BY ARTHUR BRADFIELD

Ground Water: Tennessee's Liquid Gold

Erwin, Elizabethton, Decatur, and Athens Develop Ground Water Sources

It is widely known that public water systems in west Tennessee can rely on ground water as a source for potable water. However, many utility managers and city officials may not be convinced that a plentiful supply of ground water can be found in middle and east Tennessee, as well. Tapping into the source is usually not as easy as drilling wells in the sand formations of west Tennessee, but the benefits are worth the effort.

As president of Bradfield Environmental Services, Inc., I often find myself "on the stump" talking about the benefits of ground water. Because ground water does not fluctuate in quality like surface water, initial and long-term treatment costs are significantly lower. Filtration of ground water can usually be accomplished using direct filtration at considerable savings over the costs of conventional treatment of surface water. Ground water is less likely to be contaminated with man-made chemicals or organisms that cause disease, thereby providing a safer water supply for each customer.

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Ground water is more available than most people think. Of the world's fresh water, about 85% is in the form of ice sheets and glaciers. Of the remaining fresh water, about 15 percent is ground water. Less than one percent of the fresh water in the world occurs as surface water! That one percent includes all reservoirs, lakes, streams, rivers, soil moisture, and vapor in the atmosphere. (Basic Ground Water Hydrology, USGS Water Supply Paper #2220).

The following four case studies conducted by Bradfield Environmental Services, Inc. are provided to illustrate how public water systems in east Tennessee can save millions of dollars by developing their ground water resources. Wells capable of producing 750 to 1300 gallons per minute (about one to two million gallons per day) were located and developed for water systems serving Erwin, Elizabethton, Decatur, and Athens. These public water systems saved substantial amounts of money by avoiding conventional filtration of surface water supplies, building one treatment facility instead of two to filter spring supplies, and by avoiding expensive upgrades to existing treatment facilities.

Erwin Saves Construction Expense

Problem: Erwin Utilities has relied primarily on springs as their raw water supply. Faced with requirements of the Surface Water Treatment Rule to filter springs under the influence of surface conditions, they were considering their options. These options included upgrades to exiting facilities, building new treatment plants for their springs, or conventional filtration of water from the Nolichucky River. The river would obviously meet future demands for water, but would have required millions of dollars to build an intake structure and a conventional treatment facility.

Solution: A ground water investigation conducted by BES, Inc. identified the Honaker formation as the most likely geologic formation in the area to produce ground water. Most streams lost flow to the ground water system as they flowed across the Honaker formation. Seven test wells were drilled, of which two wells each produced 500 to 700 gallons per minute (gpm). These wells are currently being developed as ground water supplies for Erwin Utilities. One well was determined not to be under the influence of surface conditions and will require only chlorination before distribution. Developing their available ground water resources saved Erwin Utilities a substantial amount of money by reducing their construction expenses and long-term treatment costs.

Elizabethton Solves High Turbidity Problem

Problem: The filter plant for Big Springs was unable to handle occasional periods of high turbidity following rainfall, forcing the plant to be out of service for days at a time. The water system was faced with routing water a long distance around the city to supply the area normally serviced by Big Springs. In addition, another spring would require filtration under the Surface Water Treatment Rule. Both options were expensive and did not increase the available water supply for the City of Elizabethton.

Solution: A ground water investigation was conducted in the vicinity of Big Springs, an area of about ten square miles. Although the results of the initial study identified areas with favorable geologic and hydrologic conditions, six test wells failed to produce more than 50 gpm. Needless to say no one was happy, but officials involved in the study did not give up. The study area was expanded to include part of the nearby Buffalo Creek basin, an area draining about 40 square miles. Four more wells were drilled, three of which proved capable of producing 500 to 800 gpm. Funding for the project allowed for drilling one more well. Permission was secured to drill another well upgradient from Big Springs in hopes of locating a source closer to the existing treatment facility. This well intercepted one fracture which supplied 1300 gpm! Pumping the well appeared to have little effect on the spring discharge, greatly increasing the available water supply for the Big Springs facility. Water quality is now being studied to determine if water from the well is subject to fluctuations in turbidity.

Decatur Builds One Treatment Facility Instead of Two

Problem: The Town of Decatur was obtaining water from two springs, located on opposite ends of the area supplied by the Decatur Water System. In response to the Surface Water Treatment

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Rule, plans were underway to build two filter plants. Not only were two plants required, but the lease on one spring had expired. This was a problem, given the significant difference between what the owner of the spring thought the water was worth and the price the utility could afford to pay for the spring.

