# Southwest Metro Ground Water Work Group Management Plan

**December 2002**

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## INTRODUCTION

This management plan details efforts that have been conducted in the Southwest Metropolitan Area to protect natural resources while supplying water for the growth of the communities in the area. In addition, the plan outlines several recommendations for future data collection and assessment as well as actions for the involved communities and agencies to take. Each of the following entities will sign a Memorandum of Agreement to work with each other to implement the recommendations contained in this plan: City of Burnsville, City of Lakeville, City of Prior Lake, City of Savage, City of Shakopee, Shakopee Public Utilities Commission, the Shakopee Mdewakanton Sioux Community (SMSC), Dakota County, Scott County, the Minnesota Department of Natural Resources (MDNR), the Metropolitan Council (MC), and Credit River Township.

This Management Plan was prepared by the Metropolitan Council (MC) in cooperation with the Minnesota Department of Natural Resources (DNR) and the communities, agencies and organizations mentioned in the following section. This report follows several years of effort by participants with the goal of protecting the State's natural resources while planning for growth in the Southwest Metro Area. Although the process is ongoing and should not be considered concluded with completion of this Plan, all the participants should be commended for the countless hours contributed to date and be proud of the progress that has been made. As areas continue to grow throughout the State, the Southwest Metro Ground Water Work Group can be looked to as a model for involved parties to work together to provide adequate water supply for growth while protecting the State's natural resources.

## HISTORY AND FORMATION

In early 1997, it became apparent that several cities in the southwest portion of the metropolitan area, south of the Minnesota River were heading for regulatory difficulties in obtaining sufficient water to supply projected growth. The regulatory problems related to the withdrawal of ground water and the impact this was having on some unique surface water features in the area. The key factor that caught the attention of the DNR was the lowering of water levels in the Savage Fen, a rare calcareous wetland containing rare plant species. These plants rely upon upwelling of calcareous ground water from the Prairie du Chien (PduC) aquifer. The PduC, in turn, is fed to some degree by water from the Jordan sandstone aquifer. The complex connection of these two bedrock units and the impact of pumping them for water supply became the primary focus of a group assembled in 1997.

The Southwest Metro Ground Water Work Group (SMGWG) was formed in April 1997 to serve as a forum to discuss the issues facing the communities and the regulators. After preliminary discussions with many of the affected parties, the MC agreed to facilitate this group. The first meeting was held on April 28, 1997. Through December 2001, the group has met 27 times as a full group and many more times as a technical sub-group evaluating data and putting together a work plan.

Participation in the SMGWG has remained very stable over the years with many of the following participants consistently at the table:

Cities: Burnsville, Lakeville, Prior Lake, Savage and Shakopee

Tribal Interests: Shakopee Mdewakanton Sioux Community (SMSC)

State/Regional/Federal Agencies: DNR, MC, Minnesota Department of Health (MDH), Minnesota Pollution Control Agency (MPCA) and the U.S. Geological Survey (USGS)

Counties: Dakota and Scott

Other Participants: Minnesota Geological Survey (MGS), community consulting engineers (Barr Engineering, Short Elliot and Hendrickson Inc., Bonestroo Rosene Anderlik & Associates, Howard R. Green Company, CH2MHill, Progressive Consulting Egineers), Minnesota Center for Environmental Advocacy, Lower Minnesota River Watershed District, Aggregate Industries (formerly CAMAS), Technical & Regulatory Evaluations Group, and occasionally members of the public

## GOALS AND OBJECTIVES

One of the first items that was undertaken by the full SMGWG was the definition of goals for the group. At its meeting of July 22, 1997, the group adopted the following goals:

- Develop consensus on a strategy that will accommodate projected growth and assure ground water availability in the south metro area, while protecting sensitive environmental features.

- Collect the best data possible upon which to make water use decisions.

- Create a long-term water supply management strategy that recognizes the importance of local control issues, the charges of regulatory agencies, and builds on the cooperation that exists between the communities and other government sectors.

These three goals have formed the basis for group actions since the time they were adopted. The statement reinforces the group's desire to be flexible in its approach, yet representative of all of the participating interests. Since the adoption of these goals, several objectives have been discussed that address how these goal statements will be achieved. Specific objectives include:

- Definition by the DNR of "acceptable" impact and aquifer "safe yield" so that communities have a framework for judging impact.

- Implementation of effective water conservation programs in each of the communities.

- Definition of how much water each community will need and the location and water source that they will use to obtain that water.

- Exploration of alternative water supplies if adequate water cannot be obtained to meet the above objective. Alternatives include using surface water such as the Minnesota River, using intercepted water at quarries, using deeper aquifers such as the Franconia-Ironton-Galesville (FIG) or the Mt. Simon-Hinckley (MTS/H), locating well fields away from areas that influence unique surface water features, and interconnecting and/or jointly developing water supplies.

- Plan for and implement additions to the monitoring network that allow monitoring of water level changes as the region develops and furthers understanding of the complex hydrogeology of the southwest metro area.

- Coordination of changes to urban land uses and the regulatory approval to obtain water to supply the population occupying the newly urbanized land. All land use approvals such as comprehensive plans, Metropolitan Urban Service Area (MUSA) extension and plat developments, should consider whether there is sufficient water to support the development without negative impact to natural resources including ground water.

- Continuation of the forum that has met under the SMGWG umbrella.

## DEMOGRAPHIC OUTLOOK AND WATER DEMAND

Two of the most important variables to define in managing the water related problems in this region are the growth that is expected to occur and the demand for water that that growth spawns. These numbers change very quickly as development proposals come and go, but the community local comprehensive plan sets the long-term framework for how the community expects to evolve. Each of the five municipalities participating in the SMGWG has prepared a comprehensive plan that has been reviewed by the MC for consistency with its overall projections for metropolitan area growth. The SMSC has voluntarily submitted its comprehensive plan to the MC as well, although state law does not apply to the autonomous Native American community.

In 2000 the five communities and the SMSC appropriated over 7 billion gallons of water from 42 wells drilled in various aquifers. Table 1 shows the wells active in 2000 and the water appropriated from each.

Projections for future water demand have been made for each community in the area. Demand is forecasted to increase by over 50% by 2020. To meet this demand, there are currently 25 additional utility wells planned in the study area. The geographic location and aquifer unit used for these wells is critical in the prevention of impact to the unique surface water features in the area. Determining this mix will be the greatest challenge that the Work Group faces in formalizing a management strategy. Table 2 shows the projections for each community.

## ISSUES

After four years of meeting, there are several issues that have emerged. This section of the plan identifies the issues, many of which will be addressed in this plan, while others will need further attention. The issues can be generally divided into technical (geology/hydrogeology and ground water quality) and institutional/regulatory/political.

### Geology/Hydrogeology

The biggest issue that faces the communities and the DNR in the study area is whether the ground water system can supply the water needed for growth while maintaining surface water levels needed by the Savage Fen, Boiling Springs, Eagle Creek and associated surface water bodies like Dean's Lake, the Minnesota River Valley lakes, and the wetland corridor of the Minnesota Valley National Wildlife Refuge. Addressing this issue is difficult due to uncertainty inherent in characterization of natural systems. Groundwater models can be used to predict the impact of withdrawals on the surface water features. However, these tools can not be relied on to be a precise prediction of the effects. Groundwater monitoring can be used to improve model accuracy and provide information of aquifer response at a specific location.

Several questions related to the above overlying issue have been raised and discussed, to some extent, by the SWMGW. Among these are: the possibility of defining a boundary within which the Jordan aquifer should not be pumped; the ability of the FIG to provide an adequate volume of water without significant drawdown; use of the MTS/H within regulatory limitations; the interconnectedness between the PduC and Jordan; and the DNR-defined "safe yield" or acceptable drawdown relative to the surface water features.

