

## Memorandum

To: Programs, Projects, and Operations Subcommittee

Subject: US Geological Survey (USGS) Water Quality Monitoring

Date: December 4, 2007

From: Gerry Bowen

As part of the District's Groundwater Management Plan (GWMP), routine monitoring of wells has occurred since 1992. It was determined at that time that the District did not possess enough data to make decisions regarding groundwater management. It was decided to initiate an irrigation well monitoring effort to build a database to help manage groundwater in the District. In 1999, the District established a series of well nests throughout the District to further define groundwater quality. Both programs are described below.

### **Irrigation Well Monitoring:**

In 1992 and with guidance from USGS, the District identified ninety-four (94) irrigation (primarily) wells in five different groundwater areas for monitoring water quality. The groundwater areas are Missouri River, Platte River, Elkhorn River, Upland, and Dakota. Each well is sampled for nitrates (mainly as an indicator) every four years. In addition, some of the wells are tested for a wide variety of parameters. The data is maintained for each well, used for comparison with other wells, and to determine if a water quality problem exists. If a problem is identified, we follow the procedures outlined in the GWMP. USGS also measures the water level in each well as an indicator to see if recharge is keeping up with usage. The network was established in 1992 and sampling has proceeded annually thereafter.

### **Well Nest Monitoring:**

Again to build a data base of water quality and quantity in the District, we established 9 well nests in the groundwater areas listed above (one nest in the Dakota, and two each in the other areas). Each well nest contains two or three wells screened at different levels (shallow, medium, or deep) so that a complete picture of the aquifer can be drawn. Shallow wells sample the upper five feet, medium measures the middle five feet, and deep wells sample the lowest five of the aquifer. This sampling has been occurring for the past six years. Each sample is analyzed for a wide array of parameters on a semi-monthly pattern between April and November.

The sampling and analysis is done by USGS personnel and the costs are shared via a cooperative agreement. The NRD share of the costs comes partially from the Natural Resources Water Quality Fund (NRWQF). The District has been budgeting approximately \$95,000 each year for this program, offset by approximately \$32,000 in NRWQF funds as a revenue source.

The District has received a proposal from USGS to conduct a Trends Analysis of the data collected since 1992 (see attached letter and proposal). In addition, USGS is proposing an analysis of the monitoring well network and alternative sampling program to better suit the needs of the District. The total cost of the sampling, analyzing, and trends report is estimated at \$311,000 over the next three fiscal years broken down as follows:

Agency	FY 2008	FY2009	FY2010	Totals
USGS	\$13,900	\$32,650	\$18,750	\$65,300
P-MRNRD	\$67,400	\$155,500	\$88,100	\$311,000
Total	\$81,300	\$188,150	\$106,850	\$376,300

The differences between the table above and that in the USGS proposal (FY's 2008 & 2009) result since the federal fiscal year starts October 1 each year, while the District's starts on July 1 each year. The District's previous agreement with USGS expired on September 30, 2007 (end of FY 2007). The proposal summarized above would involve a new agreement with USGS to accomplish.

The proposed Trends and Well Monitoring Network Analysis will provide information on the water quality trends in the District and recommendations on the adequacy and sampling schedule of the monitoring network. This information can then be used to aid in the decision to adjust the monitoring program and possibly create a groundwater management area in the District in the future. Another outcome of the project would be the development of a web page so up to date water quality data will be more readily available to the public.

To date, the District has paid \$40,700 under Account #05-00-4485 to satisfy the previous agreement, leaving a balance in that account of \$53,975. If adopted, the new agreement would require an additional \$13,425, or a total of \$67,400. This would make this account increase more than 10%, requiring Board approval.

**Management recommends that the Subcommittee recommend to the Board that the General Manager be authorized to execute an agreement with the U.S. Geological Survey to conduct a Water Quality Trends and Monitoring Well Network Analysis as proposed, in addition to the routine sampling of groundwater wells in the District, up to a maximum District expenditure of \$311,000 over the next three fiscal years, and that Account #05-00-4485 be allowed to go over 110% of the budgeted amount on the FY 2008 Budget.**



## United States Department of the Interior

U.S. GEOLOGICAL SURVEY

Nebraska Water Science Center

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Lincoln, NE 68512-1271

December 3, 2007

Gerry Bowen  
Papio-Missouri River Natural Resources District  
8901 South 154<sup>th</sup> Street  
Omaha, NE 68138

Dear Gerry:

As we discussed on November 16, 2007, I am sending you this letter with the U.S. Geological Survey (USGS) proposal to (1) produce a report on ground-water quality trends in data from water-quality monitoring in the Papio-Missouri River Natural Resources District (PMRNRD) from 1992 to 2007 and on the adequacy of the current water-quality monitoring program, and (2) do modified ground-water quality monitoring in 2008 and 2009. This letter discusses the background for the USGS and PMRNRD ground-water quality monitoring program, the ground-water monitoring program from 1994 to 2007, and a brief description of our proposal, including the cost reductions for a modified ground-water quality monitoring program in 2008 and 2009.

