Are we Helping or Hindering Development of our Future Water Resources?

By

Mark B. McNeal, P.G.
CH2M HILL, Tampa FL

R. David G. Pyne, P.E.
CH2M HILL, Gainesville FL

John Powers, P.G.
CH2M HILL, Tampa FL

Abstract

In 1974, Congress implemented the Safe Drinking Water Act (SDWA), in part to protect our Country's existing and future sources of drinking water. In 1981, the Underground Injection Control (UIC) program was established pursuant to the SDWA and is administered by the US Environmental Protection Agency (EPA). The federal UIC program established the term "Underground Source of Drinking Water "(USDW) to provide higher levels of protection to aquifers containing, among other criteria, groundwater with less than 10,000 mg/L total dissolved solids. In Florida, the EPA has delegated the UIC program to the Florida Department of Environmental Protection (FDEP), which through state rules has added additional "safeguards" to "protect" our future potential drinking water supplies. A good legal case has been proposed by others that the provisions of the UIC regulatory program, as currently implemented in Florida, are inconsistent with the original Congressional intent.

Alternative water supply projects, through Aquifer Storage Recovery (ASR) and other technologies, must be developed to meet the increasing demands on our available water resources. The intent of Congress was never to preclude the development of our water resources yet, through the regulatory web that has been woven, development of alternative water resource programs, even on a small scale, is in serious jeopardy. This paper lays out the regulatory framework that exists, presents examples of some of the current regulatory issues as applied to specific projects, and proposes innovative technical and regulatory solutions to developing our future freshwater resources.

Introduction

Alternative water supply projects are under development in Florida. Florida's freshwater resources are being stressed to the point where innovative technologies are under development to quench the thirst of its residents. Desalination, large above-ground reservoirs, urban reuse, and Aquifer Storage Recovery (ASR) projects using potable water, partially treated surface water, untreated groundwater and reclaimed water are in various stages of development and operation. Creative solutions are needed to develop sustainable water supplies to meet present and future demands.

Innovation is not readily embraced by the public or (quite often) many regulatory agencies. If projects do not fit neatly and precisely into a well defined regulation, permitting becomes difficult, expensive, time consuming, and as such, in some cases impractical. This often delays well-conceived projects to the point that utilities responsible for developing sustainable water supplies for their customers turn to more routine water supply projects to avoid the uncertainty new concepts inevitably present. Few utilities are sufficiently courageous to pave the way with a new technology, spending taxpayers dollars without guarantee of success. This is unfortunate because, as a society, we must develop more creative solutions to water resource problems if our relatively finite water supply is to be relied on to meet competing uses in the future.

ASR projects are becoming increasingly more relied upon to meet water supply shortfalls in Florida. Florida is believed to have substantially more non-potable (e.g., reclaimed water, partially treated surface water, and stormwater) ASR projects in various stages of development than any other state. Many large urban reuse systems are "built-out" while utilizing only about 50 percent of the available resource because of the seasonal imbalance between supply and demand. Florida is fortunate to have brackish water aquifer systems with substantial capacities to allow their serious consideration for storage of non-potable resources. Florida has an excellent historical record for matching the intended use of the available resource with the level of treatment necessary to protect public health without overburdening the consumer with unnecessary treatment that results in no measurable benefit.

As more of these alternative water supply projects move through construction and operational permitting, it is becoming increasingly clear that state rules do not adequately address risks versus benefits. Many current regulations are overly restrictive to the point that freshwater supplies continue to be discharged and lost unnecessarily to tide, whether as groundwater or surface water. Rules were developed long before the ASR concept became well known. ASR wells are regulated as if they are hazardous waste receptors, with no relief based on the water resource benefit that the project can provide. Pilot projects can not be constructed and tested on a small-scale to help answer the many questions that multiple regulatory agencies and the public have raised, having the net effect of stalling these programs. If ASR systems were allowed to demonstrate that water quality excursions could be dealt with effectively during storage and in a very localized portion of the aquifer, most issues that are continually raised today would have been already decisively resolved. Too often the regulatory "what if" syndrome has stalled or killed programs because the answers could not be developed without system operation. This is resulting in many cases of protection of a "resource" for some potential future use, when a current use of equal or greater value is available for development today.

