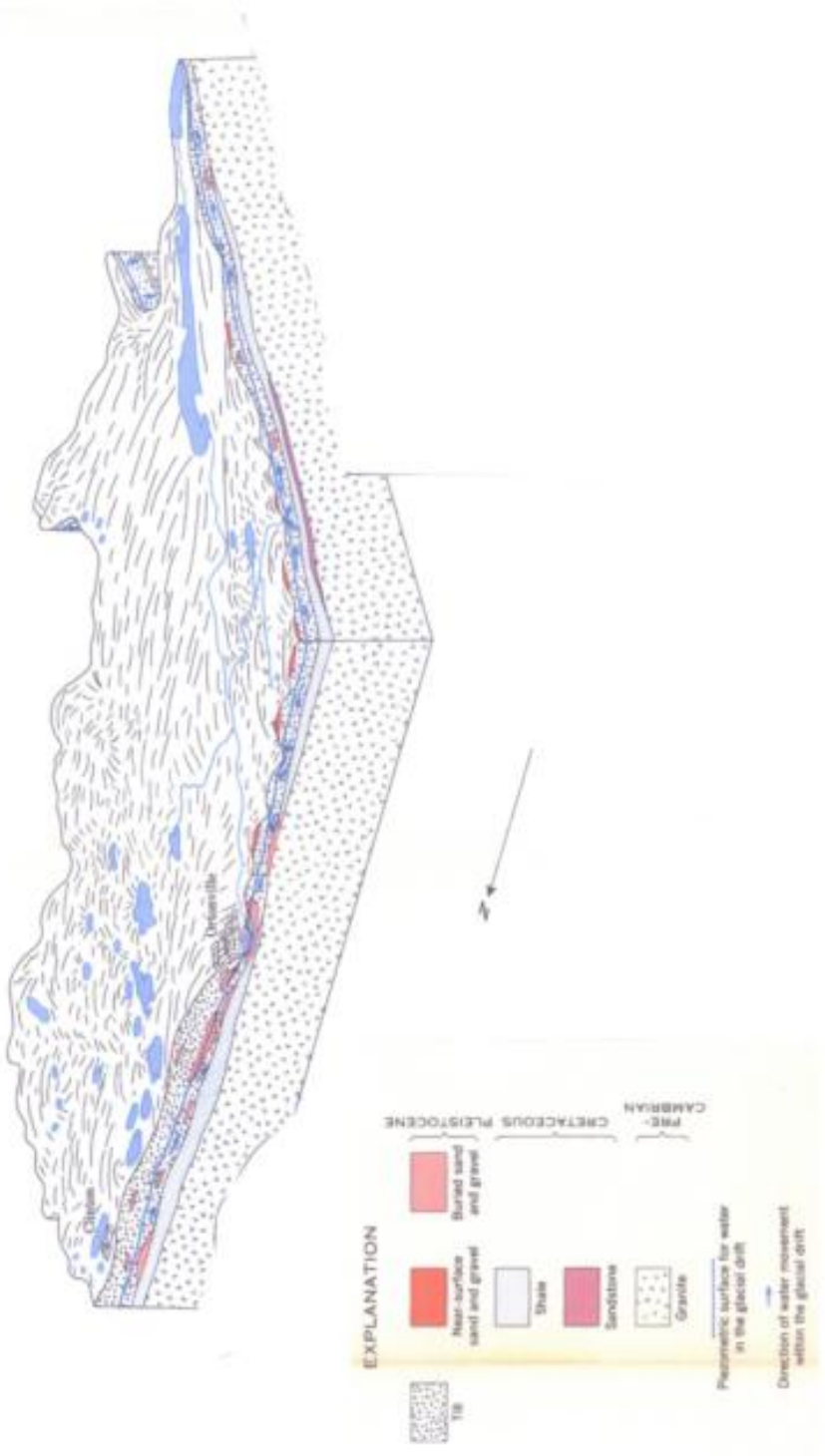