One area of discussion that will not likely be fully addressed in the near-term is the role of reduced recharge due to increasing impervious surface in the overall availability of ground water. Obviously there is a need to maintain recharge to the ground water system as the area continues to develop, so a development or

Table 1. Community Wells and 2000 Water Appropriation

| Community | Well – Aquifer | Year Installed | 2000 Pumpage Million Gallons |
|---|---|---|---|
| Burnsville | 1 – Jordan | 1964 | 229.3 |
| | 2 – Jordan | 1966 | 232.7 |
| | 3 – Jordan | 1969 | 39.7 |
| | 4 – Jordan | 1969 | 113.4 |
| | 5 – Jordan | 1970 | 156.8 |
| | 6 – Jordan | 1970 | 74.7 |
| | 7 – Jordan | 1972 | 237.4 |
| | 8 – Jordan | 1972 | 76.7 |
| | 9 – St. Lawrence through Hinckley | 1975 | 186.2 |
| | 10 – Jordan | 1975 | 245.6 |
| | 11 – MTS/H | 1981 | 159.4 |
| | 12 – Jordan | 1988 | 275.1 |
| | 13 – Jordan | 1978 | 136.4 |
| | 14 – MTS/H | 1990 | 118.0 |
| | 15 – Jordan | 1990 | 303.4 |
| | 16 – Jordan | 1994 | 35.5 |
| | 2000 Total | | 2,620.3 |
| Lakeville | 2 – Jordan | 1964 | 0 |
| | 3 – Jordan | 1968 | 7.41 |
| | 4 – Jordan | 1969 | 47.8 |
| | 6 – Jordan | 1980 | 560.37 |
| | 7 – Jordan | 1984 | 43.04 |
| | 8 – Jordan | 1989 | 127.97 |
| | 9 – Jordan | 1995 | 129.47 |
| | 10 – Jordan | 1995 | 318.24 |
| | 11 – Jordan | 1996 | 121.70 |
| | 12 – Jordan | 1997 | 267.24 |
| | 13 – Jordan | 1998 | 266.16 |
| | 2000 Total | | 1,889.4 |
| Prior Lake | 3 – Jordan | 1973 | 262.5 |
| | 4 – Jordan | 1975 | 139.3 |
| | 5 – Jordan | 1988 | 212.8 |
| | 2000 Total | | 614.6 |
| Savage | 1 – Jordan | 1961 | Abandoned – 2000 |
| | 2 – MTS/H | 1969 | Abandoned – 2000 |
| | 3 – Jordan | 1985 | 311.0 |
| | 5 – Drift | 1989 | 58.7 |
| | 6 – PDC | 1989 | 311.4 |
| | 7 – MTS/H | 1995 | 182.6 |
| | 8 – MTS/H | 1998 | 18.7 |
| | 9 – FIG | 2000 | |
| | 10 – MTS/H | 2001 | |
| | 11 – FIG | 2000 | |
| | 2000 Total | | 882.3 |

Table 1. Community Wells and 2000 Water Appropriation (cont.)

| | | | |
|---|---|---|---|
| Shakopee | 2 – FIG* | 1945 | 106.3 |
| | 3 – St. Lawrence through MTS | 1956 | 185.1 |
| | 4 – Jordan | 1971 | 106.9 |
| | 5 – Jordan | 1971 | 142.2 |
| | 6 – Jordan | 1981 | 241.8 |
| | 7 – Jordan | 1986 | 26.7 |
| | 8 – Jordan | 1989 | 266.4 |
| | 9 – Jordan | 1995 | 250.1 |
| | 10 – MTS/H | 2001 | |
| | 11 – Jordan | 2001 | |
| | 2000 Total | | 1325.5 |
| SMSC | 2 – Jordan | | |
| | 3 – Jordan | | |
| | 5 – Jordan | 1993 | 3.3 |
| | 6 – Jordan | 1994 | 14.5 |
| | 7 – FIG | 1999 | 117.3** |
| | 2000 Total | | 135.1 |

* converted from multi-aquifer to FIG well in 2002
** elevated value to well being serviced much of the year

Table 2. Community Population and Water Demand (current through 2020).

| Community | 2000 | 2010 | 2020 | New Wells |
|---|---|---|---|---|
| Burnsville – | | | | |
| Population | 62,220 | 64,058 | 67,895 | #17 – Jordan, 2003 |
| Water demand (% increase from 2000) | 7.18 | 8.33 (16%) | 9.24 (28.7%) | #18 – 21, Jordan, 2003-2016 |
| Lakeville – | | | | |
| Population | 43,128 | 58,700 | 73,700 | #14 – Jordan, 2001 |
| Water demand (% increase from 2000) | 5.1 | 6.09 (19.4%) | 7.86 (54.1%) | #15 – Jordan, 2001 |
| | | | | #16 – 24 – 2002-2038 |
| Prior Lake – | | | | #6 – Jordan, 2001 |
| Population | 16,000 | 21,300 | 27,400 | #7 – FIG, 2002 |
| Water demand (% increase from 2000) | 1.68 | 2.17 (29.2%) | 2.78 (65.5%) | #8 – Jordan, 2003 |
| Savage – | | | | |
| Population | 20,775 | 27,500 | 35,500 | #12 – MTSH, pre-2010 |
| Water demand (% increase from 2000) | 2.37 | 3.25 (37.1%) | 4.23 (78.5%) | |
| Shakopee – | | | | |
| Population | 17,568 | 35,547 | 37,653 | #10 – MTS/H, 2001 |
| Water demand (% increase from 2000) | 3.721 | 6.398 (71.9%) | 6.778 (82.1%) | #11 – Jordan, 2001 |
| | | | | #12 – Jordan, 2002 |
| | | | | #13 – Jordan, 2002 |
| | | | | #14 – FIG, 2003 |
| SMSC – | | | | |
| Population | 129 | 200 | 268 | None currently needed, but |
| Water demand (% increase from 2000) | 0.31 | 0.40 (29.0%) | 0.42 (35.5%) | could change with additions to tribal lands |
| TOTAL – | | | | |
| Population | 154,207 | 207,305 | 242,416 | Approximately 25 wells |
| Water demand | 20.36 | 26.64 (30.8%) | 31.31 (53.8%) | planned |

- Water demand in million gallons per day includes all components of utility demand (residential, commercial, industrial, unaccounted), but does not include self-supplied demand
- Burnsville's forecasts based on correspondence with city personnel
- Lakeville's forecasts based on all but 300 total population served
- Prior Lake forecasts assume total population served and use Metropolitan Council forecasts
- Savage forecasts based on City of Savage Proposed Well Pumping Schedule prepared for the DNR
- Shakopee's forecast based on of total population served, less 3,000 and 2001 Comprehensive Water Plan
- SMSC forecasts based on its 1999 Land Use Plan; population numbers are based on SAC units

redevelopment approach that maximizes infiltration is warranted. Additional study could also clarify whether "draining" ground water by putting in outflow structures below the water table has a significant impact.

Finally, the injection of calcium-rich ground water up-gradient of the Fen in order to supply it with the water that is no longer available has been considered. This technique was employed near Nichols Meadow Fen in a pilot study and is not considered to be feasible in this setting.

## Groundwater Quality

Water quality issues, which have some bearing on use of the ground water system for water supply, also emerged during SMGWG meetings.

### Nitrates

The nitrate level in a Scott County sample from bedrock (PduC) below the CAMAS quarry reached 100 mg/l, which substantially exceeds the federal drinking water standard of 10 mg/l. The Shakopee Public Utility Commission (SPUC) has seen levels approaching 10 mg/l at some of its Jordan wells, with levels increasing in winter and decreasing in summer. Scott County officials believe the sources of nitrates are agricultural practices, individual sewage treatment systems (ISTS or septic tanks) and possibly storm water ponds.

### Radium

Water from the aquifers in the area has locally high levels of radium inherent to the bedrock. Although radium content does not prohibit the use of these aquifers, it does warrant advanced levels of treatment for removal. Lakeville and Savage are both managing the problem with blending and/or increased treatment with hydrous manganese oxide or manganese greensand.

## Institutional/Regulatory

In additional to technical issues, there are many "other" issues that need to be addressed. The basic question that brought the SMGWG together in the beginning was how can the growing communities in the southwest metro area provide water for existing and future development without harming sensitive environmental features and ensuring that there is an adequate water supply for future generations? Can consensus ever be reached on a management approach and will all parties agree to implement the management plan strategy if consensus is reached?

Key among issues raised in this discussion is the role of the regulatory agency (the DNR) and the effective links between community needs and regulatory decisions on water appropriations. Part of this look to the future involves community comprehensive planning and work with the MC to better incorporate water supply assessment into its MUSA expansions.

The supply needs of the communities, and the role of conservation and water demand management in keeping increases manageable must be addressed through community conservation efforts and the DNR permitting process. Restrictions on the MTS/H will also play a role in this strategy, as will the FIG's potential to be a good resource.

Acceptance of this management plan and adoption of a Memorandum of Agreement, discussed later, will help to maintain regulatory equity while protecting the regional natural resources and will result in a satisfactory end to the issue of regulatory inequity. Sharing of resources and coordination of water supply decisions and planning by all communities will be necessary to achieve success. The final strategy should, however, be viewed as a flexible document that lays

out a means for changing future plans as more facts about the ground water system become available.

