US Army Corps
of Engineers®
St. Paul District

WATER CONTROL MANUAL

MISSISSIPPI RIVER HEADWATERS PROJECT

GULL LAKE DAM AND RESERVOIR

GULL RIVER
MINNESOTA

JANUARY 2003

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U.S. ARMY CORPS OF ENGINEERS

ST. PAUL DISTRICT

ST. PAUL, MINNESOTA

January 2003

GULL LAKE DAM AND RESERVOIR

NOTICE TO USERS OF THIS MANUAL

This manual has been reviewed and approved by the Mississippi Valley Division Office. If the pending legislation of the Water Resource Development Act changes operating levels or notification procedures, these manuals will have to be revised to reflect those changes.

Corps of Engineers regulations specify that this Water Control Manual be published in loose-leaf form to facilitate modifications. In the future, only those sections, or parts thereof, requiring changes will be revised and replaced.

Two documents used in anticipated low and high pool levels are presented in Exhibit D as Reference No. 12 and contain the latest regulations from Congress.

Exhibit D, Reference No. 12a. A copy of Public Law 100-676, Section 21, November 17, 1988, Water Resources Development Act of 1988 (WRDA 1988) regarding the headwaters of the Mississippi.

The goal of this law is to require the Secretary of the Army to notify Congress when the specified operating limits (both high and low) where going to be exceeded. The references "contingency plan" is included below as Reference 12.b.

Exhibit D, Reference No. 12b. A copy of the Reservoir Regulation Contingency Plan for the Mississippi River headwaters Reservoirs prepared to comply with the Water Resources Development Act of 1988 (WRDA 1988), Public Law 100-676, Section 21of November 17, 1988 (see Reference 12.a.).

Note. The information used to write this document was extracted from draft copies of the Water Control Manual (dated approx. 1986). The draft manuals contained errors which also appear in the Contingency Plan. Pokegama's upper notification limit should be elev. 1278.42 ft. (not 1276.42) and the dam should be wide open at 1278.42 ft. (not 1277.92). Sandy's upper notification limit should be elev. 1221.31 ft. (not 1218.31). Pine's upper notification limit should be elev. 1235.30 ft. (not 1234.82) due to the dam safety rehabilitation.
These errors are highlighted throughout the manual. When the pending WRDA is approved, these errors will be corrected and revisions will be made to this manual.

HYDRAULICS AND HYDROLOGY BRANCH
EMERGENCY REGULATION ASSISTANCE PROCEDURES

In the event that unusual conditions arise during normal business (duty) hours, contact can be made by telephone to Water Control (651.290.5617) or the District Communication Center's VHF-FM radio (call signal WUG6, Hastings, MN). Water Control's radio call signal is WUG613 (St. Paul, MN). During non-duty hours assistance can be achieved by contacting, in the order listed, one of the following persons. Their duty hour (work) phone numbers are also listed. See also **Tables 1-1 and 5-4.**

Name		Number
Jodi Kormanik,	Headwaters Project Regulator	Work 651.290.5646 [redacted]
Farley Haase,	Headwaters Project Regulator	Work 651.290.5633 [redacted]
Vacant	Chief, Water Control Section	Work 651.290.5610
Ferris Chamberlin,	Hydraulic Engineer	Work 651.290.5619 [redacted]
Michael Knoff,	Chief, Hydraulics and Hydrology Branch	Work 651.290.5600 [redacted]
Michael Bart,	Chief, Engineering Division (Dam Safety Officer)	Work 651.290.5303 [redacted]

Mississippi River Headwaters Project
Gull Lake Dam and Reservoir
Gull River

U.S. Army Corps of Engineers
St. Paul District
January 2003

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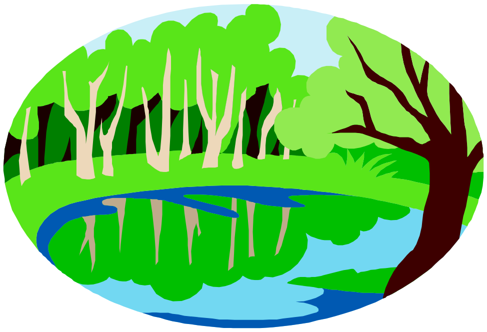

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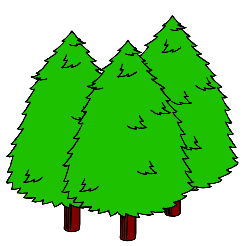


National Geodetic Vertical Datum Reference

All elevations in this manual use the 1929 National Geodetic Vertical Datum (1929 NGVD) unless otherwise stated.

Metric Equivalents and Conversions

Length:

1 Centimeter = 0.394 inches
1 meter = 3.2808 feet
1 kilometer = 0.621 miles

Area:

1 square mile = 640 acres = 2.59 kilometer^2
1 meter^2 = 10.764 feet^2
1 kilometer^2 = 0.386 miles^2
1 hectare = 2.471 acres

Volume/Flow:

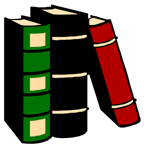
1 cfs = 448.831 gallons per minute
1 cfs x 1 day = 1 SFD = 86,400 ft^3
1 SFD = 1.9835 acre-feet
1 sq. mi. inch = 26.9 SFD
1 acre-foot = 43,560 ft^3 = 325,900 gallons
1 meter^3 = 35.31 feet^3
1 meter^3 = 1.308 yards^3
1 meter^3 = 0.81 x 10^{-3} acre-feet
1 meter^3/second = 35.31 feet^3/second

Temperature:

(Degrees Fahrenheit - 32)/1.8 = Degrees Celsius

World Wide Web Internet Address

http://www.mvp-wc.usace.army.mil



I - INTRODUCTION

1-01. Authorization. This manual was prepared in compliance with the following guidance: 1) Engineering Regulation 1110-2-240, titled "Water Control Management", dated 30 April 1987; 2) Engineering Manual 1110-2-3600, titled "Management of Water Control Systems", dated 30 November 1987; 3) DIVR 1110-2-240, 5 August 1992; 4) Engineering Regulation 1110-2-8156 titled, "Preparation of Water Control Manuals", dated 31 August 1995.

The previous manual (1963 Master Regulation Manual) for the Mississippi River Headwaters Reservoirs was authorized by multiple letter from the Office, Chief of Engineers, dated 8 May 1951, to the Division and District Engineers, subject: Operation of Flood Control Reservoirs, Re-submission of Reservoir Regulation Manuals, as required by Engineering Manual 1110-2-3600, **Chapter 6**, dated 25 May 1959.

1-02. Purpose and Scope. The purpose of this manual is to provide guidance and instruction for project personnel and as a reference source for others who may be involved with, or affected by, project regulation. The manual is for daily use in Water Control Section activities for essentially all foreseeable conditions. The scope of this manual covers all water control management activities as they relate to the hydraulic and hydrologic aspects of the project.

1-03. Related Manuals and Reports. The 1963 Master Regulation Manual, referred to in **Paragraph 1-01**, contained the Water Control Plan for all six reservoirs. It is now superseded by individual Water Control Manuals for each of the six Mississippi Headwaters reservoirs. The basic Water Control Plan in the 1963 manual remains unchanged in the individual manuals with the following notable exceptions: Lake Winnibigoshish's summer operating band was lowered one foot in 1975, and Pine River/Cross Lake's upper operating limit was raised 0.48 feet as a result of dam safety work, which was completed in 2002. Prior reports pertinent to this manual are as follows:

a. The Engineer Corps Manages Water: Problems of the Mississippi River and Six Reservoir Lakes, Conservation Volunteer, Minnesota Conservation Department, Robert Bulesmeier, Chief, Reservoir Management Section, St. Paul District, U.S. Army Corps of Engineers, July-August 1957.

b. The Upper Mississippi River Reservoirs, Gopher Historian, Lucile M. Kane, Manuscripts Curator, Minnesota Historical Society, Spring 1962.

c. Master Reservoir Regulation Manual, Headwaters Dams and Reservoirs, U.S. Army Engineer District, St. Paul, Corps of Engineers, St. Paul, Minnesota, April 1963.

d. Multiple Use Survey, Winnibigoshish and Leech Reservoirs, Report prepared by Chippewa National Forest, North Central Region, Milwaukee, Wisconsin, in cooperation with the Corps of Engineers, United States Department of the Army, (undated, however received by the Corps on 25 August 1965).

e. Master Reservoir Regulation Manual, Headwaters Dams and Reservoirs, U.S. Army Engineer District, St. Paul, Corps of Engineers, St. Paul, Minnesota, April 1963 (revised 19 February 1968).

f. Environmental Review of the Headwaters of the Mississippi River Reservoir Projects, Bemidji College, 1973.

g. Review of Design Features of Existing Dams at Mississippi River Headwaters Reservoirs, RCA ENGCW-(OT)761, St. Paul District, Corps of Engineers, March 1974.

h. Finding of Fact, Environmental Impacts of Operation and Maintenance Activities, Mississippi Headwaters Reservoirs, North Central Minnesota, Prepared in accordance with paragraph 4b(2) of Engineer Regulation 1105-2-507, Conclusion: an Environmental Impact Statement (EIS) was not required under the provisions of Section 102 of the 1969 National Environmental Policy Act (NEPA), Public Law 91-190, Signed by Colonel Max W. Noah, St. Paul District Commander, U.S. Army Corps of Engineers, 18 April 1975.

i. Mississippi River Headwaters - Master Plan for Public Use Development, St. Paul District, Corps of Engineers, August 1977.

j. Effect of Different Operating Plans for the Six Mississippi River Headwaters Dams, Saint Anthony Falls Hydraulic Laboratory Project Report No. 184, University of Minnesota, 1979.

k. Creativity, Conflict and Controversy: A History of the St. Paul District, U.S. Army Corps of Engineers, Raymond H. Merritt, U.S. Government Printing Office, 1979, 667-718.

l. Limnological Study of Reservoirs in Minnesota, North Dakota and Wisconsin Operated by the St. Paul District, U.S. Army Corps of Engineers, Robert O. Megard, Department of Ecology and Behavioral Biology, University of Minnesota, Final Report for Government Contract No. DACW37-78-C-0167, November 1980.

m. Mississippi River Headwaters Lakes Feasibility Study, Main Report and Appendices, Two Volumes, St. Paul District, Army Corps of Engineers, 1982.

n. Computer Operations Study of Reservoir Operations for Six Mississippi River Headwaters Dams, Final Report and Appendices, Three Volumes, St. Paul District, Corps of Engineers, 1982.

o. Area-capacity Table Reevaluation for the Mississippi River Headwaters Study, St. Paul District, Corps of Engineers, August 1983.

p. Reservoir Regulation Contingency Plan, Mississippi River Headwaters Reservoirs, Prepared to Comply with the Water Resources Development Act of 1988, Public Law 100-676 (November 17, 1988), Section 21, Department of the Army, Corps of Engineers, St. Paul District, St. Paul, Minnesota, April 1989.

q. Mississippi River Headwaters Lakes in Minnesota - Low Flow Review, St. Paul District, Corps of Engineers, October 1990.

r. Drought Contingency Plan, Appendix DCP to the Gull Lake Dam and Reservoir Regulation Manual, Mississippi River Headwaters, Corps of Engineers, St. Paul District, September 1992 (Draft). (This draft was never officially incorporated as an appendix. The final will be a stand-alone document.)

s. Operational Management Plan, Gull Lake Dam and Reservoir, Corps of Engineers, St. Paul District, June 1993.

t. Dam and Damages: The Ojibway, the United States, and the Mississippi Headwaters Reservoirs, Minnesota History, Minnesota Historical Society, Jane Lamm Carroll, Historian, St. Paul District, U.S. Army Corps of Engineers, Spring 1990.

u. Water Available from the Mississippi River at Minneapolis and Other Upstream Minnesota Locations During Low Flow Conditions, Section 22 Report, Corps of Engineers, St. Paul District, September 1994.

v. System-Wide Low-Flow Management Plan, Mississippi River above St. Paul, Minnesota, Interagency Agreement, September 1996.

w. The Rhetoric of Reservoirs, Minnesota History, Minnesota Historical Society, David R. Treuer, Leech lake Reservation, Leech Lake Tribe of Ojibway, Winter 1992.

x. Emergency Plan for Gull Lake Dam and Reservoir, St. Paul District, Corps of Engineers, March 1999.

1-04. Project Owner. The United States Government is the owner of the project.

1-05. Operating Agency. The U.S. Army Corps of Engineers, St. Paul District, Construction-Operations Division, is responsible for the operation and maintenance of the Gull Lake Dam and Reservoir Project. Regulation instructions for the project are provided by the District's Engineering Division Water Control Section.

The Manager is stationed at Gull Lake Dam. The Operational Project Manager, Headwaters Project Office is located at Pokegama Lake Dam. Information on contacting the Manager and the Operational Manager is listed in **Table 1-1**.

Table 1-1

Project Office Points of Contact

Name	Number
Manager - Vacant 10867 East Gull Lake Drive Northwest Brainerd, Minnesota 56401-9413	Work 218.829.2797 After hours 218.829.2166 Cell Phone 651.261.2568 Fax No 218.828.0121 VHF Radio WUG 635 FM Radio 6350
Robert Espenson, Assistant	Work 218.829.3334 After hours 218.963.4990
John O'Leary, Operations Project Manager Headwaters Projects Office Pokegama Lake Dam 34385 Highway No. 2 West Grand Rapids, Minnesota 55744-9663	Office 218.327.4027 Cell Phone 651.261.6030 Fax 218.327.3162 VHF Radio WUG 639 Mobile Radio 6390

1-06. Regulating Agency. The regulation of the project is under the supervision of the Water Control Section within the St. Paul District, U.S. Army Corps of Engineers. Information on contacting Water Control is listed in the introduction to this manual.

II - DESCRIPTION OF PROJECT

2-01. Location. Gull Lake Reservoir is part of the Mississippi River Headwaters basin and is located in the extreme southern portion of Cass County, eight miles northwest of Brainerd, Minnesota. The dam is on the Gull River about one-half river mile below the outlet of Gull Lake, 11 river miles upstream of the junction with the Crow Wing River, 16 river miles upstream of the junction of the Crow Wing and Mississippi Rivers, approximately 167.1 river miles upstream of St. Paul, Minnesota, and at river mile 1006.4 above the mouth of the Ohio River. The General Location Map and General Plan are presented on **Plates 2-1 and 2-2**, respectively.

2-02. Purpose.

a. Flow Augmentation for Navigation. The original authorized purpose of the six Headwaters Reservoirs, as authorized in the Rivers and Harbors Act of 1880, Public Law # RHA 1880, was to increase Mississippi River discharges during low-flow periods to aid navigation between St. Paul, Minnesota, and Lake Pepin, near Lake City, Minnesota (see **Paragraph 3-02**). However, the need for flow augmentation from the reservoirs was greatly reduced after completion in the 1930's of the Mississippi River 9-foot channel project, the system of 29 locks and dams from Minneapolis, Minnesota to St. Louis, Missouri with the primary purpose of maintaining a depth of nine feet for navigation. The project has rarely been operated for flow augmentation since the 1930's. Releases for navigation did occur during World War II due to low water problems in the St. Louis, Missouri area (Chain of Rocks, see **Paragraph 3-05**).

b. Other Purposes. Other authorized purposes of the reservoirs include flood control, recreation, hydropower, water supply, and enhanced fish and wildlife production. The reservoir purpose is discussed further in **Chapter 7.** The above, and other project purposes assigned by Congress following completion of the project, are listed in **Table 2-1**.

Table 2-1

Gull Lake Dam and Reservoir Project
Authorized Purposes Assigned by Congress

Authorized Purpose	Public Law No.	Description
Flood Control	74-738	Flood Control act of 1936
Recreation and Surplus Water	78-534	Flood Control Act of 1944
Fish and Wildlife	85-624	Fish and Wildlife Coordination Act of 1958
Water Supply	85-500	Water Supply Act of 1958
Recreation	89-72	Federal Water Project Recreation Act of 1965
Water Quality	92-500	Federal Water Pollution Control Act Amendments of 1972
Fish and Wildlife	93-205	Conservation, Protection, and Propagation of Endangered Species Law of 1973

2-03. Physical Components.

a. Control Structure. The control structure consists of reinforced concrete abutments and piers supported on timber pilings. The total length of the structure between abutments is 68.9 feet (see **Plates 2-3 and 2-4)**. There are five slide gate bays with five-foot wide by four-foot high steel slide gates and one 11-foot wide log sluiceway, which gives a net spillway crest length of 36 feet. Additionally, one opening above each of the five gated bays allows uncontrolled discharge to occur whenever the reservoir level is above elevation 1194.75 feet. A five-foot wide fishway on the far right side of the dam has been blocked off due to concerns about carp migration and is not available to pass flow. An eight-foot wide public roadway with a top elevation of 1198.96 feet is supported by the structure. The top of the control structure (top of the curb on roadway) is at elevation 1199.75 feet. There is a concrete spillway apron below Gull Lake Dam with a top elevation of 1188.75 feet. See also **Exhibit A**.

b. Emergency Spillway. There is no emergency spillway at Gull Lake Dam. All flow is through the main control structure.

c. Embankments and Dikes. Gull Lake Reservoir is contained by one main embankment. There are no perimeter dikes around Gull Lake Reservoir. The embankments of the control structure consist of two earth filled embankments with concrete curtain walls. The right bank embankment is 129 feet in length with 90 feet of curtain wall. The left embankment is 72 feet in length with 33 feet of curtain wall. Total length of the embankments is 201 feet and the minimum top elevation of the embankments is 1198.1 feet.

d. Reservoir. The Gull Lake Dam and Reservoir controls runoff from 287 square miles of the Gull Lake drainage basin. The backwater effect from the dam affects eight lakes, which are connected to the reservoir (see **Table 2-2**). Information on the storage capacity of the reservoir can be found in **Exhibit F**.

Table 2-2 Lakes Affected by Gull Lake Dam Operation	
1. Gull	6. Spider
2. Upper Gull	7. Bass
3. Roy	8. Margaret
4. Nisswa	9. Love
5. Round	10. Hole-In-The Day

2-04. Related Control Facilities. The Gull Lake Reservoir Project does not contain any additional integrated components (see also **Paragraphs 3-04 and 4-11**).

2-05. Real Estate Acquisition.

a. Dam Site and Recreation Area. The Federal Government holds fee title to 90.7 acres of land; 69.7 acres at the Gull Lake Dam site and 21 acres on Nisswa Lake.

b. Flowage Rights. In addition to the above, the Corps has flowage rights to 15,161 acres of land around Gull Lake reservoir. See **Plates 2-5 through 2-9** for the location of lands on which the Corps of Engineers holds fee title or flowage rights. **Table 2-3** contains a summary of the flowage rights elevations for the Headwaters reservoirs. See **Exhibit D, Reference 8** for critical information about the assumptions behind the flowage elevations listed in **Table 2-3**.

Table 2-3
Mississippi River Headwater Reservoir System
Operating Levels and Flowage Rights Elevations and Stages in Feet
(see also Paragraphs 7-16, Tables 3-1, 7-1 and 7-2 and Exhibit D Reference 8)

	Winni-bigoshish	Leech	Poke-gama	Sandy	Cross L. Pine R.	Gull
1. Original Operating Limits Informally Adopted	1288.94 -1303.14 0.0 - 14.2	1292.20-1297.94 - 0.5 - 5.24	1268.92 -1276.42 4.5 - 12.0	1207.91-1218.31 0.6 - 11.0	1217.62-1234.82 1.3 - 18.5	1188.75-1194.75 1.0 - 7.0
2. Normal Summer Range/Band Stage in Feet Middle of the Summer Band Elev.	1297.94-1298.44 9.0 - 9.5 1298.19	1294.50-1294.90 1.8 - 2.2 1294.70	1273.17-1273.67 8.75 - 9.25 1273.42	1216.06-1216.56 8.75 - 9.25 1216.31	1229.07-1229.57 12.75 - 13.25 1229.32	1193.75-1194.00 6.0 - 6.25 1193.87
3. Total Operating Range Stage in Feet	1294.94-1303.14 6.0 - 14.2	1292.70-1297.94 0.0 - 5.24	1270.42-1278.42 6.0 - 14.0	1214.31-1221.31 7.0 - 14.0	1225.32-1235.30 9.0 - 18.98	1192.75-1194.75 5.0 - 7.0
4. Flowage Rights Acquired To Approx. this Stage (see Note 5)	14.2 + 3.72 = 17.92 +	5.24 + 4.0 = 9.24 +	12.0 + 4.0 = 16 +	11.0 + 4.0 = 15 +	18.5 + 4.0 = 22.5 +	7 ft. See Exh. D, Ref. 8
Gage Zero Elev., 1929 NGVD Datum	1288.94	1292.70	1264.42	1207.31	1216.32	1187.75
5. Flowage Rights To Approx. This Elev., Ft, 1929 NGVD (see Note 5)	1306.86 1929 NGVD	1301.94 1929 NGVD	1280.42 1929 NGVD	1222.31 1929 NGVD	1238.82 1929 NGVD	1194.75 1929 NGVD
6. Gage Zero Elev., USE Datum	1290.08	1293.76	1265.27	1209.00	1218.20	1190.00
7. Flowage Rights Acquired To Approx. Elev. in Ft., U.S.E. Datum	1308.0 USE Datum	1303.0 USE Datum	1281.27 USE Datum	1224.0 USE Datum	1240.70 USE Datum	1197.0 USE Datum
8. Gage Zero Elev., 1912 M.S.L. adj.	1289.47	1293.23	1264.89	1207.70	(8.)	1188.14

1. The lower limit was generally the sill elev. of the dam at that time. The upper limits were determined through engineering judgement and were set, with the exception of Gull, approx. 4 ft. below the flowage rights elevation. Leech's lower limit is sometimes listed as a positive 0.5 instead of the correct negative 0.5 value.
2. The most desirable levels for the summer season. Lake Winnibigoshish's band was lowered one foot in 1975 and Pokegama's was lowered 0.25 feet in 1952.
3. The Total Operating Range is in accordance with the latest regulations and designs. See **Tables 3-1, 7-2** and **Para 7-16**.
4. Flowage rights on the Cass L. Chain obtained to approx. a 18.92 ft stage which is elev. 1307.86 ft. in the 1929 NGVD.
5. See **Exhibit D, Ref. No. 8.c.** for details and clarification of flowage rights. The Corps began using the1929 NGVD for the Headwaters reservoirs in July of 1973 and began to report water levels in elevation as opposed to stage.
6. The U.S. Engineer (USE) Datum was in use prior to July 1973 and water levels were reported in stage.
7. Provided here for historical reference. Elevs. on the original flowage survey maps are generally listed in the USE datum.
8. Provided for additional reference. 1912 M.S.L. adj. information for the Pine River Dam gage zero is not available.

2-06. Public Facilities. At the Corps-owned, Terry R. Johnson Recreational Area on the Gull River, there are 69.7 acres of land above the middle of the summer band (elevation 1193.87 feet). The recreation area is in the vicinity of the impounding structure with 25.1 acres located east of the dam and 44.6 acres to the west on a peninsula known as Government Point (see **Plate 2-10**).

Of the approximately 25 acres to the east, all but one is about six feet above the middle of the summer band. That one-acre parcel is about four to five feet lower than the rest of the tract. Government Point has dramatic changes in topography with its west shoreline, rising 40 to 60 feet above the lake. This steep bank offers excellent vistas. In comparison, the area east of the dam, which is developed for recreational use, is relatively flat. Back from the moderate slope of the shoreline, the terrain lies between 15 and 20 feet above the lake. Both sides of the Gull River and shoreline of the lake are heavily wooded with birch-aspen and pine-mixed hardwoods. An inventory of all the facilities available at the recreation area is included in **Table 2-4**. See also **Paragraphs 7-06 and 8-03**.

Table 2-4

Terry R. Johnson Recreation Area Facilities
Gull Lake Reservoir

Description	Facility	Description	Facility
Mixed Camping	39	Maintenance Facility	X
Camping w/ Electric Hookup	39	Residence	0
Tent Camping	X	Access to the Recreation Areas	X
Picnic Units	20	Internal Vehicular Circulation	X
Swimming Beach	1	Walkways	X
Boat Launch	1	Bulletin Boards	X
Boat Dock	2	Camp Cleaning Tools	X
Canoe Launch	X	Picnic Tables	X
Day Use Area	X	Picnic Shelters	1
Playground	X	Fireplace	X
Parking	60	Firewood	X
Ranger Station	X	Barbecue Units	X
Interpretive Facilities	X	Trash Receptacles	X
Interpretive Trails	X	Movie Screen	X
Concessions	0	Lighting	X
Potable Water Supply	X	Signage	X
Shower Building	X	Water Traffic Controls	X
Flush Toilets	X	Fences	X
Vault Toilets	X	Landscaping Practices	X
Sanitary Dumping Station	X	Telephones	X
Sewage Treatment Plant	X		

39 = No. Of Units X = Available 0 = Not Available

III - HISTORY OF PROJECT

3-01. Authorization. The River and Harbor Acts of 14 June l880 and 2 August 1882 authorized the construction of dams at each of the six Mississippi River Headwaters lakes for the purpose of forming reservoirs. The lakes affected by these acts include Winnibigoshish, Leech, Pokegama, Sandy, Cross (Pine River) and Gull. Following authorization of the reservoirs, Congress directed the Secretary of War to establish regulations governing their operation through the River and Harbor Act of 11 August 1888.

3-02. Planning and Design. A plan to build a network of dams in the Headwaters region of the Mississippi River dates back to 1850. In that year, Congress asked Charles Ellet Jr., a civilian engineer, to conduct a survey and prepare a report on flood control and navigation on the Mississippi and Ohio Rivers. Ellet recommended, in his 1852 report, that a series of dams be constructed to regulate the erratic flow of the Mississippi. Ellet's report was sent to the Corps of Engineers who in turn reported to Congress that the effort would be too expensive in comparison to the benefits.

In the meantime William D. Washburn, who has often times been called the "father of the [Headwaters] reservoir system", moved from Maine to Minnesota in 1857. His brother Cadwallader had acquired mining and lumber interests in both Wisconsin and Minnesota. William would go on to represent Minnesota in the state Legislature and both houses in Congress and Cadwallader would become governor of Wisconsin. The Washburns invested in power development on the west side of St. Anthony Falls. By 1865 they owned a controlling interest in the Minneapolis Mill Company and were actively promoting Minneapolis as a manufacturing center. However, their grand manufacturing plans were threatened in 1863 and 1864 when the flow of water in the Mississippi dropped to its lowest level in 25 years. The Washburns, and their consulting engineer, concluded that a constant flow in the river would be aided by a upstream reservoir system. In 1869, they directed a survey of the Upper Mississippi River to look for dam sites. Later that year they purchased 40 acres at Pokegama Falls above Grand Rapids as it presented a good location for a dam site.

At about the same time, in 1868, the St. Paul District engineer, Major Gouverneur K. Warren, recommended a survey be conducted above St. Anthony Falls to ascertain "the practicability of forming large reservoirs on the headwaters of the Mississippi to aid in keeping navigation at low stages". His report of April 30, 1870 suggested the construction of 41 reservoirs on the St. Croix, Chippewa, Wisconsin and Mississippi Rivers. The various watersheds covered a wilderness area of approximately 25,000 square miles. However, in the 1870's, the proponents of a reservoir system met strong opposition in Congress who were concerned that the dams would primarily benefit the logging, milling and water power industries. Congress resisted the efforts to stretch the "commerce clause" of the constitution beyond navigation. Thus, in 1878, Congress asked for an examination of the impact of a reservoir system on navigation below St. Paul to Lake Pepin. The report proposed that an experimental dam be constructed at the outlet of Lake Winnibigoshish to increase water levels below St. Paul during the summer.

In the meantime, William Washburn was elected to Congress in 1878 where he continued his fight for a federally-funded reservoir system. In turn, communities along the river pressured their Congressman to take measures to support steamboat traffic as a means to prevent a railroad monopoly. In 1879, the River Impoundment Association Convention strongly endorsed the reservoir system promoted by Congressman Washburn.

The St. Paul business community saw through the intentions of Washburn and others. Even though the argument for the reservoir system was based on improving navigation from St. Paul to Lake Pepin, and on down to St. Louis, the St. Paul Board of Trade sent resolutions to Congress condemning the plan. The city opposed the scheme to obtain federally supplied water for industrial use while using navigation below St. Paul as a smoke screen. However, Congressman Washburn's argument that there was little utility in dredging, building wing dams and making other improvements "unless there was adequate water in the channel" prevailed. As a result, in 1880, Congress approved funds for the construction of the dam at Lake Winnibigoshish and construction began in the winter of 1881. Additional funding soon followed. The construction of Leech and Pokegama dams commenced in 1883 with all three operating by 1884. The construction of Pine River Dam commenced in 1885 and was completed in 1886. When the water released from the first 3 reservoirs backed up into Sandy Lake; a fifth reservoir was constructed there (1891-1895) in an attempt to keep the Sandy River from running backwards. There were clear benefits to the water power interests at St. Anthony Falls. The reservoirs increased the flow during August and September by forty percent and during October and November by fifty percent. Although the effect that these reservoirs had on navigation is not as easy to document; the increased flow helped navigation to some degree. Prior to the construction of the lock and dam system on the Mississippi River, water from the reservoirs was released for navigation when the stage at St. Paul dropped below specified levels (see **Paragraph 3-05**).

An engineer named William de la Barre was instrumental in taking advantage of the reservoirs for water power. De la Barre worked for the Minneapolis Mill Company (for which William Washburn was a majority owner). Under his direction, and supplemented by a steadier flow in the river, millpower was more than tripled from 1883 through 1889. In 1889, Washburn merged his company with Pillsbury and De la Barre took over direction of the combined interest. De la Barre increased the revenue of the new company fivefold over the next 20 years and more than quadrupled the horsepower of the mills. He did this in part by coordinating the companies' water needs with the regulation of the reservoirs by the Corps. Soon the power interests needed additional water so they asked the federal government to construct more reservoirs. The Corps of Engineers, however, could not justify more reservoirs and recommended that the system be limited to the existing five impoundments. The power interests, however, insisted on having one more dam at Gull Lake. The site had been studied by the Corps in 1898 but abandoned because the flowage rights were too expensive. The Corps instead began rebuilding the existing dams. The push for a dam at Gull was kept alive, however, by De la Barre and his political associates. Finally, in 1900, John S. Pillsbury deeded 1,000 acres of land on Gull Lake to the federal government and subsequently Congress authorized the dam in 1907. The St. Anthony Power Company began to obtain leases from the numerous property owners around the lake and deeded them over to the federal government in 1911 and the dam was put into operation the following year.

For additional information on the Headwaters reservoirs, see Merritt: 1979 (see **Paragraph 1-03)**. For information on the effects that the reservoir project had on Indian Tribes see Carroll: 1990 and Treuer: 1992 (see **Paragraph 1-03)**.

3-03. Construction. The construction of Gull Lake Dam commenced in the spring of 1911. The dam was placed in operation in September of 1911. That basic structure remains in place except for the replacement of the stop logs in the five main bays with steel slide gates and reconstruction of the bridge supported by the structure, both completed in 1971.

3-04. Related Projects. Gull Lake reservoir is one of six Mississippi River Headwaters reservoirs. It is the sixth proceeding downstream, following Cross Lake reservoir (Pine River Dam). It is the most southerly located of the reservoirs. The regulation of Gull Lake reservoir is independent from the other Mississippi River Headwaters reservoirs. The other Headwaters reservoirs include Lake Winnibigoshish, Leech Lake, Pokegama Lake and Sandy Lake. See also **Paragraph 4-11.**

3-05. Modifications and Deviations to Regulation. General regulations for the Mississippi Headwaters reservoirs were first established by the War Department in 1889 and were formally modified in 1931, 1935, 1936, 1944 and 1988.

The first regulation governing the operation of the Headwaters dams (dated 1889) did not contain any information on water levels. The area surrounding the Headwaters lakes was largely undeveloped when the dams were first built in the late 1800's and early 1900's, consequently there were no serious objections to widely fluctuating lake elevations. However, as recreation on the reservoirs and downstream agriculture developed in the first quarter of the 1900's, local landowner interests became more important in determining reservoir regulation. In addition, the need for supplemental releases from the six Headwaters lakes for navigation, hydropower and water supply was greatly reduced during and after the 1930's. As a result, the Secretary of War issued new regulations for the six Headwaters reservoirs during the period 1931-1944 with the last addition from Congress occurring in 1988. A copy of the regulation, which incorporates all the changes made through the 1944 order, can be found in the Code of Federal Regulations, Title 33, Section 207.340 while the 1988 addition can be found in Public Law 100-676, Section 21 of the Water Resources Development Act of 1988 (see **Exhibit D**). A description of the various regulation orders, as well as various other rules, guidelines and deviations that have occurred, are listed below. Also see **Table 3-1 and Chapter 7**.

a. 1889 Regulation Order. The River and Harbor Act of Congress, dated 11 August 1888, directed the Secretary of War to establish regulations governing the operation of the Mississippi River Headwaters reservoirs. This request resulted in the 12 February 1889 regulation orders, a copy of which can be found in the 1896 Annual Report of the Chief of Engineers, Part 3, pages 1829-1831 (see **Exhibit D, Reference 1**). The 1889 regulations were probably republished in 1896 due to the recently completed dam at Big Sandy Lake in October 1895.

The 1889 regulation does not list specific reservoir levels or discharge requirements; nor does it mention specific reservoirs. [By 1896, only Lake Winnibigoshish, Leech Lake, Pokegama Lake, Sandy Lake and Pine River Dam were completed.] In general the regulation provided:

i. penalties for violating the orders.

ii. authority to the officer-in-charge to store water for use in downstream navigation "until the limit of capacity or safety of the reservoirs is reached."

iii. rules for the sluicing of logs.

iv. sole discretion for the operation of gates to the officer-in-charge.

Operating levels, however, were developed by the officer-in-charge based on physical limitations and engineering judgment. These levels through usage became known as the "Original Operating Limits" (see **Table 3-1 and Chapter 7**). The lower limits were usually the sill elevation of the dam or some other physical limitation that governed releases. The upper limits were set, with the later exception of Gull, at a point lower than the flowage rights acquired for each dam while still providing some freeboard below the top of the dam. Gull's "Original Operating Limits" are 1188.75 feet to 1194.75 feet (1.0 ft. to 7.0 ft. stage).

b. 1931 Regulation Order. In 1929 and 1930 the Headwaters reservoirs were lowered in an effort to test their capabilities to increase flows below St. Paul. Subsequent dry weather (low inflows) resulted in continued low water levels. Resort owners and local residents organized and demanded the establishment of minimum operating levels to provide them with more reliable conditions. As a result, on 11 February 1931, the Secretary of War revoked the 1889 regulations and issued the 1931 order which included both high and low water operating limits (see **Table 3-1**). A minimum discharge of 10 cfs was prescribed for Gull Lake and, at the request of the Minnesota Lake Levels Association, the lower operating limit was raised 4 feet to 1192.75 feet (5.0 ft. stage). An upper operating limit was also specified (1194.75 feet, 7.0 ft. stage) and rules regarding the release of water for navigation and the sluicing of logs were clarified in addition to other details. See **Exhibit D, References 2.a. and 2.b.** Note that

Paragraphs 3.c. and 3.d. in **Reference 2.b.** specify minimum flow values at St. Paul, MN that the reservoirs were to maintain.

c. 1935 Regulation Order. In the years 1930 through 1934 many protests were received in the District office in regards to low water levels (see **Exhibit D, Reference 6.a., Paragraph 4**). As a result, on 14 May 1935, the Acting Secretary of War modified the 1931 regulations reducing Pokegama's minimum flow value and changing the values at Pokegama, Sandy, Pine and Gull to an "average annual discharge". This allowed the dams to be completely closed at times for various reasons to include low inflows or maintenance. These minimum flow changes did not affect Lake Winnibigoshish or Leech Lake. However, a clarification to the operational limits in Paragraph 3.i. was added to minimize "The range of fluctuations in levels in any reservoir in a single year.......". Note that Paragraphs 3.c. and 3.d. in **Exhibit D, Reference 4** specify minimum flow values at St. Paul, MN that the reservoirs were to maintain. See also **Table 3-1**.

d. 1936 Regulation Order. Hearings were held in 1935 due to the failure of the Winnibigoshish, Leech and Pokegama to reach desirable levels. As a result, on 4 February 1936, the Secretary of War issued new regulations which changed, among other things, the minimum flow value at Winnibigoshish and Leech to an average annual value (all 6 reservoirs now had average annual minimum discharges). The average annual discharge of 10 cfs for Gull Lake (stated in the 1935 order) was changed to 30 cfs (see **Exhibit D, References 5.a. and 5.b.**). Only minimum operating limits are listed in this regulation. However, the regulation does not preclude the reservoirs from being operated up to the upper limits listed in both the 1931 and 1935 regulations. Correspondence indicates that storage up to the maximum limits could be used "should extremely wet years necessitate this action" (see **Exhibit D, Reference 6.a. Paragraph 8.**). See also **Table 3-1**.

e. 1944 Regulation Order. This order for the Headwaters reservoirs did not affect Gull

Lake. The order lowered the minimum elevation for Leech Lake one foot, from 1293.70 feet (1.0 ft. stage) to 1292.70 feet (0.0 ft. stage) in order to allow the "normal" (ordinary) upper limit to be reduced from 3.5 feet to 3.0 feet. A minimum stage of 0.0 feet was not possible without an official change in the regulations. This proposal came as a result of a meeting held in Walker, Minnesota on 25 October 1944, which was hosted by Congressman Harold Knutson. The meeting was held following 4 months of very wet weather conditions. See **Table 3-1 and Exhibit D**, **References 6.a., 6.b. and 6.c.**

f. Title 33, Section 207.340, Code of Federal Regulations. This document provides a codification of all the regulations affecting the Headwater reservoirs through the 1944 Regulation Order (see **Exhibit D, Reference 7**). These regulations, combined with Public Law 100-676, Section 21, of the Water Resources Development Act of 1988, and the referenced Reservoir Regulation Contingency Plan (see **Exhibit D, Reference 12**), contain the latest regulations from Congress for the Headwaters reservoirs.

g. 1940-1944. Vessels needed for the war effort could not get through the Soo Locks on the Great Lakes. The traffic (over 2,000 vessels) was instead diverted down the Illinois River to the Mississippi River and on to New Orleans. Water from the Headwaters reservoirs was released during this period (primarily in the fall and winter months) in an effort to provide sufficient water depth for navigation over the Chain of Rocks in St. Louis, Missouri. At this same time, additional water was needed to cover the industrial water intakes in the St. Louis area. At various times, water was also released to help with power generation at Keokuk, IA due to a shortage of coal and to assist in the movement of oil up the Ohio River from the St. Louis refineries.

h. September 1953. The discharge from the Headwaters reservoirs was adjusted to facilitate emergency repairs of the locks and dams in the Twin Cities area.

i. 1956. After the winter of 1943-44, additional releases from the Headwaters reservoirs for the St. Louis area were not needed until 1956, when a water shortage occurred again. This resulted in not only the release of water from the Headwaters but also the release of water from Lake Michigan by executive order.

j. August 1958. The discharge in the Mississippi River at St. Paul reached a mean daily low of 1,950 cfs in August of 1958. In a letter dated 20 August 1958, Mr. Kerwin L. Mick, Chief Engineer and Superintendent of the Minneapolis-St. Paul Sanitary District, requested that the Corps release water from the Headwaters reservoirs to aid in the dilution of sewage in the Twin Cities area. In a letter to Mr. Mick dated 22 August 1958, Colonel Brown indicated that, in response to the request, the discharge from the reservoirs was increased about 80 percent for the benefit of all the interests below the dams. Additional water was released from the reservoirs on approximately August 27.

k. August 1959. The discharge in the Mississippi River at St. Paul had reached a mean daily low of 1,970 cfs in August of 1959 and was forecasted to go as low as 1,000 cfs. In a letter dated 18 August 1959, Mr. Kerwin L. Mick, Chief Engineer and Superintendent of the Minneapolis-St. Paul Sanitary District, requested that the Corps release water from the Headwaters reservoirs to aid in the dilution of sewage in the Twin Cities area. In a letter to Mr. Mick dated 12 September 1959, Colonel Brown indicated that, in response to the request, the discharge from the reservoirs was increased on 25 August in advance of the normal fall drawdown period.

l. August 1960. The discharge in the Mississippi River at St. Paul had reached a mean daily discharge of 2,330 cfs in August of 1960. In a letter dated 16 August 1960, Mr. Kerwin L. Mick, Chief Engineer and Superintendent of the Minneapolis-St. Paul Sanitary District, requested that the Corps release water from the Headwaters reservoirs to aid in the dilution of sewage in the Twin Cities area. In a letter to Mr. Mick dated 19 August 1960, Colonel

Strandberg indicated that, in response to the request, the discharge from the reservoirs was increased on 17 August in advance of the normal fall drawdown period.

m. 1963 Findings of Fact Conclusions Order, State of Minnesota and Plan of Operation. The 1963 Findings of Fact from the State of Minnesota, Department of Conservation, Commissioner of Conservation, dated 19 April 1963, and the Plan of Operation from the Division of Game and Fish, dated 15 August 1963, outline some recommendations regarding the operation of the Headwaters reservoirs (see **Exhibit D, References 9, 10 and 11)**. The Commissioner lists various operation guidelines in the 19 April 1963 Findings of Fact and mentions that recommendations from the Division of Game and Fish will be developed and kept on file (see Section I, Paragraphs 12 and 13 of the 1963 Findings of Fact). The subsequent 15 August 1963 Plan of Operation outlines the recommendations from the earlier Findings of Fact, while adding guidelines related to changes in discharge, spring spawning, springtime operation and clarifying minimum releases, among other things. No reference is made, of course, to these guidelines in Appendix D, **Table I-8** of the Headwaters Master Reservoir Regulation Manual, dated April 1963. However, Appendix D, **Table I-8** of the revised Master Manual, dated 19 February 1968, references the State's Plan of Operation as it relates to maximum and low-flow discharges.

No formal agreement exists between the State of Minnesota and the Corps of Engineers regarding the 1963 recommendations and they are not legally binding upon the Corps. In actual practice, the Corps makes a good faith effort to regulate the Headwaters lakes in conformance with the 1963 maximum and low-flow discharge guidelines whenever possible and when not in conflict with the authorized project purposes or other federal mandates. Some small adjustments have been made to the guidelines. Following is a summary of the guidelines adopted and/or considered from the 19 April 1963 Findings of Fact and the subsequent Plan of Operation signed on 15 August 1963. Also see **Chapter 7**.

i. Maximum discharges from the reservoir were recommended for elevations ranging from 1190.75 feet to 1195.25 feet (3.0 ft. to 7.5 ft. stage). See **Tables B, C and E** in the 19 April 1963 Findings of Fact in **Exhibit D** or consult **Chapter 7** for details.

ii. A minimum discharge from the reservoir was recommended for periods when the reservoir was at, or below, critical elevations. See **Table D** in the 19 April 1963 Findings of Fact in **Exhibit D** or consult **Chapter 7** for details.

n. 1988, Public Law 100-676, Section 21, Water Resources Development Act of 1988. This Public Law, dated 17 November 1988, was a result of the drought of 1987-1988 (see **Exhibit D, Reference 12.a.**). In 1988, Minnesota Governor Rudy Perpich asked the Corps of Engineers to make supplemental releases from the Headwaters reservoirs to meet downstream water use requirements. When rainfall returned to the region in early August of 1988, the Corps denied the request. Congressman Oberstar however, determined that some Congressional oversight was needed related to the use of the water contained within the reservoirs for the benefit of upstream and downstream uses. As a result, the Public Law states that the Secretary of the Army must notify Congress 14 days in advance of any reservoir going outside prescribed minimum and maximum operating limits. In addition, a Reservoir Regulation Contingency Plan was provided to Congress in compliance with the Public Law (see **Paragraph 1-03 and Exhibit D, Reference 12.b.**). The Congressional notification elevations for Gull Lake reservoir are elevations 1192.75 feet and 1194.75 feet (see **Table 3-1 and Chapter 7**). Since the law was enacted, a situation requiring Congressional notification has not occurred.

Table 3-1
Mississippi River Headwater Reservoirs, History of Operating Elevations and Stages in Feet
(see also Paragraphs 7-05, 7-16 and Table 7-1)

	Winni	Leech	Pokegama	Sandy	Cross/Pine	Gull
1. Original Operating Limits Informally Adopted	1288.94 -1303.14 0.0 - 14.2	1292.20-1297.94 -0.5 - 5.24	1268.92 -1276.42 4.5 - 12.0	1207.91-1218.31 0.6 - 11.0	1217.62-1234.82 1.3 - 18.5	1188.75-1194.75 1.0 - 7.0
2. February 11, 1931 Regulations First Official Operating Limits	1294.94-1303.14 6.0 - 14.2	1293.70-1297.94 1.0 - 5.24	1270.42-1276.42 6.0 - 12.0	1214.31-1218.31 7.0 - 11.0	1225.32-1231.32 9.0 - 15.0 (2)	1192.75-1194.75 5.0 - 7.0
3. April 1, 1931 Letter for Pine, Later Known as "Ord. Oper. Limits"					1227.32-1231.32 11.0 - 15.0 (3)	
4. May 14, 1935 Regulations See Note No. 4.	1294.94-1303.14 6.0 - 14.2	1293.70-1297.94 1.0 - 5.24	1270.42-1276.42 6.0 - 12.0	1214.31-1218.31 7.0 - 11.0	1225.32-1231.32 9.0 - 15.0 (2)	1192.75-1194.75 5.0 - 7.0
5. February 4, 1936 Regulations, The 1935 Upper Limits still apply.	1294.94 6.0	1293.70 1.0	1270.42 6.0	1214.31 7.0	1225.32 9.0	1192.75 5.0
6. 1944 request from Cong. Knutson Adj. Pine's Ordinary Oper. Limits.					1226.32-1230.32 10.0 - 14.0	
7. 1944 Ordinary Operating Limits Summary	1296.94-1300.94 8.0 - 12.0	1294.20-1296.20 1.5 - 3.5	1270.42-1274.42 6.0 - 10.0	1214.31-1218.31 7.0 - 11.0	1226.32-1230.32 10.0 - 14.0	1192.75-1194.75 5.0 - 7.0
8. Dec. 29, 1944 revision to the 1936 Regs lowering Leech's lower limit		1292.70 0.0				
9. Revisions to Leech's + Pine's Ordinary Oper. Limits (approx. 1945)		1293.20-1295.70 0.5 - 3.0			1227.32-1230.32 11.0 - 14.0	
10. Upper Limit Mods at Pokeg and Sandy for Aitkin Flood Control			1278.42, 14.0 1277.92, 13.5	1221.31 14.0		
11. Pine River Dam, Dam Safety Improvements, New Upper Limit					1235.30 18.98	
12. Operating Range (2002) Total storage available if needed	1294.94-1303.14 6.0 - 14.2	1292.70-1297.94 0.0 - 5.24	1270.42-1278.42 6.0 - 14.0	1214.31-1221.31 7.0 - 14.0	1225.32-1235.30 9.0 - 18.98	1192.75-1194.75 5.0 - 7.0
13. Present Ordinary Operating Limits (2002), Typical annual range	1296.94-1300.94 8.0 - 12.0	1293.20-1295.70 0.5 - 3.0	1270.42-1274.42 6.0 - 10.0	1214.31-1218.31 7.0 - 11.0	1227.32-1230.32 11.0 - 14.0	1192.75-1194.75 5.0 - 7.0
14 . Public Law 100-676, Sec. 21 Cong. Notification Levels, WRDA 88	1296.94-1303.14 8.0 - 14.2	1293.20-1297.94 0.5 - 5.24	1270.42-1276.42 6.0 - 12.0	1214.31-1218.31 7.0 - 11.0	1227.32-1234.82 11.0 - 18.5	1192.75-1194.75 5.0 - 7.0
Gage Zero Elev., 1929 NGVD	1288.94	1292.70	1264.42	1207.31	1216.32	1187.75

1. The lower limit was generally the sill elevation of the dam at that time. The upper limits were determined through engineering judgement and were set, with the exception of Gull, approx. 4 ft. below the flowage rights elevation.
2. See **Exh. D, Ref. 2a and 2.b.** In the case of Pine, correspondence indicates that the District, both before and after 1931, considered elevation 1234.82 feet (18.5 ft. stage) to be the useable upper limit (see Row No. 1). See **Chapter 3** in the Pine Water Control Manual for additional details.
3. See **Exh. D, Ref. 3**. Note No. 2 above still applies. This changed Pine's normal spring drawdown level to elev. 1227.32 (11 ft. stage). This adjustment was done by agreement rather than an official change in the regulations. A min. limit of 9 feet at Pine was still authorized in the regulations and available for use if necessary (e.g. large snowpack).
4. See **Exh. D, Ref. 4**. No change was made in the operating limits. The min. discharges were changed to ave. annual flows at Pokegama (flow also lowered), Sandy, Pine and Gull.
5. See **Exh. D, Ref. 5.a and 5.b.** No upper limits are listed in the 1936 regs, however **Ref. No. 6.a., Para. 8** states that the previous upper limits (1935 regulations) still apply "should extremely wet year necessitate this action". The min. discharges were changed to average annual flows at Winnibigoshish and Leech (Leech's value was lowered).
6. Pine's upper ordinary operating limit was lowered to ease erosion. The lower limit was in turn lowered in order to retain the storage. See **Chapter 3** in the Pine Manual for details.
7. Sometime after the 1936 regulations were issued, in addition to Pine, "Ordinary Operating Limits" were adopted for all of the reservoirs. These limits represented a narrower "ordinary" or typical range, inside of the official limits, within which the reservoir might be operated in a typical year. See **Exh. D, Reference 6.b.**
8. This resulted from a request by Congressman Knutson to lower Leech's upper ordinary limit from 3.5 to 3.0 ft.. This was agreed upon as long as the lower limit in the 1936 regulations was reduced to 0.0 ft. In turn, a low ordinary operating limit of 0.5 ft. was adopted. See **Exh. D, Reference 6.a., 6.b. and 6.c.**
9. See Note No. 8 for Leech. Complaints were received when Pine's level was below 11 feet due to shallow water in the waterways connecting the various lakes in the chain. See **Chapter 3** in the Pine manual for details.
10. The 1956 Headwaters Operation Study for Aitkin flood control (see **Paragraph 1-03**) determined that storage could be utilized in Pokegama and Sandy to elev. 1277.92 ft. and 1221.31 ft. respectively. The 1963 Master Manual permitted Pokegama to fill to 1278.42 ft., however; Pokegama dam must then be wide open until the elevation falls to 1277.92 ft.
11. Pine River Dam was rehabilitated and raised to allow it to safely pass the Inflow Design Flood (70% PMF). The peak pool elev. equals 1235.3 ft. Five feet of freeboard was provided above this level. See the March 1997 Pine Design Memorandum (see **Paragraph 1-03** in the Pine Manual).
12. See Note Nos. 10 and 11 for information regarding Pokegama, Sandy and Pine's upper limits deviating from the regulations from Congress.
14. These are the Public Law 100-676, Sect. 21, Water Resources Development Act of 1988 (WRDA 1988) Congressional notification levels. See **Exhibit D, Reference 12.**

3-06. Principal Regulation Problems.

a. Bank Erosion. Bank erosion, due to higher than normal pool levels and wave action, causes destruction to shoreline archaeological and cultural sites, damages recreation and commercial interests, and contributes to degraded water quality. Gull Lake reservoir experiences a relatively small amount of shoreline erosion in comparison to the other Headwaters reservoirs. The peak inflows are not as variable and the lake level can normally be maintained within desirable regulating limits year-round. A boat survey in 1977 identified four locations of existing erosion areas, shown on **Plate 3-1**. At that time it was estimated that 1,000 feet out of 188,000 feet of total shoreline was affected.