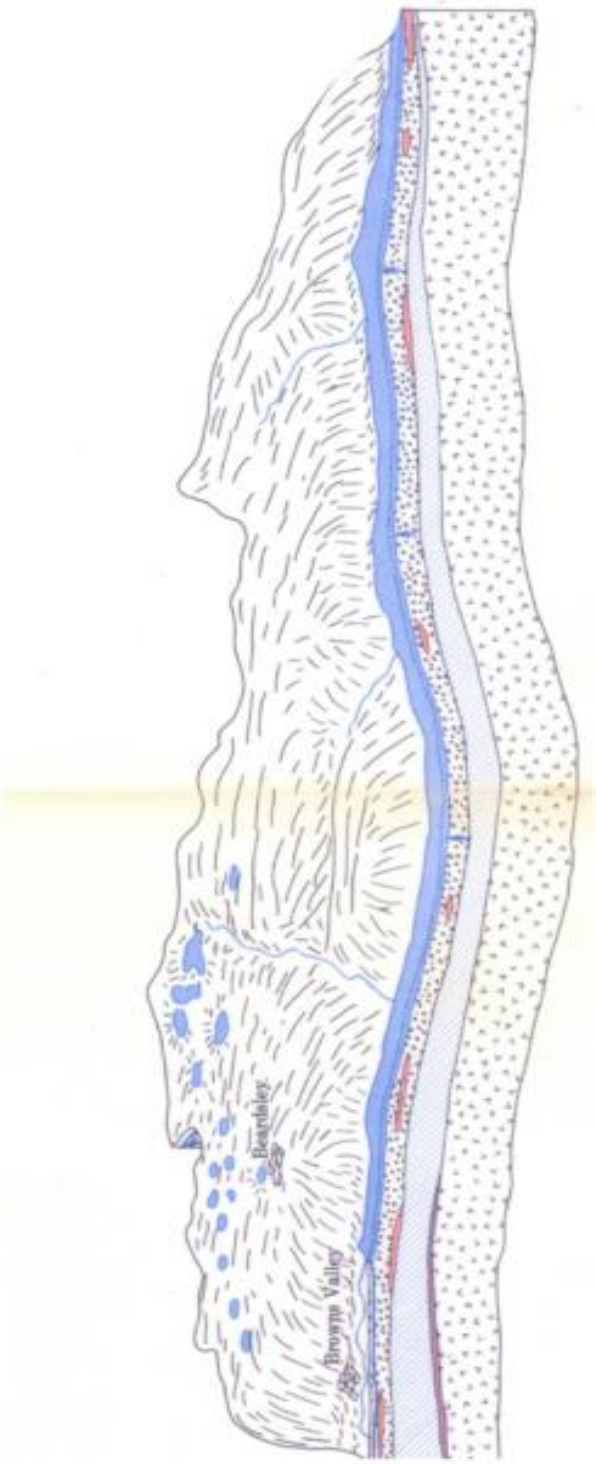
Appendix C

