METROPOLITAN AREA
WATER SUPPLY: A PLAN FOR ACTION

PREPARED FOR THE MINNESOTA LEGISLATURE BY THE METROPOLITAN COUNCIL

DRAFT FOR PUBLIC INPUT
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INTRODUCTION

LEGISLATIVE CHARGE

The 1989 Minnesota Legislature, in response to the drought of the late 1980s, passed a law (Minnesota Statutes, Sec. 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 section 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 (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 important final clause is significant since it charges the Metropolitan 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.

In order to accomplish the legislative charge, the 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; Council Report No. 590-91-011
- No. 2 - Water Demand in the Twin Cities Metropolitan Area; Council Report No. 590-91-009
- No. 3 - Water Availability in the Twin Cities Metropolitan Area: The Water Balance; Council Report No. 590-91-008
- No. 4 - The Public Water Supply System: Inventory and the Possibility of Subregional Interconnection; Council Report No. 590-91-010
- No. 5 - Water Conservation in the Twin Cities Metropolitan Area; Council Report No. 590-91-020
- No. 6 - The Effects of Low Flow on Water Quality in the Metropolitan Area; Council

Report No. 590-91-054
- No. 7 - The Economic Value of Water; Council Report No. 590-91-065
- No. 8 - The Institutional Framework for Water Supply Management; Council Report No. 590-91-064

These reports were prepared by the Council's Natural Resources and Parks Division. The reports can be ordered from the Council's Data Center (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

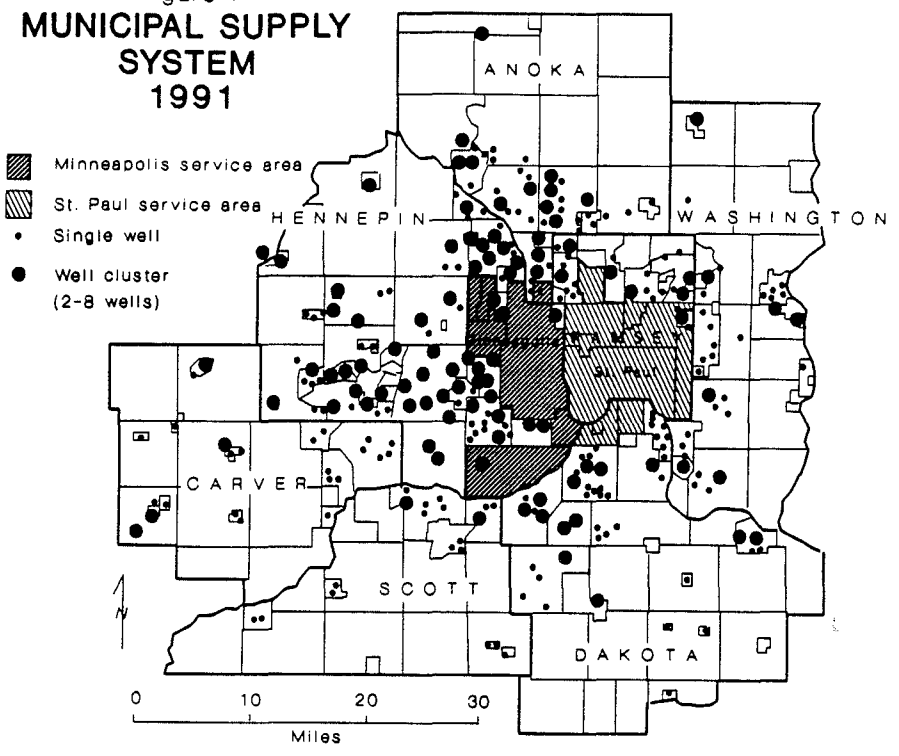
Very early on in the plan preparation process, the Mississippi Headwaters Board agreed to be the unofficial contact for communications with all "upstream" parties in the Headwaters region. We are particularly grateful to them for lending us this assistance. We would also like to thank the Blandin Foundation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

SUMMARY OF REGIONAL SUPPLY SYSTEM

The population of the Metropolitan Area is almost equally split on the source of their drinking water. 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 111 utilities that currently exist: the 112th system will begin operation in Lakeland in late 1991. 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% 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% 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

Figure 1

MUNICIPAL SUPPLY SYSTEM 1991



high capacity wells.

The remaining 96 water utilities (including Bloomington and Edina) obtain their water from wells located within their communities. These sources supply a population of about 1.2 million from approximately 500 wells as noted in Figure 1. An additional 250,000 people obtain water from their own wells or from small non-municipal systems fed by ground water.

Large volumes of surface and ground water 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 they consume less than one-percent of the water they withdraw from the river system. This use, and municipally supplied uses, comprise by far the largest component of water use in the region. Other minor uses include self-supplied commercial/industrial/institutional, building heating/cooling, irrigation, water level maintenance, and several miscellaneous uses. All of these uses add up to approximately one billion gallons per day. Details on the use of water and the source of water used occurs 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 reactions that occurred in 1988 in response to the drought situation were similar to those of 1976, when the region reacted to conditions as they unfolded without a plan in place. After 1976, we quickly forgot the magnitude of the drought related problems and went back to our normal usage patterns and failed to prepare a plan on how we would proactively 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 ground water users to declining water levels, limited aquifer capacity and contamination of their source aquifers. The Mississippi River problem is particularly serious since the city of Minneapolis would be left without a source of water if their 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 fire-fighting needs, to appreciate the magnitude of the problem the region would face if a severe contamination event occurred on the river. The Fountain City train derailment and the Grand Rapids oil spill bring into clear focus the potential for such problems to occur. The 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, there were conflicts occurring 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 the consumer, 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 problems, and others, and to assemble a plan that looks far enough into the future to head-off difficulties before they emerge. Two things we can be assured of are the inevitability of another drought, and that the severity of a future drought will eclipse the most recent experience. This plan will propose some concrete measures to begin an effort to prepare for such a drought. It will not have great detail in a number of areas because necessary work 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 get into complex problems we have not previously experienced.

GOAL STATEMENT

The health and economic well-being of the Metropolitan Area depends a great deal upon 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 over the heavily industrialized East has been its readily available supply of good quality water and the lifestyle it supports. It is imperative that we 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. It is, therefore, the goal of the Metropolitan Council in preparing this plan 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 both 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.

In spite of the difficulties that might arise in achieving this goal, we believe it is time to strive for it while we are between droughts. It must also be emphasized that a contamination event of either surface water or ground water could occur at any time. The first step toward achieving the goal of preparedness is to adopt a plan that lays out some detail on 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 the task at hand.

WATER USE, AVAILABILITY AND QUALITY

USE OF WATER

TOTAL WATER USE

The amount of water used in the Twin Cities Metropolitan Area (TCMA) is critical to the planning and development of the area. During the 1984-1989 period, the Metropolitan Area alone used an average of roughly one billion gallons of water per day (1 BGD). Figure 2 illustrates how this water is being used in the area and any changes in the use patterns for 1984-1989. From the figure, the most notable change is that the primary water users -- power generation and waterworks -- steadily increased their water use from 1984 to 1988; this increase can be attributed to increased demand in response to drought conditions. The slight decrease in use for 1989 supports this assumption.

Before going any farther, it is important to recognize the difference between water use and water consumption. Water use is synonymous with "withdrawal" and includes all water used by a facility or entity whether it is used and returned to the system or used and 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. Essentially, the primary uses of water can be grouped into nine categories: power generation, sewage treatment, water level maintenance, residential and commercial/industrial/institutional use, private water works, irrigation, miscellaneous uses, and non-municipally supplied water use. Of these nine uses, only three--power generation and commercial/industrial/institutional and residential use--account for 92% of the region's water withdrawals.

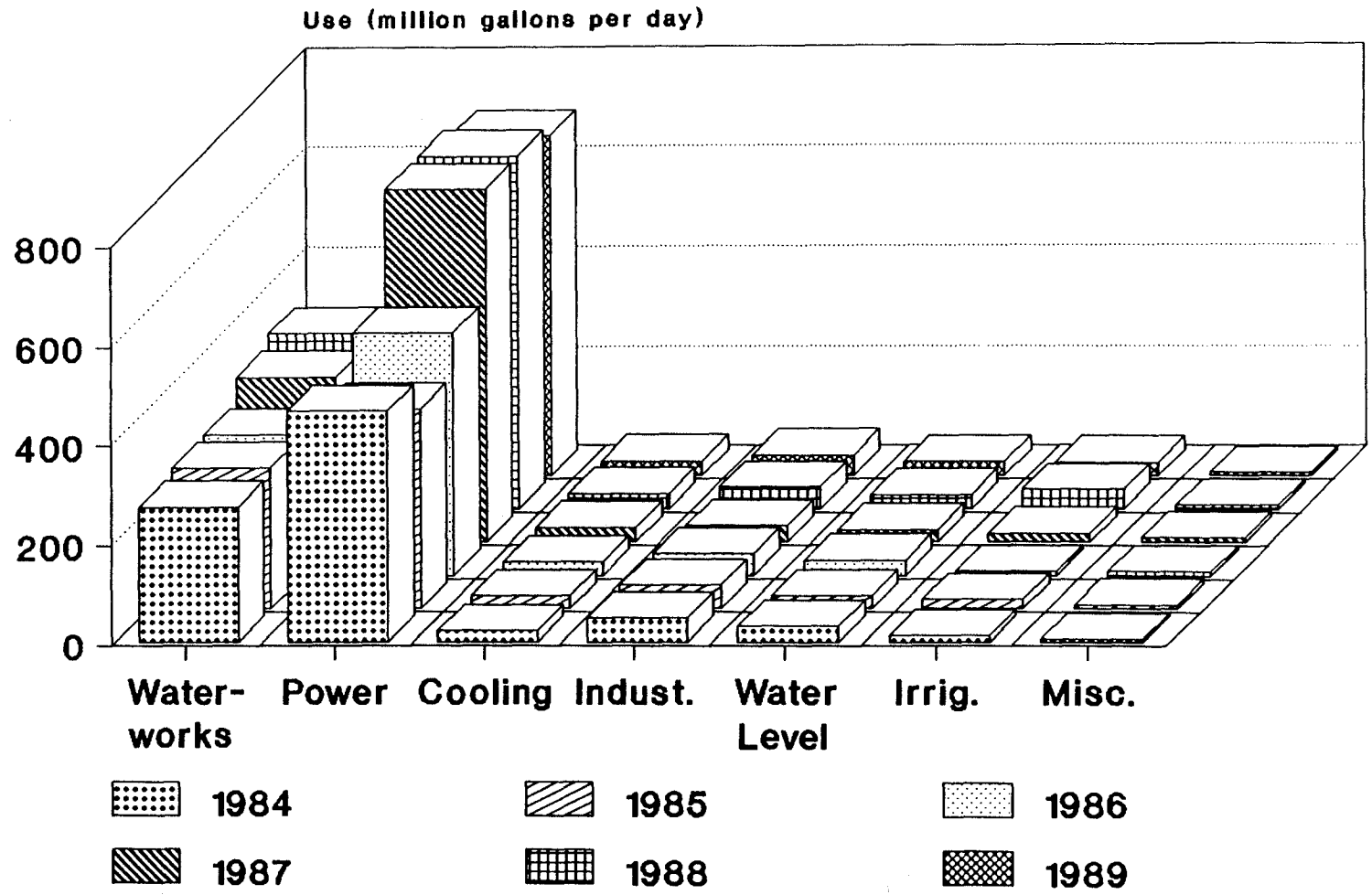
SURFACE WATER USE

The Mississippi, St. Croix, and Minnesota Rivers are the main suppliers of surface water in the TCMA. Figure 4 shows average reported water use during the 1984-1989 period for the Metropolitan Area by source. The figure shows that surface water resources are used primarily as sources of drinking water in the Metropolitan Area, and as a cooling agent for power plants. These two uses account for over 95% of total surface water withdrawals. The current average surface water withdrawal over the Metropolitan Area for these two uses alone totals just less than 690 MGD.

Figure 5 further details these two primary surface water uses. In the figure, the use categories are divided into withdrawals and consumptive use. Unlike power generation, municipal consumptive use is assumed to be 10% of the total withdrawal for each year based on information contained in our technical studies. Table 1 shows the surface water withdrawal and consumptive use 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 Water Use for 1990

