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PlumeStop Successfully Remediates PFAS at Alaska Airport

Case Study: Complete Removal of Five Targeted PFAS Contaminants Approaches Two Years

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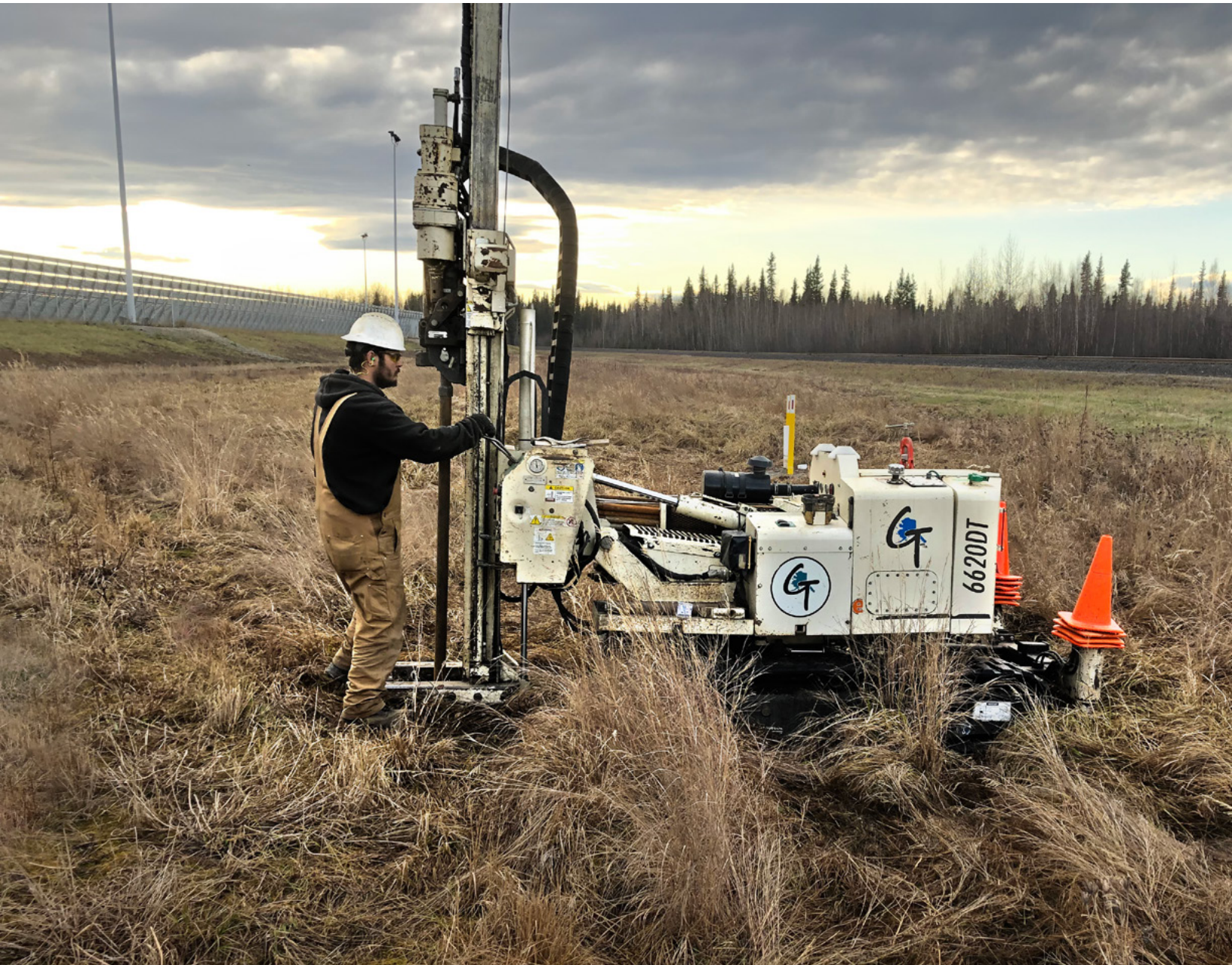
Targeted PFAS Contaminants Remediated to Below Detection Limits

PLUME STOP® Liquid Activated Carbon

PlumeStop® Colloidal Activated Carbon was applied to treat PFAS (i.e., per- and polyfluoroalkyl substances) resulting from aqueous film-forming foam (AFFF) usage at an airport facility in Alaska. The application has reduced the five targeted PFAS below detection limits and applicable cleanup levels in a challenging hydrogeologic environment over a sampling period now approaching two years. As monitoring continues, PlumeStop has already proven its effectiveness at removing PFAS from groundwater at AFFF source zones to stop further plume migration and protect downstream receptors.



