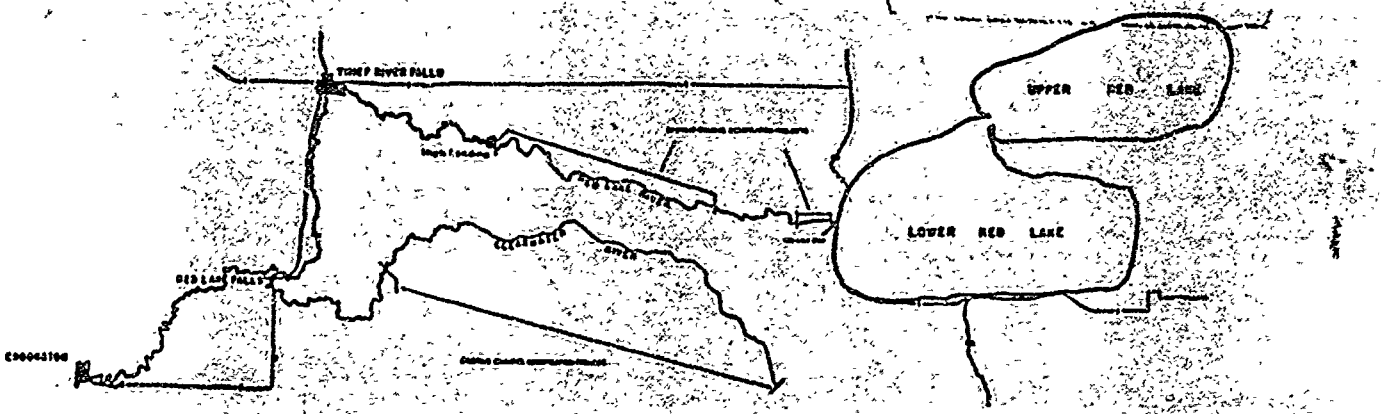
US Army Corps
of Engineers
St. Paul District

RED LAKE AND CLEARWATER RIVERS
RED LAKE COUNTY, MINNESOTA



RECONNAISSANCE REPORT
RED LAKE AND CLEARWATER RIVERS

AUGUST 1991

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The primary focus of this reconnaissance report is to evaluate the existing Corps flood control and water supply projects in the study area. The study area, the Red Lake River subbasin, occupies 5,700 square mile of the Minnesota portion of the Red River of the North basin. The major waterway is the Red Lake River and its principal tributaries are the Clearwater and Thief Rivers.

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TABLE OF CONTENTS

REPORT PLATES

WORKING PAPERS (APPENDICES)

INTRODUCTION

The Corps of Engineers has a long history of involvement in the planning and construction of water resource projects within the Red Lake River subbasin. This reconnaissance report reviews the problems and opportunities associated with existing Corps of Engineers water projects and evaluates the potential for Federal interest in construction of new water resource projects within the Red Lake River subbasin area.

STUDY AUTHORITY

This reconnaissance study is in response to an August 1988 resolution of the Committee on Public Works and Transportation, U.S. House of Representatives, which states:

> "Resolved by the Committee on Public Works and Transportation of the United States House of Representatives, that the Board of Engineers for Rivers and Harbors is hereby requested to review the reports on Red Lake River, Minnesota, including Clearwater River, Minnesota, contained in House Document Numbered 345, Seventy-eighth Congress, first session, and other pertinent reports with a view to determining whether any modifications need to be made to the existing project and the need for further development of the water and related land resources of the basin."

Authority for existing water resource projects in operation within the subbasin was provided in the 1944 Flood Control Act. It authorized the Corps of Engineers to make improvements on the Red Lake and Clearwater Rivers primarily for flood control and water supply purposes. This project was completed in 1956 and is being operated by the Corps and local sponsors.

STUDY PURPOSE

The purpose of the Red Lake and Clearwater Rivers Study is to evaluate water resource related problems, define potential solutions, determine if there is a Federal interest in further detailed study and implementation of solutions, and identify a non-Federal sponsor to participate in detailed studies, as needed. This report presents the findings of the reconnaissance study and outlines the process and procedures used to support the conclusions of the report.

The focus and scope of this reconnaissance report conforms to Corps of Engineers guidelines established by the Principles and Guidelines. The primary focus of the study, as established by the authorizing resolution language, is to evaluate the existing Corps flood control and water supply projects in the study area.

STUDY PROCESS

The Water Resources Development Act of 1986 (Public Law 99-662) requires Federal water resource development agencies to use a two-phase planning process. The first part of this process is a reconnaissance study. If the reconnaissance study identifies a Federal interest in solutions to water resource related problems and a non-Federal cost sharing partner, a feasibility study can be undertaken with costs shared equally.

The reconnaissance study process includes interdisciplinary team problem identification, plan formulation and evaluation, benefit and cost determination, and efforts to obtain interagency and public inputs. When it appears that the next planning phase of study is warranted, negotiation of a cost sharing agreement with the non-Federal sponsor is also accomplished in the reconnaissance phase.

This reconnaissance study has used available engineering and technical data extensively. In that regard, the Corps wants to thank the Red Lake Watershed District for their valuable assistance throughout the study process. This study was funded using general investigation monies and was conducted at full Federal expense, exclusive of incidental costs incurred by non-Federal entities. It was completed within a required 12-month timeframe in accordance with Corpswide guidance.

STUDY AREA

The study area, the Red Lake River subbasin, occupies 5,700 square miles of the Minnesota portion of the Red River of the North basin. This large subbasin includes all of Red Lake County and portions of Marshall, Pennington, Clearwater, Koochiching, Itasca, Mahnomen, Beltrami, Polk, and Lake of the Woods Counties. The major waterway is the Red Lake River, which rises in northwestern Minnesota at the outlet of Lower Red Lake and flows approximately 196 river miles to its confluence with the Red River at East Grand Forks, Minnesota. Its principal tributaries are the Clearwater and Thief Rivers, which are 91 and 125 miles long, respectively. Other tributaries include the Black River, Oya and Burnham Creeks, and several minor creeks. See figure 1 for Red Lake River subbasin features. While the subbasin is predominantly agricultural, wetlands and forests along the Red Lake River and its tributaries and in the Red Lake Indian Reservation provide habitat for wildlife and waterfowl.

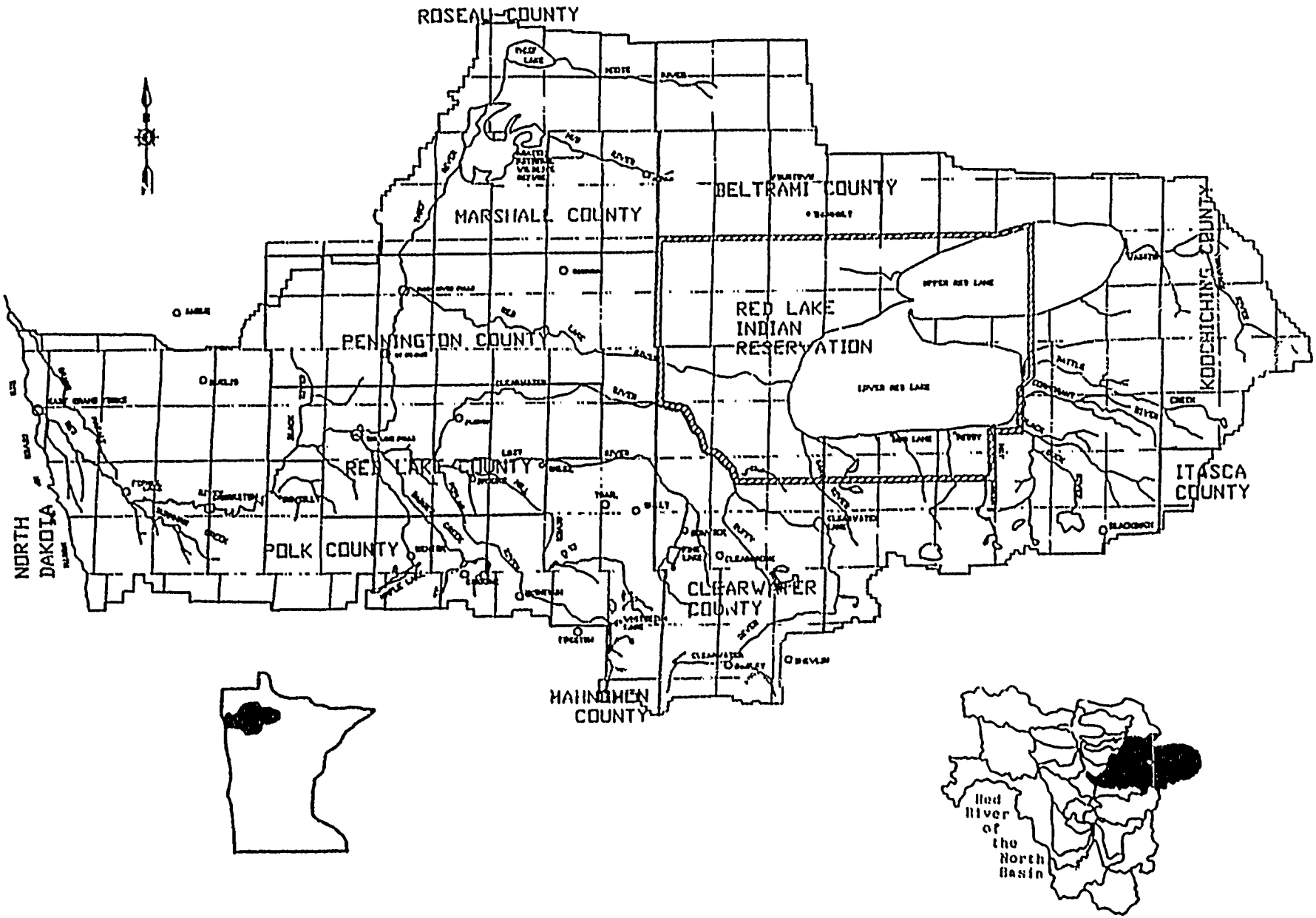


Figure I. RED LAKE RIVER SUBBASIN

WATER MANAGEMENT DESCRIPTION

The development and management/regulation of water resources in the subbasin has involved a large number of Federal, State, and local agencies. The Red Lake Watershed District, Corps of Engineers, Soil Conservation Service, Red Lake Reservation Tribal Council, various State of Minnesota offices, and numerous local governments are important development entities. A more detailed evaluation of existing water resource development follows on the next pages.

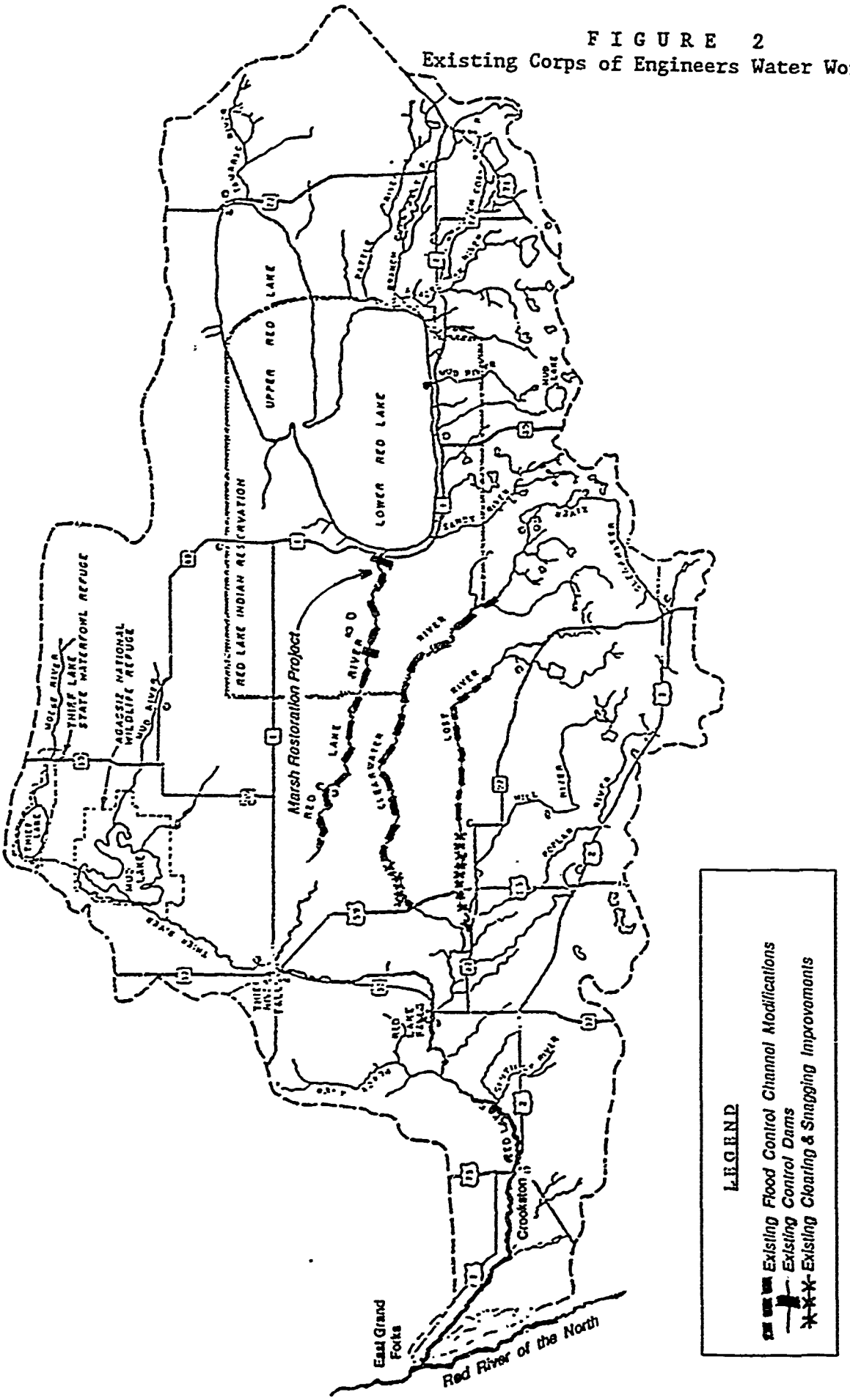
Corps of Engineers Projects

Existing Corps of Engineers flood control and water supply projects on the Red Lake River and tributaries include channel straightening and enlarging of about 25 miles of the Red Lake River upstream from a point just below High Landing, Minnesota, and 47 miles of the Clearwater River above mile 31.8; alterations to bridges on both rivers; construction of a small concrete overflow dam within the reservation to preserve marshes; and modification of the control structure and road at the outlet of Lower Red Lake. These water works were completed in 1956 (see figure 2). In 1966, a deficiency in the existing project was rectified through restoration of marsh areas bordering a 3.2-mile reach of the Red Lake River immediately below the lake outlet. Construction included a gravity inlet and outlet works to divert water from the lake into the marshes and dikes. On Lost River (a tributary of the Clearwater River), channel snagging and clearing in the lower 20-mile reach and channel enlargement and related works in the next 23-mile reach were completed by mid-December 1965. Similar improvements were authorized for Ruffy Brook, also tributary to the Clearwater River, but these were not constructed.

The Corps has also made major flood reducing modifications to the Lost River, a tributary of the Clearwater River. The project cleared the channel for almost 20 miles from the mouth to a point 2 miles west of Oklee. From that point, the channel has been enlarged or straightened for an additional 23 miles upstream ending at a point about 3 miles north of Gonvick, Minnesota.

Existing Corps of Engineers emergency bank protection water works have also been constructed at three locations along the Red Lake River: riprap protection of 630 feet of the right bank near Red Lake Falls, Minnesota; riprap protection of 400 feet of the right bank at Huot, Minnesota; and riprap protection for 1,200 feet of the left bank near Gentilly, Minnesota.

FIGURE 2
Existing Corps of Engineers Water Works



Projects by Others

The Red Lake Watershed District is an important multipurpose water development and management entity in the Red Lake River basin. The watershed district has been effective in accomplishing many water resource improvements (see figures 3 and 4). A list of the completed projects and those currently in progress follows in table 1.

Table 1 - Red Lake Watershed Projects

Project	Primary Purposes*	Drainage Area (sq. mi)	Flood Volume (ac-ft)
Completed			
Moose River	WQ/C	125	36,250
Lost River Imp.	WQ/C	53	4,500
Black River	WQ/C	107.7	4,800
Baird-Beyer Dam	WQ/FC	7	400
Thibert Dam	WQ/FC	6	6
Knutson Dam	WQ/FC	2.7	42.4
Seeger Dam	WQ/FC	6.4	230
Odney Flaat Dam	WQ/FC	5.3	81.3
Pine Lake Dam	WQ/FC	44.7	1,250
Roy Abraham Dam	WQ/FC	0.04	66
In Progress			
Maple Lake Project	WQ/C	5,860	293,775
Burnham Creek Channel	WQ/C/D	154.7	
Elm Lake	WQ/FC	63.4	7,500
Good Lake	WQ/C	72.3	10,100

*Note: WQ = water quantity
C = conservation
FC = flood control
D = drainage

Additional water works/projects exist in the subbasin. These are the result of efforts by the U.S. Fish and Wildlife Service (e.g., Agassiz Lake Project and Goose Lake Project), U.S. Soil Conservation Service (e.g., Burnham Creek Channels), Minnesota Department of Natural Resources (e.g., Thief Lake Project), and the Red Lake Tribal Council (e.g., Good Lake Project). Approximately 12,000 acres of commercial wild rice paddies are also in operation in the upper reaches of the subbasin. In addition to their primary agricultural purpose, these paddies can provide limited waterfowl habitat and upstream flood water retention. Ducks Unlimited has also been actively involved in sponsoring a number of development actions that would improve and conserve wildlife and fish habitats in the study area.

RED LAKE WATERSHED DISTRICT

PROJECTS PROGRESS STAGES

COMPLETE

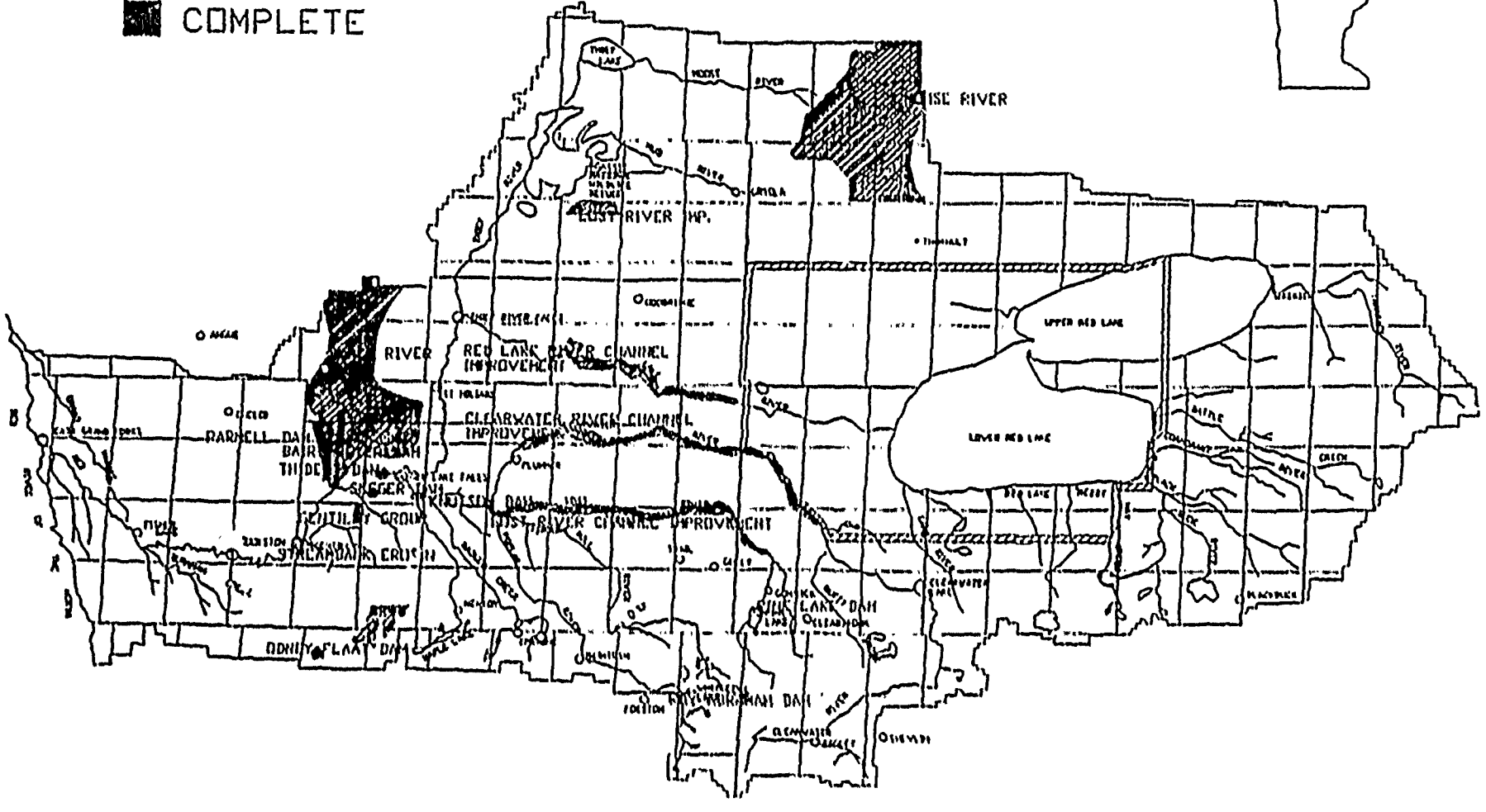
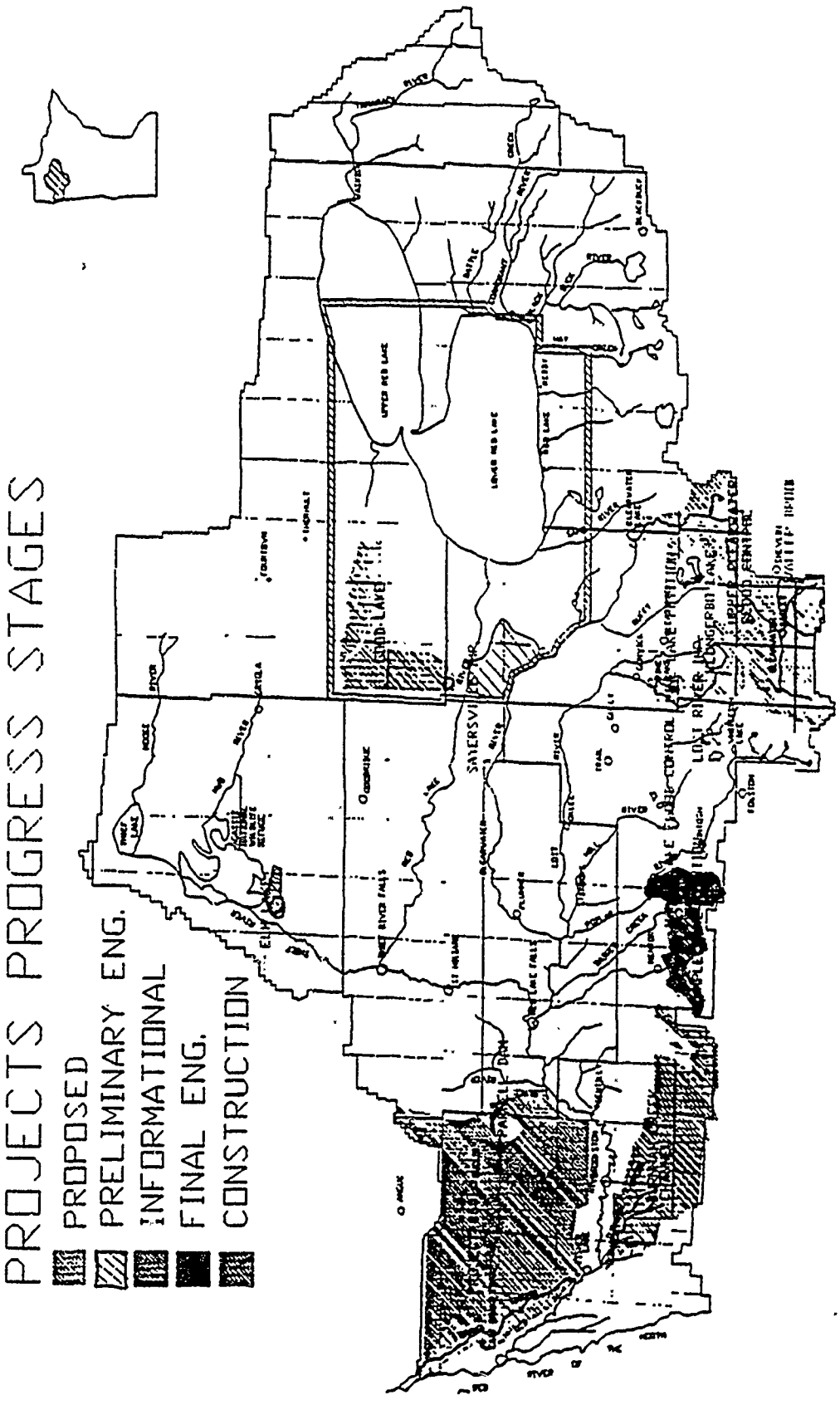


FIGURE 3

FIGURE 4


RED LAKE WATERSHED DISTRICT
PROJECTS PROGRESS STAGES
PROPOSED
PRELIMINARY ENG.
INFORMATIONAL
FINAL ENG.
CONSTRUCTION

PRIOR STUDIES AND REPORTS

Prior reports relating to the water resources of the Red Lake River subbasin or its tributaries are extensive. Only those reports used as a significant reference or source are listed. These include:

Report on Survey of Red Lake River and tributaries including Clearwater, Minnesota, dated 12 November 1942.

Crookston Flood Control Study, Reconnaissance Study by Corps of Engineers, July 1990.

Flood Insurance Study, Pennington County, Minnesota, Federal Emergency Management Agency, May 3, 1990.

Good Lake Impoundment Project - Preliminary Engineering Report for Red Lake Watershed District, January 1990.

Red Lake Watershed District: Ten-year overall plan, May 1988.

Thief River Falls Reservoir Study - Red Lake Watershed District Project #63, February 20, 1987.

Condition Survey Report, Non-Federal Levees, Red Lake River at Crookston, Minnesota, June 1986.

Red Lake Watershed District - Annual Report, 1986.

Progress Report - 1986 Red Lake Operations Work, Corps of Engineers, September 1986.

Problem Appraisal Report for the Red Lake-Clearwater Rivers, Minnesota, Project, St. Paul District, Corps of Engineers, May 1985 (In-house Report).

Water Resources Engineering/Planning Program for the Red River of the North Basin in Minnesota, McCombs-Knutson Associates, Inc., May 1984 (prepared for the Lower Red River Watershed Management Board).

Biological Survey of the Red Lake River - #134, Minnesota Department of Natural Resources, Division of Fish and Wildlife, June 1983.

Red River of the North Basin, Preliminary Basinwide Review Study - Summary Report, Gulf South Research Institute, December 1980.

Hydropower and Flood Control Potential of the Red Lake River, A Red River of the North Tributary, published by the Red Lake River Basin Planning Commission in 1979. The report discusses hydropower potentials in the subbasin.

Burnham Creek Watershed, Minnesota, Preliminary Investigation Report, Soil Conservation Service, 1979.

Red Lake River Subbasin Feasibility Study for Flood Control and Related Purposes, published by the St. Paul District, Corps of Engineers, in 1977.

Draft of the Red River of the North basin Plan of Study for flood control and related purposes, May 1976.

Flood Plain Information: Red Lake River, December 1974.

Archaeological Investigations in the Red Lake River, Minnesota, Proposed Dam and Reservoir Project for U.S. Army Corps of Engineers, University of Minnesota, 1973.

The Environmental Biological Aspects of Water Management Alternatives in the Red Lake River Subbasin, published by the Center for Environmental Studies at Bemidji State University, Bemidji, Minnesota, in 1973.

Overall Plan: Red Lake Watershed District, November 1972.

Operation and Maintenance Manual, Red Lake and Clearwater Rivers, St. Paul District, Corps of Engineers, November 1960.

Flood Control and Major Drainage, General Design Memorandum, Lost River, Minnesota, published by the St. Paul District, Corps of Engineers, in 1960. The report summarizes proposed flood control measures on Lost River.

Report on Effect of Red Lake-Clearwater Flood Control Project on Fish and Wildlife Values in the Red Lake Indian Reservation Area (Informal Report), St. Paul District, Corps of Engineers, May 1957.

Flood Control Definite Project Report on Red Lake River, Minnesota, including Clearwater River, Minnesota, St. Paul District, Corps of Engineers, March 1947.

Report on Survey of Red Lake River and its Tributaries including Clearwater River, Minnesota, St. Paul District, Corps of Engineers, March 1942.

PLANNING SETTING

LOCATION AND GEOGRAPHY

The Red Lake River subbasin is in northwestern Minnesota and includes all of Red Lake County, most of Pennington County, and parts of Clearwater, Beltrami, Marshall, Koochiching, Itasca, Mahnomen, Roseau, and Polk Counties. The Red Lake River basin, with an area of approximately 5,700 square miles, is the largest subbasin of the Red River of the North. It is bordered on the south by the Sand Hill and Wild Rice River subbasins, on the west by the Main Stem subbasin, and on the north by five subbasins: Snake, Middle, Tamarac, Two Rivers, and Roseau. The eastern margin is the border of the Red River basin. The maximum east to west dimension of the subbasin is 140 miles and the maximum north to south dimension is 80 miles. The Red Lake River is 196 miles long from its mouth on Lower Red Lake to its confluence with the Red River of the North on the Minnesota-North Dakota border at East Grand Forks. The slope of the Red Lake River above Crookston, Minnesota, is 2.2 feet per mile and below Crookston about 1.1 feet per mile. A map of the subbasin is shown as figure 1.

CLIMATE

The climate of the subbasin is continental which is characterized by wide seasonal variations of temperature, normally adequate rainfall for crops, and moderate snowfall. Weather observations can be obtained from National Weather Service stations at three locations in the subbasin: Crookston, Red Lake Falls, and Thief River Falls, Minnesota. Temperature variations within the subbasin are extreme, ranging from an all-time low of -50°F to a high of 102°F. The average annual temperatures range from 29.2°F to 49.5°F. The short growing season, from June 5 to October 27, has limited agriculture in the subbasin to small grains and forage crops. Average precipitation varies from 20 inches per year on the western edge to 23 inches per year on the eastern edge of the subbasin. Most of the precipitation occurs during June, July, and August, with an average of 10 inches per year falling during this period. During the period November to March, the precipitation accumulates in the form of snow, which normally begins to melt and run off during late March or early April. Normal snowfall is from 40 to 50 inches per year and accounts for approximately 25 percent of the total precipitation. Most of the precipitation is lost through evapotranspiration, which averages 19.4 inches per year. The remaining runoff of 2.6 inches per year occurs primarily in April during spring snowmelt.

LAND USE

The subbasin contains more forest acreage than any other subbasin in the Red River basin. The land in forest amounts to 31.7 percent of the subbasin. Water and marsh areas are significant, accounting for 9 percent and 12 percent, respectively, of the total land area. Because of the large land

acreages in other categories, cultivated crops occupy only 37 percent of the land area, and pasture amounts to 9 percent. These cultivated crops are located mostly in the western and central portions of the subbasin. Urban development is minimal. The largest acreage of cropland is in the western portion of the subbasin, most of the pastureland is found in the central area, and the largest forest acreage occupies the northeastern part of the subbasin. Table 2 summarizes the land use in the watershed.

Table 2 - Land use in acres in the Red Lake River watershed by subbasin(1)

Land Use	Red Lake River Subbasin	Thief River Subbasin	Clearwater River Subbasin	Total Red Lake Watershed	Approximate percent of total Land area
Cropland	803,700	327,400	444,700	1,575,800	41
Pasture	28,800	30,250	59,550	118,600	3
Forest	939,350	293,000	218,100	1,450,450	38
Other(2)	186,900	41,800	96,200	324,900	9
Lakes(3)	-	-	-	333,050	9

(1) Taken from Corps of Engineers Red Lake River Feasibility Study, March 1977.
(2) Includes other lands in farms, other lands not in farms, and marshland.
(3) Estimated.

Excellent transportation facilities for highway, railroad, bus, and air travel provide outlets and entrances to all parts of the basin. Good farm-to-market roads are included in this network. Numerous county and township roads also serve the area.

HYDROLOGY AND HYDRAULIC CONDITIONS

Subbasin Overview

The Red Lake River subbasin has a total drainage area of 5,661 square miles, of which 5,280 and 2,300 square miles are included in the area above Crookston and High Landing, respectively. Only 3,330 and 350 square miles of this area are effective. All the drainage area upstream of Red Lake Dam on Upper/Lower Red Lake, 1,951 square miles, is noneffective due to the very large storage capacity of the lake (3,270,000 acre-feet). Additional water storage is available at the Mud Lake National Wildlife Refuge and Thief Lake. See plate A-1 of Appendix A for details

The climate in the Red Lake River basin is variable. The area is subject to cold winters and warm summers, typical of continental conditions in the temperate zone. The mean annual precipitation is about 21.0 inches, of which about 58 percent occurs during May, June, and July and about 77 percent occurs from April through September. Approximately 25 percent of the total precipitation falls as snow.

The four major sources of water in the Red Lake River watershed are the Red Lake River, the Clearwater River, the Thief River, and groundwater from wells. The Red Lake, Clearwater, and Thief Rivers experience stagnation during prolonged droughts, somewhat lessening their water quality during these periods. All river water must be filtered and purified before being used for domestic and industrial purposes.

Red Lake River

The Red Lake River follows a general westerly direction from Red Lake Dam at Upper/Lower Red Lake to High Landing and on to Thief River Falls where it turns and flows southward toward Red Lake Falls. The river then continues on in a southwesterly direction to Crookston. The Red Lake River eventually flows into the Red River of the North at East Grand Forks, Minnesota. The Red Lake River has an average channel slope of 2.2 feet per mile between Upper/Lower Red Lake and Crookston. A flood discharge-frequency curve for High Landing and Crookston was defined as part of this study and is described in Appendix A of this report (see table A-20).

Clearwater River

The Clearwater River is a major tributary of the Red Lake River. From its origin, the river meanders for about 40 miles through the glacial moraine and lake beach area along the southern edge of the basin and discharges into Clearwater Lake. Then, continuing from the outlet of Clearwater Lake, the river follows a crooked channel in a northwesterly direction through the uplands for a distance of about 29 miles where it enters the lake plain. In flowing through the uplands, the river has developed a narrow valley sufficient to accommodate flood flows. In the lake plain, the river meanders in an extremely crooked westerly course to the vicinity of Plummer, Minnesota, in a direction roughly parallel to the Red Lake River, with only a very slight ridge separating the rivers (plate A-1). During high water, this ridge is overtopped and floodwaters of the Clearwater and Red Lake Rivers intermingle. In this reach, the Clearwater River is similar to the upper reaches of the Red Lake River in that the river has no valley, the channel is poorly defined, the banks are low, and exclusive of drainage ditches and one brook (Ruffy Brook), there are no tributaries of any importance entering the main channel. Practically all flooding from Clearwater River outflow occurs in this reach. Near Plummer, the river turns to the south and flows in a southerly direction for about 15 miles, then turns sharply to the west and continues in a westerly direction to Red Lake Falls, where it joins the Red Lake River. As the river progresses from Plummer to Red Lake Falls, the height of the bank increases, the valley develops rapidly, and numerous tributaries originating in the uplands join the river. The river slope is steep in this reach and the channel can readily accommodate flood flows. The stream covers approximately 91 miles in its general course from source to mouth, while its actual meandering length is about 205 miles. The Clearwater River has an average channel slope of about 1 foot per mile in the lake plain region upstream of Plummer.

The river has been modified extensively along 47.3 miles of its length, from 31.8 to 79.1 miles above its mouth. This reach has side slopes varying from 1 on 1 to 1 on 3, bottom widths of 38 to 49 feet, and berming of excavated

material along the side of the channel. Water is appropriated from the Clearwater River to fill approximately 12,000 acres of rice paddies for the commercial growing of wild rice. The minimum flow is designated as 36 cubic feet per second (cfs).

A flood discharge-frequency curve for the upper reaches of the Clearwater River near Plummer was defined as part of this study. (See table A-20 in Appendix A for details.)

Red Lakes

Upper and Lower Red Lakes have only one outlet, the Red Lake River. The Corps of Engineers operates that control structure in accordance with a detailed operating plan which sets allowable maximum desired lake level limits of elevation 1173.5 to 1174.5. However, the water release capacity of the control structure is very small in relationship to the size of the drainage area; therefore, control efforts to release high water can take years. The current outflow capacity of 1,000 cfs can drop lake levels only 0.2 foot per month, assuming no inflow is occurring. In contrast, normal evaporation during the summer may be equivalent to 2,000 cfs and can drop the lake level 0.4 foot per month. Furthermore, the full outflow capacity is usually not available during high water conditions because of the governing outflow restraints imposed by the downstream farming interests in accordance with project criteria. Inflow generally is also quite high in wet years.

Because the lakes are shallow and immense, the wind and seiche effects are significant on the Red Lakes and can be very damaging when combined with high water and/or ice breakup conditions. Historic data indicate that up to 3 inches of annual runoff generally will allow the maximum desired limits of 1173.5 to 1174.5 to be maintained. Between 3 and 4 inches of runoff is a "gray area" where timing of the wet periods comes into play.

The lake stages and the stage-frequency curve for Upper and Lower Red Lakes are presented in tables A-18, A-19, and A-21 of the Hydrology appendix (Appendix A).

NATURAL/ENVIRONMENTAL RESOURCES

Red Lake River

The Red Lake River is a tributary of the Red River of the North which originates at the outlet of the Red Lakes in the northwest portion of Minnesota and flows west and south before entering the Red River at East Grand Forks. The portion of the river immediately downstream of the control dam at the lake outlet is within the Red Lake Indian Reservation and is primarily bog with scattered woodlands. Downstream of the lake, the river is channelized for about 35 miles. From the Pennington/Clearwater County line to Thief River Falls, the river flows through a flat, primarily agricultural area. At Thief River Falls, where it is joined by the Thief

River, the Red Lake River turns south and the gradient increases. In this reach, the river has a distinct valley and pronounced riffles. The Clearwater River enters at Red Lake Falls. The river again flows west for 30 miles and then northwest for 35 miles to the Red River of the North. From Crookston to East Grand Forks, the land use is agricultural and the river has high banks but less gradient than the reach upstream.

A biological survey of the Red Lake River revealed that there are 38 species of fish, of 13 families, in the Red Lake River (the river reach within the Red Lake Reservation was not surveyed). The reach above Thief River Falls dam is characterized by low gradient and fine substrate. Numbers of white sucker, freshwater drum, rock bass, yellow perch, and northern pike were above the stream average, but walleye numbers were less than average. Since the survey, smallmouth bass have been introduced and have prospered. The reach between Thief River Falls and Crookston has a high gradient, coarse substrate, and numerous riffles and pools. Species which are present in above average numbers upstream are below average here. Golden redhorse were dominant and walleye were well above average. Channel catfish and carp were present but not common in this reach. From Crookston to East Grand Forks, the river is characterized by low gradient, fine substrate, and reduced clarity. Species that prefer this habitat were more abundant here: channel catfish, quillback and mooneye. Freshwater drum were more common and walleye slightly less common then in the reach upstream. There is a recreational fishery for catfish in this reach.

The distribution of fish in the Red Lake River is affected by dams. A dam at East Grand Forks is a gradual 5 feet in height and is a deterrent to fish movement much of the year. Upstream at Crookston is a dam which is 12 feet high and a fish barrier. East of Crookston, an abandoned dam, with a 2-foot head, is a barrier at low flows. A dam in Red Lake Falls collapsed years ago, leaving underwater material which is a navigation hazard but not a fish barrier. The Thief River Falls hydropower dam is 18 feet high and is a barrier to fish migration. On the Reservation portion of the Red Lake River are a low-head weir and the Red Lake outlet dam.

The Red Lake River is a hard-water stream with chemical parameters suitable for healthy aquatic organisms and communities. It is classified by the Minnesota Pollution Control Agency as suitable for the propagation of cool and warm water fish; aquatic recreation of all kinds; and use for public water supply with treatment. It is relatively clear at its source, but total solids, turbidity and phosphorus increase toward the mouth. The river receives treated sewage at five sites as well as sugar beet processing waste, municipal water treatment waste, and urban runoff.

Clearwater River

The Clearwater River is the principal tributary of the Red Lake River which originates in a morainal area near Bagley, Minnesota, south of the Red Lakes. It flows north to, and along, the western boundary of the Red Lake Indian Reservation. From there it flows west, parallel to the Red Lake River, until it joins it at Red Lake Falls. The river has been extensively modified along 47.3 miles of its length, from 31.8 to 79.1 miles above its mouth. Water is appropriated from the Clearwater River to fill paddies for

the commercial growing of wild rice. The minimum flow is designated as 36 cubic feet per second.

The biological environment of the Clearwater River is not well known. The extensive channel modification has eliminated much of the habitat for fish and organisms on which the fish depend for food. Further, the minimum flow that is provided for in regulation is probably not sufficient to provide suitable conditions for fish growth, especially with limited habitat. Because of the habitat degradation that has occurred, there has been little reason to manage the Clearwater River for fish production.

Red Lakes

Upper and Lower Red Lakes are located in northwestern Minnesota. Together they drain a total area of 1,951 square miles. The upper lake is 10 by 21 miles and the lower lake is 12 by 23 miles. Together they have a surface area of 290,800 acres and contain 1,810,000 acre-feet at a normal lake elevation of 1174.0 feet above mean sea level (3,270,000 acre-feet at maximum lake elevation).

The fishery of the Red Lakes is an important recreation feature but is even more valuable as a commercial resource. Reliable catch data have been gathered since 1930. The important species in the commercial catch have been walleye, yellow perch, lake whitefish, northern pike, freshwater drum and goldeye. The most frequently caught species is the walleye. The strength of year classes of walleye, yellow perch, and lake whitefish seem to be related to, or at least show similar response to, environmental factors. The annual catch has fluctuated from year to year but may be based on different levels of effort, rather than differences in populations. Over a million pounds per year were removed during World War II to meet wartime protein requirements. Similar catches were made during the 1970's. The commercial fishery remains an important source of income for the Red Lake Reservation.

Threatened and Endangered Species

Clearwater County is within the breeding range of the bald eagle, a federally listed threatened species. Clearwater, Pennington, Red Lake and Polk Counties are all within the peripheral range of the federally threatened gray wolf. Polk County also contains remnant populations of the western prairie fringed orchid, another federally listed threatened species.

PHYSIOGRAPHY AND GEOLOGY

Physiography

The subbasin is divided into three distinct physiographic regions. In the southeast is a glacial moraine with hills and depressions. In the west is a glacial lake plain that is extremely flat. The eastern edge of the lake plain ends in a series of narrow beach ridges running in a north-south

direction. To the east of the beach ridges is a glacial lake-washed till plain that is flat to gently rolling, with shallow bogs and peat areas. Both the lake plain and till plain areas were covered many thousands of years ago by glacial Lake Agassiz. Upper and Lower Red Lakes are remnants of this glacial lake.

The topography of the subbasin ranges from 800 feet above mean sea level in the western end at the confluence of the Red Lake River and the Red River of the North to 1,600 feet above mean sea level in the south central part. In general, the southern part of the area, which is made up of northern Clearwater County and a small tract of land in Mahnomen County, has the highest elevation, ranging from approximately 1,260 to 1,600 feet above sea level. The northern part of the subbasin is rather flat, ranging from 1,200 feet on the east to 1,140 feet on the west. The lake plain in the western part of the subbasin is also flat, ranging from 800 to 920 feet.

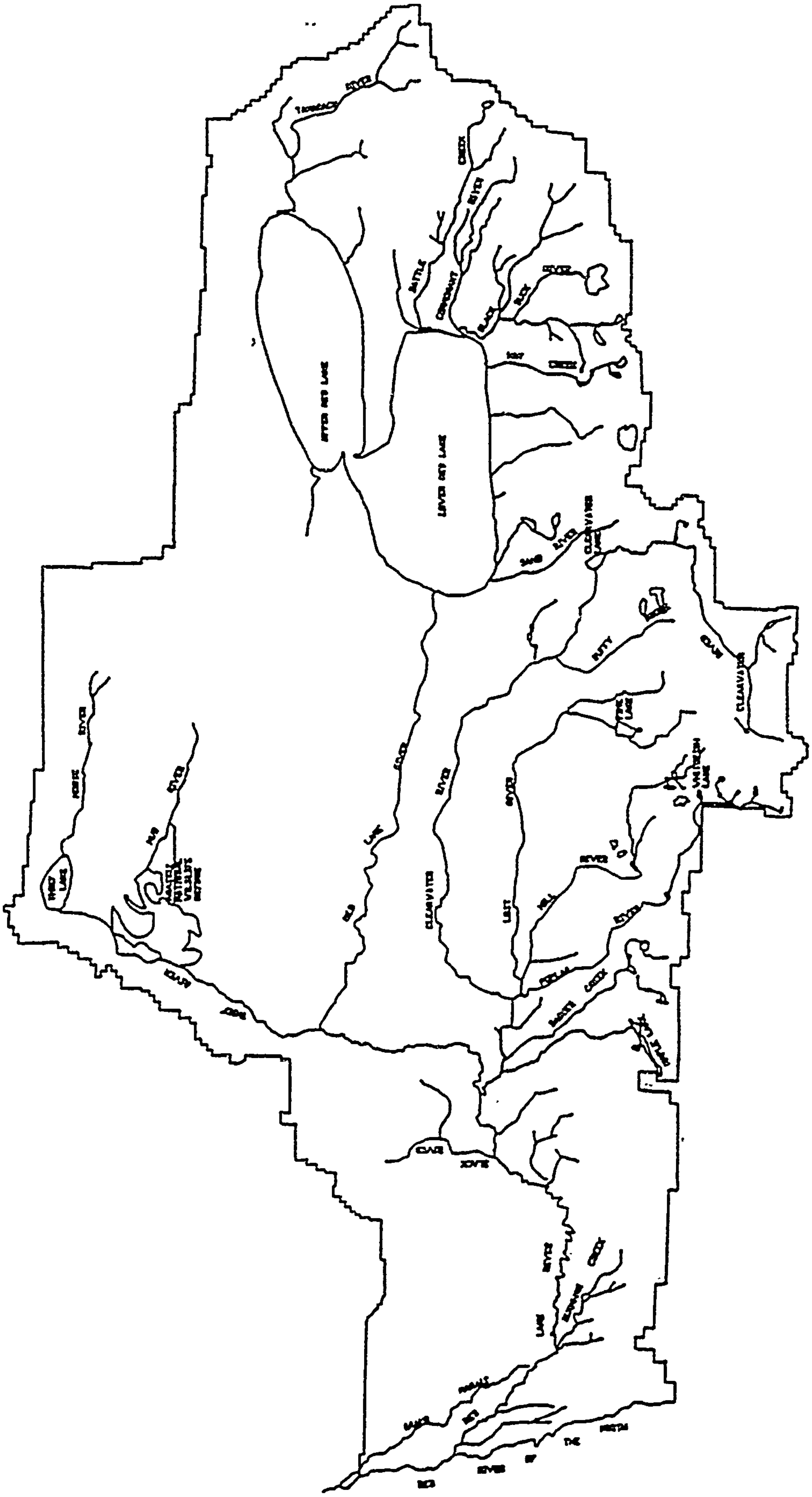
The major waterway is the Red Lake River, which has its source in Lower Red Lake. The river flows in a northwesterly direction until it meets the Thief River, at which point it flows due south in the beach ridge area and then curves upward in the lake plain area until it meets the Red River. The river is 196 miles long from its source at Lower Red Lake to its confluence with the Red River of the North on the Minnesota-North Dakota border at East Grand Forks. The slope of the river is about 2.2 feet per mile above Crookston and about 1.1 feet per mile below Crookston. The principal tributaries are the Clearwater and Thief Rivers, which are 91 and 125 miles long, respectively. Other tributaries include Black River, Oya and Burnham Creeks, and several minor creeks (see figure 5 for a map showing the river tributaries).

Geology

The subbasin lies within the Western Lake Section in the Central Lowland Province of the Interior Plains. Bedrock is predominantly undifferentiated Precambrian igneous and metamorphic rock overlain by undifferentiated Cretaceous deposits of sandstone and interbedded shale in the western portion of the subbasin. Glacial deposits of clay, till, and sands and gravel overlie bedrock and range from about 1 foot thick near Kelliher, Minnesota, to over 500 feet thick near Bagley. The largest concentration of swamp deposits (consisting of peat and muck) found in the Red River basin is located in the northeastern section of the subbasin.

Landscape features characteristic of glacial geology, including level lands, beach ridges, lakes, and swamps, are each represented in the subbasin and are distributed in fairly distinct bands trending north to south across the region. The Upper and Lower Red Lakes are major features of the subbasin. The two lakes are remnants of glacial Lake Agassiz and together comprise the largest lake area wholly contained in Minnesota. The watershed drained by the Red Lake River lies within the former bed of glacial Lake Agassiz. As the lake drained, it left a more or less featureless plain interrupted by parallel north-south ridges which represent the ancient recessional beaches of Lake Agassiz and a few independent lakes as remnants of the original lake. These lakes are Upper/Lower Red Lake, Thief Lake, and Mud Lake (plate A-1). It has been such a short time geologically since the last glacier

F I G U R E 5 - River Tributaries



withdrew from the basin that erosion has affected the area only slightly and the streams have had little opportunity to develop typical valleys. The level terrain which was originally occupied by the glacial lake is referred to as the lake plain and the rolling country comprising glacial moraine and drift areas as the uplands. The lake plain occupies about 80 percent of the entire basin and is almost devoid of relief, with elevations ranging from about 830 feet at the mouth of the Red Lake River to about 1,100 feet at the eastern limits where it merges with the uplands. Considerable tracts of land in the lake plain remain perpetually swampy and boggy. Large tracts of such lands are submarginal and are mostly uninhabited. The elevation of the uplands at the highest shoreline of the extinct Lake Agassiz is about 1,100 feet above mean sea level, and this section rises to about elevation 1,450 feet at the rim of the Continental Divide which separates the drainage areas of the Red River of the North and the Mississippi River. This area is gently rolling to undulating and contains many depressions or ponds with no outlets.

ECONOMIC AND SOCIAL SETTING

The study area for the Red Lake River basin includes Clearwater, Pennington, and Red Lake Counties located in the northwest quadrant of Minnesota. These rural counties encompass over 80,000 square miles. Also included in the study area is the Red Lake Indian Reservation.

The population of the study area was 26,140 as of 1990. Pennington County had the largest population, with 13,300 people. Clearwater County had 8,300 people and Red Lake County had 4,500 people. The aggregate population declined 11.4 percent from 1980, after an increase of 10.6 percent from 1970 to 1980. The projections for the next 5 years anticipate small gains in Clearwater County and Red Lake County, and a larger loss in Pennington County, resulting in a net loss for the study area. For additional information about population, see Appendix B; table 1 (Population Trends), table 2 (Population by Age), and table 3 (Population by Race). Crookston, Thief River Falls, Bagley, and Red Lake Falls are the population centers of the subbasin.

Minority populations in the study area are small, with the exception of the American Indian population which resides in the Red Lake Indian Reservation. The Red Lake Indian Reservation, occupying 639 square miles, lies entirely within the subbasin. An estimated 3,000 persons reside on the reservation. The reservation is the only closed reservation in the Red River basin and, as such, is exempt from all State and Federal taxes. The reservation is administered by the Red Lake Band of Chippewa Indians Tribal Council and the Bureau of Indian Affairs.

Per capita income for the study area has increased at an average annual rate of 4.9 percent over the past decade, while average household income has increased at an average annual rate of 4.5 percent. Both of these rates of increase are less than those for the State of Minnesota, where per capita income increased at an average annual rate of 6.4 percent and average household income increased at an average annual rate of 5.8 percent (refer to Appendix B, table 4 - Per Capita Income Trend and table 5 Household

Income Trend for additional information). Table 6 (Persons Living in Poverty) shows that 15.6 percent of all people in the study area live below the federally-set poverty line. In Clearwater and Red Lake Counties, one in five people lives in poverty.

Agriculture is the largest employment sector in the subbasin, followed by trade and services. Manufacturing employment constitutes only a small portion of the total employment.

The labor force in the study area numbered approximately 12,000 workers as of 1990. The chief industries are Farming, Fisheries, Forestry and Mining; Retail Sales; and Education. Approximately 45 percent of those employed work in these three industries. The unemployment rate in the study area has been high over the past decade. Each of the three counties has had annual unemployment rates much above the State average. The unemployment rates for Clearwater and Red Lake Counties have ranged from 13 percent to 20 percent, while Pennington County has had unemployment rates from 6 to 12 percent. The State unemployment rate has ranged from 4 to 8 percent during the same period. Data from 1980 to 1989 can be found in Appendix B, table 7 - Annual Unemployment Rates.

