



Chlorinated Hydrocarbon Remediation

gPRO[®] LP Hydrogen
inFusion System



What is gPRO[®] LP

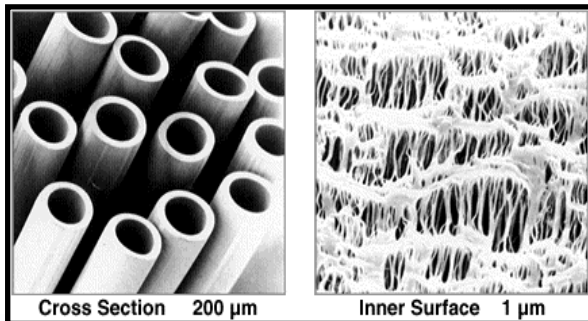
- A superior gas delivery system based on inVentures' Gas inFusion Technology
- Mass transfer device delivers high amounts of dissolved hydrogen to treatment zone
- gPRO LP system is submerged directly into the body of water
- System powered by compressed gas in cylinder



How does gPRO[®] LP Work?

- Thousands of microporous hollow fibers filled with holes
- Provides enormous surface area for mass transfer
- Water is saturated with dissolved H₂
- High levels of dissolved H₂ migrate to surrounding biomass
- Microbial population increases and degrade targeted compounds

