DROUGHT OF 1988

EXECUTIVE SUMMARY

MINNESOTA DEPARTMENT OF NATURAL RESOURCES
Division of Waters

JANUARY 1989

THE DROUGHT OF 1988

1988 will be remembered as the Year of the Drought as illustrated by the following statistics:

- Minnesota April through July precipitation at 6.61 inches was the second driest in the last 100 years.
- May through August average temperature at 69.7 degrees was nearly 2 degrees higher than the old record set in 1936.
- Minneapolis-St. Paul Airport had 44 days with 90 degrees or more. The old record had been 36 days in 1936.
- Groundwater levels throughout the state reached record low levels.
- The Mississippi River at St. Paul reached low levels previously experienced only in 1934 and 1976, prompting the first ban of outdoor water use in Minneapolis and St. Paul.

IMPACTS

AGRICULTURE - The most devastating impacts of the drought were felt by the state's agriculture community. Data from the Minnesota Agricultural Statistics Service show 1988 average corn yields at 74 bushels per acre, down from a record high 127 bushels per acre in 1987. The reduction in yields from 1987 to 1988 for soybeans, wheat and sugar beets were 33 percent, 43 percent and 29 percent, respectively.

FOREST RESOURCES - The DNR Division of Forestry estimates that 47 percent of the 66,000 acres of trees planted in Minnesota in 1987 and 1988 were affected by the drought. These seedlings as well as mature trees are now much more susceptible to insect and disease damage; the full impact of which may not be known for several years.

POWER PRODUCTION - The NSP plant at Monticello suffered periodic power production losses of as much as 160 megawatts due to cooling problems. During the peak power demand period, NSP purchased approximately 25 percent of the electrical demand.

PUBLIC WATER SUPPLY - Restrictions on nonessential uses were instituted throughout the Twin Cities, including the first total ban of outdoor water use in Minneapolis and St. Paul. The drought demonstrated the continuing need for conservation measures to reduce water demand and also the need for alternative water supplies.

INSTREAM FLOW - Large areas of dry or nearly dry river channels were observed, however, the impact of the drought on fish and wildlife is unclear. The PCA and Metropolitan Waste Control Commission concluded that dissolved oxygen levels in the Mississippi River held up well during 1988 considering the low flow and problems caused by the Minnesota River.

TOURISM - The drought did not appear to hurt the tourism industry. The Minnesota Office of Tourism conducted an informal survey of 44 motel/hotel, resort and campground owners. Sixty-four percent indicated that business improved over the previous summer, 11 percent indicated a decline of business while 25 percent said it stayed the same.

CHRONOLOGY

THE WET YEARS (1977 - 1986) - During the 10 year period from 1977 to 1986, Minnesota experienced some of the wettest conditions on record. The surplus was the equivalent of two additional years of normal precipitation. Then with extraordinary speed and magnitude, the climate reversed itself beginning in October of 1986. Figure 1 shows the 5-year precipitation departure from normal up to the end of the wet cycle.