RECREATIONAL RESOURCES

Subbasin Overview

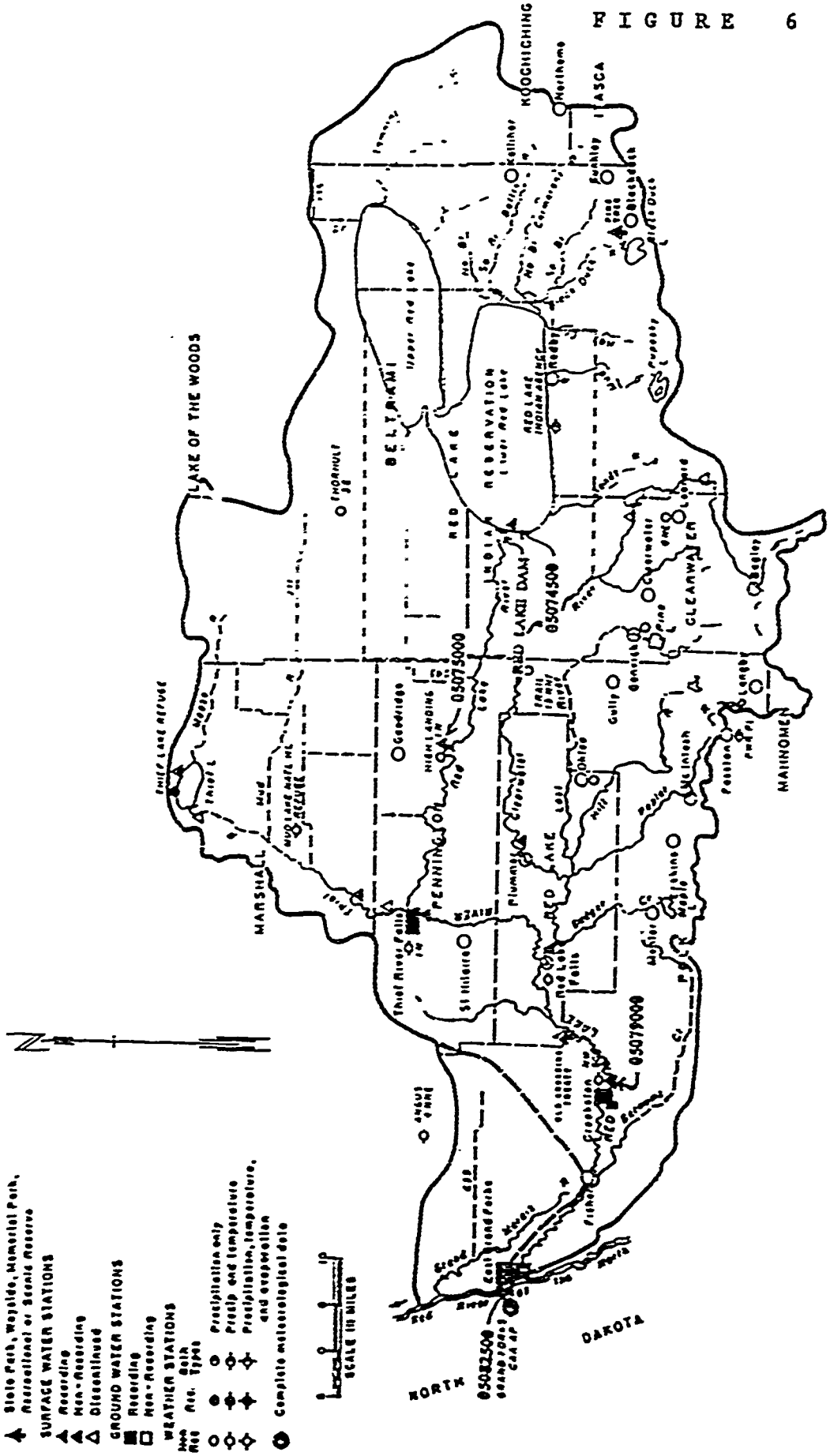
Recreational resources are abundant within the subbasin. The major recreational areas include Agassiz National Wildlife Refuge (61,487 acres) in Marshall County, a small portion of Chippewa National Forest in Beltrami County, and seven State forests that are wholly or partially located within the subbasin, including Beltrami Island (505,954 acres), Mississippi Headwaters (9,170 acres), Red Lake (59,257 acres), Pine Island (641,136 acres), Big Fork (45,293 acres), Blackduck (41,375 acres), and Buena Vista (18,488 acres). The location of these sites and other recreational areas larger than 15 acres is depicted on figure 6, and an inventory of facilities is included in Appendix C of this report.

Hunting is an important recreational activity in the subbasin, as evidenced by a total of 61 wildlife management areas that comprise 263,746 acres. Moose, elk, deer, partridge, geese, and ducks are present within the area. Furbearing animals include muskrat, mink, beaver, raccoon, and fox. In addition, there are 18 waterfowl production areas open to the public for hunting and other wildlife-oriented forms of recreation.

Approximately 50 private recreational sites, comprising about 2,000 acres, are associated (mainly) with smaller lakes in the subbasin, such as Blackduck, Maple, Julia, Pine and Clearwater. Also, many summer homes have been constructed near these lakes. The major cities and towns have county and municipal parks and school athletic fields. These provide residents with a variety of non-water based recreational activities.

Tourism is becoming a new industry in the study area. Fishing, tubing, hunting, and canoeing are the primary activities that draw visitors.

FIGURE 6


EXPLANATION
POPULATION
Over 5,000
2,500 - 5,000
Less than 2,500
STATE PARKS
State Park, Wayside, Memorial Park, Recreational or Scenic Reserve
SURFACE WATER STATIONS
Recording
Non-Recording
Discontinued
GROUND WATER STATIONS
Recording
Non-Recording
WEATHER STATIONS
Main
Reg.
Types
Precipitation only
Precip and temperature
Precipitation, temperature, and evaporation
Complete meteorological data
SCALE IN MILES
LAKE OF THE WOODS
KOOCHICHING
ITASCA
BELTRAMI
RED LAKE
RED LAKE INDIAN RESERVATION
LAKE
RED
INDIAN
RIVER
RED LAKE DAM
05074500
05075000
05079000
05082500
MARSHALL
PENNINGTON
CLEARWATER
MAHNOMEN
POLK
NORTH
DAKOTA

Red Lake River

The study area is on the northern edge of a relatively popular recreation destination area, particularly with non-Minnesota residents (primarily from North Dakota and Canada). The majority of the river oriented recreational use of the Red Lake River begins in the vicinity of High Landing and continues downstream. The upper reaches of the river are relatively remote and located on the Red Lake Indian Reservation, both of which tend to discourage use. Beyond the reservation boundary, the river has been channelized and agricultural uses of adjacent lands often extend to the riverbanks, lowering the scenic qualities of the area. The Minnesota Department of Natural Resources considers the fishery to be good for this area of the State. Major recreational uses of the river include fishing, canoeing/boating, and inner tubing. The river is a designated State Canoe Route. There is significant river based recreational use on the Red Lake River in the Red Lake Falls area; three tubing outfitters are located there, and the most desirable canoeing is above and below the city. Canoeing is also considered good on the lower reaches of the Clearwater River, near Red Lake Falls. Over summer weekends, the tubing draws visitors from as far away as Canada.

Clearwater River

The Clearwater River receives less recreational use than does the Red Lake River. The fishery is considered poor, primarily due to inadequate water levels throughout the year and water quality problems. Canoeing/boating is popular, primarily downstream of Plummer to the confluence with the Red Lake River. As with the Red Lake River, the upstream reaches are relatively remote and located on the Red Lake Indian Reservation. In addition, there is more agricultural use of the riparian areas, beyond the reservation boundary, reducing the scenic qualities.

Red Lakes

Upper and Lower Red Lakes are a tremendous natural resource offering extensive recreational opportunities. Glacial Lake Agassiz has formed Upper and Lower Red Lakes. Together these lakes comprise the largest lake area (290,800 acres) wholly contained in Minnesota and in the Red River basin. The lakes are a part of the Red Lake Indian Reservation, and only the areas on the northern and eastern shores of Upper Red Lake and the eastern shore of Lower Red Lake are available for recreational purposes (e.g., the Waskish Resort Area).

Residents of the reservation use Lower Red Lake for commercial fishing; however, Upper Red Lake is the center of walleye sport fishing in Minnesota. Other common species include perch, lake whitefish, northern pike, sheepshead, and goldeye. Reports indicate an increased use of public lands east of the lakes for hunting and snowmobiling.

INSTITUTIONAL FRAMEWORK

The subbasin is aided water resources development by the inclusion of the area in the Red Lake R er Watershed District, which maintains and updates an Overall Plan for the subbasin, consistent with the Minnesota Watershed Act. The subbasin has also achieved a legal status through the formation of the Red Lake Watershed District.

The development of effective water resources management practices in the subbasin is affected by the large number of Federal, State, and local agencies involved in project planning and implementation. There are 44 Federal agencies with various types of jurisdiction, and 14 directly involved in the water and related land resource planning process. At the State level, 27 agencies are involved. There are also regional commissions, county agencies, and municipal entities. The numerous soil and water conservation districts with jurisdiction in the subbasin include those representing Red Lake, Pennington, East Polk, Marshall, Clearwater, Mahnomen, Beltrami, Lake of the Woods, Itasca, and Koochiching Counties. The Red Lake Reservation Tribal Council is an important entity and must also be consulted for all actions that affect Indian lands and waters. Regional Development Commissions have prepared overall economic development plans that include the subbasin area and are players in subbasin water developments.

From a flood control standpoint, the main entities are the Corps of Engineers, the Red Lake River Watershed District, the Soil Conservation Service, the Minnesota Department of Natural Resources, the soil and water conservation districts, and the towns of Crookston, Thief River Falls, and Red Lake Falls.

PROBLEM IDENTIFICATION

Various resources related problems, needs, and desires were identified in three ways:

1. Scoping inputs obtained in meetings conducted as part of this study. These meetings were conducted with the Red Lake River Watershed District, key Minnesota Department of Natural Resources representatives, officials of the Red Lake Indian Tribal Council, and the interested public.

2. Professional judgments and evaluation by the Corps of Engineers study team regarding the conditions found in the study area.

3. Reviewing previous Corps and watershed district documents which provided information regarding water resource problems in the study area. This included a review of complaints found in Corps files dating back to 1947. Concerns are summarized in table 3.

Table 3 - Concerns/Problems Identified

Organization	Concerns
Chippewa Indian Nation Tribal Council, Red Lake Band of Chippewa Indians	- Water quality concerns on Red Lakes. - Loss of fish over the dam. - Red Lake water levels significantly affect fish propagation, lake access, and shoreline erosion. - Need to optimize Red Lake elevation to improve fishery. A higher elevation favored by tribe (tentatively). - Desire to put a power dam at the Lower Red Lake control structure. - Concern about the environmental effects of proposed water projects. - Marsh restoration project not operating as designed with associated production loss of wild rice, waterfowl, and furbearing animals.
Red Lake Watershed District	- Response to request for dam operation has been slow on weekends. - Would like to see original Red Lake and Clearwater Rivers channel project extended farther downstream. - There is concern about a chronic overflow problem on agricultural lands on upper reaches of the Red Lake River. The belief is that the operational control point at High Landing is too high. - A continuing ice jam problem on the Red Lake River in the southeast corner of Section 1, Township 152N, range 40W, may be a channel design problem or a silting-in problem. - Aquatic plant growth and sedimentation at the Thief River Lake is a significant problem affecting recreational use and water supplies. - Would like to see the bridge at Red Lake Dam upgraded from 40-ton to 44-ton capacity.
Minnesota Department of Natural Resources	- Environmental effects associated with water resource projects proposed and the need for detailed impact assessments. - A minimum low flow of 36 cfs has been established on Clearwater River to increase water appropriation during low flow periods. MDNR would like to maintain higher minimum flows.
Wild Rice Growers on Clearwater River	- Need additional water during low flow periods to continue to develop the wild rice industry along the Clearwater River. - Low flow/appropriation regulations on the Clearwater River appear to have significantly reduced flood control benefits afforded by the wild rice growers. Limitations have forced wild rice growers to fill their paddy areas in the fall rather than the following spring to be assured of an adequate water supply for the next growing season.

Table 3 - Concerns/Problems Identified (Continued)

Organization	Concerns
	- Wild rice growers are concerned that available water supplies may be reduced if the tribal council constructs an additional marsh or wild rice paddy.
Farmers at High Landing	- Flooding aggravated by slow response from Corps dam operators and concern about the control elevation at High Landing. - Would like to see the original channel project extended farther downstream.
Resort Owners and Other Property Owners on Upper Red Lake	- The access channel from the Tamarac River into Red Lake is unusable because of low water most of the year (elevation 1174). - Some resort interests like a high summer level (1174.5 to 1175.0). Some like it at 1173 to 1174, depending on their location and ground elevation. - Shoreline erosion at Red Lake. - Riverbank erosion at Tamarac River. - Many county ditches/creeks are blocked by sandbars where they enter Red Lake, causing spring flooding and, in the case of the creeks, poor fish propagation. - Harbor entrances can quickly become blocked by sandbars when wind and water levels are high. - Concern over fish population and possible relationship between lake level and fish population.
Resort Owners on Upper Clearwater River	- The access channel from the Tamarac River into Red Lake is unusable because of low water most of the year (elevation 1174). - Shallow shoreline on Red Lake makes it difficult to get boats out at elevation 1174. - No follow-up contact was made by Corps of Engineers following a survey of complaints in the area.
Thief River Falls, Minnesota	- Power plant: Red Lake River needs a minimum of 750 cfs to run hydropower units. Low flows have been a problem in recent years. (See photos, appendix C) - Power plant officials would like Corps of Engineers assistance in investigating scour on the lower end of the dam. - Recreational interests in the area rely on Red Lake River flows and want high summer flows.

As a result of these efforts, the following general categories of problems and opportunities were identified.

Flood Control
Streambank and Shoreline Erosion
Aquatic Plant Control
Sedimentation
Water Quality
Water Supply and Low Flow Augmentation
Environmental Issues (primarily fish and wildlife concerns)
Recreation Problems
Hydropower

Problems are discussed separately below with emphasis on flooding control, shoreline protection, aquatic plant control, sedimentation, water quality, water supply, environmental issues, and recreation concerns.

FLOOD CONTROL

Various types of flooding have historically been, and continue to be, a serious problem in the Red Lake River subbasin. Many water control developments have been implemented to control flood damages (See Water Management Description section of this report for a summary of such action). Flooding problems can be divided into three flooding categories: (1) Flooding along the banks of the Red Lake River and its tributaries; (2) Flooding along the shorelines of lake areas such as Upper and Lower Red Lakes; and (3) Overland localized flooding from runoff impounded due to poor drainage caused by plugged drainage culverts and ditches.

Flooding on the Red Lake River usually occurs in April and May in conjunction with spring snowmelt. Spring rains occurring at such times extend the duration of high flows or result in additional high peak flows. Several large lakes and extensive marsh areas also tend to extend the duration of snowmelt floods. Overbank flood stages usually persist for several days, and widespread flooding on the Red River Valley plain below Grand Forks lasts as long as 4 to 6 weeks. Floods on the Red Lake River occasionally have occurred in the summer; none have occurred in the fall or winter.

Although agriculture is less pronounced than in adjacent subbasins, spring snowmelt floods force delays in planting operations that are reflected in reduced crop yields. In view of the relatively short growing season, water standing on the land too long may make it impossible to engage in planting operations altogether.

Flood damage also occurs from high intensity summer rains. Although they occur less often than spring snowmelt floods, the summer floods are characterized by high peak flows that cause urban and agricultural damage. The condition of the soil is an important factor that affects the degree of flooding in that high soil moisture or frozen soil conditions prior to heavy rains and/or snowmelt result in greater runoff. Occasionally, ice jams on the Red Lake River can increase flood stages several feet, particularly in the vicinity of Crookston where several channel constrictions and low

From an economic perspective, the recurrent flooding of urban development in Crookston is the most critical problem in the Red Lake River basin. A 1990 Corps study showed an annual estimated $930,000 loss due to flooding in Crookston. These are expected damages in spite of local flood control actions. Between 1950 and 1965, temporary levees were constructed at Crookston through local efforts. These levees have seriously deteriorated and they no longer provide reliable protection to Crookston. Since Corps construction of the channel improvement project on the Red Lake and Clearwater Rivers, agricultural flooding is less significant (i.e., the existing project provides approximately a 5-year level of flood protection for the upper reaches of the Red Lake and Clearwater Rivers). However, it is clear that flows originating from the operation of the Lower Red Lake control structure often cause residual downstream flooding on the floodplain lands along the Red Lake River. This is due to the lag in operational response to shutdown of Red Lake outflows. Residual flood damages realized may also be affected by the current control point elevations at High Landing. These control elevations trigger the shutdown of the control structure. Downstream interests would like the Red Lake Dam shut down whenever high intensity rainstorms are predicted or whenever they occur. The Red Lake River contributes greater flood flow volumes than any other tributary to the Red River of the North, aggravating flooding of the latter, particularly in Grand Forks and at the United States-Canada border. In fact, on the average, Red Lake River subbasin flood flows account for 43 percent of the Red River of the North basin flows at Grand Forks-East Grand Forks. However, a number of upstream reservoirs constructed in the past 15 years provide some urban and agricultural flood reduction effects.

Another flooding problem is related to the lake levels on the Red Lakes. Flood damages are due to elevated lake levels attributable to higher than normal precipitation, and can be compounded by ice, seiche, and wind effects. Some lake level effects can also be attributed to the operational releases of the control structure at the outlet of Lower Red Lake. Corps operation of the control structure is described in the Alternative 2 evaluation of this report.

Overland localized flooding which is not induced by river stage increases is a concern to many local farmers, because poor drainage can seriously affect agricultural yields. However, preventing this type of flooding is not a federally authorized purpose, and it has not been evaluated in this reconnaissance study.

STREAMBANK AND SHORELINE EROSION

Soils in the subbasin are susceptible to drifting, wind erosion, and water erosion. Water erosion is most severe in the lake plain and moraine areas during the spring runoff season. The silt, clay, and other fine soil particles are carried into the streams and rivers and produce siltation problems in the stream channels. Wind erosion results in sedimentation fills or partial fills of surface drainage systems and main outlet ditches, causing additional flooding and drainage problems. Soils treated with pesticides and nutrient enrichments are carried into lakes and streams, reducing the water quality and decreasing the water holding capacity. This limits the municipal water supply and recreational potentials in the subbasin.

Recently, the Red Lake Watershed District has worked with the Corps of Engineers to identify and coordinate actions to protect public works threatened by streambank erosion. This is being accomplished under the authority of Section 14, 1946 Flood Control Act, as amended. That authority allows the Corps to develop and construct emergency streambank projects to protect endangered highways, highway bridge approaches, public works facilities such as water and sewer lines, churches, public and private non-profit schools and hospitals, and other non-profit public facilities.

Erosion of the shorelines along the Upper and Lower Red Lakes is a potential problem. Protection of public facilities that could be undercut by shoreline erosion may need to be evaluated in the future through the Corps

of Engineers continuing authorities program. Further evaluations of these problems were not pursued in this study.

The most significant shoreline erosion problems in the subbasin occur on Upper Red Lake. They are caused mainly by high water combined with wave action and are exacerbated by the sandy soil type and efforts by homeowners to keep their beaches free of water weeds (exposing these areas to the full impact of wave action). Bank erosion problems along the Tamarac River are caused by river backup due to high water and/or wave action on the lake, coupled with the steep riverbanks, the sandy soil, and the wakes of recreational boaters. Shoreline and riverbank erosion are threatening a number of structures and are causing extensive beach loss along the shores of Upper Red Lake.

AQUATIC PLANT CONTROL

Aquatic plants are an important part of the ecosystem of lakes and rivers. However, when conditions are favorable, aquatic plants can grow in densities that become a nuisance. The overabundance of aquatic plants can have negative impacts on aquatic systems, including fish populations.

Generally, aquatic plants are perceived to be a problem when they reach densities that interfere with recreation or begin to reduce channel capacity in flood prone rivers. Aquatic plants can also be a problem when their effects on diurnal dissolved oxygen concentrations lead to anoxic conditions that will cause a fishkill. Another problem with excess vegetation growth is the development of monotypic or single-species plant beds. A more diverse plant community can provide more diverse habitat which, in turn, can support a larger variety of organisms.

Excess aquatic plant growth is often associated with nonnative aquatic species because the natural control agents, such as insects or diseases, were not always introduced with the plant. Because of this and other competitive advantages, these plants often replace native species. Native species can also become established in densities that could interfere with recreation. This is often the result of a combination of excess nutrients and climatic conditions favorable to plant growth or unfavorable to controlling agents.

In Minnesota, two exotic, or nonnative, species have been found in important recreation lakes. Eurasian flowering rush is now established in Detroit Lake and Eurasian watermilfoil has been identified in 41 Minnesota lakes. Most are located in or adjacent to the Twin Cities area. These exotic species have not yet spread to the waters of the Red Lake River subbasin. However, there is concern that infestations of Eurasian watermilfoil could reach this area if better control measures are not used.

The State of Minnesota is responsible for managing aquatic plants in cooperation with the Corps of Engineers and a variety of local governments and lake associations. Aggressive efforts to control the spread of Eurasian watermilfoil and Eurasian flowering rush and to manage aquatic plants are ongoing. These efforts are being coordinated through separate Corps study efforts and are not a part of this reconnaissance study.

Aquatic plant growth has been identified as a problem at two sites in the basin. Native aquatic plant growth in combination with sedimentation at the Thief River Falls reservoir is degrading recreational and aesthetic use of the reservoir. Native aquatic plant growth downstream of the Lower Red Lake control structure has been identified as a seasonal problem that limits the capacity to release water through the structure.

SEDIMENTATION

Soils in the subbasin are highly erodible, and movement of river bottom and lake bottom materials is a natural occurrence that can cause problems in the subbasin.

Removal of sediments has historically been accomplished in many areas. Sand and silt bars have been removed from the flood control channels on the Red Lake and Clearwater Rivers. Bottom sediments have been dredged from the Thief River Falls reservoir and other lakes. Sediments have been removed from the inlet control structures leading into the marsh restoration project on the Red Lake Indian Reservation. Dredging has also been needed occasionally to open silted-in navigation inlets to allow boaters to get into the Red Lakes from resorts.

The ongoing need for dredging activities has been identified in all of the above mentioned areas. There is a need for significant and immediate dredging activity at the Thief River Falls reservoir, at the marsh restoration inlet control structures, and in a reach of the Red Lake River downstream of the Red Lake control structure.

These actions are part of the normal operation and maintenance responsibilities associated with existing projects and are being planned for by the operating governmental entities.

WATER QUALITY AND QUANTITY

The economy of the subbasin depends heavily upon agriculture, and the success of agriculture is directly related to the timely occurrence and

amount of rainfall during the growing season, assuming that crops can be planted when appropriate. Annual precipitation averages about 21 inches, but growing season rainfall is only about 15 inches. If ideally distributed, this amount of rainfall is sufficient to provide for full production of crops; however, the rainfall does not always come when necessary. In these years, irrigation would increase crop yields, providing for a more profitable farm production.

Aside from the wild rice paddies, very little irrigation is done in the Red Lake River subbasin. Wild rice is commercially grown in paddies flooded with water to an average depth of about 1 foot. Approximately 30 inches of water is required annually to saturate the subsoil, to initially fill the paddies, and to make up for water lost through evaporation. Generally, the water is appropriated during the spring runoff and continues through June. The

paddies are drained during July and August to facilitate harvest. Late fall filling is sometimes done when water supply is limited.

The appropriation of water for irrigation is regulated by State statute. In times of low flow, water supply is insufficient to meet the needs of all users and conflicts over available water have resulted between wild rice growers, environmental interests, and downstream residents. Currently, a Minnesota Department of Natural Resources permit is required for appropriation, and the amount of water each wild rice producer is able to use is based upon their percentage of riparian acreage.

Substantial acreages between Crookston and the Red River of the North would be suitable for irrigation development through construction of sprinkler systems supplied by either surface water or groundwater, according to the University of Minnesota. A portion of this acreage has Minnesota Department of Natural Resources permits for irrigation withdrawals; however, very few of the permits are being used.

The smaller communities and farm populations obtain their water supply from groundwater. Although this water is usually of good quality, traces of iron and sulfates were found in all wells tested by the Minnesota Department of Natural Resources, Division of Waters. Some communities use the Red Lake River as a water supply source. It is necessary to filter and purify all river water for domestic and industrial purposes. During high spring runoff, water purification problems are increased. A low period generally occurs in the late summer or early fall because of low precipitation. During the winter, when the river and lakes are frozen, another low flow occurs.

The largest industrial water users in the Red Lake River basin are the sugar beet factories at East Grand Forks and Crookston, which use approximately 1 million gallons of water per day. Potato processing plants also use a considerable amount of water.

Water from the Red Lake River and its tributaries generally must be treated before being used for municipal or industrial purposes. The hardness of the water is within acceptable limits except during low flow periods when dissolved solids and carbonate levels in the water increase, causing the hardness to increase. At this time, adequate data and analysis are not available on the amount of water quality deterioration that can be

attributed to industries, municipalities, and rice paddies along the Red Lake and Clearwater Rivers.

A review of existing water demands in the Red Lake River subbasin indicates that current sources of water supplies are adequate under foreseeable conditions. In addition, the groundwater and the Red Lake River are expected to be sufficient to meet future requirements in the subbasin.

As part of the Souris-Red-Rainy River basins study, an analysis was made of the existing reservoirs to determine if target water needs of the Red River basin could be met during a recurrence of a 1930 type drought. Included as part of that study was the Red Lake River subbasin. For this subbasin, the Red Lake Reservoir alone would meet the basic municipal, industrial, livestock, power, and irrigation needs at Crookston and East Grand Forks and along the Red Lake River. The study also showed an additional impoundment would meet water quality requirements by enhancing low flows for fishery and aesthetic values.

Recent evaluation by the Red Lake Watershed District indicates that flow augmentation of the Clearwater River could greatly benefit wild rice production along the Clearwater River. Some improvement to recreational use and fisheries might be realized if low flows on the Clearwater River could be consistently increased.

Improved recreation, such as tubing and canoeing, and hydropower production could be realized if higher flows were established on the Red Lake River.

ENVIRONMENTAL ISSUES

Destruction of wetlands is a significant problem that has resulted from drainage for conversion to agricultural lands and from river channelization projects. It is generally accepted that wetland protection, conservation, enhancement, and restoration of wetlands are needed. Additionally, the peatlands and bogs around Upper Red Lake need to be protected because of their uniqueness and primitive setting (U.S. Army Corps of Engineers, 1975, 1977; U.S. Fish and Wildlife Service, 1980; Mann, 1979). The Corps of Engineers, in combination with the State of Minnesota, administers a regulatory permits program that regulates dredging and wetland filling actions. This provides some protection for wetlands and navigable waters in the subbasin.

Additional environmental problems that have been expressed include the effectiveness of the marsh restoration project on the Red Lake Indian Reservation, the adverse impact of the dam at the outlet of Lower Red Lake on the fisheries of the Red Lakes, and the reduction in sport fishery below the dam as a result of channelization. The relationship between fish populations and Red Lake water surface elevations has also surfaced. The Indians, area residents, and resort owners are concerned about the current lake operating plan and its perceived impact on the quality of fishing. The Red Lake Indians are interested in a detailed evaluation of the relationship of lake elevations to fisheries in order to optimize fish production. The Corps of Engineers also is responsible for the operation of the marsh restoration project below the Lower Red Lake control structure and the lake level operations at the Lower Red Lake control/outlet structure. Detailed

study to refine operations of these existing projects is a normal operations and maintenance function separate from this general investigations reconnaissance study.

Another environmental concern is protecting endangered or threatened species. Clearwater County is within the breeding range of the bald eagle, a federally listed threatened species. Clearwater, Pennington, Red Lake, and Polk Counties are all within the peripheral range of the federally threatened gray wolf. Polk County contains remnant populations of the western prairie fringed orchid, another federally listed threatened species. All activities and developments need to avoid impacts to these important threatened resources.

RECREATION CONCERNS

There are 11 major lakes in the watershed and hundreds of miles of navigable rivers. These offer excellent opportunities for all kinds of water-based recreation including fishing, camping, hunting, and winter sports. A large number of good resorts in the area provide a wide variety of recreational opportunities. Many other nonwater-based activities, such as hunting and snowmobiling, are also in plentiful supply. However, there are problems that limit recreational use and enjoyment. These problems relate to natural conditions and processes, human practices that diminish aesthetic quality, and the distribution of prime recreational areas in relation to population centers.

Many of the lakes in the moraine area are shallow and are not suitable for recreation. Unfavorable shorelines and lake bottoms limit several larger lakes for recreational use. For example, boating on Upper and Lower Red Lakes is limited by the size and shallow depth of the lakes, which creates safety hazards during windy conditions. Also, resort development has not occurred because the majority of shoreline property is included in the Red Lake Indian Reservation and is, therefore, not available for recreational purposes for most of the subbasin residents. Only access to the eastern portion of the lakes is permitted.

Siltation from agricultural runoff is not as pronounced in this subbasin as in other areas of the Red River basin, but does present some problems. Water quality in the subbasin is generally high enough to allow for body contact activities (e.g., tubing and canoeing are popular on the Red Lake River). However, water quality limits the fishery potential of the Clearwater River and affects recreational fishing potentials.

The most significant limiting factor of recreational use of the Red Lake and Clearwater Rivers is consistently adequate flow levels in the rivers during the summer months. Improved and/or consistent flows would benefit the fisheries, especially in the Clearwater River, and provide enough depth to support boating/canoeing/floating use of the rivers. More consistent flows in the river would have a beneficial effect on recreation use and improve the recreational experience.

EXPECTED FUTURE CONDITIONS SUMMARY

Overall, if no action is taken in the Red Lake/Clearwater Rivers area, the existing riverine environmental conditions will continue. Barring unforeseen changes in land use trends, woodland habitats within the subbasin are expected to increase in areal extent to the benefit of many wildlife species in the region. Conversely, wetlands are expected to remain constant or decrease in total number and areal extent, with subsequent effects to plant and animal populations dependent upon these important ecosystems.

Natural conditions and uses of the Red Lakes are expected to remain relatively constant in the future.

The Minnesota State Planning Agency expects only one of the six component counties (Red Lake) of this subbasin to lose population during the remainder of this century. Slow-to-moderate growth is forecast for the remainder of the counties, with rapid change taking place in Pennington, Beltrami, and Clearwater Counties. Regional efforts are being directed toward establishment of agricultural processing industries, business district renovations, and public works construction and improvement in all counties. Thief River Falls and Crookston are the two communities expected to be the center of this growth.

Implementation of point and nonpoint source pollution abatement measures will continue to improve the quality of surface waters within the subbasin. Improvements in water quality will help provide better habitats for aquatic biota and wildlife. However, periodic low flows will continue in portions of the Red Lake River and its tributaries, especially on the Clearwater River. The low flows on the Clearwater River will limit the extent of biological improvements realized.

FEDERAL OBJECTIVE

The Federal objective of water and related land resources project planning is to contribute to national economic development (NED) consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders and other Federal planning requirements. This objective was established by the U.S. Water Resources Council's Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies published on March 10, 1983.

Water and related land resources project plans are to be formulated in ways that contribute to this objective. Contributions to national economic development are increases in the net value of the national output of goods and services, expressed in monetary units (i.e., benefits exceed costs). Contributions to NED include increases in net value of those goods and services that are marketed and also of those that may not be marketed.

SITE SPECIFIC PLANNING OBJECTIVES AND CONSTRAINTS

After developing an understanding of the concerns of the Federal, State, regional, tribal, and local government organizations in the study area, the following three primary planning objectives were identified:

1. Reduce flooding in the Red Lake River subbasin to increase agricultural production and reduce urban flood losses.

2. Improve the operation and river flow characteristics on the Red Lake River and its tributaries to improve flood control, fish and wildlife habitats, recreational uses, and agricultural water supplies.

3. Preserve and enhance environmental quality associated with existing water developments within the subbasin.

FORMULATION OF ALTERNATIVES

Alternative plans consist of measures, strategies, or programs that will provide some level of remedy for an identified problem in the study area. This section of the report describes alternative remedial plans for a range of water resource problems previously identified in this report.

PLAN FORMULATION PROCESS

The plan formulation process used a 5-step approach to evaluate alternative plans. These steps follow:

1. Collect relevant data about water problems in the study area from all available sources. This includes past studies and interagency scoping meetings.

2. Identify potential solutions for the water problems defined in step 1 above. Also identify existing programs that could address the specific problem.

3. Evaluate, in a preliminary level of detail, the alternative plans from a Federal interest perspective to identify alternative plans that need additional evaluation.

4. Identify and evaluate in more detail the alternative plans that merit further evaluation, from a Federal implementation perspective.

5. Summarize findings and recommendations for future action.

Plans were formulated using the skills and experience of a Corps of Engineers interdisciplinary study team. The team was comprised of hydrologists, engineers, economists, sociologists, recreation specialists, landscape architects, real estate specialists, biologists, and cultural resource specialists. Key technical inputs were also provided by the Red Lake River Watershed District, the Minnesota Department of Natural

Resources, the U.S. Fish and Wildlife Service, and the Red Lake Indian Fisheries Research and Management Office.

The study team used five criteria in formulating alternative plans to solve the identified problems. These criteria follow:

1. Effectiveness - How much of the problem would be solved with implementation of this plan?

2. Efficiency - Is this plan the least costly approach to solving the problem when compared to other solutions?

3. Acceptability - Is the plan socially acceptable and implementable?

4. Completeness - Does the plan account for all investments needed to realize a solution to the problem?

5. Environmental Sensitivity - Are the adverse environmental effects associated with the plan minimized and/or mitigated?

ALTERNATIVES INITIALLY CONSIDERED

Table 4 presents an overview of water resource problems and possible actions that could help to solve these problems.

Table 4 - Specific Problems and Actions Considered

Problem Category	Actions
Flood Control	Reduce flood losses at Crookston by constructing downstream cutoff channels and permanent levees, maintaining the existing emergency levees, and improving flood fighting capabilities.
	Reduce flood losses to agricultural lands along the Red Lake River by improving the flood warning and response time associated with operation of the Red Lake control structure. Also evaluate the downstream control point elevation to see if it needs to be changed and determine if existing channel improvements need to be extended.
	Further evaluate the Red Lake operating band to determine if flooding associated with high lake levels requires revision of the operating band.
	Improve downstream flood control by increasing upstream storage reservoirs and/or by improving operation of existing reservoirs.

Table 4 - Specific Problems and Actions Considered (Continued)

Problem Category	Actions
	Reduce shoreline flood damages due to high Red Lake levels by increasing the outlet capacity at the Red Lake control structure. Reduce flood damage on the Red Lake and Clearwater Rivers by constructing a connecting channel between the two rivers.
Streambank Erosion	Reduce Red Lake shoreline erosion by reducing the fluctuations of lake levels through changes in the operating plan and/or by increasing the outlet release capacity at the existing control structure. Reduce the damages associated with streambank erosion along the Red Lake and Clearwater Rivers by implementing measures to restore and armor sites now eroding.
Aquatic Plant Control and Sedimentation Control	Prevent the spread of Eurasian watermilfoil and Eurasian flowering rush through education programs and by monitoring for initial infestations. Control aquatic plants at Thief River Falls reservoir by harvesting or dredging. Reduce river sediment related damages by implementing improved farming practices and related watershed land use management.
Water Quality and Quantity	Improve water quality in the Red Lake and Clearwater Rivers through changes to the Red Lake operating plans. Improve the amount of water available for wild rice production on the Clearwater River by constructing a connecting channel between the Red Lake and Clearwater Rivers, reallocating existing water supplies, or diverting Red Lake outflows directly into the Clearwater River. Enhance river water quality by improved regulation of pollution sources and better watershed land management.

Table 4 - Specific Problems and Actions Considered (Continued)

Problem Category	Actions
Environmental Restoration and Protection	Improve fish production at the Red Lakes by optimizing Red Lake water levels for fisheries.
	Improve the fishery by increasing the low flows along the Clearwater River through reallocation of existing water supplies or diversion of other water sources.
	Restore and enhance the marsh below the Red Lake control structure by dredging and improved operations.
	Improve fish and wildlife habitat along the Red Lake and Clearwater Rivers by restoring old oxbows and other environmental features.
Recreation	Improve recreational use and recreational values by implementing measures that would increase river flows and make flows more reliable.
	Improve recreation use and recreation value by dredging Thief River Falls reservoir.
	Improve recreational use on the Red Lakes by changing the Red Lake operating plan.
Hydropower	Improve hydropower production at the Thief River Falls site by increasing river flows and making flows more reliable.
	Produce power at the Red Lake Dam by implementation of a power plant at that location.

EVALUATIONS OF ALTERNATIVES MERITING FURTHER EVALUATION

Six alternative plans were formulated to address the most pressing flood control, water supply, and environmental restoration problems and opportunities identified as part of this reconnaissance study. Background descriptions, engineering evaluations, economic evaluations, environmental evaluations, and an evaluation summary of each of these alternative plans are presented in this section of the report.

It is important to note that all economic evaluations conducted as part of this study evaluated benefits attributed to a particular alternative plan from the National-Federal perspective as prescribed in Corpswide guidance. Therefore, regional and localized economic benefits have not been quantified or included in these economic benefit-to-cost evaluations (i.e., local and regional benefits cannot be included in the calculation of national benefits).

ALTERNATIVE 1 - CONNECTING CHANNEL PLAN

Background and Description

A need for additional agricultural water supply on the Clearwater River and flood control on the Red Lake River motivated local interests to develop the concept for a rivers connecting channel plan. Other benefits thought to be attributable to this project include recreation, hydropower, and fish and wildlife enhancements. A 1989 engineering report entitled "Connection Channel and Sayersville Impoundment Project" was prepared by the Red Lake Watershed District to further define this plan.

The concept of the connection channel is to construct a channel between the Clearwater and Red Lake Rivers to allow for an interchange of flows. The connection would be made at points of equal flood stage elevation so that, during a flood, the water would flow from the river with the higher water level to the river with the lower level, thus making the excess capacity of one river available to the other river.

It was believed that transfer of water from the Red Lake River to the Clearwater River would benefit both rivers, because the Red Lake River has extended periods of high flow while the Clearwater River has extended periods of low flow. Thus, additional water flows in the Clearwater River could enhance recreation, make water available for irrigation on the Clearwater River, and improve low flows on the Clearwater River to benefit fish and wildlife.

The proposed connecting channel could include a small impoundment to store some floodwaters and provide additional recreation and fish and wildlife opportunities. Materials from excavating the channel could be used to construct an impoundment levee and road. See plate 2 for a conceptual drawing of this alternative plan.

Engineering Evaluation

The proposed connection channel project would be a trapezoidal channel. The channel would approximately follow the western edge of the Red Lake Indian Reservation which lies about 14 miles west of Lower Red Lake. The intent is to transfer water between the Clearwater and Red Lake Rivers from whichever river is at the higher stage. No flow would be allowed to transfer from a river which was below a minimum protected flow. Also, no flow would transfer when both rivers were at flood stage, because the connection points would have equal flood stage elevations. Transfers to a river that was above flood stage from one at a higher flood stage would have limited

capacity, and manual intervention would be possible to reduce damages on the receiving river.

The channel design capacity would be 400 cfs, assuming low flow in the receiving river and flood stage in the sending river. A review of the flow records on the Red Lake and Clearwater Rivers revealed that, on the average, 300 cfs could be transferred to the Clearwater River when the flow in the Red Lake River was equal to or greater than 1,000 cfs. This would not be true every year. However, this would be a good assumption for the level of detail required at this stage of study. There is a 0.5-day discharge travel time between the connection channel and High Landing. The drainage area at the connection channel is 2,171 square miles (221 square miles effective).

The proposed diversion would divert water from the river with the higher relative flood stage to the one with the lower relative stage. Discharge-frequency curves were constructed for both rivers assuming that the other river would be fully capable of receiving all the water the diversion structure would be capable of delivering. In this way, the best possible scenario was evaluated. Tables A-11, A-12, and A-20 and plate A-3 of the Hydrology Appendix (Appendix A) show the discharge frequencies that would be affected with and without the connection channel in place.

Consideration was not given to the effect of the transferred flows on low flow augmentation on the Clearwater River, and potential decreases in flooding on the Red Lakes due to possible increased downstream discharge capacity.

Economic Evaluation

A number of economic benefits could be attributable to the connecting channel plan. These are discussed below.

The modified flood frequency-discharge curves for both rivers show that the connection channel would provide an average annual flood reduction benefit to 561 acres on the Red Lake River and 28 acres on the Clearwater River. This amounts to an average annual national benefit of $44,200 from the potential reduction in flood damages along the rivers. This number is somewhat overstated as it does not take into account the impact of potentially induced damages to the receiving river (see Appendix B for detailed descriptions of economic evaluations).

The proposed connection channel would potentially allow increased discharges through the Lower Red Lake dam during periods in which the lake was higher than its regulatory band. This potential is due to the increase in total downstream channel capacity which would result from the connecting channel. Benefits of reduced flooding on Red Lake would accrue from reduced flood damages around the lakes, particularly Upper Red Lake which starts receiving damages from high water when the lake reaches elevation 1176.0. Damages start on the Red Lake Indian Reservation at elevation 1177.0. The potential national benefit was not quantified because the impact of being able to discharge an additional 300 cfs from the dam is minimal.

Benefits from employing underemployed labor are an acceptable national benefit category. However, these were not quantified. Such benefits would

be relatively small and did not warrant the detailed effort required to calculate them.

Benefits from enhancing wild rice production along the Clearwater River as a result of increasing the potential water supply to be pumped into the rice paddies are primarily local and regional benefits. Currently, the 12,000 acres of wild rice grown along and near the Clearwater River depend on the river as a source of water (See figure 7 for a map showing the location of the wild rice production areas). A major constraint to optimally using all of the paddies has been the lack of water in the river. The connection channel has the potential to provide additional water to the Clearwater River during periods when the Red Lake River is high and the Clearwater River is low. The potential for National Economic Development (NED) benefits from this category is limited because the reduced production resulting from lack of water in the Clearwater River can be made up in other rice producing regions. This is evidenced by the fact that the constraint on expansion of rice paddies is not a lack of water, but rather the economic conditions in the ricing industry. In addition, when there is not enough water to fill the paddies, paddies may not be flooded and alternate crops can then be grown. This reduces the potential for net economic benefits.

The report prepared by the Red Lake Watershed District indicated that benefits would result from more efficient operation of the Thief River Falls hydropower dam by maintaining a more stable discharge in the range of 750 cfs. A consultation with the superintendent of utilities in Thief River Falls indicated that high water is not a problem for operation of the hydropower dam in Thief River Falls. The associated debris problem causes problems. Increases in flows as a result of diverting water from the Clearwater River to the Red Lake River were not believed to have a significant impact on hydropower generation.

The diversion between the Red Lake River and the Clearwater River would provide some damage reduction as a result of reduced highwater damages around Red Lake; however, this is very small in relation to the project costs. In addition, the project would provide some increment of benefit to several other minor categories; however, the increment of benefit is so small as to not merit detailed calculation.

The diversion channel would offer no significant recreational opportunities; it could not be used as a navigable waterway between the rivers. Canoeing, boating and tubing on the rivers generally occur in mid-summer when the weather is warm and river flows are normal to low. Any diversion of flows could adversely affect the usability/attractiveness of the losing river which may not be offset by the gain of the receiving river. Therefore, the diversion channel alternative would not significantly affect recreation either beneficially or adversely.

The diversion could have a beneficial effect on the fisheries in the Clearwater River when the Red Lake River was above its operating band and maximum discharges were being released into the Red Lake River. However, the flows would have to be consistent throughout the year for the fisheries to benefit. Because of the inconsistency of when the lake needs to be drawn down in the late summer, the benefit to the fisheries and associated recreational use in the Clearwater River would be very minimal.

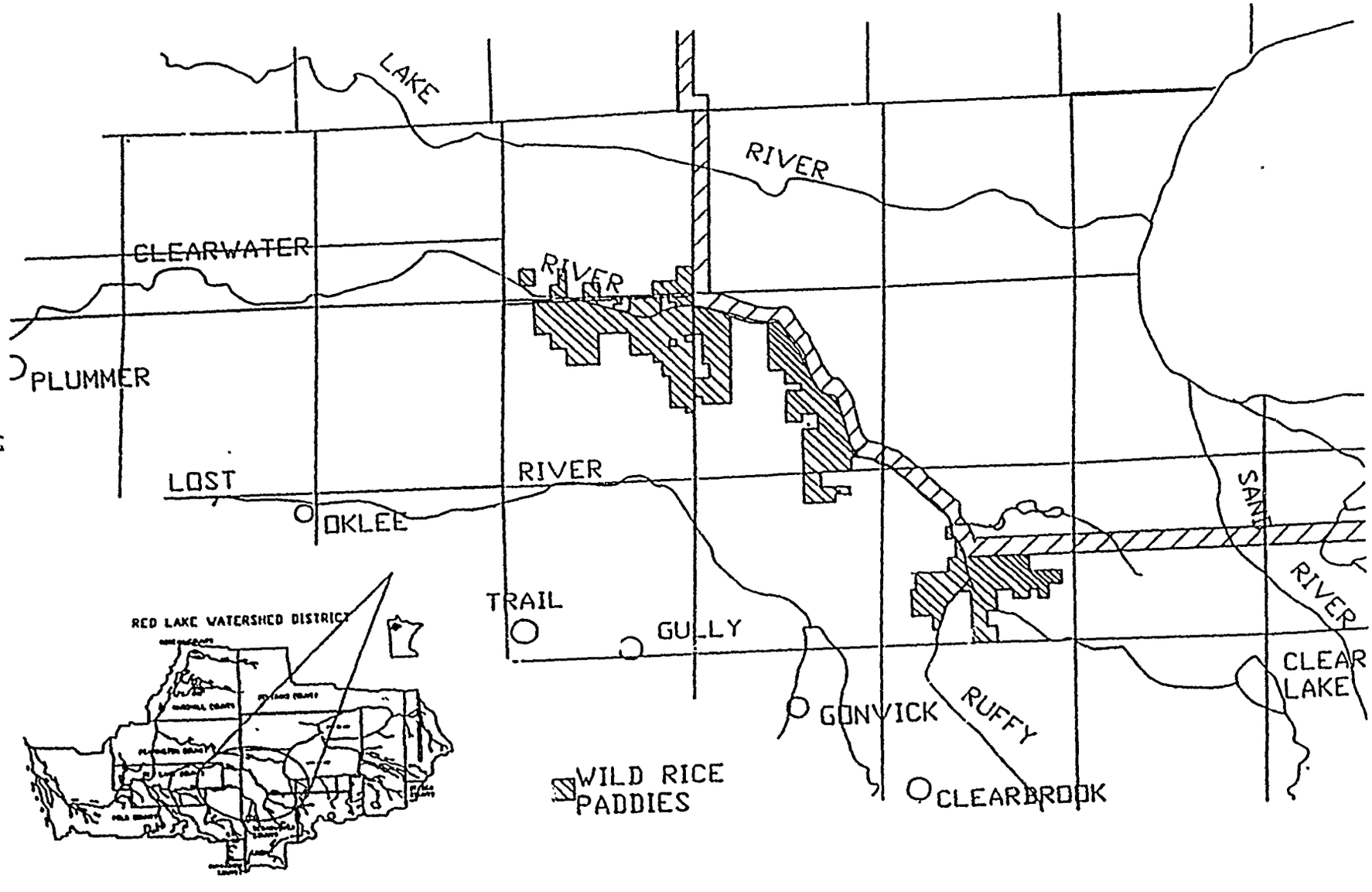

LAKE
RIVER
CLEARWATER
RIVER
PLUMMER
LOST
RIVER
OKLEE
TRAIL
GULLY
SANDY
RIVER
CLEAR
LAKE
GONVICK
RUFFY
WILD RICE
PADDIES
CLEARBROOK
RED LAKE WATERSHED DISTRICT

FIGURE 7

First costs of this alternative are $2,017,000 (see Appendix E for details about this estimate). Assuming a 50-year project life and the interest during construction on a 1-year project at an 8 3/4 percent discount rate, average annual project costs are $186,900. Comparing this with the average annual benefits of $44,500 yields a benefit-cost ratio of 0.24. Therefore, under current assumptions, prices, and conditions, and using national economic benefit, this plan is not economically feasible.

Environmental Evaluation

The connecting channel plan would provide little or no benefit to the Clearwater River unless flows were provided during late summer, especially in low runoff years. Current base flow is one-half of that desired by the Minnesota Department of Natural Resources. Discharge of water to the Clearwater River would not be beneficial to fish or wildlife unless water was provided dependably during periods when the river would be at or below the base flow of 36 cfs. An instream flow habitat analysis would be required to determine the probable effects of alteration of flow.

It is likely that water from the diversion to the Clearwater River would be used in wild rice paddies. Increase in wild rice production may be a negative impact to the Clearwater River because it would result in increased appropriation, which could lead to decreased water quality from discharge of additional nutrient-rich water.

The diversion channel may affect protected wetlands. It is not known if any wetlands would be directly affected by channel construction, but the excavation of a channel could provide the opportunity to lower ditch outlets or extend ditches farther upstream. Both actions could provide the opportunity for increased wetland drainage and would need to be considered in future implementation studies.

The proposed Sayersville impoundments could benefit waterfowl. However, they may not be suitable for waterfowl habitat because of peat; flooding of the peat which underlies much of the project area could result in floating peat blocking use by waterfowl. Considerable preparation of the impoundment basin could be required if waterfowl management was planned.

The Clearwater River presently receives a base flow which is not adequate for effective fish production. Augmentation of the low flow might provide a benefit but only if it was available when needed. The Clearwater River is already heavily altered and appropriated in its present state. There may be no net benefit from reducing flows in the Red Lake River to benefit the Clearwater River. An instream flow habitat analysis in both the Red Lake and Clearwater Rivers would be required during future design and implementation studies to determine the net effects of altered discharge on fish habitat.

Evaluation Findings (Alternative Plan 1)

The connecting channel plan could result in benefits in a number of categories as summarized below:

Improved flood control on the Red Lake River would be minimal.
Improved flood control on the Clearwater River would be minimal.
Improved agricultural water supply on the Clearwater River would be moderate.
Improved recreation on the Red Lake and Clearwater Rivers is questionable.
Improved environmental conditions on the Clearwater River would be minimal.

Issues associated with this plan include:

1) The plan would provide reliable water supply to the Clearwater River only during higher flows on the Red Lake River. This makes the plan somewhat less effective for agriculture and also negates any low flow benefits to fish habitat.

2) A costly instream flow evaluation for both rivers would be needed to determine the fishery impacts of the plan.

3) The social and environmental acceptability of the plan is questionable, based upon opposition to the plan voiced by some interests and agencies.

4) The plan is not economically feasible from the Federal perspective. Local and regional benefits attributable to the project may still make it a worthwhile project for further non-Federal consideration.

ALTERNATIVE 2 - RED LAKE OUTLET CONTROL MODIFICATION PLAN

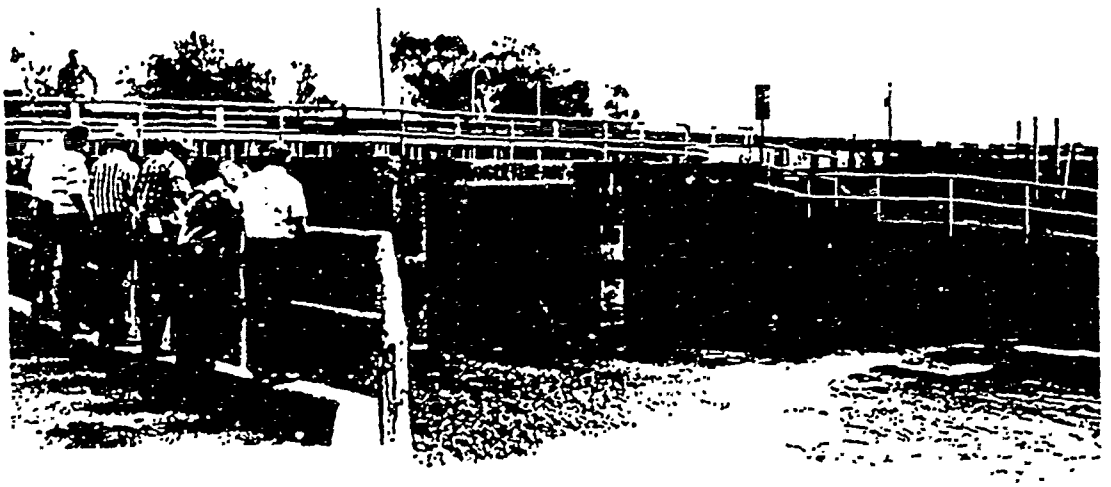
Background and Description

The Corps of Engineers currently operates the Red Lake outlet control structure and dam. The Red Lake dam and control structure serve a dual purpose: To impound water in the natural reservoir formed by the Upper and Lower Red Lakes during flood periods and to release stored water for water supply and pollution abatement during low-flow periods. For flood control purposes, storage is available above elevation 1174 with an estimated maximum probable elevation of 1179. The ability to shut down all flow through the control structure also offers the ability to provide the downstream areas with flood protection. During low-water periods, minimum releases from the lake are made to meet downstream water requirements.

The gates at the control structure on Red Lake dam are currently operated by hand-held electric motors. The gates are operated in response to river stages at the control point in High Landing. A dam tender does not live on site or nearby. To close the gates, an employee must be dispatched from

Winnibigoshish, Leech, or Pokegama Dam, all of which are approximately 100 miles away.

The capacity of the current outlet works, when compared to the size of the Red Lake impoundment, is very small; the existing gates can currently release a maximum of 1,200 cfs. In addition, the operating band for the lake is relatively narrow; the maximum desired regulatory band for lake operation is elevation 1173.5 to 1174.5. Therefore, it is difficult to maintain the lake level within the operating band. In addition, the remoteness of the structure, and resulting delays in changing the discharge levels, compounds the problem of trying to release water from the lake as quickly as necessary without exceeding channel capacities downstream.



Photograph - View of the Existing Red Lake Control Structure

A number of problems and opportunities associated with the control structure were identified. Two of these problems have a strongly related solution and were evaluated in more detail as alternative plans 2a and 2b. Alternative plan 2a is the base plan and plan 2b would be an added increment. These plans are described below.

Alternative Plan 2a - Modification of the Red Lake outlet control structure by automating the operation of the existing three gates (see plate 3). This would allow remote control of the opening and closing of the gates. Integrated into this plan is an automated downstream flood warning system that would monitor changes in river stage and rainfall events. The combination of better downstream flood warning and remote operation of the existing gates would improve the operational response time and help to reduce downstream flood losses.

Alternative Plan 2b - Features of alternative plan 2a plus the addition of a fourth automated gate to the control structure to increase the outlet release to a maximum of 1,600 cfs. This would provide additional downstream release capacity of 400 cfs to help minimize Red Lake fluctuations (especially during high water events) and could aid in the downstream supply of water.