Background

PFAS Affects Private Wells Near Airport Facility, Prompting a Remedial Response

Approximate location of Fairbanks, Alaska

AFFF releases from firefighting activities are a potential source of PFAS contamination in groundwater at airports worldwide. In many cases, "forever chemicals" migrate away from areas where AFFF was originally discharged to impact potable water wells, public water sources, and other downstream receptors.

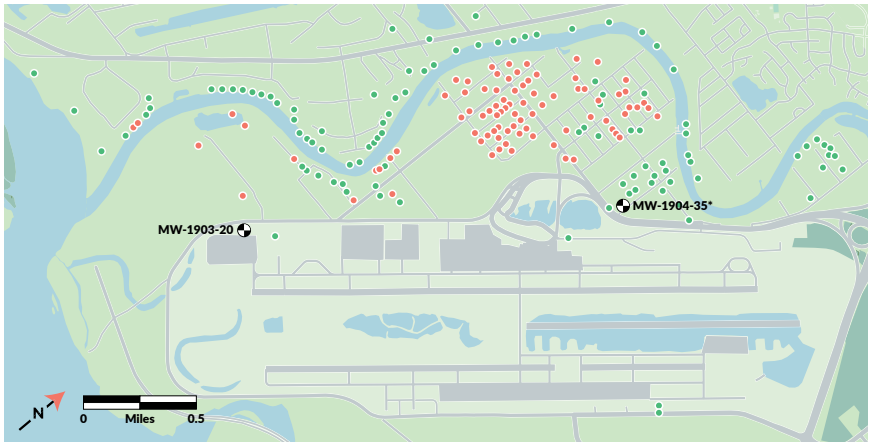
Fairbanks International Airport (FAI) sits in the heart of Alaska, just below the Arctic circle. In 2017, FAI began an investigation in collaboration with the Alaska Department of Environmental Conservation and the Fairbanks office of Shannon & Wilson, a leading Pacific Northwest-based environmental consulting firm, to investigate the extent of PFAS migration from the site. Onsite monitoring wells were sampled for PFAS, and a few of the wells had PFAS chemicals detected. Since the groundwater was known to move towards properties with private wells, FAI worked quickly with Shannon & Wilson to identify nearby private wells and sample them.

The sample results revealed several private wells at properties nearby the airport with combined PFOS and PFOA concentrations above a screening level of 65 nanograms per liter. In response, these "affected" properties were connected to municipal water.

Shannon & Wilson then engaged REGENESIS for a pilot test plan to remediate one of the identified AFFF release areas, following successful treatments demonstrated at other sites.

Key:

- **Maximum** Combined PFOS/PFOA Concentrations Below HAL (<65 ppt)
- **Over** 65 ppt



Map highlights private well locations showing PFAS groundwater concentrations relative to PFOS+PFOA screening levels. The red properties are considered affected properties and have since been connected to a municipal water line.

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About PlumeStop

PlumeStop is injected into the subsurface and acts as an *in situ* filter that removes organic contaminants from groundwater. When PlumeStop is applied to an AFFF release area, such as encountered at FAI, or other PFAS source zones, much of the contaminant mass responsible for sustaining the downgradient PFAS plume is quickly removed and tightly bound to the aquifer matrix via chemical sorption. With the contaminant source immobilized, no further plume development can occur, resulting in the PFAS exposure risk to potential downstream receptors being substantially reduced.

PlumeStop Pilot Test

Overcoming challenging environmental conditions for a successful PFAS source zone treatment

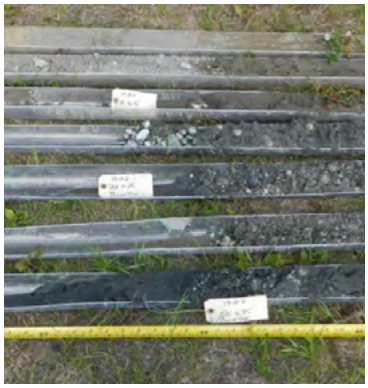
Objective and Approach

The purpose of the pilot study was to evaluate PlumeStop's effectiveness in mitigating the transport of PFAS in groundwater, particularly in the highly transmissive Fairbanks aquifer. If successful, the *in situ* remedy could then be applied to prevent PFAS from migrating to nearby private properties.