Holistic Approach to Water Quality Assessment

Far too often aquifer degradation is suggested solely because a primary or secondary drinking water standard is not reliably maintained in a proposed recharge water. While it is certainly important to characterize the recharge water and understand the possible impurities present, the presence of such impurities does not necessarily represent a public risk or a possible source of aquifer degradation. More often, if not always, the proposed recharge water is much better overall than the ambient aquifer quality. The entire quality of the recharge water must be evaluated relative to the native water quality, and the ability for each source water's use as a future resource must be assessed. The following example is presented to help illustrate this point.

The Englewood Water District (EWD) in Southwest Florida has constructed an ASR well for the storage of highly treated reclaimed water. A very comprehensive assessment of the reclaimed water has been conducted, and color is the only parameter in the reclaimed water that does not meet drinking water standards or, for the secondary standards, may be poorer than ambient groundwater quality. Average color in the reclaimed water is approximately 24 mg/L color units, relative to the state standard of 15 units. The storage zone contains ambient water quality of approximately 20,000 mg/L Total Dissolved Solids (TDS). The recharge water could potentially migrate into a zone containing (in an unstressed and "natural" state) approximately 9,700 mg/L TDS. FDEP therefore considers this to be an Underground Source of Drinking Water (USDW) purely because this zone is less than 10,000 mg/L. With the proximity of poorer quality water in the lower portion of this permeable zone, it is highly unlikely that a well constructed to this depth could provide a sustainable source of 10,000 mg/L feed water or less. The EWD utilizes brackish water from this zone (several miles away) as a source of feed water for its Reverse Osmosis (RO) Water Treatment Plant (WTP) where the zone provides feed water in the 4,000 mg/L to 8,000 mg/L TDS range. The EWD would not consider development of the brackish water resources at this depth because of the poor quality water present under unstressed conditions. Substantial historical data is available that shows the TDS from the RO supply wells increases considerably (usually approximately doubling) within a few years of operation of the supply well. Starting with a 9,700 mg/L source water, with the expectations of keeping the water quality below 10,000 mg/L TDS, would be poor engineering practice.

Since EWD is responsible for drinking water supplies in this area, in addition to reclaimed water and wastewater service, more serious consideration should be given to EWD's position on development of this zone to seasonally store excess reclaimed water for future beneficial use. EWD, as is the case with other utilities tasked with providing potable water supplies, would not do anything to jeopardize future brackish water resources in this area; in fact, it is solely because they are attempting to optimize all available water resources that they are developing the reclaimed water ASR program at this site. The more routine path forward would have been to install a deep injection well and dispose of this resource when excess supply was available, but this was not viewed by EWD as a wise use of the resource. EWD's program will move ahead, but has been stalled for an estimated 9 to 12 months while a state variance called a Water Quality Criteria Exemption (WQCE) is obtained for the "elevated" color. EWD believes this is an unnecessary process as color is purely aesthetic and would have no impact on the treatability for use as a public water supply if needed in the future. In reality, the EWD objective for this ASR system is to develop a long-term supply of reclaimed water for irrigation purposes, smoothing out seasonal and long-term imbalances between supply and demand.

