Report for 2003AR55B: Viability of Obtaining Drinking Water From the Flooded Coal Mines in the Area of Greenwood, Arkansas

- Conference Proceedings:
  - Varnell, C. and J.V. Brahana, 2003, Factors Affecting Water Quality and Surface Water/Ground Water Interaction Associated with Flooded Coal Mines in Greenwood, Arkansas, Arkansas Water Resources Center Annual Water Conference,University of Arkansas, Fayetteville, Arkansas, April 2003.
- Other Publications:
  - Brahana, J.V., 2003, Hydrogeologic Research Along a Transect from the Ozarks to the Quachitas, Northwest to West?Central Arkansas: Field guide for University of Arkansas' 2003 Field Trip, 66 p.

Report Follows

Introduction

The City of Greenwood experienced a doubling of the population during the last decade. Growth projections for this community just south of Ft. Smith, Arkansas indicate that this city will continue to grow at a rapid rate. The city obtains its present water supply from Lake Greenwood, a 95-acre reservoir located just east of the city on Vache Grasse Creek. Currently, the city can supply 1.2 million gallons per day of treated water meet demand. This amount is currently exceeded on a number of days during the summer months. The city is constructing a larger treatment plant that can exceed 1.8 million gallons of water production per day. This would meet the cities projected needs for the next five years, but the production levels would exceed the storage capacity of the lake.

Construction of a new dam would entail costs exceeding 20 million dollars. The waters from the coal mine, if proven of sufficient quality and quantity, could provide the city a viable water source for the foreseeable future.

The water storage capacity of the underground mines exceeds 500 million gallons. If the water can be utilized, the city would be able to mix it with the current supply and meet the needs of the community for the next twenty-five years. The cost of the project is minimal when compared to the construction of a new dam, or an additional reservoir. The coal mines are a readily available source of water. If the water is deemed to be of sufficient quality, it would require minimal time to begin use of it along with the existing supply.

The overall purpose of this study was to assess the feasibility of using flooded coal mines as a safe, viable source of drinking water supplies for the city of Greenwood, Arkansas. Specific objectives include:

1. Facilitate the relationship between the various players involved in using the water from the coal mines, i.e. landowners, city officials, water experts and consultants, and various local, state, and federal regulating agencies.
2. Assist the city of Greenwood in complying with the various local, state, and national regulations during initial and testing phases. Serve as a liaison between the landowners, the general public, the city water council, and the various state agencies in order to ensure public confidence in the decision process.
3. Conduct research of historical data, compare surface and sub-surface maps, locate markers, and conduct personal interviews and field reconnaissance to determine the geographical and hydrological boundaries of the water impoundment within the coal mine.
4. Monitor water levels from potentially interconnected ground water and surface water sites in the study area during drawdown. These include Vache Grasse Creek, Greenwood #2, Fidelity Mine, nearby strip pits, Greenwood Reservoir, superjacent and subjacent aquifers, mapped fault zones for which data currently exists.
5. Determine potential changes in water quality stored in the mines as a result of extensive use of water from the mines, or from the introduction of highly oxygenated water into the mines from outside sources. Testing was conducted during periods of high and low precipitation.

The scope of this study included ground-water quality determination of major constituents, minor constituents, trace constituents, nutrients, and microbial components. The water analyses include the physical properties of temperature, specific conductance, and pH at the available wells, strip pits and other sites deemed necessary to the understanding of the hydrogeology of this system. Sampling was hydrologically based, meaning that low- flow, high flow, and anomalous hydrologic conditions such as major storms triggered sample collection. The scope encompassed flow to and from the system, and development of an integrated conceptual model.

