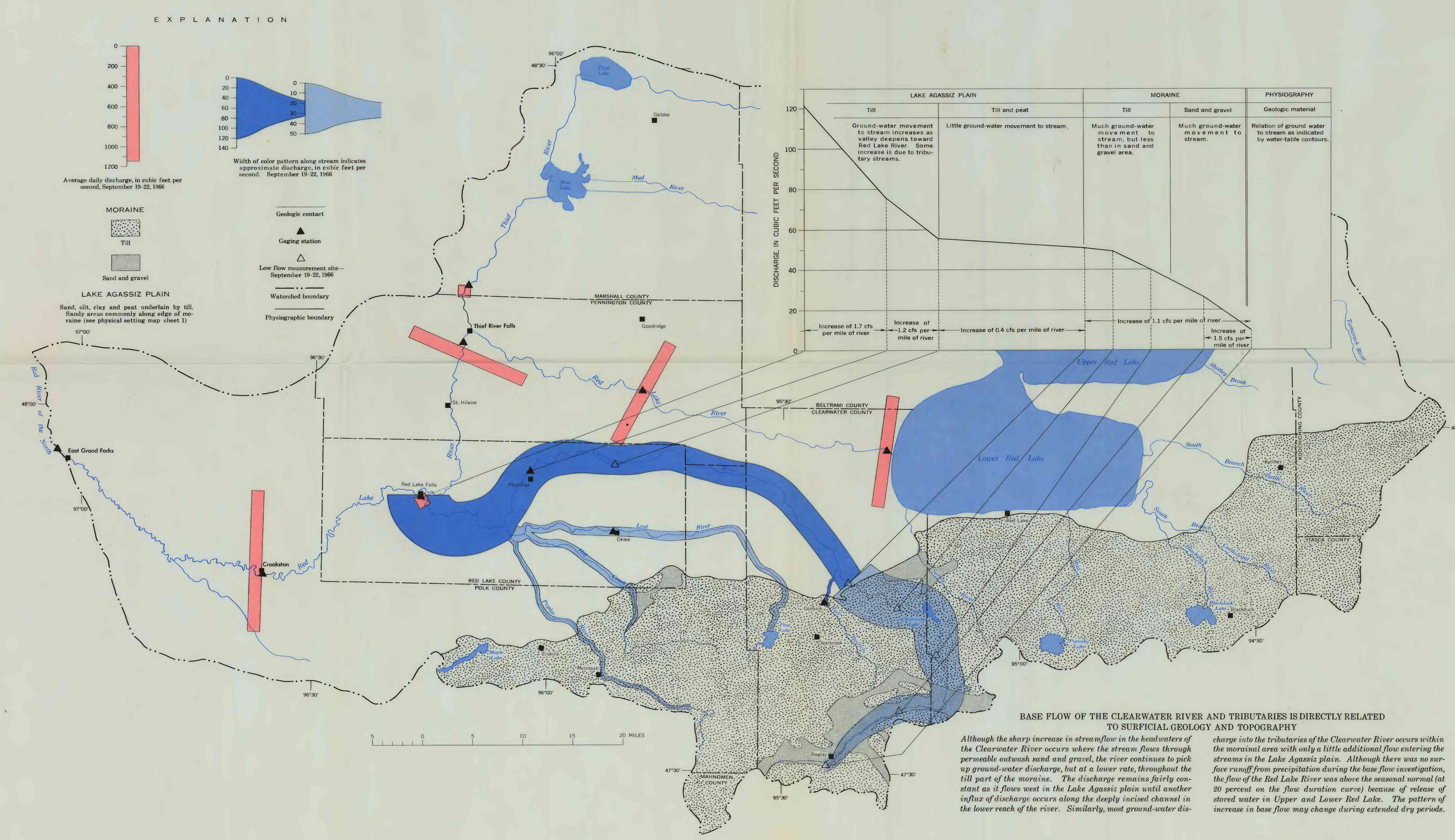
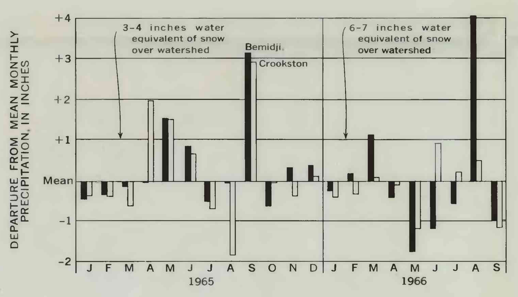
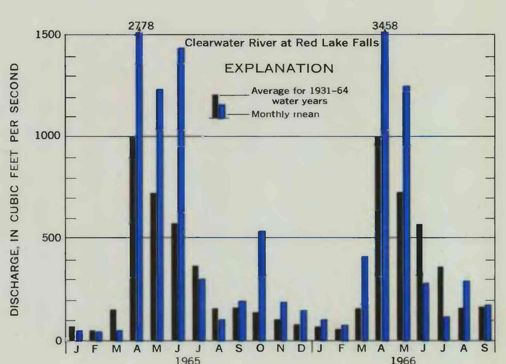
BASE FLOW AND WATER RECREATION



