Dissolved Phase Stability Assessment of Benzene at a Downstream Petroleum Facility: Case Study

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The transport and stability of petroleum hydrocarbons (PHCs) in groundwater is critical to developing risk management plans (RMPs) and/or remedial action plans (RAPs) for contaminated sites. A dissolved phase stability assessment of benzene for a downstream facility in Alberta is presented as a Case Study in support of evaluating PHC plume stability and development of a RMP and RAP for the site. Three lines of evidence are used in the stability assessment: a non-parametric Mann-Kendall analysis using ProUCL®, a visual plume assessment using the methods outlined in Ricker (2008) and Surfer®, and a fate and transport model using BIOSCREEN. The presentation reviews each line of evidence, details input selection and calculations, and reviews the results of the stability assessment. Tables, charts, and graphical model outputs will be presented for the viewer’s reference. Conclusions will be made regarding the applicability and sensitivity of each line of evidence.

The presentation of the non-parametric Mann-Kendall analysis will review the use of ProUCL®, an open source statistical analysis software developed by the U.S. EPA. The data set used for analysis will be reviewed and outputs presented for the audience’s benefit. Practical issues with variable monitoring well networks and historical data gaps will be reviewed, with conclusions regarding monitoring at sites prior to RMPs development presented.

The presentation of the visual plume stability assessment using the methodology presented by Ricker (2008) will include a review of pertinent analyses and calculations, Surfer® outputs, and results of the assessment. Changes in lateral plume extent, average representative benzene concentration, and plume representative volume (second moment of analysis) will be discussed. A sensitivity analysis of pertinent input parameters will be reviewed and the uncertainty resulting from variable monitoring well networks, low-level contaminant impulses and false-detections will also be reviewed. Conclusions regarding future implementation of the Ricker (2008) method and other visual analyses will be provided.

A screening level fate and transport model using BIOSCREEN, an open-source modelling software published by the U.S. EPA, and BIOSCREEN-AT, an exact analytical solution to the BIOSCREEN model will be reviewed. The rationale for selection of model input parameters and boundary conditions will be provided in context of the Site and observed hydrogeology. The collection of dissolved electron acceptor data (oxygen, nitrate, iron, hydrogen sulphide, etc.) in the field, along with implications of the results for future remedial efforts will be discussed. The calibration of the model using both first-order decay and instantaneous reaction models will be reviewed and a comparison to the no-decay scenario presented. A sensitivity analysis of various parameters will be presented for the viewer’s benefit.

Finally, the three lines of evidence will be reviewed in context of the Site as a whole and how they influenced the RMP and RAP for the Site, including the bioremediation potential revealed by the BIOSCREEN evaluation, coupled with trend analysis and a holistic view of the benzene plume stability.

Scott McKean
Scott McKean, P.Eng., is a geoenvironmental engineer with ten years of industry experience. His primary focus has been the assessment and remediation of downstream fuel facilities impacted with petroleum hydrocarbons. He has implemented and evaluated numerous remediation programs including ex-situ remediation, in-situ chemical oxidation, multiphase extraction, and bioremediation. His roles on projects have been varied, from conducting routine field work to managing a client portfolio with over 100 sites.