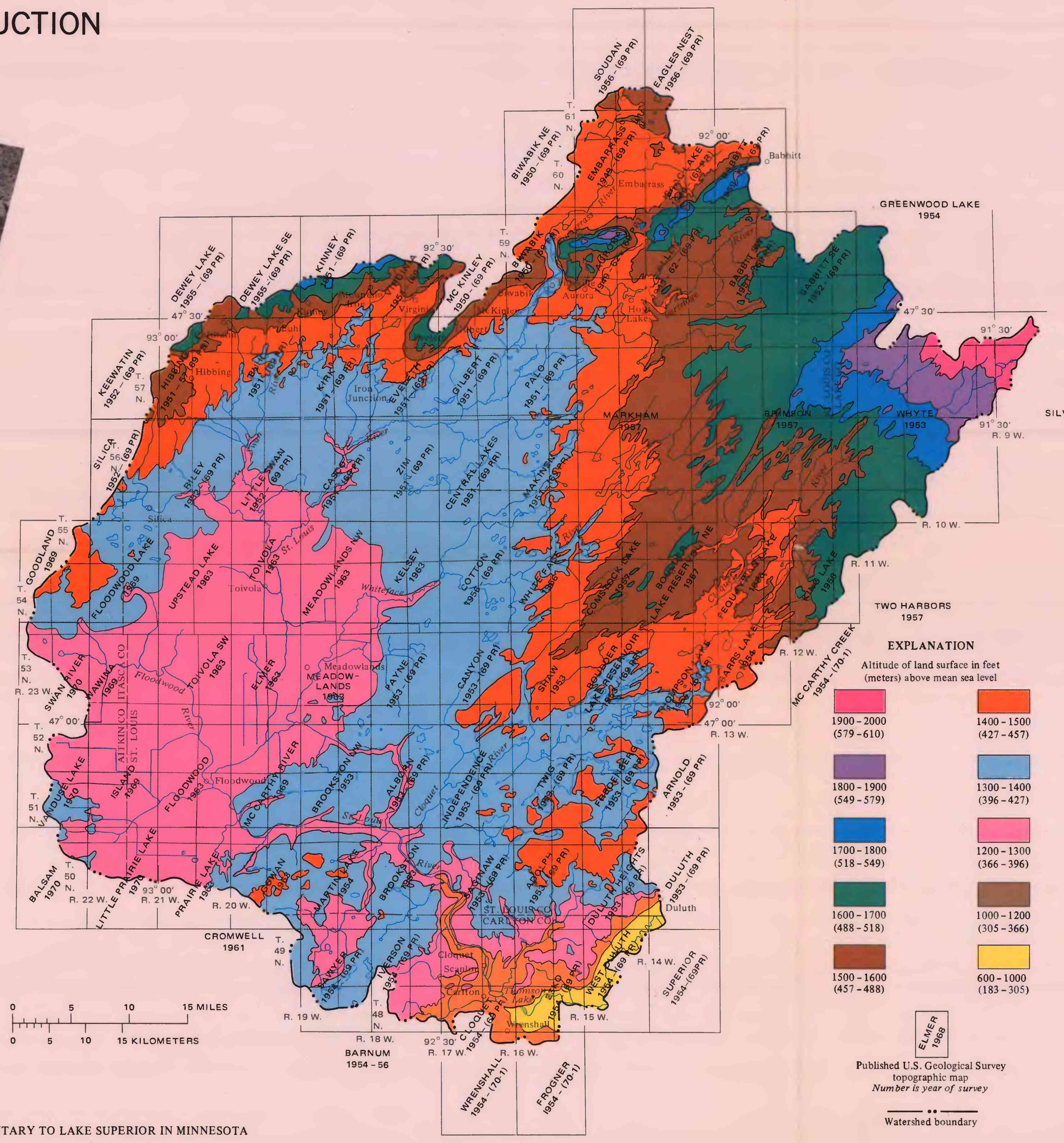
INTRODUCTION



THE ST. LOUIS RIVER IS THE LARGEST TRIBUTARY TO LAKE SUPERIOR IN MINNESOTA

It drains a predominantly forested area of about 3,650 mi² (Minnesota Department of Conservation, 1959) and discharges into the lake at Duluth.