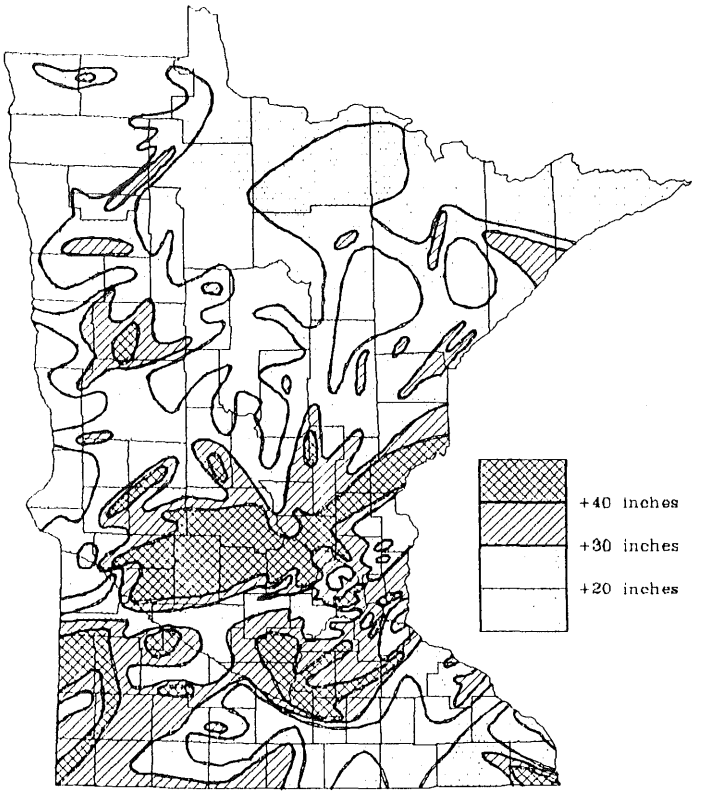

Figure 1
1982 -1986 Total Precipitation Departure from Normal

During the mid-1980's, flooding was the major water-related concern in Minnesota. Dozens of landlocked lakes rose to high levels flooding hundreds of lakeshore homes and cabins. Lake Pulaski in Wright County was undoubtedly the most publicized.

1987 - The winter of 1986-1987 was one of the warmest and driest in Minnesota's recorded history. Many areas were virtually snow-free all winter. The dry and warm conditions persisted through spring and early summer of 1987. For 1987 a large portion of Minnesota was four to eight inches of precipitation below the long-term average. However, stored soil moisture reserves from the previous year supported high agricultural yields in most areas. The Twin Cities metro area experienced two spectacular yet geographically isolated rainfall events in July, exceeding 16 inches at some urban locations.

1988 - The 1988 growing season began with a soil moisture deficit in all but north central and northeastern Minnesota. Spring is typically a period of recharge when soil moisture reserves are replenished and little water is drawn from the soil by vegetation. The April-May combined totals were generally less than 75 percent of normal and in northwest and west central Minnesota less than 50 percent of normal. Abnormally high temperatures (5 to 8 degrees above normal), low relative humidity, and high winds teamed to dry soils even further.

By the end of May the National Weather Service categorized northwest, west central, central, and east central Minnesota in an "extreme drought". The rest of Minnesota was placed in the "mild drought" category.

June 1988 - The drought intensified in June. In Minneapolis-St. Paul, a paltry 0.22 inches of rain fell for the month of June, making it the driest June ever recorded in the metro area. The combined effects of a dry fall, a poor spring recharge, and a dry and hot summer began to elicit comparisons with the Dust Bowl years of the 1930's. June was a month of heightened awareness:

- The Star Tribune published over 70 drought-related articles during June.
- On June 21, the Drought Task Force held their first meeting.
- The first suspension of surface water appropriation permits occurred on the Elk River on June 22.
- On June 30, the DNR, NSP and the cities of Minneapolis and St. Paul agreed to a water conservation plan if the Mississippi River flow dropped below 1000 cubic feet per second (cfs) at Anoka.

July 1988 - The drought continued to deepen through July. A large area of Minnesota received less than 50 percent of normal rainfall for the April through July period (Figure 2). May through July 1988 was the warmest and driest such period on record in many counties. The hardest hit areas continued to be west central and central Minnesota. By the end of July all but northeastern Minnesota was in the "extreme drought" category.

The primary concern of public officials in the Twin Cities was to ensure sufficient flow in the Mississippi River for: 1) waste assimilation downstream of the Pig's Eye wastewater treatment plant; 2) power production and 3) municipal water supply. The Mississippi River at Anoka dropped below 1000 cfs for 72 consecutive hours. This level was reached on July 25 - 27, resulting in the first total ban of nonessential water use in Minneapolis and St. Paul on August 1.