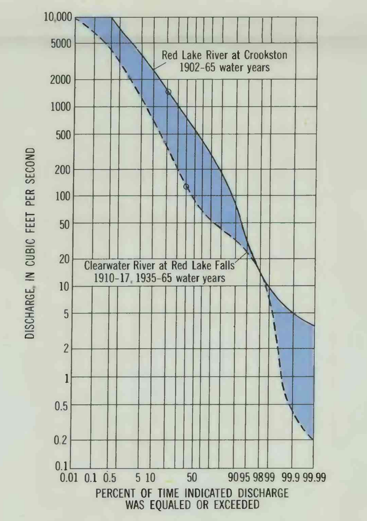
BASE FLOW OF THE CLEARWATER RIVER AND TRIBUTARIES IS DIRECTLY RELATED TO SURFICIAL GEOLOGY AND TOPOGRAPHY

Although the sharp increase in streamflow in the headwaters of the Clearwater River occurs where the stream flows through permeable outwash sand and gravel, the river continues to pick up ground-water discharge, but at a lower rate, throughout the till part of the moraine. The discharge remains fairly constant as it flows west in the Lake Agassiz plain until another inflow of discharge occurs along the deeply incised channel in the lower reach of the river. Similarly, most ground-water discharge into the tributaries of the Clearwater River occurs within the morainal area with only a little additional flow entering the streams in the Lake Agassiz plain. Although there was no surface runoff from precipitation during the base flow investigation, the flow of the Red Lake River was above the seasonal normal (at 20 percent on the flow duration curve) because of release of stored water in Upper and Lower Red Lakes. The pattern of increase in base flow may change during extended dry periods.

