

Closure Achieved at Formerly Used Defense Site

**PetroFix Application Reaches
No Further Action for UST Release Case**



Summary

An underground storage tank release (UST) case at Former Naval Auxiliary Air Station - Manteo had remained open since 2007. In 2020, PetroFix® was applied to residual 'hotspot' areas onsite where benzene, isopropylbenzene, and total petroleum hydrocarbon (TPH) concentrations remained above the stringent North Carolina Department of Environmental Quality (NCDEQ) Groundwater Quality Standards (GWQS). These contaminants were quickly reduced following PetroFix treatment.

- ✓ Following a limited extension of the treatment area and subsequent monitoring, the NCDEQ granted the site a **No Further Action** status.

Background

Years of Monitoring Show a More Aggressive Approach is Needed for Site Closure

Site History:

The Dare County Regional Airport was originally established as a Naval Auxiliary Air Station and was officially commissioned on March 3, 1943. The U.S. Navy utilized the site as an auxiliary training field and fuel storage complex during World War II. In 1947, following the war, Dare County asked for the return of the airfield. Since then, the facility has been operated by a Fix Base Operator and later by the Dare County Airport Authority, which took over the airport in 1983 and now oversees the airport's daily operations.

The site is a former Naval Auxiliary Air Station (NAAS) now operated by the Dare County Regional Airport, located in the Outer Banks region of North Carolina. In 2007, a fuel leak was discovered, prompting the removal of six USTs, 455 tons of petroleum hydrocarbon (PHC) impacted soil, and 300 tons of sludge. Soil confirmation sampling completed as part of this effort revealed PHC impacts below the USTs and piping.

A Comprehensive Site Assessment (CSA) was performed in February of 2009 to delineate the extent of PHC contamination. In March of 2011, the responsible party removed an additional 1,366 tons of contaminated soil from the site. Following the excavation, PHCs were detected above North Carolina's GWQS in site monitoring wells, including benzene, isopropylbenzene, and total petroleum hydrocarbons (TPH-C5-C8 aliphatic compounds).



Timeline

- **1943**
Naval Auxiliary Air Station, Manteo, was officially commissioned on March 3, 1943.
- **1947**
Following World War II, Dare County asked for the return of the airfield.
- **1983**
The Dare County Airport Authority took over the airport and continues to oversee its daily operations.
- **2008**
A release was identified. In response, six fuel USTs were removed, along with 455 tons of PHC impacted soil.
- **2009**
A CSA was performed to delineate the extent of the hydrocarbon-impacted soils.
- **2011**
An additional 1,366 tons of PHC- impacted soil was removed from the site. Following source removal, the site was monitored.
- **2011-2019**
Monitoring Period - after initial contaminant reductions over several years, monitoring results no longer show a declining trend.
- **2019**
Elevated concentrations persist in four monitoring wells. The project team decides a more aggressive strategy is needed for site closure and opts to conduct a PetroFix injection.
- **2020**
Approximately 23,300 gallons of PetroFix Remedial Fluid was injected into two residual PHC plume areas encompassing more than 3,000 square feet, utilizing 68 injection points.
- **2021**
Further characterization efforts lead to a small-scale expansion (approximately 100 square feet) of the PetroFix treatment area which occurred over Summer 2021. Contaminants in the expanded area are reduced below NCGWQS. Contaminants in previously treated footprint remain below NCGWQS for four consecutive quarterly sampling events.
- **2023**
Following groundwater monitoring demonstrating all treated areas meet NCGWQS, NCDEQ grants a No Further Action status for the site

The goal for this site was to achieve closure (i.e., no further action [NFA] status) as cost-effectively as possible. This required reducing contaminant concentrations below the applicable GWQS for four consecutive sampling events.

Like many other petroleum release sites, this site was monitored for a number of years following removal of the UST system. Concentrations initially declined following this effort. Over time, however, contaminant concentrations exhibited a fluctuating pattern indicative of asymptotic behavior. This condition led the project team to conclude that a more aggressive remedial approach was needed to achieve site closure.

After a thorough evaluation of viable remedies, the project team opted for an *in situ* injection of PetroFix® Remediation Fluid to remediate the contaminants associated with the residual source area (i.e., UST system) through a combination of sorption and biological reduction by adding electron acceptors. This sorption-enhanced biostimulation approach was evaluated as the most viable, cost-effective means to reach the GWQS targets and achieve site closure in a reasonable timeframe.