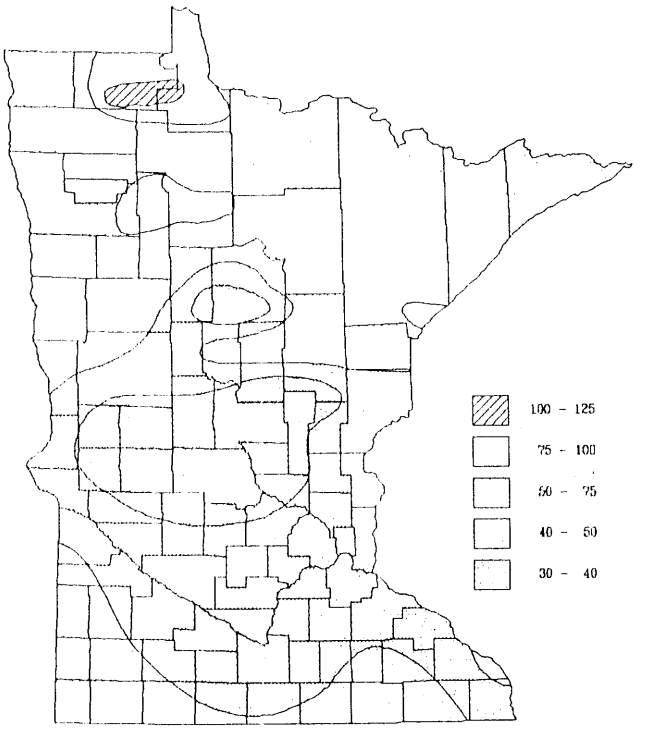

Figure 2
Percent of Normal Precipitation (April 1 - July 25, 1988)

August - November 1988 - A shift in the atmospheric circulation patterns brought wet weather the first week of August and rains returned periodically throughout the month. While the drought did not end, its intensification was curtailed. The majority of the state received normal to above normal precipitation for the first time in 1988. Unfortunately the August rains were too late to rescue much of the agricultural production. The return to "normal" precipitation generally continued throughout the fall months. These rains helped recharge soil moisture levels.

Hydrologic Effects

STREAMFLOW - The dry conditions throughout the state since fall of 1986 set the stage for abnormally low streamflow in the spring and summer of 1988.

Mississippi River flow data for 1988 are compared with data for 1934 in Figure 3. Flow rates in 1934 were similar to those of early summer 1988. However in 1934 the Mississippi River did not benefit from heavy August rains and therefore continued low throughout late summer and early fall. Streamflow projections by the National Weather Service suggested that the Mississippi River would have equalled or even dropped below 1934 levels had the rains not returned in August.

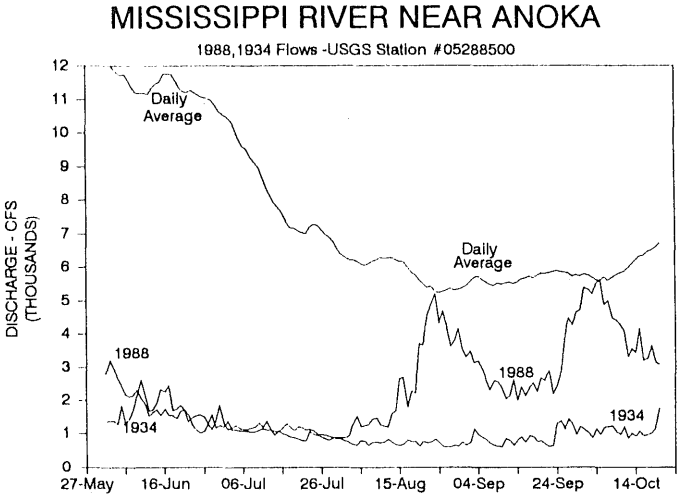

Figure 3
Mississippi River Streamflow Comparison (1934 and 1988)

Headwater Reservoirs - The near record low flow of the Mississippi River prompted consideration of alternatives to supplement flow in the river. One alternative was to release additional flow from the Mississippi River Headwater Reservoir system, built by the Federal Government in the late 1800's and early 1900's (Figure 4).

On July 28, 1988, Governor Perpich requested the U. S. Army Corps of Engineers (COE) to release an additional 300 cfs from Lake Winnibigoshish. On August 3, the COE declined, citing recent rains in the northern part of the state. At the time of the request, all reservoirs were below their normal summer operating range, although Winnibigoshish had been above the minimum operating range for most of the summer. Heavy rains in early August in northern Minnesota caused the levels of Winnibigoshish and Pokegama to rise into their normal summer range, at which time outflow rates from these two reservoirs were increased.

