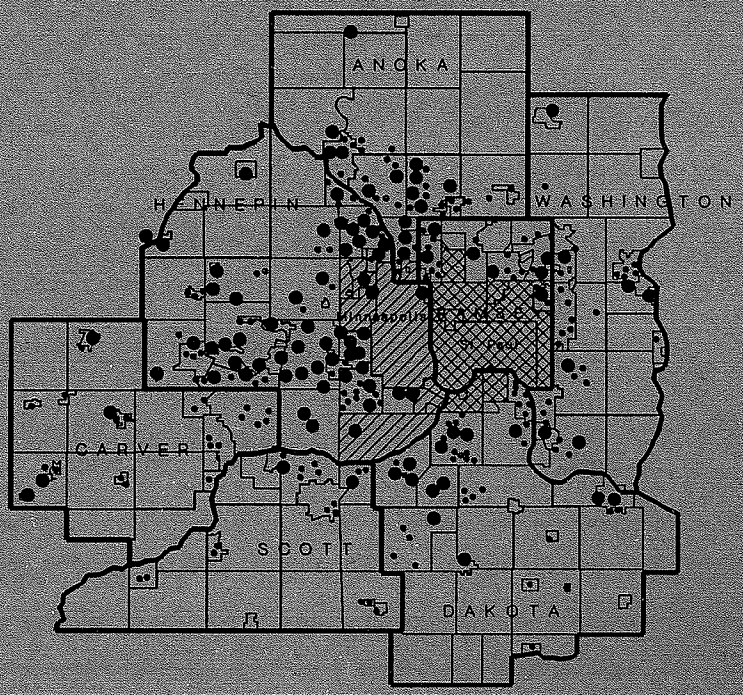
TWIN CITIES METROPOLITAN AREA WATER SUPPLY: A PLAN FOR ACTION

Prepared for the Minnesota Legislature
by the Metropolitan Council



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The Metropolitan Council coordinates the planning and development of the seven-county Metropolitan Area. The Council is authorized by state and federal laws to plan for highways and transit, sewers, parks and open space, airports, land use, air and water quality, health, housing, and aging.

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ABOUT THIS PLAN

This water supply plan was prepared in response to a legislative mandate passed in 1989 (Minn. Stat., § 473.156). The plan was prepared by Gary Oberts, Sheryl Corrigan and Judy Hartsoe of the Natural Resources and Parks Division of the Council. Technical study input was given by Jim Larsen, Florence Myslajek and Gene Knaff. Graphics were prepared by Craig Skone and format layout by Deborah Schreiner. Editing was done by Marilynn Taylor.

To accomplish the legislative charge, the Metropolitan Council undertook a series of eight background technical studies to gather data and frame issues that would need to be addressed. The technical studies were completed as a series of working papers, as follows:

- No. 1 - Alternative Sources of Water for the Twin Cities Metropolitan Area; Publication No. 590-91-011;

- No. 2 - Water Demand in the Twin Cities Metropolitan Area; Publication No. 590-91-009;

- No. 3 - Water Availability in the Twin Cities Metropolitan Area: The Water Balance; Publication No. 590-91-008;

- No. 4 - The Public Water Supply System: Inventory and the Possibility of Subregional Interconnection; Publication No. 590-91-010;

- No. 5 - Water Conservation in the Twin Cities Metropolitan Area; Publication No. 590-91-020;

- No. 6 - The Effects of Low Flow on Water Quality in the Metropolitan Area; Publication No. 590-91-054;

- No. 7 - The Economic Value of Water; Publication No. 590-91-065; and

- No. 8 - The Institutional Framework for Water Supply Management; Publication No. 590-91-064.

These reports can be obtained from the Metropolitan Council Data Center (612-291-8140).

In addition to these studies, a special issues report entitled *Water Supply Issues in the Metropolitan Area: A Staff Report* was prepared to summarize the technical issues raised in the background reports and to frame them for discussion.

Preliminary evaluation of this background material was done by an ad hoc technical review committee comprised of the following groups and individuals; their assistance in correcting technical flaws in the reports is greatly appreciated:

- American Water Works Association, Wayne Enney

- Izaak Walton League, Gene Hollenstein

- Metropolitan Waste Control Commission, Paul Aasen

- Minneapolis Office of Emergency Response, John Soderlund

- Minneapolis Water Works, Jim Hayek and Adam Kremer

- Minnesota Department of Health, Gary Englund and Tom Klaseus

- Minnesota Department of Natural Resources, Jim Japs and Kent Lokkesmoe

- Minnesota Environmental Quality Board, Marilyn Lundberg

- Mississippi Headwaters Board, Molly MacGregor

- St. Paul Water Utility, Verne Jacobsen

- U.S. Army Corps of Engineers, Lou Kowalski

- U.S. Geological Survey, Bill Herb

Very early in the plan preparation process, the Mississippi Headwaters Board agreed to be the unofficial contact for communications with all "upstream" parties in the headwaters region. We are particularly grateful to it for lending us this assistance. We would also like to thank the Blandin Foundation for sponsoring a one-day discussion of the plan among affected parties.

EXECUTIVE SUMMARY

This plan is presented at the request of the Minnesota legislature, which asked the Metropolitan Council to prepare a regional water supply plan in response to the difficulties it witnessed in the regional response to the most recent drought. The legislature detailed its expectations for the plan, ranging from an evaluation of existing problems to proposal of solutions.

A series of technical studies was conducted by the Metropolitan Council to assemble the basic background information needed to assess the condition of the water supply system. The studies showed that the region uses about one billion gallons of surface water and groundwater a day, primarily to cool power plants and to supply municipal needs. They showed that the Metropolitan Area has sufficient water in most cases, but that problems could develop locally under certain conditions of drought, contamination and growth beyond the limits of the best available supply. The studies also included a user survey and an institutional evaluation that showed the region is no better prepared to respond to water shortages than it was during the drought of the late 1980s. Specific resource problems were found to exist with flow reliability on the Mississippi River, with surface water quality during low flow and with declining groundwater levels across the region.

The plan calls for pursuit of alternatives to address some of the potential water shortages. An essential first step, however, must be conservation of those supplies currently being used. Conservation is the easiest and most efficient manner through which to obtain additional water. Other alternative sources include improved groundwater withdrawal, development of reservoir capacity in the region and elsewhere, source optimization, user interconnection, and water reuse and reclamation.

To place the region in a proactive position to respond to water supply problems, the Metropolitan Council recommends amending the Metropolitan Land Use Planning Act to require a public facilities element addressing water supply in each local comprehensive plan. Communities would be asked to describe their existing and planned water supply system, state their objectives, policies and standards for operating the system, develop a conservation program and emergency contingency plan, prepare a public education program, explore possible cooperative efforts with other communities, examine supply problems and solutions, and, for communities served by groundwater, begin preparation of a wellhead protection program. Amended plans would then be reviewed according to the comprehensive plan review process spelled out in the law, with additional provision for county review by those counties having an adopted groundwater plan.

Several recommendations are also made on the state regulatory process, including routine review of water appropriation permits by the Department of Natural Resources (DNR), mandatory contingency planning by all major water users, incorporation of Mississippi River drought response into permits, and formalization of a review mechanism for the DNR to assess water conditions prior to the Minnesota Department of Health (MDH) issuing a permit to drill a well. To further a goal of wiser water use in the state, the legislature is asked to prohibit the use of groundwater for maintenance of lake levels, improve reporting of water use and mandate customer metering of water use by public suppliers. A recommendation is also made to require an evaluation of the potential for potable and nonpotable reuse of treated pump-out and treated wastewater discharges prior to the issuance or reissuance of a state discharge permit. The legislature is also urged to charge the appropriate state agencies with assessing the condition of emergency response to contamination of the Mississippi River.

The Metropolitan Council also plans to direct the Metropolitan Waste Control Commission to evaluate the potential for treated wastewater reuse at each of its treatment facilities and to develop a program of wastewater volume reduction by communities discharging to its collection system.

The Metropolitan Council requests a one-time legislative appropriation of $1 million to pursue several aspects of water supply planning it deems essential. These efforts include development of a regional groundwater model, preparation of guidance material on water conservation and amendment of comprehensive plans, development of a regional water availability and use database, and evaluation of alternative sources of water at a more detailed, pre-engineering level.

Finally, the Metropolitan Council would like to report back to the legislature once it has an opportunity to review the success of the program that has been recommended. This would likely occur in three years, following plan guideline preparation by the Council, plan amendment by the communities, and product review by the Council. It also recommends reporting on the need for a long-term financing mechanism for regional water supply needs and possible methods to accomplish this, if necessary.

1. INTRODUCTION

LEGISLATIVE CHARGE

In response to the drought of the late 1980s, the 1989 Minnesota Legislature passed a law (Minn. Stat., § 473.156) requiring the Metropolitan Council to prepare "a short-term and long-term plan for existing and expected water use and supply in the Metropolitan Area." The specific components of the long-term plan must:

1) Update the data and information on water supply and use within the metropolitan area;

2) Identify alternative courses of action, including water conservation initiatives and economic alternatives, in case of drought conditions;

3) Recommend approaches to resolving problems that may develop because of water use and supply with consideration given to problems that occur outside of the metropolitan area but have an effect within the area; and

4) Be consistent with the statewide drought plan under Minn. Stat., § 103G.293.

A short-term plan was completed on February 1, 1990, by the Metropolitan Council and delivered to the legislature and the required parties with whom consultation was to occur (the U.S. Army Corps of Engineers, the Leech Lake Reservation business committee, the Mississippi Headwaters Board, the Minnesota Department of Natural Resources, and the Minnesota Environmental Quality Board).

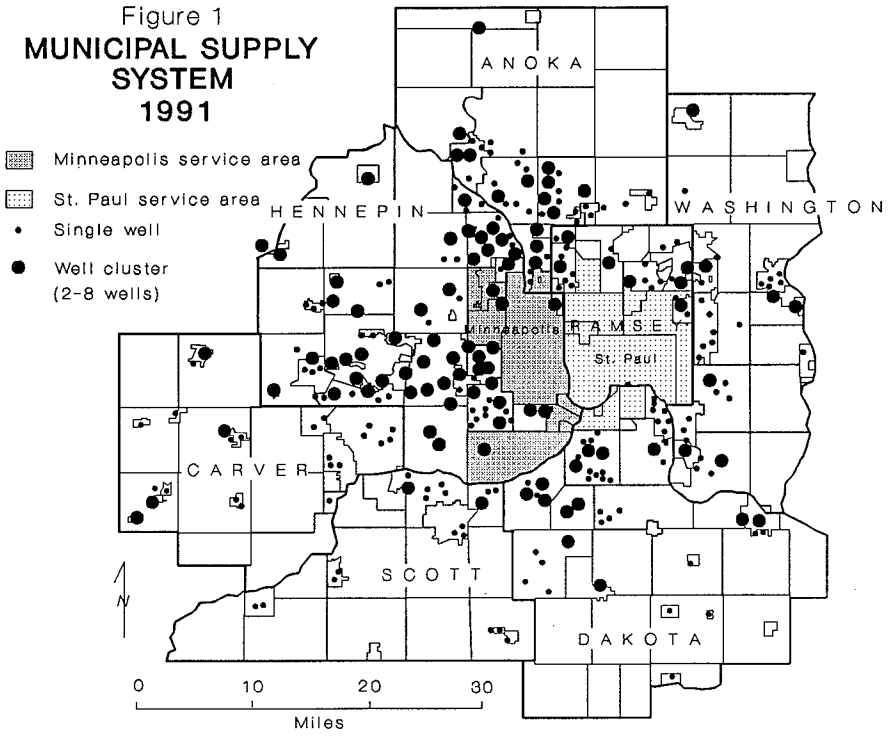
This long-term plan is to be completed and delivered to the legislature and affected parties by February 1, 1992, and is to be "continually updated as the need arises." This final clause is significant since it charges the Council with establishing a long-term presence in water supply planning for the region. The Council has long been interested in the water supply situation in the seven-county region but until passage of this law has never had specific authorization to plan in this area.

SUMMARY OF REGIONAL SUPPLY SYSTEM

The population of the Metropolitan Area draws its drinking water from one of two primary sources. Approximately 860,000 people in the central core of the region rely to some extent on the Mississippi River for their water supply. Figure 1 shows the source of municipal water for the area's 112 utilities. The 112th system began operation in Lakeland in late 1991, so it was not included in many of the analyses reported in this plan. The Minneapolis Water Works relies entirely on the river to supply its residents and those of Columbia Heights, Crystal, Golden Valley, Hilltop and New Hope. Minneapolis also provides a portion of the supplies for Bloomington and Edina. The St. Paul Water Utility relies on the river for about 70 percent of its average demand for St. Paul, as well as Arden Hills, Falcon Heights, Lauderdale, Little Canada, Maplewood, Mendota Heights, Roseville and West St. Paul. The remaining 30 percent of St. Paul's supply comes from a combination of surface water sources in the Vadnais Lake chain of lakes (through which the Mississippi River water is diverted) and the Rice Creek chain of lakes, and a system of four high-capacity wells.

The remaining 97 water utilities (including Bloomington and Edina) obtain their water from wells within their communities. These sources supply a population of about 1.2

Figure 1
MUNICIPAL SUPPLY SYSTEM 1991



million from approximately 500 wells, as noted in Figure 1. An additional 250,000 people obtain water from their own wells or from small nonmunicipal systems fed by groundwater.

Large volumes of surface and groundwater are also directly withdrawn by commercial and industrial users. Northern States Power is the largest user of surface water at over 500 million gallons per day average, yet it consumes less than 1 percent of the water it withdraws from the river system. This use, plus municipal uses, comprise by far the largest portion of water use in the region. Minor uses include self-supplied commercial/industrial/ institutional, building heating/cooling, irrigation, water level maintenance, and several miscellaneous purposes. All of these uses add up to approximately one billion gallons per day. The use of water and the source of water used are detailed in a later section of this plan.

PROBLEMS LEADING TO PASSAGE OF LEGISLATION

The water supply problems that occurred in the drought of the late 1980s convinced the legislature that something needed to be done to circumvent similar problems in the future. The region responded to the drought in 1988 as it had in 1976, when it faced similar conditions without a plan in place. After 1976, we quickly forgot the magnitude of the drought-related problems, went back to our normal usage patterns and failed to plan for how we would prepare for the next drought, which began a decade later, in the fall of 1986.

The water shortage problems of the late 1980s also brought into focus the vulnerability of Minneapolis and St. Paul to contamination of the Mississippi River and the vulnerability of municipal groundwater users to declining water levels, limited aquifer capacity and contamination of their source aquifers.
The Mississippi River problem is particularly

serious since Minneapolis would be left without a source of water if its river intake had to be closed for longer than one day. One need only consider the effect on approximately 500,000 people and the commercial/industrial sector that the Minneapolis Water Works serves, as well as the city's fire-fighting needs, to appreciate the magnitude of the problem the region would face if the river were severely contaminated. The Fountain City, Wisconsin, train derailment and the Grand Rapids oil spill, both of which occurred in 1991, bring into clear focus the potential for such problems. This potential will only increase in the future as we develop the urban corridor from Minneapolis to St. Cloud and continue to move chemicals and petroleum products in increasingly larger volumes by rail, truck and pipeline.

The final major problem to emerge during the drought of the late 1980s was the institutional morass resulting from the fact that no single agency or individual was "in charge." Because there was a lack of guidance at the state or regional level, conflicts occurred among the upstream interests, the state, water suppliers in the Metropolitan Area and the Corps of Engineers regarding "ownership" of water resources. There were also conflicts at the local level. During the drought, some cities continued supplying water without limitation to consumers, while others instituted mandatory water conservation: in some cases, the cities were across the street from each other.

The purpose of this plan is to address the above-mentioned and other problems and to assemble a plan that looks far enough into the future to head off difficulties. We can be assured of another drought at least as severe as the most recent experience. This plan will propose some concrete measures to begin an effort to prepare for such a drought.
A number of areas will lack great detail because the work needed to develop them must be sanctioned by the legislature before it can proceed. However, the framework for putting together a responsive program is outlined, and a scenario for its beginning is proposed. The time has come for us to aggressively pursue regional water supply planning so that we do not repeat past mistakes or invite new complex problems.

GOAL STATEMENT

The health and economic well-being of the Metropolitan Area relies heavily on the availability of an adequate supply of good quality water. One of the principal advantages this region has had over the arid Southwest and West and the heavily industrialized East has been its readily available supply of good quality water and the life-style it supports. We must put together an aggressive program to protect that water and access to it if we are to continue our prosperous growth and remain an economically viable Midwest urban center. In response to the legislative mandate, therefore, the goal of the Metropolitan Council is to assure the continued health and economic vitality of the Metropolitan Area by providing for a readily available supply of good quality water at a reasonable cost for all existing and new users.

This is an ambitious goal because it addresses health (environmental) and economic impacts, quantity and quality, and all users of water, for now and into the future. It also assumes that water can be obtained at a "reasonable cost", a phrase that might be very difficult to define because of its different meaning to various user groups.

The time to strive for this goal is now, while we are between droughts and before a contamination of either surface water or groundwater, which could occur at any time. The first step toward achieving the goal of preparedness is to adopt a plan that lays out in some detail the physical and institutional measures that need to be taken to address known and anticipated problems. The following document outlines a plan that the legislature can consider for accomplishing this goal.

2. WATER USE, AVAILABILITY AND QUALITY

USE OF WATER

Total Water Use

The amount of water used in the Twin Cities Metropolitan Area is a critical factor in the planning and development of the area. To track the use of water in the state, the Minnesota Department of Natural Resources (DNR) administers a permitting system that requires users who withdraw 10,000 or more gallons per day, or one million gallons per year, to obtain a permit and annually report the volume of water used. During the 1984-to-1989 period, the Metropolitan Area alone used an average of roughly one billion gallons of water per day (bgd). Figure 2 illustrates how this water is being used in the area and any changes in the use patterns for 1984-to-1989. The most notable change is that the primary water users--power generation and waterworks--steadily increased their use from 1984 to 1988; this increase can be attributed to increased demand in response to drought conditions. The slight decrease in use in 1989 supports this assumption.

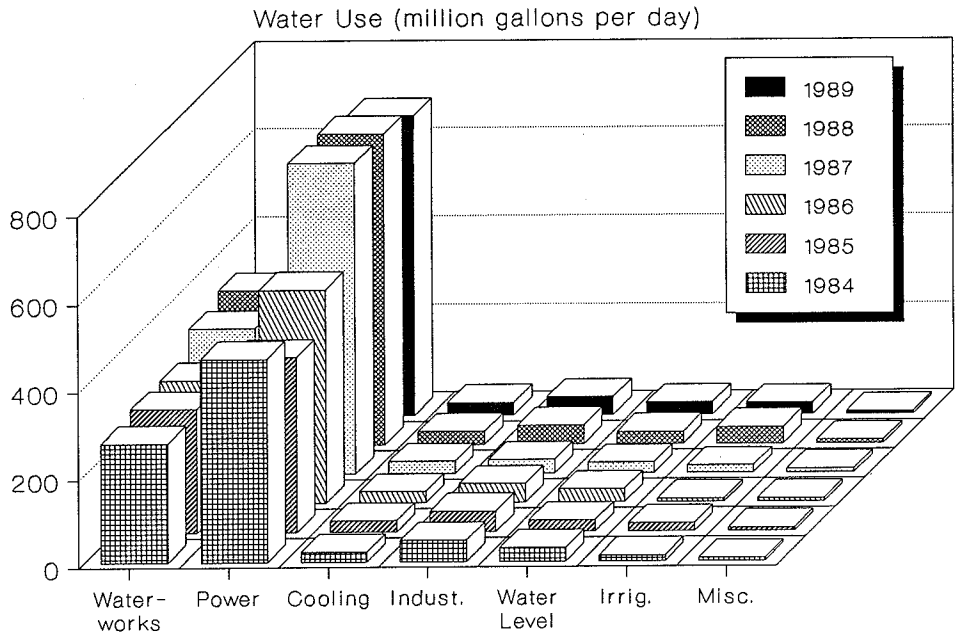
The difference between water use and water consumption is important to recognize in subsequent discussions. Water use is synonymous with "withdrawal" and includes all water used by a facility or entity, whether it is returned to the system or consumed. Water consumption, on the other hand, only refers to water that is used and not returned to the system from which it came. For example, power generation uses approximately 212 billion gallons per year (bgy) but consumes only about 1 percent of this withdrawal, or 2.12 bgy. Most of the water used for power generation is cycled through the facility and then returned to the river from which it came. Figure 3 summarizes water use for the region. The primary uses of water can be grouped into nine categories: power generation, sewage treatment, water level maintenance, municipally supplied residential and commercial/industrial/institutional uses, private waterworks, irrigation, miscellaneous uses and nonmunicipally supplied water use. Of these nine uses, only three--power generation and commercial/industrial/institutional and residential uses--account for 92 percent of the region's water withdrawals.

Surface Water Use

The Mississippi, St. Croix, and Minnesota Rivers are the main suppliers of surface water in the region. Figure 4 shows average reported water use during the 1984-to-1989 period for the Metropolitan Area by source. The figure shows that surface water resources are used primarily for drinking water in the area and cooling for power plants. These two uses account for over 95 percent of total surface water withdrawals. The current average surface water withdrawal over the region for these two uses alone totals just under 690 million gallons per day (mgd).

Figure 5 further details these two primary surface water uses. In the figure, the use categories are divided into withdrawal and consumption. Unlike power generation, municipal consumption is assumed to be 10 percent of the total withdrawal for each year based on information contained in our technical studies. Table 1 shows the surface water withdrawal and consumption in the other categories. These numbers have been updated since the release of Working Paper No. 3.