The FAI pilot test was designed for PlumeStop to remediate five specific PFAS—PFOS, PFOA, PFHpA, PFHxS, and PFNA—within a known AFFF release area. Hydraulic percussion-driven (i.e., direct push) injection points were arranged in a grid encompassing the pilot test demonstration monitoring well—MW-1903-20. The application was designed to account for water table gradient fluctuations and reversals due to the test area's position between two rivers running along the facility.

The initial pilot test demonstration was to be conducted over a one-year monitoring period following the application.

Design Verification Testing



Soil cores collected as part of DVT show coarse grain size materials in the pilot test treatment zone

As part of the pilot test and before the PlumeStop injection event, Shannon & Wilson collected treatment-zone-specific information as part of Design Verification Testing (DVT), a REGENESIS process established to confirm critical design parameters that inform product placement dosing. Information collected as part of the DVT included:

- Collection of soil cores and detailed logging of the soil grain size, sequence stratigraphy patterns (e.g., coarsening upward or downward), and degree of saturation, along with laboratory grain size analysis.
- Collection of baseline samples for comparison to post-application samples to evaluate the dose-response and effective PFAS removal rates.
- Installation of a passive flux meter (PFM) for determining the groundwater Darcy velocity and PFAS mass flux through the well screen.

Regional conductivity and hydraulic gradient information were used to calculate groundwater velocity prior to DVT. However, the PFM data indicated a higher groundwater velocity in the coarse sand and gravel soils local to the injection area and as a result, higher PFAS mass flux than the regional information suggested. In response, the PlumeStop dose, injection points and applied fluid volume were increased relative to the initial pre-DVT design.

Temporary monitoring wells are installed and monitored for PlumeStop distribution in the treatment zone.

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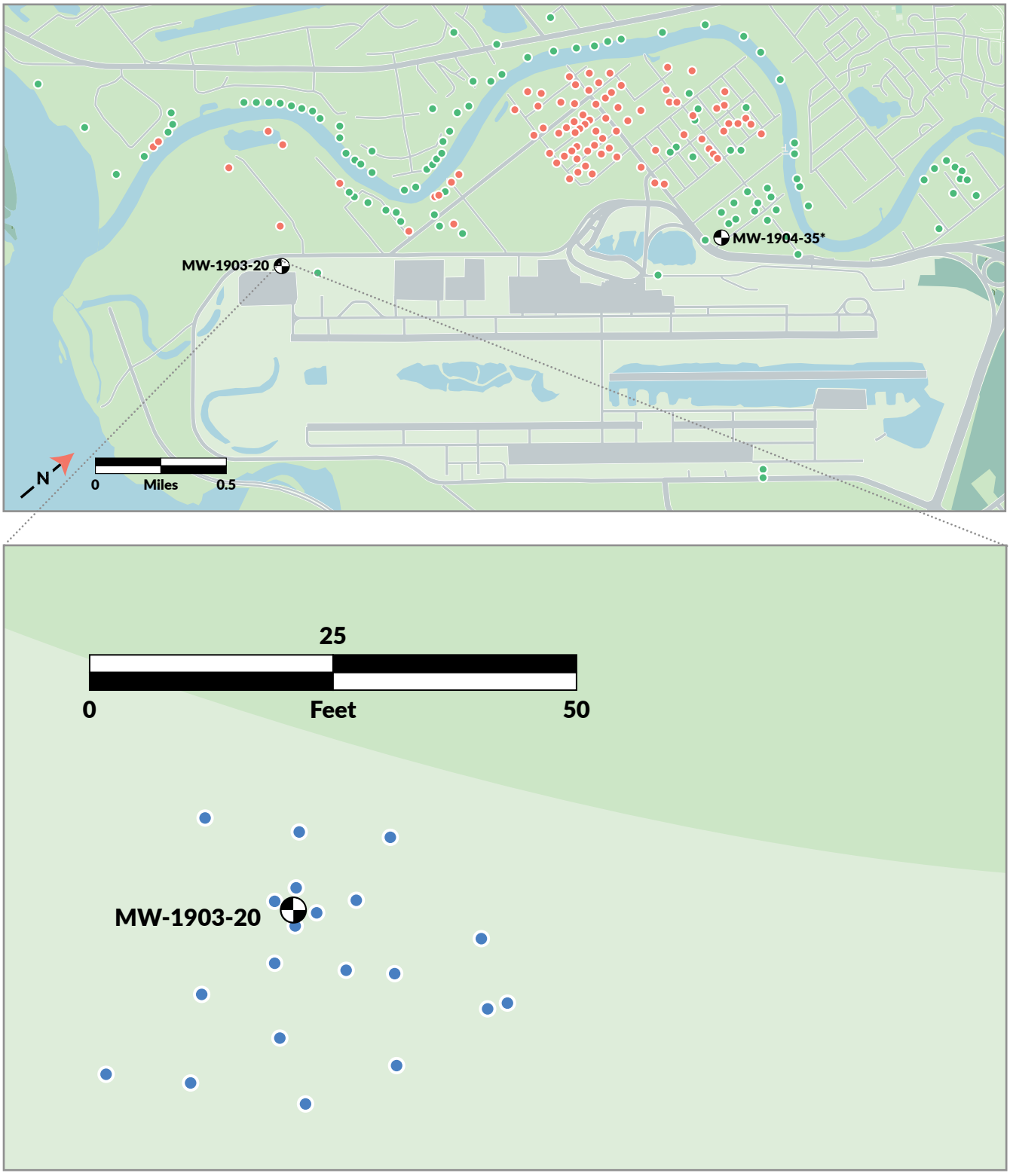
Application Summary

