Multiparameter Sonde Used In Combined Remedy Approach and Saves $200,000 in Potential Costs

A former dry-cleaning site in the Pacific Northwest, Ultra Custom Care Cleaners, was found to be contaminated with PCE (perchloroethylene). According to the U.S. Geological Survey (USGS), PCE was widely used in the dry cleaning of fabrics since the 1940s. PCE is one of the most frequently detected VOCs (volatile organic carbons) in groundwater at a national scale (Moran 2004). PCE is highly mobile, dense, and largely immiscible in water, causing it to sink below the water table, and making cleanup extremely challenging.

Multiparameter sonde used in combined remedy approach at former dry cleaning site

In-Situ® Inc. multiparameter water quality sonde helps resolve treatment challenges and saves $200,000 in drilling, reagents, and consulting at site contaminated with PCE.

Site Summary:

The Ultra Custom Care Cleaners site was acquired by the City of Bothell as a part of the city's downtown redevelopment plan. As a part of the Toxics Cleanup Program, the Washington State Department of Ecology and the City entered into an agreement for the cleanup. Groundwater contamination above cleanup standards had migrated downgradient into City rights-of-way. The cleanup actions agreed upon, including a Remedial Investigation and Feasibility Study (RI/FS) and Cleanup Action Plan (CAP), were designed to protect human health and the environment from soil and groundwater exposure to PCE (Fact Sheet 2013 and TCP Site Cleanup).

Cleanup History:

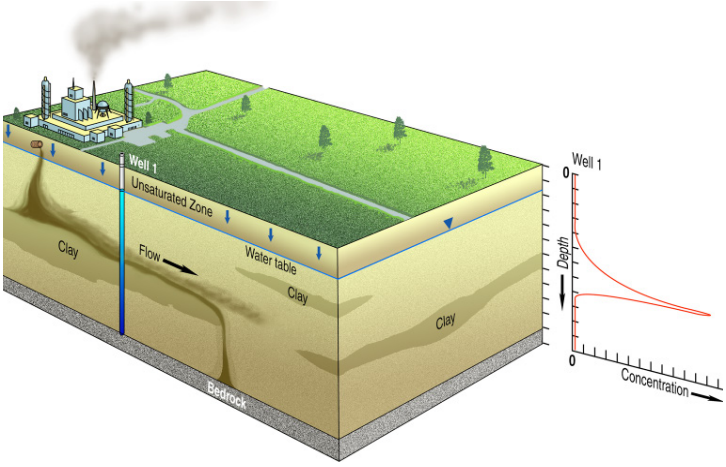
Characterization of the source area site geology indicated a surficial layer of clean, relatively homogenous, glacial outwash sand, which initially appeared favorable for in-situ chemical oxidation (ISCO), due to high permeability and low organic carbon. ISCO was attempted using a theoretically calculated injection design (i.e., not verified via real-time monitoring during treatment), but did not achieve significant removal of contaminants.

Design Approach:

A second cleanup effort was then designed, which included a combined remedy approach using in situ chemical reduction (ISCR) and enhanced bioremediation. Arnie Sugar of HWA GeoSciences Inc. led the restoration effort. HWA contracted Leo Lehmicke, Ph.D., to help design the cleanup, which included 'flipping' the aquifer chemistry to a reducing environment (by adding zero-valent iron), adding electron donor (emulsified vegetable oil), substrate (lactic acid), and chlorinated solvent-degrading bacteria. This approach was designed to address PCE and daughter products in the upper geologic unit at the site.

The design included real-time groundwater monitoring during initial treatment to establish injection spacings and volumes. During initial pilot/tracer testing, data from an In-Situ TROLL® 9500 Multiparameter Sonde was used to help develop the pore volume replacement and dilution factor necessary to achieve targeted distribution of injected materials.

A combination of Z-Loy™ (zero-valent iron), Newman Zone (emulsified vegetable oil and lactic acid), SiREM KB1 (microbial consortia), and reduced water was chosen for the source area. Several down gradient subsurface barriers were treated with Newman Zone, SiREM KB1 microbes, and reduced water.



Behavior of PCE in Subsurface. Source - USGS

Trace testing using the In-Situ TROLL 9500 Multiparameter Sonde and RuggedReader Handheld PC. Photo courtesy of HWA GeoSciences Inc.

Real-time monitoring during pilot/tracer testing to design injection parameters

In order to calculate injection volumes and spacing, two tracer tests were performed, in two geologically distinct areas:

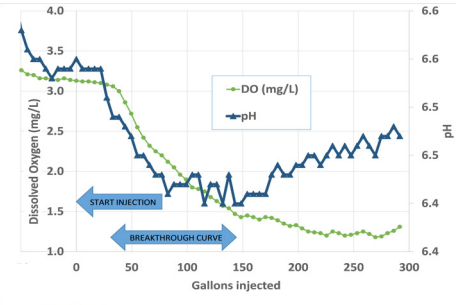
1. The source area, with homogenous, clean, glacial outwash sands.
2. A downgradient area, with alluvial, layered silts and sands.

Each test included injecting cleanup reagents into the ground, and monitoring the ground water in a nearby observation well for water level, pH, temperature, conductivity, dissolved oxygen, and oxidation-reduction potential (ORP) with a TROLL® 9500 Multiparameter Sonde.

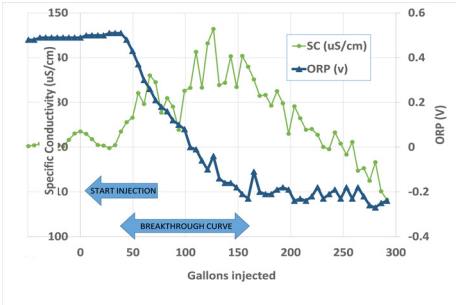
Changes in these parameters were then used to determine at what point (and injection volume) the front of injected material reached the observation well, and hence, the amount of injected fluid needed to fill/displace the pore volume of the desired treatment area.

