APPLYING AQUIFER STORAGE RECOVERY TECHNOLOGY TO ADDRESS WATER RESOURCE CHALLENGES IN DIFFERENT COASTAL PLAIN SETTINGS

Christopher Paul Foldesi, P.G.¹, Richard K. Spruill, P.G., PhD², and James K. Holley, P.G.³

ABSTRACT. Aquifer Storage Recovery (ASR) technology is becoming an increasingly important groundwater management tool in the southern Atlantic Coastal Plain. Groundwater in the coastal aquifers of the Carolinas is the predominant source of water supply for public, agricultural, and industrial purposes, and its sustainability is threatened by increasing demand, saltwater intrusion, and limited freshwater recharge. ASR provides the opportunity for water users to store treated drinking water and manage water resource demands that often vary seasonally. In addition, ASR has many secondary benefits, such as the potential to reduce disinfection by-products during storage, improve regional groundwater levels during seasonal to long-term storage periods, and locally reduce the effects of saltwater intrusion. The local hydrogeology is a major consideration for the implementation of ASR projects. The development of sand aquifers as storage zones, such as those contained in the Cretaceous Aquifer System, requires great care to avoid potential well-plugging issues during recharge/recovery operations. Local aquifer-matrix geochemistry can dramatically affect the condition of the recovered water after storage, and pre- or post-treatment measures may be required to make the project successful. Clays naturally occurring in aquifer-storage zones can also present problems to ASR recovery operations. Regulatory requirements can be dramatically different for ASR programs in different states and/or groundwater districts. We present several ASR projects in the Coastal Plain of North and South Carolina in different hydrogeological and regulatory settings. These projects have had their own challenges and secondary benefits, although the primary goal for each is seasonal storage. Greenville Utilities Commission (GUC), in Greenville, North Carolina, was the first ASR project in North Carolina, and the project has been a learning experience for both GUC and the regulatory community. Hilton Head Public Service District, Hilton Head, South Carolina has implemented an ASR project and has gone from a feasibility study to the recovery of ASR water to the distribution system in less than 2 years time. Orangeburg Department of Public Utilities has also brought two very productive Cretaceous Aquifer System ASR wells into operation in a relatively short timeframe. South Island Public Service District at Hilton Head, SC is concurrently pursing the development of brackish groundwater supplies and a new ASR program to offset the loss of Upper Floridan Aquifer wells to saltwater intrusion. We will present lessons learned from each of these projects and propose new ways of streamlining development and lowering costs.

INTRODUCTION

ASR is the practice of storing and recovering water in a suitable aquifer through a well and has been utilized as a water management technology in the United States of America since the late 1960’s (Pyne, 1995). Increased competition for water resources in the southeastern United States is creating greater interest in the use of this technology as water users look for solutions to problems with increasing demands, seasonal shortages, water quality issues, and saltwater intrusion.

In South Carolina this technology has been utilized successfully at several locations. The South Carolina Department of Health and Environmental Control (SCDHEC) considers the Myrtle Beach ASR Program to be an early success story for ASR in South Carolina, as water levels were rapidly declining in the Waccamaw Capacity Use Area prior to the application of ASR, which allowed for the seasonal storage of treated surface water along with a dramatic improvement regional water levels. Several other ASR projects in South Carolina have provided seasonal and/or long-term storage for
water providers and also achieved secondary objectives, such as locally improved distribution system pressure. Public water suppliers, industry, and agriculture should take note of the powerful opportunities that ASR provides.

**BACKGROUND**

Water purveyors who are interested in ASR usually get started by performing a feasibility study, which investigates the primary and secondary applications for the project, possible site locations and issues that may arise at each site, and the local hydrogeology. The most common primary application for ASR projects is the seasonal storage of treated drinking water, which can provide for the deferment of expensive expansions of raw water sources and/or treatment facilities. Long-term and emergency storage are also common applications of the ASR technology (Pyne, 2005).

It is common for water suppliers to achieve secondary applications of ASR including disinfection by-product reduction, restoration of local groundwater levels, improved distribution system pressure, and the prevention of saltwater intrusion (Pyne, 1995).

The choice of potential site locations is usually related to their location within the distribution system, the local hydrogeology, regulatory restrictions and guidelines, and the location of potential contaminants.

The local hydrogeology can dramatically affect the success of an ASR program. Potential sites are usually investigated through the collection of cores in both potential storage aquifers and the confining units that separate them. Cores can be sent to laboratories for analyses that test for mineral content and hydraulic properties. Test wells and monitoring wells are usually constructed to provide an initial understanding of the potential yield and water quality of potential storage aquifers. The results of initial site testing are typically incorporated into further analyses such as geochemical models, which can identify potential geochemical reactions that may occur between the aquifer matrix and/or native groundwater, and groundwater models that address the hydraulic limitations of the storage aquifer.

The regulatory environment can also greatly affect the costs and time it takes to implement an ASR program. Different states will require different types of testing, different numbers of test/monitoring wells, and have different requirements for recovering water to the distribution system.

**PROJECT DESCRIPTIONS**

Each ASR project will have its own objectives and site specific issues that often steer the direction and development of the project. Here we discuss several ASR programs in the Coastal Carolinas.

**Greenville Utilities Commission** (GUC) located in Greenville, North Carolina began a feasibility study in 1999, which investigated the potential for the seasonal storage of treated drinking water in the Cretaceous Aquifer System (CH2MHill, 1999). The GUC started the first ASR project in North Carolina and has had some difficulty in being the first to deal with the regulatory requirements of North Carolina.

