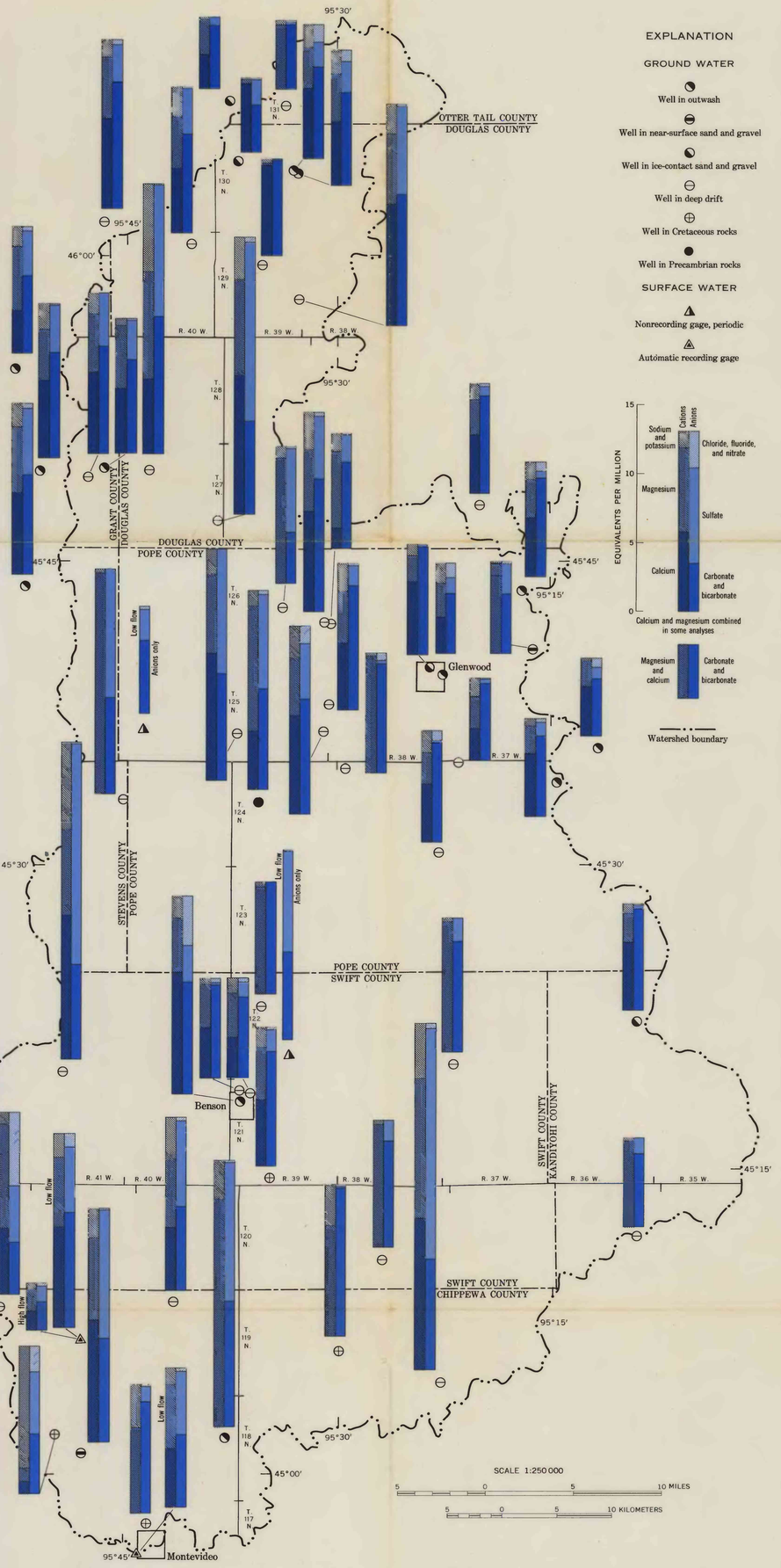
CHEMICAL QUALITY OF WATER



EXPLANATION

GROUND WATER

- Well in outwash
- Well in near-surface sand and gravel
- Well in ice-contact sand and gravel
- Well in deep drift
- Well in Cretaceous rocks
- Well in Precambrian rocks

SURFACE WATER

- Nonrecording gage, periodic
- Automatic recording gage

Watershed boundary

WATER IN THE CHIPPEWA RIVER WATERSHED IS HIGH IN CALCIUM, MAGNESIUM, BICARBONATE, AND SULFATE DERIVED FROM THE GLACIAL DEPOSITS

Surface water has lower concentrations of these constituents at high flow because of dilution by overland runoff, and it has a lower iron content. Ion exchange takes place at some localities in Cretaceous and Precambrian rocks with a resultant decrease in calcium and magnesium and an accompanying increase in chloride, but water from these rocks commonly is similar to that from glacial drift.