Engineering Evaluation

When the Red Lake River is above the authorized operating band, water is discharged at the capacity of the downstream channel. The discharge travel time between Red Lake dam and the High Landing control point is approximately 1 1/2 days. The above conditions make it difficult for the operator to respond to local runoff between the dam and High Landing when high flows are being released from the dam. During the crop and non-crop seasons, the dam is operated for a stage of 8.75 and 11 feet, respectively, at the High Landing gage (see Appendix A for details).

Under plans 2a and 2b, motorized gates, which could be operated from a remote location, would be installed at the dam. The technical capability to remotely operate the Red Lake structure is available; however, the existing gates would have to be modified so they could be electrically operated and deicing features added. Downstream monitoring precipitation gages would be included to alert the operator whenever 1/2 inch or more of rain falls in 24 hours or 48 hours total. In addition, river stage gages would alert the operator to rising stages, especially at High Landing. See the 12 June 1991 memorandum, subject: Red Lake River Flood Warning System, attached to Appendix E, for details. The gates could then be closed very quickly to allow local inflows between the dam and High Landing to run off.

Appendix A (Hydrology) includes an evaluation of frequency-discharge curves associated with the with and without project conditions.

Economic Evaluation

Currently, the operation of the control structure at Lower Red Lake does not enhance damage reduction downstream (i.e., flows are allowed to discharge at relatively high rates when storm events in the area cause the local runoff to meet channel capacity). If the discharges from the dam were reduced or eliminated, the residual downstream flooding problem would be lessened. It is believed that automation of the gates would significantly help increase the efficiency of operating the dam.

Discharge-frequency curves for the with and without project conditions were constructed to quantify the benefits associated with alternative plan 2a (see the hydraulic appendix for detailed description and a display of the data). Appendix B shows the change in frequency of a given discharge at the control point at High Landing as a result of automating the operation of the dam. Average annual acres benefited are 428. The average annual benefits are $32,500.

First costs of plan 2a are $437,400 (see Appendix E for detailed estimate). Assuming a 50-year project life and the interest during construction on a 1-

year project at an 8 3/4 percent discount rate, average annual project costs are $40,500. Comparing this with the average annual benefits of $32,500 yields a benefit-cost ratio of 0.80. Therefore, this alternative is not economically feasible under current prices and conditions.

It is noteworthy that the potential savings in operational costs associated with a remotely operated control structure have not been quantified or incorporated into this evaluation. Also, a relatively high contingencies cost has been assumed in the calculation of costs. This was found to be true because: (1) The additional downstream flow capacity that adding a gate provided was not able to add significant operational flexibility to lake level control. (2) The downstream channel capacity was not adequate to increase high flow maximums without flood and erosion damages. (3) The flooding and shoreline erosion problems around Red Lakes were related more to wind and seiche effects than to the actual lake elevation. Given the

above findings and the high incremental cost of adding an automated gate, plan 2b was not considered to be an efficient plan as compared to plan 2a.

The first costs of plan 2b are $575,400. Assuming a 50-year project life and the interest during construction on a 1-year project at an 8 3/4 percent discount rate, average annual project costs are $53,300. Comparing this with the average annual benefits of $32,500 yields a benefit-cost ratio of 0.61. Therefore, this alternative is not economically feasible.

Environmental Evaluation

Environmental concerns regarding the implementation of plan 2a are minimal because it would not alter the existing control structure operating plan.

Environmental concerns regarding plan 2b were numerous and include:

(1) Increased discharges in the Red Lake River could damage fish habitat. Fish have optimums for velocity and substrate which could be exceeded by increased discharges. Conversely, certain minimum flows are required to preserve moderate temperatures and adequate oxygen supplies. These requirements vary seasonally and differ for the various life stages of each fish species, both game and forage.

(2) A change in the operating band might provide an opportunity to manage lake discharges for higher spring flows to promote fish spawning through flushing flows and overbank flooding in the Red Lake River. This may provide a greater frequency of high spring flows than presently occurs (assuming the water would be available).

(3) A change in reservoir operation could increase the stability of lake edge habitat with better water level management. If bank erosion and/or siltation of spawning habitat would be a problem at high lake levels, then this could be an improvement. However, the Minnesota Department of Natural Resources and the U.S. Fish and Wildlife Service do not believe the impacts that may occur downstream would be offset by benefits within the lake.

(4) A detailed reservoir operation plan evaluation would be required to coordinate and predict the potential effects of any changes.

Evaluation Findings (Alternative Plan 2)

Modification to the control structure, plan 2a and plan 2b, could result in benefits in a number of categories. Plan 2a, flood warning and automation of existing gates, and Plan 2b, flood warning and automation of existing gates plus one additional gate, could improve flood control along the Red Lake River substantially. Plan 2b could also reduce flooding on the Red Lakes, which could result in some recreation and shoreline erosion benefits.

Issues associated with this plan include:

1) Expanding the release capacity (plan 2b) would require additional downstream channel improvements not incorporated into the costs evaluation. This would further reduce the feasibility of this alternative.

2) Increased downstream flows could affect the fisheries, and a costly instream flow fishery evaluation would be required to determine the effects.

3) As currently formulated, plans 2a and 2b are not economically feasible. However, there may be an opportunity to improve the Corps operating efficiency at the control structure simply by coordinating an operating agreement with the Watershed District and the Red Lake Indians. If so, the economic feasibility of improved flood warning might be feasible.

ALTERNATIVE 3 - THIEF RIVER FALLS LAKE RESTORATION PLAN

Background and Description

A recreation and water supply reservoir known as Thief River Falls Lake was completed in 1969. The city of Thief River Falls constructed the reservoir by dredging approximately 280,000 cubic yards of material and constructing a dike system (see figure 8 for plan view of the site). A field examination conducted by a consultant for the city in November 1986 shows that the existing reservoir is silting in with fine sediments and that aquatic plant growth is becoming a problem. This deteriorated condition is affecting recreation uses. Dredging is proposed to restore the lake to its 1969 condition.

Engineering Evaluation

Restoration of Thief River Falls Lake by dredging has been proposed (for details see Thief River Falls Reservoir Study, Feb 1987 - prepared by the Red Lake Watershed District). Dredging could be done with a small hydraulic dredge (8-inch-diameter slurry line). The dredged material would be pumped to a retention area, a maximum distance of approximately 8,800 linear feet. The watershed district estimated the cost of implementing this plan to be approximately $730,000. It appears that dredging would be required at 20-year intervals to maintain the 1969 reservoir condition.

Economic Evaluation

National economic benefits attributable to restoration of the reservoir would be limited to public recreation and water supply. However, Federal participation in recreation and water supply developments is limited. Current Federal policies specify that recreation and/or water supply projects cannot be built by the Corps unless these purposes are associated with a primary purpose such as navigation or flood control. There is an active Federal aquatic plant control program authorizing Corps involvement, but it is intended primarily to control exotic species of aquatic plants such as Eurasian watermilfoil. Therefore, there is no Federal authority allowing detailed studies or implementation of this plan. Accordingly, detailed economic evaluations were not pursued in this study.

Environmental Evaluation

The Corps of Engineers, Minnesota Pollution Control Agency, and Minnesota Department of Natural Resources will need to process regulatory permits if dredging is to be accomplished. Evaluations of the environmental effects of the proposed action will be conducted at that time.

Evaluation Summary (Alternative Plan 3)

The Thief River Falls Lake restoration plan could result in benefits in a number of categories as summarized below:

Improved water supply could be substantial.
Improved recreation could be substantial.
Improved flood control would be very minimal.

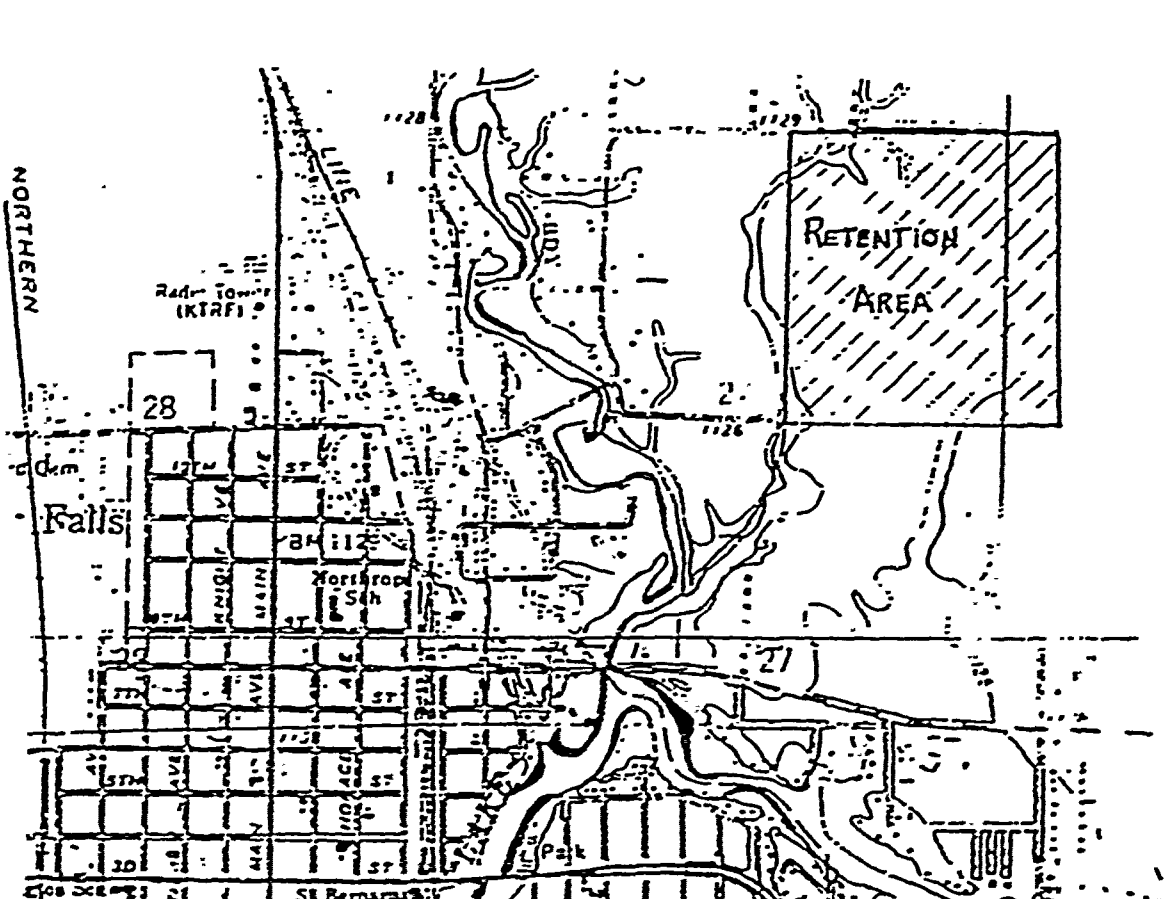
Issues associated with this plan include:

1) The Federal authority to pursue new water supply and recreation projects is currently not available.

2) Upstream land management improvements are an important part of the long-range solution to these sedimentation and aquatic plant problems. Further coordinated interagency actions are needed to resolve these issues.

3) Unless the lake becomes infested with exotic plant species such as Eurasian watermilfoil, it is unlikely that the Corps of Engineers or the State of Minnesota will help to control the aquatic plant problems in the lake.

FIGURE 8 - Thief River Falls Reservoir Restoration Site



ALTERNATIVE 4 - CHANNEL MODIFICATIONS ON THE RED LAKE AND CLEARWATER RIVERS

Background and Description

Over 30 years ago, the Corps of Engineers and th. .ed Lake Watershed District modified portions of the Red Lake and Clearwa.. r Rivers to provide local flood protection. Project features included about 27 1/2 miles of clearing, straightening, and enlarging of the Red Lake River channel between High Landing and a point 4 1/2 miles east of the west boundary of the Red Lake Indian Reservation. At that point, a small concrete dam was built to restore the marshes for wildlife in the reservation between the dam and a point some 3 miles below the outlet of Red Lake. The channel was improved for about 3 miles below the dam (see plate 4).

Also included were alterations of the existing control structure built by the Bureau of Indian Affairs at the outlet of Lower Red Lake, about 7 miles of highway raising in the vicinity of Lower Red Lake, and 47.3 miles of channel improvement in the Clearwater River channel from a point near Plummer to above Ruffy Brook.

The Bureau of Indian Affairs reconstructed a bridge on the reservation, with reimbursement of costs by the Corps of Engineers. In 1966 and 1967, additional dikes with inlets and outlets for the marshes were constructed to help restore the marshes to their former conditions.

The existing project was designed to protect agricultural lands from frequent floods (2-year to 5-year events) but would not protect floodplain lands from larger flood events. The local sponsor for this project is the Red Lake Watershed District.

The project, as originally proposed, would have extended about 8 miles below High Landing, but as actually constructed, extends downstream only about 5 miles (mile 154.28). The Red Lake Watershed Board indicates the lower 3 miles of the project were not completed because of excessive costs required for acquisition of rights-of-way from uncooperative farmers. Apparently, the rights-of-way would not be a problem at this time, according to the watershed district. As part of this reconnaissance study, the enlargement of the existing channels and the downstream extension of the channels were evaluated. These proposed channel modifications would increase the local flood protection in the area of the project to include floods up to the 10-year flood event.

Engineering and Economic Evaluations

Evaluations of the existing floodplain topography, riverbed gradient, and acreage of productive lands on various reaches of the Red Lake and Clearwater Rivers were conducted. These evaluations and calculations revealed that only 2,220 acres are currently located in the 100-year floodplain along the Clearwater River. This is a small acreage and benefits attributable to improvements would be minor. For this reason, the remainder of the evaluations focused upon modifications for the Red Lake River (see Appendix B for additional discussions). Typical existing condition cross sections and enlarged project cross sections were defined for the Red Lake

River (see figure 9 for the assumed existing condition cross sections). This allowed calculation of quantities of dredging required which was instrumental in estimating the cost for a 100-foot bottom width channel and a 125-foot bottom width channel.

The stage reduction associated with a given volume of water was determined. See details in Appendix A. Then, to determine the benefits of this alternative, the frequency curve was modified by identifying the frequency of flood required with project conditions to obtain the same level of flooding at a particular point on the exist .ıg stage-frequency curve. See Appendix B for details.

First costs of the 100-foot bottom width channel were estimated to be $1,790,000 (see Appendix E for cost information). Assuming a 50-year project life and the interest during construction on a 1-year project at an 8 3/4 percent discount rate, average annual project costs are $165,800. Comparing this with the average annual benefits of $83,300 yields a benefit-cost ratio of 0.50. Therefore, this alternative is not economically feasible under current prices and conditions.

First costs of the 125-foot bottom width channel are $3,513,000. Assuming a 50 year project life and the interest during construction on a 1-year project at an 8 3/4 percent discount rate, average annual project costs are $325,000. Comparing this with the average annual benefits of $127,400 yields a benefit-cost ratio of 0.39. Therefore, this alternative is not economically feasible under current prices and conditions. (see Appendix B for details).

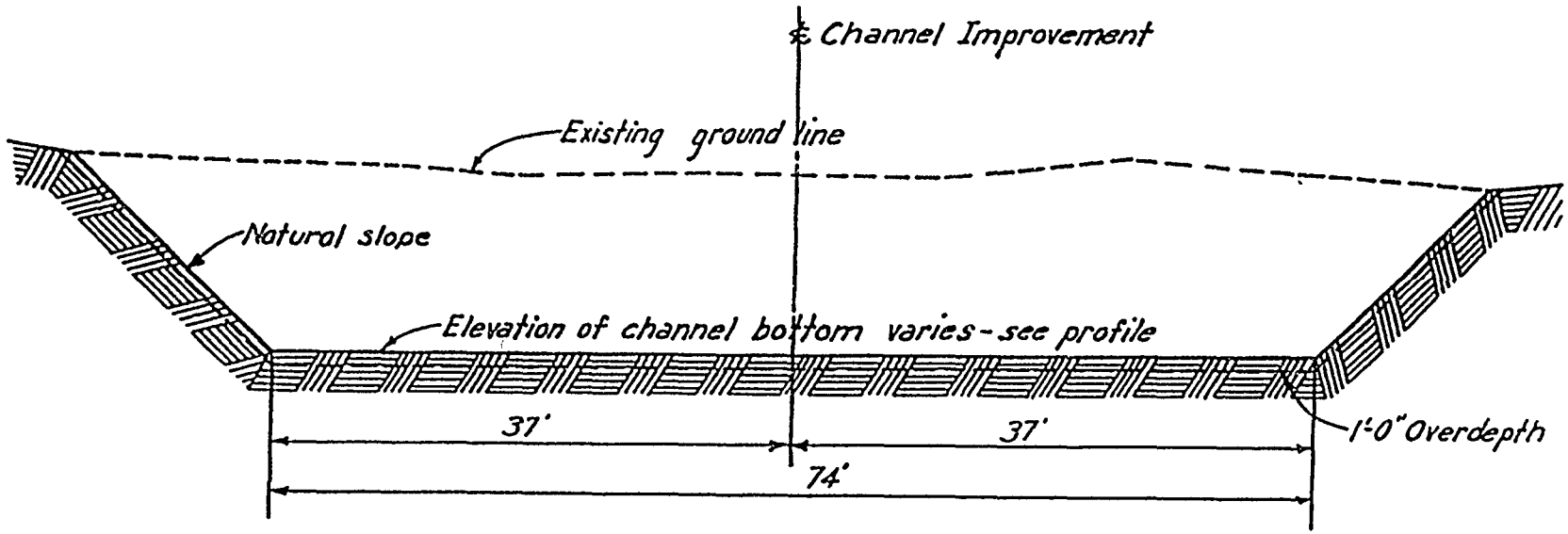
At this time, there are no economically feasible alternatives to reduce the flooding and related problems in the Red Lake and Clearwater River basins.

Environmental Evaluation

Modifications to the existing channel improvements project have many environmental issues that would need to be addressed. Any channelization project would have an adverse effect on recreation, primarily for aesthetic reasons. The river corridor would be changed from a natural state to a more man-made state, even in areas previously channelized. The effects would be most pronounced immediately after construction. As trees and shrubs became established, the effects would be lessened. Where extension of the channel modifications was proposed, the meandering character of a natural river would be lost.

The Red Lake River is the only river in northwestern Minnesota designated by the Department of Natural Resources as a State canoe and boating river. Any added channelization would probably be opposed by related interests.

Channel modification could result in loss of low flow habitat for fish. Channel modification generally increases channel cross section, reducing the depth of water in the river. Fish require that the water be of sufficient depth to provide: cover from predators, access to food, moderation of temperature fluctuations, and regulation of water chemistry/quality. Clearing and snagging, or clearing of riparian vegetation and fallen trees in the stream, would cause an increase in the maximum water temperature and



TYPICAL CHANNEL SECTION

FIGURE 9

RED LAKE RIVER

TYPICAL CHANNEL SECTION

RED LAKE AND CLEARWATER RIVER
RECONNAISSANCE STUDY

the amount of temperature fluctuation, reducing the habitat of fish and other organisms that are part of the food supply of the fish. Riparian vegetation, in addition to moderating river temperature fluctuations by shading, provides organic matter in the form of vegetative parts of plants and terrestrial insects which may live in the riparian vegetation. Lastly, vegetation close to the banks, or growing in the water, provides cover from predation.

Some wetlands may require inundation from overbank flows for recharge. Some fish species, like northern pike, require overbank flooding for reproduction. In addition, channel modification could lead to increased wetland drainage. Increasing the channel depth or cross section would provide an opportunity to deepen or extend tributary ditches. On another project in the vicinity, the U.S. Fish and Wildlife Service was insistent on fixing all ditch elevations to prevent extension or enlarging of ditches.

Any plan that induced local increases in peak discharges to downstream areas would have to be carefully analyzed to see what, if any, effect it would produce on communities such as Thief River Falls, Crookston, and East Grand Forks. The net social and environmental trade-offs of this plan were not quantified and would need detailed evaluation if further studies were warranted from an economic standpoint.

A new Corps environmental authority, Section 1135 of the 1986 Water Resource Development Act, offers an opportunity for cost-shared environmental restoration. Using this authority, it may be possible to restore some of the old oxbow habitat along the Red Lake and Clearwater Rivers.

Evaluation Summary (Alternative Plan 4)

Channel modifications on the Red Lake and Clearwater Rivers could result in substantial flood reduction benefits. Generally, these benefits would be the result of an improved level of protection.

Issues associated with this plan include:

1) The downstream impacts of a significant channel improvement project could make the plan socially and/or environmentally unacceptable.

2) As formulated for this study, this plan is not economically feasible. However, as conditions change, a small Federal snagging and clearing plan could possibly be economically feasible.

3) The existing Red Lake and Clearwater Rivers project could be environmentally restored. This could be accomplished by reestablishing old river oxbows and flooding old riverside marshes to re-create wetlands adjacent to the project. Such action is possible under a new Corps authority, Section 1135 of the 1986 Water Resources Development Act.

ALTERNATIVE 5 - MARSH RESTORATION PLAN

Background and Description

In 1958, the channel control works constructed as part of the Corps of Engineers Red Lake and Clearwater Rivers Project at mile 178.8 were modified (see plate 5). This action was taken by the Corps of Engineers as a remedial measure to retain water stages in the Red Lake Indian Reservation upstream from the structure at levels which would approximate pre-project conditions. This was accomplished by replacing the existing rock and brush weir with an 80-foot concrete weir, raising dike abutments, providing closures of the dredged material banks along both sides of the Red Lake River in the 3.2-mile reach below the Red Lake Dam, together with construction of low tieback dikes at the low end of the dredged material bank. In 1964, the bridge at the Clearwater Road crossing of the Clearwater River was replaced as a remedial measure, since damage of the existing structure was attributed to design and construction deficiencies of the Clearwater River channel improvement project. In 1967, restoration of 3,300 acres of marshlands was completed as a remedial measure attributed to the channel improvement project in the 3.2-mile reach of the Red Lake River beginning at the Red Lake outlet by diverting water from the Red Lake directly into low marsh areas north and south of the channel. The remedial work included dredging 6,200 feet of inlet channel, placing two control inlets and two control outlets, constructing 7,100 feet of tieback diking, and grading 32,000 feet of continuous dredged material bank along the river. All project features were constructed and are operated by the Federal Government. The operating plan for the marsh was prepared by the U.S. Fish and Wildlife Service.

Over the past two decades, the effectiveness of the marsh project has deteriorated due primarily to siltation problems. The Red Lake Band of Indians has been concerned about this situation and has brought its concerns to the St. Paul District, Corps of Engineers, the constructing and primary operating agency. In response to these concerns, the Corps has developed a siltation dredging plan that would restore the bottom depths of the north and south inlet structures. Other project features would also be evaluated by the Corps with assistance from the Red Lake Band to insure that remedial actions needed are identified.

Engineering and Economic Evaluations

The Corps of Engineers has evaluated the condition of the north and south marsh inlets and determined that dredging is needed. Preliminary estimates of the cost to accomplish this work range from $15,000 to $30,000 and are being included in future Corps operations and maintenance budgets. These costs are part of the normal operation and maintenance responsibilities of the project and do not require an economic justification. Therefore, no post-project economic evaluation has been conducted as part of this reconnaissance study.

Environmental Evaluation

The fish and wildlife habitat restoration planned for when the marsh restoration project was implemented has not been fully realized. There is a need to further evaluate the project to see if additional habitat enhancement/restoration opportunity exists. This can be accomplished under a new environmental projects authority, Section 1135 of the 1986 Water Resource Development Act, and should be further coordinated with the Red Lake Band and other interested parties.

Evaluation Findings (Alternative Plan 5)

The marsh restoration plan could result in minimal flood reduction benefits and substantial fish and wildlife and recreation benefits.

Issues associated with this plan include:

1) The relative priority of operations funding to implement this plan.

2) Use of Section 1135 of the 1986 Water Resource Development Act to provide wetland restoration along the Red Lake River and on the Red Lake Indian Reservation.

ALTERNATIVE 6 - UPSTREAM STORAGE PLAN

Background and Description

Reservoir storage projects in the basin are a potential means of controlling flooding in the Crookston, Grand Forks, and East Grand Forks areas. A number of such projects have been studied and some have been constructed. These man-made lakes can also provide significant recreation, water supply, and fish and wildlife benefits. However, reservoir creation is not without economic, social, and environmental trade-offs.

A number of previous studies have investigated the feasibility of constructing a dam upstream of Crookston in the vicinity of Huot, Minnesota (Plate A-1 in Appendix A). The proposed dam would have 205,000 acre-feet of flood control storage, a top elevation of 970 feet above mean sea level, and a maximum release rate of 10,000 cfs. This same project was reevaluated using current conditions and is identified as alternative 6 of this study (see plate 6).

Engineering and Economic Evaluations

The existing conditions curve, described in this report, was developed for the Crookston Reconnaissance study. The existing condition and future with project condition instantaneous peak discharge-frequency curves for the Red Lake River at Crookston were developed from the U.S. Geological Survey gages at Crookston and at Grand Forks, North Dakota. The curves were

developed by following the guidelines and procedures outlined in the Water Resources Council Bulletin No. 17B and the Hydrologic Engineering Center's computer programs (see Appendix A for details).

Then, rough economic evaluations of flood reduction benefits were conducted to determine how the current hydraulic and economic conditions compared to conditions when the previous Huot study was completed. These evaluations revealed that the hydraulic conditions had not changed significantly. However, the project cost would significantly increase, the interest rate was higher, and the flood reduction benefits that could be taken for the project would be substantially decreased. This decrease in average annual flood damage reduction is based upon a significant decrease in urban damages attributed to Crookston (i.e., the $2 million average annual loss to Crookston was updated to $930,000 average annual losses based on a 1991 Corps study of Crookston).

The above changes would further erode the 0.80 benefit-cost ratio established in the previous study. Therefore, no additional evaluations of this plan are merited at this time.

Evaluation Summary (Alternative Plan 6)

Upstream reservoirs along the Red Lake and Clearwater Rivers could provide significant flood reduction benefits for the downstream communities of Crookston and East Grand Forks. Reservoirs also could provide moderate net recreation, water supply, and environmental benefits if they were designed to accomplish these purposes.

Issues associated with this plan include:

1) The capacity of upstream reservoir storage is limited by the topography of the upper reaches of the subbasin. Therefore, the full development of upstream storage capacity will not totally solve the downstream flooding problems.

2) Larger reservoirs, such as the one formulated in plan 6, are not economically feasible from a Federal perspective.

3) Environmental and cultural impacts and trade-offs associated with plan 6 make the plan unacceptable. Smaller reservoirs designed for multi-purpose use are less likely to have unacceptable environmental and social impacts.

4) Operation of upstream reservoirs can strongly affect flood reduction capacity.

PUBLIC INVOLVEMENT AND COORDINATION

The initial coordination efforts associated with this reconnaissance study were undertaken in the fall of 1990 when a series of letters were sent to interested parties. These letters advised the recipients of the initiation of the study and asked for pertinent information regarding water resources problems in the study area. Information and scoping meetings were conducted with the prospective non-Federal sponsor, the Red Lake Watershed District. The Corps was able to significantly benefit from existing information and ongoing project initiatives taken by the watershed district. The watershed district sponsored a joint field review of the problems suggested for Corps evaluation as part of this reconnaissance study. Periodic study coordination activities between the Corps study team members and key representatives of the watershed district, the Red Lake Tribal Council, the Minnesota Department of Natural Resources, and the U.S. Fish and Wildlife Service were conducted.

Preliminary findings of this study were presented at a public Red Lake Watershed District meeting in April 1991. Input received at the meeting and from a Red Lake Watershed District letter, dated 30 April 1991, was incorporated into this study. A summary of the preliminary findings presented, Watershed District written comments, and Corps responses follow as figure 10.

In separate meetings, the preliminary findings of the study were presented to key representatives of the Red Lake Band Tribal Council and the Bureau of Indian Affairs and to representatives of the U.S. Fish and Wildlife Service and the Minnesota Department of Natural Resources. Inputs obtained from these meetings were also incorporated into this study.

FIGURE 10

PRELIMINARY FINDINGS

AS PRESENTED BY

CORPS OF ENGINEERS REGARDING RED LAKE & CLEARWATERS STUDY

AT RED LAKE DISTRICT WATERSHED MEETING OF APRIL 11, 1991

FIGURE 10 - Continued

RECONNAISSANCE REPORT

RED LAKE AND CLEARWATER RIVERS, MINNESOTA

Information needed to evaluate project alternatives:

1. Extension of the authorized channel improvement project on the Red Lake and Clearwater Rivers.

a. Composition of the existing fishery, Red Lake and Clearwater.
b. Instream flow habitat analysis, Red Lake and Clearwater Rivers, by species and life stage, pre- and post- channel modification.
c. Land use in riparian areas.
d. Opportunities for environmental enhancement.

2. Automate and/or structurally improve the Lower Red Lake Dam (include operational changes and increased release capacity).

a. Quantification of high lake level damages.
b. Identification of habitats affected by water level fluctuation.
c. Quantification of habitat to be affected by altered operation.

3. Diversion of the Red Lake River to Clearwater River and construct impoundments with the excavated material.

a. Composition of the existing fishery, Red Lake and Clearwater.
b. Instream flow habitat analysis of Red Lake and Clearwater Rivers, by species and life stage, by range of flows, for existing and future flow conditions.

Problems and Opportunities:

1. Extension of the authorized channel improvement project on the Red Lake and Clearwater Rivers.

a. Propose flood control by wetland restoration.

2. Automate and/or structurally improve the Lower Red Lake Dam (include operational changes and increased release capacity).

a. New reservoir operating plan.

3. Diversion of the Red Lake River to Clearwater River and construct impoundments with the excavated material.

a. Consider alternative diversion from Red Lake directly to Clearwater.

FIGURE 10 - Continued

Potential Adverse Impacts of Proposed Alternatives

1. Extension of the authorized channel improvement project on the Red Lake and Clearwater Rivers.

a. Reduction of overbank flooding would be detrimental to fish spawning. The MDNR is very concerned. Northern pike require flooded vegetation, preferably terrestrial, for successful spawning. Other fish require flows of increased velocity or cool temperatures to effect successful spawning.

b. Wetlands may require inundation from overbank flows. Wetlands which are not groundwater discharge points may require recharge from overbank flooding.

c. Channel modification would result in loss of low flow habitat for fish. Channel modification generally increases channel cross section, reducing the depth of water in the river. Fish require that the water volume contains sufficient depth to provide cover from predators, access to food, moderation of temperature fluctuations, and regulation of water chemistry/quality.

d. Clearing and snagging, or clearing of riparian vegetation for construction would cause an increase in the maximum water temperature and the amount of temperature fluctuation, reduce fish habitat, and the food supply of the fish. Riparian vegetation, by shading the river, moderates the temperature fluctuations that could occur because of solar heating. Further, most rivers depend on the input of organic matter in the form of vegetative parts of plants and terrestrial insects which may live in the riparian vegetation. Vegetation close to the banks, or growing in the water provides cover from predation.

e. Channel modification could lead to increased wetland drainage. On another project in the vicinity the FWS was insistent on the fixing of all ditch elevations to prevent extension or enlarging of ditches.

2. Automate and/or structurally improve the Lower Red Lake Dam (include operational changes and increased release capacity).

a. Increased discharges in Red Lake and Clearwater could damage fish habitat. Fish have optimums for velocity and substrate which could be exceeded by increased discharges. Conversely, certain minimum flows are required to preserve moderate temperatures and adequate oxygen supplies. These requirements vary seasonally and differ for the various life stages of each fish species, both game and forage.

b. Change in reservoir operation could be detrimental to recreational and commercial fisheries. The availability of spawning habitat should not be compromised by any alteration in the release plan.

FIGURE 10 - Continued

3. Diversion of the Red Lake River to Clearwater River and construct impoundments with the excavated material.

a. An upstream reach of Clearwater is designated as a trout stream. It would probably not be affected by diversion from Red Lake River but could be affected by a direct discharge from Red Lakes.

b. There would be no benefit to Clearwater unless flows are provided during late summer especially in low runoff years. Current baseflow is one-half of that desired by the MDNR. Discharge of water to Clearwater would not be beneficial to fish or wildlife unless provided dependably during periods when the river would be at or below the base flow of 36 cfs.

c. Increase in wild rice production is a negative impact to the Clearwater. It would result in increased appropriation and decreased water quality from discharge of additional nutrient rich water. According to the MDNR, the discharge from the wild rice paddies is detrimental to the water quality of the Clearwater River. Promoting increased wild rice production with the resultant increased discharge would further degrade a heavily impacted river according to MDNR.

d. The diversion channel may affect protected wetlands. There are probably wetlands along the alignment which would require MDNR concurrence for mitigation. Mitigation may be hampered, see e, below.

e. Impoundments are not suitable for waterfowl habitat because of peat. According to the area wildlife manager, flooding of the peat which underlies much of the project area would result in considerable floating peat blocking use by waterfowl.

f. Fish culture may not be compatible with fish management goals in river. Cultured fish could escape to the Red Lake River with possible detrimental effects and MDNR would not have the ability to regulate such use on the reservation. The MDNR has additional concern about water quality and timing of discharge from impoundments.

4. Miscellaneous

a. An environmental impact statement will be required for this project. Potential impacts and controversy would be significant.

b. The MDNR and FWS will request that an Instream Flow Habitat Analysis be accomplished on both rivers before conclusions could be made about potential impacts and required mitigation. Instream flow analysis requires high precision hydraulic modeling of representative reaches at a range of flows to represent all potential conditions. Fish habitat requirement information may or may not be sufficient for analysis of these rivers. This is a costly procedure whose results may still be subject to controversy.

c. A reservoir operation study would be required before changing the discharge plan for the Red Lakes. The Red Lakes are a significant

fisheries resource and, as such, would require careful analysis before changes in water levels and their rates of change could be proposed. The MDNR and the Reservation may or may not have the same management objectives for the fishery.

Potential Beneficial Impacts of Proposed Alternatives

1. Extension of the authorized channel improvement project on the Red Lake and Clearwater Rivers.

a. Opportunity for fixing outlet ditch elevations to prevent additional wetland drainage. In the past the Fish and Wildlife Service has held that limiting the alteration of existing ditches would limit increases in wetland drainage with benefits to wildlife and flood control. It may be MDNR policy to fix the elevations of road culverts during alterations or repairs.

b. Opportunity for wetland restoration as an alternative to channel modification for flood control. Wetland restoration could be used a method of flood control which would reduce the necessity for channel alteration avoiding impacts to fish habitat, as well as provide increased waterfowl habitat, and improve the water quality of runoff discharged to the river from the watershed.

2. Automate and/or structurally improve the Lower Red Lake Dam (include operational changes and increased release capacity).

a. Opportunity to manage lake discharges for higher spring flows to promote fish spawning through flushing flows and overbank flooding. This may provide a greater frequency of high spring flows than presently occurs (assuming the water would be available).

b. Increase the stability of lake edge habitat with better water level management. If bank erosion and/or siltation of spawning habitat would be a problem at high lake levels, then this could be an improvement. The MDNR and the FWS do not think that the impacts that may occur downstream would be offset by benefits within the lake.

c. Red Lake River may benefit from greater flexibility in lake discharge control according the MDNR. Fish are put under stress during periods of low precipitation by low oxygen and high temperatures as well as increased vulnerability to predation.

3. Diversion of the Red Lake River to Clearwater River and construct impoundments with the excavated material.

a. Clearwater River would benefit from higher dependable base flow during low flow periods (i.e. late summer). As discussed in 2c, above, the late summer is frequently stressful to fish. The MDNR would agree that the Clearwater could benefit from augmentation, but, the water should not be paddy discharge and it would only be a benefit if available when it is needed. The Clearwater is already heavily altered and appropriated. In its present state there would be no net benefit to be obtained by reducing flows in the Red Lake River to benefit the Clearwater.

FIGURE 10 - Continued

RED LAKE - CLEARWATER RIVERS
FLOOD CONTROL RECONNISANCE STUDY

RECREATION ASSUMPTIONS

Based on conversations with Minnesota Department of Natural Resources field staff and with Corps tea- members, the following assumptions have been developed:

Recreational use of the Red Lake River begins in the vicinity of High Lanoing and continues downstream. The upper reaches of the river are relatively remote and located on the Red Lake Indian Reservation; both of which tend to discourage use.

Major recreational uses of the river include fishing, canoeing and inner tubing. The river is a designated State Canoe Route.

Most of the use is centered around the city of Red Lake Falls. There are three outfitters located in the city offering tubing opportunities. The more scenic stretches of the river are up- and downstream of the city.

The Clearwater River receives less recreational use than the Red Lake River. The fishery is considered poor, primarily due to water levels and water quality problems. Canoeing/boating is popular, primarily downstream of Plummer to the confluence with the Red Lake River. As with the Red Lake River, the upstream reaches are relatively remote and located on the Red Lake Indian Reservation. In addition, there is more agricultural use of the riparian areas, reducing the scenic qualities.

The primary limiting factor for recreation on the rivers is lack of adequate flows. The fisheries on the Clearwater would improve if adequate flows were provided during the late summer. Low flows on the Red Lake River reduce the tubing use around the city of Red Lake Falls.

FIGURE 10 - Continued

WATERSHED DISTRICT LETTER

COMMENTING ON PRELIMINARY

STUDY FINDINGS

Red Lake Watershed District

102 North Main Avenue
P.O. Box 803
Thief River Falls, MN 56701
(218) 681-5800
(218) 681-5839 FAX

April 30, 1991

RESPONSES

N [illegible]lly
U[illegible] Corps of Engineers
1421 USPO & Custom House
St. Paul, MN 55101-1479

Dear Mr. McNally:

First of all, let me say thank you for your visit to our Board meeting on April 11, 1991, and for your report on the reconnaissance study for the Red Lake and Clearwater Rivers in the Red Lake Watershed District. We appreciate your concern and support for good, sound water management.

Our Board of Managers are in support of the remote control operation of the dam, and the other phases of the reconnaissance study. We feel that there are some additional benefits and some errors that you should know about. On the Red Lake and Clearwater Rivers you stated that there were no flooding problems downstream from where the channel dredging ends. The Board of Managers state that flooding does occur downstream from where the dredging ended and that your report did not address this. We feel it would be beneficial to dredge the channel on the Clearwater River to Highway 59. The channel dredging on the Red Lake River should be extended to the Kratka Bridge. If channel dredging cannot be deemed feasible, cleaning and snagging should be considered for that undredged portion that I mentioned above.

We have no problem with the channel enlargement phase as far as the cost benefit ratio.

Under Potential Adverse Impacts, 2A, we don't feel that this will have an increase in damage to the fish habitat because we are not changing the operating range.

Under Item 3A, we do not feel there will be any adverse impacts upstream on the Clearwater Rivers in regard to the trout streams. This is downstream of the dam and will have absolutely no effect.

Under Item 3B, we don't feel that that is an accurate statement because there would be benefits in spring if there was a low water supply and that most paddies are being drained during what you refer to as late summer.

Alternative 4 of the plans evaluated in our study did look at the feasibility of dredging a larger and/or longer flood control channel. Our study found that, given current conditions, there were flood reduction benefits attributed to such a project but that the costs of implementation far outweighed those benefits. It is possible that a future snagging and clearing plan could be formulated in such a way as to be economically feasible. Future Corps formulations and evaluations of such a plan through the Corps continuing authorities program may be worth pursuing.

Concur; damages to the fishery referred to do not result from discharge with the present operating limits. But, Item 2a not only refers to the automation of the dam. It also refers to the structural enlargement of the dam and an associated increase in outlet flow capacity. If the dam discharges were increased beyond the present operating limits, then, damage to fish habitat could result. An instream flow habitat analysis would determine such affects.

We state that impacts to the trout stream portion of the Clearwater River would probably only occur if there are direct discharge from the Red Lakes. Such an alternative plan was considered, but was rejected early. However, there is a potential adverse environmental impact associated with the physical connection of the Red Lake and Clearwater River and that is associated with the concern for the spread of exotic fish, plants, etc. (e.g., connection could cause the spread unwanted species such as the Zebra mussel or Eurasian watermilfoil).

The need for, and benefit of, low flow augmentation can not be definitely determined without an instream flow habitat analysis. Increases in flow may or may not be beneficial, depending upon: the existing flow, the available volume, the time of year, the duration of availability, among other factors.

FIGURE 10 - Continued

Under Item 3C, we do not agree with your statement that wild rice decreases the water quality. The study that was completed was not comprehensive enough to identify the point source. The water quality study that we are now participating in with the Minnesota Pollution Control Agency should better quantify the impacts of wild rice on the water quality in the Clearwater River, and we will supply you with the results when available.

Under Item 3D, we feel that the diversion channel will not create a wetland loss but, if so, it would be minimal and we could definitely mitigate any losses.

Under Item 3E, at this point the Sayersville impoundment on the Red Lake Indian Reservation is not a part of our plans for the project, but if we do, we do not feel that there will be a problem from floating peat. If you take note of the fact that there are over ten thousand acres of wild rice, there is a minimal amount of floating peat on these ten thousand acres.

Under Item 3F, we will not have an impoundment; so, therefore, the concern of fisheries is not of concern for this report. If we were to have an impoundment, I wonder where you have come up with the fact that there will be exotic fish raised there that would be detrimental to any of the species in either the Red Lake or Clearwater Rivers.

Under the Potential Beneficial Impacts, number 3, the diversion channel, letter A, the very last sentence, we feel there would be benefits obtained by reducing the high flows in the Red Lake River and would benefit the Clearwater River.

Under the category "Recreational Assumptions", we feel with a diversion channel we could provide more constant flows that would be beneficial for the recreational use on the Red Lake River, which is primarily tubing around the City of Red Lake Falls. We also feel that this could help manage the high water levels on Upper Red Lake. Also, we note in here that you have not addressed the fact that the rice paddies are a benefit to flood control. We also feel that you should address the economic impact of the rice operation. We feel that the wild rice growers have summarized the economic portion that should be included in your reconnaissance study. As we discussed on the telephone, I hope that you will incorporate the economic benefits of the wild rice operation. Also, as you mentioned in our telephone conversation, you should look at the wildlife benefits, especially at the waterfowl population.

RESPONSES

The discharge of water from agricultural land, in general, contributes excessive amounts of nutrients and sediment to the receiving water. This increased loading lowers water quality even if it does not impair water use. We have not seen the 1979 MPCA study, but your comment seems to imply that the study suggested that paddy discharge may carry excess phosphorus (wild rice growers supporting comments, page 2) a common problem in Minnesota. Hopefully, the completion of the current MPCA study will clarify this issue.

The exact alignment of the diversion channel is not known. Therefore, is is not possible to conclusively determine what types of habitat would be impacted. However, in addition to the direct excavation or filling of some wetlands, there is a possibility that the channel could change the groundwater elevations in adjacent wetlands or allow the extension of drainage ditches intersecting the channel (source- Paragraph 4.6 DRAINAGE, page 24, Widseth Smith Nolting and Assoc. Report for the RLWD, Jan. 1989).

If the reservoir is not a part of the plan, this is a non-issue. However, if the reservoir is to be an increment of the plan, then the MDNR Area Wildlife Manager concerns expressing doubt that the impoundment would provide suitable habitat for nesting waterfowl because of the floating peat substrates is relevant. Does the preparation of a site for the cultivation of wild rice minimize floating peat problems? We would agree that these issues are debatable and need further evaluation.

The concern of fisheries is a concern of this report. Fish culture has been proposed for the Sayersville impoundment (Paragraph 4.5.1 IMPOUNDMENTS, Page 23, Widseth Smith Nolting Assoc. Report for RLWD, Jan. 1989). The MDNR would have no jurisdiction over the use of the impoundment for fish culture and this potential situation has caused them to express concern about the possible raising and escape of non-native species of fish. The government of Canada expressed serious concern about this subject with regard to the Garrison Diversion project.

The fishery of the Red Lake River is apparently not adversely affected by high flows with the present operating limits and high flows may be critical to spawning of certain species. Water flow in the Clearwater River is below optimum for fish and a simple increase in river flow on the Clearwater Riv[illegible] not, in itself, be beneficial to the fishery due to other limiting factors. An instream flow [illegible] analyses is needed for both rivers to quantify the effects of changes in flow.

It is debatable whether more constant, but lower flows on the Red Lake River, are an improvement from the recreation perspective. Our contention is that the higher flows which are now experienced in a normal year on the Red Lake River would offer a better ride for those tubing and canoeing.

During high water years, the connecting channel could not, in itself, allow greater outflow from Red Lake. There would need to be structural changes at the control structure and in the channel below the dam to allow an increase in lake releases. Increasing the lake outflow capacity was evaluated in this study and determined to be incrementally unfeasible at this time.

We sympathize with the Clearwater rice growers situation and agree that there are real economic benefits associated with continued commercial wild ricing in along the Clearwater River and these benefits will be identified in the revised reconnaissance report. However, it is important to explain that the water storage that [illegible] rice paddies provide can not be claimed as a flood control benefit of connecting channel b[illegible]st storage would exist with or without that project and the local and regional spin-off bus[illegible] resulting from ricing can not be claimed in our evaluation of national benefits. Also, from the environmental benefits perspective, we agree that the wild rice paddies are beneficial in providing a staging area for waterfowl. However, the paddies, of themselves, do not provide waterfowl production. It is our professional opinion that substantial waterfowl benefits could not be attributed to wild rice production unless the paddies were managed specifically for waterfowl production. Presumably this would be incompatible with the agricultural objectives.

FIGURE 10 - Continued

RESPONSES

Mr. Ed McNally
April 29, 1991
Page Three (3)

Under your paragraph that you stated you feel you were very conservative on construction costs, we feel that you are very liberal on the construction cost of this project. Where you state that your benefits are very liberal, we think they are extremely conservative since you have not taken into account the economics of wild rice or waterfowl benefits.

We understand and appreciate your perspective regarding the costs and benefits that our preliminary evaluations identified; Non-Federal implementation can be less expensive because your contracting/procurement procedures, engineering design standards, and environmental protection requirements can be less rigid. Also, your perspective of the types of economic benefits attributable to a project are quite different from the Federal viewpoint. In order to be responsive to your concerns to the extent possible, we have revised report to include a short description of the local and regional benefits that wild ricing provides to the region. We have also re-evaluated the waterfowl benefits attributable to the connection channel and rechecked our cost estimates for errors.

Under the heading "Effects on Recreation" your statement where you say that when water is diverted from Red Lake to Clearwater River in low flows it would have a diverse effect of recreational use on the Red Lake River is incorrect because we agree and feel that when a connection channel is built there will be a protected low flow on the Red Lake River that will meet all recreational needs.

We concur that the low flow and associated recreational uses on the Red Lake River would not be impacted by the connection channel plan. The revised text is being adjusted to clarify this position.

We feel the agricultural aspect is an important scenic part of the United States and that we do not have to have the entire U.S. in its natural state. The definition of scenic is "in the eyes of the beholder" and, hopefully, in considering projects the US Army Corps of Engineers will share this view.

We concur that aesthetics is a personal thing and we will adjust the revised text to include your concern.

Again, I appreciate your visit and the fact that the District Corps offices are located in Minnesota. I hope that the final report of the reconnaissance study will be changed to be more accurate to the true cost of the benefits under the connection channel.

If you have any questions, please feel free to contact me.

Sincerely,

Lowell C. Emerson
Administrator

LCEisr

FIGURE 10 - Continued

RESPONSES

SUMMARY OF COMMENTS SUBMITTED TO THE RED LAKE WATERSHED DISTRICT BY CLEARWATER RIVER RICE GROWERS ON THE ARMY CORPS OF ENGINEERS DRAFT REPORT ON THE CLEARWATER RIVER AND RED LAKE RIVER CONNECTION CHANNEL - APRIL 23, 1991

1) The Army Corps study states that wild rice paddy return flows are detrimental to the Clearwater River. Every study that we know of has found that return flow waters have tested to be of good quality. They also augment flows during normal low flow times, thus improving the river.

Interagency concerns regarding the quality of water leaving rice paddies has been expressed. Some studies of this issue have apparently been conducted but the interpretion of the results are mixed and debatable. Hopefully, the ongoing MPCA study will help clarify this issue.

2) No mention of the flood control benefits provided by the wild rice farms was made in the Army Corp's report. This should be a federal benefit as the Red River floods lands and cities, notably Grand Forks, in both North Dakota and Minnesota This flood control is at no cost to the taxpayer

Some downstream flood reduction does result from water storage capacity of the existing wild 12,000 acres of rice patties. This fact will be included in the revised report text. However, you have indicated that the connecting channel would not likely increase the acres of rice paddies. Therefore, it is important to note that flood reduction associated with the rice paddies is part of the existing conditions and would not change substantially with implementation of the connection channel. Accordingly, the net flood reduction benefits associated with the proposed plan 1 are minimal.

3) No credit is given the wild rice paddies for creating waterfowl habitat. The Federal Waterbank program is federally funded, as is the CRP which now accepts wetlands. If an average CRP contract is $50 per year and 12,000 acres (acreage of wild rice paddies along the Clearwater River) were restored under this program, a $600,000 annual payment would be paid out in addition to the cost sharing funds paid out to restore the wetlands.

Again, any waterfowl habitat benefits the existing rice paddies provide can not be claimed as part of the benefits attributable to the proposed plan 1. Also, it is the opinion of this office and other interagency professions that the waterfowl benefits associated with each acre of rice paddy are not substantial.

4) Wild rice production acres in Minnesota have not increased in the last several years due to low prices, not lack of water. Wild rice acreage along the Clearwater River is not likely to increase significantly as a result of the connection channel unless there is a price increase in wild rice, which is not probable. A more likely occurrance would be a significant number of growers going out of business due to a combination of low prices and low water availability. Keeping the existing paddies in production provides significant local benefit. Flood control and migratory waterfowl production are federal benefits.

We concur that there is some federal value in maintaining waterfow. staging areas along the flyway and there are State and Federal programs designed to assist in providing such habitat. However, from a federal flood control perspective the existing wildlife values can not be claimed as a economic benefit to the connecting channel plan. We concur that keeping the existing paddies in production provides significant <u>local benefit</u> but unfortunately very minimal <u>national</u> economic benefit. Therefore, flood control benefits attributable to the connecting channel are minimal.

Respectfully submitted by:

Gunvalson & Imle Farms

Pine Lake Wild Rice Farms

Gunvalson Bros. Farms

Clearwater Rice, Inc.

STUDY FINDINGS - SUMMARY

During this reconnaissance study, many water resource problems and opportunities were identified and evaluated. Solutions to a number of these water resource problems can best be addressed through ongoing government programs and initiatives, separate from this general investigation study. These solutions will require coordinated interagency participation in their study and implementation. The specific water problems identified and the associated program and entities that have key roles in providing remedial actions follow:

1. The City of Crookston, Corps of Engineers, Red Lake Watershed District, and State of Minnesota should coordinate actions that would provide additional urban flood protection for Crookston, Minnesota. These actions will be coordinated in a future Corps feasibility flood control study, currently being scoped and negotiated with non-Federal sponsor/s.

2. The City of Thief River Falls, with the assistance of the Red Lake Watershed District, should restore Thief River Falls reservoir by dredging and improved upstream land use management practices. The local conservation districts and the Soil Conservation Service also need to play key roles. The Corps of Engineers and Minnesota Department of Natural Resources would be involved in the regulatory permitting of this work.

3. Entities that currently operate reservoirs in the subbasin should review and revise operating plans, as needed, to improve flood retention capacity. The Red Lake Watershed District, the Corps of Engineers, the U.S. Fish and Wildlife Service, the Red Lake Band, and the Soil Conservation Service all have upstream storage capacity that, if operated effectively, would provide additional downstream flood reduction.

4. The Bureau of Indian Affairs, with technical assistance from the Corps of Engineers, should evaluate the potential of developing hydropower at the Lower Red Lake dam. The Red Lake Band has indicated an interest in pursuing construction of such a power generation facility.

5. The Red Lake Watershed District and the Corps of Engineers should continue efforts to provide protection where streambank erosion threatens public works. Joint study and funding through the Corps of Engineers Section 14 continuing authority program should be pursued for such problems thoughout the subbasin.

6. Problem and opportunity scoping and technical evaluations conducted as part of this reconnaissance study has shown that the existing Red Lake operation plan is acceptable to most interests and that the operating plan reasonably serves its intended purposes. Therefore, at this time, no significant changes to the Corps of Engineers Red Lakes operating plan is needed. However, improvement in the implementation of the existing operating plan would decrease downstream flooding and warrants further Federal evaluation. As conditions change, the Corps of Engineers should continue to periodically assess the need to update and refine the Upper and Lower Red Lakes operating plan.

7. The Minnesota Department of Natural Resources and the Corps of Engineers should take steps to prevent the spread of exotic species of plants and animals into the subbasin. The Minnesota Department of Natural Resources has the lead for this activity, but the Corps has taken steps to become a partner in the control of exotic aquatic plants such as Eurasian watermilfoil. The zebra mussel is another species for which control is being planned.

8. The Corps of Engineers and unspecified non-Federal sponsor/s should jointly plan and implement fish and wildlife restoration projects at existing Corps water projects using the new environmental authority, Section 1135 of the 1986 Water Resources Development Act. Potential projects include additional marsh restoration and oxbow restoration along the Red Lake and Clearwater Rivers.

The primary water resources related problems in the subbasin result from changing water uses and demands associated with existing Federal water works and the need for water resources development and management that will improve flood control, agricultural water supply, and environmental restoration/enhancement. Six alternative plans were developed to solve these most pressing water resources problems. Each plan was evaluated from the Federal perspective to determine if there was a reasonable chance of formulating a feasible Federal project, and if so, using what Federal study/implementation source of funding. The Federal interest for the six alternatives is summarized below:

Alternative 1, Connecting Channel Plan, was determined to be not economically feasible and no further Federal study is merited.

Alternative 2, Modifications of the Red Lake Outlet Control Structure, are not feasible, as formulated. However, a plan that would include a downstream flood warning system, in combination with a gate operating agreement with the Red Lake Watershed District and Red Lake Band, could be more efficient than the automated gate plans evaluated as alternative plans 2a and 2b. Such a plan appears to be cost effective and should be further formulated using operation and maintenance study funds.