Microporous Hollow Fiber



Mass Transfer Module

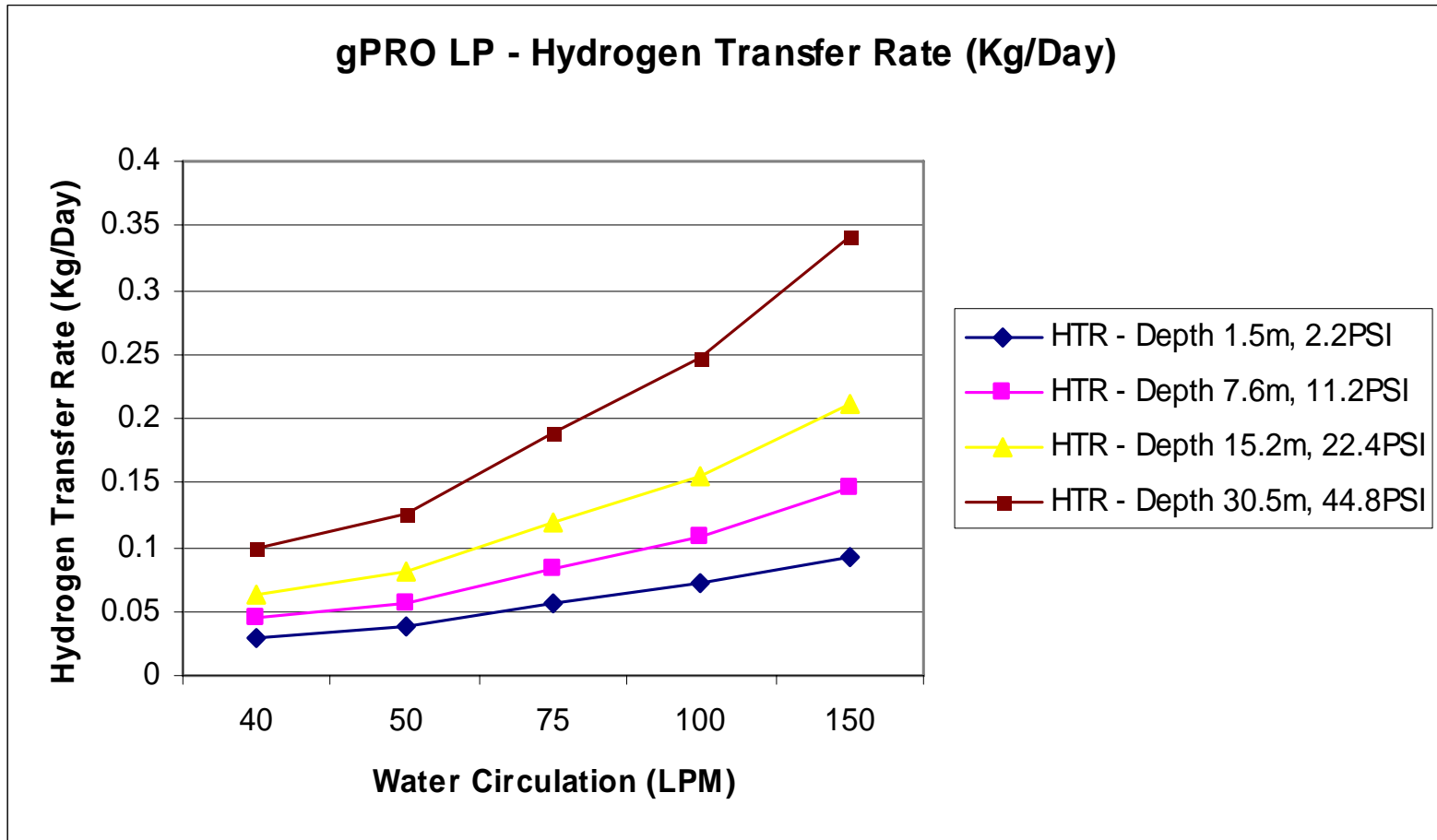


gPRO[®] LP

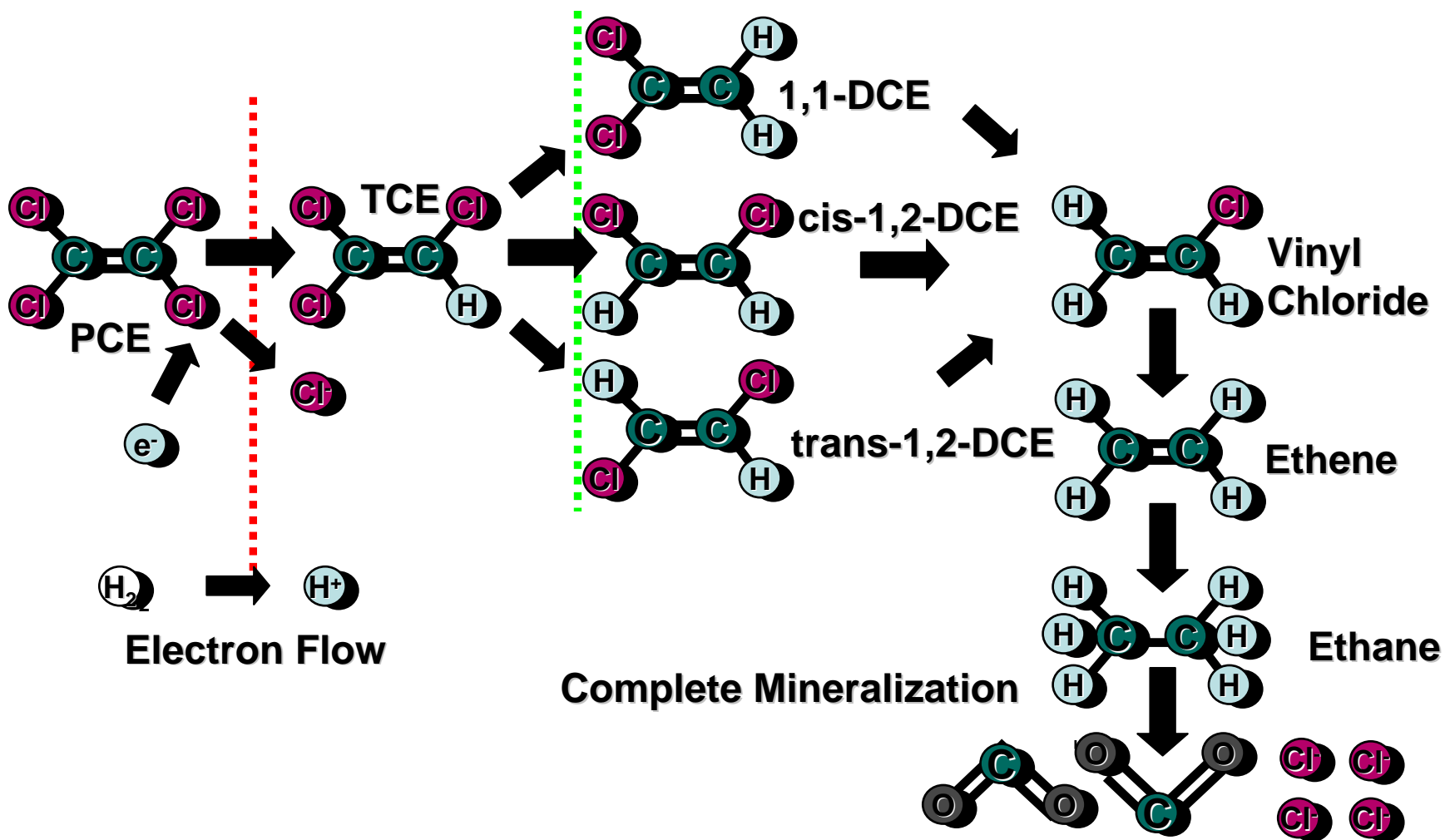