Treatment

PetroFix Applied at Two PHC-Impacted Plume Areas

Treatment Area 1	
Treatment Surface Area	625 sq. ft.
Injection Points	17
Treatment Interval	3-12.5 ft. bgs.
Soil Type	Coarse/Fine Mix
PetroFix Applied	1,200 lbs
Total Volume (Diluted)	4,913 gal

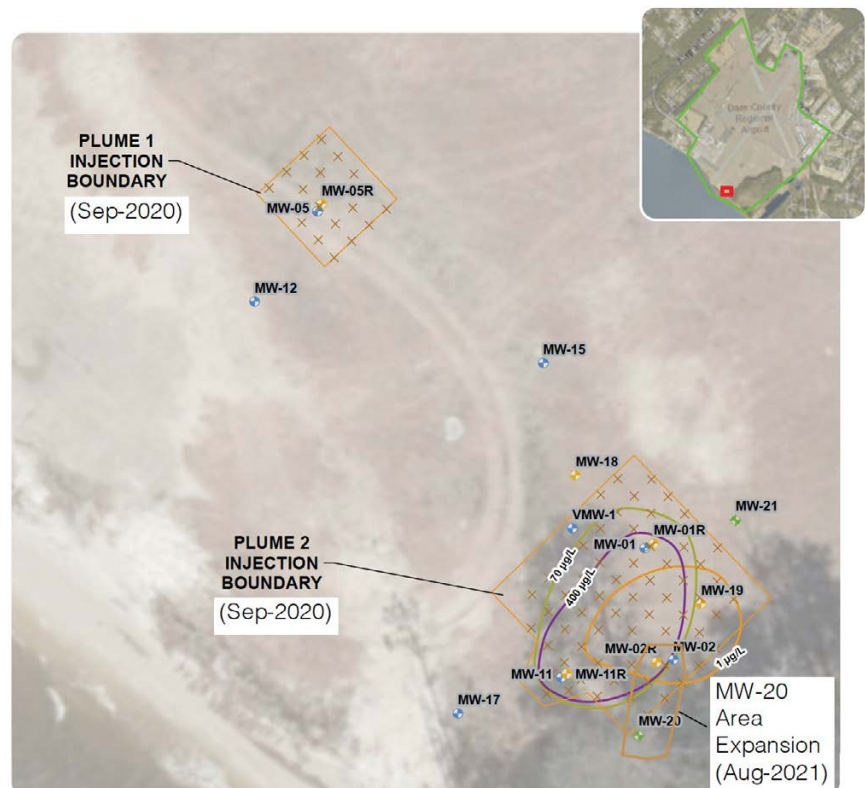
Treatment Area 2	
Treatment Surface Area	2,500 sq. ft.
Injection Points	69
Treatment Interval	3-12.5 ft. bgs.
Soil Type	Coarse/Fine Mix
PetroFix Applied	3,600 lbs
Total Volume (Diluted)	18,424 gal

In September 2020, approximately 23,300 gallons of PetroFix/water mixture were applied through 68 direct push injection points. The injection points were arrayed in a grid pattern encompassing two site areas totaling more than 3,100 square feet. The vertical injection interval was 3 to 12.5 feet below ground surface, spanning the contaminated section of the shallow aquifer.

In August 2021, the PetroFix treatment area was expanded slightly, including six injection points near MW-20, totaling an additional 400 pounds of PetroFix applied (740 gallons diluted volume).

Legend

- ✕ Proposed Temporary Injection Points
- Boundary of Injections
- ⊕ Proposed Monitoring Wells
- ⊕ Monitoring Wells (Installed 2019)
- ⊕ Monitoring Wells (Installed Pre-2019)
- ⊕ Benzene, September 2019
- ⊕ Isopropylbenzene, September 2019
- ⊕ C5-C8 Aliphatics, September 2019



Using REGENESIS' detailed documentation to apply PetroFix, the field personnel oversaw equipment needed for the injection was obtained, such as multi-port injection tooling and flow and pressure meters, and observation soil cores were taken pre-and post-injection on the first day of fieldwork to document PetroFix distribution at the site.

Based on the visual confirmation of PetroFix in soil cores and monitoring wells, the field crew was able to assess PetroFix distribution and adjust injection tooling, injection volumes, and injection pressures to optimize distribution throughout the treatment areas.



Pre-injection soil core:
(3-12 ft. bgs.)