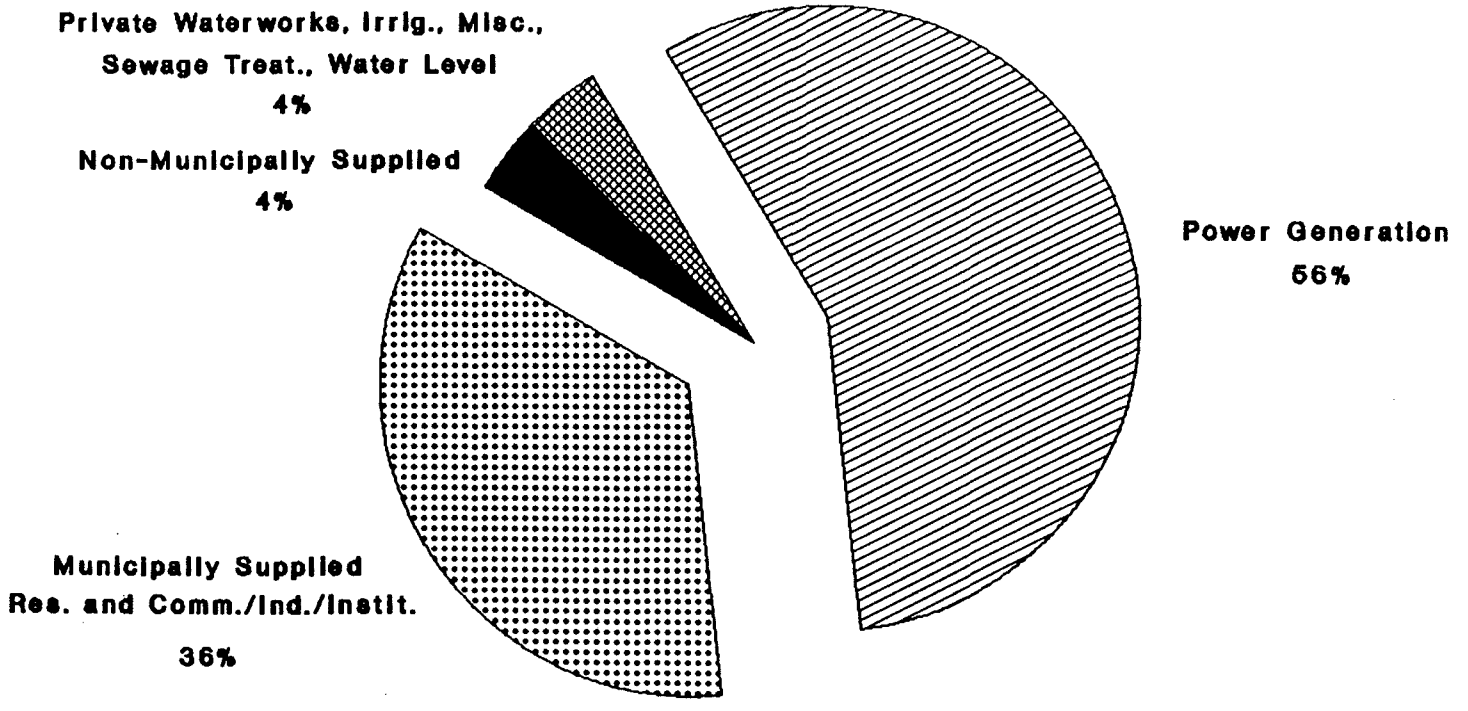
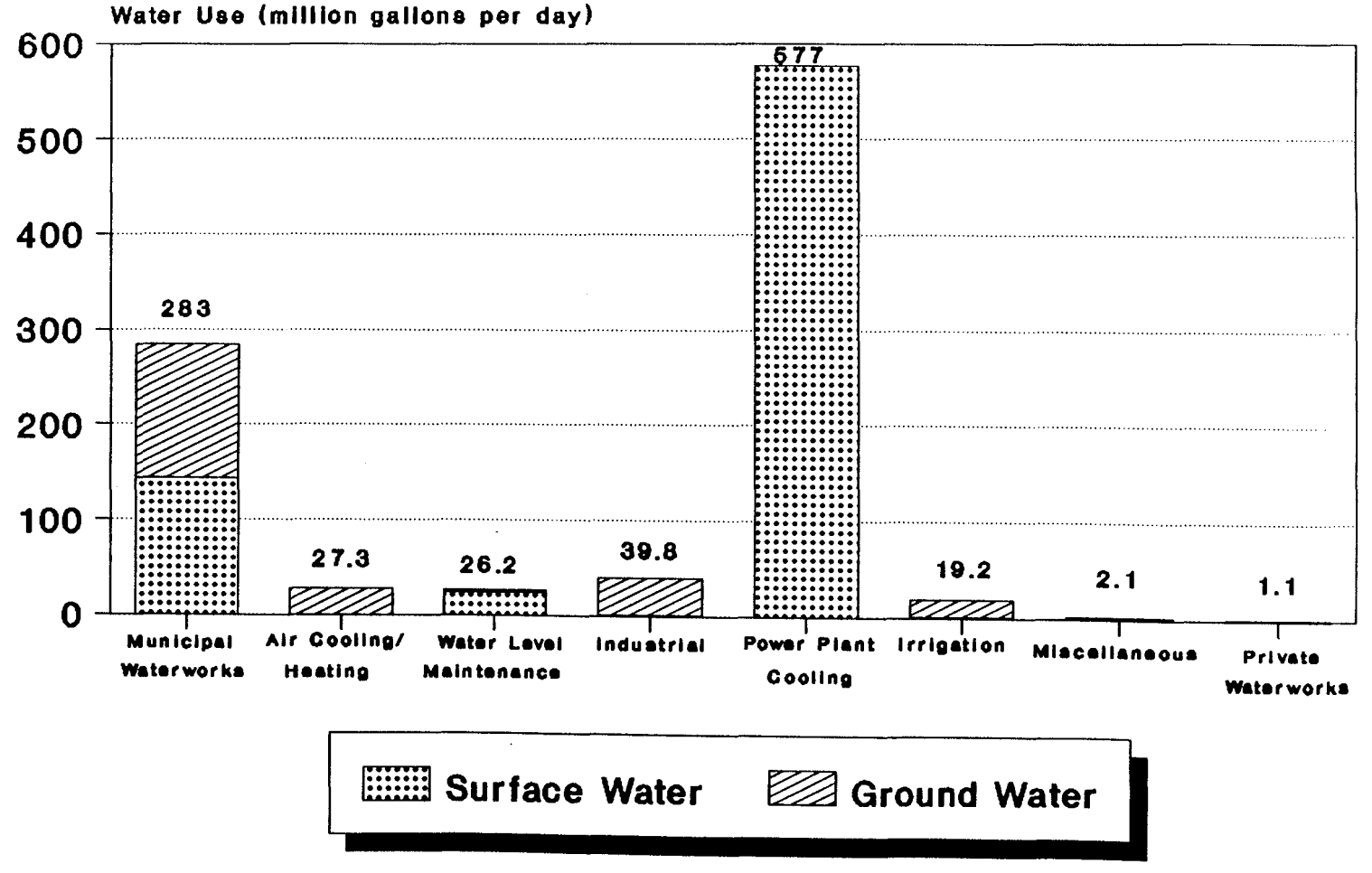


Figure 4

1984-1989 Average Reported Water Use For the Metropolitan Area



From DNR Permit Data

Figure 5

Surface Water Withdrawals and Consumptive Use, 1984-1989

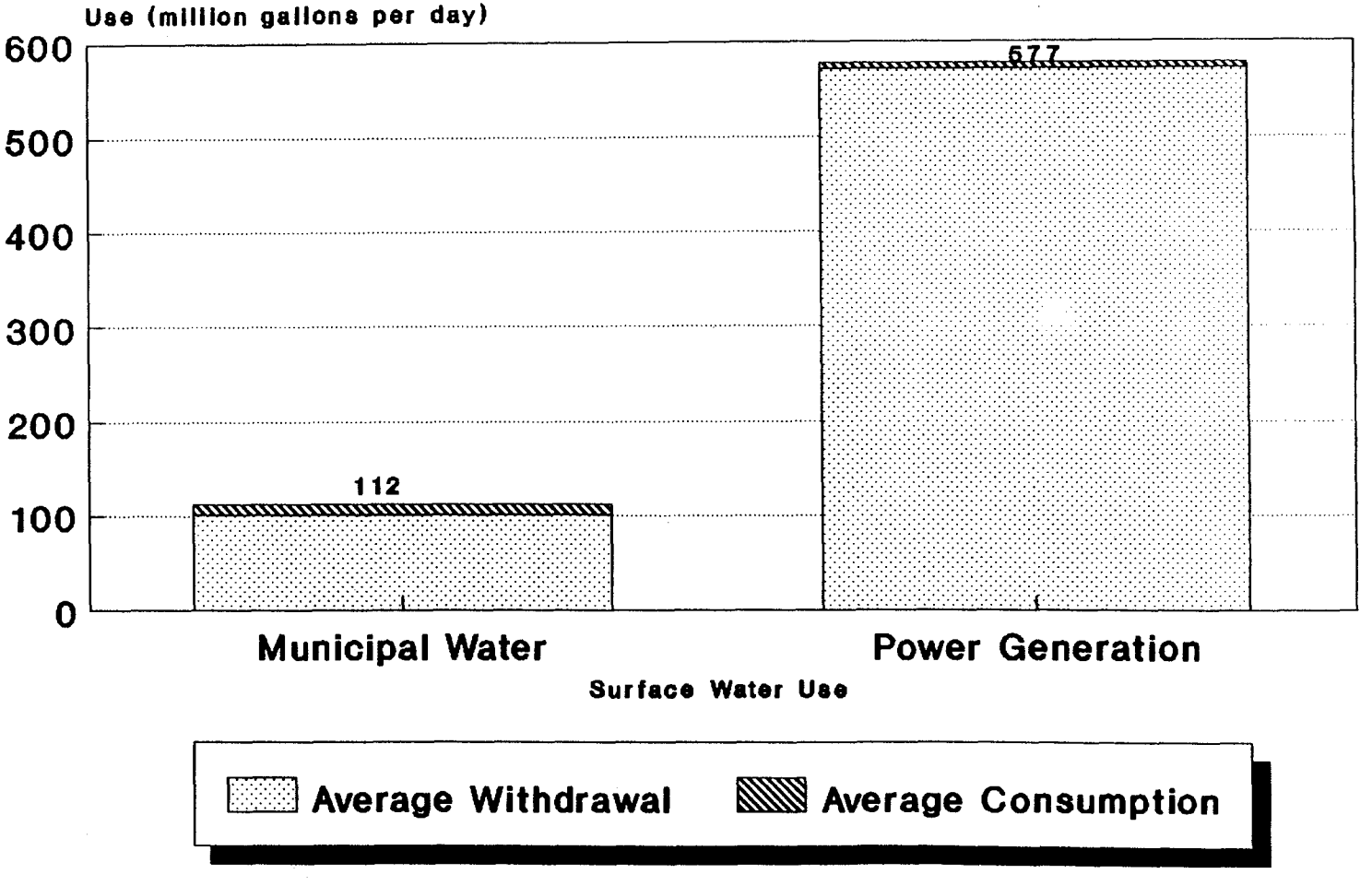


Table 1.
Surface Water Withdrawals
and Consumptive Use, 1984-1989

SURFACE WATER USES	AVERAGE WITHDRAWALS* (MGD)	AVERAGE CONSUMPTION (MGD)
Municipal Water Works	112	11
Private Water Works	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.

GROUND WATER USE

The TCMA depends heavily on ground water as a source for municipal supply, and for industrial/commercial and agricultural needs.

To track the major users of ground water, the Minnesota Department of Natural Resources (DNR) administers a permitting system that requires users who withdraw 10,000 or more gallons per day or 1 million gallons per year to obtain a permit. For ground water users, the permit contains information about the aquifer used, the permitted withdrawal, and an estimate of the actual amount withdrawn for every year it is valid. This DNR information was used to determine ground water withdrawals and consumptive use for the region.

Table 2 and Fig. 6 show ground water withdrawals and consumptive use for 1984 to 1989. According to the figure, municipal and commercial uses are the primary users of ground water. Approximately 262 MGD of ground water was withdrawn for the six year period. Of this 262 MGD, an estimated 45 MGD was consumed, based on consumptive use rates of 10% for municipal, commercial, miscellaneous, and industrial withdrawals, 90% for irrigation, 3% for air-conditioning, and 100% for water level maintenance.

Figure 6

Ground Water Withdrawals and Consumptive Use, 1984-1989

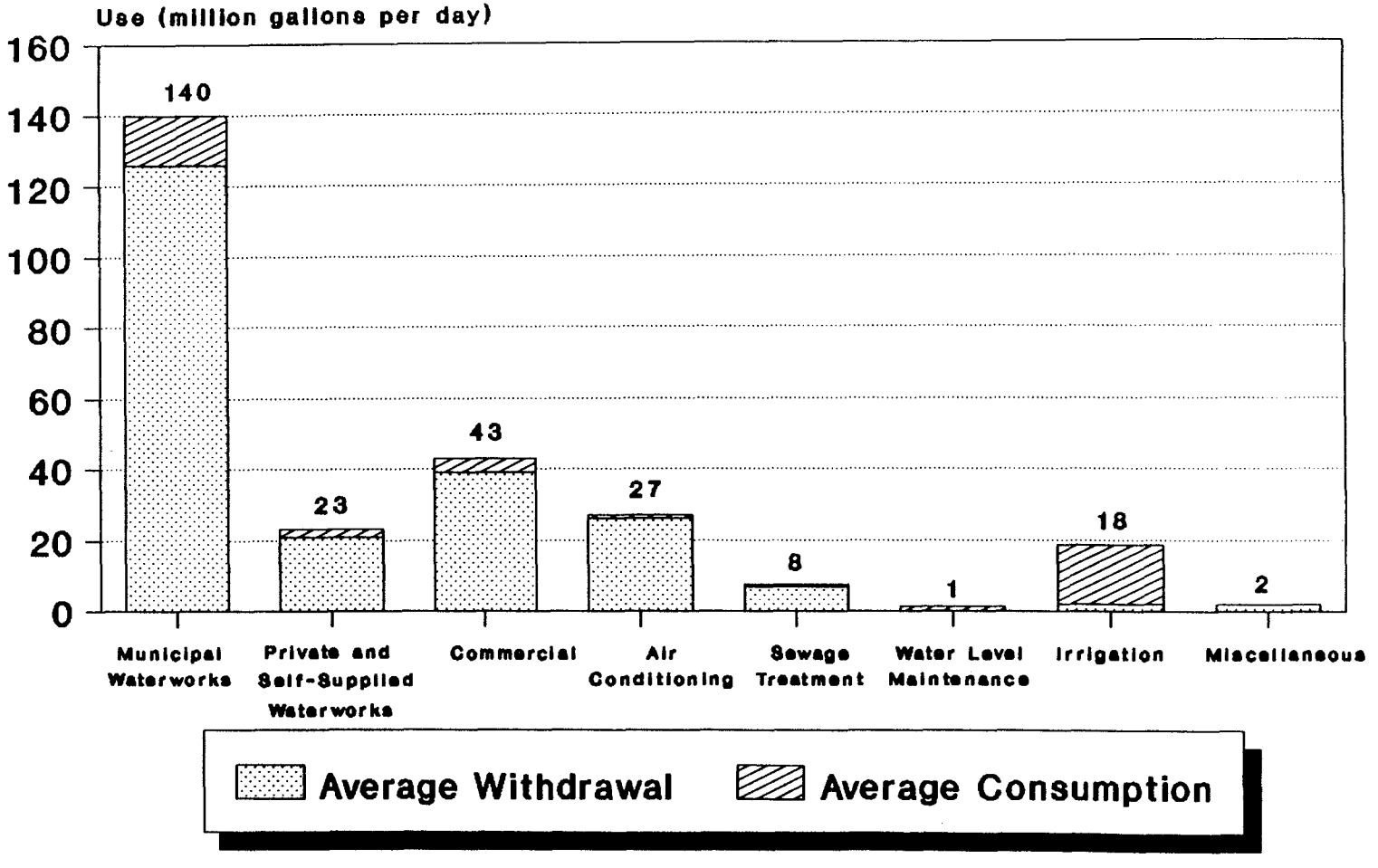


Table 2.
Ground Water Withdrawals
and Consumptive Use, 1984-1989

GROUND WATER USES	AVERAGE WITHDRAWALS (MGD)	AVERAGE CONSUMPTION (MGD)
Municipal Water Works	140	14
Private Water Works	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 consumptive use 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 ground water withdrawal can be estimated to be 22 MGD across the TCMA, with 10% consumed. Combining these figures with the permitted ground water withdrawal and consumptive use yields approximately 262 MGD, and 45 MGD, respectively.