gPRO[®] LP Hydrogen Transfer Rates

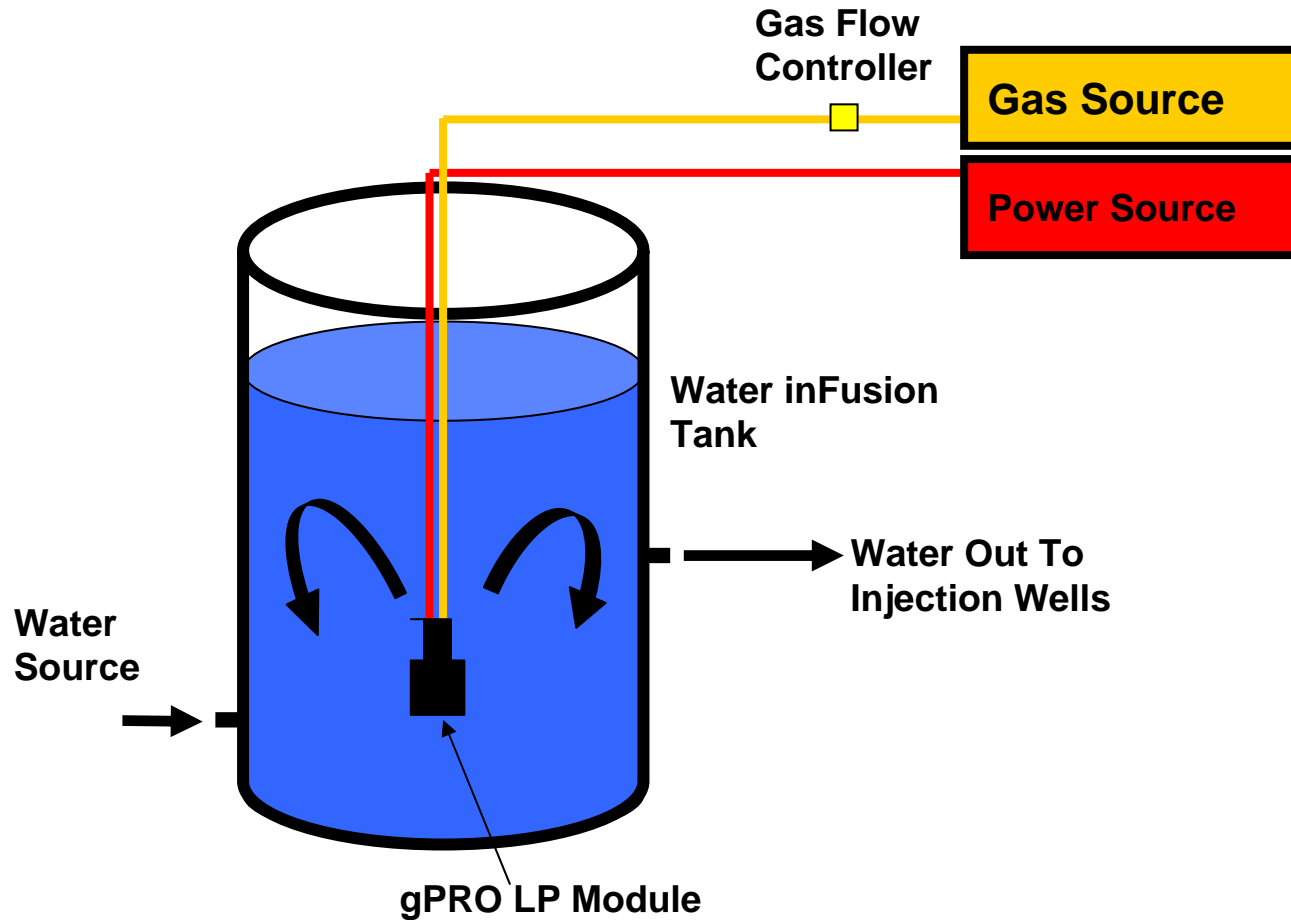


Anaerobic Reductive Dechlorination