

Subsurface Characterization of DNAPLs in a Karstic Setting, Redstone Arsenal, Alabama

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Redstone Arsenal is a 38,000 acre facility located in Huntsville Alabama. The site includes roughly 140 CERCLA sites listed in the NPL designation; these sites are distributed across 18 designated Operable Units and twelve watershed-based groundwater sites. The hydrogeologic setting is extremely complex, owing to a well developed karst groundwater flow system and highly dynamic groundwater-surface water interactions. Over the last two years, the Army has completed a detailed investigation of the subsurface in Operable Unit 10 in order to delineate the vertical and horizontal extent of DNAPLs and dissolved phase plumes within the bedrock. OU-10 is a 1,980-acre area within Redstone where from 1949 to 1996, research and development of rocket propellants was conducted. Long term operation of five distinct degreaser facilities have resulted in releases of solvent-based DNAPLs to the subsurface and a complex set of commingled plumes at various depths and “compartments” within the aquifer. Further, perchlorate grinding and blending operations related to the manufacture and testing of solid rocket propellants resulted in extensive perchlorate plumes.

Standard investigations conducted from 1998 through 2001 indicated the presence of DNAPLs within the overburden, highly karstic upper bedrock, and a solutionally enlarged bedding plane fracture interval at a depth of approximately 150-180 ft bgs. Continuous groundwater monitoring in well clusters and dye trace results indicated that all of these zones were hydraulically interconnected in a very dynamic fashion. Therefore, in order to attempt any remedial action, a primary technical objective was to delineate the extent of the DNAPLs within the bedrock. The data acquired through this investigation was expected to support identification of remedial alternatives and to delineate the possibly lateral and vertical limits of practicability with respect to remediation. The methods employed included gridded hydropunch sampling of the overburden to delineate the limits of hotspots indicative of DNAPLs, a reflection seismic survey to define likely DNAPL migration pathways in the bedrock and potential points of accumulation, detailed subsurface characterization of the bedrock to depths of roughly 300 ft bgs (to the regional aquitard), construction of monitoring well clusters, and continuous monitoring. Subsurface characterization included rock coring and UV fluorescence screening, open hole geophysical logging, FLUTE reactive ribbon liner surveys for detection of DNAPLs, hydrophysical surveys, and packer testing/sampling. This presentation provides a detailed overview of the methods and techniques applied in this effort, with specific emphasis on the relative success or failure of each “tool” employed. Key investigative tools for subsurface characterization and delineation of DNAPL extent to be described include optical televiewer surveys, hydrophysical logging, reactive ribbon liners (FLUTE), and packer testing, conducted in open coreholes. Additional observations regarding the role of subtle geologic structure on the apparent distribution and migration of DNAPLs will be presented.