Design, Field Application and Verification of Pneumatically Injected Permeable Reactive Barriers

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The installation of permeable reactive barriers (PRBs) or permeable reactive treatment zones (PRTZs) requires targeted emplacement of the injected material and overlap which results in a continuous barrier. When using the pneumatic injection method, a mixed barrier of soil and remedial product is emplaced, providing longer residence time for groundwater contact and minimizing the potential of reducing the permeability. Successful installation of barriers, namely zero valent iron, has been conducted in various geologies including brittle clays, coarse geologies comprised of sands, gravel and cobbles, and bedrock. The geology dictates the preliminary design and information required for successful implementation using the pneumatic injection method.

Zero valent iron has been proven as a means for successful remediation of chlorinated solvents in groundwater. However, pertinent information for design of conventional installation methods, such as trenching, is required. Such information includes site contaminants and their concentrations, intrinsic groundwater flow velocity, geology and other groundwater constituents. As sites become more challenging, there has been a shift in PRB construction towards subsurface delivery methods, including pneumatic injection. For construction of injected PRBs, other parameters for preliminary design are as critical. One parameter is the grain size distribution of both the zero valent iron and the geology to ensure that the permeability is not reduced and the longevity of the PRB is not compromised. Another more critical parameter is the calculation of zero valent iron required to attain the remedial goals. This calculation can be highly variable and depends on the geology and concentrations and sometimes the injection vendor.

For successful implementation by injection methods, site mobilization and layout is critical. Unlike trenching methods, zero valent iron PRB construction using subsurface delivery mechanisms is not visible. The vendor must be capable of constructing a continuous barrier by modifying sequence of injections and adjusting injection pressures to create continuous lenses or homogenous distribution of the injected material. Real-time performance monitoring and repeatability of the injections provides the client with a construction as-built of the injected zero valent iron. The vendor can also utilize this information to adjust the injection parameters and determine if any gaps exist within the treatment area. Additionally, geophysical techniques have been used to map subsurface distribution.

A discussion of three site applications will be presented, encompassing three diverse geologies. A PRTZ in Texas was installed in clay; four parallel PRBs were constructed in a coarse geology at a site in California; and a PRTZ was installed in bedrock in New Jersey. At all sites, the zero valent iron was injected as a dry material, which also has its advantages. Preliminary design considerations, the field approach to construction and verification using real-time monitoring will be discussed. Lessons learned and a discussion of alternative approaches and design considerations will also be presented.