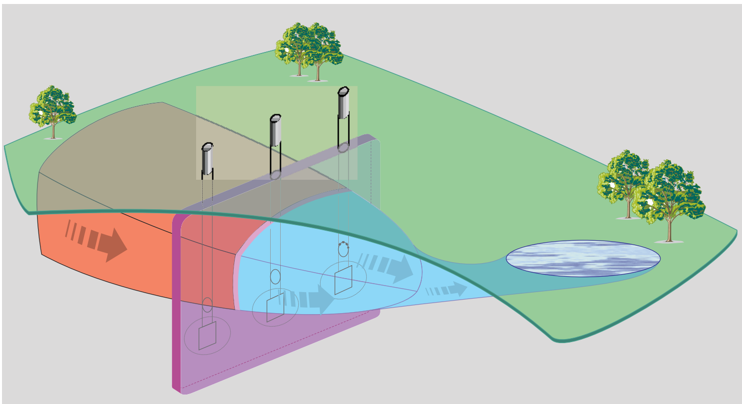
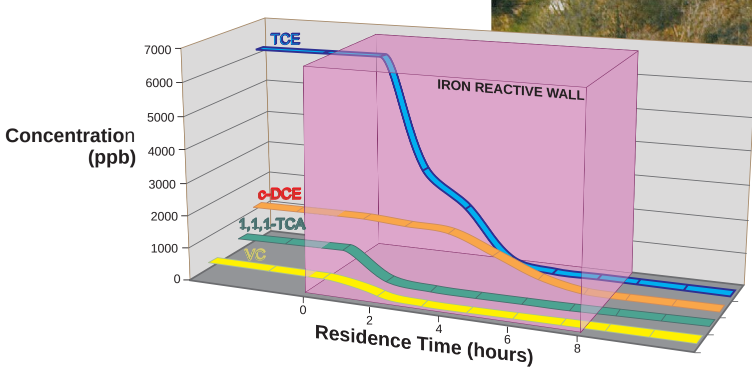
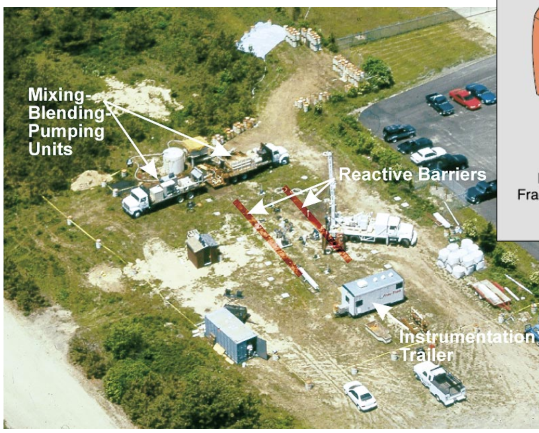
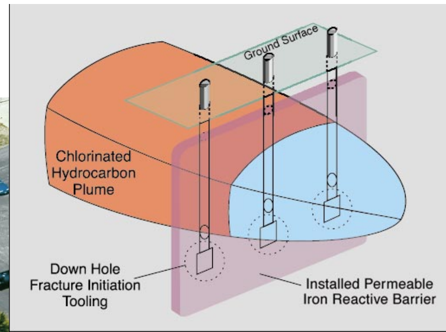
In Situ Permeable Reactive Barriers





GeoSierra





The in situ reactive barriers are constructed from a series of wells installed along the barrier alignment. A controlled vertical fracture is initiated in each well at the required azimuth orientation and depth. Iron filings are injected into the wells in a highly viscous cross linked proprietary HPG gel, to form a continuous permeable iron reactive barrier. The barrier's geometry is monitored in real time by the active resistivity method to ensure the barrier is constructed as designed.