Alternative 3, Thief River Falls Lake Restoration, was determined not to be a project for which Federal authorization was available to conduct further study and/or implementation. Local study and implementation efforts need to be pursued.

Alternative 4, Channel Modifications on the Red Lake and Clearwater Rivers, was determined to be not economically feasible at this time. (A snagging and clearing plan could be feasible and should be formulated in the future using the Continuing Authorities program.)

Alternative 5, Marsh Restoration Plan, will be considered with ongoing Corps of Engineers operations study and remedial actions.

Alternative 6, Upstream Storage Plan, was determined to be not economically feasible and no further Federal study is merited.

RECOMMENDATIONS

Given current conditions, no economically feasible water development plans were identified for further cost-shared general investigations study. However, a number of Federal actions to improve current Corps of Engineers operations at Federal works are needed to fully realize authorized flood control and environmental restoration purposes. The specific actions needed are as follows:

1. The Corps of Engineers should evaluate Federal actions that might reduce the residual agricultural flood damages on the Red Lake River. This would be accomplished through future Corps project operations studies focusing upon: formulating methods to reduce the operational response time at the Lower Red Lake control structure, improving downstream flood warning, and evaluating the need for a change in the downstream operational control point elevations.

2. The Corps of Engineers should fully restore the existing marsh restoration project below the Red Lake control structure on the Red Lake Indian Reservation and work with the Indians to realize additional wetland restoration on the Indian Reservation. This is currently being pursued by the Corps with the assistance of the Red Lake Band and may also require involvement from the Red Lake Watershed District and the Bureau of Indian Affairs.

The above Federal actions should be actively pursued using available Federal operations and maintenance funding. Also, whenever a cost-sharing sponsor can be found, additional environmental enhancement projects should be implemented under Section 1135 of the 1986 Water Resource Development Act.

Therefore, subject to the documentation of this information, I recommend that no further general investigations study be made of the water resource problems on the Red Lake River subbasin at this time.

for RICHARD W. CRAIG LTC, EN
Colonel, Corps of Engineers
District Engineer
8 AUG 91

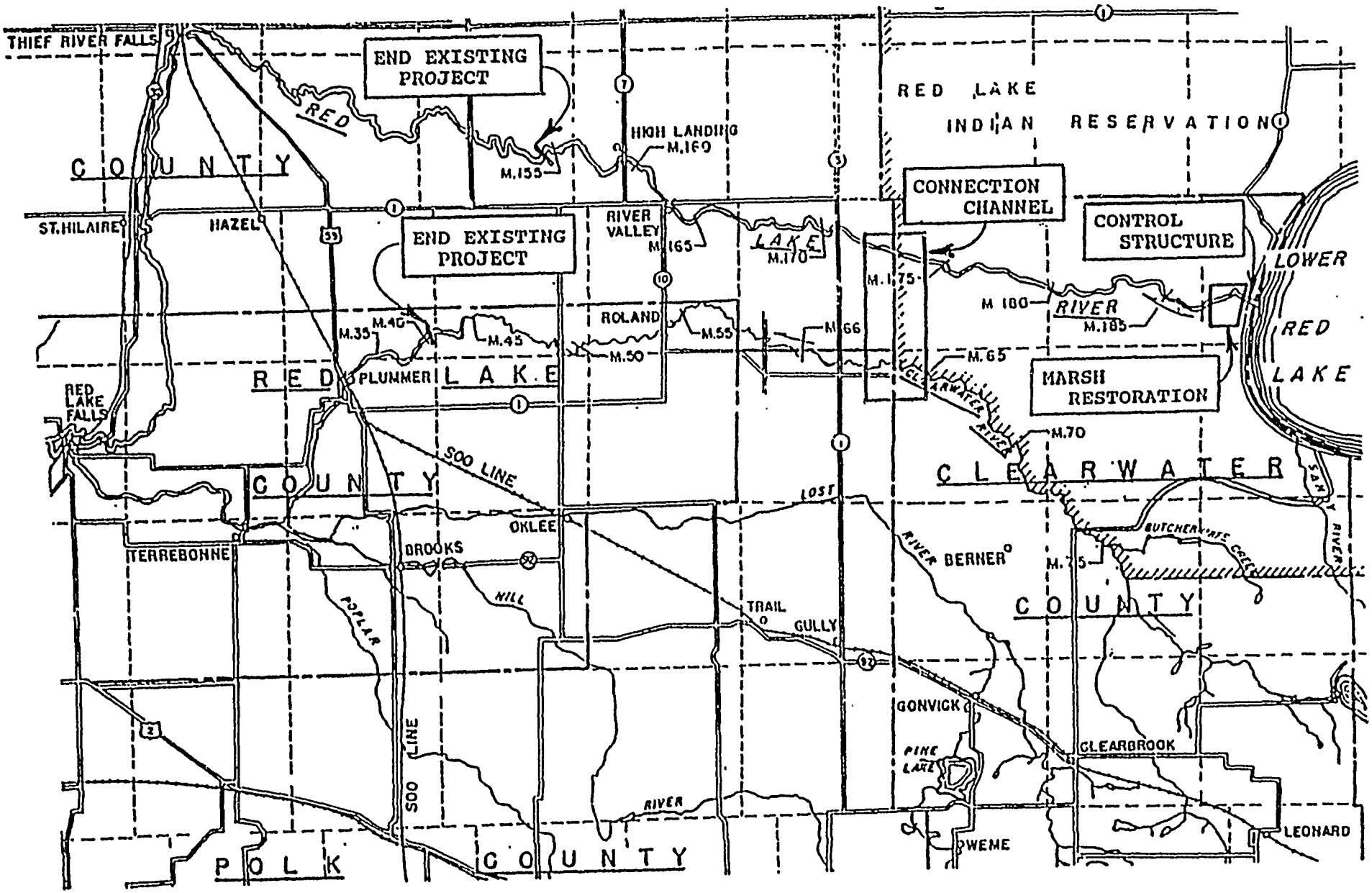


PLATE 1 - OVERVIEW MAP

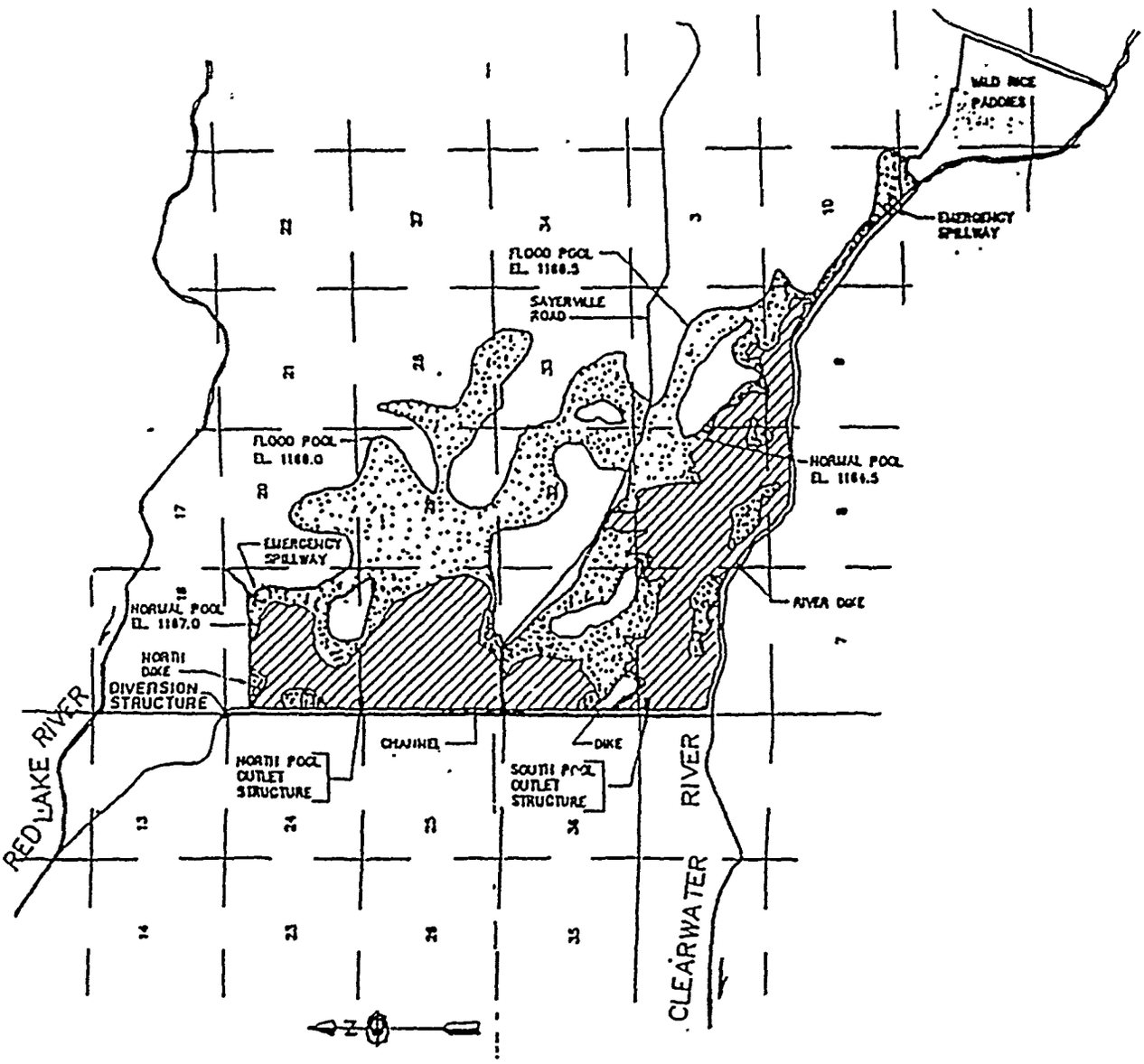
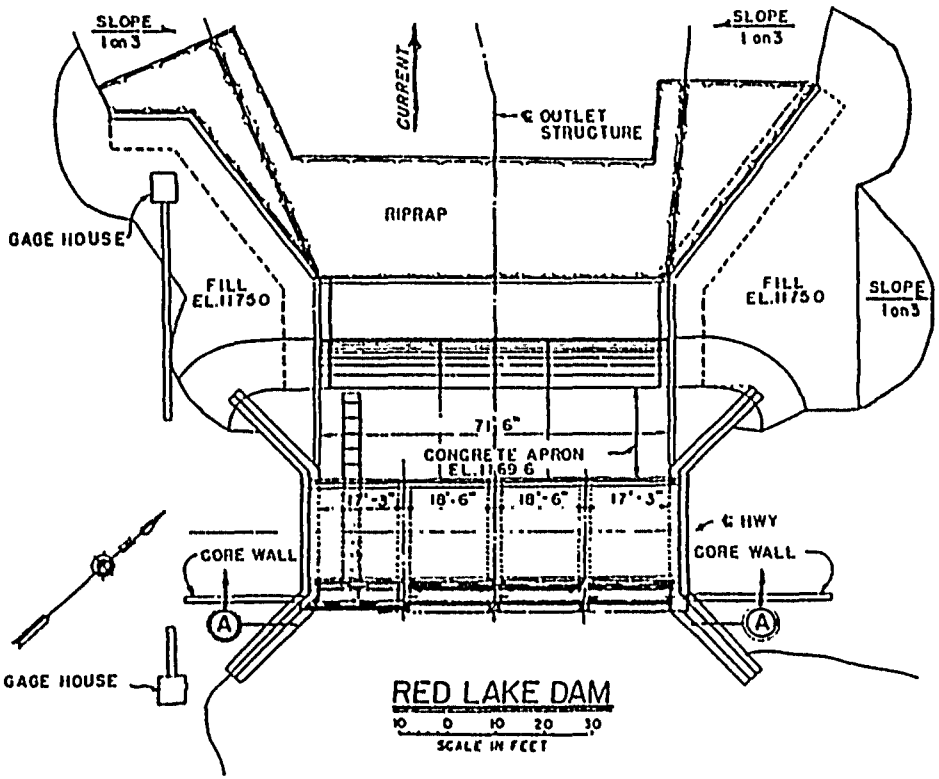


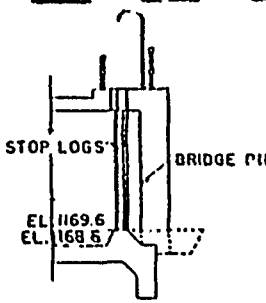
PLATE 2 - ALTERNATIVE 1



RED LAKE DAM

10 0 10 20 30

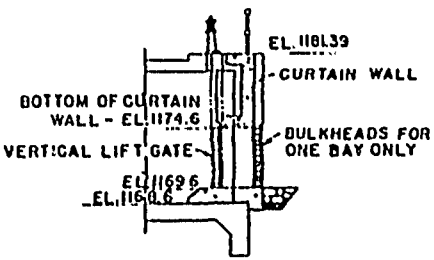
SCALE IN FEET



SECTION C-C

5 0 5 10 15

SCALE IN FEET



SECTION B-B

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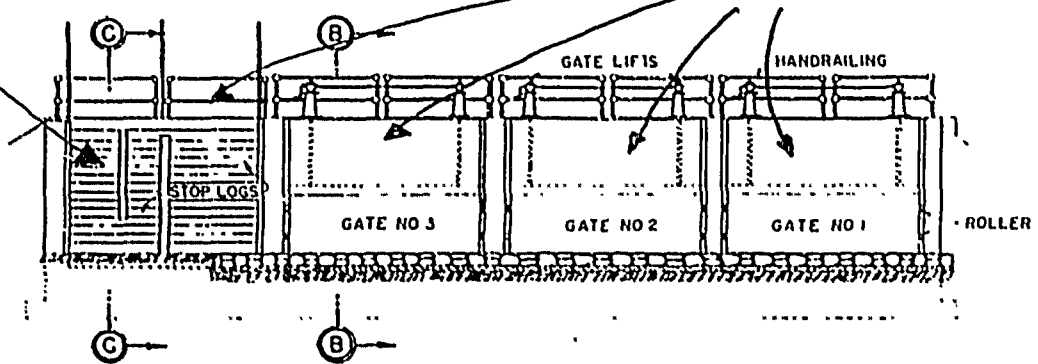
SCALE IN FEET

Add Additional Gate

Automate all Gates



SECTION A-A

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SCALE IN FEET

FLOOD CONTROL PROJECT
RED LAKE RIVER, MINN.

STRUCTURES

PLATE 3 - ALTERNATIVE 2

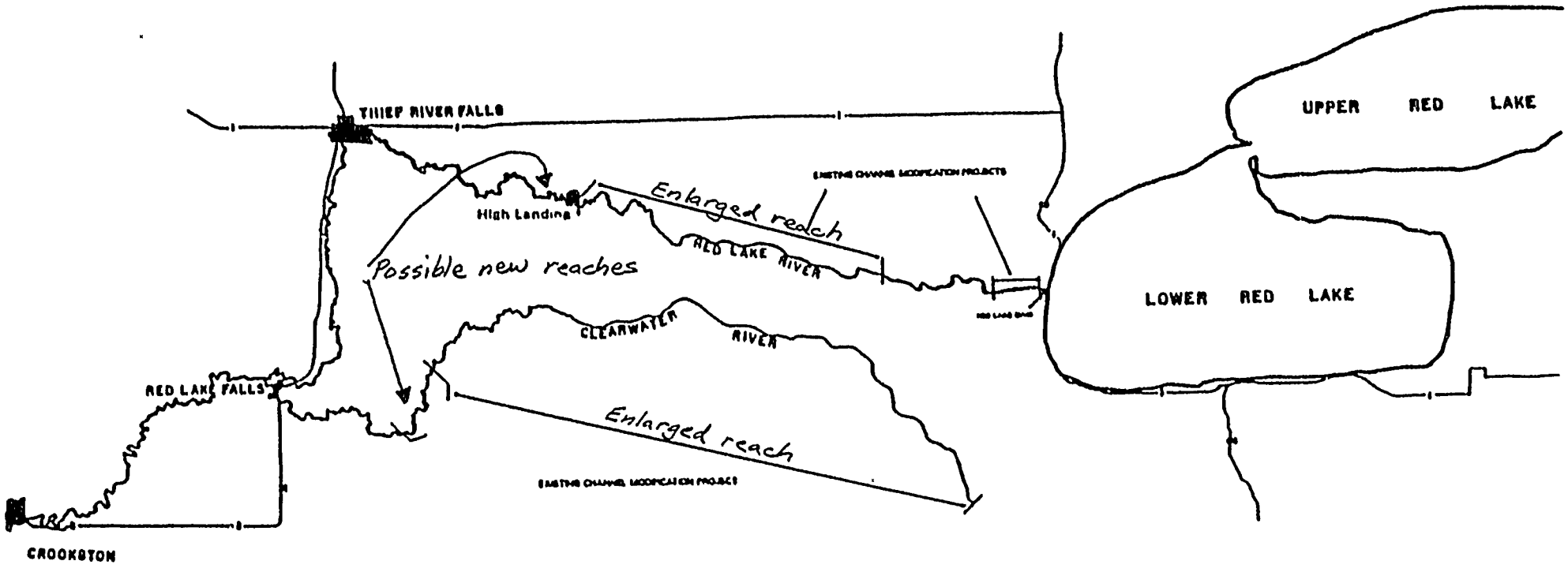

PLATE 4 - ALTERNATIVE 4

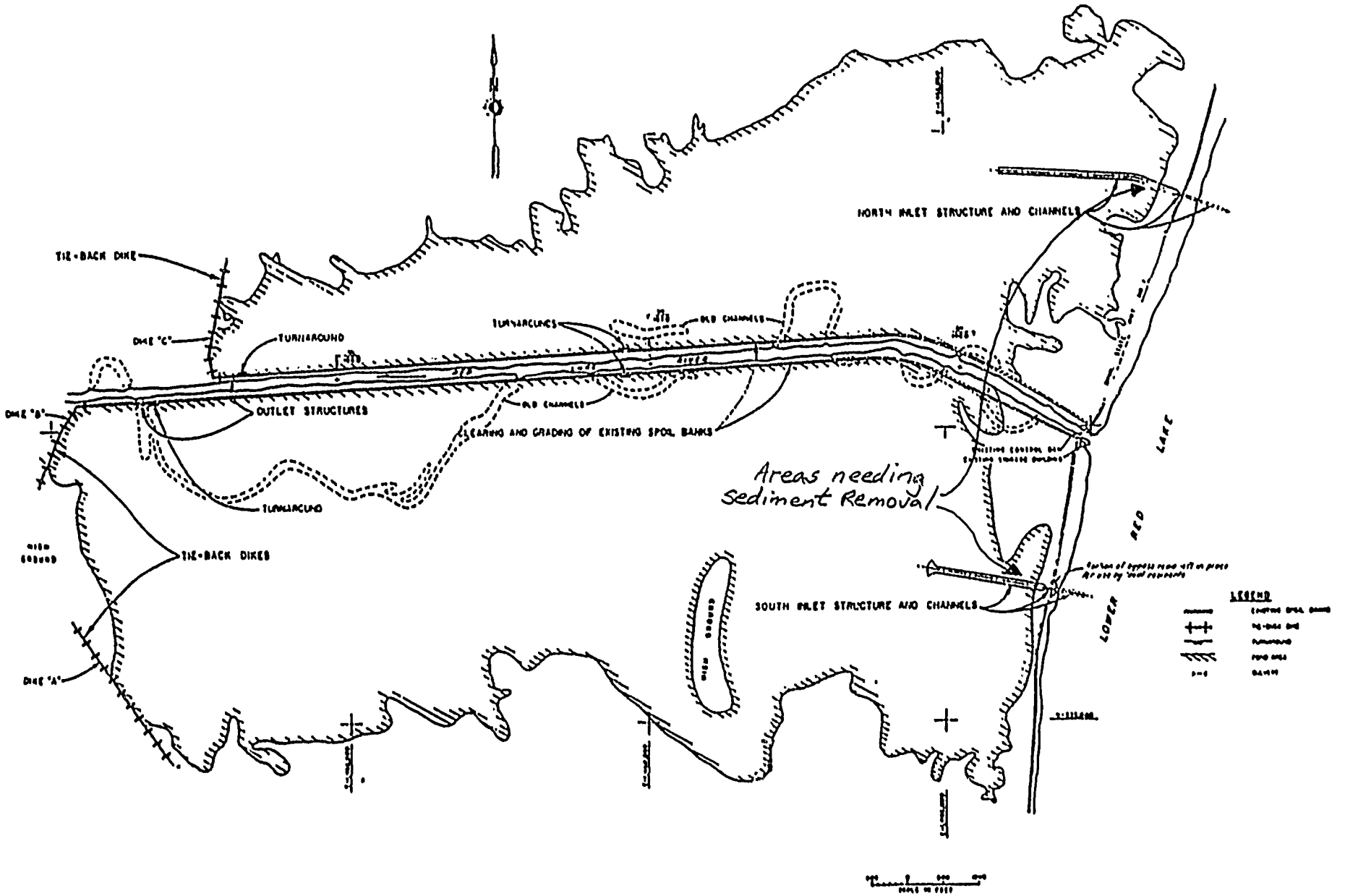

PLATE 5 - ALTERNATIVE 5

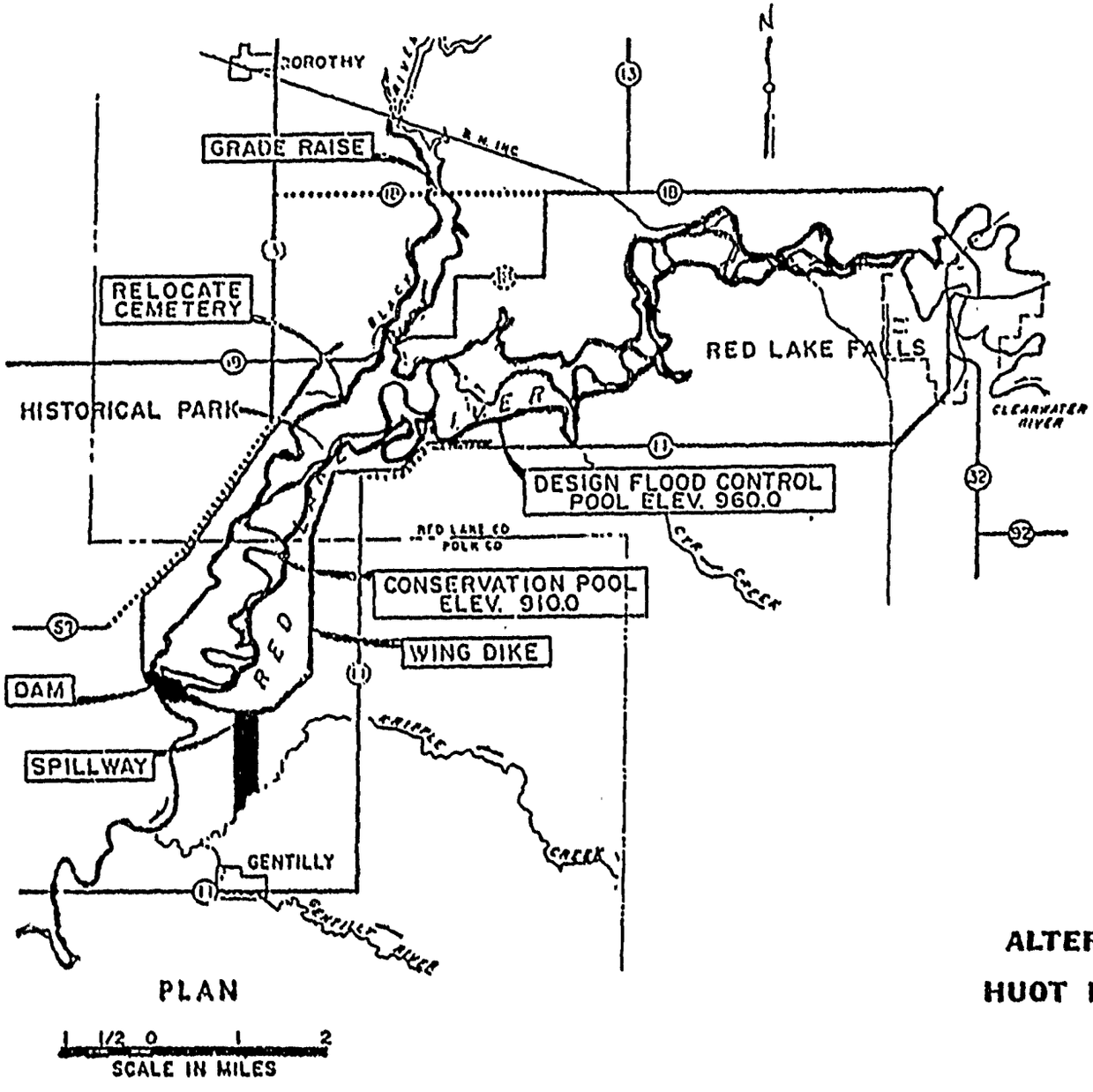

PLATE 6 - ALTERNATIVE 6

ALTERNATIVE 6

HUOT DAM & LAKE

RED LAKE AND CLEARWATER RIVERS
RED LAKE COUNTY, MINNESOTA

WORKING PAPERS (APPENDICES)

RECONNAISSANCE REPORT
RED LAKE AND CLEARWATER RIVERS

AUGUST 1991

WORKING PAPERS (APPENDICES)

Appendix A - Hydrology & Hydraulics

Appendix B - Economic & Social

Appendix C - Recreation

Appendix D - Environmental

Appendix E - Cost Estimates

Appendix F - Coordination Letters

WORKING PAPERS (APPENDICES)

Appendix A - Hydrology & Hydraulics

APPENDIX A

HYDROLOGY

TABLE OF CONTENTS

HYDRAULICS

Appendix A - Continued

APPENDIX A

HYDROLOGY

TABLES

APPENDIX A

HYDROLOGY

TABLES

APPENDIX A

HYDROLOGY

PLATES

APPENDIX A

HYDROLOGY

GENERAL

A number of alternatives within the Red Lake River watershed were analyzed. This report focuses on Upper/Lower Red Lake, High Landing, Minnesota; and vicinity; Crookston, Minnesota; and areas along the Clearwater River (Plate A-1).

CLIMATE

The climate in the vicinity of the Red Lake River basin is variable. The area is subject to cold winters and warm summers, typical of continental conditions in the temperate zone. The mean annual precipitation is about 21.0 inches, of which about 58% occurs during May, June, and July and about 77% occurs during the months of April through September. During the period November to March, the precipitation accumulates in the form of snow which, normally begins to melt and run off during the later part of March or early April. During the period May through September, the precipitation is usually the heaviest. About 80% of the excessive storms occur during June, July, and August and the remaining 20% occur in May and September. However, precipitation after 1 July appears to cause little run-off unless it occurs at excessive rates. During this period, evaporation and transpiration normally are heavy and tend to offset the effect of the rainfall. The result is a material reduction in run-off after June. The mean annual temperature is about 39 degrees F with extremes ranging from -51 degrees F to +110 degrees F. The growing season averages about 120 days. However, killing frosts have been recorded in June and August under exceptional conditions. The climate is generally favorable for the agricultural activity carried on in the area.

DRAINAGE AREA

RED LAKE RIVER

The Red Lake River follows a general westerly direction from Red Lake Dam at Upper/Lower Red Lake to High Landing and on to Thief River Falls where it turns and flows southward toward Red Lake Falls, Minnesota. The river then continues on in a southwesterly direction to Crookston, Minnesota. The Red Lake River eventually flows into the Red River of the North at Grand Forks, North Dakota (Plate A-1).

The watershed drained by the Red Lake River lies within the former bed of Glacial Lake Agassiz. As the lake drained, it left a more or less featureless plain interrupted by parallel north-south ridges which represent the ancient recessional beaches of Lake Agassiz and a few independent lakes as remnants of the original lake. These lakes are Upper/Lower Red Lake. Thief Lake, and Mud Lake (Plate A-1). It has been such a short time geologically since the last glacier withdrew from the basin that erosion has affected the area only

slightly and the streams have had little opportunity to develop typical valleys. The level terrain which was originally occupied by the glacial lake is referred to as the lake plain and the rolling country comprising glacial moraine and drift areas as the uplands. The lake plain occupies about 80% of the entire basin and is almost devoid of relief with elevations ranging from about 830 feet at the mouth of the Red Lake River to about 1,100 feet at the eastern limits where it merges with the uplands. Considerable tracts of land in the lake plain remain perpetually swampy and boggy. Large tracts of such lands are sub-marginal and are mostly uninhabited. The elevation of the uplands at the highest shoreline of the extinct Lake Agrassiz is about 1,100 feet above mean sea level and this section rises to about elevation 1,450 feet at the rim of the Continental Divide which separates the drainage areas of the Red River of North and the Mississippi River. This area is gently rolling to undulating and contains many depressions or ponds with no outlets.

The Red Lake River has a total drainage area of 5,661 square miles, of which 5,280 and 2,300 square miles are included in the area above Crookston and High Landing respectively. Only 3,330 and 350 square miles of this area are effective. All the drainage area upstream of Red Lake Dam on Upper/Lower Red Lake (Plate A-1) (1,950 square miles) is noneffective due to the very large storage capacity of the lake (3,270,000 acre-feet). Additional storage is also available at the Mud Lake National Wildlife Refuge and the Thief Lake Wildlife Refuge. The Red Lake River has an average channel slope of 2.2 feet per mile between Upper/Lower Red Lake and Crookston.

CLEARWATER RIVER

The Clearwater River is the prinicipal tributary of the Red Lake River. From its origin the river meanders for about 40 miles through the glacial moraine and aforementioned lake beach area along the southern edge of the basin and discharges into Clearwater Lake. Thence, continuing from the outlet of Clearwater Lake, the river follows a crooked channel in a northwesterly direction through the Uplands for a distance of about 29 miles where it enters the Lake Plain. In flowing through the Uplands the river has developed a narrow valley sufficient to accommodate flood flows. In the Lake Plain the river meanders in an extremely crooked westerly course to the vicinity of Plummer, Minnesota, in a direction roughly parallel to the Red Lake River, with only a very slight ridge separating the rivers (Plate A-1). During high water, this ridge is overtopped and flood waters of the Clearwater and Red Lake Rivers intermingle. In this reach the Clearwater River is similar to the upper reaches of the Red Lake River in that the river has no valley, the channel is poorly defined, the banks are low, and exclusive of drainage ditches and one brook (Ruffy Brook), there are no tributaries of any importance entering the main channel. Practically all flooding from Clearwater River outflow occurs in this reach. Near Plummer the river turns to the south and flows in a southernly direction for about 15 miles, thence turns sharply to the west and continues in a westerly direction to Red Lake Falls, where it joins the Red Lake River. As the river progresses from Plummer to Red Lake Falls, the height of the bank increases, the valley develops rapidly and numerous tributaries originating in the Uplands join the river. The river slope is steep in this reach and the channel can readily accommodate floodflows. The distance covered by the stream in its general course from source to mouth is approximately 90 miles, while its actual

meandering length is about 205 miles. The Clearwater River has an average channel slope of about 1 feet per mile in the Lake Plain region upstream of Plummer.

STREAMFLOW RECORDS

RED LAKE RIVER

There currently are three stream flow gages on the Red Lake River (Plate A-1). These gages are listed in Table A-1.

TABLE A-1

RED LAKE RIVER
SURFACE WATER STATIONS

U.S.G.S. Gage No.	Drainage Area Sq. Mi.	Location	Years of Record
05074500	1950	Red Lake River near Red Lake, MN	May 1933 - 1988
05075000	2300 (1)	Red Lake River at High Landing, Near Goodridge, MN	Sep 1929 - 1988
05079000	5280 (1)	Red Lake River at Crookston, MN	May 1901 - 1988

(1) Subtract 1950 sq. mi. to obtain the effective drainage area.

Records from all of the above gages were used in this study. Peak discharges are listed in Tables A-2, A-3, and A-4. The Red Lake River near Red Lake gage is located approximately 50 feet downstream of Lower Red Lake Dam.

TABLE A-2

RED LAKE RIVER NEAR RED LAKE, MINNESOTA
RECORDED INSTANTANEOUS PEAK FLOWS
OUTFLOWS FROM LOWER RED LAKE DAM

Date	Peak Flow CFS
June 25, 1950	3600
Oct. 06, 1950	2320
June 10, 1947	1960
July 20, 1957	1870
July 29, 1975	1680
June 01, 1945	1650
May 18, 1952	1510

TABLE A-3

RED LAKE RIVER AT HIGH LANDING NEAR GOODRIDGE, MINNESOTA
RECORDED INSTANTANEOUS PEAK FLOWS

Date	Peak Flow At High Landing CFS	Peak Stage Feet (1) (3)	Estimated Exceedance Discharge - Frequency (Percent)
July 7, 1975	4060	13.39 (2)	2.0
May 11, 1950	3720	13.42	3.8
April 25, 1979	3660	12.30	4.3
April 20, 1948	3390	9.20	6.5
April 3, 1966	3340	12.68	6.7
June 11, 1962	3060	12.10	9.3
July 18, 1968	2770	11.98	14.9

(1) Gage datum = 1141.57 Feet (NGVD 1912).

(2) The peak stage for the year occurred on July 03, 1975 (13.44 Feet) due to backwater conditions.

(3) Flood Stage = 8.75 feet for crop season and 11.00 feet for non-crop season.

TABLE A-4

RED LAKE RIVER AT CROOKSTON, MINNESOTA
RECORDED INSTANTANEOUS PEAK FLOWS

Date	Peak Flow at Crookston CFS	Estimated Peak Elevation (Ft. 1929 NGVD) (1)	Estimated Exceedance Discharge-Frequency (Percent)
April 12, 1969	28,400	860.05	2.0
May 7, 1950	27,400	858.42	2.5
April 26, 1979	21,900	857.71	5.5
April 4, 1966	21,500	857.13	6.0
April 14, 1965	19,400	856.23	8.5
April 1, 1967	19,300	856.21	8.7
April 11, 1897	18,900	857.92	9.0

(1) Flood Stage = 17 Feet = 849.72 Feet (1929 NGVD).

CLEARWATER RIVER

There currently are two stream flow gages on the Clearwater River (Plate A-1). These gages are listed in Table A-5.

TABLE A-5

CLEARWATER RIVER
SURFACE WATER STATIONS

U.S.G.S. Gage No.	Drainage Area Sq. Mi.	Location	Years of Record
05078000	512	Clearwater River at Plummer, MN	Apr. 1939-1987
05078500	1,370	Clearwater River at Red Lake Falls, MN	June 1909-1917
			Oct. 1934-1987

The gage at Plummer, Minnesota was used in this study. Peak discharges for this gage are listed in Table A-6.

TABLE A-6

CLEARWATER RIVER AT PLUMMER, MINNESOTA
RECORDED INSTANTANEOUS PEAK FLOWS

Date	Peak Flow at Plummer CFS	Peak Stage Feet (1) (3)	Estimated Exceedance Discharge - Frequency (Percent)
April 25, 1979	3940	12.31	4.2
June 9, 1962	3640	11.90	5.8
May 6, 1950	3630	11.33	5.9
April 11, 1969	3630 (2)	11.89	5.9

(1) Gage Datum = 1099.12 Feet (1912 NGVD).

(2) The peak stage for the year occurred on April 10, 1969 (12.31 Feet) due to backwater from ice.

(3) Flood Stage = 8.68 Feet.

LAKE STAGE RECORDS

LOWER RED LAKE

Lake stage records are available on Lower Red Lake (U.S.G.S. Gage No. 05074000, Lower Red Lake near Red Lake, Minnesota, 1933 - present.). The U. S. Army Corps of Engineers also maintains a lake stage gage since assuming control of the dam in 1950. Peak stages are listed in Table A-7.

TABLE A-7

LOWER RED LAKE NEAR RED LAKE, MINNESOTA
RECORDED PEAK LAKE STAGES

Date	Peak Stage Feet (1)	Estimated Exceedance Stage - Frequency (Percent)
June 25, 1950	9.53	1.3
June 10, 1947	8.25	5.7
June 3, 1943	8.23	5.8
July 11, 1975	8.03	7.3
June 1, 1945	7.84	9.2

(1) Gage Zero = 1169 Feet (1912 NGVD).
The normal operating band is between 4.5 and 5.5 feet.
Crest Elevataion of the spillway is 1169.6 feet or a stage of 0.6 feet.
Elevation of top of dam is 1181.39 feet or a stage of 12.39 feet.

GENERAL INFORMATION, OPERATION OF RED LAKE DAM

EXISTING CONDITIONS

The gates on Red Lake Dam are currently operated by hand held electric motors. The gates are operated in response to river stages at the control point in High Landing (Plate A-1).

A dam tender does not live on site or near by. To close the gates, an employee must be dispatched from Winnibigoshish, Leech, or Pokegama Dam, all of which are approximately 100 miles away. When the lake level is above the authorized operating band, water is discharged at the capacity of the downstream channel. The discharge travel time between Red Lake Dam and the High Landing control point is approximately 1 1/2 days. The above conditions make it difficult for the operator to respond to local runoff between the dam and High Landing when high flows are being released from the dam. During the crop and non-crop season, the dam is operated for a stage of 8.75 and 11 feet, respectively, at the High Landing gage.

PROPOSED MODIFIED CONDITIONS, REMOTE CONTROL GATES

Under this plan, motorized gates, which could be operated from a remote location, would be installed at the dam. A precipitation gage would alert the operator whenever 1/2 inch or more of rain falls in 24 hours or 48 hours total. In addition, a river stage gage would alert the operator to rising stages at High Landing. The gates could then be closed very quickly in order to allow local inflows between the dam and High Landing to runoff.

GENERAL INFORMATION, CONNECTION CHANNEL PROJECT

The proposed connection channel project would connect the Red Lake River and

the Clearwater River with a trapezoidal channel. The channel would approximately follow the western edge of the Red Lake Indian Reservation which lies about 14 miles west of Lower Red Lake. The intent is to transfer water between the Clearwater and Red Lake Rivers from whichever river is at the higher stage. The design capacity of the connection channel is 400 cfs assuming low flow in the receiving river and flood stages on the sending river. No flow will be allowed to transfer from a river which is below a minimum protected flow. Also, no flow will transfer when both rivers are at flood stage because the connection points have equal flood stage elevations. Transfers to a river which is above flood stage from one at a higher flood stage will have limited capacity and manual intervention is also possible to reduce damages on the receiving river.

FLOOD FREQUENCY

RED LAKE RIVER AT HIGH LANDING NEAR GOODRIDGE, MINNESOTA

EXISTING CONDITIONS, RED LAKE RIVER

The existing condition discharge-frequency curve at High Landing was plotted graphically due to the regulation effects of Red Lake Dam. Weibull plotting positions were used. The rank and assigned plotting positions are shown in Table A-8. The existing condition curve is shown on Plate A-2 and A-3. Discharges for selected frequencies are listed in Table A-20.

MODIFIED CONDITIONS, RED LAKE RIVER, AUTOMATED GATES AT RED LAKE DAM

A modified condition discharge-frequency curve was developed by comparing hydrographs at the dam and High Landing (U.S.G.S. Gage No. 05074500 and 05075000, Table A-1 and Plate A-1) along with precipitation records at High Landing. The period of record was studied to determine which years a flood warning system and remote controlled gages could have reduced flooding at High Landing. The flows that were adjusted are listed in Table A-9. The rank and assigned plotting positions are listed in Table A-10. The modified condition discharge-frequency curve is shown on Plate A-2. Discharges for selected frequencies are listed in Table A-20.

TABLE A-8
RANK AND ASSIGNED PLOTTING POSITIONS
INSTANTANEOUS PEAK DISCHARGE VALUES
RED LAKE RIVER AT HIGH LANDING NEAR GOODRIDGE, MINNESOTA

RANK	WATER YEAR	FLOW, CFS	WEIBULL PLOT POS
1	1975	4060.	.0169
2	1950	3720.	.0339
3	1979	3660.	.0508
4	1948	3390.	.0678
5	1966	3340.	.0847
6	1962	3060.	.1017
7	1968	2770.	.1186
8	1965	2740.	.1356
9	1974	2670.	.1525
10	1947	2660.	.1695
11	1945	2540.	.1864
12	1985	2490.	.2034
13	1967	2480.	.2203
14	1986	2470.	.2373
15	1978	2440.	.2542
16	1969	2320.	.2712
17	1946	2310.	.2881
18	1984	2210.	.3051
19	1951	2170.	.3220
20	1970	2120.	.3390
21	1943	2010.	.3559
22	1957	1960.	.3729
23	1976	1890.	.3898
24	1942	1800.	.4068
25	1982	1800.	.4237
26	1952	1730.	.4407
27	1971	1610.	.4576
28	1963	1600.	.4746
29	1972	1580.	.4915
30	1958	1520.	.5085
31	1983	1510.	.5254
32	1980	1500.	.5424
33	1938	1460.	.5593
34	1949	1360.	.5763
35	1956	1330.	.5932
36	1944	1320.	.6102
37	1940	1300.	.6271
38	1939	1300.	.6441
39	1973	1290.	.6610
40	1955	1240.	.6780
41	1964	1170.	.6949
42	1987	961.	.7119
43	1930	912.	.7288
44	1941	912.	.7458
45	1954	742.	.7627
46	1953	670.	.7797
47	1977	667.	.7966
48	1981	577.	.8136
49	1960	530.	.8305
50	1959	326.	.8475
51	1937	285.	.8644

TABLE A-8 (Continued)
RANK AND ASSIGNED PLOTTING POSITIONS
INSTANTANEOUS PEAK DISCHARGE VALUES
RED LAKE RIVER AT HIGH LANDING NEAR GOODRIDGE, MINNESOTA

*	52	1961	282.	.8814	*
*	53	1931	254.	.8983	*
*	54	1936	248.	.9153	*
*	55	1932	241.	.9322	*
*	56	1935	111.	.9492	*
*	57	1933	85.	.9661	*
*	58	1934	58.	.9831	*

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TABLE A-9

RED LAKE RIVER AT HIGH LANDING
MODIFIED FLOWS DUE TO REMOTE CONTROL GATES

Date	Peak Instantaneous Flow CFS	Modified Flow CFS
May 11, 1950	3720	2420
April 29, 1951	2170	870
June 28, 1957	1960	1260
June 11, 1962	3060	2160
July 18, 1968	2770	2270
June 16, 1970	2120	1220
April 28, 1974	2670	2370
August 18, 1985	2490	1940
April 29, 1986	2470	1570

TABLE A-10
RANK AND ASSIGNED PLOTTING POSITIONS
INSTANTANEOUS PEAK DISCHARGE VALUES

MODIFIED FLOWS DUE TO REMOTE CONTROL
OPERATION OF RED LAKE DAM

RED LAKE RIVER AT HIGH LANDING NEAR GOODRIDGE, MINNESOTA

RANK	WATER YEAR	FLOW, CFS	WEIBULL PLOT POS
1	1975	4060.	.0169
2	1979	3660.	.0339
3	1948	3390.	.0508
4	1966	3340.	.0678
5	1965	2740.	.0847
6	1947	2660.	.1017
7	1945	2540.	.1186
8	1967	2480.	.1356
9	1978	2440.	.1525
10	1950	2420.	.1695
11	1974	2370.	.1864
12	1969	2320.	.2034
13	1946	2310.	.2203
14	1968	2270.	.2373
15	1984	2210.	.2542
16	1962	2160.	.2712
17	1943	2010.	.2881
18	1985	1940.	.3051
19	1976	1890.	.3220
20	1942	1800.	.3390
21	1982	1800.	.3559
22	1952	1730.	.3729
23	1971	1610.	.3898
24	1963	1600.	.4068
25	1972	1580.	.4237
26	1986	1570.	.4407
27	1958	1520.	.4576
28	1983	1510.	.4746
29	1980	1500.	.4915
30	1938	1460.	.5085
31	1949	1360.	.5254
32	1956	1330.	.5424
33	1944	1320.	.5593
34	1940	1300.	.5763
35	1939	1300.	.5932
36	1973	1290.	.6102
37	1957	1260.	.6271
38	1955	1240.	.6441
39	1970	1220.	.6610
40	1964	1170.	.6780
41	1987	961.	.6949
42	1930	912.	.7119
43	1941	912.	.7288
44	1951	870.	.7458
45	1954	742.	.7627

TABLE A-10 (Continued)
RANK AND ASSIGNED PLOTTING POSITIONS
INSTANTANEOUS PEAK DISCHARGE VALUES

MODIFIED FLOWS DUE TO REMOTE CONTROL
OPERATION OF RED LAKE DAM

RED LAKE RIVER AT HIGH LANDING NEAR GOODRIDGE, MINNESOTA

*	46	1953	670.	.7797	*
*	47	1977	667.	.7966	*
*	48	1981	577.	.8136	*
*	49	1960	530.	.8305	*
*	50	1959	326.	.8475	*
*	51	1937	285.	.8644	*
*	52	1961	282.	.8814	*
*	53	1931	254.	.8983	*
*	54	1936	248.	.9153	*
*	55	1932	241.	.9322	*
*	56	1935	111.	.9492	*
*	57	1933	85.	.9661	*
*	58	1934	58.	.9831	*

MODIFIED CONDITIONS, RED LAKE RIVER, CONNECTION CHANNEL PROJECT

The proposed connection channel project is described in detail in a report prepared for the Red Lake Watershed District (Reference 1). The connection channel would transfer water from the Red Lake River to the Clearwater River and visa-versa. The design capacity is 400 cfs assuming low flow in the receiving river and flood stage in the sending river. A review of the flow records on the Red Lake and Clearwater Rivers revealed that, on the average, 300 cfs could be transferred to the Clearwater River when the flow in the Red Lake River is equal to or greater than 1000 cfs. This would not be true every year. However, it was felt that this would be a good assumption for the level of detail required at this stage of the study. There is a 0.5 day discharge travel time between the connection channel and High Landing. The drainage area at the connection channel is 2171 square miles (221 square miles effective). A best case scenario was assumed. Consideration was not given to the effect of the transferred flows on the Clearwater River. Low flow augmentation on the Clearwater River was not studied. The flows that were adjusted are listed in Table A-11. The rank and assigned plotting positions are listed in Table A-12. The modified discharge-frequency curve is shown on Plate A-3. Discharges for selected frequencies are listed in Table A-20.

TABLE A-11

RED LAKE RIVER AT HIGH LANDING
MODIFIED FLOWS DUE TO THE CONNECTION CHANNEL

Date	Peak Instantaneous Flow CFS	Modified Flow CFS
05/13/38	1460.0	1160
04/21/39	1300.0	1000
04/19/40	1300.0	1000
04/02/42	1800.0	1500
04/08/43	2010.0	1710
04/11/44	1320.0	1020
03/27/45	2540.0	2240
03/30/46	2310.0	2010
06/15/47	2660.0	2360
04/20/48	3390.0	3090
04/13/49	1360.0	1060
05/11/50	3720.0	3420
04/29/51	2170.0	1870
05/19/52	1730.0	1430
04/08/55	1240.0	940
04/20/56	1330.0	1030
06/28/57	1960.0	1660
10/17/57	1520.0	1220
06/11/62	3060.0	2760
04/08/63	1600.0	1300
10/24/63	1170.0	870

TABLE A-11 - (CONTINUED)

RED LAKE RIVER AT HIGH LANDING
MODIFIED FLOWS DUE TO THE CONNECTION CHANNEL

Date	Peak Instantaneous Flow CFS	Modified Flow CFS
04/13/65	2740.0	2440
04/03/66	3340.0	3040
03/30/67	2480.0	2180
07/18/68	2770.0	2470
04/10/69	2320.0	2020
06/16/70	2120.0	1820
04/08/71	1610.0	1310
05/29/72	1580.0	1280
09/25/73	1290.0	990
04/28/74	2670.0	2370
07/07/75	4060.0	3760
10/25/75	1890.0	1590
04/08/78	2440.0	2140
04/25/79	3660.0	3360
04/05/80	1500.0	1200
04/15/82	1800.0	1500
10/12/82	1510.0	1210
06/09/84	2210.0	1910
08/18/85	2490.0	2190
04/29/86	2470.0	2170

TABLE A-12
RANK AND ASSIGNED PLOTTING POSITIONS
INSTANTANEOUS PEAK DISCHARGE VALUES

MODIFIED FLOWS DUE TO THE CONNECTION
CHANNEL TO THE CLEARWATER RIVER

RED LAKE RIVER AT HIGH LANDING NEAR GOODRIDGE, MINNESOTA

ORDERED EVENTS			
RANK	WATER YEAR	FLOW, CFS	WEIBULL PLOT POS
1	1975	3760.	.0169
2	1950	3420.	.0339
3	1979	3360.	.0508
4	1948	3090.	.0678
5	1966	3040.	.0847
6	1962	2760.	.1017
7	1968	2470.	.1186
8	1965	2440.	.1356
9	1974	2370.	.1525
10	1947	2360.	.1695
11	1945	2240.	.1864
12	1985	2190.	.2034
13	1967	2180.	.2203
14	1986	2170.	.2373
15	1978	2140.	.2542
16	1969	2020.	.2712
17	1946	2010.	.2881
18	1984	1910.	.3051
19	1951	1870.	.3220
20	1970	1820.	.3390
21	1943	1710.	.3559
22	1957	1660.	.3729
23	1976	1590.	.3898
24	1942	1500.	.4068
25	1982	1500.	.4237
26	1952	1430.	.4407
27	1971	1310.	.4576
28	1963	1300.	.4746
29	1972	1280.	.4915
30	1958	1220.	.5085
31	1983	1210.	.5254
32	1980	1200.	.5424
33	1938	1160.	.5593
34	1949	1060.	.5763
35	1956	1030.	.5932
36	1944	1020.	.6102
37	1940	1000.	.6271
38	1939	1000.	.6441
39	1973	990.	.6610
40	1987	961.	.6780
41	1955	940.	.6949
42	1930	912.	.7119
43	1941	912.	.7288
44	1964	870.	.7458
45	1954	742.	.7627
46	1953	670.	.7797
47	1977	667.	.7966

TABLE A-12 (Continued)
RANK AND ASSIGNED PLOTTING POSITIONS
INSTANTANEOUS PEAK DISCHARGE VALUES

MODIFIED FLOWS DUE TO THE CONNECTION
CHANNEL TO THE CLEARWATER RIVER

RED LAKE RIVER AT HIGH LANDING NEAR GOODRIDGE, MINNESOTA

*	48	1981	577.	.8136	*
*	49	1960	530.	.8305	*
*	50	1959	326.	.8475	*
*	51	1937	285.	.8644	*
*	52	1961	282.	.8814	*
*	53	1931	254.	.8983	*
*	54	1936	248.	.9153	*
*	55	1932	241.	.9322	*
*	56	1935	111.	.9492	*
*	57	1933	85.	.9661	*
*	58	1934	58.	.9831	*

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HUOT DAM, RED LAKE RIVER AT CROOKSTON, MINNESOTA

GENERAL

A number of previous studies (Reference 6) have investigated the feasibility of constructing a dam upstream of Crookston in the vicinity of Huot, Minnesota (Plate A-1). The proposed dam would have 205,000 acre-feet of flood control storage, a top elevation of 970 feet above mean sea level, and a maximum release rate of 10,000 cfs. The reservoir would benefit Crookston, Grand Forks, and East Grand Forks as well as lands downstream of Crookston and Grand Forks.

EXISTING CONDITIONS, RED LAKE RIVER AT CROOKSTON, MINNESOTA

The existing conditions curve, described in this report, was developed for the Crookston Reconnaissance study (Reference 7). A complete description follows.

The existing condition instantaneous peak discharge-frequency curve for the Red Lake River at Crookston was developed from the U.S.G.S. gages at Crookston and Grand Forks, North Dakota. The Crookston curve was developed by following the guidelines and procedures outlined in the Water Resources Council Bulletin No. 17B and the Hydrologic Engineering Center's computer programs, "Flood Flow Frequency Analysis" and "Regional Frequency Computation" (Reference 2, 3, and 4). The effective drainage area at Crookston is 3,330 square miles. As a result, a generalized skew of -0.45 was obtained from the St. Paul District's regional skew map (Reference 5). Crookston's short-term record statistics were then correlated to Grand Forks' longer record according to Bulletin No. 17B. The 1969 event at Crookston is considered to be the largest since 1897. This information, however, was not used in order to avoid a double adjustment with Grand Forks (the 1897 event was included at Grand Forks). The 1897 information at Crookston was used, however, to obtain a better estimate of the station skew. The rank and assigned plotting position at Crookston are shown in Table A-13. The existing condition, annual discharge-frequency curve at Crookston is shown on Plate A-4. Discharges for selected frequencies are listed in Table A-20.

