

AFCEE Source Zone Initiative - Back Diffusion of Contaminants in Source Zones and Plumes

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Abstract. A fundamental question associated with managing historical releases of chlorinated solvents is how DNAPL depletion, or source zone containment, will effect downgradient water quality through time. A common perception is that near-term risks can be addressed through complete DNAPL depletion or source containment. Unfortunately, this is not always true. Building on Sudicky et al., (1985), Parker et al., (1994), and Parker et al., (1997), significant amounts of contaminant mass can be stored as dissolved and sorbed phases in stagnant zones within source zones and in plumes downgradient of sources. Under select conditions, “this non-NAPL source mass” can be the dominant factor governing downgradient groundwater quality after DNAPL depletion and/or source containment.

Building on the above, a 3-year project (Colorado State University and Colorado School of Mines) was funded by the United States Air Force Center for Environmental Excellence (AFCEE) in July 2002. The overall objective is to build tools that will assist site owners in resolving appropriate actions for sources zones. The project involves 1) process related laboratory tank studies, 2) development of models that predict emissions from source zones through time, 3) review of remedy performance data from field sites.

Laboratory tank studies involve horizontal layers of sand and silt, with a contaminant source (emulating a DNAPL source) at the sand/silt interface over an extended time. Results of tank effluents through time indicate that a significant portion of the total mass introduced into the tank is driven into the stagnant silt layer via transverse diffusion, at the time when the DNAPL source is depleted. Subsequent back diffusion from the stagnant zones sustains contaminant discharge from the tank along after the DNAPL has disappeared. These experimental results are in agreement with an analytical model. Additionally, field scale data at three selected Department of Defense sites (F.E. Warren AFB, Naval Air Station Fort Worth, and Air Force Plant 4 Fort Worth) support the concept that these non-NAPL sources can be a significant contaminant source after NAPL depletion.