

Application of Numerical Modeling for Optimization of Groundwater Remediation Methods of the Site Contaminated with Organic Compounds on the Example of Old Gasworks in Bydgoszcz (Poland)

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Background/Objectives. Remediation of the groundwater contamination is complex process, which requires a detailed studies and proper management. The more complex the site, especially in the build-up area (e.g., within the city) and/or the complexity of the processes that determine the contaminant plume migration in groundwater, the harder is to design and perform effective remediation actions without affecting the surrounding area. It is becoming even more difficult in case of organic pollutants (DNAPL and LNAPL) as due to their physicochemical properties, they often migrate in separate phase. One of the most reliable tools to support design and then evaluation and assessment of complex remediation techniques is a numerical modeling. It allows for prediction of system behavior during the remediation process, its effectiveness and time and thus allow for optimization and verification of selected solution. An example of the site where, due industrial activity and improper storage of solid and liquid waste, the groundwater contamination of BTEX was detected (with maximum concentrations around 5–10 mg/L within the plume core), and thus required on immediate remediation action, was the Old Gasworks, located in Bydgoszcz (North-West part of Poland). Due the site location within the city and adjacency to the Brda river technical aspects of remediation design required detailed verification and evaluation of applied technical solution to prevent rising the groundwater lever what would cause the flooding of the surrounding buildings.

Approach/Activities. To represent the LNAPL plume migration and evaluate the remediation options and /or effectiveness of the applied technical solutions the numerical model was developed. The modelled area of 300x300 m was divided into 30 columns and rows with the finite difference grid size 10x10 m. The vertical model grid spacing consisted of six layers: mainly gravel and sands of sediments of Brda Valley. The main aim of the model was to predict the groundwater system behavior and contaminant spreading in natural condition without any changes related to the remediation action. The main problem at the stage of modeling was very small amount of data characterizing the locations of pollutant sources and the temporal character of the pollutant load into groundwater. Actually, groundwater and soil is still highly polluted by BTEX compounds, despite a very long history of the Old Gas Works and their effective leaching from the ground into the Brda river.

Results/Lessons Learned. The remediation of groundwater contaminated with BTEX in the Old Gasworks area have been designed based on many series of calculations for various scenarios. The numerical model applied at the Old Gasworks area at Bydgoszcz city helped to design, and evaluate selected remediation technology with optimized costs and low environmental impact on the surrounding area. Finally, the optimal remediation system was composed of an (i) impermeable horizontal barrier parallel to the Brda River with length of about 250 m (ii) horizontal drain for capture of the polluted groundwater flux and also (iii) the pump-and-treat system with 8 extractions and 8 injection wells. Pumping rate of the extraction/ injection wells system was 270 m³/d. The proposed solution is probably typical for the site cases of the brownfields and contaminant plumes located in a neighborhood of the river with considerable size but also recognized as optimal and effective. Moreover, the numerical modeling results showed a high efficiency for the remediation system in the first year of its operation (removal of BTEX up to 80%). Removal of the remaining 20% of pollutant load is

expected to be much more difficult and requires up to 5 years of remediation, using pump-and-treat method.