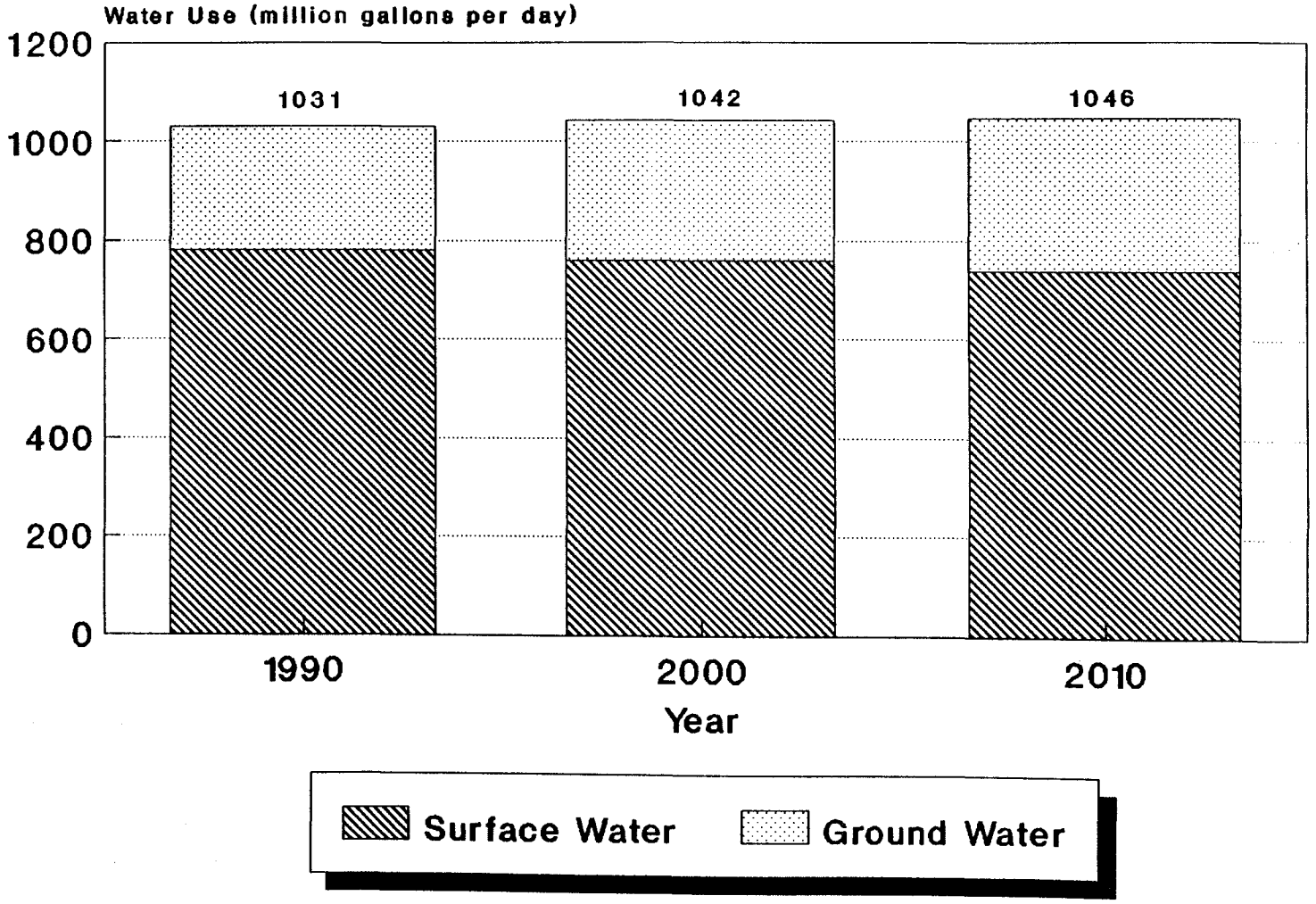
PROJECTED WATER USE

Working Paper No. 2 projected the water demand for 1990, 2000 and 2010. The DNR had only automated their water use records 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 1984-1989 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. Figure 7 shows the results of the statistical analysis for these two use categories. According to the model, municipal commercial/industrial/institutional and municipal residential water withdrawals increased from a projected annual average of 372 MGD in 1990 to 415 MGD in 2010--a 10% increase. It is important to note that these projections do not include water use by self-supplied domestic sources.

Power generation, private water works, sewage treatment, irrigation, and miscellaneous uses were

Figure 7

Projected Water Use



assumed to remain constant through the year 2010, and thus models were not developed for these categories. Water level maintenance was incrementally phased out in our projections, based on the DNR policy that requires the elimination of water level maintenance by the year 2010.

Figure 8 shows 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 that a 17% and a 9% increase is expected in municipal residential and commercial/industrial/institutional use, respectively. 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 non-municipal purposes is supplied from ground water sources. Projections were calculated on a per capita basis, assuming an average per capita use of 102 gallons. Overall, the non-sewered 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.

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 together with the non-sewered projections were added. The updated final analysis of water use projected a total of 1,012 MGD for 1988. Projections for 1990, 2000, and 2010 yield total water use rates of 1,031, 1,042, and 1,047 MGD, respectively for increases of 1.8%, 2.9%, and 3.3% 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 1181, 1191, and 1194 MGD, respectively.

Figure 9 shows where the predicted demand will occur. As shown in the figure, the increases in demand 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% in the Brooklyn Park, Golden Valley, Maple Grove, and Plymouth area; 12% in the Chaska, Chanhassen, Minnetonka, and Eden Prairie area; and 12% 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 four percent. This de-centralization of demand is a key factor in identifying future water supply problems in the region.

Surface Water Projections

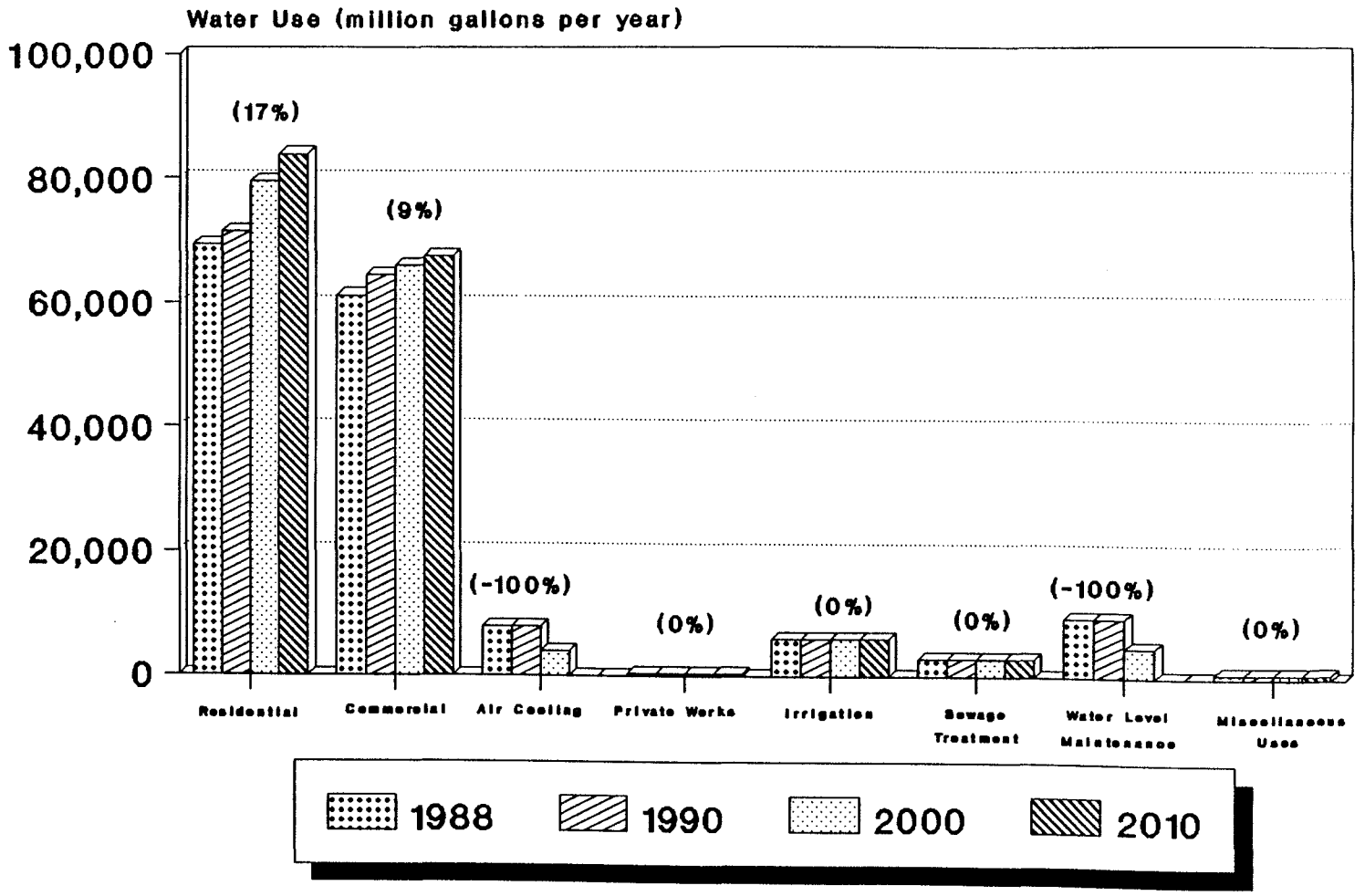
Turning back to Figure 7, a breakdown of the projected municipally supplied water use for surface water and ground water for 1990 to 2010 is shown. According to the figure, surface water use is projected to decrease from 780 MGD in 1990 to 740 MGD in 2010. This decrease is primarily a result of the elimination of water level maintenance and commercial/industrial air-conditioning uses.

Ground Water Projections

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

Figure 8

Projected Water Use

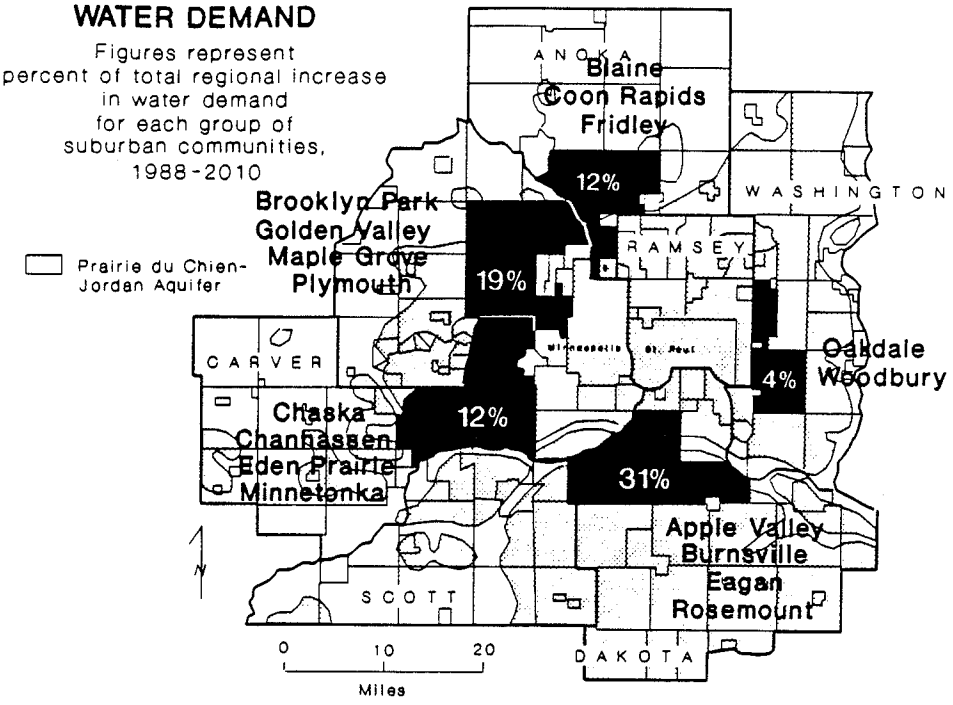


*Numbers in parentheses represent the percent of increase from 1988 to 2010.

Figure 9

PREDICTED MUNICIPAL WATER DEMAND

Figures represent percent of total regional increase in water demand for each group of suburban communities, 1988-2010



to 307 MGD in 2010.

AVAILABILITY OF WATER

GROUND WATER AVAILABILITY

The ground water system underlying the TCMA can be thought of as a layer cake of aquifers and aquitards. Figure 10 shows the five principal aquifers, or water-bearing units, along with the aquitards, or confining layers. The TCMA relies primarily on the PDCJ, the drift, and the MTSH aquifers as sources of supply.

The Working Paper No. 3 and recent USGS studies indicate between 500-800 MGD of ground water is available for use in the TCMA. Present pumpage over the entire system is roughly 250 MGD which suggests that we have only reached roughly 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 shows this trend quite nicely. While this decline is not major from year to year, over several decades it could affect our ability to obtain optimal amounts of ground water.

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

SURFACE WATER AVAILABILITY

The amount of water entering the Metropolitan Area via the Mississippi River at Anoka can be thought of as the maximum amount of surface water available. Under normal conditions, roughly 7,000 MGD flows into the area (see Working Paper No. 3). Most of this water, in addition to the ground water that is added to the river within the area passes through unused. Because of the abundance of surface water, more surface water could be used for water supply without affecting the overall surface water system.

Figure 12 shows surface water 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 ground water system.