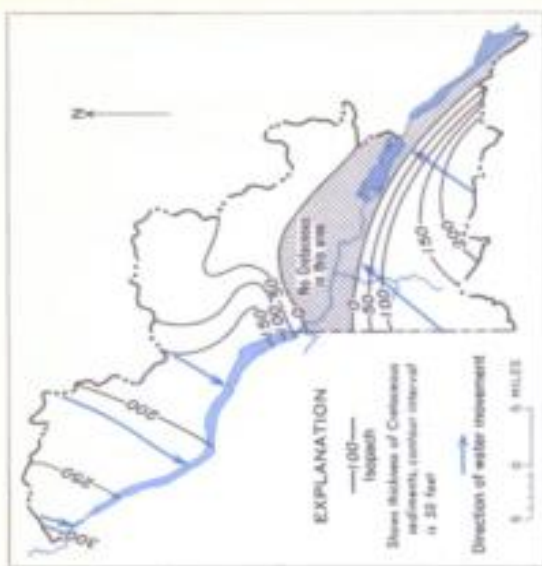
Ground Water Information

10 YEAR PLAN UPDATE

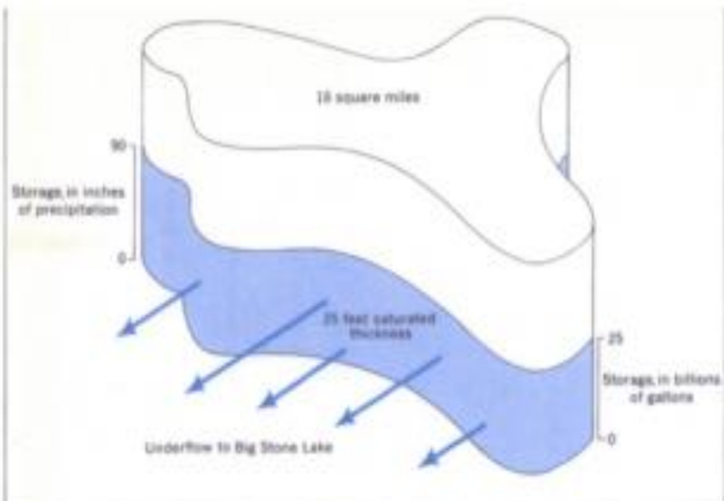

Ontario
Orleans
N
EXPLANATION
PLEISTOCENE
CRETACEOUS
PRE-CAMBRIAN
Buried sand and gravel
Near-surface sand and gravel
Shale
Sandstone
Granite
Piezometric surface for water in the glacial drift
Direction of water movement within the glacial drift
Till


Beardsley
Browns Valley

GLACIAL DRIFT.—The probability of a well tapping several aquifers in the drift is greatest where the drift is thickest (See block diagram)



CRETACEOUS SEDIMENTS.—Wells tapping Cretaceous sediments are concentrated within the area where these sediments are over 100 feet thick