TABLE A-13

RANK AND ASSIGNED PLOTTING POSITIONS
INSTANTANEOUS PEAK DISCHARGE VALUES
RED LAKE RIVER AT CROOKSTON, MINNESOTA

EVENTS ANALYZED					ORDERED EVENTS				
MON	DAY	YEAR	FLOW,CFS	RANK	WATER YEAR	FLOW,CFS	WEIBULL PLOT POS	
4	11	1897	18900.	1	1969	28400.	.0108	
5	21	1902	5170.	2	1950	27400.	.0219	
4	24	1904	13700.	3	1979	21900.	.0334	
5	13	1905	8730.	4	1966	21500.	.0449	
4	15	1906	14600.	5	1965	19400.	.0564	

TABLE A-13 (CONTINUED)

RANK AND ASSIGNED PLOTTING POSITIONS
INSTANTANEOUS PEAK DISCHARGE VALUES
RED LAKE RIVER AT CROOKSTON, MINNESOTA

EVENTS ANALYZED					ORDERED EVENTS			
MON	DAY	YEAR	FLOW,CFS	RANK	WATER YEAR	FLOW,CFS	WEIBULL PLOT POS	
4	04	1907	6330.	6	1967	19300.	.0679	
4	10	1908	10700.	7	1897	18900.	.0794	
7	21	1909	3680.	8	1978	18100.	.0910	
3	20	1910	7920.	9	1962	16700.	.1025	
6	10	1911	3620.	10	1974	16400.	.1140	
9	29	1912	2120.	11	1916	15900.	.1255	
4	08	1913	7170.	12	1975	15600.	.1370	
6	12	1914	2630.	13	1971	15300.	.1485	
6	29	1915	7860.	14	1919	14900.	.1600	
4	17	1916	15900.	15	1972	14700.	.1715	
4	11	1917	5480.	16	1906	14600.	.1830	
4	02	1918	1950.	17	1984	14400.	.1946	
7	05	1919	14900.	18	1956	14000.	.2061	
3	25	1920	9520.	19	1940	13700.	.2176	
5	13	1922	6910.	20	1970	13300.	.2291	
4	20	1923	5820.	21	1951	12600.	.2406	
4	23	1924	1140.	22	1976	12500.	.2521	
6	09	1925	7300.	23	1947	12400.	.2636	
3	24	1926	6500.	24	1955	12400.	.2751	
4	13	1927	7700.	25	1957	11800.	.2867	
4	08	1928	3910.	26	1986	11500.	.2982	
3	19	1929	7620.	27	1968	11100.	.3097	
5	13	1930	4770.	28	1949	10700.	.3213	
3	26	1931	10??	29	1908	10700.	.3327	
4	09	1932	4390.	30	1985	9580.	.3442	
4	02	1933	1440.	31	1948	9520.	.3557	
4	08	1934	1490.	32	1920	9520.	.3672	
3	27	1935	2490.	33	1943	9420.	.3787	
4	18	1936	4540.	34	1982	9320.	.3903	
8	04	1937	3750.	35	1945	9130.	.4018	
5	10	1938	5910.	36	1946	9020.	.4033	
4	24	1939	3050.	37	1905	8730.	.4248	
4	16	1940	6000.	38	1910	7920.	.4363	
6	09	1941	6190.	39	1915	7860.	.4478	
3	28	1942	7090.	40	1927	7700.	.4593	
4	08	1943	9420.	41	1929	7620.	.4708	
8	11	1944	5770.	42	1983	7330.	.4824	
3	28	1945	9130.	43	1925	7300.	.4939	
3	24	1946	9020.	44	1913	7170.	.5054	
6	12	1947	12400.	45	1981	7120.	.5169	
4	19	1948	9520.	46	1942	7090.	.5284	
6	02	1949	10700.	47	1922	6910.	.5399	
5	07	1950	27400.	48	1963	6820.	.5514	

TABLE A-13 (CONITNUED)

RANK AND ASSIGNED PLOTTING POSITIONS
INSTANTANEOUS PEAK DISCHARGE VALUES
RED LAKE RIVER AT CROOKSTON, MINNESOTA

EVENTS ANALYZED				ORDERED EVENTS			
MON	DAY	YEAR	FLOW,CFS	RANK	WATER YEAR	FLOW,CFS	WEIBULL PLOT POS
4	07	1951	12600.	49	1980	6600.	.5629
4	11	1952	6320.	50	1926	6500.	.5744
3	24	1953	2560.	51	1907	6330.	.5860
4	12	1954	5330.	52	1952	6320.	.5974
4	08	1955	12400.	53	1941	6190.	.6090
4	20	1956	14000.	54	1940	6000.	.6205
6	29	1957	11800.	55	1938	5910.	6320
7	07	1958	3370.	56	1923	5820.	.6435
4	05	1959	5630.	57	1944	5770.	.6550
4	06	1960	5520.	58	1959	5630.	.6665
3	27	1961	1450.	59	1964	5550.	.6781
6	11	1962	16700.	60	1960	5520.	.6896
4	09	1963	6820.	61	1917	5480.	.7011
6	20	1964	5550.	62	1987	5360.	.7126
4	14	1965	19400.	63	1954	5330.	.7241
4	03	1966	21500.	64	1902	5170.	.7356
4	01	1967	19300.	65	1988	5090.	.7471
7	19	1968	11100.	66	1973	4960.	.7586
4	12	1969	28400.	67	1930	4770.	.7701
4	26	1970	13300.	68	1936	4540.	.7817
4	10	1971	15300.	69	1932	4390.	.7932
4	16	1972	14700.	70	1928	3910.	.8047
9	26	1973	4960.	71	1937	3750.	.8162
4	23	1974	16400.	72	1909	3680.	.8277
4	18	1975	15600.	73	1911	3620.	.8392
4	03	1976	12500.	74	1977	3440.	.8507
5	20	1977	3440.	75	1958	3370.	.8622
4	07	1978	18100.	76	1939	3050.	.8738
4	26	1979	21900.	77	1914	2630.	.8853
4	09	1980	6600.	78	1953	2560.	.8968
6	29	1981	7120.	79	1935	2490.	.9083
4	17	1982	9320.	80	1912	2120.	.9198
6	23	1983	7330.	81	1918	1950.	.9313
6	10	1984	14400.	82	1934	1490.	.9428
8	19	1985	9580.	83	1961	1450.	.9543
4	01	1986	11500.	84	1933	1440.	.9658
5	28	1987	5360.	85	1924	1140.	.9744
4	08	1988	5090.	86	1931	1030.	.9889

RED RIVER OF THE NORTH

The discharge-frequency curve at Grand Forks was developed using the Water Resources Council Bulletin No. 17B and the Hydrologic Engineering Center's computer program "Flood Flow Frequency Analysis" (Reference 2 and 3). This curve was adopted from a previous study (Reference 7). The 1826 and 1852 events were considered to be historic events. The rank and assigned plotting positions at Grand Forks are shown in Table A-14. The adopted discharge-frequency curve is shown on Plate A-5. Discharges for selected frequencies are listed in Table A-20.

TABLE A-14

RANK AND ASSIGNED PLOTTING POSITIONS
INSTANTANEOUS PEAK DISCHARGE VALUES
RED RIVER OF THE NORTH AT GRAND FORKS, NORTH DAKOTA

EVENTS ANALYZED				ORDERED EVENTS			
MON	DAY	YEAR	FLOW,CFS	RANK	WATER YEAR	FLOW,CFS	WEIBULL PLOT POS
0	0	1861	65000.	1	1826	135000.	.0061
4	18	1882	75000.	2	1852	95000.	.0122
4	26	1883	38600.	3	1897	85000.	.0198
4	16	1884	20600.	4	1979	82000.	.0289
4	17	1885	13040.	5	1882	75000.	.0380
5	03	1886	10800.	6	1861	65000.	.0471
4	15	1887	7300.	7	1966	55000.	.0561
4	19	1888	19000.	8	1978	54200.	.0652
4	01	1889	3000.	9	1950	54000.	.0743
4	15	1890	3470.	10	1969	53500.	.0834
4	13	1891	6000.	11	1893	53300.	.0925
4	17	1892	23000.	12	1965	52000.	.1016
4	24	1893	53300.	13	1975	42800.	.1107
4	24	1894	16450.	14	1883	38600.	.1198
4	06	1895	2000.	15	1947	35000.	.1298
5	30	1896	21600.	16	1974	34300.	.1380
4	10	1897	85000.	17	1948	34200.	.1470
4	14	1898	4500.	18	1904	33000.	.1561
4	17	1899	9000.	19	1984	32300.	.1652
4	10	1900	4000.	20	1986	31900.	.1743
4	07	1901	14000.	21	1972	31400.	.1834
3	30	1902	15000.	22	1907	30400.	.1925
4	11	1903	18800.	23	1920	30300.	.2016
4	27	1904	33000.	24	1916	29000.	.2107
5	16	1905	16800.	25	1943	28200.	.2198
4	18	1906	27600.	26	1967	28200.	.2289
4	07	1907	30400.	27	1906	27600.	.2379
4	11	1908	20500.	28	1962	26600.	.2470
7	30	1909	9260.	29	1952	23900.	.2561
3	22	1910	18500.	30	1982	23900.	.2652
6	12	1991	3520.	31	1970	23700.	.2743

TABLE A-14 (CONTINUED)

RANK AND ASSIGNED PLOTTING POSITIONS
INSTANTANEOUS PEAK DISCHARGE VALUES
RED RIVER OF THE NORTH AT GRAND FORKS, NORTH DAKOTA

EVENTS ANALYZED				ORDERED EVENTS			
MON	DAY	YEAR	FLOW,CFS	RANK	WATER YEAR	FLOW,CFS	WEIBULL PLOT POS
4	08	1912	4730.	32	1976	23600.	.2834
4	08	1913	17200.	33	1951	23600.	.2925
6	16	1914	8240.	34	1892	23000.	.3016
7	03	1915	21500.	35	1980	22000.	.3107
4	23	1916	29000.	36	1946	22000.	.3198
4	06	1917	19800.	37	1896	21600.	.3288
3	28	1918	4480.	38	1915	21500.	.3379
7	08	1919	13600.	39	1956	21400.	.3470
3	31	1920	30300.	40	1945	21300.	.3561
4	10	1921	11500.	41	1884	20600.	.3652
4	11	1922	19000.	42	1908	20500.	.3743
4	22	1923	16200.	43	1917	19800.	.3834
5	02	1924	2530.	44	1888	19000.	.3925
6	12	1925	9690.	45	1922	19000.	.4016
3	28	1926	7720.	46	1903	18800.	.4107
4	13	1927	10600.	47	1910	18500.	.4197
4	02	1928	12200.	48	1985	17800.	.4288
3	24	1929	17100.	49	1987	17500.	.4379
4	07	1930	9610.	50	1913	17200.	.4470
4	10	1931	1630.	51	1960	17200.	.4561
4	10	1932	10400.	52	1929	17100.	.4652
4	03	1933	4380.	53	1905	16800.	.4743
4	12	1934	3210.	54	1894	16450.	.4834
3	29	1935	2920.	55	1923	16200.	.4925
4	18	1936	14500.	56	1971	15800.	.5016
5	04	1937	4180.	57	1955	15400.	.5106
5	12	1938	6600.	58	1949	15200.	.5197
4	06	1939	6720.	59	1902	15000.	.5288
4	18	1940	10000.	60	1957	14700.	.5397
4	12	1941	13400.	61	1953	14600.	.5470
4	05	1942	11000.	62	1936	14500.	.5561
4	12	1943	28200.	63	1983	14300.	.5652
8	13	1944	10400.	64	1901	14000.	.5743
3	29	1945	21300.	65	1919	13600.	.5834
3	27	1946	22000.	66	1941	13400.	.5925
4	21	1947	35000.	67	1964	13200.	.6015
4	16	1948	34200.	68	1885	13040.	.6106
4	10	1949	15200.	69	1928	12200.	.6197
5	12	1950	54000.	70	1921	11500.	.6288
4	12	1951	23600.	71	1973	11300.	.6379
4	20	1952	23900.	72	1942	11000.	.6470
6	25	1953	14600.	73	1886	10800.	.6561
4	15	1954	9620.	74	1963	10800.	.6652

TABLE A-14 (CONTINUED)

RANK AND ASSIGNED PLOTTING POSITIONS
INSTANTANEOUS PEAK DISCHARGE VALUES
RED RIVER OF THE NORTH AT GRAND FORKS, NORTH DAKOTA

EVENTS ANALYZED				ORDERED EVENTS			
MON	DAY	YEAR	FLOW,CFS	RANK	WATER YEAR	FLOW,CFS	WEIBULL PLOT POS
4	10	1955	15400.	75	1927	10600.	.6743
4	23	1956	21400.	76	1944	10400.	.6834
7	02	1957	14700.	77	1932	10400.	.6924
7	09	1958	7500.	78	1940	10000.	.7015
4	06	1959	6300.	79	1925	9690.	.7106
4	12	1960	17200.	80	1954	9620.	.7197
3	28	1961	3400.	81	1930	9610.	.7288
6	16	1962	26600.	82	1968	9420.	.7379
4	11	1963	10800.	83	1909	9260.	.7470
4	19	1964	13200.	84	1899	9000.	.7561
4	17	1965	52000.	85	1988	8500.	.7652
4	04	1966	55000.	86	1914	8240.	.7742
4	04	1967	28200.	87	1926	7720.	.7833
6	11	1968	9420.	88	1958	7500.	.7924
4	16	1969	53500.	89	1887	7300.	.8015
4	28	1970	23700.	90	1939	6720.	.8106
4	11	1971	15800.	91	1981	6710.	.8197
4	17	1972	31400.	92	1938	6600.	.8288
3	20	1973	11300.	93	1959	6300.	.8379
4	19	1974	34300.	94	1891	6000.	.8470
7	14	1975	42800.	95	1912	4730.	.8561
4	03	1976	23600.	96	1898	4500.	.8651
4	10	1977	2190.	97	1918	4480.	.8742
4	11	1978	54200.	98	1933	4380.	.8833
4	23	1979	82000.	99	1937	4180.	.8924
4	06	1980	22000.	100	1900	4000.	.9015
7	01	1981	6710.	101	1911	3520.	.9106
4	12	1982	23900.	102	1890	3470.	.9197
4	06	1983	14300.	103	1961	3400.	.9288
4	02	1984	32300.	104	1934	3210.	.9379
5	19	1985	17800.	105	1889	3000.	.9470
4	02	1986	31900.	106	1935	2920.	.9560
3	29	1987	17500.	107	1924	2530.	.9651
4	05	1988	8500.	108	1977	2190.	.9742
0	00	1826	135000.	109	1895	2000.	.9833
0	00	1852	95000.	110	1931	1630.	.9924

MODIFIED CONDITIONS, RED LAKE RIVER AT CROOKSTON, MINNESOTA, HUOT DAM

A modified discharge-frequency curve at Crookston, Minnesota, due to the storage effects of Huot Dam, was developed by approximate methods. The existing curve, described above, was modified by the same percent reductions in flow that were used in a previous study (Reference 8). A maximum release rate of 10,000 cfs was assumed. The modified curve is shown on Plate A-6.

CLEARWATER RIVER AT PLUMMER, MINNESOTA

GENERAL

Existing and modified discharge-frequency curves were developed at the U.S.G.S. gage at Plummer, Minnesota. This was done to see what effect the connection channel would have on flows in the Clearwater River.

EXISTING CONDITIONS, CONNECTION CHANNEL PROJECT, CLEARWATER RIVER

The existing conditions instantaneous peak discharge-frequency curve for the Clearwater River at Plummer was developed from records at the U.S.G.S. gage located in Plummer, Minnesota. The curve was developed by following the guidelines and procedures outlined in the Water Resources Council Bulletin No. 17B and the Hydrologic Engineering Center's computer program "Flood Flow Frequency Analysis" (References 2 and 3). A generalized skew equal to -0.44 was adopted from a skew study conducted by the U. S. Army Corps of Engineers, St. Paul District (Reference 5). The rank and assigned plotting positions are shown in Table A-15. The existing condition curve is shown on Plate A-7. Discharges for selected frequencies are listed in Table A-20.

MODIFIED CONDITIONS, CONNECTION CHANNEL PROJECT, CLEARWATER RIVER

Discharge records for the Clearwater River at Plummer and the Red Lake River at High Landing were compared. When the annual instantaneous peak flow at Plummer was greater than the corresponding annual peak or secondary peak at High Landing, 300 cfs was transferred to the Red Lake River. No flow was transferred if the peak on the Clearwater River was less than or equal to 1000 cfs. The discharge travel time between the connection channel and Plummer is 1 1/2 days. The drainage area of the Clearwater River at the connection channel is 400 square miles. A best case scenario was assumed. Consideration was not given to the effect of the transferred flows on the Red Lake River. The flows that were adjusted are listed in Table A-16. The rank and assigned plotting positions are listed in Table A-17. The modified discharge-frequency curve is shown on Plate A-7. Discharges for selected frequencies are list in Table A-20.

TABLE A-15
RANK AND ASSIGNED PLOTTING POSITIONS
INSTANTANEOUS PEAK DISCHARGE VALUES
CLEARWATER RIVER AT PLUMMER, MINNESOTA

RANK	WATER YEAR	FLOW,CFS	WEIBULL PLOT POS
1	1979	3940.	.0200
2	1962	3640.	.0400
3	1950	3630.	.0600
4	1969	3630.	.0800
5	1965	3620.	.1000
6	1957	3570.	.1200
7	1978	3270.	.1400
8	1968	3000.	.1600
9	1975	2960.	.1800
10	1972	2550.	.2000
11	1974	2540.	.2200
12	1967	2470.	.2400
13	1956	2240.	.2600
14	1970	2080.	.2800
15	1966	2000.	.3000
16	1984	1880.	.3200
17	1949	1870.	.3400
18	1955	1800.	.3600
19	1982	1700.	.3800
20	1985	1650.	.4000
21	1964	1640.	.4200
22	1954	1640.	.4400
23	1971	1520.	.4600
24	1952	1440.	.4800
25	1986	1430.	.5000
26	1947	1420.	.5200
27	1987	1290.	.5400
28	1973	1270.	.5600
29	1976	1250.	.5800
30	1983	1200.	.6000
31	1944	1160.	.6200
32	1981	1150.	.6400
33	1951	1110.	.6600
34	1946	1030.	.6800
35	1963	966.	.7000
36	1945	952.	.7200
37	1948	929.	.7400
38	1980	898.	.7600
39	1940	840.	.7800
40	1953	834.	.8000
41	1958	822.	.8200
42	1943	800.	.8400
43	1941	756.	.8600
44	1942	722.	.8800
45	1960	710.	.9000
46	1959	702.	.9200
47	1961	461.	.9400
48	1977	429.	.9600
49	1939	380.	.9800

TABLE A-16

CLEARWATER RIVER AT PLUMMER, MINNESOTA
MODIFIED FLOWS DUE TO THE CONNECTION CHANNEL

Date	Peak Instantaneous Flow CFS	Modified Flow CFS
August 10, 1944	1160	860
June 1, 1949	1870	1570
April 15, 1952	1440	1140
April 13, 1954	1640	1340
April 6, 1955	1800	1500
April 21, 1956	2240	1940
June 27, 1957	3570	3270
June 9, 1962	3640	3340
April 17, 1964	1640	1340
April 12, 1965	3620	3320
June 18, 1968	3000	2700
April 11, 1969	3630	3330
April 26, 1970	2080	1780
April 16, 1972	2550	2250
September 6, 1973	1270	970
April 1, 1976	1[illegible]	950
April 13, 1978	3270	2970
April 25, 1979	3940	3640
June 29, 1981	1150	850
June 27, 1987	1290	990

RANK AND ASSIGNED PLOTTING POSITIONS
INSTANTANEOUS PEAK DISCHARGE VALUES

MODIFIED FLOWS DUE TO THE CONNECTION
CHANNEL TO THE RED LAKE RIVER

CLEARWATER RIVER AT PLUMMER, MINNESOTA

RANK	WATER YEAR	FLOW, CFS	WEIBULL PLOT POS
1	1979	3640.	.0200
2	1950	3630.	.0400
3	1962	3340.	.0600
4	1969	3330.	.0800
5	1965	3320.	.1000
6	1957	3270.	.1200
7	1978	2970.	.1400
8	1975	2960.	.1600
9	1968	2700.	.1800
10	1974	2540.	.2000
11	1967	2470.	.2200
12	1972	2250.	.2400
13	1966	2000.	.2600
14	1956	1940.	.2800
15	1984	1880.	.3000
16	1970	1780.	.3200
17	1982	1700.	.3400
18	1985	1650.	.3600
19	1949	1570.	.3800
20	1971	1520.	.4000
21	1955	1500.	.4200
22	1986	1430.	.4400
23	1947	1420.	.4600
24	1964	1340.	.4800
25	1954	1340.	.5000
26	1983	1200.	.5200
27	1952	1140.	.5400
28	1951	1110.	.5600
29	1946	1020.	.5800
30	1987	990.	.6000
31	1973	970.	.6200
32	1963	966.	.6400
33	1945	952.	.6600
34	1976	950.	.6800
35	1948	929.	.7000
36	1980	898.	.7200
37	1944	860.	.7400
38	1981	850.	.7600
39	1940	840.	.7800
40	1953	834.	.8000
41	1958	822.	.8200
42	1943	800.	.8400
43	1941	756.	.8600
44	1942	722.	.8800
45	1960	710.	.9000
46	1959	702.	.9200
47	1961	461.	.9400
48	1977	429.	.9600
49	1939	380.	.9800

STAGE FREQUENCY

LOWER RED LAKE NEAR RED LAKE, MINNESOTA

A stage-frequency curve for Red Lake was developed for a previous study (Reference 9). That curve (Reference 10) was adopted for this report. A brief description follows.

Two frequency curves were developed for Red Lake to represent the annual peak stage and the maximum daily average stage. The annual peak stage curve curve represents stages that would occur from the temporary action of wind and seiches. The maximum daily curve should be used to determine storage or average trends. The upper end of the maximum daily curve was anchored at the design storm stage of 10.03 feet, (Probable Maximum Flood Stage). The annual peak curve was assumed to be one foot above this. Normal pool is at 5.0 feet and the operating band extends from 4.5 to 5.5 feet. The curves were plotted graphically. The rank and assigned plotting positions for the annual peak and maximum daily curve are listed in Tables A-18 and A-19 respectively. The curves are shown on Plate A-8. Stages for selected frequencies are listed in Table A-21.

Lower Red Lake Peak Stage Frequency Data
Gage zero is 1169.0 ft, adjustment of 1912

RANK	YEAR	DATE	STAGE	WEIBULL	
1	1950	25 JUN	9.53	1.92	Design Storm stage is 10.03 ft (PMF)
2	1947	10 JUN	8.25	3.85	
3	1943	3 JUN	8.23	5.77	
4	1975	11 JUL	8.03	7.69	Easement stage is 8.0 ft (70yr. event in
5	1945	1 JUN	7.84	9.62	operation manual, 1.43%)
6	1944	17 JUN	7.72	11.54	
7	1962	10 JUL	7.52	13.46	
8	1938	9 JUN	7.37	15.38	
9	1946	31 MAY	7.32	17.31	
10	1948	23 OCT	7.23	19.23	
11	1951	2 JUN	7.20	21.15	
12	1979	3 JUL	7.20	23.08	
13	1976	14 OCT	7.18	25.00	
14	1941	6 JUN	7.11	26.92	
15	1949	14 AUG	7.05	28.85	
16	1969	30 JUL	7.03	30.77	
17	1974	25 JUN	6.96	32.69	
18	1982	5 JUL	6.94	34.62	
19	1966	28 MAY	6.92	36.54	
20	1978	5 JUL	6.88	38.46	
21	1983	26 AUG	6.86	40.38	
22	1939	16 JUN	6.78	42.31	
23	1957	22 JUN	6.78	44.23	
24	1968	16 JUL	6.77	46.15	
25	1940	16 JUN	6.76	48.08	
26	1965	27 JUN	6.73	50.00	
27	1967	30 APR	6.73	51.92	
28	1963	1 OCT	6.70	53.85	
29	1970	10 JUN	6.69	55.77	
30	1942	17 MAY	6.56	57.69	
31	1955	8 JUL	6.40	59.62	
32	1964	26 SEP	6.33	61.54	
33	1972	25 MAY	6.33	63.46	
34	1973	2 SEP	6.23	65.38	
35	1954	10 JUL	6.13	67.31	
36	1952	15 JUN	6.10	69.23	
37	1953	2 SEP	6.05	71.15	
38	1960	1 SEP	6.04	73.08	
39	1958	22 OCT	5.97	75.00	
40	1959	20 JUL	5.97	76.92	
41	1956	28 AUG	5.95	78.85	
42	1981	2 AUG	5.94	80.77	
43	1971	19 JUN	5.88	82.69	
44	1980	31 OCT	5.85	84.62	
45	1961	25 MAY	5.83	86.54	
46	1937	23 SEP	5.67	88.46	
47	1977	19 MAY	5.21	90.38	Maximum Normal Pool stage is 5.5 ft
48	1936	16 JUN	4.65	92.31	NORMAL POOL STAGE IS 5.0 FT
49	1933	6 JUL	4.60	94.23	Minimum Normal Pool stage 4.5 ft
50	1935	13 JUN	4.36	96.15	
51	1934	25 JUN	3.90	98.08	

Crest elevation of spillway is 1169.6 feet.

Lower Red Lake Maximum Daily Stage Frequency Data

RANK	YEAR	DATE	STAGE	WEIBULL
1	1950	25 JUN	8.26	1.92
2	1975	11 JUL	8.03	3.85
3	1947	10 JUN	7.69	5.77
4	1945	1 JUN	7.54	7.69
5	1943	3 JUN	7.24	9.62
6	1962	12 AUG	7.18	11.54
7	1974	25 JUN	6.96	13.46
8	1968	23 OCT	6.91	15.38
9	1946	31 MAY	6.83	17.31
10	1951	2 JUN	6.82	19.23
11	1944	17 JUN	6.80	21.15
12	1966	27 MAY	6.80	23.08
13	1979	3 JUL	6.70	25.00
14	1963	1 OCT	6.69	26.92
15	1976	13 OCT	6.59	28.85
16	1941	7 JUN	6.58	30.77
17	1957	1 JUL	6.58	32.69
18	1965	12 JUN	6.49	34.62
19	1970	12 JUN	6.47	36.54
20	1969	2 JUN	6.43	38.46
21	1949	14 AUG	6.42	40.38
22	1942	17 MAY	6.34	42.31
23	1967	30 APR	6.27	44.23
24	1978	12 SEP	6.21	46.15
25	1972	29 MAY	6.19	48.08
26	1940	8 JUN	6.07	50.00
27	1982	20 MAY	6.06	51.92
28	1938	9 JUN	6.04	53.85
29	1952	2 MAY	5.93	55.77
30	1968	16 JUL	5.92	57.69
31	1973	29 SEP	5.85	59.62
32	1958	23 OCT	5.74	61.54
33	1954	27 JUN	5.70	63.46
34	1955	11 JUN	5.70	65.38
35	1964	27 JUN	5.66	67.31
36	1983	9 OCT	5.62	69.23
37	1980	18 NOV	5.61	71.15
38	1956	15 JUN	5.60	73.08
39	1939	16 JUN	5.52	75.00
40	1961	25 MAY	5.47	76.92
41	1981	14 JUL	5.37	78.85
42	1959	17 JUN	5.31	80.77
43	1971	31 MAY	5.30	82.69
44	1953	10 JUN	5.24	84.62
45	1960	1 SEP	5.08	86.54
46	1977	24 SEP	4.68	88.46
47	1933	7 JUN	4.52	90.38
48	1937	23 SEP	4.19	92.31
49	1934	25 JUN	3.88	94.23
50	1935	11 MAY	3.74	96.15
51	1936	29 MAY	3.04	98.08

SUMMARY

Table A-20 and A-21 contain a summary of the values adopted for this report. These values are estimates and are not intended to be used for design purposes.

TABLE A-20

SUMMARY OF DISCHARGE-FREQUENCY VALUES
RED LAKE, RED RIVER OF THE NORTH, AND CLEARWATER RIVER BASINS

Condition	Location	Eff. D. A. Sq. Mi.	Recurrence Interval (Years) Discharge (cfs) 2	5	10	25	50	100
Existing	Red Lake River at High Landing, MN 05075000	350	1550	2510	3040	3650	4050	4400
Modified Due To Remote Control Gates	Red Lake River at High Landing, MN 05075000	350	1400	2330	2700	3450	3900	4300
Modified Due To The Connection Channel	Red Lake River at High Landing, MN 05075000	350	1260	2250	2760	3370	3750	4050
Existing	Red Lake River at Crookston, MN 05079000	3330	7610	13800	18300	24000	28400	32600
Modified Due To Huot Dam	Red Lake River at Crookston, MN 05079000	3330	7610	10000	10000	10000	10000	10000
Existing	Red River Of The North At Grand Forks, ND 05082500	30100	15300	31700	45600	66300	84000	104000
Existing	Clearwater River At Plummer, MN 05078000	512	1490	2430	3100	3990	4670	5380
Modified Due To The Connection Channel	Clearwater River At Plummer, MN 05078000	512	1370	2230	2860	3720	4390	5100

TABLE A-21

SUMMARY OF STAGE-FREQUENCY VALUES
LOWER RED LAKE NEAR RED LAKE, MINNESOTA
GAGE ZERO = 1169 FEET, 1912 NGVD

Condition	Location	Eff. D. A. Sq. Mi.	Recurrence Interval (Years) Stage (Feet) 2	5	10	25	50	100
Existing Annual Peak Stages	Red Lake River Near Red Lake, MN 05074000	1950	6.7	7.2	7.8	8.6	9.2	9.8
Existing Annual Max. Mean. Daily	Red Lake River Near Red Lake, MN 05074000	1950	6.1	6.8	7.2	7.9	8.4	9.0

REFERENCES

1. Red Lake Watershed District, Connection Channel and Sayersville Impoundment Project, Project No. 559C026-7, January 1989.

2. U. S. Water Resources Council, Guidelines for Determining Flood Flow Frequency, Bulletin 17B, March 1982.

3. U. S. Army Corps of Engineers, The Hydrologic Engineering Center, Flood Frequency Analysis, Computer Program 723-X6-L7550, Davis, California, February 1982.

4. U. S. Army Corps of Engineers, The Hydrologic Engineering Center, Regional Frequency Computation, Computer Program 723-X6-L7350, July 1972.

5. U. S. Army Corps of Engineers, St. Paul District Skew Study, 1985.

6. U. S. Army Corps of Engineers, Red Lake River Basin Reconnaissance Report, December 1980.

7. U. S. Army Corps of Engineers, Red Lake River At Crookston, Minnesota, Reconnaissance Report, Appendix A, 1990.

8. U. S. Army Corps of Engineers, Open Files, Storage Box No. 950, Curves dated August 1972.

9. U. S. Army Corps of Engineers, Progress Report, 1986 Red Lake Operations Work, September 1986.

10. Disposition Form From NCS-ED-GH to NCS-PD-FS by Mark Ziemer, Subject: Red Lakes, Minnesota, Economic Damage Evaluation, dated 16 October 1986.

HYDRAULICS

CHANNEL MODIFICATIONS ON THE RED LAKE AND CLEARWATER RIVERS

GENERAL

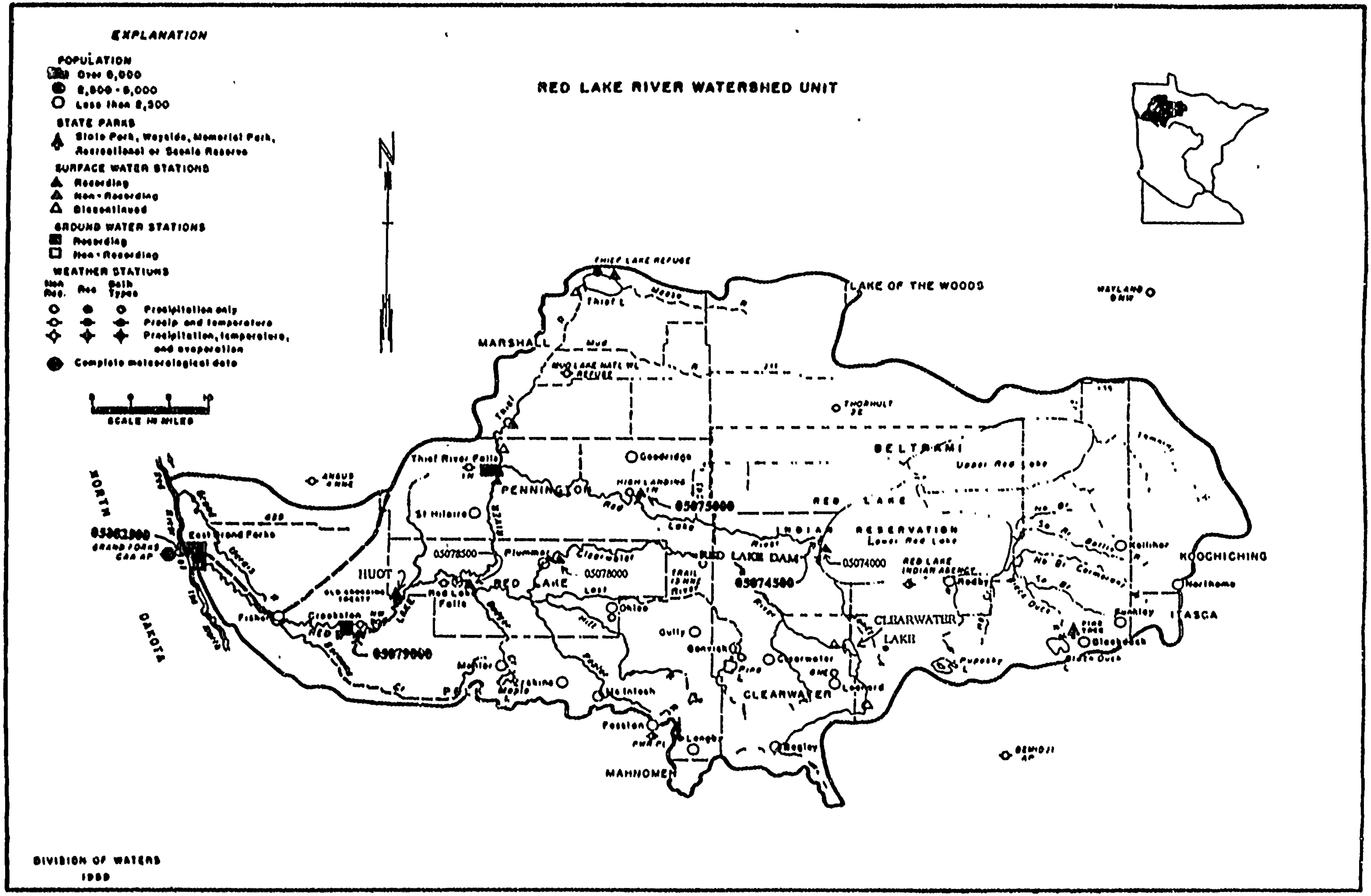
The evaluations of the existing floodplain topography, riverbed gradient, and acreage of productive lands on various reaches of the Red Lake and Clearwater Rivers were conducted. These evaluations and calculations revealed that only 2,220 acres are currently located in the floodplain of the 1-percent exceedence frequency (100-yr) flood along the Clearwater River. This is a small acreage and benefits attributable to improvements would be minor. For this reason, the remainder of the evaluations focused upon modifications for the Red Lake River.

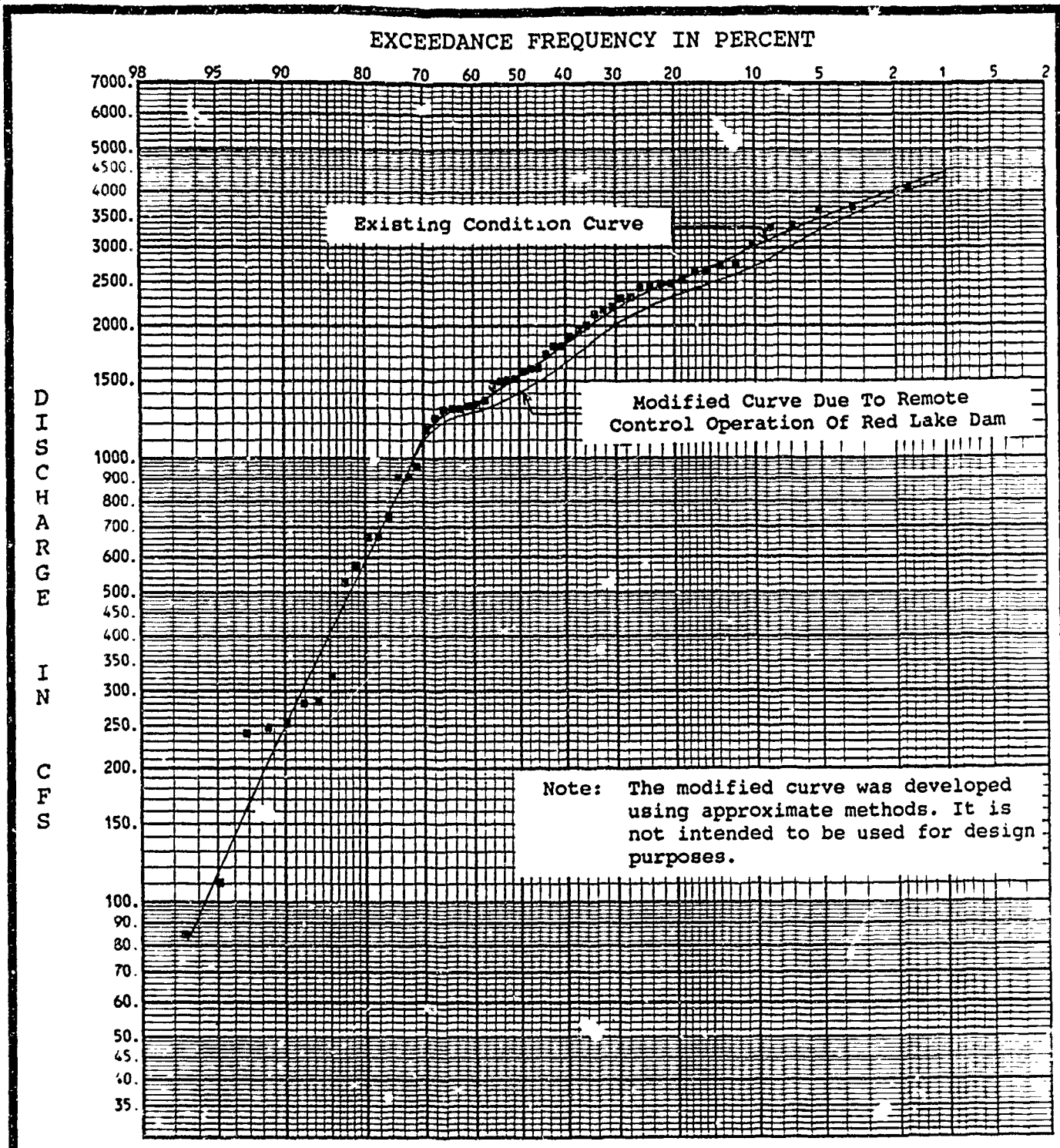
EXISTING CONDITIONS ELEVATION-DISCHARGE RATING CURVES

To determine the capacity of the existing channel, high water marks at several locations were used to determine an average slope for use in Manning's equation. An average slope of .00014 ft/ft was determined. A typical cross section was obtained from plans for a completed channel straightening and enlarging project on the Red Lake River. The existing channel used has a bottom width of 74 ft. with 1v on 2.5h side slopes. A Manning's 'n' value of 0.04 was selected for the channel. Using these values, a discharge of 1700 cfs was determined as the channel capacity. The High Landing gage is used to operate the Red Lake Dam. A gage reading of 8.75 is used for the crop season and 11.00 is used for the non-crop season. These gage readings correspond to discharges of 1650 and 2500 cfs respectively. Based on these numbers, the computed channel capacity of 1700 cfs is considered appropriate. Existing conditions elevation-discharge rating curves based on historic data are shown on Plates A-9 and A-10. The curve shown on Plate A-9 is at the U.S.G.S. gage at High Landing. The curve shown on Plate A-10 is at the Kratha bridge located about 10 miles downstream of High Landing.

MODIFIED CHANNEL ELEVATION-DISCHARGE RATING CURVES

An analysis was done to determine the reduction in flooding as the result of modifying the existing channel. Two different channel bottom widths were considered; a channel with a bottom width of 100 ft. and a channel with a bottom width of 125 ft. The same channel slope and Manning's 'n' value for the channel as existing conditions were used. The revised elevation-discharge rating curves for the two modified channel alternatives are shown on Plate A-9 along with the rating curve for the existing channel. Plate A-11 shows the channel capacity for various channel bottom widths. Plate A-12 compares the quantity of excavation required to the channel capacity disharge.


RED LAKE RIVER WATERSHED UNIT
EXPLANATION
POPULATION
Over 6,000
2,500 - 6,000
Less than 2,500
STATE PARKS
State Park, Wayside, Memorial Park, Recreational or Scenic Reserve
SURFACE WATER STATIONS
Recording
Non-Recording
Discontinued
GROUND WATER STATIONS
Recording
Non-Recording
WEATHER STATIONS
Precipitation only
Precip and temperature
Precipitation, temperature, and evaporation
Complete meteorological data
SCALE IN MILES
LAKE OF THE WOODS
MARSHALL
PENNINGTON
BELTRAMI
RED LAKE
INDIAN RESERVATION
CLEARWATER
KOOCHICHING
ITASCA
MAHNOMEN
NORTH DAKOTA
Thief River Falls
St Hilaire
Goodridge
Red Lake Falls
Crookston
East Grand Forks
Fisher
Plummer
Oklee
Gully
Clearwater
Bagley
Fosston
Mentor
Erskine
McIntosh
Lengby
Redby
Kelliher
Northome
Blackduck
Upper Red Lake
Lower Red Lake
RED LAKE DAM
HUOT
CLEARWATER LAKE
05075000
05074500
05074000
05078000
05078500
05079000
05082500
DIVISION OF WATERS
1959



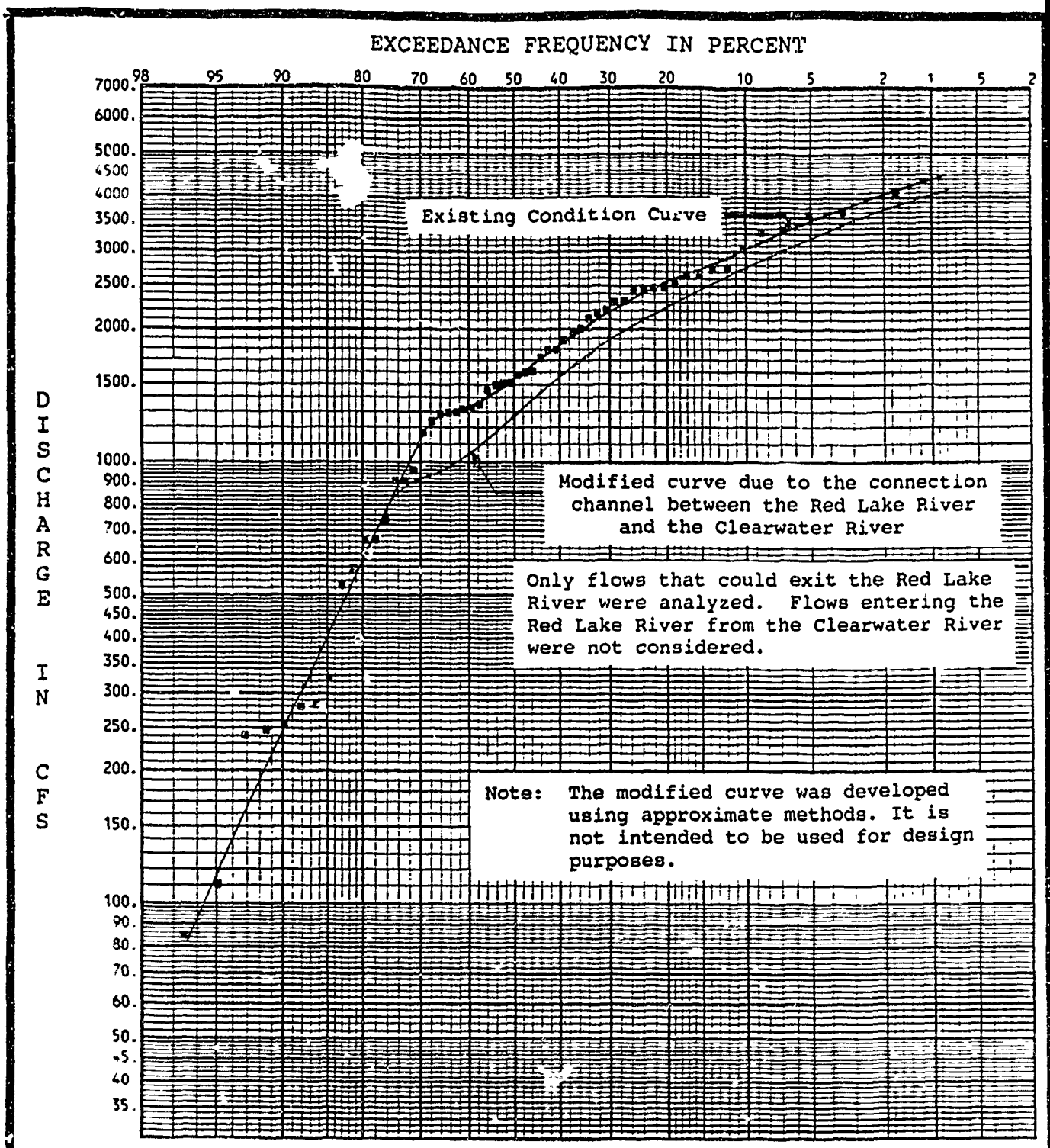
RED LAKE RIVER AT HIGH LANDING

GRAPHICAL ANALYSIS

DISCHARGE-FREQUENCY CURVE
WEIBULL PLOTTING POSITIONS

U.S.G.S GAGE No. 05075000
TOTAL DRAINAGE AREA = 2300 SQ. MI.
DRAINAGE AREA BELOW
RED LAKE DAM = 350 SQ. MI.
58 YRS. OF RECORD, 1930-1987

April 1991



RED LAKE RIVER AT HIGH LANDING

GRAPHICAL ANALYSIS

DISCHARGE-FREQUENCY CURVE
WEIBULL PLOTTING POSITIONS

U.S.G.S GAGE No. 05075000
TOTAL DRAINAGE AREA = 2300 SQ. MI.
DRAINAGE AREA BELOW
RED LAKE DAM = 350 SQ. MI.
58 YRS. OF RECORD, 1930-1987

April 1991

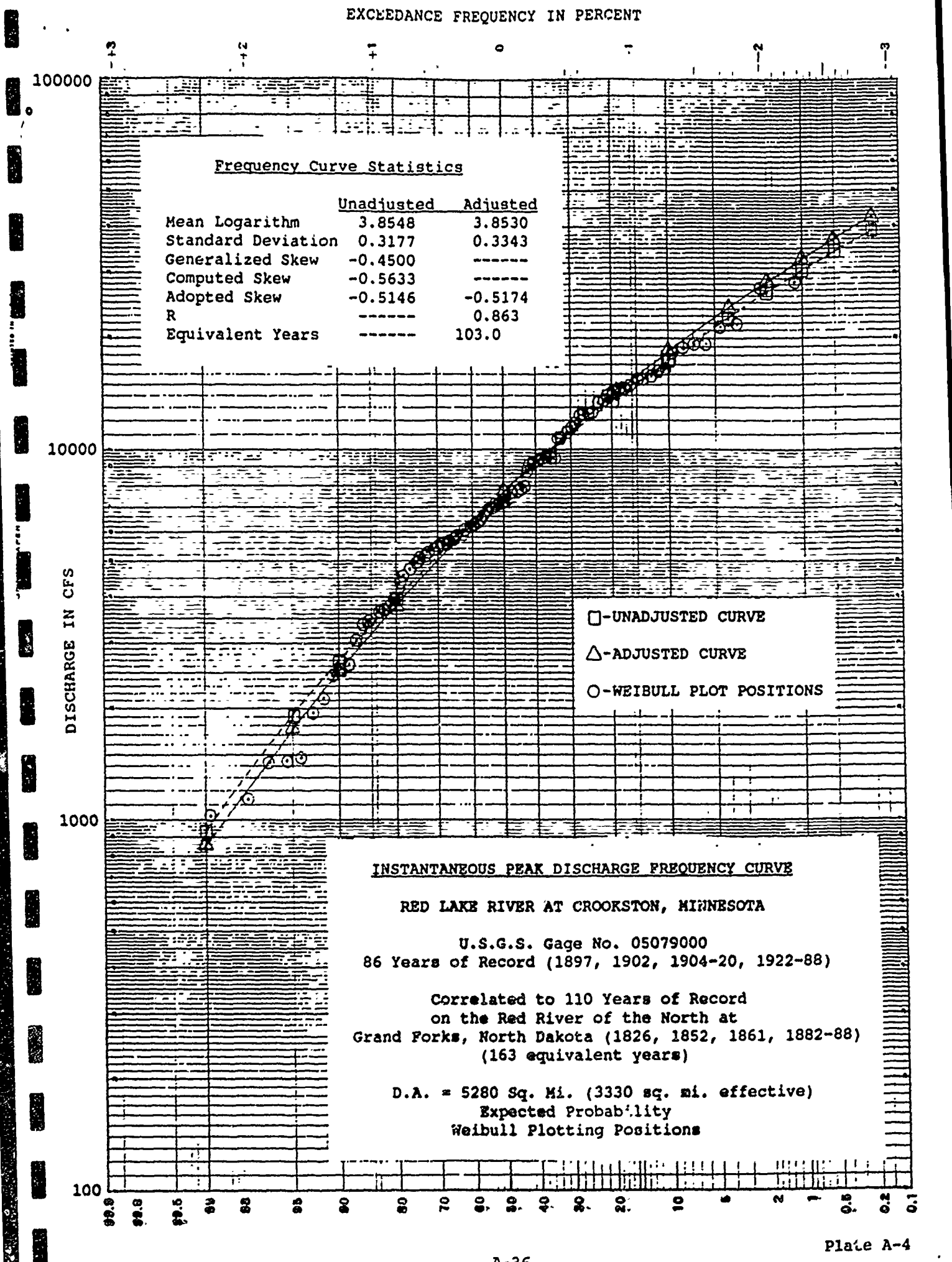
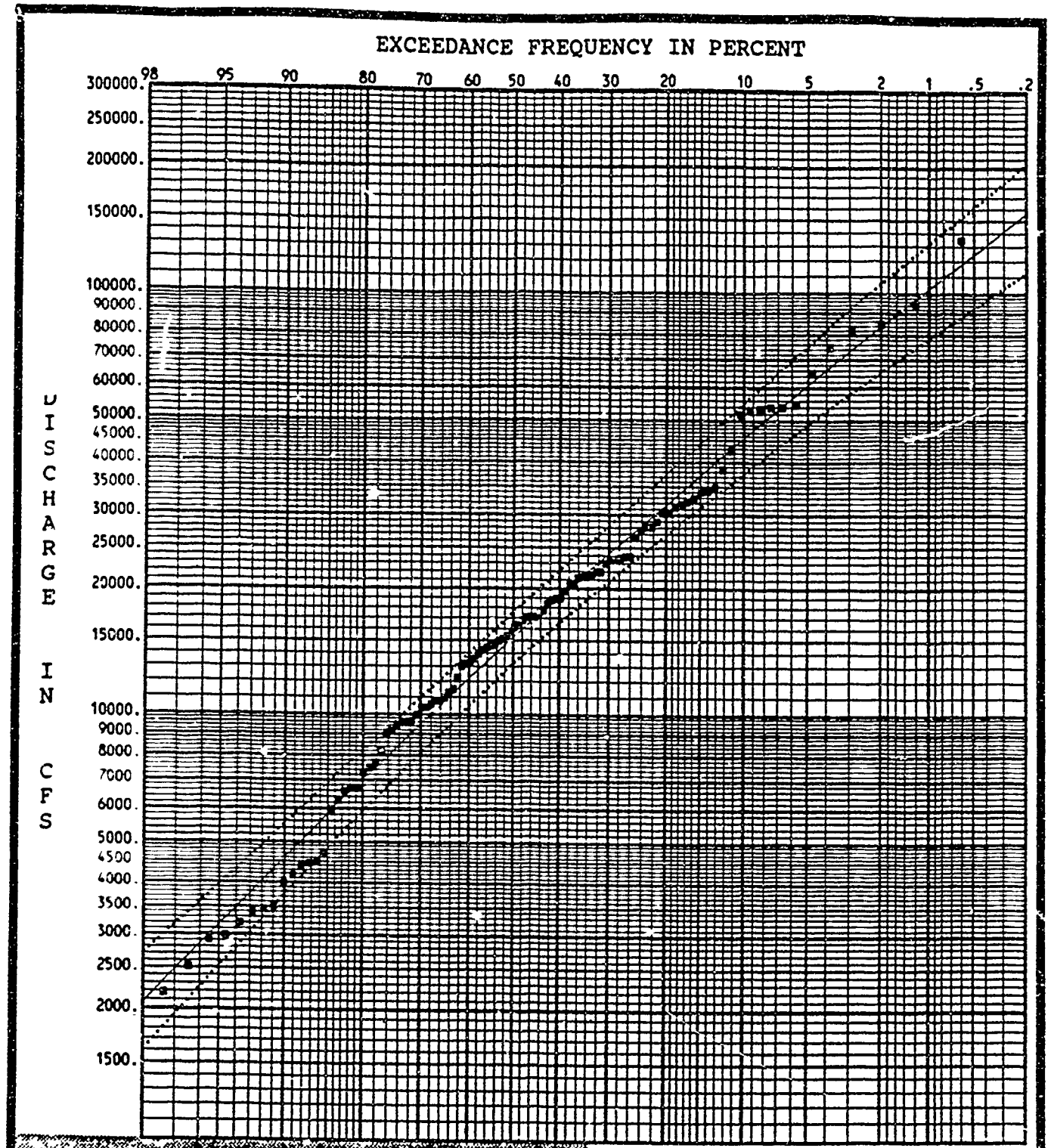

EXCEEDANCE FREQUENCY IN PERCENT
+3
+2
+1
0
-1
-2
-3
100000
10000
1000
100
DISCHARGE IN CFS
Frequency Curve Statistics
Unadjusted Adjusted
Mean Logarithm 3.8548 3.8530
Standard Deviation 0.3177 0.3343
Generalized Skew -0.4500 ------
Computed Skew -0.5633 ------
Adopted Skew -0.5146 -0.5174
R ------ 0.863
Equivalent Years ------ 103.0
□-UNADJUSTED CURVE
△-ADJUSTED CURVE
○-WEIBULL PLOT POSITIONS
INSTANTANEOUS PEAK DISCHARGE FREQUENCY CURVE
RED LAKE RIVER AT CROOKSTON, MINNESOTA
U.S.G.S. Gage No. 05079000
86 Years of Record (1897, 1902, 1904-20, 1922-88)
Correlated to 110 Years of Record
on the Red River of the North at
Grand Forks, North Dakota (1826, 1852, 1861, 1882-88)
(163 equivalent years)
D.A. = 5280 Sq. Mi. (3330 sq. mi. effective)
Expected Probability
Weibull Plotting Positions
99.8
99.5
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.5
0.2
0.1