IV - WATERSHED CHARACTERISTICS

4-01. General Characteristics. Gull Lake Reservoir controls the runoff from 287 square miles. The basin is located 100 miles northwest of Minneapolis, Minnesota, and the same distance west of Duluth, Minnesota. The watershed shares a common boundary with the Cross Lake Reservoir basin to the north and the Crow Wing River basin to the south. Its extent in both the north to south and east to west directions is about 20 miles.

Gull Lake Reservoir is actually a chain of lakes. It includes the following eight natural lakes: Nisswa, Roy, Spider, Bass, Upper Gull, Margaret, Gull and Round Lakes. The water originates from Mayo Creek in the north, Stony and Home Brooks from the west, and from a chain of lakes starting with Lake Edward in the eastern portion of the basin. Mayo Creek has a slope of 16 feet per mile before it enters Sibley Lake just north of Upper Gull Lake. Its source is a relatively high lake at elevation 1446 feet in the northwestern corner of the basin. Beyond Sibley Lake at elevation 1221 feet, through Gull Lake Dam and on to the Mississippi River at elevation 1170 feet, the average river slope is approximately 2.0 feet per mile. Gull Lake shoreline has been extensively developed.

The Mississippi River Headwaters basin lies within the Minnesota section of the hemlock-white pine-northern hardwoods region of the deciduous forest in eastern North America. Sugar maple and basswood dominate in the southern portion; white spruce, balsam fir, and paper birch dominate the northeastern reaches; and intermediate communities occupy the central areas. Pine subclimaxes are common throughout the region. Pines often occupy sites which have light-textured soils, while hardwoods prefer the heavier soils. Oaks and aspen form successional communities on upland sites, while elms and ash form communities on low-lying areas. Lowland conifers occupy wet areas having organic soils. Forest communities dominate the shoreline vegetation of the six headwaters lakes; lesser amounts of bog, marsh, and grassy areas are present. Upland sites are occupied by birch-aspen and pine-mixed hardwoods communities, while elm-ash is common in the lowlands. Maple-basswood communities are found on higher ground behind elm-ash stands. Marsh communities are also abundant. The marsh vegetation consists mainly of cattail with scattered alder, willow, ash, aspen, and birch.

4-02. Topography. The topography in the Gull Lake basin ranges from 1524 feet on some of the rises in the western portion of the watershed to the reservoir shoreline elevation at about 1194 feet. The topography is typical of glacial effects, mostly level with gentle rolling hills. The slopes around the shoreline are predominantly 6 to 19 percent.

4-03. Geology and Soils. Cass County, in which Gull Lake Reservoir is located, is comprised of undulating upland surface dotted with many lakes. There are three types of glacial drift, whose deposition during the Wisconsin age over 10,000 years ago, is responsible for the gently rolling topography. A red drift region about 200 feet thick covers the reservoir area. The Gull Lake area is part of the St. Croix moraine system. The soils in the area of Gull Lake fall into two groups. The first group is a coarse to medium textured forest soil of glacial material consisting of gravel, sands, loam or a mixture of these. Stones are abundant. Major problems include stoniness, erosion control, and poor drainage in level areas. The second group is also coarse to medium textured. It consists of glacial outwash material comprised mostly of gravel and sandy gravel near the surface, often underlain with fine sandy loams. These soils may be excessively drained and subject to drought and wind erosion.

4-04. Sediment. Erosion and sediment production from rivers within the watershed is a relatively minor problem due to the forest cover, soil types and land topography in the area. Sediment production from shoreline erosion within the reservoir boundaries is of concern for the loss of real estate and water quality reasons, but has only a very minor impact on the elevation-storage characteristics of the reservoir. Shoreline erosion within the Mississippi River Headwaters lakes is caused primarily by high lake levels combined with wind and wave action which accelerate erosion. The progressive loss and deterioration of lakeshore lands and related vegetation can destroy shoreline archaeological and cultural sites, damage recreational, residential, and commercial interests and contribute to reduced water quality. Sedimentation surveys have never been performed due to physical and fiscal restrictions and a perceived lack of need. A more complete discussion of bank erosion problems can be found in **Paragraph 3-06.**

4-05. Climate. The headwaters lakes area has warm, short summers which can be followed by long, severe winters with snow on the ground from November to March. At the northern end of the headwaters region, temperatures average approximately +5 degrees Fahrenheit in January and +65 degrees Fahrenheit in the summer months. In the southern portion of the headwaters area, temperatures are typically about 5 degrees Fahrenheit warmer. Great extremes can occur, and temperatures below -50 degrees Fahrenheit and above +100 degrees Fahrenheit have been recorded. Winds in the area blow predominantly from the northwest (see **Plates 4-1 and 4-2**).

The growing season, between the last killing frost in the spring and the first killing frost in late summer or early fall, varies from about 143 days in Aitkin and Itasca Counties (Leech, Winnibigoshish and Pokegama Dam area) to 148 days in Aitkin and Crow Wing Counties (Sandy, Pine and Gull Dam area). Warm summer days and cool evenings during the growing season contribute to favorable conditions for production of soybeans, oats, barley, flax, hay and wild rice.

Annual precipitation in the eastern half of the headwaters lakes area varies from 17 to 38 inches and averages 28 inches. On the western side, precipitation varies from 15 to 34 inches yearly, with an annual average of 22 inches. Annual snowfall in the area is typically 43 to 60 inches, and the average annual runoff of about 3 inches in the western half of the region is approximately half of that in the east. Normally, the winter months of December, January, and February are the driest, while the greatest amount of precipitation occurs during June and July. A general description of the climate for the Gull Lake area can be drawn from **Tables 4-1 and 4-2**.

The seasonal (May-October) average evaporation of 24.4 inches in **Table 4-2** corresponds very well with Free Water Surface (FWS) seasonal evaporation of 24 to 26 inches found in the National Weather Service Technical Report 33. Monthly values will deviate somewhat since the model data in **Table 4-2** accounts for the heat storage effects of the reservoir water.

Table 4-1

Extreme Climatological Data

Extremes	Temperature[1] Degrees, F	Annual[2] Precipitation Inches	Lake Evaporation[3] Inches	
			Annual	July
Minimum	- 45 (Feb. 2, 1996)	13.13 (1976)	24.8 (1928)	3.7 (1950)
Maximum	102 (Aug. 18, 1976)	38.74 (1944)	36.2 (1974)	8.1 (1936)

1. Gull Lake Dam, National Oceanic and Atmospheric Administration, Climatological Data, 1919-2000. (NOAA Station No. 213411)
2. Gull Lake Dam, National Oceanic and Atmospheric Administration, Climatological Data, 1911-2000. (NOAA Station No. 213411)
3. Watershed Study in Northeastern Minnesota, 1916-1980 (Meyer Model, Barr Engineering Co.)

Table 4-2

Gull Lake Dam, Average Climatological Data

Month	Normal Temp[1] Degrees F	Normal Precip[1] Inces	Normal Snowfall[2] Inches	Lake Evap[3] Inches	Wind Speed MPH	Wind Prevailing Direction
January	5.4	0.78	14.0	0.3	8	WNW
February	13.0	0.57	7.4	0.5	8	NNW
March	24.8	1.41	9.5	0.9	9	WNW
April	40.0	1.72	2.5	1.3	10	NW
May	54.4	3.25	0.1	3.2	9	NW
June	63.7	4.27	--	5.0	8	WNW
July	68.3	3.97	--	5.4	7	NW
August	66.2	3.73	--	4.7	6	S
September	56.1	2.64	--	3.6	7	NW
October	43.7	2.54	0.6	2.5	8	NNW
November	27.2	1.34	6.8	2.2	8	NNW
December	11.8	0.54	8.9	0.4	8	WNW
Annual	39.6	26.76	49.8	30.0	8	NW

1. Gull Lake Dam, National Oceanic and Atmospheric Administration, Climatological Data, 1971-2000, (NOAA Station No. 213411)
2. Gull Lake Dam, National Oceanic and Atmospheric Administration, Climatological Data, 1971-2000, (NOAA Station No. 213411)
3. Based on Watershed Study in Northeastern Minnesota, 1916-1980 (Meyer Model, Barr Engineering Co.), Note: evaporation data was collected at Lake Winnibigoshish, Leech Lake and Pine River Dam from 1931 through 1934.
4. St. Cloud, Minnesota Records, Climatic Atlas of the United States

4-06. Storms and Floods. Floods of damaging proportions occur in the Mississippi River Headwaters basin above Brainerd, Minnesota, as a result of rapid snowmelt, heavy spring rains, or prolonged periods of above-normal summer rainfall. Large areas of poorly-drained marsh and timberlands throughout the basin have been frequently flooded.

Selected floods at Gull Lake are tabulated in **Table 4-3.** A brief description of these floods follows. Refer to **Chapter 5 and Paragraph 8-02** for further information.

Table 4-3

Peak Elevations and Discharges for Selected Events at Gull Lake Dam [1]

Date [2]	Lake Elevation [3] in Feet	Pool Elevation [3] in Feet	Discharge in cfs
30 June 1914	1195.05	1194.70	1,010 (Peak for Water Year (WY))
16 July 1937	1195.04 (PM)	1194.64 (PM)	505 (Peak WY=516 on 15 July)
11 May 1938	1195.01	1194.78	733 (Peak for WY=1,123 on 15 May) [4]
10 May 1950	1195.01	1194.46	1,115 (Peak for WY) [5]
22 July 1952	1195.09 [6]	1194.51	1,050 (Peak for WY=1,105 on 23 July) [5]
17 May 1999	1194.79	1194.31	929 (Peak for WY)

1. Unless otherwise noted, values are from Corps log sheets and are assumed to be AM readings.
2. The period of record is not homogeneous. The current operating plan began in 1936. Caution must be exercised when comparing pre-1936 events to later events. See **Paragraph 3-05**. Due to regulation effects, Water Years may not provide hydrologically independent events.
3. Gage zero = 1187.75 feet (1929 NGVD). Pool elevations, which can be affected by head loss in the approach channel, are recorded at the dam. Lake elevations are recorded on the lake proper (not affected by head loss). In some years, lake elevations were not recorded daily. Morning pool readings are shown. Most of the time, afternoon pool values were also recorded on the log sheets and, in some cases, those values are slightly higher that the morning pool values. The log sheets and USGS records should be consulted for additional information to include the time when the values were recorded and other details.
4. Maximum outflow of record through 2001.
5. From records supplied to the United States Geologic Survey. See USGS Water Supply Paper (WSP) No. 1175 (for 1950) and WSP No. 1238 (for 1952). Also see Corps log sheets and **Chapter 5**.
6. Maximum lake elevation of record through 2001. Recorded at 1200 hours. From records supplied to the United States Geologic Survey. See **Chapter 5** and USGS WSP No. 1238 (for 1952).

a. June 1914 Flood. A wet spring and prolonged rains in the month of June filled Gull Lake Reservoir to peak levels. There were 10.79 inches of rain recorded in June with 4.10 inches falling in the last week. A maximum reservoir elevation of 1195.05 feet was recorded on 30 June with a maximum outflow of 1,010 cfs on the same day. Large releases from the reservoir until mid-July and below average rainfall brought reservoir level back near normal stages by the end of July.

b. July 1937 Flood. The causes of the peak reservoir elevation of 1195.04 feet on 16 July included wet antecedent conditions, an intense 4.25 inch rainfall on 14 July, and higher than normal pool levels before the storm. The pool elevations in June and early July were maintained about 0.5 feet above normal, perhaps because the year 1937 followed a severe drought period. The pool level remained relatively high after the storm until late August. The maximum reservoir outflow of 516 cfs occurred on 15 July.

c. May 1938 Flood. This flood event is the result of a combination of several factors. The winter of 1937-38 yielded about the average amount of precipitation and the pool elevation on 1 April was 0.25 feet above the winter drawdown elevation of 1192.75 feet. The month of April set the stage for the flood event with 2.80 inches above normal precipitation. In the first eight days of May, 6.74 inches of rain fell, bringing Gull Lake Reservoir to a peak pool elevation of 1195.01 feet on 11 May. The maximum discharge of record was set a few days after on 15 May at 1,123 cfs. Outflows averaging approximately 700 cfs brought the reservoir pool to near normal elevation by the end of May.

d. May 1950 Flood. Precipitation during the winter of 1949-50 was about 3 inches above normal. The snow cover remained on the ground until early May as April temperatures averaged about 10 degrees below normal. Deeply frozen ground conditions and the rapid melt of the snow, combined with 3.3 inches of rain in early May, produced the flood of record throughout much of the headwaters area, although not on Gull Lake. The peak pool elevation of 1195.01 feet occurred on 10 May based on USGS records at the lake gage. Outflow from the reservoir peaked at 1,115 cfs on 10 May and averaged about 800 cfs for the month to bring the pool elevation back to normal by the end of the month.

e. July 1952 Flood. Heavy rainfall from 17 July to 20 July deluged the area with 6.62 inches of water, 5.90 inches fell on 17 July. Discharge from the dam was immediately increased and was maintained near 1,050 cfs for about a week after the storm. Flood inflow still caused the peak pool elevation of record on 22 July at 1195.09 feet based on USGS records at the lake gage. The lake was back to normal elevation by mid August. The peak reservoir outflow of 1,105 cfs also occurred on 23 July.

f. May 1999. Over 7 inches of rain fell between 1 May and 17 May. Gull Lake reservoir peaked at elevation 1194.79 feet on 17 May 1999.

4-07. Runoff Characteristics. The runoff from Gull Lake Reservoir watershed is slow and significantly attenuated as a result of the relatively flat topography and the presence of many lakes and wetlands. Gull Lake Dam controls the runoff from a 287 square mile area, of which 54 percent is dry land, 23 percent is water, and 23 percent is wetlands. In general, the land not covered by wetlands is forested. The average overland slope is 58.08 feet per mile.

During the development of this Water Control Manual, information about the runoff characteristics of the watershed was obtained by utilization of the reservoir's hydrologic records together with computer modeling of the basin. A computer model of the watershed was developed and calibrated using computed inflows for selected floods together with corresponding storm or snowmelt data (see **Chapter 6**). Flow duration curves, exceedence-frequency curves and streamflow distributions were derived from observed data and the data resulting from the model. These curves give a graphical display of important watershed runoff characteristics.

The exceedance frequency of a given average monthly inflow can be determined for each month from **Plates 4-3 and 4-4**. The monthly exceedance frequency curves show a wide variation due to the unique weather conditions of each month, although seasonal patterns are evident. The percent time a given inflow or outflow is equaled or exceeded is given on the flow duration curves on **Plates 4-5 and 4-6**. See also **Paragraph 8-11**.

The monthly streamflow distribution determined from the period of record is presented on **Plate 4-7**. Minimum monthly discharges occur in mid or late summer. The maximum monthly inflow occurs in April from snowmelt and spring rain runoff. Some of this inflow is retained in the reservoir for flood protection purposes. Maximum monthly outflows as a result are significantly lower and occur in May. Monthly inflows generally exceed outflows during spring and summer as the reservoir is filling and evaporation losses occur. The inverse is true during the fall and winter as the reservoir level is drawn down for use in spring flood protection. The annual streamflow distribution is shown in **Plate 4-8**. The peak annual inflow and outflow occurred in 1944.

4-08. Water Quality. Gull Lake is a mesotrophic lake in north central Minnesota in the Northern Lakes and Forests (NLF) ecoregion. The lakes dissolved oxygen and water temperature profiles exhibit the characteristics of a classically stratified dimictic lake. Stratification usually occurs prior to the end of May and continues throughout the summer until late September or October. Mean summer (June thru September) total phosphorus, chlorophyll a, and secchi transparency are 22 ug/l, 6.5 ug/l, and 9.9 feet (3.0 meters) respectively. These values are comparable to "typical" Northern Lakes and Forest ecoregion lakes as shown in **Table 4-4.**

Gull Lake currently meets all public use classification criteria including swimming. The lake however is extremely vulnerable to cultural-induced eutrophication from both point and non-point source pollution. Small increases in the lake's phosphorus content could result in a perceptible loss in secchi transparency and increased frequency of nuisance algal blooms. Specific pollution concerns in the watershed result from extensive land development, urban and agricultural runoff, and malfunctioning or outdated septic systems. The Corps of Engineers, Gull Area Lakes Association (GALA), Minnesota Pollution Control Agency, and several other local agencies are cooperating in an effort to track, control, and limit the cultural-induced eutrophication of Gull Lake.

A limnological survey of the headwaters reservoirs was conducted in 1980 (see **Paragraph 1-03**). Also see also **Paragraphs 5-02, 7-07, and 8-04**.

Table 4-4

Comparison of Gull Lake To Ecoregion Data Set Lakes

	Gull Lake	Typical Northern Lakes and Forest Ecoregion Lake
Mean Total Phosphorus (ppb)	22	14 - 27
Mean Chlorophyll a (ppb)	6.5	<10
Maximum Chlorophyll a (ppb)	16.7	<15
Mean Secchi Transparency (meters)	3.0	2.5 - 4.5
Trophic State	Mesotrophic	Mesotrophic to mildly eutrophic

4-09. Channel and Floodway Characteristics. Gull Lake Dam is located on the Gull River 11 miles upstream of its confluence with the Crow Wing River. The confluence of the Crow Wing and the Mississippi Rivers (at river mile 990.4 above the Ohio River) is approximately 16 river miles downstream of the dam and 11.5 river miles downstream from Brainerd, Minnesota. The nearest community downstream of Gull Lake Dam is Fort Ripley, Minnesota, about 25 river miles downstream on the Mississippi River.

4-10. Upstream Structures. There are no reservoir structures above Gull Lake Dam on the Gull River.

4-11. Downstream Structures. There are no reservoir structures below Gull Lake Dam on the Gull River.

a. Sylvan Dam. Sylvan Dam is located on the Crow Wing River downstream of its confluence with the Gull River, about 3.6 miles upstream of its confluence with the Mississippi River. It is constructed in seven basic sections. These are, from south to north (or right bank to left bank), two earth fill dikes about 4- to 6-feet high and a combined length of approximately 1560 feet; a concrete core wall 41-feet long and about 45-feet high; a concrete ogee spillway 168-feet long and 30-feet high with 3-foot high flashboards at its crest; four slide gates, one 6-feet wide and three 12-feet wide; a concrete ogee spillway 19.5-feet long and 35-feet high; and a 32-foot-long concrete retaining wall. The crest elevation of both ogee spillways is 1174 feet (1912 MSL), the crest elevation of Gate No. 1 is 1170.7 feet (1912 MSL) and the crest elevation of Gates No. 2, 3, and 4 is 1168.4 feet (1912 MSL).

Sylvan Dam was originally constructed in 1913 with two generator units. The third unit was added in 1915. The dam is owned and operated by the Minnesota Power Company for hydroelectric generation. Each unit has a generating capacity of 650 kw. Because of its location, immediately downstream of the confluence of the Gull and Crow Wing Rivers, the operation of Gull Lake Dam can have a significant impact on the operation of Sylvan Dam.

b. Pillager Dam. The dam is owned and operated by the Minnesota Power Company for hydroelectric generation. The dam is on the Crow Wing River upstream of the Gull River confluence, and is thus impacted little, if at all, by the operation of Gull Lake Dam.

c. Little Falls Dam. The dam, which is on the Mississippi River at Little Falls, MN, is owned and operated by the Minnesota Power Company for hydroelectric generation. The Hennepin Paper Company also uses a portion of the water. The Corps notifies Minnesota Power when large releases are made from Gull Lake Dam.

4-12. Economic Data.

a. Population. The lakes, which form Gull Lake Reservoir, are mostly within the Cass County boundaries. Eastern portions of the Gull Lake basin are located in Crow Wing County. Population figures for the area are given in **Table 4-5**. Crow Wing County includes the city of Brainerd (population 12,353) which accounts partially for the large difference between the two counties. The northern half of Cass County consists of the sparsely populated Chippewa National Forest and part of the Leech Lake Indian Reservation.

Table 4-5 Census Information for Crow Wing and Cass Counties		
	Crow Wing	**Cass**
Population, 1970	34,826	17,323
1980	41,722	21,050
1990	44,249	21,791
2000	55,099	27,150
Area, Square Miles	997	2,018
Density, Persons/Square Mile, 200	55.3	13.5
Percent Rural Population, 1990	64.0	100
Percent Rural Farm Population, 1990	1.7	5.0
Percent Rural Non-Farm Population, 1990	62.3	95.0
Median Household Income, 1997	$32,616	$27,704
Note: Average density state-wide, 2000 = 61.8 persons/sq. mi		

b. Agriculture. Agriculture in Crow Wing and Cass Counties is economically unattractive due to the generally poor soil conditions and the relatively short growing season. **Table 4-6** presents a profile of the agriculture in the area. Dairying is the primary agricultural pursuit, but the milk production was well below the state average and that of more southerly located farms. A few mixed crops such as soybeans, corn, rye and oats are produced. Livestock production, beef cattle, and the farrowing of pigs supplement the county's agricultural income.

Table 4-6 1997 Agricultural Profile of Crow Wing and Cass County		
Item	**Crow Wing**	**Cass**
Number of Farms	593	598
Average Size (Acres)	228	321
No. Of Beef Cows	7,235	13,769
No. Of Milk Cows	2,210	2,409
No. Of Hogs & Pigs	5,330	11,402
No. Of Sheep & Lambs	1,112	912
No. Of Chickens, Broilers, Layers, & Pullets	NA	672
Hay in Acres	30,332	49,068
Wheat, Barley, & Oats for Grain in Acres	2,298	1,961
Corn for Grain or Seed in Acres		
Soybeans in Acres	7,819	4,350
	592	80

c. Industry. Industry in the Crow Wing and Cass County areas around Gull Lake Reservoir includes tourism, lumber, firewood, pulp cutting, and some mining. Gull Lake Reservoir contributes substantially to the tourism base of the area. The activities associated with the natural amenities are very important factors in the overall economic picture. In 1975, 86,557 visits were made to the Terry R. Johnson recreation area.

Not only are the lakes important economically in attracting recreational visitors, but they are also an important resource in attracting permanent residents, both retired and non-retired. About 60 percent of the population in the area is classified as rural, non-farm, compared with the state average of 20 percent.

The industries of agriculture, forestry, fishing and mining have shown a very significant decline in employment. Their past prominence economically is now shifting to the tourism related industries. The lumber and wood industry is more significant in Cass County than Crow Wing County. The total value of timber cut on public lands in these counties in 1970 represented 4.1 percent of the state total.

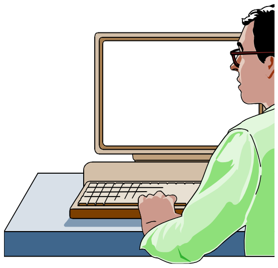
d. Flood Damages. High water damages consist of flood fight or preparedness measures, damage and loss of personal property, clean-up and repair for both residential and commercial units, and damage of public facilities including roads. In addition to the above damages, commercial establishments experience a decline in net income because of the high water. High water damages also include the effects of high stages, wave action and ice movement on reservoir shorelines, permanent residences, summer homes, resorts, cottages, roads, bridges, and farmlands. High water losses are greatest during the 1 June to 30 September peak resort period.

The low water damages for Gull Lake Reservoir occur during the May-September recreation season. These low water losses consist of changes in net income to commercial activities. Some of these losses are increased expenditures for harbor maintenance, reduced or canceled reservations because of access problems to fishing areas, shortened stays because of poor fishing, and damaged equipment because of shallow depths. Private landowners also experience increased expenses and equipment damage from low water. Low water damages are especially severe at locations in Gull Lake Reservoir with very gradually sloping bottoms.

The elevation-damage curve derived for Gull Lake Reservoir is shown on **Plate 4-9**. The curve shows both the low and high water damage relationships.

The high water damage-frequency curve for Gull Lake Reservoir, shown on **Plate 4-10**, was developed using data from 1936 to 1976. Average annual high water damages are based on this curve and were estimated to be $236,000, based on October 1977 prices.

No flood damage data are available for the Gull River downstream of Gull Lake Dam. There has been increasing development in recent years, but as of the date of this manual, it has all been out of the downstream flood plain.



V - DATA COLLECTION & COMMUNICATION NETWORKS

5-01. Hydrometeorological Stations. Several hydrometeorological stations are utilized to collect the various hydraulic and hydrologic parameters used in the regulation of the project.

a. Facilities. **Table 5-1** lists the data collection facilities at the dam. **Plate 5-1** shows the locations of the facilities in the area. **Table 5-2** lists some of the gages in the watershed. Locations for the snow survey sites are shown on **Plate 5-2** and listed in **Table 5-3**.

b. Reporting. The information needed to operate the dam and regulate the reservoir is reported to the Water Control Section by the project staff. Daily (8:00 a.m.) readings for the pool, tailwater and outflow are provided as well as precipitation and wind readings. Water Control calculates daily inflow to the reservoir from the change in reservoir elevation and the outflow.

On Monday mornings, from approximately the end of November until the end of March, the project staff reports "winter conditions" at the dam along with the normal data reports. The reports consist of the amount of snow on the ground, the water content of the snow, the thickness of the ice on the lake and the ground frost depth.

Prior to the spring snowmelt, the project staff conducts a snow survey in the basin. The survey is normally conducted during the last week of February or the first week of March. The Water Control Section issues instructions as to the exact date to start. A report of this survey is forwarded to Water Control as soon as possible after completion. Prior to conducting the snow survey, the project staff might perform a snow reconnaissance in the basin to determine if a detailed snow survey is necessary. The project staff drives through the watershed making a visual inspection the general area. If an appreciable amount of snow should fall after the a survey has been completed, another survey may be required. See **Plate 5-2** and **Table 5-3**.

c. Maintenance. Corps personnel and the U.S.G.S. on a periodic or as-needed basis maintain the gages associated with this reservoir. Snow survey equipment repair is the responsibility of the Corps' gage crew.

Table 5-1

Gull Lake Streamflow and Hydrometeorological Stations

Location	Data Type	Equipment	Ownership
Gull Lake Dam	Pool Elevation [1]	DCP and Staff Gage [2]	Corps of Engineers
So. Arm of Pike Bay, SW of Dam	Lake Elevation [1,3]	DCP and a Talk-a-Mark	Corps of Engineers
Gull Lake Dam	Tailwater Elevation [4]	DCP and Staff Gage [2]	Corps of Engineers
Gull Lake Dam	Precipitation	Recording and Nonrecording Gages	National Weather Service
Gull Lake Dam	Temperature	Thermometer	Corps of Engineers
Gull Lake Dam	Wind Speed and Direction	Anemometer and Wind Vane	Corps of Engineers
Gull Lake Dam	Snow Depth and Water Equivalent	Snow Tube	Corps of Engineers
Gull Lake Dam	Frost Depth	Frost Tube	Corps of Engineers
Gull Lake	Ice Thickness	Manual Estimate	Corps of Engineers

1. The "Pool" gage is located at the dam while the "Lake" gage is on the main body of the reservoir. The lake gage is necessary due to the drawdown effects in the channel upstream of the dam. Data is available on Corps log sheets dating back to September 1895. Some of the early records are for a logging dam which was in place before the Corps dam was constructed in 1922-12.
2. One DCP transmits both pool and tailwater readings.
3. Some lake data was published by U.S. Geological Survey (Gage No. 05246500) October 1941 thru 1997 based on records provided by the Corps of Engineers. In some years the USGS lists a peak lake stage that differs from the value listed on the Corps log sheet (e.g. 1952). This is in all likelihood due to the fact that a strip chart was consulted to determine the peak prior to providing the data to the USGS for official publication. The location of the gage has varied over the years. **See Paragraph 4-06.**
4. Discharge data was published by U.S. Geological Survey October 1941 thru 1994 (Gage No. 05247000) based on records provided by the Corps of Engineers. **See Paragraph 4-06**.

Table 5-2

Stations in the Vicinity of Gull Lake Dam and Reservoir

Owner/Gage No.	Drainage Area Sq. Mi.	Location	Notes
USGS. Gage No. 05247500	3,520	Crow Wing River near Pillager, MN	At the Sylvan Dam, Minnesota Power Company
USGS. Gage No. 05261000	11,010	Mississippi River near Fort Ripley, MN	On the left bank 600 ft. upstream from Nokasippi River, 1.0 mile north of Fort Ripley
See Table 5-1 for information on U.S.G.S. gage Nos. 05246500 and 05247000.			

Table 5-3

Snow Survey Sites for Gull Lake Dam and Reservoir (see Plate 5-2)

Number and Name	Location
1. Gull Lake Dam	Gull Lake Dam Site
2. Barrows	Along MN Hwy. 371, South of Brainerd, MN at the turn off to Barrows, MN
3. Ft. Ripley	Along 273rd St. in the northwest quadrant at the intersection with MN Hwy. 371
4. Little Falls	Along Edmund St. in the southwest quadrant at the intersection with MN Hwy. 371
5. Long Prairie	East of Long Prairie, North of MN Hwy. 27 off of 2nd Avenue near the power plant
6. Eagle Bend	So. of Eagle Bend, East of U.S. Hwy. 71, Across from the automotive salvage yard
7. Wadena	So. of Wadena in the northeast quadrant of Bottlemiller Dr. and CSAH 103
8. Sebeka	So. edge of Sebeka, East of U.S. Hwy. 71 in an open field
9. Leader	North of the juncion of MN Hwy. 64 and Cass County 109 near Leader, MN
10. Motley	2 miles north of MN Hwy. 210, along east side of MN Hwy. 64, So. of Leader, MN

5-02. Water Quality. See also **Paragraphs 4-08, 7-07 and 8-04.**

a. Facilities. The Corps regularly maintains three (3) water quality data collection stations on Gull Lake. Stations locations are shown on **Plate 5-3.** Data collected is used to define baseline water quality conditions, identify water quality trends, support locally sponsored lake management programs, and to analyze water quality problems and concerns as they relate to natural conditions and to reservoir operations.

When part of a water quality program at Gull Lake, data collection activities are concentrated during the open water period from May through October. Vertical profiles of water temperature, dissolved oxygen, pH, and specific conductance are electronically monitored on a regular basis at each lake station. In addition, two meter integrated surface samples are collected analyzed for total and ortho phosphorus, total kjeldahl nitrogen, nitrate-nitrite nitrogen, ammonia nitrogen, and chlorophyll a. Additional depth specific samples and parameters are obtained at sporadic intervals to further define water quality relationships. Laboratory analyses are performed by Corps inspected and approved laboratories.

b. Reporting. In situ water quality data is electronically recorded, downloaded onto magnetic media, and mailed to the Water Quality Unit in the District office. Lake samples analyzed for nutrients and chlorophyll are processed at the project site and shipped to a Corps-approved laboratory for analysis. All chemical analyses follow recommended EPA or equivalent procedures. Laboratory results are forwarded to the Water Quality Unit in the District office. Both in situ and nutrient data are reviewed and entered into DBASE. The data is also provided to the Minnesota Pollution Control Agency who enter it into the United States Environmental Protection Agency's STORET data storage system under the agency code 21MINNL. The Corps produces periodic data reports describing project data collection activities and laboratory results. All water quality data is available in hard copy or on magnetic media upon request.

c. Maintenance. Project personnel are trained to do routine calibration and maintenance of equipment. Water Quality Unit staff performs any additional maintenance required.

5-03. Sediment Stations. There are no sediment monitoring stations in the Mississippi River Headwaters region.

5-04. Recording Hydrologic Data. The project staff obtains river elevations, reservoir elevations and other data from gages in the vicinity of the dam and other pertinent locations. The staff connects by modem to the computers in the Water Control Section to enter the project data into the electronic database. This data is also recorded on a log sheet, which is sent to the section through the mail. The pool, tailwater and various river elevations and Hydrometeorological data are also recorded by Data Collection Platforms (DCP) and transmitted via satellite to Water Control's electronic database. At some DCP gages, project personnel check the correspondence between the gage and DCP readings visually at regular intervals.

A National Weather Service precipitation gage is used at the dam to record the daily precipitation. The 24-hour precipitation and weather observations are recorded daily. The recorder chart and Form B-91 are mailed monthly to the National Weather Service. Precipitation for weekends and holidays is recorded on the next workday. The data are archived by the National Climatic Data Center in Asheville, North Carolina. The data from some of the U.S.G.S.-maintained stations are archived in the U.S.G.S. WATSTORE database in Reston, Virginia. The U. S. Geological Survey and various contractors conduct streamflow measurements as requested by the District office.

During the annual snow survey, three to four snow samples are recorded at each station (see **Plate 5-2** and **Table 5-3)**. The average snow depth and water content of the snow in inches is recorded and sent to the District office for analysis of the probable runoff to be expected. In addition to the snow samples, notes are recorded on the general conditions of snow cover in fields, timbered areas, river channels, dry runs and ditches both at the stations where measurements are taken and between the stations. The water content of the snow is determined by instructions contained in the National Weather Service Observing Handbook No. 2. Frost depths from power company crews and construction crews, or from anyone who may have occasion to penetrate the ground surface, are obtained and recorded.

5-05. Communication Network. The staff can transmit hydrologic data and information by telephone, modem, facsimile and via the United States mail. The Headwaters sites have access to VHF radios. However, present radio facilities do not allow for a reliable audible signal between St. Paul and the Headwaters region. Data Collection Platform data is transmitted hourly to a GOES satellite and then back down to a Direct Readout Ground Station (DRGS) in Wallops Island, Virginia. The DRGS transmits the data to a Domestic Communication Satellite (DOMSAT), which then transmits the data to a Domestic Receive Station (DRS) in the Water Control Section. The entire project related data is available on the World Wide Web. The project data is also provided to the National Weather Service via a dedicated communication line.

5-06. Emergency Communication with Project.

a. Regulating Office with Project Office. The introduction to this Water Control manual contains emergency regulation contact procedures. If the project staff cannot connect with anyone in the District office, they will follow the regulations in **Chapter 7** with due consideration for any unusual circumstances that might prevail.

b. Between Project Office and Others. Local residents have access to project-related information from the project staff either by telephone, in person, on the World Wide Web or through the local news media. Press releases are issued when conditions warrant. Flash-flooding is not a problem in this area. Notifications of severe weather or impending unusual conditions are handled by the National Weather Service and through local law enforcement and civil defense authorities.

The Project office and the District office communicate with the Minnesota Power (Sylvan Dam and Little Falls Dam), the National Weather Service and others as needed.

5-07. Project Reporting Instructions. The pool and tailwater elevations that are recorded on the project's log sheet are followed by a letter code to indicate the source of the data. Sources include visual readings of float tapes or staff gages, data from voice modems, data from Data Collection Platforms (sometimes obtained from a website) and wire weight gage data. It is preferred that the data recorded on the project log sheet be obtained from a float tape, staff gage or wire weight gage daily or at a minimum once or twice a week.

5-08. Warnings. In the event of impending emergency conditions, or advisories requiring interim gate changes, Water Control will call the project staff. **Paragraph 1-05** contains phone numbers for project personnel. The introduction to this manual contains phone numbers for Water Control and various District personnel. In the event of emergencies affecting project regulation and concerns downstream, the officials listed in **Table 5-4** will be contacted (also see **Paragraphs 7-13 and 8-10**).

Table 5-4

Points of Contact for Emergency Notification

Point of Contact	Telephone Numbers	
	Work	After Hours
Cass Co., MN, Civil Defense Director, 24 Hr	218.547.3300 Extension 222	218.335.6191
County Sheriff, 24 Hr	218.547.3345	-------
Crow Wing County, MN Civil Defense Director, 24 Hr County Sheriff	 218.829.1711 218.829.4749	 218.829.9329
Mississippi Valley Division U.S. Army Corps of Engineers	601.634.5946	-------
National Weather Service, Chanhassen, MN National Weather Service, Duluth, MN	952.361.6708 218.729.0653	-------
Minnesota Div. Emergency Man. Minnesota Statewide Emergency	651.649.5451 1.800.422.0798	24 Hours 24 Hours

Note: Phone Nos. for Water Control, District, and project personnel are listed in the introduction to this manual and in **Paragraph 1-05.**

VI - HYDROLOGIC FORECASTS

6-01. General. The National Weather Service Forecast Office in Chanhassen, Minnesota performs all stream-stage forecasting in the public interest. The St. Paul District, Corps of Engineers, will provide advisory forecasts as needed for its projects. These Corps forecasts may arise from either wet or dry conditions, and they may be used to guide Water Control Section regulators and the Managers in their tasks. In the public interest, the Water Quality Division of the State of Minnesota, Pollution Control Agency, will forecast water quality conditions when warranted. The St. Paul District may provide test data through its Water Quality Unit in the Engineering Division.

6-02. Flood Condition Forecasts.

a. Introduction. During the development of this Water Control Manual, the runoff characteristics of the Gull Lake Dam watershed were simulated using the HEC-1 computer model and selected historical runoff events. The elevation and outflow records from 1912 to 1985, and average lake evaporation values were utilized in a reverse routing procedure to compute estimated daily inflows to the reservoir. The computed inflows were used to calibrate the model to historic events and create data for statistical analyses (see also **Paragraph 4-07**). The HEC-1 model was used to develop **Plates 6-2 thru 6-4.** The following paragraphs discuss the development of the model and subsequent tools that were developed for forecasting purposes.

b. Watershed Subbasins. In order to generate unit hydrographs by computer modeling, the watershed above the Gull Lake Dam was divided into sub-areas based on the drainage pattern. The boundaries of the watershed sub-areas and a schematic of the HEC-1 model are presented on **Plate 6-1.** The watershed above the dam was divided into six sub-areas for use in the model. Sub-areas A, B, C, D and E were assumed to discharge directly into the reservoir. The sixth sub-area is the surface of the Gull Lake chain of lakes. Rain falling directly into the lake is treated as an instantaneous addition to the reservoir volume with no infiltration losses. The curves on **Plate 6-2** include the rain which falls directly into the reservoir.

c. Forecast Tools. The Water Control Section makes reservoir inflow and downstream flow forecasts as conditions warrant. **Plates 6-2, 6-2a, 6-3 and 6-4** are the result of HEC-1 computer model simulations or calculations and can be used to develop runoff forecasts. The total surface runoff from a precipitation event for the entire watershed above Gull Lake Dam can be estimated based on the rainfall-runoff curves on **Plate 6-2.** To define the rainfall-runoff curves, various basin-mean areal precipitations were input to the calibrated HEC-1 model of the watershed for each of the three antecedent soil moisture conditions. The resulting curves compare favorably with National Resource Conservation Service standards.

The hydrologic response of the watershed, or the rate of runoff following a precipitation event is demonstrated by the watershed unit hydrograph. The HEC-1 watershed model produced reservoir inflow hydrographs based on a three-hour time increment. The unit hydrographs derived for the reservoir for this manual are illustrated on **Plate 6-2a.** The three-hour unit hydrographs represent one-inch of runoff from a three-hour rainfall over each watershed sub-area.

The time of concentration of the overall unit hydrograph is relatively short at 1.0 day. This is the time from the end of the rainfall period to the inflection point of the recession limb of the runoff hydrograph, or approximately the time to the peak discharge. The steeper slope of the recession limb is an indication of the relative lack of storage by swamps and lakes within the watershed. These unit hydrographs do not include the amount of precipitation which falls directly into the reservoir.

The total inflow hydrograph for the reservoir following a precipitation event can be forecast by multiplying ordinates of the unit hydrograph (**Plate 6-2a**) by the predicted runoff volume from the corresponding rainfall-runoff curve (**Plate 6-2**). The volume of rain that falls directly into the reservoir is included in **Plate 6-2.**

Another useful forecasting tool for reservoir regulation is the family of inflow recession volume curves on **Plate 6-3.** If the peak inflow from the watershed into the lake after a given rainfall event is known, the remaining inflow volume at any given time past the peak may be estimated from this plate. The curves are intended to provide additional guidance for reservoir regulation during flood conditions. The curves do not account for evaporation losses from the lake.

d. Discussion. **Plate 6-4** illustrates a comparison between Gull Lake inflows computed by the calibrated HEC-1 model, and those calculated by a reverse routing procedure using the observed lake elevations and outflows. Rainfall floods were simulated in the HEC-1 model using three-hour computation intervals. The observed data used for the reverse routing is from daily discharge records and elevation records, which were recorded at frequencies varying from daily to every ten days. Consequently, the reverse-routed inflows are 24-hour average values which are not as sensitive as the HEC-1 model (based on a three-hour interval) to large, rapid variations in inflow, particularly with regard to instantaneous additions to lake volume from precipitation directly into the lake.

In general, the accuracy of the HEC-1 model was verified by comparing modeled inflows with reverse-routed flows. However, both methods of estimating inflows involve some margin of error. A small error in lake-elevation measurement due to human error or wind effects, for example, will result in a large error in the calculated lake volume for that day. This will then cause a large error in calculated reverse-routed daily inflow.

The user of the aforementioned forecast tools must consider the underlying assumptions inherent in the HEC-1 model. The HEC-1 computer model is a "single event" model. Precipitation events separated by a period of dry weather can not be included in the same runoff simulation because HEC-1 has no provision to increase soil infiltration rates during dry periods. The HEC-1 model has no provision to account for lake evaporation losses, which at some point following a storm, will exceed the rate of inflow. Use of the aforementioned graphical relationships should be limited to computing reservoir inflow volumes during the periods of high runoff following storms.

6-03. Conservation Purpose Forecasts. Forecasting for water-related activities such as hydropower regulation, recreation, fish spawning, water supply and water quality are not a part of the daily Water Control Section routine. Short-term projections of water level, flows, temperature and local hydrologic conditions may be obtained from Water Control upon request.

6-04. Forecasts During Drought Conditions. Hydrologic and meteorologic forecasts are issued by the National Weather Service (see **Paragraph 6-01**). The Minnesota Department of Natural Resources has provided minimum discharge guidelines for the reservoirs that are based on reservoir levels (see **Chapter 7**).

6-05. Long-Range Forecasts. Long-range forecasts of reservoir inflows and levels are not normally required due to the very limited water supply use of the reservoir. A seasonal drawdown is required to prepare the reservoir for spring runoff. The difference in storage between the average fall elevation of the lake and the spring lake level is adequate to store the average spring inflow. Predictions of pool levels for project purposes are based on current precipitation trends.

VII - WATER CONTROL PLAN

7-01. General Objectives. The reservoir is regulated primarily for recreation, flood control and fish and wildlife. The Water Control Plan supports recreation by maintaining, when possible, stable reservoir levels within a specified elevation band during the summer. Flood control objectives are met by a fall/winter drawdown schedule and a designated flood control storage pool, which provides storage capacity for spring and summer flood events. Water levels are managed, when conditions permit, for various fish and wildlife concerns. The low-flow plan manages water resources both upstream and downstream of the dam during critical periods. See **Paragraph 2-02** for information on these and other authorized purposes.

7-02. Constraints and Issues Related to the Water Control Plan.

a. Connecting Channel Obstructions. Gull Lake reservoir is part of a chain of lakes (see **Plate 2-1**). Sand bars in connecting channels between several of the lakes poise a hazard to boats and are an issue when water levels are low such as occurred in 1976. In some cases, the connecting channels are very narrow and tend to silt in fairly rapidly due to littoral drift. The connecting lake inlets provide serious problems to boats moving from one lake to another.

b. Flowage Rights. Unlike the other Headwaters reservoirs, Gull Lake's flowage rights elevation is equal to its Upper Operating Limit (elev. 1194.75 ft.). See **Table 7-2** and **Paragraph 2-05** for additional information.

c. Sylvan Dam. Sylvan Dam is located on the Crow Wing River downstream of its confluence with the Gull River, about 3.6 miles upstream of the Crow Wing's confluence with the Mississippi River. The dam is owned and operated by the Minnesota Power Company for hydroelectric generation. The operation of Gull Lake Dam can have a significant impact on the operation of Sylvan Dam. The operation of Gull Lake Dam is not constrained by Sylvan Dam, however, the Corps coordinates with the dam operator during critical periods. See **Paragraph 4-11**.

d. Little Falls Dam. Little Falls dam, which is on the Mississippi River at Little Falls, MN, is owned and operated by the Minnesota Power Company for hydroelectric generation. A paper plant can also uses a portion of the water. The Corps notifies Minnesota Power when large releases are made from Gull Lake Dam. The operation of Gull Lake Dam is not constrained by Little Falls Dam, however, the Corps coordinates with the dam operator during critical periods. See **Paragraph 4-11**.

7-03. Overall Plan for Water Control. Gull Lake reservoir is regulated between a minimum elevation of 1192.75 feet and a maximum elevation of 1194.75 feet. If possible, the reservoir level should be within its summer range/band of 1193.75 feet to 1194.00 feet by the first day of the fishing season (approx. mid-May). The winter drawdown of the reservoir for spring flood control begins in the fall. The ordinary (normal) spring drawdown elevation is 1192.75 feet, which is the lower operating limit of the reservoir. Details of the water control plan are given in the following paragraphs.