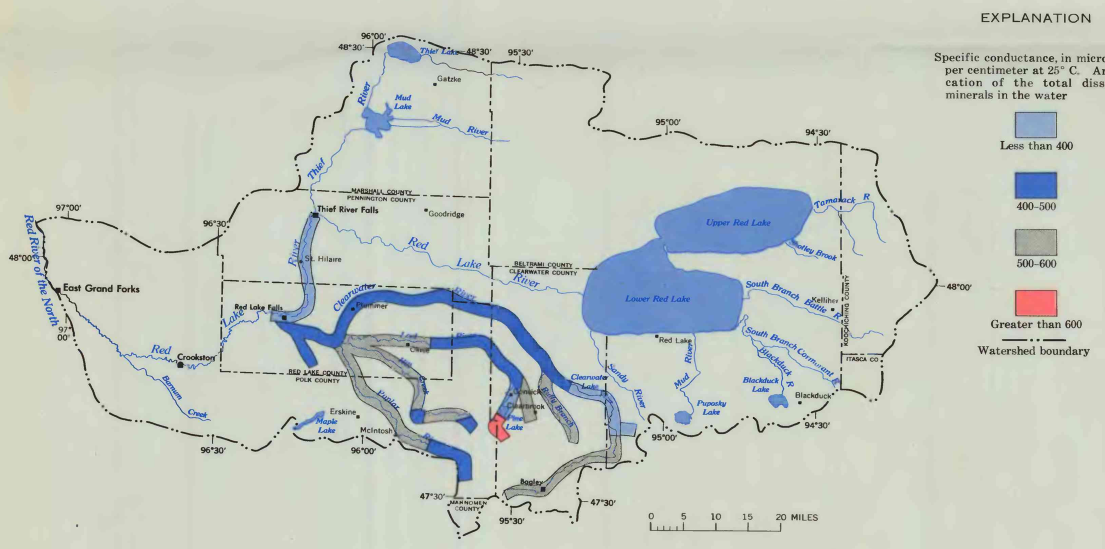




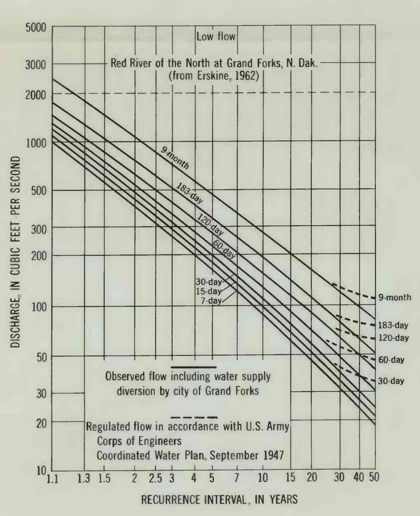
HIGH BASE FLOW IN THE CLEARWATER RIVER DURING THE BASE FLOW INVESTIGATION OF SEPTEMBER 19-22, 1966, WAS CAUSED BY EXCESSIVE PRECIPITATION DURING THE PREVIOUS MONTH OF AUGUST.—*By September 1966 the precipitation totaled about 3 inches above the mean for the previous year and a half, and prior to the 1966 spring breakup the water content of snow on the ground in the upper part of the watershed exceeded the normal by about 3 inches. Although discharge in the Clearwater River was above the mean during the spring the deficient precipitation in early summer caused a decrease in streamflow during June and July. Since the sand and gravel aquifer along the Clearwater River is a water-table aquifer, it responds rapidly to deficient or excessive precipitation; therefore, the heavy August rains resulted in above average streamflow (40 percent on the duration curve).*



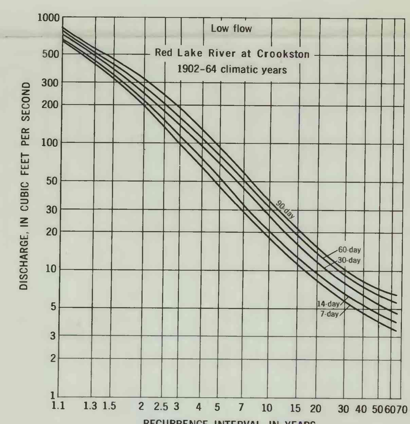
DISCHARGE OF THE CLEARWATER RIVER AT RED LAKE FALLS DURING THE BASE FLOW INVESTIGATION SEPTEMBER 19-22, 1966, AVERAGED 126 CUBIC FEET PER SECOND, WHICH IS 40 PERCENT ON THE FLOW DURATION CURVE.—*The average discharge of the Red Lake River at Crookston for the same period was 1,410 cubic feet per second or 20 percent on the duration curve.*

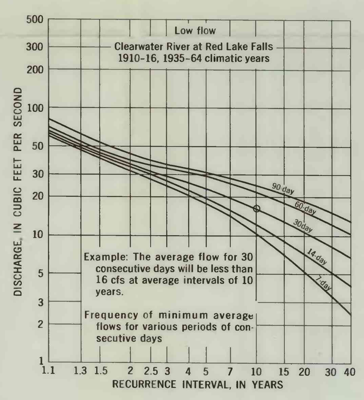


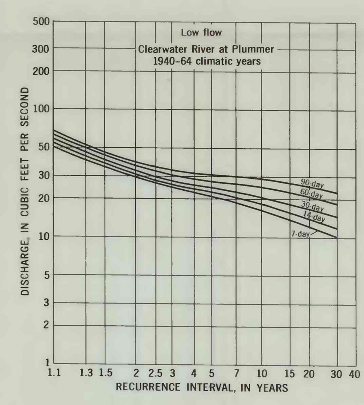
QUALITY OF SURFACE WATER IN THE WATERSHED DURING A TIME OF BASE FLOW IS MODIFIED BY WATER OF LOWER SPECIFIC CONDUCTANCE FROM LAKE STORAGE.—*The conductivity is substantially reduced on the Clearwater River and tributaries in reaches below lake outflow. Water quality in streams that do not drain lake areas have higher specific conductance because of the inflow of more highly mineralized ground water. The low conductivity of the Red Lake River reflects the large influence of the Red Lakes.*