Plate A-4

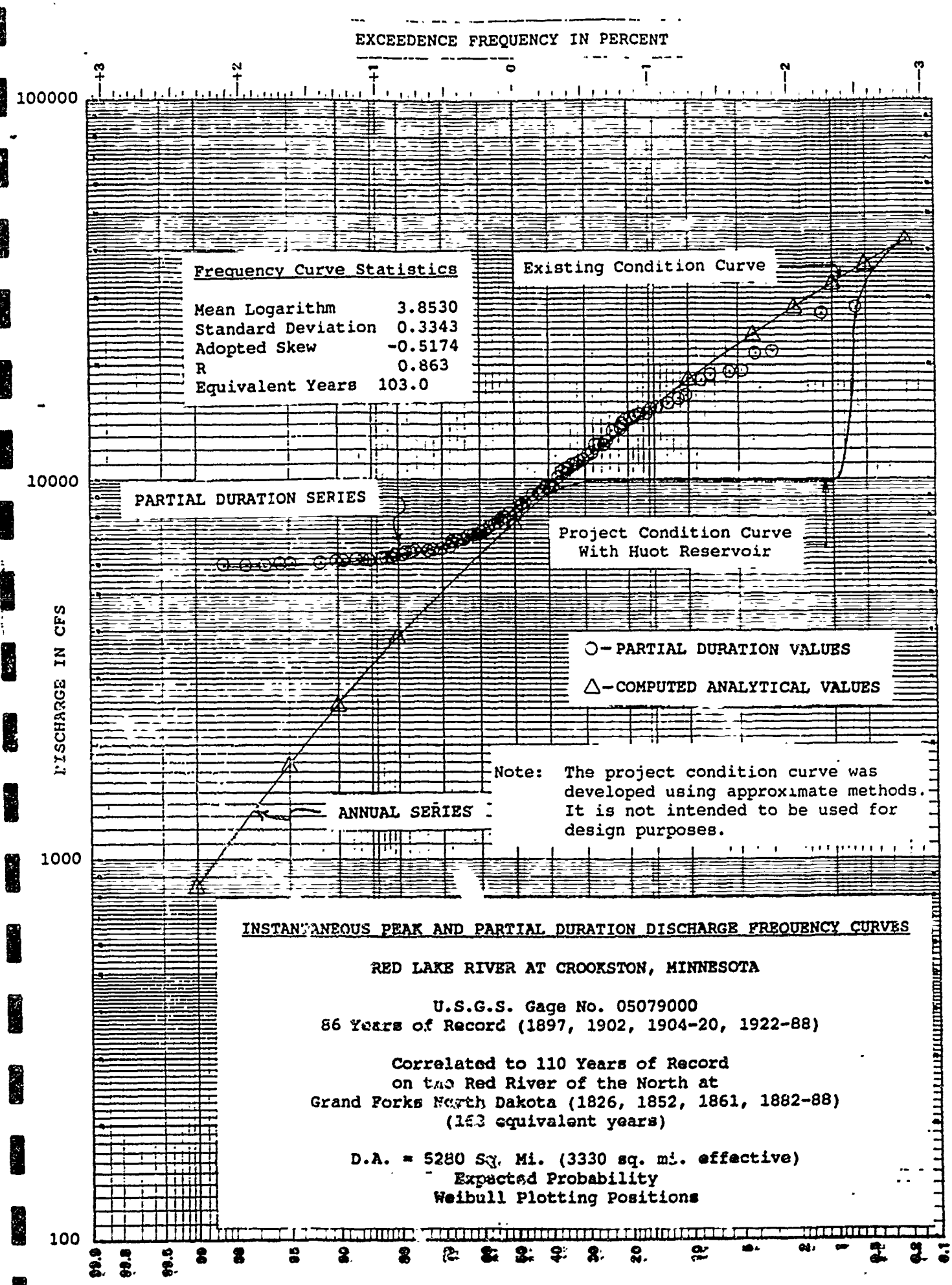


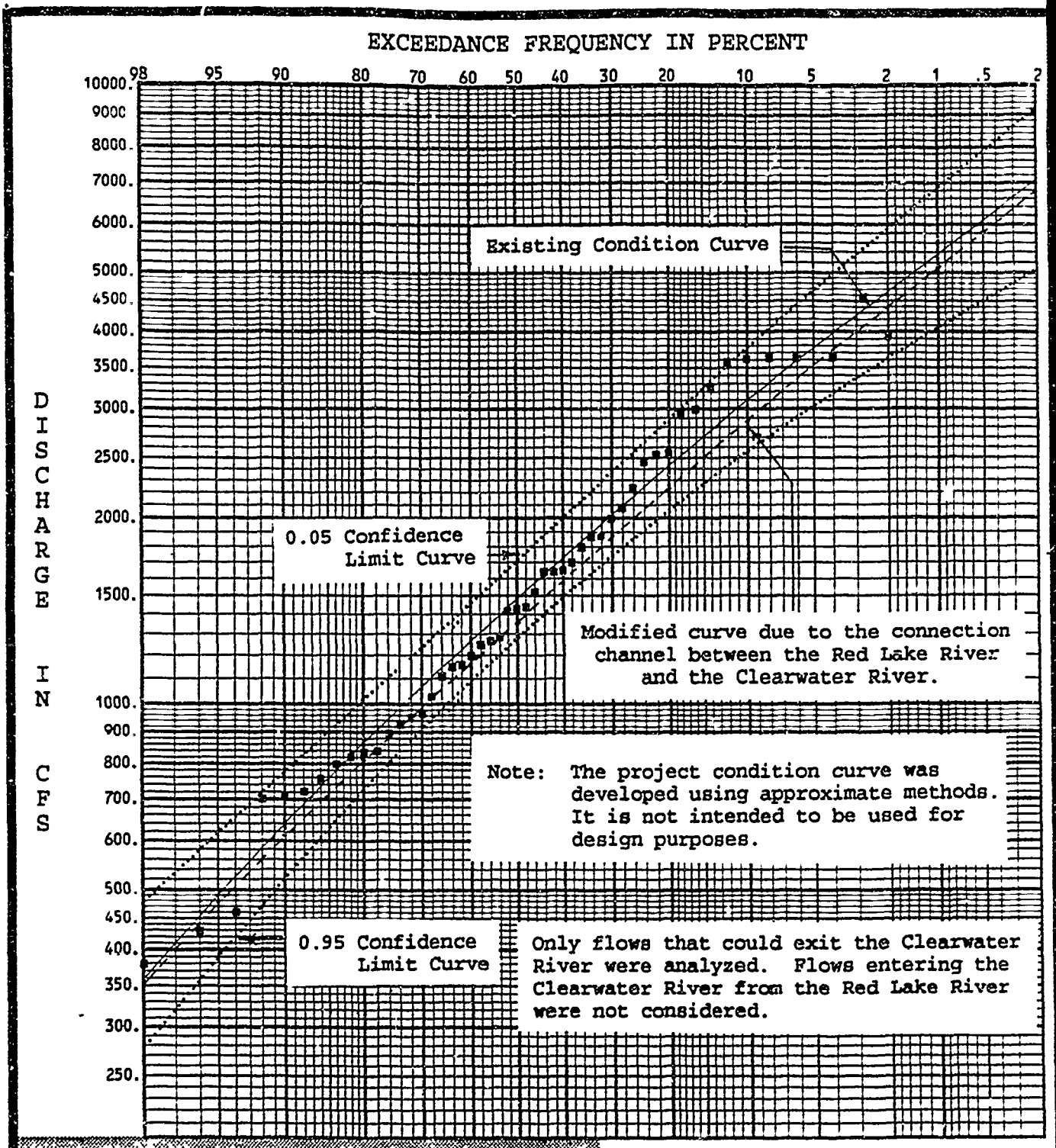
156000.	.002	MEAN LOGARITHM	4.1708
125000.	.005	STANDARD DEVIATION	.3853
104000.	.010	COMPUTED SKEW	-.2338
84000.	.020	GENERALIZED SKEW	-99.0000
66300.	.040	ADOPTED SKEW	-.2338
45600.	.100	HISTORIC EVENTS	2
31700.	.200	HIGH OUTLIERS	0
15300.	.500	LOW OUTLIERS	0
7060.	.800	ZERO OR MISSING	0
4600.	.900	SYSTEMATIC EVENTS	107
3180.	.950	HISTORIC PERIOD	162.
1540.	.990		

RED RIVER OF THE NORTH AT GRAND FORKS, NORTH DAKOTA

EXPECTED PROBABILITY
DISCHARGE-FREQUENCY CURVE
WEIBULL PLOTTING POSITIONS

U.S.G.S. GAGE No. 05082500
182(, 1852, 1861, 1882-1988
D.A.=30100 SQ. MI.


EXCEEDENCE FREQUENCY IN PERCENT
+3
+2
+1
0
-1
-2
-3
100000
10000
1000
100
DISCHARGE IN CFS
Frequency Curve Statistics
Mean Logarithm 3.8530
Standard Deviation 0.3343
Adopted Skew -0.5174
R 0.863
Equivalent Years 103.0
Existing Condition Curve
PARTIAL DURATION SERIES
Project Condition Curve
With Huot Reservoir
○ - PARTIAL DURATION VALUES
△ - COMPUTED ANALYTICAL VALUES
ANNUAL SERIES
Note: The project condition curve was developed using approximate methods. It is not intended to be used for design purposes.
INSTANTANEOUS PEAK AND PARTIAL DURATION DISCHARGE FREQUENCY CURVES
RED LAKE RIVER AT CROOKSTON, MINNESOTA
U.S.G.S. Gage No. 05079000
86 Years of Record (1897, 1902, 1904-20, 1922-88)
Correlated to 110 Years of Record
on the Red River of the North at
Grand Forks North Dakota (1826, 1852, 1861, 1882-88)
(163 equivalent years)
D.A. = 5280 Sq. Mi. (3330 sq. mi. effective)
Expected Probability
Weibull Plotting Positions

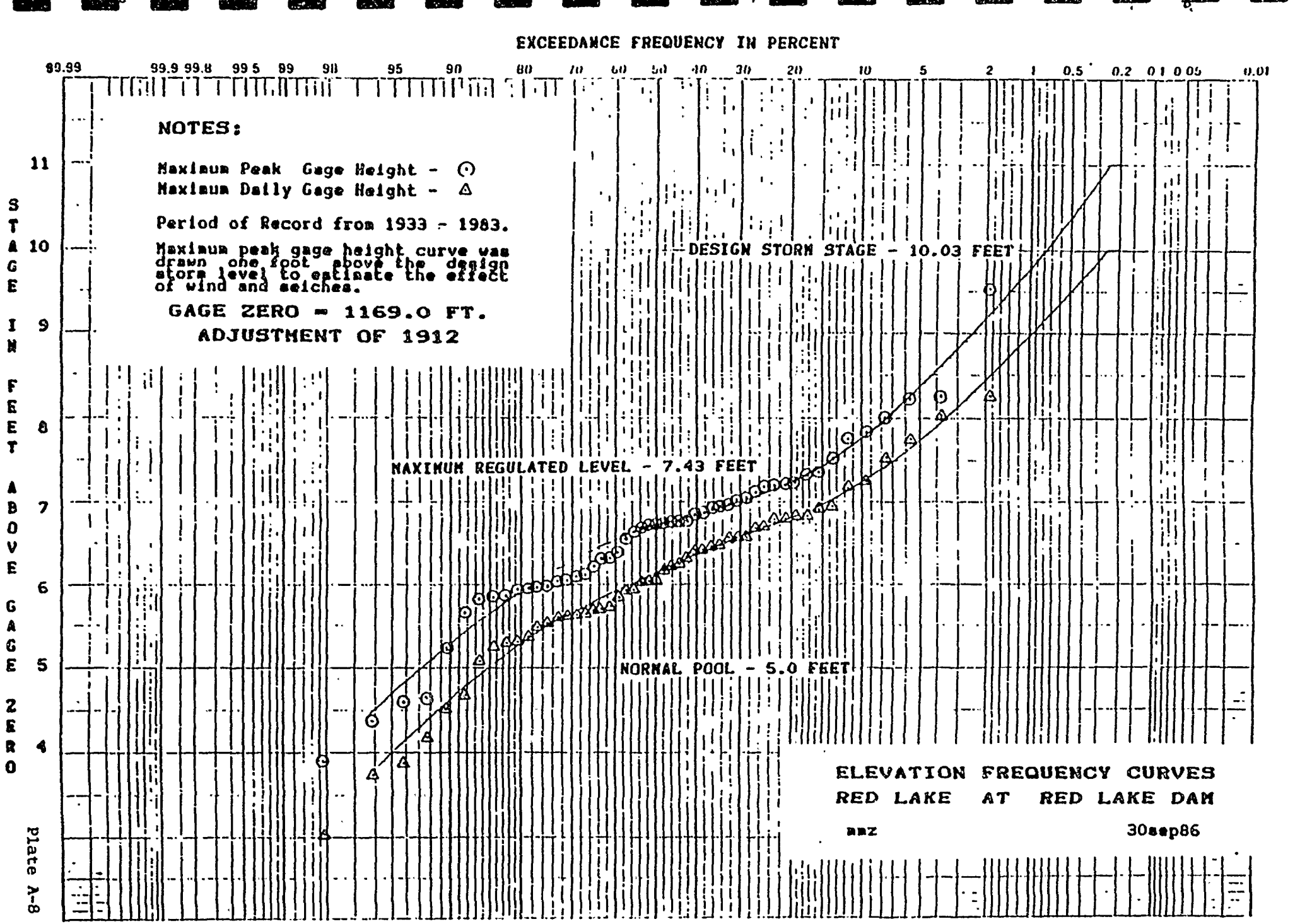


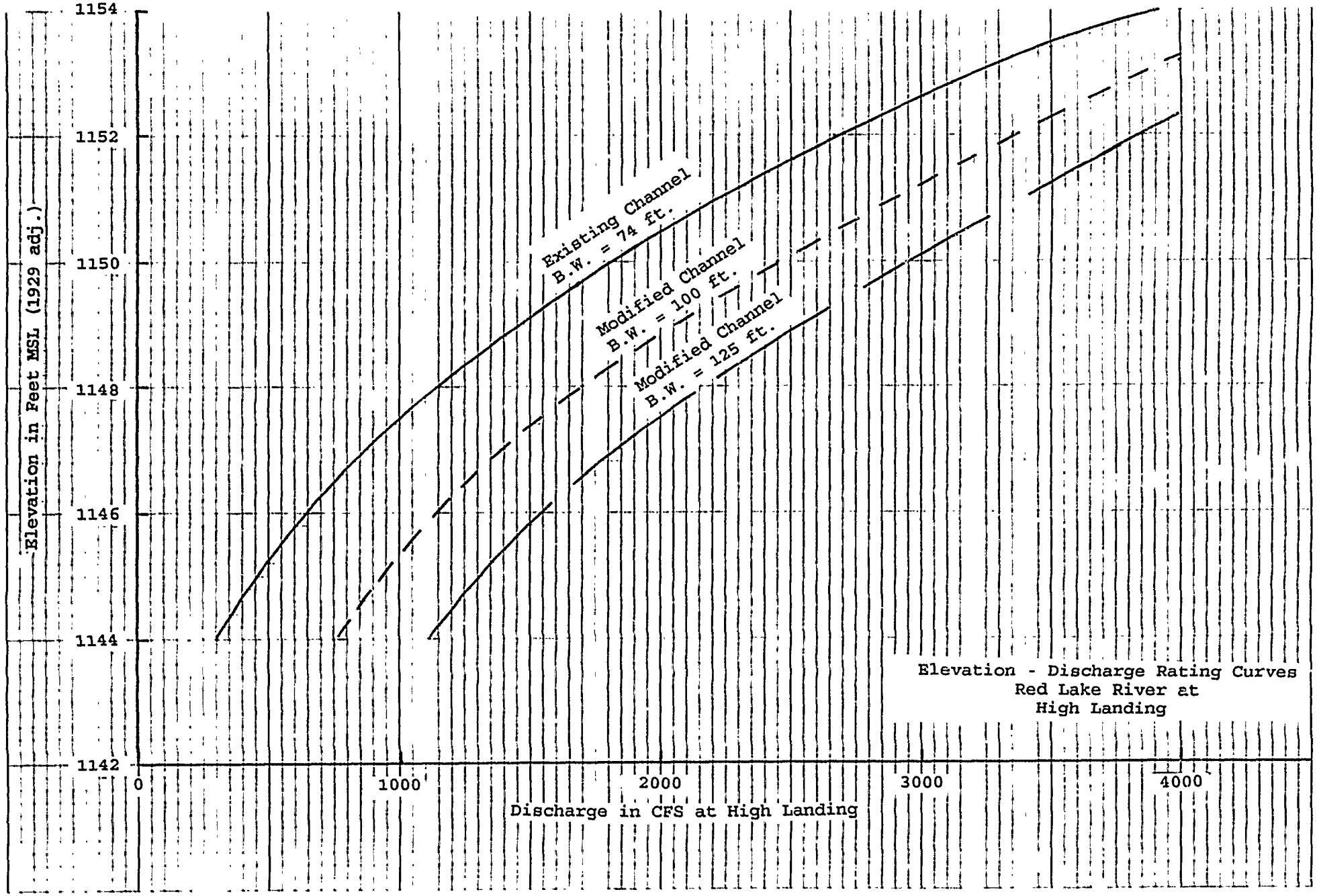
7090.	.002	MEAN LOGARITHM	3.1588
6100.	.005	STANDARD DEVIATION	.2618
5380.	.010	COMPUTED SKEW	-.1092
4670.	.020	GENERALIZED SKEW	-.4400
3990.	.040	ADOPTED SKEW	-.3000
3100.	.100	HISTORIC EVENTS	0
2630.	.200	HIGH OUTLIERS	0
1490.	.500	LOW OUTLIERS	0
868.	.800	ZERO OR MISSING	0
641.	.900	SYSTEMATIC EVENTS	49
492.	.950		
287.	.990		

CLEARWATER RIVER AT PLUMMER, MINNESOTA

EXPECTED PROBABILITY
DISCHARGE-FREQUENCY CURVE
WEIBULL PLOTTING POSITIONS

USGS ID Number 05078000
Drainage Area = 512 sq. mi.
N = 49 yrs., 1939-1987


EXCEEDANCE FREQUENCY IN PERCENT
99.99
99.9
99.8
99.5
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
NOTES:
Maximum Peak Gage Height - ⊙
Maximum Daily Gage Height - △
Period of Record from 1933 - 1983.
Maximum peak gage height curve was drawn one foot above the design storm level to estimate the effect of wind and seiches.
GAGE ZERO = 1169.0 FT.
ADJUSTMENT OF 1912
DESIGN STORM STAGE - 10.03 FEET
MAXIMUM REGULATED LEVEL - 7.43 FEET
NORMAL POOL - 5.0 FEET
STAGE IN FEET ABOVE GAGE ZERO
11
10
9
8
7
6
5
4
ELEVATION FREQUENCY CURVES
RED LAKE AT RED LAKE DAM
amz
30sep86
Plate A-8



Elevation - Discharge Rating Curves
Red Lake River at
High Landing

Plate A-9

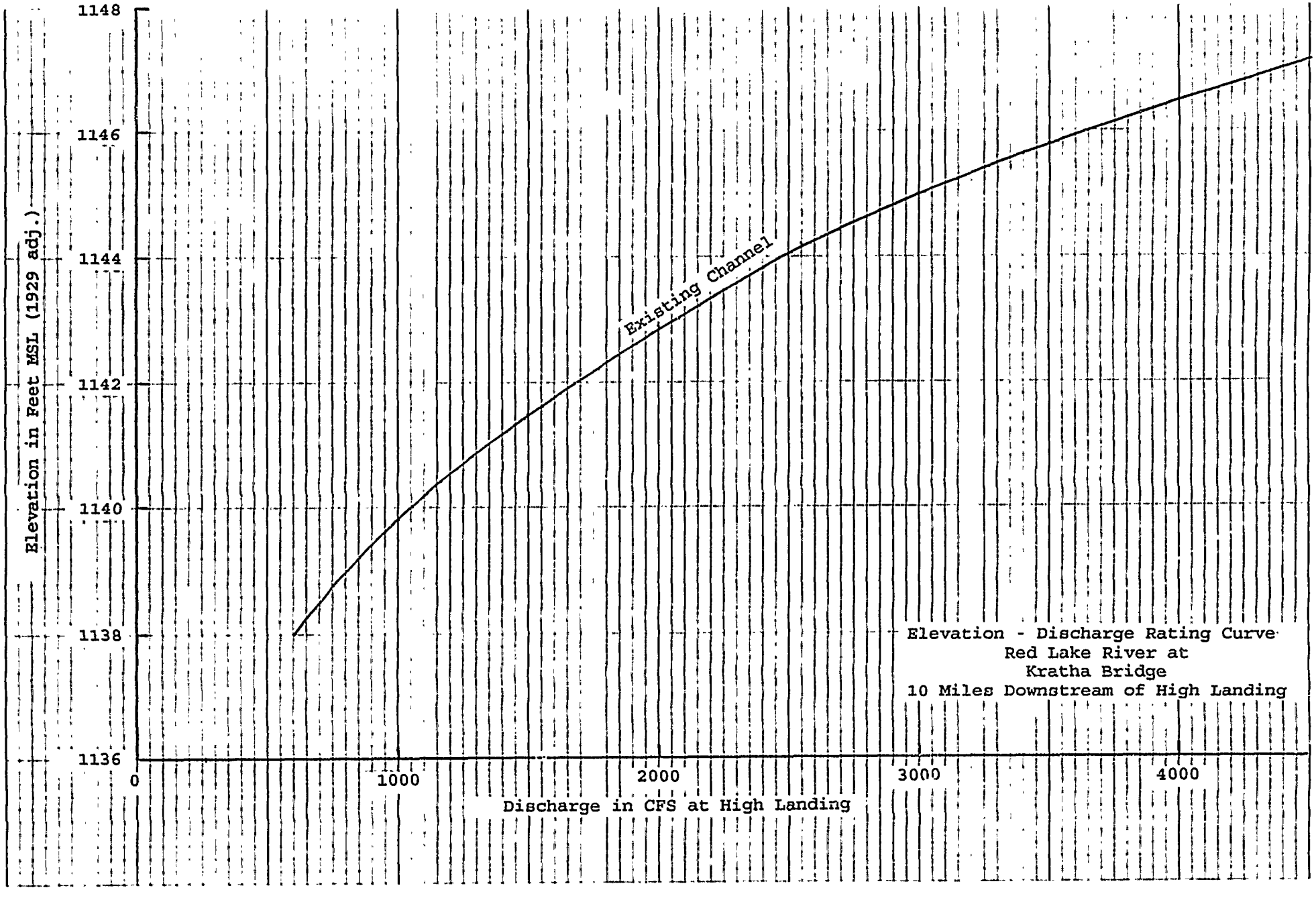

1148
1146
1144
1142
1140
1138
1136
Elevation in Feet MSL (1929 adj.)
Existing Channel
0
1000
2000
3000
4000
Discharge in CFS at High Landing
Elevation - Discharge Rating Curve
Red Lake River at
Kratha Bridge
10 Miles Downstream of High Landing

Plate A-10

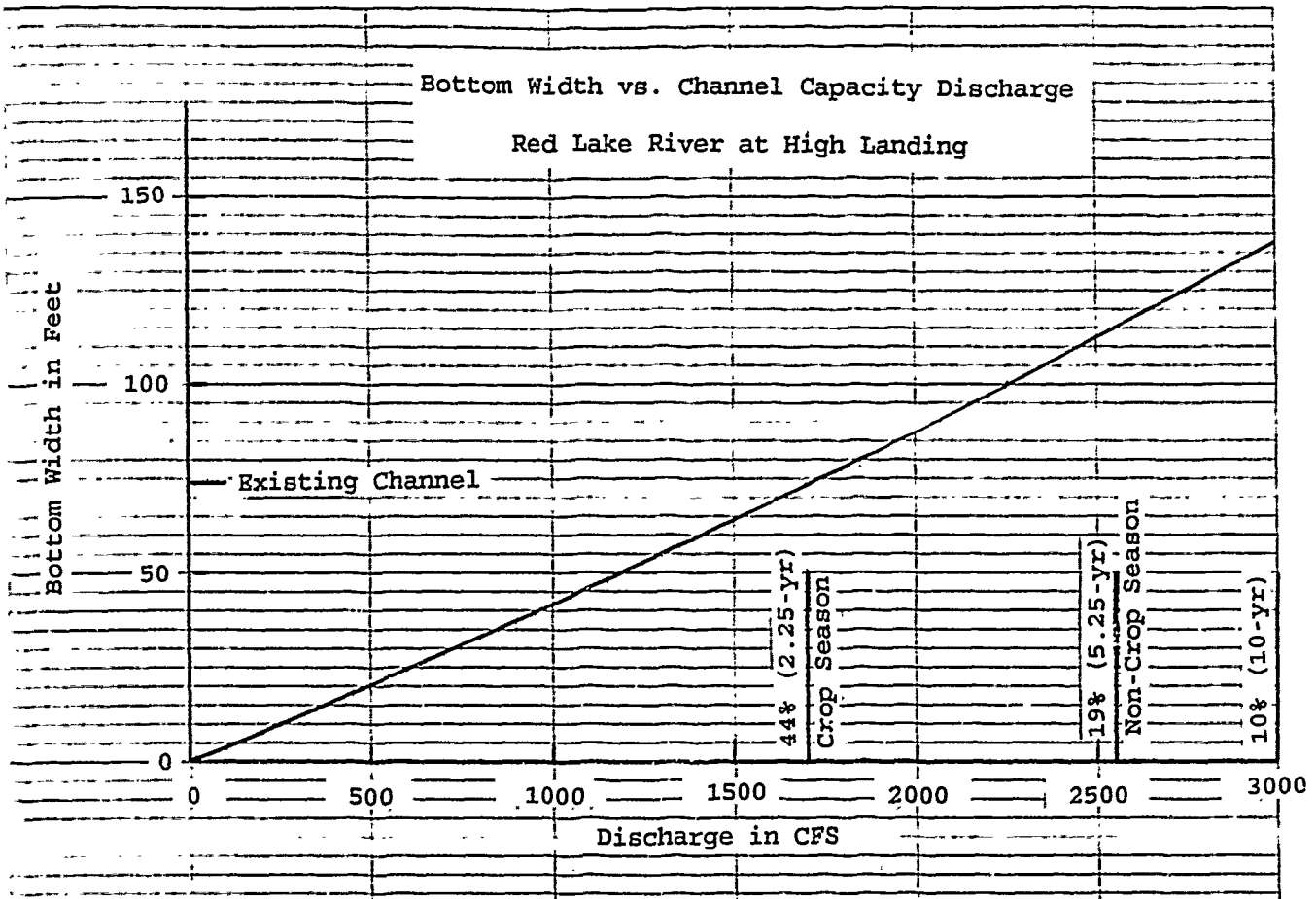


Plate A-11

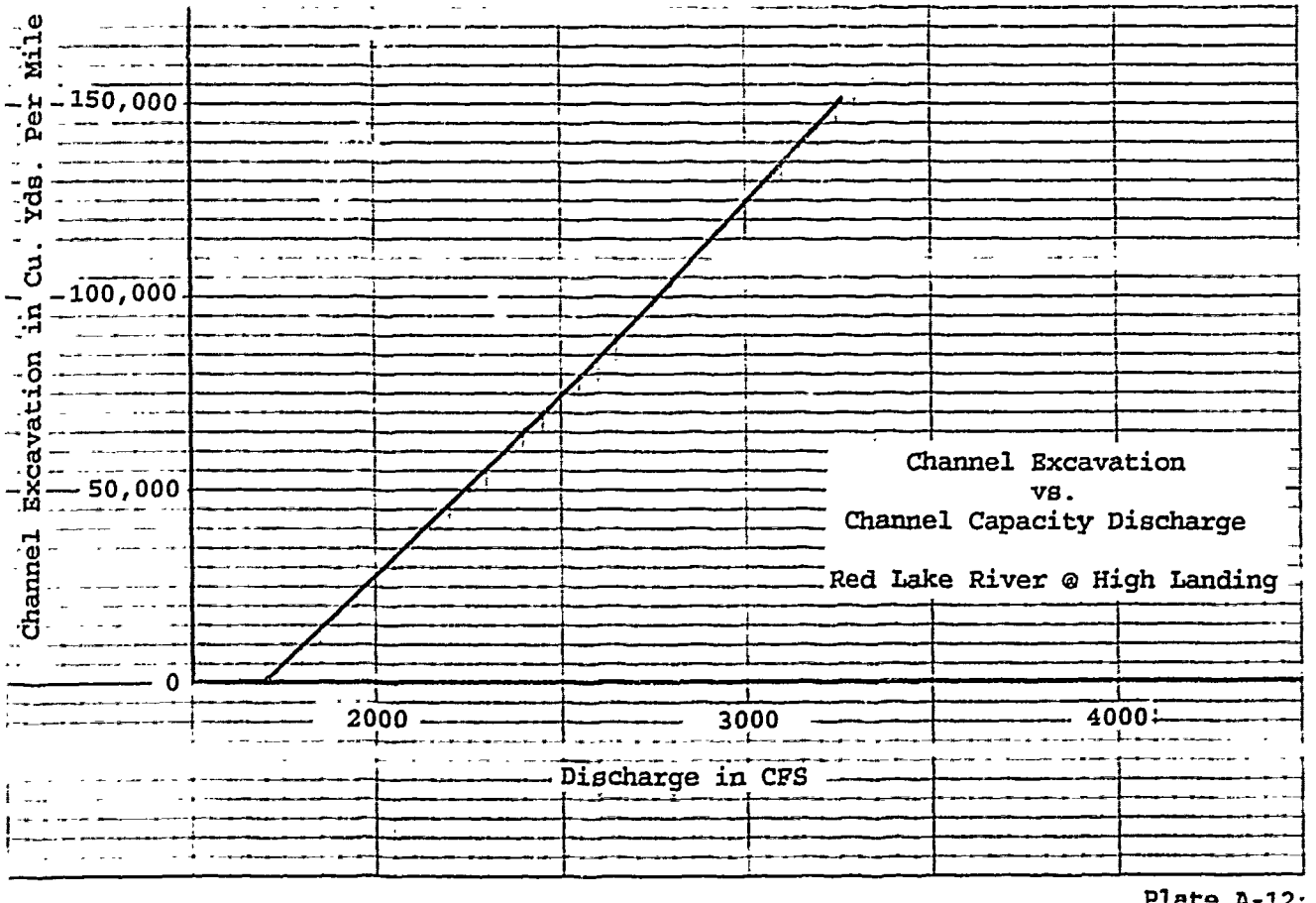


Plate A-12

WORKING PAPERS (APPENDICES)

Appendix B - Economic & Social

APPENDIX B

ECONOMIC ANALYSIS

1. Introduction: This is a report on the Red Lake and Clearwater Rivers Reconnaissance Study Economic Analysis. This report was completed in July 1991 using the current applicable interest rate of 8 3/4 percent to annualize project benefits and costs.

2. Study Purpose: The study evaluates the economic impacts of various flood control projects and related project purposes such as recreation, hydropower, and environmental enhancement in the Red Lake River watershed.

3. Study Area: The study area consists of the entire length of the Red Lake River from its mouth at the Red River of the North in East Grand Forks to the source at Red Lake, and the Clearwater River from its mouth at the Red Lake River in Red Lake Falls to its source.

4. Primary Study Area: The primary study area is along both rivers starting from the western portion of the Red Lake Indian Reservation downstream to, but not including, Crookston.

5. Social Profile:

a. Study Area: The study area for the Red Lake and Clearwater River basins includes Clearwater, Pennington, and Red Lake Counties of Minnesota. Located in the northwest quadrant of Minnesota, these rural counties are approximately 240 miles northwest of the Twin Cities area and approximately 50 miles east of Grand Forks, North Dakota. Also included in this area is the Red Lake Indian Reservation. These boundaries of the study area encompass over 80,000 square miles.

b. Population: The population of the study area was 26,140 as of 1990. Pennington County had the largest population with 13,300 people. Clearwater County had 8,300 people and Red Lake County had 4,500 people. The aggregate population declined 11.4 percent from 1980, after an increase of 10.6 percent from 1970 to 1980. The projections for the next 5 years anticipate small gains in Clearwater County and Red Lake County, and a larger loss in Pennington County, resulting in a net loss for the study area. Additional information is included in table 1 (Population Trend), table 2 (Population by Age), table 3 (Population by Race), and table 8 (Housing Units).

c. Employment: The labor force in the study area numbered approximately 12,000 workers as of 1990. The chief industries are Farming, Fisheries, Forestry and Mining; Retail Sales; and Education. Approximately 45 percent of those employed work in

these three industries. The unemployment rate in the study area has been high over the past decade. Each of the three counties has had annual unemployment rates much above the State average. The unemployment rates for Clearwater and Red Lake Counties have ranged from 13 percent to 20 percent, while Pennington County has had unemployment rates from 6 percent to 12 percent. The State unemployment rate has ranged from 4 percent to 8 percent during the same period. Data from 1980 to 1989 can be found in table 7 (Annual Unemployment Rates).

d. Income: Per capita income for the study area has increased at an average annual rate of 4.9 percent over the past decade, while average household income has increased at an average annual rate of 4.5 percent. Both of these rates of increase are less than the average for the State of Minnesota, where per capita income increased at an average annual rate of 6.4 percent and average household income increased at an average annual rate of 5.8 percent. Refer to table 4 (Per Capita Income Trend) and table 5 (Household Income Trend) for additional information. Table 6 (Persons Living in Poverty) shows that 15.6 percent of all people in the study area live below the federally-set poverty line. In Clearwater and Red Lake Counties, one in five people lives in poverty.

6. Existing Conditions - Agricultural Damages

a. In the study area, the primary complaint is agricultural flooding along the Red Lake River, particularly in the area of High Landing. In order to evaluate the potential benefits, data on the extent of riverine flooding was determined by constructing discharge-area flooded maps of the Red Lake and Clearwater River floodways. The hydraulic engineer provided rating curves at various locations on both rivers, from which area flooded maps were drawn on U.S. Geological Survey (USGS) topographic maps with 5-foot contour intervals. This information was deemed reliable enough for screening purposes for projects that would provide reductions in flooding along either river. Plate 1 is a discharge-area flooded curve for the Red Lake River, downstream of the dam on Red Lake to Red Lake Falls. Plate 2 is a discharge-area flooded curve of the Clearwater River from the border of Clearwater County to its confluence with the Red Lake River at Red Lake Falls. Plates 3 and 4 are frequency-area flooded curves for the Red Lake and Clearwater Rivers, respectively, under existing conditions. Each alternative was analyzed comparing the annualization of the existing frequency-area flooded curve with the modified frequency-area flooded curve to determine benefits. Table 9 shows the input used to determine the benefits for each alternative.

b. For initial screening purposes, it was assumed that 30 percent of the acres flooded from a 5-year event would be forested floodplain and wetlands that would not be damaged by flooding. This assumption is based on observations of the flooded area map

for this event. It was also assumed that increases in flooding would affect only agricultural land.

c. Composite agricultural damages are $75 per acre in October 1991 prices and were based on similar reports in the area in which the same general crop mix is grown with approximately the same yields. This figure includes damages to stored grain, machinery, fences, private roads and ditches, as well as the associated damages of reduced crop yields.

d. Existing average annual agricultural damages are $173,000 on the Red Lake River in the study area. Existing average annual damages are $38,000 along the Clearwater River (See table 9 for a summary of all of the alternatives). This is consistent with the Reconnaissance Report: Red River of the North Basin, Red Lake River Sub-Basin, prepared by Gulf South Research Institute for the St. Paul District, which indicated that there are $326,500 (updated to current price levels) in agricultural damages for the entire Red Lake River basin.

7. Evaluation of Alternatives:

a. The following is a list of the alternatives considered for this report.

Alternative 1 - Red Lake and Clearwater Rivers Connection Channel

Alternative 2a - Lower Red Lake Control Structure Modifications to Automate Operation of Gates

Alternative 2b - Lower Red Lake Control Structure Modifications Including Automation and Addition of a 4th Gate

Alternative 3 - Thief River Falls Lake Restoration

Alternative 4 - Channel Improvements on Red Lake and Clearwater Rivers

Alternative 5 - Marsh Restoration Below Lower Red Lake

Alternative 6 - Upstream Storage Plan

b. No economic evaluation was done for alternatives 3, 5 and 6 for this report. See the main report for a discussion of why these were eliminated prior to analysis. See table 10 for a comparison of the remaining alternatives.

c. Evaluation of Alternative 1 - Red Lake and Clearwater Rivers Connection Channel.

(1) The proposed connection channel would run along the border of the Red Lake Indian Reservation and would potentially

reduce flood stages on both the Red Lake and Clearwater Rivers. The connection channel would have the ability to transfer water in either direction, depending upon which river was higher, presumably from the river in flood stage to the other river with a lower stage. It also would have the potential to increase flood stages on either river if the receiving river was already at flood stage when water was being diverted.

(2) A report was prepared by the engineering firm of Widseth Smith Nolting & Assoc., Inc. entitled Connection Channel and Sayersville Impoundment Project, January 1989. The report stated that the proposed diversion would provide benefits from reduced flood damages along both rivers, improved water supply on both rivers, increased recreation opportunities, and more efficient hydropower generation at the Thief River Falls plant, among others. The report quantified these benefits qualitatively without economically comparing project costs with benefits. The current analysis attempts, where possible, to economically quantify benefits in relation to the costs.

(3) The proposed connection channel would divert water from the river with the higher relative flood stage to the one with the lower relative stage. In order to quantify the benefits, the frequency-discharge curves were constructed for both rivers, assuming that the other river would be fully capable of receiving all the water the diversion structure would be capable of delivering. In this way, the best possible scenario was evaluated. Table 9 shows the various discharges and associated acres flooded that would be affected with and without the connection channel in place. The connection channel would provide an average annual reduction of 561 acres on the Red Lake River and 28 acres on the Clearwater River. This amounts to an average annual benefit of $44,500 from the potential reduction in flood damages along the rivers. Again, this number is somewhat overstated as it does not take into account the impact of potentially induced damages to the receiving river.

(4) The proposed connection channel would potentially allow increased discharges through the Lower Red Lake dam during periods in which the lake was higher than its regulatory band. Benefits of reduced flooding on the Red Lake would accrue from reduced flood damages around the lakes, particularly Upper Red Lake which starts receiving damages from high water when the lake reaches elevation 1176.0. Damages on the Red Lake Indian Reservation start at elevation 1177.0. The potential benefit was not quantified because the impact of being able to discharge an additional 300 cfs from the dam is very minimal. It would take 4 months to lower the lake 0.2 foot.

(5) Benefits from employing underemployed labor were not quantified. When amortized over the life of the project, these benefits would be relatively small and would not warrant the

detailed effort required to calculate them.

(6) Benefits from enhancing wild rice production along the Clearwater River as a result of increasing the potential water to be pumped into the rice paddies are primarily local and regional benefits. Currently, the 12,000 acres of wild rice grown along and near the Clearwater River depend on the river as a source of water. A major constraint to optimally using all of the paddies has been the lack of water in the river. The connection channel has the potential to provide additional water to the Clearwater River during periods when the Red Lake River is high and the Clearwater River is low. The potential for National Economic Development (NED) benefits from this category is limited because the reduced production resulting from lack of water in the Clearwater River can be made up in other rice producing regions. This is evidenced by the fact that the constraint on expansion of rice paddies is not a lack of water, but rather the economic conditions in the ricing industry. In addition, when there is not enough water to fill the paddies, several paddies may not be flooded and alternate crops can then be grown. This reduces the potential for net economic benefits.

(7) The report prepared by the consulting agency indicated that benefits would result from more efficient operation of the Thief River Falls hydropower dam by maintaining a more stable discharge in the range of 750 cfs. A consultation with the superintendent of utilities in Thief River Falls indicated that high water is not a problem for operation of the hydropower dam in Thief River Falls. The associated debris problem causes problems. Increases in flows as a result of diverting water from the Clearwater River to the Red Lake River were not believed to have a significant impact on hydropower generation.

(8) The diversion between the Red Lake River and the Clearwater River would provide some damage reduction as a result of reductions in flooding along both rivers. However, the net reduction as a result of induced damages is relatively very small in relation to the project costs. In addition, the project would provide some increment of benefit to several other minor categories, but the increment of benefit is so small as to not warrant the effort needed for calculation.

(9) First costs of this alternative are $2,017,000. Assuming a 50-year project life and the interest during construction on a 1-year project at an 8 3/4 percent discount rate, annual project costs are $186,900. Comparing this with the average annual benefits of $44,500 yields a benefit-cost ratio of 0.24. Therefore, this alternative is not economically feasible under current prices and conditions.

(10) As a result of the intense local interest in this alternative, additional benefits were analyzed, though the chances

for Federal interest were extremely remote. A description of the analysis and potential for additional benefits follows.

	BENEFIT CATEGORY	DESCRIPTION
1.	Flood reduction benefits:	Flood reduction benefits were quantified on the Red Lake and Clearwater Rivers in a manner that in all likelihood significantly overstated the benefits from this category. Flood damage reduction around Red Lake was not quantified because the abovementioned calculation showed that an additional discharge of 300 cfs would have an insignificant impact on lake levels.
2.	Hydropower benefits:	The potential for hydropower benefits was evaluated for this report. It was determined that the potential for improved hydropower generation as a result of this project was insignificant.
3.	Recreation benefits:	Recreation benefits were considered to balance out between the rivers when water was diverted from one to the other. (See the recreation appendix for a description of recreation benefits.) Therefore, no benefits were claimed for this category.
4.	Employment benefits:	Employing underemployed labor is a potential benefit category for this alternative because Red Lake and Clearwater Counties are labor surplus areas. When calculating employment benefits, only the portions of project costs associated with direct labor qualify as potential benefits. In addition, this number would be reduced to the portion that is actually going to employing unemployed workers during the construction of the project.

This number would then be amortized over the life of the project at the current interest rate. For example, if project first costs are $1,000,000 and 30 percent is paid out as wages, 15 percent of this $300,000 is being paid out to previously unemployed workers, yielding a total benefit of $45,000. When amortized over the life of the project at the current interest rate of 8 3/4 percent, this figure yields an annual benefit of $4,000. Calculating the actual numbers for this alternative would improve the benefit-cost ratio by only several percentage points.

5. Environmental enhancement: Environmental enhancement benefits are difficult to quantify under the best circumstances in which there is a clear and marked improvement in the environmental conditions of a particular area. In this situation, there is no clear and marked improvement in the with project condition as opposed to the without condition. There is a potential that this alternative would have negative environmental impacts; therefore, no benefits for this category were quantified for this report.

6. Water supply enhancement: The diversion channel has the potential to increase the supply of water going to the Clearwater River which has the potential for improving or increasing the production of wild rice grown in the area. When the water supply is low, the addition of water from the Red Lake River may facilitate increases in production of rice, presumably a higher value

crop. However, when the paddies cannot be filled, an alternative crop is grown, so the potential for benefits would be restricted to the difference in value of the crops. In the case of this alternative, 12,000 acres of rice are grown along the Clearwater River, and the constraint on development of additional rice paddies is not the lack of water, rather the low price of rice, according to a letter received from the local rice growers. This indicates that the difference between rice and the next best crop is rather small, which in turn indicates that potential benefits from this category are not significant.

7. Local benefits:

There is the potential for benefits that would not be considered national to accrue to the local economy. These would include the associated benefits from secondary impact generated as a result of increased business from increased (or maintaining) rice production. Here again, these benefits are limited to the difference between what the money would be spent on in the absence of the project. For example, if the rice growers grew small grains instead of rice, there would still be the local benefits associated with the production and processing of the alternate crop, though there would be a reduction in the processing of the rice crop. The benefit would be the difference in the two, presuming that processing rice generated more secondary income than processing small grain. Here again, the benefits are rather small in comparison with project costs.

d. Evaluation of Alternative 2a - Lower Red Lake Control Structure Modifications to Automate Operation of Gates.

(1) In the past, operation of the dam on Lower Red Lake has not always enhanced damage reduction downstream, because flows are discharged at relatively high rates when storm events in the area cause the local runoff to meet channel capacity. If the discharges from the dam were reduced or eliminated, the downstream flooding problem would be lessened. It is believed that automation of the gates would help increase the efficiency of operating the dam.

(2) Frequency-discharge curves for the with and without project conditions were constructed to quantify the benefits of this alternative (see the hydraulic appendix for detailed description and a display of the data). Table 9 shows the change in frequency of a given discharge at the control point at High Landing as a result of automating the operation of the dam. Average annual acres benefited are 428. The average annual benefits are $32,300.

(3) First costs of this alternative are $437,400. Assuming a 50-year project life and the interest during construction on a 1-year project at an 8 3/4 percent discount rate, annual project costs are $40,500. Comparing this with the average annual benefits of $32,500 yields a benefit-cost ratio of 0.80. Therefore, this alternative is not economically feasible under current prices and conditions.

(4) It was assumed that all of the monitoring equipment and changes to the dam were needed to realize the benefits of this alternative. However, any means of making the operation of the dam more responsive and efficient would realize some portion, if not all, of these benefits.

e. Evaluation of Alternative 2b - Lower Red Lake Control Structure Modifications Including Automation and Addition of a 4th Gate.

(1) This alternative is the same as 2a, except for making the fourth bay of the Lower Red Lake dam operational to facilitate additional discharges from the lake during high periods. Quantification of high water damages around the lake was done for a Rese voir Operation Plan Evaluation (ROPE) study in 1986 by the St. Paul District. However, these damages were not annualized for that report or for this one, as the limiting capacity is not the dam but rather the channel downstream of the dam.

(2) First costs of this alternative are $575,400. Assuming a 50-year project life and the interest during construction on a 1-year project at an 8 3/4 percent discount rate, annual project costs are $53,300. Comparing this with the average

annual benefits of $32,500 yields a benefit-cost ratio of 0.61. Therefore, this alternative is not economically feasible under current prices and conditions.

f. Evaluation of Alternative 4 - Channel Improvements on the Red Lake and Clearwater Rivers.

(1) Two alternatives to improve the efficiency of the Red Lake River channel to convey flood flows were analyzed, one with a 125-foot bottom width and one with a 100-foot bottom width. The amount of reduction in stage associated with a given volume of water is presented in the hydraulic appendix.

(2) To determine the benefits of this alternative, the frequency curve was modified by identifying the frequency of flood required with project conditions to obtain the same level of flooding at a particular point on the existing stage-frequency curve.

(3) First costs of the 100-foot bottom width channel are $1,790,000. Assuming a 50-year project life and the interest during construction on a 1-year project at an 8 3/4 percent discount rate, annual project costs are $165,800. Comparing this with the average annual benefits of $83,300 yields a benefit-cost ratio of 0.50. Therefore, this alternative is not economically feasible under current prices and conditions.

(4) First costs of the 125-foot bottom width channel are $3,513,000. Assuming a 50-year project life and the interest during construction on a 1-year project at an 8 3/4 percent discount rate, annual project costs are $325,500. Comparing this with the average annual benefits of $127,400 yields a benefit-cost ratio of 0.39. Therefore, this alternative is not economically feasible under current prices and conditions.

(5) Given the limited magnitude of flooding on the Clearwater River, 2,220 acres flooded for a 100-year event, it was determined that this alternative had a very limited chance for economic feasibility. As a result, the costs associated with this alternative and the magnitude of potential stage reductions were not calculated. Therefore, the benefits of this alternative could not be calculated. It is assumed that this alternative is economically infeasible because of the relatively small floodplain, and the high costs associated with channel modification.

8. Conclusions:

At this time, according to this analysis, there are no economically feasible alternatives to reduce the flooding and related problems in the Red Lake and Clearwater River basins.

TABLE 1: POPULATION TREND

County	1970	Percent Change	1980	Percent Change	1990	1994 Proj *
Clearwater	8013	9.3%	8761	-5.2%	8309	8423
Pennington	13266	15.0%	15258	-12.8%	13306	12524
Red Lake	5388	1.5%	5471	-17.3%	4525	4548
Total	26667	10.6%	29490	-11.4%	26140	25495

* Projections from ETIS — Environmental Technical Information System

TABLE 2: POPULATION BY AGE -- 1980 CENSUS

Age	Aggregate	Percent	Minnesota	Percent
< 5	2447	8.3%	307249	7.5%
5 - 9	2343	7.9%	296295	7.3%
10 - 14	2495	8.5%	333378	8.2%
15 - 19	2987	10.1%	399818	9.8%
20 - 24	2425	8.2%	393566	9.7%
25 - 29	2067	7.0%	363435	8.9%
30 - 34	1907	6.5%	313104	7.7%
35 - 44	3011	10.2%	449216	11.0%
45 - 54	2569	8.7%	380250	9.3%
55 - 59	1284	4.4%	189457	4.6%
60 - 64	1387	4.7%	170638	4.2%
65 - 74	2475	8.4%	270148	6.6%
75 +	2093	7.1%	209416	5.1%
Total	29490	100.0%	4075970	100.0%

TABLE 3: POPULATION BY RACE -- 1990 CENSUS

Race	Aggregate	Percent
White	25238	96.5%
Native American	741	2.8%
Asian	61	0.2%
Black	13	0.0%
Other	87	0.3%
Total	26140	100.0%

TABLE 4: PER CAPITA INCOME TREND

County	1979	Percent Change	1989 Est	1994 Proj *
Clearwater	4437	76.0%	7808	9606
Pennington	6206	60.0%	9931	11723
Red Lake	4674	52.2%	7114	8223
Aggregate	5396	62.0%	8739	10399
Minnesota	7451	84.8%	13770	17445

* Projections from ETIS — Environmental Technical Information System

TABLE 5: HOUSEHOLD INCOME TREND

County	1979	Percent Change	1989 Est	1994 Proj *
Clearwater	12786	77.7%	22727	28288
Pennington	17206	47.8%	25436	28876
Red Lake	13938	50.1%	20920	24215
Aggregate	15388	55.1%	23861	27937
Minnesota	20727	74.5%	36174	44525

* Projections from ETIS — Environmental Technical Information System

TABLE 6: PERSONS LIVING IN POVERTY -- 1980 CENSUS

County	Persons	Percent
Clearwater	1884	21.5%
Pennington	1665	10.9%
Red Lake	1058	19.3%
Total	4607	15.6%

TABLE 7: ANNUAL UNEMPLOYMENT RATES *

Year	Clearwater	Pennington	Red Lake	Minnesota
1980	16.9%	11.8%	15.6%	5.9%
1981	16.0%	11.9%	13.3%	5.5%
1982	17.8%	9.6%	15.9%	7.8%
1983	18.5%	10.0%	16.3%	8.2%
1984	19.2%	9.2%	17.7%	6.3%
1985	16.9%	9.5%	17.4%	6.0%
1986	16.4%	8.0%	19.2%	5.3%
1987	16.4%	8.6%	18.1%	5.4%
1988	13.0%	6.8%	14.5%	4.0%
1989	13.8%	6.6%	14.8%	4.4%

* Unemployment rates are seasonally unadjusted.

TABLE 8: HOUSING UNITS -- 1989 ESTIMATE

County	1989 Est
Clearwater	2916
Pennington	5132
Red Lake	1621
Total	9669

Owned-Property Vacancy:	1.5%
Rental-Property Vacancy:	11.9%

Vacancy rates based on 1980 data.

TABLE 9A: RED LAKE RIVER AGRICULTURAL DAMAGES

								Average Annual Acres Flooded	Average Annual Acres Benefited	Potential Average Annual Benefits
YEAR	2	5	10	25	50	100	500			
FREQUENCY (%)	50	20	10	4	2	1	0.2			
CURRENT CONDITIONS	0	4800	6600	10200	13000	15000	16500	2325		
YEAR	2.3	6.7	14.3	28.6	90.9	142.9	500			
FREQUENCY (%)	44	15	7	3.5	1.1	0.7	0.2			
REMOTE CONTROL OF DAM	0	4800	6600	10200	13000	15000	16500	1892	433	$32,464
YEAR	2.5	6.7	14.3	40.0	100.0	166.7	500			
FREQUENCY (%)	40	15	7	2.5	1	0.6	0.2			
CONNECTION CHANNEL	0	4800	6600	10200	13000	15000	16500	1760	565	$42,375
YEAR	3.2	11.8	25.0	52.6	166.7	333.3	500			
FREQUENCY (%)	31	8.5	4	1.9	0.6	0.3	0.2			
MODIFIED CHANNEL (100 FOOT BOTTOM)	0	4800	6600	10200	13000	15000	16500	1214	1111	$83,291
YEAR	5.9	25.0	58.8	111.1	333.3	500	1000			
FREQUENCY (%)	17	4	1.7	0.9	0.3	0.2	0.1			
MODIFIED CHANNEL (125 FOOT BOTTOM)	0	4800	6600	10200	13000	15000	16500	626	1699	$127,414

TABLE 9B: CLEARWATER RIVER AGRICULTURAL DAMAGES

								Annual Acres Flooded	Annual Acres Benefited	Average Annual Benefits
YEAR	2	5	10	25	50	100	500			
FREQUENCY (%)	50	20	10	4	2	1	0.2			
CURRENT CONDITIONS	0	1220	1500	1800	2000	2220	2620	502		
YEAR	2.0	5.6	11.8	28.6	62.5	142.9	500			
FREQUENCY (%)	49	18	8.5	3.5	1.6	0.7	0.2			
CONNECTION CHANNEL	0	1220	1500	1800	2000	2220	2620	473	28	$2,135

TABLE 10: RED LAKE/CLEARWATER RIVERS ALTERNATIVE SCREENING ANALYSIS

	FIRST COSTS	FIRST COSTS PLUS IDC *	ANNUAL COSTS **	ANNUAL BENEFITS	BENEFIT/ COST RATIO
REMOTE CONTROL OF DAM	$437,400	$456,100	$40,520	$32,464	0.80
REMOTE CONTROL OF DAM AND 4TH GATE	$575,400	$600,000	$53,304	$32,464 ***	0.61
MODIFIED CHANNEL RLR (100 FOOT BOTTOM)	$1,790,000	$1,866,600	$165,829	$83,291	0.50
MODIFIED CHANNEL RLR (125 FOOT BOTTOM)	$3,513,000	$3,663,400	$325,456	$127,414	0.39
CONNECTION CHANNEL	$2,017,000	$2,103,300	$186,857	$44,510	0.24

* Interest During Construction (IDC) assumed for one year construction period @ 8 3/4% (.0428 factor).