7-04. Standing Instructions to the Project Staff. The project is to be regulated in accordance with **Paragraph 7-05**. Information on data collection and transmission of reports, refer to **Chapter 5**. For procedures to be followed in the event of lost communications, refer to **Paragraph 7-15**. In the event of a communication failure, the procedures outlined in this chapter should be followed as far as practicable until communication channels are restored. An emergency contact list, and other points of contact, can be found in the introduction to this manual, in **Chapter 1** and in **Chapter 5**.

7-05. Water Management and Flood Control. The regulation of the reservoir and the operation of the dam is done in accordance with the instructions given below.

a. Information Sources. A description of the project, to include the control structure, and other pertinent project data can be found in **Chapter 2** and **Exhibit A**. A brief history and changes that have been made to the Water Control Plan, since the project was authorized, are discussed in **Chapter 3**. A description of the watershed, climate and past floods can be found in **Chapter 4**. **Chapter 5** contains information on the project's data collection and communication networks, while **Chapter 6** discusses hydrologic forecasts. Frequency and duration curves and flood hydrographs are referenced in **Chapters 4 and 8**. Examples of reservoir regulation during selected floods are shown on **Plates 8-3 through 8-9.** See **Chapter 9** for information related to the coordination of Water Control activities.

1. Water Control Plan Summaries. The Water Control Plan that is currently in use is described below. The following discussion uses terms like Normal Summer Range/Band, Present Ordinary Operating Limit and Present/Total Operating Limit. These terms were carried over from the previous manual (dated 1963) in order to provide consistency with the earlier manual and are defined in **Paragraph 7-16.** **Table 7-1** provides a summary of the regulation for Gull Lake only. **Table Nos. 7-2, 7-3, 7-4 and 7-5** provide a summary of the regulation parameters for the entire Mississippi River Headwaters system for comparison and easy reference. Both stages and elevations are included in **Table 7-2,** and elsewhere in this chapter, to facilitate references to historical documents that refer to stages only (e.g. in **Exhibit D**). **Table 7-6** lists recommended maximum discharge rates and **Table 7-7** and **Plate 7-1** contains drawdown information.

2. Rating Curves/Tables and Project Information. **Plate 7-2** (Free/Submerged Flow Decision Matrix) should always be consulted prior to determining the outflow from the dam. The following rating curves, tables and guidelines are useful for the operation of the project.

Location	Description
Plate 7-1	Drawdown Curve
Plate 7-2	Free/Submerged Flow Decision Matrix
Plate 7-3	Slide Gate Rating Table
Plate 7-4	11-Foot Stop Log Bay Rating Table
Plate 7-5	Submerged Flow Slide Gate Rating Curve
Plate 7-5a	Discharge Measurements for Various Slide Gate Openings
Plate 7-6	11-Foot Stop Log Bay Rating Curve
Plate 7-7	Tailwater Rating Curve
Exhibit E	Stage-Discharge Tables for Aitkin, Brainerd Pillager and Ft. Ripley, MN
Exhibit F	Elevation-Storage Curve / Table and Area-Capacity Curve

b. Emergency Regulation. See **Paragraph 7-13**.

c. Minnesota Department of Natural Resources Guidelines. The Minnesota Department of Natural Resources has provided the Corps with guidelines for the regulation of the Headwaters reservoirs. These guidelines are discussed below where applicable with key provisions covered in **Tables 7-1, 7-2, 7-5 and 7-6**. The guidelines are effective only when the reservoir is not functioning for the primary purposes of navigation and flood control. See **Paragraph 3-05.m.** and **Exhibit D (Reference Nos. 9, 10 and 11)**.

d. Rate-of-Release Change. Unlike Winnibigoshish, Leech and Pine, the District has no informal agreement with the Minnesota Department of Natural Resources regarding routine rate-of-release changes for Gull Lake Dam. Reasonable judgement, however, must be exercised. For example, a large percent increase or decrease in the total magnitude of the flow is not advisable (e.g. going from 100 to 500, 500 to 100 cfs or 1,000 to 500 cfs in one gate move). The District's Environmental Section should be consulted when changes are being made during critical flow periods particularly during low-flow conditions. Two or three gate changes per day may be necessary during critical flow periods to alleviate stress to fish and wildlife resources. See **Table 7-5 and Exhibit D, Reference 11**.

e. Regulation For Dry Conditions. The Federal low-flow regulations and State low-flow guidelines are included in the Low Water Contingency Plan, which was provided to Congress as a requirement of Public Law 100-976, Water Resources Development Act of 1988 (see **Exhibit D, Reference 12**). The information is outlined below. Area-capacity curves and a storage table for Gull Lake are in **Exhibit F**. See **Paragraph 7-12** for information on the draft Drought Contingency Plan and other applicable reference documents. See **Tables 7-1 and 7-2** for a summary of the Federal and State low-flow regulations and guidelines.

1. Federal Regulations, Title 33, Sect. 207.340 and P.L. 100-676. Federal regulations (Title 33, Sect. 207.340) require that the average annual discharge from the reservoir must equal or exceed 30 cfs (10,950 SFD or 21,719 ac-ft) (see **Exh. D, Ref. 7, Para. d.2)**. The exception being if inspections, repairs, or the prevention of damages, is necessary (see **Exh. D, Ref. 7, Par. d.1).** The average is assumed to be over the course of a water year. In addition, whenever the reservoir is at or below the minimum elevation of 1192.75 feet (5.0 ft. stage), no discharge other than the specified minimum of 30 cfs shall be permitted "except such increases of discharge as may specifically be directed by the Chief of Engineers" (see **Exh. D, Ref. 7, Para. d.5**). If the reservoir falls below elevation 1192.75 feet, the minimum level "will be restored at the first practicable opportunity". The average annual requirement is satisfied in most years by the spring runoff. During prolonged dry periods, however, a careful consideration of the attendant hydrometeorlogical variables is necessary in order to insure, if practicable, that the average annual requirement is satisfied.

Note that the Secretary of the Army must notify Congress 14 days prior to the reservoir level falling below elevation 1192.75 feet (P.L. 100-676, see **Exh. D, Ref. 12**).

2. Minnesota Department of Natural Resources (MDNR) Guidelines. After taking measures to insure that the average annual federal discharge/volume/minimum flow requirement can be satisfied (see above), Minnesota Department of Natural Resources (MDNR) guidelines are followed. The MDNR guideline states that, if the reservoir is at or above elevation 1192.75 feet (5.0 ft. stage), the minimum discharge is 20 cfs. Furthermore, if the reservoir is below elevation of 1192.75 feet, the minimum discharge is reduced to 10 cfs. See **Tables 7-1 and 7-2 and Exhibit D, Reference 10**. In most cases, anytime the reservoir is above elevation 1192.75 feet, 20 cfs is the minimum discharge. However, during an extreme dry period, over the span of many months or years, while it may appear that the MDNR guidelines could conflict with the Federal average annual discharge requirement (e.g. 10 or 20 cfs vs. 30 cfs), the Federal regulations will be taken as primary.

f. Recreation Season Regulation. The main portion of the recreation season encompasses the period from the first day of the fishing season through Labor Day weekend (approx. mid-May to early Sept.). When runoff conditions permit, the reservoir level should be within the Normal Summer Band of 1193.75 to 1194.00 feet by the first day of the fishing season, and held there by discharging inflow until October, after which the fall/winter drawdown can begin (see **Tables 7-1 and 7-2)**. As the recreation industry has grown, the number of people using the resource in the late fall (at least thru Sept.) has also increased. A gradual drawdown, beginning on approximately 1 October, keeps the pool within the summer band in the fall to accommodate late season recreation (see drawdown discussion for details).

g. Fall/Winter Drawdown. The fall/winter drawdown of the reservoir normally begins on 1 October, however, if necessary, it can begin anytime after Labor Day (approx.10 Sept.). The 1 October start of the drawdown allows for an extended recreation season in the fall (see **Plate 7-1**). The timing of the start of the drawdown may vary from year to year depending on the magnitude of the inflow and other variables. However, the drawdown of the reservoir requires a careful consideration of the attendant hydrometeorlogical variables as discussed below.

1. Drawdown Discharge. In the fall, the total discharge and the length of time required to lower the pool to the normal drawdown level (elev. 1192.75 ft.) by 1 March, are determined. An average discharge from 1 October to 1 March of approximately 50 cfs <u>above</u>

inflow is required for a drawdown from elevation 1193.87 (mid-summer band) to 1192.75 feet. However, the required drawdown discharge may change as the winter/snowpack progresses. The area-capacity curves and storage tables in **Exhibit F** and the drawdown curve on **Plate 7-1** can be used to assist in this calculation and to adjust for different dates and target elevation ranges as the fall and winter hydrometeorlogic conditions materialize. If the drawdown is completed before the spring snowmelt begins, discharge inflow to maintain the drawdown level.

2. Drawdown Target Elevations. The final drawdown target level, which may be higher than 1192.75 feet, is based on inflow projections, expected storage requirements, snow surveys (see **Chapter 5**), the precipitation outlook forecast and other variables, all of which may change as the winter progresses. The snow water content guidelines in **Table 7-7** can be used to assist in this decision making process. Periodic checks of inflow, and the hydrologic conditions in the basin (e.g. snowpack), are made and the outflows are adjusted as necessary to accomplish the goal. In periods of drought, or when light snow cover (low water content) exists, the reservoir may be drawn down only as far as conditions warrant. See **Tables 7-1, 7-2, 7-7** and **Plate 7-1** for a summary. It is recommended that the draw down be reviewed after the January snow survey results have been published.

Some caution must be exercised when drawing down the reservoir. There is always the danger (although in the case of Gull it is slight) of not being able to fill the reservoir back up to the Normal Summer Band in the spring if a reasonable balance between the drawdown target elevation, snowmelt, spring rains and other factors are not weighed properly. On the other hand, the appropriate amount of storage must be obtained to provide for flood control while considering the fact that the drawdown must begin many months prior to the snow pack and spring rainfall manifest themselves. **Tables 7-3 and 7-4** can be used to assess the storage capacity of the system relative to the snowpack and the respective drainage area of the reservoirs.

h. Flood Control, General. Gull Lake Dam is operated, if necessary, for flood control to prevent damages downstream. The majority of the benefits occur in the areas adjacent to the river immediately downstream of the dam. The dam does not have a specific downstream control point or trigger stage that governs the flood control operation. For additional details see **Tables 7-1 and 7-2**.

The spring melt can occur as early as March or as late as May with runoff extending into early June. As such, the 1 March drawdown target date allows for an early spring runoff. Unlike spring floods, the flood events that occur during the other three seasons do not benefit from advanced drawdown measures. In the summer, fall or winter, if downstream areas require flood control operation, the discharge from Gull River Dam is adjusted as necessary and the applicable procedures below will be followed.

The High Water Contingency Plan, delivered to Congress as a requirement of the Water Resources Development Act of 1988 (Public Law 100-976) is, with additional details, outlined below (see **Exhibit D, Reference 12**).

1. Flood Control, Regulation and Operation. Storage is available between the elevations of 1192.75 feet (max. drawdown level) and 1194.75 feet (Upper Operating Limit) with a drawdown target elevation determined each year based on conditions (see **Tables 7-1, 7-2, 7-7 and Paragraph 7-05.g.**). After the reservoir fills from the drawdown elevation to the summer band (1193.75 to 1194.00 ft.), discharge inflow if downstream conditions permit. However, if conditions warrant, inflow can be stored for downstream protection up to the Upper Operating Limit (1194.75 ft.). During floods, daily estimates of the remaining inflow volume will be made (see **Chapter 6**). After the reservoir exceeds the top of the summer band (elev. 1194.00 ft.) the outflow will be adjusted, based on the daily inflow forecast and the remaining storage in the reservoir, to utilize the storage, if necessary, up to elevation 1194.75 feet while not exceeding that elevation. As the storage in the reservoir below elevation 1194.75 feet is filled, the discharge from the control structure will, out of necessity, be ramped upwards until the dam is completely open by the time the reservoir reaches elevation 1194.75 feet (which is also the top of the flowage rights, see **Paragraph 2-05** and **Table 7-2**). Open river conditions will then exist until the reservoir level falls below elevation 1194.75 feet and regulation is again possible. The control structure must be opened completely when the reservoir is at or above elevation 1194.75 feet to insure the safety of the dam. After it is no longer necessary to operate for flood control, the pool will be returned to the summer band by the first day of the fishing season (approx. Mid-May), whenever possible, at a rate that will not endanger wildlife or cause other problems within the reservoir or downstream. The Secretary of the Army must notify Congress 14 days prior to the reservoir level going above elevation 1194.75 feet (see **Exhibit D, Reference 12**).

Table 7-6 should be consulted if the flood control operation requires large discharges from the dam. Based upon an informal agreement between the Minnesota Department of Natural Resources and the St. Paul District Corps of Engineers, maximum reservoir releases will follow, as closely as possible, the recommended values (see, **Exhibit D, Reference 10**). Whenever possible, the discharge from the reservoir will follow the guidelines, however; reasonable judgment must be exercised to provide balanced benefits for flood control, in stream resources and considerations for dam safety.

See **Paragraph 7-05.d and Table 7-5** for information on rate-of-release change guidelines.

2. Travel Times. The travel time from Gull Lake Dam down to Ft. Ripley, MN is approximately 1 day.

3. Flood Forecasts. The National Weather Service (NWS) river forecasts extend 7 days into the future, which allows time to reduce the discharge at Gull Lake Dam for the benefit of points downstream (e.g. approx. 1-day travel time to Fort Ripley). The NWS should be contacted daily during flood periods to ensure that the Corps' operation decisions coincide with the NWS forecasts. See also **Chapter 6**.

Table 7-1
Gull Lake Regulation Parameters, (see Paragraphs 3-05, 7-05 and Table 7-2)

Date or Period	Reservoir Elevation, Ft.	Discharge, cfs	Comments
Recreation Season, Start of Fishing Season into Sept. Approx. 15 May to 10 Sept.	1193.75-1193.87-1194.00 Normal Summer Band 1193.87 = Middle	As needed to maintain the band but not less than 20 cfs. (1)	See Note No. 1 on min. flows. The summer band is usually held until October.
Fall/Winter Drawdown Approx. 1 Oct. to 1 Mar. (Varies)	1194.0 down to 1192.75 Varies, see **Table 7-7** and **Plate 7-1** (2)	Approx. 50 cfs above inflow.	If necessary, the winter drawdown can begin any time after Labor Day.
Flood Control Operation Approx 1 Mar. to 15 May → Approx 15 May to Fall →	Can go up to 1194.75 (3) 1192.75 up to 1194.75 (2) 1194.00 up to 1194.75	If necessary, reduce flow for flood control downstream. (1) (4)	See **Paragraph 7-05.h.** Elev. 1194.75 ft. is the top of the flowage rights. (3)
Wet Conditions/High Inflow 1 Jan. to 31 Dec.	At or Above 1194.75 (3) 14 Days Prior to 1194.75 notify Sec. Army (7)	Dam wide open to insure the safety of the structure.	See **Paragraph 7-05.h.**
Federal Average Annual Outflow Requirement 1 Jan. to 31 December	All Conditions and Levels	Average annual outflow/ volume must equal or exceed 30 cfs. (5) (7)	The spring runoff assists in fulfilling this requirement. See **Paragraph 7-05.e.**
MDNR Guideline, Dry Conditions/Low Inflow 1 Jan. to 31 December	≥ 1192.75, 14 Days Prior to 1192.75 Notify Sec. Army (7) (Exclusive of Drawdown)	20 cfs (6), But, see average annual outflow requirement above. (5)	The minimum flow is 20 cfs. when the pool is ≥1192.75 ft. See **Paragraph 7-05.e.**
MDNR Guideline, Very Dry Cond./Low Inflow 1 Jan. to 31 December	Less than 1192.75	10 cfs (6), But, see average annual outflow requirement above. (5)	<1192.75 MDNR guideline is 10 cfs. Reservoir is below minimum operating limit.

1. At or above 1192.75 ft., the MDNR minimum flow guideline is 20 cfs. However, the average annual outflow must equal or exceed 30 cfs over a water year (see **Para. 7-05.e.**). For max. discharge ranges see **Table 7-6**. See **Table 7-2**. Gull Lake is regulated according to the lake gage at Government Point.
2. Elev. 1192.75 ft. is the normal drawdown target elevation. The drawdown elevation can be higher than this depending on runoff/snowpack conditions (see **Table 7-7**). Elevation 1192.75 ft. is the lower operating limit.
3. Shoreline erosion intensifies above elev. 1194.75 ft. The Total Operating Limits extend from 1192.75 to 1194.75 feet (see **Table 7-2** and **Paragraph 7-16**). Elevation 1194.75 ft. coincides with Gull's flowage rights elevation (see **Para. 2-05**).
4. The travel time to Ft. Ripley is approx. 1 day. See **Paragraph 7-05**.
5. See Title 33, Code of Fed. Regulations, Sect. 207.340(d) which prescribes the minimum operating limits and min. ave. annual flows (see **Exh. D, Ref. No. 7**). At or below 1192.75 ft., no flow, greater than the specified min. of 30 cfs is permitted unless directed by the Chief of Engineers. Fed. ave. annual flows are primary over MDNR guidelines. See **Para. 7-05.e.**
6. Minnesota Department of Natural Resources Guideline. See **Exhibit D, Reference No. 10**. See **Note No. 5**.
7. P. L. 100-676, Sec. 21, WRDA, 1988 contains min. and max. notification elevations. The Secretary of the Army must notify Congress 14 days prior to the reservoir being below the min. or above the max. elevation (see **Exhibit D, Reference No. 12**). The District will notify the Secretary well in advance of the 14-day period.

Table 7-2
Mississippi River Headwater Reservoir System
Operating Elev. and Stages in Feet, (see also Paragraphs 3-05, 7-05, 7-16 and Table 7-1)

	Winni-bigoshish	Leech	Poke-gama	Sandy	Cross L. Pine R.	Gull
1. Normal Summer Range/Band Stage in Feet Middle of the Summer Band Elev.	1297.94-1298.44 9.0 - 9.5 1298.19	1294.50-1294.90 1.8 - 2.2 1294.70	1273.17-1273.67 8.75 - 9.25 1273.42	1216.06-1216.56 8.75 - 9.25 1216.31	1229.07-1229.57 12.75 - 13.25 1229.32	**1193.75-1194.00 6.0 - 6.25 1193.87**
2. Ordinary Operating Limits Stage in Feet	1296.94-1300.94 8.0 - 12.0	1293.20-1295.70 0.5 - 3.0	1270.42-1274.42 6.0 - 10.0	1214.31-1218.31 7.0 - 11.0	1227.32-1230.32 11.0 - 14.0	**1192.75-1194.75 5.0 - 7.0**
3. Present/Total Operating Limit Stage in Feet (2002)	1294.94-1303.14 6.0 - 14.2	1292.70-1297.94 0.0 - 5.24	1270.42-1278.42 6.0 - 14.0	1214.31-1221.31 7.0 - 14.0	1225.32-1235.30 9.0 - 18.98	**1192.75-1194.75 5.0 - 7.0**
4. Congressional Notification Levels Public Law 100-676, Sect. 21, WRDA 88	1296.94/1303.14 8.0 / 14.2	1293.20/1297.94 0.5 / 5.24	1270.42/1276.42 6.0 / 12.0	1214.31/1218.31 7.0 / 11.0	1227.32/1234.82 11.0 / 18.5	**1192.75/1194.75 5.0 / 7.0**
5. Fed. Min. Ave. Annual Flow and Min. Level, Code Fed. Reg., Title 33, See No. 6	1294.94 / 6.0 150 cfs	1292.70 / 0.0 70 cfs	1270.42 / 6.0 200 cfs	1214.31 / 7.0 80 cfs	1225.32 / 9.0 90 cfs	**1192.75 / 5.0 30 cfs**
6. MDNR Minimum Flow Guidelines The Federal Minimum Average Annual Flow Regulations are Primary *See No. 5 and Paragraph 7-05.e.*	≥ 1294.94 / 6.0 100 cfs, < 1294.94 50 cfs	≥ 1292.70 / 0.0 100 cfs, < 1292.70 50 cfs	(See Note No. 6.)	≥ 1214.31 / 7.0 20 cfs, < 1214.31 10 cfs	≥ 1225.32 / 9.0 30 cfs, < 1225.32 15 cfs	**≥ 1192.75 / 5.0 20 cfs, < 1192.75 10 cfs**
7. Flowage Rights Acquired To Elev.: Stage in Feet	1306.86 17.92 +	1301.94 9.24 +	1280.42 16 +	1222.31 15 +	1238.82 22.5 +	**1194.75 7.0**
8. Est. Downstream Chan. Cap., cfs	2,000	1,500	6,000	(8.)	2,000-2,500	**950**
Gage Zero Elev., 1912 M.S.L. adj.	1289.47	1293.23	1264.89	1207.70	(9.)	**1188.14**
Gage Zero Elev., U.S.E. Datum	1290.08	1293.76	1265.27	1209.00	1218.20	**1190.00**
Gage Zero Elev., 1929 NGVD	1288.94	1292.70	1264.42	1207.31	1216.32	**1187.75**

1. The most desirable levels for the summer season.
2. Gull's Ordinary Oper. Limits coincide with its min. and max. Total Oper. Limits (see **No. 3**). The lower limit is the normal/ max. spring drawdown level (see **Table 7-7**). The upper limit is the max. design pool level. See **Table 7-1** and **Para. 7-16**.
3. Gull's Present Operating Limits are in accordance with the latest regulations from Congress. The upper and lower limits provide maximum storage for flood control and other purposes. See **Para. 3-05, Table 7-1** and **Para. 7-16**. Note **Row No. 7**.
4. Public Law 100-676, Section 21, of the Water Resources Development Act of 1988 requires the Secretary of the Army to notify Congress 14 days prior to a reservoir being below the minimum or above the maximum listed here. The District will notify the Secretary well in advance of the 14-day period (see **Exhibit D Reference 12**).
5. Title 33, Code of Federal Regulations, Sect. 207.340(d) prescribes the min. operating limits and min. ave. annual discharges as set forth in the 1936 and (for Leech) 1944 regulations (see **Para. 3-05, 7-05.e., 7-16 and Exh. D Ref. 7**).
6. The MDNR elev. and flows are based on an informal agreement between the Corps and the MN Dept. of Natural Resources and are followed after taking measures to insure the federal ave. annual flow requirement is met (see **Para. 7.05.e.**). When Pokegama is below elev. 1273.17 ft., releases are limited to the sum of the Winni. and Leech discharges. In addition, 200 cfs has been adopted as the minimum discharge when Pokegama is at or above elev. 1273.17 ft.
7. See **Para. 2-05** for information. Flowage rights on the Cass L. Chain obtained to elev. 1307.86 (18.92 ft stage).
8. The channel below Sandy Lake is affected by backwater from the Miss. River. The channel capacity below the confluence of the Miss. River and the Leech Lake River is 2,200 cfs (see **Exhibit D Reference 14**). High flows in the 2,000 to 2,500 cfs range from Pine River Dam cause high water problems on Big Pine Lake.
9. 1912 M.S.L. adjustment information for the Pine River Dam gage zero is not available.

Table 7-3 Drainage and Reservoir Surface Areas of Mississippi River Headwaters Reservoirs			
Dam/Reservoir	**Drainage Area in Sq. Mi.**	**Surface Area at Max. Oper. Limit in Sq. Mi. (see Exh F.)**	**Ratio of Drainage Area to Surface Area**
Winnibigoshish	1,442	179 at 1303.14 ft.	8.06
Leech	1,163	250 at 1297.94 ft.	4.65
Pokegama	660 (1) (2)	38 at 1278.42 ft.	17.37
Sandy	421 (2)	20 at 1221.31 ft.	21.05
Pine/Cross Lake	562	24 at 1235.30 ft.	23.42
Gull	287	20 at 1194.75 ft.	14.35

1. The local drainage between Winnibigoshish/Leech and Pokegama = 660 sq. mi. Total D.A. = 3,265 sq. mi (see Note No. 2).
2. Of the 6,240 sq. mi. of drainage area above Aitkin, MN, 3,265 sq. mi. are controlled by Winnibigoshish, Leech and Pokegama (see Note No. 1), 421 sq. mi. are controlled by Sandy and 2,554 sq. mi. are uncontrolled.

Table 7-4 Mississippi River Headwaters Reservoirs Comparative Storage per Change in One Unit of Reservoir Level						
	General Ratios of One Unit of Reservoir Volume Enter Table From the Top Row					
Reservoir	**1 Unit at Winni =**	**1 Unit at Leech =**	**1 Unit at Pokeg =**	**1 Unit at Sandy =**	**1 Unit at Pine/Cross =**	**1 Unit at Gull =**
Winni	**1.00**	1.93	0.26	0.15	0.21	0.20
Leech	0.52	**1.00**	0.13	0.08	0.11	0.10
Pokegama	3.88	7.49	**1.00**	0.56	0.81	0.78
Sandy	6.88	13.27	1.77	**1.00**	1.44	1.38
Pine/Cross	4.78	9.23	1.23	0.70	**1.00**	0.96
Gull	5.00	9.65	1.29	0.72	1.05	**1.00**

Examples: A change in storage of 1.0 ft. in Winni = 0.52 ft. in Leech (or 0.1 ft = 0.052 ft.)
A change in storage of 1.0 ft. in Leech = 1.93 at Winni and 7.49 at Pokegama
(Leech has almost twice as much storage as Winnibigoshish)

Table 7-5
Mississippi River Headwaters Dams
Minnesota Department of Natural Resources Guidelines for Rate of Release Changes

Dam	Rate of Release Guideline
Winni-bigoshish	For increases and decreases limit changes to approx. 200 cfs/day or a change in the tailwater elev. of not more than 0.5 feet. No more that a 10% change in outflow in any 2 hr. period when the USGS gage at Grand Rapids reports an ave. daily flow of 400 cfs or less. No restriction when oper. for walleye spawning.
Leech	For increases and decreases limit changes to approximately 100 cfs per day or a change in the tailwater elevation of not more than 0.25 feet.
Pokegama	Reasonable judgment must be exercised. In general changes are limited to 20-30% of the total flow except when operating for flood ctrl. and/or to prevent property damage. No more that a 10 % change in outflow in any 2 hour period when the USGS gage at Grand Rapids reports an average daily flow of 400 cfs or less.
Sandy	No guideline was provided. Reasonable judgment must be exercised. In general changes are limited to 20-30% of the total flow except when operating for flood control and/or to prevent property damage.
Pine/Cross Lake	For increases and decreases limit changes to approximately 60 cfs per day or a change in the tailwater elev. of not more than 0.25 feet except when operating for flood control and/or to prevent property damage.
Gull	No guideline was provided. Reasonable judgment must be exercised. In general changes are limited to 20-30% of the total flow except when operating for flood control and/or to prevent property damage.

Note on Source: Plan of Operation, Miss. R. Headwaters, Minnesota Department of Conservation, Division of Fish and Game, 15 August 1963 (see **Exh. D, Ref. 11**). Not applicable when operating for flood control and/or to prevent property damage. During other times, reasonable judgment must be exercised. For example, a large percent increase or decrease in the magnitude of the flow is not advisable (e.g. going from 300 cfs to 100 cfs in one move). The District's Environmental Section should be consulted when changes are being made during critical flow periods particularly during low-flow conditions. Two or three gate changes per day may be necessary during critical flow periods to alleviate stress to fish and wildlife resources. For the 10 percent guideline at Winni and Pokeg see **Exh. D, Ref. 13**.

Table 7-6
Informal Agreement With the Minnesota Department of Natural Resources
Maximum Releases From Gull Lake Dam (see Exhibit D, Reference No. 10)

Reservoir Pool Elevation, Feet	Max Discharge Recommended by MDNR, cfs (1)
1190.75	10
1191.25	20
1191.75	40
1192.25	60
1192.75	100
1193.25	200
1193.75	400
1193.87 (2)	
1194.25	600
1194.75	1000
1195.25 and above	1400

1. These guidelines are effective only when the reservoirs are not functioning for flood control, navigation or other authorized purposes.
2. Middle of the Normal Summer Band (see **Tables 7-1 and 7-2**).

Table 7-7 Gull Lake, Suggested Drawdown Target Elevations	
Average Basin Snow Water Equivalent	**Suggested Drawdown Target Elev. In Feet**
Less Than or Equal to Approximately 2 Inches	**1193.25 or Higher**
Approximately 2 to 3 inches	**1193.25 to 1193.00**
Greater than Approximately 3 inches	**1193.00 to 1192.75 Maximum/Normal Drawdown**

Note: The above guidelines were developed after consultation with experienced operators and regulators of the dam and reservoir combined with the assumption of 30 percent runoff of the snowpack over the drainage area of 287 square miles.

The drawdown can begin any time after Labor Day (approx. 10 Sept.) if conditions warrant (e.g. high inflows, wet conditions etc.). However, the drawdown is often times delayed (depending on conditions) until approximately 1 Oct. due to the use of the reservoir in the fall for recreation purposes (see **Paragraph 7-05** for details). The relatively small size of the reservoir compared to, for example, Winnibigoshish and Leech, permits the start of the drawdown to occur later in the fall. The drawdown should be targeted for completion by approximately 1 March to be prepared for the possibility of an early spring melt. See **Plate 7-1**.

7-06. Recreation. Recreation is an important feature of Gull Lake reservoir. There are numerous lakeshore homes and resorts around the lakes and a public recreation area (see **Paragraph 2-06)**. Excessive inflows can cause the reservoir level to exceed the Normal Summer Band due to the relatively small outlet capacity of the dam and the limited downstream channel capacity. See also **Paragraphs 7-05 and 8-03**.

7-07. Water Quality. All Corps of Engineers reservoirs must comply with Public Law 92-500 that requires all Federal facilities be managed, operated, and maintained to protect and enhance the quality of water through conformance with applicable Federal, State, and local standards. The only water quality concern relates to the threat of eutrophication. At this time no physical routine regulation procedures are identified that would improve reservoir water quality. See **Paragraphs 2-02, 4-08, 5-02, and 8-04**.

7-08. Fish and Wildlife. All Corps of Engineers reservoirs must comply with Public Law 85-624 and 93-205 that requires all Federal facilities be managed, operated, and maintained to protect and enhance issues related to fish and wildlife (see **Paragraph 2-02**). See **Paragraphs 7-05 and 8-05**.

7-09. Water Supply. The reservoir is not used for water supply. There is no provision in the Water Control Plan for the use of water in or from the reservoir for water supply. An analysis of the feasibility of using water from the Headwaters region to supplement downstream needs is contained in the September 1994 Section 22 report (see **Paragraph 1-03**).

7-10. Hydroelectric Power. In the Gull Lake basin area, there is no existing or planned Federal hydropower development.

7-11. Navigation. The need for flow augmentation from the reservoirs for navigation was greatly reduced after completion, in the 1930's, of the Mississippi River 9-foot channel project (i.e., locks and dams). The project has rarely been operated for this purpose since then. See **Paragraphs 2-02 and 3-05**.

7-12. Drought Contingency Plans. The Drought Contingency Plan is a stand-alone document (see **Paragraph 1-03**). The plan is currently a draft pending approval. It contains procedures for interagency basin-wide planning procedures. A copy of the draft plan is kept in the Water Control Section. **Paragraph 7-05** contains information on the Federal and Minnesota Department of Natural Resources requirements, guidelines and interagency agreements for regulation during dry conditions that are designed to balance resources in the reservoir with in-stream flow requirements.

The October 1990 “Mississippi River Low-Flow Review” report and the September 1994 “Water Available from Upstream Locations” Section 22 Report (see **Paragraph 1-03**) should be consulted for further guidance during low-flow conditions.

7-13. Flood Emergency Action Plans. The Emergency Action Plan is a stand-alone document (see **Paragraphs 1-03**). It outlines procedures to be followed under various emergency conditions to include a dam failure. A copy of the plan is kept in the Water Control Section and at the project office. The report includes: an emergency identification plan, an emergency operations and repair plan, an emergency notification list, and an inundation map. See also **Paragraphs 5-08 and 8-10**. The Emergency Regulation Assistance Procedures are discussed in the introduction to this manual preceding the **Table of Contents.** See also **Paragraph 7-05**.

7-14. Deviation from Normal Regulation. The District’s Water Control Section chief will determine if a desired deviation is minor, significant or major. Minor deviations can be handled between the Section chief and the Division Office. The Division can give an oral (sometimes conveyed by email) approval to the Section chief for minor deviations. A formal recommendation from the District’s Chief, Engineering Division is required for all significant and major deviations. Deviations may be implemented prior to reporting to higher authority for catastrophic incidents that involve the protection of human life, public property and the safety of project structures.

7-15. Loss of Communication. In the event of failure of normal (telephone) communications, the project staff will maintain contact with the District Office by any other means available, including radio, alternate telephone services, the internet or by sending a messenger to the nearest point where communication is available. The messenger will then transmit written or verbal instructions from Water Control if special operation is required. If Water Control cannot be contacted at the District Office, one of the regulators, in order of preference as shown in the introduction to this manual, is to be contacted.

If contact cannot be made the primary objective of the project staff will be to ensure the safety of the dam and provide the most effective operation of the project by following the guidance in this chapter. It may also be necessary for the project staff to monitor the effects of any reservoir releases on downstream damage centers. During flood control or emergency operation, the appropriate procedure in this chapter will be followed until contact with the District Office is re-established.

7-16. Definitions, Operation Levels. The following terms are used in **Paragraph 7-05** (e.g. see **Tables 7-1 and 7-2**) and elsewhere in this manual. This information is provided here to assist in interpreting the regulations (see **Exhibit D**) and other historical references (see **Paragraph 3-05**).

a. Normal Summer Range/Band. (Sometimes called Desirable Summer Range/Band) Investigations were made of desirable levels for the Headwaters Reservoirs through public consultation. The Normal Summer Range/Band represents the reservoir level which is the most beneficial to a majority of the users during the summer months (see **Table 7-1 and 7-2**).

b. Ordinary Operating Limits. (Sometimes called Present Ordinary Operating Limits) This represents the range that the reservoir is ordinarily operated in during an annual cycle, which minimizes the degree of high and low water damages (see **Paragraph 3-05 and Tables 7-1 and 7-2**). The full range, of course, is not experienced every year.

c. Present/Total Operating Limits. The term "Total Operating Limits" (in addition to Present Operating Limits) is used in this manual (e.g. in **Tables 3-1 and 7-2**). This is due to the fact that Pokegama, Sandy and Pine, due to subsequent flood control studies involving Pokegama and Sandy and, in the case of Pine, a dam safety upgrade, are operated above the limits specified in the various regulations (see **Paragraph 3-05** in the respective manuals). The term "Present Operating Limits" is used when it is felt that it will provide the easiest reference back to historic documents (e.g. primarily at Winnibigoshish, Leech and Gull). In any case, these limits represent the absolute upper and lower reservoir levels that the Corps can operate within (see **Tables 7-1 and 7-2**). The Present Operating Limits were established and/or modified in regulations dated 1931, 1935, 1936 and 1944. Modifications to the upper limits at Pokegama and Sandy were published in the 1963 (revised 1968) Master Regulation Manual (see **Paragraph 1-03)** and Cross Lake/Pine's upper limit was modified in the 1997 Design Memorandum (see also **Paragraph 1-03)**. Congressional notification of upper and lower reservoir levels is required by Public Law 100-676, Section 21, of the Water Resources and Development Act (WRDA) of 1988 (see **Exhibit D, Reference 12**). See **Paragraphs 3-05, 7-05** and **Exhibit D** of this manual for more information.

VIII - EFFECT OF WATER CONTROL PLAN

8-01. General. The Water Control Plan primarily affects flood control, recreation and fish and wildlife. The flood control benefits of the reservoir are very small. The plan strives to maintain stable water levels during the summer months which provides many benefits related to recreation and fish and wildlife (see also **Chapter 2**).

8-02. Flood Control. The unit hydrographs used in the following studies were developed separately from the information discussed in **Chapter 6**.

a. Probable Maximum Flood. The dam was constructed prior to the development of current spillway design flood standards. As a result, the original design of the dam was not based upon Probable Maximum Flood (PMF) criteria. A PMF was developed, however, for the March 1999 Emergency Plan report (see **Paragraph 1-03**), and has been incorporated into this manual for comparative purposes. The computed peak inflow from the PMF is 27,800 cfs. Routing of the PMF through the reservoir, resulted in a computed peak pool elevation of 1204.7 feet and a maximum outflow of 7,300 cfs. The PMF hydrographs for both the with and without dam failure scenarios are presented on **Plates 8-1 and 8-2.**

b. Spillway Design Flood. The dam was constructed before the advent of current Spillway Design Flood criteria (see next paragraph).

c. Standard Project Flood. A Standard Project Flood (SPF) for Gull Lake Dam was developed and presented in the Corps of Engineers report titled, "Review of Design Features of

Existing Dams (RCS ENGCW-(OT) 761; Supplement No. 1), Mississippi River Headwaters Reservoirs", in March 1974 (see **Paragraph 1-03**). The purpose of this report was to determine a Spillway Design Flood (SDF) for each of the Headwaters reservoirs. The term "Spillway Design Flood" as used in the report does not refer to the design used to construct the dam but rather to a flood derived by means of the criteria available at the time (i.e. 1974). The report adopted the SPF as the SDF. The SPF series was developed by assuming that the Standard Project Storm occurred immediately following the 1950 spring flood. The computed peak inflow from the SPF is 7,520 cfs. Routing of the SPF through the reservoir resulted in a peak pool elevation of 1197.65 feet.

An index Standard Project Storm rainfall of 9.0 inches was used. An initial loss rate of 1.0 inch was satisfied by placing the second largest day of rainfall before the maximum day. A uniform loss rate of 0.20 inch per hour was used and only one six-hour period had rainfall greater than the loss rate. The rainfall excess during that period was 6.01 inches.

d. Other Floods. Selected floods are described in **Paragraph 4-06** and are listed in **Table 4-3.** The reservoir routings for some of these floods are shown on **Plates 8-3 through 8-7.** The plates present reservoir stage and storage data, in addition to the reverse-routed inflow hydrograph and the outflow hydrograph for each year to show the overall effects of the Water Control Plan. The corresponding data for one normal year and one dry year are presented on **Plates 8-8 and 8-9.**

8-03. Recreation. The current Water Control Plan for the reservoir provides dependable and stable summer lake levels which benefit resort owners, lakeshore residents and area commerce. Stable summer levels reduce shoreline erosion, improve wildlife habitat, and provide a known reference for landowners to use for cabins and docks. See **Paragraphs 2-06 and 7-06**.

8-04. Water Quality. Gull Lake Reservoir's water quality is not significantly impacted by the current Water Control Plan. The current water quality is excellent, however there is concern that accelerated eutrophication will occur if extensive lakeshore development, urban runoff, and non-point source pollution is not controlled using best management practices. The Corps conducts a water quality monitoring program in conjunction with the Gull Area Lakes Association to evaluate the water quality impacts of reservoir operation and identify emerging water quality trends and problems. Additional efforts by local organizations focus on controlling eutrophication by reducing reservoir phosphorus loading through implementation of best management practices in the watershed. See **Paragraphs 4-08, 5-02, and 7-07**.

8-05. Fish and Wildlife. The U.S. Fish and Wildlife Service has performed studies of the water levels maintained during the operation of Gull Lake Reservoir and has concluded that the present reservoir regulation schedules are generally satisfactory from the wildlife point of view. The current Water Control Plan provides for stable summer levels and consistent recurring year round levels, which benefit fish and wildlife. See **Paragraph 7-08**.

8-06. Water Supply. The headwaters reservoirs are not used for water supply. The Drought Contingency Plan should be referenced for information on water supply issues in the region. The Drought Contingency Plan is in draft form (dated September 1992) and is a stand-alone document. See **Paragraphs 1-03, 7-09 and 7-12**.

8-07. Hydroelectric Power. The Water Control Plan's streamflow regulation provides flow-duration characteristics, which benefit downstream hydropower plants. Privately owned and operated hydropower dams on the Mississippi and Crow Wing Rivers downstream of Gull Lake Dam are discussed in **Paragraph 4-11**. See also **Paragraph 7-10.**

8-08. Navigation. The benefits of the Water Control Plan with respect to navigation, occurred primarily in the years prior to the l930's. After this time, the 9-foot channel project below Minneapolis eliminated the need for releases to aid navigation. See **Paragraph 2-02.**

Navigation within the reservoir can be adversely affected when pool levels fall below elevation 1193.75 feet. Below this elevation the east side of Gull Lake becomes shallow, which affects access to docks along that shoreline while the channel to Love Lake becomes very shallow. The access channel to Upper Gull Lake and the lakes upstream from there also can become very shallow at low lake elevations.

8-09. Drought Contingency Plans. The Water Control Plan is complimentary to the Drought Contingency Plan. The water stored in the reservoir provides a source to augment in-stream flow needs during dry periods while providing maximum benefits to the reservoir.

The Drought Contingency Plan should be referenced for additional information. The Drought Contingency Plan is in draft form (dated September 1992) and is a stand-alone document (see **Paragraph 1-03**). Also see **Paragraph 7-12.**

8-10. Flood Emergency Action Plans. The Emergency Action Plan provides a guide for the necessary actions to identify, mitigate and respond to various types of emergencies, which while rare, could occur in the operation of the dam. The plan is a stand-alone document (see **Paragraph 1-03**).

8-11. Frequencies. See also **Paragraph 4-07**.

a. Inflow Volume-Frequency. **Plate 8-10** illustrates the probability of given inflow volumes into Gull Lake for durations of 1, 3, 10, 30 and 90 days. The inflow curves are based on data developed by reverse routing using daily lake elevation and discharge records from 1912 through 1985. The one-day volume-frequency curve, as well as the remaining curves, were developed in accordance with the methods presented in Water Resources Council Bulletin 17B. The curves were smoothed graphically to correlate with the one-day curve.

Lake elevations used in the reverse routing analysis are likely to have been affected by wind speed and direction. No smoothing was done to the reverse routed hydrographs prior to the statistical analysis to account for wind-related, and other data irregularities and resulting "negative inflows".

b. Pool Elevation-Duration/Frequency. The annual probability of a given peak pool elevation is given on **Plate 8-11**. The percent of the time the pool is at, or above, a given elevation is presented on **Plate 8-12**. These curves were developed for the period 1936 through 1985. Outflow values prior to 1936 are nonhomogeneous due to a change in the reservoir regulation schedule.

c. Discharge-Frequency Curve. The discharge-frequency curve for the Gull Lake Dam outflow is shown on **Plate 8-13.** This curve was developed for the period 1936 through 1985. Outflow values prior to 1936 are nonhomogeneous due to a change in the reservoir regulation schedule.

8-12. Other Studies.

a. Examples of Regulation. The House Committee on Rivers and Harbors passed a resolution on June 7, 1945 requesting a review of the Mississippi River Headwaters reservoirs. Since then, several studies have been completed to determine the effectiveness of the present regulation plan for each reservoir. These studies include:

(1) Mississippi River Headwaters Lakes Feasibility Study, 1982, Main Report and Appendices, Two Volumes.
(2) Computer Operations Study of Reservoir Operations for Six Mississippi River Headwaters Dams, 1982, Final Report and Appendices, Three Volumes.
(3) Environmental Review of the Headwaters of the Mississippi River Reservoir Projects, Bemidji College, 1975.
(4) Review of Design Features of Existing Dams at Mississippi River Headwaters Reservoirs, RCS ENGCW-(OT)761, March 1974.
(5) Mississippi River Headwaters- Master Plan for Public Use Development, August 1977.

Studies (1) and (2) resulted from several earlier studies in which the effects of regulation plans at the Mississippi Headwaters Reservoirs were examined. Study (3) is devoted entirely to environmental aspects of the headwaters reservoirs. In general, the conclusions of reports (1), (2), and (3) favored the present regulation plan as the best means of meeting the existing problems. The purpose of study (4) was to determine the Spillway Design Flood for each of the headwaters reservoirs using 1974 criteria. Study (5) describes and evaluates resource management at the six Corps of Engineers' administered recreation areas.

b. Channel and Floodway Modification. Floodplain studies have been performed for several communities on the Mississippi River below Gull Lake Reservoir. The flood discharge was computed for each city for the 10-, 50-, 100- and 500-year floods. In some cases, corresponding elevations were also tabulated. Such studies are referenced in **Table 8-1**.

Table 8-1

Floodplain Studies Downstream of Gull Lake Reservoir

Community	Study Number	County	Comments
Fort Ripley	270097	Crow Wing	Mississippi River below Brainerd
Little Falls	270299#	Morrison	Mississippi River above St. Cloud

- This community has a map with a 10-digit ID number. Each map with such a number will be published as one or more Z-fold panels (like road maps).

IX - WATER CONTROL MANAGEMENT

9-01. Responsibilities and Organization.

a. Corps of Engineers. The Corps of Engineers is the owner, operator and regulator of the Gull Lake Dam and Reservoir. The Water Control Section has direct day-to-day responsibility for the regulation, and the Construction-Operations Division has responsibility for the operation and maintenance of the project.

b. Other Federal Agencies. The National Weather Service has the responsibility for all hydrologic forecasts within the Upper Mississippi River Basin. The U.S. Geological Survey collects data on the discharges at various stations within this basin (see map, **Plate 5-1**). The U.S. Fish and Wildlife Service, National Resource Conservation Service, U.S. Geological Survey, U.S. Forest Service, and the Environmental Protection Agency, all have an ongoing interest in the regulation of the Gull Lake Reservoir.

c. State and Local Agencies. State agencies having an interest in Gull Lake regulation are the Minnesota Pollution Control Agency and the Minnesota Department of Natural Resources. Local agencies include Cass County and Crow Wing County Highway Departments, Minnesota Power and Light Company and the Civil Defense representatives for Cass and Crow Wing Counties. Other local interests include area resorts, homeowners, and recreational users.

9-02. Interagency Coordination.

a. Local Press. Information concerning the regulation of the reservoir is provided by the St. Paul District's Public Affairs Office (PAO) to the local news media in response to their requests. Additionally, the PAO provides news releases of an advisory nature to the local news media regarding important aspects of project regulation. These news releases do not provide public forecasts of river stages or flows however, because such forecasts are a Congressionally mandated responsibility of the National Weather Service.

b. National Weather Service. Current readings from the headwaters reservoirs are supplied to the National Weather Service on a regular basis. These readings include discharges, reservoir levels, snow depth/water content, frost depths and precipitation. The National Weather Service uses this information in developing their river forecasts.

c. U.S. Geological Survey. This agency receives data from its own and co-operative observer gages, as well as from the Water Control Section, on a regular schedule and other times on request.

9-03. Interagency Agreements. There is an informal agreement between the St. Paul District, the Indian Tribes and the State of Minnesota, Department of Natural Resources (MDNR), that in all regulatory matters affecting Tribal or state interests, issues will be resolved through consultation. The Corps follows informal guidelines from the MDNR. These are described in **Paragraph 3-05** and **Chapter 7**.

9-04. Commissions, River Authorities, Compacts, and Committees. The Upper Mississippi River Basin Commission (UMRBC), superseded by the Upper Mississippi River Basin Association (UMRBA), is a multi-state organization formed by the Federal Government. Its primary responsibility is the coordination of Federal, State, Interstate, local and non-Governmental plans for regional development of water and related land resources in the basin.

