# Conceptual Site Model Development for Migration of MGP Tar and Related Groundwater Impacts in a Highly Deformed Fractured Rock Unit

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**Background/Objectives.** At a former manufactured gas plant (MGP) in Cohoes, New York, MGP tar, occurring as a DNAPL beneath the site, migrated into fractures in a lithotectonic unit known as the Cohoes Mélange and is a source of dissolved contaminants in groundwater. This unit, now structurally positioned directly below the westernmost Taconic thrust sheet, originally consisted of bedded shale, with some siltstone and sandstone strata, but was subsequently deformed such that on a local scale the unit displays: closely-spaced cleavage; folded and disrupted/discontinuous bedding; small-scale reverse faults; and high-angle normal faults. The rock matrix is very low in porosity and permeability as a result of the generally fine-grained nature of the parent sedimentary rock and subsequent low-grade metamorphism during deformation. One objective of the Remedial Investigation was to develop a conceptual site model (CSM) in this complex setting to assess if potential exposure pathways exist for MGP-related constituents in rock in off-site areas, including the Mohawk River, and to identify on-site remedial alternatives in the overburden to mitigate continued DNAPL migration into rock.

**Approach/Activities.** Systematic patterns of open fractures that may control groundwater flow and DNAPL migration that are often present in sedimentary rock units in the northeastern USA were not readily apparent in cores or outcrops adjacent to the site due to the complexity of the rock structure. Thus, this investigation required a phased, weight-of-evidence approach. Initially, real-time field evaluations of cores, packer test data and geophysics were used at individual locations to characterize the rock and changes in hydraulic conductivity with depth, and to facilitate the selection of well screen intervals. Equipotential mapping, pumping tests, groundwater quality data, and an evaluation of regional structure (based on literature review and regional outcrop evaluations) to assess the potential presence large scale structural features in the subsurface were then used to evaluate water-bearing zone continuity, 3D groundwater flow and contaminant distribution. After each phase of field work, the CSM was refined, and the program for the next phase of field work was planned in a way to test the CSM and eventually complete the characterization of the nature and extent of impacts while controlling cost. 3D visualization modeling was used to facilitate CSM development.

**Results/Lessons Learned.** This phased approach indicated that DNAPL migration and groundwater flow in this bedrock unit are largely controlled by an open, low-angle fracture zone associated with a thrust fault. The fault subcrops beneath the former MGP, thus facilitating movement of DNAPL and impacted groundwater into bedrock. The fault dips eastward under the adjacent Mohawk River. Indications of DNAPL were identified along the fault down-dip of the former MGP at depths up to ±100 feet. Groundwater recharges the fault near the subcrop and then flows approximately parallel to the fault strike. Concentrations of dissolved constituents associated with the DNAPL decrease in the downgradient direction. The CSM demonstrated that potential exposure pathways for dissolved constituents and DNAPL in the rock are limited to the overburden and shallow rock on-site, and that no exposure pathways exist in the hydraulically downgradient off-site area, including the Mohawk River. Further, this CSM helped identify remedial targets on-site that would likely continue to contribute constituents to the bedrock system, i.e., NAPL-saturated overburden above the area of the fracture zone subcrop.