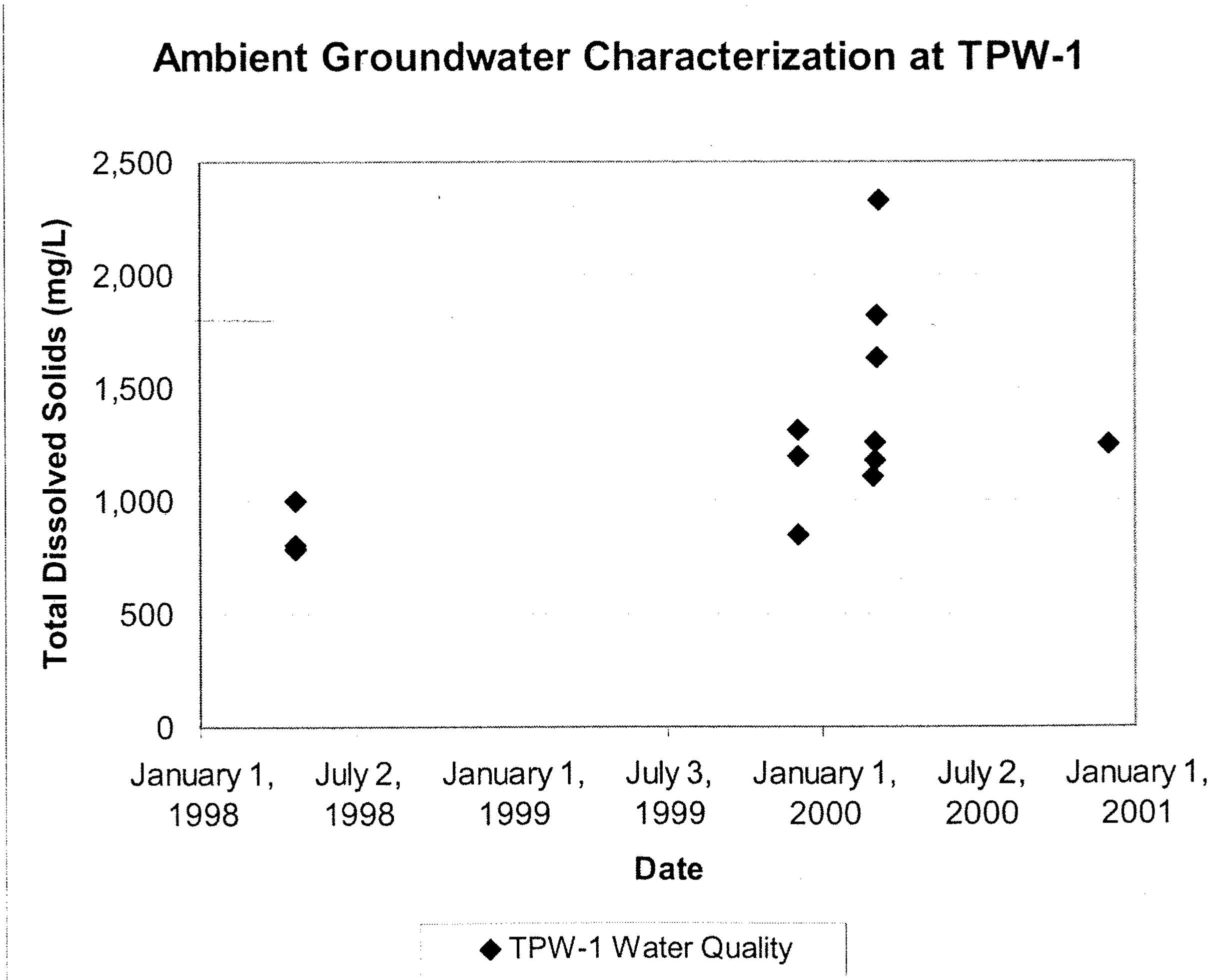
If a primary drinking water standard is not met in the recharge water, the permittability and therefore feasibility of the ASR program is questionable under current regulations. An aquifer exemption is currently required to provide regulatory relief of putting any "contaminants" or impurities into the aquifer that exceed primary drinking water standards.