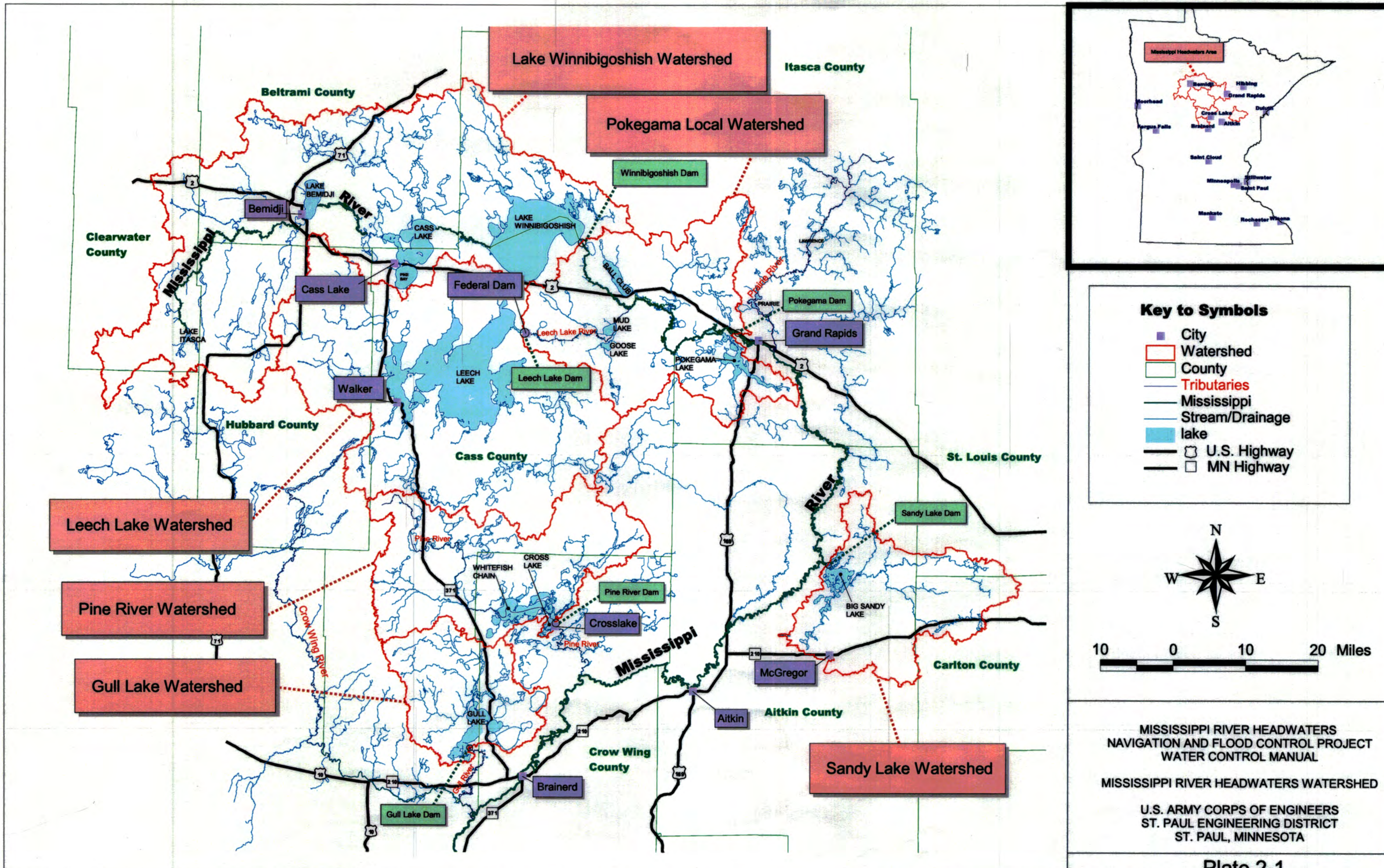
9-05. Non-Federal Hydropower. The Mississippi River Headwaters dams do not contain any hydropower facilities.

9-06. Reports. **Table 9-1** presents a listing of reports and other data sources related to the regulation of the reservoir.

Table 9-1

Reports

Report Name	Form Number
Monthly Log Sheet	CEMVP 64E
Climatological Report	WS-E15
Emergency Reports when Requested	By Phone

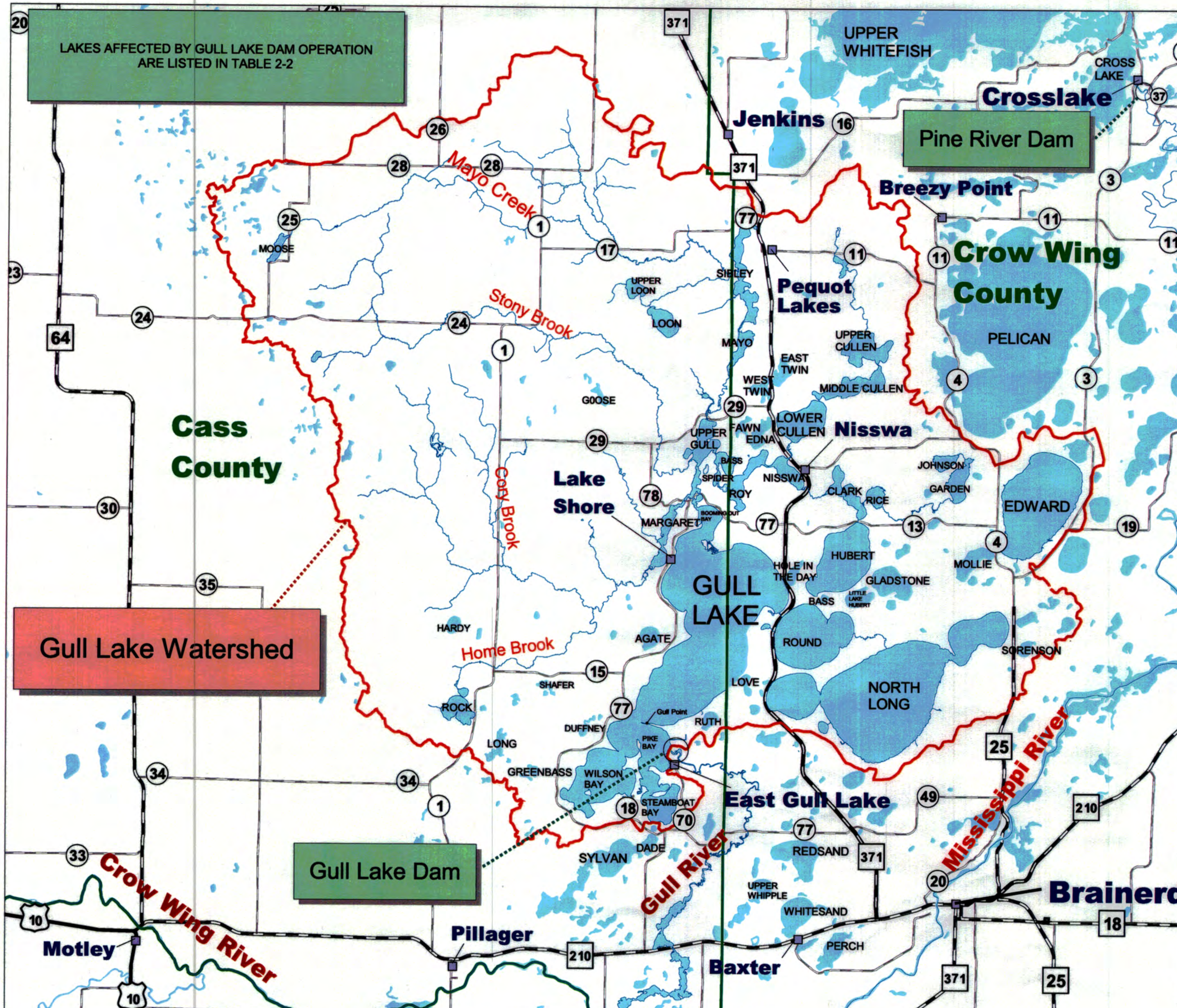


MISSISSIPPI RIVER HEADWATERS
NAVIGATION AND FLOOD CONTROL PROJECT
WATER CONTROL MANUAL

MISSISSIPPI RIVER HEADWATERS WATERSHED

U.S. ARMY CORPS OF ENGINEERS
ST. PAUL ENGINEERING DISTRICT
ST. PAUL, MINNESOTA

Plate 2-1

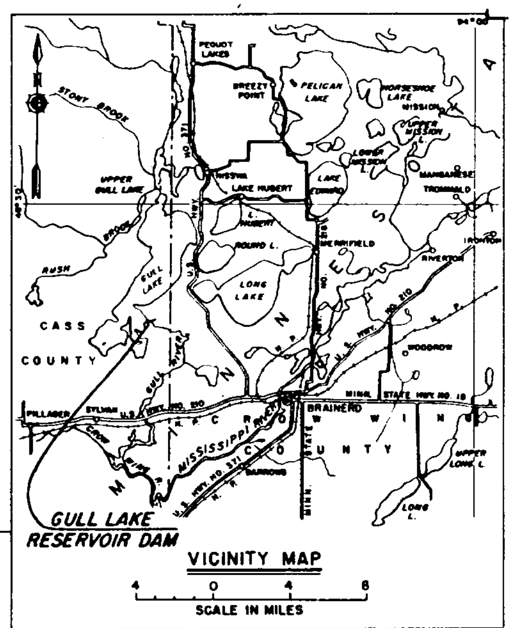


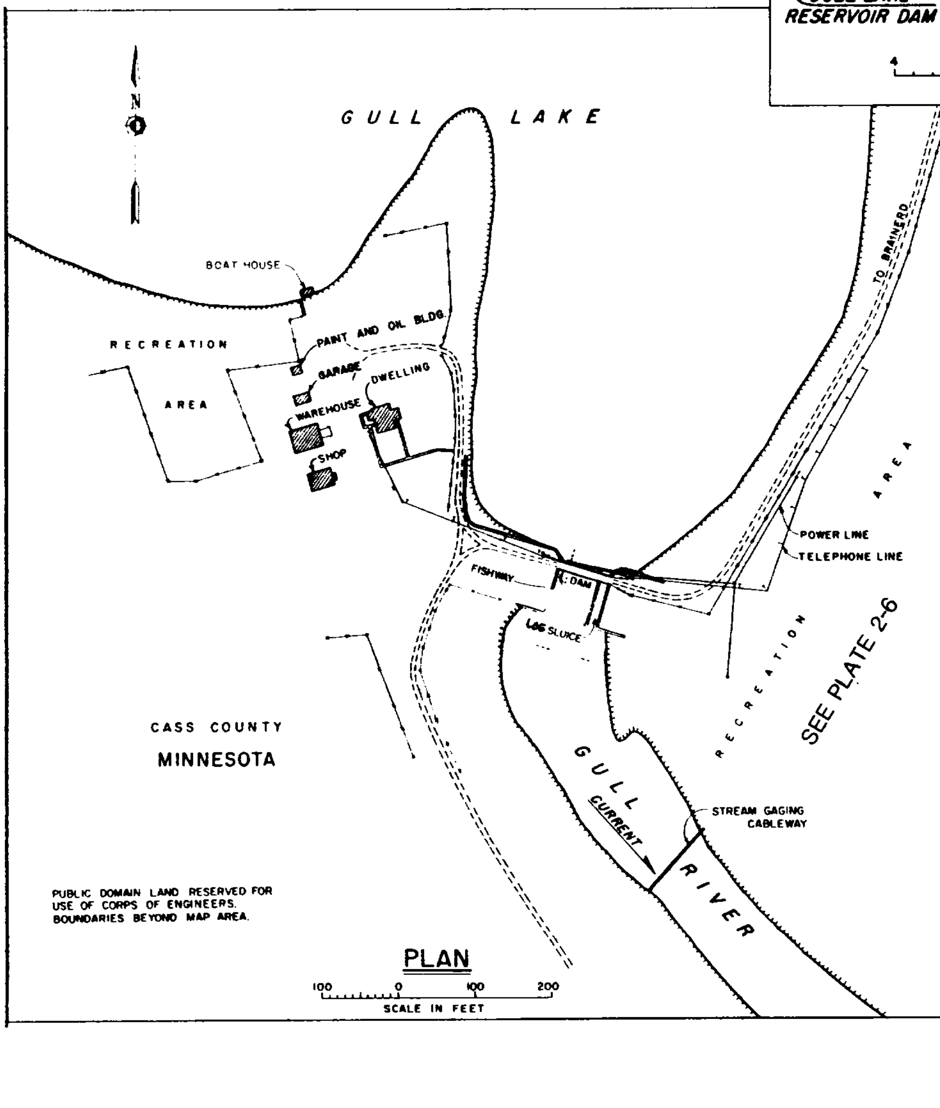
MISSISSIPPI RIVER HEADWATERS
NAVIGATION AND FLOOD CONTROL PROJECT
WATER CONTROL MANUAL
GULL LAKE

GULL LAKE WATERSHED

U.S. ARMY CORPS OF ENGINEERS
ST. PAUL ENGINEERING DISTRICT
ST. PAUL, MINNESOTA

Plate 2-1a



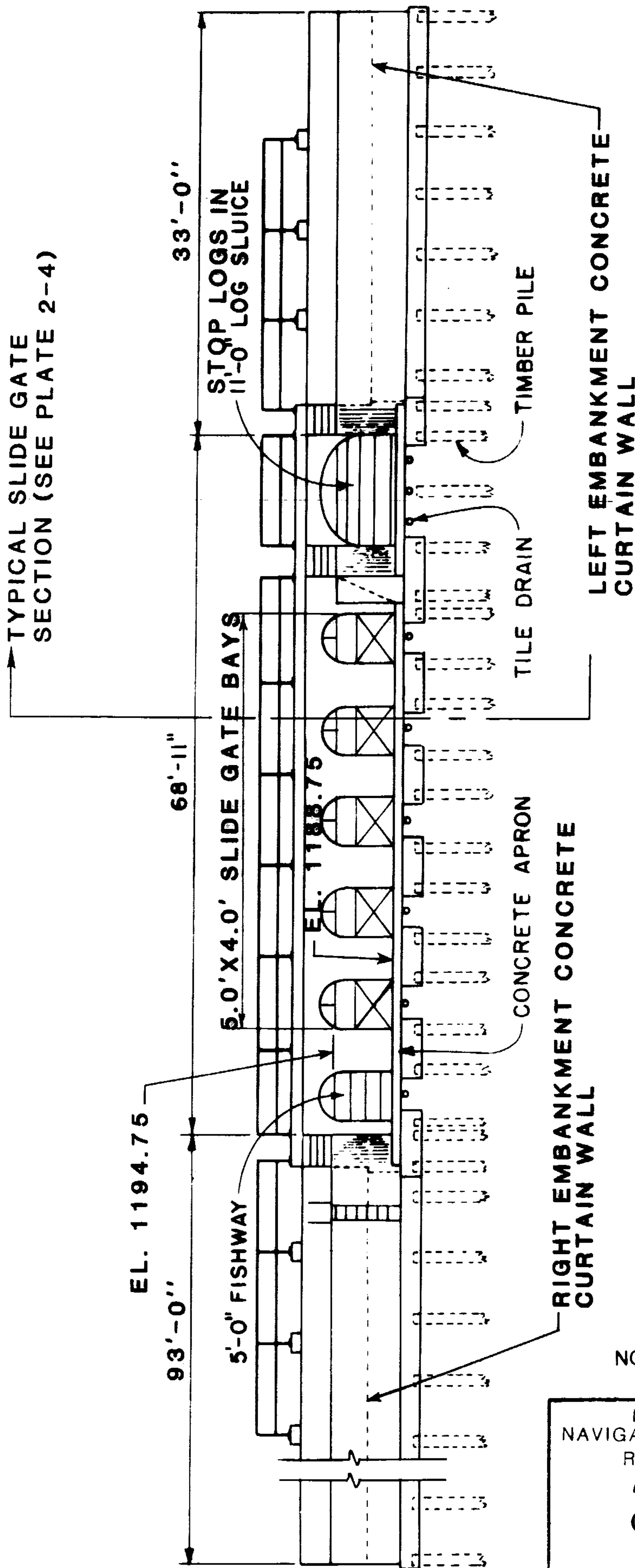


MISSISSIPPI RIVER HEADWATERS
NAVIGATION AND FLOOD CONTROL PROJECT
RESERVOIR REGULATION MANUAL

APPENDIX 6, GULL LAKE

GENERAL PLAN

CORPS OF ENGINEERS, U.S. ARMY
ST. PAUL ENGINEERING DISTRICT
ST. PAUL, MINNESOTA



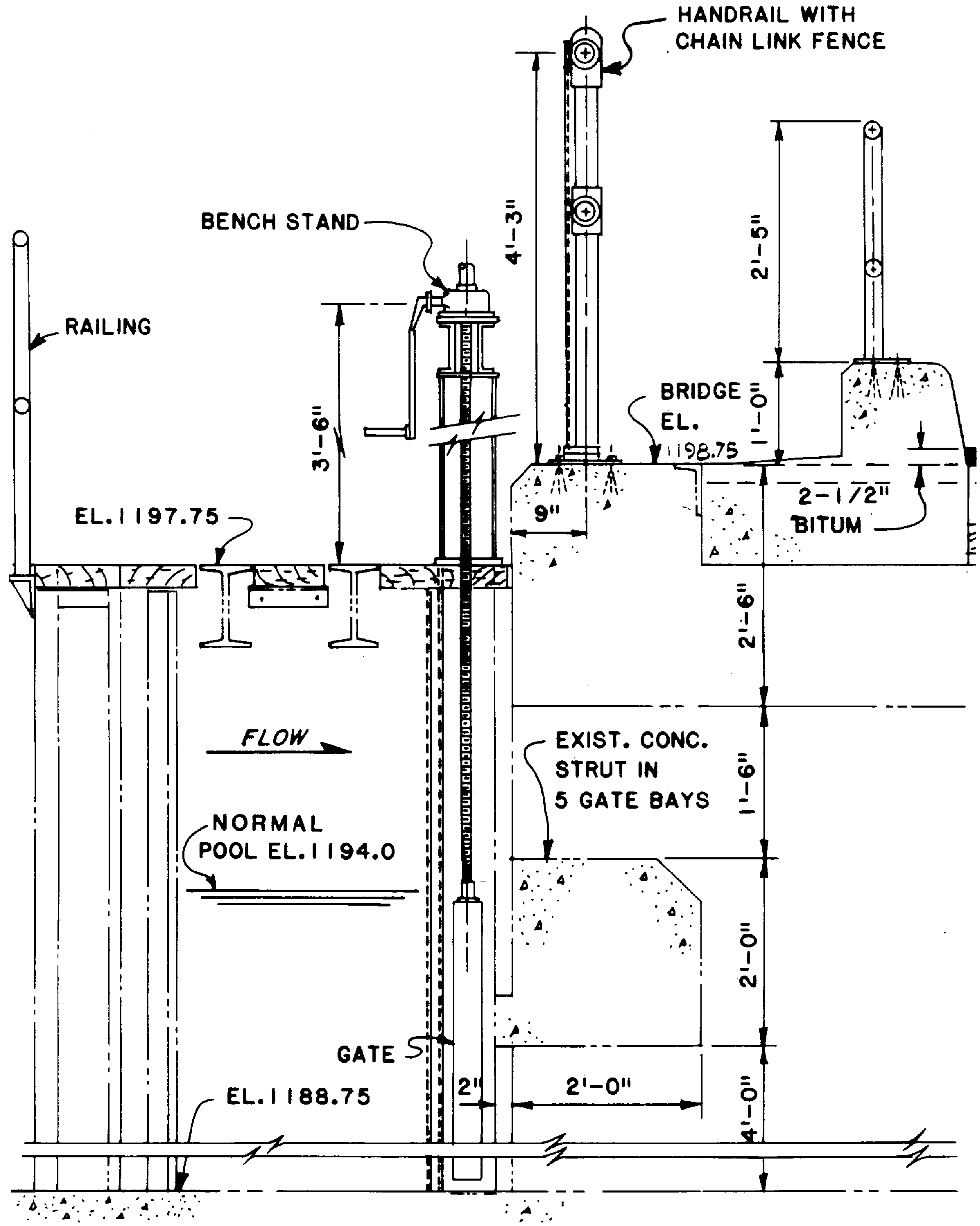
NOTE: ELEVATIONS (N.G.V.D. of 1929)

MISSISSIPPI RIVER HEADWATERS
NAVIGATION AND FLOOD CONTROL PROJECT
RESERVOIR REGULATION MANUAL

APPENDIX 6, GULL LAKE

CONTROL STRUCTURE ELEVATION

CORPS OF ENGINEERS, U.S. ARMY
ST. PAUL ENGINEERING DISTRICT
ST. PAUL, MINNESOTA



NOTE: ELEVATIONS (N.G.V.D. of 1929)

MISSISSIPPI RIVER HEADWATERS
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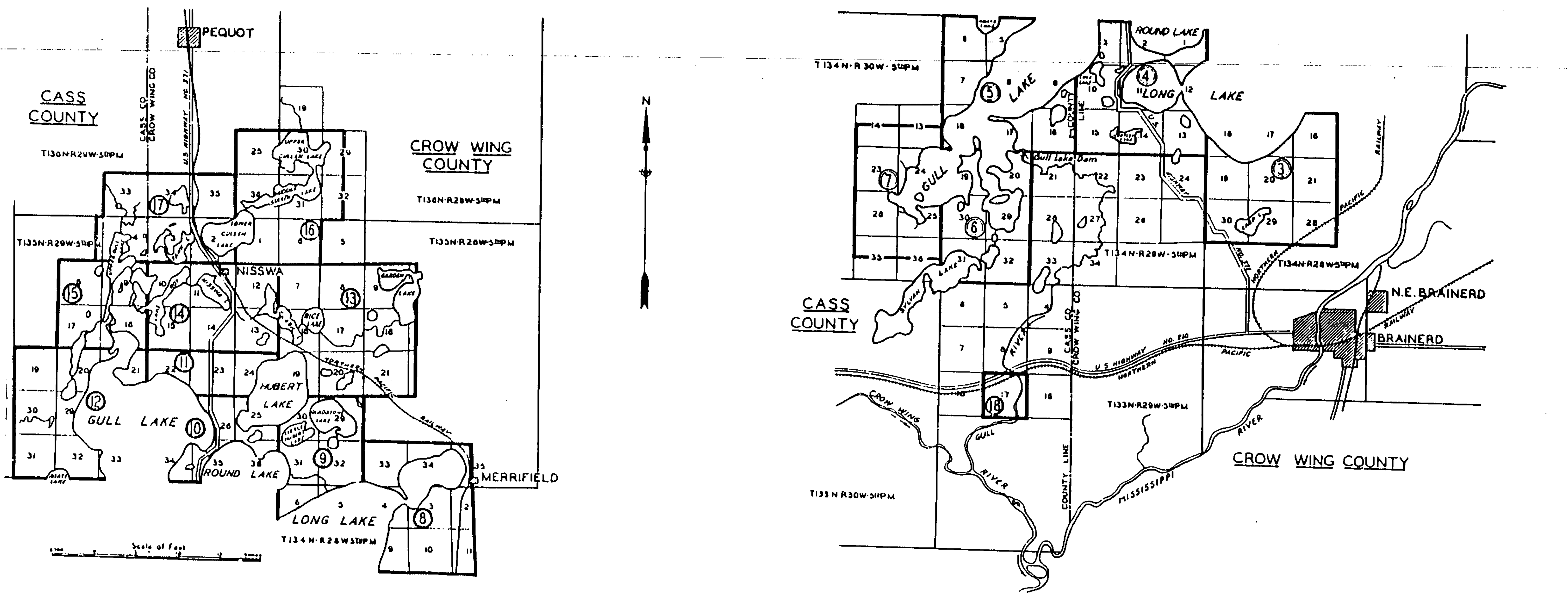
SLIDE GATE SECTION

CORPS OF ENGINEERS, U.S. ARMY
ST. PAUL ENGINEERING DISTRICT
ST. PAUL, MINNESOTA

PLATE 2-4



MISSISSIPPI RIVER HEADWATERS
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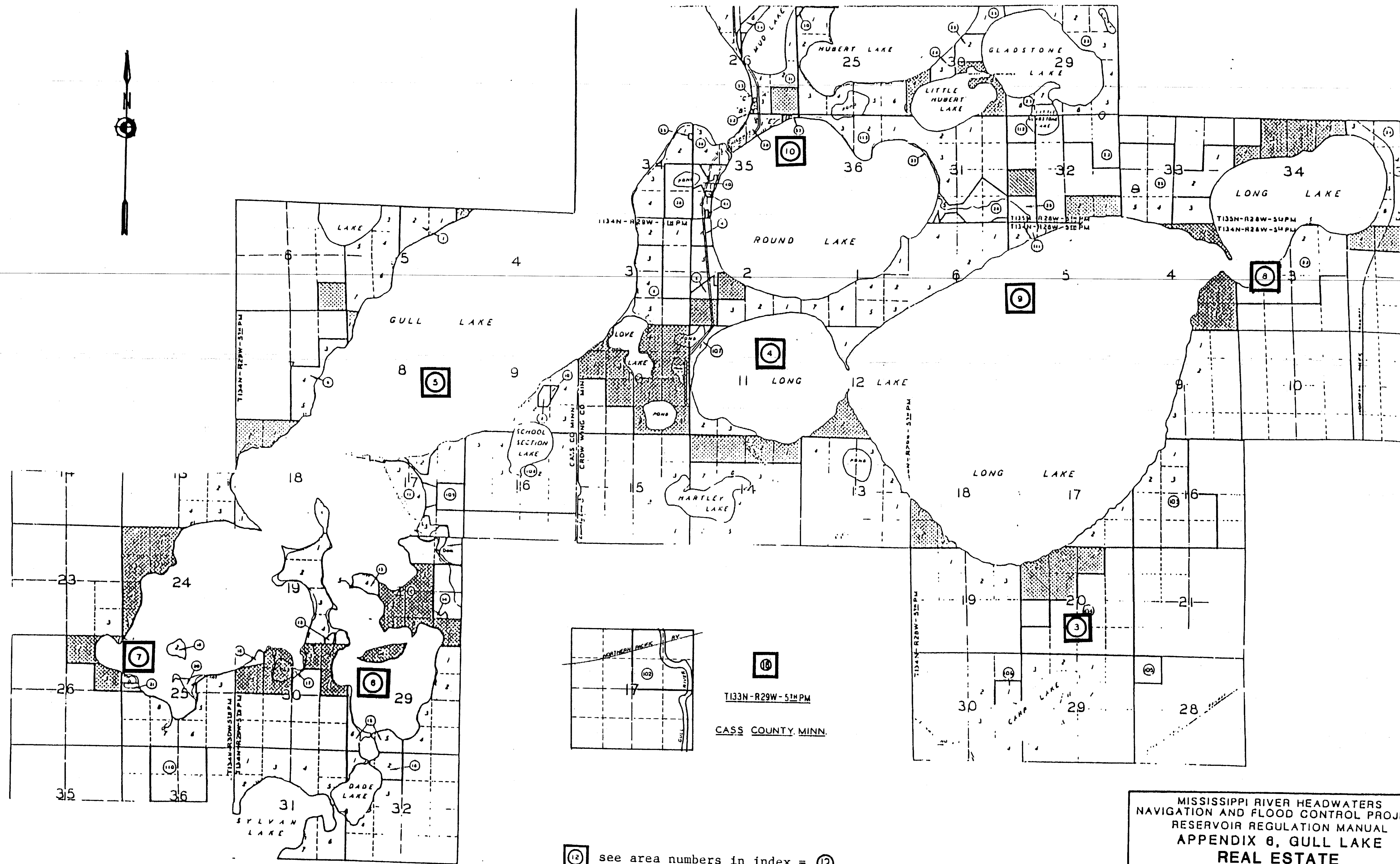
RESERVOIR REGULATION MANUAL

APPENDIX 6, GULL LAKE

REAL ESTATE INDEX MAPS

CORPS OF ENGINEERS, U.S. ARMY
ST. PAUL ENGINEERING DISTRICT
ST. PAUL, MINNESOTA

PLATE



MISSISSIPPI RIVER HEADWATERS
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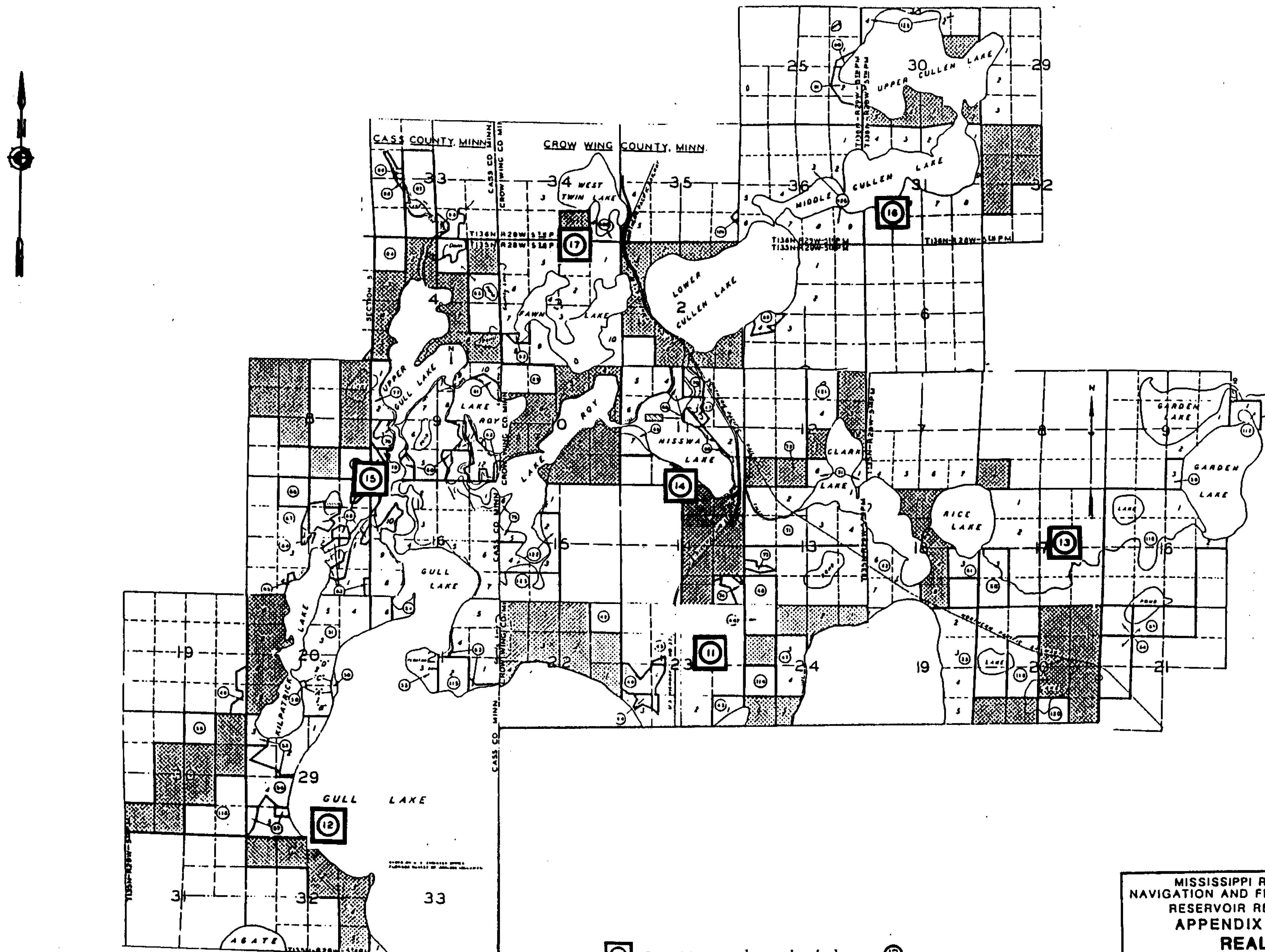
REAL ESTATE

LOCATION MAP

CORPS OF ENGINEERS, U.S. ARMY
ST. PAUL ENGINEERING DISTRICT
ST. PAUL, MINNESOTA

PLATE



(12) see area numbers in index = (12)

MISSISSIPPI RIVER HEADWATERS
NAVIGATION AND FLOOD CONTROL PROJECT
RESERVOIR REGULATION MANUAL
APPENDIX 6, GULL LAKE

REAL ESTATE
LOCATION MAP

CORPS OF ENGINEERS, U.S. ARMY
ST. PAUL ENGINEERING DISTRICT
ST. PAUL, MINNESOTA

(3)

Tract Location	Source of Title	Interest Acquired	Acres	Tract No.
T134N,R28W,5th PM				
Sec.16 – Lot 1	Ceded by State of Minnesota	Easement	38 14	
" Lot 2	Do Do	Do	32 62	
" Lot 3	Do Do	Do	40.00	103
" SW¼	Do Do	Do	160 00	
" W½SE¼	Do Do	Do	80.00	
Sec 18 – Lot 1	Executive order on Public Domain		16 70	
" Lot 2	Do Do		40 25	
" Lot 3	Do Do		13 25	
Sec 20 – Lot 1	Do Do		36 56	2
" Lot 2	Do Do		19 90	
" S½NW¼	Do Do		80.00	
" NW¼NE¼	Do Do		40 00	
" NE¼NE¼	Ceded by State of Minnesota	Easement	40 00	
" S½NE¼	Do Do	Do	80 00	
" SE¼	Do Do	Do	160 00	104
" S½SW¼	Do Do	Do	80.00	
" NE¼SW¼	Do Do	Do	40 00	
Sec 28–NW¼NW¼	Do Do	Do	40.00	105
Sec 30 – Lot 1	Do Do	Do	31 15	106

(4)

Tract Location	Source of Title	Interest Acquired	Acres	Tract No.
T134N,R29W,5th PM				
Sec 2 - Lot 4	Executive order on Public Domain		30 60	2
" SW¼SW¼	Do Do		40 00	
" Lot 8	Deed from Gull River Lumber Co	Easement	26 22	4
" Part NE¼SE¼	Do Hilda Hallett	Do	21 50	5
Sec 3 - Lot 3	Do Gull River Lumber Co	Do	34 50	
" Lot 4	Do Do	Do	39 30	
" Lot 5	Do Do	Do	45 70	6
" SE¼SE¼	Do Do	Do	40 00	
Sec 10 - Lot 1	Executive order on Public Domain		[illegible]	
" Lot 2	Do Do		17 35	
" Lot 3	Do Do		[illegible]	
" Lot 4	Do Do		[illegible]	
" Lot 5	Do Do		[illegible]	
" Lot 6	Do Do		[illegible]	2
" Lot 7	Do Do		30 50	
" Lot 8	Do Do		26 15	
" Lot 9	Do Do		[illegible]	
" [illegible] NE¼	Do Do		[illegible]	
" NE¼SW¼	Do Do		40 00	
Sec 11 Lot 1	Ceded by State of Minnesota	Easement	37 20	107
Sec 12 - Lot 2	Executive order on Public Domain		67.20	
Sec 14 - Lot 1	Do Do		37 00	
" Lot 2	Do Do		38 75	2
" N½NW¼	Do Do		70 00	

(5)

Tract Location	Source of Title	Interest Acquired	Acres	Tract No.
T134N, R29W, 5th PM				
Sec 4 - Lot 1	Executive order on Public Domain		2 40	2
Sec 5 - Lot 1	Ceded by State of Minnesota	Easement	22.85	
" Lot 1	Deed from Gull River Lumber Co	Do		
" Lot 2	Ceded by State of Minnesota	Do	46 00	7
" Lot 2	Deed from Gull River Lumber Co.	Do		
Sec 6 - SE¼SE¼	Executive order on Public Domain		3 00	2
Sec 7 - Lot 3	Deed From Gull River Lumber Co.	Easement	20 55	
" Lot 4	Do Do	Do	41 75	8
" Lot 5	Do Do	Do	29 30	
Sec 8 - Lot 1	Executive order on Public Domain		7 00	2
Sec 9 - Part Lot 2	Deed from Frank A White et al	Easement	12 00	9
" Part Lot 4	Cond against Howard P Bell	Do	3.60	10
Sec 16 - Lot 1	Ceded by State of Minnesota	Do	34 80	
" Lot 2	Do Do	Do	31 65	
" Lot 3	Do Do	Do	29.30	
" Lot 4	Do Do	Do	24 40	
" Lot 5	Do Do	Do	36 40	108
" SW¼NW¼	Do Do	Do	40.00	
" SE¼NE¼	Do Do	Do	40 00	
" N½SE¼	Do Do	Do	80 00	
" N½SW¼	Do Do	Do	80 00	
Sec 17 - Part Lot 2	Cond against E and P Waite	Do	23 70	
" Part Lot 3	Do Do	Do	28 60	
" Part Lot 4	Do Do	Do	45 30	11
" Part Lot 5	Do Do	Do	18.80	
" Part [illegible]	Do Do	Do	1 70	
" NE¼SE¼	Ceded by State of Minnesota	Do	40 00	109
Sec 18 - Lot 1	Executive order on Public Domain		32.60	
Lot 2	Do Do		38 50	
" Lot 3	Do Do		31 15	2
" Point of Land A	Do Do		15 00	

(6)

Tract Location	Source of Title	Interest Acquired	Acres	Tract No.
T134N,R29W,5th PM				
Sec.19 - Part Lot 4	Deed from T.W Harrison	Easement	3.40	12
Sec 20 - Lot 2	Executive order on Public Domain		30 25	
" Lot 3	Do Do		31.90	
" Lot 5	Do Do		29.70	2
" Lot 6	Do Do		14.25	
" Lot 7	Do Do		35 65	
" NW¼SE¼	Do Do		40 00	
" Lot 4	Deed from Charles T. Kindred	Easement	26 62	13
" Part NE¼SW¼	Cond against E. and P Waite	Do	6 60	14
Sec 29 - Lot 5	Deed from Charles T Kindred	Do	43.40	15
" Lot 6	Do Do	Do	43.00	
Sec. 30 - Lot 1	Executive order on Public Domain		30.80	
" Lot 2	Do Do		28.90	
" Lot 3	Do Do		28.50	2
" Lot 4	Do Do		30.40	
" Part Lot 5	Do Do		47.35	
" SE¼NW¼	Do Do		40 00	
" Part Lot 5	Deed from T.W. Harrison	Easement	8.80	16
" Part SE¼NE¼	Do Do	Do	2.50	17
Sec 32 - Lot 1	Do Charles T Kindred	Do	82.70	
" Lot 1	Ceded by State of Minnesota	Do		18
" Lot 2	Deed from Charles T. Kindred	Do	36.80	
" Lot 2	Ceded by State of Minnesota	Do		
Sec 29 - Island "A"	Executive order on Public Domain		29.70	2

(7)

Tract Location	Source of Title	Interest Acquired	Acres	Tract No.
T134N,R30W,5th PM				
Sec 24 - Lot 1	Executive order on Public Domain		35 30	
" Lot 2	Do Do		20 20	
" Lot 3	Do Do		36 40	2
" Lot 4	Do Do		25 25	
" Lot 5	Do Do		13 25	
" NW¼NW¼	Do Do		40 00	
Sec 25 - Lot 2	Deed from T W Harrison	Easement	13 95	19
" Part Lot 4	Do Do	Do	14 40	20
" Part Lot 5	Do Do	Do	1 30	
" Part Lot 9	Do Do	Do	8 00	21
Sec 26 - Lot 1	Executive order on Public Domain		2 63	
" Lot 2	Do Do		43 70	2
" Lot 3	Do Do		34 65	
Sec 36 E½NW¼	Ceded by State of Minnesota	Easement	80 00	110
" W½NE¼	Do Do	Do	80 00	

(8)

Tract Location	Source of Title	Interest Acquired	Acres	Tract No.
T134N,R29W,5th PM				
Sec 2 - Lot 4	Executive order on Public Domain		29.03	2
" NE¼NW¼	Do Do		35.05	
Sec 3 - Lot 1	Deed from Charles N Parker	Easement	28 05	
" Lot 2	Do Do	Do	29.55	
" Lot 3	Do Do	Do	20.30	
" Lot 4	Do Do	Do	33 50	22
" Lot 5	Do Do	Do	26 20	
" S½NE¼	Do Do	Do	80.00	
" NW¼SE¼	Do Do	Do	40 00	
Sec 4 - Lot 1	Executive order on Public Domain		31 73	
" Lot 2	Do Do		33 87	2
" Lot 3	Do Do		60 40	
T135N,R29W,5th PM				
Sec 33 - Lot 1	Deed from Gull River Lumber Co	Easement	39 80	
" Lot 2	Do Do	Do	57 95	
" Lot 4	Do Do	Do	37 75	23
" Lot 5	Do Do	Do	35 00	
" N½SW¼	Do Do	Do	80.00	
" S½NW¼	Do Do	Do	80.00	
Sec 34 - Lot 1	Executive order on Public Domain		32.00	
" Lot 2	Do Do		32.40	2
" Lot 3	Do Do		31 40	
" Lot 4	Do Do		21.00	
Sec 35 - Lot 3	Deed from Gull River Lumber Co.	Easement	29 85	
" Lot 4	Do Do	Do	41 75	
" Lot 5	Do Do	Do	25.50	24
" Lot 9	Do Do	Do	37 45	
" NE¼NW¼	Do Do		40.00	

(9)

Tract Location	Source of Title	Interest Acquired	Acres	Tract No.
T134N R28W 5th PM				
Sec 5 - Lot 1	Ceded by State of Minnesota	Easement	22.60	111
" Lot 2	Do Do	Do	31 43	
T135N, R28W 5th PM				
Sec. 29 - Lot 1	Deed from Gull River Lumber Co	Easement	11.50	
" Lot 2	Do Do	Do	35 45	
" Lot 3	Do Do	Do	39 00	
" Lot 4	Do Do	Do	16 45	
" Lot 5	Do Do	Do	31 25	23
" Lot 6	Do Do	Do	14 45	
" Lot 7	Do Do	Do	28.60	
" Lot 8	Do Do	Do	26.00	
" NE¼NE¼	Do Do	Do	40.00	
Sec 30 - Lot 1	Do Do	Do	33.30	
" Lot 2	Do Do	Do	40.90	25
" Lot 2	Ceded by State of Minnesota	Do		
" Lot 3	Do Do	Do	15.25	26
" Lot 3	Deed from Loren Fletcher	Do		
" Lot 4	Executive order on Public Domain		17.00	
" Lot 5	Do Do		18.70	2
" Lot 6	Do Do		12.55	
Sec 31 - Part Lot 3	Deed from August Mulskeit	Easement	3.00	27
" Part Lot 4	Do Bessie Mahlum	Do	2.50	
" Part Lot 5	Do Do	Do	19 00	
" Part NW¼SE¼	Do Do	Do	7 00	28
" Part NE¼SE¼	Do Do	Do	12.00	
" Part SE¼SE¼	Do Do	Do	38.50	
" Part SW¼SE¼	Do Do	Do	30.50	
Sec 32 - Lot 1	Executive order on Public Domain		28 45	
" Lot 2	Do Do		37.75	2
" NW¼SW¼	Do Do		40.00	
" SW¼SW¼	Ceded by State of Minnesota	Easement	40.00	29
" SW¼SW¼	Deed from Gull River Lumber Co	Do		
" NE¼NW¼	Ceded by State of Minnesota	Do	40.00	112
" N½NE¼	Deed from Gull River Lumber Co	Do	80.00	28
" SE¼NE¼	Do Do	Do	40 00	

(10)

Tract Location	Source of Title	Interest Acquired	Acres	Tract No.
T135N,R28W,5th PM				
Sec 25 - Part Lot 1	Deed from Freeman Thorpe	Easement	2.30	30
Sec 26 - Lot 1	Do E.B. Lynch et al	Do	21.90	
" Lot 2	Do Do	Do	32.50	31
" Tract A Part Lot 3	Do Do	Do	30.20	
" Lot 4	Do Do	Do	19.90	
" Tract B Part Lot 3	Cond against Christy A White	Do	0.45	32
" Tract C Part Lot 3	Do Charles A Walker	Do	0.30	33
" Part Lot 5	Do Minnie E. Polk	Do	3.50	
" Part Lot 6	Do Do	Do	6.50	34
" Part Lot 7	Do Do	Do	0.40	
" SE¼SE¼	Executive order on Public Domain		40.00	2
Sec. 34 - Part Lot 1	Deed from J.M. Elder	Easement	2.90	35
" Part Lot 2	Do Do	Do	0.40	
" E½SE¼	Do Gull River Lumber Co	Do	80.00	36
Sec. 35 - Tract "D" Part Lot 1	Cond against Frank W. Hanft	Do	5.00	37
" Tract "E" Part Lot 1	Deed from E.B. Lynch et al	Do	34.25	38
" E½ Lot 2	Do Do	Do	13.60	
" Part Lot 2	Do Gull Lake Outing Co	Do	3.90	
" Lot 3	Do Do	Do	3.70	39
" Lot 4	Do Do	Do	37.75	
" Part Lot 5	Do J.M. Elder	Do	20.50	40
" Part Lot 6	Cond against Hugo Togg	Do	4.50	41
Sec. 36 - Lot 1	Ceded by State of Minnesota	Do	31.30	
" Lot 2	Do Do	Do	5.80	113
" Lot 3	Do Do	Do	[illegible]	

MISSISSIPPI RIVER HEADWATERS
NAVIGATION AND FLOOD CONTROL PROJECT
RESERVOIR REGULATION MANUAL

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REAL ESTATE

TITLE DESCRIPTION

CORPS OF ENGINEERS, U.S. ARMY
ST. PAUL ENGINEERING DISTRICT
ST. PAUL, MINNESOTA

Tract Location	Source of Title	Interest Acquired	Acres	Tract No.
T135N, R29W, 5thPM				
Sec. 22 - Lot 1	Executive order on Public Domain		31.25	2
" Lot 2	Do Do		51.20	
" Lot 3	Do Do		42.15	
" Lot 4	Do Do		15.85	
" NE¼ NW¼	Do Do		40.00	
" W½ NW¼	Do Do		30.00	
" NW¼ NE¼	Do Do		40.00	
" SE¼ NE¼	Do Do		40.00	
" NE¼ NE¼	Deed from Gull River Lumber Co.	Easement	40.00	42
Sec. 23 - Lot 1	Do St Paul & Chicago R.R.Co.	Do	26.50	43
" Part Lot 3	Cond. against S.F. Grover	Do	8.28	44
" Part SE¼NE¼	Do Minnesota Permanent	Do	6.00	45
" Part NE¼SW¼	Do Fred E. Pepe	Do	10.00	46
" Part NW¼SW¼	Do Do	Do	30.00	
" Part SE¼SW¼	Do Do	Do	4.40	
Sec. 24 - Lot 1	Executive order on Public Domain		24.07	2
" Lot 2	Do Do		33.85	
" Lot 5	Do Do		22.75	
" Lot 6	Do Do		38.00	
" NE¼NW¼	Do Do		40.00	
" SW¼NW¼	Do Do		40.00	
" Lot 9	Do Do		10.00	
" Lot 3	Deed from Gull River Lumber Co.	Easement	36.10	47
" Lot 4	Do Do	Do	35.40	
" NW¼NW¼	Do Do	Do	45.00	48
" NW¼NW¼	Ceded by State of Minnesota	Do		
" NW¼SW¼	Do Do	Do	45.50	114

Tract Location	Source of Title	Interest Acquired	Acres	Tract No.
T135N, R29W, 5thPM				
Sec. 19 - Part NE¼SE¼	Cond. against Minn. Land & Colonization Co.	Easement	6.30	49
" Part SE¼NE¼	Do Do	Do	12.00	
Sec. 20 - Part Lot 1	Deed from Charlotte M. Cobban	Do	2.81	50
" Part Lot 1	Do Do	Do	3.80	
" Part Lot 1	Do Gull River Lumber Co.	Do	37.56	51
" Part Lot 2	Do Do	Do	43.60	
" Lot 3	Do Do	Do	43.28	
" Lot 4	Do Do	Do	35.30	
" Lot 5	Do Do	Do	20.80	
" Lot 6	Executive order on Public Domain		31.48	2
" Lot 7	Do Do		33.00	
" Lot 8	Do Do		40.73	
" Lot 9	Do Do		34.00	
Sec. 21 - Part Lot 1	Cond. against Ole Aronnes	Easement	4.20	52
" Part Lot 4	Do Do	Do	3.20	
" Lot 2	Ceded by State of Minnesota	Do	47.25	115
" Lot 3	Do Do	Do	43.42	53
" Lot 3	Deed from St Paul & Chicago R.R.Co.	Do		
Part Lot 6	Cond. against Minn. Land & Colonization Co.	Do	14.20	54
Sec. 29 - Part Lot 2	Deed from Charlotte M. Cobban	Do	1.30	55
" Part Lot 3	Do Do	Do	20.50	
" Part Lot 4	Do Walter H. Cobban	Do	33.00	56
" Part SE¼SW¼	Do Do	Do	24.50	
" Part Lot 3	Cond. against Park Region Land Co.	Do	15.24	57
Sec. 30 - SE¼SE¼	Ceded by State of Minnesota	Do	40.00	116
" SW¼SE¼	Do Do	Do	40.00	
NE¼SE¼	Do Do	Do	40.00	
NW¼SE¼	Executive order on Public Domain		40.00	2
SW¼SW¼	Do Do		31.33	
E½SW¼	Do Do		80.00	
SE¼NW¼	Do Do		40.00	
" SW¼NE¼	Do Do		40.00	
E½NE¼	Do Do		80.00	
NW¼NE¼	Deed from Gull River Lumber Co.	Easement	40.00	58
Sec. 32 - Lot 1	Executive order on Public Domain		38.64	2
Lot 2	Do Do		37.00	
" Lot 4	Do Do		27.90	
" Lot 5	Do Do		28.90	
NW¼NW¼	Do Do		40.00	
" Lot 3	Do Do		23.76	
Sec. 33 - Part SW¼NW¼	Do Do			