### **Background**

Ground-water quality monitoring in the PMRNRD began in 1992 with a synoptic study conducted by the USGS. The objective of the synoptic study was to identify sets of appropriate network wells, which were existing wells screened in one of the five aquifers in the PMRNRD, to sample the network wells, and to use the sampling results from the network wells to establish base-line ground-water quality in each of the aquifers. The results of the synoptic study were presented in USGS Water-Resources Investigations Report 94-4197, "Reconnaissance of ground-water quality in the Papio-Missouri River Natural Resources District, Eastern Nebraska, July through September, 1992." Based on the results of the synoptic study, USGS identified suggested locations for several well nests. The recommended design for the well nests were sets of short-screened monitoring wells, generally screened at the top, middle, and bottom of the aquifer. In 1998, eight well nests with three monitoring wells and one well nest with two monitoring wells were installed; USGS oversaw well installation.

**Ground-water monitoring program, 1994 to 2007**

In each summer from 1994 to 2007, a subset of network wells were selected by aquifer and sampled for nutrients and pesticides. Wells in each of the five aquifers were sampled at least once every three years. In summer 2007, we sampled 40 network wells screened in the Missouri, Elkhorn, and Platte River alluvial aquifers.

From 1999 to 2007, the well nests have been sampled on a varying schedule; initially, the wells were sampled monthly, then bimonthly, then six of the nests, which had little variance in the nitrate concentrations, were sampled biannually and the remaining well nests were sampled bimonthly. The well nests that continue to be sampled bimonthly are in areas with nitrate results near or exceeding the U.S. Environmental Protection Agency's Maximum Contaminant Level or are in other areas of interest to the PMRNRD. The well nests have been sampled for nutrients, major ions, pesticides, age-dating constituents, dissolved gases, and nitrogen isotopes. From October 2006 to September 2007, we sampled the Springfield, Tekamah, and Venice well nests bimonthly and we sampled the remaining six nests biannually; the wells were sampled for nutrients, major ions, and pesticides.

**Proposal for 2008 through 2009**

In 2008 and 2009, we propose to study the ground-water quality trends in the analysis results, which we have collected since 1992, and to recommend changes to the ground-water monitoring program in all wells starting in 2010. While we are working on the trends and network analysis report in 2008 and 2009, we recommend a temporary reduction in the ground-water monitoring schedule of the network wells and well nests to offset some of the cost for the trends and network analysis report. We suggest sampling the 30 network wells screened in the Platte River alluvial, Upland, and Dakota aquifers in summer 2008 and sampling 30 network wells screened in the Elkhorn and Platte River alluvial aquifer in summer 2009. We suggest sampling all the well nests one time in 2008 and 2009 for nutrients, major ions, and pesticides and sampling and sampling the Springfield, Tekamah, and Venice well nests three additional times for nutrients. These suggested changes in the annual sampling schedule for the network wells (12 fewer samples than in 2007) and for the well nests (54 fewer samples than in 2007) will result in a savings to USGS and to the PMRNRD of \$26,000 in 2008 and 2009. Attached is the proposal for the trends and analysis report and for the ground-water monitoring in 2008 and 2009.

If you have any questions, contact Virginia (Ginny) McGuire at (402) 328-4126 or send e-mail to [vlmcguir@usgs.gov](mailto:vlmcguir@usgs.gov).

Sincerely,

Robert B. Swanson, Director  
Nebraska Water Science Center

Enclosure

**Analysis of water-quality trends and evaluation of existing water-quality monitoring network, 1992 to 2007, Pappio-Missouri River Natural Resources District, eastern Nebraska**

By

V.L. McGuire

U.S. Geological Survey  
Lincoln, Nebraska

November 29, 2007

## **Evaluation of existing water-quality monitoring network and analysis of water-quality trends, 1992-2007, Papio-Missouri River Natural Resources District, eastern Nebraska**

**Problem:** From 1992 to the present time (2007), the U.S. Geological Survey (USGS) Nebraska Water Science Center (NEWSC), in cooperation with the Papio-Missouri River Natural Resources District (PMRNRD), has collected and analyzed samples from the PMRNRD's network of water-quality wells, which consist of about 170 domestic, industrial, irrigation, municipal, stock (DIIMS) wells (fig. 1) and 26 monitoring wells in 9 well nests (fig. 2). The primary purpose of the sampling is to assess nutrient and pesticide concentrations in the area's five aquifers in accordance with the PMRNRD's Ground-water Management Plan. The water-quality network was initially established after a USGS synoptic study, which was conducted in 1992; the well nests were installed in 1999.