Figure 2
WATER USE CHANGES, 1984-1989



Data from DNR

Figure 3
BREAKDOWN OF TOTAL AREA WATER USE FOR 1990

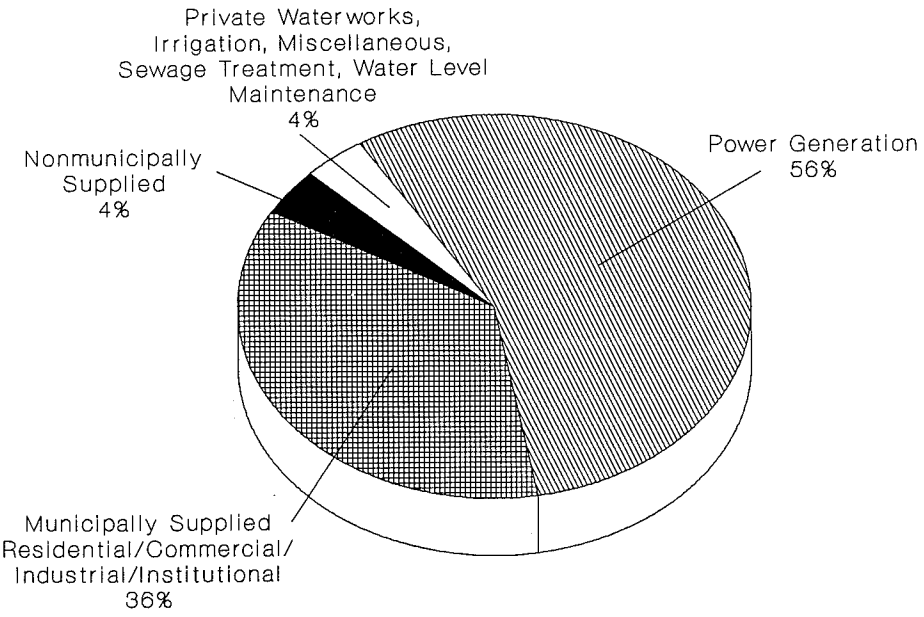
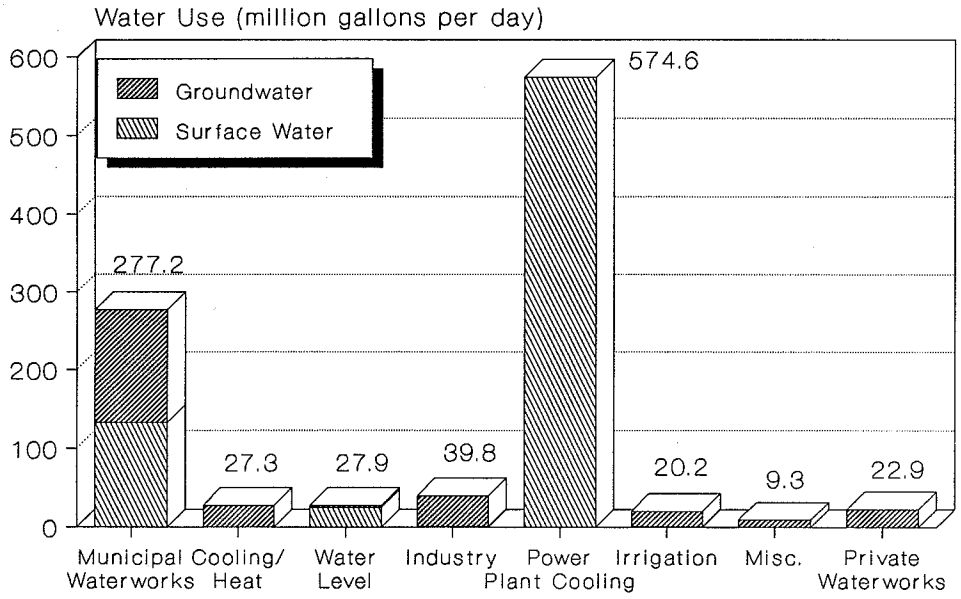


Figure 4
1984-89 AVERAGE REPORTED WATER USE FOR THE METROPOLITAN AREA



From DNR permit data

Figure 5
SURFACE WATER WITHDRAWALS AND CONSUMPTION, 1984-1989

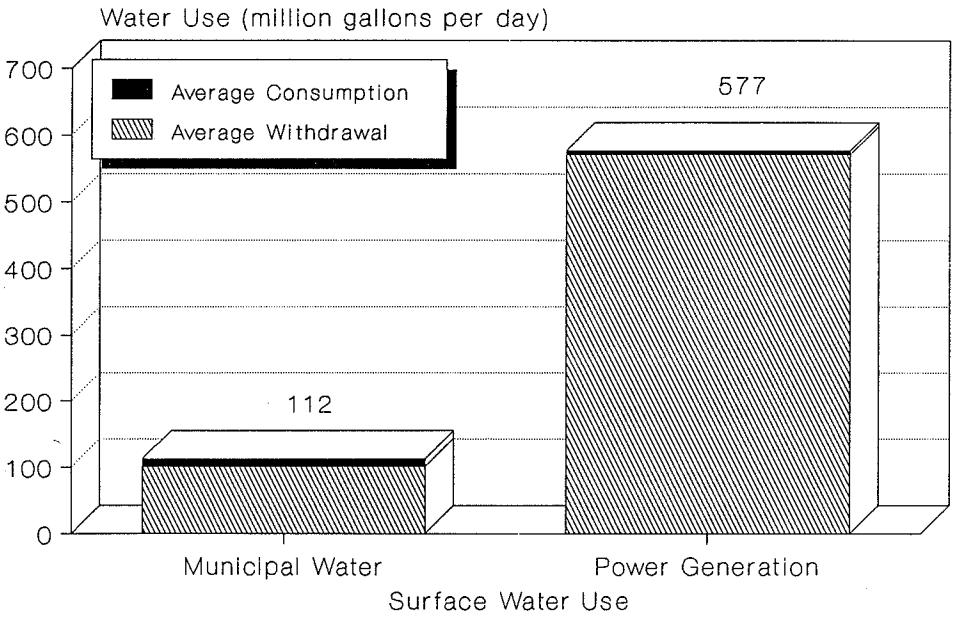


Table 1
SURFACE WATER WITHDRAWAL AND CONSUMPTION, 1984-1989

SURFACE WATER USES	AVERAGE WITHDRAWALS* (mgd)	AVERAGE CONSUMPTION (mgd)
Municipal Waterworks	112	11
Private Waterworks	0	0
Power Generation	577	6
Commercial, Industrial and Institutional	<1	<1
Air-conditioning	0	0
Sewage Treatment	0	0
Water Level Maintenance	<1	<1
Irrigation	<1	<1
Miscellaneous	<1	0
TOTAL	690	19

*Represents withdrawals from major rivers only.

Groundwater Use

The Metropolitan Area depends heavily on groundwater as a source for municipal supply and for industrial/commercial and agricultural needs. For groundwater users, the DNR permit requires reporting information about the aquifer used, the permitted withdrawal, and an estimate of the actual amount withdrawn for every year the permit is valid. This DNR information was used to determine groundwater withdrawals and estimates of consumption (groundwater not returned to any receiving water) for the region.

Figure 6 and Table 2 show groundwater withdrawals and consumption for 1984 to 1989. According to the figure, groundwater is used primarily for municipal and commercial needs. Approximately 262 mgd of groundwater were withdrawn for the six-year period. Of this amount, an estimated 45 mgd were consumed, that is, not returned to any receiving water system, based on consumption rates of 10 percent for municipal, commercial, miscellaneous and industrial withdrawals, 90 percent for irrigation, 3 percent for air-conditioning and 100 percent for water level maintenance (lost to evaporation).

Figure 6
GROUNDWATER WITHDRAWALS
AND CONSUMPTION, 1984-1989

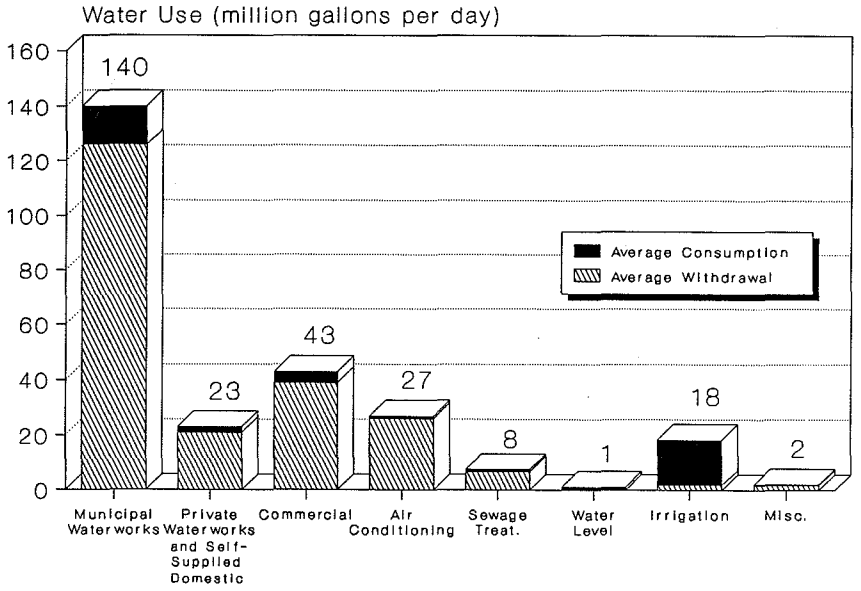


Table 2
GROUNDWATER WITHDRAWAL AND CONSUMPTION, 1984-1989

GROUNDWATER USES	AVERAGE WITHDRAWALS (mgd)	AVERAGE CONSUMPTION (mgd)
Municipal Waterworks	140	14
Private Waterworks	1	0
Power Generation	0	0
Commercial, Industrial and Institutional	43	7
Air-conditioning	27	<1
Sewage Treatment	8	1
Water Level Maintenance	1	1
Irrigation	18	17
Self-supplied Domestic	22	2
Miscellaneous	2	2
TOTAL	262	45

Neither the reported withdrawals nor the consumption reflects withdrawals from unpermitted wells. The self-supplied component was estimated based on per capita use for the region and then multiplied by the self-supplied population. Using this method, the total domestic self-supplied groundwater withdrawal can be estimated to be 22 mgd across the Metropolitan Area, with 10 percent consumed. Combining these figures with permitted groundwater withdrawal and consumption yields approximately 262 mgd withdrawn and 45 mgd consumed.

Projected Water Use

Working Paper No. 2 projected the water demand for the years 1990, 2000 and 2010. The DNR had automated its water use records only through 1988 at the time of the study, so 1988 had to be used as the base year for all projections. Since then, the projections have been updated by using the 1984-to-1989 median value for each water use category. Water use was projected by developing two statistical models, one projecting municipal residential use and the other projecting municipal commercial/industrial/institutional water use, and by making assumptions on future demand for the other use categories. Figure 7 shows the results of the projection analysis for the region. According to the models, municipal commercial/ industrial/institutional and municipal residential water withdrawals will increase 10 percent, from a projected annual average of 372 mgd in 1990 to 415 mgd in 2010. It is important to note that these projections do not include water use by self-supplied domestic sources.

Power generation, private waterworks, sewage treatment, irrigation and miscellaneous uses were assumed to remain constant through the year 2010. Water level maintenance was incrementally phased out in our projections, based on the DNR position paper that suspended permits that used groundwater for water level maintenance. This position is not part of a law or adopted rules and regulations but makes good sense in light of the resource value we place on groundwater. Legislative action eliminating this use, similar to the manner in which once-through air-conditioning water was discontinued, will be recommended later in this plan.

Figure 8 breaks down the overall projections shown in Figure 7, showing projections in use from 1988 to 2010 for the primary water use categories. Power generation is not listed because it is expected to remain constant through 2010. The figure shows expected increases of 17 percent in municipal residential and 9 percent in commercial/industrial/ institutional use. Commercial/industrial/ institutional and supplied residential water use account for the majority of the changes in water withdrawals for municipalities.

Water use was also projected for non-municipally supplied cities and townships. All water used for nonmunicipal purposes is supplied from groundwater sources. Projections were calculated on a per capita basis, assuming an average per capita use of 102 gallons reported in Working Paper No. 4 on municipal water use. Overall, the nonsewered cities' water use projections for the region were 26, 24 and 25 mgd for 1990, 2000 and 2010, respectively. These numbers have been updated since the release of Working Paper No. 2 on water demand.

Figure 7
TOTAL PROJECTED WATER USE BY SOURCE

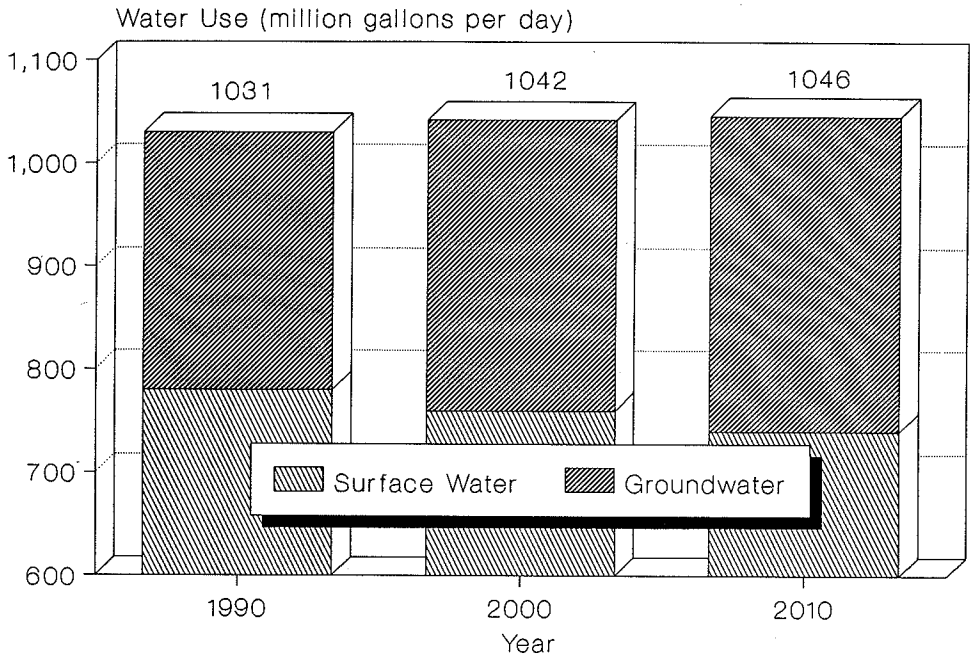
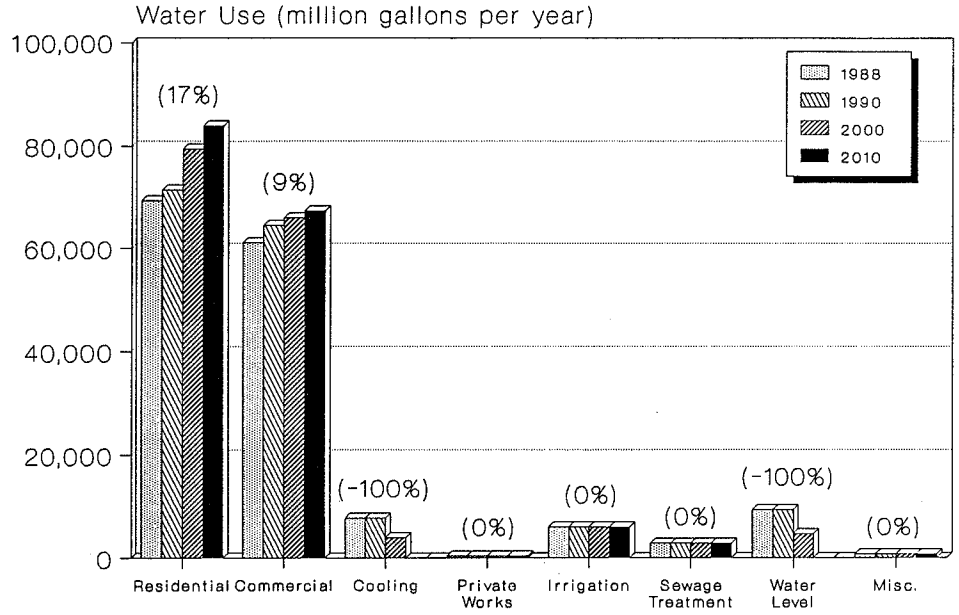


Figure 8
PROJECTED WATER USE



Numbers in parentheses represent the percent of increase from 1988 to 2010.

Figure 9
PREDICTED MUNICIPAL WATER DEMAND

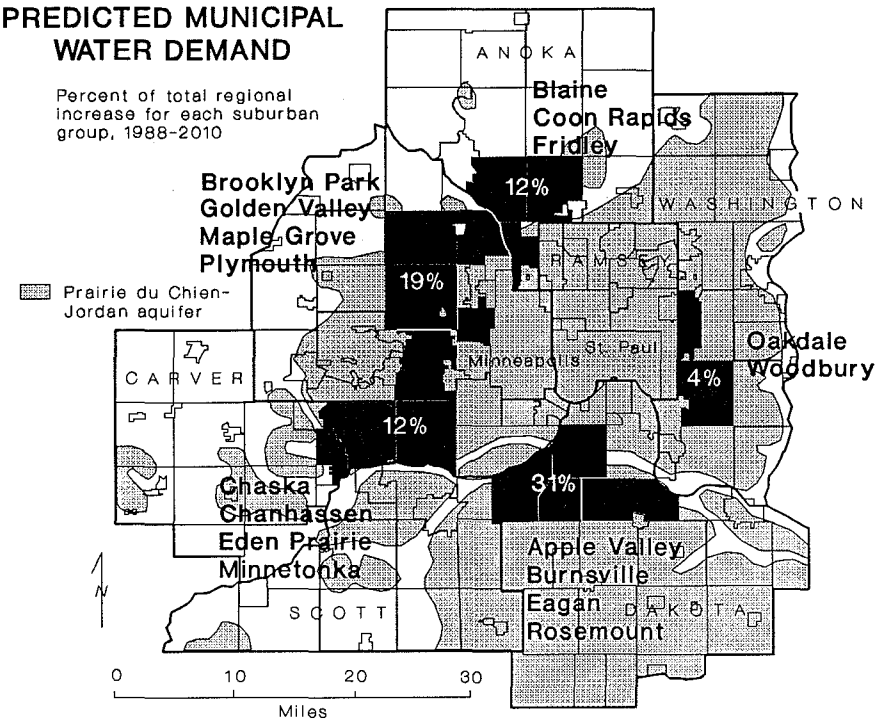
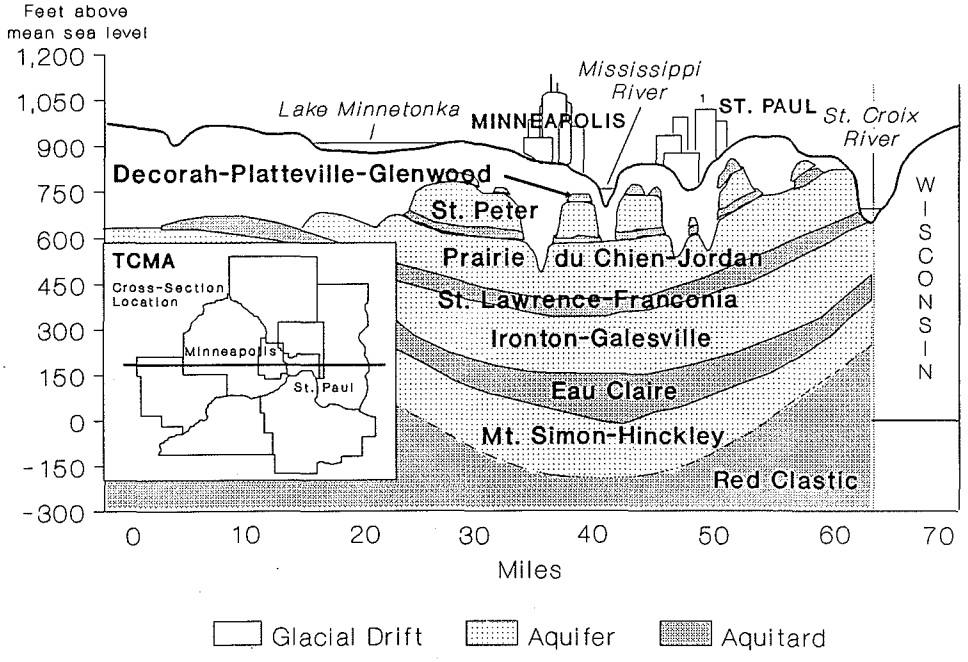


Figure 10
GENERALIZED AREA GEOLOGIC CROSS-SECTION



To obtain a total water use projection for the Metropolitan Area, municipally supplied residential and commercial/industrial/ institutional water use, power generation, miscellaneous uses, irrigation, wastewater treatment, water level maintenance and private waterworks were added together with the nonsewered projections. The updated final analysis of water use for 1988 totaled 1,012 mgd. Projections for 1990, 2000 and 2010 yield total water use rates of 1,031, 1,042 and1,046 mgd, respectively, meaning increases of 1.8 percent, 2.9 percent and 3.3 percent over 1988 use.

Projections were also completed by using water use numbers representative of a drought year. Under a prolonged drought scenario, projections for water use for 1990, 2000 and 2010 are 1,181, 1,191 and 1,194 mgd, respectively.

Figure 9 shows where the predicted increases in demand between 1988 and 2010 will occur. As shown, the increases are not evenly spread across the area. Thirty-one percent of the increase in demand is expected to occur in the Apple Valley, Burnsville, Eagan and Rosemount area; 19 percent in the Brooklyn Park, Golden Valley, Maple Grove and Plymouth area; 12 percent in the Chaska, Chanhassen, Minnetonka and Eden Prairie area; and 12 percent in the Blaine, Fridley and Coon Rapids area. Thus, about three-quarters of the increases by the year 2010 are expected to occur in just 15 cities. Woodbury and Oakdale contribute another 4 percent. This decentralization of demand is a key consideration in identifying potential water supply problems in the region.

Surface Water Projections

Figure 7 also shows a breakdown of the projected water use for surface water and groundwater for 1990 to 2010. Surface water use is projected to decrease from 780 mgd in 1990 to 740 mgd in 2010. This decrease is primarily a result of the decrease in population within communities served by surface water.