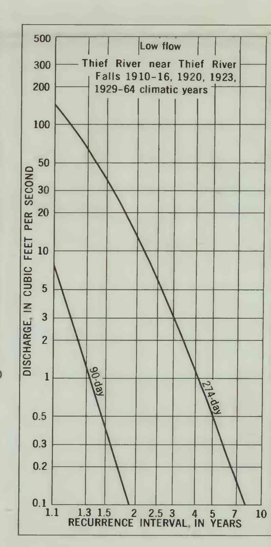


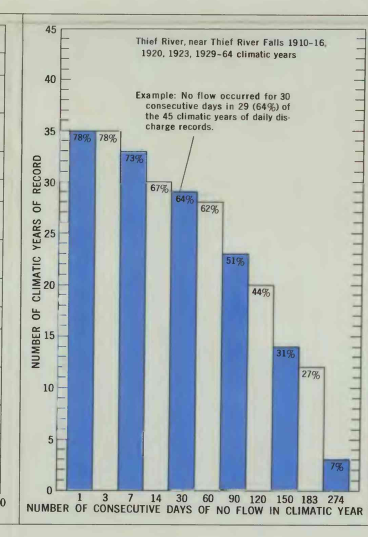
UNREGULATED LOW FLOW OF THE RED RIVER OF THE NORTH IS INADEQUATE AT TIMES FOR RIPARIAN WATER NEEDS AND FOR QUALITY CONTROL.—*The dependability of low flow is increased by a coordinated release of water stored in Orwell Reservoir and Lake Ashtabula on upstream tributaries and on the Upper and Lower Red Lakes. It is planned that during years of normal wetness at least 40 cubic feet per second will be released from Orwell Dam for the period June through September, although during critically low periods outflow may be reduced to 5 cubic feet per second. Following the spring runoff the release from Lake Ashtabula will never be less than 3 cubic feet per second but will be increased as required to supplement flows on the Red River. During periods of extreme drought and low lake levels the minimum discharge from Upper and Lower Red Lakes will not be less than 5 cubic feet per second. At higher, but below normal lake levels, requirements for water supply and pollution abatement and total annual release are other considerations governing release from the Red Lakes. (Data from U.S. Corps of Engineers).*