Amendments:	PlumeStop
Injection Points:	20
Injection Volume:	8,500 gal

Field Application

The PlumeStop injection was completed in the late Fall of 2019. Approximately 8,500 gallons of PlumeStop were injected into 20 points. The early onset of cold weather in the Fairbanks region provided initial challenges to the injection. These challenges were overcome by the experienced field crew as they modified the injection system and used engineering controls to prevent freezing, successfully completing the application in the near-Arctic climate.

Field application confronts late Fall weather in Fairbanks.



Area map depicts PlumeStop pilot test area and detailed view of injection points

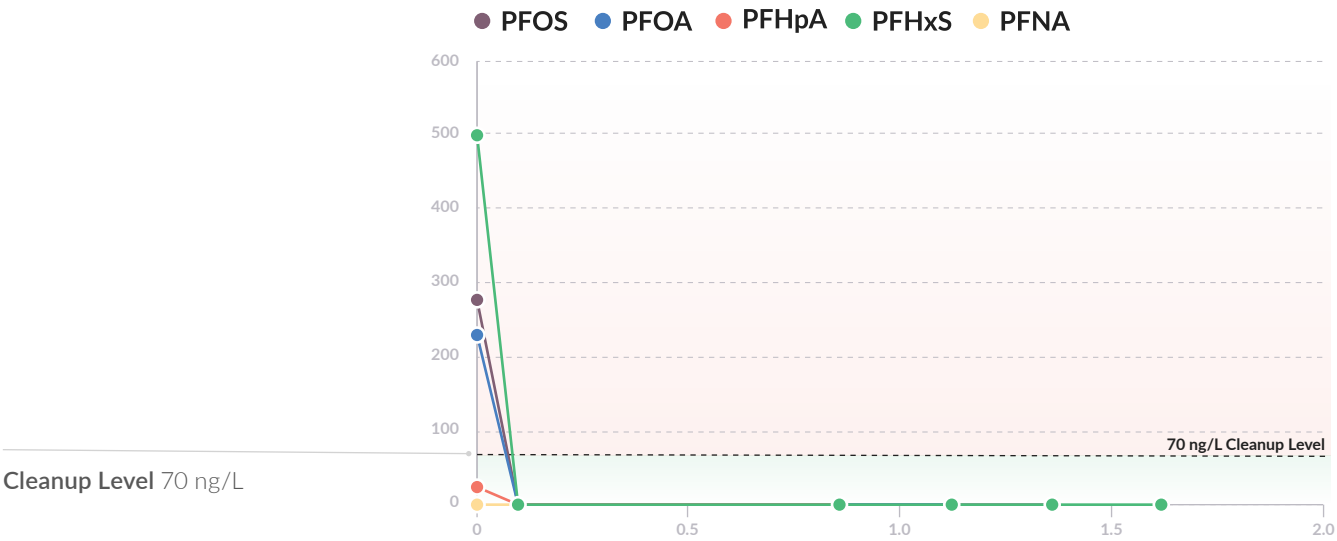
Results

The PlumeStop application has completely remediated the five individual PFAS targeted, reducing concentrations from 1,200 ng/L to non-detect

The pilot test injection was successfully completed following the in-field equipment and design modifications. The distribution of PlumeStop was confirmed by installing temporary wells to document PlumeStop's lateral placement in the liquid phase. In addition, soil cores were collected to observe PlumeStop deposition relative to the targeted vertical interval. These activities informed the injection rates and sequencing needed to ensure complete distribution in the treatment zone.