of Chlorinated Ethenes

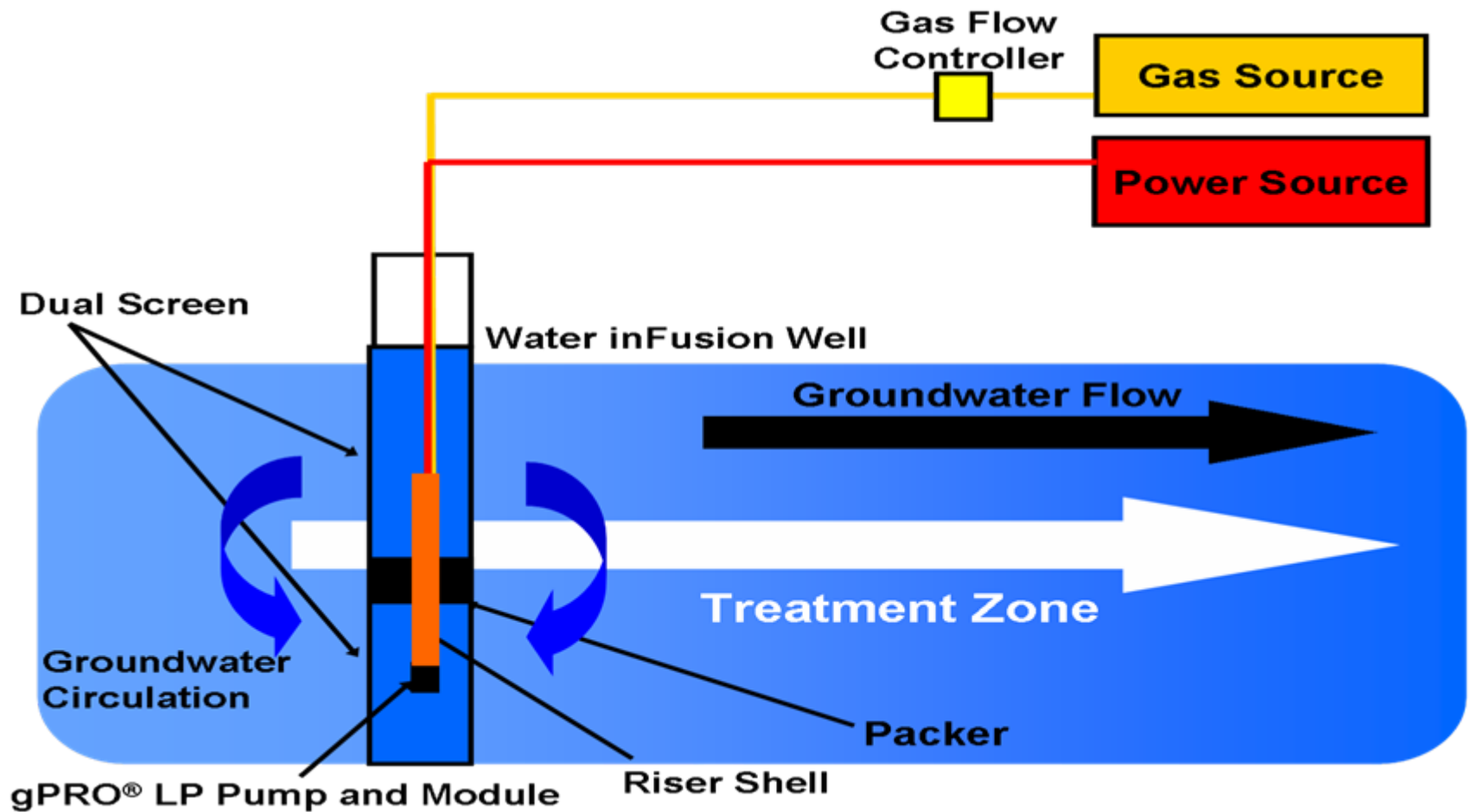


(Drawing Modified from AFCEE, Technology Transfer Division)