Groundwater Projections

The majority of the municipal systems (85 percent) are supplied by groundwater. Looking at Figure 7, it can be seen that groundwater use is about one-third of surface water use, but unlike surface water use, which is projected to decrease, groundwater use is projected to increase from 251 mgd in 1990 to 306 mgd in 2010.

AVAILABILITY OF WATER

Groundwater Availability

The groundwater system underlying the Metropolitan Area can be thought of as a layer cake of sediments that transmit or retard the movement of water. Figure 10 shows the five principal "aquifers," or water-bearing units, along with the confining layers, or "aquitards," that retard water flow. The region relies primarily on the Prairie du Chien-Jordan (PDCJ) aquifer, the drift (unconsolidated glacial material on top of the bedrock), and the Mount Simon-Hinckley (MTSH) aquifer as sources of groundwater.

Working Paper No. 3 and a recent U.S. Geological Survey study (Schoenberg, 1990) indicate that the five-layer groundwater system can yield between 500 and 800 mgd of groundwater in the Metropolitan Area. Present pumpage over the entire system is roughly 250 mgd, which suggests that we have reached only less than half of our capacity. However, this assumes that we will be able to intercept the second half as easily as the first, which may not be the case. Well hydrographs

from various locations around the region indicate that water levels are slowly declining in the PDCJ and MTSH aquifers in the vicinity of St. Paul and Minneapolis. Figure 11 is one example of a well located in Bloomington that clearly shows this trend. While this decline is not major from year to year, over several decades it could affect our ability to obtain optimal amounts of groundwater.

As we begin to approach the maximum capacity of the groundwater system in the future, we may encounter withdrawal problems. Also, as pumpage increases, groundwater inflow to streams decreases, which could have a negative impact on water quality by reducing in-stream flows during the critical low-flow period.

Surface Water Availability

Under normal conditions, roughly 7,000 mgd flows into the Metropolitan Area via the Mississippi River at Anoka (see Working Paper No. 3). Most of this water, in addition to the groundwater that is added to the river within the area, passes through unused. Because of the abundance of surface water, more surface water from the Mississippi River could be easily used for water supply without affecting the overall surface water system. The Minnesota River is not considered suitable for municipal water supply because of its poor quality, and the protected status of the St. Croix River limits its use.

Figure 12 shows surface water (Mississippi River) availability during the summer for normal (4,800 mgd available), wet (9,300 mgd available), dry (2,800 mgd available), and drought (1,200 mgd available) conditions, based on flow data at Anoka. The ability of the surface water system to support new uses is a function of the season and the demand associated with the new use. The figure shows that with the exception of summer low flow periods during drought, the surface water system capacity far outweighs that of the groundwater system and far exceeds the design flow for wastewater flow assimilation (7Q10; see Definitions section at end of plan) and the "critical flow" of 358 mgd (554 cubic feet per second {cfs}) defined in the technical studies.

Figure 11
HENNEPIN COUNTY
OBSERVATION WELL 27010
(437 FEET DEEP IN THE PRAIRIE DU CHIEN-JORDAN AQUIFER)

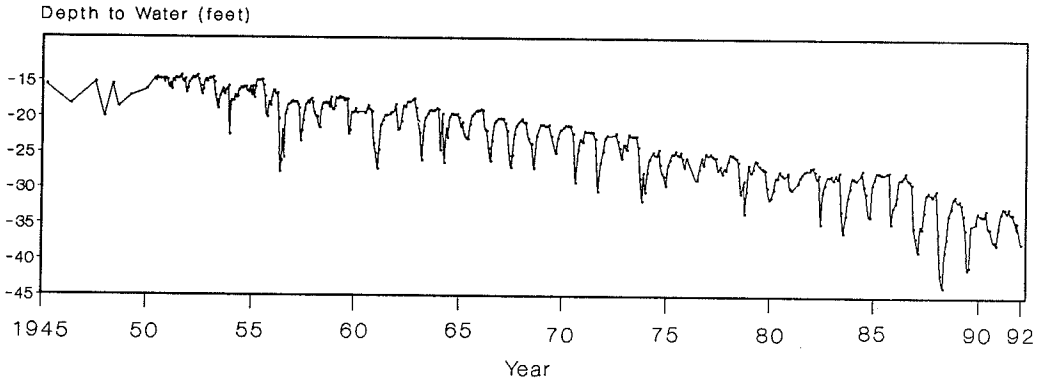
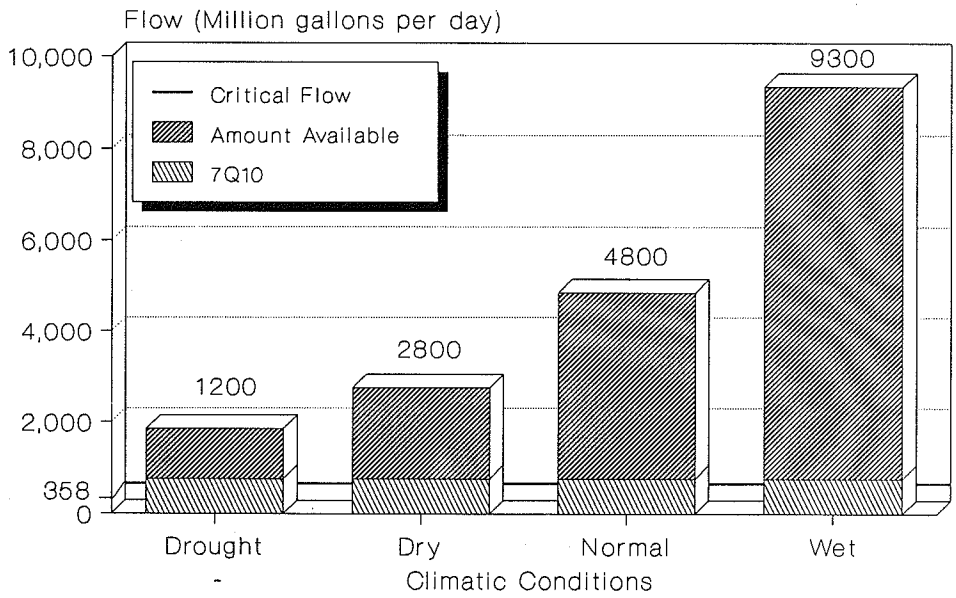


Figure 12
SURFACE WATER AVAILABILITY
DURING SUMMER LOW FLOW AT ANOKA



Based on median of the mean monthly flow data, 1963-1989

QUALITY OF WATER

Surface Water Quality

If the region turns to surface water to satisfy increasing demand, the most feasible choice for a source would be the Mississippi River, since it is centrally located and could provide large volumes of water. Currently, the Mississippi River north of the Metropolitan Area to the Upper Lock and Dam at St. Anthony Falls is used for drinking water after stipulated levels of treatment are applied. From the discharge point of the Metropolitan Waste Control Commission's Metropolitan wastewater treatment plant (Metro) to river mile (RM) 830, it is used for fishing but not for swimming. The entire river is used for industrial consumption, agriculture, wildlife and navigation.

The major constraints on increased future use of the river include flow reliability, drought and contaminant spills. In times of reduced flow or drought, the use of surface water may be hindered. A minimum flow rate is required to supply surface water, in addition to municipal use, for wastewater assimilation, navigation and power plant electric generation. The threat of a spill or contamination of the surface water supply also exists. In the case of reduced flow or contamination, surface water use may be discontinued and a backup source, such as groundwater or stored water, would be needed.

Groundwater Quality

Contamination of groundwater must be considered when discussing water quality. Large- and small-scale groundwater contamination is a significant problem in the Metropolitan Area. There are currently 78 sites on the Minnesota Pollution Control Agency (MPCA) Permanent List of Priorities (Superfund), which represents only major sites of documented contamination. Leaky storage tanks, improper application of pesticides and fertilizers, and malfunctioning septic systems also contribute unquantifiable amounts of contamination to the system. Figure 13 shows the Metropolitan Area Superfund groundwater contamination sites. Because pretreatment of groundwater typically consists of only disinfection and softening, contamination from hydrocarbons and organics would require greatly expanded treatment systems. Contaminated groundwater, therefore, is effectively removed from the potable water supply unless a community is willing to spend the large amount of revenue required to treat the water to potable levels.

Figure 14 shows the estimated volumes of affected groundwater associated with each aquifer, based on information obtained from the MPCA. The most widely used aquifer in the region, the PDCJ, contains an estimated 124 billion gallons of contaminated groundwater. Figure 15 shows the estimated volume of contaminated groundwater and the potential yield of the aquifer. From the figure, the PDCJ aquifer has a potential yield of 782 billion gallons, and of this, 124 billion gallons, or 16 percent, is contaminated. Overall, there may be about 230 billion gallons of contaminated groundwater underlying the Metropolitan Area. This number is roughly equivalent to three times the volume of groundwater used in the Metropolitan Area over one year.

Figure 13
SITES ON THE 1991 MPCA PERMANENT LIST OF PRIORITIES

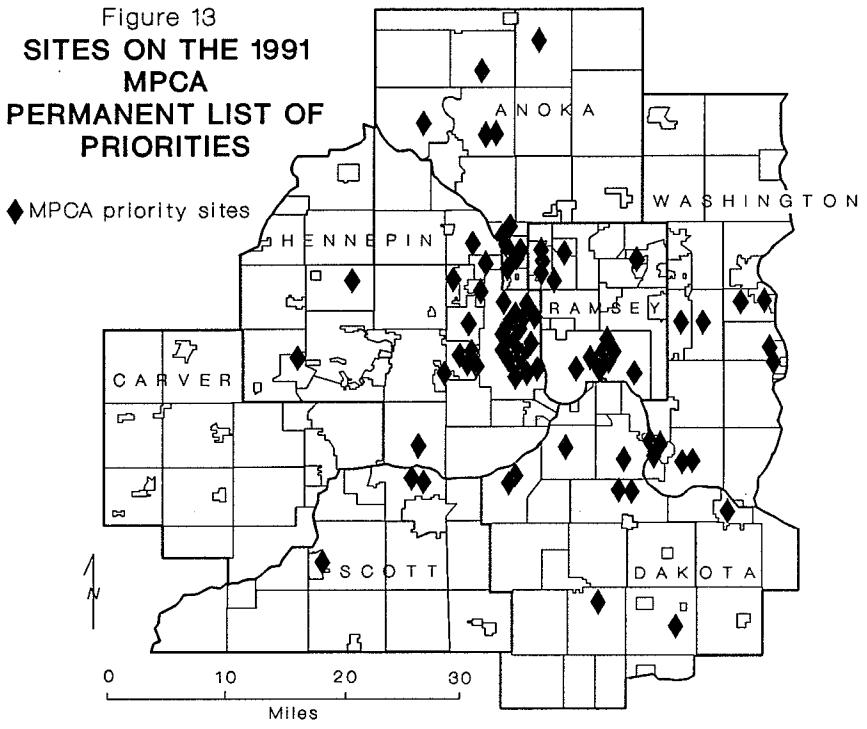
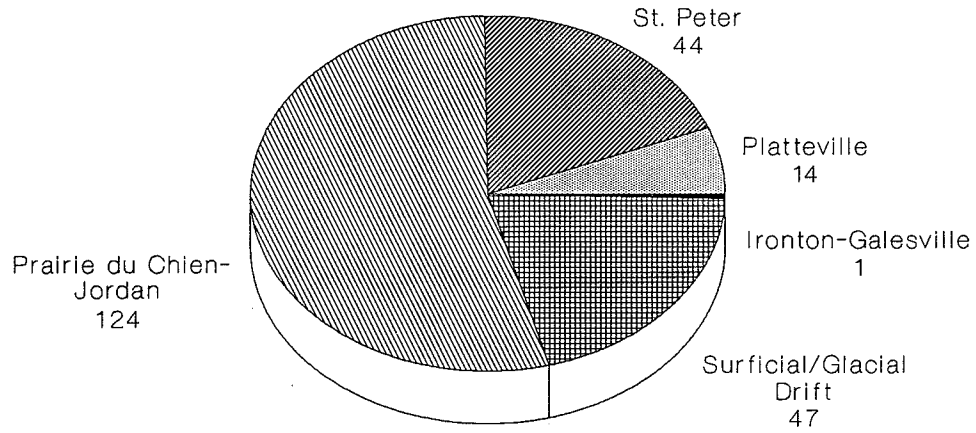
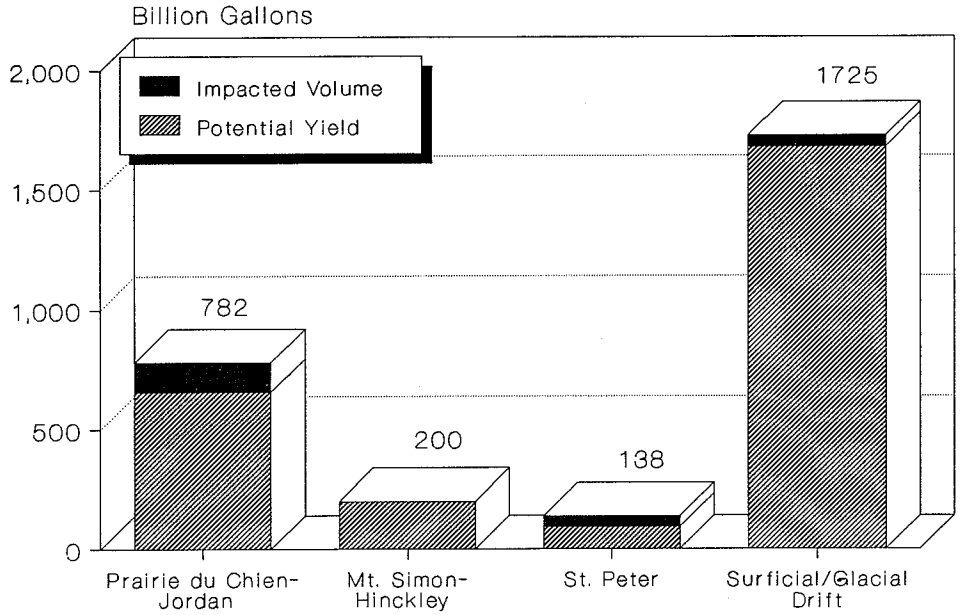


Figure 14
ESTIMATED VOLUMES OF CONTAMINATED GROUNDWATER BY AQUIFER
IMPACTED VOLUME IN BILLION GALLONS



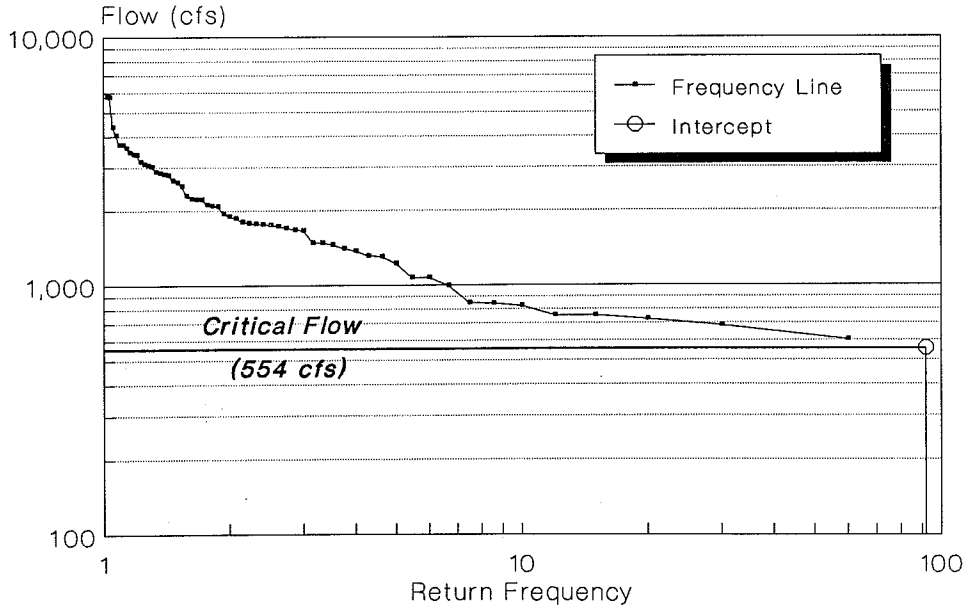
Based on data supplied by MPCA

Figure 15
ESTIMATED VOLUMES OF CONTAMINATED GROUNDWATER AND POTENTIAL YIELD



Based on information from MPCA

Figure 16
ANOKA FLOW FREQUENCY LOWEST ANNUAL DAILY SERIES



Data from USGS

3. PROBLEM DEFINITION

FLOW RELIABILITY IN THE MISSISSIPPI RIVER

Minneapolis and St. Paul use the Mississippi River as a source of municipal water supply. Because these two cities also provide water for 13 suburban communities plus parts of two other cities, over 820,000 people in the Metropolitan Area depend on these two systems. For this reason, it is imperative that a sustainable source of good quality surface water continue to be available for new and existing users.

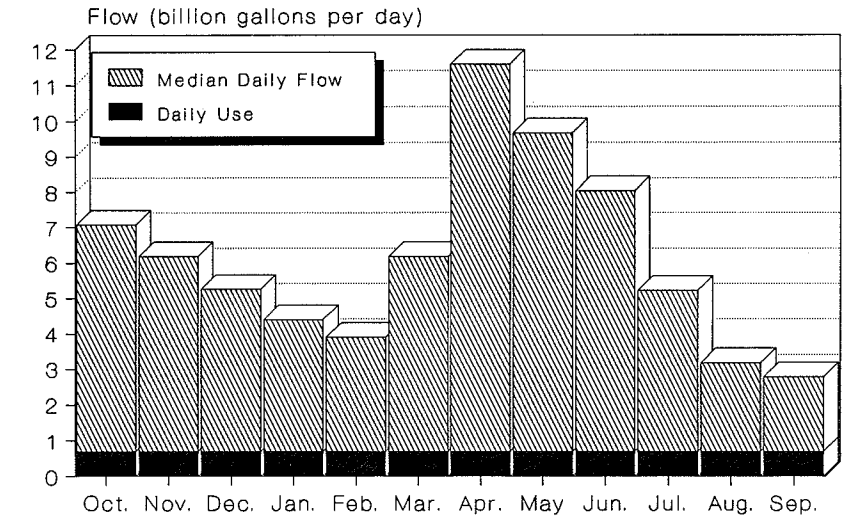
The availability information gathered for Working Paper No. 3 indicates that under normal climatic conditions, roughly 7,000 mgd flows into the area via the Mississippi River at Anoka. At this flow rate, the existing demand and the total projected demand for 2010, or roughly 1,047 mgd, could be easily met. However, when dealing with the surface water system, normal or average conditions cannot be used to develop plans; instead, a worst-case scenario must be used to assess the likelihood of potential water supply problems.

The short-term water supply plan gave an idea of what a worst-case scenario might be by identifying a "critical flow" of 554 cfs (358 mgd). At flows below this level, not all of the existing municipal, navigation, power production and wastewater assimilation uses of the river can be maintained, requiring the initiation of drought management activities and restriction of certain low-priority uses. Figure 16 is a duration curve based on daily average flows at Anoka. According to the figure, we can expect to reach this critical flow approximately once every 100 years for at least one day. To date, this critical level has not been reached; however, probability theory indicates that there is about a 1 percent chance in any given year that flow could drop to this level.

Reaching this flow level is an issue for all users of the river, but it is particularly important for St. Paul and Minneapolis since they supply such a large residential and commercial sector of the Metropolitan Area. St. Paul recognized the danger in relying totally on the river after the drought of the 1930s, and built a reservoir system on the Rice Creek chain of lakes, adding several ground-water "reserve" wells in response to the drought of the mid-1970s. As a result, St. Paul is now able to go off-line for up to a month with no adverse impacts. With conservation measures, this period could be extended even further.

Minneapolis, on the other hand, is vulnerable to drought-induced low flows because it has no backup system and only about 24 hours (without conservation) of off-line storage. This means that if the intakes at the Minneapolis Water Works were shut down for longer than a day, the city would not be able to provide water for adequate fire protection or other residential and commercial/industrial uses. Clearly, the lack of a completely reliable supply of water is a major problem for Minneapolis, but it also has potential regional implications because of the adverse economic impact that might occur as a result of an interruption of water service. Although the city has been aware of this problem for decades and has conducted several studies regarding possible alternatives, the cost and feasibility of implementing the alternatives has precluded it from instituting solutions.

Figure 17
MEDIAN DAILY FLOW AND SURFACE WATER USE, ANOKA GAGE



Based on median of the mean daily flows

Although the problems outlined above are quite serious, it should be emphasized that they stem primarily from shortsightedness and a poor understanding of the river at the time the Minneapolis system was developed--not necessarily from a problem with the resource itself. Indeed, our studies have shown that for the vast amount of the time, the Mississippi River is capable of providing much more water than is currently being used, as is illustrated in Figure 17. From the figure, we see that the normal capacity of the river is far greater than the current demand, which suggests that the river should be used to a greater extent in the future. With a reasonable backup system in place in the event of contamination or severe low flow, the Mississippi River could be an excellent source of good quality water.

SURFACE WATER QUALITY DURING LOW FLOW

If the Mississippi River is used more extensively, the potential effects that an increased withdrawal could have on water quality need to be examined. Working Paper No. 6 pointed out that increased consumptive use of the Mississippi River could have an impact on its assimilative capacity particularly during low-flow periods when flows approach the established 7Q10. As the flow drops in the stream, less water is available for assimilation of wastewater. If additional assimilative capacity is lost through increased withdrawals, problems meeting in-stream water quality standards could arise. Even if standards are not breached, it is likely that future calculated 7Q10 values would be reduced, perhaps leading to more stringent effluent limitations on wastewater discharges.