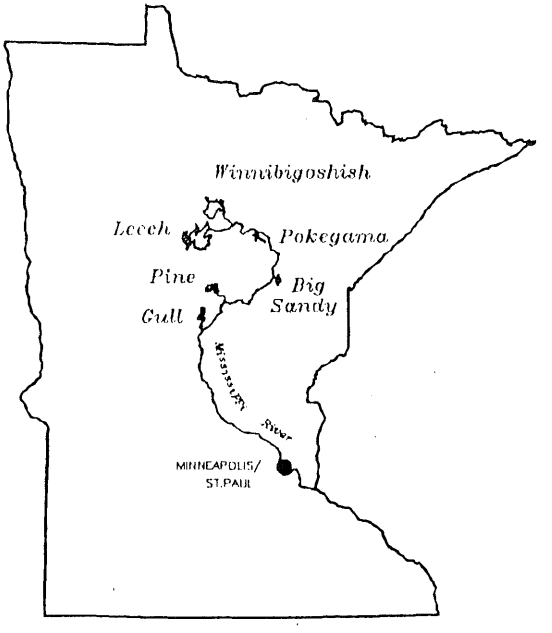

Figure 4
Mississippi River Headwater Reservoirs

REGULATORY ACTIVITIES

WATER APPROPRIATION PROGRAM - Of the 4,200 permitted irrigators in the state, 1,200 pump from surface water sources. Irrigation permits issued for surface water are intended as a supplemental supply in years of normal precipitation. Unfortunately, the times when crops need water often coincide with times of low surface water levels. Therefore the DOW has encouraged irrigators since 1975 to use groundwater when an adequate supply exists.

1988 Drought - While the drought affected all rivers in Minnesota, the smaller rivers were the first to show the greatest impact. Suspension of appropriations within some of these smaller watersheds was instituted to protect the instream flow requirements and the rights of higher priority water users.

During the summer of 1988, appropriation permits were suspended in 13 watersheds where river levels were at critically low levels or were below established protected flows (Figure 7). A total of 195 surface water permits were suspended including 167 for agricultural irrigation, 17 for golf courses and 11 for other types of appropriations.

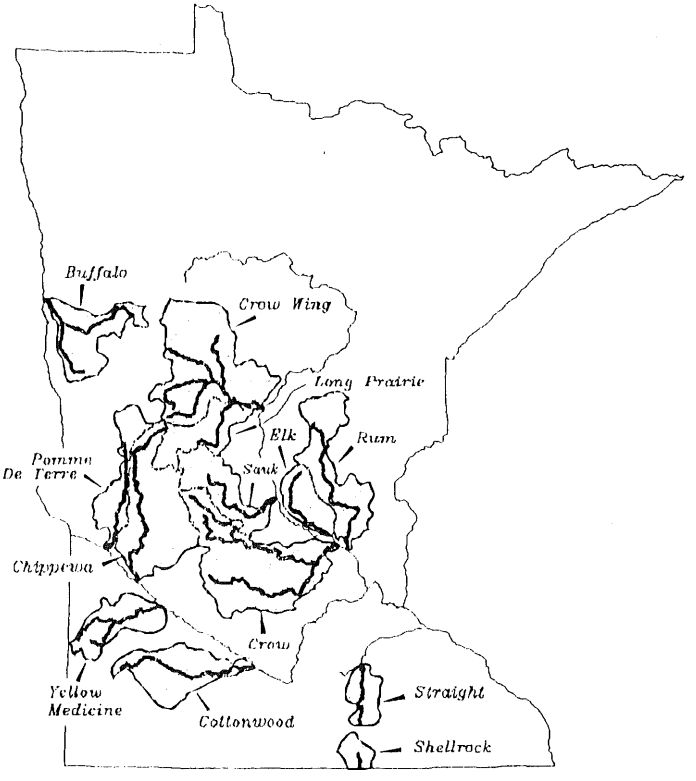

Figure 7
Watersheds with Suspended Appropriation Permits (Summer 1988)

Well Interference - There were many inquiries from domestic well owners alleging well interference due to irrigation. However, there have been only 21 formal complaints received so far. Without adequate recharge there may be many more well interference situations this year.

PROTECTED WATERS PERMITS - While the major focus of the DOW this past year has been on appropriations, there has also been a dramatic increase in the number of permit applications for work in a protected water. Navigational access became a number one priority for many lakeshore owners. Also, the generally lower water levels in streams and lakes provided the opportunity to complete projects previously not required or feasible during the years of generally high water levels.

