

# Hydrogen Release Compound *HRC*<sup>®</sup>

## Bedrock Application of HRC

### General Background

HRC delivery techniques into bedrock aquifers are generally determined by aquifer characteristics and borehole drilling techniques.

HRC can be delivered into cased or open-hole completed groundwater wells via two general installation procedures: A) injection using down-hole packers and B) backfill/tremie-backfill methods. The HRC installation method should be a function of the aquifer material type, the nature and presence of fractures and the potential radius of influence

### Technical Approach

#### ➤ Fractured Aquifer Setting:

Typically, the best delivery conduit in a fractured bedrock aquifer is an open-hole completed well bore. Open-hole well completion method does not have casing material or gravel pack and allows HRC direct contact with the fracture. This direct contact can be via tremie-backfill or packer assisted delivery methods. In many cases its advantageous to apply HRC in conjunction with a packer system. The down hole packer can be used as a single or double “straddle” system, depending how much application focus is desired (Figures 1-1 and 1-2). To successfully place HRC into direct contact with the fracture system under pressure the operator must apply HRC at a pressure that does not exceed the inflation pressure of the down-hole packer/packers. This method provides a “rifle shot” application of HRC into defined sections of the aquifer that are responsible for the majority of the contaminant transport. To date, the use of HRC in fractured bedrock has not resulted in detectable levels of aquifer obstruction. This is likely because HRC completely biodegrades in the aquifer.

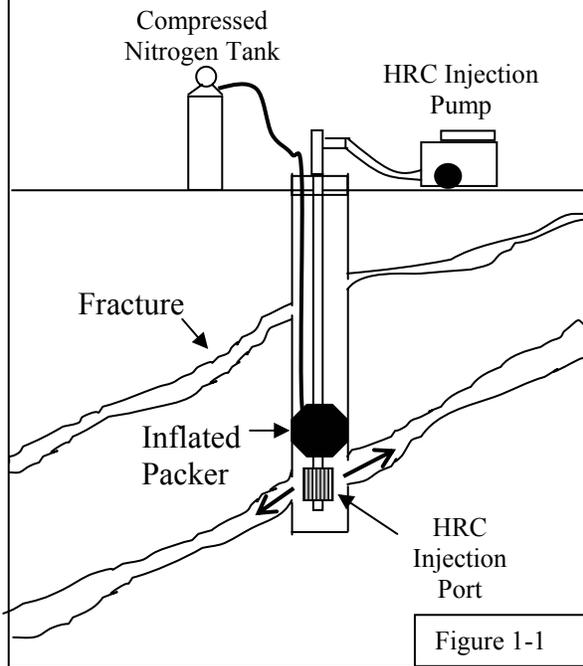
A second delivery method is to tremie backfill an open-hole completed well bore. This approach is a low-resolution application method. It relies on the volumetric backfill of the entire saturated section of the borehole with HRC material. This delivery approach relies on direct contact of HRC with the fractures and the tendency of HRC to “seep” into the fractures (Figure 1-4).

A third delivery method/option is HRC application via small diameter delivery wells (2-inch). These delivery wells are typically completed at surface to allow connection to a pump so HRC can be delivered under pressure. This method has low application resolution because it requires the wells annular space being filled prior to HRC entering the aquifer material (Figure 1-3).

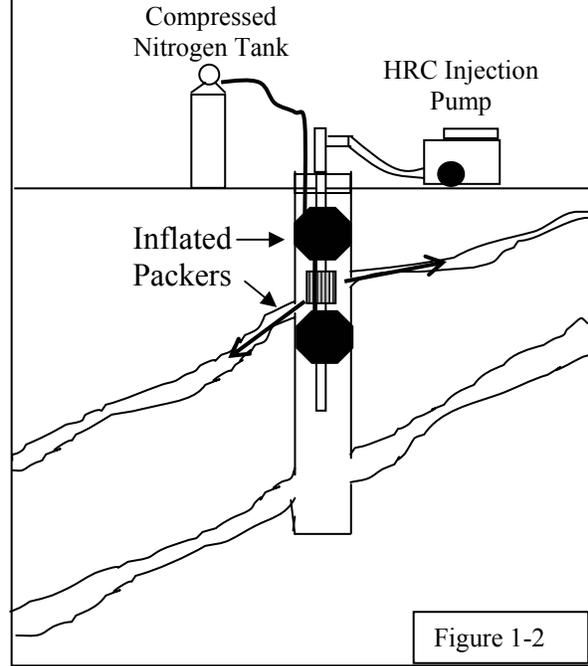
➤ Non-Fractured (Massive) Aquifer Setting:

Typically, the best delivery method in massive aquifers is an open-hole completed well bore. In this aquifer setting no developed fracture systems are present to conduct the HRC beyond the well bore. The HRC remains in the well bore as a column. The lactic acid created from HRC is delivered into the aquifer via advection and diffusion. Delivery of HRC is accomplished via typical tremie techniques (Figure 1-4).

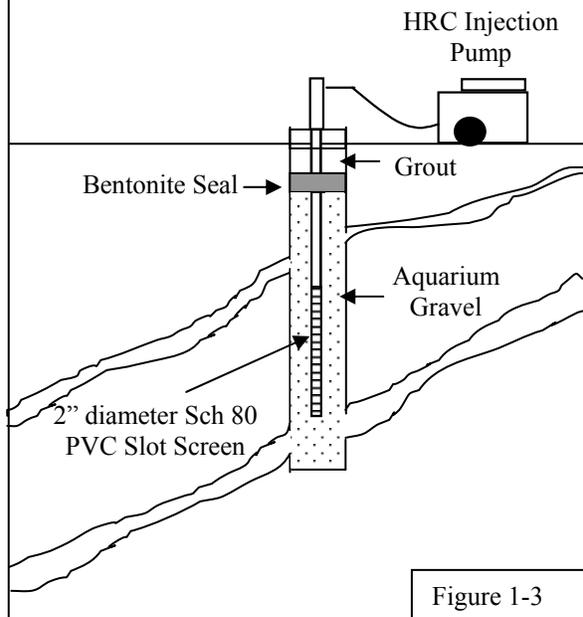
### Single Packer System (Lower Fracture)



### Double "Straddle" Packer System (Upper Fracture)



### HRC Injection via 2" Well



### HRC Backfill via Tremie Techniques