Tract Location	Source of Title	Interest Acquired	Acres	Tract No.
T135N, R28W, 5thPM				
Sec. 3 - Lot 1	Executive order on Public Domain		35.80	2
Sec 9 - Lot 3	Deed from Gull River Lumber Co.	Easement	16.90	55
Lot 3	Do Dorilus Morrison	Do		
Sec 10 Lot 1	Ceded by State of Minnesota	Do	23.50	117
Sec 16 Lot 1	Do Do	Do	33.20	118
" Lot 2	Do Do	Do	18.00	
" W½SE¼	Do Do	Do	80.00	
" SW¼NE¼	Do Do	Do	40.00	
" NW¼	Do Do	Do	160.00	
" SW¼	Do Do	Do	160.00	
Sec 17 Lot 3	Do Do	Do	36.75	60
" Lot 3	Deed from Dorilus Morrison	Do		
" SW¼SW¼	Ceded by State of Minnesota	Do	40.00	
" SW¼SW¼	Deed from Dorilus Morrison	Do		
Sec 18 - Lot 1	Executive order on Public Domain		32.10	2
" Lot 2	Do Do		33.35	
" Lot 4	Do Do		38.70	
" Lot 8	Do Do		37.75	
" Lot 3	Deed from Gull River Lumber Co.	Easement	21.30	61
" Lot 5	Do Do	Do	38.65	62
" Lot 6	Do Do	Do	37.15	
" Lot 7	Do Do	Do	31.30	
Sec. 19 - Lot 1	Do Do	Do	6.65	23
" Lot 2	Do Do	Do	33.90	
" Lot 3	Do Do	Do	38.45	
" Lot 4	Do Do	Do	43.00	
" Lot 5	Do Do	Do	40.30	
Sec 20 - S½SW¼	Executive order on Public Domain		80.00	2
" NE¼	Do Do		160.00	
" N½SE¼	Do Do		80.00	
" SE¼SE¼	Do Do		40.00	
" NE¼SW¼	Ceded by State of Minnesota	Easement	40.00	
" SE¼NW¼	Do Do	Do	80.00	119
" SW¼SE¼	Do Do	Do	40.00	120
Sec 21 - NW¼NE¼	Deed from Gull River Lumber Co.	Do	40.00	63
" NE¼SW¼	Do Do	Do	40.00	
" NW¼NW¼	Do Do	Do	40.00	
" NE¼NW¼	Do Do	Do	40.00	
" NW¼NW¼	Do Do	Do	40.00	64
" NW¼NW¼	Ceded by State of Minnesota	Do		

Tract Location	Source of Title	Interest Acquired	Acres	Tract No.
T135N, R28W, 5thPM				
Sec. 6 - SE¼SE¼	Deed from John S. Pillsbury	Easement	40.00	76
" SW¼SE¼	Executive Order on Public Domain		40.00	2
" NE¼SE¼	Do Do		40.00	
" E½NE¼	Do Do		80.00	
" N½SW¼	Do Do		80.00	
" NW¼	Do Do		160.00	
Sec. 5 - Lot 1	Deed from St Paul & Chicago R.R.Co.	Easement	12.95	77
" Lot 1	Ceded by State of Minnesota	Do		
" Lot 2	Deed from St Paul & Chicago R.R.Co.	Do	14.60	
" Lot 2	Ceded by State of Minnesota	Do		
" Part Lot 3	Deed from Walter H. Cobban	Do	15.70	78
" Part Lot 4	Do Park Region Land Co.	Do	3.40	79
" Part Lot 5	Do John B. Bemis et al	Do	10.50	80
" Part SW¼SE¼	Do Do	Do	29.80	
" Part Lot 10	Do Frederick Hoffman	Do	11.50	81
" Part Lot 11	Do Frederick L. Hoffman	Do	13.00	82
" Part Lot 12	Do Do	Do	12.90	
Sec 16 - Lot 1	Ceded by State of Minnesota	Do	24.80	124
" Lot 2	Do Do	Do	47.40	
" Lot 3	Do Do	Do	38.00	
" Lot 4	Do Do	Do	18.00	
" Lot 5	Do Do	Do	20.30	
" Lot 6	Do Do	Do	33.32	
" Lot 7	Do Do	Do	31.00	
" Lot 8	Do Do	Do	40.30	
" Lot 9	Do Do	Do	22.75	
" Lot 10	Do Do	Do	22.90	
" Lot 11	Do Do	Do	12.75	
" SW¼NE¼	Do Do	Do	40.00	
" SE¼NE¼	Do Do	Do	40.00	
" SW¼NE¼	Do Do	Do	40.00	
Sec 17 - Part Lot 1	Deed from Walter H. Cobban	Do	10.50	83
" Part Lot 2	Do Do	Do	6.40	
" Part NE¼SE¼	Do Do	Do	4.30	
" Part Lot 3	Cond. against J.S. Merrill	Do	1.70	84
" Part Lot 4	Do John G Carson	Do	2.30	85
" Part NE¼SE¼	Deed from Park Region Land Co.	Do	1.30	86
" Part SE¼SE¼	Do Do	Do	7.30	
" Part SW¼NE¼	Do Do	Do	26.50	
" Part NW¼NE¼	Do Do	Do	4.30	
" Part NE¼NE¼	Do Do	Do	12.00	
" Part SE¼NW¼	Cond. against William Helmquist	Do	7.20	87
" NE¼NW¼	Deed from Gull River Lumber Co.	Do	40.00	88

Tract Location	Source of Title	Interest Acquired	Acres	Tract No.
T135N, R28W, 5thPM				
Sec. 10 - Lot 1	Executive order on Public Domain		33.90	2
" Lot 2	Do Do		27.85	
" Lot 3	Do Do		16.75	
" Lot 4	Do Do		16.86	
" Lot 5	Do Do		34.40	
" Lot 6	Do Do		43.00	
" Lot 7	Do Do		19.90	
" Lot 8	Do Do		34.00	
" E½SE¼	Do Do		80.00	
" N½NW¼	Deed from Gull River Lumber Co.	Easement	80.00	65
Sec. 11 - Part Lot 2	Do Ezra B. Merrill	Do	3.00	66
" Part Lot 3	Cond. against William Murray et al	Do	14.50	67
" Part Lot 4	Deed from Northern Pacific Ry.	Do	19.00	68
" Lot 7	Do St Paul & Chicago R.R.Co.	Do	27.30	69
" Lot 7	Ceded by State of Minnesota	Do		
" Part NW¼NE¼	Deed from Park Region Land Co.	Do	23.30	70
Sec. 12 - Lot 1	Do Gull River Lumber Co.	Do	12.00	71
" Lot 6	Do Do	Do	22.75	
" SE¼SW¼	Do Do	Do	40.00	72
" SW¼SW¼	Executive order on Public Domain		40.00	
" Lot 2	Do Do		10.05	2
" Lot 3	Do Do		35.70	
" Lot 5	Do Do		21.20	
" NE¼NW¼	Do Do		40.00	
" SW¼SW¼	Do Do		40.00	
" Lot 4	Ceded by State of Minnesota	Easement	34.70	121
" NW¼NE¼	Do Do	Do	40.00	
Sec. 13 - Lot 1	Deed from Gull River Lumber Co.	Do	0.35	71
" Lot 2	Do Do	Do	41.50	
" Lot 3	Do Do	Do	51.50	
" Lot 4	Do Do	Do	40.02	
" SW¼SW¼	Do Do	Do	40.00	48
" SW¼SW¼	Ceded by State of Minnesota	Do		
" NW¼NW¼	Deed from Gull River Lumber Co.	Do	40.00	71
" S½NW¼	Do Do	Do	80.00	
" Part NW¼SW¼	Deed from Mrs. R. A. Carlisle	Do	8.50	73
Sec. 14 - Lot 1	Executive order on Public Domain		32.75	2
" Lot 2	Do Do		38.30	
" S½NE¼	Do Do		80.00	
" W½SE¼	Do Do		80.00	
" NE¼SE¼	Do Do		40.00	
" Part SE¼SE¼	Cond. against John D. Smith	Easement	19.00	74
Sec. 15 - Lot 2	Ceded by State of Minnesota	Do	32.38	122
" Lot 3	Do Do	Do	24.60	
" Lot 4	Do Do	Do	32.85	
" Lot 5	Do Do	Do	14.30	75
" Lot 5	Deed from St Paul & Chicago R.R.Co.	Do		
" Lot 6	Ceded by State of Minnesota	Do	6.55	
" Lot 6	Deed from St Paul & Chicago R.R.Co.	Do		
" S½SW¼	Ceded by State of Minnesota	Do	80.00	123

0.50 Ac. (Part of Tract 68) conveyed to Mrs Mary Murray Nisswa, Minn. by quitclaim deed dated 27 July 1977 with PERPETUAL FLOWAGE EASEMENT reserved to U.S. of America.

PUBLIC DOMAIN - F

Tract Location	Source of Title	Interest Acquired	Acres	Tract No.
T135N R29W 5thPM				
Sec. Part Lot 3	Deed from Gertrude L. Upton	Easement	2.50	89
" Part Lot 3	Do Park Region Land Co.	Do		
" Part Lot 4	Do Gertrude L. Upton	Do	18.20	
" Part Lot 4	Do Park Region Land Co.	Do		
T134N R28W 5thPM				
Sec. Lot 1	Executive Order on Public Domain		33.00	2
" Lot 3	Do Do		22.82	
" Lot 6	Do Do		36.30	
" Lot 7	Do Do		38.40	
" Lot 8	Do Do		78.00	
" Lot 2	Ceded by State of Minnesota	Easement	24.50	125
" Lot 3	Do Do	Do	11.30	
" Lot 4	Do Do	Do	22.30	
" NE¼NE¼	Do Do	Do	48.00	
Sec. 12 - NW¼SW¼	Executive Order on Public Domain		40.00	2
" SW¼NW¼	Do Do		40.00	
" E½NW¼	Do Do		80.00	
" NW¼NW¼	Do Do		46.66	
T134N R29W 5thPM				
Sec. 27 - Part Lot 1	Deed from Frank Crowell	Easement	5.08	90
" Part Lot 2	Cond. against A.R. Zeak	Do	21.60	91
" Part SE¼SE¼	Do Do	Do	7.00	
Sec. 36 - Lot 1	Ceded by State of Minnesota	Do	38.25	126
" Lot 2	Do Do	Do	18.50	
" Lot 3	Do Do	Do	38.75	
" Lot 4	Do Do	Do	18.50	
" Lot 5	Do Do	Do	31.00	
" Lot 6	Do Do	Do	18.75	
" Lot 7	Do Do	Do	23.75	
" Lot 8	Do Do	Do	47.75	
" Lot 9	Do Do	Do	47.50	
" NW¼NE¼	Do Do	Do	40.00	
" NW¼	Do Do	Do	160.00	

Tract Location	Source of Title	Interest Acquired	Acres	Tract No.
T135N R28W 5thPM				
Sec. 2 - Lot 1	Executive order on Public Domain		29.75	2
" Lot 2	Do Do		18.00	
" Lot 3	Do Do		40.34	
" Lot 4	Do Do		16.60	
" Lot 5	Do Do		34.40	
" Lot 6	Do Do		43.00	
" Lot 7	Do Do		15.75	
" Lot 8	Do Do		48.75	
Sec. 3 - Part Lot 6	Deed from James M. Elder	Easement	4.60	92
Sec. 4 - Lot 1	Executive order on Public Domain		29.00	2
" Lot 2	Do Do		39.13	
" Lot 3	Do Do		37.75	
" Lot 4	Do Do		28.25	
" Lot 5	Do Do		30.00	
" Lot 6	Do Do		33.38	
" Lot 7	Do Do		18.75	
" NE¼NE¼	Do Do		48.57	
" NE¼SE¼	Deed from Gull River Lumber Co.	Easement	40.00	93
" SE¼NE¼	Do Do	Do	48.00	
" NW¼NE¼	Do Do	Do	46.33	
" NW¼NW¼	Do Do	Do	45.91	94
Sec. 5 - Part NE¼SE¼	Do Park Region Land Co.	Do	5.00	95
T136N R28W 5thPM				
Sec. 33 - Part SW¼SE¼	Cond. against William Weige	Do	10.00	96
" E½SW¼	Deed from Gull River Lumber Co.	Do	80.00	97
" SE¼NW¼	Do Do	Do	40.00	
" Part NW¼SW¼	Cond. against M. Lauritson	Do	2.00	98
" Part SW¼SW¼	Deed from W.H. Kromp	Do	8.00	99
Sec. 34 - Lot 4	Do Gull River Lumber Co.	Do	27.75	100
" SW¼SE¼	Executive order on Public Domain	Do	40.00	2
Sec. 35 - Part NE¼SE¼	Cond. against Eliza F. Cole	Do	4.60	101
" Part NE¼SE¼	Do Do	Do	0.70	

Tract Location	Source of Title	Date of Deed	Acres	Tract No.
T133N-R29W-5thPM				
Sec. 17 - NW¼ NE¼	Deed from Gull River Lumber Co.	Aug 16, 1898	40.00	102
" NE¼ NE¼	do do	do	40.00	
" SW¼ NE¼	do do	do	40.00	
" SE¼ NE¼	do do	do	40.00	

MISSISSIPPI RIVER HEADWATERS
NAVIGATION AND FLOOD CONTROL PROJECT
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APPENDIX 6, GULL LAKE

REAL ESTATE

TITLE DESCRIPTION

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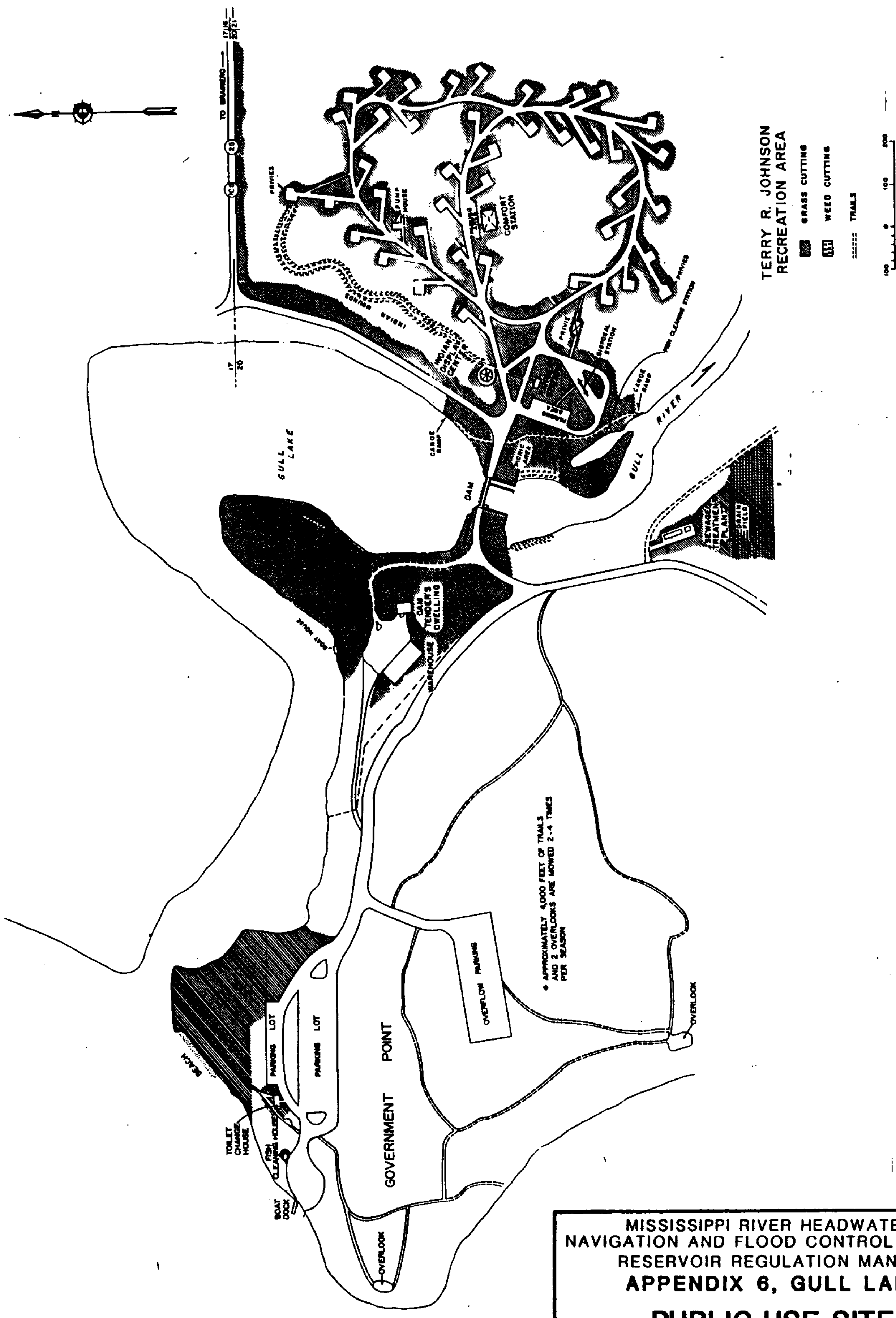
ST. PAUL, MINNESOTA

PLATE 2-6



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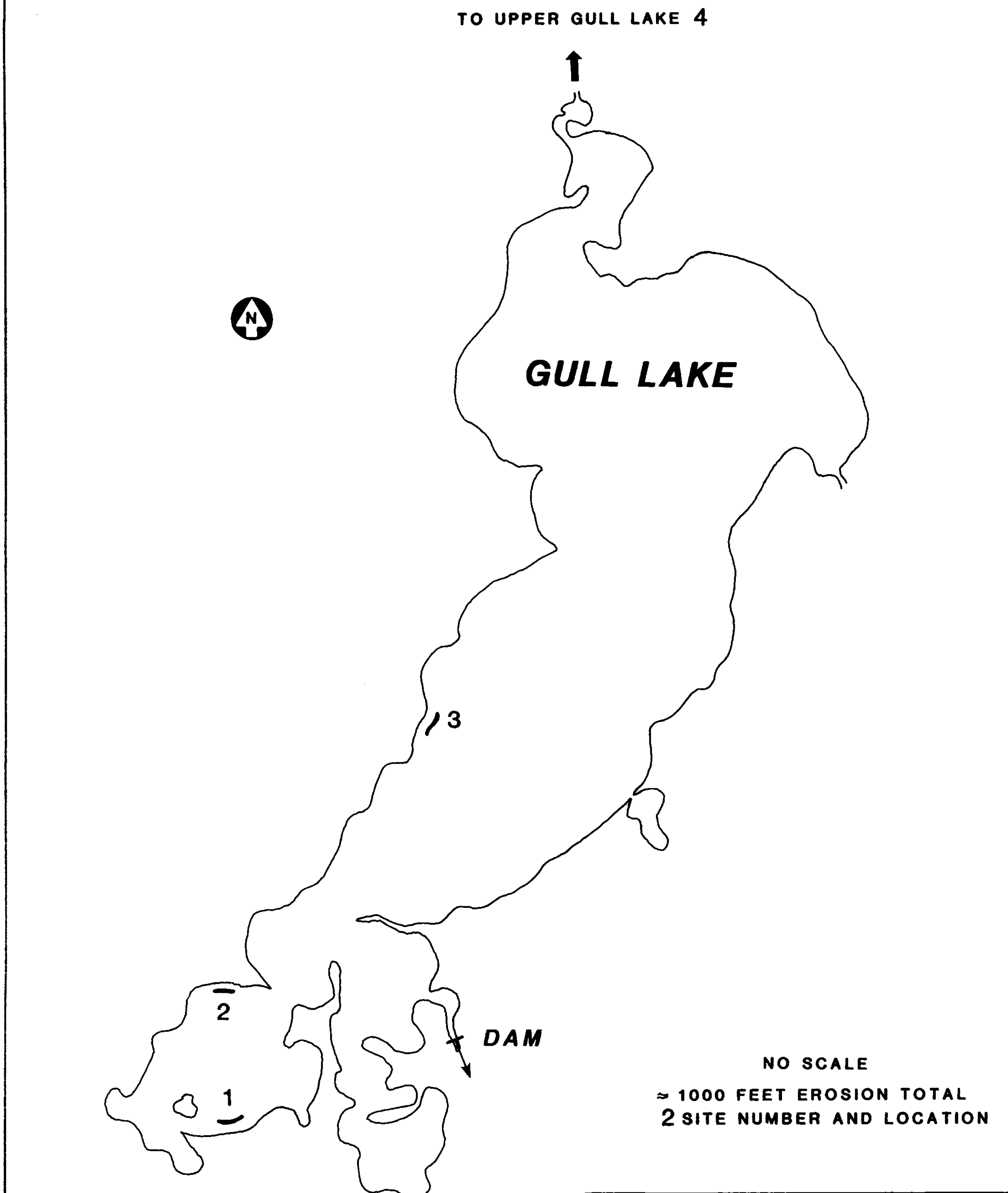
APPENDIX 6, GULL LAKE

PUBLIC USE SITE

CORPS OF ENGINEERS, U.S. ARMY
ST. PAUL ENGINEERING DISTRICT
ST. PAUL, MINNESOTA

PLATE 2-10



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APPENDIX 6, GULL LAKE

BANK EROSION AREAS

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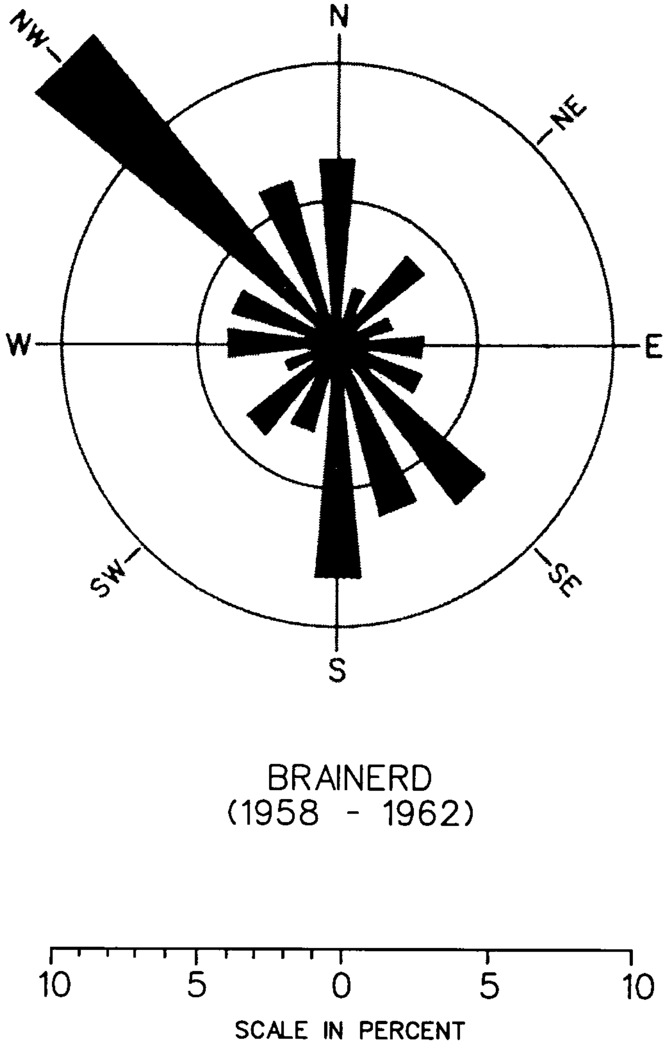
ST. PAUL, MINNESOTA

PERCENT OF TIME WIND BLOWS FROM EACH OF 16 MAJOR DIRECTIONS



BRAINERD
(1958 - 1962)

SOURCE: U.S. DEPT. OF COMMERCE
ASHVILLE, NORTH CAROLINA

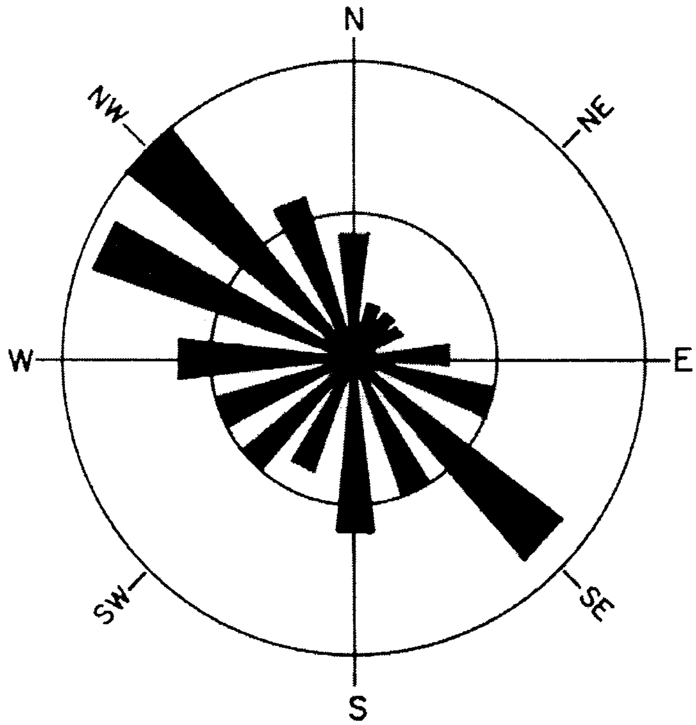
MISSISSIPPI RIVER HEADWATERS
NAVIGATION AND FLOOD CONTROL PROJECT
RESERVOIR REGULATION MANUAL

APPENDIX 6, GULL LAKE
BRAINERD, MN
WIND ROSES

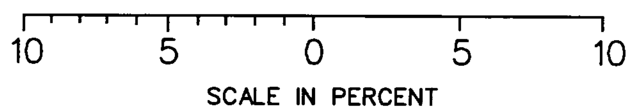
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL ENGINEERING DISTRICT
ST. PAUL, MINNESOTA

PLATE 4-1

PERCENT OF TIME WIND BLOWS FROM EACH OF 16 MAJOR DIRECTIONS



BEMIDJI
(1956 - 1961)



SOURCE: U.S. DEPT. OF COMMERCE
ASHVILLE, NORTH CAROLINA

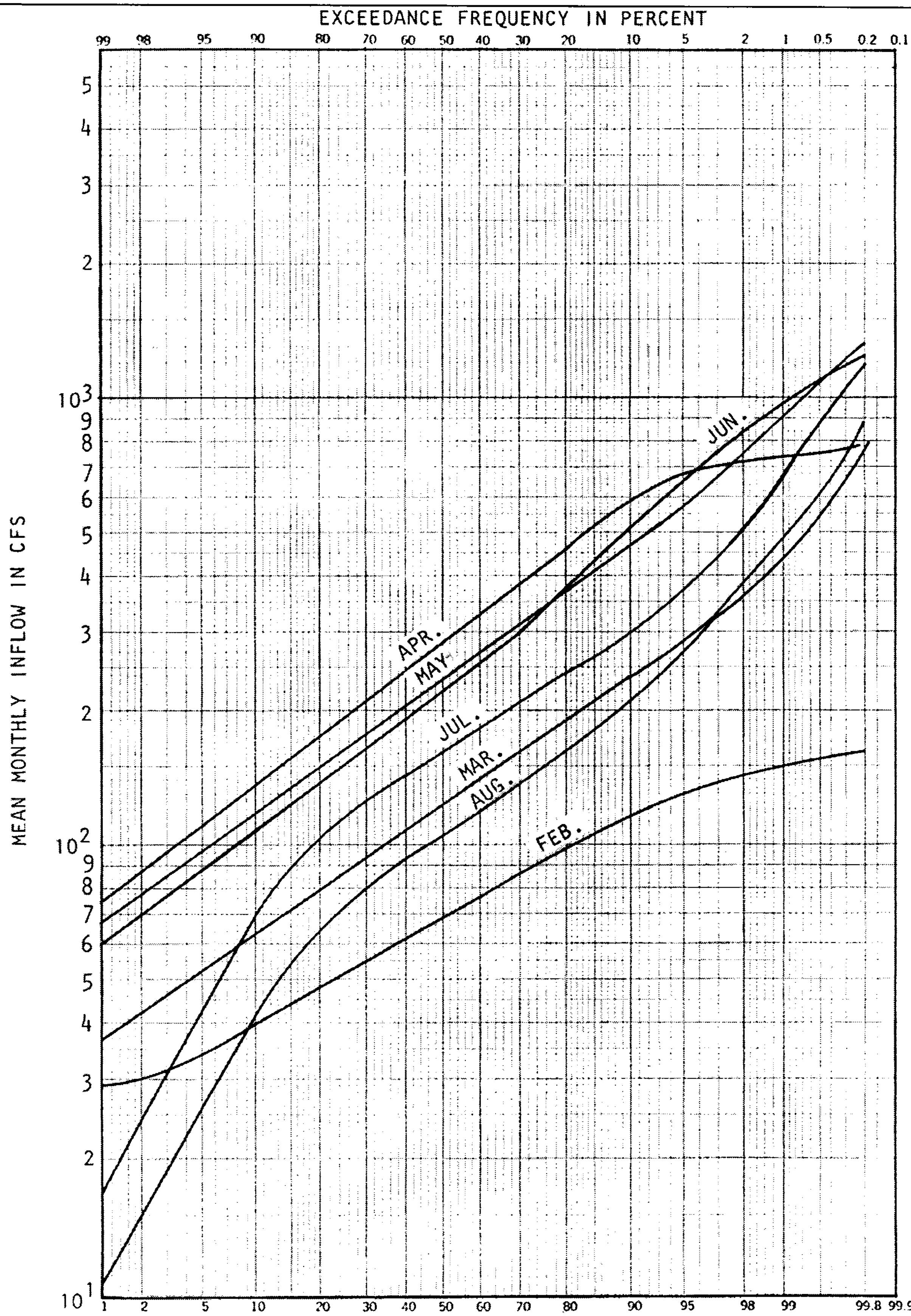
MISSISSIPPI RIVER HEADWATERS
NAVIGATION AND FLOOD CONTROL PROJECT
RESERVOIR REGULATION MANUAL

APPENDIX 6, GULL LAKE

BEMIDJI, MN
WIND ROSES

U.S. ARMY CORPS OF ENGINEERS
ST. PAUL ENGINEERING DISTRICT
ST. PAUL, MINNESOTA

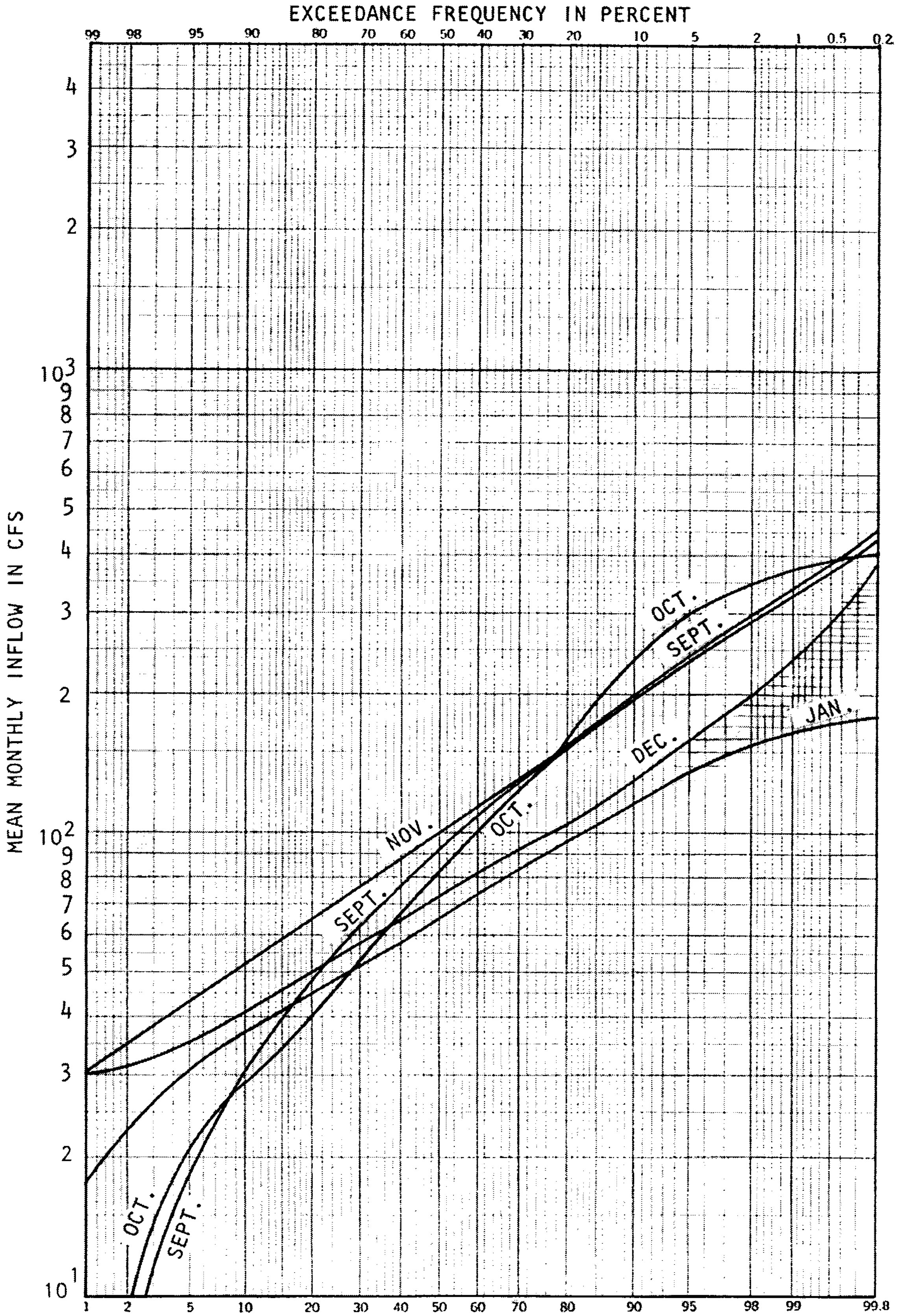
PLATE 4-2



Period of Record Used
1912 -- 1985

MISSISSIPPI RIVER HEADWATERS
NAVIGATION AND FLOOD CONTROL PROJECT
RESERVOIR REGULATION MANUAL
APPENDIX 6, GULL LAKE
INFLOW FREQENCY CURVES
MEAN MONTHLY FLOW
(FEBUARY - AUGUST)
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL ENGINEERING DISTRICT
ST. PAUL, MINNESOTA

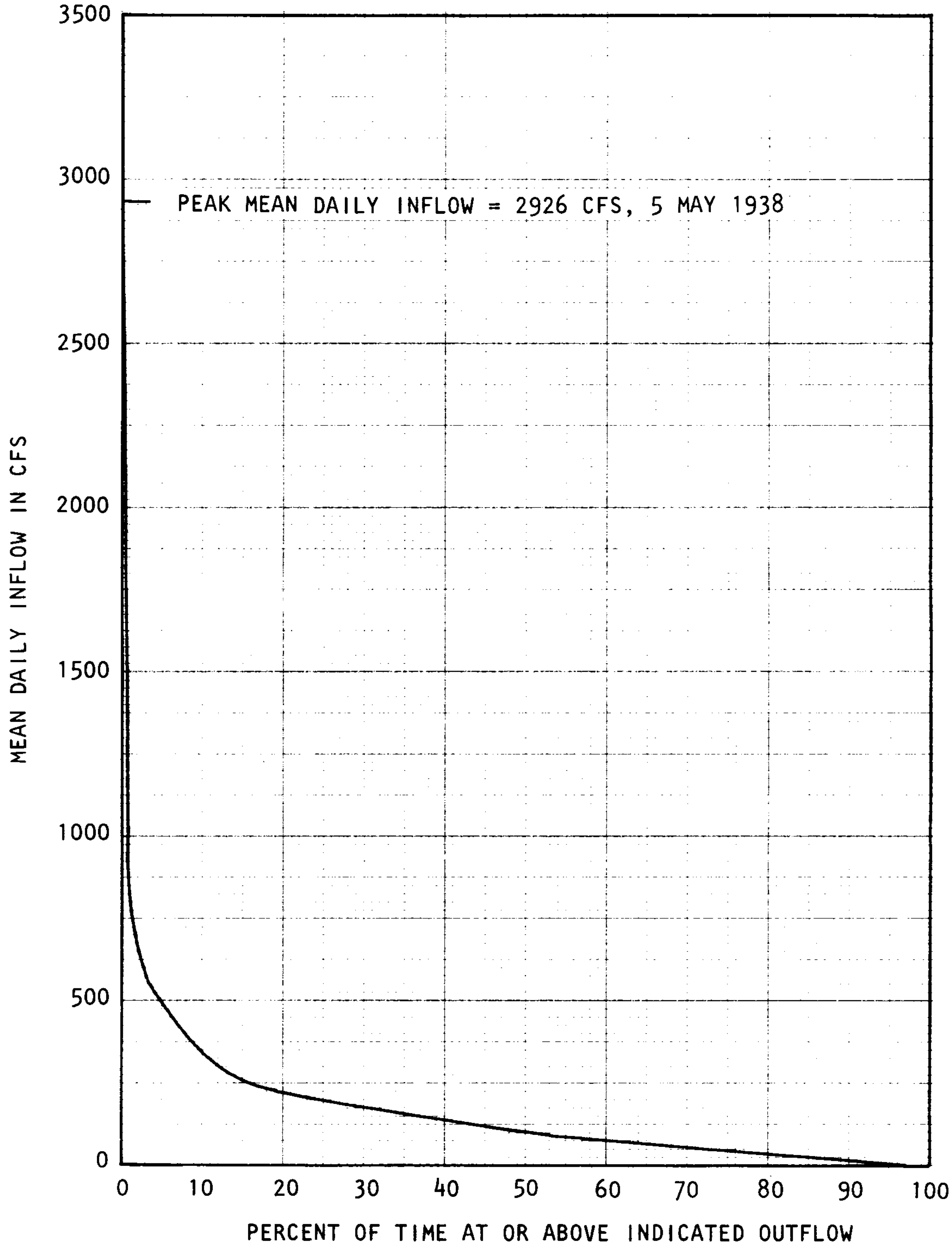
PLATE 4-3



Period of Record Used
1912 -- 1985

MISSISSIPPI RIVER HEADWATERS
NAVIGATION AND FLOOD CONTROL PROJECT
RESERVOIR REGULATION MANUAL
APPENDIX 6, GULL LAKE
INFLOW FREQENCY CURVES
MEAN MONTHLY FLOW
(SEPTEMBER - JANUARY)
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL ENGINEERING DISTRICT
ST. PAUL, MINNESOTA

PLATE 4-4



MISSISSIPPI RIVER HEADWATERS
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RESERVOIR REGULATION MANUAL

APPENDIX 6, GULL LAKE

INFLOW DURATION CURVE

(1912-1985)

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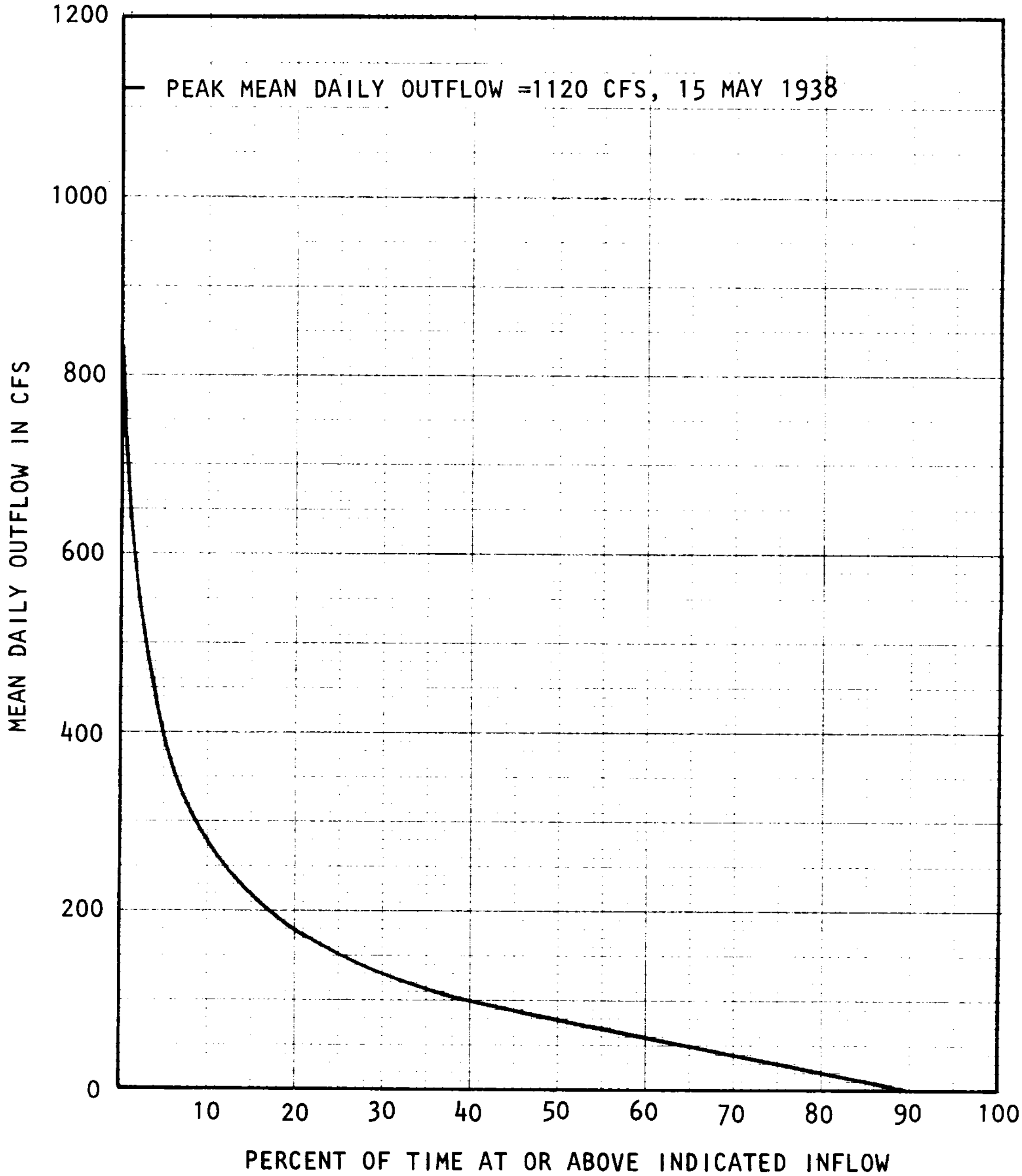
ST. PAUL, MINNESOTA

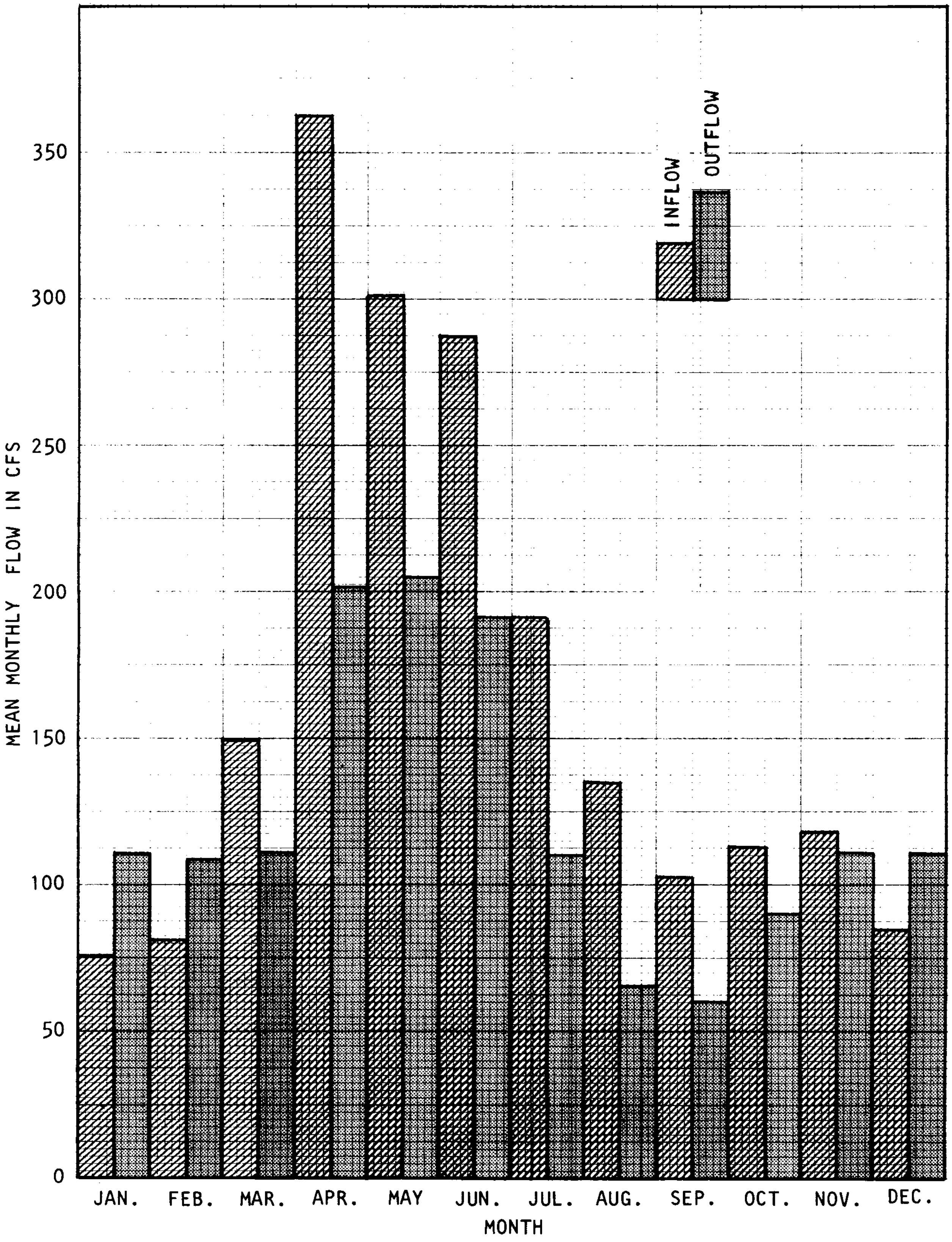


MISSISSIPPI RIVER HEADWATERS
NAVIGATION AND FLOOD CONTROL PROJECT
RESERVOIR REGULATION MANUAL
APPENDIX 6, GULL LAKE

OUTFLOW DURATION CURVE
(1936-1985)