The enactment of the Central Coastal Plain Capacity Use Area had recently curtailed GUC’s future groundwater capacity and led GUC to investigate the use of ASR as a water management tool. The primary objective of the GUC ASR program is the seasonal storage of excess treated drinking water produced from the Tar River Water Treatment Plant (WTP) during off-peak periods when demands are low. The stored water can be recovered during periods of peak demands, which may exceed the capacity of the WTP. The GUC ASR program is expected to defer potential future expansions to the WTP and will ultimately be long-term costs savings for GUC. GUC has constructed and tested two monitoring wells, an ASR well, and a secondary recovery at a site located northeast of Greenville (GMA, 2002). The ASR wellhead facilities have also been constructed and tested. The storage aquifer consists of unconsolidated sandy deposits in the Cretaceous Aquifer System. Cycle testing has identified the presence of kaolinite clays in the recovered water, which have caused a turbidity problem. GUC is currently addressing this issue.

**Cape Fear Public Utility Authority** (CFPUA) provides water to the City of Wilmington and residents of New Hanover County in North Carolina. The CFPUA uses the Cape Fear River as its primary source of raw water supply and also has a large wellfield in the northeastern portion of New Hanover County. Both of these raw water resources are treated at WTPs and projected demands are expected to exceed their capacities in the future.

The CFPUA has identified seasonal storage, the deferment of WTP expansions, the reduction of capital costs, and improvement of water quality as their objectives for the development of their ASR program (ASRS and GMA, 2004). The CFPUA initially performed a core collection to depth of 650 feet beneath the land surface and test well program at the Westbrook site. A large diameter (20-inch) ASR has been constructed into the upper Peedee Aquifer and tested at rates that exceed 1000 gallons per minute (gpm). The
CFPUA has been required to construct several monitoring wells to address the potential location of the stored ASR water and the potential impacts to overlying aquifers. The CFPUA is currently working towards completion of the ASR wellhead facilities at the Westbrook site.

The Orangeburg Department of Public Utilities (DPU), located in Orangeburg, South Carolina, has developed two high capacity ASR wells in the Cretaceous Aquifer System. Recovery rates for the two ASR wells are designed for up to 3.5 million gallons per day (MGD) from ASR Well #1 and 3.0 MGD from ASR Well #2 (GMA, 2008). The ASR wells are located at the Orangeburg WTP, which treats surface water from the North Fork of the Edisto River. Orangeburg DPU’s primary objective is emergency/seasonal storage of treated drinking water produced from the WTP. The river experiences periods of both low flow and poor quality. The Orangeburg DPU utilizes stored water from the ASR wells during these periods. The Orangeburg DPU has completed cycle testing and is regularly storing water and recovering it to the distribution system.

Hilton Head Public Service District (HHPSD) has implemented an ASR program in record time (David Pyne, oral communication, 2011). The HHPSD began its ASR feasibility study in 2009 and first recovered water to the distribution system in 2011. A large capacity ASR well was completed into the Middle Floridan Aquifer (MFA), a limestone/dolomite aquifer, that is capable of recovering water at rates that exceed 2,000 gpm (Figure 1). SCDHEC allowed for a period of interim recharge after the ASR well was initially completed at the Royal James site, which was prior to the completion of the ASR wellhead facilities. This allowed the HHPSD to store a substantial amount of treated drinking water and to get an early start on cycle testing as soon as the wellhead facilities were completed. Last year the HHPSD stored more than 300 million gallons of treated drinking water into the Royal James ASR well and began recovering substantial amounts of water to the distribution system over the summer of 2012.

The HHPSD initiated their ASR program in response to increasing losses of raw water supplies due to saltwater intrusion. The ASR program allows the HHPSD to both purchased and produced water at low rates during off-peak periods, which can be used to meet peak demands in summer months. The Royal James ASR is located in an area that has experienced distribution system pressure problems during periods of peak demands. The ASR well is now providing additional pressure to this area of the distribution system during recovery periods.

South Island Public Service District (SIPSD) has recently implemented an ASR program that also looks to utilize the MFA as a storage zone. The SIPSD has also had problems with saltwater intrusion that has led to the loss of raw water supplies. SIPSD has a WTP that treats water from a deep (greater than 3,000 foot) well completed in the Cretaceous Aquifer System. The development of an ASR program will allow SIPSD to divert excess water produced during off-peak periods to storage that can be used to meet peak demands during summer months. The ASR wells will also improve distribution system pressures in areas that have recently lost wells to saltwater intrusion. SIPSD expects to begin ASR well construction in the Fall of 2012.

CONCLUSIONS

Water purveyors can look to the ASR technology to assist them in meeting the growing demands of the future. Although ASR is not a source of water, it is a powerful water management tool. Often expensive raw water development projects and/or water treatment facility expansions can be delayed or avoided when ASR is utilized to manage seasonal, long-term, and emergency demands.

Secondary applications of ASR are diverse and often very helpful for water providers as they try to meet the increasingly demanding requirements of the regulatory community and other issues. ASR should have a long and successful future in Carolinas.

ACKNOWLEDGEMENTS

GMA would like to recognize ASR Systems, LLC, B.P. Barber and Associates/URS, the Hilton Head Public Service District, the South Island Public Service District, the Greenville Utilities Commission, the Orangeburg Department of Public Utilities, and the Cape Fear Public Utility Authority for their contributions to these projects and our knowledge of ASR.

LITERATURE CITED