The five aquifers in the PMRNRD area are the Elkhorn, Missouri, Platte, and Upland alluvial aquifers and the Dakota aquifer. All the aquifers, except the Dakota, are the uppermost aquifer in the respective area. Each well in the water-quality network generally is screened in only one aquifer; the DIIMS wells may not be sealed with bentonite above the well's screen, so for wells screened in the Dakota aquifer, where the Dakota aquifer underlies one of the other aquifers, these wells may be connected to the overlying aquifer through the gravel pack.

Currently, the DIIMS wells are generally sampled once every 3 years during irrigation season; however, some wells, which are in areas of interest for the PMRNRD, have been sampled annually. The areas of interest for the PMRNRD generally are areas where the nitrate concentration exceeds the U.S. Environmental Protection Agency's (EPA) Maximum Contaminant Level (MCL); the MCL for nitrate is 10 mg/L. Samples are collected from the DIIMS wells for nitrate plus nitrite or nutrient (ammonia, nitrate plus nitrate, nitrite only, and phosphate) analysis, atrazine screening, and, for the 6 wells with the highest atrazine screening results, pesticide analysis.

Currently, the monitoring wells in the well nests are sampled on two schedules. Three nests are in areas of interest for the PMRNRD; these three nests are sampled bimonthly. The remaining six nests are sampled biannually. Samples are collected from the monitoring wells for major ions, nitrate plus nitrite or nutrient analysis, atrazine screening, and, for the 6 wells with the highest atrazine screening results, pesticide analysis. Water samples have been collected one or two times at selected wells for dissolved gases, chlorofluorocarbons (CFCs), nitrogen ( $N^{15}$ ) and oxygen ( $O^{18}$ ) stable isotopes in dissolved nitrate, and  $N^{15}$  in dissolved nitrogen gas. Soil samples were analyzed for nitrate and organic matter.

Each time a well is sampled, field parameters consisting of; pH, water, temperature, specific conductance and dissolved oxygen are measured. Prior to sampling, the static water level is measured in each monitoring well in the well nests.

The trends in water-quality results from 1994 to current (2007) in the DIIMS wells and from 1999 to current (2007) in the well nests have not been formally analyzed. In some parts of the Platte, Elkhorn, and Upland alluvial aquifers, nitrate concentrations are greater than 7 mg/L; and, in parts of the Dakota aquifer, nitrate concentrations exceed 20 mg/L. Nitrate concentrations may relate to explanatory factors such as depth to water, proximity to agricultural activities and surface water, ground-water flow direction, and other factors. There are also indications of extensive denitrification especially in the Platte and Elkhorn alluvial aquifers; however the extent of denitrification has not been identified. Denitrification (reduction in nitrate concentration) occurs when bacteria in the water use nitrate as a terminal electron acceptor. The denitrification indicators are low dissolved oxygen and very low nitrate concentrations and the presence of dissolved methane and nitrogen gas and changes in the N<sup>15</sup> ratio in nitrogen gas and nitrate. Municipalities pumping from wells screened in the Platte alluvial aquifer may reduce denitrification in the aquifer near the well field by increasing ground-water velocity.

**Objective:** The three objectives of the proposed study are 1) to analyze the ground-water-quality and, where practical, ground-water-level trends, 2) to review the ground-water-monitoring network and sampling schedule of the PMRNRD, and 3) to continue to sample the PMRNRD wells on a reduced schedule for 2008 and 2009. The study will examine the water-quality trends, and, to the extent feasible, correlate the trends to natural and human factors and, if applicable, recommend changes to the ground-water-monitoring network. Knowledge of trends in ground-water flow and quality in the PMRNRD will provide additional understanding to help PMRNRD personnel to better manage the overall system.

**Approach:** The objectives of the water-quality trends and network analysis parts of the study will be accomplished in a 2-year period while carrying out the third part of the study—to sample the PMRNRD wells on a reduced schedule. In the of the water-quality trends and network analysis part of the study, the first step will be to collect and review the relevant historical ground-water-quality, rainfall, and streamflow data maintained by the USGS and others and identify areas with insufficient data or areas where different water-quality analysis or a revised sampling schedule could result in more useful data. To the extent possible, initial evaluation and delineation of the water-quality data will include input of data into geographical information system (GIS) databases so that computer-generated maps can be used for further analysis and evaluation. The second step will be used to review 2007 water-quality results, analyze trends in the water-quality data from 1992 to 2007, prepare and release a PMRNRD web-site USGS public web site with access to historical and current water-quality results, and publish the water-quality and network analysis findings in a USGS Scientific Investigations Report (SIR). Historical data and data collected during this study will be compiled with respect to water-quality characteristics and general geochemistry, water levels, and ground-water-flow directions. Data review and report compilation will continue through the third quarter of 2009. The last quarter of 2009 and the first month of 2010 will be used to publish a USGS SIR documenting the findings of the water-quality trends and network analysis part of the study.