CORPS OF ENGINEERS, U.S. ARMY
ST. PAUL ENGINEERING DISTRICT
ST. PAUL, MINNESOTA

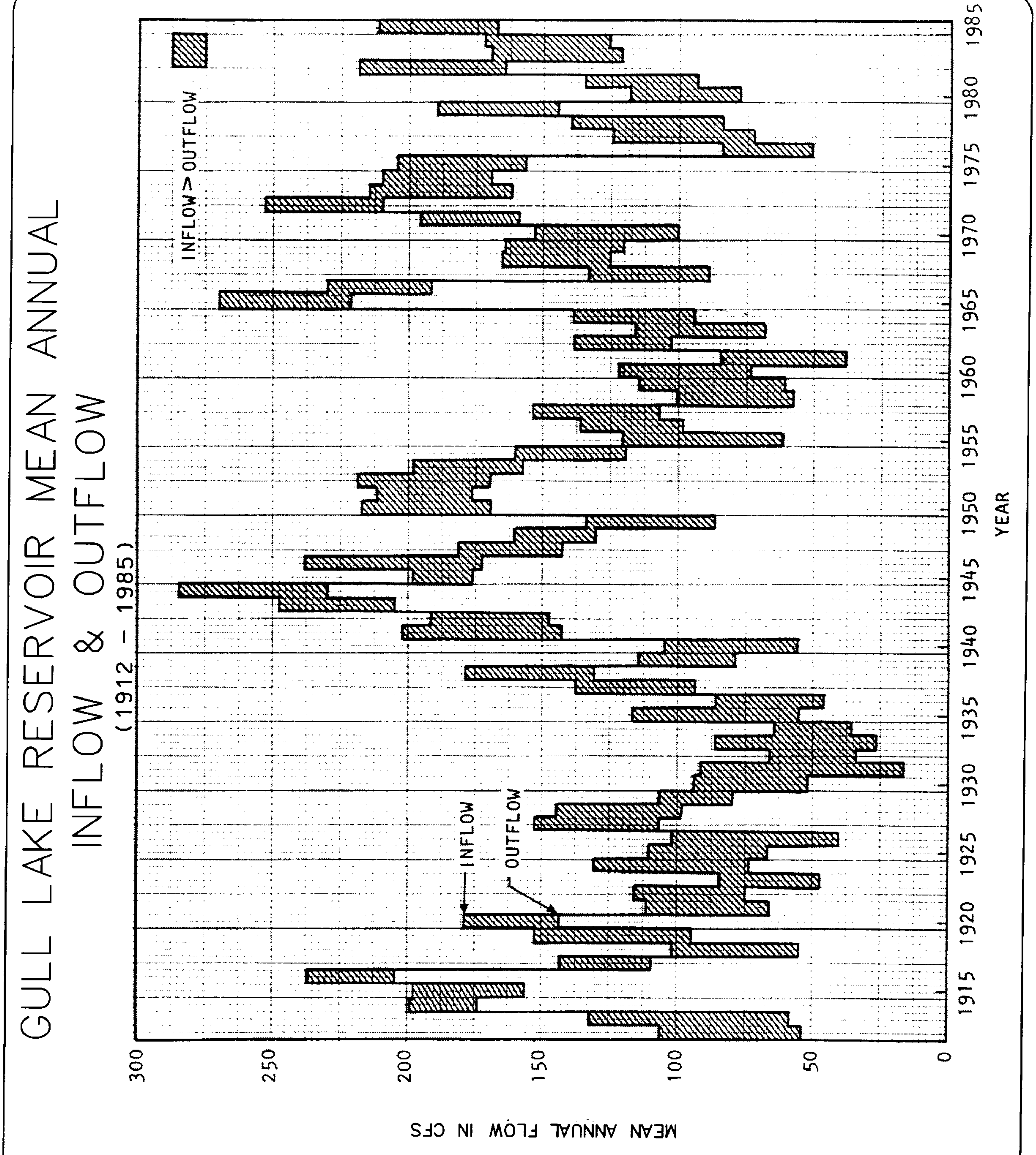
PLATE 4-6



MISSISSIPPI RIVER HEADWATERS
NAVIGATION AND FLOOD CONTROL PROJECT
RESERVOIR REGULATION MANUAL

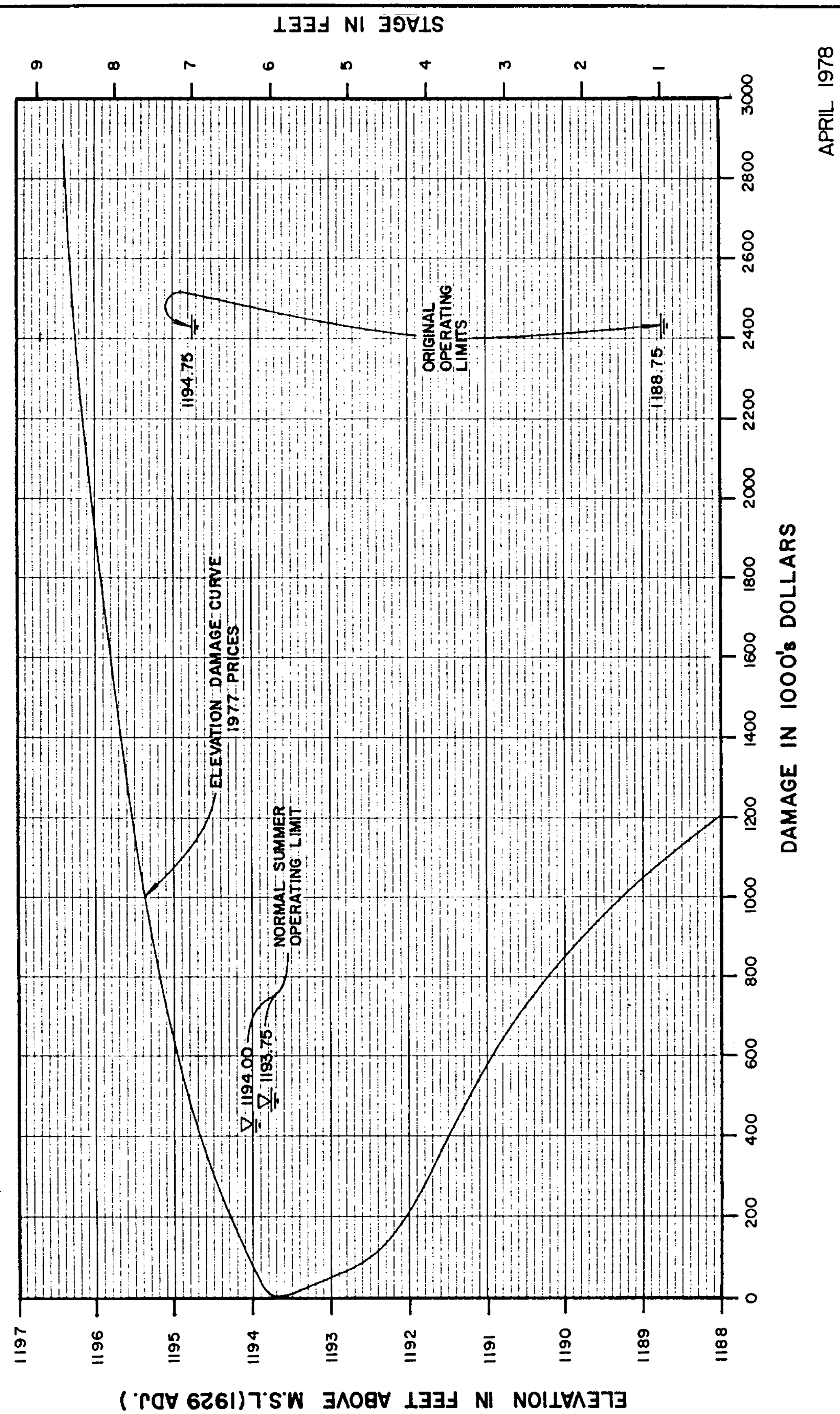
APPENDIX 6, GULL LAKE
MONTHLY STREAMFLOW DISTRIBUTION
INFLOW-OUTFLOW
(1936-1985)

CORPS OF ENGINEERS, U.S. ARMY
ST. PAUL ENGINEERING DISTRICT
ST. PAUL, MINNESOTA



NAVIGATION AND FLOOD CONTROL PROJECT
RESERVOIR REGULATION MANUAL
APPENDIX 6, GULL LAKE
ANNUAL STREAM FLOW
DISTRIBUTION
INFLOW - OUTFLOW
U.S. ARMY CORPS OF ENGINEERS
ST. PAUL ENGINEERING DISTRICT
ST. PAUL, MINNESOTA

PLATE 4-8

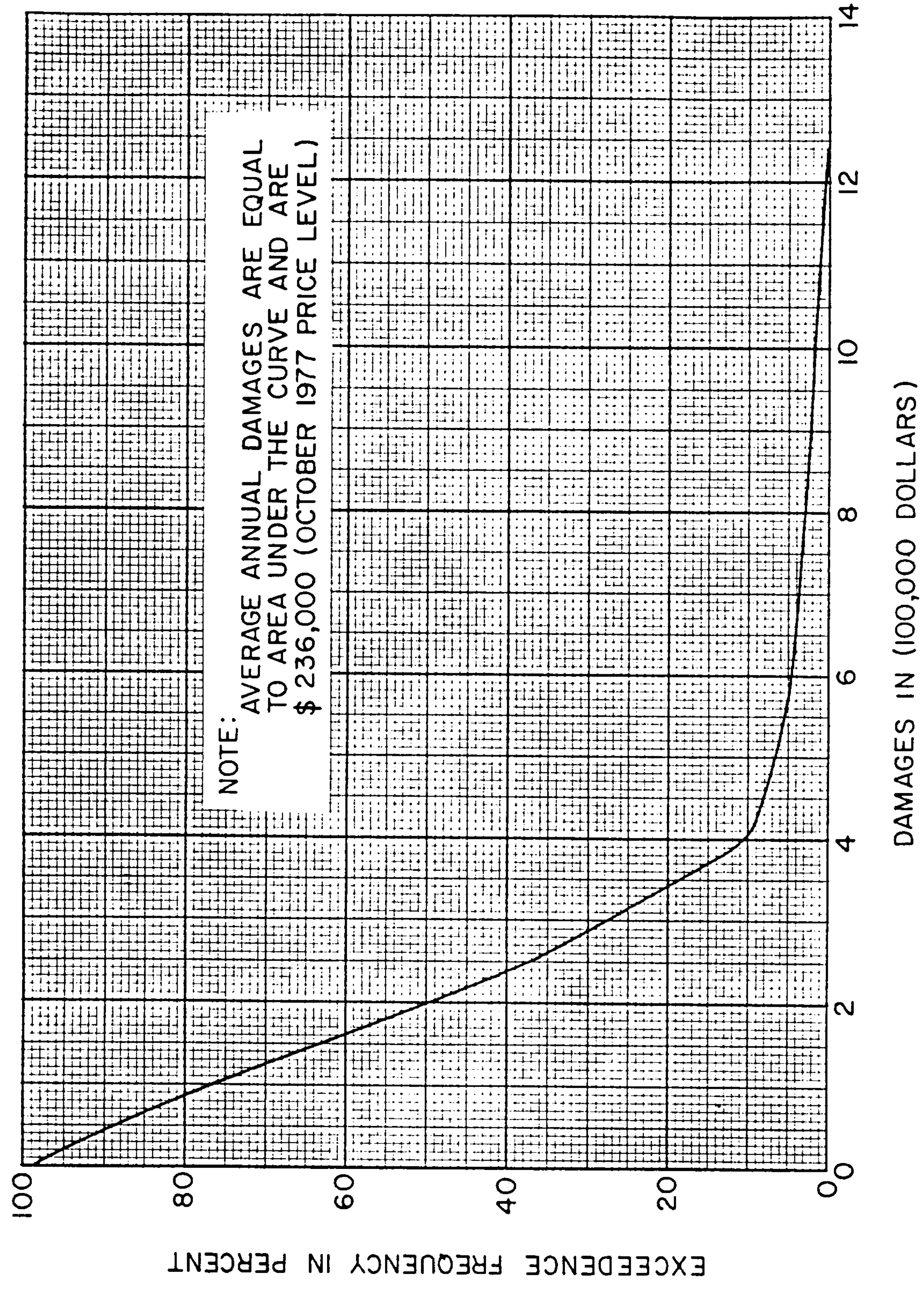


MISSISSIPPI RIVER HEADWATERS
NAVIGATION AND FLOOD CONTROL PROJECT
RESERVOIR REGULATION MANUAL

APPENDIX 6, GULL LAKE

ELEVATION-DAMAGE CURVE
(GULL LAKE RESERVOIR)

CORPS OF ENGINEERS, U.S. ARMY
ST. PAUL ENGINEERING DISTRICT
ST. PAUL, MINNESOTA



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RESERVOIR REGULATION MANUAL

APPENDIX 6, GULL LAKE
HIGH WATER
FREQUENCY-DAMAGE CURVE
(GULL LAKE RESERVOIR)

CORPS OF ENGINEERS, U.S. ARMY
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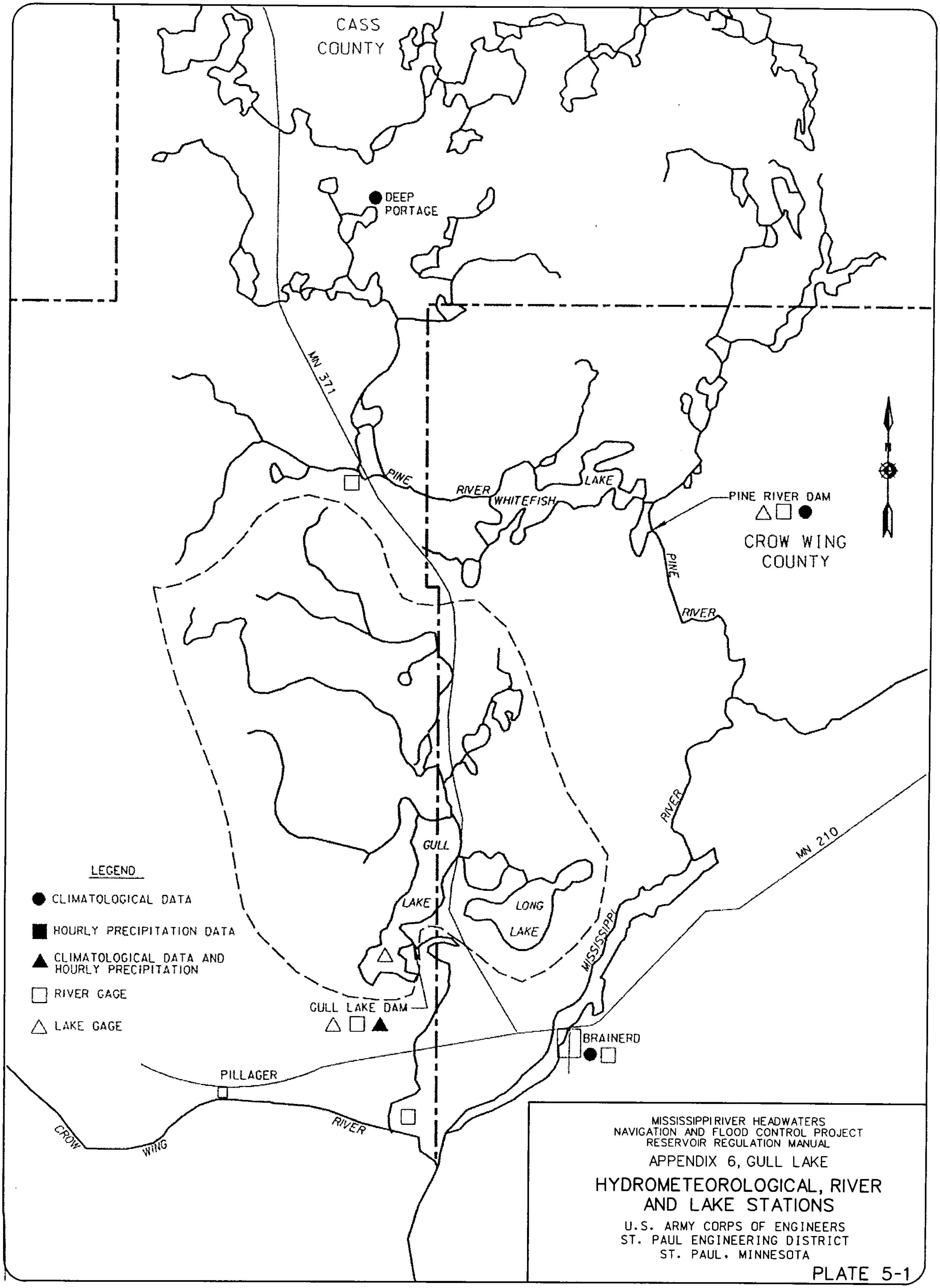


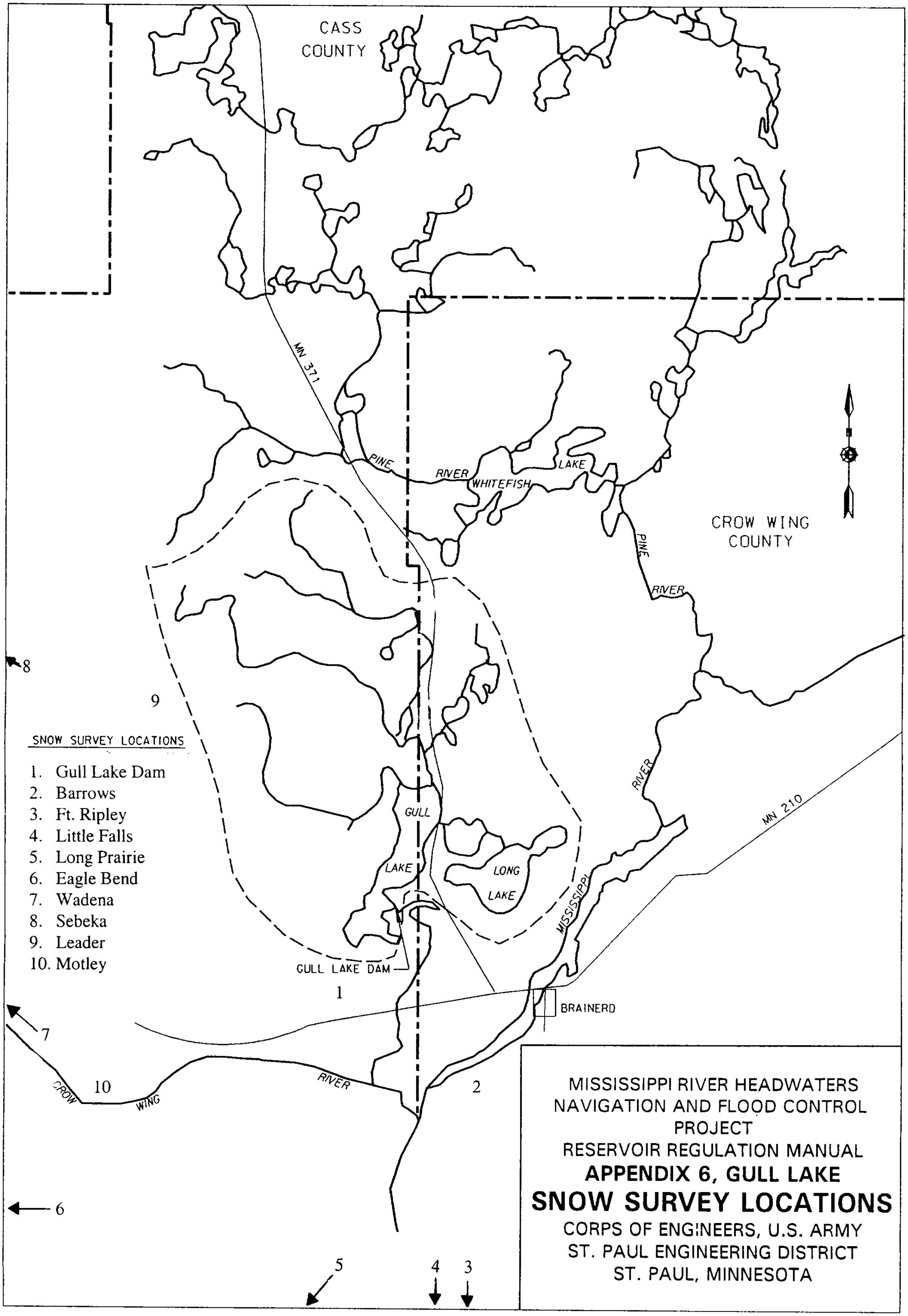
MISSISSIPPI RIVER HEADWATERS
NAVIGATION AND FLOOD CONTROL PROJECT
RESERVOIR REGULATION MANUAL

APPENDIX 6, GULL LAKE

HYDROMETEOROLOGICAL, RIVER AND LAKE STATIONS

U.S. ARMY CORPS OF ENGINEERS
ST. PAUL ENGINEERING DISTRICT
ST. PAUL, MINNESOTA

PLATE 5-1



MISSISSIPPI RIVER HEADWATERS
NAVIGATION AND FLOOD CONTROL
PROJECT
RESERVOIR REGULATION MANUAL
APPENDIX 6, GULL LAKE
SNOW SURVEY LOCATIONS
CORPS OF ENGINEERS, U.S. ARMY
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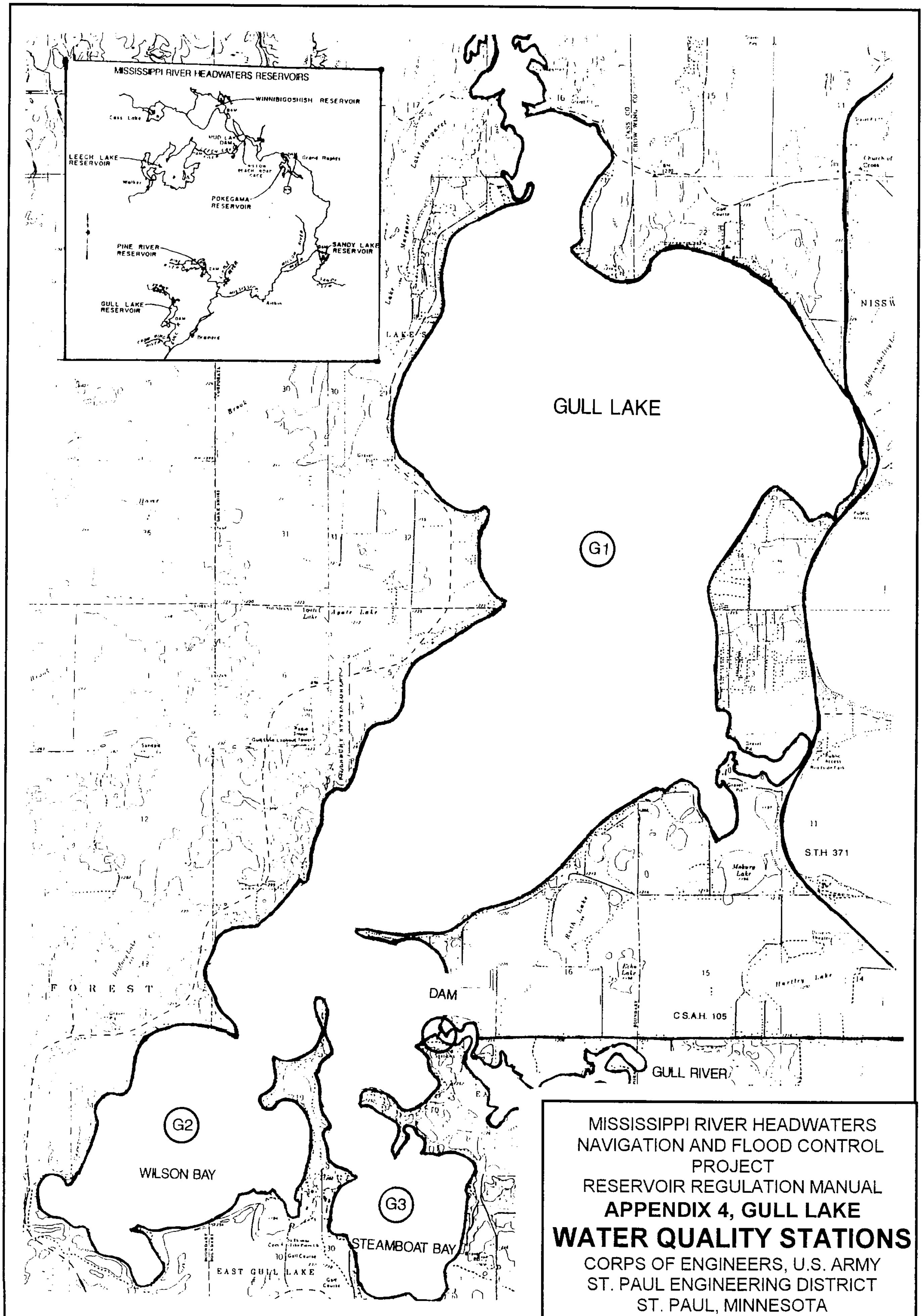

MISSISSIPPI RIVER HEADWATERS
NAVIGATION AND FLOOD CONTROL
PROJECT
RESERVOIR REGULATION MANUAL

APPENDIX 4, GULL LAKE

WATER QUALITY STATIONS

CORPS OF ENGINEERS, U.S. ARMY
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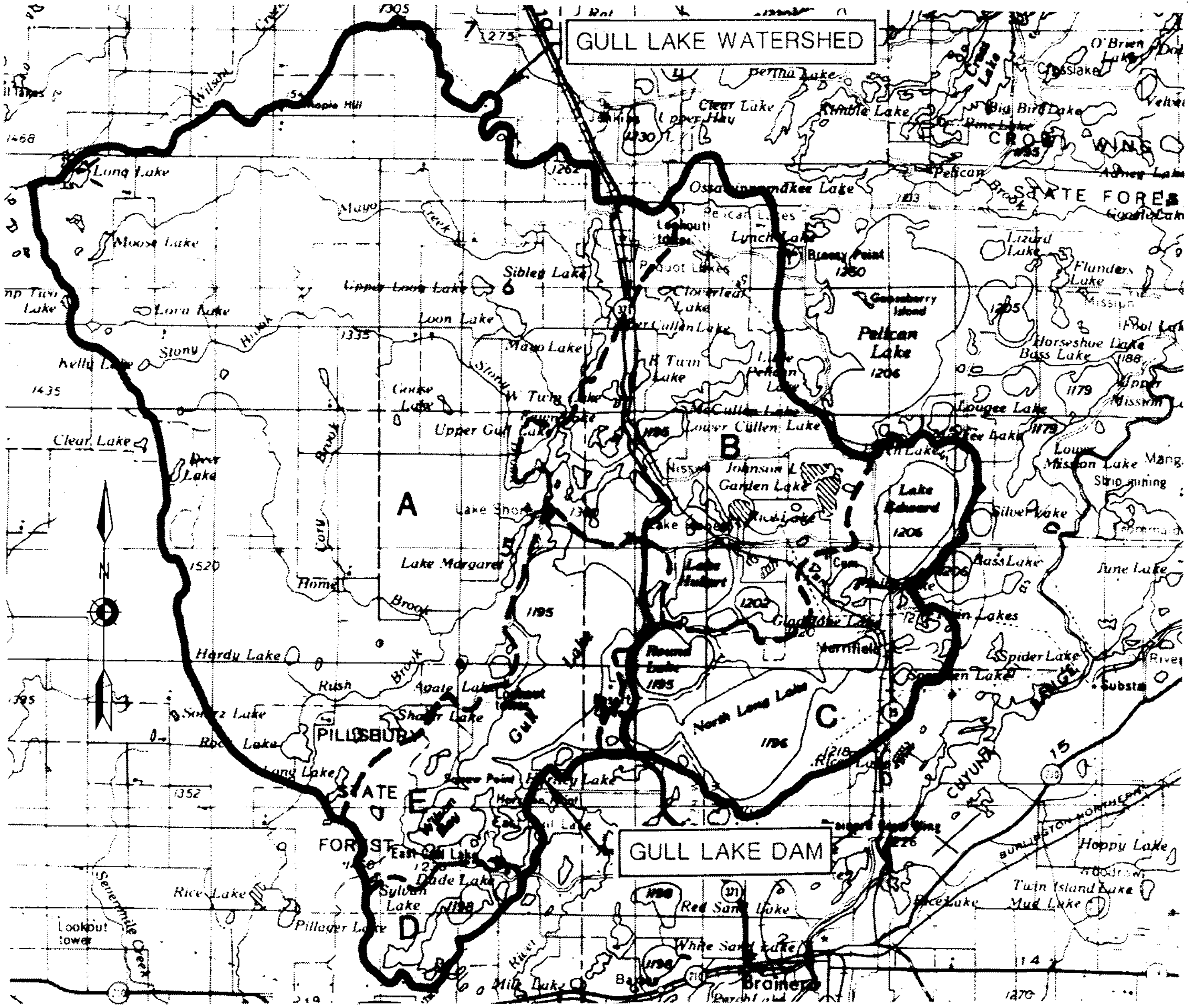

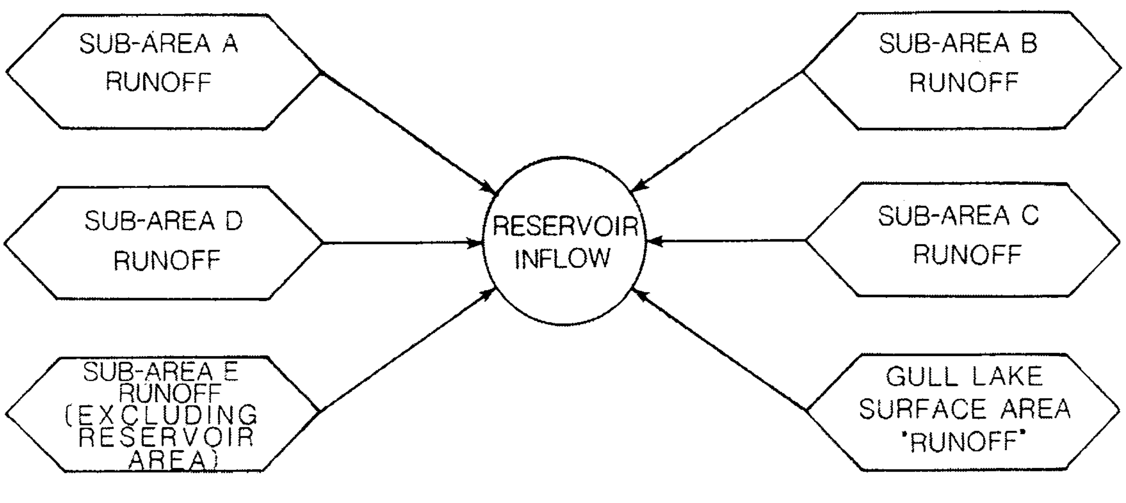

MISSISSIPPI RIVER HEADWATERS
NAVIGATION AND FLOOD CONTROL PROJECT
RESERVOIR REGULATION MANUAL

APPENDIX 6, GULL LAKE

SUBWATERSHED MAP AND
HEC-1 SCHEMATIC

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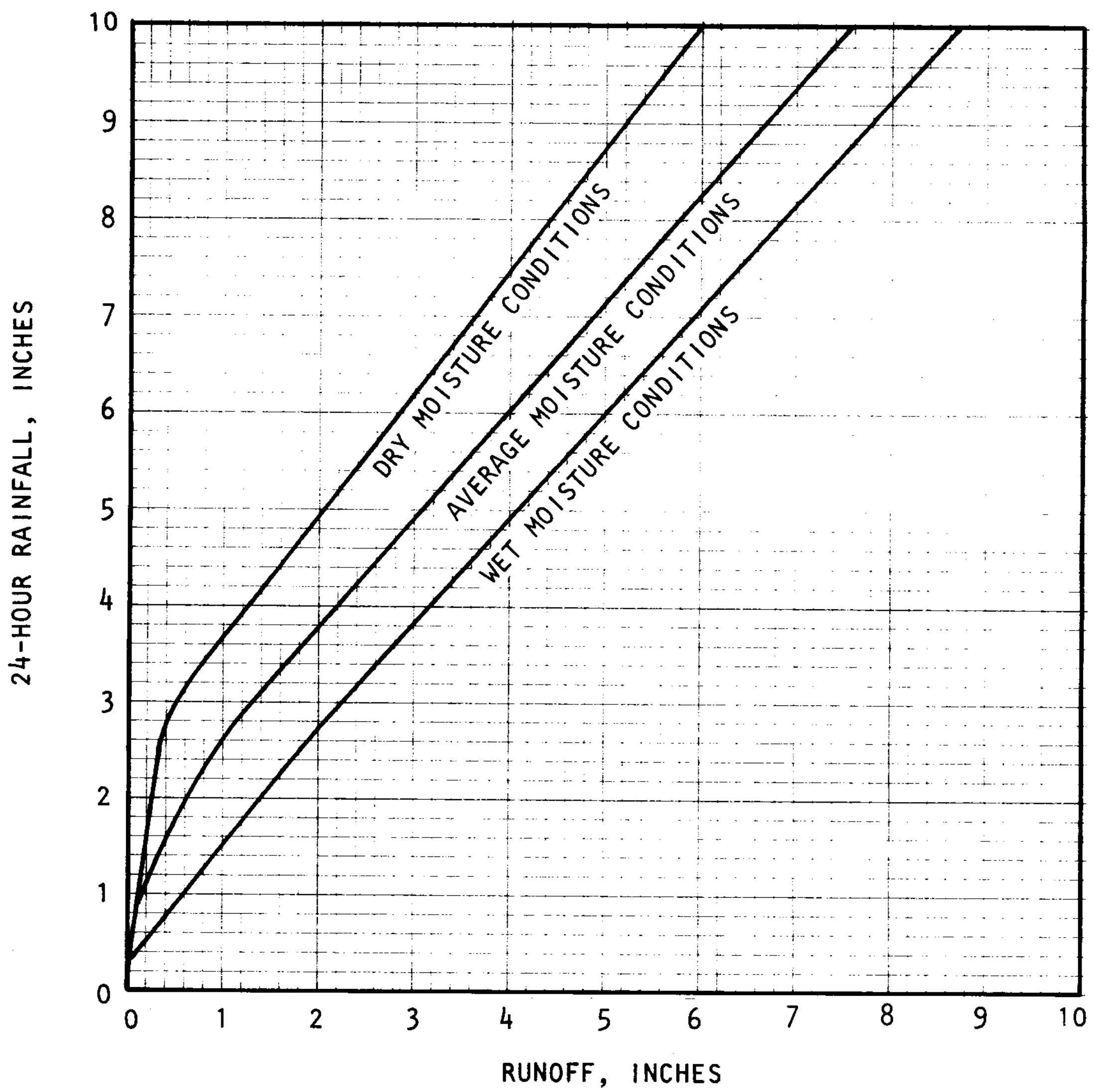
ST. PAUL, MINNESOTA

PLATE 6-1



NOTE: RAINFALL AND RUNOFF ARE MEAN AREAL VALUES OVER 287 SQUARE MILE GULL LAKE RESERVOIR DRAINAGE BASIN.

MISSISSIPPI RIVER HEADWATERS
NAVIGATION AND FLOOD CONTROL PROJECT
RESERVOIR REGULATION MANUAL
APPENDIX 6, GULL LAKE

RAINFALL -RUNOFF CURVES

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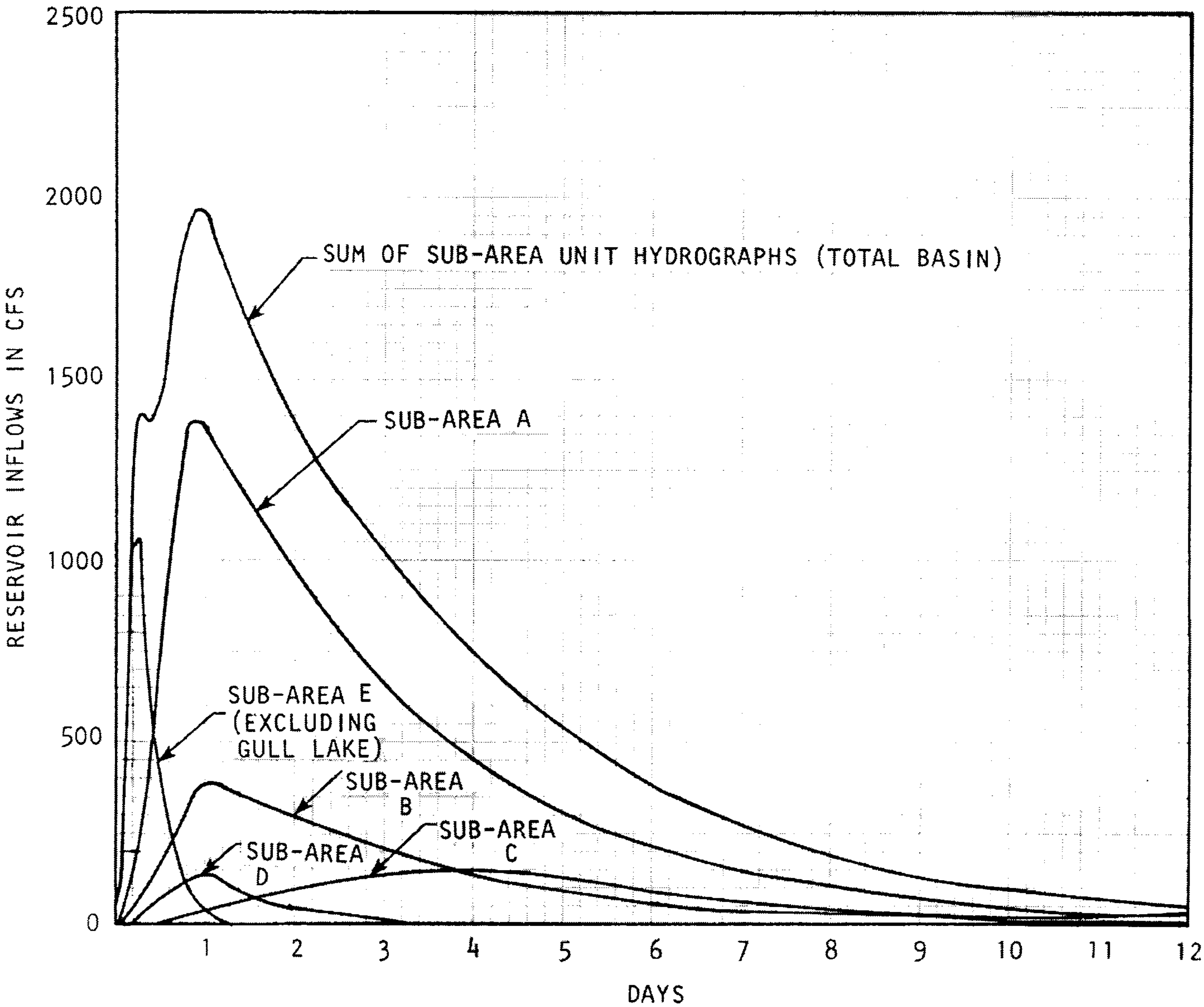

MISSISSIPPI RIVER HEADWATERS
NAVIGATION AND FLOOD CONTROL PROJECT
RESERVOIR REGULATION MANUAL

APPENDIX 6, GULL LAKE
3 - HOUR HYDROGRAPHS
ALL SEASON

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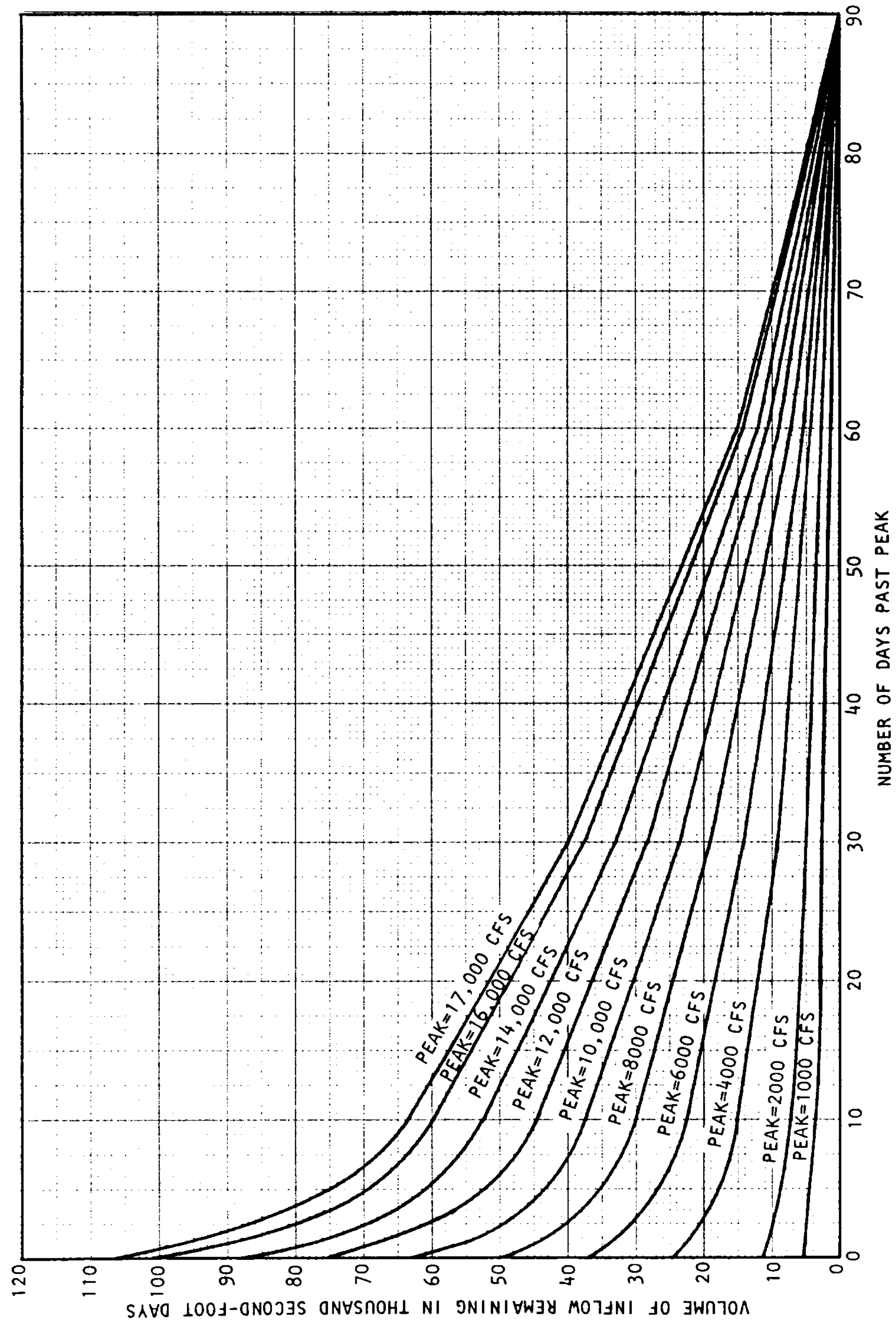
ST. PAUL, MINNESOTA

PLATE 6-2A



MISSISSIPPI RIVER HEADWATERS
NAVIGATION AND FLOOD CONTROL PROJECT
RESERVOIR REGULATION MANUAL

APPENDIX 6, GULL LAKE

INFLOW RECESSION VOLUME CURVE

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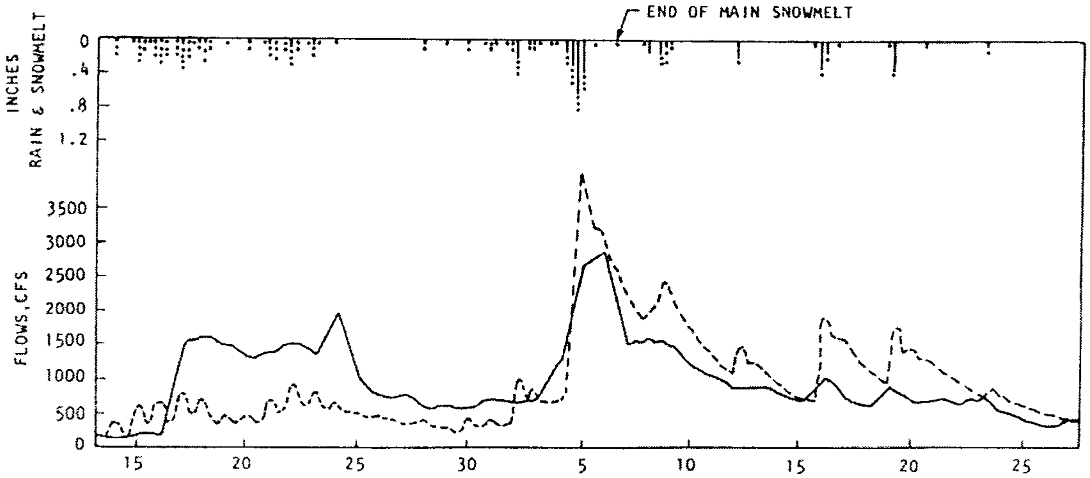

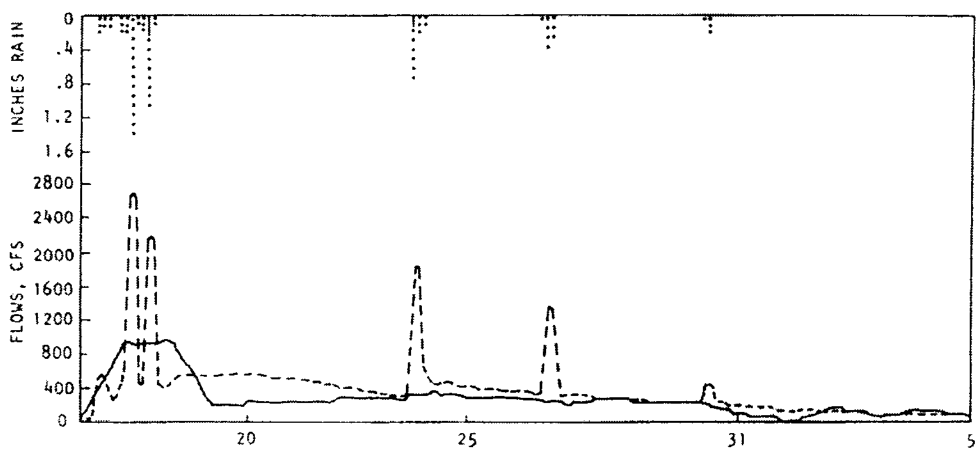

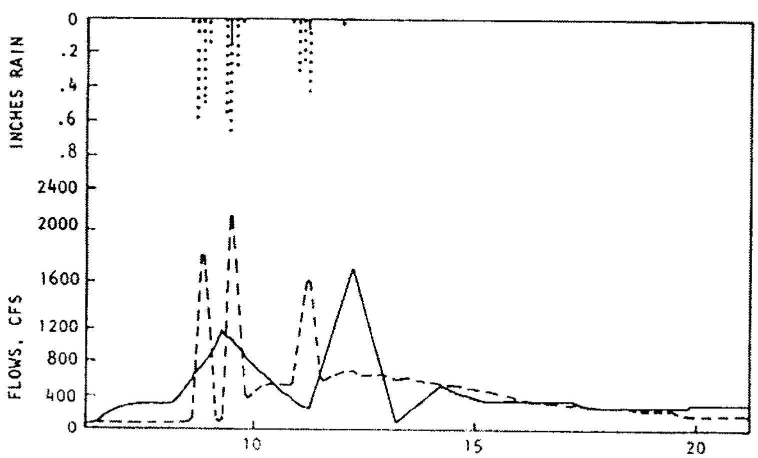

——— REVERSE ROUTED INFLOW, 24-HR. AVERAGE
– – – – HEC-1 MODELED INFLOW, 3-HR. TIME STEP
········ PRECIPITATION AND/OR SNOWMELT
——— PRECIPITATION EXCESS (NON-RESERVOIR AREA)

MISSISSIPPI RIVER HEADWATERS
NAVIGATION AND FLOOD CONTROL PROJECT
RESERVOIR REGULATION MANUAL
APPENDIX 6, GULL LAKE

FLOOD RECONSTITUTIONS

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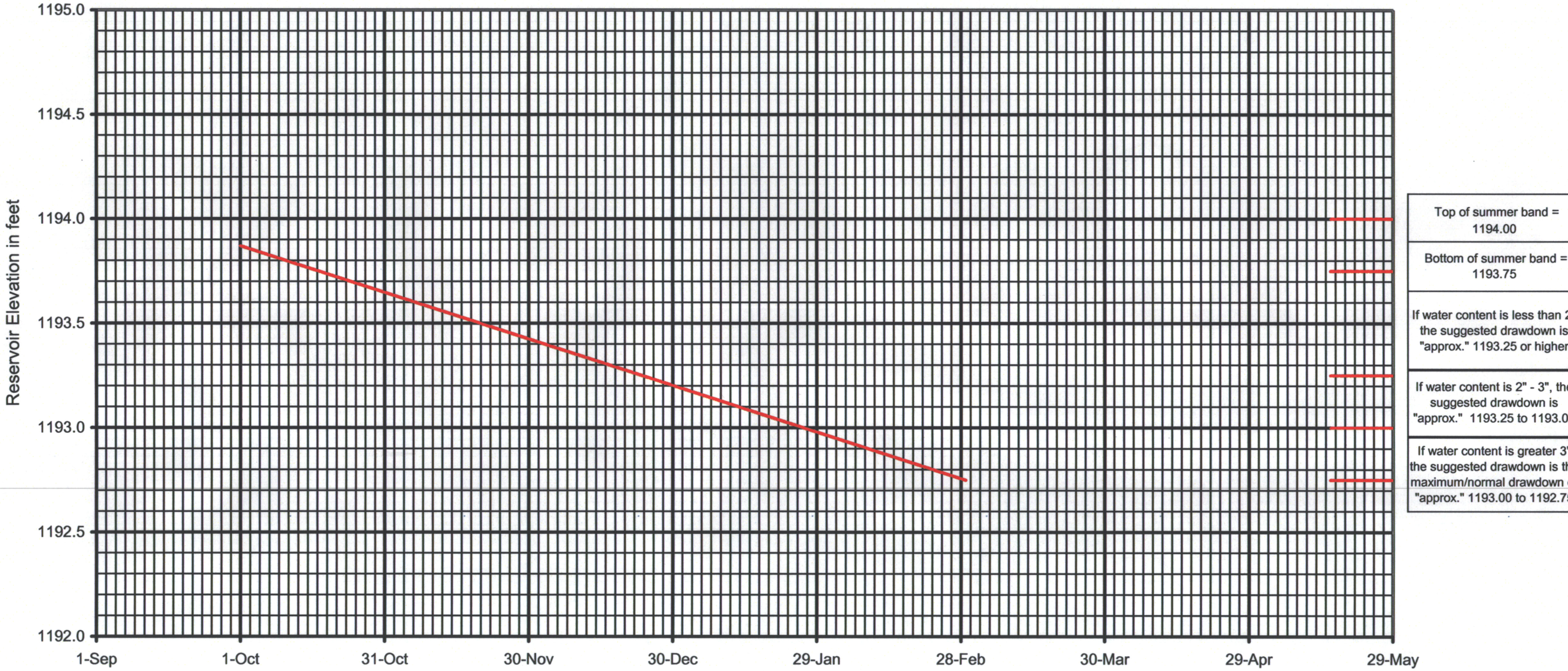
ST. PAUL, MINNESOTA

PLATE 6-4

Gull Lake



1. See Paragraph 7-05 and Table 7-7.
2. The drawdown curve should be followed until the middle of December.
   Snow water content should then be monitored to determine the final drawdown target elevation.
3. The discharge for a "Normal" drawdown to 1192.75 Ft. is approximately 50 cfs above inflow.
4. All Elevations are 1929 NGVD.