This is too severe of a rule and is hindering development of many water resources project that have serious merit. For example, there is considerable data available that Total Trihalomethanes (TTHMs) dissipate with storage time in most, if not all, aquifers. In the case of Hillsborough County's reclaimed water ASR program, the County was required to add ammonia to its wastewater that undergoes high level disinfection. This is necessary because TTHMs can be as high as 150 μg/L in the treated wastewater by the time it arrives at the reclaimed water ASR site. A few miles away, at the City of Tampa's potable water ASR system, the rapid reduction of TTHMs during storage time is well documented for the same storage zone, decreasing from approximately 80 μg/L to less than 10 μg/L within 1 to 2 months or less. The County should have been allowed to test the aquifer's ability to treat the water on a small pilot scale to demonstrate the site specific ability to control this parameter near the ASR well. The recovered water from the ASR well and a storage zone monitoring well 370 feet away would provide adequate data to make this demonstration. Other aquifer treatment (based on more limited data) is an aquifer's ability to reduce coliform, phosphorus, nitrate and nitrite, among other constituents.

Background Water Quality Determination

Significant debate is ongoing as to the appropriate method to establish background (ambient) groundwater conditions. This is important because the ambient groundwater quality affects the permitting requirements for groundwater recharge projects. In Florida, aquifers with groundwater TDS concentrations of 1,000 mg/L, 3,000 mg/L, and 10,000 mg/L are provided various levels of protection. In addition, a bill is being proposed this year to allow recharge of water containing coliform under certain conditions, into aquifers containing greater than 1,500 mg/L TDS, adding yet a fourth TDS isopleth for regulatory consideration. FDEP maintains that the initial sample collected from the well is representative of background conditions and that any subsequent samples would not be representative since a stress has been placed on the well. In other words, they maintain that the aquifer should be characterized in an "undisturbed" state. It is not possible to collect an "undisturbed" sample because the very act of drilling the well and collecting the sample, no matter how passive, disturbs the natural system. Furthermore, FDEP contends that the aquifer must be protected in the event a potential future domestic well owner who would use no treatment desires to develop a well and pump 2 gallons per minute (gpm) or less. In contrast, much of the regulated community contends that the well should be pumped for a "reasonable rate and for a reasonable duration for the intended use, from a well completed into the zone under consideration". Furthermore, FDEP maintains that the background water quality determination for the well cannot change, even if saltwater intrusion is known to be occurring in the area.

The current debate in Hillsborough County offers an example to compare the two sides of this argument. Figure 1 shows TDS data collected to date from the County's reclaimed water ASR well that was completed in early 1998 at a site which is relatively close to the shoreline of Tampa Bay. A 10-hour pump out test on the newly completed ASR well was performed to collect limited water quality data and well hydraulic data to assist with the vertical pump design for the well. During this initial 10-hour withdrawal test, TDS increased from approximately 780 mg/L to 1,000 mg/L. The initial samples from this 10-hour test were very possibly affected by the limited well development that occurred prior to collection of the sample, and possibly impacted by drilling operations. The County followed with a 6-day aquifer test, which saw the TDS in the well climb from 1,100 mg/L at the end of the first day to 2,300 mg/L at the end of 6 days. The well was pumped at a rate of 1,000 gpm, a typical rate for a golf course irrigation well or an RO supply well if this brackish resource was developed for either. The County had agreed to collect a sample on the fifth day of the aquifer test to establish background, a sample that was found to be 1,800 mg/L TDS. FDEP continues to maintain that the background in the well is 780 mg/L TDS and that a variance is necessary to allow this program to move forward. It is the County's position that this permeable unit is not capable of producing 1000 mg/L TDS water or less for any sustainable period of time for any realistic future groundwater use. Furthermore, an ordinance is already in place that would preclude any future private potable water supplies from being developed within 1 mile from this project location. Once again, a variance or exemption process is being unnecessarily required to complete the operational permitting of this project prior to beginning cycle testing activities.