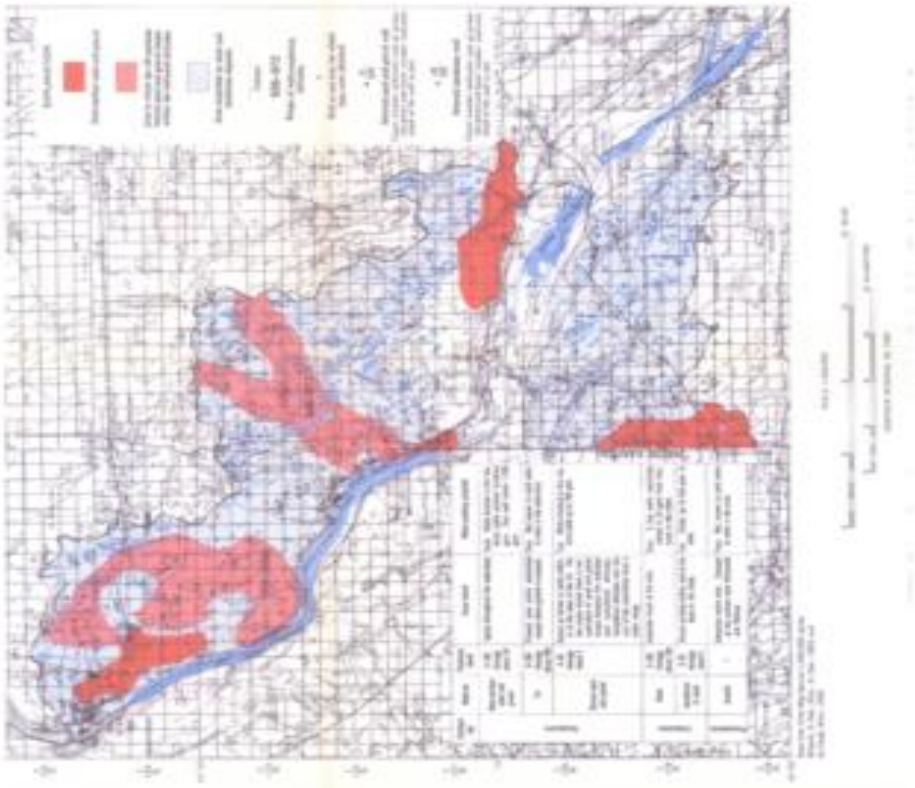


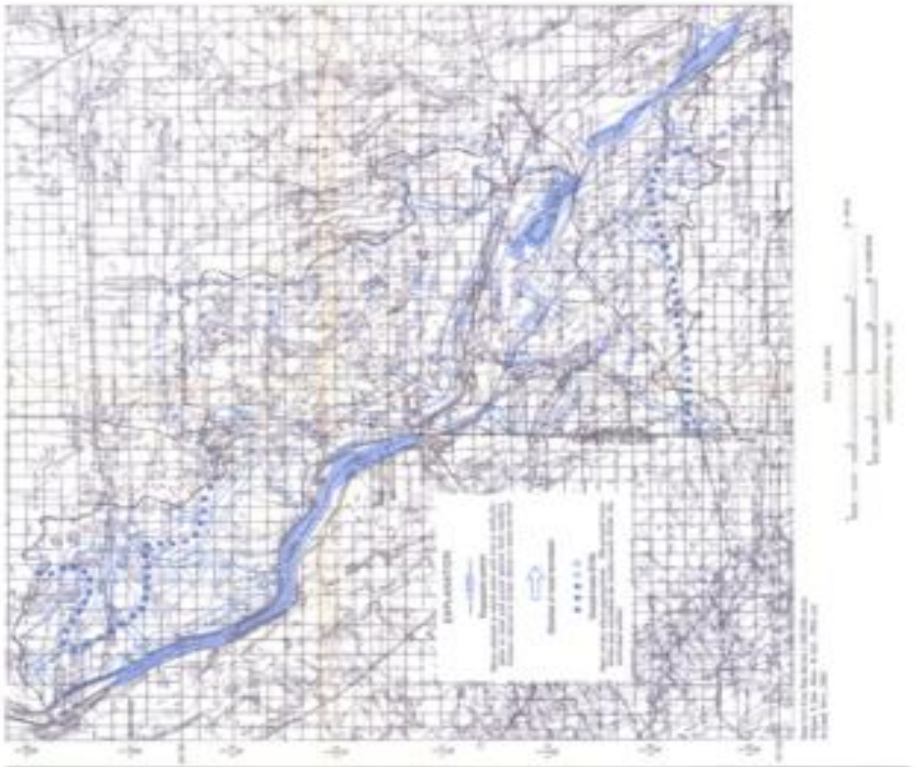
AN EXAMPLE OF THE NEAR-SURFACE SAND AND GRAVEL AQUIFER NEAR BEARDSLEY.—*Using an estimated permeability, it is calculated from Darcy's Law that about one billion gallons of ground water leaves this aquifer each year*