In Situ Permeable Barriers

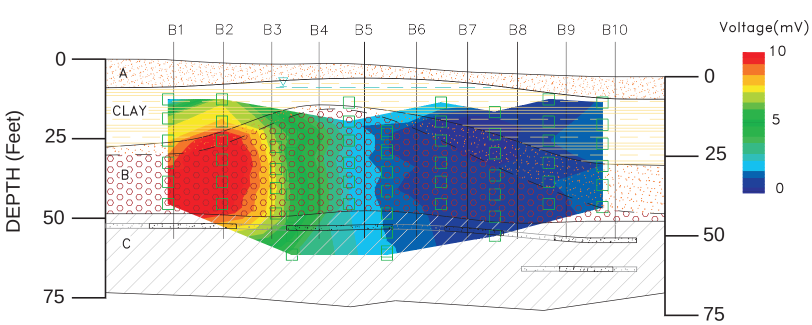
In situ reactive barriers, i.e. treatment walls, are replacing pump and treat remedies for contaminated groundwater with cost savings greater than 75%. Iron reactive permeable barriers remediate chlorinated solvent contaminated groundwater by abiotic degradation of the halogenated volatile organic compounds into harmless daughter products. Azimuth orientated vertical hydraulic fracturing is an alternate mode of placing iron reactive barriers in situ, resulting in significant cost savings and allows reactive barriers to be installed at greater depths than conventional technologies. Orientated vertical fracturing technology has installed permeable iron reactive barriers at a number of sites in highly permeable sands and gravel down to moderate depths and a number of cases greater than 100.′

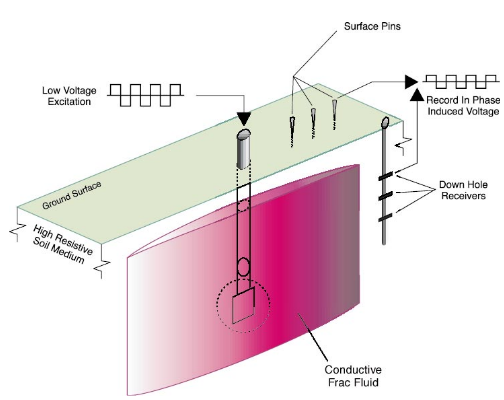
The advantages of orientated hydraulic fracture placed reactive barriers are:

- cost savings
- minimal site disturbance
- no excavation of contaminated material
- deep application of treatment technology
- minimal impact on groundwater flow regime

Monitoring of Barrier Geometry

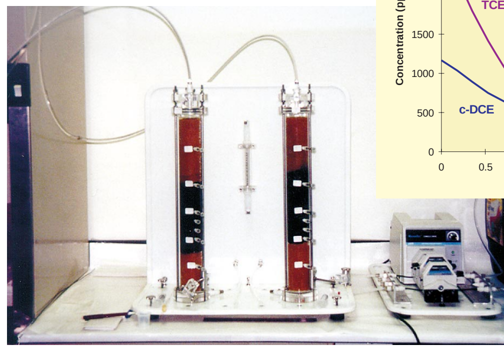
The reactive barrier installation is monitored in real time during injection to determine its geometrical extent and to ensure fracture coalescence or overlap occurs. The gel iron mixture is energized by a 100Hz low voltage source. Down hole resistivity receivers are monitored to detect changes in induced voltages by the propagation of the fracturing fluid. From these induced voltages and utilizing an incremental inverse integral method, the fracture geometry is displayed in real time during the installation process.

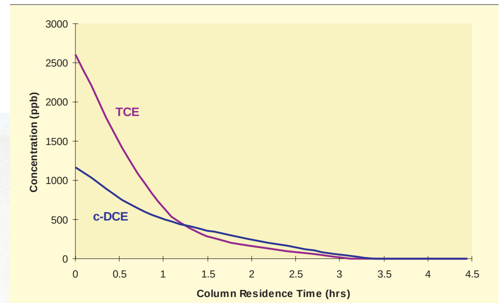




Column Reactivity Tests

Laboratory column reactivity tests performed on site specific groundwater quantify degradation rates of the contaminants. The column tests determine the applicability of a particular reactive barrier system for a site. Column tests conducted both in house and at UW/ETI and AFCEE have determined that the gel, hydroxypropylguar (HPG)—a natural polymer used in the food industry as a thickener, has minimal impact on barrier reactivity and upon degradation leaves an extremely low residue with no measured impact on barrier permeability.