The performance monitoring period began following the application. Post-application groundwater samples were collected from D-MW1903-20 during four events, beginning at one month through almost 20 months post-application.

Observed PFAS Compounds in D-MW1903-20
Concentrations shown in ng/L



Five targeted PFAS compounds are completely reduced, with reductions maintained in the pilot test monitoring well (PFNA was non-detect at baseline).

"In June of 2021 (19 months post application), we found that the five compounds that this product was designed for, were fully sequestered."

Kristen Freiburger
Associate
SHANNON & WILSON

Laboratory analytical results from the application demonstrate complete removal of the five targeted PFAS compounds from a combined starting concentration of 1,200 ng/L. PFAS were eliminated from groundwater by the first sampling event (34 days) and remain below detection limits—and far below 70 ng/L, which was the EPA's Health Advisory Level at the time —through and beyond the initial pilot test performance period. Only PFOS was detected below the laboratory reporting limit in the first two sampling events. The pilot test has achieved its designed goal. Based on these results, the performance monitoring period has been extended and will continue to evaluate PlumeStop's effectiveness at PFAS removal over the longer term.

The results achieved thus far prove PlumeStop's effectiveness at treating AFFF source zones, even in highly conductive aquifer materials observed at FAI. This pilot test adds to a growing number of PFAS sites successfully treated with PlumeStop to below applicable regulatory standards.