The Mesabi Iron Range, noted for rich deposits of iron ore, parallels much of the northern watershed boundary. [illegible]

Details of topography can be obtained from 7½- and 15-minute quadrangle maps, indexed above.

The watershed is sparsely settled except for its northern and southeastern parts. About 80 percent of the urban population lives on the Iron Range. Most of the suburban and rural residents also live on or near the range or in the southeastern part of the watershed. Total population (1970), exclusive of those in the city of Duluth, which is included in the Lake Superior watershed (Olcott and others, 1976), was about 117,000.

WATER BUDGET

OVER A LONG PERIOD OF TIME THE AMOUNT OF WATER ENTERING THE WATERSHED IS EQUAL TO THE AMOUNT OF WATER LEAVING. A SUMMARY OF EACH OF THE MAJOR ITEMS IN THE WATER BUDGET FOLLOWS. THE PERIOD OF RECORD IS 1931 - 74.

PRECIPITATION (P)

For practical purposes, it is assumed that all water enters the watershed as precipitation. Precipitation generally increases from west to east. It is greatest in June, July, and August, when rainfall accounts for about 40 percent of the annual total. It is least in December, January, and February, when snowfall accounts for about 10 percent of the annual total. Monthly variations in precipitation at the Cloquet station are shown in the graph at right. Average annual precipitation on the watershed is 27.5 inches.

RUNOFF (R)

Runoff from about 95 percent of the watershed is determined at the gage on the St. Louis River at Scanlon. The figure used in the water budget is not adjusted for changes in content in reservoirs in the Cloquet and Whiteface River basins and, thus, represents the actual amount of water flowing past the gage. Adjusted monthly variations in streamflow are shown in the graph at right. Average unadjusted annual runoff from the watershed is 9.7 inches.

CHANGE IN STORAGE (S)

Over a long period of time, gains and losses in ground-water and surface-water storage are equal. The opposite is true for a short period, depending upon several factors, most notable of which are climatic variations. Long-term changes in ground-water storage in the drift and Buvalik Iron-formation are shown by the well hydrographs at right. For purposes of the budget equation, change in storage is assumed to be zero.