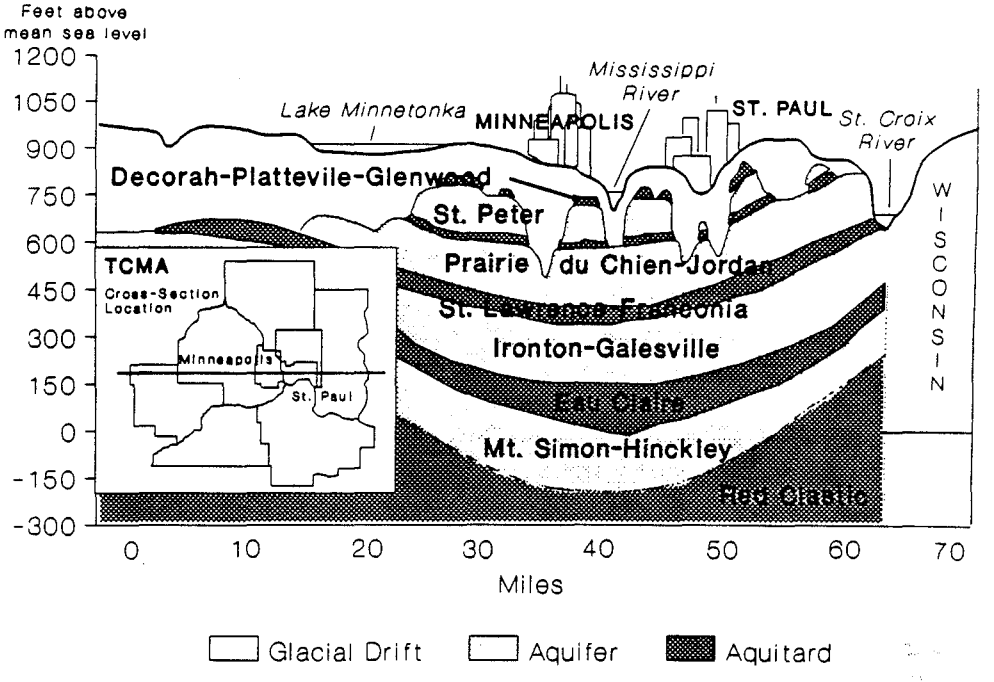
QUALITY OF WATER

SURFACE WATER QUALITY

If the region turns to surface water to satisfy increasing demand, the most feasible choice for a source

Figure 10

GENERALIZED TCMA GEOLOGIC CROSS-SECTION



Vertical exaggeration approximately 130x

Figure 11

HENNEPIN COUNTY
OBSERVATION WELL 27010
437 feet deep in Prairie du Chien-Jordan Aquifer

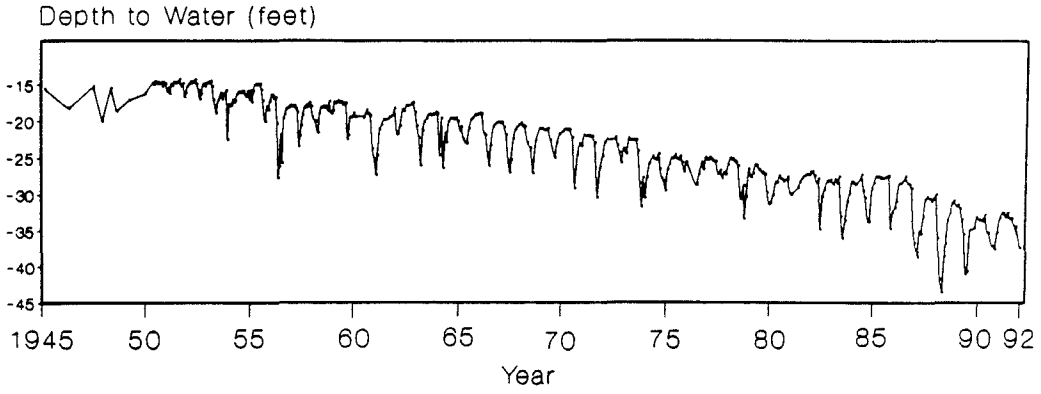
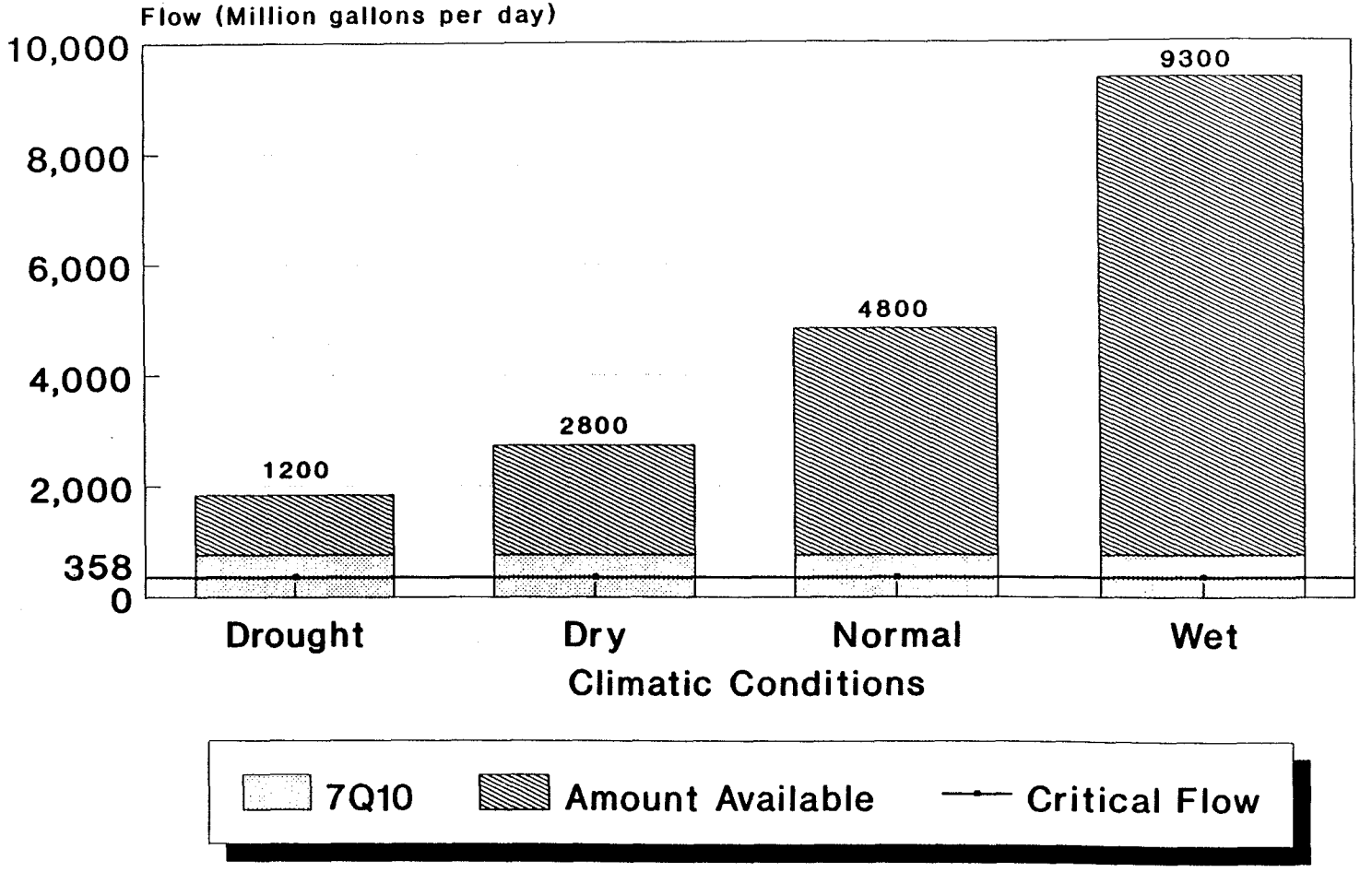


Figure 12

Surface Water Availability During Summer Low-Flow at Anoka



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

would be the Mississippi River, since it is centrally located and could provide large volumes of water. Currently, the Mississippi River north of the TCMA to the Upper Lock and Dam at St. Anthony Falls, is used for drinking water after receiving stipulated levels of treatment. From the discharge point of the MWCC's Metropolitan wastewater treatment plant (Metro) to RM 830 it is used for fishing, but not for swimming. The entire river is used for industrial consumption, agriculture and wildlife, and navigation.

The major constraints on increased future use of the river include flow reliability, drought, and 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 for wastewater assimilation 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 a spill, surface water use may be discontinued and a back-up source such as ground water or stored water would be needed.

GROUND WATER QUALITY

Contamination of ground water must be considered when talking about water quality. Large- and small-scale ground water contamination is a significant problem in the Metropolitan Area. There are currently 78 sites on the Superfund list which represent only major sites of contamination. Underground 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 ground water contamination sites. Because pretreatment of ground water typically consists of only disinfection and softening, contamination from hydrocarbons and organics would require greatly expanded treatment systems. Contaminated ground water, therefore, is effectively removed from the potable water supply.

Figure 14 shows the estimated volumes of affected ground water associated with each aquifer, based on information obtained from the Minnesota Pollution Control Agency (MPCA). The most widely used aquifer in the TCMA, the PDCJ, contains an estimated 124 billion gallons of contaminated ground water. Figure 15 shows the estimated volume of contaminated ground water 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.

There may be about 230 billion gallons of contaminated ground water underlying the Metropolitan Area. This number is roughly equivalent to three times the volume of ground water used in the TCMA over one year.

Figure 13

SITES ON THE PROPOSED 1991 MPCA PERMANENT LIST OF PRIORITIES

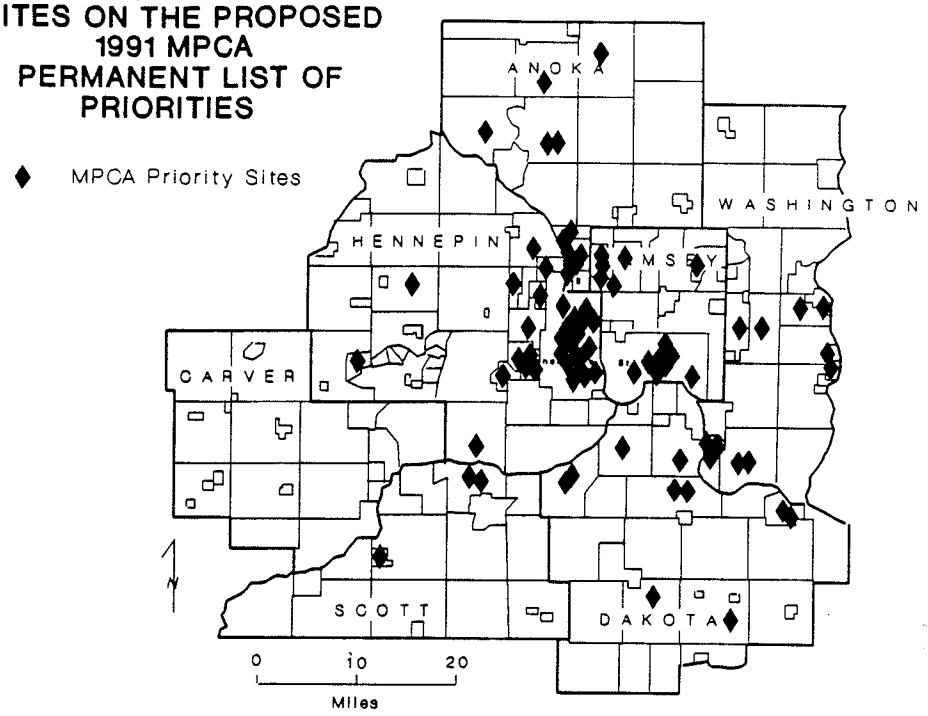
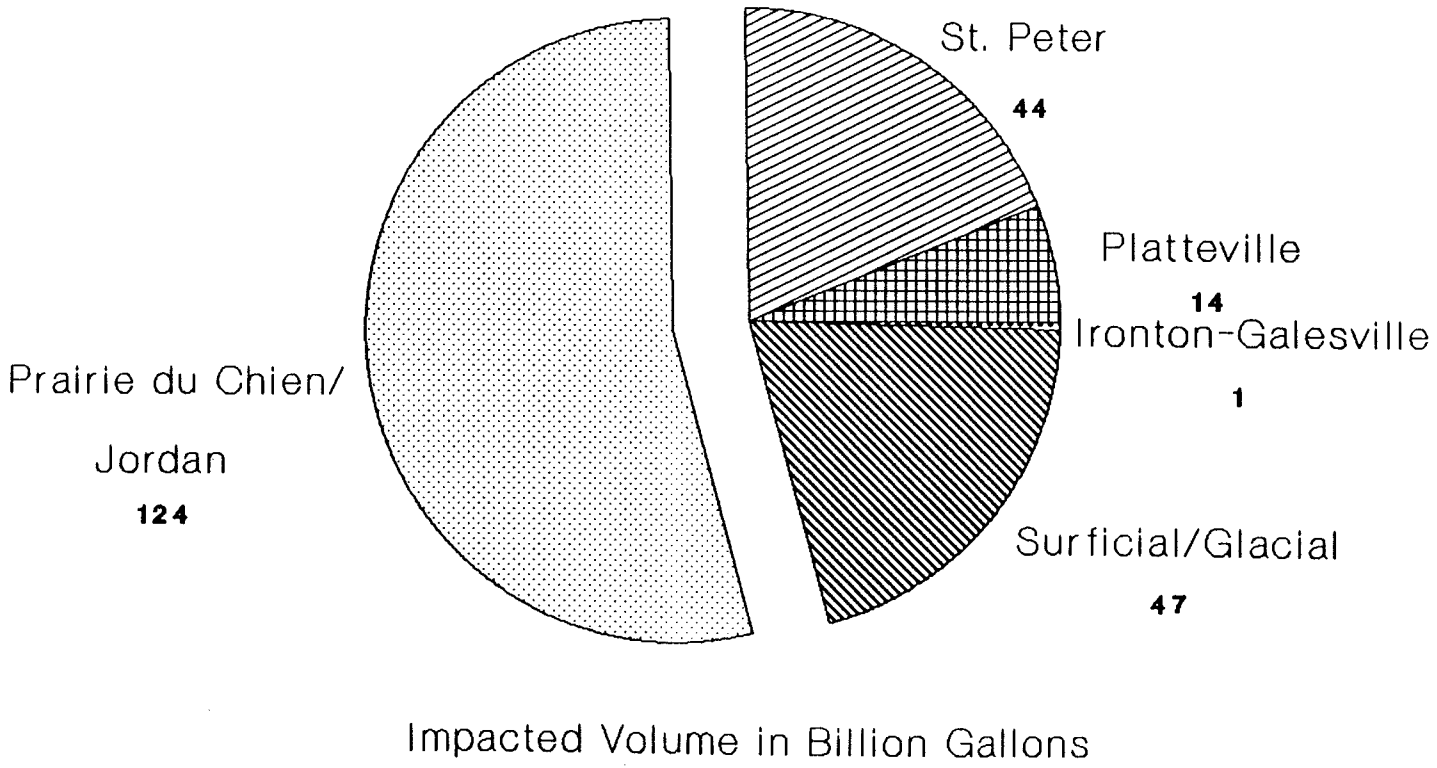