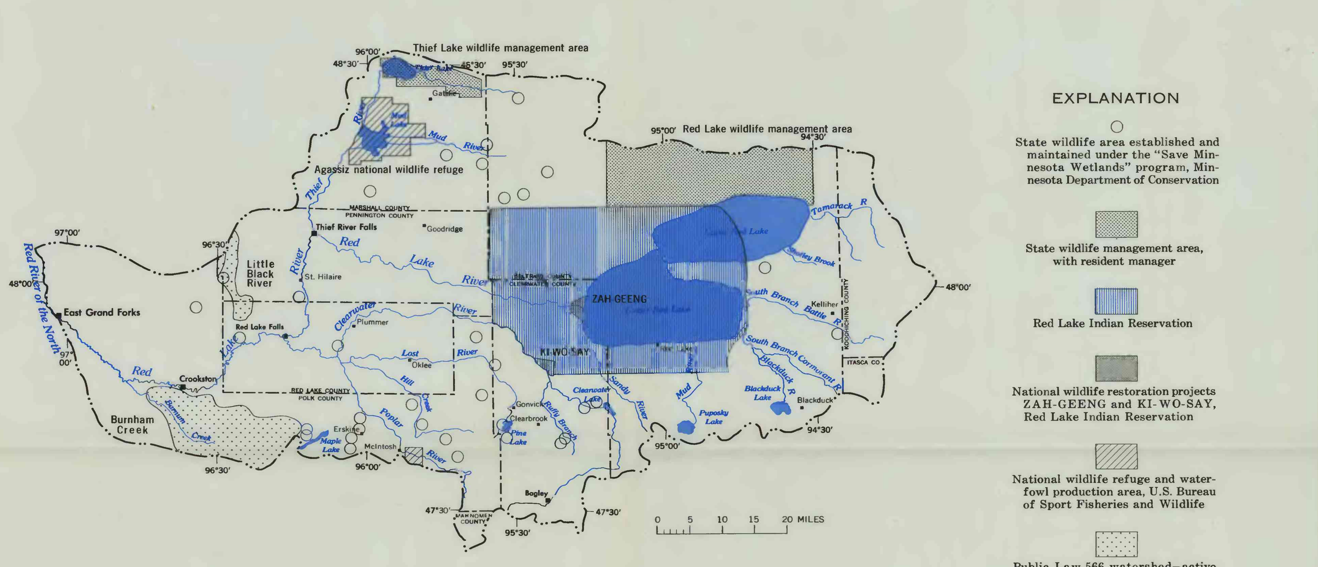






LOW FLOW IS LARGELY FROM GROUND-WATER SOURCES AND THE DURATION AND OCCURRENCE OF LOW STREAMFLOW ARE CONSIDERED IN THE DESIGN OF A WATER SUPPLY, POLLUTION ABATEMENT STUDY, AND RECREATIONAL DEVELOPMENT

Discharge from lakes, springs, and glacial deposits of sand and gravel sustain low flow in the Clearwater River. In contrast, the Thief River has long periods of no flow during many years because of a lack of ground-water contribution to the stream channel. The discharge of Red Lake River at Crookston is the integrated flow from streams of both high and low base flow and from the regulated discharge from Upper and Lower Red Lakes. Frequency curves for other sites would differ from those shown because of variations in surficial geology. The shapes of the low flow frequency curves for sites at Crookston, Red Lake Falls and near Thief River Falls have been affected by the low flows during the drought of the 1930's.



RIVER BASIN PLANS AND MANAGEMENT INCLUDE IMPROVED LAND-TREATMENT PRACTICES, DRAINAGE, AND DEVELOPMENT OF WETLAND WILDLIFE AREAS.

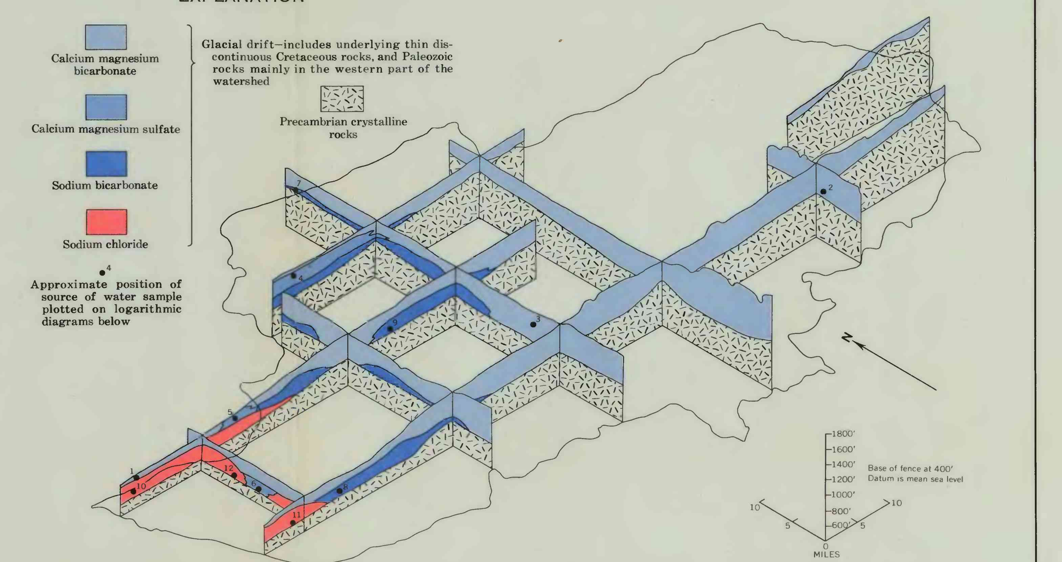
The State wildlife management areas and the national wildlife refuges are managed for maximum waterfowl and wildlife production and public hunting. The lakes and potholes in the wildlife areas provide nesting, resting, and feeding areas for waterfowl, and the surrounding marsh and upland areas provide habitat for furbearers and other wildlife. Conditions for the production of waterfowl are almost ideal in the prairie potholes in this watershed because of the abundance of food and cover and the proximity to permanent lakes which provide an alternate source of food and cover during droughts when the potholes are dry. The Soil Conservation Service watershed projects are designed to reduce erosion, sediment damage, and flooding, and make better use of the land and water resources. The two Indian Reservation wildlife areas of about 10,000 acres are managed for production of waterfowl, aquatic furbearers, and wild rice and to assist in the maintenance of the tribal economy. Blinds are leased for waterfowl hunting. Commercial fishing in the Red Lakes within the Reservation is managed to insure continuing fish production.