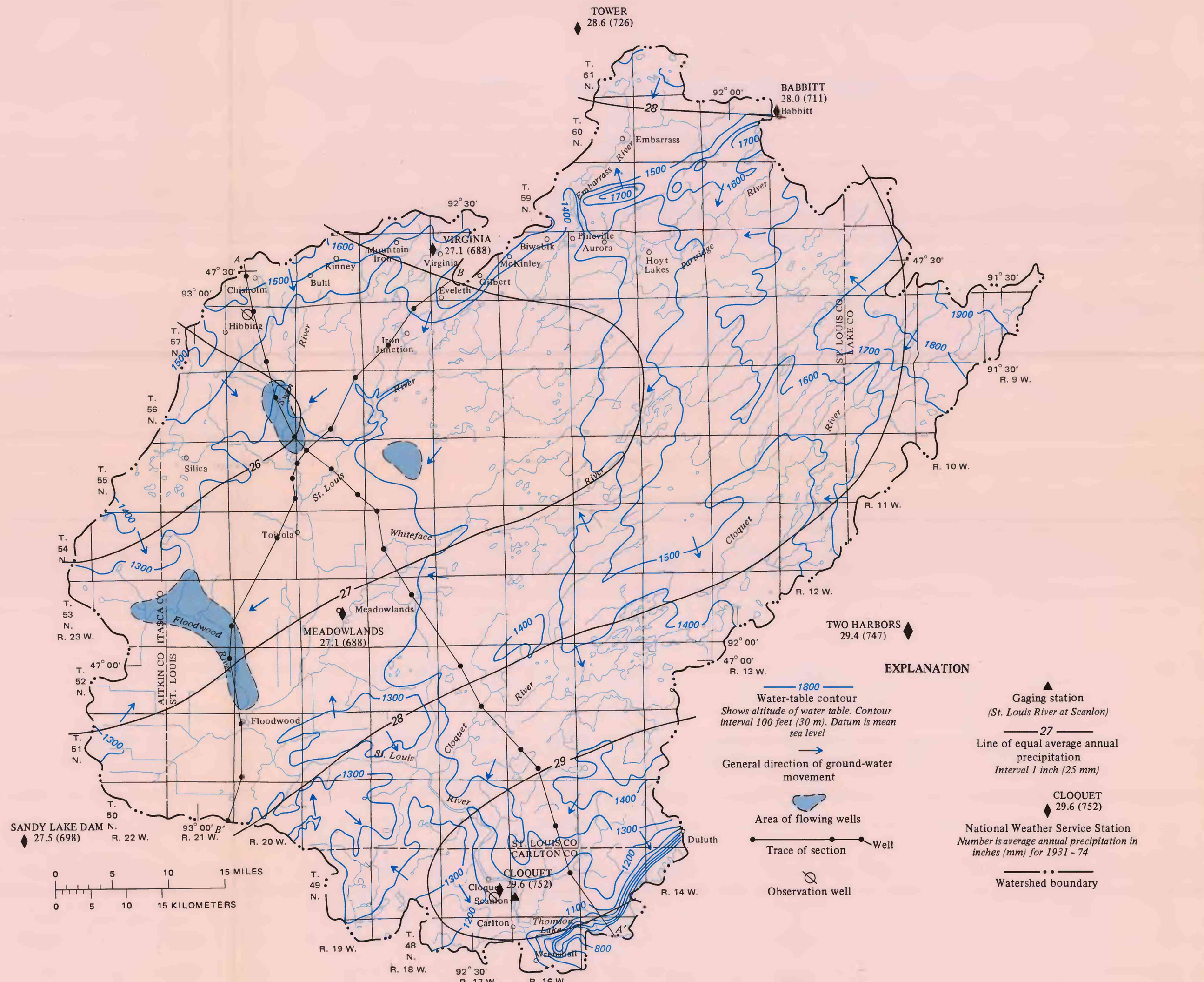
UNDERFLOW (U)

Ground-water divides largely coincide with surface-water divides, so ground-water flow into the watershed is considered to be negligible. In the extreme southeastern part, less than 0.05 inch of water was calculated to move out of the watershed as underflow. For purposes of the budget equation, underflow is assumed to be zero.

EVAPOTRANSPIRATION (ET)