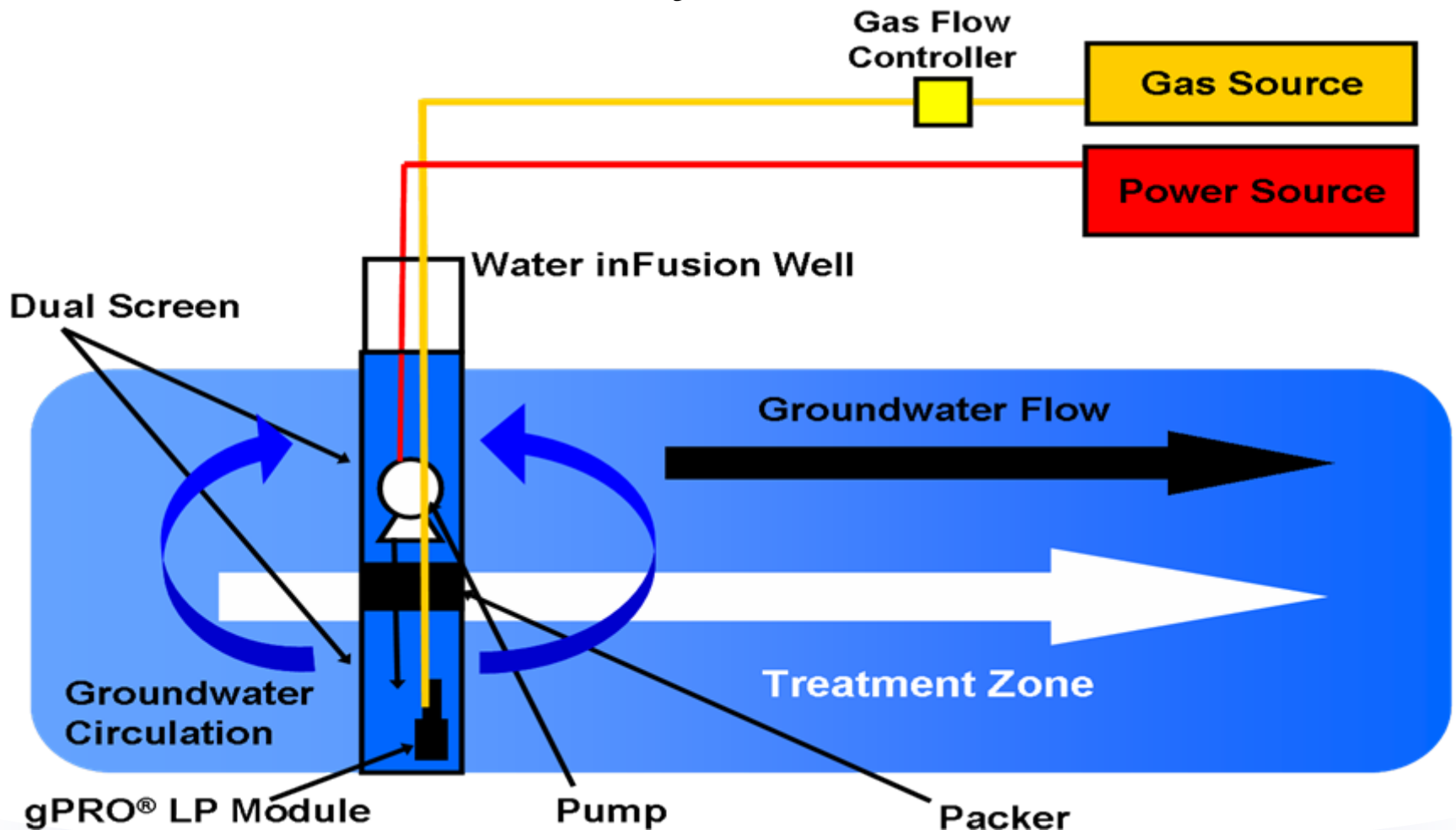
gPRO[®] LP Tank System



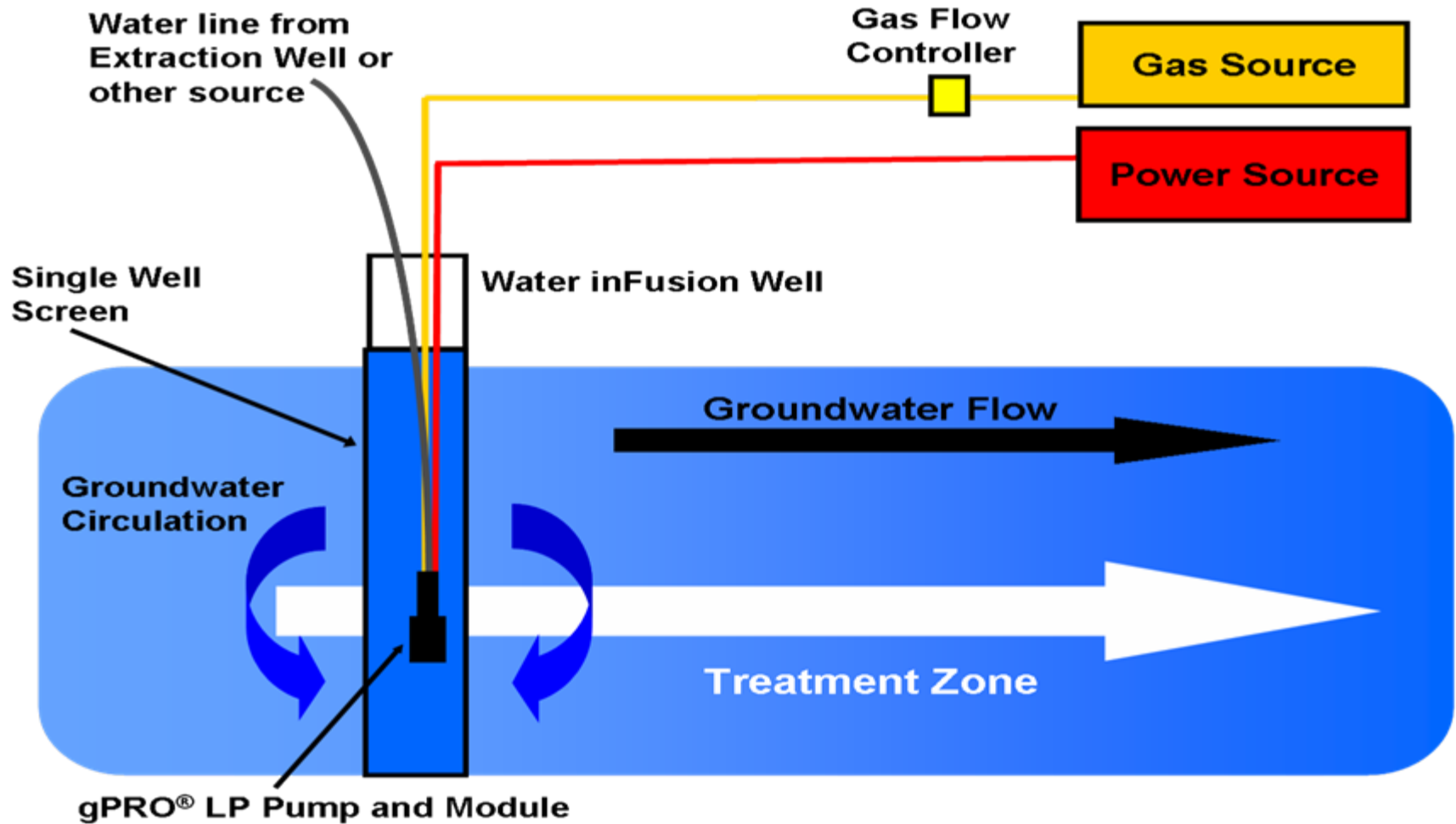
gPRO[®] LP Dual Screen in-Well System (Shallow to Deep)