Post-injection soil core:
shows PetroFix distribution within the
target treatment interval



Results

Site Meets Stringent North Carolina GWQS, Achieving No Further Action

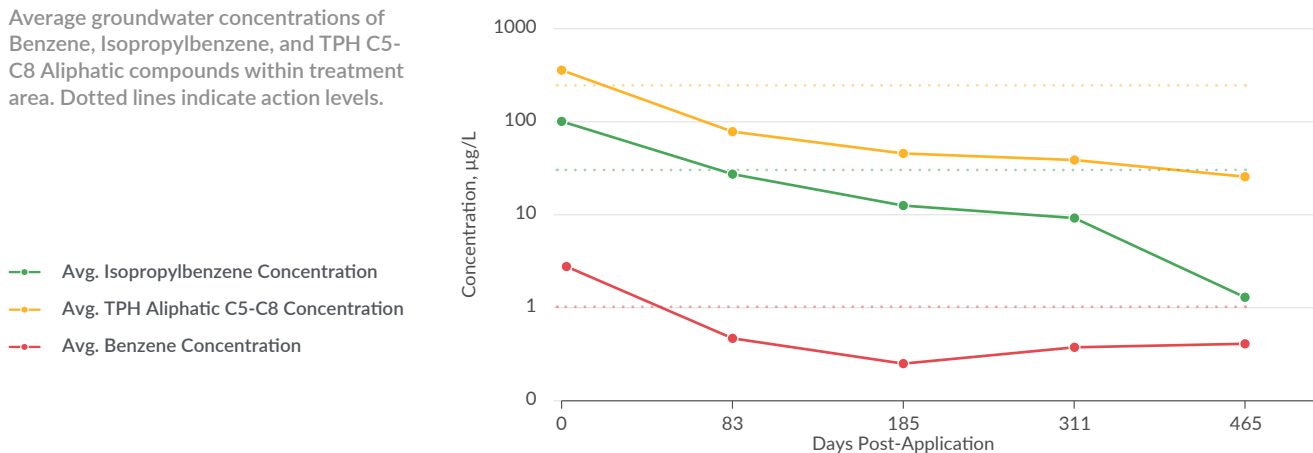
Following the remedial application, benzene, isopropylbenzene, and TPH (C5-C8 aliphatic compounds) were reduced to below the GWQS in the five monitoring wells, including one part per billion (ppb) for benzene. All have remained below these levels for four consecutive quarters, spanning 15 months. Total reductions of these compounds range from 73 to 97 percent in the five impacted wells.

During the monitoring period, additional characterization was completed which identified isopropylbenzene and TPH (C5-C8 Aliphatic) concentrations slightly exceeding the NCGWQS in a monitoring well, MW-20, just outside of the initial treatment area. In response, the treatment area was expanded to cover an additional approximate 100 square feet encompassing MW-2R and expanding to MW-20. Following this application, groundwater samples collected over four consecutive quarters demonstrated that no contaminants of concern remained above North Carolina's GWQS. This led NCDEQ to grant the site No Further Action in the Summer of 2023.

Figure 1

Average Groundwater Contaminant Concentrations

Average groundwater concentrations of Benzene, Isopropylbenzene, and TPH C5-C8 Aliphatic compounds within treatment area. Dotted lines indicate action levels.



Conclusion

Following soil excavation to remove high concentrations of contaminants at UST release sites, residual PHC contaminants can prevent meeting cleanup objectives in a reasonable timeframe without further remediation. When lower cleanup targets are applied, it is even more challenging. After almost 10 years of groundwater monitoring following soil removal, the cleanup goals were not likely to be met for many more years at NAAS-Manteo.

The PetroFix application reached the site closure objectives soon after application in prescribed the treatment areas and maintained these results for a sufficient period to earn an NFA ruling from the NCDEQ. As a result, PetroFix proves to be a practical, low-cost *in situ* remediation solution to achieve stringent closure objectives for many similar PHC-impacted sites.

