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To gwtf@emsus.com

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Subject COMMENT ON DNAPL SOURCE ZONE CLEANUP OPTION PAPER

Ken Lovelace,

I participated in the Internet Seminar and have read the DNAPL and groundwater discussion papers. I offer the following comments.

Comment 1

During the Internet Seminar a question from one of the participants was something like: How does USEPA define DNAPL? How do you determine if DNAPL is present in a soil sample?

This is a very common question and I have heard it repeated numerous times at a number of different forums. I think this issue is also a very essential question to clarify if there is going to be a national policy or guidance with regard to cleaning DNAPL source zones. Everybody needs to be on a level playing field.

A model has been developed at the Savannah River Site called NAPL Calculator to determine if NAPL is present in any type of environmental media sample. It is primarily oriented toward evaluating soil samples. The software has recently been copyrighted and is available to any governmental entity free of charge but use must be registered with the Savannah River Site. Westinghouse Savannah River Company is just beginning to market this software. This is the only software in existence that I am aware of that will accurately calculate NAPL thresholds for up to six components in a mixture. The software will calculate many other important data for remedial decision making. It will calculate the soil saturation limit for each component, residual saturation (really important for volume estimates), total mass of NAPL, NAPL mass for each component, equilibrium concentrations, mass distribution, mass balance, volume balance, mixture solubility, mixture vapor pressure, component solubility (because it changes) and component vapor pressure, mass fractions, USEPA VFLUX model input parameters, and an imbedded database of over 300 organic chemical properties to mention a few.

The above question does have an exact answer, but for NAPL mixtures in soils it is sometimes not a simple answer. However, the answer from the model is consistent with USEPA Guidance, Publication 9355.4-07FS, January 1992, Estimating Potential for the Occurrence of DNAPL at Superfund Sites and Soil Screening Guidance, EPA/540/R-95/128 and the work of Feenstra et. al, and Mariner, et. al, an accurate estimation can be computed. Generally speaking the multi-component NAPL mixtures have lower solubilities thus the threshold for a NAPL can occur at a much lower concentration than would normally be expected causing a NAPL presence to be overlooked. Additionally, the NAPL mixtures are much more difficult and resistant to treatment due to changes in their physical properties (solubility and vapor pressure) and is the reason (including geological setting) many conventional remedies fail to achieve successful NAPL cleanup results.

This is not a commercial plug because the Department of Energy encourages technology transfer resulting from its work to the scientific and technical community at large. This is a viable tool that would greatly assist in achieving DNAPL source zone cleanup because it will make the DNAPL definition consistent and the presence of NAPL recognizable to more than an informed few academics.

Comment 2
With regard to the Discussion Paper on Cleanup Goals Appropriate for DNAPL Source Zones, my comment is that the subsurface geology is directly related to how much, if any DNAPL, can be removed from the vadose source zone and the degree of cleanup that can be attained with a given remedial technology. Therefore, any national guidance on cleanup goals should first be based on a graduated scale of "remove potential" of DNAPL from the soil. For example,

Geological Type	DNAPL Removal Potential	Relevant Type of Cleanup Goal
Homogeneous sands	High	Backcalculated soil concentration based on MCL
Homogeneous clay/silt	Low	Removal efficiency of the selected remedial technology
Heterogeneous sands/clays	Medium	Removal efficiency of the selected remedial technology
Fractured limestone/karst	None	Default Technical Impracticability

Normally, regulatory authorities use soil concentrations backcalculated from the MCL using an equilibrium equation as a Remedial Goal in the ROD. While theoretically this approach seems logical, this value has nothing to do with a relevant or achievable cleanup goal. This type of cleanup goal is one dimensional and assumes oversimplified, reversible, linear sorption isotherms that control the distribution and behavior of the DNAPL in the subsurface. This approach is not even close to capturing the important dynamics that really occur and this is the reason there is such a disparity between what the technology actually delivers and the cleanup goal. The vadose zone is not one dimensional but is at least three dimensional, that is to say, contaminants are not located at a single discrete point (x,y) in the subsurface as the one dimensional model assumes. Contaminants in reality are dispersed across a contaminant field in three dimensions (x,y,z) with varying moisture contents, concentration gradients, and geotechnical properties. The other major fallacy is the reliance on the linear absorption isotherms (commonly called distribution coefficient or Kd) to describe contaminant behavior in the subsurface. DNAPL behavior is not influenced by the Kd in the subsurface - it is the wrong mechanism. Even the most sophisticated models use the Kd isotherm and these models fail time after time to accurately estimate contaminant behavior in the subsurface. Finally, a rhetorical question could be asked, "What relationship does a backcalculated soil concentration have with the removal efficiency of the selected remedial technology?" The answer is probably, "None - it is the wrong measuring stick".

The real mechanism of DNAPL behavior in the subsurface is not well understood or explained but may be related to the polarity or the organic compound with the geological material and/or the presence of secondary porosity. DNAPL retention in the subsurface could use much more research and the development of a suitable model(s).

The magnitude of DNAPL removal as stated previously is related to the subsurface geology and the remedial technology. Not all of the contaminant, and not nearly enough to achieve the backcalculated cleanup goal, will be removed from the subsurface under the most aggressive treatment regimens. The remedial technologies will efficiently remove a given fraction of product within a given time for given amount of money. Beyond this point, diminishing returns are realized. Once this point is reached, it is not economically feasible to continue treatment. In this scenario, the remedial technology will quickly and efficiently remove the amount of contaminant that can easily be scavenged. The residual contaminant is now rate-limited and this portion of the contaminant mass in the vadose zone is currently not well addressed by existing technology.

EPA should consider a graded approach for cleanup of DNAPL source zones. The active remedial technology will only remove what quantity of contaminant it is capable of removing. Therefore, there is no predetermined cleanup goal. The effectiveness of cleanup is measured by total mass of contaminant actually removed by the remedial technology. The point of shutdown of the remedial technology coincides with the point of diminishing returns which can be demonstrated with asymptotic curves, flat line of mass removal rates, or soil sample concentrations. At this juncture, an assessment should be made as to the potential of future release from the rate-limited residual still in the fixed in soils. This assessment can use soil sampling, vapor sampling, flux modeling, vadose zone transport modeling, decreasing groundwater concentrations, etc., to assess the magnitude of residual contamination and the potential for future release to the aquifer. If the assessment concludes that the residual contamination is minor and immobile, final closure could occur. If the assessment concludes that the residual contamination is significant and could re-mobilize, passive treatment technologies such as baroballs and microblowers should be installed and operated. The idea behind the passive treatment is to intercept any re-mobilized contaminant flux while keeping cost to a minimum.

This graded approach would require departure from the status quo. Performance is directly measured by the quantity of contaminant removal not by comparison to an unrelated soil concentration. Shut down of the active system is dynamic and determined by the point of diminishing return. This approach would also require an increased focus on effective characterization to adequately delineate the source areas for effective treatment system design. Likewise, increased focus would have to placed on proper system design to locate the system in high concentration areas for treatment and maximum removal rates.

Thank you.

Greg Rucker
Environmental Engineer
Westinghouse Savannah River Company
DOE Savannah River Site