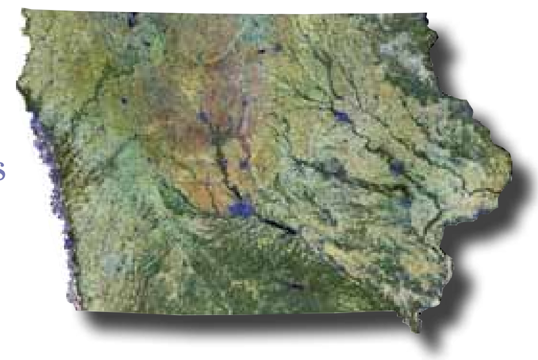
Our Common Ground
Iowa Department of Natural Resources

Iowa Geological and Water Survey
Resource Information Fact Sheet 2012-1



Groundwater Availability Modeling of The Silurian Aquifer

Will We Run Out of Water?

This question is often asked when a proposed industrial plant or other large water user applies for a water-use permit. The potential for new jobs and economic benefits are often counter-balanced with the concern over the potential negative impacts this new water user may have on existing private and public water supplies in the area.

A large industrial plant often requires anywhere between one and two million gallons of water per day, which is equivalent to the volume of water used by a city of 10,000 to 20,000 residents. Combining this new use with existing municipal, other industrial, irrigation, livestock, geothermal and quarry water uses, and the potential for water use conflicts are likely to increase.

To help evaluate the potential impact of large water users and other water allocation issues, the Iowa Department of Natural Resources (IDNR) initiated a Water Resources Management Program. This program uses computer simulation models or Groundwater Availability Modeling (GAM) to evaluate past, current, and future water use and the potential impacts on an aquifer. GAM will help us answer questions such as: "How much water can be pumped from an aquifer over 10, 20 or 100 years?" "Will my well go dry?" "Will the water level drop below my pump?" "What impact will increasing water use have on water quality?"

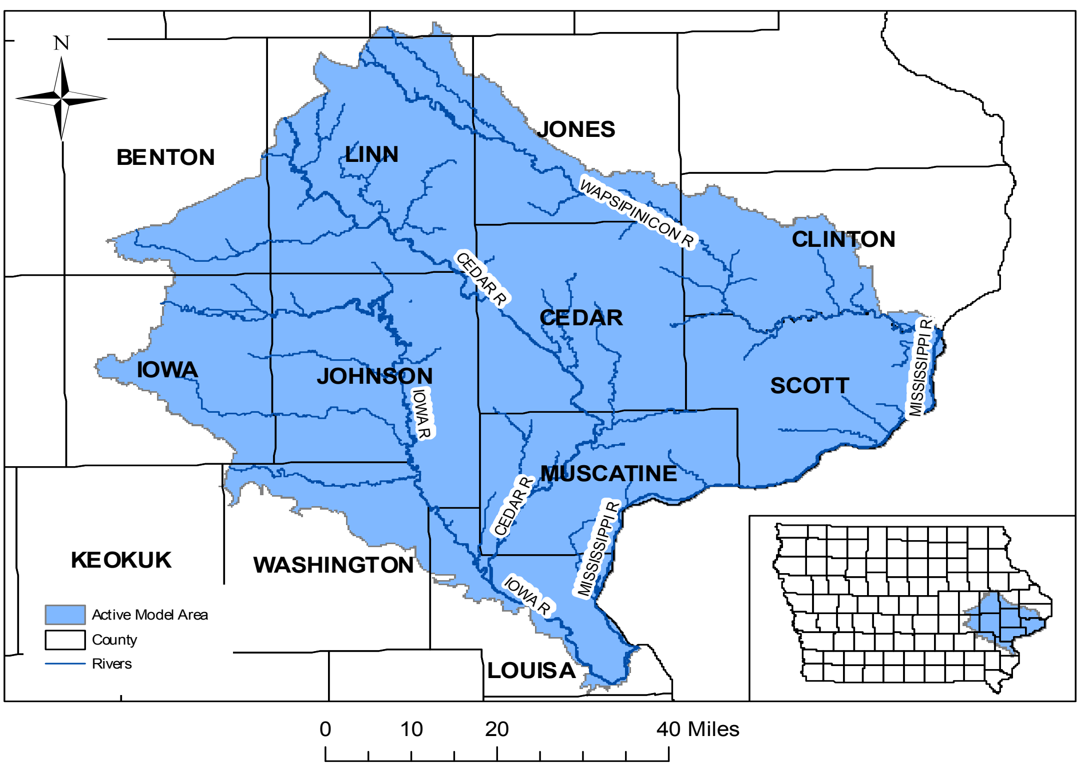


Figure 1. *Silurian aquifer study area in Iowa.*

What is Groundwater Availability Modeling?