Technology

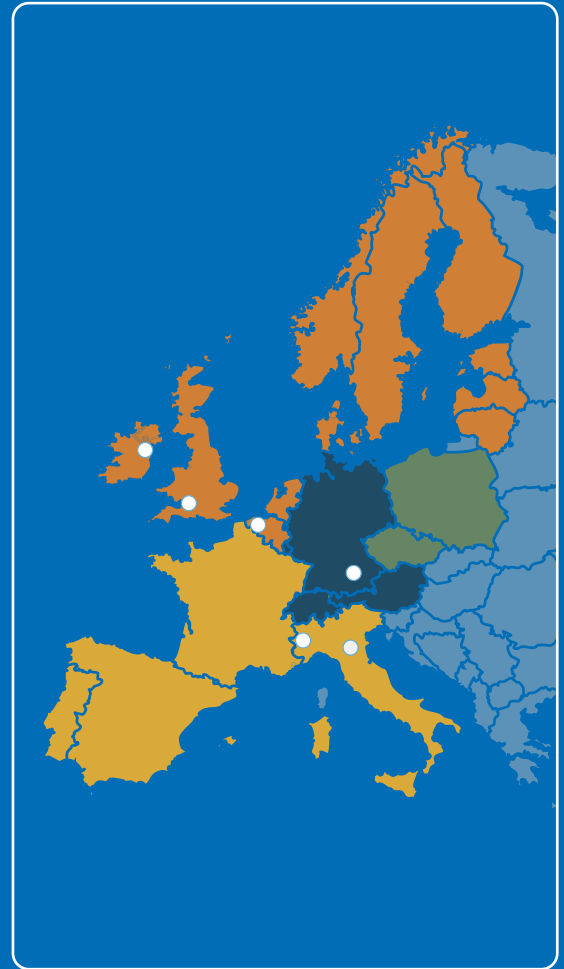
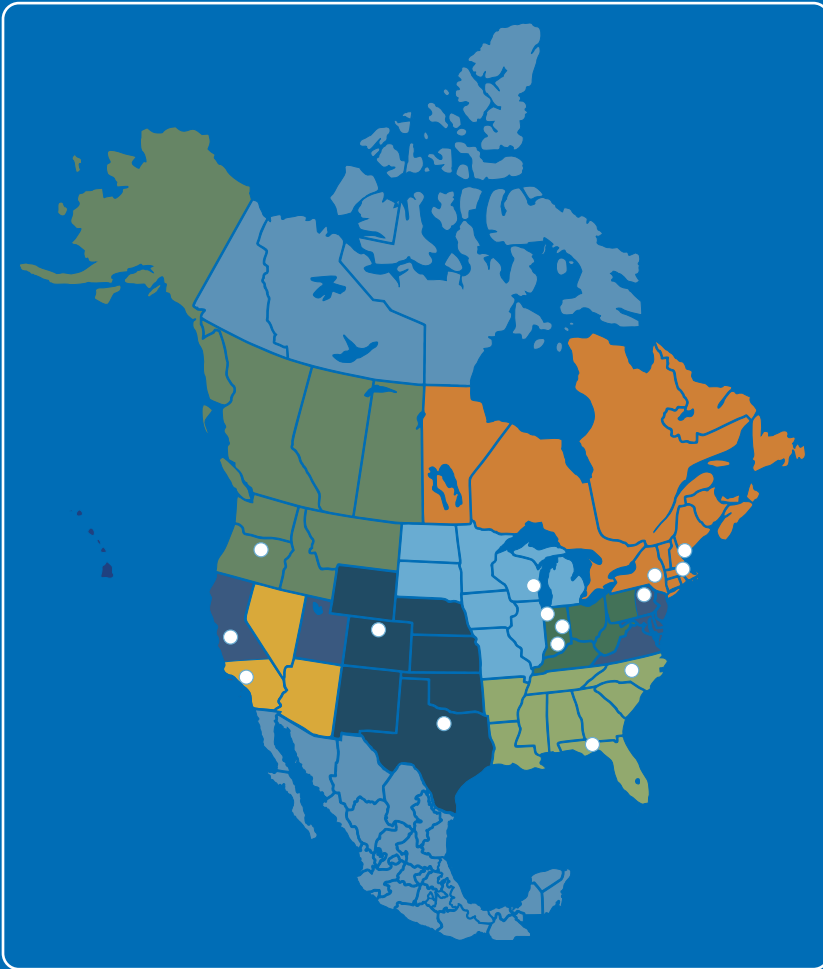
PetroFix Remediation Fluid



PetroFix Remediation Fluid is a concentrated, water-based, activated carbon suspension specifically designed to treat PHC plumes stemming from bulk storage, gas station, and UST spills. Safe, fast, effective, and easy-to-apply, PetroFix is designed to specifically sorb and biodegrade petroleum hydrocarbons (PHC), diesel, BTEX, MTBE, and TPH. Composed of a mix of micron-scale activated carbon and electron acceptors to promote biodegradation, PetroFix offers an *in situ* approach designed specifically for sites where PHC levels are above regulatory standards for complete remediation at the lowest total cost-to-closure. PetroFix can also be applied to excavation sites.



We're Ready to Help You Find the Right Solution for Your Site



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