High-Resolution Mass Discharge Evaluation at a Chlorinated Solvent Release Site in Sao Paulo, Brazil

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Background/Objectives. Contaminant mass flux is a useful parameter for characterizing discrete sources of dissolved contaminants emanating from complex source zones. The integrated form of mass flux – mass discharge – is a useful metric of the overall “strength” of the release. While mass flux/mass discharge calculations are conceptually simple (hydraulic gradient, concentration, and hydraulic conductivity [K] are the basic inputs) each one of those parameters is spatially variable and classic interpolation schemes and data collected from low resolution site assessments are not optimal. As high-resolution site investigation techniques become more common, techniques to utilize high-resolution data in mass flux/mass discharge calculations are needed. Also, as visualization techniques improve, mass flux can be viewed at different scales for better defining the nature, extent, and significance of discrete contaminant source zones and their resulting dissolved plumes.
Commonly used tools and methods used to estimate mass flux are limited to two dimensions, and by interpolation methods. Thiessen polygon estimates and linear interpolation methods can over- or underestimate mass flux if the method misses a high K zone, or apply a certain mass flux to an inappropriately large area of the transect. This study used high-resolution site data, which was viewed and processed using Earth Volumetric Studio (EVS, made by C Tech Inc.), which has many three-dimensional interpolation capabilities. The data was used to calculate mass flux and mass discharge at different transects along the flow path, which was then viewed in three-dimensions. Data were collected at a chlorinated solvent site in Sao Paulo, Brazil.

Approach/Activities. EVS was used to interpolate K in three dimensions. Index of hydraulic conductivity (iK) values were first collected using the Waterloo APS™ profiler, and the data were correlated to K calculated from slug tests. Groundwater samples were collected with the profiling tool as well as in CMT multilevel and conventional monitoring wells. This chemistry data was used to interpolate groundwater concentrations using three-dimensional kriging. Hydraulic head data were collected in conventional and CMT wells, and used to interpolate groundwater gradient across the transects. EVS was also used to create a grid of 1 meter discretization and mass flux was estimated at each node in the grid, and displayed in three dimensions. Mass flux was integrated across transects to estimate contaminant mass discharge for certain portions of the transect, and used to compare mass between transects. Finally, mass discharge values calculated along the transects were compared to mass removal rates from a network of downgradient extraction wells that fully captures the site CVOC plume.

Results/Lessons Learned. This method was useful in identifying zones of high mass flux along transects, and is being used to guide the design of a long-term remedy. The possible uses for interpolation with EVS include evaluating specific sources of mass flux, which could be useful in designing targeted treatment systems. Also, displaying mass flux in three-dimensions, along with the critical input parameters, makes the concept easier to convey to stakeholders. Mass discharge values calculated along transects were comparable to mass removal rates from the downgradient extraction wells except along the northern boundary of the site where the extraction wells appear to be capturing an additional plume emanating from a neighboring property.