Figure 18
SURFACE WATER AVAILABILITY DURING SUMMER LOW-FLOW PERIOD, 1984-89

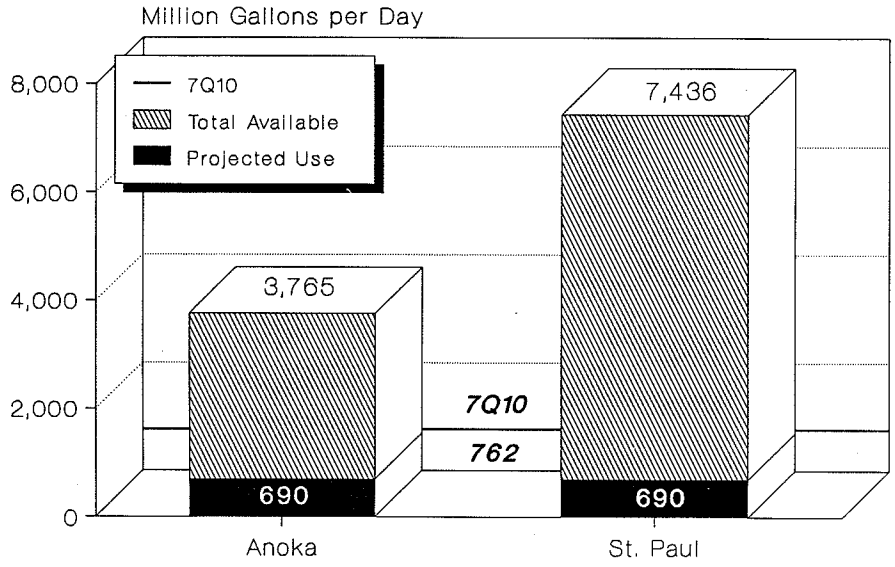


Figure 18 shows the relationship between median daily flow at Anoka and St. Paul, the current 7Q10 flow for each station and projected surface water use. From the figure, we see that there is a comfortable margin between the future-use projections and the 7Q10, indicating that even during routine low-flow periods, the river could withstand increased withdrawals without compromising future water quality.

A much more serious problem that warrants immediate attention is the vulnerability of the river to contamination. In the event of an oil or chemical spill upstream of Fridley, the intakes for both St. Paul and Minneapolis would have to be closed for an unspecified amount of time. While this is not a major concern for St. Paul, it is for Minneapolis because of its lack of a backup system or adequate storage. Moreover, if more cities turn to the river as a source of supply, the impact a spill or contamination could have on the region is greatly increased.

DECLINING GROUNDWATER LEVELS

As was shown earlier, the Metropolitan Area depends heavily on groundwater as a source for municipal supplies and for commercial, industrial and agricultural needs. Unfortunately, the groundwater resource is being slowly depleted in many locations, as is illustrated in Figure 19. The set of four well hydrographs depicted in the figure shows local examples of the long-term downward trends in groundwater levels within the area. It is important to keep in mind that these hydrographs are influenced by factors unique to their locations and were chosen to illustrate what might be occurring at high withdrawal locations; other well hydrographs in lower use areas might show an entirely different picture,

depending on the physical factors within the zone of influence of the well. Nevertheless, the fact that steadily declining groundwater levels are pervasive over much of the region is cause for concern.

Despite this evidence, we learned during a series of public meetings that a perception still exists that there are no groundwater problems, since users can get all the water they want by merely adjusting pumping elevations or looking elsewhere in the groundwater system for supplemental supplies. It was also stated that decreases in groundwater levels are nothing to worry about because they "always" rebound after the cessation of drought. These perceptions are very difficult to change, but we must move forward in our efforts as a region to recognize the finite nature of our groundwater and use it accordingly.

The way we withdraw water from the groundwater system in the Metropolitan Area contributes to the decrease in groundwater levels or piezometric "head," particularly in areas undergoing rapid growth. Cities tend to cluster their wells in one or two wellfield areas, primarily to optimize treatment and distribution system costs. This clustering causes the drawdown associated with each well to merge and form one large drawdown, or "cone of depression," in the vicinity of the wellfield. These cones can represent head losses up to 100 feet in some areas. If we continue to withdraw groundwater from existing or new large-scale pumping centers or wellfields, we can expect increased head losses and subsequent withdrawal difficulties, particularly as we grow outward away from the major production centers of the groundwater system.

The answer to groundwater supply or withdrawal problems has traditionally been to pump longer, drill deeper or turn to another aquifer that has higher head or better water quality. However, we are now realizing that our choices are limited. In the Metropolitan Area, as previously mentioned, there are essentially three aquifers that are capable of supporting large capacity municipal uses; they are the drift, the Prairie du Chien-Jordan and the Mt. Simon-Hinckley aquifers. Of the three, the PDCJ, and multi-aquifer wells that rely primarily on the PDCJ, is the most widely used, accounting for close to 75 percent of current groundwater withdrawals. The drift and the MTSH supply 10 percent and 7 percent, respectively. Other less-productive aquifers make up the remainder of the withdrawals.

The PDCJ is the region's most productive aquifer where it exists, but it is not laterally extensive across the region. Figure 20 shows the boundaries of the PDCJ aquifer superimposed over an outline of the Metropolitan Area. Note that the aquifer is not fully present in the northern and western portions of the region, which contain a large part of the rapidly growing developing ring of suburbs. Council projections indicate that 74 percent of the increase in residential and commercial/industrial water demand by the year 2010 will be focused in the developing ring, some portions of which have limited or no access to the PDCJ aquifer. This implies that an alternative to the PDCJ will have to be used in these areas--either another aquifer source, for example, the drift or the MTSH, or surface water where feasible. Preliminary modeling has shown that the drift is locally capable of sustaining pumping rates suitable for municipal supplies; however, it is more vulnerable than the deeper, more protected aquifers to contamination from surface spills, agricultural chemicals, and leachate from buried wastes. It must be noted, however, that the PDCJ can be susceptible to contamination when protective aquitards are thin or absent, when glacially cut

Figure 19

HISTORICAL OBSERVATION WELL WATER LEVELS IN THE TWIN CITIES METROPOLITAN AREA

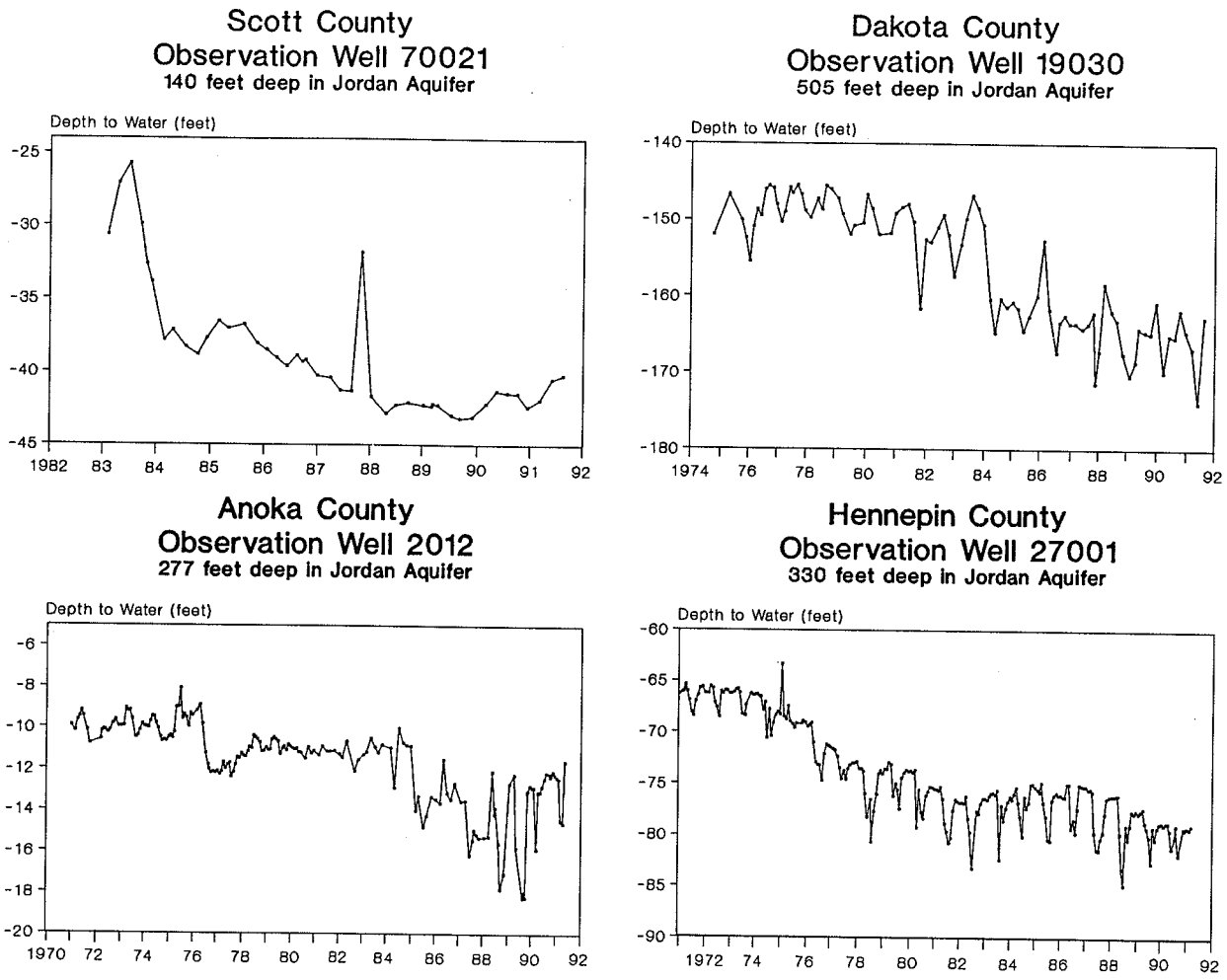
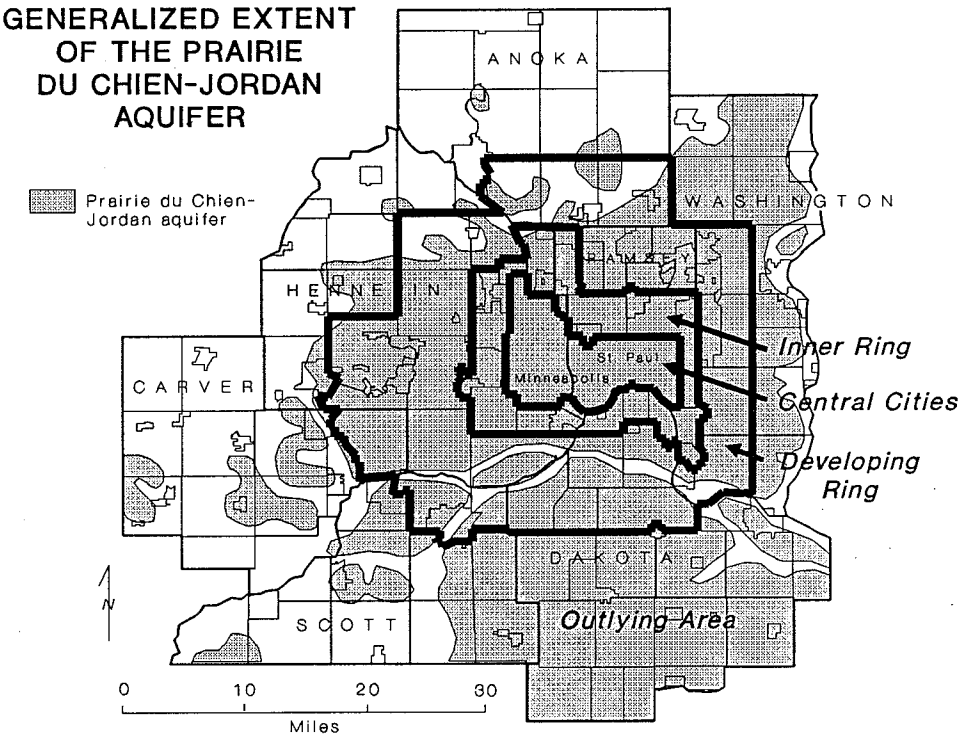


Figure 20
GENERALIZED EXTENT OF THE PRAIRIE DU CHIEN-JORDAN AQUIFER



valleys intrude through protective layers and when wells deliver contamination directly to the aquifer. The MTSH is the other groundwater alternative, but limited production qualities and recent DNR policy restricting its use could preclude cities from using this aquifer for large-volume, nonessential supplies.

A major impediment to understanding the intricacies of the groundwater system in the Metropolitan Area is the lack of an easily usable model. A U.S. Geological Survey (USGS) groundwater model exists but does not meet our needs for several reasons:

- Access to the USGS model is limited. Because of the size and complexity of the model, it must be run on a supercomputer by USGS personnel. This causes logistic and economic problems for any outside user of the model, since USGS staff must be available and budgeted to run the model and computer time must be scheduled at outside facilities.

- The USGS model is based on data collected only through the early 1980s. It is not representative of current conditions, particularly in the faster growing, groundwater-dependent suburbs.

- The USGS model is a grid-based numerical model, which limits its flexibility. For example, the model is based on so large a grid that it cannot be used to focus on small subareas within the originally modeled domain without extensive alterations and data reentry. As a result, the model is severely limited in application for the type of local situation that we need to model. The current observation well network is not extensive enough to provide the detailed data that would

be needed to adapt the USGS model to small-scale application. Although expanding the well observation network is important, the priority for the region at this time should be to develop an easily usable modeling tool to assist us in addressing the questions raised in our technical studies.

In place of the USGS model, we are advocating the development of an analytical modeling approach based on common groundwater flow phenomena. An accurate analytical model of the region could be constructed from the data we now have and run on readily available hardware that most planning and regulatory agencies possess. In addition, a model of this type could easily be broken down into smaller subareas for site specific analysis. Perhaps the greatest advantage of the analytical modeling approach is its ease of use by anyone with access to the base data files.

This tool could greatly enhance water supply planning efforts. During times of drought, the model could be used to forecast the response of aquifers to reduced recharge and increased pumpage. It could also be used to determine the groundwater contribution to streamflow. Aside from drought planning, the model could be used to aid municipal government in planning and protecting wellfields, in determining the optimum placement of wells, in delineating capture zones and in designing monitoring systems. The model could also be used for regulatory work at the state level and for the water supply planning functions at the local and regional levels.

A proposal to develop an analytical groundwater model occurs later in this plan in the Financing section. We anticipate a multiagency effort to construct a model and make it centrally available to all interested users.

INSTITUTIONAL PROBLEMS IN WATER MANAGEMENT

Working Paper No. 8 details the institutional problems related to water supply management in the region. The technical findings leading to the preparation of that report do not point to a water supply system in total disarray and unable to meet demand, but rather to a system that has successfully met two recent challenges, avoiding major difficulties by a change in climatic conditions. Although no community or major user went without water in the droughts of 1976 or the late 1980s, a marked lack of overall planning for water shortages still exists in spite of repeated calls for the preparation of such plans. Institutional problems exist in the area of drought preparedness, leadership, contamination preparedness, problem definition during an emergency and data collection and monitoring.

Drought Response and Regional Leadership

Numerous laws and rules exist to affect good water supply planning in the region, yet no agency is in charge of assuring that the programs are implemented in a future-looking manner. Our approach to water can still be characterized as reactive to problems as they arise, rather than as proactive in anticipation of problems before they occur. Even though we have numerous laws and rules, the resources necessary to implement them have generally not been allocated by the state or by the water users and suppliers. That is, new regulatory authorities would not be needed if suppliers and users chose to be prepared for a water shortage and if the regulatory agencies had sufficient staff to aggressively pursue conservation planning. A very clear need exists to formalize a unified regional approach to water supply planning in which water users and suppliers decide ahead of time how they will react to diminishing supplies.

The problems of regional drought response become further complicated when competing uses for limited water arise. Perhaps the largest problem to arise in 1988, and the most unnecessary, was the arguing between Metropolitan Area citizens and those from the Mississippi River headwaters area over whose water was in the Headwaters Lakes.

The root of this problem was that no plan existed for phasing down demand in the Metropolitan Area and for determining what conditions would lead to a request for the release of additional water from the Headwaters Lakes. Once the press got involved in the Mississippi River flow watch and began to cover the "us versus them" debate, state officials were subjected to a tremendous amount of pressure to do something--such as ask for the release of additional water from the Headwaters Lakes, even though the cities of Minneapolis and St. Paul felt such emergency releases were not warranted.

When the state, the Corps of Engineers, the Metropolitan Area water suppliers and up-stream users all have conflicting positions, the perception formed is of an apparent lack of leadership. Trying to establish the lines of responsibility as conditions unfolded further fed the appearance of discordance among the various governmental agencies and water users, even though all of the parties were participating in the Governor's Drought Task Force, which was convened by the DNR.

Legislation exists that should lay the framework for a coordinated statewide response to drought; however, the application of the legislation is limited and has not led to many results. Minn. Stat., Chapter 103G gives the DNR rather substantial authority to institute conservation efforts within the state as part of its water appropriation authorities. Minn. Stat., § 103G.101 authorizes the commissioner of the DNR to develop a water resources conservation program for the state, including conservation, allocation and development of waters for the best interests of the citizens. The DNR implements this charge through its rules and does not have a document that could be easily identified as the strategy for implementing "The State Conservation Program." This approach makes it difficult to identify the DNR's effort for other than those intimately aware of DNR activities. The preparation of a document spelling out exactly how the DNR is meeting its legislative charge would lend some much needed visibility to its efforts in conservation.

This is not to say, however, that the DNR's effort through the rules is not yielding positive results. DNR staff has begun to introduce conservation requirements into its appropriation permits. An examination of Part 6115 of the rules shows that the DNR has included a number of provisions aimed at achieving a more efficient use of the waters of the state. Part 6115.0770, for example, states:

> In order to maintain water conservation practices in the water appropriation and use regulatory program, it is necessary that existing and proposed appropriators and users of waters of the state employ the best available means and practices based on economic considerations for assuring wise use and development of the waters of the state in the most practical and feasible manner possible to promote the efficient use of waters.
>
> Based on the data submitted by applicants and permittees and current information on best available water conservation technology and practice, the commissioner, in cooperation with the owners of water supply systems, may analyze the water use practices

and procedures and may require a more efficient use of water to be employed by the permittee or applicant, subject to notice and opportunity for hearing.

This effort is accompanied in rules by a quite detailed list of data that the DNR can request from applicants in order to evaluate their proposed use of the water and attempts to conserve. Additional information can be requested of public water suppliers through Parts 6115.0670 and 6115.0690 of the rules.

Although a fair amount of authority is available to the DNR, it is limited by its application to "applicants" (new and amended permits) and by the amount of staff time available to manage the program. Because the staff in the Division of Waters that actually writes and follows up on appropriation permits is small, it has very little time to actually seek the submittal of detailed information on the individual uses and consumption of water and to analyze that data. The appropriation laws and accompanying conservation language are easily applied to applications for new use or for amendments to existing use. However, unless the DNR detects that a problem exists, it does not require a review of the appropriation permit or the insertion of conservation language.

The DNR has indicated that it has the authority to insert such language into any permit, but a routine program to methodically review existing permits is not in place. The best intentions are meaningless if the resources are not available to implement a program. Legislation is proposed later in this section to require the DNR to periodically reissue permits to existing water users and to include water conservation measures as part of its permit conditions. Additional staff resources to implement the programs suggested are essential if we are to move forward through the regulatory process.

The DNR has instituted a legislatively mandated graduated rate schedule for water use fees that bases the amount paid on the actual amount of water withdrawn, gradually increasing in per unit cost as volume increases. A flat-fee structure of 20 cents per 1,000 gallons was put into effect for most once-through heating and cooling systems using over 5 million gallons annually until the systems are eventually phased out by the year 2010 (Minn. Stat., § 103G.271, subd. 5 and 6).

This movement by the legislature to better reflect the actual value of water in the fee structure is very positive and will likely do more to save water than the passage of legislation without concomitant staff resources. The legislature supported this new law by also requiring that all appropriations have to be metered (Minn. Stat., § 103G.281, subd. 2), a law that should be amended to require metering of all municipal water customers in the Metropolitan Area.

The legislature gave the DNR some additional authority to request the preparation of contingency plans when application for surface water appropriation is made through Minn. Stat., § 103G.285. This legislation requires these surface water appropriators to prepare plans outlining where they will get an alternative supply of water if flow drops to the point where water cannot be obtained. Again, this provision is easily applied to new or amended permits, but becomes much more bureaucratically cumbersome for existing permits. In addition, the law has a large loophole that allows appropriators to avoid responsibility for contingency planning by signing a waiver stating that they will "withstand the results of not being able to appropriate water."

This potentially powerful piece of legislation should be expanded to obtain emergency contingency plans from all existing and new public water suppliers, whether supplied by groundwater or surface water. The law should also be amended by dropping the loophole clause and by requiring the supplier to consider not just alternative sources but also demand reduction. The law as written gets us no closer to being prepared for a water supply emergency and actually works against it by accepting complacency.

The Minnesota Department of Health (MDH) has a similar authority through the federal Safe Drinking Water Act (SDWA), under which the MDH has "primacy" or principal authority on behalf of the U.S. Environmental Protection Agency (EPA). A provision in the SDWA requires municipal water suppliers to adopt an emergency contingency plan. The MDH has not enforced this provision of the federal law and has assigned it a "low priority." Its staff was not aware of any municipal supplier who had in fact prepared one of these plans in accordance with the SDWA requirement.

The DNR was also authorized by the 1990 legislature to prepare a statewide drought plan, which must consider the water supply plans prepared by the Metropolitan Council (Minn. Stat., § 103G.293). This provision reinforces Minn. Stat., § 103G.271, subd. 2, which requires the commissioner to issue permits in conformance with state, regional and local water resource management plans. Similarly, the law requiring the Council to prepare the long-term water supply plan for the region (Minn. Stat., § 473.156) calls for the plan to be consistent with the state's drought plan. As with the state conservation program, however, the DNR does not have a document that could be identified as the state Drought Plan. Rather, it intends to use the "Drought Contingency Plan for 1989," which is the matrix that formed the basis for Table 3, taken from the Council's short-term water supply plan. The original DNR matrix was developed as part of the Governor's Drought Task Force deliberations in the summer of 1988.

We do not believe that merely adopting a matrix keyed to flow at Anoka and embellished with some explanation really meets the needs of the state for a statewide drought plan. The legislation requiring this DNR plan called for a "statewide framework" in order "to respond to drought-related emergencies."

