Groundwater:

Plan to Develop a Groundwater Level Monitoring Network for the 11-County Metropolitan Area

October 2009

Minnesota
Department of Natural Resources
Waters

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The cost of producing this report is $23,560.00.

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EXECUTIVE SUMMARY

This report is produced in response to Minnesota Session Laws 2009 Chapter 37 Section 4 Subd. 3., which reads in part:

> *By October 1, 2009, the commissioner shall develop a plan for the development of an adequate groundwater level monitoring network of wells in the 11-county metropolitan area. The commissioner, working with the Metropolitan Council, the Department of Homeland Security, and the commissioner of the Pollution Control Agency, shall design the network so that the wells can be used to identify threats to groundwater quality and institute practices to protect the groundwater from degradation. The network must be sufficient to ensure that water use in the metropolitan area does not harm ecosystems, degrade water quality, or compromise the ability of future generations to meet their own needs. The plan should include recommendations on the necessary payment rates for users of the system expressed in cents per gallon for well drilling, operation, and maintenance.*

Background

Minnesota's water supply has long been taken for granted. This legislation recognizes the urgency for sustainable water management and the need for an integrated monitoring network to help achieve that goal.

The aquifers underlying the 11-county metropolitan area have provided a robust supply of water for an ever-growing population since statehood. Today, many communities in the metropolitan area are 100% dependent on groundwater for drinking water (Figure 1) and it is the source of drinking water for at least 75% of all Minnesotans. Demand for groundwater for all uses, especially public water supply, will continue to increase (Figure 2).

Considering the known risks threatening these critical aquifers, more decision-makers agree that it is imperative to increase efforts to learn more about flow pathways, rate of water movement and other characteristics of how they function. The current monitoring network, based largely on monthly individual hand measurements, is inadequate for the level of understanding needed. Automated systems capable of more frequent measurements are essential. We cannot manage what we do not measure.

Additional investments are needed to understand and protect groundwater systems so that future generations will also have an abundant source of clean water that is so integral to Minnesota's enviable quality of life.

Language in this law covers major work responsibilities for several agencies, including the Department of Natural Resources, the Pollution Control Agency, the Department of Agriculture, the Department of Health and the Metropolitan Council. Prior to passage of this law, these agencies along with numerous other partners were already working together to address more coordinated approaches to sustainable water management. This report was collaboratively produced by these agencies.

There are numerous initiatives currently underway that

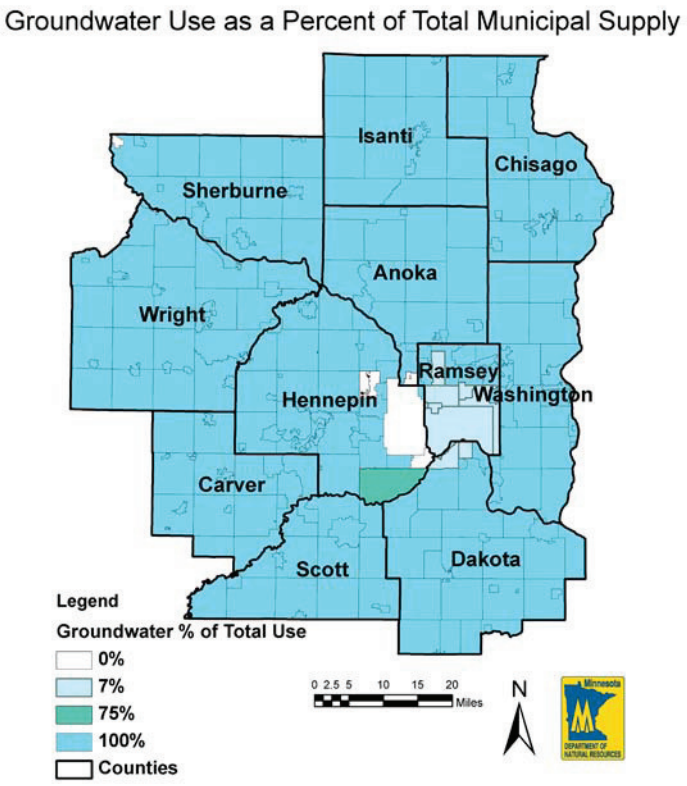

Figure 1: Dependency on groundwater for drinking water supply by municipality as a percent of total water used.