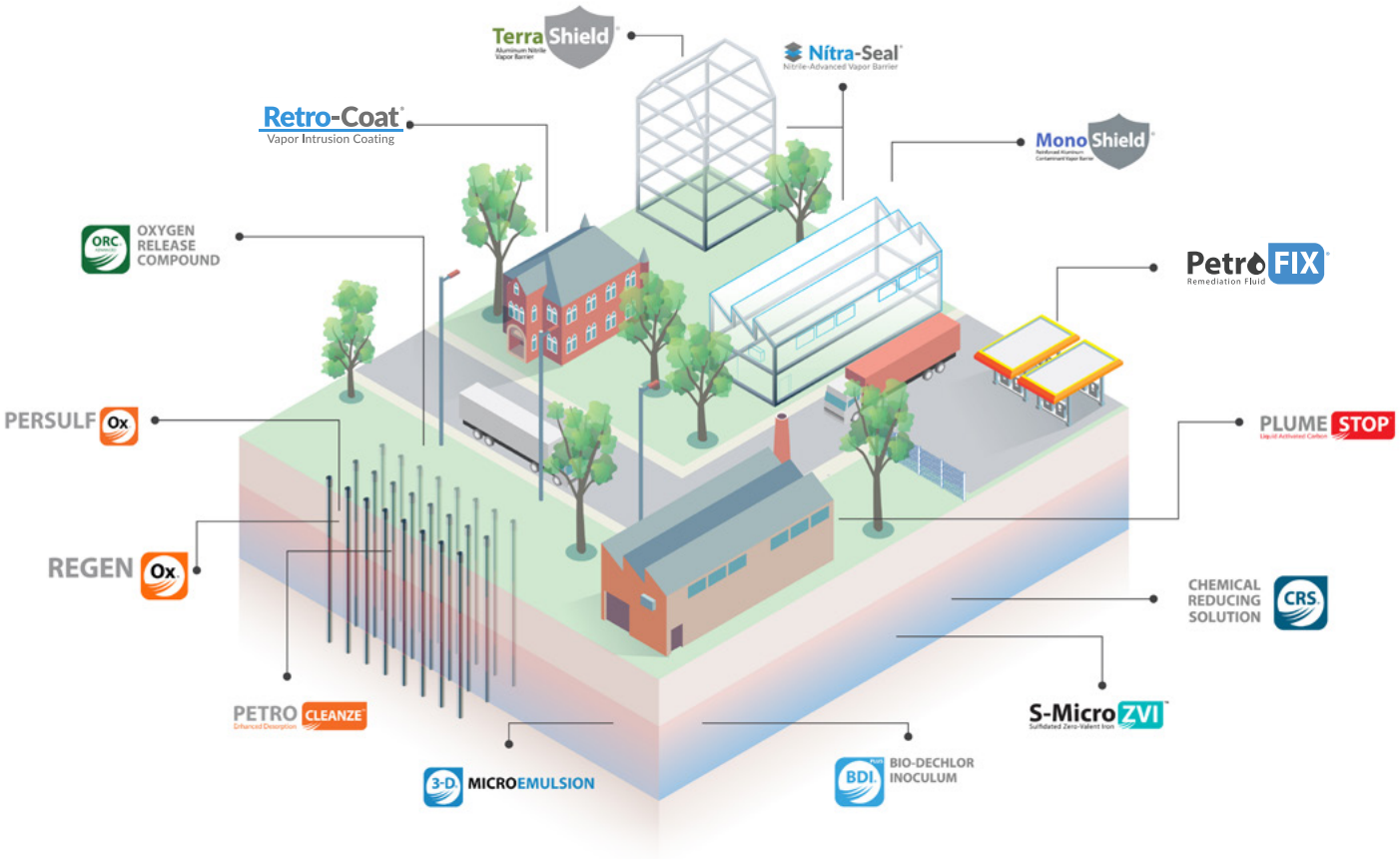
About The Consultant
Shannon & Wilson

Shannon & Wilson is an employee-owned consulting firm headquartered in Seattle, Washington. Committed to technical excellence and high-quality service, they provide integrated geotechnical engineering, engineering geology, environmental, and natural resource services for clients worldwide. Since 1954, Shannon & Wilson has delivered comprehensive engineering and environmental solutions for the most challenging infrastructure planning, design, permitting, and construction conditions.

Shannon & Wilson is dedicated to improving our communities, preserving the environment, and utilizing the most innovative science practices in all our work.

About The Project Manager
Kristen Freiburger

Kristen Freiburger, Associate, led Shannon & Wilson in winning a 15-year contract with the State of Alaska to investigate, characterize, and remediate PFAS contamination near several Part 139 airports in Alaska. She and her team are currently assisting the State of Alaska with addressing legacy PFAS contamination originating from the international and rural airports in Anchorage, Fairbanks, Gustavus, Dillingham, King Salmon, Yakutat, Iliamna, Nome, Homer, Valdez, Cordova, and Bethel, Alaska. Kristen's team is also responsible for community outreach, including public meetings and communication with stakeholders, where necessary. Efforts at each airport have been adjusted to meet the unique needs of the site. Kristen is knowledgeable in federal and state compliance regulations, and has coordinated with local, state, and federal agencies on environmental issues, including high-profile written and oral communications on behalf of clients. She works with a variety of clients with different perspectives, resources, and regulatory requirements and understands the need to tailor each project site to meet the objectives of the site. Over the last 15 years she has played a central role in developing and implementing S&W's large-scale sampling programs of private wells near a former refinery and Part 139 airports.



About REGENESIS

At REGENESIS we value innovation, technology, expertise and people which together form the unique framework we operate in as an organization. We see innovation and technology as inseparably linked with one being born out of the other.