The use of the DNR matrix certainly accomplishes a small portion of the legislative charge, that being response of surface water users for the Mississippi River, but it clearly does not provide a planning framework for statewide response to problems. It does not, for example, say anything about groundwater users or surface water users not listed in the matrix, or the institutional needs of implementing drought response so that the events of the last two droughts do not recur.

Development of an identifiable, readily available plan that spells out how the DNR intends to respond to droughts would help the state in its drought preparedness.

Table 3
DROUGHT RESPONSE PLAN

Participant	Median Monthly Flow*	72-Hour Flow at Anoka: 2,000 cfs	1,200 cfs	1,000 cfs	750 cfs
DNR - Division of Waters	Monitor flows including tributaries; notify affected parties in matrix that river flows have dropped below median for month	Intensify flow monitoring and commence low flow predictions; initiate awareness program among users; convene meeting of Drought Task Force** to develop strategy	Continue flow monitoring and predictions; begin intensive public information program; meet with Drought Task Force to implement strategy	Continue all activities with emphasis on prediction of flow and movement toward critical flow; explore need to limit appropriations	Continue all activities; evaluate the need for upstream supplements and other alternatives based on conditions and outlook
Minneapolis Water Works	Verify that flows have dropped below average for summer conditions	Continue normal use while alert to low-flow potential	Institute voluntary*** conservation program in order to reduce demand from river; begin coordination with St. Paul on river withdrawals	Institute sprinkling restrictions*** and reduce demand to 85 mgd	Institute mandatory*** conservation program and reduce demand to 75 mgd; work with Drought Task Force to define critical supply needs
St. Paul Water Utility	Verify that flows have dropped below average for summer conditions; in anticipation of low flows, begin to pump surplus river flow into reservoir system	Continue normal use while alert to low-flow potential	Institute voluntary*** conservation program in order to reduce demand from river; begin coordination with Minneapolis on river withdrawals	Institute sprinkling restrictions*** and reduce demand to 56 mgd; begin consideration of shift from river source to reservoir system and groundwater supplements as required to optimize use of river	Continue optimizing river versus supplemental source use; institute mandatory** conservation program and reduce demand to 45 mgd; work with Drought Task Force to define critical supply needs
Metropolitan Waste Control Commission (MWCC)	Maintain treatment levels to assure compliance with water quality standards; begin aeration protocol at flows <7,000 cfs	Maintain treatment levels to assure compliance with water quality standards; continue aeration protocol	Continue program from 2,000 cfs level	Continue program from 2,000 cfs level	Continue program from 2,000 cfs level

Table 3 (continued)
DROUGHT RESPONSE PLAN

Participant	Median Monthly Flow*	72-Hour Flow at Anoka: 2,000 cfs	1,200 cfs	1,000 cfs	750 cfs
Northern States Power (NSP)	Withdrawals as specified by permit conditions; begin public energy conservation program	Withdrawals as specified by permit conditions; continue public conservation program	Withdrawals as specified by permit conditions; as dictated by electrical demand: -interrupt oil customers -obtain power from most reliable and economic sources (includes purchases)	Withdrawals as specified by permit conditions; continue program from 1,200 cfs level; as dictated by electrical demand: -implement water savings programs inside plants -reduce water appropriation rates at Monticello	Withdrawals as specified by permit conditions; respond to energy demand b implementing voluntary and emergency measures to conserve energy and keep plants operating at as high a level as possible; continue activities from previous flow levels
Mississippi Headwaters Board	Verify that flows have dropped below average for summer conditions	Begin contacts with headwaters interests in anticipation of low flows; serve as information liason between upstream interests and Drought Task Force	Continue in liason position	Continue in liason position	Continue in liason position

* From USGS data (cfs); subject to annual revision:

January - 4080	July - 6173
February - 4069	August - 4416
March - 5624	September - 4666
April - 15560	October - 5137
May - 11990	November - 4971
June - 10770	December - 4419

** The Drought Task Force is an officially constitued DNR advisory committee comprised of representatives of DNR-Division of Waters, NSP, St. Paul Water Utility, Minneapolis Water Works, Metropolitan Council, Mississippi Headwaters Board, MWCC and MPCA. Coordination with the Corps of Engineers is also assumed.

*** Voluntary conservation would typically involve a request by the supplier for its customers to limit the discretionary use of water. Sprinkling restrictions could very from an odd-even system of use to a total ban. Mandatory conservation would likely include a ban on all outside and discretionary uses of water, including possible limits on industrial/commercial uses.

One of the more surprising findings of the Metropolitan Council's 1990 municipal water supply survey was the large number of systems that have no emergency plans or means of reducing demand in an emergency situation. Sixty-four of the 111 suppliers surveyed (the 112th utility started after the survey was conducted) indicated that they have no formal emergency contingency plan. The remaining suppliers have some sort of contingency plan, most of which merely involve the institution of a sprinkling ban on an as-needed basis. Very few municipalities have a well defined set of actions that they will pursue in response to predefined emergency conditions.

The reasons for the failure of most municipal suppliers to have emergency contingency plans or demand reduction plans are numerous. One of the primary reasons is that the suppliers rely on the revenue generated by water sales to pay the operating expenses and debt service for the utility. Obviously, the best time to sell water is during a shortage, when demand is highest, but this is also the time when the need is greatest to reduce use. This dichotomy could be overcome through the institution of seasonal or conservation water pricing, wherein the price of water, and thus the revenue generated, increases during periods of high demand. The result of this pricing system would be collection of the same amount of revenue as usual, even though water use would decline.

Some suppliers note that they do not initiate conservation because the citizens do not like it. The 1988 drought showed very clearly that the public is far ahead of government in its willingness to do its share to cut water use. The Minneapolis and St. Paul water reduction experience is ample proof that the public will gladly respond to a need if asked to do so and shown the reasons why the actions are needed. The series of public meetings held by the Metropolitan Council reinforced this view.

Another point raised by suppliers is that there has always been plenty of water, so there really is no proven need to conserve. The series of technical studies has shown that supply problems do in fact occur now and that the likelihood of these problems becoming more widespread and serious exists. Also, the manner in which we have historically responded to emergencies calls for better preparation by all parties. Changes in comprehensive planning legislation requiring conservation programs, with consideration of conservation pricing, will be proposed in the Program Implementation section of this plan.

As noted previously, Minn. Stat., § 103G.285, subd. 6 requiring contingency planning for water appropriation applicants obtaining their water from surface waters allows users to escape responsibility for preparing a contingency plan by simply signing a statement. This allows complacency and spawns the reactive response typical of the last droughts. Also, Minn. Stat., § 103G.285 does not apply to a significant number of the state's water users, those being groundwater users. The law should be changed to apply to all large users, whether they obtain water from surface or groundwater sources. Additionally, the law should be changed to eliminate the provision that allows users to opt out of their responsibility to prepare a contingency plan. Minimum content for user contingency plans essentially exists in the state rules (Parts 6115.0670 and 6115.0690).

A provision in Minn. Stat., § 103G.291 allows the governor to declare by executive order that a "critical water deficiency" exists. This provision of the law then calls for public water suppliers to "adopt and enforce water conservation restrictions within their jurisdictions" that "must limit lawn sprinkling, vehicle washing, golf course and park irrigation, and other nonessential uses, and have appropriate penalties for failure to

comply with the restrictions." Failure to respond to the governor's order is ground for modification of the user's permit.

This law, although never used, could provide the state a very strong means of immediately curtailing the use of nonessential water during a deficiency. Even during the drought of 1988, when surface water withdrawals were restricted on numerous Mississippi River tributaries, the governor did not declare a "water deficiency." Rather, reductions from large Twin Cities users, such as Minneapolis and St. Paul, were prompted by feelings of civic responsibility and by the urging of the DNR and the Governor's Drought Task Force. Substantial reductions occurred voluntarily without the use of Minn. Stat., § 103G.291, but Minneapolis and St. Paul each eventually imposed mandatory conservation measures to further reduce demand.

Again, the actions surrounding the demand reductions noted above were reactive and not according to any predetermined plan or course of action. The laws of Minnesota have provided a very strong tool to the governor, yet even severe drought did not lead to the use of the authority. Criteria for use of the deficiency declaration and the means through which it can be used should be part of the DNR statewide conservation program prepared under Minn. Stat., § 103G.101.

The short-term plan that was presented to the legislature in 1990 contains a matrix (see Table 3) of flow at Anoka versus response actions by the DNR (Division of Waters), Minneapolis Water Works, St. Paul Water Utility, the Metropolitan Waste Control Commission (MWCC), Northern States Power (NSP) and the Mississippi Headwaters Board. Although this matrix has no force of law, the parties listed agreed in principle with the Council that they would respond to a drought according to the matrix until such time as a long-term plan is adopted by the legislature, thus putting in place an institutional framework for dealing with surface water shortages.

This matrix was prepared from a base put together by DNR, and is similar in most respects to a Corps of Engineers matrix in its study of the Headwaters Lakes. The institutional framework established in this matrix should be formalized in the long-term plan to protect Mississippi River users in the event of extreme low flows. This matrix does not, however, address the problems of groundwater supply during a drought.

Institutional Need To Protect Water Quality

The Twin Cities water supply is not only threatened by drought but also by contamination. This point was dramatically shown when 1.7 million gallons of crude oil spilled from a Lakehead Pipeline Company pipe near Grand Rapids in March 1991. The movement of large quantities of this oil into the Prairie River and then to the Mississippi River could have created a serious contamination threat to the drinking water intakes of Minneapolis and St. Paul, as well as to the intakes of the city of St. Cloud and NSP. Fortunately, due to a tremendous amount of luck, chiefly from the weather, only 400,000 gallons of oil reached the Prairie River and only a small, undetermined volume actually reached the Mississippi River.

Further incentive to move towards a well-planned emergency response program for the region occurred on July 8, 1991, when 29 cars of a train derailed at Fountain City, Wisconsin, and spilled the contents of some of the cars and fuel from the train into the Mississippi River. Although downstream of the Metropolitan Area, this incident exemplified the vulnerability of surface water supplies.

Only eight days after this spill, a similar incident occurred in California, where the supply to millions of Californians was contaminated by a toxic agent (the herbicide metam sodium) apparently not hazardous unless mixed with water.

Water quality problems associated with water supply arise out of two situations: contamination and increased use of water upstream of wastewater discharges.

Contamination of a water supply can occur at any time. It has become markedly evident that those who rely on the surface water system in the region are most vulnerable to closure of intakes because of contamination. This fact has led to studies of alternative water supplies by both the city of Minneapolis and the Metropolitan Council.

The St. Paul Water Utility responded to the drought of 1976 by adding a groundwater source to its surface water system, thus furthering the backup capabilities provided by the Rice Creek and Vadnais chains of lakes. However, even this diversified system is vulnerable to contam-ination, since several surface inflows and diversions feed it. The previously mentioned oil spill in Grand Rapids shows exactly the scenario that could lead to closure of intakes on any water body.

Just because a water supplier does not rely on surface water does not assure that a good quality source will always be available. The large number of groundwater contamination sites in the Metropolitan Area is evidence of the widespread and often unknown nature of contamination events in the region (see also Working Paper No. 3).

Major municipal water contaminations have come from sources ranging from intentional disposal of waste down a multiaquifer well or into a highly permeable surficial sand to leakage from old dumps and newer "sanitary" landfills that were thought to be well sealed against seepage of leachate. Continued vigilance is needed by groundwater users whose supply might be jeopardized by unseen yet dangerous inputs.

Perhaps the biggest success story of the summer of 1988 was the maintenance of dissolved oxygen levels in the Mississippi River as it flowed past the MWCC's Metro Plant (Pig's Eye). Artificial aeration by the MWCC, at a cost of approximately $1,200 per day, resulted in river oxygen conditions actually improving as supersaturated effluent mixed with the river water. MWCC has instituted this approach as part of its routine response to extremely low river flows and plans to continue the effort as long as treatment plant design allows it to do so. Consideration of MWCC's continued ability to conduct this aeration should be a part of any permit issuance discussions among MWCC, the Metropolitan Council, the MPCA and the EPA.

The prevailing assumption seems to be that the institutional response to an emergency water quality condition is covered, but in fact few mechanisms are in place for identifying problems quickly and responding accordingly. Again, the recent oil spill in Grand Rapids provides a great study in how the system now operates. The spill of 1.7 million gallons of crude oil (400,000 gallons of which actually flowed into the Prairie River) was verified not by the pipeline company or any detection system it had in place, but rather by citizens in the area who smelled oil. Once the spill was detected, action to contain the oil and prevent it from traveling the few miles to the Mississippi River began with cooperation from the pipeline company, the local community, the MPCA and the DNR. The actual move to begin containment appeared to be relatively fast and well directed. It was, however,

predicated on someone other than the responsible party detecting the spill and notifying authorities.

In a rather timely report, the MPCA warned in December 1990 that the state is ill-prepared to deal with a spill of contaminants along the Mississippi River. The MPCA stated, "There is little doubt that a major river spill would pose a serious environmental threat, since at present industry's response to such a major incident would likely be slow, understaffed, and lacking in specialized equipment."

Even when combined with governmental resources, Minnesota would be unable to respond well to a large spill, due primarily to the "absence of statewide efforts at contingency planning and resource coordination." The report noted that threats are posed by refineries, chemical plants, product transfer facilities, rail and highway crossings and parallel lines, barges and pipelines.

A preliminary inventory of the Mississippi River corridor upstream of the Minneapolis and St. Paul water intakes shows that 35 roads, 8 rail lines and an oil pipeline cross the river, with the Lakehead pipeline also crossing just above the confluence of the Mississippi and Prairie Rivers. Additionally, there are nine locations where rail lines pass within one-quarter mile of the river, a particularly pertinent finding given the recent Fountain City train derailment into the river. There are also two large sanitary sewer crossings within the Metropolitan Area upstream of the intakes. This preliminary inventory does not include crossings and storage areas on tributary streams. A detailed inventory and flow analysis is being conducted as part of the cooperative Minnesota/Corps of Engineers Section 22 study, described below.

The MPCA goes on to report that laws requiring spill prevention and response for potential industrial or transportation sources are inadequate and do not usually address downstream environmental aspects. Emergency planning is limited in the law to "on-site or near-site" protection and is more oriented to public safety than to environmental protection. While this priority is certainly well placed, the environmental consequences of a major spill could be very significant and, in the case of drinking water intakes, could also relate directly to human health if not corrected.

The MPCA notes that adequate federal and state staff are not available to check plans even if they are prepared and that the state and its industries are "ill-prepared" to handle a medium-sized or major spill. Part of this ill-preparedness relates to the lack of adequate emergency response personnel and equipment.

Another apparent flaw in the existing response efforts is the lack of any kind of notification procedure for downstream users. Although the pipeline spill in Grand Rapids did not pose an immediate threat to the Minneapolis and St. Paul water utilities, an alert for them to be prepared for the movement of oil in their direction was never sounded. A spill at a closer location and of a more difficult to detect contaminant might lead to severe repercussions for the nearly one million people who rely on the Mississippi River for their water. Clearly, a better detection system and more detailed lines of communication are needed to alert downstream water suppliers to at least the potential for contaminant movement toward them.

In its report, the MPCA also presents 15 recommendations that should be pursued to improve spill prevention and cleanup. These recommendations include suggested changes and additions to state law to achieve such

things as preparation of spill prevention and cleanup plans, enhanced capabilities within the state to respond to emergencies, improved response communications, development of a river defense network to detect and respond to spills, an improved communication scheme to alert affected parties of a spill and enhanced follow-ups on spill remediation. The report includes excerpts from Governor Rudy Perpich's Executive Order 90-2, which assigns emergency responsibilities to state agencies. The 1991 Legislature passed a law (Chapter 305 of the session laws) addressing some of the problems noted by the MPCA. At this date, implementation of the 1991 law is just beginning, so judgments on its effectiveness cannot yet be made.

A joint effort to address many aspects of emergency readiness is underway by the Minnesota Environmental Quality Board (EQB), Minneapolis, the Metropolitan Council and the Corps of Engineers through the federal Section 22 (Water Resources Development Act of 1974, PL 93-251, as amended) water planning assistance program. The purpose of this study is to identify potential contaminant sources, such as river crossings and chemical/oil storage facilities, and to define the scenarios under which a spill at any of these locations would move toward water intakes. The effort will culminate in the preparation of a response plan that lays out in detail the actions that should occur when a spill is detected; one of the additional products of the study will be an analysis of instream pollution detection systems that would automatically signal the occurrence of any spilled pollutant. If properly funded, the study will be completed in 1993.

In addition to this preliminary fact-finding effort and state legislative action, the MPCA notes that the federal Oil Pollution Act of 1990 holds some promise of solving response problems related to transportation facilities. On an interstate basis, the Upper Mississippi River Basin Association has prepared an "Upper Mississippi River Spill Response Plan and Resource Manual" (1991) that details a five-state (including Minnesota), four-federal agency response plan for spills on the river. Unfortunately, this document does not extend upstream of the Twin Cities area, but the foundation it provides can certainly be built upon by any effort that results from the Section 22 study. We encourage the state to increase the geographic scope of this document above the current limit at the Interstate Highway 694 bridge.

Also of note is the Mississippi Headwaters Board Riverwatch Program, which uses educational institutions to collect water quality data on the Mississippi River upstream of the Metropolitan Area. Although not specifically geared to spill detection, this program would help to discover any large-scale problems on the river.

Finally, to incorporate these activities, we think it would make a great deal of sense to formalize an upper Mississippi River basin protection effort. Following completion of the Section 22 study and some experience with implementing the 1991 state law, it will be necessary to evaluate the technical and institutional aspects of river protection to see if the problems noted herein have been addressed. Part of the solution might be to establish some specific institutional response on a basin-wide basis and to begin some type of continual monitoring to detect accidental contamination of the river. Since this protection effort affects so many users in the state, the legislature should mandate and fund the study as soon as some of the remaining gaps can be evaluated.

Drought/Emergency Definition

Before any corrective actions can begin, a clear statement is needed that a drought or an emergency related to contamination exists. Minnesota has never had an official definition of drought, as evidenced in 1988 when a somewhat arbitrary Mississippi River flow of 1,000 cfs (646 mgd) at Anoka became the default definition that triggered action. This figure was arrived at by the Governor's Drought Task Force and served to define the flow at which the governor would request additional releases from the Headwaters Lakes. The 1,000 cfs level was thought to be sufficient to allow for the more than 20 days it takes released water to arrive at the Twin Cities before critical shortages occur.

Drought can be defined in numerous ways, from reduced soil moisture and precipitation levels to decreases in river flow and groundwater levels. From a water supply standpoint, the most appropriate measures to look at are flow in the river and lowered groundwater levels. Critical river flow on the Mississippi River was defined in the short-term water supply plan according to the matrix shown in Table 3.

A definition of drought for groundwater users is far more difficult because of the artesian conditions under which most suppliers withdraw water. Groundwater is slower to react to climatic conditions and might lag behind other indicators of dryness, such as precipitation or river flow. As such, the region could be very deeply into a drought before groundwater levels would reflect a shortage. For this reason, we are not suggesting that a separate definition of drought be developed for groundwater conditions, but rather that groundwater suppliers and users remain attuned to the climatic conditions and to the surficial indicators of drought and that they respond accordingly by using water wisely well in advance of detrimental system impact. Actions suggested later in this report might be triggered by some criteria related to the potential seriousness of drought to groundwater levels.

Emergency conditions for water quality develop much more quickly than drought. Critical conditions can occur immediately after a spill incident, leaving absolutely no time for a semantic definition. There is a tremendous need for a much better defined emergency response function designed to initiate immediate action once an incident is discovered, as noted previously. There also is a similar need to institute a detection system for spills of contaminating material into the Mississippi River.

Data Management and Monitoring

To keep abreast of the use and management of water within the region, it is essential to have a good database of information on water users, volumes used, and locations where the water is used. The information that the Metropolitan Council uses in its various evaluations of regional water use comes from the DNR (Division of Waters), the MDH or from surveys of the users. The DNR collects data as part of its responsibilities to issue water appropriation permits and receive reports from users on the amount of water they use. The MDH receives reports from public water suppliers on the basic design of their systems and periodically receives updates on water demand. The Council's data collection has been oriented around filling data gaps and verifying data obtained from the state.

We have found that major strides have been made by the DNR in its compilation of data. Data are now available from a computerized

system, but obtaining the data still relies upon the good graces of the DNR staff, who have to drop routine responsibilities to retrieve requested data. However, the staff have been most cooperative and have customized data retrievals for us on several occasions. The only problems encountered have been the length of time required to obtain the data (a function of workload and priorities) and the revisions that commonly follow based on auditing of the data. The MDH data have been equally as good, although they are accessible only from paper files and are often out-of-date in areas experiencing rapid growth.

In neither of the cases noted above is a routine Metropolitan Area subbase put together and analyzed, nor is a compilation of nonessential use required. The two agencies collecting the data are regulatory agencies not charged with planning for the use of water, but rather with regulating its use. Special studies have historically been the basis for compiling the regional water use data and evaluating it. Thus, examining the regional water use situation typically occurs as a snapshot, rather than as part of any long-term planning function--another argument for some agency being charged with responsibility for water planning in the region. The logical outcome of this responsibility would be routine periodic reports of how water is being used, the definition of potential problems before they occur, and assessment of the water resource available for use. This program would place the region in a position to attack our problems proactively.

Maintaining an up-to-date regional database of water use is a relatively simple yet crucial task. However, it becomes more complicated if we add the need to document water availability. To properly document availability, we must do a more effective job of collecting and assimilating data on the occurrence of water in the region. This task is not particularly difficult for surface inflows, but it does become potentially very complex when groundwater needs are considered. Although state, county and local resource managers are continually upgrading the amount and quality of groundwater data available, there usually is a shortage of data in most parts of the region for most of the groundwater system. Even though the DNR maintains an observation well network in the region, the limited number of wells--both laterally and vertically--leaves major gaps in our coverage of the groundwater system.