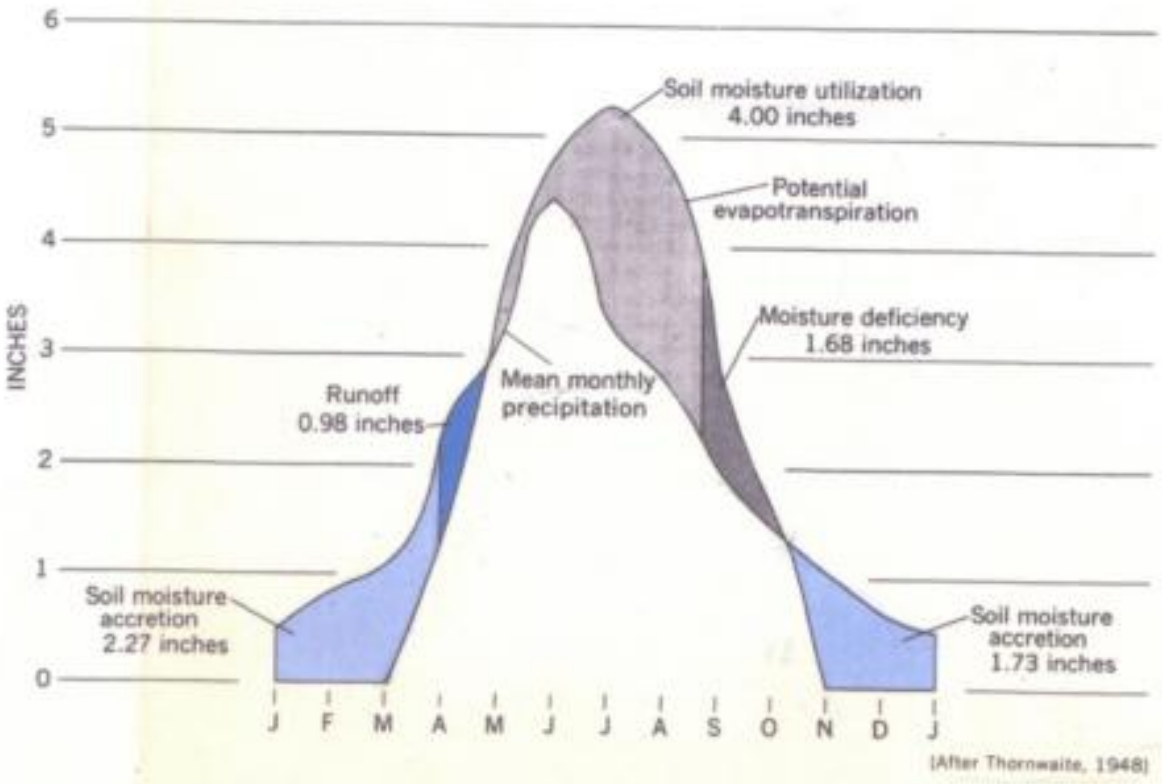
THE GROUND-WATER POTENTIAL OF THE THREE AQUIFER TYPES.—*Few pumping tests have been conducted in the watershed (See municipal water-supply table)*

Aquifer		Domestic wells (small diameter)		Municipal wells		Industrial or commercial wells
		Range	Average	Range	Average	Range
Near-surface sand and gravel	Yield gpm	3	------	50-400	220	19-1,200
	Specific capacity (gpm/ft of drawdown)	<1	------	2-75	30	38-150
	No. of wells	1 well		9 wells		2 wells [1]
Buried sand and gravel	Yield gpm	4-125	15	250-260	255	------
	Specific capacity (gpm/ft of drawdown)	<1-15	3	13-21	17	------
	No. of wells	19 wells		2 wells		------
Cretaceous sandstone and shale	Yield gpm	7-15	11	150	------	------
	Specific capacity (gpm/ft of drawdown)	<1-10	2	7	------	------
	No. of wells	7 wells		1 well		------

[1] Wells are at Nassau (19 gpm) and Big Stone Canning Company







EVAPOTRANSPIRATION DURING THE YEAR FOR THE BIG STONE LAKE WATERSHED FOR 1945–62 WAS COMPUTED BY THORNWAITE'S (1948) METHOD.—*The diagram shows some departure between the calculated runoff and measured runoff for the watershed. Meyer's (1944) method allows the following breakdown of evapotranspiration for the watershed. Evapotranspiration from land = 56%; evapotranspiration from water = 11%; transpiration = 33%.*

