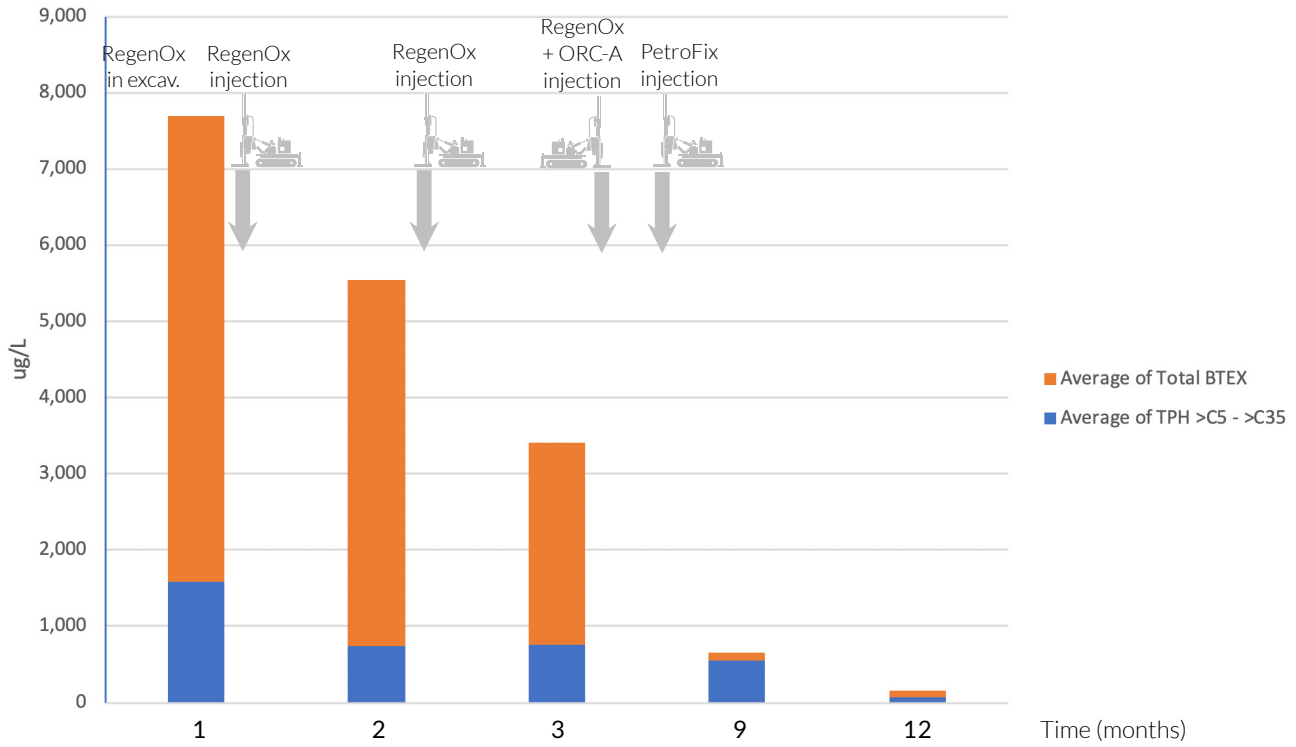
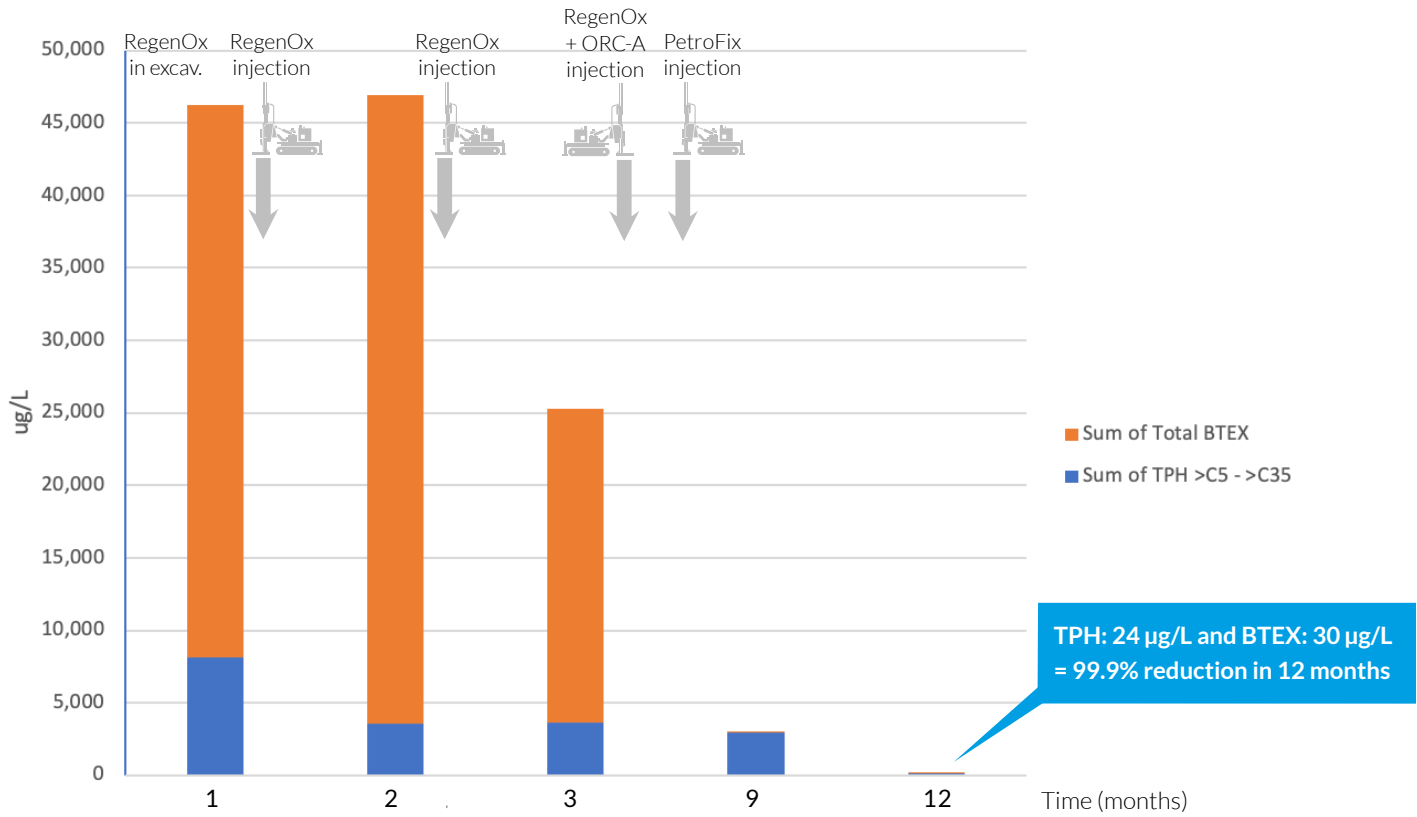


Fig. 7 Source Area Concentrations





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We are very pleased with the PetroFix product. Easy to work with and the results are incredible. It helped us reach the target for the site and with good margin.

”

Erika Geisler
 Head of projects, West & South
 RGS Nordic

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CONCLUSION

- By combining physical, chemical and biological remediation techniques, RGS Nordic was able to reduce gasoline range petroleum hydrocarbon concentrations in the groundwater by **>98%**.
- Utilising an **integrated remediation treatment** strategy ensured that optimum treatment efficiency was maintained throughout the phases of works.
- The amount of **excavation and offsite disposal was minimised**.
- All underground **infrastructure remained in situ**.
- All works were completed at an active petrol filling station with **minimal disruption** to the commercial operations of the facility.



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