Message

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Sent: 2/9/2017 11:38:25 PM
To: Davis, Eva [Davis.Eva@epa.gov]; Dan Pope [DPope@css-inc.com]
CC: Wayne Miller [Miller.Wayne@azdeq.gov]
Subject: ST12 EBR RDRAWP RTCS

What do you think about this response?

Air Force (AF) Response to Comment (RTC) pg 39- 43

The EBR phase of the selected remedy is a source control technology to the extent that it will deplete COCs/COPCs such that groundwater cleanup criteria can be met. The blanket statement that EBR is not a source remedy is not consistent with the state of practice as supported by the following points:

• Source control by bioremediation has been implemented at many sites. Bioremediation is more extensively documented for chlorinated solvent source areas but has also been applied for petroleum hydrocarbon sites. One study for chlorinated solvent sites shows that bioremediation source control performance is competitive and in some cases better than other source control technologies (McGuire et al, 2006).
• Natural Source Zone Depletion (NSZD) is an established process for LNAPL (ITRC, 2009). Dissolution and biological degradation is one of the primary removal pathways for NSZD. Generally, the timescales of NSZD are not consistent with the timescales in the OU2 RODA 2; however, the proposed approach is designed to accelerate the biological process by providing excess sulfate.
• Recent developments in NSZD assessment and monitoring consider the use of measuring carbon dioxide (CO_2) flux from above a LNAPL body as a means to quantify its biodegradation rate. Results of CO_2 flux monitoring above LNAPL bodies show that natural biodegradation of LNAPL can be significant; ranging from hundreds to thousands of gallons per acre per year. Under natural conditions, biodegradation

of LNAPL is rate limited based on the flux of TEA.
• The primary biodegradation pathway is in dissolved phase; however, there is some evidence of direct biological degradation of LNAPL (ITRC, 2009)
• Dissolution of COCs from residual LNAPL may be the rate limiting step (depletion to the point that rate of remaining LNAPL dissolution does not generate MCL exceedances). The AF expects that, with the establishment of a robust bacteria population, dissolution will be enhanced by concentration gradients and generation of biosurfactants.
• Sulfate reduction has been observed to be effective at bioremediation of LNAPL associated hydrocarbons (Irianni-Renno et al, 2016). This study points out that "...during the preceding century of LNAPL influence, LNAPL-tolerant microbial communities have been established and microorganisms present readily grow in the presence of LNAPL." Not only are microbes able to biodegrade LNAPL hydrocarbons, they are actively adapting to be more efficient. Irianni-Renno's study also observed metal-sulfide precipitates with no suggestion of deleterious effects.
• The notion that bioremediation is not effective on LNAPLs is misleading (Yadav and Hassanizadeh, 2010). In order for bioremediation to occur, the hydrocarbons may need to become solubilized in order to be utilized by microorganisms, so the LNAPL is being degraded, but only after the surface materials partition into solution. Biodegradation rates can exceed advective or dispersive flux thereby driving solubility equilibrium. Also, LNAPL represents the presence of a large electron donor source. As Yadav and Hassanizadeh point out, bioremediation is electron acceptor limited. Because of this, the ST012 site is a uniquely good candidate for the potential success of LNAPL bioremediation due to the high background concentration of sulfate. For bioremediation to be successful, all of the LNAPL does not need to be removed, only enough so that the hydrocarbon flux from the LNAPL is less than or equal to the kinetic capacity of the microorganisms. Yadav and Hassanizadeh point out that the three primary factors that determine the success of LNAPL conditions

are: 1) Kinetics (which will be addressed by increasing the sulfate concentration); 2) site-specific conditions (which the field test has shown us to be favorable) and 3) temperature (which is also favorable as a result of the recent SEE operation).

• LNAPL is a constant hydrocarbon source, creating a concentration gradient on the periphery. Research has shown that chemotactic bacteria will move toward the LNAPL in response to this gradient (Wang et al, 2012).

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"Because a waste is a terrible thing to mind…"