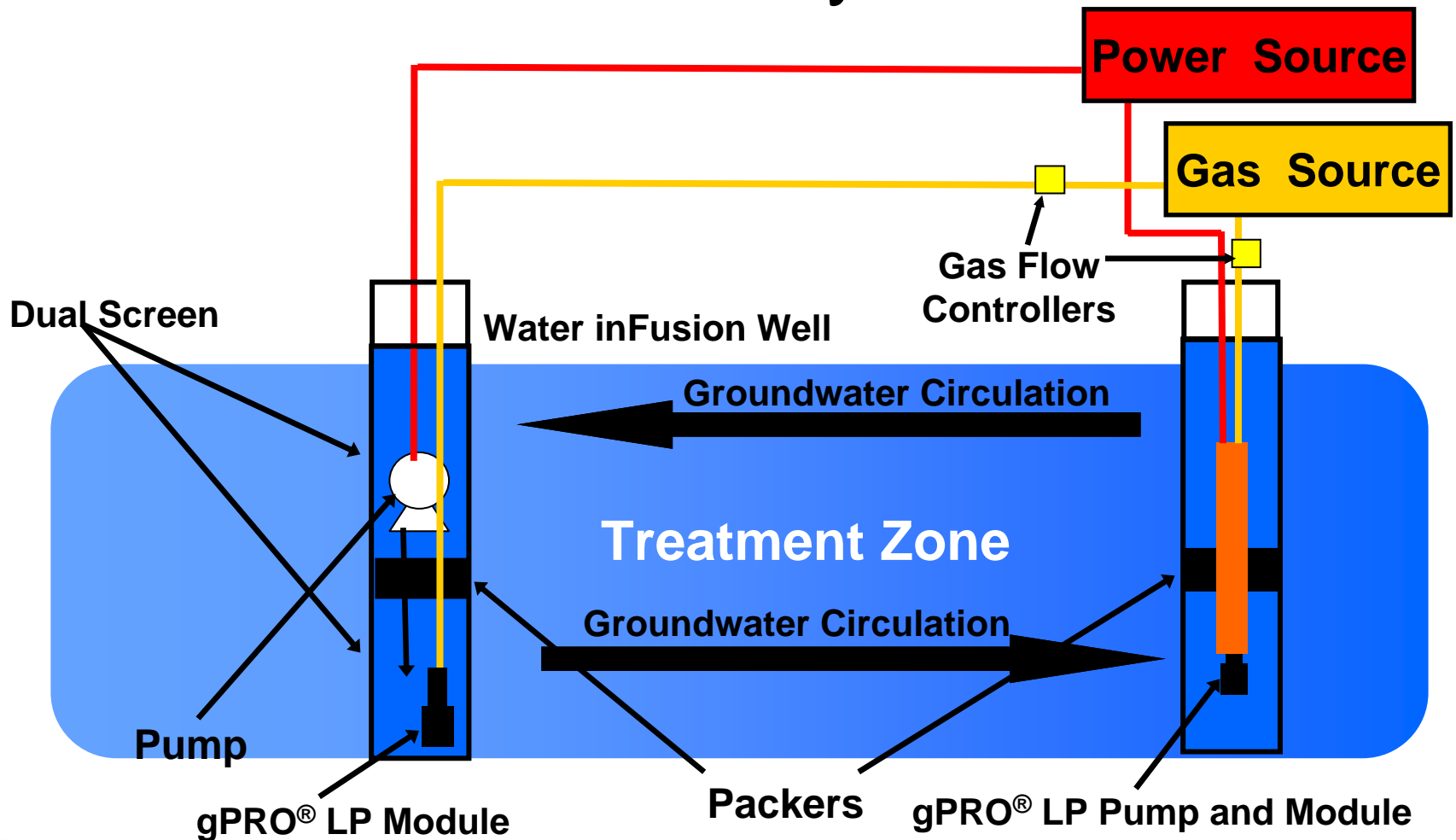
gPRO[®] LP Dual Screen in-Well System



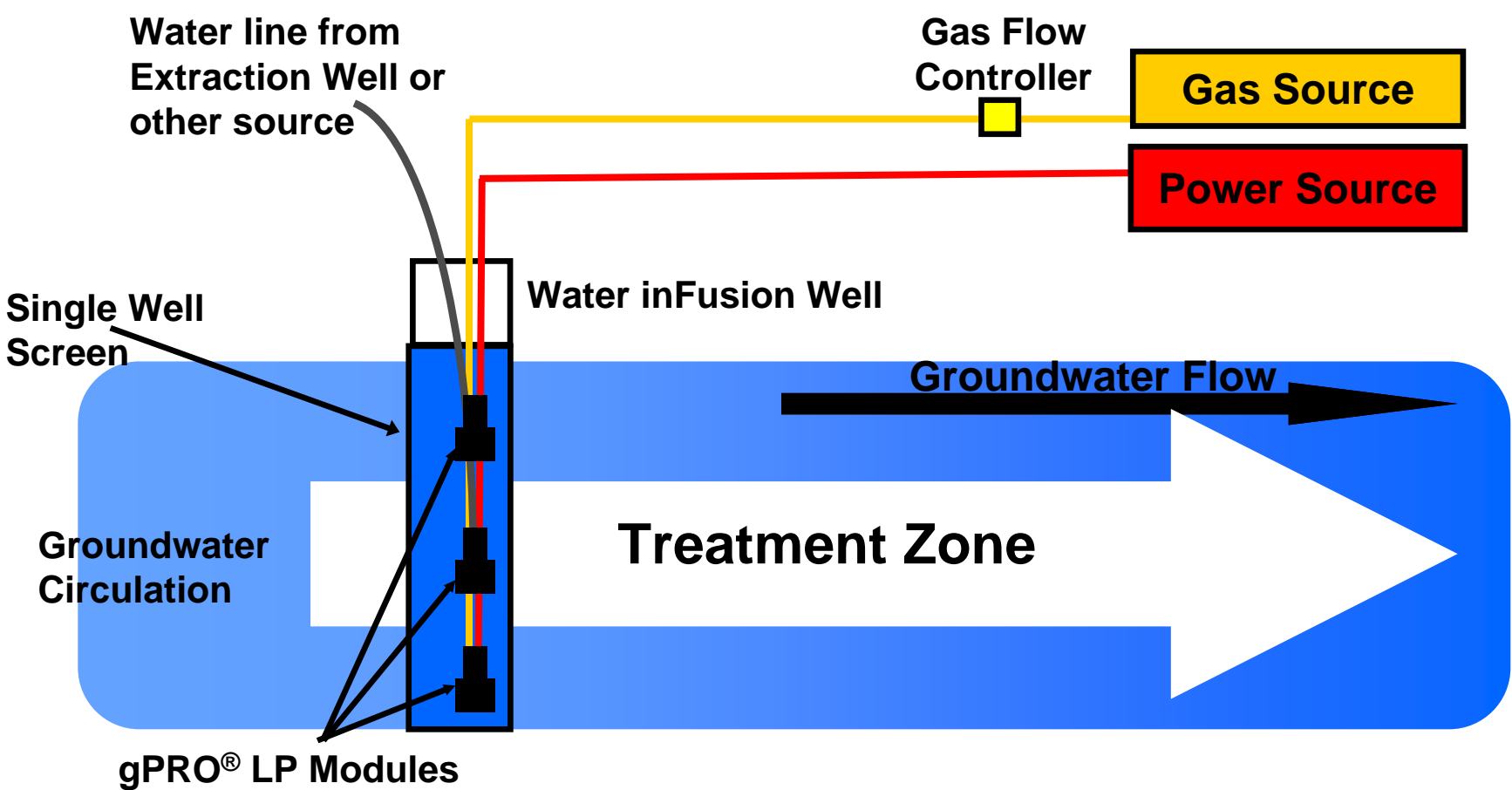
gPRO[®] LP In-Well Amended Groundwater Recharge System



gPRO[®] LP Dual Horizontal Flow In-Well System



gPRO[®] LP Stacked Delivery System for High Hydrogen Demand Sites





Hydrogen is Safe

- H_2 is a flammable gas used in numerous industrial applications
- Store gas cylinders in well ventilated cage or open shelter
- H_2 is 18 times lighter than air and will dissipate, not collect
- Use stainless steel tubing, fittings and required OSHA signage
- Use H_2 gas sensors in storage areas and well vaults



