A novel permeable reactive barrier for in-situ groundwater remediation

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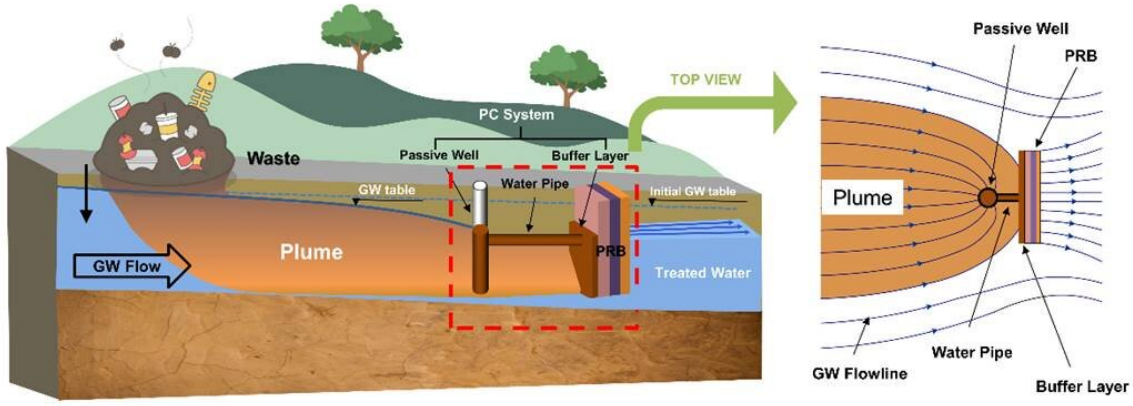

Credit: Kaixuan Zheng et al

A permeable reactive barrier, or "PRB," is a wall constructed below ground to clean up contaminated groundwater. The wall is "permeable," which means that contaminated groundwater can flow through the PRB to be treated. The reactive materials that make up the wall either trap harmful contaminants or make them less harmful. The treated groundwater flows out the other side of the wall. PRB has emerged as a promising and sustainable in situ groundwater remediation technology, which has the advantages of low maintenance costs, service longevity,

and in situ treatment of a variety of groundwater pollutants (e.g., heavy metals, inorganic and organic pollutants).

An appropriate PRB configuration is critical to the PRB engineering design, which should be selected considering site-specific hydrogeologic conditions and contaminant plume characteristics. The most common PRB configuration is the continuous permeable reactive barrier (C-PRB). This configuration has a simple structure, convenient installation, less disturbance to the natural groundwater flow field, and low sensitivity to the complexity of the groundwater flow field. However, for sites with deep groundwater depth and large plumes, the application of C-PRB is limited due to its high construction and materials cost.

To overcome the shortcomings of the C-PRB, Prof. Hongtao Wang from the Tsinghua University, Dr. Tan Chen from the Minzu University of China and their team members have proposed an innovative and sustainable PRB configuration, namely the passive convergence-permeable reactive barrier (PC-PRB). The PC-PRB is designed to make the plume converge towards the PRB due to the passive hydraulic decompression-convergent flow effect. The corresponding passive groundwater convergence (PC) system is deployed upstream of the PRB system, which consists of passive wells, water pipes, and a buffer layer. This study entitled "Passive convergence-permeable reactive barrier (PC-PRB): an effective configuration to enhance hydraulic performance" is published online in *Frontiers of Environmental Science & Engineering*.

In this study, the research team developed a two-dimensional (2D) finite-difference hydrodynamic code, entitled PRB-Flow, to examine the hydraulic performance parameters (i.e., capture width (W) and residence time (t) of PC-PRB. The research team found the horizontal 2D capture width (W_h) and vertical 2D capture depth (W_v) of the PC-PRB remarkably increase compared to that of the continuous reactive barrier (C-PRB). The aforementioned relative growth values in order are greater

than 50% and 25% in this case study. Therefore, the PRB geometric dimensions as well as the materials cost required for the same plume treatment lessens. The sensitivity analysis reveals that the dominant factors influencing the hydraulic performance of the PC-PRB are the water pipe length (L_p), PRB length (L_{PRB}), passive well height (H_w), and PRB height (H_{PRB}). The discrepancy between the W_h of PC-PRB and that of the C-PRB (i.e., ΔW_h) has a low correlation with PRB parameters and mainly depends on L_p, which could dramatically simplify the PC-PRB design procedure. Generally, the proposed PC-PRB exhibits an effective PRB configuration to enhance hydraulic performance.

More information: Kaixuan Zheng et al, Passive convergence-permeable reactive barrier (PC-PRB): An effective configuration to enhance hydraulic performance, *Frontiers of Environmental Science & Engineering* (2022). DOI: 10.1007/s11783-022-1591-y

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