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LNAPL Deep Below the Water Table – How Did It Get There? The Importance of Proper Site Characterization and Implications for Remediation

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A detailed site investigation was completed at a former gasoline service station located in southeastern BC. The investigation revealed the presence of fresh LNAPL up to 10 metres below the water table surface, contradicting traditional LNAPL transport conceptual models. Early conceptual models describing LNAPL transport indicate that upon reaching the capillary fringe or water table surface, vertical migration of LNAPL ceases as it becomes immobilized largely by capillary and LNAPL buoyancy forces. This was thought to prevent LNAPL from penetrating vertically below the water table surface. This study highlights that this is not always the case and LNAPL can migrate deep below the water table. An alternative conceptual model is presented to describe this phenomenon. This presentation also stresses the importance of performing proper vertical and geologic site characterization. This was found to be critical in developing an accurate site conceptual model that would enable an appropriate remedial plan to be developed. The surficial geology was comprised of predominantly fine grained silty-clayey soils. Initial site investigation efforts targeted the local water table where measurable levels of LNAPL related to a historic UST gasoline release were detected. It was initially believed that the LNAPL extent was laterally delineated. Subsequent vertical delineation of deeper soil impacts revealed the presence of LNAPL at depths over ten metres below the water table. Measured LNAPL thicknesses in monitoring wells were on the order of nine metres and had characteristics of fresh un-weathered gasoline. Further delineation of deep LNAPL revealed it traveled approximately 90 metres horizontally from the former UST area with limited to no lateral and vertical dispersion. A site conceptual model has been developed to describe the transport mechanism of the observed deep LNAPL. Preliminary theories are that secondary porosity features such as macropores are controlling LNAPL migration, allowing it to penetrate below the water table surface, and thereby contradicting traditional LNAPL conceptual models. Large downward vertical hydraulic gradients are also believed to be an important contributing driving force. The vertical and lateral extent of LNAPL occurrence is believed to be geologically and hydraulically controlled, where LNAPL and associated dissolved constituent transport is through secondary features rather than traditional primary porosity. Based on the revised conceptual model, there are direct implications for the evaluation of effective remedial options. Due to the fact that LNAPL is stored and transported in macropores that constitute a small proportion of the overall volume of the soil, relatively low LNAPL volumes are expected. Also, potential LNAPL removal rates may be much slower than predicted for more typical homogeneous soils consistent with traditional LNAPL transport conceptual models.

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