Making sense of the available data is another need that arises when dealing with groundwater. The best way to approach the extreme complexity of the groundwater system is through a model. The USGS released a groundwater model that it developed for the region in cooperation with the Metropolitan Council, the DNR and the Minnesota Geological Survey (MGS). Unfortunately, operation of this model is so complex and requires so much computer time that using it for day-to-day problem solving is not feasible. Additionally, the USGS has developed newer models than the one just recently finished for the region. Clearly, other functions of a regional water planning agency should include the development and continuing operation of a regional water database and the preparation, or cooperation in the preparation of, regional water models. A user-friendly groundwater model will be a key tool in determining the capacity of the groundwater system and the potential for problems arising out of use proposals.

The reporting of data on nonessential water use should be required by the state so that we know the portion of demand that goes to such uses. This would fill in a serious gap in our knowledge of water use and would be necessary information for the state in its application of the water use priority system in the event of an emergency shortage. Both DNR and MDH permit reporting requirements should be amended to obtain nonessential use data.

4. SOURCE ALTERNATIVES

A number of possible solutions address the needs thus far identified in this water plan. The following sections describe these options and recommend which options appear most able to meet the need.

CONSERVATION

Water conservation is the least expensive source of additional water because we merely use what we have more efficiently and for more essential uses. Any effort to obtain water from other than currently used sources will require the initiation of conservation planning so that we use water wisely and not waste it on nonessential uses. To begin movement toward this conservation ethic, we clearly need a regionally coordinated effort.

The technical series report on alternatives (Working Paper No. 1) concluded that prior to the use of any alternative source of water from within or outside of the region, a "wise use" or conservation plan must be put in place. In the Council's survey, municipal water suppliers were asked if they had conservation plans in effect and, if so, what the nature of those plans was. Responses were wide-ranging, which was expected, given the different definitions used by suppliers and the way in which the respondents interpreted the questions. Twenty-three of the 111 suppliers (now 112 with the addition of the Lakeland system) responded that they have no program for conservation. Of the remaining positive responses, 70 (the totals are not additive because some cities use more than one approach) relied upon sprinkling restrictions on an as-needed basis. Twenty-three cities use some kind of public education effort; 19 use leak detection and repair to cut treated water losses; and 15 claim to use pricing, although an examination of their pricing schemes does not support most of the claims. Less than 10 each responded that they use recycling, pressure reduction, plumbing codes, low water landscaping (no details offered) and some program with no details given. Sixty-four of the 111 suppliers indicated that they have no formal emergency contingency plans, meaning that many of the suppliers' conservation efforts independent of any formal program.

We recommend that a "uniform baseline" set of conservation practices be adopted by every community in the region. This approach will result in a regional program in which every community does its part to conserve water. With this approach, there would not be communities that choose to ignore good resource planning and forgo conservation efforts. The elements of the program should be mandated by the legislature through the local comprehensive planning program and should apply as a minimum level of effort for every community in the Metropolitan Area. We are not recommending that the Metropolitan Council dictate the specifics of how a community chooses to implement conservation; rather, we are recommending that some minimum level of effort be established upon which communities can build their own programs. Implementation of this approach will be discussed in the Program Implementation section.

The baseline conservation requirements should begin with a supply reduction program that would address at a minimum metering, leak detection and repair, and source protection. Customer water metering is essential so that customers know the volume of water they use and the municipality knows the amount of water that it loses in its system. Currently, five

municipalities in the region do not meter their water. Previously in this plan, we recommended legislative amendment of Minn. Stat., § 103G.281 to require metering of all municipal utility customers. The metering element of the program should include not only the installation of meters but also routine reading of meters to recognize problems as they develop and to keep the utility and the consumer aware of water use practices within the service area. Leak detection and repair will reduce the loss of treated water on its way to the user and could save substantial volumes of water, particularly for older systems. Finally, a source protection element would describe how the community proposes to protect its supply source from contamination. For groundwater users, a wellhead protection program, as will be mandated by the MDH shortly, will be an essential element of the baseline program.

The second major section of a baseline conservation program would be a demand reduction component. This part of the program would discuss how the community will reduce its user demand during a shortage. The elements of this component should include initiation of a program to identify and reduce nonessential uses, such as lawn sprinkling, low-priority commercial/industrial uses and car washing; an examination of conservation or seasonal pricing; and an evaluation of the local plumbing code to assure the use of water-efficient plumbing fixtures. Additional efforts could include the distribution of water-saving kits throughout the community.

The final baseline element that should be required of every community is an education program to advise the public of the need for water conservation and the role that it can play. Simple educational material could be handed out with the water bill or in separate mailings by each community.

Although the DNR has the authority and has begun to incorporate conservation language into water appropriation permits, conservation initiatives are essentially left to the user to implement. The DNR is one of many sources of information on water conservation, but there is no focal point for information on conservation programs and no agency that is a clear leader in efforts to get conservation going throughout this region. Undertaking conservation on a wide scale would require that some agency devote a good deal of time to the collection and dispersal of information on conservation techniques and that some mandate occurs within the region to take conservation seriously. This approach is now particularly critical since linkage to any supplemental sources will depend upon first reducing demand within the region.

The matrix prepared for the short-term water supply plan in 1990 asks the cities of Minneapolis and St. Paul and NSP to conserve water, but no requirement currently exists for them to honor the matrix if they disagree on its use (see Table 3). Perhaps more difficult to address is the lack of an organized program for instituting use reduction plans for existing municipal users of the groundwater system or for nonmunicipal water users. However, the approach recommended later through local comprehensive planning amendments and periodic review of appropriation permits by the DNR should address this deficiency.

Perhaps the biggest factor preventing large-scale implementation of conservation by municipal water suppliers is the dependence upon the communities for the revenue generated from the sale of water. Although facts on this topic are difficult to collect, staff at both the DNR and the MDH claim that water conservation efforts will be extremely difficult to undertake because municipal water suppliers will be unwilling to reduce the sale of water during water shortages when their sales

are highest. Only those communities with real source or storage problems will be willing to entertain conservation programs. This fact further argues for the institution of a region-wide, baseline conservation program, with some components (for example, leak detection, public education, routine meter reading) begun immediately and others (sprinkling restrictions, conservation pricing) implemented when a need arises. This approach would also address the problem of equity raised by communities complaining that they try hard to conserve water while their neighboring communities continue to allow unlimited use of water.

The best way to address the loss of revenue from conservation could be through the use of a "revenue neutral" conservation pricing scheme in which per-unit costs increase during a declared water shortage or a seasonal scheme in which prices rise in the peak-use summer season.

IMPROVED GROUNDWATER WITHDRAWAL

Another alternative that is completely within our own means to implement, yet will be difficult to implement, is more efficient use of the regional groundwater system. We learned in the recent drought that the groundwater system is not infinite and that we must use it more efficiently if we want to keep using it in the long-term. The question again, however, is who is in charge of making sure we move toward more efficient use? The answer to this question is a little clearer than the conservation question because we have a state agency--the DNR--that has clearly been charged with the regulatory authority to make sure groundwater is used appropriately. The problem is that the DNR is often in a reactive position, responding to applications for water appropriation after wells have been drilled, and is often not able to easily introduce new conservation measures into existing permits that are not subject to renewal.

The typical sequence of events for the development of a large municipal well starts with a desire by a municipality to serve an area of population or industrial/commercial growth. The community designs a well and distribution lines close to the area in order to minimize costs. The well is drilled, with permission from the MDH, and once its capacity is determined through pumping tests, a permit for appropriation of water is applied for from the DNR, which now sees a request for water after a tremendous expenditure from the municipality. Any permit constraints by the DNR would likely cause a hardship for the community.

A similar sequence exists for industrial/ commercial wells, generally without the need for MDH approval, however. The sequence for well approval is clearly not oriented toward promotion of a well-planned groundwater withdrawal system. Instead, we have a riparian use approach under which each user/supplier identifies a water source, drills a well and then seeks a permit to use water. Legislation on the sequence of well drilling and water appropriation could be the key to assuring that the DNR reviews well proposals and the appropriateness of them before the expense of well installation is incurred.

A requirement for approved DNR contingency plans under a revised Minn. Stat., § 103G.285 prior to well installation would help eliminate boxing the DNR into a corner when an appropriation permit is submitted after a well is drilled. This requirement could also be placed on other MDH functions relative to municipal suppliers, such as watermain extensions, treatment system development and well-house repair.

Other options include a preliminary checkoff by the DNR prior to review by the MDH for municipal systems and a similar review prior to drilling by any industrial or commercial user. Possibly the state permitting functions relating to well placement and appropriation of groundwater could be placed in a single water agency, rather than split as they are now.

Another option could involve a regional water planning agency that works with the DNR to prepare a system plan and provide technical assistance information for groundwater users in an effort to direct the use of groundwater more efficiently. This type of approach could help to guide regional growth toward portions of the seven counties where water sources are better able to support growth. This would address one of the supply problems that threatens to become among the most serious we will face in the coming years.

An approach that focuses on regional water planning places emphasis on the regional benefits that derive from good supply planning and could thus spread the costs of providing this assistance across the region.

If we hope to improve our efficiency in using the groundwater system, we must have a better model of the system. The only model of the region currently available is the USGS model, which is difficult to use, data intensive, and obsolete. New generations of models are available that are much easier to use; unfortunately, such models are not in place and being used on a large scale in the region.

One of the primary functions in regional water planning should be to develop a groundwater model and use it to assist water managers in answering questions on the resource, its use and the impact of that use. It would make sense to model the rapidly growing portions of the region first, gradually building the model to a regional scale.

RESERVOIRS

The report on alternatives (Working Paper No. 1) identifies several possibilities for the development of water supply reservoirs (Table 4). Options that serve primarily the needs of Minneapolis and the suburbs it serves are identified in the alternatives of the Rice Creek and Minneapolis chains of lakes and artificial reservoirs constructed to hold water. Minneapolis could act, on behalf of the city and the suburbs it serves, to pursue any of these options, thus avoiding any prolonged debate over how best to obtain an immediate alternative source. However, it can be easily argued that any emergency shortage that Minneapolis faced would indeed be a regional emergency affecting the economic and social health of the entire region. In that case, perhaps the solution should involve some regional assistance.

As pointed out by the Metropolitan Council many times in the course of looking at the regional water situation, any severe shortage of water experienced by Minneapolis and its suburbs would dramatically affect a large segment of the Metropolitan Area population that lives in, does business within or is in any fashion associated with Minneapolis. This is not to say that Minneapolis' solution should be fully regionally funded; rather, the region should assist individual cities in arriving at solutions that benefit the entire region.

Other reservoir possibilities identified in the alternatives report are shown in Table 4. The feasibility of using the Headwaters Lakes for emergency supply is quite limited in practical application because of the varied interests who might view the reservoir water as "theirs." The release of Headwaters Lake water under extreme emergency conditions has, however, been assured by the Corps, after certain conservation actions occur in the Metropolitan Area (U.S. Army Corps of Engineers, 1990).

Table 4
SUMMARY OF PREFERRED ALTERNATIVES*

ALTERNATIVE	ADVANTAGES	DISADVANTAGES	COST (IN 1990 $)
Additional Mississippi River Headwaters Lakes releases	Directly tributary to Mississippi River; large volume usually in storage	Use conflicts and priorities; travel time; susceptibility to drought	No additional direct costs but some impact costs to regional interests in headwaters area
Rice Creek chain of lakes (13 lakes)	Tributary stream to Mississippi River; could supply both St. Paul and Minneapolis systems if river is contaminated	Limited volume; environmental and social impact; competing uses (recreation); aqueduct needed at mouth of stream	$5.5 million estimate with pipeline from mouth to plant in Fridley
Abandoned mining pits (3) on Mesabi Range	Combined available volume over 95,000 acre-feet; use of existing supply	Rights to water; travel time; cost of installation, transport, annual operations and maintenance	Range of costs from $3.4 million to $58 million, depending on volume needed and source(s) chosen
3-day off-line storage for Minneapolis Water Works			
a) structure	Improves upon current 24- hour emergency storage; immediately available; under city's control	Economic impact	$75 million plus land acquisition (if needed)
b) Minneapolis chain of lakes	New facility not needed and pumping system in place from river to lakes if volume needed	Economic and social impact	$20 million
Interconnect Minneapolis and St. Paul systems	Shared water during an emergency; use existing systems	Incompatible systems and high cost	Unknown; would include major hydraulic adaptations
Improved groundwater withdrawals	Use existing system more efficiently	History of unilateral decision-making; all factors of system not known	Unknown; mostly involve creation of institutional solution
Optimization of surface and groundwater use through Regional planning	Regional self-reliance; optimization of available resource; least economic and environmental costs	Creation of new institutional structure	Unknown; detailed studies of management and design of system needed before cost can be determined

* See Working Paper No. 1 for a full discussion of these alternatives and those not on preferred list.

The benefits of any releases beyond the routine low flows from the Headwaters Lakes would be felt by the entire region, because the water would be put to use satisfying water supply, wastewater assimilation, power plant cooling, and navigational needs. Benefits will also accrue for the natural river system downstream from any release.

The institutional aspects that would lead to increased release are in place in the short-term water plan and the Corps of Engineers' routine low flow operation scheme. Under the short-term plan, a flow of 750 cfs (485 mgd) at Anoka would trigger consideration for requesting additional flow releases by the DNR, acting as the agent for the state. As flow drops further towards a critical flow of 554 cfs (385 mgd) at Anoka, the Corps will evaluate the situation and determine the need for additional releases, considering at the same time its federally mandated priorities for water from the Headwaters Lakes.

Although the two flow scenarios do not exactly match, they really do say the same thing: that is, as flow appears to be heading towards extremely low levels, the Corps and the DNR will evaluate the need to respond with additional releases from the Headwaters Lakes and act accordingly.

In a December 1991 letter responding to a Metropolitan Council staff request, the Corps of Engineers reviewed its criteria for emergency releases from the Headwaters Lakes. The Corps determined that emergency releases for downstream water supply and water quality relief are legitimately eligible as "public welfare" benefits under the federal authorities defining Corps operating procedures, within certain criteria defining necessity and likelihood for alleviating the problem. The current authority was adopted in a series of actions stretching from the latter part of the last century through the 1940s.

Although the need to assure flow from the headwaters for navigation was reduced substantially in the 1930s with the installation of the lock and dam system, there continues to be a need to maintain a flow of approximately 350 cfs (226 mgd) through the Metropolitan Area for navigation purposes. The second Corps priority under federal law is the protection of Native American treaty rights, followed by the third priority of local public welfare. Acknowledging downstream water supply and water quality should not detract from the original priorities; rather, it formally recognizes that the priority system should reflect the changes in demographics and the state's heavy reliance on the river.

Another option for flow releases from upstream of the Metropolitan Area is the use of abandoned Mesabi Iron Range pits. Several pits that are no longer used for active mining hold very large volumes of extremely clean water. Although some potential exists for use of these water bodies for recreation, the pits pose serious safety concerns for large-scale public use. In short, the pits remain a resource that is not being used to its full potential, assuming that use of the water for potable reasons in the Metropolitan Area is a higher priority than occasional, small-scale recreational use.

The use of these pits will, however, present an institutional challenge because there is no institution in place to pursue their acquisition for supplementing Mississippi River flow. Also, any release of water to the river at present could not be assured to flow in its entirety all of the way to the downstream users. Direct beneficiaries of any pit release would include Minneapolis, St. Paul, the suburbs they each supply, NSP, St. Cloud, the MWCC and several smaller communities along the river.

Of course, any of these entities could take it upon itself or in a consortium to negotiate the means necessary to preserve the pits for river flow augmentation and construct the necessary conveyance system to move the water to the river. Means assuring that the volume of water released would reach the participating parties downstream would have to be explored. The potential costs involved and the number of other beneficiaries work against a single party taking a lead, but a consortium of users could put together a combined effort to accomplish a common goal. An agency such as the Metropolitan Council could act on behalf of the region and attempt to negotiate an agreement, but a legislative amendment extending its authority would be required since the Council is limited in its capability to expend any "regional" money on facilities of this sort located outside of its legally defined jurisdiction and in its ability to acquire any property. The Council could also be asked to issue bonds for a regional water authority that would function in a manner similar to any of the regional commissions (such as the MWCC).

If such a regional commission were created by the legislature, the Council could then provide a funding mechanism to accomplish regional goals through the acquisition of upstream facilities. Other options include state operation of the diversion system and privatization.

OPTIMIZATION AND INTERCONNECTION

The greatest benefit of a regional approach to water supply planning is the development of a framework under which optimum use of available resources can be made through continued evaluation of the occurrence and use of both surface water and groundwater in the region. Other benefits include the development of drought and emergency contingency plans, potential development of a regional financing mechanism to develop an optimum use system and alternative sources of supply and positive movement toward assuring the orderly development of the region through the provision of a supply system that can meet its growth needs. The negative aspects include additional responsibilities for some agency in a time when resources are limited, an additional element of planning that communities must incorporate into their planning framework, and possible infrastructure changes in the long-term to distribute water to those who might need it. Costs associated with the regional benefit derived from any project could be off set by a regional water fund (discussed later).

Optimization of water use through regional management is the process of obtaining the best possible mix of water sources and providing water to users in the best, most efficient possible manner. It has been shown that much regulatory authority exists for water use, but little is done to plan for the long-term use and management of water supplies for the region.

The alternatives report presents arguments for and against the establishment of municipal supply interconnections and concludes that interconnecting parts of the supply system make a great deal of sense, particularly those parts of the system that might experience shortages as rapid growth occurs. The report also introduces the concept of optimizing surface water use while adequate flows are available and reserving groundwater until needed to supplement surface water.

The current method of operation within the municipal system would mean that each individual supplier would have to negotiate separately with its neighboring community(ies) to interconnect in some fashion under some

predetermined set of circumstances to obtain a backup source of water. This approach fosters the attitude that each supplier must act alone and works against the notion that we should be moving toward a planned regional system if we hope to avoid problems associated with growth and drought.

To proceed with regional optimization, a regional water planning agency would need to quantify the resource available and the degree to which it is used and then coordinate its use so as to minimize adverse impacts. This approach could mean that major new infrastructure development would be needed to connect users with sources and with other users willing to cooperate in joint supply systems. A major venture of this sort could be explored in a regional water planning effort. In concept, the figures on available water and on future use support subregional distribution systems, but an institutional framework must be in place first to evaluate the practical feasibility of such a system and to develop the concept and direct the effort. Time and effort will be needed to convince users who have generally acted alone.

The complexity that would be involved in most efforts to distribute water within the region and/or to share water among adjacent communities must be acknowledged. The pattern of water supply development in the region has led to over 100 independently operated systems, each with its own infrastructure designed to fit its own needs. Changing to incorporate a new distribution concept would mean in many cases that the infrastructure pattern would need radical adjustment at substantial cost. Also, the water treatment practices of communities are likely to be different, as are the differences in treating surface water and groundwater--a major consideration if Mississippi River water were to be distributed to areas currently using groundwater.

The distribution of treated water could overcome some of the treatment concerns, but the very real issue of "local tastes" might be raised by those citizens who prefer drinking groundwater to surface water. It is for all of these reasons that any proposal for redistributing water within the region must be carefully scrutinized, as we would propose to do under the legislative proposal for system study.

WATER REUSE AND RECLAMATION

Another potential source of water that has not been used in the region is reclaimed wastewater that has been treated to adequate levels and pump-out water from groundwater remediation projects. Each day, roughly 288 million gallons of treated effluent is discharged to the region's surface water system. While this water is not currently treated to potable standards, it could be used for nonpotable uses, such as agricultural and golf course irrigation, industrial noncontact cooling, irrigation of parks and public properties and aquifer recharge.

In the southwest portion of the United States, reclamation has become a very attractive cost-effective means of supplying water to meet ever-increasing demands. At an estimated cost of $500-to-800 per acre-foot of water, reclamation can compete with other more expensive source alternatives, such as new reservoirs. Even in the Metropolitan Area, this cost is competitive with many of the alternatives previously identified. As an example, the estimated costs of obtaining water from abandoned Mesabi Iron Range pits ranges from $100-to-400 per acre-foot, not including the engineering or site development costs or the initial costs of acquiring the pits. As an added benefit, reclamation provides the least source impact when compared with other

source alternatives. Because water is continually being reused, the need for "new" water withdrawals is minimized.

While we certainly are not experiencing the immediate water problems plaguing the Southwest, reclamation as a long-term alternative supply still makes sense for the Metropolitan Area. In addition to the fact that withdrawals are reduced, the reclamation treatment process typically provides water that is of better quality than conventionally treated wastewater and can replace potable water for nonpotable water uses. As wastewater treatment levels increase in response to more stringent effluent limits, reclamation will become even more attractive.

Instituting a wastewater reclamation program throughout the Metropolitan Area at this time would require far-reaching infrastructure changes. In its most efficient application, it would entail a decentralization of the wastewater collection system in the outer-ring suburbs and the construction of several small-scale reclamation centers where wastewater could be treated and then distributed to the nearby area. However, there is no reason why existing smaller wastewater treatment facilities such as Hastings, Cottage Grove, Blue Lake, and Seneca, and the non-MWCC operated rural treatment plants, could not be used now, while longer-term options are considered for the developing portion of the region.

Clearly any activity dealing with wastewater collection and treatment would have to be done in cooperation with the MWCC, as it is charged with the construction, operation, and maintenance of regional wastewater facilities in the Metropolitan Area. The MWCC is currently examining issues related to the centralization and decentralization of the regional sewer system; it should be charged by the Metropolitan Council with further studying the feasibility of reclamation in existing and future facilities. Funding of reclamation efforts could be generated through wastewater fees and user fees for the reclaimed water.

Reuse of groundwater that has been pumped and treated to an adequate level is another possibility. Numerous remediation projects across the region could be a source of nonpotable or supplemental potable water, provided it is treated sufficiently well, to neighboring communities.

The legislature should mandate an MPCA evaluation of the potential for treated water reuse for every discharge permit from wastewater treatment plants and groundwater remediation projects.

5. PROGRAM IMPLEMENTATION

The bottom line in evaluating the institutional aspects of water supply in the region is to see if we can readily apply the lessons learned from such things as drought and contamination events and not repeat our mistakes. It is imperative for us to address the problems identified during the drought.