## DATA AND MODELS

### Data

Very early in the SMGWG meeting process, it was realized that data was going to be crucial to determining the impact of ground water use on surface water features. The SMGWG established a Data Collection and Assessment Subgroup and charged it with finding the best data available and identifying those data that were needed, but not in existence. The Subgroup prepared a *Data Collection and Assessment Plan* in December 1997. This plan identified 26 tasks that involved the collection of both existing and new data, its evaluation and its use in modeling (Table 3).

Additional data sources not reflected in Table 3 include: CAMAS/MC Blue Lake area water level monitoring and modeling; historic Dean's Lake data; MPCA and county water quality data; and a USGS/DNR study of water movement through fractures near Savage well #8.

Data on the geologic units in the study area vary by unit. Data on deeper ground water aquifers (FIG and MTS/H) are less available than on units closer to the surface. The cost of obtaining data is very expensive, but understanding the relationship of geology to the flow patterns and hydrologic behavior of the study area is essential to proper management of the system. For this reason, the DNR is working with the communities to obtain data on the various units as the communities seek state authorization to appropriate ground water. Prior Lake has installed two monitoring wells in conjunction with a DNR approved Jordan appropriation well. In addition, the DNR has required Savage and Shakopee to stop drilling while in the FIG and test the formation prior to drilling into the MTS/H.

### Modeling

The complex geology and hydrogeology of the study area can be approximated and understood with the help of mathematical models. The hydrogeologic setting of the SW Metro area is difficult to model due to the changes in elevation, multiple conversions from confined to unconfined conditions, and the importance of the bluff edge seepage faces and springs as resources which are the focus of the assessment. Over the past 20 years, there have been many "improvements" over past models, however they can not provide numerically precise results.

General trends and net upward or downward movement can be fairly reliable model results, especially when well calibrated models are used. However, modeling has not replaced the need for field measurements to verify model predictions and improve future model runs.

There are several ground water models that have been applied for different purposes within the southwest metro area. Most of the ground water models constructed for areas in Scott and Dakota Counties have been locally focused and limited in scope. The detail and geological foundations for these models are extremely variable, but have generally improved as more information has been collected and more attempts made to model the area. The following collection of models have been used by the SMGWG to varying degrees:

- Barr Engineering model for Lakeville (1993)
- DNR Fen model using 1980s version of Otto Strack MLAEM model (later switched to Barr's 1994 model)

Table 3. Status of *Data Collection and Assessment Plan* Tasks

| Study Task (Number) | Description | Status |
|---|---|---|
| IA1 | Low flow/baseflow surveys | 1997, 1998, 1999, 2000 |
| IA2 | MC watershed outlet monitoring | Sites established at Credit R., Eagle Cr. |
| IA3 | Study of Prior Lake outlet | LMRWD and PLSLWD joint effort to route flows around Dean's Lake and clean channel from Prior Lake to Minnesota River |
| IB1 | Surface water level measurement | Continuous on Prior Lake (PLSLWD) and Savage Fen (DNR) |
| IC1 | Evaluation of impacts of SW management plans of cities and WMOs | Unfunded |
| IIA1 | MGS evaluation of existing geologic data | Complete |
| IIB1 | MGS study of PduC/J geology/hydrogeology | Complete 1999 |
| IIC1 | Incorporate results of Brick (MPCA) seepage study | Complete as part of MPCA Metro Ground Water Model |
| IIIA1 | Enhance DNR ground water level monitoring network | Several wells added in study area by DNR, Prior Lake & Savage |
| IIIA2 | Collect available ground water level readings | MDH as part of ground water model development; MPCA Metro Model calibration data set; DNR ground water level monitoring network; cities as part of regulatory process |
| IIIA3 | Synoptic ground water survey | Conducted through Feb. 1999 (Aug.'99 missed) |
| IIIB1 | Aquifer and well testing | Completed by DNR, MDH and several of the communities |
| IIIB2 | SMSC pumping tests on community wells | Completed by SMSC as part of PduC/J tests; USGS cooperative study of Jordan wells |
| IIIC1 | Collection of data associated with MDH wellhead program | On-going by MDH and communities |
| IIID1 | CAMAS quarry expansion and Blue Lake WWTP impact | Expansion abandoned; Barr assessment of ground water impact on WWTP complete (MC); all pumping at CAMAS stopped and pumps removed |
| IIIE1 | Stable isotope/chemical character evaluation | Unfunded |
| IIIE2 | Water budget and regional ground water recharge | Underway as part of USGS study on regional recharge (Sept. 2001 completion) |
| IVA1 | Construction of Metro ground water Model framework | Completed by MPCA. No further funding anticipated. |
| IVA2 | Development of conceptual Scott-Dakota ground water model | Completed by MDH |
| IVA3 | Construction of Scott-Dakota ground water model | Completed by MDH |
| VA1 | Study use and role of deep aquifers | Study unfunded, but evaluation by DNR continues |
| VB1 | Identify need for alternative sources | On-going by DNR and communities |

| | | |
|---|---|---|
| VB2 | Evaluate alternative sources of water | Large study unfunded, but partial evaluation done by Savage and Shakopee |
| VIA1 | Assemble available data, and contribute data in return | On-going as needed |
| VIB1 | Conduct assessment of demand management | On-going by DNR and communities; MC demand projections |
| VII | Prepare management plan | 2002 |

DNR = MN Dept. of Natural Resources
LMRWD = Lower Minnesota River Watershed District
MC = Metropolitan Council Environmental Services
MDH = MN Dept. of Health
MGS = MN Geological Survey
MPCA = MN Pollution Control Agency
PduC/J = Prairie du Chien-Jordan Aquifer
PLSLWD = Prior Lake-Spring Lake Watershed District
SMSC = Shakopee Mdewakanton Sioux Community
USGS = U.S. Geological Survey
WMO = watershed management organization
WWTP = wastewater treatment plant

- Barr Savage Fen model (1994)
- Barr/Dakota Co. MLAEM (cooperative effort for drift and PduC/J among the County, Apple Valley, Burnsville, Eagan, Hastings, Rosemount and So. St. Paul for wellhead protection, 1995)
- Barr model for Shiely Corp. (1997)
- MC 1998 Barr MODFLOW model of Blue Lake WWTP de-watering system
- Dakota/Scott MODFLOW WHP model (PduC/J) for MDH (Barr, 1999)
- Barr MODFLOW model of FIG for Savage (1999)
- MPCA Metro Model (1999)
- SEH models of Burnsville's Kraemer intercept (Metro Model base, 2000)
- MDH MODFLOW runs to evaluate impact of cessation of CAMAS Quarry pumping (2000) (Dakota/Scott MODFLOW model base)
- MC current scenario effort (Metro Model base 2001)

**Additional Studies**

Additional studies have contributed valuable information to the understanding of the geology and hydrogeology of the study area. The MDH is active in both Scott and Dakota Counties with assistance to communities in developing wellhead protection programs. The MDH has provided each of the five cities in the study area with draft assessments and is working with the SMSC to prepare a comparable assessment. The Scott-Dakota County ground water model referenced above was also prepared as advisory material for the communities.

The USGS has provided inputs to the study effort. The USGS, under contract to the Metropolitan Area Ground Water Alliance (MAGWA), conducted a recharge study for the entire metropolitan area. This effort provides information on recharge characteristics within the study area that can be used to run model scenarios. The USGS also performed a study of flow through fractured rock in the same area as the Savage/DNR pump test and conducted a pump test in the SMSC wells.

A series of surface water flow measurements were collected during fall low flow for four years on tributaries to the Minnesota River and the river itself. These measurements provided valuable information for calibration of groundwater models in the area. Table 4 contains the summary water level measurements collected.

Ongoing monitoring of water levels in the calcareous fens in the Minnesota River Valley began in 1987. Savage Fen, Black Dog Fen, Fort Snelling Fen and Nichols Meadow Fen have been instrumented for varying periods of time. Long-term (over the period of record) changes observed at Savage Fen include subsidence of up to three feet and summer drawdowns that lead to regular dewatering of the peat. Budget priority changes have resulted in reduced staff involvement in calcareous fen monitoring, thus measurements have been less frequent in recent years. Assistance from volunteers such as hydrogeology students from UW River Falls has been helpful.

Continuous monitoring of Eagle Creek and miscellaneous out flow measurements of Boiling Springs has been conducted by the DNR from 1998-2000. Additionally, Eagle Creek was monitored on two separate occasions by the DNR to assess the potential impacts of nearby dewatering for construction.