GROUND WATER

1. Ground water in the watershed is from three principal aquifers.
   a. Near-surface sand and gravel aquifers are spotty throughout the watershed, but have the highest well yields. These aquifers, which are commonly exposed at the surface, receive high recharge but are more easily contaminated. The water is hard and commonly high in iron.
   b. Buried sand and gravel aquifers are present throughout most of the watershed. Well yields are low to moderate; the water is hard, and is commonly high in iron.
   c. Most of the wells in Cretaceous aquifers are in the northwest and southwest parts of the watershed. Yields are small to moderate. Most of the water is relatively soft and low in iron, but high in chloride, sulfate, sodium, and boron.
2. More ground water is available than is presently being pumped (1.4 mgd), or than is presently being discharged to surface water (3.5 mgd). Water can be salvaged from evapotranspiration losses by lowering the water table where it is near the land surface. However, lowering of the water table may result in changes in vegetation and wildlife habitat.

Aquifer	Estimated discharge to surface water (Million gallons per day)[1]	Estimated discharge to wells (mgd)[1]	Additional amount that could probably be developed by wells (mgd)[2]	Estimate of discharge to surface water (gpd/sq. mile)[1]	Estimated discharge to wells (gpd/sq. mile)[1]	Additional amount that could probably be developed by wells (gpd/sq. mile)[2]
Near-surface sand and gravel	3.5	0.9	over 4	50,000	13,000	over 60,000
Buried sand and gravel	negligible	0.4	over 12	negligible	600	over 15,000
Cretaceous sandstone	negligible	0.1	over 4	negligible	300	over 10,000

CONCLUSIONS

SUMMARY OF WATER RESOURCES IN THE BIG STONE LAKE WATERSHED

Use \ Source	Minnesota River and major tributaries	Reservoirs- Lac qui Parle Marsh Lake Big Stone Lake	Small lakes and minor streams	Near-surface sand and gravel	Buried sand and gravel	Cretaceous sandstone
Municipal and industrial supply	Favorable location Adequate flow with development of storage facilities Storage necessary Treatment necessary No flow in droughts Flood damage	Favorable location Adequate storage capacity for present demand Adequate inflow Enlargement possible Treatment necessary Limited usable storage capacity without further development	Wide distribution Limited capacity Limited inflow Many dry up in droughts Treatment necessary	Several favorable locations High well yields Rapid recharge Limited distribution	Wide distribution Limited recharge Low to moderate well yields	Fair distribution Quality often unsuitable Low well yields
Rural-domestic and stock supply	Adequate for stock Restricted areal distribution Treatment necessary for domestic use No flow during droughts	Adequate storage capacity Adequate inflow Restricted areal distribution Treatment necessary for domestic use	Wide distribution Treatment necessary for domestic use Many dry up Limited inflow	Adequate well yields Restricted areal distribution	Wide distribution Adequate well yields	Fair distribution Adequate well yields "Soft" water preferred by some Quality may be undesirable May be better water at a shallower depth
Irrigation supply	Adequate flow with development of storage facilities Storage required Low flow during irrigation season Restricted areal distribution	Adequate storage capacity Adequate inflow Enlargement possible Restricted areal distribution Limited usable storage capacity without further development	Wide distribution Limited storage capacity Limited inflow Many dry up during irrigation season	High well yields Rapid recharge Restricted areal distribution Soil formed on aquifer may be too permeable to irrigate	Wide distribution Limited recharge Low to moderate yields	Fair distribution Limited recharge Low yields Quality often unsuitable
Recreation	Favorable location Suitable for fishing and hunting Variation in flow	Adequate area and depth Favorable for hunting and watersports Camping sites at parks Enlargement possible	Wide distribution Favorable for water-sports on a few lakes Hunting areas on many lakes and swamps Shallow Many dry up during droughts			
Fish and wildlife habitat	Suitable for wildlife along banks Variable streamflow	Marsh areas suitable for wildlife habitat Conservation pools maintained Floods	Scattered marsh areas Excellent for wildlife habitat Shallow Many dry up			

EXPLANATION

Color—indicates relative worth of source over entire watershed

Good

Fair

Poor