EXPLANATION

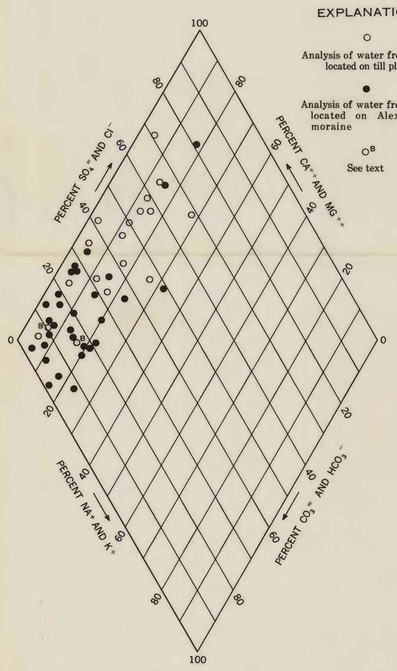
- Well finished in glacial drift for which analysis was made

400 — Line of equal hardness content. *Dashed where approximately located. Interval 200 parts per million*

Watershed boundary

WATER FROM GLACIAL DRIFT IS VERY HARD

Water which exceeds a hardness of 180 ppm (parts per million) requires softening for some purposes. It is commonly a little softer in the morainal area than on the till plain.

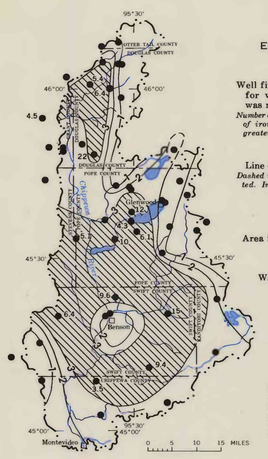


EXPLANATION

- Analysis of water from well located on till plain
- Analysis of water from well located on Alexandria moraine
- ^{B} See text

WELL WATER FROM GLACIAL DRIFT AQUIFERS IS OF THE BICARBONATE OR SULFATE TYPE

Wells on the moraine more commonly yield bicarbonate type and those on the till plain the sulfate type. This is the pattern expected, based on the piezometric map. The sulfate concentration increases downgradient. Although the two wells (^{B}) at Benson are southwest of the moraine, they yield water of the bicarbonate type. The piezometric map shows a depression at Benson implying local recharge that affects the water type.



EXPLANATION

- 15 Well finished in glacial drift for which water analysis was made. *Number designates parts per million of iron where iron content is greater than 3 ppm*

2 — Line of equal iron content. *Dashed where approximately located. Interval 1 part per million*

Area in which iron exceeds 3 ppm

Watershed boundary

WATER FROM THE GLACIAL DRIFT IS HIGH IN IRON

The distribution is not correlative with ground-water movement although the recharge area of Benson has a lower iron content than the surrounding area. Water containing more than 0.3 ppm (parts per million) iron is unsatisfactory for many uses.

MUNICIPAL SUPPLY POTENTIAL AND WATER USE

ALL THE MUNICIPALITIES IN THE WATERSHED OBTAIN THEIR WATER SUPPLIES FROM WELLS FINISHED IN GLACIAL DRIFT

All of these municipalities have some potential for additional development from ground or surface water. Cretaceous and Precambrian rocks may yield water but probably not enough for a municipal supply.