Table 4. Summary Table of Low Flow Data (1997 – 2001)

| LOCATION | FLOW (cfs) | | | |
|---|---|---|---|---|
| **SAND CREEK WATERSHED** | 11/4-5/97 | 10/28/98 | 10/27/99 | 10/26/00 |
| Sand Creek at Hwy. 282, Jordan | 76.9 | 41.7 | 7.84 | 3.90 |
| Porter Creek at Xanadu Rd., south of Jordan (Sand Creek Township) | 19.6 | 8.7 | 0.93 | 0.21 |
| Raven Stream at Scott Co. Road 64 (230th St., West), Helena Township | 16.5 | 13.2 | 2.49 | 1.78 |
| Sand Creek at Hwy.67 (near 220th St.) Helena Township | 32.2 | 15.0 | 2.06 | No flow |
| Jordan Wetland tributary (west) to Sand Creek at Creek Lane (old Hwy.9), Jordan | 6.8 | 7.9 | 2.26 | 0.94 |
| Sand Creek at Co. Rd. 65, north of Hwy. 169 and NE of Jordan in Sand Creek Township | 77.3 | 50.5 | 10.03 | 2.97 |
| | | | | |
| **SHAKOPEE BASIN WATERSHED** | 10/29/97 | 10/28/98 | 10/27/99 | 10/26/00 |
| Shakopee Basin outlet, about 200 yds. Downstream of Mill Pond outlet, Shakopee | 7.06 | 2.62 | 5.02 | 3.94 |
| | | | | |
| **PRIOR LAKE (OUTLET) WATERSHED** | 10/29/97 | 10/28/98 | 10/27/99 | 10/26/00 |
| Prior Lake outlet, Prior Lake | 4.80 | No outflow | No outflow | No outflow |
| Pike Lake outlet at Pike Lake Trail, Prior Lake | 5.09 | 0.13 | No flow | No flow |
| Pike Lake outlet at Co. Rd. 16 (0.18' @ staff gage) | Not measured | 0.12 | 0.06 | No flow |
| Dean's Lake outlet 25 yds. upstream of Hwy. 169 culvert, Shakopee (further downstream than 1997, beaver dam) | 4.34 | 0.34 | 0.04 | No flow |

| LOCATION (continued) | FLOW (cfs) | | | |
|---|---|---|---|---|
| **EAGLE CREEK WATERSHED** | 10/29/97 | 10/28/98 | 10/27/99 | 10/26/00 |
| Eagle Creek inflow into Boiling Springs about 75' upstream of Springs – one of two gaged with identical rate assumed based on visual observation (new site) | Not measured | Not measured | Not measured | 1.33 |
| Eagle Creek (west branch) 15 ft. downstream of entry of Boiling Springs outflow into channel at staff gage, Savage | Not measured | 2.95 | 2.14 | 3.41 (gage hts. at site at 0.71' and in B.S. pond at 3.75') |
| Net gain outflow from ground water to Boiling Springs | --- | --- | --- | 2.08 |
| Eagle Creek west branch at Town and Country Campsite, Savage, just upstream of confluence with east branch | 3.94 (at 126th St. bridge) | 4.14 | 3.38 | 6.90 |
| Eagle Creek east branch, Savage, just upstream of confluence with west branch | Not measured | Not measured | 1.91 | 2.72 |
| Eagle Creek 150 ft. downstream from confluence of east and west branches at 125th St. bridge, Savage | 8.82 (25 yds. Upstream of Hwy. 101 frontage road) | 7.95 | 7.98 | 7.64 |
| | | | | |
| SAVAGE FEN WATERSHED | 10/29/97 | 10/28/98 | 10/27/99 and 11/4/99 | 10/26/00 |
| Savage Fen*, at head of stream traversing fen from bottom of bluff northward to access road | Not measured | 0.18 | 0.15 | 0.2 |
| Savage Fen outlet at Hwy. 101 frontage road near MC pump station, Savage | 0.64 | 0.73 | 0.46 | Not measured |

| LOCATION (continued) | FLOW (cfs) | | | |
|---|---|---|---|---|
| **CREDIT RIVER WATERSHED** | 10/29/97 | 10/28/98 | 10/27/99 | 10/27/00 |
| Credit River at 123rd St., Savage | 13.1 | 9.0 | 4.93 | 7.59 (site moved to 125th St., Savage) |
| Credit River at 154th & Allen Blvd., Savage | 8.8 | 4.7 | 2.32 | 1.15 |
| Credit River at Murphy Lake Blvd., south of Savage (Credit River Township) | 7.6 | 1.7 | 0.26 | No flow |
| **MINNESOTA RIVER** | 10/29/97 | 10/28/98 | 10/27/99 | 10/26/00 |
| Minnesota River near Jordan, Scott Co. Rd. 9 bridge (USGS gaging station) | Not measured | 3,680 | 1,117 | 580 |
| Minnesota River 0.5 mile above Chaska (east of Chaska Lake) | Not measured | 3,792 | Not measured | Not measured |
| Minnesota River 1/3 mile downstream of Hwy. 101 bridge, Shakopee | 2,376 | 3,862 | 1,167 | Not measured |
| Minnesota River 1.3 mile (corrected 10/21/99) upstream of new Hwy. 169 bridge, Shakopee | 2,498 | 3,822 | 1,210 | Not measured |
| Minnesota River 2.7 miles downstream of new Hwy. 169 bridge, Savage | 2,665 | 3,742 | 1,438 | Not measured |
| Minnesota River 33 yds. Upstream of Hwy. 77 bridge, Burnsville | 3,053 | 3,885 | 1,301 | Not measured |
| Minnesota River at MC monitoring station, Ft. Snelling | 3,205 | 3,785 | 1,451 – MC<br>1,176 – USGS | Not measured |
| Mississippi River at St. Paul (USGS gaging station) | 9,508 | 14,025 | 9,327 – USGS | 12,700 |

## FINDINGS (POINTS OF AGREEMENT)

With the issues raised, and through the gathering of data and identification of additional data needs, the SMGWG was able to agree on several things in both the technical and non-technical areas. The following sections contain statements that reflect consensus items arrived at by the group.

### Physical Attributes

It is generally agreed that the discharge that sustains the Minnesota Valley's wetland system, including the Savage Fen, Eagle Creek and the Boiling Springs, is fed upward through glacial material by water discharging from the PduC Group which is recharged south of the features. The water discharged is calcium rich which is critical to the existence of the Fen's unique vegetation. Depending upon local geologic conditions, the Jordan might feed water into this system from deeper within the bedrock section. Figure 1 is a generalized geologic column for those units occurring in the study area. Figure 2 shows the geologic plan view of the area. Features to note in Figure 2 are the buried bedrock valley cut into the Franconia Formation transecting the study area and the Minnesota River Valley.

As part of a geologic/hydrogeologic study of the PduC/J in the spring of 1999, the MGS found that the lower unit of the PduC Group, the Oneota Dolomite has less fractures than the upper Shakopee Formation and may act as a leaky confining layer separating the PduC from the Jordan (Runkel et.al, 1999). This may be especially true where the Oneota is greater than 100 feet below the bedrock surface. In this situation the Oneota appears to be relatively unfractured and has few dissolution features. This suggests that in shallow situations where the Oneota is less than 100 feet from the bedrock surface such as near buried bedrock valleys, the PduC and Jordan may be more hydraulically connected. The study states that the PduC and Jordan have not been shown to be connected regionally nor regionally separated.