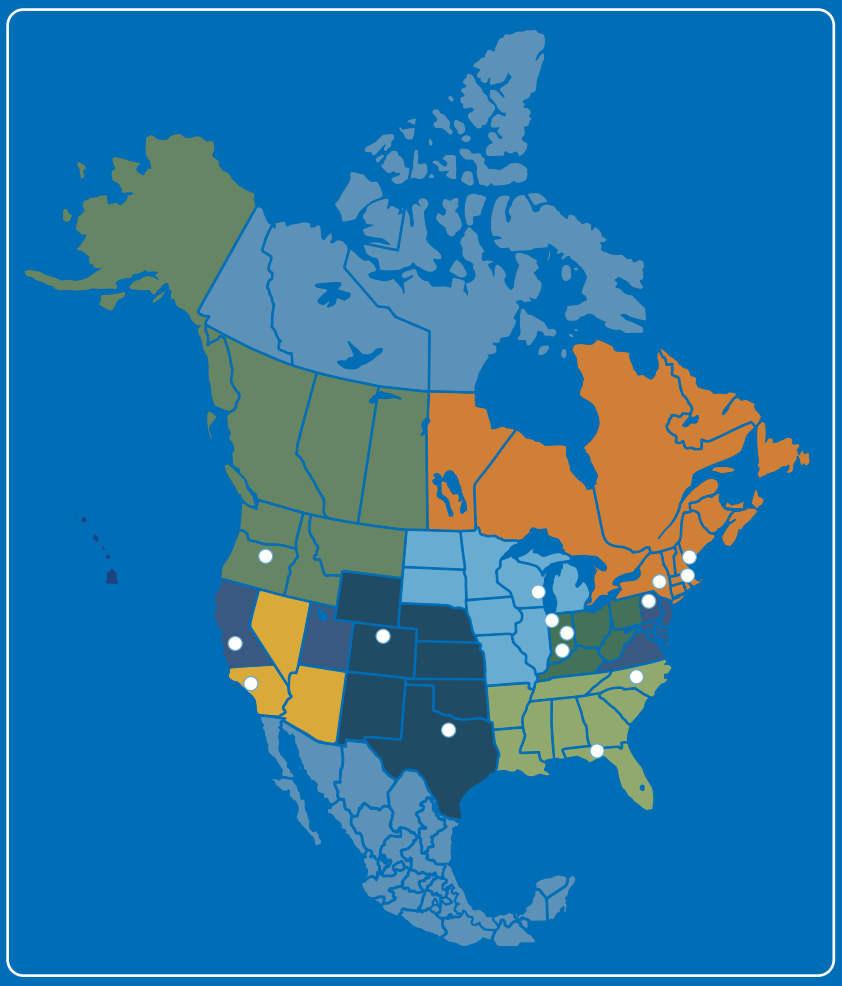
Inherently, innovation imparts new and better ways of thinking and doing. For us this means delivering expert environmental solutions in the form of the most advanced and effective technologies and services available today.

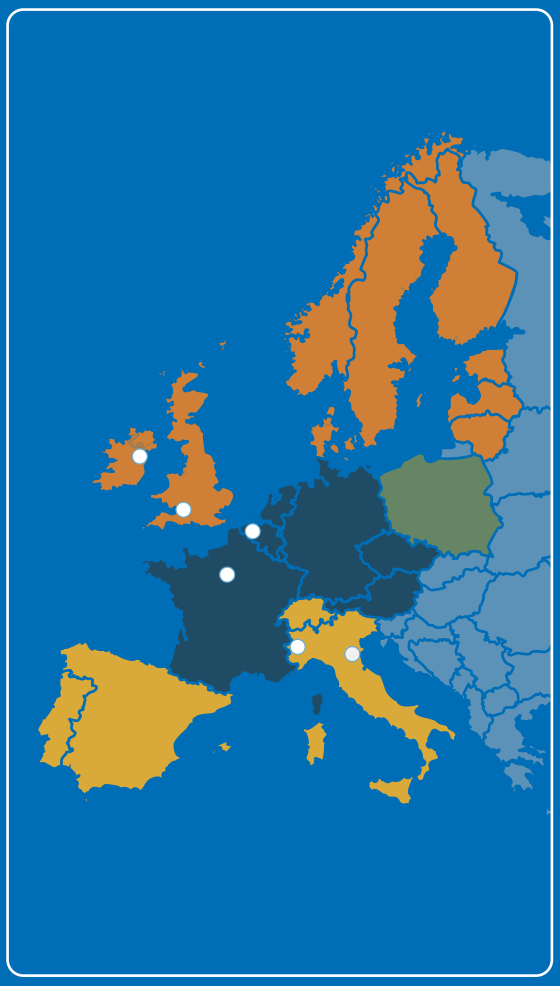
We value expertise, both our customers' and our own. We find that when our experienced staff collaborates directly with customers on complex problems there is a high potential for success including savings in time, resources and cost.

At REGENESIS we are driven by a strong sense of responsibility to the people charged with managing the complex environmental problems we encounter and to the people involved in developing and implementing our technology-based solutions. We are committed to investing in lasting relationships by taking time to understand the people we work with and their circumstances. We believe this is a key factor in achieving successful project outcomes.

We believe that by acting under this set of values, we can work with our customers to achieve a cleaner, healthier, and more prosperous world.

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





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