Community	Number of wells: In use	On standby	Abandoned	Depth (feet)	Diameter (inches)	Year drilled	Pumpage rate (gallons per minute)	Pumpage (million gallons per year)	Specific capacity (gallons per day per foot of drawdown)	Aquifer	Water-quality problems	Water treatment	Remarks	Potential for development of additional water: Surface water	Buried sand and gravel	Ice-contact sand and gravel	Outwash sand and gravel
Benson	3			164	20	1926	450	100	12	Buried sand and gravel.	Fe-1.6 H-305	Aeration, filtration chlorination, phosphate stabilization, fluoridation.	City well no. 1; 20 ft screen. T=10,000 S=.004.	Good-Located on the Chippewa River.	Good-Present source will support additional development.	Poor-None in area.	Probably poor-Much outwash or lake sand in area, but probably too thin to support well development.
				162	24	1931	600		12	Buried sand and gravel.			City well no. 2, 20 ft screen.				
				158	24	1957	600		10	Buried sand? and gravel.			City well no. 3; 30 ft screen. T=26,000 S=.0001.				
		1		160	8	1957	250		6	Buried sand? and gravel.			City well no. 4; 20 ft screen.				
Brandon	2			300	8	1939	190	15		Buried sand and gravel.		Aeration, filtration.	T=10,000 S=.0002.	Fair-Many lakes nearby.	Fair-Present aquifer will probably not support much increased development. Others may be present.	Fair-Village abuts narrow tongue of ice-contact topography which may be productive.	Poor-None in area.
				305	12	1960	310			Buried sand and gravel.			30 ft screen.				
Cyrus	1			190	6	1934	300	9	3	Buried sand and gravel.	Fe-2.4 H-510	None.	20 ft. screen.	Good-Located on the Chippewa River. Some lakes nearby.	Good-Present source will probably support additional development.	Poor-None in area.	Good-River outwash adjacent to village.
DeGraff	1			364	8	1937	100	5	5	Buried sand and gravel.		None (chlorination).	20 ft. screen.	Very poor-No reliable source nearby.	Unknown-But adequate for present use.	Poor-None in area.	Probably poor-Outwash sand in area probably too thin.
Evansville	2			200		1957	300		10	Buried sand and gravel.		None.		Poor-Within 2 miles of small lakes.	Unknown-But adequate for present use.	Good-Village abuts area of ice-contact topography which may be productive.	Poor-None in area.
				185	10	1953	400	27	22	Buried sand and gravel.	Fe-3.6 H-440		Village well no. 2; 20 ft screen.				
		1		240	8	1920	100			Buried sand and gravel.	Fe-5.4 H-420		Village well no. 1; perforated casing.				
Glenwood	3			0			121	64		Ice-contact sand and gravel.		None.	"Old" spring.	Good-Located on Lake Minnewaska.	Unknown.	Good-Present source will probably support increased development.	Good-Outwash plain east of city will support large well development.
				0						Ice-contact sand and gravel.			"New" spring.				
				90	12	1965				Ice-contact sand and gravel.	Fe-0.2 H-340		18 ft screen T=10,000 S=.001. Pumpage not included in yearly use.				
		2		273	12	1936	140			Buried sand and gravel.			High, hard in iron.				
				65	5		12		9	Ice-contact sand and gravel.			Cluster of 3 wells.				
Hancock	2			133	12	1951	500	15		Buried sand and gravel.		Aeration, infiltration, softening, pH adjustment.	City well no. 3; 20 ft screen.	Fair-Within 3 miles of Chippewa River.	Unknown-But adequate for present use.	Poor-None in area.	Poor-None in area.
				137	12	1960	100			Buried sand and gravel.			City well no. 4; 23 ft screen.				
		1		112	8		150		15	Buried sand and gravel.			Village well no. 2; 15 ft screen.				