Many water users and suppliers have taken it upon themselves to correct their own problems, and this is certainly in accord with their responsibilities to obtain and provide water. However, the most apparent regional institutional problem is that we have well over 100 municipal suppliers, over 400 commercial/ industrial/institutional users, and over 800 agricultural and miscellaneous users who are all pursuing their own sources of water and developing their systems without consideration of the overall regional availability of water. Each individual user looks at its own need and responds accordingly.

Riparian water law allows individual users the right to reasonable use of their water resources, so dictating where water must be withdrawn is not possible unless it can be shown that a conflict will result if a user proceeds with well development in a particular location or aquifer. The state has regulated the appropriation of water so that users do not conflict with each other, but regulation is not analogous to planning. If we are serious about avoiding problems in the future, a forward-looking approach is needed that guides users to the best source available, as opposed to responding to the likely presence of a problem.

INSTITUTIONAL OPTIONS

Several options exist for putting together an institutional framework for regional water planning. A detailed presentation of options is contained in Working Paper No. 8 on the institutional framework for water supply management. Following is a brief synopsis of that examination.

The easiest framework to pursue would be for the state regulatory agencies to add a more defined planning function to their current workloads. The positive aspects of this option include the familiarity of the staff with the issues, the authoritarian role that the agencies play in the eyes of most users and the maintenance of "institutional status quo" in a time of limited state funds. The authority to address many of the problems that have been identified with water supply and demand exists if the state chooses to pursue them aggressively. However, resources devoted to the state's programs have not managed to keep up with the workload, with the result being very limited staff available to address a mix of regulatory and planning functions. Integrating the regulatory functions of the state into a regional water supply effort, however, is essential to successful implementation.

It becomes far more difficult in these times of severe limitations on governmental programs to propose new programs that would require some additional expenditure. Nonetheless, some such options must be considered. Adding a major water planning function to a nonregulatory state agency is one such possibility. Both the EQB and the Board of Water and Soil Resources (BWSR) have legislative mandates to coordinate water activities in some manner, but the EQB's orientation is toward state agency coordination, while the BWSR's is more

towards local soil and water management. Neither of these agencies, however, has worked in detail with water supply issues pertaining to the Metropolitan Area, although the EQB has certainly addressed them in the context of overall state issues and the BWSR has become quite active in regional watershed issues.

Historically, planning for any aspects of growth or resource need in the Metropolitan Area has been done by the Metropolitan Council, with implementation of the plans carried out by one of the regional commissions or by local or special units of government.

Since its creation by the 1967 legislature, the Council has undertaken several studies to address water supply topics. We have adopted water supply policies in our Metropolitan Development Guide, but until the passage of Minn. Stat., § 473.156, it had not been in the Council's purview to prepare a regional plan for the use of water. The Council is authorized in various parts of Minn.Stat., Chapter 473 to plan for the "orderly and economic" development of the region and to implement these plans through the operation of "regional systems" for sewer, transportation, airports and parks and much less authoritatively for other aspects related to growth, including water.

Addition of water as a fifth regional "system" would accord it a far more important status, with implementation likely occurring through the existing supply framework and the local comprehensive planning process. The Metropolitan Council is required under Minn. Stat., § 473.156 to periodically update the regional water supply plan currently being developed. In accordance with this charge, the Council will examine the water supply system as often as needed to make the users and the legislature aware of the state of the resource. This periodic review authority could be enhanced with amended legislation to an ongoing system planning function under which the Council could actively implement many of the suggested actions contained in this institutional evaluation.

Another regional approach could be realized through a newly created regional water commission or addition of some water supply responsibilities to the MWCC. Creation of such a commission would require new legislation and some thought to the kind of functions that the commission would perform. Establishment of a regional water commission should be a long-term consideration that would be addressed only after a specific need is determined in accord with a broader regional water supply planning effort.

Metropolitan Area counties were given an opportunity to develop groundwater supply plans in a 1987 amendment (Minn. Stat., § 473.8785) to the Metropolitan Surface Water Management Act of 1982. This amendment provides for voluntary preparation of county groundwater plans.

At this time, six counties have begun the preparation of groundwater plans, while Anoka County has decided to study the need for a plan, in light of several groundwater studies already completed in the county, before it commits to plan preparation.

The potential effectiveness of these plans in the furtherance of water supply planning and protection is unknown at this time, since none of the plans has been submitted to the Council for review under Minn. Stat., § 473.8785, subd. 8. These plans will certainly address the condition of the groundwater resource in each of the six counties having a plan, and any effort to look comprehensively at groundwater should make full use of the material contained in the county plans.

The regional water supply planning framework should also include some means for the counties to review the plans of municipal and self-supplied users to make sure they are consistent with the county plan. Sole reliance on the county plans to address the basic water supply issues raised for the region, however, is not recommended at this time because the plan content guidelines in the law do not specifically charge the counties with addressing water supply issues or with looking beyond the limits of each individual county. Additionally, the plans are not charged with addressing the surface water aspects of water supply in counties within which surface water provides a source of supply. To effectively use this level of planning, some historic differences and planning limitations between cities and the counties in which they lay would also have to be overcome. As with some of the other institutions evaluated, there is not much of a history of counties participating in water supply issues, but a regional effort could present an opportunity to develop that participation.

A comment was offered in the public meetings that the Council's plan diminishes the water planning and management functions legislatively mandated to local government and watershed management organizations (WMOs). The plan attempts to be responsive to the legislative charge and address water supply planning on a regional basis. It does not minimize the efforts of local government, and in fact, recommends incorporating water supply planning into the local comprehensive planning process, thus recognizing that local efforts are vital to a successful regional water supply plan.

WMOs were not suggested as a lead agency for several reasons: first, the legislation authorizing the watershed planning process does not charge the WMOs with preparation of water supply plans, focusing rather on surface water issues; secondly, WMOs are not established on a community level, where water supply issues are historically dealt with; finally, after 10 years, only 39 of 46 plans are completed, with many of these only recently prepared and most not addressing water supply (consistent with their charge in the law).

Continuation of the current water supply situation is certainly an option, given the fact that we have not experienced major supply problems even during the extended drought of the late 1980s. Following this course, however, would mean that we continue to react to problems--a situation the legislature hoped to avoid starting with its charge to the Metropolitan Council to prepare a long-term water supply plan. The material presented previously in this report suggests that a larger-scale plan should indeed be done for the region. However, implementation of the plan could occur in any number of different ways, including through local water suppliers or commercial/industrial/agricultural users as part of their permit requirements.

Another option that would keep the local suppliers as direct implementors of any plan would be joint powers agreements or less formal arrangements under which various groups of suppliers could cooperatively develop a water supply system. Addressing these joint efforts could be done as part of local comprehensive plan development under Minn. Stat., Chapter 473.

RECOMMENDED APPROACH FOR REGIONAL WATER SUPPLY PLANNING

After reviewing the options for fulfilling the responsibilities assigned to the Council by the legislature, it seems prudent to address regional water supply problems through adding

a water supply component to the public facilities section of the local comprehensive planning process contained in the governing statute.

Minn. Stat., § 473.851-.872 (Metropolitan Land Use Planning Act, MLUPA) lays out a framework for the preparation of development plans for every local unit of government within the Metropolitan Area. The legislation requires communities to adopt a plan that contains "objectives, policies, standards and programs to guide public and private land use, development, redevelopment and preservation for all lands and waters..." within the jurisdiction of the local unit of government (Minn. Stat., § 473.859, subd. 1). The plan must also "designate the existing and proposed location, intensity and extent of use of land and water for agricultural, residential, commercial, industrial and other public and private purposes..." (Minn. Stat., § 473.859, subd. 2).

Among the required elements of a local comprehensive plan is a public facilities plan that describes "the character, location, timing, sequence, function, use and capacity of existing and future public utilities" (Minn. Stat., § 473.859, subd. 3). To implement this plan, the local unit must adopt an implementation program describing "public programs, fiscal devices, and other specific actions to be undertaken...to implement the comprehensive plan."

The comprehensive planning approach outlined above lends itself quite well to the development of a regional water supply plan, with subsequent implementation by the local water suppliers. The MLUPA, however, is not explicit about water supply, although water is mentioned frequently throughout the law. In order to place direct emphasis on the water supply issue, the legislature will be asked to amend the law and make direct reference to water supply and the expectations that it has for the water supply effort.

Consideration was given by the Council to making water a "fifth metropolitan system" under the planning authority in Chapter 473. This action would have given the Council authority to prepare an overall regional water supply "system plan" within which water suppliers would operate. This approach would be the most direct means of immediately coordinating local comprehensive planning with water supply planning on a regional basis. However, the Council believes that a system approach is premature at this time and that the communities should have a chance to respond to the needs identified in this plan before other options are pursued.

Efforts directly related to the comprehensive planning process, as well as some indirectly related, also must be undertaken in order to properly address all of the needs for regional water supply. The Metropolitan Council has been authorized by the legislature to undertake these studies through its charge to continually update the water supply as the need arises (Minn. Stat., § 473.156). However, specific direction by the legislature on the items it expects to see the Council pursue would be extremely helpful in determining further program efforts by the Council.

Items that could be included in a direct legislative charge include the development of resource availability and demand projection models; preparation of water conservation guidelines and public education materials; formalization of Council authority to pursue alternative sources of water on behalf of the region--a charge that might require some activities outside of the region; evaluation of the need for a metropolitan water supply fund to finance planning and infrastructure needs; and continued evaluation of the region's water supply system and advocacy for proper use of that system.

Nonmunicipal users would not be subject to the comprehensive planning provisions, since they are not part of the planning process under Chapter 473. Industrial, commercial, agricultural and other miscellaneous users would perhaps better be covered within a regional approach through their DNR permits or through some sort of local or watershed water allocation (permitting) approach.

Under this scenario, the DNR would proceed to incorporate up-to-date information on conser-vation techniques and legislative desires into its routine permitting scheme. As noted before, however, the DNR would need additional staff resources to undertake this endeavor. This implies the addition of staff or the reorientation of work programs of existing staff. Local or watershed efforts would make a great deal of sense in light of the new wellhead protection initiatives likely to be implemented in the near future.

The framework for local planning contained in the MLUPA has been in place and working effectively for over a decade. This approach places the local units of government in direct control of their water supply systems and charges them with preparing a forward-looking plan that could be used to address both short- and long-term water supply issues. Communities are familiar with the process and recognize the responsibilities for coordinating with neighboring communities that is an integral part of the process.

The Metropolitan Council recommends that the language in the MLUPA be amended to require a water supply component in the public facilities section of the comprehensive plan (Minn. Stat., § 473.859, subd. 3). Water supply is not proposed as a fifth metropolitan system at this time, but progress toward achieving the objectives set out in this plan will be monitored, and a report re-evaluating the need to add water supply as a system will be prepared for the legislature after plan amendments, as outlined below, are reviewed. The required elements of the facilities plan would include:

a) A description of the existing water supply system, including source of water, well and treatment plant locations and supply lines; an inventory of commercial and industrial users; and an indication of the community's intent for future changes and/or additions to the system, including the projections for population and industrial and commercial use and the methods by which this growth will be served;

b) A statement of the community's objectives, policies and standards for operating the water supply system;

c) A conservation program that addresses at least emergency preparedness, demand and supply conservation techniques to be used (for example, sprinkling restrictions, leak detection and repair), pricing methods that could be used to reduce demand and conditions under which actions would occur; the program should include a process for cutting nonessential and commercial/industrial uses according to state priority system;

d) A public education program that indicates how each community will convey to its citizens the need to use water wisely;

e) An indication of the possibility for joint efforts with neighboring communities or other official entities for sharing water supply and treatment, interconnecting for routine or emergency supply, pursuing alternative supplies and protecting groundwater and surface water sources;

f) A statement of the water supply problems that the community experiences or expects to experience and any proposed solutions, especially those that would impact other communities or the region; and

g) For those communities served by groundwater, a wellhead protection plan, prepared in accord with the MDH requirements that are scheduled for implementation in 1993; this element could lead to cooperation among communities to establish "aquifer protection" programs to more efficiently implement protection of the groundwater resource.

Implementation of the water supply facility plan should follow Minn. Stat., § 473.859, subd. 4 and would typically include any ordinances and land use controls that the community intends to use to manage and protect its water supply system.

The Metropolitan Council's role in this process would follow the comprehensive planning framework detailed in Minn. Stat. Chapter 473. The Council would prepare guidelines and procedures for plan review (Minn. Stat., § 473.854) and then review the amended plans according to the procedures outlined in Minn. Stat., § 473.175 and 473.858, with the addition of review by the county if the county has an adopted groundwater plan under Minn. Stat., § 103B.255.

The time frame for incorporation of the water supply component into the local plan would be two years after the Council supplies the local units with guidelines for preparation of the plans. Three years after passage of legislation, the Council will report back to the legislature on the progress that has been achieved and reevaluate the need for additional measures. If the problems identified in this water supply study are not adequately addressed in the local plans and through the regulatory changes that follow in the next section, the Council will explore more effective options, including consideration of formally adopting water supply a metropolitan system under Chapter 473.

REGULATORY CHANGES

The Council also recommends that several changes be made to the state regulatory process for appropriating water. Foremost is the need for each permittee to examine their use of water and identify how they will institute their own conservation or wise-use program. Currently, such programs are not retroactively required of permit holders, although the DNR has begun to put conservation language into new and amended permits. A routine permit reissuance would allow the DNR to regularly review each permit and incorporate into it items it deems necessary for good water management.

This approach would allow for the introduction of conservation language into self-supplied user permits outside of the comprehensive planning amendments described above and make the appropriation process consistent with most state permits that require periodic review. We suggest a review period of five years until all permits are reviewed at least once, followed by an adjusted review period of as little as once every ten years, reflective of the permit specifics and the withdrawal activity in the area of the permit.

The amount of effort that would be required by the DNR to review these permits should not be underestimated, particularly in the first round when long-held permits would be reviewed for the first time since issuance. If the legislature agrees that bringing all

appropriation permits up to date is necessary, it should make the necessary personnel resources available to the DNR.

We want to emphasize, however, that this review is intended primarily as a mechanism to include conservation and contingency planning in older permits. It is not intended to be used as a tool to reduce permitted withdrawals.

Another recommended change to the DNR permit process is the elimination of the waiver that surface water permit holders can sign stating that they will bear the impact of not having an emergency plan if a severe shortage occurs. Perhaps the belief is that this provision addresses only the ability of a community to obtain a back-up supply, and groundwater users have no other alternative. Instead, the emphasis should be on a community's ability to reduce demand and take measures to secure emergency assistance, such as from the Corps of Engineers (through its emergency water assistance program) or the Regional Mutual Aid Association of about 45 water utilities.

The existing waiver provision does not contribute to the state of readiness that we would like to maintain for the region. If, as we have recommended above, the legislature institutes a conservation and emergency program requirement for all major permit holders, it should also eliminate this waiver provision and insist on adopting shortage preparedness.

To assure that municipal water appropriation permits are in conformance with the amended local comprehensive plan, the appropriation law should be amended to allow for Metropolitan Council review in a manner similar to the Chapter 473 review of comprehensive plans. That is, the DNR should submit all permit reviews on municipal appropriation permits, whether new or subject to the newly established periodic reissuance, to the Council for review and comment to the DNR on the conformity of the permit to the adopted water supply component of the local comprehensive plan.

Finally, the issuance of municipal well permits by the MDH and water appropriation permits by the DNR should be coordinated prior to the actual drilling of the municipal well. Currently, a MDH permit is issued prior to authorization given by the DNR to appropriate water. The well is drilled before a permit is issued by the DNR so that pumping information can be used to determine the actual well capacity.

We recommend that some type of predrilling approval process occurs so that the DNR does not have to review a pumping request after the expenditure of up to several hundred thousand dollars by a community. If the DNR can conduct a preliminary analysis of appropriation impact, perhaps it could suggest alternatives when it believes a problem could result from the proposed location or aquifer.

The EQB has also recognized this permit sequencing problem and proposed a DNR checkoff prior to well drilling. The same checkoff procedure should occur also for nonmunicipal wells, which can also be drilled prior to receiving an appropriation permit.

FINANCING

Undertaking water supply planning and potentially long-term projects to address issues of regional concern requires a financing mechanism. Such an approach would be most helpful if it assured a reliable source of funds available every year; this is extremely important to any long-term planning or project programs. Asking local or private suppliers to

fund projects beneficial to the whole region ignores the need to equitably assess those who benefit directly from a particular action. Our goal in financing should be to develop a scheme that fairly charges those who receive a direct benefit.

The amount of funding needed to pursue the program outlined in this evaluation would begin at a minimal level and increase according to the solutions that are defined in the future. Initially, most of the work would be in preparation of planning material, building a regional water supply database, developing groundwater and surface water modeling and detailing alternatives proposals. Following this preliminary work more funds could be needed to pursue the procurement of alternatives, design and build a system of interconnection to better distribute water, collect data where voids are identified and continue updates on the regional water supply plan.

The estimated costs of the first phase would be as follows:

a) Groundwater model development -- costs of staff (two years), data acquisition, computerization of model, and model development consultant: $500,000.

b) Planning guideline development -- costs of staff (six months) and materials: approximately $80,000.

c) Building a regional supply database -- costs of staff (one year) and data acquisition/computerization and updating projection model: approximately $80,000.

d) Pursuing alternatives in more detail -- costs of staff (one year) and consultant for pre-engineering-level study of promising alternatives: approximately $300,000, assuming extensive study of alternatives within and outside of region.

The first phase costs of approximately $1 million assumes the pursuit of several alternatives at pre-engineering levels of detail and the development of a model for all of the Twin Cities groundwater basin.

The cost details of any subsequent efforts are difficult to determine at this time, since they depend entirely on the level of regional program activity authorized by the legislature. If the legislature determines that major regional emphasis should be placed on alternatives development and interconnection, then costs associated with alternatives acquisition and engineering and with building an interconnection infrastructure could be quite large.

If, however, the results of our near-term planning effort lead local entities to major initiatives to solve the defined problems on their own or in conjunction with interested neighbors, then regional funding would be needed only for continued system monitoring and plan evaluation.

Several approaches could be used to generate a metropolitan water supply fund for planning and projects of regional interest. The first and most direct way to assess those directly using the resource is to place a surcharge on the volume of water used by each user. A surcharge of one cent placed on all municipal use in the region would generate a total of close to $1 million. This approach would not apply to self-supplied users who do not use a municipal supply source and, therefore, would not be equitable in obtaining funds from all benefitted parties. If the same rate is placed on all users, the figure becomes approximately $3.5 million: this approach, however, places an undue burden on power producers who

withdraw a tremendous volume of water but return essentially all of it to the receiving stream, albeit at a slightly increased temperature.

If a system that collects revenue based on consumption is used, a one-cent surcharge per thousand gallons consumed would yield approximately $220,000--an amount that would not likely build up a fund as quickly as it might be needed if major regional projects are pursued. The amount of revenue collected in any given year under these scenarios would have to be determined by the needs for that year, including the inception of long-term projects into future years.

A related option for building a metropolitan water fund would be to collect for water used at the disposal end. Under this approach, the MWCC would add the use surcharge as a component of the sewer bills that it sends to communities. The users would still be paying as benefitted parties, and most self-supplied users would be picked up since they discharge into the community sewer system. This approach would have to be supplemented by another to address users like power plants that do not withdraw from, or discharge to, municipal facilities.

The MWCC collection for an average year based on current discharges into its wastewater system would be slightly over $1 million. This would raise to almost $1.2 million when the phase-outs occurred and the plants reached design capacity. Adding the 16 non-MWCC treatment plants to the funding scheme would add slightly over $10,000.

A third option for accomplishing some of the program initiatives under a regional fund would be to ask the legislature for a special appropriation equal to the amount identified above for the studies needed in the first phase and then report back to the legislature on the need to continue the fund and the best means to collect the funds from benefitted parties on a continuing basis, if needed. This approach results in a single allocation of funds, with any future efforts, such as pursuit of alternatives and model refinement, dependent upon the legislature's formalization of a longer-term funding program.

Another option would be to dedicate a portion of the water use fees that the DNR collects for the state appropriation permits to Metropolitan Area programs. This approach would again provide a reliable fund that would be available for planning and projects of regional interest. The permit fee collection system was amended in the recent past to get the DNR some of the funds that it needed to operate its permit program. Given the DNR staffing problems noted earlier in this plan and the ongoing costs associated with running the permit program, it would seem counter-productive to propose further uses for the fees when they cannot now fully support the program for which they were intended.

Yet another option would be pursuit of grants through existing state grant programs, specifically through the Legislative Commission on Minnesota's Resources (LCMR) or the Minnesota Environment and Natural Resources Trust Fund (lottery proceeds). These grant programs have funneled millions of dollars into water resource projects over many years. However, the downside of the grant route is that the time period is short-term (usually two years) and the highly competitive nature of the grant process requires rather extensive attention to acquiring the biennial grant. Grants are also short-term solutions to the funding needs because they are intended for one-time research efforts or for getting programs up and running so they can subsequently be rolled over into the budget of some supporting agency. This approach has merit to get the first-phase work

underway but is not a long-term solution to the funding need once the grant period ends.

There are obviously variations on these possible funding mechanisms. The recommended approach at this time is to seek a $1 million legislative appropriation to do the first-phase work. Once this work is accomplished, we will be in a far better position to evaluate the need for a continual source of funds, which, if needed, could come from one of the other options listed above.

The criteria for continuation and selection of a future funding scheme should include: the long-term need to have a source of funds available to address problems; the applicability of funds for planning and projects of regional interest; long-term reliability; equitability of assessment; and a "benefitted party pays" approach. The suggested approach seeks a one time appropriation from the legislature to pay for some of the initial planning needs, with the long-term funding decision postponed until further evaluation can occur. The report back to the legislature after review of the amended public facilities plans should include a recommendation on future funding.