Economic Aquifer Sustainable Yield (EASY)

As a method of establishing a quantitative evaluation as to the likelihood of a future potential groundwater user, the authors offer the term "Economic Aquifer Sustainable Yield". The EASY value for a well is defined as the estimated cost of a well for a specific purpose, divided by the sustainable yield of the well when used for the same purpose. A well's EASY index is presented in units of cost per flow rate, for example capital investment dollars per gallon per minute of installed capacity ($/gpm). Use of the EASY index to compare and contrast different aquifer uses could provide a degree of standardization to evaluate the probable use of the aquifer in the future. In general, the higher the EASY value, the less practical it is to develop the source of groundwater supply.

Table 1 provides a summary of EASY data compiled in southwest Florida. This table shows that EASY values in southwest Florida may be expected to range from approximately 20 to 200 US$/gpm in 2000. The more sophisticated wells which require more hydrogeologic testing fall on the high side of this range, while domestic and agricultural wells tend to be less expensive due primarily to the limited testing required during construction. Well costs include only the cost of the well; wellhead piping and other surface facilities, and engineering services (if necessary) represent an additional cost.

TABLE 1

ECONOMIC AQUIFER SUSTAINABLE YIELD (EASY) ANALYSIS IN SOUTHWEST FLORIDA – YEAR 2000 DATA

Well Owner and Use	*Well Diameter (inches)*	*Well Depth (feet)*	*Well Yield (gpm)*	*Well Cost (US$)*	*Economic Aquifer Sustainable Yield ($/gpm)*
Public – ASR	16	400	1,000	150,000	150
Public – Freshwater Supply (shallow)	8	100	100	20,000	200
Public – Freshwater Supply (deep)	24	700	2100	150,000	70
Public – Reverse Osmosis Supply	16	800	1400	200,000	140
Private – Irrigation (shallow)	2	30	10	800	80
Private – Irrigation (deep)	4	150	200	4,000	20
Private – Agricultural Irrigation	16	700	1,400	70,000	50
Private – Deep Domestic	4	150	50	5,000	100
Private – Shallow Domestic	4	75	20	2,500	125

Regulators have suggested that it is their responsibility to protect a deep aquifer system in the event that someone wants to develop a 2 gpm source of water for private domestic use, even if better quality and less expensive water is available from a shallower aquifer. It is difficult to find data to evaluate the EASY values of such wells, since there are few, if any, wells constructed that meet these specifications. A reasonable approximation of the cost of such a well in the case of the Hillsborough County ASR project area may be a 4-inch diameter well constructed to 400 feet in depth, a well that is expected to cost approximately $25,000 or more. This would result in an EASY value of $12,500/gpm which is 1 to 3 orders of magnitude higher than other realistic EASY values.

The EASY index is affected by a number of variables. Market conditions, inflation, regulatory requirements, site access, and native water quality are but a few of the factors. Even with these factors, however, this comparison offers an obvious illustration of how the optimum use of an aquifer can be subverted by overly narrow regulation interpretation. It can provide a reality check to help establish what a reasonable future use of the aquifer may be.

Summary

The future of Florida's water supply is becoming increasingly dependant on alternative sources of water such as that provided by ASR programs. The regulations governing ASR programs are antiquated and unrealistic. Economic hardships are placed on utilities attempting to develop these programs, with typical construction permitting taking a year or more to complete, even for potable ASR applications. In two instances, ASR permitting has extended for more than three years. When even one well-conceived and properly designed project is terminated due to an overly-restrictive regulatory process, many other promising projects will have a similar fate. The drought that much of Florida has experienced over the past two years has been devastating, and should provide a wake-up call for our state water managers and resource protectors. We were not prepared as a state entering into this drought, and will be even less prepared for the next serious drought without a serious change in the regulatory process governing ASR programs. More emphasis should be placed on local water leaders to manage their resources according to the needs of their current and future water customers.

FDEP and the water management districts should meet to expedite changes in the regulatory process to provide a more streamlined approach to permitting alternative water supply projects. The approach should weigh the environmental benefits of a project with the realistic potential risks that the project may present. We have done a remarkable job in the state in this regard for reclaimed water programs; it is now time that this same process be used to bring ASR permitting into the new millennium.