** Assumes 50 year project life @ 8 3/4 percent interest rate (.08884 factor).

*** Benefits are assumed to be the same for this alternative as Automation of the Dam.

PLATE 1: RED LAKE RIVER

DISCHARGE/AREA FLOODED EXISTING COND.

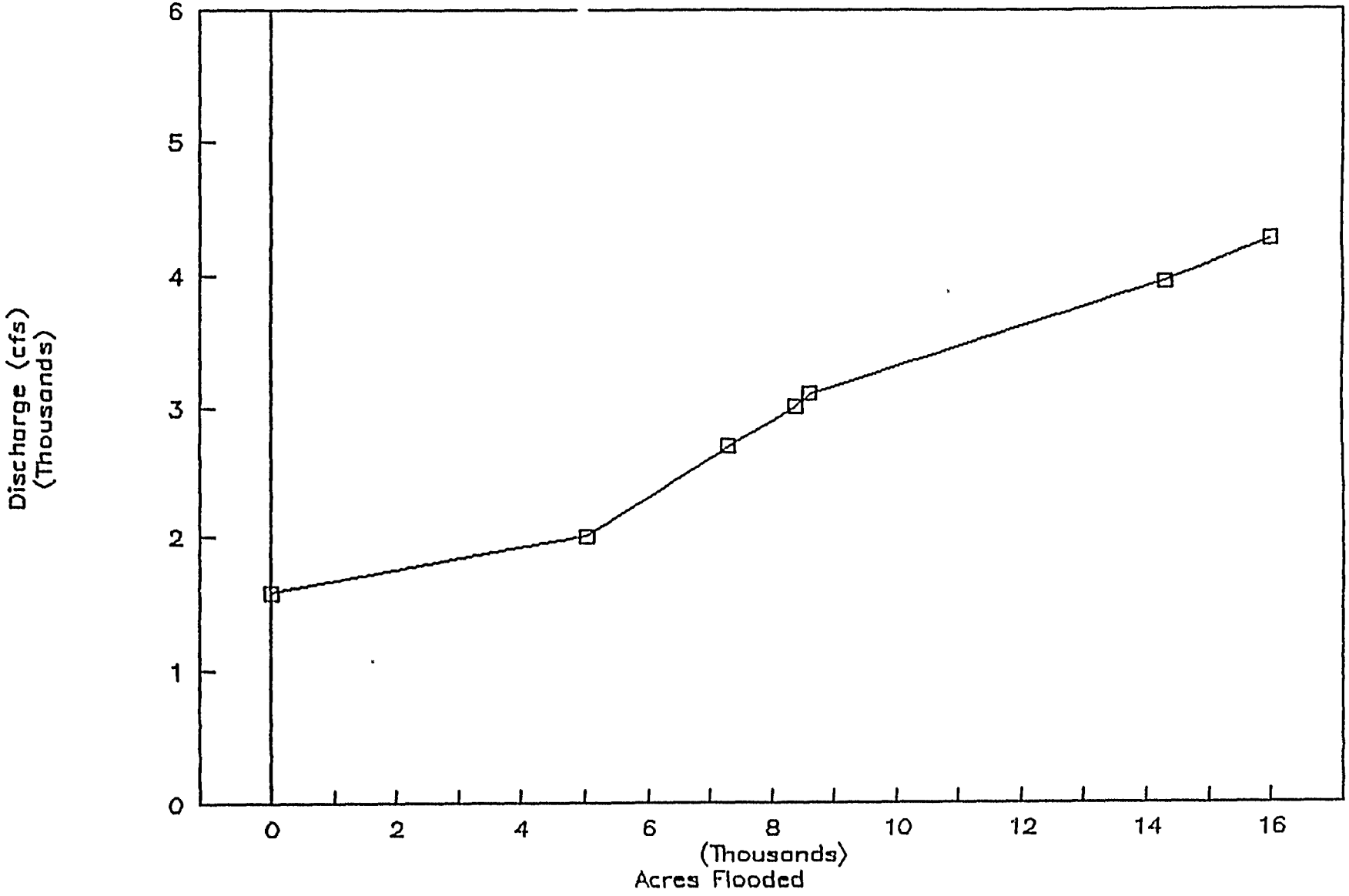


PLATE 2: CLEARWATER RIVER

DISCHARGE/AREA FLOODED EXISTING COND.

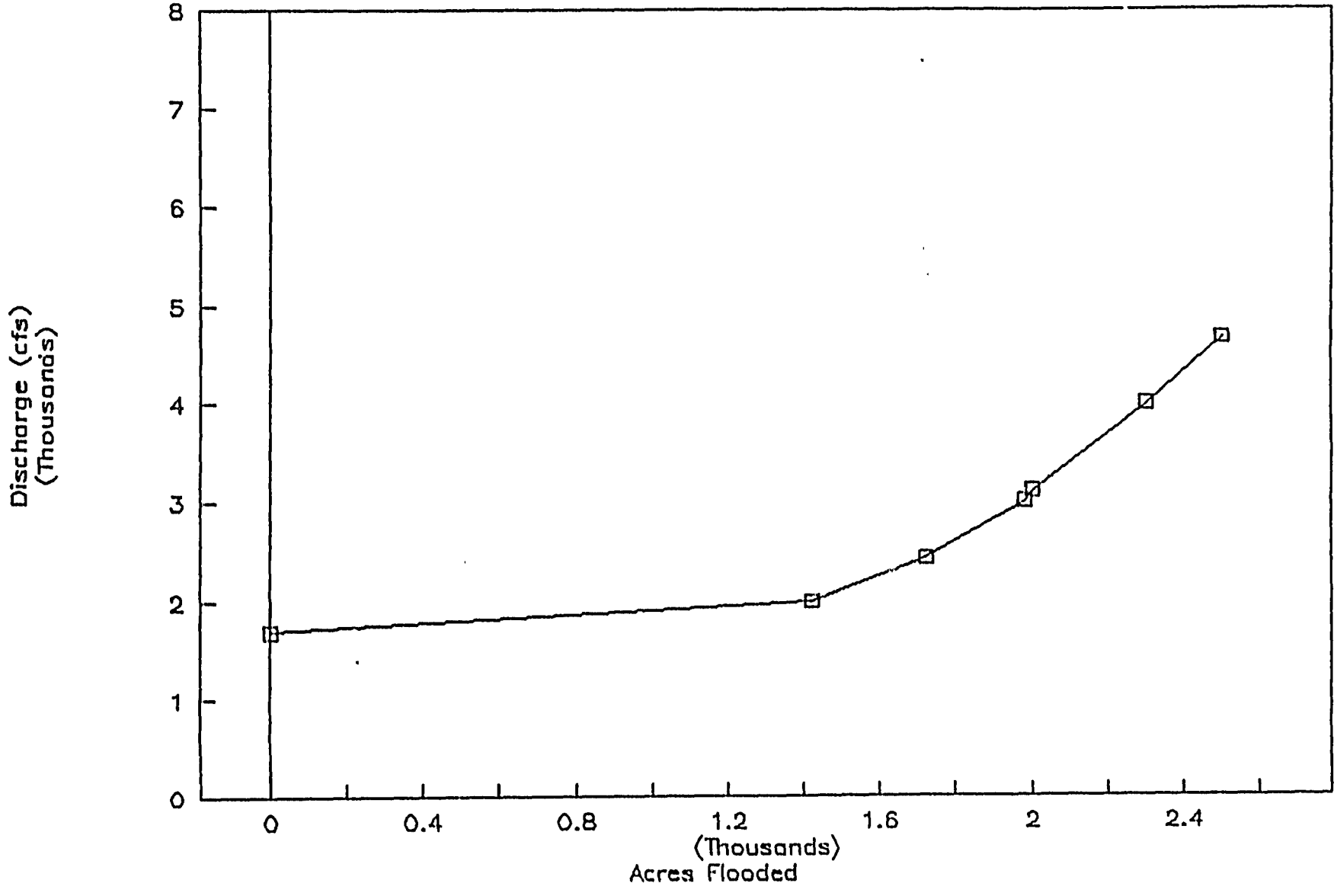


PLATE 3: RED LAKE RIVER

FREQUENCY/AREA FLOODED EXISTING COND.

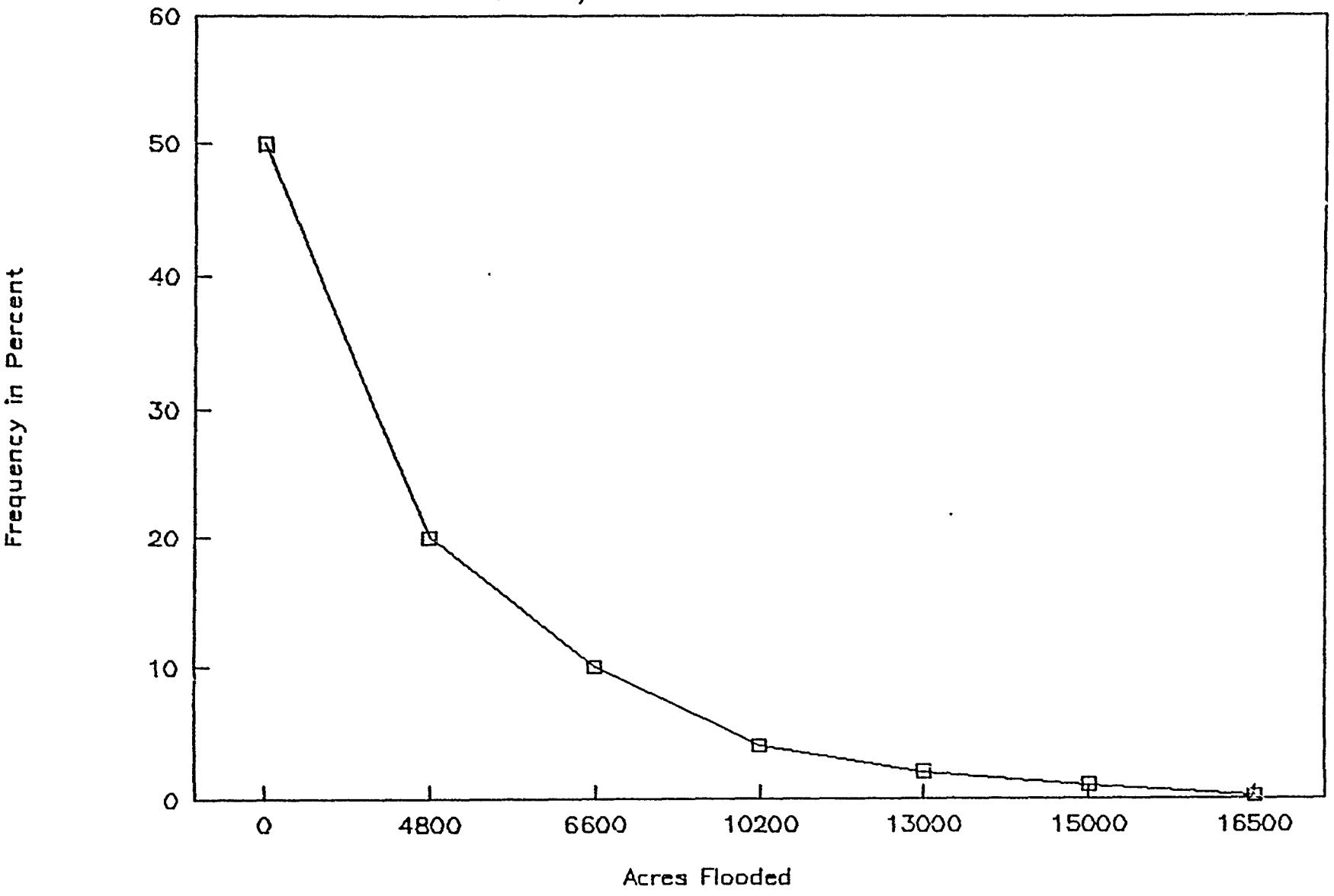
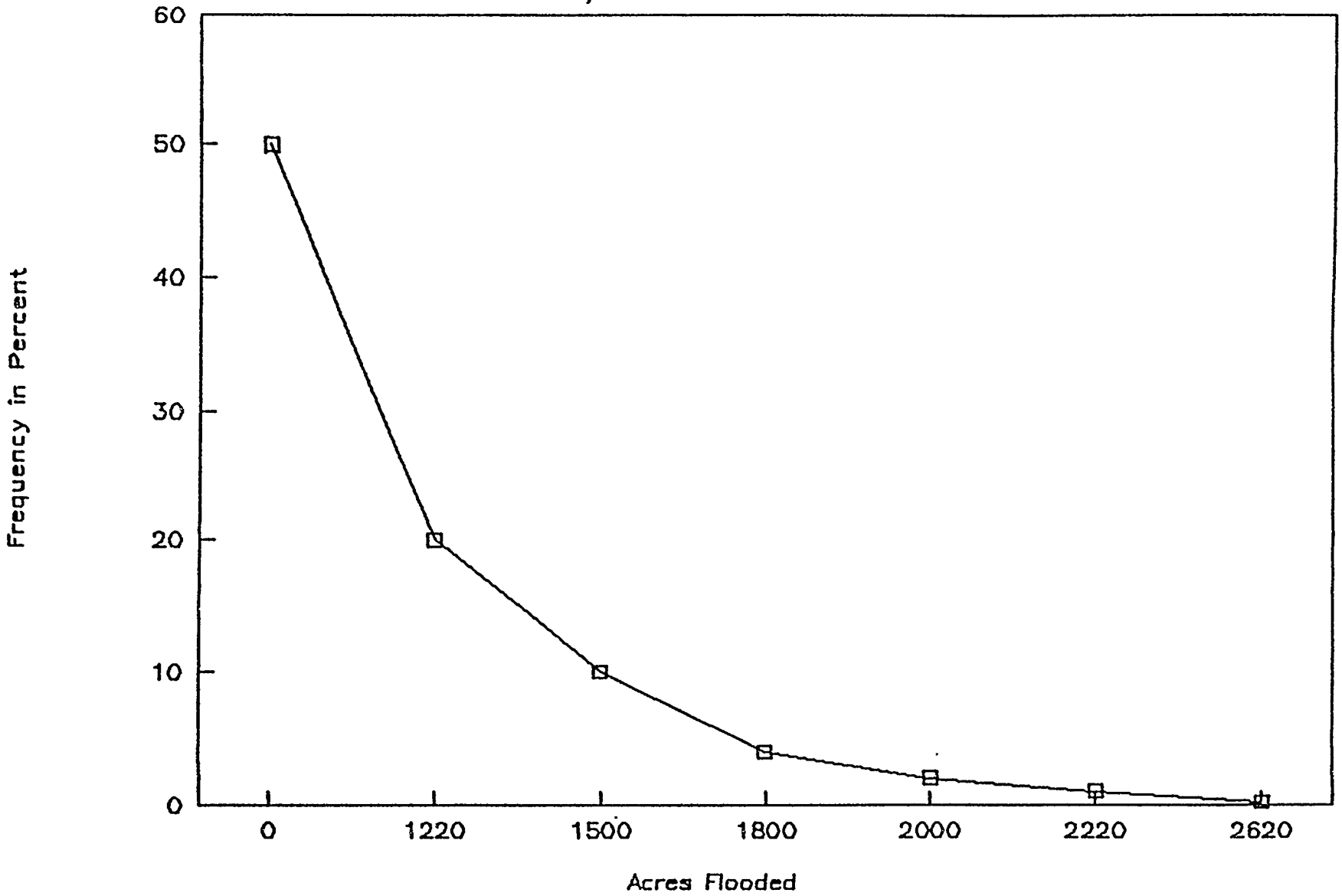


PLATE 4: CLEARWATER RIVER

FREQUENCY/AREA FLOODED EXISTING COND.



WORKING PAPERS (APPENDICES)

Appendix C - Recreation

RED LAKE RIVER -CLEARWATER RIVER
FLOOD CONTROL RECONNISANCE STUDY

Inputs to main report:

"Socioeconomic Conditions"
There is significant recreational use of the Red Lake River in the Red Lake Falls area; there are three tubing outfitters located there, and the most desirable canoeing is above and below the city. Canoeing is also considered good on the lower reaches of the Clearwater River, near Red Lake Falls. The tubing draws visitors from as far away as Canada over summer weekends.

"Setting"
The Red Lake River begins at the control structure for Upper and Lower Red Lakes. The Clearwater River has its headwaters in the peat bogs just south and west of Lower Red Lake. For the first 20 miles or so, both rivers flow through a virtually level area dominated by peat bogs that are part of the Red Lake Indian Reservation. The lands beyond the reservation boundary have been extensively drained for agricultural purposes. There was extensive channelization of both rivers by the Corps of Engineers in the early 1950's in their upper reaches. The material excavated was deposited along the banks of the river. In some areas, lands adjacent to the river are farmed right to the rivers' edge. In other areas, there is a narrow buffer strip of trees and shrubs along the banks. Downstream of the channelized reaches, at about High Landing on the Red Lake River and at Plummer on the Clearwater River, the gradient of the channels increase and there was no channelization. As a result, the character of the rivers are more natural.

"Problems and Opportunities"
The study area is on the northern edge of a relatively popular recreation destination area, particularly by non-Minnesota residents (primarily from North Dakota and Canada). The majority of the recreational use of the Red Lake River begins in the vicinity of High Landing and continues downstream. The upper reaches of the river are relatively remote and located on the Red Lake Indian Reservation; both of which tend to discourage use. Beyond the reservation boundary, the river has been channelized and agricultural uses of adjacent lands often extends to the river banks, lower the "natural" scenic qualities of the area. The fishery is considered to be good for this area of the state by the Minnesota Department of Natural Resources. Major recreational uses of the river include fishing, canoeing/boating, and inner tubing. The river is a designated State Canoe Route.

The Clearwater River receives less recreational use than the Red Lake River. The fishery is considered poor, primarily due to inadequate water levels at various times throughout the year and water quality problems. Canoeing/boating is popular, primarily downstream of Plummer to the confluence with the Red Lake River. As with the Red Lake River, the upstream reaches are relatively remote and located on the Red Lake Indian Reservation. In addition, there is more agricultural use of the riparian areas, beyond the reservation boundary.

The most significant limiting factor of recreational use of the Red Lake and Clearwater Rivers is consistently adequate flow levels in the rivers during the summer months. Improved and/or consistent flows would benefit the fisheries, especially in the Clearwater River, and provide enough depth to support boating/canoeing/floating use of the rivers. Any project that would provide consistent flows in the rivers would have a beneficial effect on recreation.

RED LAKE RIVER -CLEARWATER RIVER
FLOOD CONTROL RECONNISANCE STUDY

APPENDIX D - RECREATION

The study area is located in northwestern Minnesota, approximately 60 miles east of East Grand Forks, Minnesota - Grand Forks, North Dakota. Other large communities near the study area include Crookston, Thief River Falls and Red Lake Falls. Winnipeg, Manitoba is about 150 miles north of the study area.

The study area is just north of what is usually considered Minnesota's lake country. The eastern half of the study area is predominately flat with extensive peat bogs, especially the portion that is within the Red Lake Indian Reservation. Beyond the reservation, there has been extensive agricultural drainage. The predominate land use outside the reservation is agriculture. There are extensive areas of rice paddies along the Clearwater River.

There are no major park areas within the study area. There are several boat access points along both rivers. There are parks with picnicking and camping facilities at Red Lake Falls and Thief River Falls.

The major outdoor recreational activities within the study area are canoeing and boating on the rivers, inner tubing on the Red Lake River in the Red Lake Falls area, fishing, and waterfowl hunting. The Red Lake River is a designated State Canoe Route.

The majority of the recreational use of the Red Lake River begins in the vicinity of High Landing and continues downstream. The river above this point has a relatively flat gradient. The upper reaches are within the Red Lake Indian Reservation and flows through an area that is predominately peat bog, both of which tend to discourage use. Beyond the reservation, the area has been extensively drained. Agricultural uses of the adjacent riparian areas often extends to the river's edge. In addition, the Corps constructed channelization projects along several reaches of the river. The excavated material was deposited along the banks. As a result, these stretches of the upper reaches of the Red Lake River have relatively lower scenic qualities than undeveloped/undistrubed stretches.

Downstream of High Landing, the gradient of the river increases. The channel modification project ended about five river miles below High Landing. The surrounding topography also changes with more hills, etc. As the surrounding area becomes more "interesting" with the changing topography and more undistrubed, the scenic quality of the river corridor increases.

The Clearwater River receives less recreational use than the Red Lake River. The same peat bog/ extensive agriculture use patterns exist along the Clearwater as they do along the Red Lake River. The most significant difference in land use is the extensive areas of rice paddies along the Clearwater. The fishery is considered poor, primarily due to water levels and water quality problems. Canoeing/boating is popular, primarily downstream of Plummer to the confluence with the Red Lake River at Red Lake Falls. As with the Red Lake River, the upstream reaches are relatively remote and located on the Red Lake Indian Reservation.

Most of the recreational activity in the study area is centered around the city of Red Lake Falls. There are three outfitters located in the city offering tubing opportunities. The more scenic stretches of the river are up- and downstream of the city on both rivers.

The primary limiting factor for recreation on the rivers is lack of adequate flows. Clearly, the canoe/boatability of the rivers is effected by low flows. The fisheries on the Clearwater would improve if adequate flows were provided during the late summer. Water quality is also a problem on the Clearwater. Low flows on the Red Lake River reduce the tubing use around the city of Red Lake Falls.

PROJECT PURPOSES

The primary purposes of the proposed project is to control agricultural flooding along the upper reaches of both rivers, and to more effectively maintain Lower Red Lake within its operating band. Seven alternatives have been evaluated. The following paragraphs briefly describe each of the alternatives and its potential effects on recreation.

Alternative 1 - Red Lake River and Clearwater River Connecting Channel
Briefly, a channel would be constructed just beyond the reservation boundary connecting the rivers. There would a control structure constructed at the Red Lake River end. The purpose would be to divert flows from the Red Lake River to the Clearwater during high flow periods. It would not be used to supplement flows during low flow periods on the Clearwater unless excess flows were available on the Red Lake River.

The diversion channel itself would offer no significant recreational opportunities, nor would it adversely effect existing opportunities. It could not be used as a navigable waterway between the rivers.

The diversion could have a beneficial effect on the fisheries in the Clearwater during those times when Red Lake is above its operating band and maximum discharges are being released into the Red Lake River. However, the

flows would have to be consistent throughout the year for the fisheries to benefit. Because of the inconsistency of when the lake needs to be drawn down in the late summer, the benefit to the fisheries in the Clearwater would be minimal.

Canoeing, boating and tubing activities on the rivers generally occur during the middle of the summer, when the weather is warm and river flows usually are in the normal to low range. Any diversion of flows could adversely effect the usability/attractiveness of the losing river which may not be offset by the gain of the receiving river.

In summary, the diversion channel alternative does not significantly effect recreation either beneficially or adversely.

Alternative 2 - Lower Red Lake Control Structure Modifications
The size of the current outlet works when compared to the size of the Red Lake impoundment, is very small. In addition, the operating band for the lake is relatively narrow. Therefore, it is very difficult to maintain the lake level within the operating band. In addition, the remoteness of the structure and resulting delays in changing the discharge levels, compounds the problem of trying to release water from the lake as quickly as necessary without exceeding channel capacities downstream.

There are two sub alternatives: (2a) modifying the existing structure; and, (2b) modifying the structure including the addition of a fourth gate and automating the operations. The purpose would be to allow for a greater range of discharges and, under 2a., to be more responsive in terms of required discharge changes.

This alternative would not directly effect any existing recreational opportunities or create any new opportunities. However, the implementation of this alternative would have beneficial and potentially adverse effects on recreation. By improving the capability to maintain Lower Red Lake within its operating band, less high water damages would result to the riparian areas, including the recreational facilities around the lake. The total amount of time those recreational facilities are available to be used would increase, and resulting benefits would be greater.

However, downstream of the control structure, there may be greater fluctuations in flow, which may change the usability/desirability of the river for certain recreational, such as tubing. Under current conditions, it takes a long time to draw the lake down, and the resulting river flows "stay up" for a relatively long period of time. Given a greater discharge capability, the duration of the higher than normal flows could be less. Given the limited data available, it is virtually impossible to determine what the effects would be on downstream uses.

Alternative 3 - Channel Improvements on the Clearwater River
Under this alternative, the channel capacities would be reexamined to determine if the existing modifications are at the designed capacity and/or if additional reaches need to be improved to provide for flood protection. It is

assumed that any additional channel modifications would occur in the general area of the original project.

Any channelization project would have an adverse effect on recreation. primarily for aesthetic reasons. The river corridor would be changed from a natural state to a more man-made state, even in those areas previously channelized. The effects would be most pronounced immediately after construction. As trees and shrubs become established, the effects would be lessen. However, the meandering character of a natural river would be lost.

Another area of concern would be the disposal of the excavated material. Without careful placement, the material could adversely effect terrestrial and/or aquatic habitats and associated wildlife species, thereby effecting hunting and trapping. Through careful placement, habitats could be improved or created. Any changes within the channel would effect fisheries habitat.

The net effects of a channel improvement project on recreation would be adverse in the near term due to construction activities. In the long term, the effects would be come less as the area returned to a more natural state. However, since any modification activities would occur in an area which has little recreation use when compared to the entire study area, the overall effects on recreation in the study area would be minor.

Alternative 4 - Channel Improvements on the Red Lake River
This alternative and its effects on recreation would be identical to those discussed in Alternative 4. However, there is one another area to be evaluated on the Red Lake River. Currently, there is an abundance of aquatic plants in the discharge channel immediately downstream of the dam. During the summer, the plants are dense enough to cause a decrease in channel capacity and a decrease in the discharge head, combining to decrease the effective discharge without causing flooding.

The effects on recreation on the Red Lake River under this alternative would be similar those describe for the Clearwater River.

Alternative 5 - Marsh Restoration Below Lower Red Lake
The purpose of this alternative would be to have the restored marsh areas store potential flood waters, and naturally release the water during low flow periods. There would be no adverse effects on existing recreational opportunities. One of the major benefits of this alternative would be the potential to increase waterfowl habitat and the resulting waterfowl hunting opportunities. However, given the remoteness of the area of the restoration, the areas may be used by waterfowl for resting/loafing and be subject to hunting pressure in other locations.

Instream recreation may benefit because of an increased base flow in the river due to the slow release of water from the wetlands. It is virtually impossible to estimate the benefits due to a lack of data. However, it is assumed any increase in benefits would be minor.

Alternative 6 - Thief River Falls Lake Restoration
This alternative would be the dredging of an existing lake for water supply and recreation purposes. This alternative was dropped from consideration very early in the study process as the proposed activity is not covered in the study authorities. Therefore, no recreation evaluation was accomplished

Alternative 7 - Upstream Reservoirs
Given the relatively flat terrain, the likelihood of this alternative being feasible, both economically and constructibility, would be remote. Any resulting impoundments would be relatively shallow with limited boating/fishing-type recreational opportunities. There would be good potential for waterfowl habitat.

SUMMARY

The most significant limiting factor of recreational use of the Red Lake and Clearwater Rivers is adequate flow levels in the rivers during the summer months. Improved and/or consistent flows would benefit the fisheries, especially in the Clearwater River, and provide enough depth to support boating/canoeing/floating use of the rivers.

It does not appear that any of the proposed alternatives would significantly effect recreational use of the rivers. Modifications to the dam may benefit recreational use/users/providers on Red Lake by allowing the lake to be maintained within its operating band more consistently. However, that capability may have an adverse effect on the Red Lake River recreation due to varying discharges from the dam and resulting water level changes downstream.

While a diversion channel would provide for additional flows into the Clearwater River, the additional water would be available during high flow events. During low flow times when additional water would be most beneficial, the diversion would not be operated.

Most likely, any channel modifications would occur upstream of High Landing on the Red Lake River, an area that is currently not heavily used for recreation. The resulting channel sections would have a decreased aesthetic quality, and would be less attractive for scenic canoeing/boating activities. The channel modifications would disrupt fisheries habitat. Therefore, the modifications would have some adverse effects on existing recreational uses. These effects most likely would not be offset by any opportunities created and/or enhanced by the channel modification efforts. One possible benefit would be if the discharge channel's capacity were improved, greater releases could be made from the dam during the critical summer months which could result in improved flow conditions on the Red Lake River. However, this assumes that Red Lake would be at a level to allow/require the releases.

RED LAKE - CLEARWATER RIVERS
FLOOD CONTROL RECONNISANCE STUDY

RECREATION ASSUMPTIONS

Based on conversations with Minnesota Department of Natural Resources field staff and with Corps team members, the following assumptions have been developed.

Recreational use of the Red Lake River begins in the vicinity of High Landing and continues downstream. The upper reaches of the river are relatively remote and located on the Red Lake Indian Reservation; both of which tend to discourage use.

Major recreational uses of the river include fishing, canoeing/boating, and inner tubing. The river is a designated State Canoe Route.

Most of the use is centered around the city of Red Lake Falls. There are three outfitters located in the city offering tubing opportunities. The more scenic "natural" stretches of the river are up- and downstream of the city.

The Clearwater River receives less recreational use than the Red Lake River. The fishery is considered poor, primarily due to water levels and water quality problems. Canoeing/boating is popular, primarily downstream of Plummer to the confluence with the Red Lake River. As with the Red Lake River, the upstream reaches are relatively remote and located on the Red Lake Indian Reservation. In addition, the agricultural uses of the riparian areas, tend to reduce the "natural river" scenic qualities often sought by canoers and boaters.

The primary limiting factor for recreation on the rivers is lack of adequate flows. The fisheries on the Clearwater would improve if adequate flows were provided during the late summer. Low flows on the Red Lake River reduce the tubing use around the city of Red Lake Falls.

PROJECT PURPOSES

The primary purposes of the project is to control agricultural flooding along the upper reaches of both rivers, and to more effectively maintain Red Lake within its operating band. Three alternatives have been evaluated: a diversion to transfer water from the Red Lake River to the Clearwater River during high flow events; modifying the existing dam at Red Lake to allow greater discharges; and, channel modifications to accomdate higher discharges from the dam.

Based on very conservative construction cost estimates and liberal benefit calculations, the diversion channel would not be economically justified.

The size of the current outlet works when compared to the size of the Red Lake impoundment, is very small. It is very difficult to maintain the lake level within the operating band. In addition, the remoteness of the structure and resulting delays in changing the discharge levels, compounds the problem of

trying to release water from the lake as quickly as necessary without causing flood conditions downstream. It is proposed to construct an additional gated outlet in an existing bay of the dam to allow for more control.

A current problem is the abundance of aquatic plants in the discharge channel immediately downsteam of the dam. During the summer, the plants are dense enough to cause a decrease in channel capacity and a decrease in the discharge head, combining to decrease the effective discharge without causing flooding. It is suspected that other sections of the river channel are no longer at the capacity calculated when extensive channel modifications were made in the early 1950's. One alternative being considered is the re-examine the existing channel modifications and other potential locations to determine the feasibility of additional modifications.

EFFECTS ON RECREATION

The most significant limiting factor of recreational use of the Red Lake and Clearwater Rivers is adequate flow levels in the rivers during the summer months. Improved and/or consistent flows would benefit the fisheries, especially in the Clearwater River, and provide enough depth to support boating/canoeing/floating use of the rivers.

It does not appear that any of the proposed alternatives would significantly effect recreational use of the rivers. Modifications to the dam may benefit recreational use/users/providers on Red Lake by allowing the lake to be maintained within its operating band more consistently. However, that capability may have an adverse effect on the Red Lake River recreation due to varying discharges from the dam and resulting water level changes downstream.

While a diversion channel would provide for additional flows into the Clearwater River, the additional water only would be available during high flow events. During low flow times when additional water would be most beneficial, the diversion would not be operating.

Most likely, any channel modifications would occur upstream of High Landing on the Red Lake River, an area that is currently not heavily used for recreation. The resulting channel sections would have a decreased "natural" scenic quality, and would be less attractive for scenic canoeing/boating activities. The channel modifications would disrupt fisheries habitat. Therefore, the modifications would have some adverse effects on existing recreational uses. These effects may not be offset by any opportunities created and/or enhanced by the channel modification efforts. One possible benefit would be if the discharge channel's capacity were improved, greater releases could be made from the dam during the critical summer months which could result in improved flow conditions on the Red Lake River. However, this assumes that Red Lake is at a level to allow/require the releases.

WORKING PAPERS (APPENDICES)

Appendix D - Environmental

ENVIRONMENTAL RESOURCES BRANCH
RECONNAISSANCE REPORT INPUT
RED LAKE AND CLEARWATER RIVERS, MINNESOTA

ENVIRONMENTAL SETTING

Red Lake River

The Red Lake River is a tributary of the Red River of the North. It originates at the outlet of the Red Lakes in the northwest portion of Minnesota and flows west and south for 193 miles before entering the Red River at East Grand Forks, Minnesota. The portion of the river immediately downstream of the control dam at the lake outlet is within the Red Lake Indian Reservation and is primarily bog with scattered woodlands. Downstream of the lake the river is channelized for about 35 miles. From the Pennington/Clearwater County line to Thief River Falls the river flows through a flat, primarily, agricultural area. At Thief River Falls, where it is joined by the Thief River, the Red Lake River turns south and the gradient increases. In this reach the river has a distinct valley and pronounced riffles. The Clearwater River enters at Red Lake Falls. The river again flows west for 30 miles and then northwest for 35 miles to the Red River. From Crookston to East Grand Forks the land use is agricultural and the river has high banks but less gradient than the reach upstream.

A biological survey of the Red Lake River revealed that there are 38 species of fish, of 13 families, in the Red Lake River (the river reach within the Red Lake Reservation was not surveyed). The reach above Thief River Falls dam is characterized by low stream gradient and fine substrate. Numbers of white sucker, freshwater drum, rock bass, yellow perch and northern pike were above the stream average, but, walleye numbers were less than average. Since the survey, smallmouth bass have been introduced and have prospered. The reach between Thief River Falls and Crookston has a high gradient, coarse substrate, and numerous riffles and pools. Species which are present in above average numbers upstream are below average here. Golden redhorse were dominant and walleye were well above average. Channel catfish and carp were present but not common in this reach. From Crookston to East Grand Forks, the river is characterized by low gradient, fine substrate, and reduced clarity. Species that prefer this habitat were more abundant here: channel catfish, quillback and mooneye. Freshwater drum were more common and walleye slightly less common than the reach upstream. There is a recreational fishery for catfish in this reach.

The distribution of fish in the Red Lake River is affected by dams. There is a dam at East Grand Forks which is a gradual 5 feet in height and is a deterrent to fish movement much of the year. Upstream at Crookston there is a dam which is 12 feet high and a fish barrier. East of Crookston, an abandoned dam, with a 2 foot head, is a barrier at low flows. A dam in Red Lake Falls collapsed years ago leaving underwater material which is a navigation hazard but not a fish barrier. The Thief River Falls hydropower dam is 18 feet high and is a barrier to fish migration. There is a low head weir and the Red Lake outlet dam on the Reservation portion of the Red Lake River.

The Red Lake River is a hard-water stream with chemical parameters suitable for healthy aquatic communities. It is classified by the Minnesota Pollution Control Agency as suitable for the propagation of cool and warm water fish; aquatic recreation of all kinds; and use for public water supply with treatment. It is relatively clear at its source but total solids, turbidity and phosphorus increase towards the mouth. The river receives treated sewage at five sites as well as sugar beet processing waste, municipal water treatment waste and urban runoff.

Clearwater River

The Clearwater River is a tributary of the Red Lake River. It originates in a morainal area near the city of Bagley, south of the Red Lakes. It flows north to, and along, the western boundary of the Red Lake Indian Reservation. From there it flows west, parallel to the Red Lake River, until it joins it at Red Lake Falls. The river has been extensively modified along 47.3 miles of it's length from 31.8 to 79.1 miles above its mouth. The modification consists of the excavation of a trapezoidal channel with side slopes varying from 1 on 1 to 1 on 3, bottom widths of 38 to 49 feet and berming of excavated material along the side of the channel. Water is appropriated from the Clearwater River for the filling of paddies for the commercial growth of wild rice. The minimum flow is designated as 36 cubic feet per second.

The biological environment of the Clearwater River is not well known. The extensive channel modification has eliminated much of the habitat for fish and organisms on which the fish depend for food. Further, the minimum flow that is provided for in regulation is probably not sufficient to provide suitable conditions for fish growth, especially with limited habitat. As a consequence of the habitat degradation which has occurred, there has been little reason to manage the Clearwater River for fish production.

Red Lakes

Upper and Lower Red Lake are located in northwestern Minnesota. Together they drain a total area of 1,951 square miles. The upper lake is 10 by 21 miles and the lower lake is 12 by 23 miles. Together they have a surface area of 288,800 acres and contain 1,810,000 acre feet at a normal lake elevation of 1174.0 ft m.s.l..

The fishery of the Red Lakes is an important recreational feature but is even more valuable as a commercial resource. Reliable catch data has been gathered since 1930. The important species in the commercial catch have been: walleye, yellow perch, lake whitefish, northern pike, freshwater drum and goldeye. The most frequently caught species is the walleye. The strength of year classes of walleye, yellow perch, and lake whitefish seem to be related or, at least, show similar response to environmental factors. The annual catch has fluctuated from year to year but may be based on different levels of effort, rather than differences in populations. Over a million pounds per year were removed during World War II to meet wartime protein requirements. Similar catches were made during the 1970's. The commercial fishery remains an important source of income for the Red Lake Reservation.

[INPUT FROM PLANNING AID LETTER: Endangered/threatened species concerns.]

FUTURE WITHOUT THE PROJECT

If no action is taken in the Red Lake/Clearwater River area then, for the most part, the existing environmental conditions will continue. However, it would not be possible to improve response to precipitation events at the Red Lake Dam. The incomplete restoration of marshes downstream of the dam, a result of the original project, would be completed under separate Corps of Engineers authority, regardless of the outcome of this study.

ENVIRONMENTAL EFFECTS

The following is preliminary assessment of the potential impacts of the proposed alternative. The accounts listed under Section 122 of Public Law 91-611 were evaluated. Any parameters not discussed below would not be appreciably affected.

No non-structural alternatives were considered for this project. The objectives of this study were to determine if existing structural features should be expanded or altered.

Extension of the authorized channel improvement project on the Red Lake and Clearwater Rivers.

About 27.5 miles of the Red Lake River channel and 38.0 miles of the Clearwater River were modified during 1948-1951. This alternative would extend that channel modification on the Red Lake River and the Clearwater River. The purpose of this would be to decrease flooding on the two rivers.

Channel modification could result in loss of low flow habitat for fish. Channel modification generally increases channel cross section, reducing the depth of water in the river. Fish require that the water be of sufficient depth to provide cover from predators, access to food, moderation of temperature fluctuations, and regulation of water chemistry/quality. Clearing and snagging, or clearing of riparian vegetation and fallen trees in the stream would cause an increase in the maximum water temperature and the amount of temperature fluctuation reduce the habitat of fish and other organisms that are part of the food supply of the fish. Riparian vegetation, in addition to moderating river temperature fluctuations by shading, provides organic matter in the form of vegetative parts of plants and terrestrial insects which may live in the riparian vegetation. Lastly, vegetation close to the banks, or growing in the water provides cover from predation.

Some wetlands may require inundation from overbank flows for recharge. Some fish species, like northern pike, require this overbank flooding for reproduction. In addition, channel modification could lead to increased wetland drainage. Increasing the channel depth or cross section would provide an opportunity to deepen or extend tributary ditches. On another project in the vicinity the U.S. Fish and Wildlife Service (FWS) was insistent on the fixing of all ditch elevations to prevent extension or

enlarging of ditches.

Wetland restoration could be an alternative to channel modification for the purpose of flood control. Reducing the necessity for channel alteration would avoid impacts to fish habitat, as well as provide increased waterfowl habitat, and improve the water quality of runoff discharged to the river from the watershed.

Automate and/or structurally improve the Lower Red Lake Dam (include operational changes and increased release capacity).

Increased discharges, above the operating band, in the Red Lake River could damage fish habitat. Fish have optimums for velocity and substrate which could be exceeded by increased discharges. Conversely, certain minimum flows are required to preserve moderate temperatures and adequate oxygen supplies. These requirements vary seasonally and differ for the various life stages of each fish species, both game and forage.

A change in the operating band might provide an opportunity to manage lake discharges for higher spring flows to promote fish spawning through flushing flows and overbank flooding in the Red Lake River. This may provide a greater frequency of high spring flows than presently occurs (assuming the water would be available).

Changing reservoir operation could be detrimental to recreational and commercial fisheries. The availability of spawning habitat should not be compromised by any alteration in the release plan.

A change in reservoir operation could increase the stability of lake edge habitat with better water level management. If bank erosion and/or siltation of spawning habitat would be a problem at high lake levels, then this could be an improvement. The Minnesota Department of Natural Resources (MDNR) and the FWS do not believe that the impacts that may occur downstream would be offset by benefits within the lake.

A reservoir operation plan evaluation would be required to predict the potential effects.

Diversion of the Red Lake River to Clearwater River and construct impoundments with the excavated material.

An upstream reach of the Clearwater River is designated as a trout stream. It would probably not be affected by diversion from Red Lake River but could be affected by a direct discharge from Red Lakes.

There would be no benefit to the Clearwater River unless flows are provided during late summer especially in low runoff years. Current baseflow is one-half of that desired by the MDNR. Discharge of water to Clearwater would not be beneficial to fish or wildlife unless provided dependably during periods when the river would be at or below the base flow of 36 cfs. An Instream Flow Habitat Analysis would be required to determine the probable effects of alteration of flow.

It is likely that water from the diversion to the Clearwater River would be used in wild rice paddies. Increase in wild rice production may be a negative impact to the Clearwater River. It would result in increased appropriation and decreased water quality from discharge of additional nutrient rich water.

The diversion channel may affect protected wetlands. It is not known if any wetlands would be directly affected by channel construction but the excavation of a channel could provide the opportunity to lower ditch outlets or extend ditches further upstream. Both actions would provide the opportunity for increased wetland drainage.

The proposed impoundments may not be suitable for waterfowl habitat because of peat. Flooding of the peat which underlies much of the project area would result in considerable floating peat blocking use by waterfowl. Considerable preparation of the impoundment basin could be required if waterfowl management was planned.

Although fish culture might be practiced in the impoundments, it would be restricted to native species and coordinated with the MDNR. Otherwise, it may not be compatible with fish management goals in river. Cultured fish could escape to the Red Lake River with possible detrimental effects. If exotic species were cultured, there would be the possibility of their introduction into the watershed. Exotic species frequently have an competitive advantage over native species and can become dominant. There is also the possibility that water quality and volume of the discharge from the impoundments could have adverse effects on downstream habitat.

The Clearwater River presently receives a base flow which is not adequate for fish production. Augmentation of the low flow might provide a benefit but the only if available when it was needed. The Clearwater is already heavily altered and appropriated. In its present state there may be no net benefit to be obtained by reducing flows in the Red Lake River to benefit the Clearwater. An Instream Flow Habitat Analysis would be required to determine the effects of altered discharge on fish habitat.

FUTURE STUDIES

Primary concerns related to this project include minimizing impacts to fish and wildlife habitat both in the Red Lakes and in the Red Lake River and in any wetlands that may be affected.

During the next phase of study, a 404(b)(1) evaluation of the impacts of the placement of fill in water would be prepared. A Section 401 Water Quality Certificate would be requested from the State of Minnesota as part of that evaluation. The impacts of the proposed plan would be analyzed and further information on the value of the local fish and wildlife resources would be collected. The possibilities for enhancing fish and wildlife values would be explored, and the need for mitigation would be determined at that time. A determination of whether to prepare an environmental assessment or environmental impact statement would depend on the final version of the proposed plan.

The MDNR and FWS will request that an Instream Flow Habitat Analysis be

accomplished on both rivers before conclusions could be made about potential impacts and required mitigation for any feature which would include alteration of stream habitat or discharge. Instream flow analysis requires high precision hydraulic modeling of representative reaches at a range of flows to represent all potential conditions. Fish habitat requirement information may or may not be sufficient for analysis of these rivers. This is a costly procedure whose results may still be subject to controversy.

A reservoir operation study would be required before changing the discharge plan for the Red Lakes. The Red Lakes are a significant fisheries resource and, as such, would require careful analysis before changes in water levels and their rates of change could be proposed. The MDNR and the Reservation may or may not have the same management objectives for the fishery.

RECORD OF TELEPHONE CONVERSATION	DATE:November 6, 1990

Paul Stolin	MDNR, ES, Bemidji	218 755 4068
John Shyne	NCSPD-ER	612 220 0270

SUBJECT: Red Lake/Clearwater Recon Coordination

1. I called Mr. Stolin to notify him that the Corps was investigating a new project and outlined the proposed features.

2. Mr. Stolin said that he was acquainted with versions of this project as proposed by others.

3. He said that the MDNR was interested in the project and would cooperate fully.

4. He also said that there could be serious concerns within the MDNR about the proposed cross-basin feature. The MDNR would like to review proposed scenarios for operation since they view the potential operation as of greater concern than the construction. He said that the MDNR would be unable to determine if the channel would be a "project stopper" until the operation plan was evaluated.

5. I said that certain time and money constraints might limit the availablility of necessary hydrologic data until the feasibility stage and that it might be necessary to wait until then.

John T. Shyne
Fishery Biologist
Environmental Resources Branch

RECORD OF TELEPHONE CONVERSATION	DATE:April 24, 1991

John Shyne	NCSPD-ER	612 220 0270
Dave Connor	Red Lake Fisheries	218 679 3959

SUBJECT: Fishery of the Red Lakes

Dave Connor is the fishery biologist and environmental liaison for the Red Lake Band.

The portion of the Red Lakes which is within the reservation is designated for commercial fishing. This fishery is a significant resource to the reservation and could be vulnerable to changes in operation of the lake.

The fishery is composed of walleye, yellow perch, northern pike, black crappie, drum, goldeye, and lake whitefish. Freshwater drum has become the predominant species landed, by weight, in recent years.

If alteration of the operation of the lake was proposed, the concern would be that the potential effects would not be known. Mr. Connor said that the biological optimum for the fishery has not been established. In other words, the effect of raising, or lowering, water levels could not be predicted at this time. Further, it is not known whether bank erosion contributes to or reduces fish spawning habitat. That is, sedimentation in the lake could form or cover spawning beds.

If a change in reservoir operation would be proposed, it would be the Red Lake Band's position that an investigation of the relationship between lake levels and fishery productivity would be required.

John T. Shyne
Fishery Biologist
Environmental Resources Branch

WORKING PAPERS (APPENDICES)

Appendix E - Cost Estimates

ALG
4/5/91

RED LAKE PROJECT

I. CHANNEL DIVERSION COST SUMMARY

A. EXCAVATION (BY DRAGLINE)	1,076,677 C.Y. × 1.21/C.Y. =	$ 1,302,(
B. EXCAVATION (BY SCRAPER)	84,098 C.Y. × 2.00/C.Y. =	$ 168,(
C. CLEARING	154 ACRES × 1770.00/AC =	$ 273,(
D. SEEDING	238 ACRES × 436.00/AC =	$ 104,(
E. INLETS	16 INLETS × 1750.00/INLET =	$ 28,(
F. DIVERSION STRUCTURE	L.S.	$ 103,(
G. N. POOL OUTLET STRUCTURE	L.S.	$ 19,(
H. S. POOL OUTLET STRUCTURE	L.S.	$ 20,(
	TOTAL COST	$2,017,(

I. CALCULATE RANGE (ASSUME A RANGE OF (-20% TO + 30%).

1). LOW END = $ 2,017,000.00 / 1.20 = $ 1,680,000.00

2). HIGH END = $ 2,017,000.00 × 1.30 = $ 2,622,000.00

J. ASSUMPTIONS:

1). TOPSOIL WILL BE OBTAINED FROM REQUIRED EXCAVATION. NO STRIPPING REQUIRED.

2). MOB / DEMOB INCLUDED IN COSTS.

3). NO TREATMENT REQUIRED TO CHANNEL FOR STABILIZATION JUST TO SPOIL BANKS

4). COSTS DO NOT INCLUDE E&D & S&A COSTS OF 30%.

ALG
4/5/91

PROJECT — RED LAKE PROJECT

I. MODIFICATION OF RED LAKE DAM OUTLET

A.	MOB / DEMOB	L.S.	=	$ 10,000.00
B.	CONCRETE REMOVAL	144 FT³ x 22.00/FT³	=	3,000.00
C.	CONCRETE SAWING	56 L.F. x 20.00/L.F.	=	1,000.00
D.	CONCRETE REPLACEMENT	13 C.Y. x 800.00/C.Y.	=	10,000.00
E.	REBAR	875 lb. x 0.75/lb.	=	1,000.00
F.	STRUCTURAL STEEL	850 lb. x 2.00/lb.	=	2,000.00
G.	STEEL GRATING	30 FT² x 30.00/FT²	=	1,000.00
H.	MECHANICAL COSTS	(1) NEW GATE (52,000.00) + (3)(30,000.00)	=	142,000.00
I.	ELECTRICAL COSTS	L.S.	=	30,000.00
		TOTAL CONST. COSTS =		$ 200,000.00

J. CALCULATE RANGE (ASSUME RANGE FROM (-20% TO +30%)

1). LOW END. $ 200,000.00 / 1.2 = $ 167,000.00

2). HIGH END $ 200,000.00 x 1.3 = $ 260,000.00

K. ASSUMPTIONS

1). ASSUMPTIONS FOLLOW ON ATTACHED SHEETS FOR ELEC. & MECH. WORK.

2). COSTS DO NOT INCLUDE E&D OR S&I COSTS OF APPROXIMATELY $ 100,000.00

3). ASSUMES (3) EXISTING GATES AND (1) NEW GATE WILL BE MOTORIZED.

ALG
4/5/91

RED LAKE PROJECT

I. CHANNEL ENLARGEMENT TO 1000'.

A). EXCAVATION (DRAGLINE) 1,200,000 C.Y. x 1.21/C.Y. = $ 1,452,

B). CLEARING 150 ACRES x 1770/AC. = 266,

C). SEEDING 165 ACRES x 436/AC. = 72,0

TOTAL COST $ 1,790,0

D). CALCULATE RANGE (ASSUME A RANGE OF (-20% TO + 30%)

1). LOW END $ 1,790,000 / 1.2 = $ 1,492,000

2). HIGH END $ 1,790,000 x 1.3 = $ 2,327,000

II. CHANNEL ENLARGEMENT TO 1250'

A). EXCAVATION (DRAGLINE) 2,400,000 C.Y. x 1.21/C.Y. = $2,904,0

B). CLEARING 270 ACRES x 1770/ACRE = 478,0

C). SEEDING 300 ACRES x 436/ACRE = 131,0

TOTAL COST $ 3,513,000

D). CALCULATE RANGE (ASSUME RANGE FROM (-20% TO + 30%):

1). LOW END $ 3513000 / 1.2 = $ 2,927,000

2) HIGH END $ 3513000 x 1.3 = $ 4,567,000

ASSUMPTIONS :

1). TOPSOIL WILL COME FROM REQUIRED EXCAVATION

2). HCE/DEMOS INCLUDED IN COSTS.

3). UNIT PRICES DERIVED FROM CHANNEL DIVERSION ALTERNATIVE

4). NO TREATMENT REQUIRED FOR CHANNEL BOTTOM OR SLOPES

ED-C(ALG) PROJECT COST ESTIMATE: ALT. 2 21-Jun-91 /

RED LAKE CLEARWATER RIVERS RECON

ACCOUNT CODE	ITEM	UNIT	QUANTITY	UNIT PRICE	AMOUNT ¶	CONTINGENCIES AMOUNT	PERCENT	REASON
04.-.-.-	DAMS							
04.3.-.-	OUTLET WORKS							
04.3.A.-	MOB AND DEMOB	JOB	1	*****	8,000	2,400	30%	1,2,3
04.3.1.Q	MECHANICAL	JOB	1	*****	90,000	36,000	40%	1,2,3
04.3.1.E	ELECTRICAL	JOB	1	*****	34,000	14,000	41%	1,2,3
04.3.1.E	FLOOD WARNING SYSTEM	JOB	1	*****	90,000	18,000	20%	1,2,3
	SUBTOTAL CONSTRUCTION COSTS				222,000	70,400		
30.-.-.-	ENGINEERING AND DESIGN	JOB	1	*****	100,000	20,000	20%	4
31.-.-.-	SUPERVISION AND INSPECTION	JOB	1	*****	21,000	4,000	19%	4
	SUBTOTAL CONSTRUCTION E&D, S&A				343,000			
	SUBTOTAL CONTINGENCIES			27.5%		94,400		
	TOTAL					437,400		

REASONS FOR CONTINGENCIES

1. QUANTITY UNKNOWNS
2. UNIT PRICE UNKNOWNS
3. UNKNOWN SITE CONDITIONS
4. UNKNOWN HOURS

NOTES

1. EXTENSIONS ARE ROUNDED TO THE NEAREST $1,000
2. PRICE LEVEL EQUALS JUNE 1991.

RED LAKE CLEARWATER RIVERS RECON

ACCOUNT CODE	ITEM	UNIT	QUANTITY	UNIT PRICE	AMOUNT	%	CONTINGENCIES AMOUNT	PERCENT	REASON
04.-.-.-	DAMS								
04.3.-.-	OUTLET WORKS								
04.3.A.-	MOB AND DEMOB	JOB	1	*****	10,000		3,000	30%	1,2,3
04.3.1.C	CONCRETE REMOVAL	CF	144	22.00	3,000		1,200	40%	1,2,3
04.3.1.C	CONCRETE SAWING	LF	56	20.00	1,000		400	40%	1,2,3
04.3.1.C	CONCRETE REPLACEMENT	CY	13	1,000.00	13,000		5,200	40%	1,2,3
04.3.1.C	RESTEEL	LBS	875	1.00	1,000		400	40%	1,2,3
04.3.1.E	STRUCTURAL STEEL	LBS	850	2.00	2,000		800	40%	1,2,3
04.3.1.E	STEEL GRATING	SF	30	30.00	1,000		400	40%	1,2,3
04.3.1.Q	MECHANICAL	JOB	1	*****	142,000		60,000	42%	1,2,3
04.3.1.E	ELECTRICAL	JOB	1	*****	36,000		14,000	39%	1,2,3
04.3.1.E	FLOOD WARNING SYSTEM	JOB	1	*****	90,000		18,000	20%	1,2,3
	SUBTOTAL CONSTRUCTION COSTS				299,000		103,400		
30.-.-.-	ENGINEERING AND DESIGN	JOB	1	*****	120,000		24,000	20%	4
31.-.-.-	SUPERVISION AND INSPECTION	JOB	1	*****	24,000		5,000	21%	4
	SUBTOTAL CONSTRUCTION, E&D, S&A				443,000				
	SUBTOTAL CONTINGENCIES		29.9%				132,400		
	TOTAL						575,400		

REASONS FOR CONTINGENCIES

1. QUANTITY UNKNOWNS
2. UNIT PRICE UNKNOWNS
3. UNKNOWN SITE CONDITIONS
4. UNKNOWN HOURS

NOTES

1. EXTENSIONS ARE ROUNDED TO THE NEAREST $1,000
2. PRICE LEVEL EQUALS JUNE 1991.

4 April 1991

RED RIVER PROJECT

OUTLET STRUCTURE AUTOMATION - ELECTRICAL COSTS

Cost Electrical Service and Distribution $10,000

For 3 gates material and installation. Assume 2 horsepower or less for gate lift motors and all controls integral to lift. Assume no additional cost to upgrade the power company service.

