

American Water Resources Association
2009 ANNUAL WATER RESOURCES CONFERENCE
November 9-12, 2009
Seattle, WA

Wednesday, Nov. 11

1:30 PM – 3:00 PM

SESSION 49: Groundwater I

Groundwater Supplies in Colorado's Front Range – Challenges and Opportunities for Municipalities - N. Jordan Dimick, CDM, Denver, CO (co-author: John Rehring)

Colorado's Front Range area has a valuable water supply in the deep bedrock and alluvial aquifers. Many water providers in the Denver metropolitan area have begun to notice significant declines in both well yields and water levels. With declining well yields, additional wells are needed to meet existing demand, placing further stress on this nonrenewable supply. Alluvial aquifer supplies are replenished by surface water and are considered renewable supplies. However, Colorado's water rights system requires that alluvial groundwater wells do not impact more senior water users, which requires additional planning and storage. Because of these challenges, many water providers are beginning to diversify their water supply portfolios to include renewable surface water rights. The combination of groundwater and surface water supplies presents operational challenges, but provides system flexibility with opportunities for blending water sources, aquifer storage and recovery, and drought protection. In order for municipalities to meet the future demands, regional cooperative planning is required as well as innovative use of existing groundwater infrastructure and supplies. In this presentation, case studies of collaborative planning will be presented, as well as successful endeavors of using groundwater to help diversify water portfolios. Also discussed will be strategies used to improve the reliability of existing groundwater supplies as well as to help municipalities plan for future growth, such as blending low total dissolved solids (TDS) groundwater with higher TDS surface water to minimize or reduce the need for reverse osmosis treatment, aquifer storage and recovery, and using groundwater for base flows while peaking off renewable surface water.

Hyperalkaline Mineral Waters of Zlatibor ultramafic massif in Western Serbia, Europe - Dejan Milenic, Hydrogeologist, Belgrade, Serbia (co-authors: V. Dragisic, M. Vrvic, Di. Milankovic, A. Vranjes)

Part of groundwater with pronouncedly high pH values (>9.5) is called hyperalkaline, and because of its balneologic properties it is classified into a group of healing mineral waters. The origin of hyperalkaline waters in fresh and partly serpentinite ultramafite is explained by current serpentinizing of primary unhydrated minerals (olivine, enstatite and diopside) and by forming of chrysotile-lizardite serpentine rocks. On the basis of investigations carried out so far it has been determined that the process of harzburgite and lherzolite serpentinisation (contemporary serpentinisation) is currently occurring. Adequate changes in chemical composition of ground water accompany geological processes of this kind. Hyperalkaline mineral ground waters of Serbia are mostly related to the ultramafic massif of Zlatibor, i.e. to its western part. The mentioned region is a true oasis of these rare ground waters of which some are used for balneologic purposes (Kamišna reka and Ribnica). According to their chemical composition these waters are characterised by the presence of calcium-hydroxide (Ca-OH), and pH values ranging from 11.20 to 11.80. Discharging of hyperalkaline waters is followed by free gases (CH₄, H₂, N₂). The Zlatibor ultramafic massif is situated in the ophiolitic belt of the Inner Dinarides of Serbia. The Zlatibor ultramafic massif with the surface of about 800 km² is one of the largest in Europe. This massif is a plate shape body whose thickness reaches 1000 metres. Owing to the intensive surface decay during the Palaeogene, the decaying crust with the thickness of about 40 metres was formed on these rocks. Besides Serbia, hyperalkaline mineral waters are known in only a few countries in the world. They are: the USA (California and Oregon), Jordan, Oman, Greece, Bosnia & Herzegovina, Bulgaria, New Caledonia and the Philippines. The number of occurrences and pH values as well, and hyperalkaline water temperatures vary among themselves. Among the most alkaline, there are waters in the region of Jarmuk in Jordan and waters in California (the USA). The survey of chemical composition of these

waters, the description of the formation conditions, their biological significance and the impact on health are given in this paper.

