

Substrate Delivery by Recirculation

Benjamin D. Grove, Jr. (Stantec Consulting Services, Inc.)

Background/Objectives. An in situ bioremediation system was constructed to mitigate migration of chlorate, perchlorate, and trichloroethylene (constituents of concern or COCs) with groundwater. Operation of the bioremediation system requires routine replenishment of substrate that is consumed by microbes as they degrade the COCs. Past substrate applications were performed using direct push techniques. Others have shown that substrates and reagents can be successfully delivered using closed-loop recirculation of groundwater amended with the substrate or reagent (Cho, 2017). This study was performed to evaluate if substrate delivery by recirculation can be a technically effective and economic alternative to use of direct push techniques.

Approach/Activities. The study was performed in three phases. The first phase consisted of engineering calculations to develop overall approach and design, and to select practical and economical equipment to be used for this test. This phase included selecting wells to use for extraction and application, selecting type of pumps that can achieve project goals, and means to power these pumps (no power source at the site).

The second phase was a groundwater recirculation pilot test (no substrate added) to verify that groundwater recirculation can be successfully achieved between wells that would be used long-term. Key parameters to evaluate included achieving desired flow rates, desired number of pore volume exchanges, and a detectable and desirable shift of geochemical parameters.

The third phase was a recirculation pilot test with addition of substrate using wells that would be used for long-term substrate delivery. Key goals of the test are to verify ability to achieve desired flow rates, planned operation of a dosing pump, desired number of pore volume exchanges, and detectable and desirable shift of geochemical parameters.

Results/Lessons Learned. The first two phases are complete. Prior well sampling and slug testing indicated that recirculation flow rates of 0.5 gallons per minute (gpm) would result in desirable drawdown or rise in extraction and application wells and provide a desirable number of pore volume exchanges given the layout of extraction and application wells, formation porosity, and planned duration of recirculation. Selected equipment consisted of 12-volt purge pumps powered by marine batteries. A key finding was that the battery can operate the pump for two continuous days without recharging. Sampling of monitoring wells several days after the recirculation test showed desirable changes of geochemical parameters that were attributed to the recirculation.

The third phase of this study is scheduled to be performed in September 2018. The same pair of extraction and application wells will be used. During this recirculation event a soybean oil substrate will be added to the recirculation stream. Plans are to recirculate for 24 hours with continuous dosing of soybean oil, then recirculate for an additional 2 to 4 hours to chase the substrate into the subsurface. Effectiveness of adding substrate by recirculation will be evaluated by sampling nearby groundwater monitoring wells in October 2018. Success will consist of detectable geochemical changes and enhanced microbial activity in key wells that can be attributed to the addition of substrate by recirculation.