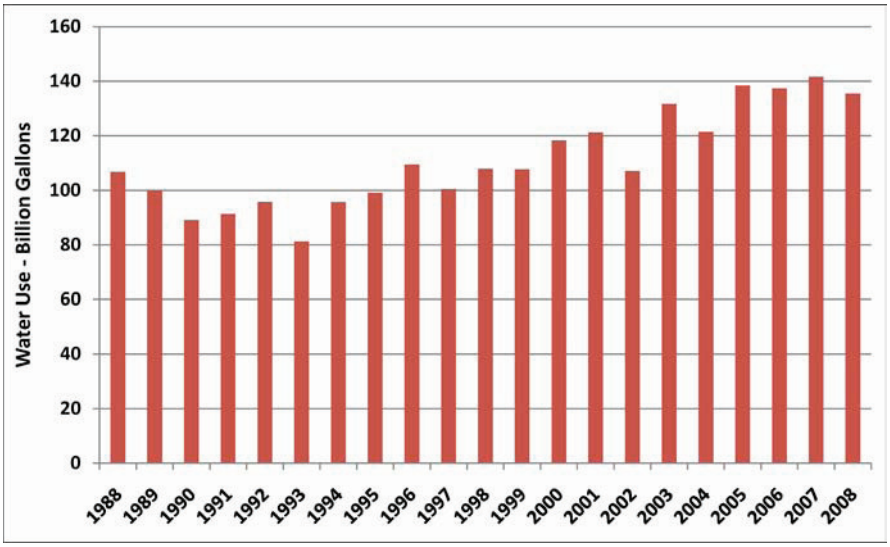

Figure 2: Groundwater use in the 11-County Metropolitan Area in billions of gallons.

will continue to move the state forward in addressing the very issues identified in this law. Nevertheless, we appreciate the legislative support and direction this law brings to help keep focus on the importance of achieving sustainable water use in the greater metropolitan area, as well as statewide.

Beginning with the first part of the legislative requirement:

By October 1, 2009, the commissioner shall develop a plan for the development of an adequate groundwater level monitoring network of wells in the 11-county metropolitan area.

The attached report entitled Plan to Develop a Groundwater Level Monitoring Network for the 11-County Metropolitan Area constitutes the major body of work related to this report. This report identifies a long-term plan for the data and monitoring systems needed to more fully understand these aquifers and flow pathways. That information will ultimately enable us to better protect long-term supplies, prevent water quality degradation, and ensure that water use does not harm ecosystems.

The plan, based on the National Framework for Groundwater Monitoring in the United States, is tailored to meet Minnesota's needs. The Groundwater Technical Work Group, comprised largely of technical groundwater professionals from the U.S. Geological Survey, Minnesota Geological Survey, University of Minnesota, Met Council, the departments of Natural Resources, Pollution Control, Health, and Agriculture, Environmental Quality Board, Dakota County and the professional consulting firms of Barr Engineering, Braun Intertec, and HDR, provided direction, input, content review and guidance in the development of this plan.

Additionally, we used guidance and recommendations from Groundwater Workshops sponsored by the Freshwater Society and the University of Minnesota Water Resources Center, the American Water Resources Association, the EQB, and other nationally recognized technical reports and papers on the topic of sustainable groundwater management in producing this plan.

Developing an integrated monitoring network and data management system called for in this plan will require both public and private involvement and investment in order to achieve the desired goals. It is essential to recognize that these investments will be much smaller than the cost of managing supply conflicts, remediation of threats to water quality and ecosystem health, and future treatment of impaired groundwater supplies if our current ample supplies of relatively clean water are permanently harmed.