MISSISSIPPI RIVER HEADWATERS
NAVIGATION AND FLOOD CONTROL PROJECT WATER CONTROL MANUAL

GULL LAKE DRAWDOWN CURVE

U.S. ARMY CORPS OF ENGINEERS
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ST. PAUL, MINNESOTA

Slide gate flow ?

Yes

Is slide gate in the water ?

No → **Weir Flow** Head = pool - invert

Stop Log flow ?

Yes → **Weir Flow** Head = pool - invert

$Q = C\,L\,H^{1.5}$

C = Weir Coef.

C = 3.33 for 11-foot bays & gate bays

L = Weir Length

H = Head

Is (tailwater – invert)/(pool – invert) greater than 0.76?

No → **Free Flow**

See Plates 7-3, 7-4, 7-5, or 7-6.

Yes → **Submerged Flow**

Apply Flow Reduction Factor to values from Plates 7-3, 7-4, 7-5, or 7-6.

Reference No. 1

Percent Submergence	Flow Reduction Factor
76 or less	1.0
78	0.998
80	0.995
82	0.99
84	0.985
86	0.975
88	0.96
90	0.93
92	0.885
94	0.82
96	0.72
98	0.58
100	0.30

(Is slide gate in the water ?) Yes → **Orifice Flow**

Q = C A (SQRT(64.4 H))

C = Flow Coef.

C = 0.49 for free-orifice flow

A = Flow Area

H = Head

Is (tailwater - invert)/ gate opening less than or equal to 1.4 ? Reference Nos. 2 & 3

No → **Submerged Flow** Head = pool – tailwater

See top of Plate 7-3 and 7-5.

Yes → **Free Flow** Head = pool - (invert + (0.5 x gate opening))

See bottom of Plate 7-3.

References:

1. Hydraulics of Bridge Waterways, HDS No.1, U.S. Department of Transportation, Federal Highway Administration, March 1978.
2. Practical Hydraulics, 2nd Edition, Andrew L. Simon, University of Akron, John Wiley and Sons Inc. 1981, (see Figure 9.8 titled: "The range of downstream influence on flow under gates").
3. Discharge Ratings for Tainter Gates and Roller Gates at Lock and Dam No. 7 on the Mississippi River, La Cresent, MN, U.S. Geological Survey Water Resources Investigations Report 95-4089, Madison, WI, 1995.

Tailwater effects: See Plate 7-7 for the Tailwater Rating Curve.

Gull Lake Dam

Free/Submerged Flow Decision Matrix

Plate 7-2

Submerged-Orifice Flow

Discharge Table for Gull Lake Dam Slide Gates

(Discharge for one foot of opening through one gate only)

(See Plate 7-2 to determine Free Flow versus Submerged Flow conditions)

Head in feet	Discharge in cfs	Head in feet	Discharge in cfs	Head in feet	Discharge in cfs	Head in feet	Discharge in cfs
0.1	9	**1.1**	40	**2.1**	49	**3.1**	58
0.2	18	**1.2**	41	**2.2**	50	**3.2**	59
0.3	23	**1.3**	42	**2.3**	51	**3.3**	60
0.4	27	**1.4**	43	**2.4**	52	**3.4**	60
0.5	30	**1.5**	44	**2.5**	52	**3.5**	61
0.6	32	**1.6**	44	**2.6**	53	**3.6**	62
0.7	34	**1.7**	45	**2.7**	54	**3.7**	63
0.8	36	**1.8**	46	**2.8**	55	**3.8**	64
0.9	37	**1.9**	47	**2.9**	56	**3.9**	65
1.0	39	**2.0**	48	**3.0**	57	**4.0**	66

note : A curve found in Water Control files dated 1 July 1974 were used to create this table.

note : 5 Slide gates, each 5.0 ft.wide x 4.0 ft. tall, Invert elevation = 1188.75 ft.

note : Head = Pool Elevation - Tailwater Elevation (for submerged-orifice flow).

note : The sill elevation at Gull Lake Dam is 1188.75 ft. The tailwater below the dam is above 1190.75 a large percentage of the time and occasionally exceeds elevation 1193.0 ft. This results in submerged-orifice flow for most flow conditions.

note : See Plate 7-5 for Slide Gate Rating Curve.

Discharge Through Slide Gates For Free Flow

1. See Plate 7-2 for Free Flow versus Submerged Flow.
2. Use C = 0.49 (See Plate 7-5).
3. Use Head = Pool -(Invert + (0.5 x gate opening)).
4. Q = C A (SQRT(64.4 H)).

MISSISSIPPI RIVER HEADWATERS
NAVIGATION AND FLOOD CONTROL PROJECT
WATER CONTROL MANUAL

GULL LAKE DAM
SLIDE GATE RATING TABLE

U.S. ARMY CORPS OF ENGINEERS
ST. PAUL ENGINEERING DISTRICT
ST. PAUL, MINNESOTA

Discharge Table for Gull Lake Dam 11-Foot Stop Log Bay

Free Flow Only

(See Plate 7-2 to determine Free Flow versus Submerged Flow conditions)

Head in feet	Discharge in cfs	Head in feet	Discharge in cfs	Head in feet	Discharge in cfs	Head in feet	Discharge in cfs	Head in feet	Discharge in cfs
0.1	3.0	**1.1**	41.5	**2.1**	110.5	**3.1**	200.0	**4.1**	304.0
0.2	5.5	**1.2**	47.5	**2.2**	119.0	**3.2**	210.0	**4.2**	316.0
0.3	8.0	**1.3**	54.0	**2.3**	127.0	**3.3**	219.5	**4.3**	327.0
0.4	11.0	**1.4**	60.0	**2.4**	136.0	**3.4**	230.0	**4.4**	338.5
0.5	15.0	**1.5**	67.0	**2.5**	144.0	**3.5**	240.0	**4.5**	350.0
0.6	18.5	**1.6**	74.0	**2.6**	153.5	**3.6**	250.0	**4.6**	362.0
0.7	22.5	**1.7**	81.0	**2.7**	162.0	**3.7**	261.0	**4.7**	374.0
0.8	27.0	**1.8**	88.0	**2.8**	171.5	**3.8**	271.5	**4.8**	386.0
0.9	31.0	**1.9**	95.5	**2.9**	181.0	**3.9**	282.0	**4.9**	398.0
1.0	36.0	**2.0**	103.0	**3.0**	190.0	**4.0**	293.0	**5**	410.0

note : Free weir flow, Q = C * L * (H^1.5), C = 3.33, L = 11 ft., H = Difference in feet between water surface and top of stop logs.

note : This table was plotted based on data from a curve obtained from a bound file in the Water Control Section labeled "Headwaters Reservoirs, Rating Tables and Discharge Curves". The curve used an average "C" value of 3.33.

note : See Plate 7-6 for 11-Foot Stop Log Bay Rating Curve.

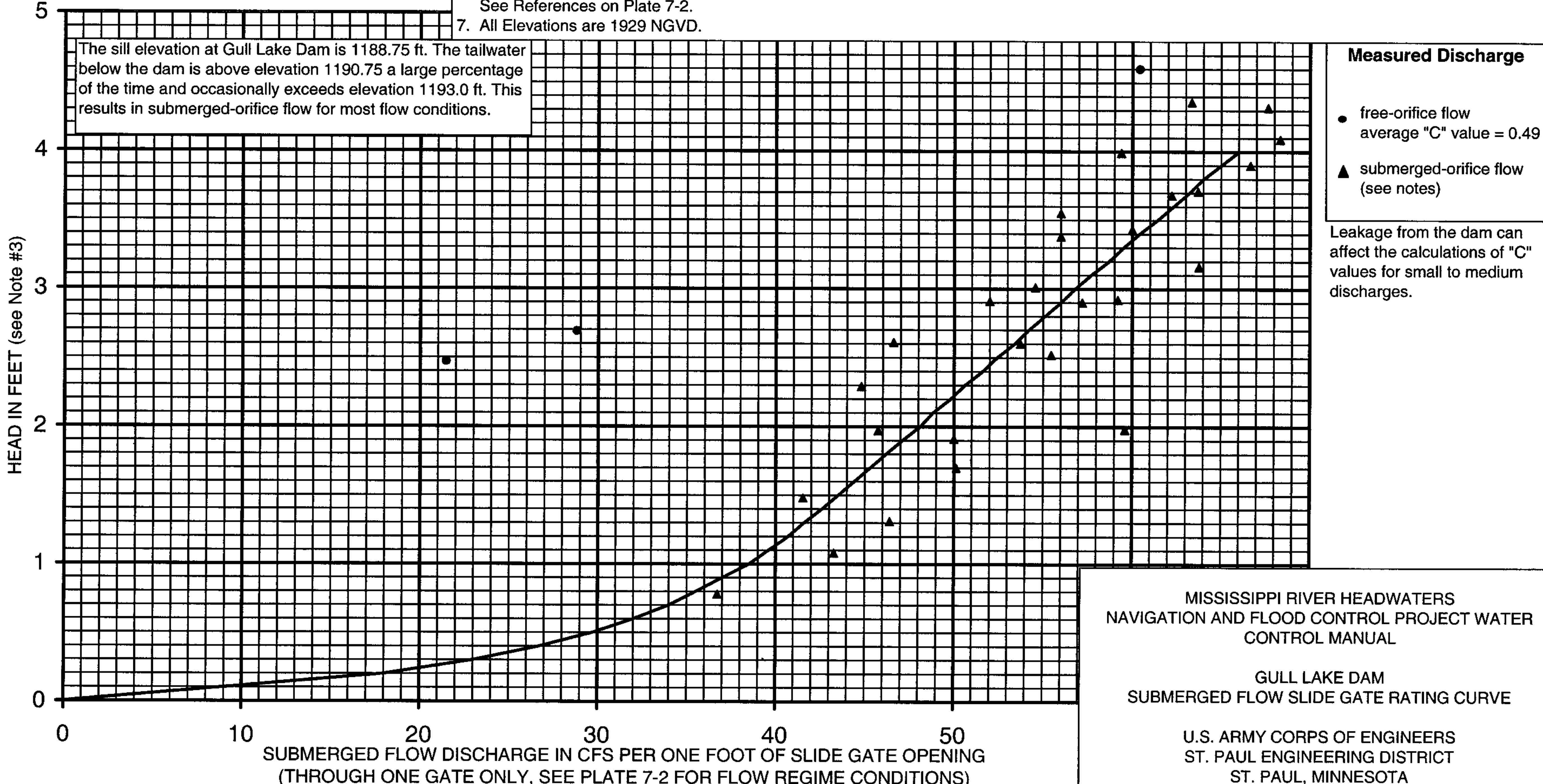
MISSISSIPPI RIVER HEADWATERS
NAVIGATION AND FLOOD CONTROL PROJECT
WATER CONTROL MANUAL

GULL LAKE DAM
11-FOOT STOP LOG BAY RATING TABLE

U.S. ARMY CORPS OF ENGINEERS
ST. PAUL ENGINEERING DISTRICT

Gull Lake Dam

1. 5 Slide gates, each 5.0 ft. wide x 4.0 ft. tall, sill elevation = 1188.75 ft.
2. See Table 7-5a for measured discharge values.
3. A curve found in Water Control files dated 1 July 1974 were used to create this plate.
4. Free-orifice flow calculations = C A (SQRT(64.4 H)), using an average "C" value = 0.49 .
5. Head for free-orifice flow = Pool El. - (1188.75 + (0.5 x Gate opening)), head for submerged-orifice flow =Pool El.-Tailwater El.
6. Submerged-orifice curve is valid if the gate is in the water and ((Tailwater El. - 1188.75)/ gate opening) is greater than or equal to approximately 1.4. See References on Plate 7-2.
7. All Elevations are 1929 NGVD.



Leakage from the dam can affect the calculations of "C" values for small to medium discharges.

See Plate 7-3 for Rating Table

MISSISSIPPI RIVER HEADWATERS
NAVIGATION AND FLOOD CONTROL PROJECT WATER CONTROL MANUAL

GULL LAKE DAM
SUBMERGED FLOW SLIDE GATE RATING CURVE

U.S. ARMY CORPS OF ENGINEERS
ST. PAUL ENGINEERING DISTRICT
ST. PAUL, MINNESOTA

Slide Gate Discharge Measurements for Gull Lake Dam

Date	Average Gate Opening	Head in feet	Discharge per foot of gate opening (CFS)	"C" Value	Flow Regime
22-Oct-01	0.33	3.90	67	0.84	submerged-orifice
04-Sep-01	0.16	3.99	59	0.74	submerged-orifice
21-Jun-99	0.20	4.09	68	0.84	submerged-orifice
04-Oct-99	0.32	3.16	64	0.89	submerged-orifice
16-Jun-98	1.00	2.61	47	0.72	submerged-orifice
06-Oct-97	0.25	3.55	56	0.74	submerged-orifice
01-May-97	0.45	3.38	56	0.76	submerged-orifice
16-Oct-96	0.34	4.32	68	0.81	submerged-orifice
18-Apr-90	0.27	3.68	62	0.81	submerged-orifice
06-Sep-89	0.80	1.97	46	0.81	submerged-orifice
17-May-89	0.27	3.71	64	0.82	submerged-orifice
19-May-88	0.30	4.36	63	0.76	submerged-orifice
19-May-87	0.70	3.01	55	0.78	submerged-orifice
04-Sep-86	1.30	1.48	42	0.85	submerged-orifice
17-Jun-74	0.75	2.52	55	0.87	submerged-orifice
04-Jun-73	0.50	2.91	52	0.76	submerged-orifice
30-Apr-73	0.50	2.90	57	0.84	submerged-orifice
26-Mar-73	0.50	2.29	45	0.74	submerged-orifice
08-Nov-72	2.50	0.78	37	1.04	submerged-orifice
12-Oct-72	0.25	2.92	59	0.86	submerged-orifice
09-Aug-72	1.00	1.91	50	0.90	submerged-orifice
03-Aug-72	0.50	3.43	60	0.81	submerged-orifice
18-May-72	1.50	1.70	50	0.96	submerged-orifice
16-May-72	2.00	1.31	46	1.01	submerged-orifice
09-May-72	2.50	1.08	43	1.04	submerged-orifice
24-Jan-72	0.67	2.60	54	0.83	submerged-orifice
11-Jan-72	0.50	1.98	60	1.06	submerged-orifice
16-May-96	1.20	4.60	60	0.70	free-orifice
24-Jul-72	4.00	2.47	21	0.34	free-orifice
08-Nov-72	4.00	2.69	29	0.44	free-orifice

note : This table is based on a series of discharge measurements that were made from 1972 through 2001.
An average "C" value of 0.49 for free-orifice flow was determined from these measurements.

note : See Plate 7-5 for Slide Gate Rating Curve.

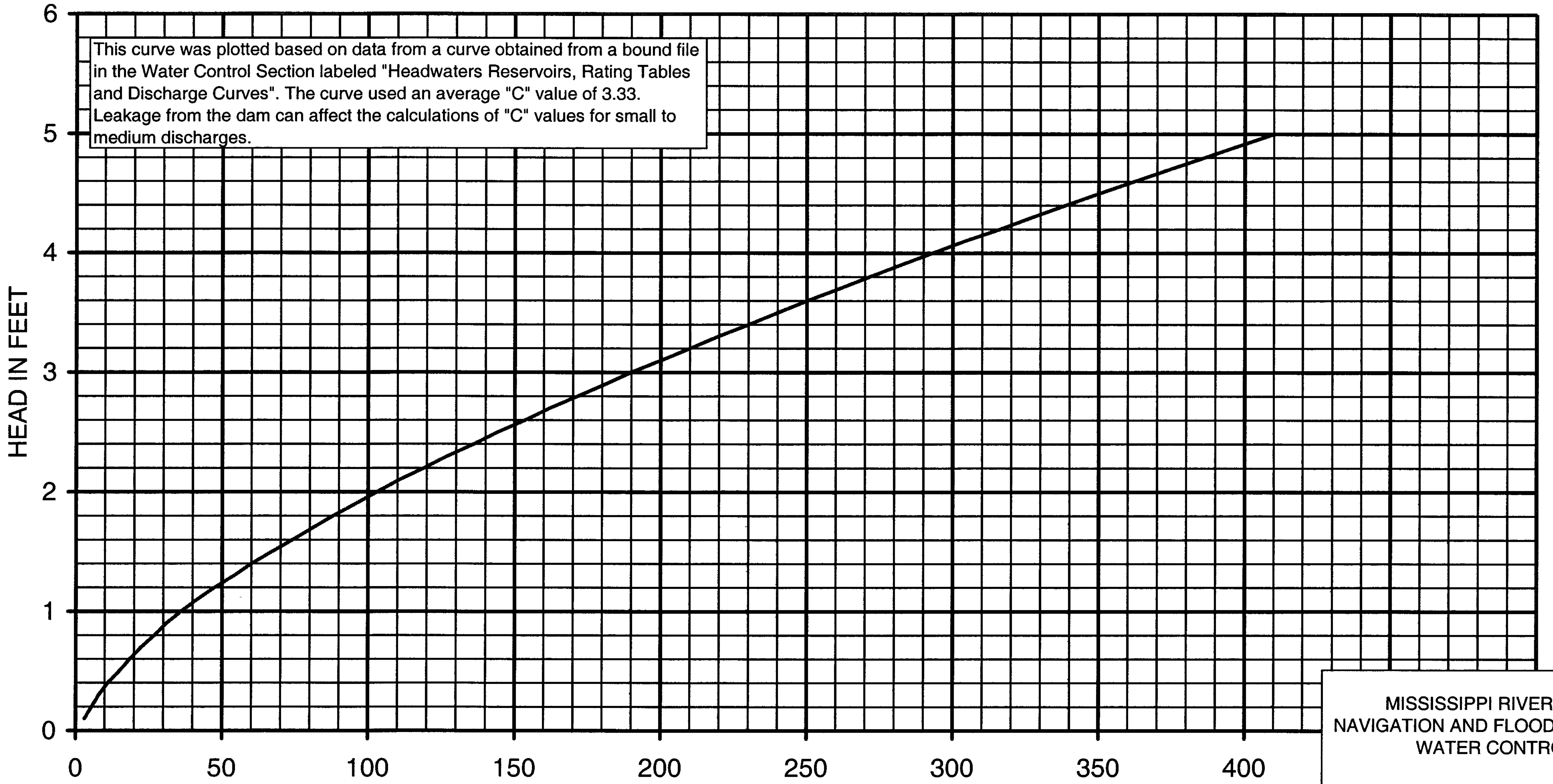
MISSISSIPPI RIVER HEADWATERS
NAVIGATION AND FLOOD CONTROL PROJECT
WATER CONTROL MANUAL

GULL LAKE DAM
DISCHARGE MEASUREMENTS
FOR VARIOUS SLIDE GATES OPENINGS

U.S. ARMY CORPS OF ENGINEERS
ST. PAUL ENGINEERING DISTRICT
ST. PAUL, MINNESOTA

Gull Lake Dam

1. There is one 11-foot wide stop log bay in the Control Structure.
2. Head = Difference between the water surface and top of stop logs.
3. Free weir flow, Q=C*L*(H^1.5), C = 3.33, L = 11ft., H = Head.
4. Sill elevation = 1188.75. All Elevations are 1929 NGVD.



DISCHARGE THROUGH 11-FOOT STOP LOG BAY, IN CFS
FREE FLOW ONLY

(See Plate 7-2 to determine Free Flow versus Submerged Flow conditions)
See Plate 7-4 for Rating Table

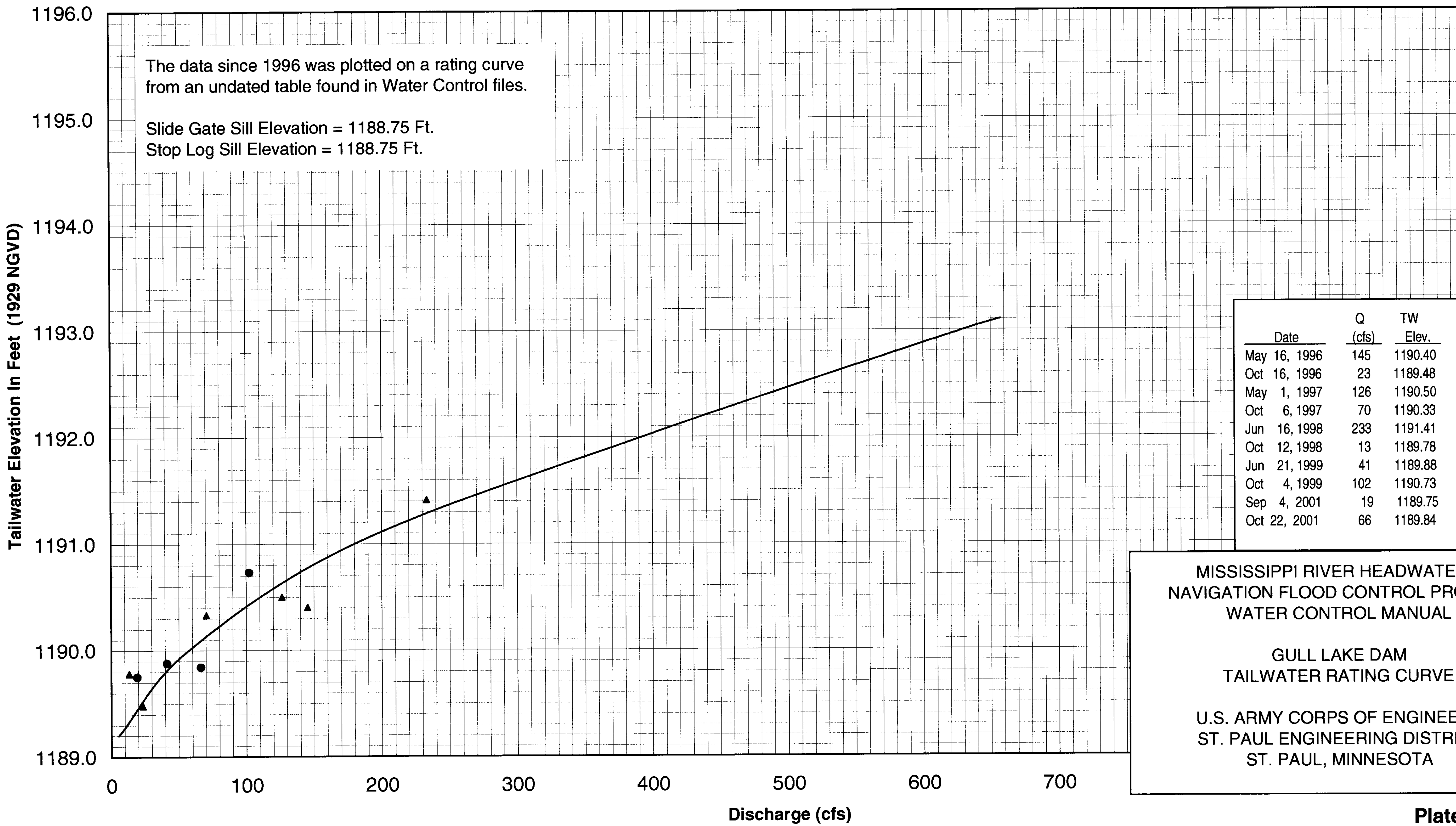
MISSISSIPPI RIVER HEADWATERS
NAVIGATION AND FLOOD CONTROL PROJECT
WATER CONTROL MANUAL

GULL LAKE DAM
11-FOOT STOP LOG BAY RATING CURVE

U.S. ARMY CORPS OF ENGINEERS
ST. PAUL ENGINEERING DISTRICT
ST. PAUL, MINNESOTA

Gull River Below Gull Lake Dam - Station No. 05247000

April 15, 2002



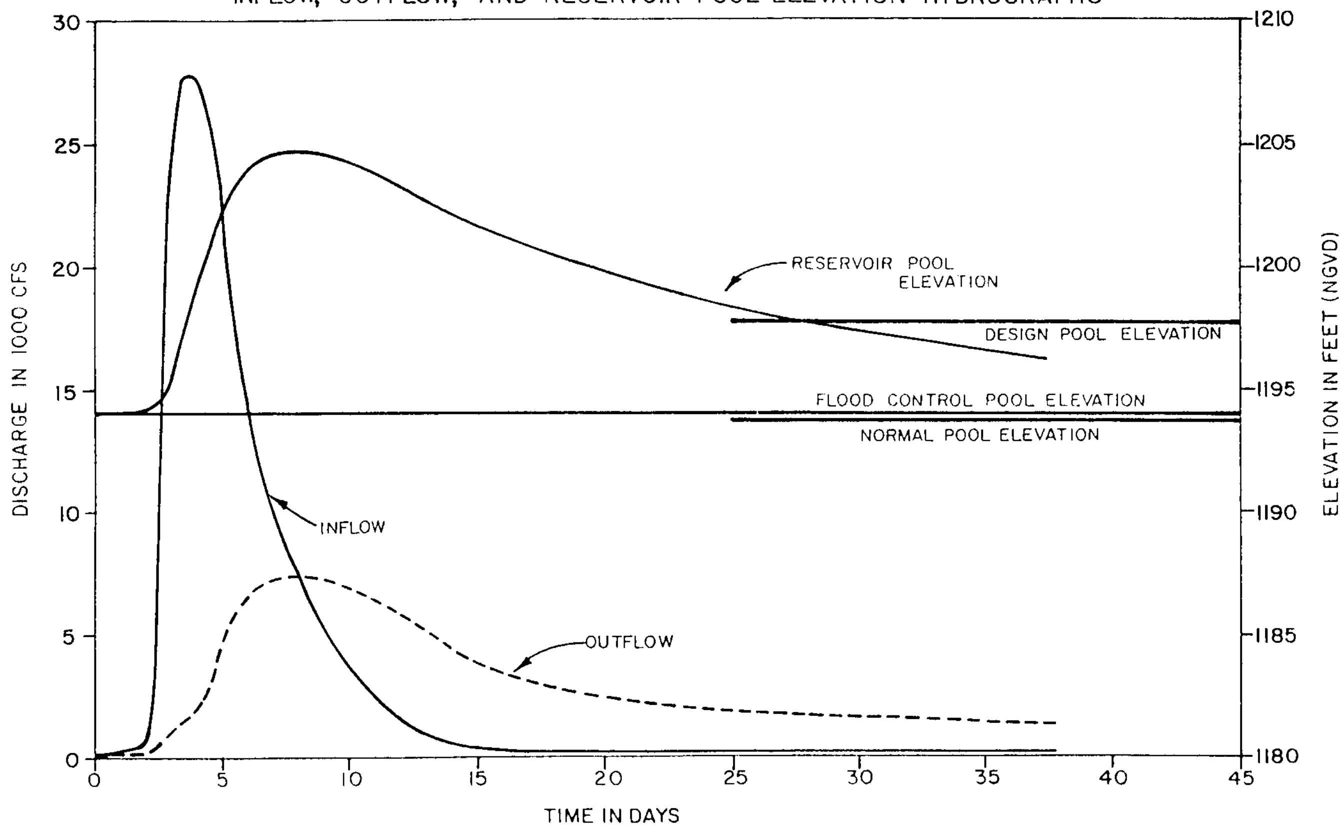
Date	Q (cfs)	TW Elev.	Q Rating
May 16, 1996	145	1190.40	-
Oct 16, 1996	23	1189.48	-
May 1, 1997	126	1190.50	-
Oct 6, 1997	70	1190.33	-
Jun 16, 1998	233	1191.41	-
Oct 12, 1998	13	1189.78	-
Jun 21, 1999	41	1189.88	Excellent
Oct 4, 1999	102	1190.73	Good
Sep 4, 2001	19	1189.75	Excellent
Oct 22, 2001	66	1189.84	Good

MISSISSIPPI RIVER HEADWATERS
NAVIGATION FLOOD CONTROL PROJECT
WATER CONTROL MANUAL

GULL LAKE DAM
TAILWATER RATING CURVE

U.S. ARMY CORPS OF ENGINEERS
ST. PAUL ENGINEERING DISTRICT
ST. PAUL, MINNESOTA

PROBABLE MAXIMUM FLOOD - "PROJECT WITHOUT FAILURE"
INFLOW, OUTFLOW, AND RESERVOIR POOL ELEVATION HYDROGRAPHS



MISSISSIPPI RIVER HEADWATERS
NAVIGATION AND FLOOD CONTROL PROJECT
RESERVOIR REGULATION MANUAL
APPENDIX 6, GULL LAKE
PMF HYDROGRAPHS
CORPS OF ENGINEERS, U.S. ARMY
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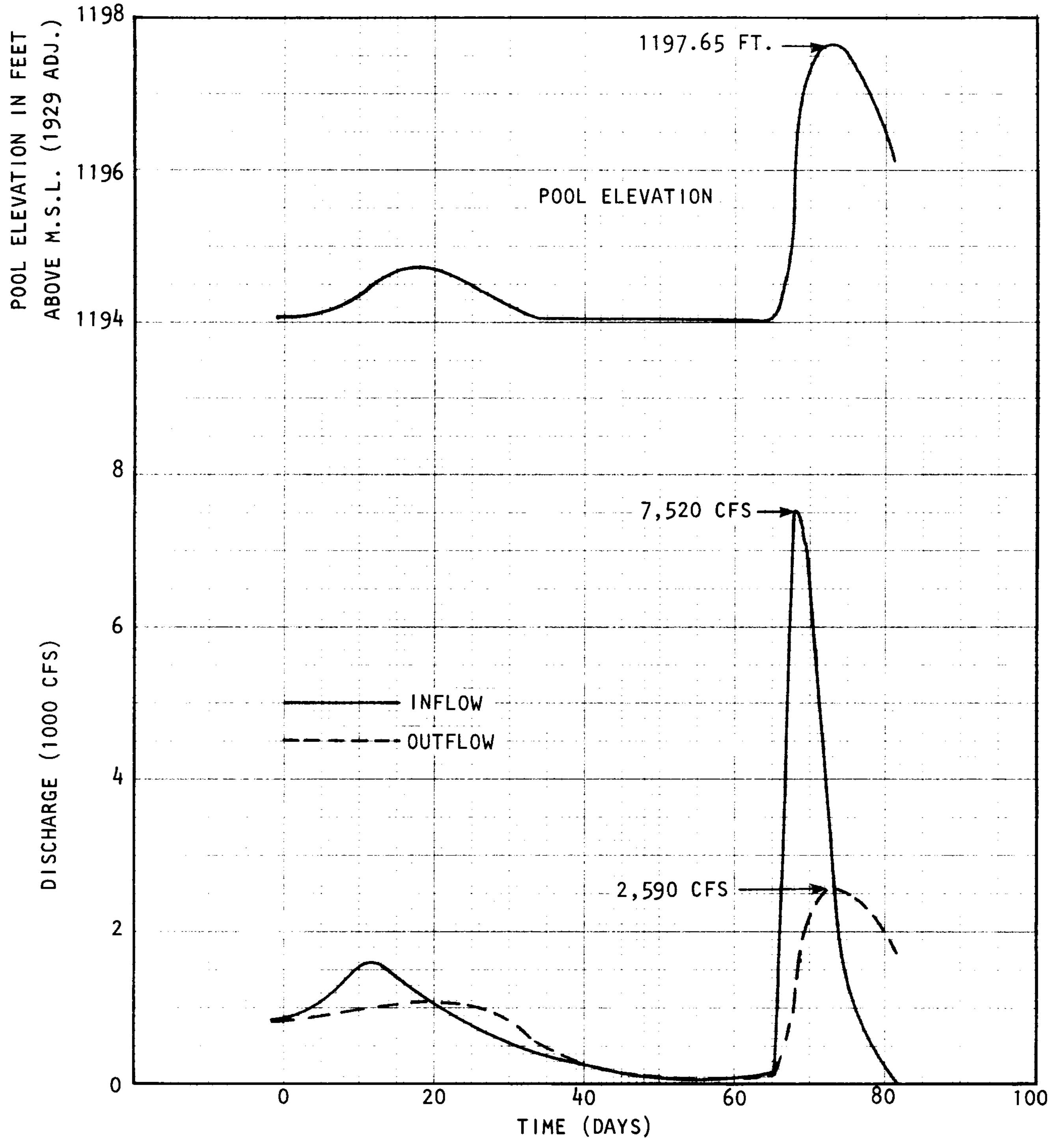

MISSISSIPPI RIVER HEADWATERS
NAVIGATION AND FLOOD CONTROL PROJECT
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APPENDIX 6, GULL LAKE

SPILLWAY DESIGN FLOOD

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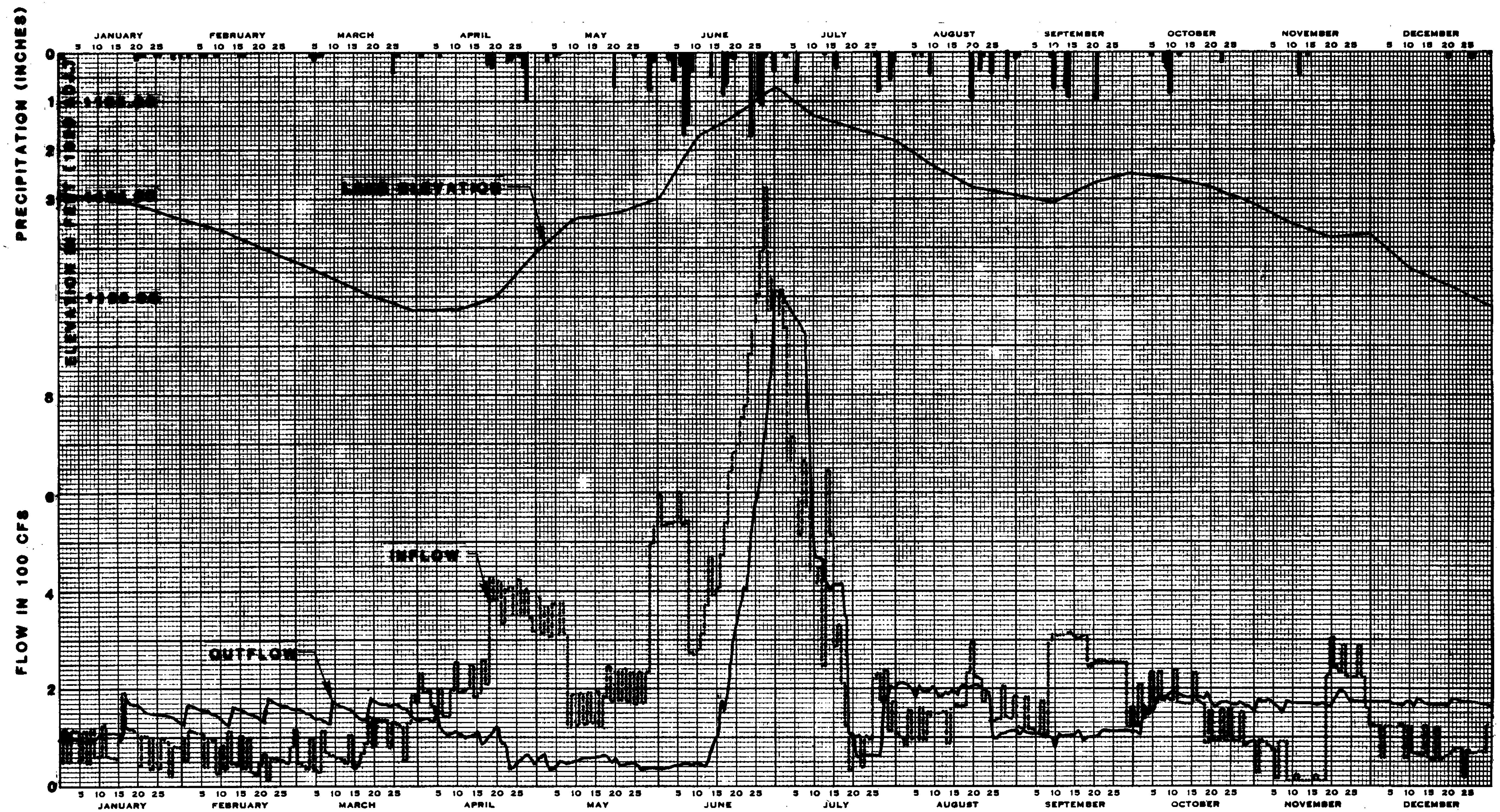

SPRING DRAWDOWN 1192.75 ON 15 FEBRUARY

MISSISSIPPI RIVER HEADWATERS
NAVIGATION AND FLOOD CONTROL PROJECT
RESERVOIR REGULATION MANUAL
APPENDIX 6, GULL LAKE

1914 FLOOD REGULATION

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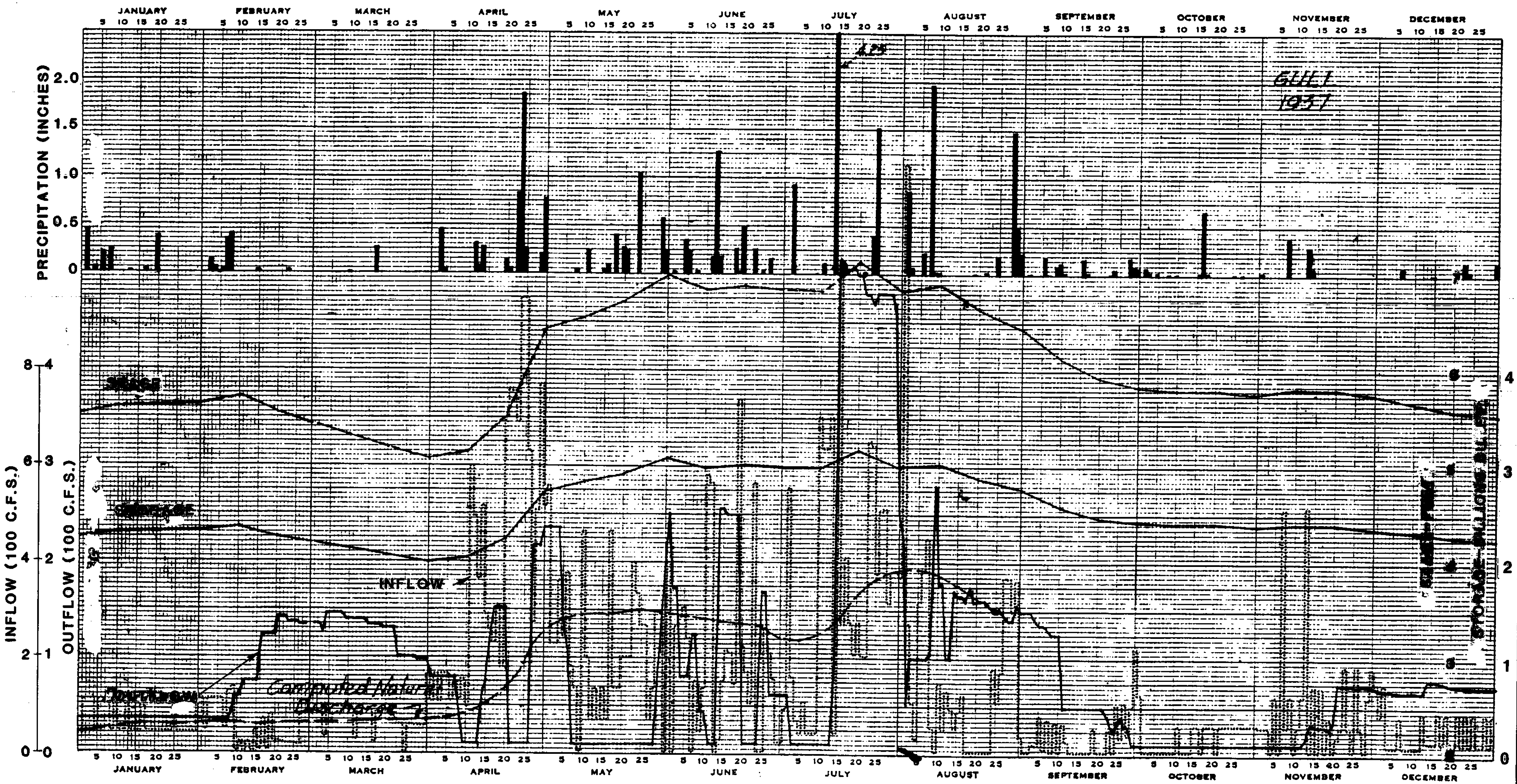
ST. PAUL, MINNESOTA



GAGE ZERO = ELEVATION 1187.75 (1929 ADJ.)

MISSISSIPPI RIVER HEADWATERS
NAVIGATION AND FLOOD CONTROL PROJECT
RESERVOIR REGULATION MANUAL

APPENDIX 6, GULL LAKE

1937 FLOOD REGULATION

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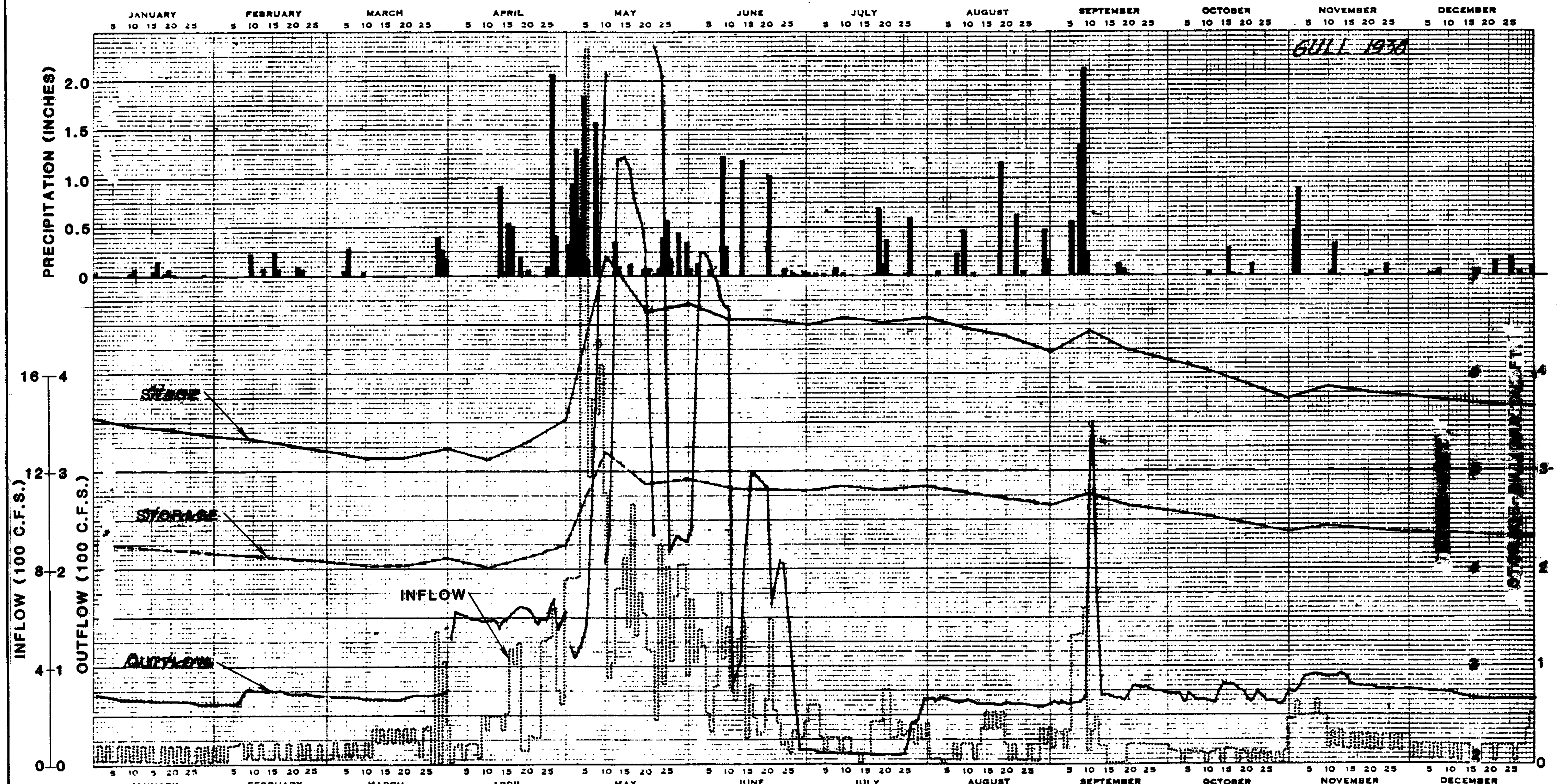
ST. PAUL, MINNESOTA



GAGE ZERO = ELEVATION 1187.75 (1929 ADJ.)