Hoffman	2			154	10	1950		31		Buried sand and gravel.		Aeration, infiltration, chlorination.	Replaced column and bowls and acidized in 1961.	Fair-Within 1 mile of Chippewa river. Small lakes nearby.	Unknown-But adequate for present use.	Poor-None in area.	Fair-River outwash within 1 mile.
				140	10	1934	100		5	Buried sand and gravel.			Low Fe.				
Holloway	1			45		1951		5		Outwash sand and gravel.		None.	Village well no. 4; 20 ft screen.	Poor-No reliable source nearby.	Unknown.	Poor-None in area.	Good-Present source will support additional development.
Kensington	1			210	8	1957	250	5	15	Buried sand and gravel.		None (chlorination).	Village well no. 1; 20 ft screen.	Poor-No reliable source nearby.	Unknown-But adequate for present use.	Fair-Area of ice-contact topography within 1 mile may be productive.	Poor-None in area.
		1		256	8	1938	50		2	Buried sand and gravel.	Hard, high in iron		U.S.G.S observation well; 11 ft screen.				
			1	259	10	1953	25			Buried sand and gravel.							
Kerkhoven	2			110					7	Buried sand and gravel.		None (chlorination).		Fair-Shakopee Creek nearby. Storage required.	Unknown-But adequate for present use.	Poor-None in area.	Probably poor-Outwash and lake sand in area is probably too thin.
				110						Buried sand and gravel.			8 ft screen; cleaned in 1961.				
Lowry	1			220	8	1939	70	9		Buried sand and gravel.	Fe-2.2 H-490	None.		Poor-No reliable source nearby.	Good-Present source will support additional development.	Good-Nearby area of ice-contact topography may be productive.	Poor-None in area.
Montevideo	4			114	12	1958	100		2	Buried sand and gravel.		Chlorination, fluoridation.	City well no. 9; T=7,500 S=0.2 15 ft screen.	Good-Located on Chippewa and Minnesota Rivers.	Unknown-But adequate for present use.	Good-Present or additional aquifers will yield additional water.	Probably poor-Valley alluvium and outwash probably too thin and fine grained.
				109	16	1944	500		15	Ice-contact sand and gravel.			City well no. 6; replaced bowls and columns in 1963; 20 ft screen.				
				71	24	1956	450	88	29	Ice-contact sand and gravel.			City well no. 8; 14 ft screen. T=46,000 S=.00002.				
				69	16	1961	350		14	Ice-contact sand and gravel.			City well no. 10; 20 ft screen.				
				72	16	1950	200		10	Ice-contact sand and gravel.			City well no. 7; 15 ft screen.				
			3	63	10	1934			75	Ice-contact sand and gravel.			City well no. 4; 10 ft screen. U.S.G.S. observation well.				
				140	10	1928				Cretaceous sandstone.			12 ft screen.				
Murdock	1			422	14	1946	100	11		Buried sand and gravel.	High in iron	None.	Iron clogs pipes; replaced column and bowls in 1963.	Poor-No reliable source nearby.	Unknown.	Poor-None in area.	Poor-None in area.
Starbuck	2			140	12	1944	250	58		Ice-contact sand and gravel.		Aeration, filtration.	City well no. 1; T=25,000 S=.001 12 ft screen.	Good-Located on Lake Minnewaska.	Unknown.	Good-Ice-contact areas adjacent to present source are probably productive.	Probably poor-Outwash sand at west end of Lake Minnewaska is probably too thin.
				145	12	1957	250			Ice-contact sand and gravel.			City well no. 2; 12 ft screen.				
Watson	2			150	8	1946		9		?		None (chlorination).	20 ft screen; gravel packed.	Fair-Within 2 miles of Minnesota River and within 1 mile of Chippewa River.	Unknown.	Poor-None in area.	Good-Present source will support additional development.
				53	12	1953	220		16	Outwash sand and gravel.	Fe-1.5 H-740		Village well no. 2; 10 ft screen.				
			1	167		1946	100			Cretaceous sandstone.							