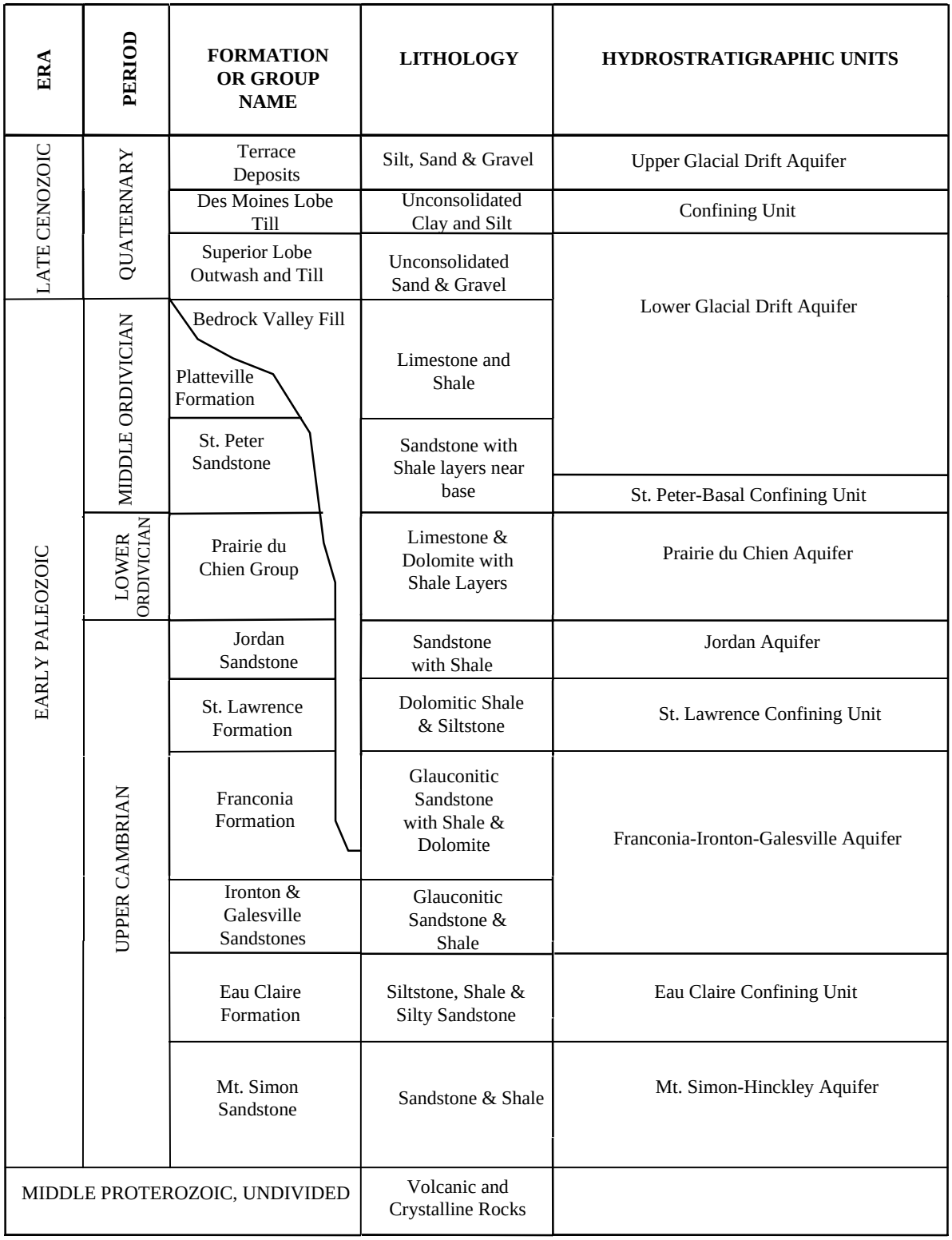
DNR hydrograph analysis of aquifer tests conducted in 1998 for Savage, showed that the PduC and Jordan were acting as single unit, with pumping in the Jordan drawing down the water level in the PduC. This study also found transmissivities increasing with proximity to the river, which the MGS also found true as a function of increased fractures in the PduC. The DNR also found that some of the observation wells did not respond to aquifer test pumping possibly due to local geologic variability.

The MGS findings, MC geologic data on the Blue Lake Wastewater Plant de-watering project, and the Savage aquifer tests, suggest that the PduC and Jordan connection is a function of proximity to valleys (ie buried bedrock or Minnesota River Valley) and of the extent of fracturing and dissolution in the PduC. The area around the Savage Fen probably falls in the "shallow" category described by MGS. It is still unclear whether an area can be defined where pumping the Jordan will have no effect on the Fen.

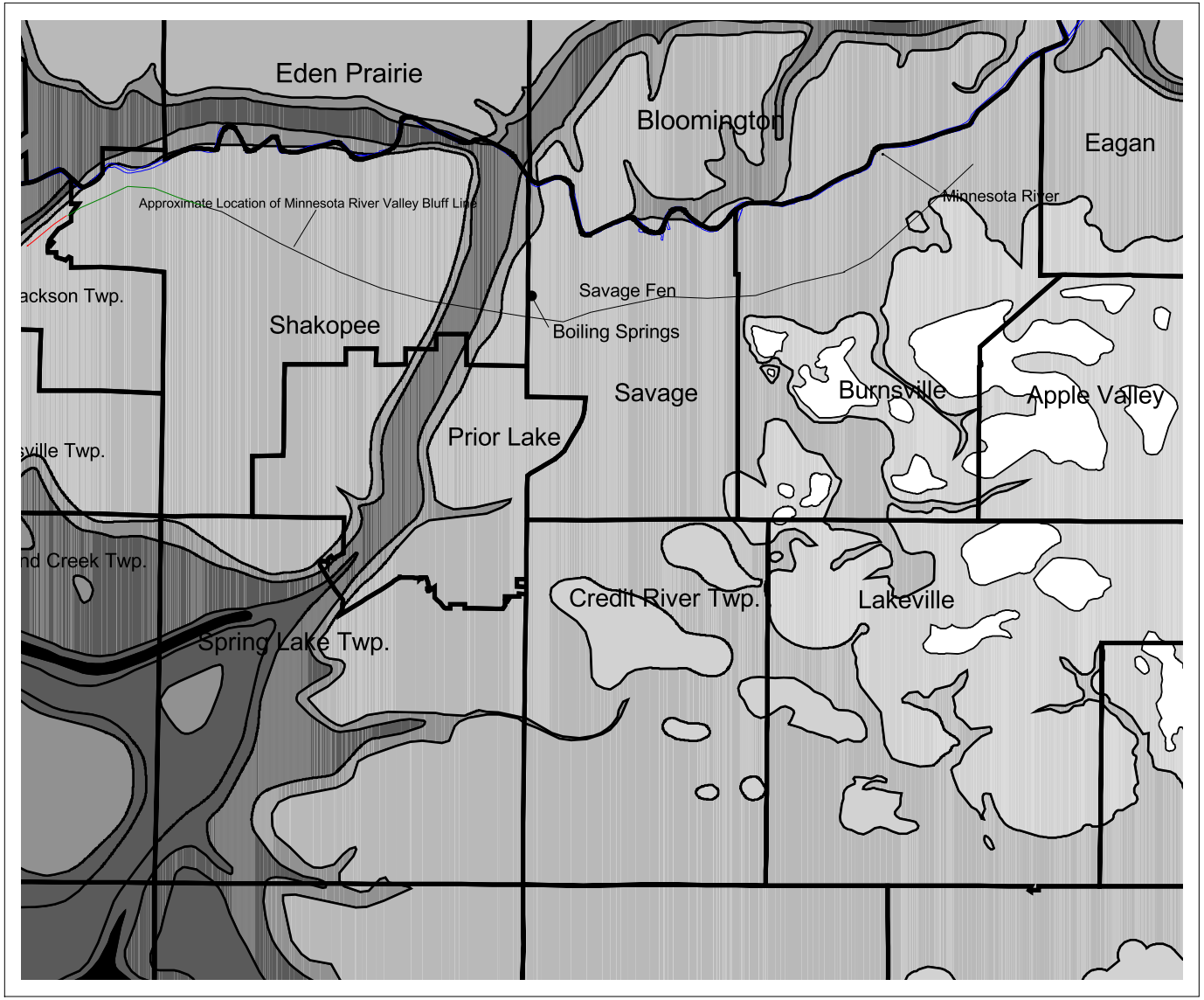
Although definitive statements about aquifer connectivity are difficult to make, it appears that well locations more distant from the river valleys and buried bedrock valleys could provide better hydraulic separation between the PduC and Jordan aquifer. Continued data collection as part of already established water level monitoring and by permitted pumping operations should help define this variability.

The effect the buried bedrock valley traversing the study area has on ground water is not completely understood. The sand and clay content of the sediments in the valley through the study area varies. A brief review of water well records by the MDH indicates that the material that fills the northern portion of the buried valley is relatively sandy. In contrast, the southern portion contains large amounts of clay. In areas where the hydraulic conductivity in the valley differs significantly from the surrounding bedrock, it may act as a barrier to or diversion of ground water flow.

Figure 1 Generalized Stratigraphic Column for Scott and Dakota Counties



# Figure 2
# Bedrock Geology of Southwest Metro Area



MDH data suggest that PduC/J recharge in the study area has generally occurred within the past 35 years. USGS data indicates that water in MTS/H is "thousands of years" old.