PHYSICAL AND ECOLOGICAL CHARACTERISTICS OF SELECTED LAKES

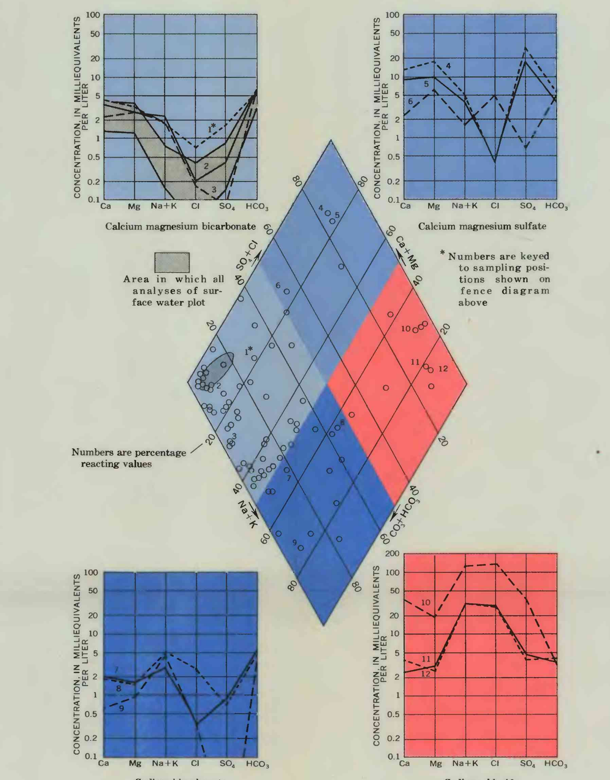
Name	Surface area (acres)	Length of shoreline (miles)	Depth (feet)		Fish and game classification	Secchi disk transparency (feet)	Total alkalinity* (mg/l)	Vegetation	Composition of bottom	Shoreline description	Remarks
			Maximum	Median							
Balm	508	6.59	33	12	Largemouth bass and panfish.	6.0 (green)	135	Submerged vegetation is sparse. Emergent plants include bulrush, cattail, and yellow water lily.	Sand.	90 percent sand and 10 percent muskeg.	4 resorts and 14 cottages.
Blackduck	2,749	—	29	—	Walleye and northern pike.	4.0	137	—	Sand.	Sand and muskeg, flat, mixed conifer and hardwood.	17 resorts and 95 cottages.
Clearwater	977	—	65	—	Bass, panfish and walleye.	10.0	187	Pondweed and smartweed.	Muck.	—	1 resort and 36 cottages.
Julia	484	5.75	45	—	Walleye.	16.0	137	Water lily, muskgrass, and pondweed.	Sand and muck.	Mixed hardwood and pines.	4 resorts and 10 cottages.
Lower Red	157,208	69	35	18	Walleye.	—	152	Open-emergent vegetation along shoreline.	Sand and muck.	Flat, sand and bog.	Fished commercially by Indians.
Upper Red	107,832	58	20	3	Walleye.	—	—	—	—	Flat, bog.	Fished commercially by Indians in part of lake in reservation.
Maple	1,695	—	13	10	Walleye.	—	237	Pondweed and bulrush.	Sand and gravel near shore and mud toward center.	30 percent open pasture and 70 percent wooded.	—
Pine	1,188	7.9	15	8	Northern pike.	6.5	—	Muskgrass and pondweed.	Muck.	Mud and sand, hardwood, marsh vegetation.	1 resort and 10 cottages.
Puposky	2,141	—	14	5.7	Marginal—some panfish.	Clear to bottom	103	25 percent lake area covered by standing emergent vegetation.	Peat and marl.	Moderate slope fringed with emergent and submergent vegetation.	—
Thief	7,100	—	4.5	3.2	Waterfowl and muskrat.	2.0	—	Pondweed and duckweed. Submerged vegetation over 30 percent of lake.	Soft muck.	Gentle slope-peat, emergent vegetation.	Managed for waterfowl production.