Is Nitrate Contamination Likely in Private Wells in the Glacial Aquifer System? - Kelly Warner, U.S. Geological Survey, Urbana, IL (co-authors: Kelly L. Warner, Terri L. Arnold, George E. Groschen)

Vulnerability of private wells to nitrate contamination is a concern for an estimated 17 million people using private wells in the glacial aquifer system, although less than 5 percent of private wells sampled in this study had nitrate concentrations greater than 10 mg/L as N. This study is part of the USGS National Water-Quality Assessment program reporting on principal aquifers. Background concentration of nitrate in the glacial aquifer system was less than 1 mg/L as N. Samples from private wells were a mixture of old and young water, regardless of depth, but wells with a significant fraction of young water (post 1953) had a higher median nitrate concentration than wells with predominantly old water (pre 1953). Additionally, the wells with young groundwater were more likely to have measurable dissolved oxygen indicating oxic conditions, under which nitrate is stable and mobile. Nitrate concentration was low relative to USEPA's Maximum Contaminant Level of 10 mg/L as N, but concentrations were variable over short distances and with depth. The heterogeneity of the aquifer materials and the subsequent effect on redox and transport of nitrate is a major factor affecting nitrate concentration. A series of logistic regression models was developed to estimate the probability of nitrate concentration greater than thresholds ranging from 1 to 10 mg/L as N, by increments of 1 mg/L. The significant predictors for nitrate concentrations greater than 4 mg/L as N included well characteristics, such as open-interval diameter, depth to the top of the open interval, and depth to water table. Environmental variables in the models were the average percentage of silt in soil and the soil type. The 10-year average (1992-2001) of farm-applied nitrogen fertilizer was included as the potential source variable for models greater than 4 mg/L, but was not significantly correlated to nitrate concentrations. A linear regression model was developed to predict nitrate concentrations in groups of wells (networks). The linear regression model incorporated the same variables as the logistic regression model, but the variables were averaged for a network. The use of network averages resulted in a model with better fit at this regional scale.

Arsenic in the Chamokane Valley Aquifers – Michael Klisch, Golder Associates Inc., Redmond, WA, (co-authors: Bryony Stasney, Alex Dailey, Robert Anderson,)

Golder Associates is working with the U.S. Indian Health Service's Spokane District Office and the Spokane Tribe of Indians to characterize hydrogeology and identify options to address elevated arsenic levels above the new Environmental Protection Agency (EPA) Maximum Contaminant Level (MCL) for arsenic of 0.01 mg/L for two water systems that are owned and operated by the Spokane Tribe. The two systems are located on the Spokane Indian Reservation, in northeastern Washington. Both systems withdraw water from wells located in the Chamokane Valley. The Indian Health Service and Spokane Tribe selected a phased approach for the project: Phase 1 – identify arsenic source(s), characterize the local hydrogeology to support new well siting and conduct a preliminary assessment of options to meet arsenic standards; Phase 2 – if new sources appear feasible, confirm potential new well sites through the installation and development of test wells and/or testing existing wells, and develop plans and cost estimates for installation of production wells and delivery of an adequate supply of good quality water to the two systems; and, Phase 3 - if new sources do not appear feasible, assess arsenic treatment alternatives and provide recommendations for the appropriate technology or technologies to implement. At the time of writing this abstract (May 2009), Phase 1 is complete. It is anticipated that Phase 2 will be complete by November 2009. The Phase 1 study results indicate that: elevated arsenic is associated with the lower Chamokane Valley aquifer; arsenic occurs naturally within these sediments; redox and pH conditions are favorable for arsenic release into solution; and, the most likely release mechanism for arsenic is oxidation of sulfides containing arsenic and dissolution of arsenic. Ongoing work has identified sites that have the potential for installation of wells to produce water with low arsenic levels. These sites have been selected for further investigation by balancing the potential for better quality water with the cost to develop a new source.