Key Factors for Modeling Jet Fuel-Contaminated Site to Assess NSZD in Subtropical/Tropical Climates

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Background/Objectives. Over a 15-year period, research was conducted at a jet fuel-contaminated site, located in the state of Sao Paulo, Brazil. A large volume of jet fuel is present in the subsurface, with an estimated volume of 520 m^3. To determine the limit of the LNAPL spread and the plumes of the dissolved phase of BTEX compounds, 104 monitoring wells were installed in an area of approximately 260.000 m^2. The contamination was identified during a site investigation in 2002. The studied Cenozoic shallow aquifer is heterogeneous and is composed of clayey sands interfingered with coarse sand lenses, sandy clays, and clayey silts. The water table is located at approximately 10 m bellow surface and seasonally fluctuates up to 2 meters. Based on the geochemical results obtained from the many field investigation campaigns, we will present a calibrated water table fluctuation model to assess NSZD in subtropical climate.

Approach/Activities. To examine the effectiveness of natural attenuation process to constraint the migration of dissolved plume of BTEX, a monitoring plan based on sampling and measurement campaigns was deployed, beginning in May 2006, to evaluate the water quality of the groundwater, and water table fluctuation, resulting in a long-term series of monitoring data. The water table is the most important feature entrapping both light non-aqueous phase liquids (LNAPL) and air in the saturated zone. We developed a conceptual and numerical model that reproduce the long-term and seasonal variation of BTEX concentration in aqueous phase by continuous depletion of LNAPL.

Results/Lessons Learned. A conceptual and numerical model is proposed to explain the observed LNAPL dissolution in the study area, where LNAPL saturation in the pores and the water table elevation with respect to the smear zone are the controlling factors. The water table can fluctuate partially within, completely within or above the smear zone. The smear zone is subdivided in two portions denominated unsaturated smear zone (USZ) and saturated smear zone (SSZ), lying respectively above and below the water table. LNAPL saturation of SSZ is always higher than that of USZ, because LNAPL tend to migrate downward whenever is freed. Contrary to saturation, BTEX concentration of the SSZ LNAPL is lower than that of USZ LNAPL, because it is continually removed by mass transfer, as opposed to that in unsaturated portion where LNAPL is only occasionally in contact with water. Our results indicate that the long-term BTEX depletion is mainly controlled by LNAPL saturation. On the other hand, the overlapping seasonal variation is governed by water table fluctuating within or above the top of the smear zone.