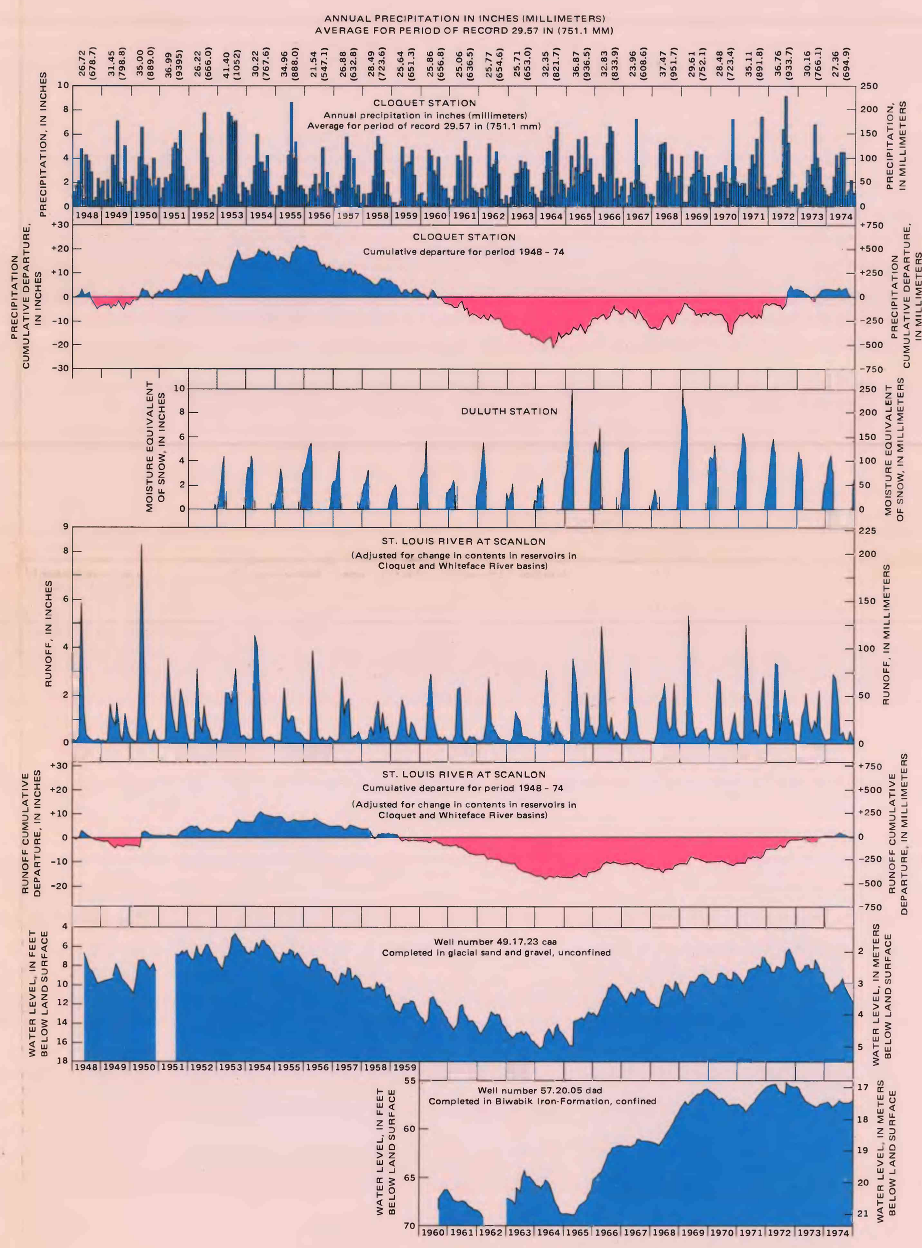
About 65 percent of the long-term water loss is evapotranspiration. In this report, evapotranspiration is assumed to be the difference required to balance the budget equation. About 65 percent of total annual evapotranspiration takes place during June, July, and August, when precipitation and temperature are highest. Average annual evapotranspiration is 17.8 inches.

BASED ON THE ABOVE FIGURES, 1.7 TRILLION GALLONS OF WATER IS ESTIMATED TO MOVE ANNUALLY THROUGH THE WATERSHED, 1.5 PERCENT OF WHICH IS PRESENTLY BEING USED FOR PURPOSES OUTLINED IN THE WATER-USE SECTION ON THIS SHEET.



$$P = R \pm \Delta S \pm U + ET$$

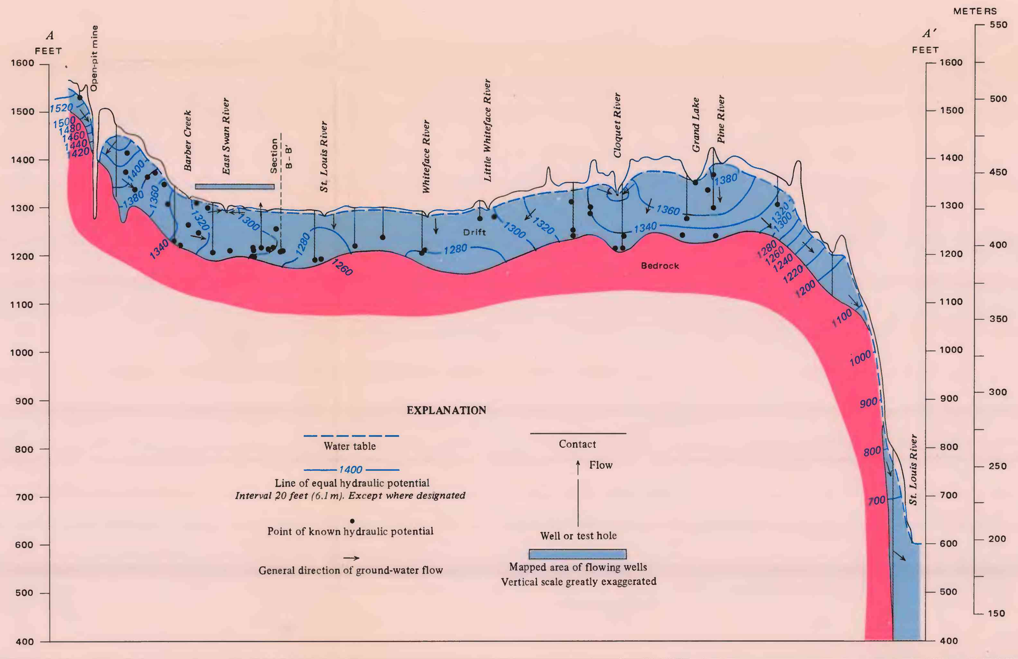
27.5 in (698 mm) = 9.7 in (246 mm) ± 0 ± 0 + 17.8 in (452 mm)