SCHOOLS AND CREAMERIES ARE LARGE WATER USERS

Irrigation use is not known, but numerous wells are in use in the outwash area east of Glenwood. Some water for irrigation is obtained from pits in the outwash near Holloway.

Source	Estimated use, in millions of gallons per year: Domestic	Industrial, Commercial, and Institutional	Agricultural (stock)	Total
Community wells	323	221	0	544
Private wells	365	70	680	1,115
Surface water	0	0	36	36
Total	688	291	716	1,695

SUMMARY

SUMMARY OF WATER RESOURCES

Purpose \ Source	Chippewa River and tributaries	Minnesota River	Large lakes	Small lakes and sloughs	Ice-contact sand and gravel	Outwash sand and gravel	Buried lenses of sand and gravel	Cretaceous sandstone
Municipal and industrial supply	Adequate with development of storage facilities. Favorable location. — Inadequate flow in some reaches. Storage necessary. Treatment necessary.	Adequate with development of storage facilities. — Restricted areal distribution. Storage necessary. Treatment necessary.	Adequate for limited use. Additional storage possible. Some have adequate ground water inflow. Some have limited surface inflow. Restricted areal distribution. Treatment necessary.	— Inadequate storage capacity. Many dry up during droughts. Treatment necessary. Inadequate inflow.	Adequate well yields. Recharge commonly rapid. — Limited distribution. Commonly hard and high in iron.	Adequate well yields. Recharge rapid. — Limited distribution. Commonly hard and high in iron.	Wide distribution. Well yields commonly adequate. — Recharge slow. Commonly hard and high in iron.	May be softer than "drift" water. — Present only in southern one third of watershed. Well yields probably inadequate. Recharge probably inadequate.
Rural domestic and stock supply	Adequate for stock. Suitable quality. — Available only to riparian lands. Some tributaries have no flow for short periods most years. Treatment necessary for domestic use.	Adequate for stock. Adequate inflow. Suitable quality. — Available only to riparian lands. Treatment necessary for domestic use.	Adequate storage capacity. Adequate inflow. Suitable quality. — Available only to riparian lands. Treatment necessary for domestic use.	Adequate for stock. Suitable quality. — Many dry up during droughts. Treatment necessary for domestic use.	Adequate well yields. Recharge commonly rapid. — Limited distribution. Commonly hard and high in iron.	Adequate well yields. Recharge rapid. — Limited distribution. Commonly hard and high in iron.	Wide distribution. Adequate well yields. Adequate recharge. — Commonly hard and high in iron.	Adequate well yields. May be softer than "drift" water. Adequate recharge. — Present only in southern one third of watershed.
Irrigation supply	Adequate with development of storage facilities. Suitable quality. — Restricted to riparian lands. Inadequate flow during irrigation season.	Adequate with development of storage facilities. Suitable quality. — Restricted to riparian lands. Inadequate flow during irrigation season.	Adequate for limited use. Additional storage possible. Some have adequate ground-water inflow. Suitable quality. — Restricted to riparian lands. Some have limited surface inflow.	Suitable quality. — Many dry up during droughts. Inadequate storage capacity. Inadequate inflow. High evaporation losses.	Adequate well yields. Recharge commonly rapid. — Distribution limited to marginal agricultural land.	Adequate well yields. Recharge rapid. — Limited distribution.	Wide distribution. — Well yields may be inadequate. Recharge probably inadequate.	— Present only in southern one third of watershed. Well yields inadequate. Recharge inadequate. Water quality may be harmful to crops.
Recreation	Suitable for hunting and fishing. Favorable location. — Variation in flow. Floods.	Suitable for fishing, hunting, and water sports. Favorable location. — Variation in flow. Floods.	Suitable for fishing, hunting, and water sports. Lakeshore resorts and cottages. Most are permanent. — Most are located in northern and eastern parts of watershed.	Suitable for hunting. Wide areal distribution. — Shallow. Many dry up during droughts.	EXPLANATION: Color indicates relative worth of source over entire watershed. Good Fair Poor. Adequate well yields. Recharge commonly rapid. = Advantage. Limited distribution. Commonly hard and high in iron. = Disadvantage			
Fish and wildlife habitat	Suitable for wildlife along banks. Wildlife areas established. — Undesirable variation in flow. Floods.	Suitable habitat. — Floods.	Excellent habitat. Most are permanent. Most have adequate inflow.	Excellent habitat for wildlife. Wildlife areas established. — Many dry up during droughts.				

CONCLUSIONS

1. Most of the water supplies in the watershed are from aquifers and the potential for additional withdrawals is good.
2. The Chippewa River, its major tributaries, the Minnesota River, and large lakes are potential sources of water supply for most uses if storage and transmission facilities were constructed. Evaporation of about 2.3 cfs per square mile of lake or reservoir surface must be considered in design of storage reservoirs.
3. Natural storage of surface and ground water is higher in the moraine area; whereas, in the till plain there is less storage and more intermittent streamflow.
4. Streams, lakes and sloughs are habitat for fish and wildlife and provide excellent recreational opportunities.
5. Ground-water potential is best from glacial drift, especially in the moraine area. The Cretaceous and Precambrian rocks commonly yield only small supplies.
6. Ground water commonly is very hard and high in iron; surface water is less hard and low in iron.
7. Flood retarding reservoirs, channel modification, and land ditching alleviate damage in the Mud and Shakopee Creek basins. The Chippewa diversion channel and Lac qui Parle reservoir reduces damage along the lower Chippewa River and the Minnesota River above Montevideo, except during extreme floods.

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By

R. D. Cotter, L. E. Bidwell, W. A. VanVoast, and R. P. Novitzki

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