

How Much Buffer Do You Need to Adjust Aquifer pH?

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Background/Objectives. Enhanced reductive dechlorination (ERD) can be very effective for in situ treatment of chlorinated solvents and other contaminants. However, dechlorinators are pH sensitive and anaerobic bioremediation processes can release large amounts of acid. We have developed a new design tool to estimate the amount of buffer or base required to raise aquifer pH to the target range and maintain it at that level for the treatment duration. Results from the design tool are compared to field evaluations of pH buffering at sites in North Carolina and Florida.

Approach/Activities. With support from ESTCP, we have conducted detailed field investigations at several low pH sites treated with emulsified vegetable oil (EOS Pro™) with base/buffer addition to stimulate ERD. In several cases, too little base was added and pH remained inhibitory leading to accumulation of cDCE and VC.

To assist in the design of future ERD projects, we have developed an Excel-based design tool to calculate the amount of base required to maintain the pH within a desired range. Required design tool input includes: (a) treatment zone dimensions and groundwater flow rate; (b) background geochemistry (pH, total inorganic carbon, mineral acidity, aquifer buffering capacity [meq/Kg/pH unit]); (c) initial and background electron acceptor and CVOC concentrations in soil and groundwater; (d) amount and type of organic substrate. Design tool output includes total equivalents of base required and specific quantities of common bases (NaOH, KOH, Na₂CO₃, NaHCO₃ and Mg(OH)₂). Design tool results were compared with field monitoring data from sites where pH adjustment was successful and where it was not as successful.

Results/Lessons Learned. pH less than 6 can significantly reduce cDCE reduction to VC and ethene. Low pH can result from a variety of factors including low background pH, HCl release during dechlorination, and VFA/carbonic acid produced during substrate fermentation.

- When the aquifer pH is less than 6.3, site characterization should include measurement of inorganic carbon, mineral acidity and aquifer buffering capacity (pHBC). With this information, designers can generate reasonable estimates of the amount of alkaline material require to maintain pH within a suitable range.
- In some cases, the amount of base required to maintain an appropriate pH can equal or exceed the amount of organic substrate required.