THE RELATIONSHIP OF PRECIPITATION (WATER ENTERING) TO RUNOFF (WATER LEAVING) AND GROUND-WATER LEVELS (CHANGES IN STORAGE) ARE INDICATED GRAPHICALLY ABOVE

Over a long period, cyclical precipitation variations and their effect on the hydrologic system become apparent. Above normal precipitation in the late forties and early fifties, and in the late sixties to early seventies, resulted in increased runoff and rising ground-water levels. Below normal precipitation in the late fifties and early sixties resulted in decreased runoff and declining ground-water levels. Timeliness and amount of precipitation are important, as indicated by the relationship of moisture stored as snow both to amount of runoff and to ground-water levels. When large amounts of snow melt in the spring, runoff and ground-water levels are correspondingly high.

Data suggest that a precipitation cycle of 15- to 20-year duration occurs in the watershed and should be considered when interpreting long-term hydrologic variations.



THE MESABI IRON RANGE IS A MAJOR RECHARGE AREA FOR THE WATERSHED'S REGIONAL GROUND-WATER SYSTEM (MAP ABOVE AND SECTIONS)

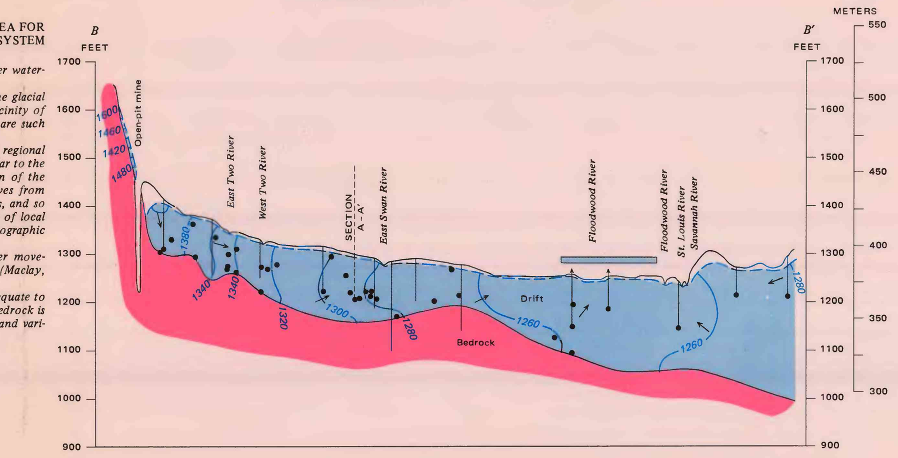
Less significant recharge areas are along topographically lower watershed boundaries elsewhere.

Regional discharge is to major streams and to wetlands in the glacial lake plain in the western half of the watershed. In the vicinity of some streams that dissect the lake plain, hydraulic heads are such that many wells flow (map and sections).

The water-table map above shows the general direction of regional ground-water movement. Water moves generally perpendicular to the water-table contour lines that define the head distribution of the shallowest ground water. Water in local flow systems moves from topographic highs toward topographic lows, streams, lakes, and so forth (not apparent at illustration scales). The complexity of local flow systems can be surmised by examining the detailed topographic maps.