The first step in Ground Availability Modeling is to understand the geology of a particular aquifer. Groundwater flows through rock and sediment, and the success and accuracy of GAM are dependent on conceptualizing and evaluating geologic data. Geologic data includes the lithology, thickness, permeability (measures the movement of groundwater), storage, and stratigraphy (relationship between the various geologic layers).

The next step in GAM is to represent the hydrologic properties of the various geologic units. Hydrologic parameters are usually obtained from field tests performed on large capacity wells using nearby wells as observation points. These hydrologic properties must be entered for each layer in the model. Also included in this step are the pumping rates in each well, and the hydrologic boundary conditions.

The third step is to break the three-dimensional model layers into small grids or cells. Complex sets of groundwater flow equations are simplified and solved within each individual grid or cell. The grid solutions are summed for each time interval, and groundwater elevations and flow data are produced.

The final step is to compare the simulated results to water level data collected from observation wells. The closer the correlation between simulated and observed data, the more accurate and useful the model is at evaluating the long-term availability of water in a particular aquifer.

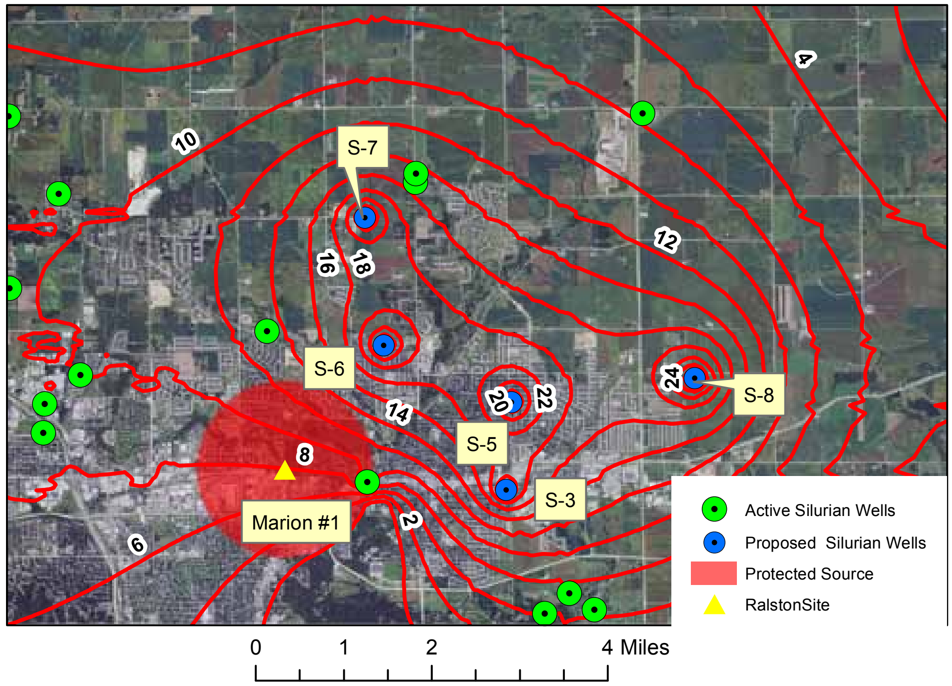


Figure 2. *Proposed Silurian well locations for the City of Marion and simulated drawdown in the silurian aquifer based on proposed City of Marion Silurian wells with 1.64 mgd withdrawal.*

An intensive two-year investigation of the geology and hydrogeology of the Silurian aquifer was undertaken to provide a more quantitative assessment of the groundwater availability, and to construct a groundwater flow model that can be used as a planning tool for future water resource development. The Silurian aquifer is used extensively in a 12-county area in east-central Iowa (Figure 1). The Silurian aquifer consists of various limestone and dolomite units that vary in thickness and horizontal extent. Groundwater withdrawals from both public and industrial wells total over 11.3 million gallons per day (mgd) over the study area. Additional withdrawals from quarries and private wells also occur and vary seasonally.