Figure 14

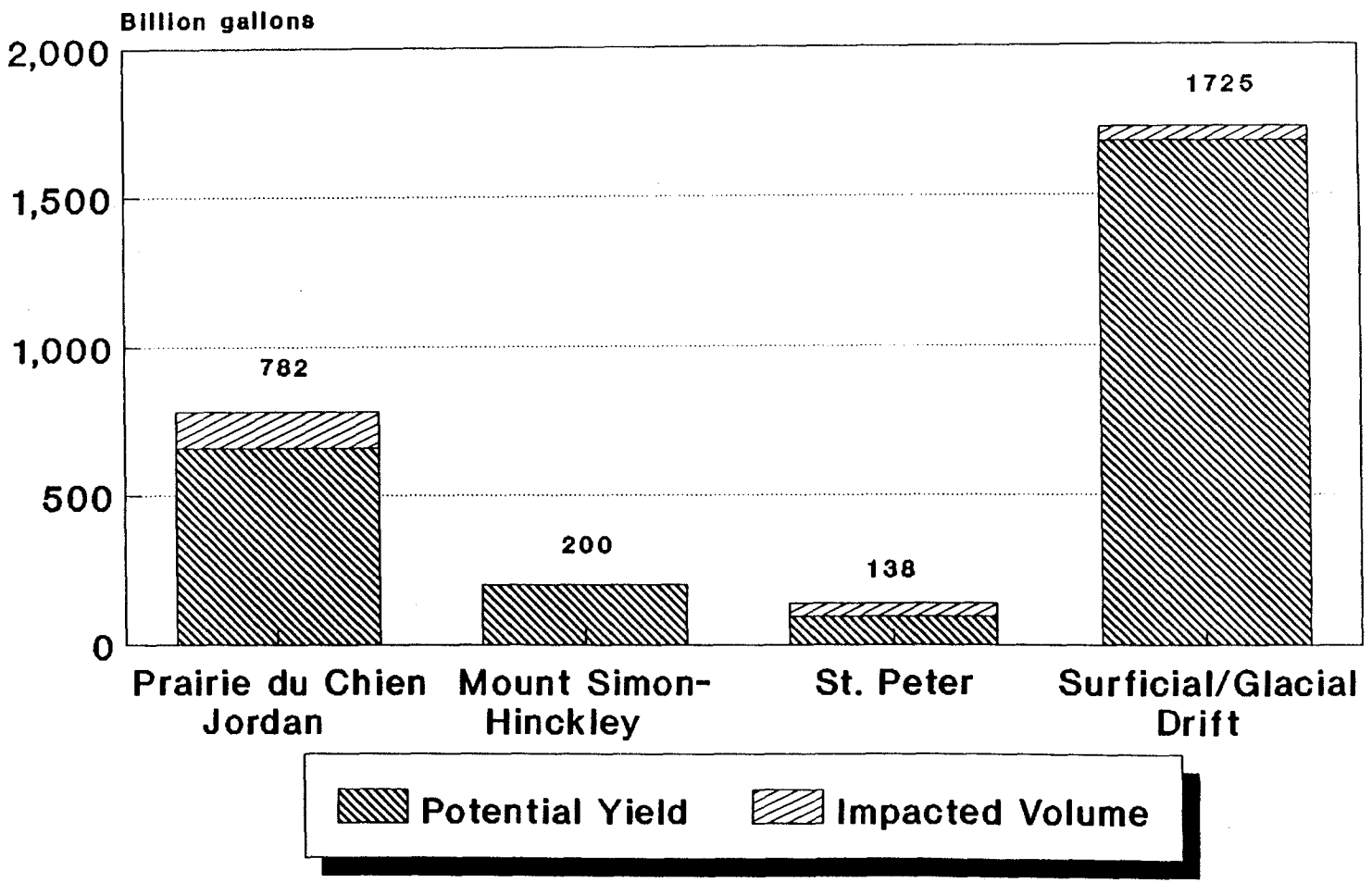
Estimated Volumes of Contaminated Ground Water by Aquifer



•Based on Data Supplied by MPCA

Figure 15

Estimated Volumes of Contaminated Ground Water and Potential Yield



*Based on Information from MPCA

PROBLEM DEFINITION

FLOW RELIABILITY IN THE MISSISSIPPI RIVER

Two cities, Minneapolis and St. Paul use the Mississippi River as a source of supply. Because these two cities also provide water for 13 suburban communities, over 820,000 people in the Metro 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 indicates that under normal climatic conditions, roughly 7,000 MGD flows into the Metro 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, we can't just look at normal or average conditions; we must look at a worst-case scenario in order to assess the likelihood of potential water supply problems.

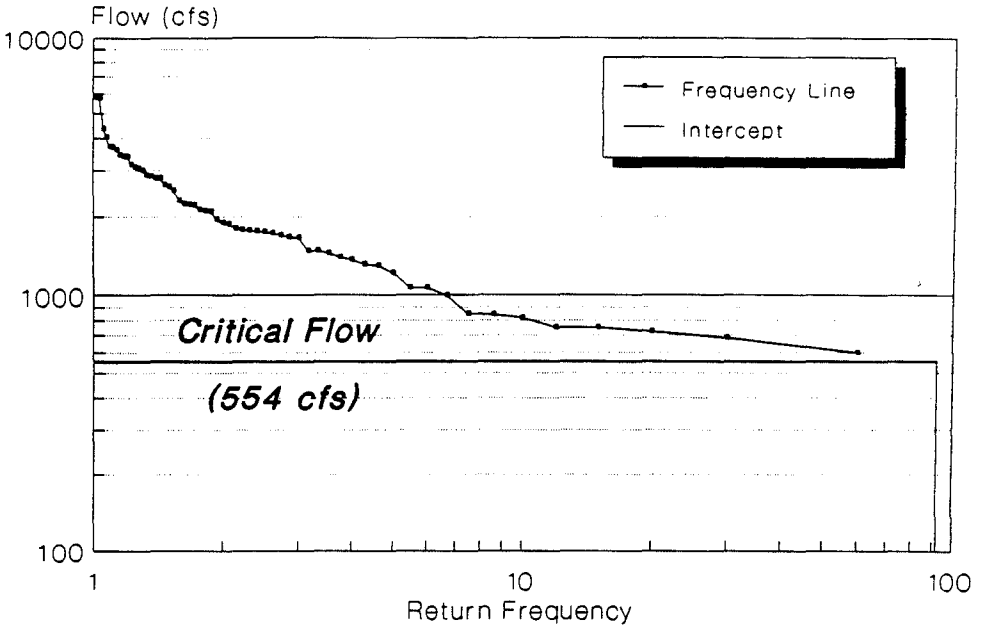
The short-term water supply plan gave an idea of what a worst-case scenario might be by identifying a "critical" flow of 554 cfs (358 MGD). At flows below this level, not all of the existing uses of the river can be maintained, requiring the initiation of drought management activities and restriction 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, we haven't hit the critical level; however, probability tells us that it is only a matter of time before we do.

Reaching this flow level is an issue for all users of the river, but it is particularly important for the cities of St. Paul and Minneapolis since they supply such a large residential and commercial sector of the Metro 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, and added 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 they have no back-up system and only about 24 hours 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 them from doing anything.

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 the vast amount of the time, the Mississippi River is capable of providing much more

Figure 16
ANOKA FLOW FREQUENCY
LOWEST ANNUAL DAILY SERIES



Data from USGS

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 back-up system in place, the Mississippi River could be an excellent source of good quality water.

SURFACE WATER QUALITY DURING LOW-FLOW

If the 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 aren't breached, it is likely that future calculated 7Q10 values would be reduced, perhaps leading to more stringent effluent limitations on wastewater discharges.

Figure 18 shows the relationship between median daily flow at Anoka and St. Paul, the current 7Q10 flow for each station, and projected SW 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 their lack of a back-up system or adequate storage. Moreover, if more cities turn to the river as a source of supply, the impact a spill or contamination event could have on the region is greatly increased.

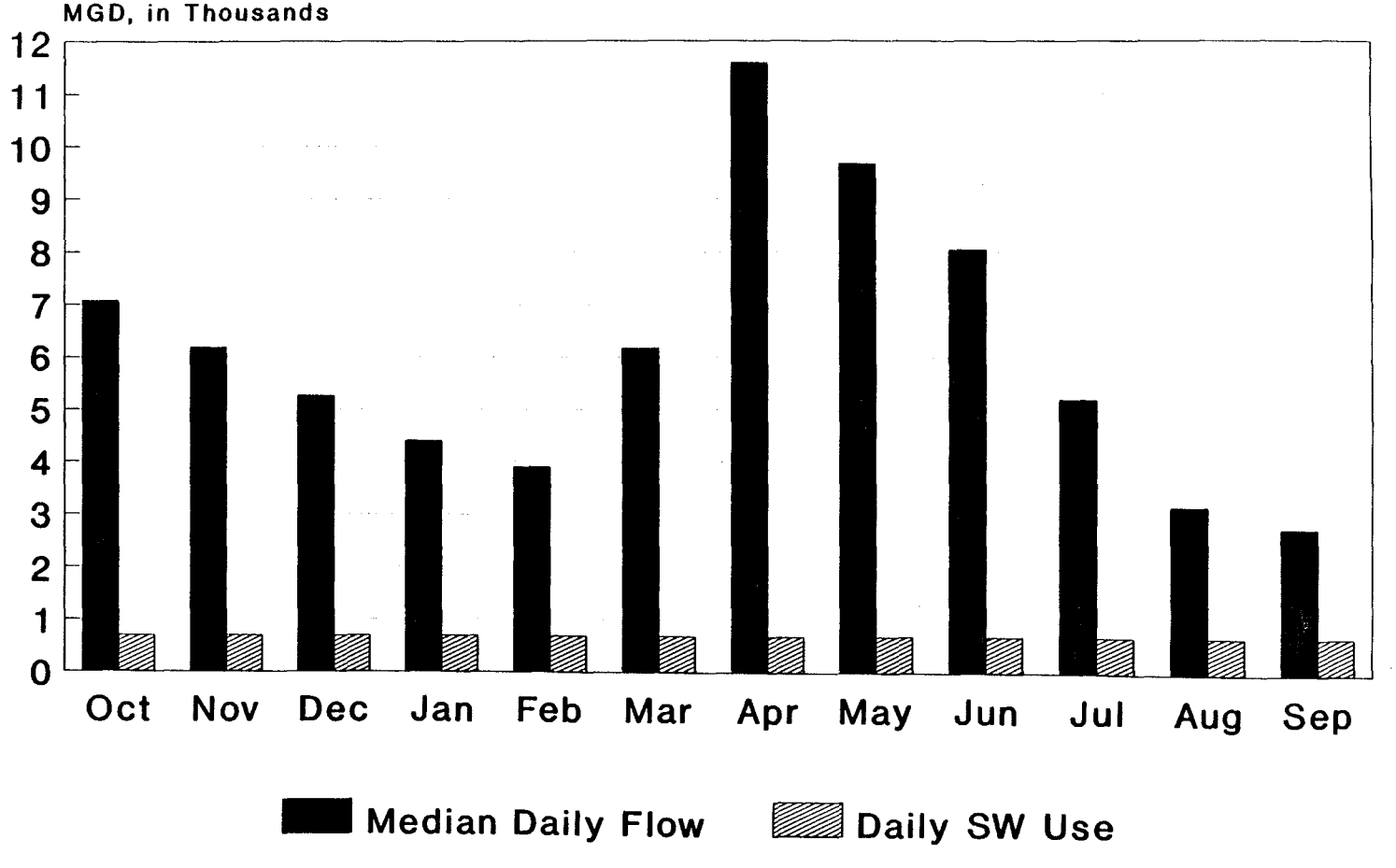
DECLINING GROUND WATER LEVELS

As was shown earlier, the Metro Area depends heavily on ground water as a source for municipal supplies, and for commercial, industrial, and agricultural needs. Unfortunately, the ground water resource is being slowly depleted as illustrated in Figure 19. The set of four well hydrographs depicted in the figure show the long-term trend within the metro area of declining water levels. It is important to keep in mind that these hydrographs are influenced by factors unique to their locations; other well hydrographs may show an entirely different picture, depending on the physical factors within the zone of influence of the well. However, looking at the hydrographs presented here, there is no denying a definite down-ward trend.

