American Water Resources Association
2007 ANNUAL WATER RESOURCES CONFERENCE
November 12, 2007 – November 15, 2007

Tuesday, November 13
10:30 AM – 12:00 Noon

POSTER 4: Aquifer Storage and Recovery

1. ASR Implementation: Techniques for Improving Success - Leslie Turner, CDM, Maitland, Fl (co-authors: Barika Poole, Lee Wiseman, Doug Munch, Glenn Forrest, W. Kirk Martin)

ASR has become a major component in water resource management initiatives and plans in Florida and other areas around the world. Despite the focus and reliance on this important management tool, there have been challenges in developing ASR due to poorer rates of water recovery and undesirable water chemistry changes. In some cases, failure to achieve a successful ASR system has been the result of inappropriate storage zone selection. Recent applications of a number of specific diagnostic tools and methods have been shown to significantly improve probability for development of a successful ASR system. This paper describes some of the tools shown to be most useful in ASR implementation and how they were applied in selecting the storage zone for a central Florida ASR project. Selection of an ASR storage zone, where mixing of injected potable water with native water would be minimized, will result in greater local storage capacity and higher recovery efficiency. Ideally, the storage zone for this type of ASR system should have native water chloride concentrations in the 250 to 1,000 mg/L range. The storage zone should have a transmissivity and well specific capacity to efficiently accept the target well capacity. Flow into and out of the storage zone should be largely from matrix flow. Adequate confinement above and below the proposed storage zone is needed to minimize vertical flow into and out of the storage zone. The potential for adverse reactions between the storage zone rock and native water should be carefully considered and minimized to the greatest extent possible. The test program for the project site included specialized drilling and well construction methods, geophysical logging analyses, field and laboratory testing, bench-scale studies of geochemical reactions between aquifer matrix materials and various qualities of injectate, and hydrologic and chemical modeling. Application of key diagnostic methods was critical to the identification of unique site characteristics and development of specific design considerations. As ASR is increasingly utilized in regional and local water management strategies, use of these tools will become important to ASR system siting, design, operation, and critical go / no-go decision points.

2. Results of a Regional Underground Water Storage Study in Colorado - Gordon McCurry, CDM, Denver, CO (co-authors: Andy Horn, Nathan Smith, Andy Moore)

Increasing population in Colorado and recent years of drought has placed an ever greater strain on Colorado's water resources. In addition to increasing water conservation and water reuse, there is a need to increase water storage. Due to increasing difficulties with building surface water storage reservoirs, there has been a growing interest in storing water underground in natural reservoirs associated with groundwater aquifers. The State of Colorado is actively working to manage its water supplies in a sustainable and environmentally beneficial manner. To identify areas which could be used for underground water storage, Colorado State legislature directed the Colorado Water Conservation Board (CWCB) to evaluate potential underground water storage areas within alluvial and bedrock aquifers located within the South Platte and Arkansas River Basins. These basins comprise the eastern half of Colorado. The study included developing criteria and weighting factors by which to evaluate potential storage sites, compiling and mapping relevant information for each of the evaluation criteria, and identifying the highest-ranking sites in each basin and aquifer setting. The criteria included ten hydrogeologic, environmental and implementation considerations. The technical analysis was based on available data and information from published reports from federal and state agencies, universities, and local water management districts, from water resource databases and from unpublished information provided by over 50 local water experts. The aquifer regions were subdivided in 44 areas for detailed analysis. This evaluation showed that a number of areas for potential underground water storage exist in both basins, in both alluvial and bedrock settings. Alluvial aquifer areas located away from the South Platte and Arkansas Rivers scored the highest due to larger storage volumes and longer residence times. Several bedrock aquifer areas also received high scores due to their suitable characteristics for infrastructure, proximity to demand and minimal adverse impacts despite scoring low on the hydrogeologic characteristics. Further investigations on a more local scale along and an examination of several issues that were not considered in this study were recommended. The results of this study were submitted to the State legislature and will serve as the foundation for additional study.

