LNAPL Remediation in Complex Geologic Setting Using an Activated Carbon-Based Injectate

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Background/Objectives. The site was formerly a retail service station with primary constituents of concern being benzene, toluene, ethylbenzene, and xylenes (BTEX), exhibiting concentrations above North Carolina GCL threshold and indicative of residual LNAPL within the subsurface. Historic monitoring wells installed at the site were screened across the overburden saprolite and bedrock unit, a shallow, highly fractured metamorphic bedrock unit with varying depths ranging from 12 to19 feet (ft) below ground surface (bgs). The conceptual model theorized that hydrocarbon mass resided at the overburden/bedrock interface and was contributing to groundwater exceedances in bedrock.

Approach/Activities. Based on the limited historical soil and groundwater data and that multiple zones were represented in the monitoring well network, additional investigation was warranted to characterize the mass present in the subsurface. Discrete soil and groundwater samples were collected from the saprolite, while new, open-borehole bedrock wells were installed to isolate the bedrock unit and collect data from water bearing fractures within the vertical interval. To investigate the saprolite, six overburden soil borings were completed with soil samples collected every 2 feet vertically to quantify the soil mass contributing to groundwater impacts. The soil borings were converted to temporary piezometers to obtain groundwater samples; however, all temporary wells were dry and no groundwater samples were collected. The characterization of the bedrock consisted of identification of fractures/weathered zones within the bedrock using a borehole geophysical study, downhole camera, discrete groundwater sampling from identified fractures/bedding planes using a custom designed straddle packer assembly with an 18-inch sample interval, and high resolution water level monitoring of the surrounding well network during groundwater sampling using pressure transducers to define the horizontal and vertical connectivity between existing monitoring wells and the vertical connection between formations.

Based on the data collected from the additional investigation, a clear picture of the subsurface lithology and hydrological connectivity between the overburden and bedrock was confirmed. The data collected from the discrete groundwater sampling, provided information to assist in injection location and remediation product loading.

Upon completing the investigation, it was discovered that an approximate 5 to 10 ft weathered transition zone was present and that the majority of the BTEX mass resided in this zone. The injection method used to reach the transition zone consisted of pre-drilling the injection points with air rotary drilling through the saprolite and weathered transition zone, then backfilling with hydrated bentonite. Once the bentonite had set, a direct push rig was used to advance tooling to the desired depths and deliver the injection fluid.

Results/Lessons Learned. The results of the groundwater sampling following the BOS 200® injections indicated that the injections were successful in reducing BTEX concentrations in the injection area to levels below the cleanup goals in the target wells. Results will be presented along with lessons learned regarding high density site characterization to determine the appropriate injection loading, vertical intervals, and injection methods. In addition, this site

represents successful application of in situ activated carbon based injectates to reduce LNAPL concentration within the subsurface. Quarterly sampling events confirmed the initial post injection results and a No Further Action letter was issued to the responsible party in May 2018.