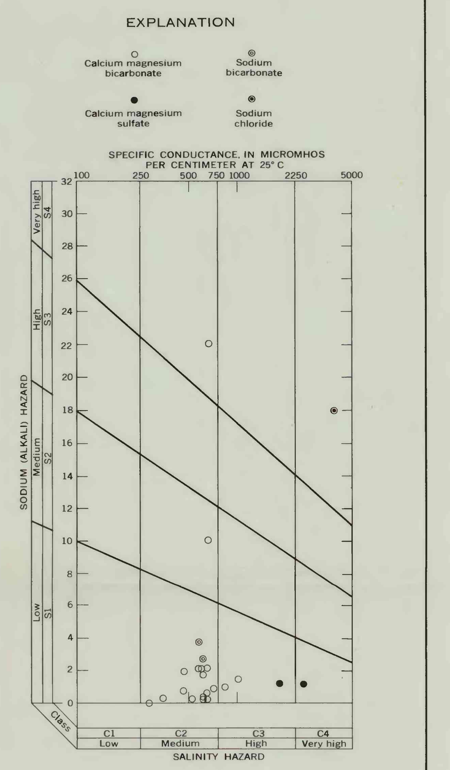
Data from Minnesota Department of Conservation.
*Water sample collected during summer from surface of lake.

WATER QUALITY



CALCIUM-MAGNESIUM BICARBONATE, THE MOST COMMON TYPE OF GROUND WATER IN THE AREA, OCCURS THROUGHOUT THE WATERSHED.—*However, it generally lies only within the upper 50 feet or less of the ground-water reservoir within the western one-third of the watershed. Calcium magnesium sulfate water occurs at depths between 25 and about 150 feet below land surface in the northwestern part of the watershed. The conditions causing a higher sulfate content in this area are not known but they may be due to a high sulfate content of the waters within the ground-water reservoir and consequently little reduction of the sulfate ion, or to low permeability deposits allowing greater time in contact with sulfate-producing minerals. Sodium bicarbonate water occurs throughout much of the western part of the watershed at depths generally greater than 100 feet. Water of this type results from natural softening of calcium magnesium bicarbonate or calcium magnesium sulfate waters by ion exchange (calcium and magnesium ions in water are exchanged with sodium ions on exchange positions) and is therefore generally associated with the clayey Cretaceous sediments. Sodium chloride water, which exists at depths generally greater than 50 feet in the western part of the watershed, is water associated with marine deposits, both Cretaceous and Paleozoic.*





CHEMICAL QUALITY OF GROUND WATER VARIES WIDELY IN THE WATERSHED.—*Water can be classified into different types of chemical quality depending on the percentage distribution of the major ions in solution. The water type is controlled principally by the solubility of the minerals within the ground-water reservoir, the time water is in contact with these minerals, and the intermixing of water of different types. Some of the sodium bicarbonate water is due to softening, which is a decrease in calcium and magnesium ion concentration and an increase in sodium ion concentration.*