Near open-pit mines on the Iron Range, natural ground-water movement is altered and water flows northward, toward the pits (Maclay, 1966, Lindholm; 1968).

Water movement is defined only in the drift, for data are inadequate to define movement in the bedrock. Water movement in the bedrock is undoubtedly complex because of diversity of rock types and variability of hydrologic characteristics.

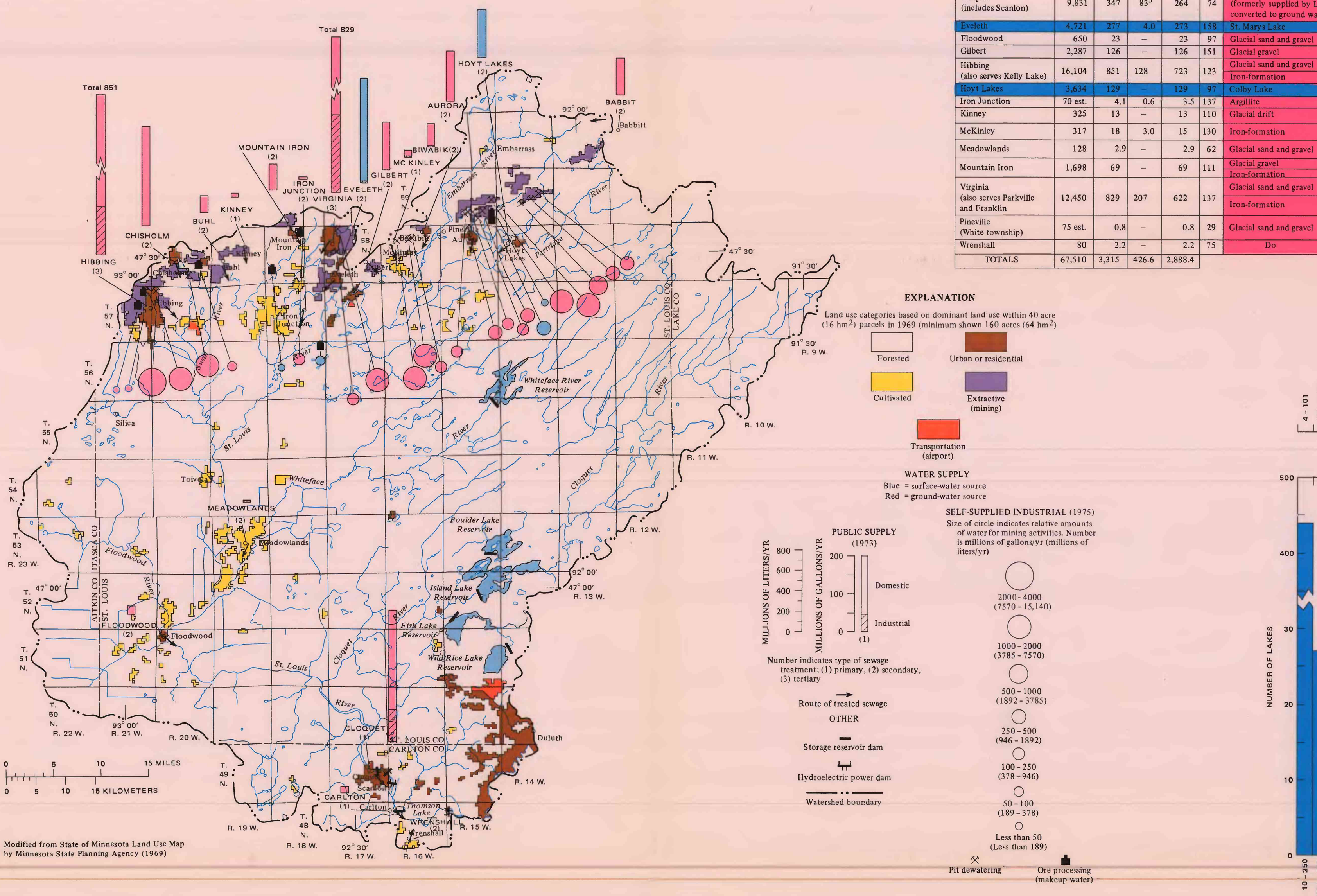


WATER USE

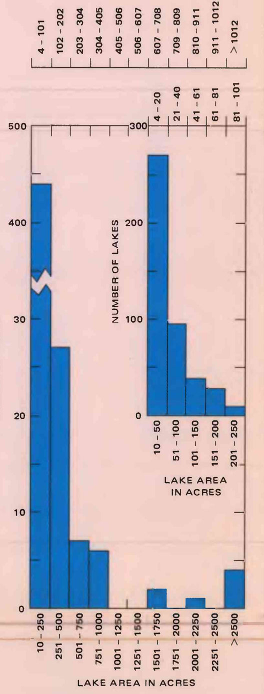
MUNICIPAL SUPPLIES

Municipality	Population (1970)	Total annual pumpage (millions of gallons)	Annual industrial use (millions of gallons)	Annual domestic use (millions of gallons)	Per capita domestic use (gal/day)	Water source	Number of wells	Well depth (feet)	Static water level (feet below land surface)	Available drawdown[1] (feet)	Specific capacity (gallons per minute per foot of drawdown)	Normal pumping rate (gallons per minute)	Year(s) sampled (single sample for each well)	Iron (Fe)	Manganese (Mn)	Sulfate (SO_4)	Chloride (Cl)	Dissolved solids (calculated)	Total hardness as $CaCO_3$
Aurora	2,531	134	–	134	145	Iron-formation	Mine pit	–	–	–	–	500	–	–	–	–	–	–	–
Babbitt[2]	3,076	99	–	99	88	Glacial sand and gravel	2	127-157	15-26	82-85	5.9-23	525-800	1966-67	0.10	<0.02-0.74	<5.0	9.0	–	110-120
Biwabik	1,483	61	1.0	60	111	Iron-formation	2	262-278	122	–	9.5	225-400	1963-64	.15-.59	.24-.54	41-49	2.6-6.9	–	280
Buhl	1,303	46	–	46	97	Do	2	593-598	145-210	–	1.4-5.0	190-325	1959-71	.24-.55	.02-.15	11-39	1.2-5.0	–	200-250
Carlton	834	19	–	19	62	Glacial drift	2	29-31	8	13-15	100	150-250	1968	.79-6.40	.02-.08	15-23	5.1-5.3	170-410	140-280
Chisholm	5,913	264	–	264	122	Glacial sand and gravel	4	42-78	10-16	24-43	2.4-15	120-325	1968-69	<.02-2.4	<.02-.43	10-43	1.0-9.2	210-260	150-250