3. Modeling Aquifer Storage: Options for Albuquerque's San Juan-Chama River Allotment - Steven Archambault, University of New Mexico, Albuquerque, NM (co-author: Bishwa S Koirala)

This research uses a simulation model to explore the impacts on Albuquerque's water supply if the city were to store a portion of its San Juan-Chama diversion water by injecting it underground into the aquifer. This modeling approach aims to demonstrate the optimal levels of pumping and injecting over time, considering society's welfare from water includes consumption levels and costs of consumption. Costs are considered to come from the processes associated with pumping, injecting, and using water directly from diversion. The model provides a simulation of the impact injection, along with groundwater pumping, would have on the level of the aquifer. This is a hybrid model, as the dynamic hydrologic conditions such as rates of recharge, evapotranspiration, and groundwater flows impact the economic decisions to pump water from and inject water into the aquifer. Namely, this model takes into account increasing costs of pumping as the level of the aquifer decreases. Such research is important for water policy decisions being made in Albuquerque, particularly as the 48,200 acre-feet of San Juan-Chama water is now beginning diverted from the Rio Grande River to supplement the City's primary reliance on groundwater for urban consumption. Water injection has been considered as a possible medium or long range strategy for the most appropriate use of the diversion water. The plan would call for water to be stored in the aquifer during times of low urban demand, to be available in times of greater scarcity. Injection could also replenish the aquifer faster than would occur naturally. This modeling gives policy makers insight into how different management strategies will impact the short, medium, and long range supply of water resources. Developing the most sustainable approaches for using Albuquerque's water resources requires demonstration and discussion of all available management strategies. This model could be extended to other locations where the use of aquifer storage and recovery systems is a potential solution for developing a sustainable use strategy of surface water or treated wastewater.

4. Numerical Simulation of a Proposed Artificial Recharge System - Eric Margrave, California State University Northridge, Santa Clarita, CA (co-authors: Lance Eckhart, M. Ali Tabidian)

The Mojave River groundwater basin, located approximately 70 miles northeast of Los Angeles has experienced rapid growth in population and, consequently, an increase in the demand for water. Groundwater demand within the semi-confined regional aquifer, which consists of predominately alluvium and fan deposits, has caused documented overdraft conditions within the local regional aquifer over the last several decades. The Mojave Water Agency has proposed an enhanced recharge program, within the City of Hesperia, consisting of spreading grounds using State Water Project water by way of the California Aqueduct. In an effort to better understand the effect of recharge on the regional aquifer within the Antelope Valley Wash, a numerical groundwater flow model of a portion of the Mojave River groundwater basin was developed. The groundwater flow model was calibrated using data from previous reports and recent aquifer tests within the City of Hesperia. The model simulated the change in water levels from 1990 to 2030 using several recharge scenarios. The three recharge scenarios, from 3000 to 9000 acre-ft per year, were then simulated over stress periods ranging from 5 to 23 years. Although all three volumes of recharge affect the regional aquifer, the increase in volume of recharge does not seem to directly correspond with higher regional water levels at significant distances away from the recharge basins. The limited effect may be due to ponding within the spreading basins, which would in effect negate the larger volumes of recharge and seem to indicate that the optimum volume of recharge would be approximately 6000 acre-ft per year. The extent of the effect of recharge was limited to an approximate three to four mile radius, mostly down gradient of the spreading grounds. These results are consistent with previous studies which indicate that at least three separate locations (northwest and northeast of Antelope Valley Wash) of spreading grounds will be necessary to recharge the regional aquifer and reverse the effects of overdraft conditions in a timely manner.

5. Strategies for Groundwater Extraction in an Area with a Complex Spatial Planning and Enough Surface Water - Ritsche Anne (Rian) Kloosterman, Vitens, Meppel, Netherlands

Managing groundwater resources in the Netherlands Vitens is the largest water company in the Netherlands and supplies high-quality drinking water to over five million domestic and industrial consumers in more than 1/3 of the Netherlands. Groundwater is our preferred and most used resource for the production of more than 350 million m3 per year (Mm3/y). We want to be recognised by our customers, the public, our staff and our shareholders as a leading water company which operates in a sustainable way on the basis of sound principles of corporate social responsibility. Sustainable extraction of groundwater in a crowded land, with European ecological guidelines and ambitions, a lot of historical pollutions (agriculture, industries etc) requires a creative way in managing the groundwater resources. Furthermore the fact that there is enough good surface water in our area, makes it clear that it is very difficult to get permission to extract groundwater. Managed Aquifer Recharge is applied in various ways to realize the extraction of groundwater: • Compensation of the negative effects on the environment by infiltration and recharge of surface water. • Bank infiltration. • Compensation of water balance deficiencies by surface water. Compensation by storage of storm water runoff. • Combination of water extraction with other functions (recreation, nature, extensive agriculture). • Infiltration of brackish/salt water in deep aquifers. • Reuse of treated sewage water on 4 isles in the Waddenzee In the presentation I'll explain our strategies by examples.