Application of the Silurian Aquifer Model: City of Marion

The City of Marion's population (Linn County) is growing at approximately 3 percent a year and is projected to double in approximately 24 years. The city has one active Silurian well that withdraws an average of 135,000 gallons per day (gpd). The city currently obtains most of its water supply from four Cambrian-Ordovician wells, and a fifth Cambrian-Ordovician well is scheduled to go on-line in 2012. Decreases in the groundwater elevations in the Cambrian-Ordovician aquifer beneath Marion are approaching the regulatory limit established in the Iowa Administrative Code. To provide additional water for the projected 3 percent growth rate, the City of Marion

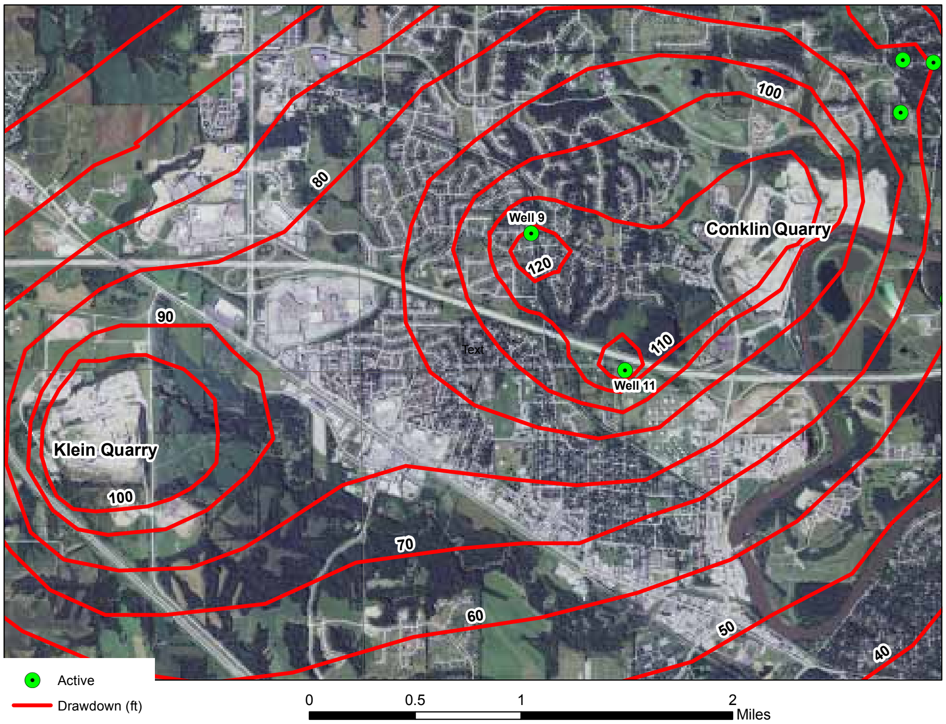


Figure 3. *Current drawdown in the Silurian aquifer near the City of Coralville.*

is proposing to add three to five additional Silurian wells.

Using the December 2010 groundwater elevation contours as the initial groundwater surface, a simulation was run using five proposed Silurian wells S-3, S-5, S-6, S-7 and S-8 as shown on Figure 2. The daily production per well was equally divided among the five wells. The total usage of 328,000 gpd per well was used or a total withdrawal of 1,644,000 gpd. The 1,644,000 gpd pumping rate equates to 0.6 billion gallons per year (bgy), which is the amount in the existing water-use permit assigned to the Silurian aquifer.

Figure 2 represents the additional drawdown (decrease in groundwater elevations) based on the proposed pumping scenario. Based on the groundwater model, an additional 30 to 33 feet of drawdown would occur near the proposed Marion wells, and 2 to 10 feet of additional drawdown would occur near the City of Hiawatha wells and at the Ralston hazardous waste site. The Silurian aquifer beneath the Ralston hazardous waste site is a protective water source as defined by Iowa Administrative Code Chapter 53.7(1), which prevents any new private or public well usage within a one-mile radius from the Ralston site. City of Marion Well 1 is within the one-mile radius as shown on Figure 2. Marion Well 1 may need to be used as a standby well or properly abandoned. The five proposed Silurian wells are approximately two miles from the Ralston site. Additional hydrologic data will be necessary to evaluate the potential impact the proposed wells may have on the Ralston site. Additional pumping stress may cause the contamination to migrate toward the proposed Silurian wells.