Despite this concrete evidence, we learned during a series of public meetings that a perception still exists that there are no ground water problems, since a user can get all the water they want by merely adjusting pumping elevations or looking elsewhere in the ground water system for supplemental supplies. It was also stated that decreases in ground water 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 ground

Figure 17

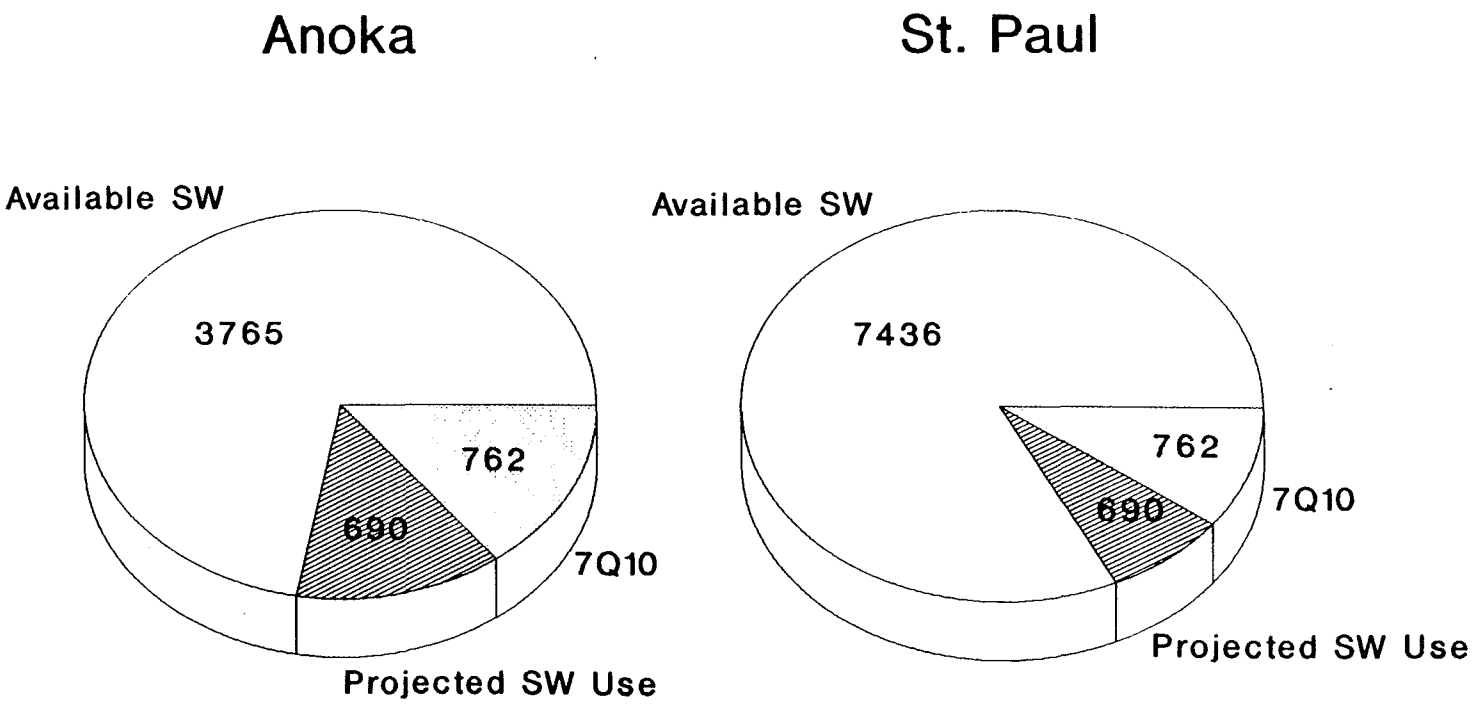
Median Daily Flow and Surface Water Use
Anoka Gage



Based on median of the mean daily flows

Figure 18

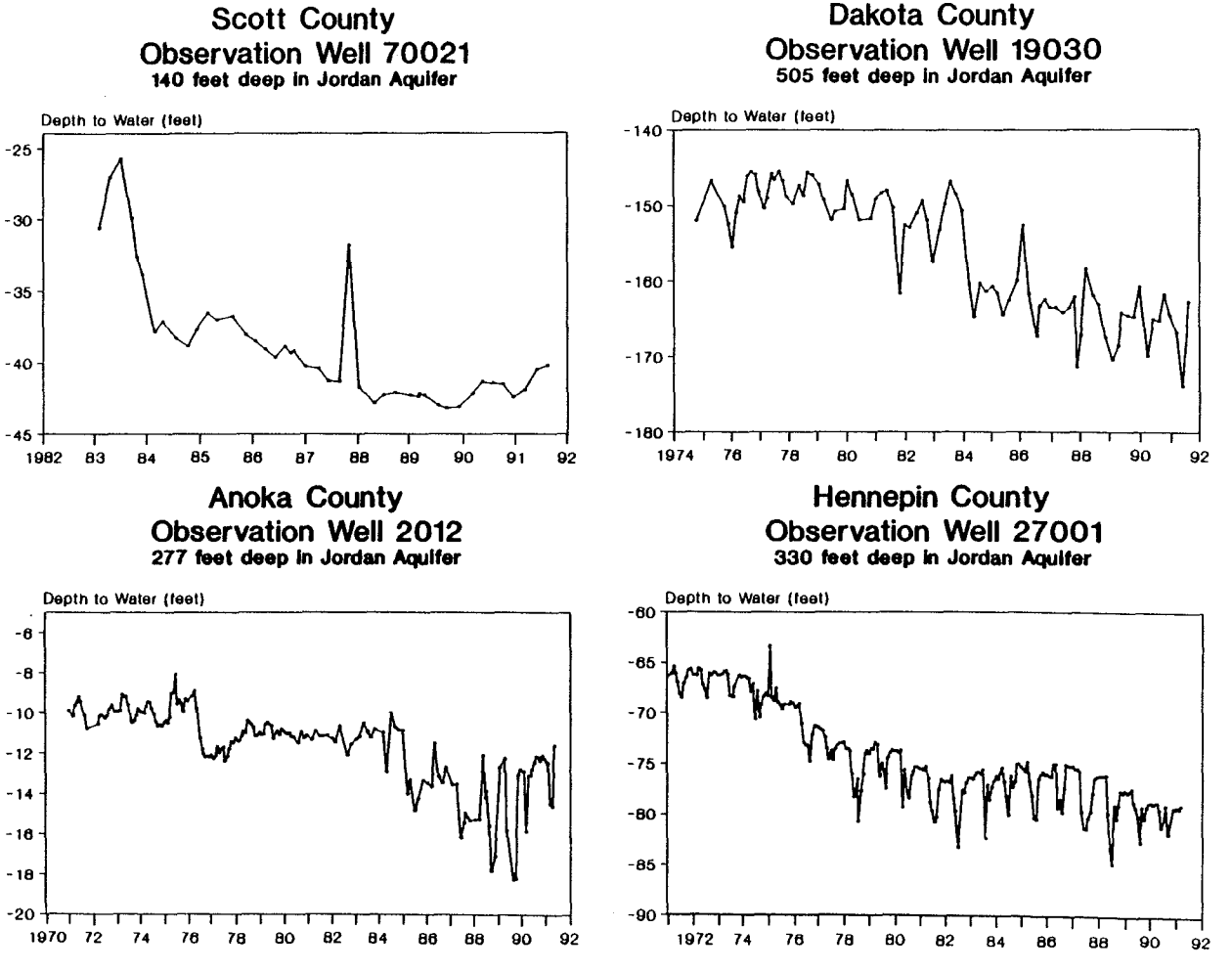
Surface Water Availability During Summer Low-Flow Period 1984-1989



All values in MGD

Figure 19

HISTORICAL OBSERVATION WELL WATER LEVELS IN THE TWIN CITIES METROPOLITAN AREA



water and use it accordingly.

The way we withdraw water from the ground water system in the Metropolitan Area contributes to the decrease in ground water levels or piezometric "head", particularly in areas undergoing rapid growth. Cities tend to cluster their wells in one or two wellfield areas, primarily to save on 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 wellfields. These cones can represent head losses up to 100 feet in some areas. If we continue to withdraw ground water from existing or new large-scale pumping centers or wellfields, we can expect increased head losses and subsequent withdrawal difficulties.

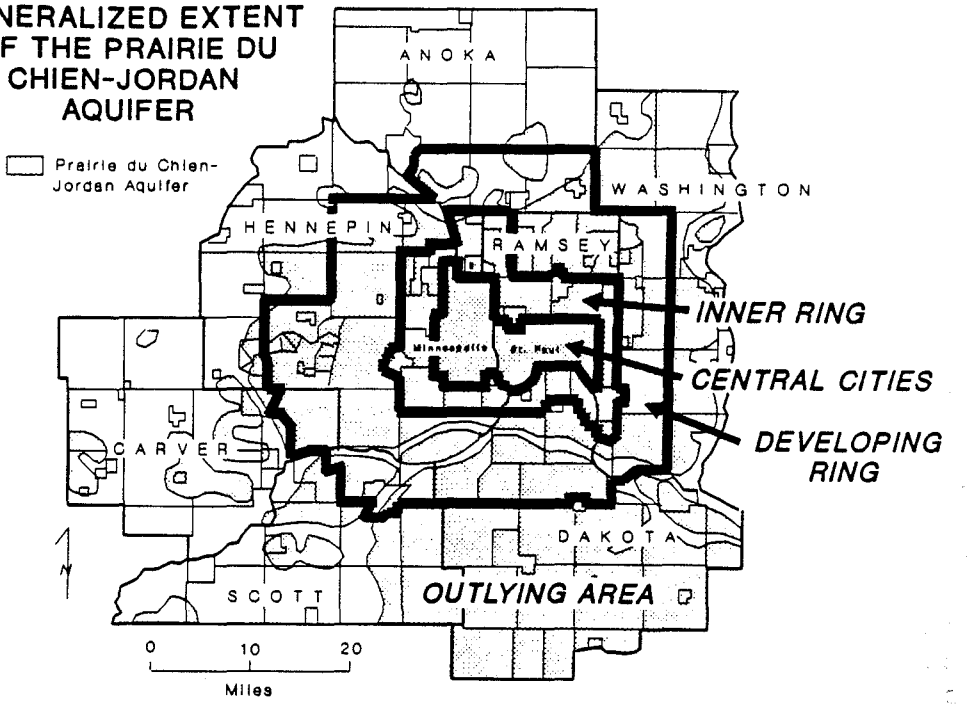
The answer to ground water supply or withdrawal problems has traditionally been to pump longer, drill deeper or turn to another aquifer that has higher head or better water quality. However, we are now realizing that our choices are limited. In the Metro Area, there are essentially three aquifers that are capable of supporting municipal uses, the drift, the Prairie du Chien-Jordan (PDCJ), and the Mt. Simon-Hinckley (MTSH) aquifers. Of the three, the PDCJ aquifer is the most widely used, accounting for over 66 percent of current ground water withdrawals. The drift and the MTSH supply 10 and 7 percent, respectively. Other less productive aquifers and multi-aquifer wells 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 Metro Area. Note that the aquifer is not present in the northern and western portions of the area, which represents a large part of the rapidly growing developing ring of suburbs. Council projections indicate that 74% of the increases in residential and commercial/industrial water demand will be focused in the developing ring, which means that the future demand for water will occur in locations that have limited or no access to the PDCJ aquifer. This implies that an alternative to the PDCJ will have to be developed in these areas--either another aquifer source i.e., the drift or 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 to contamination from surface spills, agricultural chemicals, and leachate from buried wastes than the deeper, more protected aquifers. The MTSH is the other ground water alternative available, but recent MDNR policy restricting its use could preclude cities from using this aquifer.

Figure 20

GENERALIZED EXTENT OF THE PRAIRIE DU CHIEN-JORDAN AQUIFER



INSTITUTIONAL

Working Paper No. 8 goes into detail on 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, luckily avoiding major difficulties by a change in climatic conditions. Although no community or major user suffered 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, water quality/contamination preparedness, problem definition during an emergency, and data collection/monitoring.

REGIONAL LEADERSHIP AND DROUGHT RESPONSE

It is clear in evaluating the institutional structure of water management in the region that numerous laws and rules exist to affect good water supply planning, 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 proactive in anticipation of problems before they occur. Even though numerous laws and rules exist, the resources necessary to implement them have generally not been allocated by the state or by the water users and suppliers. That is, new 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 Headwaters area over whose water was in the reservoirs. 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 Reservoirs. 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 Reservoirs even though the cities of Minneapolis and St. Paul felt such emergency releases were not warranted. The perception when the state, the Corps of Engineers, the Metropolitan Area water suppliers and upstream users all have conflicting positions is 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 DNR.

There is some existing legislation 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. Minnesota Statutes, Section 103G gives DNR rather substantial authority to institute conservation efforts within the state as part of its water appropriation authorities. Section 103G.101 authorizes the commissioner of 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. DNR implements this charge through its rules and does not have a document that could be easily identified

as "The State Conservation Program." This approach makes it difficult to identify DNR's effort for other than those intimately aware of DNR activities. The preparation of a document spelling-out exactly how DNR is meeting its legislative charge would lend some much needed visibility to DNR's efforts in conservation.

This is not to say, however, that 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 rules in Part 6115 shows that 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 DNR can request from any applicant in order to evaluate their proposed use of the water and attempts to conserve. There is additional information that 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 DNR, it is limited by its application to "applicants" (new and amended permits) and by the limited amount of staff time available to manage the program. Because of the small staff in the Division of Waters that actually writes and follows-up on appropriation permits, there is 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 in existing use. However, unless DNR detects that a problem exists, it does not require review of the appropriation permit or the insertion of conservation language. DNR has indicated that it has the authority to insert language into any permit, but a routine program to methodically review existing permits is not currently 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 DNR to periodically reissue permits to existing water users and to include water conservation measures as part of their permit conditions. Additional staff resources to implement the programs suggested are essential if we are to move forward through the regulatory process.

DNR has instituted a legislatively-mandated graduated rate schedule for water use fees that bases amount paid on actual amount of water withdrawn, gradually increasing in per unit cost as volume increases. A flat fee structure of $0.20/1,000 gallons was put into effect for most once-through heating and cooling systems using over five million gallons annually until the systems are eventually phased out by the year 2010 (Minn. Statutes, Section 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 passage of legislation without concomitant staff resources. The legislature supported this new law by also requiring that all appropriations have to be metered (Sec. 103G.281, subd. 2), a law that should be amended to require metering of all municipal water customers in the Metropolitan Area.

The Minnesota legislature gave DNR some additional authority to request the preparation of contingency plans when application for surface water appropriation is made through Section 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, a large loophole in the law exists allowing an appropriator to sign a waiver that says he/she 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 ground water or surface water. The law should also be amended by dropping the clause that allows a supplier to ignore their responsibility for contingency planning by stating they will live with the consequences and by requiring the supplier to explore 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 MDH has "primacy" or principal authority on behalf of USEPA. The SDWA has a provision that requires municipal water suppliers to adopt an emergency contingency plan. MDH has not enforced this provision of the federal law and has assigned it a "low priority". MDH staff was not aware of any municipal supplier who had in fact prepared one of these plans in accordance with the SDWA requirement.