- An increase in water level (groundwater mounding) indicates hydraulic influence prior to the arrival of the amendment front. Typically, water level is the first parameter to shift followed by ORP, temperature, and pH.
- A trend from positive to negative ORP indicates the arrival of the reduced water, and transition from an oxidizing to a reducing environment.
- Increasing conductivity indicates the arrival of the zero-valent iron and sodium lactate.
- Temperature and pH also change as the amendment reaches the observation well.

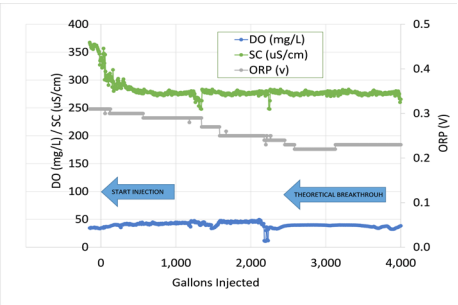
The downgradient test proceeded predictably, with classic breakthrough curves observed for most of the parameters monitored.



Classic Tracer Test Breakthrough Curves



Classic Tracer Test Breakthrough Curves (Cont.)



No Breakthrough – "Flat Line" plots, time for emergency CPR (Cleanup Program Redesign)

Real-time monitoring results

At the source area tracer test, no breakthrough was observed long after the theoretical volume of fluid needed to reach the observation well was injected. A direct push soil boring was then drilled two feet away from the injection well, and discrete water samples collected at depths of 10, 20 and 30 feet, to ascertain where the liquid was going. Measurement of groundwater field parameters in the direct push boring, using the same TROLL 9500 with a flow-through cell, indicated no breakthrough in the 10-foot depth sample, full breakthrough in the 20-foot sample, and partial breakthrough in the 30-foot sample, indicating that the injected liquid was moving downwards as well as outwards.

Based on these results, and the planned objective to include the upper part of the aquifer in the treatment zone, a field decision was made to inject at the source area into shallow direct push wells screened from 8 to 13 feet, instead of using the previously planned deeper-screened (8 to 23 feet) injection wells, to achieve a more uniform and better-targeted distribution of injected liquids into the desired treatment zone. Continued monitoring during full scale injection indicated the reagents had reached the target zones.

Summary:

When injecting anything into the ground, it is critical to know where it is going, how far, and in what direction. Using data from a TROLL 9500, HWA and Dr. Lehmicke were able to refine the understanding of the site geology to address cleanup objectives. Refined site characterization and real-time monitoring of the target formation during injection allowed for dynamic adjustments to the work strategy, reducing uncertainty by enhancing knowledge of the subsurface, and improving the ability to inject amendments at the proper location. This more targeted approach prevented improper location of the treatment area and amendment, saving the project upwards of $200,000 in drilling, reagents, and consulting costs.

To learn more about how In-Situ water quality instruments can be used to improve remediation project outcomes, accelerate site closures, and reduce total project costs, download the Remediation Brochure today.

References:

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HWA GeoSciences, Inc.: http://www.hwageo.com/
Leo Lehmicke, Ph.D.: http://www.co2andwater.com/

A new standard in water quality

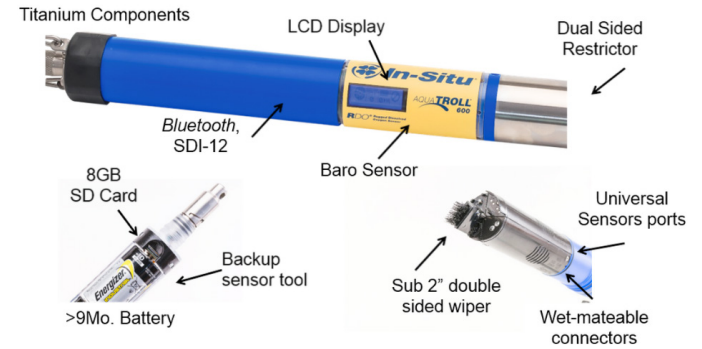
The Aqua TROLL® 600 Multiparameter Sonde with field access through the VuSitu™ Mobile App is the latest advancement in state-of-the-art water monitoring technology. With a 9+ month battery life, advanced antifouling systems, and drift-resistant smart sensors, this water quality sonde is suited for all applications – fresh water, saltwater, contaminated sites, long-term deployment, short-term testing, low-flow sampling, and everything in-between.

The Aqua TROLL 600 is the only multiparameter sonde to have a sub-2 inch passive and active antifouling system for *all* sensors, including conductivity.

- **One, easy-to-use probe** to determine radius-of-influence, detect breakthrough, and monitor pressure fronts in real-time throughout your injection tests. No need for multiple probes or to manage multiple sets of level and quality data.
- **Monitor all key sentinal parameters** and eliminate the need for added restrictors.
- **Wet-mateable connectors eliminate risks** due to flooding, and the associated potential for loss of data and repair costs.
- **Redesigned sensors reduce maintenance and calibration** requirements, cutting back on the amount of site visits needed during treatability studies and extended monitoring.
- **Enhance dynamic decision-making** by emailing data during injection to off-site stakeholders.

"At In-Situ, we believe that environmental monitoring is about having quality information at your fingertips to make the right decisions. With the Aqua TROLL 600 Multiparameter Water Quality Sonde, we challenged ourselves to make the most accurate, reliable, and easy to deploy instrument on the market. From the completely redesigned sensors to the custom titanium screws, every detail has been thought through and tested for maximum accuracy and minimum hassle."

–Ben Kimbell, VP of Research & Design



Watch the video and request your free trial by visiting our website!