Application of the Silurian Aquifer Model: City of Coralville

The City of Coralville (Johnson County) utilizes wells in the Cambrian-Ordovician, Silurian, and buried sand and gravel aquifers for its water supply. Coralville's two active Silurian wells withdraw an average 310,000 gpd each (620,000 gpd total), which is approximately one-third of the city's total water usage. The total drawdown in the Silurian aquifer caused by the pumping of the City of Coralville wells and the dewatering of two large limestone quarries nearby varies from 80 to over 120 feet (Figure 3). To provide additional water for the city's projected growth, the City of Coralville is proposing to add two new Silurian wells.

Using the December 2010 groundwater elevation contours as the initial groundwater surface, a simulation was run using existing city wells 9 and 11, and adding two proposed wells P-13 and P-14 as shown on Figure 4. The daily production per well was equally divided among the four wells. The total usage of 155,000 gpd per well results in a total withdrawal of 620,000 gpd, which was the August 2010 average withdrawal from existing wells 9 (327, 000 gpd) and 11 (293,000 gpd). Figure 4 represents the simulated additional drawdown/recovery (an increase in groundwater elevations) based on the proposed pumping well scenario using 2010 water usage. Spreading out the pumping stress using four wells rather than two wells allows for approximately 28 feet of recovery in existing wells 9 and 11. This increases the long term availability of water for the City of Coralville from the Silurian aquifer by approximately 15 percent. Future water supply planning by the City of Coralville may involve more wells or an alternative water source.

Conclusions

A numerical model of the Silurian aquifer was developed to evaluate groundwater availability and sustainability using historical water use, current usage and several future usage scenarios. The future use scenarios involved the projected pumping rates in both the City of Coralville and City of Marion, where further withdrawals from the aquifer are currently planned. These examples demonstrate the utility of the model for assessing the local impact of increased pumping stress, and for assisting communities in making informed decisions related to their long term water supply.

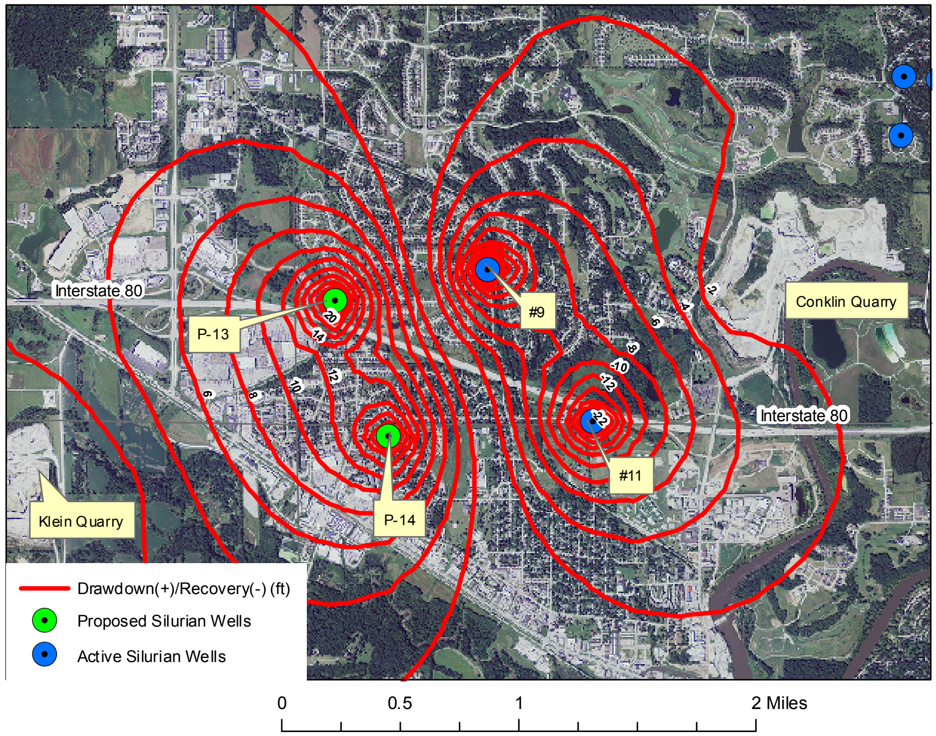


Figure 4. *Simulated drawdown in Silurian aquifer using proposed and existing City of Coralville Silurian wells based on 2010 water usage rates.*

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