Methodology:

The general physical boundaries of Fidelity and Greenwood #2 are known. It is also known that the mines began as slope mines, starting at or near the strip pits which are located on the east side of the city of Greenwood. The mineshafts follow a 7-degree dip to the east and the coal was confined in a layer varying from two to five feet in thickness. The base of the coal layer is found along the top of the Atoka Sandstone Formation. Void areas are generally five feet plus in height in the main tunnels and varying heights, usually less than 5 feet, in the side shafts. The coal was extracted by the room and pillar method, meaning that some areas of the mine have standing walls of coal left to support the overburden. The mines became flooded in 1929 and have not been used commercially since that time other than a surface venture to extract coal near the land surface in 1939. This endeavor proved uneconomical and was soon abandoned. These pits cut across the mine openings and have filled with water to become pits; in essence, small lakes interconnected to the waters of the coal mine.

Old mine maps and surface reconnaissance of such features as airshafts were used to determine drilling areas. Four wells were drilled into the void space from the surface; two of these are located in the Fidelity mine, two in Greenwood #2. One known well already existed on the property belonging to a local landowner and is located in the Fidelity mine. These subsurface sites as well as sites located on interconnected surface water sources are the primary sites for water sample extraction. These samples allow us to monitor the water quality for our watershed area.

Samples collected from the sites listed above were analyzed for major constituents, minor constituents, trace metals (beryllium, arsenic, aluminum, selenium, zinc), organic scans related to coals, microbial pathogens, nutrients, and other EPA drinking water requirements.

Surface reconnaissance and other geophysical methods were used to determine the recharge, inflow, outflow and the degree of interconnection between the strip pits, mines, Vache Grasse Creek, Jack Nolan Lake, Greenwood Reservoir, waste treatment discharge, sub-surface aquifers, and other water sources. Remote transducers were placed in well #4 and #7. These instruments continuously measure water temperature and pressure changes and were downloaded onto a laptop computer to provide water data over time. A weather station, including a tipping bucket rain gauge was installed at well #4 to determine precipitation events. Staff gauges were placed at the Alkali Pit, Holland's Pit, Patterson Pit, Vache Grasse, and Round Hole. These were continuously monitored in order to provide data concerning surface water flow rates. Water samples, stream flow, water temperature, pH, conductivity, turbidity rates, and coliform bacteria tests were conducted at each site.

Historical data compilation and consultation with scientists and individuals from other regions utilizing coal mines as a water source provided insight into the best methods to use to determine the viability of using water from the mines. They also provided useful insight into any possible health concerns that might arise.

A very important component in conducting the research was to coordinate the activities and data collection with the various involved parties. These include the property owners, the engineering firm, the city council, the city water treatment employees, the general public, and the various regulating agencies. These include the EPA, DEQ, Game and Fish Commission, State Health Board, Arkansas Geologic Survey, and others.

Significant Findings

Final determination about the viability of using the coal mines as a source of public water for the City of Greenwood has not yet been made. This project provided supplemental funding to support a Ph.D. graduate research assistant for the summer of 2003 to assist with this project. Significant findings based on research completed to date are listed below.

The quality of the water in the mines appears to change with the season. Changes from August 2001 to February 2002 include: decreased concentration in specific conductance, bicarbonate, chloride, sulfate, calcium and sodium.

These chemical changes appear to be caused by the following: decreased residence time that promotes dissolution; increased recharge rate to the mine causing mixing and dilution of chemical species; and location in mine with respect to main flow pathways that determines the extent of the mixing and dilution.

Specific concerns with using water from the mines that must be addressed are: 1) Presence of identified contaminants in the coal and the water in the surrounding containment basin, 2) changing mine chemistry (redox conditions), 3) debris from various sources that has been dumped into the mines over the years, 4) treated waste water that may enter the mine via surface water-ground water exchange, 5) storm water that may enter the mine via surface water-ground water exchange.

While utilization of these reservoirs offers many advantages, the presence and concentrations of undesirable constituents and the changing chemistry within the mine require the development of a monitoring system that will ensure a continuous and healthy water supply, if this is the option finally selected as the future water supply for the City of Greenwood.