Cloquet (includes Scanlon)	9,831	347	83[3]	264	74	Do (formerly supplied by Lake Superior converted to ground water in 1973)	6	47-113	34-55	31-35	3.0-18	120-590	–	.10	–	23	5.0	–	170
Eveleth	4,721	277	4.0	273	158	St. Marys Lake	–	–	–	–	–	800	[4]1957	.17	.06	13	3.2	93	67
Floodwood	650	23	–	23	97	Glacial sand and gravel	2	86-104	8	88	9.4	225-330	1970	<.02-4.7	.02-.11	<5.0	9.4-11	–	140
Gilbert	2,287	126	–	126	151	Glacial gravel	2	55	–	–	–	450	1972	.01-2.2	.02-3.4	26	6.0	–	95-195
Hibbing (also serves Kelly Lake)	16,104	851	128	723	123	Glacial sand and gravel	12	100-183	5-59	40-136	4.0-16	90-750	1960-70	<.02-11	<.02-1.10	5.7-110	<1-10	240-330	100-390
						Iron-formation	1	291	–	–	–	450	1960	.06	<.02	23	7.0	–	150
Hoyt Lakes	3,634	129	–	129	97	Colby Lake	–	–	–	–	–	–	1965	1.5	<.02	30	2.3	–	94
Iron Junction	70 est.	4.1	0.6	3.5	137	Argillite	1	194	32	52	–	25	1971	.44	.08	7.8	2.5	–	130
Kinney	325	13	–	13	110	Glacial drift	1	67	20	25	47	140	1970	3.3	2.0	11	3.1	–	130
McKinley	317	18	3.0	15	130	Iron-formation	Mine pit	–	–	–	–	–	–	–	–	–	–	–	–
Meadowlands	128	2.9	–	2.9	62	Glacial sand and gravel	2	62-89	22-38	18-56	2.2-4.4	22-35	1971	.18	.09	17	3.0	–	270
Mountain Iron	1,698	69	–	69	111	Glacial gravel	2	56-60	30	12-16	20	300	1967	.14-2.3	.02-.56	87-140	10-14	–	280-410
						Iron-formation	1	225	100	–	–	500	1971	.46	.16	<5	5.0	–	170
Virginia (also serves Parkville and Franklin	12,450	829	207	622	137	Glacial sand and gravel	1	94	21	48	47	1000	1962	.92	.29	16	1.0	–	230
						Iron-formation	Mine pit	–	–	–	–	1000	–	–	–	–	–	–	–
Pineville (White township)	75 est.	0.8	–	0.8	29	Glacial sand and gravel	1	100	–	–	–	25	–	–	–	–	–	–	–
Wrenshall	80	2.2	–	2.2	75	Do	2	106-140	85-90	15-40	2.4	12-60	1971	.06	.02	7.8	2.0	–	150
TOTALS	67,510	3,315	426.6	2,888.4															

