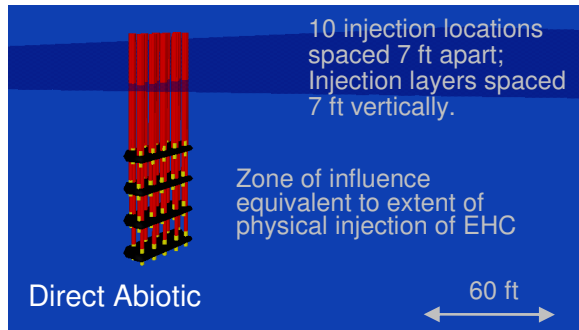
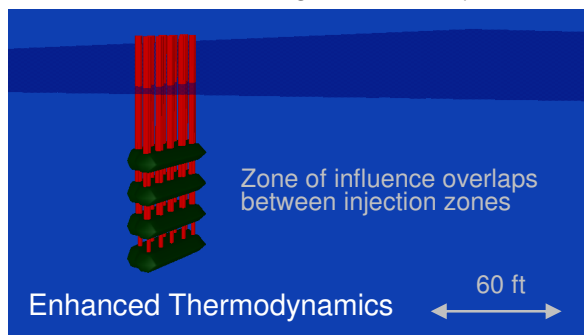


EHC relies on a combination of chemical and biological treatment mechanisms as follows:

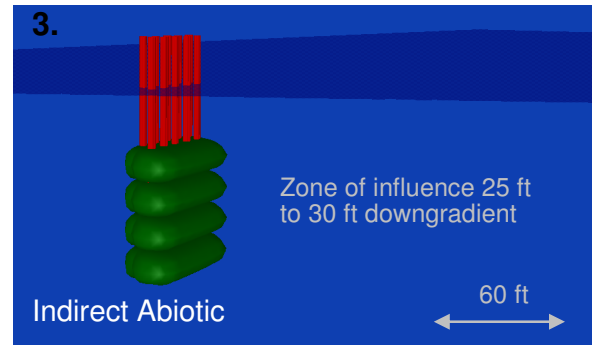
1. Direct abiotic reduction (primarily  $\beta$  elimination) due to contact with zero-valent iron (ZVI). (Gillham, 1993).



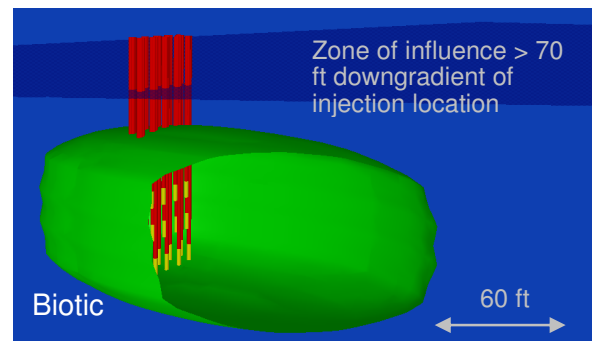
2. Enhanced thermodynamic conditions result in more complete in situ chemical reduction (ISCR) due to lowered redox potential ( $E_h < -550$  mV) engendered by the carbon and iron combination (Seech et al., 2000; Dolfig et al., 2008).



3. Indirect chemical reduction via reduced metals, i.e. reactive surface areas due to dissolved iron and secondary precipitates formed from products of iron corrosion, such as magnetite.



4. Biostimulation as EHC fermentation produces volatile fatty acids (VFAs) and hydrogen to stimulate dehalogenators downgradient of injection locations.



These pathways are synergistic; thus, individual mechanisms are not always quantifiable on a site-specific basis. For example, maintaining near-neutral pH via the first two mechanisms makes dehalogenation more efficient, and lowered  $E_h$  due to the combined effects of iron and carbon increases the rate of dehalogenation.

### **EHC mass requirements:**

Experiments on electrochemical reduction of chlorinated aliphatic compounds show that reaction rates are proportional to the applied potential with complete decomposition of PCE occurring at potentials of -800 mV (Liu et al., 2000) and lower percentages of decomposition occurring at potentials higher than -800 mV. Therefore lower redox potentials result in increasing levels of abiotic degradation. EHC treatment zones in the field show redox levels as low as -550 mV.

Calculation of EHC mass requirements based only on hydrogen demand are strongly dependent on poorly-known factors such as  $f_{oc}$ , and do not take into account many factors such as non-uniform injection distribution. Most theoretical calculations underestimate actual requirements. Therefore, EHC requirements are based on data from successful bench, pilot and field-scale studies that have been conducted.

EHC mass requirements for solvent sites typically range from 0.05% to 1% to soil mass (non-PRB applications), and up to 2% to soil mass for injected PRBs and up to 10% to soil mass for trenched PRB applications.

### **Site-specific factors necessary to estimate EHC mass requirements:**

- Prevailing pH, Eh, DO and naturally occurring electron acceptors (affects ratio of carbon to iron used to maintain near-neutral pH and amount of material required to create reductive conditions)
- Concentration reduction goal
- Required speed of remediation
- Presence/absence of daughter products and/or microbial data
- Soil type
- Recharge and infiltration of rain water in the reactive-reducing zone
- Contaminant flux and groundwater velocity

- Density of data (sparse data increases factor of safety needed)
- Cost of injection (high cost of re-injection suggests use of higher loading rate initially)
- Use of injection contractors experienced with local geology and Adventus oversight (reduces factor of safety needed)
- Performance-based or alternate warranty request.

### **References:**

Dolfing, J., M. Eekert, A. Seech, J. Vogan, and J. Mueller (2008). *In Situ* Chemical Reduction (ISCR) Technologies: Significance of Low Eh Reactions. *Journal of Soil & Sediment Contamination*. Vol. 17, No.2. (March/April, 2008; In Press).

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Liu, Z., E. Betterton, and R. Arnold (2000). Electrolytic Reduction of Low Molecular Weight Chlorinated Compounds: Structural and Thermodynamic Effects on Process Kinetics. *Environ. Sci. Technol.* Vol. 34, pp. 804-811.

Seech, A.G., J.E. Cairns, and I.J. Marvan (2000). Composition and method for degradation and dehalogenation of halogenated organic contaminants. United States Patent No. 6,083,394.