Since a network must be viable for a long period of time, dedicated or endowed funding is recommended due to:

- the extensive amount of knowledge needed to be collected about the systems through research, sampling and monitoring points;
- the research required to gain a greater understanding of the geologic processes that formed the multiple aquifer layers that are buried beneath us; and
- the data and information systems that must be built to enable easy access to, and sharing of, historic information in conjunction with new data streams that will be added on an on-going basis.

The second part of the legislative requirement states:

The commissioner, working with the Metropolitan Council, the Department of Homeland Security, and the commissioner of the Pollution Control Agency, shall design the network so that the wells can be used to identify threats to groundwater quality and institute practices to protect the groundwater from degradation.

The groundwater level monitoring network plan identified in the first part will not replace the need for the existing and separate authorities and programs that are in place and designed to identify the threats and protect groundwater from degradation. Multi-agency coordination is at the heart of the Ground Water Protection Act and is how agencies will operate to a much greater degree going forward. We recognize that we must "Do together what we can't do alone."

Led by the Department of Agriculture, the Pollution Control Agency and the Department of Health, in collaboration with the Department of Natural Resources and the Metropolitan Council, an interagency groundwater monitoring strategy and groundwater protection strategy are under development that will enhance and support this plan from a water quality management aspect. All monitoring wells installed under this plan will be sampled for a basic set of water quality parameters.

The MPCA and MDA have plans to meet their statutory responsibilities to improve monitoring to help track both known and emerging threats in order to protect groundwater from degradation. Those plans should be utilized to provide the basis for continued support and funding for water quality management beyond needs described in this plan.

Beyond agency efforts, local government land use management decisions must avoid and, where possible, reverse trends that threaten our aquifers. Unsustainable usage demands and the introduction of pollutants will ultimately result in limits on availability and significantly higher long-term treatment costs for present supplies. Success will not come until all decision-makers understand the impacts of their decisions on groundwater resources.

The third part of the legislative requirement states:

The network must be sufficient to ensure that water use in the metropolitan area does not harm ecosystems, degrade water quality, or compromise the ability of future generations to meet their own needs.

The ultimate purpose of the monitoring network and data management system is to provide the information that will enable decision-makers to understand the threats to ecosystem health, water quality and sustainable supplies for future generations. Well data will enable us to better understand the flow pathways and rate of water movement of water through subsurface layers. Using improved models and actual measurements to understand the amount and rate of water movement into, through and out of the different aquifers will enable us to better manage supply and demand. Ecosystem managers and both water quality and water supply managers need this information to make more sustainable decisions. All water users will benefit from a systematic program for long-term collection of water level and chemical data.

Ecosystem impacts are difficult to measure for two primary reasons. First, there is a lack of knowledge about how much groundwater flows from aquifers to surface water systems, except where intensive monitoring has been undertaken to address known impacts from pumping. Second, we do not have sufficient understanding of all the lifecycle water needs of all the plants and animals that make up an ecosystem and how changes in volume of groundwater flow might affect their individual or collective health.

We will continue to improve our understanding of site specific management needs, expand monitoring, and require specific studies where modeling and data suggest ecosystem harm might occur from overuse of an aquifer. Where known sensitive resources such as calcareous fens, trout streams, lakes, wetlands and streams are at potential risk based on our analyses, DNR currently uses an adaptive management approach. Adaptive management is a structured, iterative process of decision making, with a goal of reducing uncertainty via system monitoring. Monitoring accrues information needed to improve future management. Adaptive management can be characterized as "learning by doing."

The DNR will work to develop a monitoring plan over the next few years that will better address ecosystem health. The establishment of the monitoring network, outlined in our response to the final legislative requirement below, will be an important step to improve our understanding of water movement in our aquifers as a predictive tool for protecting ecosystem health.

The fourth and final part of the legislative requirement states:

The plan should include recommendations on the necessary payment rates for users of the system expressed in cents per gallon for well drilling, operation, and maintenance.