Added Electrical Cost for One Additional New Gate $2,000

Cost per Gate Electrical Gate de-icing $3,000

Assume approximately 8 KW heat per gate Cost derived from review of Lac Qui Parle project.

Remote Control of all Gates $15,000

Assume equipment required at the site only. Equipment and software at control location not included. Does not include cost for telephone connection and operation.

Engineering and Design Cost Electrical $20,000

David Valen
Electrical Engineer

CENCS-ED-GH (1110-2-1403) 12 June 1991
Murphy/dml/607

MEMORANDUM FOR Chief, CENCS-PD-PF

SUBJECT: Red Lake River Flood Warning System

1. As requested by Mr. Ed McNally, we have investigated the concept of designing a flood warning system for the Red Lake River downstream of the Red Lake Dam. We understand that the primary damage center is in the vicinity of High Landing. Three types of systems have been investigated by Mr. Jim Murphy of the Hydrology Section and are described below.

a. A sophisticated, state of the art system using vendor-supplied equipment. Equipment consists of river stage gages, precipitation gages, transmitters, repeaters, receivers, solar panels, battery backup, and a base station including a personal computer with software. Typical vendors are Handar and Sierra-Misco. Drawbacks of this type system are high initial cost, high maintenance cost, training costs for system user, and high degree of technical expertise on the users part. Omaha District has had major problems with using this type of system in small rural communities.

b. The second system is one "invented" and in use at several locations in the Omaha District. It consists of a stage warning device which is a telephone alarm dialer mounted in a shelter atop a stilling well which contains float switches mounted on a vertical rod. The telephone alarm dialer plays prerecorded flood warning messages to individuals designated to receive them. The dialer is activated by the float switches. Several of these devices could be installed in the Upper Red Lake River basin. The drawback to this type system is the unreliability of telephone service during severe thunderstorms, precisely the time when the system is needed.

c. The third system would make use of existing river stage gages and data collection platforms (DCP's) already installed in the basin at Red Lake Dam and High Landing. This system would be expanded by adding an additional stage gage at an intermediate point between Red Lake Dam and High Landing. We would also add tipping-bucket rain gages at the 3 stage gage locations and at another location in the northern part of the basin in Beltrami County. The gage locations are shown in Enclosure 1. Stage and precipitation data collected by the DCP's will be transmitted to the district office via LandSat and a Domestic Satellite (DomSat) down link. The Dom Sat has been ordered by the Water Control Center and will be used for collecting all DCP information in the district. Water Control personnel will interpret the collected data and have the capability to make gate changes at Red Lake Dam from the district office using remote gate operating equipment.

2 The recommended plan for a Red Lake River flood warning system is option c as described above. Option a has been ruled out because of the high cost and potential operating problems as experienced in another district. Option b has been ruled out because our water control people have found our telemark gages (telephone line intensive) to be less reliable than the DCP gages.

3. The cost estimate for design of the system by Hydrology Section and installation of the hardware by water control center personnel is as follows:

a. Hardware:

(1)	Tipping bucket rain gage at High Landing	$500
(2)	Tipping bucket rain gage at Red Lake Dam	$500
(3)	Rain gage in Beltrami County with DCP	$7,500
(4)	River stage gage and Rain Gage at an intermediate point on Red Lake River	$20,000
	Subtotal ---	$28,500

b. Computer Programming and Office Equipment:

(1)	Dom Sat with 386 computer and software	N/C
(2)	Program to monitor data	$6,000
(3)	Speaker, modem, and dialer	$5,000
(4)	Program to call water control center personnel at home during off-duty periods	$3,000
(5)	Debugging Programs	$3,000
(6)	Contingency plan to operate the gates automatically if no one can be reached	$4,000
	Subtotal ---	$21,000

c. Basin Model:

(1)	HEC-1 Forecasting model to tell water control center when rainfall poses a potential problem in the Red Lake Basin	$40,000
	Summary of Subtotal Costs ---	$89,500
	20% Contingencies ---	$17,900
	Total Cost --	$107,400

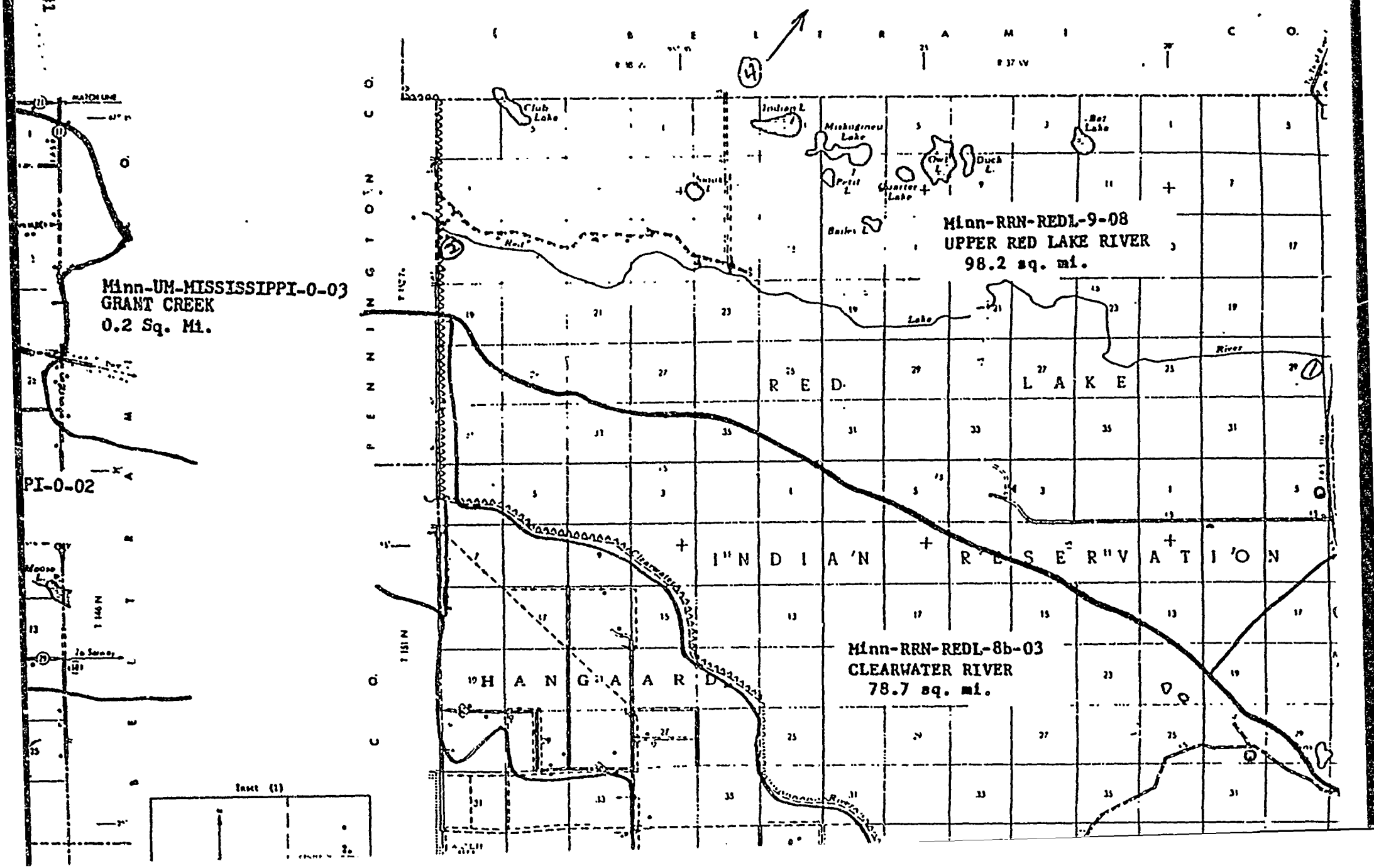
This cost does not include costs for remote gate operating equipment as Mr. Ed McNally indicated he has an estimate for these costs.

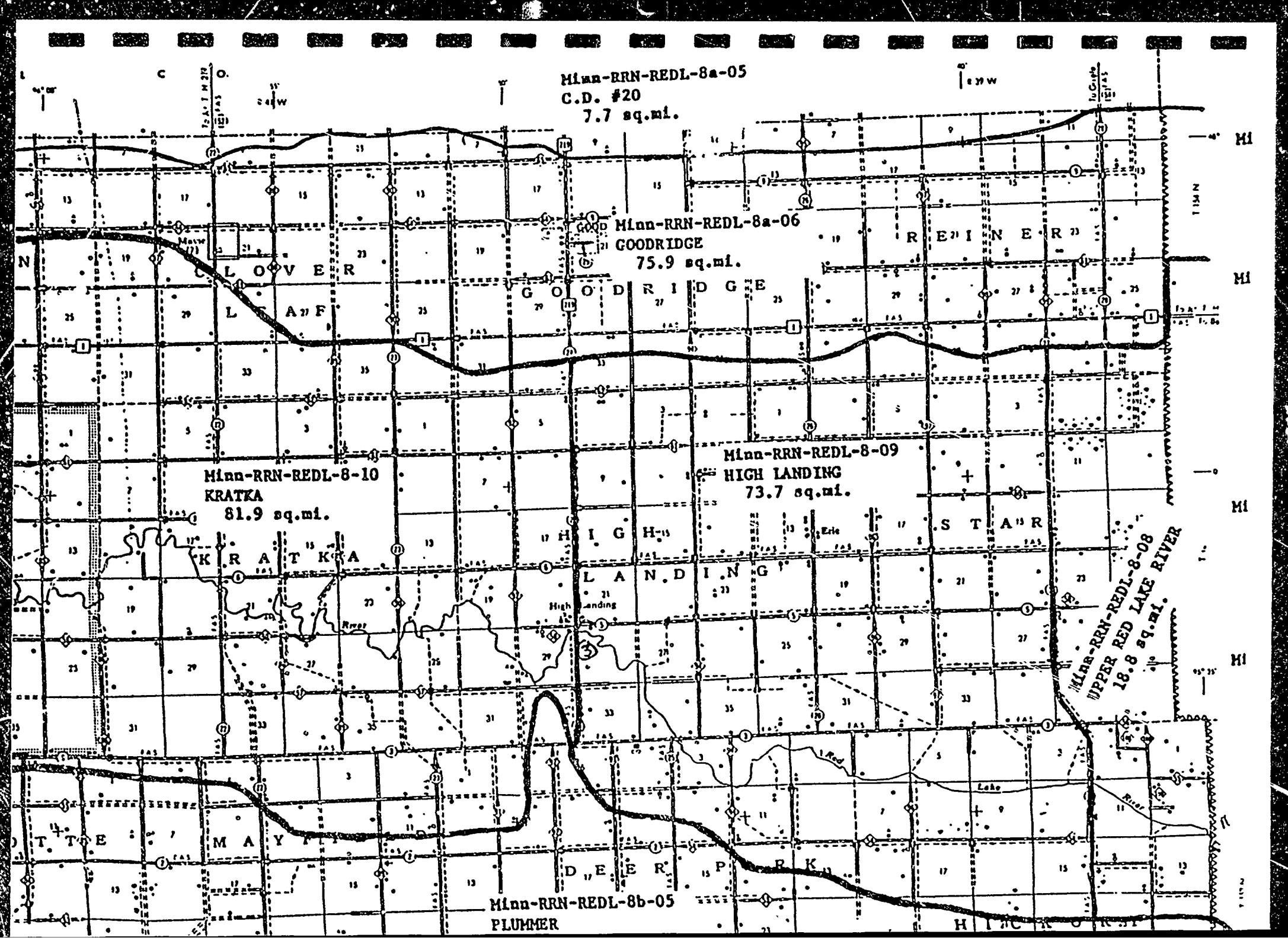
4. If we can be of further assistance, please contact Mr. Jim Murphy at X-608.

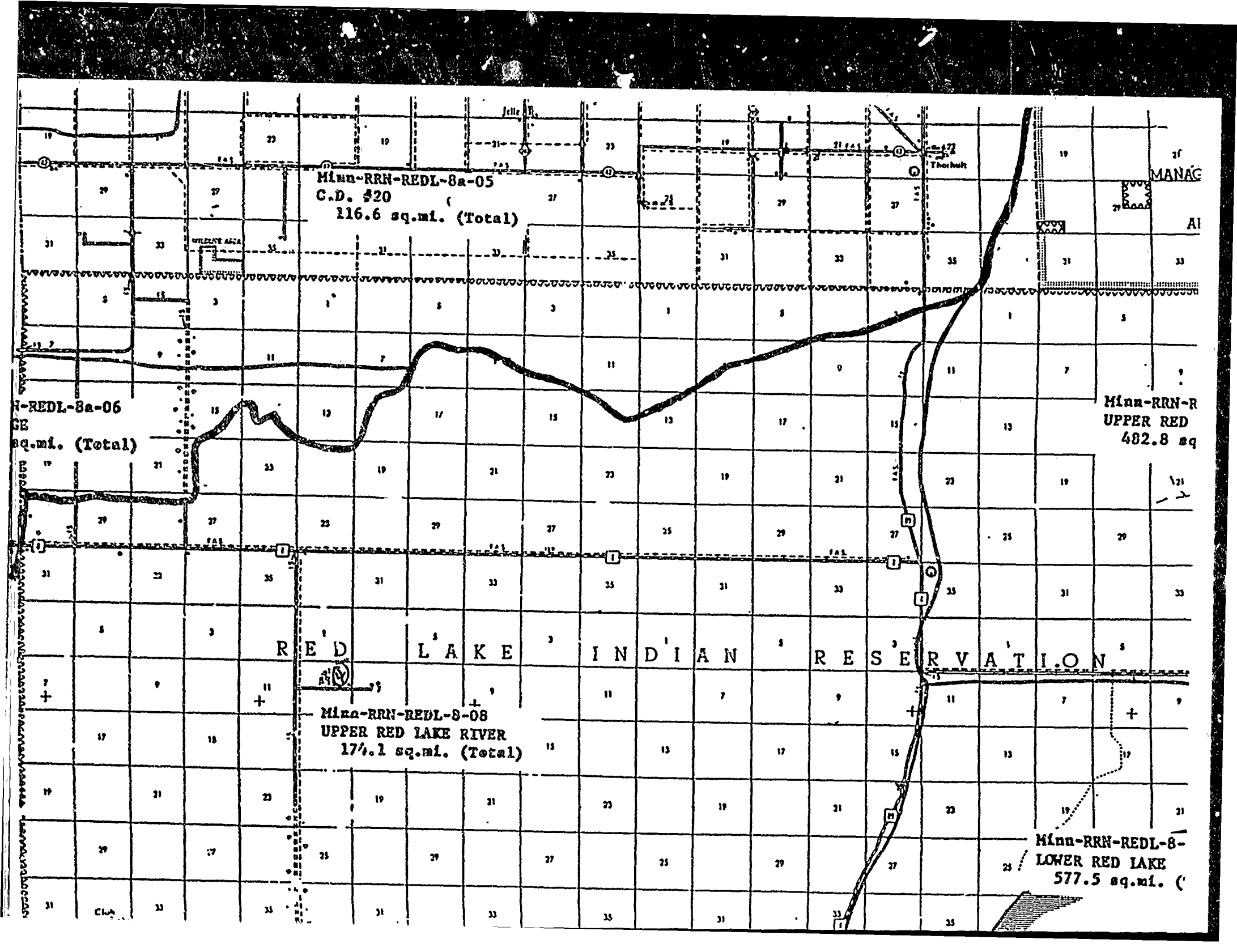
Encl

HELMER O. JOHNSON
Chief, Geotechnical, Hydraulics,
& Hydrologic Engineering Branch

Issue #1


Minn-UM-MISSISSIPPI-0-03
GRANT CREEK
0.2 Sq. Mi.
PI-0-02
Minn-RRN-REDL-9-08
UPPER RED LAKE RIVER
98.2 sq. mi.
Minn-RRN-REDL-8b-03
CLEARWATER RIVER
78.7 sq. mi.
R E D L A K E
I N D I A N R E S E R V A T I O N
H A N G A A R D
P E N N I N G T O N C O.
Club Lake
Indian L.
Mississippi Lake
Red Lake
Duck L.
Quarter Lake
Baker L.
Inset (1)


Minn-RRN-REDL-8a-05
C.D. #20
7.7 sq.mi.
Minn-RRN-REDL-8a-06
GOODRIDGE
75.9 sq.mi.
Minn-RRN-REDL-8-09
HIGH LANDING
73.7 sq.mi.
Minn-RRN-REDL-8-10
KRATKA
81.9 sq.mi.
Minn-RRN-REDL-8-08
UPPER RED LAKE RIVER
18.8 sq.mi.
Minn-RRN-REDL-8b-05
PLUMMER
NEW LOVER
GOODRIDGE
REINER
KRATKA
HIGH LANDING
STAR
TEMAY
DEER PARK
HIGH


Minn-RRN-REDL-8a-05
C.D. #20
116.6 sq.mi. (Total)
Thorhult
MANAG
AI
-REDL-8a-06
GE
sq.mi. (Total)
Minn-RRN-R
UPPER RED
482.8 sq
RED LAKE INDIAN RESERVATION
Minn-RRN-REDL-8-08
UPPER RED LAKE RIVER
174.1 sq.mi. (Total)
Minn-RRN-REDL-8-
LOWER RED LAKE
577.5 sq.mi. (

WORKING PAPERS (APPENDICES)

Appendix F - Coordination Letters

McNally

July 20, 1990

Plan Formulation Branch
Planning Division

Mr. Gerald F. Brun
Chairman
Red Lake Reservation
Red Lake, Minnesota 56671

Dear Mr. Brun:

I am writing to tell you about an upcoming Corps of Engineers water resources study we will be conducting for the Red Lake and Clearwater Rivers. This study was authorized by the U.S. Congress and is scheduled to begin in late July or early August. The study is scheduled to be completed within one year from the time it begins. The cost of accomplishing this initial study is totally a Federal expense.

The primary focus of the study will be to provide improved downstream flood control and to improve water supply. However, a number of other study purposes could be included (i.e., providing for fish and wildlife and improving recreation opportunities, etc.). We are very interested in getting the Red Lake Band's ideas regarding possible additional water resource studies that could be evaluated as part of this study.

Although this study has not yet begun, we are starting to contact interested parties to help identify specific water resource measures that might be evaluated as part of the study. A number of possible measures have already been identified. These measures include: 1) possible Lower Red Lake Dam outlet modifications and operating plan changes; 2) sediment dredging and aquatic weed control project in the Red Lake River at Thief River Falls; 3) channel improvements for flood control in the Red Lake River and in the Clearwater River; and 4) a connecting channel between the Clearwater and Red Lake Rivers. Other measures that would be of interest to the Red Lake Band could be added to the study, if that is the wish of the Band.

We recognize that some of the above measures identified for study could affect tribal lands and waters. I want to assure you that in any case the tribe will be kept involved throughout this study and that your full concurrence will be sought before any such projects would be constructed.

In order to discuss ideas the Band may have and to answer any questions regarding our upcoming study, we would like to meet with tribal representatives. Mary Schommer, our District Indian coordination representative, will be contacting you soon to see if you are interested in meeting and, if so, to determine the best time and location for the meeting.

We look forward to working closely with you to find mutually beneficial solutions to water resource problems in the Red Lake River and Clearwater River subbasins.

Sincerely,

Roger L. Baldwin
Colonel, Corps of Engineers
District Engineer

ROUTING AND TRANSMITTAL SLIP

Date: Weds. 25 July '90

TO: (Name, office symbol, room number, building, Agency/Post)	Initials	Date
1. ATTN: Mr. Q Brown		
2. U.S.D.I. - Bureau of Indian Affairs		
3. Minneapolis Area Office		
4. 15 South 5th St.		
5. Minneapolis, MN 55402-1020		

	Action		File	X	Note and Return
	Approval		For Clearance		Per Conversation
	As Requested		For Correction		Prepare Reply
	Circulate		For Your Information	X	See Me
	Comment		Investigate		Signature
	Coordination		Justify		

REMARKS

This is a copy of a recent letter which was sent to Chairman Brun. Mary Schommer, the Districts P.O.C. on Indian affairs, has contacted you by phone regarding this matter.

We will keep you informed of future coodination efforts that we undertake with the tribe ...

DO NOT use this form as a RECORD of approvals, concurrences, disposals, clearances, and similar actions

FROM: (Name, org. symbol, Agency/Post)

Edward J. McNally

Room No.—Bldg.

Phone No. 612 - 220-0387

5041-102

GPO : 1987 0 - 196-409

OPTIONAL FORM 41 (Rev. 7-76)
Prescribed by GSA
FPMR (41 CFR) 101-11.206

July 20, 1990

Plan Formulation Branch
Planning Division

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Chairman
Red Lake Reservation
Red Lake, Minnesota 56671

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The primary focus of the study will be to provide improved downstream flood control and to improve water supply. However, a number of other study purposes could be included (i.e., providing for fish and wildlife and improving recreation opportunities, etc.). We are very interested in getting the Red Lake Band's ideas regarding possible additional water resource studies that could be evaluated as part of this study.

Although this study has not yet begun, we are starting to contact interested parties to help identify specific water resource measures that might be evaluated as part of the study. A number of possible measures have already been identified. These measures include: 1) possible Lower Red Lake Dam outlet modifications and operating plan changes; 2) sediment dredging and aquatic weed control project in the Red Lake River at Thief River Falls; 3) channel improvements for flood control in the Red Lake River and in the Clearwater River; and 4) a connecting channel between the Clearwater and Red Lake Rivers. Other measures that would be of interest to the Red Lake Band could be added to the study, if that is the wish of the Band.

We recognize that some of the above measures identified for study could affect tribal lands and waters. I want to assure you that in any case the tribe will be kept involved throughout this study and that your full concurrence will be sought before any such projects would be constructed.

In order to discuss ideas the Band may have and to answer any questions regarding our upcoming study, we would like to meet with tribal representatives. Mary Schommer, our District Indian coordination representative, will be contacting you soon to see if you are interested in meeting and, if so, to determine the best time and location for the meeting.

We look forward to working closely with you to find mutually benericial solutions to water resource problems in the Red Lake River and Clearwater River subbasins.

Sincerely,

Roger L. Baldwin
Colonel, Corps of Engineers
District Engineer

MEMO FOR THE RECORD

15 June 1990

SUBJECT: Field Review of the Clearwater River and Red Lake River

1. On June 14, 1990, Chuck Workman and I traveled to Thief River Falls to meet with the Red Lake River Watershed District and to participate in the subject field reconnaissance.

2. At the Watershed Board meeting, Mr. Workman provided the Board with an overview of the process involved in conducting the upcoming Red Lake - Clearwater Rivers reconnaissance study. The study was briefly discussed.

3. I presented the findings and tentative recommendations of the Crookston flood protection reconnaissance study and answered a number of questions from board members about that study. Watershed District representatives have previously indicated a desire to be kept informed on our study progress at Crookston and have indicated that they will consider providing economic assistance to the City (non-Federal sponsor). No commitments were made, but the reaction of the board to the tentative study findings and recommendations seemed favorable.

4. From 1 p.m. to approximately 5 p.m. Mr. Workman and I traveled with board members as we were bused to a number of sites where possible project flood control measures should be evaluated during the upcoming Red Lake River - Clearwater River reconnaissance study. The possible measures for inclusion in the study included: 1) Outlet channel modifications a the Lower Red Lake Dam; 2) A possible change in the operating plan at the Lower Red Lake Dam; 3) Sediment dredging and aquatic plant control on the Red Lake River at Thief River Falls; 4) A connecting channel for flood reduction and low flow augmentation to be located between the Red Lake River and the Clearwater River; 5) Channel modifications in the Red Lake River and Clearwater River to improve flood control. A packet of information showing the areas visited is attached.

Edward J. McNally

Ed McNally
Study Manager (PD-PF)

1 Attachment

MEMORANDUM FOR THE RECORD September 4, 1990

SUBJECT: Initial Coordination Meeting with Red Lake Band of the Chippewa Indians Regarding the Red Lake and Clearwater Rivers Recon Study

1. On 29 August 1990 at 10:45am the subject meeting was conducted in the Natural Resource Building in Red Lake, Minnesota. A list of participants is attached as enclosure 1.

2. Corps representatives provided the tribal representatives with an overview of the Corps study process and described the study area and the water resource problems and opportunities as we now know them. Most of these problems and opportunities had been identified by the Red Lake Watershed District during a previous field trip and meeting with representatives of the Red Lake Watershed District. Some of the potential project features would be located within the Indian Reservation as currently envisioned. We assured the tribal representatives that tribal involvement and concurrence will be sought before any actions affecting the reservation lands are taken.

3. Corps representative told the tribal representatives that the Reconnaissance Study is in the scoping stage and that other measures of interest to the Red Lake Band could be added to the study. We requested that they discuss water resource problems and opportunities with the Tribal Council and then contact the St. Paul District's Indian coordination representative with their ideas and/or concerns. We will then address and incorporate these tribal inputs into the Red Lake and Clearwater River Reconnaissance Study. Corps representatives also indicated a willingness to meet with the Tribal Council to discuss ideas and concerns that they might have about this study. Tribal representatives felt that future meetings with the Tribal Council and the Tribal Chairman would be needed to fully inform them and to adequately obtain their inputs.

4. Tribal representatives indicated that the tribe was generally supportive of water resource developments which could be shown to have long-term wildlife and fish production potentials. They sited examples of recent water resource developments that have been constructed on the reservation. They indicated that the tribe might also be interested in developing additional water development projects if it could be shown that the projects would create more productive wet farmlands for wild rice and cranberry farming or would improve dryland farming areas on the reservation. They indicated that key tribal members were not pleased with the existing Corps marsh restoration project because it is not functioning as it was intended to. They indicated an interest in seeing a U.S. FWS representative that they have worked closely with in the past, involved in this study. They indicated that the tribe had not been

fully involved in the formulation of the Connecting Channel and Sayersville Impoundment Project being recommended by the Watershed District - But, they seemed willing to considered the plan if it could be shown to have significant long-term benefits the Band.

5. This initial coordination meeting could be best characterized as very constructive and friendly. Cooperative follow-up meetings with the initial meeting participants and with key tribal representatives were mutually promised.

Edward L. McNally
Study Manager (PD-PF)

Encl. 1
Roster

CF: All on Roster
Lawrence Bedeau

Mary Schommer	Tribal Coordinator
Ed McNally	Study Manager
Jim Rutak	Area Manager
John Florhaug	Wild Rice Manager
David Conner	Fisheries Biologist

Participant Roster
(Encl. 1)

CONVERSATION RECORD

TIME: 1:15 | DATE: 24 Sept '90

TYPE: ☐ VISIT ☐ CONFERENCE ☒ TELEPHONE ☐ INCOMING ☒ OUTGOING

Location of Visit/Conference:

NAME OF PERSON(S) CONTACTED OR IN CONTACT WITH YOU	ORGANIZATION (Office, dept., bureau, etc.)	TELEPHONE NO:
Brent Johnson	Watershed Dist.	218 681-5800

ROUTING	
NAME/SYMBOL	INT

SUBJECT: Background Data follow-up Call Clearwater & Red Lake River Recon

SUMMARY: I call Brent to ask him about what he has found re: econ, H&H, on Management Plans as background for Clearwater & RLR's recon. Said little econ but would get Charlie Johnson to put together the other info...

I also asked him to provide other info on projects proposed by Watershed District as Future condition background... He said he had provide similar info on Crookston and I indicated I would check and get back to him...

ACTION REQUIRED

Check Crookston files & return call...

NAME OF PERSON DOCUMENTING CONVERSATION	SIGNATURE	DATE
Edward L. McNally		24 Sept '90

ACTION TAKEN

SIGNATURE	TITLE	DATE

5027.1-101

CONVERSATION RECORD

TIME: 8:30 am | DATE: 21 Sept '90

TYPE: ☐ VISIT ☐ CONFERENCE ☒ TELEPHONE ☐ INCOMING ☒ OUTGOING

Location of Visit/Conference:

NAME OF PERSON(S) CONTACTED OR IN CONTACT WITH YOU	ORGANIZATION (Office, dept., bureau, etc.)	TELEPHONE NO:
Joe Gibson	MDNR	296-2773

ROUTING

NAME/SYMBOL	INT

SUBJECT: Coord. re: Clearwater & Red Lake River Project and Crookston Grant Requests...

SUMMARY

I call Joe to get info on subject above and obtained the following information:

1) MDNR Flood Hazard Mitigation Grants can be requested in succeeding years for $35,000 each year.

2) The FHM Grants should be requested this spring and $ could be available in Dec. '91. However, State budget trimming may impact this program!!

3) The application/Grant request needs to be well organized to allow for its acceptance but Crookston is a priority area!!

4) The Connecting Channel project was submitted for FHM $ but denied because of a poor submittal package. That does not preclude follow-up requests!

5) Numerous Watershed projects are on books (eg., Maple River) which could be worthy of review...

ACTION REQUIRED

None

NAME OF PERSON DOCUMENTING CONVERSATION	SIGNATURE	DATE
Edward L. McNally		21 Sept '90

ACTION TAKEN

SIGNATURE	TITLE	DATE

United States Department of the Interior

FISH AND WILDLIFE SERVICE

IN REPLY REFER TO:

TWIN CITIES FIELD OFFICE
4101 East 80th Street
Bloomington, Minnesota 55425-1665

FWS/AFWE-TCFO

JUN 28 1991

Colonel Roger L. Baldwin
District Engineer
U. S. Army Corps of Engineers
1135 U. S. Post Office and Custom House
St. Paul, Minnesota 55101-1479

Dear Colonel Baldwin:

This planning aid letter provides the preliminary views of the U. S. Fish and Wildlife Service (Service) with respect to the reconnaissance phase of a general design study that the St. Paul District has initiated for the Red Lake and Clearwater River basins in northwestern Minnesota. Our comments are based on the preliminary information recently provided by the Corps relative to this proposed study and generally address the work items listed in our scope of work for Fiscal Year 1991.

The study area essentially includes the central portion of the watershed of the Red Lake and Clearwater Rivers in Clearwater, Pennington, Red Lake and Polk Counties, Minnesota (see attached map). A number of water resource problems and needs have been identified and evaluated by the Corps within the study area. Some of the water resource problems being evaluated include such things as downstream flooding along the Red Lake and Clearwater Rivers, a need for low flow augmentation to improve the quality of the habitat for fish and wildlife resources along the Clearwater River, and problems associated with regulation of the reservoir of Upper and Lower Red Lake.

Various structural alternatives have also been evaluated by the Corps to reduce some of the above water resource problems in the study area. These alternatives included such things as channel improvements along both the Red Lake and Clearwater Rivers, a connecting channel between the Red Lake and Clearwater Rivers, modifications to the control structure on Lower Red Lake, restoration of Thief River Falls Lake and constructing upstream reservoirs along the Red Lake or Clearwater Rivers. However, only one of the above alternatives (modifications to the control structure on Lower Red Lake) was ultimately determined by the Corps to be economically feasible from a federal perspective and warrants further study. This alternative would only involve undertaking additional studies to determine how the existing gates of the control structure on Lower Red Lake can be modified so that they will operate more efficiently. The Corps has indicated that this would likely be done by installing a new "automated" electrical system of motors and other electrical equipment so that the gates of the control structure

JUL 5 1991

can be operated (opened or closed) from a remote location. The recommended alternative would not require any change in the existing reservoir operating plan for Upper or Lower Red Lake or downstream on the Red Lake River. A significant amount of high quality fish and wildlife habitat is found within the study area. Of particular environmental concern to both the Minnesota Department of Natural Resources and the Service is that no actions be undertaken by the Corps that would inappropriately degrade either of the Upper or Lower Red Lakes, the Red Lake River, the Clearwater River or any other important fish and wildlife habitat. However, based on the information recently provided to the Service by the St. Paul District relative to this general design study, we concur that the alternative that is being recommended by the Corps for further evaluation, even if it is ultimately implemented, should have no more than a minimal,if any, adverse impact on the fish and wildlife resources within the study area. We will provide the St. Paul District with more specific resource information and environmental concerns within the study area, if deemed necessary, and our final comments and recommendations, when more detailed information becomes available relative to the recommended alternative plan during the next phase(feasibility phase) of this study.

Clearwater County is within the breeding range of the bald eagle, a federally listed threatened species, and Clearwater, Pennington, Red Lake and Polk Counties are all within the peripheral range of the federally threatened gray wolf. Polk County also contains remnant populations of the western prairie fringed orchid, another federally listed threatened species. However, because of the type of activity being proposed, the proposed action will not affect the bald eagle, gray wolf, western prairie fringed orchid or any other federally listed or proposed threatened or endangered species or their critical habitat. This precludes the need for further action on this project as required under Section 7 of the Endangered Species Act of 1973, as amended. However, if the project is modified or new information becomes available which indicates that listed or proposed species may be affected, consultation with this office should be reinitiated.

These comments have been prepared under the authority of and in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; U.S.C. 661 et seq.), the National Environmental Policy Act and the Fish and Wildlife Service's Mitigation Policy. This proposal was also examined for its conformance with the Endangered Species Act of 1973, as amended and Executive Orders 11988 and 11990.

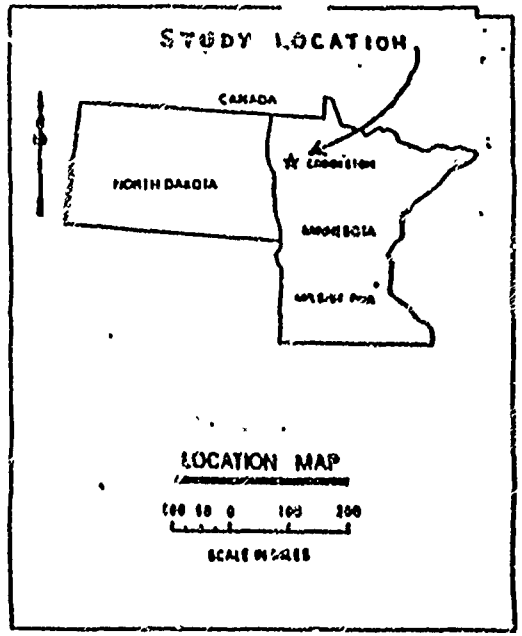
Sincerely,

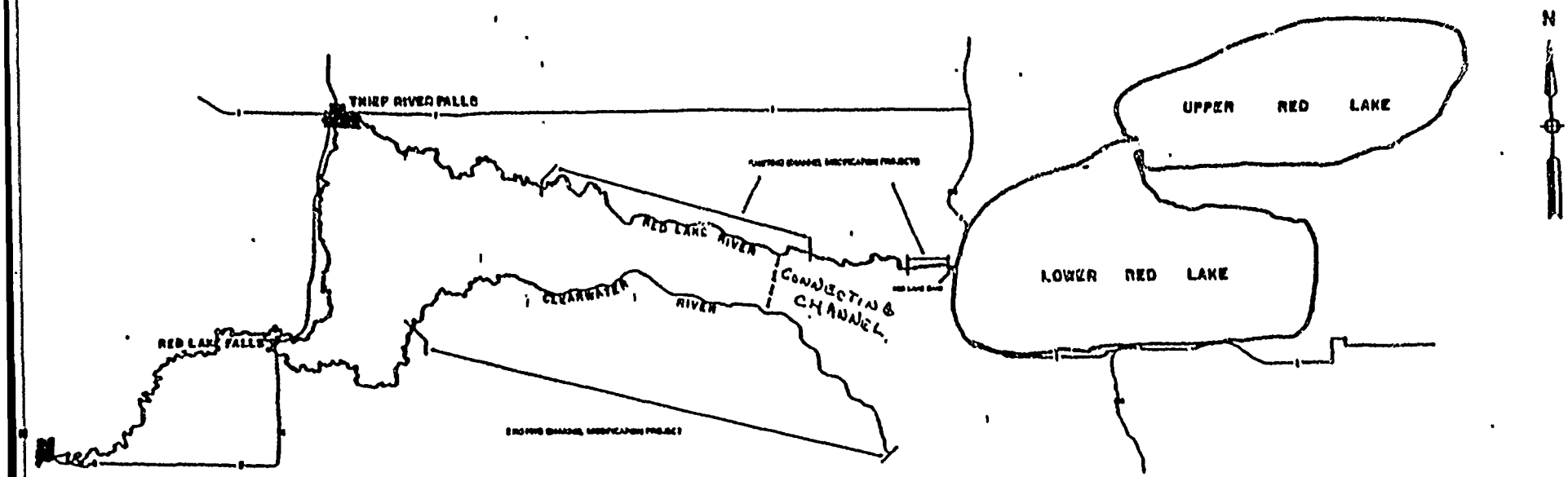
James L. Smith

for Lynn Lewis
Field Supervisor

Enclosure

cc: Steve Colvin, MN Dept. of Natural Resources, St. Paul
Paul Stolin, MN Dept. of Natural Resources, Bemidji
Louis Flynn, MN Pollution Control Agency, St. Paul
Ted Rockwell, U.S. Environmental Protection Agency, St. Paul





RED LAKE AND CLEARWATER RIVERS MN

MEETING ROSTER

Date: APRIL 11, 1991

Location: RED LAKE WATERSHED DISTRICT OFFICE

Subject: RED LAKE & CLEARWATER RIVERS STUDY COORDINATION MEETING

Participants:	Office:	Telephone #:
Ed McNally	Corps of Eng.	779-9136
Damian Yerbich	" " "	612-720-0580
Richard Engelby	Red Lake Watershed	218-294-6286
[illegible]	Red Lake Watershed	218-796-5126
Eleanor Swanda	Red Lake Watershed	218-435-6534
Leonard Mor	Red Lake Watershed	218-294-6188
Bernard Rose	Red Lake Watershed	218-281-2807
[illegible]	"	218-776-3580
Lowell C Enerson	" "	218-681-5800
Arnold Penson	" "	218-796-5126
KEVIN ADALES	" "	218 681-5800
Ed Stucy	Committee Member	218 378 4223
Greg Hitzeman	Clearwater River Advisor	218-796-5395
[illegible]	Chairman of Red Lake River	218-796-5548
John Jensen	Ex. Com. Pennington County	218-478-4203
Larry Lane	Penn. Soil & Water Dist	218-681-3348
Bob Melden	Wild Rice Farmer-Clearwater River	218-776-3260
Cleatus Stenerson	Co Comm Clearwater Co	218-776-3778
Mark Thul	LRRWMB & MN DNR	218-755-3639
Art Seibel		
	Co. Com. Red Lake	219 2534120
Goldie Larson	Co. Com. Red Lake Co	218-796-5216
Donald Barron	City T. R. Falls Alternate	218-681 3684-6901
JOHN GUNVALSON	WILD RICE GROWER, CLEARWATER RIVER	advisor 218-268-4415

MEETING ROSTER

Date: APRIL 11, 1991

Location: RED LAKE WATERSHED DISTRICT OFFICE

Subject: RED LAKE & CLEARWATER RIVERS STUDY COORDINATION MEETING

Participants:	Office:	Telephone #:
Milton Burstad	Thief River Falls Councilman	218-681-1109
KENNETH D. MURPHY	PENNINGTON Cty COMMISSIONER	218-681-3366
Albert [illegible]	[illegible] Co. Commissioner	218-681-0278
Clifford Arveson	Trail MN	218-796-5411
John Hoffman	Viewer assn. [illegible]	218 778-4178

MEETING ROSTER

Date: APRIL 11, 1991

Location: RED LAKE LIBRARY

Subject: RED LAKE & CLEARWATER RIVERS STUDY COORDINATION MEETING

Participants:	Office:	Telephone #:
Ed McNally	Corps of Eng.	612-220-0387
BILL HALLETT	RED LAKE BAND OF CHIPPEWA	218-679-3341
Gregg Struss	U.S.C.O.E REMER, MN.	218-566-2306
Q BROWN	USDI-BIA MPLS AREA	612-373-1143
Joel Rohde	Red Lake DNR - Ag. Biologist	679-3959
DAVID CONNIER	RED LAKE DNR	679-3959
John Florhaug	Red Lake DNR R.L. Farms	679-3959
BOBBY WHITEFEATHER	RED LAKE TRIBAL COUNCIL	679-3341
Damian Yerbich	Corps of Engineers	612-220-0580
Gerald F. Wilson	Red Lake Min	679-3341
John Lambert	BIA / Bemidji	218-751-2011

Red Lake Watershed District

102 North Main Avenue
P.O. Box 803
Thief River Falls, MN 56701
(218) 681-5800
(218) 681-5839 FAX

April 30, 1991

Mr. Ed McNally
US Army Corps of Engineers
1421 USPO & Custom House
St. Paul, MN 55101-1479

Dear Mr. McNally:

First of all, let me say thank you for your visit to our Board meeting on April 11, 1991, and for your report on the reconnaissance study for the Red Lake and Clearwater Rivers in the Red Lake Watershed District. We appreciate your concern and support for good, sound water management.

Our Board of Managers are in support of the remote control operation of the dam, and the other phases of the reconnaissance study. We feel that there are some additional benefits and some errors that you should know about. On the Red Lake and Clearwater Rivers you stated that there were no flooding problems downstream from where the channel dredging ends. The Board of Managers state that flooding does occur downstream from where the dredging ended and that your report did not address this. We feel it would be beneficial to dredge the channel on the Clearwater River to Highway 59. The channel dredging on the Red Lake River should be extended to the Kratka Bridge. If channel dredging cannot be deamed feasible, cleaning and snagging should be considered for that undredged portion that I mentioned above.

We have no problem with the channel enlargement phase as far as the cost benefit ratio.

Under Potential Adverse Impacts, 2A, we don't feel that this will have an increase in damage to the fish habitat because we are not changing the operating range.

Under Item 3A, we do not feel there will be any adverse impacts upstream on the Clearwater Rivers in regard to the trout streams. This is downstream of the dam and will have absolutely no effect.

Under Item 3B, we don't feel that that is an accurate statement because there would be benefits in spring if there was a low water supply and that most paddies are being drained during what you refer to as late summer.

Under Item 3C, we do not agree with your statement that wild rice decreases the water quality. The study that was completed was not comprehensive enough to identify the point source. The water quality study that we are now participating in with the Minnesota Pollution Control Agency should better quantify the impacts of wild rice on the water quality in the Clearwater River, and we will supply you with the results when available.

Under Item 3D, we feel that the diversion channel will not create a wetland loss but, if so, it would be minimal and we could definitely mitigate any losses.

Under Item 3E, at this point the Sayersville Impoundment on the Red Lake Indian Reservation is not a part of our plans for the project, but if we do, we do not feel that there will be a problem from floating peat. If you take note of the fact that there are over ten thousand acres of wild rice, there is a minimal amount of floating peat on these ten thousand acres.

Under Item 3F, we will not have an impoundment; so, therefore, the concern of fisheries is not of concern for this report. If we were to have an impoundment, I wonder where you have come up with the fact that there will be exotic fish raised there that would be detrimental to any of the species in either the Red Lake or Clearwater Rivers.

Under the Potential Beneficial Impacts, number 3, the diversion channel, letter A, the very last sentence, we feel there would be benefits obtained by reducing the high flows in the Red Lake River and would benefit the Clearwater River.

Under the category "Recreational Assumptions", we feel with a diversion channel we could provide more constant flows that would be beneficial for the recreational use on the Red Lake River, which is primarily tubing around the City of Red Lake Falls. We also feel that this could help manage the high water levels on Upper Red Lake. Also, we note in here that you have not addressed the fact that the rice paddies are a benefit to flood control. We also feel that you should address the economic impact of the rice operation. We feel that the wild rice growers have summarized the economic portion that should be included in your reconnaissance study. As we discussed on the telephone, I hope that you will incorporate the economic benefits of the wild rice operation. Also, as you mentioned in our telephone conversation, you should look at the wildlife benefits, especially at the waterfowl population.

Under your paragraph that you stated you feel you were very conservative on construction costs, we feel that you are very liberal on the construction cost of this project. Where you state that your benefits are very liberal, we think they are extremely conservative since you have not taken into account the economics of wild rice or waterfowl benefits.

Under the heading "Effects on Recreation" your statement where you say that when water is diverted from Red Lake to Clearwater River in low flows it would have a diverse effect of recreational use on the Red Lake River is incorrect because we agree and feel that when a connection channel is built there will be a protected low flow on the Red Lake River that will meet all recreational needs.

We feel the agricultural aspect is an important scenic part of the United States and that we do not have to have the entire U.S. in its natural state. The definition of scenic is "in the eyes of the beholder" and, hopefully, in considering projects the US Army Corps of Engineers will share this view.

Again, I appreciate your visit and the fact that the District Corps offices are located in Minnesota. I hope that the final report of the reconnaissance study will be changed to be more accurate to the true cost of the benefits under the connection channel.

If you have any questions, please feel free to contact me.

Sincerely,

Lowell C. Enerson

Lowell C. Enerson
Administrator

LCE:sr

SUMMARY OF COMMENTS SUBMITTED TO THE RED LAKE WATERSHED DISTRICT BY CLEARWATER RIVER RICE GROWERS ON THE ARMY CORPS OF ENGINEERS DRAFT REPORT ON THE CLEARWATER RIVER AND RED LAKE RIVER CONNECTION CHANNEL - APRIL 23, 1991

1.) The Army Corps study states that wild rice paddy return flows are detrimental to the Clearwater River. Every study that we know of has found that return flow waters have tested to be of good quality. They also augment flows during normal low flow times, thus improving the river.

2.) No mention of the flood control benefits provided by the wild rice farms was made in the Army Corp's report. This should be a federal benefit as the Red River floods lands and cities, notably Grand Forks, in both North Dakota and Minnesota This flood control is at no cost to the taxpayer

3.) No credit is given the wild rice paddies for creating waterfowl habitat. The Federal Waterbank program is federally funded, as is the CRP which now accepts wetlands. If an average CRP contract is $50 per year and 12,000 acres (acreage of wild rice paddies along the Clearwater River) were restored under this program, a $600,000 annual payment would be paid out in addition to the cost sharing funds paid out to restore the wetlands.

4.) Wild rice production acres in Minnesota have not increased in the last several years due to low prices, not lack of water. Wild rice acreage along the Clearwater River is not likely to increase significantly as a result of the connection channel unless there is a price increase in wild rice, which is not probable. A more likely occurrance would be a significant number of growers going out of business due to a combination of low prices and low water availability. Keeping the existing paddies in production provides significant local benefit. Flood control and migratory waterfowl production are federal benefits.

Respectfully submitted by:

Gunvalson & Imle Farms

Pine Lake Wild Rice Farms

Gunvalson Bros. Farms

Clearwater Rice, Inc.

SUPPORTING COMMENTS SUBMITTED TO THE RED LAKE WATERSHED DISTRICT BY CLEARWATER RIVER RICE GROWERS ON THE ARMY CORPS OF ENGINEERS DRAFT REPORT ON THE CLEARWATER RIVER AND RED LAKE RIVER CONNECTION CHANNEL - APRIL 23, 1991

Wild rice growers attending the Red Lake Watershed meeting on April 11, 1991, were dissapointed in the Army Corps' preliminary report on the connection channel. We feel that a response is necessary to counter misleading information in the report.

We growers feel that a connection channel would be helpful as a supplemental supply of water to the Clearwater River. We realize that it would not help us through every drought situation, but due to the long drawdown time of Red Lake when it gets overfull, it is possible to have water shortages on the Clearwater River and relatively high flows on the Red Lake River simultaneously. Fall flooding is also desirable to wild rice growers. If the connection channel made water available in the fall, growers would gladly take advantage of the opportunity to pump it then as a hedge against shortages in the spring.

Given the past crop losses farmers have suffered as a result of the Red Lake River flooding, digging the channel makes economic sense. From a fisheries standpoint it has always been the position of the DNR personnel with whom we have dealt that higher water levels in the Clearwater River were desirable for fish and recreation. If that is true, the DNR should be supportive of the project.

The Army Corps' position is that if the project has no net monetary gain at a federal level, it isn't considered feasible. Therefore, helping to stabilize a water source that provides $3-$4 million annually to a depressed economy has no value, because if Minnesota doesn't grow the wild rice, California will. On the Red Lake River crop losses on only the actual flooded area are considered, although the whole eastern Pennington County drainage system would function better if the Red Lake River remained in its channel. Of course, if crop yields are reduced in Pennington County, North Dakota can make up the difference, so there is no federal benefit.

The $273,000 projected cost for clearing a few acres of brush seems high, as does the $104,000 for reseeding the construction area. We would recommend that the excavation costs be compared to those of the recently completed Moose River and Good Lake projects to see if the Army Corps cost estimates are in line.

To us the most disturbing part of the report are the statements concerning flow rates on the Clearwater River and water quality concerns. Under the heading Recreation Assumptions the study states, "The fishery is considered poor, primarily due to water levels and water quality problems." Later in the same paragraph it states, "The fisheries in the Clearwater River would improve if adequate flows were provided during

A different part of the study titled Potential Adverse Impacts of Proposed Alternatives states that "Increased discharges in Red Lake (River) and Clearwater (River) could damage fish habitat. Fish have optimums for velocity and substrate which could be exceeded by increased discharges." The DNR has maintained for years that historic inflows and velocity on the Clearwater River are lower than optimum and have desired increased flows to enhance fish habitat.

The fact of the matter is that the Clearwater River has limited potential as a fishery even with optimum flows. The fishery potential was destroyed when the Army Corps dredged and straightened it forty years ago turning it into a silt bottomed drainage ditch. The undredged part of the river to the west also is affected because silt and dissolved solids are picked up as water passes through the dredged portion. Before the dredging the meandered Clearwater River flooded over its banks, which allowed silt deposits to settle out on riparian acreage. The river water was able to maintain its clarity and aesthetic appeal. The riparian wetlands or meadows which flooded during high flows allowed sediment to settle out. When the channel was straightened, this desedimentation process was lost, and instead a faster flow with increased erosion resulted in a river carrying a heavier sediment load. Increased agricultural activity in recent years also adds to sediment in the river

We growers feel that the DNR, influenced perhaps by people further west who remember the river before it was dredged, blame wild rice growers for the Clearwater River not being the same river it was 50 years ago. A survey of the river reveals that the largest silt deposits are in the upper part of the dredged portion. This silt is working its way west down the channel. This would occurr with or without wild rice farming. If anything, grower appropriation slows down the silt transfer due to reduced flows. We agree that the dredging and resultant erosion is a negative impact to the fishery. However, rice growers didn't dredge the river and, if there is a negative impact on the water as it flows through the dredged channel, it more likely comes as a result of the dredging than as a result of wild rice growing.

Section 3 c. states that according to the DNR "the discharge from the wild rice paddies is detrimental to the water quality of the Clearwater River." Every study that we are familiar with, including the Minnesota Pollution Control Agency report of October 1979, states that this is not the case. The 1979 study states that return flows from wild rice paddies appear to threaten water quality only where discharges enter small lakes low in phosphorus. All reports that we are aware of indicate paddy discharge waters are well within acceptable limits. We question where the Minnesota DNR got their information and how they concluded that wild rice paddies are detrimental to water quality.

It has been our understanding that at least some water would be diverted to the Clearwater River when the Red lake River is moderately low during seasons when tubing is not a priority. It seems the Army Corps' study has been done using a somewhat higher flow on the Red Lake River before any transfer takes place.

The study is conspicuous in its oversight of the benefits provided to migratory waterfowl by wild rice paddies. Paddies provide a staging area for thousands of swans and tens of thousands of ducks and geese. Abundant food is available in the paddies helping waterfowl to replenish their energy levels, enabling them to lay large clutches of eggs. Many geese and ducks remain to nest in adjacent uplands. Tundra Swans, numbering in the thousands, stay in the paddies about six weeks each spring. Organizations such as the Nature Conservancy, as well as the government, spend millions restoring wetlands that do this. Our paddies should be given equal value to one of these projects. We have no reason to believe that nesting success adjacent to our paddies is anything but good. Once the ducklings and goslings enter the paddies after they are hatched, they are in an ideal environment that is free of predators and contains abundant food. Ditches within paddies remain flooded throughout the summer and fall. Ducks fly up from these ditches ahead of our combines or sun themselves on mud flats far out in our paddies, far from terrestrial habitat where predators could be a factor. Peregrine falcons take a few ducks, bald eagles scare them and may kill a few, but the only dead ducks, feathers, etc., that we can find are those that hit power lines.

During periods of drought, county ditches adjacent to paddies flow, while those not supplemented by paddy seepage are less likely to. If there is any chance of a fish spawning in the dredged portion during low flows, it's likely that this seepage, albeit small, is a benefit that wouldn't be there without the paddies.

ABOUT 1,200 SWANS AND SEVERAL THOUSAND MALLARD DUCKS FEED ON WILD RICE IN THIS 48 ACRE PADDY

THOUSANDS OF TUNDRA SWANS UTILIZE CLEARWATER AREA PADDIES FOR WEEKS IN THE SPRING