Conversations Conferences on Nebraska Environment and Sustainability

White Paper: Water

By James Goeke, State Resource Coordinator for Water

To think of Nebraska's water resources, consider the water cycle as it operates in Nebraska. Considering it in generalized cross section provides the opportunity to discuss components, connections, variability, and development of historic problems.

First of all we must realize the components of the water cycle apply to the complex variability of the 77,354 square miles that is Nebraska. Of all the components precipitation has been the most accessible with records back to 1850. From 1895-2008 Nebraska's average precipitation has been 22.85 inches. Precipitation varies across the state from 32 inches in the southeast to less than 16 inches on the west. Repeated and extensive droughts have been documented for the last 500 years and suggested for the last 10,000 years.

Rainfall runs off the land surface to contribute to streamflow. Surface water in Nebraska is currently measured at 335 sites, 109 measured by the United States Geologic Survey (USGS) and 226 by the Nebraska Department of Natural Resources (DNR) and other agencies. The longest continuous record is for the North Platte River at North Platte, 1896 to the present. Most gaging didn't start until the 1930's and 1940's. From 1950 to 2008 the median surface water inflow to Nebraska was 1.7 million acre feet and the median outflow was 8.9 million acre feet. Average rainfall on Nebraska amounts to almost 95 million acre feet. Subtracting the median outflow leaves 87 million acre feet to be consumed by evaporation and transpiration.

Probably the easiest aspects of the water cycle to measure are precipitation and streamflow and estimates of evaporation and transpiration. Measuring the rest of the water cycle is much more difficult. Precipitation that doesn't run off or become ET must move through the unsaturated zone to recharge the groundwater system. The unsaturated zone varies in thickness from only a few feet to over 300 feet and its composition can include a vast variety of geologic materials. Much of the unsaturated zone in Nebraska is either sand or silt providing recharge rates that vary from a fraction of an inch to 4 inches per year.

In our water cycle cross section, the water table marks the top of the groundwater system which is composed of numerous aquifers. It is good to think of this groundwater in this system as a massive, inexorably moving conveyor belt transferring groundwater from higher to lower elevations eventually connecting to streams. Ground water moves in terms of feet/year while surface moves in terms of miles/hour. To appreciate the groundwater resources of Nebraska we need to understand our geologic history .

The primary aquifer in Nebraska has been accumulating for 30 million years as material eroded from the rising Rocky Mountains has been carried eastward to build Nebraska. From geologic mapping, well logs, and the drilling of over 5500 test holes since 1930 we have been able to identify the composition and ages of the aquifer units of the High Plains aquifer. The units are: the Brule Formation, a siltstone-claystone deposited from 32-28 million years ago; the Arikaree Formation, a silty sandstone deposited from 28-19 million years ago; the Ogallala Formation, the primary component of the High Plains aquifer that include everything from sands and gravels to sandstone to siltstones deposited from 19-5 million years ago; the Broadwater Formation, a sand and gravel deposited from 5-2 million years ago; and any sands and gravels deposited since. We have been able to estimate our ground water in storage in Nebraska at approximately 2.5 billion acre feet. The UNL Conservation and Survey Division (the Nebraska Geologic Survey) has created state maps showing the depth to water, the configuration of the water table, the configuration of the base of the aquifer, the saturated thickness, and transmissivity. Using these maps we can determine the directions of groundwater flow and gradients to estimate the contribution of ground water to Nebraska's rivers.

Streams emanating from the Sandhills are among the most constant flowing streams in the world deriving more than 90% of their flow from groundwater. The contribution of flow from the Sandhill streams insures the flow of the Platte east of Columbus guaranteeing flow to support the wells fields of Omaha and Linclon.

The problem in Nebraska has been timing. We have developed a legal system to manage water while we were working to understand the surface water and groundwater systems and their connection. We started to manage surface water under the Prior Appropriation Doctrine (first in time, first in right) in 1895 just as we were beginning to measure streamflow in a few places. It was another 80 years until we passed the Groundwater Management Act to manage ground water under the concept of correlative rights. By this time surface waters had been over appropriated, irrigation wells were being installed in record numbers, and groundwater levels had declined 20-30 feet in the Blue River basin, southwest Nebraska, and the Alliance area. It wasn't until 1996 and the passage of LB 108 that we finally recognized the connection between surface water and ground water.

In 2004 LB962 was passed requiring DNR to work with the NRD's to manage the hydrologically connected waters of Nebraska. DNR is required to conduct an annual assessment of the water balance in each watershed and classify each watershed as being under, fully, or over appropriated based upon a set of criteria that includes the concept of stream depletion lines for the delineation of fully or over appropriated. Nearly half of the state has been designated as fully appropriated or over appropriated. In over and fully appropriated areas new high capacity wells and new surface water rights were banned. NRD's have been required to develop integrated management plans to insure stream flows and water use efficiency.

This is a unique time in Nebraska history. Our long history of easy access to water is coming to an end. The biggest question today related to the future of water resources in Nebraska is how do we manage our interconnected water resources fair and equitably for all the competing interests? Other questions include how do we meet the requirements of the 1997 Cooperative Agreement with Colorado and Wyoming and the terms of the Republican River Compact settlement agreement of

2002 with Kansas and Colorado? Our answers and solutions will come from sophisticated models. Even with our extensive data network, do we have enough insights to support our models? Do we know enough about stream-aquifer relationships to provide the creative solutions we need? Are there solutions available that won't cripple the agricultural foundation of Nebraska and provide for a sustainable future? In consideration of the historic partnerships that have been responsible for our current understanding of our water resources, what partnerships are needed to meet future challenges? Do we need a water management plan for Nebraska? What is the role of the University of Nebraska?

Water is simply the lifeblood of Nebraska. There is a saying that "In the end we conserve only what we love, we love only what we understand, and we understand only what we are taught." I am optimistic about the future of water and the vital role the University of Nebraska will continue to play.