It is generally agreed that because the water supplying the surface water features comes primarily from the PduC/Jordan aquifer, pumping from the lower aquifers (FIG and MTS/H) which are separated by aquatards, will have little or no effect on those features. The pumping rate from FIG wells in the southwest metro varies from about 400 - 1,000 gpm. Cities have economic concerns about the use of low yielding wells to meet their non-essential uses as required by the DNR rather than the MTS/H. The DNR considers the FIG aquifer to be a viable source and has required testing and continued water level monitoring before agreeing to approve use of the MTS/H aquifer. Higher yielding FIG wells present a productive alternative to the PduC/J and MTS/H. Savage is conducting several pumping tests on the FIG at its well #9 site. Water level monitoring continues while Savage pumps the well using different pumping scenarios. Use of the FIG has become part of the agreement between Savage and the DNR for current and future appropriations. This agreement is discussed later in this plan as a model for others to consider.

The water quality characteristics of ground water in the region could present some volume and/or financial limitations to its use. As mentioned above, nitrate and radium are problems in some areas. Treatment or blending can be used to reduce concentrations to below drinking water standards.

**Ground Water Modeling Findings**

Although most of the ground water models listed above were developed to address a localized situation, some common findings have occurred. First, the MGS statement that the PduC and Jordan act more as a single unit as the Minnesota River and buried bedrock valleys are approached appears to be generally accurate. The SEH model for Burnsville, however, characterized the two units as separated by a leaky confining layer in the vicinity of the Kraemer Quarry.

Modeling indicates that the buried bedrock valley has some effect on ground water flow in the area. The magnitude of the influence on ground water remains uncertain. Modeling using the results of the DNR's Savage aquifer tests showed that pumping the PduC/J west of the valley will have less of an effect on water levels at the Fen and at Boiling Springs than pumping from east of the valley.

A model series run by the MDH using the Scott-Dakota County regional model was used to evaluate the response of ground water levels when the CAMAS quarry ceased pumping. The results showed a potential rebound of about 45 feet in the PduC near the quarry after pumping ceased and about 33 feet in the Jordan. The MDH modeling also showed ground water levels at the Boiling Springs and Fen rebounding up to one foot when pumping stops. Modeling conducted by Barr Engineering for the MC Blue Lake Wastewater Treatment Plant verified this conclusion. This suggests that water could be appropriated while maintaining the hydrogeologic conditions present prior to cessation of quarry operations.

SEH conducted groundwater modeling to evaluate the potential for intercepting ground water prior to its discharge to the Kramer Quarry. As mentioned above, the PduC and Jordan were treated as separate aquifers divided by a leaky confining layer. The ground water modeling showed up to a one-half foot increase in water levels at the Fen with Jordan pumping wells capturing Kraemer quarry water and the cessation of pumping of Savage's Jordan well #1.

The MC adapted the MPCA Metro Model for the study area. This model helped to estimate the areas that provide ground water to the Boiling Springs, Eagle Creek and Savage Fen, and Dean's Lake areas (Figure 3). This area can change in response to pumping and changes in infiltration inside or outside of the area.

This figure is provided to show the general direction of flow and time of travel for water discharging to the surface water features of interest. Specific attention should also be placed on activities that could adversely impact water quality within this zone. This model was also used to evaluate potential impact of additional wells in the area. The model predicted some impact at the Savage Fen of virtually any high capacity well in the study area in the PduC/Jordan aquifer. This is however, a modeling artifact. The concept of defining an area where the Jordan could be pumped with no adverse effect on the Savage Fen was also explored. It generally agreed that there are too many variables (other wells pumping schedules, geologic variability, climatic change etc.) that make it very difficult to define that area. Evaluation of each individual wells impact on the total system through monitoring and modeling may be a better approach.

Mathematical ground water modeling is a rapidly developing field. Data developed in conjunction with the many models available in the study area can be used in other model applications. Various ground water models have shown that the further away wells are from the Fen, the less impact occurs from a single well's appropriation on the Fen's water level. However, the cumulative effects of pumping have already adversely affected the Fen and other surface water features. Increased distance could be the basis for future well siting in the area, provided there is sufficient flexibility to change the concept if new information becomes available.

**Institutional/Regulatory Statements**

The Savage Fen receives DNR protection under the Minnesota Wetland Conservation Act. Increased ground water pumping by southwest metro communities and reduced recharge from increased development over many years has adversely affected the Fen, as well as Eagle Creek (trout stream), the Boiling Springs, valley bottom lakes, and wetlands in the surrounding area.

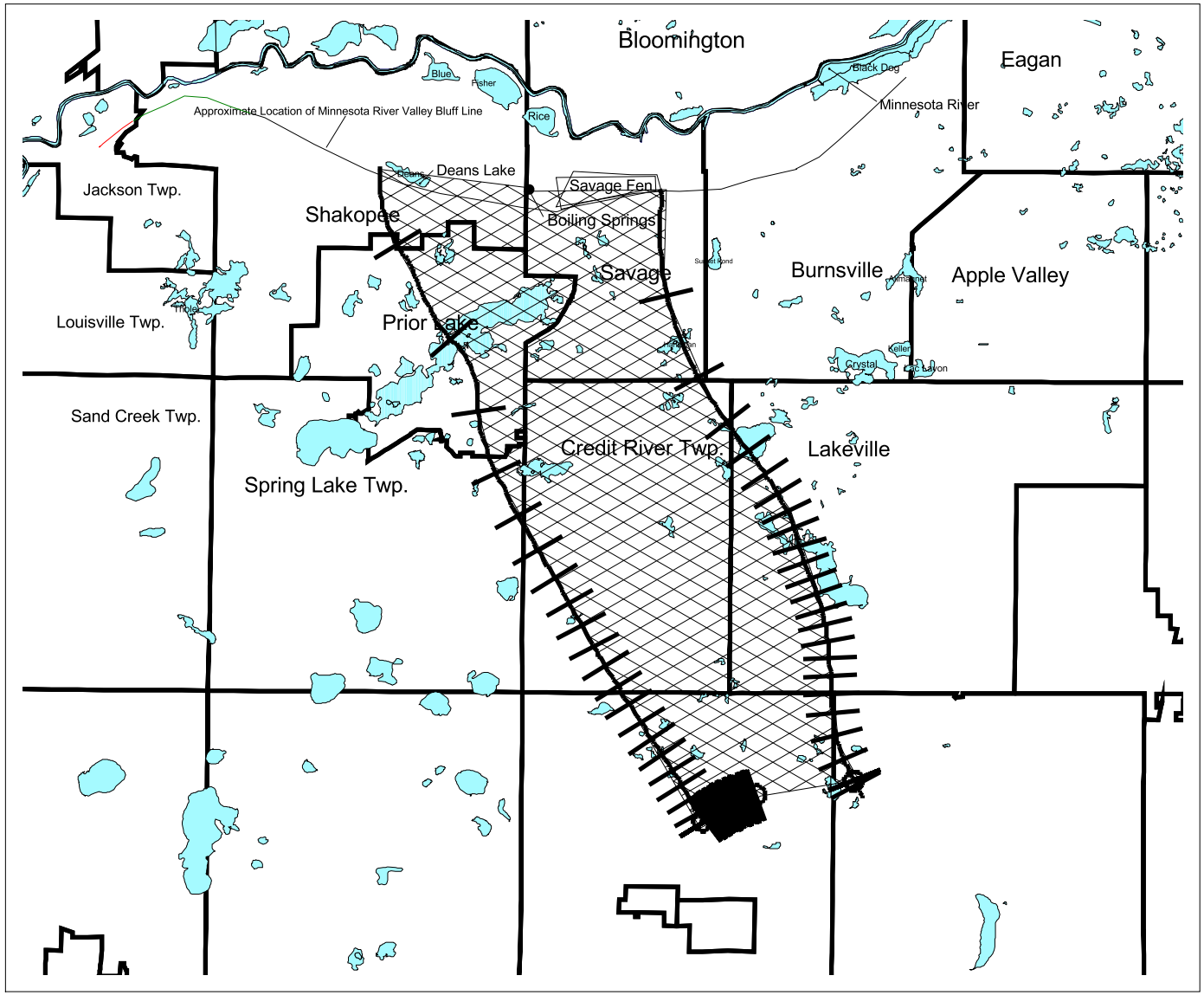
The Southwest Metro Area has numerous unique surface water features that need to be protected, while communities in the area need a continued reliable source of water to support existing demand and future growth. Communities in the study area are seeking additional water to meet increasing demand, but their options to withdraw ground water are limited. The DNR has restricted further development of the PduC/J in some areas, and Minnesota Statutes has strict guidelines for withdrawals from the MTSH (see below). The MC is forecasting significant growth for Savage, Shakopee, Prior Lake, Burnsville and Lakeville. Additionally, the Shakopee Mdewakanton Sioux Community will see an increase in demand to support its growing commercial needs.