During 2008 and 2009, there will be a temporary reduction in the ground-water monitoring schedule of the DIIMS wells and the monitoring wells in the well nests to offset some of the cost water-quality trends and network analysis parts of the study. The reduced sampling plan is

- For the DIIMS wells, to sample 30 DIIMS wells screened in the Platte River alluvial, Upland, and Dakota aquifers in summer 2008 and sampling 30 DIIMS wells screened in the Elkhorn and Platte River alluvial aquifer in summer 2009
- For the monitoring wells in the well nests, to sample all the monitoring wells in the well nests one time in 2008 and one time in 2009 for nutrients, major ions, and pesticides and sampling and to sample the monitoring wells in the Springfield, Tekamah, and Venice well nests three additional times for nutrients.

**Quality Assurance:** To assure the quality of the water-quality trends and network analysis parts of the study, the USGS has an extensive agency protocol for internal review and peer reviews of data and the resulting publications or web sites. To assure the quality of the USGS on-going sampling in 2008 and 2009 for the PMRNRD, all samples will be analyzed by the USGS National Water Quality Laboratory, Denver, Colorado or by the USGS Organic Geochemistry Research Laboratory, Lawrence, Kansas. During each sample collection period, wells designated for quality assurance samples will be selected randomly. The quality assurance samples will consist of a field blank and field replicate set for ten percent of the wells sampled.

**Products:** The results of the water-quality trends and network analysis parts of the study will be published in a USGS SIR. In addition, a web page will be added to the USGS Nebraska Water Science Center web site to enable the PMRNRD and the public to easily access the historical and current PMRNRD water quality data, including water quality data collected from public supply wells in the PNRNRD, however, the location of the public supply wells will not be made available on the web site in accordance with State and National policy. The results of the water-quality trends and network analysis parts of the study will be presented, if requested, to the PMRNRD Staff and Board of Directors.

**Relevance and Benefits:** The concentrations of various analytes in ground water in the PMRNRD aquifers have been measured since the early 1990's, but the trends in the water-quality results, especially in relation to explanatory variables, or the adequacy of the monitoring well network and sampling schedule have not been analyzed. A product of this proposal, a USGS SIR on the trends in the water-quality results and an assessment of the monitoring well network, will make the analysis available to the public and to the PMRNRD decision makers, which will increase understanding of water-quality conditions in the PMRNRD and lead to an improved monitoring network for the future. This proposed work is consistent with the first of the USGS's Strategic Actions related to the Water Census; specifically, the relevant USGS Strategic Action addresses expanding the capabilities of time-series data-collection for status and trends of water quality and making the information available to the public and to decision makers in a nationally consistent manner. The USGS SIR will benefit the cooperator by providing an analysis of the trends in the geochemical data and an assessment of their monitoring network so that informed decision can be made on ground-water management issues.



**Personnel:**

USGS Personnel	Days	
	FY08	FY09
	Hydrologic Technician	78
Hydrologist	106	114
Webmaster		8

**Timeline:** The schedule for publication of the USGS SIR by January 30, 2010 assumes the USGS and PMRNRD cooperative water agreement is signed by January 15, 2008.

Activity	2008			2009				2010		
	PMRNRD Fiscal Calendar									
	FY08		FY09				FY10			
	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
	USGS Fiscal Calendar									
	FY08			FY09				FY10		
Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	
Ground-water sampling	X	X	X	X	X	X	X	2010 agreement		
Collection of historical data for report		X	X							
Data analysis			X	X	X	X				
Report preparation					X	X	X	X		
Report completed								X	X	

**Cost** The estimated cost of sample analysis, data interpretation, and delivery of the results in the form of a USGS SIR is about \$311,000.

Item	FY08	FY09	TOTAL
Labor	\$124,600	\$147,000	\$271,600
Travel	7,700	6,000	13,700
Supplies, equipment, shipping, and miscellaneous	6,700	7,600	14,300
Laboratory	23,600	26,200	49,800
Publishing	—	26,900	26,900
<b>TOTAL</b>	<b>162,600</b>	<b>213,700</b>	<b>376,300</b>
<b>USGS Share</b>	<b>27,800</b>	<b>37,500</b>	<b>65,300</b>
<b>PMRNRD Share</b>	<b>134,800</b>	<b>176,200</b>	<b>311,000</b>