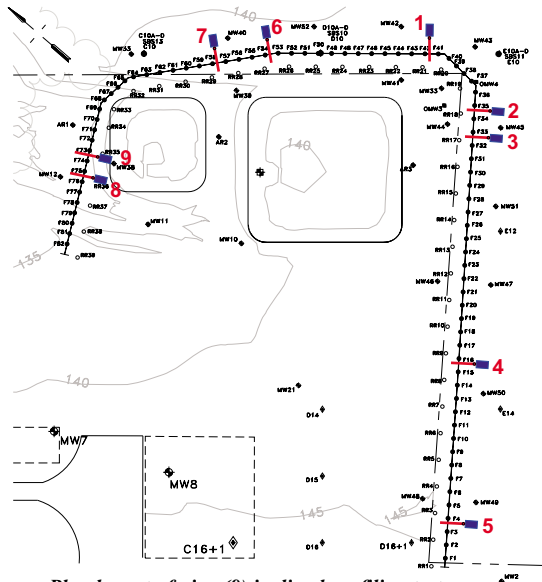


Iron Reactive Barriers

Inclined Profiling of PRB Thickness

PRB Inclined Profiling

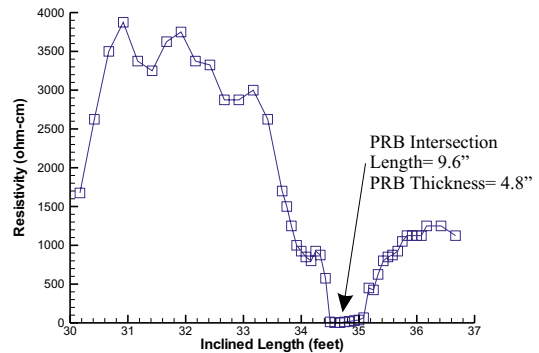
Verification procedures of the *in situ* constructed geometry of the permeable reactive barrier (PRB) is important for a high confidence in the quality control/quality assurance of the constructed PRB. Difficulties in direct sampling of iron PRBs have been experienced at both shallow and moderate depth due to the inability to contain the iron filings within the sampler. At significant depth and/or in flowing ground conditions, direct inclined sampling of undisturbed iron PRBs have been found to be extremely difficult. Under these conditions the ground in front of the sampler flows into the outer protective casing when the sampler is withdrawn and thus disturbs the ground for the next sampling interval. The next sampling attempt then samples disturbed ground consisting of a mixture of native soils and iron filings.



Plan layout of nine (9) inclined profiling tests

GeoSierra recently completed the construction of an iron PRB over 1000' in length by the azimuth controlled vertical hydraulic fracturing technology. The site consists of silts and fine sands overlying an aquitard consisting primarily of clays and silts. The iron reactive barrier was constructed in upper sands and silts and keyed into the underlying aquitard. The iron reactive barrier was constructed from 82 frac injection wells and is over 1160 feet in length, ranging in depth from 17 feet down to a total depth of 44 feet below ground surface.

A total of approximately 700 tons of iron filings were injected into the subsurface for the construction of the 4.5" thick iron PRB. Nine (9) inclined profiling tests were conducted along the barrier alignment. All of the inclined profiling tests quantified the barrier thickness and verified that the system was within the technical specifications.



Inclined Resistivity PRB Probing Location #1 Inclination 30 degrees



Equipment used in Inclined Profiling Tests

Such direct PRB sampling difficulties have led to the utilization of an inclined direct push soil electrical conductivity/resistivity probe to determine indirectly the iron PRB geometry. The electrical resistivity contrast between native soils and the iron PRB are generally sufficient to clearly identify the iron PRB geometry. The electrical conductivity probe is approximately 6" in length and 1.5" in diameter. The probe contains four electrodes spaced approximately 1" apart. The probe electrodes are excited by a low voltage current and soil conductivity can be quantified by the instrument. When the probe penetrates an iron PRB a significant change in conductivity is recorded.