The use of the MTS/H aquifer is limited by legislation (M.S., §103G.271, Subd.4a) passed as part of the 1989 Ground Water Act. This law states:

> *"The commissioner may not issue water use permits that will appropriate water from the Mt. Simon Hinkley aquifer in a metropolitan county…..unless the appropriation is for potable use, there are no feasible or practical alternatives to this source, and a water conservation plan is incorporated with the permit."*

This law was passed to protect the MTS/H as the deepest aquifer in the region. The DNR has documented 75 feet of recent drawdown in the MTS/H in the vicinity of Savage's abandoned well #2. The DNR adopted guidelines in 1998 that are applied when communities are considering MTS/H use requests. Consistent with Minnesota Statutes, these guidelines contain strict criteria for consideration of the MTS/H, once agreed that it can be used, by applying a formula to determine how much water can be withdrawn based upon historic use and the mix of water sources available to the community.

# Figure 3
# Area Discharging to Deans Lake - Savage Fen




**Area where groundwater in the Prairie duChien/Jordan aquifer flows to Deans Lake, Boiling Springs, and Savage Fen. Tick marks represent 10 year time of travel.**

Source: Metropolitan Council revision of MPCA Metro Model 08/01

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Several alternatives exist for source water development in the region. The possibility of multiple water suppliers cooperating on development of a well site or sharing water from a single source looks promising from a technical and practical standpoint, but difficult from a political standpoint. Joint development in these areas could be a long-term outcome of the SMGWG effort.

DNR has stated that any further degradation of the Savage Fen Wetland Complex will not be allowed, but that some degradation has occurred. The mean annual water level in 1991 of 758 feet above mean sea level was adopted as the base level from which all future changes will be judged. DNR will regulate water appropriations to obtain zero additional negative impact on the complex. Additionally, resource management methods such as voluntary water management will be used to help restore the hydrology of the fen complex.

DNR considerations in granting increased appropriations are based upon statutory requirements including the 1989 Ground Water Act, and the Wetland Conservation Act, as well as consistency with local water supply plans, including effective implementation of a conservation program. Timelines for permit review include 60 days to take action on a permit (see MS103G). Delays often occur because of difficulties in obtaining complete information. DNR is committed to faster action for defining permit completion requirements. DNR's September 1997 short-term strategy for permitting includes the promotion of conservation efforts, an examination of alternative sources, an increase in monitoring activities, a request for communities to continue SMGWG participation, and continued pursuit of Legislative funding for related activities. DNR is receptive to and encourages joint water supply planning among the cities.

Peak demand for municipal water supplies is associated with seasonal pumping, such as lawn watering and general increased summer demand. Attention to demand management via conservation practices could reduce demand during this critical period. DNR requires effective conservation programs as part of water appropriation permit action.

Quarry de-watering operations in southwest metro, generally located side/down-gradient from the surface waters of concern, have historically pumped more water from the ground than the communities participating in the SMGWG use for water supply. This water has historically been discharged into the Minnesota River, and has not been used for any other purpose. With the cessation of operations at CAMAS and removal of the pumps, de-watering will continue only at the Kraemer Quarry in Burnsville. The total Kraemer use is just slightly below the demand of the SMGWG communities. Use of this water for municipal supplies from the quarry would allow for a "higher and better" use of this discharge water.

A model for future cooperative agreements between the communities and the DNR has been in effect for Savage for several years. This model agreement sets out in a flexible manner the number, location and aquifer unit of wells, as well as the possibility for interconnection and well development with adjoining cities. Changes in the agreement details have already been necessitated by information learned during implementation. Creation of similar agreements with the other communities would seem desirable.

## NEEDS IDENTIFIED BY THE SMGWG

Consensus has been reached on many of the needs that exist in the southwest metro area to make informed decisions about assuring water supply and protecting water resources. The following is a detailed list of needs identified by the SWMGWG. They are not necessarily listed by priority. Many of the data items will be collected as a necessary part of adequately supplying the future water demand of the area. The SMGWG will continue to be a forum for determining what the future needs are and who will address them as well as a means for dissemination of the additional information collected. General goals and recommendations for meeting these needs are contained in a subsequent section.

**Geology/Hydrogeology/Hydrology Data Collection**

- Determine the vertical movement of water between the various surficial and bedrock units
- Document the degree of hydraulic connection between the PduC & Jordan aquifers
- Collect additional hydrogeological information including water levels and aquifer characteristic from pump tests
- Identify generalized recharge areas and rates of recharge and the effects of increased impervious surface on ground water recharge and surface water flow
- Further define the aquifer characteristics of the FIG in the study area and its ability to meet the demands of communities as a replacement or alternative aquifer for the PduC/J and MTS/H
- Evaluate alternative pumping well and monitoring well locations
- Continue to explore the feasibility of intercepting water from a quarry for municipal supply
- Monitor water levels to evaluate the rebound around the CAMAS site now that all pumping has ceased
- Establish a long-term monitoring program to document availability, water demand/use and water levels, possibly implemented as part of city operations when new wells are added
- Document changes in Dean's Lake hydrology
- Monitor stream behavior during both high and low flows
- Document the effect of seasonal water demand fluctuations
- Study the isotope/chemical characteristics of the aquifers, and the water budget/recharge of the ground water system
- Analyze the impact of an extended drought on the overall water situation in the area
- Analyze existing data to determine the local geologic variability within the buried valley and its influence on the hydrogeologic system, identify and fill data gaps
- Document the current condition of Black Dog Fen
- Reinstate fen water level monitoring
- Incorporate additional data to improve local ground water models

**Water Quality**

- Collect details on the extent and treatability of radium and nitrate in ground water
- Determine the impacts of storm water management practices on surface and ground water quality
- Explore methods of locating wells so that nitrate and radium concerns can be avoided such as in areas with a thicker glacial till layer to avoid nitrates
- Implement land and water management practices to limit, reduce and ultimately eliminate nitrate introduction to the ground water system

**Institutional**

- Consider water supply in MUSA extensions and comprehensive plan approvals
- Promote early DNR coordination of permit related issues through continued participation in the SWMGWG forum as well as through other means

**Regulatory**

- Identify non-permitted, large volume users and quantify the extent of their water use

- Track the progress of implementing the community/DNR agreements, and any new agreements that come out of the SMGWG process

**CONCLUSIONS**

1) The Southwest Metro Area has numerous unique surface water features that need to be protected, while communities in the same area need a continued reliable source of water to support existing demand and future growth. Groundwater withdrawals are limited due to potential impacts on the surface water features and/or by regulatory requirements. The mean annual water level in 1991 in the Savage Fen of 758 feet above mean sea level, has been adopted as the base level from which all future changes will be judged.

2) Demand will likely increase by over 50% by 2020 without increased conservation. To meet this demand, there are approximately 25 additional utility wells planned in the study area.

3) Nitrate and radium levels in some municipal wells have raised questions on the source of the problem and the possible options to solve them. Moving laterally away or deeper to another aquifer does not assure that water of better quality will be found.

4) All parties need to be treated in a fair and equitable manner in the regulatory process while maintaining flexibility to meet individual needs.

5) Strategies for supplying projected needs should be viewed as flexible plans that can change as more information about the ground water system become available.

6) The cost of obtaining data is high, but data are the key to understanding a very complex system in this area and important in making good local decisions.

7) Findings on the connection between the PduC and Jordan aquifers suggest that this connection is a function of proximity to valleys and of the extent of fracturing in the PduC. Although definitive statements about aquifer connectivity are difficult to make, it appears that movement away from the river valleys and buried bedrock valleys may provide better hydraulic separation between the PduC and Jordan aquifer.

8) It is generally agreed that the discharge that sustains the Minnesota Valley's wetland system, including the Savage Fen, Eagle Creek and the Boiling Springs, is fed upward through glacial material by water discharging from the PduC Group which is recharged south of the features. The water discharged is calcium rich which is critical to the existence of the Fen's unique vegetation. Depending upon local geologic conditions, the Jordan might feed water into this system from deeper within the bedrock section.

