

Integrated methods and scenario development for urban groundwater management and protection during tunnel road construction.

A case study of urban hydrogeology in the city of Basel, Switzerland.

Epting Jannis* & Huggenberger Peter*.

*Applied and Environmental Geology Group, Department of Environmental Science, University of Basel, Switzerland

Increasing pressure on groundwater resources of urban areas often results in considerable changes of hydrogeologic regimes. Besides permanent anthropogenic impacts that come along with urbanization, like increased surface impermeability for instance, the hydrogeologic regime can temporarily be affected during the development of subsurface infrastructure.

Generally, solitary impacts on urban hydrogeologic regimes are regarded as locally limited to their vicinity neglecting possible effects at regional scale as well as possible interactions with other impacts. To consider and manage all impacts and their interactions on urban groundwater adequately, a holistic perspective is necessary. Whereas the various stresses on the system, like groundwater extraction, recharge, building activity and subsurface tunnel road construction as well as their impacts on the hydrogeologic regime are regarded simultaneously together with possible interactions with potentially contaminated sites. To accomplish these issues it is necessary to develop instruments, that adequately quantify the consequences of the cumulative effects from the numerous impacts on the hydrogeologic regime and groundwater quality, on the one hand, as well as to develop goals and profiles for specific groundwater areas, on the other hand.

The present work illustrates important steps in such a process based on an ongoing suburban tunnel highway construction within the densely populated area of the city of Basel (Switzerland). In a first step, goals for a desired sustainable development of the hydrogeologic regime were defined. Based on these goals, possible scenarios could be defined and groundwater management could be customized to the various construction phases. Single construction phases required groundwater withdrawal resulting in considerable changes in the dynamics of the local and regional hydrogeologic regime. In order to prevent, predict and mitigate environmental problems and to assure the supply of groundwater users during the various project phases an integrated multi-disciplinary approach was chosen, including a close collaboration between key players. The objective of this approach was to setup a groundwater management system consisting of extensive groundwater monitoring, a high resolution numerical groundwater model and the development and evaluation of different scenarios. The groundwater management system was continuously adapted considering the current specific requirements during planning phases and throughout the construction process and allowed to regard simultaneously local effects and cumulative effects on the entire system. Obviously, the knowledge of local geological and hydrological conditions as well as the understanding of the processes taking place in the system can considerably contribute to solutions of regional problems.

This integrated approach helps to meet challenges posed by major constructions in a sensitive urban environment. A systematic consideration of groundwater management in urban development can serve as a decision tool for project planners and official departments and allows ongoing adaptation dealing not only with current issues but also with future demands. Together with well guided supervision, this can support a sustainable development of groundwater resources in and around cities, achieving a long-term improvement of groundwater quality.

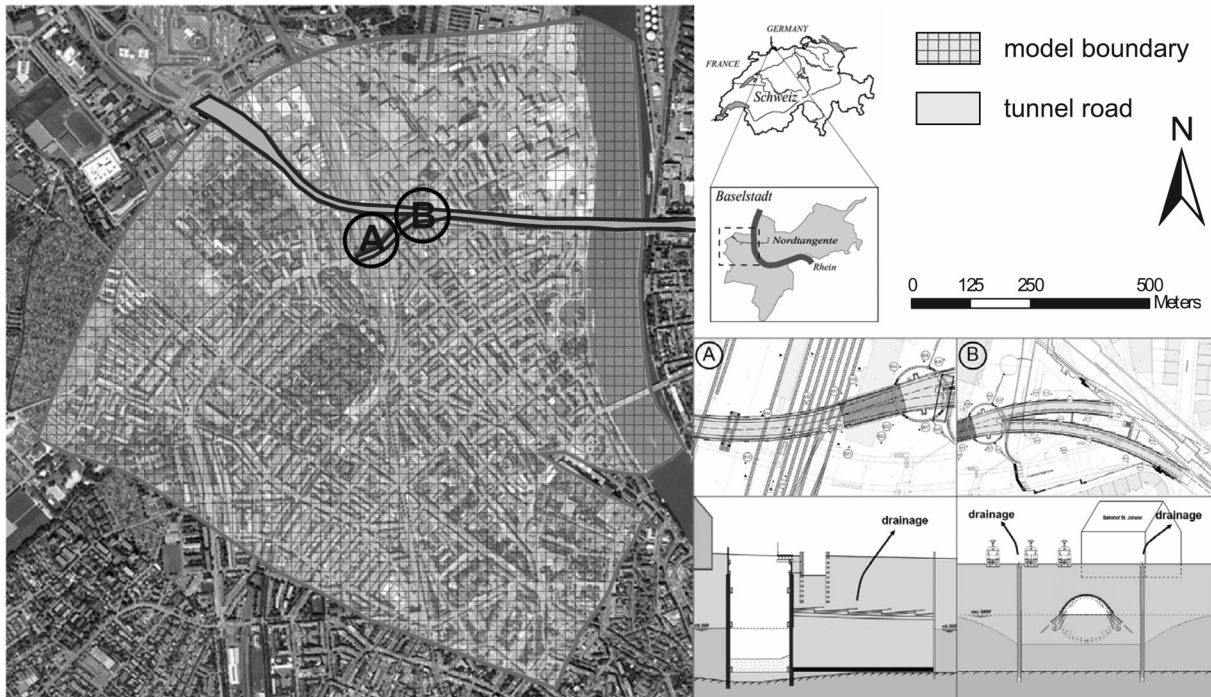


Figure 1. Groundwater management on the construction site "Luzernerring". Extent of the research area and figures of two different drainage methods. (A) Drainage of residual water in sections that are enclosed by sheet piles; (B) open sump drainage.



Figure 2 & 3. Tunnel-gate shaft and "micro pale" mining technique.

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