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 (Sec. 103G.293). This provision reinforces Section 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 (Sec. 473.156) requires it to prepare the plan to be consistent with the state's drought plan. As with the state conservation program, however, DNR does not have a document that could be identified as the state "Drought Plan." Rather, they intend 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 ground water users, or surface water users not listed in the matrix, or about the institutional needs of implementing drought response so that the events of the last two droughts do not occur. Development of an identifiable, readily available plan that spells-out how DNR intends

TABLE 3.
DROUGHT RESPONSE PLAN

Participant	Median Monthly Flow*	72 Hour Flow at Anoka: 2000 cfs	1200 cfs	1000 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 future 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

72 Hour Flow at Anoka

Participant	Median Monthly Flow*	2000 cfs	1200 cfs	1000 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 1200 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.

to respond to droughts would help the state in its drought preparedness.

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 indicated that they have no formal emergency contingency plan. Of the remaining suppliers that indicated they have some sort of contingency plan, most 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 pre-defined 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.

Other suppliers note that they do not initiate conservation because the citizens do not like it. The drought of 1988 showed very clearly that the public is far ahead of government in their willingness to do their 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. The series of public meetings held by the Metropolitan Council reinforced this view. Every city representative at these meetings agreed that some kind of water conservation program would be a good idea.

Another argument raised by suppliers against conservation is that there has always been plenty of water, so there really is no proven need to conserve. This 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 unprepared manner in which we have historically responded to emergencies call for a better response by all parties. Changes in legislation requiring conservation programs, with perhaps some sort of conservation pricing, will be proposed in this report.

As noted previously, Minnesota Statutes, Section 103G.285, subd.6 requiring contingency planning for water appropriation applicants obtaining their water from surface waters allows users to escape responsibility for doing a good plan by simply signing a clause. This allows complacency and spawns the reactive response typical of the last droughts. Also, Section 103G.285 does not apply to a significant number of the state's water users, those being ground water users. The law should be changed to apply to all large users, whether obtaining water from surface or ground water sources. Additionally, the law should be changed to eliminate the provision that allows a user 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).

There exists a provision in Minnesota Statutes, Section 103G.291 for 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 grounds for modification of the user's permit. This law, although never used, could provide the state a very strong means to immediately curtail 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 invoke a "water deficiency" declaration. 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 DNR and the Governor's Drought Task Force. Substantial reductions occurred voluntarily without the use of Section 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 pre-determined 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 Section 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 DNR (Division of Waters), Minneapolis Water Works, St. Paul Water Utility, MWCC, 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 their study of the Headwaters Reservoirs. 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 ground water supply occurring during a drought.

INSTITUTIONAL NEED TO PROTECT WATER QUALITY

The Twin Cities water supply is not only threatened by drought, but also by contamination of its surface and ground water supplies. This point was dramatically shown when 1.7 million gallons of crude oil spilled from a Lakehead Pipeline pipe near Grand Rapids. 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 jeopardy that surface water suppliers are in relative to the protection of their supply source. 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 are two-fold: first, problems exist with the

contamination of supplies; and, secondly, river water quality problems develop when there is increased use of water upstream of wastewater discharges. Contamination of a water supply can occur at any time, not just under dry weather conditions. 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 city of St. Paul Water Utility responded to the drought of 1976 by adding a ground water source to their surface water system, thus furthering the back-up capabilities provided by the Rice Creek and Vadnais chains of lakes. However, even this diversified system is vulnerable to contamination, since several surface inflows and diversions feed the St. Paul reservoir system. Reference to 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 ground water contamination sites in the Metropolitan Area are evidence of the widespread and often unknown nature of contamination events in the region (see also Working Paper No. 3). Major municipal water impacts have been documented from sources ranging from intentional disposal of waste down a multi-aquifer 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 ground water 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 Metropolitan Waste Control Commission's (MWCC) Metro Plant (Pig's Eye). Artificial aeration by the MWCC, at a cost of approximately $1200 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 them 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, MPCA and the Environmental Protection Agency (EPA).

Institutional response to an emergency water quality condition is a situation that everyone seems to think is covered, but in fact there are few mechanisms in place to identify problems quickly and respond accordingly. Again, the recent oil spill in Grand Rapids by the Lakehead Pipeline Company provides a great study in how the system operates at present. The spill of 1.7 million gallons of crude oil (400,000 gallons of which actually flowed into the Prairie River) was first detected not by the pipeline company or any detection system they 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, MPCA and 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, MPCA (1990) warned that the state is ill-prepared to deal with a spill of contaminants along the Mississippi River. MPCA states that "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, under-staffed, 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, eight 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.

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. 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 Lakehead 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 that at least the potential for contaminant movement toward them exists.

In their report, 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 (Ch. 305 of the session laws) addressing some of the problems noted by MPCA. At this date, implementation of the 1991 law is just beginning, so judgements on its effectiveness cannot yet be made.

A joint effort to address other aspects of the readiness problem is underway by the state Environmental Quality Board (EQB), the city of Minneapolis, the Metropolitan Council and the U.S. Army Corps of Engineers (Corps) through the federal Section 22 (Water Resources Development Act of 1974, PL 93-251, as amended) water planning assistance program. The purpose of this effort 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 terminate in the preparation of a response plan that lays out in detail the

response actions that should occur when a spill is detected; one of the additional products that hopefully will be included in the effort is an instream system of pollution detection that would automatically signal the occurrence of any spilled pollutant. This effort has begun (summer, 1991) and, if properly funded, will last for about eighteen months.

In addition to this preliminary fact-finding effort and state legislative action, MPCA notes that the federal "Oil Pollution Act of 1990" holds some promise of solving response problems related to transportation facilities. On an inter-state 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 which 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 I-694 bridge.

Also of note is the Mississippi Headwaters Board Riverwatch Program that 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 different efforts, 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 basinwide 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. The state of 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 Reservoirs. The 1,000 cfs level was thought to be sufficient to allow for the over 20-day travel time for released water to arrive at the Twin Cities before critical shortages occurred.

Drought can be defined in numerous ways, from reduced soil moisture and precipitation levels to decreases in river flow and ground water levels. From a water supply standpoint, the most appropriate measures to look at are flow in the river and lowered ground water 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 ground water users is far more difficult because of the artesian conditions under which most suppliers withdraw water. Ground water 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 situation before ground water levels would reflect a shortage. For this reason, we are not suggesting that a separate definition of drought be developed for ground water conditions, but rather that ground water 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 ground water 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 in the previous section. There also is a similar need to institute a detection system for spills of contaminating material into the Mississippi River.

DATA MANAGEMENT AND MONITORING

In order 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 DNR (Division of Waters), the MDH or from surveys of the users. 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. 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 DNR in its compilation of data. The data are now available from a computerized system, but obtaining the data still relies upon the good graces of 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 it is accessible only by hand from paper files and is often out-of-date in areas experiencing rapid growth.

In both cases noted above, the data are collected by the state agencies, but in neither case is a routine Metropolitan Area sub-base put together and analyzed. 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, 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, if we add to this the need to also document water availability, the situation becomes more complicated. In order 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 does become potentially very complex when ground water needs are considered. Although state, county and local resource managers are continually upgrading the amount and quality of ground water data available, one is usually faced with a shortage of data in most parts of the region for most of the ground water system. Even though 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 ground water system.

Making sense of the available data is another need that arises when dealing with ground water. The best way to approach the extreme complexity of the ground water system is through a model. The U.S. Geological Survey (USGS) released a ground water model that it developed for the region in cooperation with the Metropolitan Council, DNR and the Minnesota Geological Survey (MGS). Unfortunately, operation of this model is so complex and requires so much computer time that using the model for day-to-day problem solving is not feasible. Additionally, USGS has developed newer models that they support rather 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 ground water model will be a key tool in determining the capacity of the ground water system and the potential for problems arising out of use proposals.

SOURCE ALTERNATIVES

There are a number of solutions possible to address the needs thus far identified in this water plan. The following sections describe options for addressing the needs and recommendations on which option appears the best 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 prove as a region that we are using water wisely and not wasting it on nonessential uses. To begin movement toward this conservation ethic, we clearly need a regionally coordinated effort.

The report on alternatives 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. Twenty-three of the 111 suppliers (currently 112 with the addition of the Lakeland system) responded that they have no program for conservation. Of the remaining positive responses, 70 (note that the totals are not additive because of more than one approach used by some cities) 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. Recall also that 64 of the 111 suppliers indicated that they have no formal emergency contingency plans, meaning many of the suppliers use their 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 forego conservation efforts. Implementation of this approach will be discussed in a later section.

The elements of the program should be mandated by the legislature and should apply as a minimum level of effort for every community in the region. 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.

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 the customer knows the volume of water they use and the municipality knows the amount of water that they lose in their system. Currently, five municipalities in the region do not meter their water. The metering element of the program should not only include the

installation of meters, but also routine reading of meters to recognize problems as they develop and to keep the utility and 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 ground water users, a wellhead protection program, as will be mandated by the state Department of Health 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 non-essential 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 they can play. Simple educational material could be handed-out with the water bill or in separate mailings by each community.

Although DNR has the authority and wants to do a better job of staffing a conservation program, conservation requirements for non-municipal water users are essentially left to the user to implement. Information on water conservation exists, 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 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 for some reason they disagree on its use. Perhaps more difficult to address is the fact that no organized program exists for the institution of use reduction plans for existing municipal users of the ground water system or for non-municipal water users. However, new and amended permit applicants and those systems experiencing or causing difficulties can be addressed through the DNR permit process.

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 we have few facts on this topic, both DNR and 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 (ex., leak detection, public education, routine meter reading) begun immediately and others (ex., sprinkling restrictions, conservation pricing) implemented when a need arises. This approach would also address the problem of communities complaining that they try hard to conserve water while their neighboring communities continue to allow unlimited use of water. The best means 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 GROUND WATER 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 ground water system. We learned in the recent drought that the ground water 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 towards more efficient use? The answer to this question is a little more clear than the conservation question because we have a state agency--DNR--that has clearly been charged with the regulatory authority to make sure ground water is used appropriately. The problem is that 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 need 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 DNR, which now sees a request for water after a tremendous expenditure from the municipality. Any permit constraints by DNR would likely cause quite a hardship for the community that has spent the money for the well. 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 towards promotion of a well planned ground water withdrawal system. Instead, we have a condition 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 DNR reviews well proposals before the expense of well installation.

A requirement for approved DNR contingency plans under a revised Section 103G.285 prior to well installation would also eliminate "boxing" 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 check-off by DNR prior to review by 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 ground water 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 DNR to prepare a system plan and provide technical assistance information for ground water users in an effort to direct the use of ground water in a more efficient manner. 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 ever hope to improve our efficiency in using the ground water system, we must have a better model of the system. The only model of the region currently available is the U.S. Geological Survey model that 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 of a regional water planning agency would be to develop a ground water model and use it as a tool to assist water managers in answering questions on the resource, its use, and the impact of that use. It would make sense to submodel the rapidly growing portions of the region first, gradually building the model to a regional scale.

RESERVOIRS

The technical series 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, ground water development and artificial reservoirs constructed to hold water. Minneapolis could act, on behalf of the city and the suburbs it supplies, 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 be a regional effort rather than a Minneapolis effort. 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 impact a large segment of the Metropolitan Area population that lives in, does business within, or is in any fashion associated with Minneapolis.

TABLE 4. SUMMARY OF PREFERRED ALTERNATIVES*.

SUMMARY OF 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)	Tributary stream to Mississippi River; could supply both St. Paul and Minneapolis systems if Miss. R. contaminated	Limited volume; environmental and social impact; competing uses (recreation); aqueduct needed at mouth of stream	$5,500,000 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 and transport, annual O&M	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 mill. plus land acquisition (if needed)
b) Mpls. chain of lakes	New facility not needed and pumping system in place from river to lakes if volume needed	Economic and social impact	$20 mill.

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 ground water 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 ground water 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.

There are other reservoir possibilities identified in the alternatives report and shown in Table 4. The feasibility of using the Headwaters Lakes for emergency supply is quite limited both in the U.S. Army Corps of Engineers' priority system and 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). The benefits of any releases beyond the routine low flows from the Headwaters 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.

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 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 Reservoirs. 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 DNR will evaluate the need to respond with additional releases from the Headwaters and act accordingly.

Any attempt to formalize an agreement between Minnesota and the Corps of Engineers on emergency releases from the Headwaters Lakes would require a change in the federal authorities under which the Corps operates. 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 subsequent Corps' priorities of Native American rights and local public welfare certainly continue to merit attention by the Corps, but a fourth priority recognizing the potential for emergency releases to get water to a population close to one million people should be formally added through Congressional action. This amended priority system would not attempt to detract from the original priorities, but would rather attempt to update the priority system to better reflect the changes in demographics and recognize the region's 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 currently no institution in place to pursue the acquisition of abandoned pits to assure their use 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 and the suburbs each supply, plus NSP, St. Cloud, the Metropolitan Waste Control Commission (MWCC) and several smaller communities along the river. Of course, any of these entities could take it upon themselves 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 would have to be explored to assure that the volume of water released would reach the participating parties downstream. 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 our authority would be required since we are limited in our capability to expend any "regional" money on facilities of this sort located outside of our legally defined jurisdiction, and in our ability to acquire any property. The Council could also be asked to bond for a regional water authority that would function in a manner similar to any of the regional commissions (MWCC, MTC, MAC, RTB, MSFC). If such a regional commission was created by the legislature, the Council could then provide a funding mechanism to accomplish regional goals through acquisition of upstream facilities. Other options include state operation of the diversion system and privatization by some entity willing to develop and operate the system.

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 ground water in the region. Other benefits include development of drought and emergency contingency plans to avoid "reacting" to events as they occur; potential development of a regional financing mechanism to develop an optimum use system and alternative sources of supply; and positive movement towards assuring the orderly development of the region through the provision of a supply system that can meet the needs of a growing region. 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 ground water 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) in order to interconnect in some fashion for some pre-determined set of circumstances to obtain an alternate source of water. This approach fosters the attitude that each supplier must act alone, and works against the notion that we should be moving towards 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. All of this will take time and effort to convince users who have generally acted alone.