1. For confined aquifers available drawdown is vertical distance between static water level and first perforation
2. City is in Rainy Lake watershed but city wells are in St. Louis River watershed
3. City also obtains about 2,300 million gallons of water from Lake Superior
4. Analysis by U.S. Geological Survey



Modified from State of Minnesota Land Use Map by Minnesota State Planning Agency (1969)



WATER USE (MILLIONS OF GALLONS)			
Type of Use and Year	Ground water	Surface water	Total
Municipal (1973)	2,909	406	3,315
Rural domestic (1970)	1,295 est.		1,295 est.
Livestock (1970)	65 est.	65 est.	130 est.
Irrigation (1975)		11	11
Self-supplied industrial (1975)			
Iron mining			
Dewatering	16,719		16,719
Ore processing			
Circulated	5,354	6,385	11,739
Makeup	321	383	704
Other	79		79
Wood processing			
Circulated[1]		4,464	4,464
Makeup		263	263
Steam power			
Circulated[2]		49,290	49,290
Makeup		2,464	2,464
Other	69		69
TOTAL[3]	21,457	3,592	25,049

[1]An additional 2044 million gallons of Lake Superior water was supplied by city of Cioquet

[2]An additional 242 million gallons of Lake Superior water was supplied by city of Cloquet

[3]Totals include only makeup part of circulated water

WATER USE IS CONCENTRATED IN THE NORTHWESTERN AND SOUTHEASTERN PARTS OF THE WATERSHED, ON THE MESABI IRON RANGE, AND ALONG LOWER REACHES OF THE ST. LOUIS RIVER

SUMMARY AND CONCLUSIONS

RELATIVE ADEQUACY OF WATER SOURCES

PURPOSE	CONSIDERATIONS	SURFACE WATER: St. Louis River	SURFACE WATER: Major tributaries	SURFACE WATER: Minor tributaries	SURFACE WATER: Reservoir lakes	SURFACE WATER: Other lakes	GROUND WATER: Surficial sand and gravel	GROUND WATER: Buried sand and gravel	GROUND WATER: Animikie Group	GROUND WATER: Other bedrock
Municipal or industrial supply	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Rural domestic or stock supply	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Irrigation supply	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fish and wildlife habitat	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Recreation	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

EXPLANATION

Good — Fair — Poor

Colors indicate overall adequacy of water sources as evaluated for specific purposes

CONVERSION TABLE

SUMMARY AND CONCLUSIONS

ACKNOWLEDGMENTS

SELECTED REFERENCES

Base from U.S. Geological Survey, Duluth, 1953
Two Harbors, 1954 and Hibbing, 1954

WATER RESOURCES OF THE ST. LOUIS RIVER WATERSHED, NORTHEASTERN MINNESOTA

By
G. F. Lindholm, D. W. Ericson, W. L. Broussard, and M. F. Hult
1979

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