While the first three parts of the legislative requirement address broad concepts on sustainable management of our groundwater system in the 11-county metropolitan area, this final part will be limited to work necessary to understand and sustainably manage the water supply.

To address monitoring needs, a "backbone network" for long-term groundwater level monitoring must first be established for the 11-county metropolitan area and ultimately expanded statewide. The design of this network will include a long-term plan for the collection of data, development of systematic monitoring systems, and creation of a real-time water level information data management system that will help local and state water managers protect long-term supplies. Development of the monitoring system will occur sequentially as data from each successive year inform and guide placement of additional wells in subsequent years.

Monitoring is a shared responsibility of all users. Coordination of monitoring at the aquifer level rather than jurisdictional level is more appropriate since impacts of groundwater use can occur far from the point of taking. Also, no jurisdictional boundaries, not even watershed district boundaries, are necessarily accurate for purposes of groundwater management. While the backbone network will provide essential data on how water moves through the aquifers, to plan for sustainable supplies we will also need water users to accurately report water level information from their production wells and local groundwater level monitoring wells for inclusion in the data management system.

Our initial estimation for an adequate "backbone" water level monitoring network for the 11 county metropolitan area will consist of all useable existing monitoring locations, which is estimated at 200 sites. It will also require establishment of 60 well "nests" consisting of a series of closely located wells in each of the monitored subsurface formations at a selected location. All wells will need to be instrumented with automated data systems and each of the well nests will need to be instrumented with real-time access to the automated data systems.

Costs include well drilling and construction, monitoring equipment and installation, ongoing operations and maintenance, data storage system costs, land rights costs for the well nest locations, and costs for interpretation and analysis of the data. It is estimated this will cost $8,861,150 over a four year period. The annual on-going cost for operation and maintenance of the water level monitoring

network is estimated to be $825,000. The following table describes cost components for the first four years of network build-out and for subsequent years.

An estimated 140 billion gallons of groundwater per year are used in the 11-county metropolitan area. During the four years of network buildout, the costs will be:

$8,861,750.00 /4 years = $2,215,437.50 per year

$2,215,437.50 per year / 140 billion gallons per year= $0.00001582 per gallon =

0.001582 cents per gallon, or

$15.82 per million gallons.

Once the backbone network is established, costs for ongoing operation and maintenance will be:

$825,000.00 per year

$825,000 per year / 140 billion gallons per year= $0.00000589 per gallon =

0.000589 cents per gallon, or

$5.89 per million gallons.

Table 1: Costs for the Creation, Maintenance, and Operation of a Groundwater Level Monitoring Network for the 11-County Metropolitan Area.

	Year 1	Year 2	Year 3	Year 4	Total Development	Subsequent Years
Total Wells in Backbone Network	80	175	270	380	380	380
Backbone Network Establishment: Well Drilling, Easements, Instrumentation, Operation and Maintenance	$ 1,083,400	$ 1,310,750	$ 1,440,600	$ 1,627,000	$ 5,461,750	$ 627,000
Technical Support / Quality Control / Groundwater Analysis	$ 350,000	$ 350,000	$ 350,000	$ 350,000	$ 1,400,000	$ 105,000
Data Management and Access through Web Portal	$ 500,000	$ 500,000	$ 500,000	$ 500,000	$ 2,000,000	$ 93,000
	$ 1,933,400	**$ 2,160,750**	**$ 2,290,600**	**$ 2,477,000**	**$ 8,861,750**	**$ 825,000**
Dollars per Million Gallons	$ 13.81	$ 15.43	$ 16.36	$ 17.69	$ 15.82	$ 5.89
Cents per Gallon	0.001381	0.001543	0.001636	0.001769	0.001582	0.000589

Notes:

All values 2009 dollars

By the end of the fourth year of network build-out, the backbone network will consist of 60 nests for which data are transmitted real time (approx. 3 wells per nest) and 200 monitoring wells with dataloggers