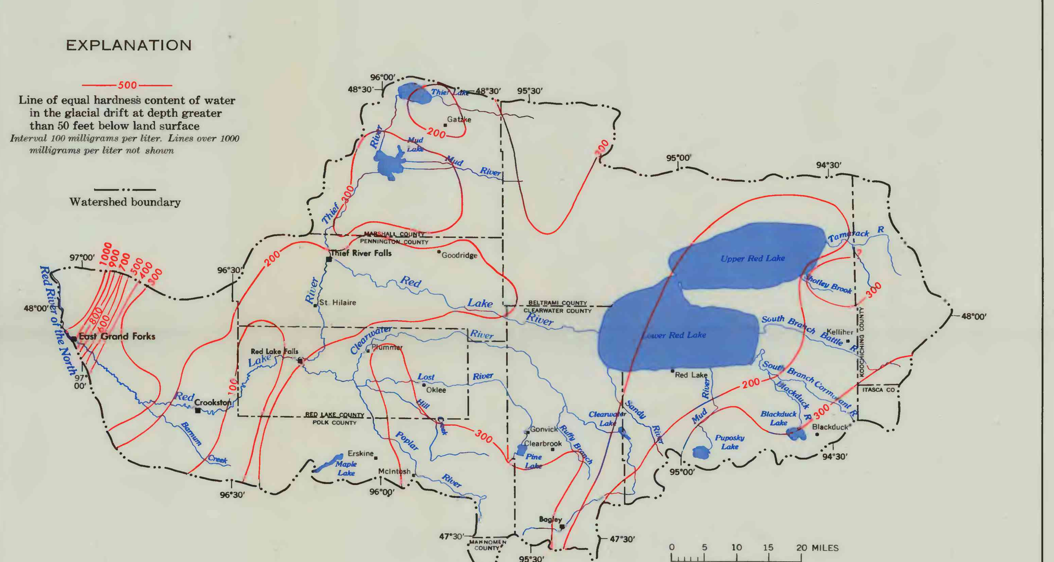
The logarithmic plots show the concentration of the major ions for selected water samples. Surface water is of the calcium magnesium bicarbonate type. The concentration of most ions in the calcium magnesium bicarbonate and sodium bicarbonate type range between 0.1 and 5 milliequivalents per liter but in the calcium magnesium sulfate type the concentration of calcium magnesium and sulfate ions are around 20 milliequivalents per liter in some samples. In the sodium chloride type the concentration of sodium plus potassium and chloride ions may range as high as 150 milliequivalents per liter. Quality of surface water is nearly constant but concentrations of dissolved minerals are generally less at higher flows.

MOST GROUND WATER FOR IRRIGATION USE HAS A LOW SODIUM HAZARD BUT MEDIUM TO HIGH SALINITY HAZARD.—*The calcium magnesium sulfate and sodium chloride water particularly are not suitable for irrigation because of high salinity hazard. Sodium hazard is very high for the sodium chloride waters.*

DISSOLVED SOLIDS IN WATER OF THE GLACIAL DRIFT ARE HIGHER IN THE WESTERN QUARTER OF THE WATERSHED.—*The higher mineralization of water indicates that the water has been in contact with minerals in the ground-water reservoir for a longer period, and that water movement is probably slower than elsewhere in the watershed.*

The very high values in the western quarter reflect the influence of highly mineralized water from the underlying sedimentary rocks, which moves upward and mixes with water in the glacial drift.

Water containing dissolved solids of less than 1,000 milligrams per liter is suitable for domestic and stock uses. Some water containing 1,000 milligrams per liter or more of dissolved solids contains certain constituents which produce a noticeable taste. Concentration of nitrate in ground water is generally less than 1 milligram per liter.



MOST GROUND WATER IN THE WATERSHED IS VERY HARD—GREATER THAN 180 MILLIGRAMS PER LITER.—*Water of extreme hardness occurs in the lake plain. Hardness is due mainly to the presence of calcium and magnesium ions. Mineral salts cause hardness and can form incrustation on well screens. Where hardness exceeds 500 milligrams per liter, incrustation of well screens may be rapid in small diameter wells that are heavily pumped.*

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WATER RESOURCES OF THE RED LAKE RIVER WATERSHED, NORTHWESTERN MINNESOTA

By
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1970