Solution: A ground water investigation identified several areas with the potential for producing abundant ground water. Because of capital investments already made near Eaves Spring, the test drilling program was limited to one area. The first well drilled was located down-gradient from the spring near the Tennessee River. This well encountered gravel deposits from 130 to 170 feet below land surface that produced 650 gpm. Another well drilled near the spring produced about 100 gpm and a third well encountered mud zones that would have made the well difficult to develop as a water source.

The town of Decatur is now in the process of building one treatment facility instead of two. The yield of the new well, combined with the spring discharge, will produce sufficient water to meet demand. The cost for a second facility and court costs that may have been necessary to continue using the second spring were avoided. The well near the Tennessee River is considered to be under the influence of surface conditions, but is consistently producing water with a turbidity of about one NTU, a level that can be economically treated by direct filtration.

Athens Finds Safer Water Supply

Problem: The city of Athens, served by the Athens Utilities Board (AUB), obtains much of its water from Ingleside Spring. Approximately two thirds of the water treated by the AUB comes from Ingleside Spring (about 1250 gpm), along with additional water from Oostanaula Creek. The sources are combined before they reach a conventional treatment facility. Water from Oostanaula Creek has tested positive for Cryptosporidium, a protozoan know to cause disease in humans. The turbidity of water from Oostanaula Creek increases rapidly following rainfall, causing most of the water treatment problems and associated treatment costs for the AUB.

Solution: A ground water investigation recently completed by Bradfield Environmental Services, Inc. identified areas of the Oostanaula Creek basin that are underlain by limestone formations of the Knox Group. Stream discharge data indicated areas draining these formations were deficient in discharge relative to streams in areas of the basin underlain by shale. Six test wells were drilled. Of the six wells drilled, three were dry holes, while three wells produced several hundred gallons of water per minute. Two wells, estimated to produce 800 gpm each, were selected for aquifer tests. These wells will eliminate the need for the AUB to obtain water from Oostanaula Creek, thereby providing a safer water supply for the city of Athens.

Components for Successful Ground Water Investigation

There are several important components for a successful ground water investigation. A favorable climate is needed, for without plenty of precipitation, there cannot be sustained ground water discharge. In Tennessee, we receive approximately 50 inches of rainfall each year. Much of the rain that does not leave a basin as surface runoff goes to replenish the ground water system.

A second factor is favorable geology. The geology of the study area must be evaluated to locate those formations most likely to produce ground water. Geologic formations vary in the amount of pore space and fractures available to store and transmit ground water. While there are some areas, particularly in middle Tennessee, that are underlain by impermeable rock formations; much of middle and east Tennessee is underlain by more soluble limestone formations capable of producing abundant ground water.

Stream flow characteristics should also be studied to identify those stream reaches that are gaining water from the ground water systems and those steams that lose water to the underlying aquifer. Locating sites for test drilling based on hydrogeologic data will save money by minimizing the number of test wells required to locate a productive well.

Perhaps one of the most critical factors in determining the success of a ground water investigation involves the commitment of water system management and city officials. When drilling for large volumes of ground water in areas underlain by rock formations, it is necessary to drill a sufficient number of test wells to achieve success. This can result in a degree of uncertainty regarding the total cost of developing a ground water source, making some officials reluctant to try.

For example, it took only three wells to identify the best well for Decatur, Tennessee, but it took 11 wells to complete the investigation for Elizabethton. Had Elizabethton officials decided to halt the test drilling program after the initial six wells funded were drilled, we would have failed to achieve the study objectives and all money invested would have been considered wasted. As it turned out, Elizabethton has a 1300 gpm well near their exiting facility and has located three additional sources of ground water that will meet future demands for water.

While locating highly-productive wells is not without risk, ground water is a viable option for many public water systems in Tennessee. One thing for certain is that filtration of most surface water sources is the most expensive option. As the saying goes, "Nothing ventured, nothing gained." If the initial study of the geology and hydrologic characteristics of an area indicate the potential for ground water exists, it is usually worth going to the expense of a test drilling program.

As professionals, we must continue to educate those charged with running public water systems, as well as those agencies that fund water projects, about the advantages and availability of ground water. If your community is considering expanding its current water supply, having water-quality problems, or will soon need to upgrade an existing treatment facility, make sure ground water is considered as an option. It could save you and your customers a lot of money. Ground water truly is Tennessee's liquid gold! TPW