COORDINATION WITH THE UPSTREAM COMMUNITY

On October 28 and 29, 1991, a series of meetings was held in the upper part of the Mississippi River basin to gather response to the proposals outlined in this plan. The reaction of the upstream community was generally that we are heading in the proper direction with our efforts to maintain self-sufficiency and promote conservation prior to pursuing alternative sources of water from outside of the Metropolitan Area. The participants made it very clear that the upstream community is ready to respond to requests for supplemental water to assist the Metropolitan Area, but only in an emergency when no further reductions in our ongoing uses can be obtained. The upstream community does not want to contribute water to the Metropolitan Area just so that we can grow, unimpeded by any limitations on available water. A visible, region-wide conservation program is essential in their view, and our proposal seems to fit that need.

Participants thought that use of water stored in the Headwaters Lakes should continue at routine release rates unless a true emergency exists in the Metropolitan Area, at which time the Corps of Engineers should consider additional releases. This approach is the position that the Corps has taken since release of its Headwaters Lakes evaluation in 1990. Participants urged a clear distinction in use of the word lakes, rather than reservoirs, for the water bodies controlled by the Corps. This distinction, which is currently used by the Corps, will better reflect the history of the water bodies, which existed prior to the development of dams and addition of supplemental storage.

The attendees at the meetings also favored the formalization of some type of organization to coordinate communication and various activities in the Mississippi River basin. Clearly, a new regulatory function is not desired or needed, but all agreed that communication is essential and should become easier if an organization were in place to serve as a focal point for basin-wide efforts.

Other functions of such an organization could include definition and coordination of emergency response from both accidental spill and shortage events; coordination of a water monitoring system to detect problems in the river that might otherwise escape detection; evaluation of alternative water sources; and education of the public on matters pertaining to the river.

Options for establishing a basin organization are quite varied and could include a compact, a memorandum of understanding or association of interested regulatory, planning and local officials; a subgroup of an existing group, such as the Upper Mississippi River Basin Association; or an expansion of a smaller group, such as the Mississippi Headwaters Board. A recommendation from the legislature to pursue formalization of a basin organization would legitimize the organization and give it a charge. The group also felt that representation on any organization should include industry and small business, all affected units of government or their representative, and both of the Native American tribes in the area.

Participants were intrigued with the possible use of abandoned Mesabi Iron Range pits for supplementing flow in the Mississippi River and felt that it merited further study, as proposed in our plan. Potential users of the water noted, however, that the infrequency of use of the pits for supplementing flow would detract substantially from the economic feasibility of developing them. It was also noted that much technical evaluation is needed to determine if pit development would have an adverse local effect.

Some of the participants were expecting a plan that had all of the implementation specifics spelled out in detail. Clearly, the plan that we have developed here is a blueprint for what needs to be done, not an implementation plan that itemizes specific responses for all affected parties. The program we have suggested recommends several actions that have to occur before we can get to the specifics of implementing a region-wide effort. Support was expressed for the concept of regional plan preparation in that a visible effort is underway to respond to the need for action.

Overall, the discussion was very positive and cooperative. Continued efforts to keep communicating and incorporating both upstream and Metropolitan Area concerns into our planning efforts can only result in eventual elimination of the interregional difficulties that surfaced in past droughts.

CONFORMITY WITH MINNESOTA WATER PLAN

The EQB developed The Minnesota Water Plan in January 1991 to help guide the various long-term water resource management efforts undertaken within the state, particularly by the DNR, the MDH, the BWSR and the MPCA. The state plan focuses on the issue of sustainability as the key to ensuring a viable water supply in the future. In the state plan, as in the Metropolitan Council's proposed plan, there are several recurrent themes, such as focusing on long-term needs and potential problems, looking at the water as a finite resource, promoting education and wise use of water and developing and maintaining a comprehensive database. Both plans seek to establish the same thing--a foundation on which to base sound public policy and resource management decisions.

The recommendations for Council plan implementation made in a following section can be viewed as one of many actions within the state to implement the state water plan. We are supportive of the statewide effort and intend to do our part within the Metropolitan Area to assure the sustainability of the water resource.

6. CONCLUSIONS

1. A system of 112 municipal water utilities serves a population of approximately 2.1 million. The technical analyses done for the water plan, however, included only the 111 in existence during the study period; the Lakeland system began operation in the fall of 1991. The remaining 250,000 residents of the region obtain their water from their own wells.

2. Of those served by municipal utilities, 860,000 receive water to some degree from the Mississippi River, while the remaining 1.2 million rely on groundwater. The Minneapolis Water Works relies totally upon the river to serve itself and all or part of seven suburbs. The St. Paul Water Utility relies on the river for an average of 70 percent of its needs, supplemented by groundwater and inflow into two lake chains, to serve itself and eight suburbs.

3. Approximately 950 million gallons of water are used per day in the seven-county region, with 72.5 percent of the water withdrawn from surface water and 27.5 percent from groundwater sources. However, a marked reversal occurs when consumption is considered, with only 23 percent of the water consumed in the region coming from surface water and the remaining 77 percent from groundwater. These figures are skewed substantially by the large volume of river water withdrawn for power plant cooling, about 99 percent of which is returned to the river.

4. Response to the drought of the late 1980s was as reactive as it was in 1976, leading the legislature to charge the Metropolitan Council with preparing a plan for action that addresses the problems and proposes solutions for them. In researching the preparedness of the region for water shortages, it became evident that we are also unprepared for source contamination.

5. The health and economic well-being of the Metropolitan Area depends heavily on the availability of an adequate supply of good quality water. However, there are no plans or processes in place in the region to address resource assessment, shortage preparedness, or alternative source development on a regional level, thus there is no assurance that we are adequately prepared to address the next shortage, which could occur at any time.

6. Water demand by the year 2010 will increase only 3.3 percent over use levels in 1988 (a drought year). This increase in demand results from an anticipated 17 percent increase in municipally supplied domestic and a 9 percent increase in municipally and self-supplied commercial/industrial use sectors; both sectors reflect growth in portions of the region relying on groundwater as the sole source of supply. Surface water use will actually decrease by the year 2010.

7. Approximately three-quarters of the increase in water use in the region by the year 2010 is expected to occur in only 15 cities, all of which are supplied by groundwater sources. Access to the Prairie du Chien-Jordan (PDCJ)

aquifer in some of these areas is limited or nonexistent, leaving them with only the drift and Mt. Simon-Hinckley (MTSH) aquifers as options for supply source. The drift should be locally able to meet demand, but in areas where coarse-grained sediments predominate, contaminants introduced at the surface or near surface can reach the water table rapidly, with little opportunity for attenuation. The MTSH aquifer is much less capable of transmitting the volumes of water needed than the PDCJ and is stringently protected by the DNR, which allows use only for domestic purposes only if other alternatives have been exhausted.

8. Generally decreasing groundwater levels and the tendency to concentrate wells to more efficiently treat and distribute water lead to concerns that continuation of this approach might result in severe drawdowns in rapidly growing areas. The actual occurrence of this phenomenon and the local and regional impacts are not known but should be studied because of the rapid growth currently being experienced in areas supplied by groundwater.

9. Approximately 500-to-800 mgd are available from the groundwater system, according to estimates by the USGS. By the year 2010, we will be using one-half of that volume. We cannot remain complacent knowing that one-half of the capacity remains because of the increased difficulty of removing the last half, the need to keep some groundwater in reserve for emergencies, the possibility of impacting both surface water flow and the movement of contaminants further into the system with increased pumping, and the uncertainty that our inexact models have accurately shown the capacity, given the fluctuations that can occur during periods of drought, as well as seasonal stresses on the system.

10. Even during dry years, there appears to be over 2,800 mgd excess water available from the Mississippi River on a long-term basis. However, the usable volume decreases to 1,200 mgd during periods of drought. These numbers indicate that the Mississippi River could provide substantially more water than it now supplies. However, caution must be exercised not to rely on the river without a backup source to call upon during contamination or extended periods of extreme drought when the above numbers can decrease to a point where critical flow is approached. Increased river use must also consider the water quality impacts of reducing flow in the stream, particularly when the 7Q10 flow is approached.

11. The municipal water supply systems in the region have risen to the recent challenges presented by droughts in the last two decades. However, a marked lack of overall regional planning and preparedness for water shortages exists. Institutional improvements are also needed for collection and analysis of data, problem and solution definition and pursuit of alternative sources of water.

12. The DNR's efforts to introduce conservation language into water appropriation permits could be enhanced by periodic routine review and reissuance of permits and by augmented staff to handle the increase in workload that the reissuance

schedule would demand. This approach would free the DNR from the need to individually identify permits that it would like to call in for review.

13. A water shortage contingency plan from every DNR permit holder would place the region in a much better state of preparedness for emergencies. Currently, the law requires these plans only from surface water permit holders, but few have produced them and permit holders are allowed to waive their responsibility for contingency plan preparation, which works against the establishment of total regional preparedness.

14. State policy on regulation of water during shortages could be dramatically clarified through the preparation of the DNR "Drought Plan" and "Conservation Program" in document form. The DNR currently implements these mandates through rules and regulations, which are visible only to those who work with rules frequently.

15. The need for communities to generate revenue to retire debt and operate the water utility works against the concept of water conservation. "Revenue neutral" pricing could be achieved through the initiation of increased block pricing, wherein those responsible for increased system demand pay for it, and by seasonal pricing, wherein users pay more for water used during peak summer periods than in low-demand periods.

16. The responsibilities of large-volume Mississippi River users during a drought are spelled out in a matrix prepared as part of the Council's short-term water supply plan. This matrix is a variation of one developed by the Governor's Drought Task Force in 1988. As currently constituted, none of the parties covered in the matrix has any formal responsibility to abide by it when called upon to do so. Formalization of the matrix responses into the state-issued permits would clarify the expectations associated with the matrix.

17. The worst-case scenario for affecting the largest number of water users in the region is an accidental spill on the Mississippi River leading to closure of water intakes. Approximately 860,000 people and a substantial commercial and industrial sector rely on the river as a source of water. Loss of this source even temporarily has a tremendous regional impact. The state has found that we are ill-prepared to respond to accidental spills on the river. An evaluation of the programs in place to identify spills and respond to them suggests that some comprehensive basin prevention, detection and response action is needed.

18. Although state agencies collect some useful information on the use of water, more specific data needs are not met, and analysis of collected data is often not done on a regional basis other than for special studies. An on-going data compilation and analysis function for the Metropolitan Area is needed to keep abreast of water use and availability.

19. Preferred alternative sources of water for the region include conservation of available supplies, more efficient use of the groundwater and surface water system, use of water stored in

abandoned Mesabi Iron Range pits and additional storage in the Rice Creek and Minneapolis chains of lakes. Emergency alternatives can be obtained locally through interconnection to neighboring utilities. Emergency release of additional water from the Mississippi Headwaters Lakes system is an option that should be pursued only when use reduction efforts in the Metropolitan Area cannot yield sufficient reductions. Protection of currently used surface and groundwater sources, although not an alternative, is essential.

20. The level of conservation practiced by the 111 surveyed communities served by a water utility varies from none to quite comprehensive. A uniform set of conservation elements adopted by each community and applied according to its needs is essential in furthering the region's efforts to use water more wisely and to establish equitable expectations across the region.

21. More efficient use of the regional groundwater system is essential if we are to meet the expected demand resulting from population growth in portions of the region relying solely on groundwater. The first step toward this efficient use is the development of a groundwater model that can be used as a tool to help us direct users to the most productive area of their community or part of the region.

22. Analysis of available supplies shows that sufficient water exists to meet all of our needs, but the water resource is not exactly where it might be needed. Optimization of available supplies, or the distribution of available sources to the point of demand, is a concept that should be pursued to assure continued orderly growth in the region. Interconnection of municipal users should also be pursued through both small-diameter emergency connections and larger connections to promote optimal source distribution. Both optimization and interconnection are long-term pursuits that might require major infrastructure changes, but evaluation of their feasibility should begin now.

23. Each day, approximately 288 million gallons of treated wastewater effluent and an unknown volume of groundwater from remedial pump-outs are discharged to the region's receiving waters. Reclamation of some of this water for nonpotable uses could eliminate the use of treated, potable quality water for irrigation, groundwater replenishment and industrial noncontact cooling, among others.

7. RECOMMENDATIONS

1. This water supply plan, addressing both the availability and quality of water, should be adopted as the regional water supply plan and updated as needed to reflect the changing water conditions of the Metropolitan Area.

2. A readily available, usable analytical model of the Metropolitan Area groundwater system should be developed and made available to water resource managers so that the capacity of the system, the potential impacts of withdrawal and optimal withdrawal design schemes can be ascertained.

3. The DNR and the MPCA should include the responsibilities contained in the short-term plan matrix for Mississippi River drought response as conditions of the permits issued to the matrix-covered parties.

4. The state should formalize its emergency response program for the Mississippi River, defining how it will identify and manage the potential for accidental spills, detect contaminants in the river and implement any emergency response and cleanup efforts. Legislative consideration should be given to formalizing an organization of parties dealing with, and affected by, the Mississippi River within the state. This organization would not be another layer of government; rather, it would be an attempt by existing parties to work together for the common good and be a focal point for action and communication on issues affecting the river and its adjacent communities.

5. The Corps of Engineers should consider the reliance of the Metropolitan Area on the Mississippi River for water supply when it reviews the need for emergency releases from the Headwaters Lake system. We do not propose to supersede the existing priority system but merely recognize that consideration should be given to those who rely on the flow of the river to meet basic health and economic needs.

6. New emphasis should be given by the state to assuring the wise use of the water resource, beginning with legislative action prohibiting the use of groundwater for maintenance of lake levels. For cases where the use of water is not clear, the DNR and MDH annual use reports from water appropriators and public suppliers, respectively, should detail separately the domestic, industrial, commercial and institutional components of their use. This will allow the state to become aware of the volume of water used categorically each year and allow it to apply its water use priorities in a time of shortage. In furtherance of accurate water use reporting, Minn. Stat., § 103G.281 should be amended to require metering of all municipal customers in the Metropolitan Area.

7. The Metropolitan Council should charge the MWCC with incorporating an evaluation of the use of reclaimed wastewater into its decentralization study, examining immediate use of reclaimed wastewater at each of its facilities and developing a program of wastewater volume reduction by communities.

8. The state should require an evaluation of the potential potable and nonpotable reuses of treated pump-out water as part of every remediation scheme associated with a contamination cleanup and as part of every wastewater discharge permit.

9. In response to the legislative mandate in Minn. Stat., § 473.156, an implementation program as follows is proposed:

a) The Metropolitan Land Use Planning Act (Minn. Stat., § 473.851-.872) should be amended to include a public facilities section that requires the following components:

- A description of the existing water supply system, including the source of water, well and treatment plant locations and major supply lines; an inventory of commercial and industrial users; an indication of the community's intent for future changes and/or additions to the system, including projections for population and industrial and commercial use; and the methods by which this growth will be served;

- A statement of the community's objectives, policies and standards for operating the water supply system;

- A conservation program that contains the goals of the program, an emergency preparedness (contingency) plan, demand and supply conservation techniques to be used, a program for meter installation and reading if neither exists, an evaluation of pricing methods that could be used to reduce demand, the conditions under which conservation actions will occur, a process for reducing nonessential uses according to the state priority system and the education program that will be used to inform the public of the need to conserve and the methods available to achieve conservation;

- An indication of the possibility for joint efforts with neighboring communities or other official entities to share water sources and treatment, interconnect for routine or emergency supply, pursue alternative supplies and protect water sources;

- A statement of water supply problems that the community experiences or expects to experience and any proposed solutions to those problems, especially those that would impact other communities or the region;

- For those communities served by groundwater, a wellhead protection plan (or aquifer protection plan), prepared in accord with the MDH requirements that are scheduled for implementation in 1993; and

- An implementation program that indicates the manner in which the community will carry out its public facilities plan.

b) Review of the amended local comprehensive plans should occur as outlined in the law (Minn. Stat., Chap. 473), with the addition of review and comment by the county if the county has an adopted groundwater plan under Minn. Stat., § 103B.255 and review of DNR water appropriation permits for municipalities by the Metropolitan Council for conformity to amended local comprehensive plans, as outlined above.

c) State water appropriation law appearing in Minn. Stat., Chap. 103G should be amended to require the following:

- Examination of each appropriation permit within five years so that the DNR can evaluate the permittees' performance and incorporate provisions that promote wise use of the water resource; subsequent review periods for each permit or group of permits should be determined by the DNR based on need, but not to exceed once every ten years;

- Preparation of a water supply contingency plan by each permittee, identifying the actions that the permittee would take in the event of a water shortage or contamination event; the previous waiver provision for preparation of a contingency plan allowed surface water permittees would be eliminated;

- The DNR and the MDH should develop a formal mechanism for DNR review of groundwater availability prior to the drilling of any permitted well; and

- The DNR should incorporate the short-term water supply plan's matrix for large water users on the Mississippi River (Table 3 of this report) into the permits it issues those parties.

d) A one-time legislative appropriation should be made to provide the funds needed to finish the elements necessary for moving water supply planning in the region forward. The initial funds required to develop the database, modeling tools, conservation guidelines, refinement of alternatives and definition of future needs total $1 million. Assessment of the need to develop a metropolitan water supply fund beyond the first phase and the method to fund this through benefitted parties within the region will be made in the report to the legislature on the effectiveness of the program (see recommendation f below).

e) The Metropolitan Council should be charged by the legislature to continue the following efforts as part of its ongoing work program:

- Development of a water use and availability database for the Metropolitan Area and continual analysis of that data;

- Development of regional groundwater, surface water and use projection models for resource evaluation;

- Preparation of technical assistance information on water conservation;

- Continual updating of the region water supply plan;

- Evaluation of alternative water supplies and pursuit of those most promising, whether in the region or outside of it; and

- Evaluation on a long-term basis of opportunities for source optimization and supplier interconnection.

f) The Metropolitan Council should report back to the legislature after the items listed above have been implemented and evaluated for effectiveness in achieving solutions to the problems noted in this plan and supporting technical documents; if the program as outlined does not address

the problems, the Council should propose additional actions, including consideration of a metropolitan system approach to water supply. The Council's report to the legislature should also contain a recommendation for further implementation of a metropolitan water supply fund.

DEFINITIONS

acre-foot
A measure of volume equal to one foot of water spread over an acre of land; total volume of 325,851 gallons.

appropriation
The allocation of water permitting process conducted by the state Department of Natural Resources (DNR) under the authorities granted in Minn. Stat., § 103G.255 -.297.

aquifer
A saturated, consolidated (bedrock) or unconsolidated (glacial drift) geologic unit that can transmit and yield large volumes of water.

aquitard
A geologic unit that retards the flow of water, and hence, hydraulically separates an aquifer from other geologic units.

bgd, bgy
Billion gallons per day (D) or year (Y); a measure of water use or flow rate.

BWSR
Minnesota Board of Water and Soil Resources.

cfs
A measure of cubic feet of water flowing by a specified location every second.

comprehensive plan
As used in this plan, this refers to a specific plan prepared by all local units of government within the seven-county Metropolitan Area under the Metropolitan Land Use Planning Act (Minn. Stat., § 473.851 - .872).

cone of depression
The lowering of groundwater levels around a pumping center; typically assumes the three-dimensional shape of a cone centered around a well.

confining layer
An impermeable geologic unit that restricts the flow of water between aquifers; see also aquitard.

consumption (consumptive use)
The portion of water withdrawn from a surface water or groundwater source that is not returned to any receiving water.

contingency plan
A strategy put together in anticipation of a water shortage that defines the manner in which a user will respond to the shortage; actions could include obtaining other sources of water or reducing demand.

Corps
U.S. Army Corps of Engineers

DNR
Minnesota Department of Natural Resources

drawdown
The lowering of groundwater levels in response to a pumping well.

duration curve
A graph showing the percentage of time that a given flow will be equaled or exceeded.

EPA
U.S. Environmental Protection Agency

EQB
Minnesota Environmental Quality Board

groundwater
Water occurring below the surface of the ground in a confined or unconfined geologic unit.

hydrograph
A graphic representation of water level fluctuation versus time.

interconnection
The connection via pipeline or conduit of more than one water supply system.

LCMR
Legislative Commission on Minnesota Resources

MDH
Minnesota Department of Health

mgd
Million gallons per day; a measure of water use or flow rate.

MGS
Minnesota Geological Survey

MLUPA
Metropolitan Land Use Planning Act

MPCA
Minnesota Pollution Control Agency

Minn. Stat., §
Minnesota Statutes, Section

MTSH
Mt. Simon-Hinckley aquifer

multiaquifer
A well that is open or screened in more than one aquifer.

MWCC
Metropolitan Waste Control Commission

nonessential use
Partially defined in M.S., Sect. 103G.291 as lawn sprinkling, vehicle washing, golf course and park irrigation; could also include any use of water not intended for maintenance of public health.

NSP
Northern States Power Company

optimization
The process of obtaining the best possible mix of water sources and providing it to users in the best, most efficient manner.

PDCJ
Prairie du Chien-Jordan aquifer

piezometric head
The elevation, in any specific aquifer, to which water rises in a standpipe or well.

potable
Of a suitable quality to drink without adverse health consequences.

revenue neutral pricing
Maintaining a constant influx of revenue by increasing the per unit price of water at a time of decreasing use or conservation.

SDWA
Federal Safe Drinking Water Act

Section 22
Section 22 of the federal Water Resources Development Act of 1974, PL 93-251, as amended

self-supplied use
The acquisition of water from a nonpublic water supplier; can be withdrawn from either surface water or groundwater.

"Seven-Q-Ten" (7Q10)
A statistical measure of the average seven-day low flow with a return frequency of once in 10 years; used as the design flow for the assimilation of wastewater.

surface water
Water occurring on the surface of the ground in such locations as rivers, lakes, ponds, wetlands.

TCMA
Twin Cities Metropolitan Area

uniform baseline conservation
The minimum level of conservation efforts recommended in this plan from all cities under an amended local comprehensive planning program.

USGS
U.S. Geological Survey

wastewater assimilation
The natural ability of a receiving water body to mitigate the effect of contaminants added to it.

water use
As used in this plan, synonymous with "withdrawal", from either surface water or groundwater.

waterworks
Public or municipal water supply utility.

wellfield
A collection of wells in a single location.

withdrawal
The removal of water from a source for subsequent use.

WMO
Watershed management organization

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