Proposed Study in the Republican River Basin

Prepared by:
United States Geological Survey
Lincoln, Nebraska

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ISSUES NEEDING STUDY

In the Republican River Basin, the High Plains aquifer is the primary or sole source of drinking water. Unfortunately, it is also the source of water for most if not all irrigation wells and is close enough to the surface to be affected by infiltration of irrigation water laden with agricultural chemicals. A thorough ground-water quality reconnaissance of the entire Nebraska portion of the Republican River Basin has never been conducted. In many areas the ambient ground-water quality is unknown. Although anecdotal evidence of nitrate contamination in some areas exists, it is insufficient to determine the extent.

Surface-water flows in the Republican River Basin have declined in some areas over the past 30-40 years. This decline has likely affected the surface-water quality because as flows decrease, contaminant concentrations tend to increase. Declining streamflows are likely the result of increased use of ground water in the basin. The extent to which ground-water/surface-water interaction affects surface-water quality and quantity in the Republican River Basin in Nebraska is unknown. If in fact ground-water pumpage dramatically affects streamflow in the basin, no information exists that would enable management of ground-water pumpage in the basin to ensure adequate streamflow in the river.

OBJECTIVES

1. Determine the areal extent of nitrite plus nitrate concentrations in ground water in the Nebraska portion of the Republican River basin.
2. Determine the association of nitrite plus nitrate concentrations with hydrogeological and land-use variables within the Republican River basin.
3. Estimate the extent of surface- and ground-water interaction at selected sites on three principal tributaries of the Republican River.
4. Quantify the interaction between ground water and surface water throughout the basin using a ground-water flow model of the entire Basin.
5. Use the ground-water flow model to predict future streamflow conditions under various ground-water pumpage scenarios, enabling the water-managers in the basin to ensure adequate streamflows in the basin's streams.

APPROACH

Ground-water samples will be collected from 300 private and public wells over a 2-year period from the Upper Republican, Middle Republican, Lower Republican, and Tri-Basin Natural Resources Districts and analyzed for nitrite plus nitrate concentrations. Twenty-five percent of these samples also will be analyzed for major ions. These data will provide a general characterization of ground-water quality in an part of the state in which little areal data is currently available. These data will be compiled and compared with local hydrogeologic and land-use conditions.

Surface-/ground-water interaction will be estimated at three locations, each on a major tributary of the Republican River, during the first two years of the study. Two transects of nested observation wells will be installed perpendicular to each of the tributaries. Each transect will consist of three nests of three wells each with each nest located about 2 kilometers apart. The two transects will be parallel to each other and will be separated by 1.5 to 3 kilometers. The first nest of wells in each transect will be within 100 meters of the tributary. Water levels will be continuously measured at the nest of wells nearest the stream in one of each pair of transects. Water levels in the tributaries near the instrumented nest of wells also will be continuously monitored. Head and stage measurements will provide a continuous record of flow direction to and from the tributaries. Quarterly water-level measurements will be made at the

noninstrumented observation wells and water quality samples will be collected from all wells in each transect and analyzed for nitrite plus nitrate. During one of the sample collection periods, water samples from all observation wells and from the tributaries immediately adjacent to the instrumented nest of wells in each transect will be collected and analyzed for major ions. The chemical analyses and specific conductance measurements, which are made prior to sample collection at all wells, will be used to further characterize the flow of water to and from the tributaries. The combined head and stage information and water-quality data will provide a means to check and fine-tune the ground-water model for the basin.

A ground-water-flow model will be developed for the entire Republican River Basin, including parts of Nebraska, Kansas, and Colorado. This model will have boundaries that will allow for the simulation of ground-water/surface-water flow between the aquifers and major streams in the study area. Input data will be assembled by organizing a partnership of Federal, State, and local agencies and interest groups from all three states. This partnership is intended to facilitate an open and active interchange of information and ideas. These partners will be asked to provide data for model input. The goal of this study is to develop a ground-water flow model of the entire Republican River Basin using consistent methodology and data preparation methods for all three states. To reach this goal, project partners will be consulted on a regular basis to seek their input and to ensure that their concerns are addressed. The model will be developed using a finite difference model code such as MODFLOW, the USGS's modular finite-difference model (McDonald and Harbaugh, 1986) with extensive use of GIS techniques to generate model data sets. After model calibration, various predictive pumping scenarios will be simulated to demonstrate the effectiveness of the model as a management tool. A particle-tracking program such as MODPATH (Pollock, 1994) will be used to estimate travel times between the streams in the basin and different parts of the basins aquifer(s).

PRODUCTS

1. A hydrologic atlas that contains analytical results from the areal ground-water quality sampling and describes possible associations between ground-water quality and various hydrologic and land-use characteristics will be published during the third year of the study.
2. A 2- to 4- page fact sheet that interprets the water-quality and water-level measurements from the well transects along the Republican River tributaries will be published within 6 months of the last quarterly sample collection period.
3. A detailed description of the ground-water flow model will be published in a U.S. Geological Survey Water-Resources Investigations Report. This report will contain a description of the development of the ground-water flow model, simulated results for predictive scenarios, and estimated ground-water/surface-water interaction throughout the basin, based on model output and particle tracking.
4. An interactive web site will be developed to allow project partners to keep abreast of progress and to showcase the study's findings as they become available. Eventually, the site will become a depository for information about the basin. All partners will have equal access to the data assembled for the study.
5. At the conclusion of the project, a full-color fact sheet that describes the modeling results in layman's terms will be published.
6. The ground-water-flow model developed will be made available to all interested parties. This model can be used extensively as a management tool for many years after the completion this study.

lican Basin Study--Ground-Water Flow, May 22, 1997. Prepared By: Pat Emmons File name: TIMEL

Activity	<--Project Year One-->												<--Project Year Two-->							
	FY-1997										FY-1998									
	May	Jun	Jul	Au	Sep	Oct	No	De	Jan	Fe	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Workplan	XX	XX																		
Literature Search		XX	XX	XX																
Library			XX	XX	XX															
Setup Database		XX	XX																	
Compile Existing Data		XX	XX	XX	XX															
Enter Data into Database			XX	XX	XX	XX														
Data Analysis						XX	XX	XX	XX	XX										
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Cooperator meetingS						XX														
Conceptual Model				XX	XX															
Modeling Method					XX															
Develop Model Grid								XX	XX											
Boundary Conditions									XX	XX										
Active Cells									XX	XX										
River Cells									XX	XX										
Other SW features									XX	XX										
Develop Model Layers						XX	XX	XX	XX	XX	XX									
Alt. of Land Surface						XX	XX	XX	XX	XX	XX									
Alt. of Aquifer Bottom																				
									XX	XX	XX	XX								
Hydraulic Conductivity									XX	XX	XX	XX								
Specific Yield									XX	XX	XX	XX								
Recharge									XX	XX	XX	XX								
Evapotranspiration																				
Model Input									XX	XX										
River Stage									XX	XX										
Altitude of River Bottom									XX	XX										
River Bed Conductivity									XX	XX										
River Bed Thickness								XX	XX	XX	XX	XX								
Water Level Data								XX	XX	XX	XX	XX								
Pumpage																				
Steady-State Model													XX	XX	XX	XX	XX	XX	XX	
Calibration																				
Transient Model																		XX	XX	XX
Calibration																				
Verification																				
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Publication																				
Fact Sheet Writing																				
Review																				
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Electronic Data Report (OF)																				
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Publication																				

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Timeline

SW/GW Interaction