9) Alternative water sources available to communities that need to avoid impacting the PduC/Jordan/surface water system include the deeper FIG and MTS/H aquifers the Minnesota River and the quarries. Data on deeper ground water aquifers are less available than units closer to the surface.

10) Pumping rates of FIG wells vary from about 400 -1,000 gpm. Cities have economic concerns about the use of low yielding wells to meet their non-essential uses as required by the DNR rather than the MTS/H. The higher volume FIG wells present a productive alternative for the PduC/J and MTS/H.

11) Properly calibrated ground water models can be used as a tool to explore ground water behavior and cause-and-effect relationships, but the results should not be used without human judgement and interpretation and coordinated monitoring efforts.

12) Modeling can identify the area where ground water flows to the surface water features. Within this zone, special provisions such as pre-determined demand reduction (conservation) measures or seasonal operation limits (volume, pumping rate, time) could be made to minimize impact.

13) Many additional needs exist in the areas of hydrology/hydrogeology, data collection, water quality, and institutional/regulatory matters. The SWMGWG should serve as the forum for communication of agency and community efforts to address these needs.

14) Studies have shown a potential significant rebound of water levels in the PduC and Jordan near the former CAMAS quarry after it stops pumping, thus indicating that water could be appropriated while maintaining conditions that existed during quarry operations. Modeling scenarios have indicated that water levels at the Boiling Springs and Fen should rebound when pumping stops. However, these modeled results do not take into account climatic and human impacts. Monitoring should be employed to verify the results.

15) Peak demand for municipal water supplies is associated with seasonal pumping, such as lawn watering and general increased summer demand. Attention to demand management via conservation practices could reduce demand during this critical period.

16) Development techniques and runoff management methods that maximize recharge are important to maintaining ground water levels in the study area.

17) Wells which could potentially impact the Fen will require special provisions in addition to monitoring. The special provisions will include such things as pre-determined demand reduction (conservation) measures or seasonal operation limits (volume, time) and will include use of alternate water sources.

## RECOMMENDATIONS AND GOALS

The following are general recommendations and goals based on this management plan. Specific actions and goals that several interested parties are agreeing to are described in the Memorandum of Agreement.

### Institutional/Regulatory

- The agreement between the DNR and the City of Savage should serve as a model for the other communities in setting forth a mutually agreeable scenario for ground water development to meet anticipated community needs while protecting local water resources. Under this approach, DNR sets the standard for water use, but the cities remain autonomous in securing water in a manner that works best for the community. Each community would formalize its plan with the DNR, including criteria for flexibility to amend the plan. These “Framework Agreements” must be flexible enough to allow agency or community adjustment as the need arises, yet lay out a program for future well locations, aquifer units, pumping scheme, and total volume of use. This approach addresses the need for a long-term reliable supply for a community and upholds DNR’s Legislative mandate to protect the water supply and natural resources of the state. This could be incorporated into a comprehensive broad scale water supply plan that identifies each community’s water supply source through 2020.

- The SMGWG will work to increase water levels from the adopted ‘base level’ in the Savage Fen of 758 feet above mean sea level. This long-term goal will be accomplished through some combination of the following: eventual elimination of dewatering in nearby quarries; well orchestrated pumping schemes that locate pumping centers in areas that do not impact sensitive surface water features during critical times of

the year; recharge enhancement through low impact development practices; implementation of effective community demand reduction and water conservation programs.

- Ground water modeling should continue to be used to help evaluate the potential impact of additional proposed wells. Due to the nature of the models used, it is likely that they will show that most proposed PduC/J wells in the area will cause some change at the Fen. Because additional wells can not cause a drawdown at Savage Fen, the communities should work with the DNR to implement a monitoring plan which may include installation of monitoring wells to more accurately determine the impact of the pumping and improve future model runs. A strategy of reducing withdrawals in wells in closer proximity to the surface water features to compensate for increased withdrawal further away could also be evaluated with the model.

- Development practices that promote infiltration of water should be used in all areas to off-set the loss of recharge and minimize the impact to surface waters due to increased impervious surfaces. A set of management practices that can be used to achieve this objective while ensuring that the water infiltrated does not contain high contaminant concentrations should be explored and discussed by the participants.

- Use of discarded quarry water has been supported by the SMGWG since its inception. Efforts to use part of the water discharged by the Kraemer quarry should be supported, provided water influenced by nearby landfills do not compromise finished water quality and water levels in the nearby Black Dog Fen are not adversely affected.

- All users of ground water in the study area, including industry, non-municipally supplied development and those that pump water to control ground water levels, must be considered in overall management of ground water in the area.

**Inter-Community Cooperation**

- Joint development of water supply between communities or sales of water by one community to another should be promoted as part of a long-term solution that would minimize the number of new wells. Cooperative ventures could also include joint water treatment for nitrate and radium in ground water and for surface water and ground water under the influence of surface water. Discussions should continue on the possibility of development of a sub-regional supply system(s), under local control, for the procurement and distribution of water among communities.

**Data Collection**

- The DNR, MDH, MGS, MC and the communities using the southwest area ground water resource should continue to collect and evaluate data including, pump test data, water level measurements, surface water measurements, and groundwater withdrawals. This information should be used to better assess the effects of pumping on surface water features (Savage Fen, Boiling Springs, Eagle Creek, Minnesota River Valley wetlands, Blackdog Fen) and address such topics as the capability of the FIG to supply an adequate volume of water, and changes in ground water behavior due to decreased recharge and increase water use.

- The SMGWG should continue as a forum for discussion and dissemination of additional information collected.

- A long-term cooperative monitoring program should be established to document ground water parameters in the area, and to track availability and use of the resource. The program should be established through the DNR in cooperation with the communities and other participating agencies as part

of the permitting of new and existing wells. This approach would allow for a preliminary informed decision, with follow-up monitoring data to allow for adjustment. Funding for this program should come from communities as part of the permit approval process, from a continuation of the DNR's ground water level monitoring program, and from any future regional program (recommended below) that provides funds in cooperative ventures addressing regional water problems.

**Conservation**

- A good conservation plan that promotes wise use of the water resources and reduce demand is essential for every community and non-community water user in the southwest metro area. It should be realized that there will be more scrutiny of conservation plans in this part of the region if the MTS/H aquifer is the source of water or if some adverse impact of unique surface water features is possible. The City of Savage has shown how effective this approach can be with a reduction in per capita use.

**Costs**

- Potential funding sources for regional data collection and evaluation efforts, and for alternative source and interconnection evaluation should be explored. The costs of implementing this Management Plan should not present an unreasonable burden to the water users, nor should the costs be used as a justification to prevent action that will preserve the water resources of the area. DNR and MC should work with the communities to develop the means to cost-share projects of regional interest in achieving the goals of this Management Plan.

**Organizational Role**

- The SMGWG fulfills a needed role in providing a forum for discussion among the agencies, communities and public interested in water issues in this part of the region. The SMGWG should continue to meet after adoption of the Management Plan.

**MEMORANDUM OF AGREEMENT**

The City of Burnsville, City of Lakeville, City of Prior Lake, City of Savage, City of Shakopee, Shakopee Public Utilities Commission, SMSC, Credit River Township, Dakota County, Scott County, MC, and DNR will sign a Memorandum of Agreement (MOA) to work with each other on implementing this management plan. The primary focus will be working toward addressing the priorities set forth in the beginning of the Needs section of this plan. A minimum set of water conservation practices will also be outlined in the MOA for the communities to work toward. In addition, each community will agree to minimize impact of increased impervious surface on infiltration due to development. Specific community activities will also be outlined in the agreement.

**ACRONYMS**

DNR = MN Dept. of Natural Resources
FIG = Franconia-Ironton-Galesville Aquifer
Jordan = Jordan Formation
LMRWD = Lower Minnesota River Watershed District
MC = Metropolitan Council
MDH = MN Dept. of Health
MGS = MN Geological Survey
MOA = Memorandum of Agreement
MPCA = MN Pollution Control Agency
MTS/H = Mt. Simon-Hinckley Aquifer
MUSA = Metropolitan Urban Service Area
PduC = Prairie du Chien Group
PduC/J = Prairie du Chien-Jordan Aquifer
PLSLWD = Prior Lake-Spring Lake Watershed District
SMGWG = Southwest Metro Ground water Work Group
SMSC = Shakopee Mdewakanton Sioux Community
SPUC = Shakopee Public Utilities Commission
USGS = U.S. Geological Survey
WMO = watershed management organization
WWTP = wastewater treatment plant