OUTLOOK FOR 1989

At the end of November 1988, the National Weather Service Climate Analysis Center still classified seven of nine Minnesota regions as having drought indices of "mild to severe" drought. Only the north central and northwest regions have "moist" indices. Much of the state still requires more than 4 inches of precipitation over normal amounts to reduce the drought severity index to zero. Without adequate spring moisture the outlook for the 1989 growing season will be as sketchy as it was entering 1988.

The slightly above normal September through November rains have led to a partial recovery of soil moisture in much of Minnesota. Being more dependent on runoff for replenishment, lakes and rivers will be slower to recover. Groundwater can be expected to gain only after soil moisture reserves and surface water systems have returned to a more normal state.

Even with normal amounts of precipitation throughout 1989, drought conditions will not necessarily vanish. The timing of rainfall and temperatures can be as important as the amount of rainfall. A hot, dry spring could easily deplete soil moisture in the upper portions of the soil profile. Moderate temperatures and timely rains for seed germination and plant growth throughout the growing season will be required for reasonable farm yields.

FUTURE CONSIDERATIONS

The fact that Minnesota is blessed with abundant water does not preclude periodic shortages. The 1988 drought dramatically illustrates how quickly several years of excess precipitation can change to widespread drought. As the state's population, industry and power production needs increase, so too will the demand for high quality water. Future conflicts over the allocation of water will also increase unless alternative supplies are developed and increased conservation measures are employed.

This past summer also demonstrated the continuing need for wise land use management. The Minnesota River dramatically demonstrates the consequences of uncontrolled soil erosion and nonpoint source pollution. Symptoms include a river channel clogged with sediment, baseflow reduced by the continual drainage of wetlands and extremely poor water quality.

POSITIVE ASPECTS - The Drought Task Force established by Governor Perpich should be at the top of the list of positive aspects of the 1988 drought. The task force presented an excellent opportunity for numerous public agencies and private organizations to discuss all aspects of the drought. All sides had the opportunity to present their side of the story. At each meeting the most up-to-date and best available information was presented, limiting the spread of rumors and misinformation.

Many actions were taken to communicate with the general public in an effective and meaningful way. The media stayed involved throughout the drought, generally providing excellent coverage and presenting all sides of the issues.

FUTURE ACTIONS -

1. Re-evaluate the Current Water Allocation Framework.

No water allocation policy can be expected to resolve all problems arising from a constraint on water supplies. Therefore, current statutes and rules should be re-evaluated and more appropriate guidelines and procedures should be established. However, proposed changes to the water use priorities need to be based on actual, rather than perceived, conflicts with the existing system. Water appropriation rules also need to be updated to reflect new trends in water use like pumpouts for contamination confinement and removal.

2. Expand Data Collection Activities.

The 1988 drought highlighted the importance of accurate, timely data to informed and effective planning and policy decisions. Three specific areas need improvement:

Instream Flow Requirements - The protection of instream flow values is not an exact science. The 1988 drought provided a good opportunity to test theories and the existing water allocation program, especially for surface waters. However, much work and study is still required to improve our ability to establish reasonable protected flows.

Data - The second major area that needs work is the availability of streamflow and groundwater data. Expanded data collection of both surface and groundwater are needed for crisis management and program implementation and evaluation.

Groundwater Investigations - Groundwater is the predominate source of water supply throughout Minnesota. The current drought heightened the awareness that groundwater supplies are not uniformly distributed and that some areas may not have enough groundwater to satisfy everyone's needs. In order to further the management of groundwater supplies to assure long-term availability for all users, additional studies are needed to assess the yield potential of aquifers throughout the state and to study the ground/surface water relationship.

3. Expand Water Conservation Measures.

The most effective conservation measures are taken by individual water users at the local level. A water conservation program which would provide public education and technical assistance for local conservation planning is needed.

4. Establish Surface Water Allocation Plans.

The water use priorities are important in allocating available water above resource protection limits. However, allocation planning is needed to provide the maximum use of limited water supplies among all users within a priority class. Allocation plans are developed for surface water sources by local water users within a defined area. Because all water users must agree to the allocation plan to make it work, existing and proposed users are responsible for the actual development of allocation plans. This provides local participation in planning and resolution of water user conflicts to better serve local interests. The DNR will assist with the development process.