It is essential to state the complexity that would be involved in most efforts to distribute water subregionally and/or to share water among adjacent communities. 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 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 ground water -- a major consideration if Mississippi River water was to be distributed to areas currently using ground water. 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 ground water to surface water. It is for all of these reasons that any proposal for redistributing water within the region 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. 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 non-potable uses such as agricultural and golf course irrigation, industrial non-contact cooling, irrigation of parks and public properties, and aquifer recharge.

In the southwest portion of the U.S., reclamation has become a very attractive cost-effective means of supplying water to meet ever-increasing demands. At an estimated cost of $500-800 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 $100-400 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

non-potable 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 they are charged with the construction, operation and maintenance of regional wastewater facilities in the Metropolitan Area. The MWCC is currently examining issues related to centralization/decentralization of the regional sewer system; they should be charged with further studying the feasibility in terms of reclamation in existing and future facilities. Funding of reclamation efforts could be generated through wastewater fees and through user fees for the reclaimed water.

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 their 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 done the job assigned by the legislature and 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

There are several options 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 demand, with the result being very limited state 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 by someone. Nonetheless, there are options that must be considered outside of the current framework. Adding a major water planning function to a non-regulatory state agency is one such possibility. Both the Environmental Quality Board (EQB) and the Board of Water and Soil Resources (BWSR) have legislative mandates to coordinate water activities in some manner, but EQB's orientation is towards state agency coordination, while 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 EQB has certainly addressed them in the context of overall state issues and 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 been interested in water issues and 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 Section 473.156 it had not been in the Council's purview to prepare a regional plan for the use of water. Legislatively, the Council is authorized in various parts of Minnesota Statutes, Section 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 Minnesota Statutes, Sec. 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 MWCC. Creation of such a commission would require new legislation and some thought on 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 ground water supply plans in a 1987 amendment (Sect. 473.8785) to the Metropolitan Surface Water Management Act of 1982. This amendment in the law provides for voluntary preparation of county ground water plans. At this time, six counties have begun the preparation of ground water plans, while Anoka Co. has decided to study the need for a plan, in light of several ground water studies already completed in the county, before they commit 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 have been submitted to the Council for review under Sect. 473.8785, subd.8. These plans will certainly address the condition of the ground water resource in each of the six counties having a plan and any effort to look comprehensively at ground water 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. Major 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. Additionally, the plans are not charged with addressing the surface water aspects of water supply in counties within which surface water provides a source for 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.

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 1980's. Following this course, however, would mean that we continue to react to problems--a situation the legislature hoped to avoid starting with their 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 chapter 473.

RECOMMENDED APPROACH FOR REGIONAL WATER SUPPLY PLANNING

After reviewing the options for achieving the responsibilities assigned to the Council by the legislature, it seems prudent to address regional water supply problems through the addition of a water supply component to the public facilities section of the local comprehensive planning process contained in Chapter 473. Minnesota Statutes, Section 473.851-.872 (Metropolitan Land Use Planning Act - MLUPA) lays out a framework for the preparation of forward-looking 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 (M.S., Sec. 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..." (M.S., Sec. 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" (M.S., Sec. 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 Land Use Planning Act, however, is not explicit as far as water supply is concerned, although water is mentioned frequently throughout the law. In order to place direct emphasis on the water supply issue, the legislature could amend the law and make direct reference to water supply and the expectations that it has for the water supply effort. This process could be given added emphasis by making water a "fifth metropolitan system" under the planning authority given the Metropolitan Council under Section 473. This action, if desired by the legislature, would charge the Council with the preparation of an overall regional water supply "system plan" within which water suppliers would operate. Implementation could be undertaken by the local suppliers in accordance with the regional plan. This approach would be the most direct means of coordinating local comprehensive planning with water supply planning on a regional basis, thereby introducing this essential health and welfare issue into regional growth considerations.

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 (Sect. 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; development of 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.

Non-municipal users would not be subject to the comprehensive planning provisions, since they are not part of the planning process in Ch. 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/watershed water allocation (permitting) approach. Under this scenario, DNR would proceed to incorporate up-to-date information on conservation techniques and legislative desires into its routine permitting scheme. As noted before, however, DNR would need additional staff resources to devote the time necessary 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 Metropolitan Land Use Planning Act 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 coordination 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 (Section 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; an indication of the community's intent for future changes/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; 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 such efforts as sharing water supply and treatment, interconnecting for routine or emergency supply, pursuit of alternative supplies and ground water and surface water source protection

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

g) For those communities served by ground water, 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 ground water resource

Implementation of the water supply facility plan should follow Section 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 timeframe 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 re-evaluate the need to establish water as a fifth metropolitan system. 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 formally move to make water supply a metropolitan system under Chapter 473.

Review of the amended plans should follow the procedure described in Section 473.858, with the addition of review by the county if the county has an adopted ground water plan under Section 103B.255.

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 DNR has begun to put conservation language into new and amended permits. A routine permit reissuance would allow DNR to regularly review each permit and incorporate into it items they deem necessary for good water management. This approach would allow for 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 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, they should make the personnel resources available to 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 elimination of the waiver that a surface water permit holder 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 ground water users have no other alternative. Instead, it should address a community's ability to reduce demand and take measures to secure emergency assistance from some emergency response entity such as the U.S. Army Corps of Engineers (through its emergency water assistance program) or from 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, 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 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 DNR to appropriate water. The well is drilled before a permit is issued by DNR so that pumping information can be used to determine the actual well capacity. We recommend that some type of pre-drilling approval process occurs so that DNR does not have to review a pumping request after the expenditure of up to several hundred thousand dollars by a community. If DNR can conduct a preliminary analysis of appropriation impact, perhaps it could suggest alternatives when it believed a problem could result from the proposed location or aquifer. The EQB has also recognized this permit sequencing problem and proposed a DNR check-off prior to well drilling. The same check-off procedure should occur also for non-municipal 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 planning material preparation, building a regional water supply database, ground and surface water modeling, and detailing alternatives proposals. Following this preliminary work, there could be some larger demand for funds 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) Ground water model development - costs of staff (2 years), data acquisition, computerization of model, and model development consultant $500,000
b) Planning material development - costs of staff (6 months) and materials approximately $80,000
c) Building a regional supply database - costs of staff (1 year) and data acquisition/computerization and updating projection model approximately $80,000
d) Pursuing alternatives in more detail - costs of staff (1 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 total $960,000, assuming pursuit of several alternatives at pre-engineering levels of detail, and development of a model for all of the Twin Cities ground water basin. The cost details of any subsequent efforts are difficult to determine at this time, since they rely entirely on the level of regional program activity authorized by the legislature. If the legislature determines that a major regional emphasis on alternatives development and interconnection should occur, 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 to major local initiative 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.

There are several approaches that could be used to generate a "Metropolitan Water Supply Fund" to use 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 $1.0 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 lead to fund build-up 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 they send 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 approach 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 yield 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 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 DNR some of the funds that they needed to operate its permit program. Given the DNR staffing problems noted earlier in this plan and their on-going costs associated with running the permit program, it would seem counter-productive to propose further uses for the fees when they cannot fully support the program for which they were intended at the present time.

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. Again, however, the downside of the grant route is that the time period is short-term (usually two years) and the competitive nature of the grant process requires rather extensive attention to acquiring the biennial grant. Another aspect of these grants that makes them short-term solutions to the funding needs is that 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 work noted in the first phase. 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.

COORDINATION WITH 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 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 respondents 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 on-going 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 the proposal we have made 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. The group urged a clear distinction in use of the word "lakes" rather than "reservoirs" for the waterbodies controlled by the Corps. This distinction, which is currently used by the Corps, will better reflect the history of the water bodies, which did exist prior to the development of dams and additional of some 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 of the parties in attendance agreed that communication is essential and should become easier if an organization was in place to serve as a focal point for basin-wide efforts. Other functions of 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 variable, and could include a compact, 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 should be sought to 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.

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 must occur to determine if the impact from 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 herein 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, a very positive cooperative discussion occurred. Continued efforts to keep communicating and incorporating the thoughts of both upstream and Metropolitan Area concerns into our planning efforts can only result in eventual elimination of the inter-regional difficulties that surfaced in past droughts.

CONFORMITY WITH MINNESOTA WATER PLAN

The Minnesota Environmental Quality Board (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 DNR, MDH, and MPCA. The state plan focuses on the issue of sustainability as the key to ensuring a viable water supply into 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 for the future.

CONCLUSIONS

1. A system of 112 municipal water utilities serve 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 ground water. 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% of its needs, supplemented by ground water and inflow into two lake chains, to serve itself and eight suburbs.

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

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 the preparation of a plan for action that addresses the problems and proposes solutions for them. In researching the preparedness of the region to 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 a great deal upon the availability of an adequate supply of good quality water. However, there are no forward-looking 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% over use levels in 1988 (a drought year). This increase in demand results from an anticipated 17% increase in municipally supplied domestic and a 9% increase in municipally and self-supplied commercial/industrial use sectors; both sectors reflect growth in portions of the region relying on ground water 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 ground water sources. Access to the Prairie du Chien-Jordan (PDCJ) Aquifer in some of these areas is limited or non-existent, 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 rapdily, 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 DNR, which allows use only for domestic purposes only if other alternatives have been exhausted.

8. Generally decreasing ground water 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 ground water.

9. Approximately 500-800 MGD is available from the ground water 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 ground water 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 2800 MGD excess water available from the Mississippi River on a long-term basis. However, the usable volume decreases to 1200 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 back-up source to call upon during 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/solution definition, and pursuit of alternative sources of water.

12. DNR's efforts to introduce conservation language into water appropriation permits could be enhanced by periodic routine review and reissuance of permits, and by increased staff to accomplish the increase in workload that the reissuance schedule would demand. This approach would free DNR from the need to individually identify permits that they 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. The current practice of allowing surface water permit holder's to waive their responsibility for contingency plan preparation 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. DNR currently implements these mandates through rules and regulations, which are visible only to those few 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, there is no formal responsibility for any of the parties contained in the matrix to abide by it when called upon to do so. Formalization of the matrix responses into the state-issued permits of the matrix parties 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. 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, perhaps through a basinwide authority.

18. Although state agencies collect some useful information on the use of water, there are more specific data needs that are not met and analysis of collected data is often not done. Certainly, analysis of the data is 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 ground 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 ground water sources, although not an "alternative", is essential.

20. The level of conservation practiced by the 111 communities served by a water utility varies from none to quite comprehensive. A uniform set of conservation elements adopted by each community according to their 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 ground water system is essential if we are to meet the expected demand resulting from population growth in portions of the region relying solely on ground water. The first step toward this efficient use is the development of a ground water 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 does not exactly occur 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 is discharged to the region's receiving waters. Reclamation of some of this effluent for nonpotable uses could eliminate the use of treated, potable quality water for such uses as irrigation, ground water replenishment and industrial non-contact cooling.

RECOMMENDATIONS

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

2. A usable model of the Metropolitan Area ground water 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. Water appropriation law should be rewritten to require periodic routine review and reissuance of permits, preparation of shortage contingency plans for all permit holders, and prohibition of the right to waive the preparation of a contingency plan.

4. DNR and 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 parties.

5. The state should formalize its emergency response program for the Mississippi River and should consider the establishment of a basinwide authority to identify and manage the potential for accidental spills, install a contaminant detection system, and implement any emergency response/cleanup efforts.

6. The legislature should require a conservation program with specified elements as part of the amended comprehensive plan process. At a minimum, the conservation program should address:

- conservation goals
- meter installation and routine reading
- demand reduction scheme for reducing use during shortages or peak periods
- supply reduction techniques supplier will use (such as leak detection and repair)
- conservation or seasonal water pricing
- public education initiatives, and
- source protection (wellhead or surface water).

7. An amendment in the federal priority system should be pursued to recognize Metropolitan Area water supply and downstream water quality as eligible priorities in the operation of the Headwaters Lakes. We do not propose to supersede the existing priority system, merely recognize that consideration should be given to those who rely on the flow of the river to meet basic health and economic needs.

8. The Metropolitan Council should charge the Metropolitan Waste Control Commission with incorporating an evaluation of the use of reclaimed wastewater into their decentralization study and with examining immediate use of reclaimed wastewater at each of their facilities.

9. In response to the legislative mandate in Section 473.156, an implementation program as follows should is proposed for their consideration:

a) The Metropolitan Land Use Planning Act (Section 473.851-.872) should be amended to include a public facilities section that contains the following required 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/additions to the system, including the 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 addresses at least emergency preparedness, demand and supply conservation techniques to be used, pricing methods that could be used to reduce demand, conditions under which actions would occur, a process for reducing nonessential uses according to the state priority system, and the nature of the public education program that will be used to inform the public of the need to conserve and methods available to achieve conservation;

- An indication of the possibility for joint efforts with neighboring communities or other official entities for such efforts as sharing water sources and treatment, interconnecting for routine or emergency supply, pursuit of alternative supplies, and ground and surface water source protection;

- A statement of 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;

- For those communities served by ground water, 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 forward its public facilities plan.

b) Review of the amended local comprehensive plans should occur as outlined in the law, with the addition of review and comment by the county if the county has an adopted ground water plan under Section 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 Chapter 103G should be amended to require the following:

- Examination of each appropriation permit within five years so that 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 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;

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

- 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 Metropolitan Water Supply Fund should be established to provide the funds needed to plan and implement regional water supply improvements. The initial funds required to develop the database, modeling tools, conservation guidelines, refinement of alternatives and definition of future needs should be provided through a $1 million appropriation from the legislature. Suggestions for continuation of the 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 following recommendation f).

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

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

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

- Preparation of technical assistant 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 report; if the program as outlined does not address the problems, the Council should propose additional actions, including the formalization of water as a "metropolitan system", to achieve the desired result; the Council's report to the legislature should also contain a recommendation for further implementation of a Metropolitan Water supply Fund.

g) Legislative consideration should be given to formalization of an organization of parties dealing with, and affected by, the Mississippi River within the state of Minnesota. 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.