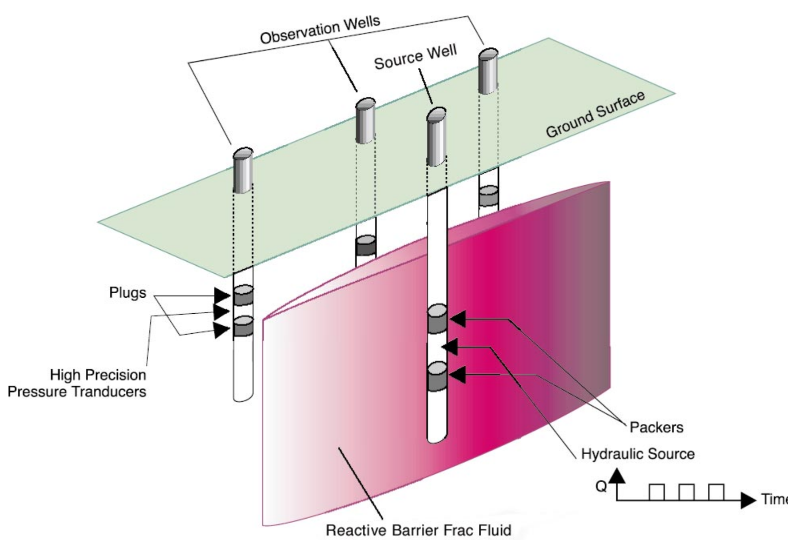


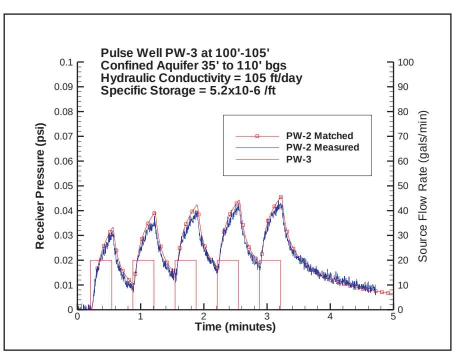


Pulse Interference Tests

The hydraulic continuity of the reactive barrier is quantified by pulse interference tests, with pulse source wells on one side of the wall and high precision receiver transducers installed in wells on the opposite side. The test involves a cyclic injection of fluid into the source well and high precision measurement of the pressure pulse in a neighboring well. The time delay and attenuation of the hydraulic pulse enables the hydraulic effectiveness and continuity of the wall to be assessed.

The pulse interference test is also ideal for the hydraulic characterization of complex flow systems, such as fractured bedrock, braided stream and esker deposits. Being a transient hydraulic test, transmissivity and storativity can be determined, and hydraulic flow regimes can be clearly delineated.





UW/ETI—University of Waterloo/Envirometal Technologies Inc.
AFCEE—USAF Center for Environmental Excellence

GeoSierra

GeoSierra LLC

GeoSierra, a privately owned company, is based in Atlanta, GA. GeoSierra concentrates on technological driven products and services in geotechnical, environmental and earthquake engineering. GeoSierra typically turnkeys projects from investigation, through to design and build. GeoSierra has been successful in modifying soil and groundwater remedies, to save costs, eliminate O&M, and reduce the time to site closure.

Environmental Services

- ☐ Field Investigation
- ☐ Site Assessment
- ☐ Risk Assessment
- ☐ Remedial Investigation/ Feasibility Study (RI/FS)
- ☐ Site Remediation (Design/Build)
- ☐ Performance Monitoring & Site Closure

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