gPRO[®] LP and H₂

- H₂ is quickly used by dechlorinating bacteria (no fermentation time)
- H₂ gas is very inexpensive
- H₂ does not leave any environmentally unfriendly residue
- Much more flexible system than other chlorinated solvent remediation techniques
- Minimizes secondary water quality issues



gPRO[®] LP and H₂

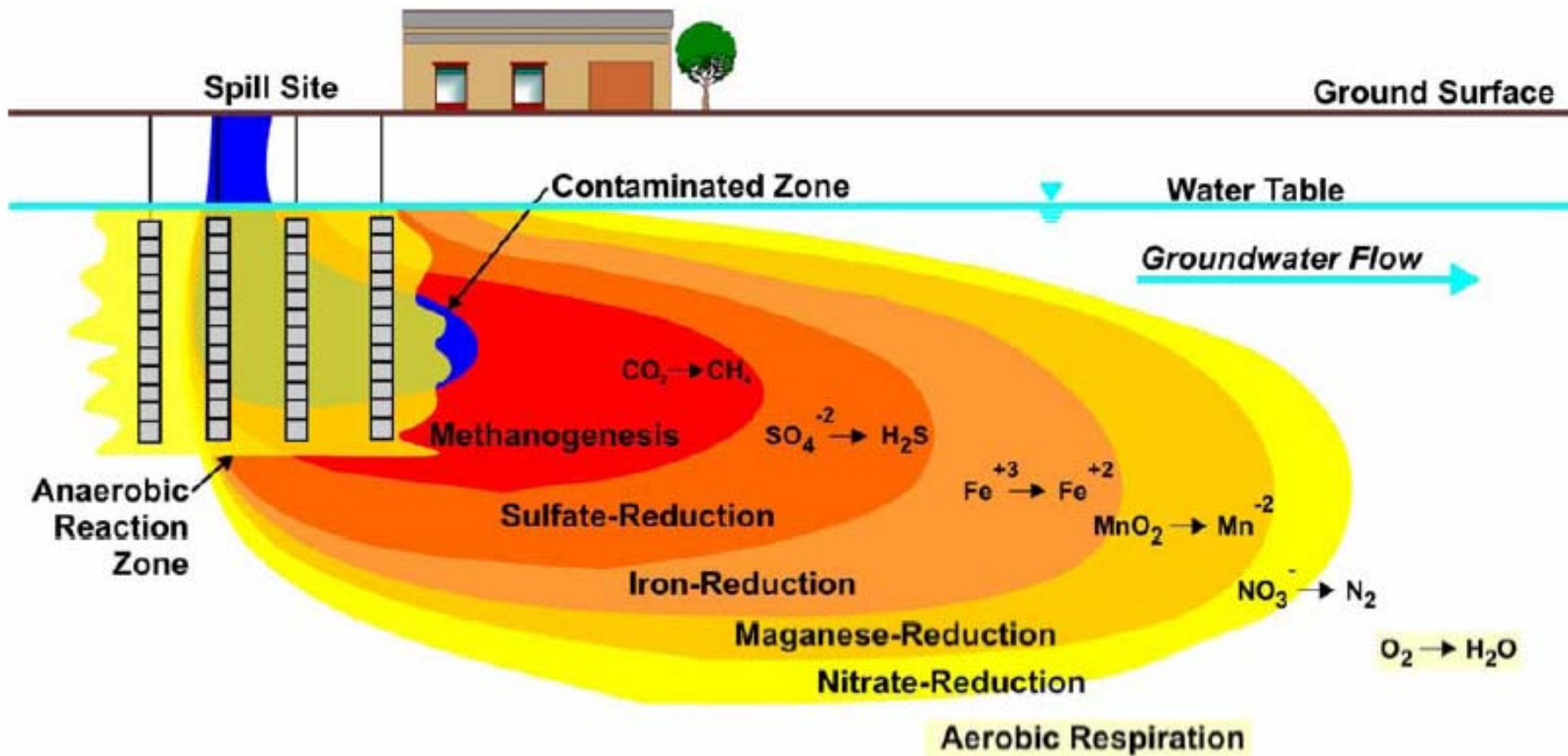
- When coupled with lactate, direct H₂ addition has been observed to significantly lower dissolved iron concentrations; reducing iron fouling issues
- H₂ addition with lactate significantly increases the rate of complete degradation of PCE AND TCE to ethene over lactate alone.



Target Redox Conditions

Anaerobic dechlorination has been demonstrated under a range of reducing conditions including nitrate, iron, and sulfate reducing conditions, but the most rapid biodegradation rates, affecting the widest range of CAHs, at near methanogenic conditions (AFCEE 2004).

Reducing Zones Downgradient of H_2 inFusion



(AFCEE 2004)



Typical Hydrogen Gas Setup





Typical Water Supply Tank





gPRO[®] LP Module