NOTE: OUTFLOW GRAPH IS SHIFTED DOWN BY 500 CFS BETWEEN 5/10 AND 5/27

MISSISSIPPI RIVER HEADWATERS
NAVIGATION AND FLOOD CONTROL PROJECT
RESERVOIR REGULATION MANUAL
APPENDIX 6, GULL LAKE

1938 FLOOD REGULATION

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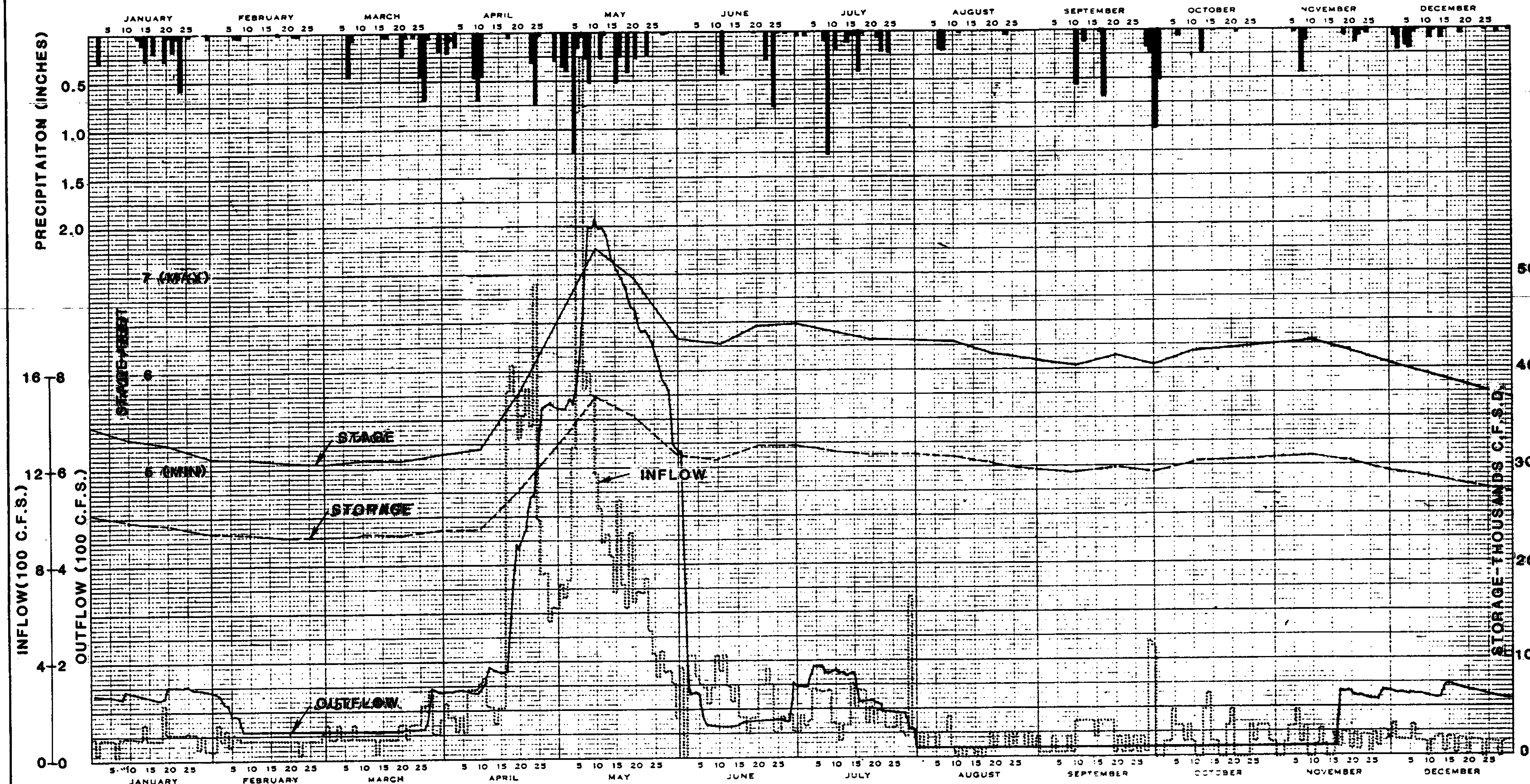
ST. PAUL ENGINEERING DISTRICT
ST. PAUL, MINNESOTA

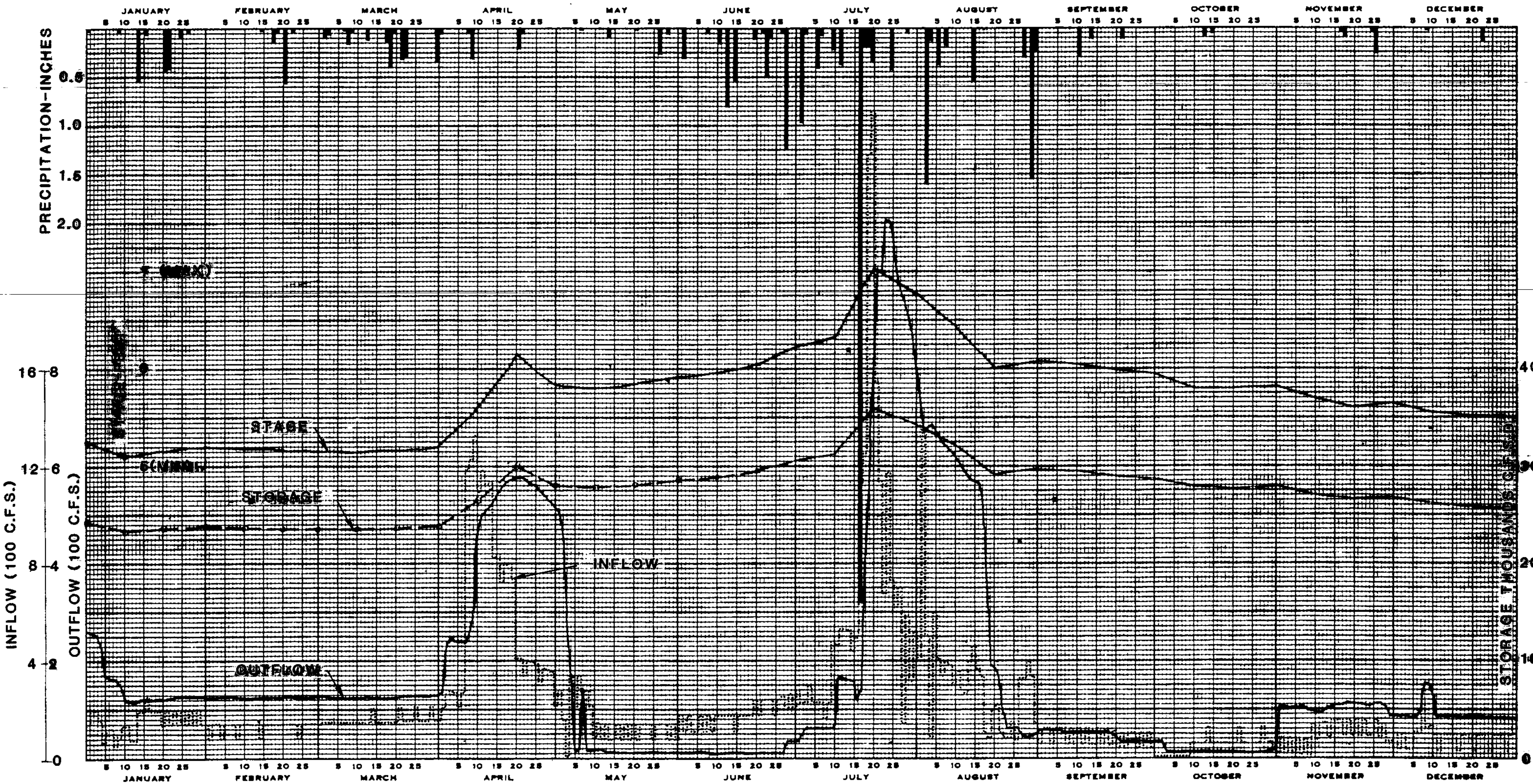


GAGE ZERO = ELEVATION 1187.75 (1929 ADJ.)

MISSISSIPPI RIVER HEADWATERS
NAVIGATION AND FLOOD CONTROL PROJECT
RESERVOIR REGULATION MANUAL
APPENDIX 6, GULL LAKE

1950 FLOOD REGULATION

CORPS OF ENGINEERS, U.S. ARMY
ST. PAUL ENGINEERING DISTRICT
ST. PAUL, MINNESOTA

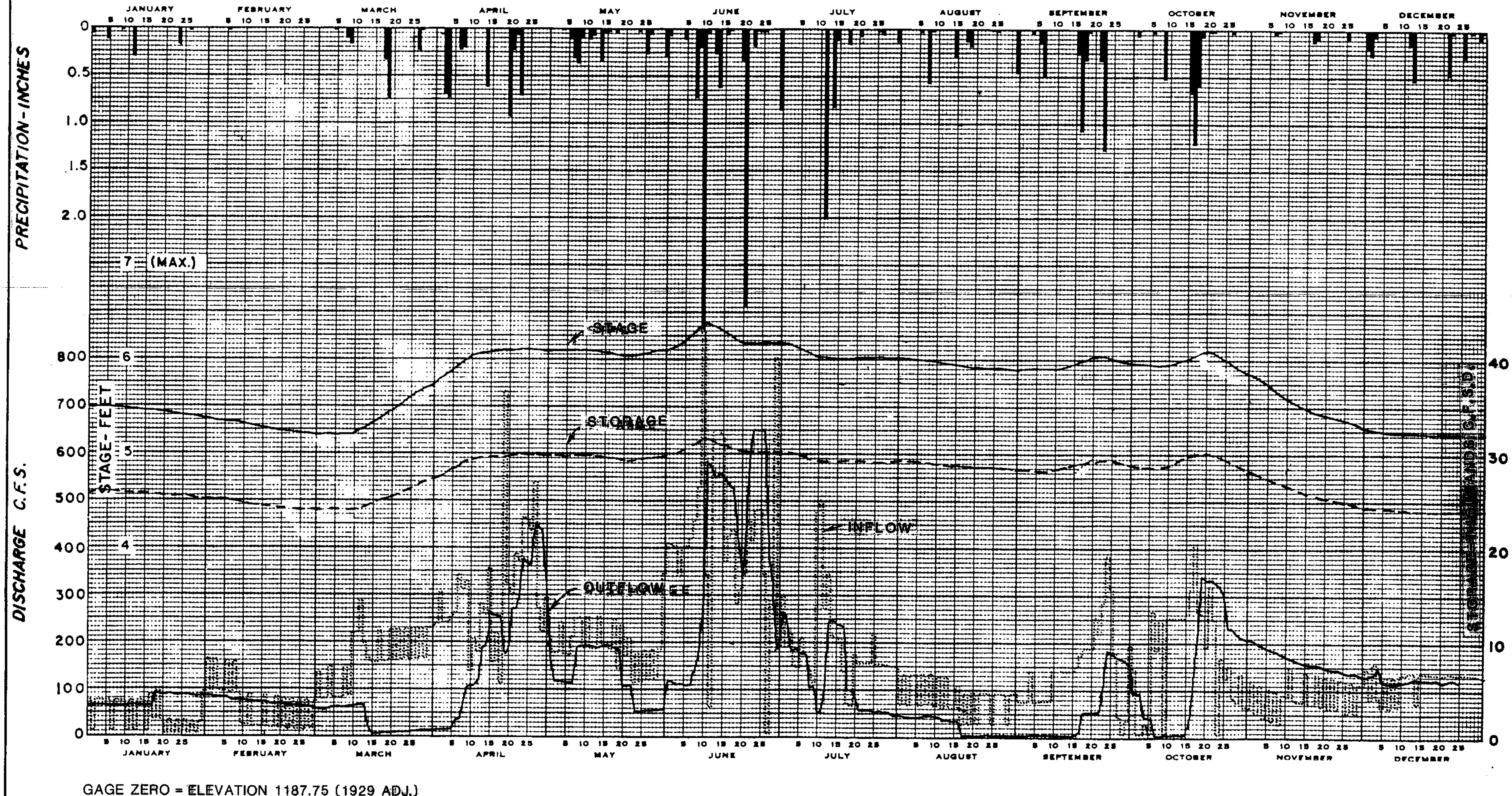


GAGE ZERO = ELEVATION 1187.75 (1929 ADJ.)

MISSISSIPPI RIVER HEADWATERS
NAVIGATION AND FLOOD CONTROL PROJECT
RESERVOIR REGULATION MANUAL
APPENDIX 6, GULL LAKE

1952 FLOOD REGULATION

CORPS OF ENGINEERS, U.S. ARMY
ST. PAUL ENGINEERING DISTRICT
ST. PAUL, MINNESOTA



MISSISSIPPI RIVER HEADWATERS
NAVIGATION AND FLOOD CONTROL PROJECT
RESERVOIR REGULATION MANUAL

APPENDIX 6, GULL LAKE

1968 NORMAL REGUALTION

CORPS OF ENGINEERS, U.S. ARMY
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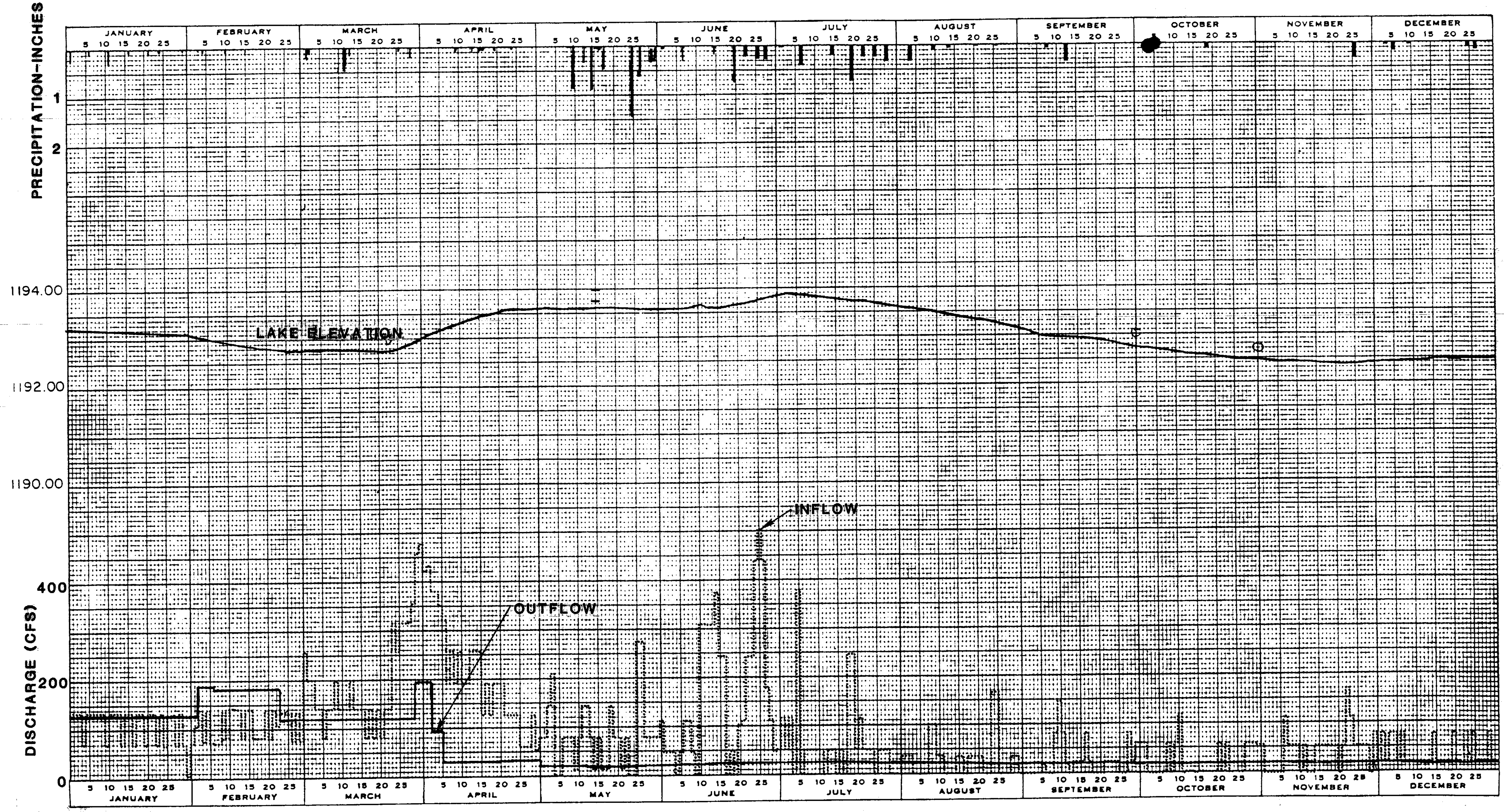
ST. PAUL, MINNESOTA



MISSISSIPPI RIVER HEADWATERS
NAVIGATION AND FLOOD CONTROL PROJECT
RESERVOIR REGULATION MANUAL

APPENDIX 6, GULL LAKE

1976 DROUGHT REGULATION

CORPS OF ENGINEERS, U.S. ARMY
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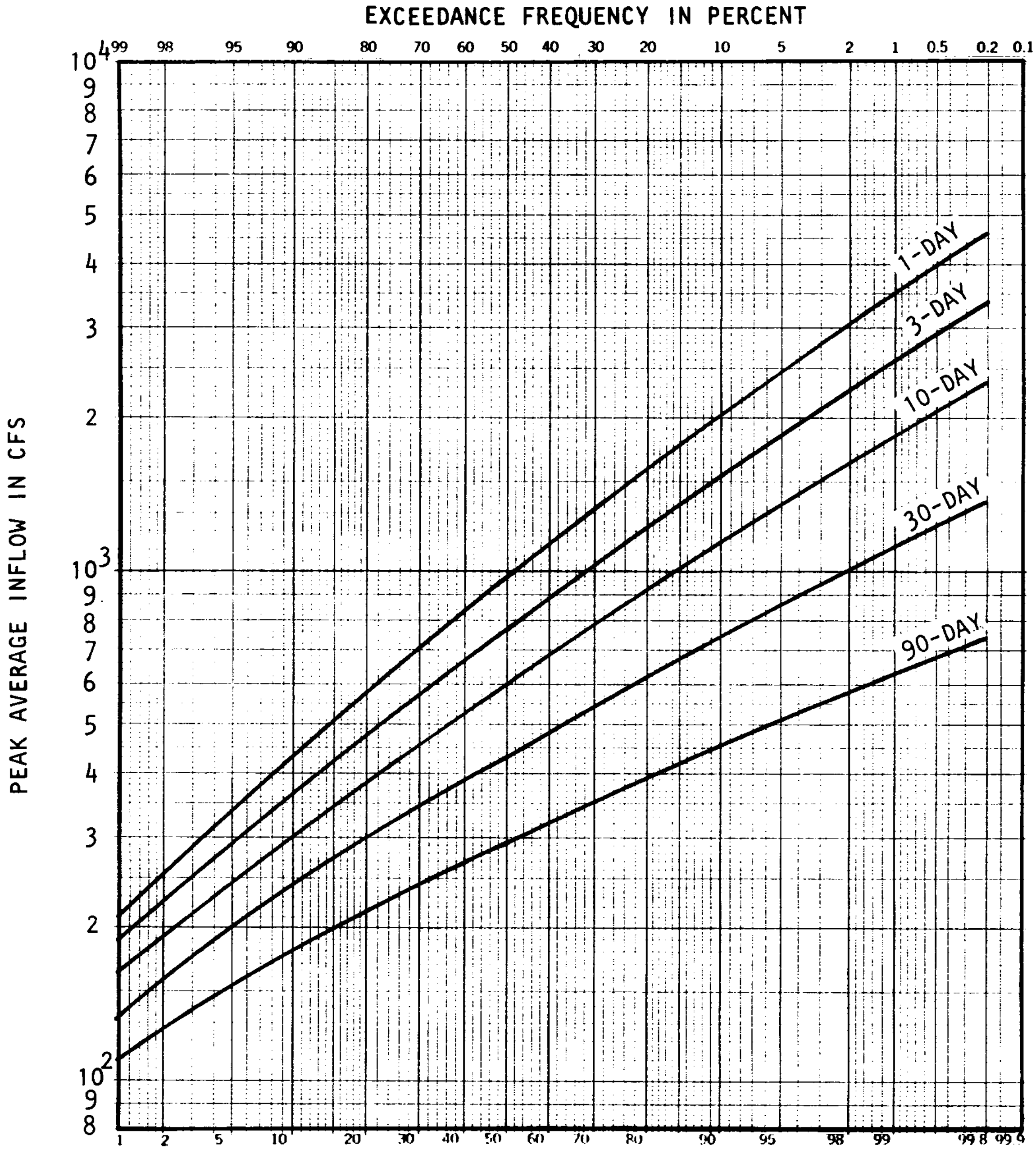
ST. PAUL, MINNESOTA



MISSISSIPPI RIVER HEADWATERS
NAVIGATION AND FLOOD CONTROL PROJECT
RESERVOIR REGULATION MANUAL

APPENDIX 6, GULL LAKE

VOLUME-FREQUENCY CURVES
PEAK AVERAGE INFLOW
(1912-1985)

CORPS OF ENGINEERS, U.S. ARMY
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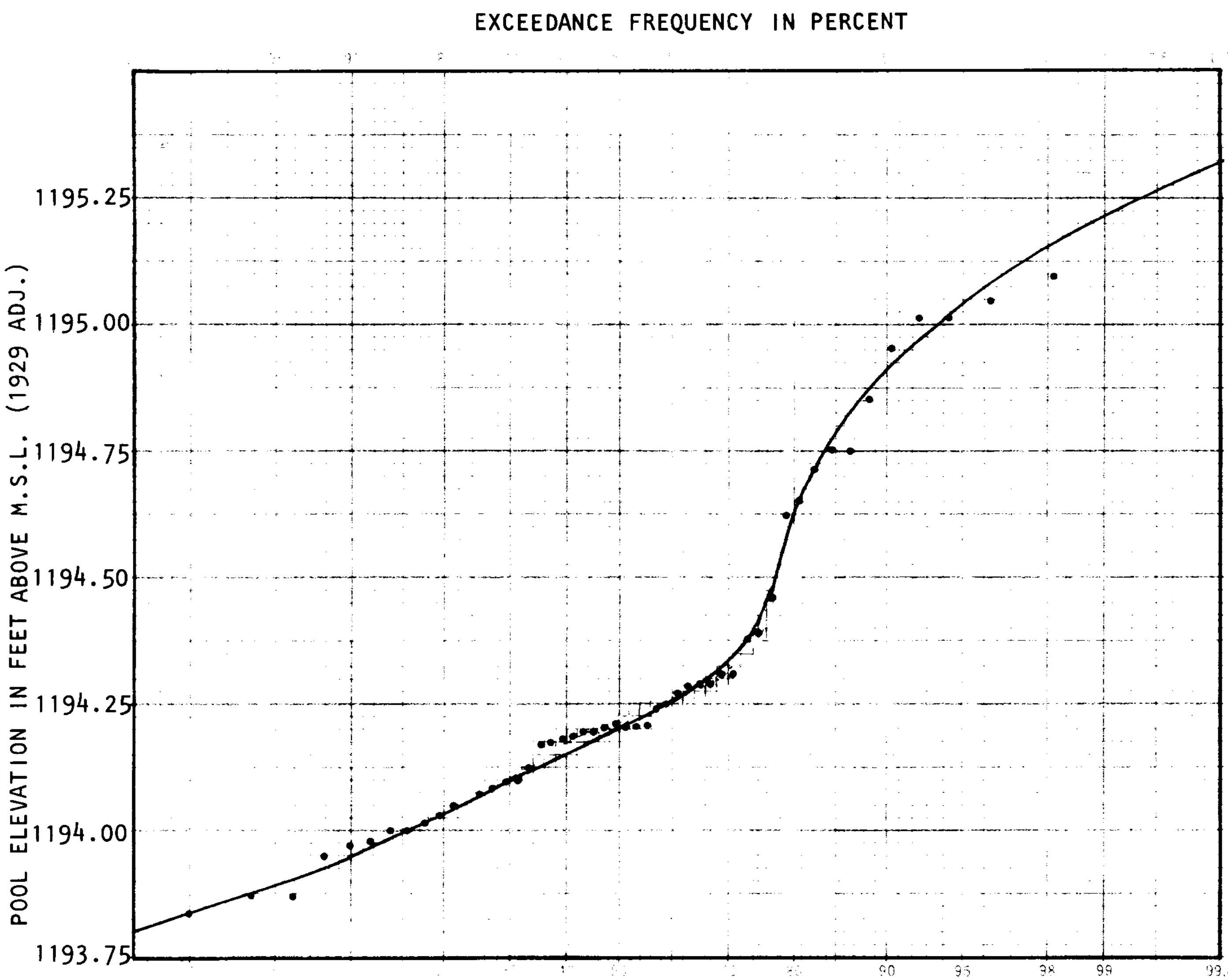
ST. PAUL, MINNESOTA



MISSISSIPPI RIVER HEADWATERS
NAVIGATION AND FLOOD CONTROL PROJECT
RESERVOIR REGULATION MANUAL

APPENDIX 6, GULL LAKE

ELEVATION-FREQUENCY CURVE

GULL LAKE POOL

(1936-1985)

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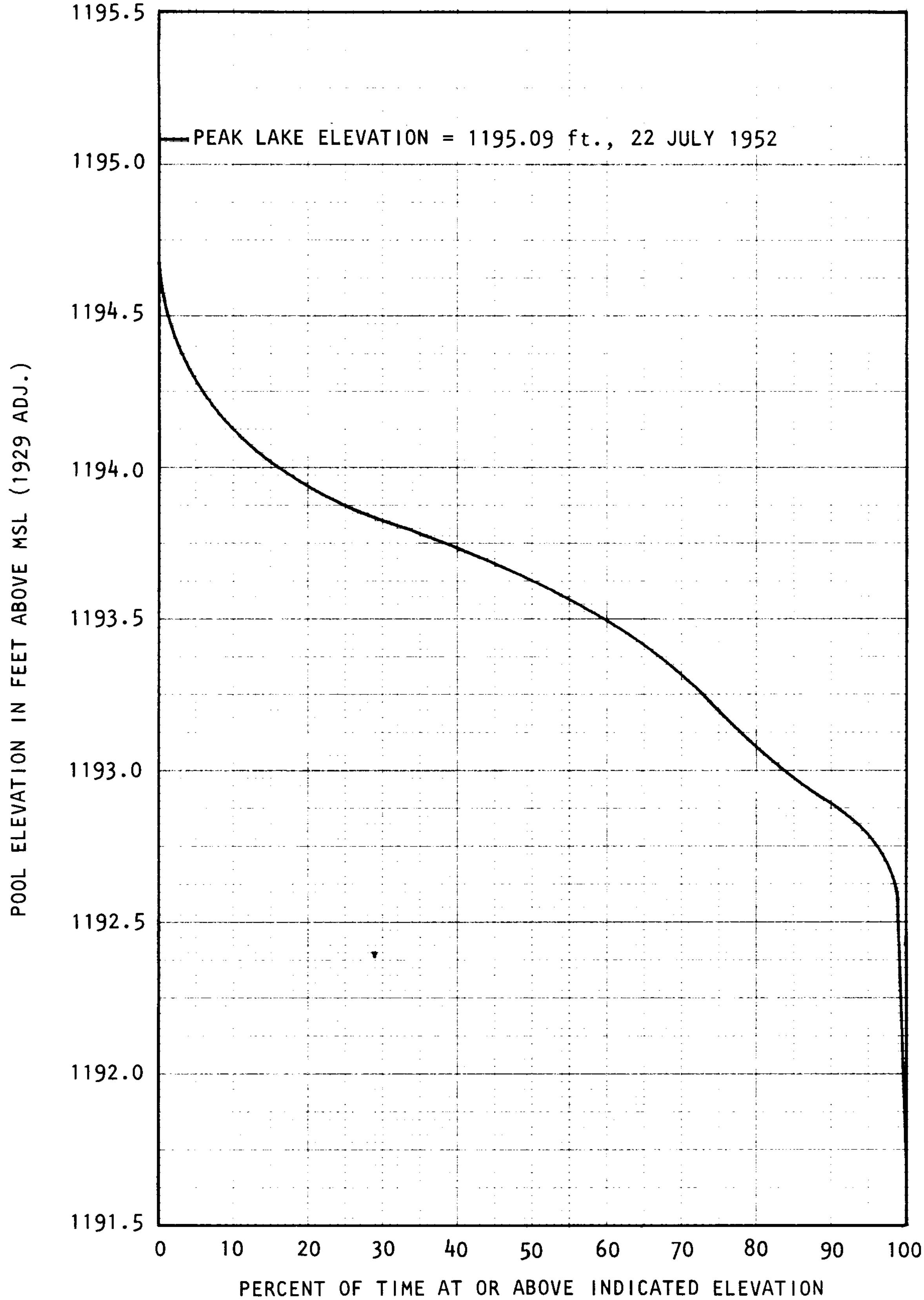
ST. PAUL, MINNESOTA



MISSISSIPPI RIVER HEADWATERS
NAVIGATION AND FLOOD CONTROL PROJECT
RESERVOIR REGULATION MANUAL

APPENDIX 6, GULL LAKE
ELEVATION-DURATION CURVE
GULL LAKE POOL
(1936-1985)

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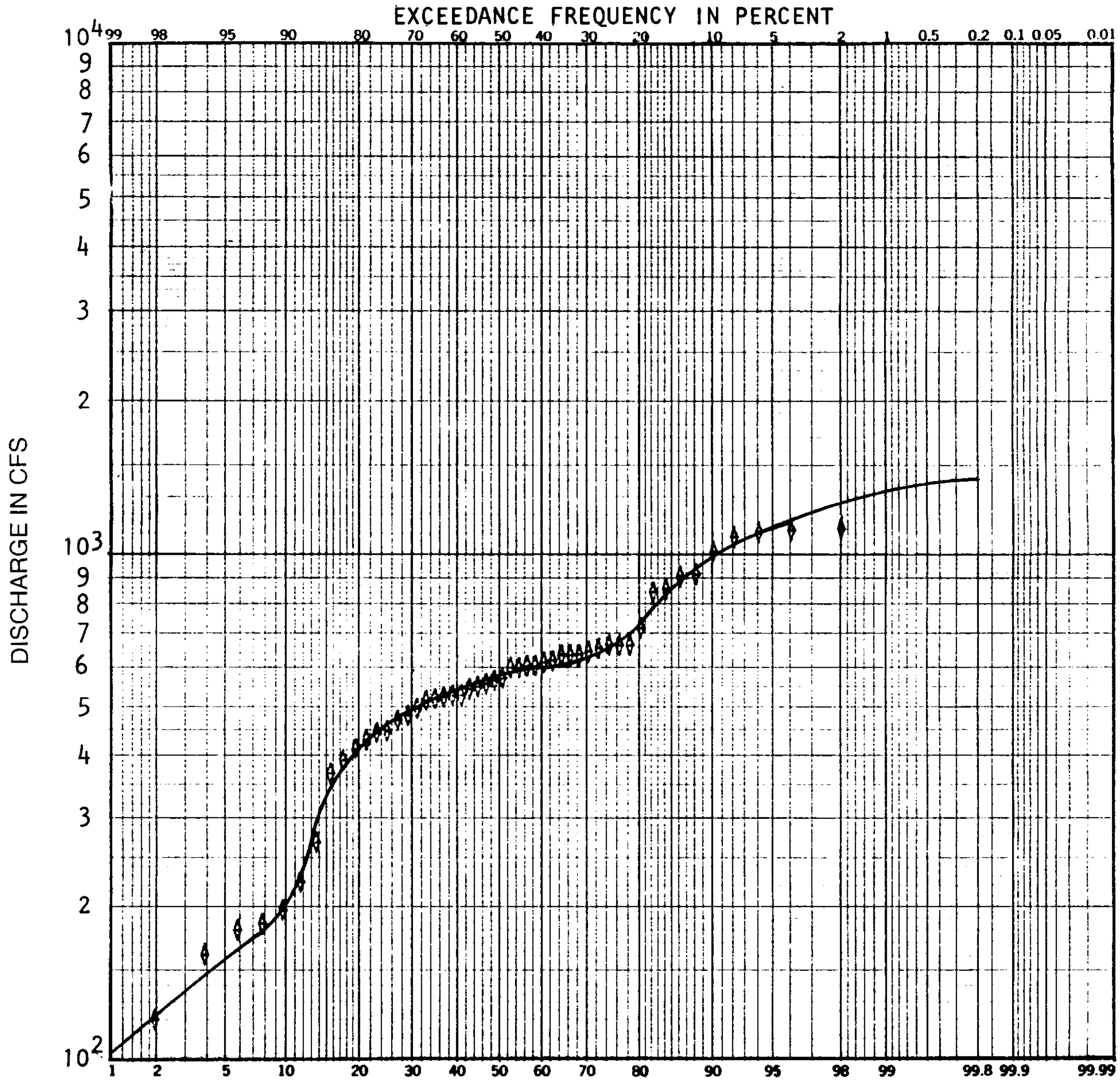
ST. PAUL ENGINEERING DISTRICT
ST. PAUL, MINNESOTA



MISSISSIPPI RIVER HEADWATERS
NAVIGATION AND FLOOD CONTROL PROJECT
RESERVOIR REGULATION MANUAL

APPENDIX 6, GULL LAKE
DISCHARGE - FREQUENCY CURVE
RESERVOIR OUTFLOW
(1936-1985)

CORPS OF ENGINEERS, U.S. ARMY
ST. PAUL ENGINEERING DISTRICT
ST. PAUL, MINNESOTA

EXHIBIT A

PERTINENT DATA

GULL LAKE DAM AND RESERVOIR

EXHIBIT A
PERTINENT DATA
GULL LAKE DAM AND RESERVOIR

GENERAL INFORMATION

Location	Gull Lake Dam is located at the outlet of Gull Lake on the Gull River, 11 miles upstream of its confluence with the Crow Wing River. This confluence is 16 miles upstream of its confluence of the Crow Wing and Mississippi River. The confluence with the Mississippi River is at river mile 990.4 above the Ohio River. The dam is in Cass County, 8 miles northwest of Brainerd, Minnesota. It is at Lat. 46^{o} 24' 40", Long. 94^{o} 21' 12", in Section 20, T134 N, R29 W.
Type of Project	Dam and Reservoir
Project Owner	U.S. Government, Department of the Army
Operating Agency	U.S. Army Corps of Engineers, St. Paul District
Regulating Agency	U.S. Army Corps of Engineers, St. Paul District.
Closure Dam	Dam discharge records begin 1 September 1911, concrete structure complete 1912. Some records for the logging dam at the outlet of Gull Lake are available back to September 1895.

RESERVOIR

Gull Lake	Elevation in Feet	Area in Acres	Cumulative Storage in Acre-Feet
Maximum Operating Limit	1194.75	13,100	71,000
Normal Summer Pool Level	1193.87	13,000	59,000
Minimum Operating Limit	1192.75	12,750	45,000
Sill	1188.75	---	0

Maximum Pool Elevation (Historic) — 1195.09 ft., 22 July 1952 event
See Paragraph 4-06.e

Real Estate Taking Line for Easement — Elevation 1194.75 feet
(See **Chapter 2**)

Reservoir Length at Top of Summer Pool Level — 8.4 miles

Shoreline Length at Top Summer Pool Level — 35.6 miles

HYDROLOGY

Drainage Area — 287 square miles

One Inch of Runoff Equals — 15,307 acre-feet

Storm Types — Thunderstorm, frontal rain, snow

Flood Season — 15 March - June

Low Flow Season — July - October

Note: All inflows are based on 24-hour averages from reverse routing.

Minimum Mean Daily Inflow — Flow is very low during dry periods.

Minimum Mean Monthly Inflow — Flow is very low during dry periods.

HYDROLOGY (continued)

Minimum Mean Annual Inflow	63 cfs, 1934
Maximum 24-hr. Average Inflow	2,930 cfs, 5 May 1938
Maximum Mean Monthly Inflow	898 cfs, May, 1950
Maximum Mean Annual Inflow	283 cfs, 1944
Average Annual Inflow	152 cfs, 1912-1985
Maximum Flood Volume	84,600 acre-feet, 17 April-26 May, 1950
Type of Meteorological Data Recorded at Site	Rainfall, snowfall, temperature, cloud cover, wind, See **Chapter 5**
Maximum Snowpack	15-31 March
Number of Sediment Ranges	None

EMBANKMENT AND DIKES

Embankment	
Type	Earthfill with concrete curtain wall
Slope Protection	Riprap and grass; bituminous top (roadway)
Length	269.9 ft. (total left and right excluding outlet structure)
Height	9.4 feet
Top Width	26 feet
Minimum Top Elevation	1198.10 feet
Dikes	No perimeter dikes

OUTLET STRUCTURE

Type	Gated multi-bay concrete control structure with concrete apron
Structure Length Between Abutments	68.9 feet
Number/Size/Type of Gates	5 - 5.0 ft. wide x 4.0 ft. high slide gates 1 - 11.0 ft. wide stoplog bay (log sluice) (The 5.0 ft. wide fishway is blocked off.)
Entrance Invert Elevation	1188.75 feet
Top of Roadway Elevation (top of the curb)	1199.75 feet

SPILLWAY

No Service or Emergency Spillways only.	Gated concrete sluiceway outlet facility

SPILLWAY APRON

Type:	Concrete on Timber Piles
Length:	73.0 feet
Width:	68.9 feet between abutments
Floor Elevation:	1188.75 feet

Mississippi River Headwaters Dams
Summary of Control Structure Features

	Winni-bigoshish	Leech	Pokegama	Sandy	Pine	Gull
Slide Gates:						
Number of Gates	5	5	6	6	13	5
Gate Sill Elevation, Ft.	1285.22	1288.49	1265.92	1207.31	1216.65	1188.75
Gate Width, Ft.	3.5	4.0	8.0	5.0	6.0	5.0
Gate Height, Ft.	5.0	4.0	12.5	4.0	17.0	4.0
Gate "C" Coefficient [4]	0.63	0.74	0.64	0.78	0.73	0.49
Log Sluice Bays: [1]						
Number of Bays	1	1	1	1	None	1
Log Bay Sill Elev., Ft.	1290.04	1287.74	1264.42	1207.31	------	1188.75
Log Bay Width, Ft.	12	12	12	11	------	11
Log Bay "C" Coef. [4]	3.33	3.33	3.33	2.85	------	3.33
Stop Log Bays:						
Number of Bays	15 [2]	20	7	5 [3]	None	None
Sill Elevation, Ft.	5 @ 1290.64 10 @ 1285.22	1287.74	1264.42	All at 1216.81	------	------
Bay Width, Ft.	5 @ 3.8 10 @ 4.25	6.0	8.0	2 @ 5' 3.25" 3 @ 5' 2"	------	------
Bay "C" Coef. [4]	5@ 3.17 10@3.53	3.61	3.04	3.19 (all)	------	------
Fish Sluiceway	Sealed	None	None	None	None	Sealed

1. The log sluice bays are large stop log bays that were formerly used to pass logs downstream.
2. The dam has 5, 14-foot wide bays and one 12-foot wide log sluice bay. Each of the 5 bays has a 3.5 ft. wide by 5.0 ft. tall slide gate in the bottom center which is anchored in place by two vertical H-beams. The H-beams hold stop logs both above the gates and on either side.
3. There are 5 stop log bays on top of the old lock chamber. The two outer bays are wider than the 3 inner bays.
4. See Chapter 7 plates.

EXHIBIT B

RELATED MANUALS AND REPORTS

GULL LAKE DAM AND RESERVOIR

EXHIBIT B

RELATED MANUALS AND REPORTS

GULL LAKE DAM AND RESERVOIR

1. General. Prior reports concerning the Mississippi River Headwaters Reservoirs date from about 1868. See **Exhibit D** for additional information and copies of some of the documents.

2. *Letter Report, Major Governeur K. Warren, St. Paul District Engineer, 30 April 1870, This report contemplated the construction of 41 reservoirs on the St. Croix, Chippewa, Wisconsin and Mississippi Rivers.*

3. River and Harbor Acts of June 1880 and August 1882, Authorized the construction of dams at each of the six Mississippi River Headwaters Lakes for the purpose of forming reservoirs.

4. *River and Harbor Act of 11 August 1888 (25 Stat. 419; 33 U.S.C. 601), Directed the Secretary of War to establish regulations governing the operation of the six* Mississippi River Headwaters *Reservoirs.*

5. Letter, Regulations for the use and Administration of the reservoirs at the headwaters of the Mississippi River, Patrick J. Hurley, Secretary of War, 11 February 1931, This letter established new regulations and revoked the previous orders issued by the secretary dated 21 February 1889.

6. Letter to Representative Harold Knutson (St. Cloud, MN) from Major General Lytle Brown, Chief of Engineers, 1 April 1931, Modified the minimum level of the Pine River Reservoir.

7. Letter, Regulations for the use and Administration of the reservoirs at the headwaters of the Mississippi River, Harry H. Woodring, Acting Secretary of War, 14 May 1935, Modified the allowable discharges from some of the reservoirs.

8. Letter, Regulations for the use and Administration of the reservoirs at the headwaters of the Mississippi River, Geo. H. Dern, Secretary of War, 4 February 1936, This letter modified the allowable discharges from the some of the reservoirs. This letter established new regulations and revoked the previous orders issued by the secretary dated 11 February 1931.

9. Letter, Modifying the minimum operating level of Leech Lake Reservoir, Major H.J. Manger, Acting St. Paul District Engineer, 25 January 1945, with attached amendment from Henry L. Stimson, Secretary of War dated 29 December 1944. This letter established new regulations and revoked the previous orders issued by the secretary dated 4 February 1936.

10. Flood Control Act of 30 June 1948, House Document No. 599, 80th Congress, 2nd Session, Authorized the Aitkin Diversion Channel Project.

EXHIBIT C

DATA COLLECTION PLATFORM TRACKING CHART

GULL LAKE DAM AND RESERVOIR

GULL LAKE DAM POOL & T/W READINGS

MONTH / YEAR :_______________

The following DCP pool gage and Data Log readings were checked against a plot (From the COE Web Page) of the DCP data in the Water Control Data Base. Any significant deviations are noted in the remarks column.

NOTE : If DCP Pool Reading and Tape Indicator differ by more than 0.03' contact Water Control.

DATE	TIME	TAPE INDICATOR	DCP POOL READING	DIFF.	DATA LOG POOL READING	DCP T/W READING	T/W TAPE INDICATOR	REMARKS/INITIALS
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								
31								

DCP=Sutron 8210 Goes / Sp. Mod. DATA LOG=Sutron 8200 Datalogger

SIGNED : ________________________________

EXHIBIT D

PROJECT LETTERS, AGREEMENTS, AND RESOLUTIONS

GULL LAKE DAM AND RESERVOIR

(Primarily referenced from Chapters 2, 3, 7 and 9)

EXHIBIT D

TABLE OF CONTENTS

c. A letter from the United States Attorney, Department of the Justice, St. Paul, Minnesota, dated January 24, 1910 , which **transmits a quit-claim deed for property on Gull Lake,** plus a copy of sheet No. 6 from the **June 1943 Land Acquisition maps.** This letter is provided here for use in sorting out some discrepancies related to Gull Lake's flowage rights.

9 A copy of **Minnesota Statutes** 1961, Sections 110.47 through 110.53, which lead to the subsequent Finding of Fact and Plan of Operation for the Headwaters reservoirs from the State of Minnesota (see **Exhibit D, Reference Nos. 10 and 11**).

10 A Findings of Fact, Conclusion ORDER from Clarence Prout, Commissioner of Conservation, Department of Conservation, State of Minnesota, dated 19 April 1963. This document contains recommendations from the Department of Conservation (now the MDNR) regarding the **regulation of the Mississippi River Headwaters Reservoirs**.

11 a. A letter from Colonel W. B. Strandberg, District Engineer, Corps of Engineers, St. Paul, Minnesota, dated 18 December 1962, which **discusses outflow rate-of-change guidelines** proposed by the State of Minnesota for the Headwaters reservoirs (see 11.b.)

b. A copy of the **Plan of Operation, Mississippi Headwaters Reservoirs** from Gordon Wollan, Acting Director of Game and Fish, Department of Conservation, State of Minnesota, dated 15 August 1963**,** which lists rate-of-change guidelines proposed by the State of Minnesota for the Headwaters reservoirs.

12 a. A copy of **Public Law** 100-676, Section 21, November 17, 1988, Water Resources Development Act of 1988 (WRDA 1988) **regarding the headwaters of the Mississippi River** the goal of which was to require the Secretary of the Army to notify Congress when the specified operating limits (both high and low) where going to be exceeded. The referenced "contingency plan" is included below as **Reference 12.b.**

b. A copy of the Reservoir Regulation Contingency Plan for the Mississippi River Headwaters Reservoirs prepared to comply with the Water Resources Development Act of 1988 (WRDA 1988), Public Law 100-676, Section 21 of November 17, 1988 (see **Reference 12.a.**).

EXHIBIT D

REFERENCE NO. 1

A copy of pages 1829 through 1831 from the Annual Report of the Chief of Engineers, United States Army to the Secretary of War, for the Year 1896, House or Representatives, 4th Congress, 2nd Session, Document No. 2, Volume II, containing regulations dated 21 February 1889, from William C. Endicott, Secretary of War regarding the operation of the Headwaters reservoirs.

The 1889 regulations were developed by the War Department to provide some guidelines for operating the newly constructed Headwaters reservoirs and were in use until the 1931 regulations were issued. The 1889 regulations do not specify any reservoir operating levels, however; operating levels were developed by the officer-in-charge based on physical limitations and engineering judgement (See **Paragraphs 2-05, 3-05 and Table 3-1**).

EXHIBIT D

REFERENCE NO. 2

a. A cover letter from Lieutenant Colonel Wildurr Willing, St. Paul District Engineer, dated February 21, 1931, transmitting the February 11, 1931 letter from the Secretary of War (see below) regarding regulations concerning the operation of the Headwaters reservoirs (see 2.b. below).

This document provides an explanation for the various provisions set forth in the February 11, 1931 regulations, which revoked the 1889 regulations. Note the reference in Paragraph 3.i to the minimum operating levels of the reservoirs being raised “substantially as requested by the Minnesota Lake Levels Association”

b. A letter from Patrick J. Hurley, Secretary of War, dated February 11, 1931, containing Regulations for the Use and Administration for the Reservoirs at Headwaters of the Mississippi River. This regulation revoked the 1889 regulations.

This letter, among other things set, for the first time, minimum flows for the dams and upper lower and reservoir limits for water levels. See the cover letter (referenced above) for more details. See also **Paragraph 3-05**.

The upper limit for Pine River is listed as 15 feet. However, research conducted for the preparation of this manual revealed that the St. Paul District office considered the maximum available for storage to be 18.5 feet.

EXHIBIT D

REFERENCE NO. 3

A letter from Major General Lytle Brown, Chief of Engineers, dated April 1, 1931, which grants permission to **utilize a higher minimum stage at Pine River reservoir.**

This was done by agreement rather than by an official change in the regulations. It appears that the agreement essentially provided for a normal spring drawdown level of 11 feet. The nine-foot minimum, set forth in the earlier 1931 regulations, was still available for emergency situations (e.g., very wet snow pack). See also **Paragraph 3-05**.

EXHIBIT D

REFERENCE NO. 4

A letter from Harry H. Woodring, Acting Secretary of War, dated May 14, 1935, containing Regulations for the Use and Administration for the Reservoirs at Headwaters of the Mississippi River. These regulations replaced the 1931 regulations.

This letter set average annual outflow values, which replaced the minimum flow values, for Pokegama, Sandy, Pine and Gull Lake reservoirs. Minimum flow values, as opposed to average annual flows, remained for Lake Winnibigoshish and Leech Lake (but were included in the 1936 regulations). The regulation lists a minimum stage of nine feet for Pine River reservoir, however; the St. Paul District had agreed to not lower the reservoir below 11 feet if possible (see **Exhibit D, Reference No. 3)**. Presumably, lowering the reservoir to nine feet was still possible under a strict interpretation of the regulations. See also **Paragraph 3-05**. The upper limit for Pine River is still listed as 15 feet. However, research conducted for the preparation of this manual revealed that the St. Paul District office considered the maximum available for storage to be 18.5 feet.

EXHIBIT D

REFERENCE NO. 5

a. A cover letter from Major Dwight F. Johns, District Engineer, Corps of Engineers, St. Paul, Minnesota, dated February 24, 1936, transmitting the February 4, 1936 letter from the Secretary of War (see 5.b. below).

The letter alludes to the fact that the 1936 regulation specifies average annual discharge values for Lake Winnibigoshish and Leech Lake. Average annual values for the other four reservoirs had already been listed in the May 14, 1935 regulations.

b. A letter from Geo. H. Dern, Secretary of War, dated February 4, 1936, containing Regulations for the Use and Administration for the Reservoirs at Headwaters of the Mississippi River.

Only minimum operating limits are listed in this regulation. See also **Paragraph 3-05**. However, the regulation does not preclude the reservoirs from being operated up to the previously listed upper limits. Later correspondence indicates that storage up to the maximum limits in the reservoir could be used if necessary (see **Exhibit D, Reference 6.a. Paragraph 8.**).

EXHIBIT D

REFERENCE NO. 6

a. A letter from Colonel Lynn C. Barnes, District Engineer, Corps of Engineers, St. Paul, Minnesota, dated 9 November 1944, regarding the justification for lowering the minimum operating limit for Leech Lake reservoir and other issues.

This letter recommends that the minimum operating level for Leech lake be lowered from 1.0 foot, as specified in the 1936 regulations, to 0.0 feet in order to allow the "normal" upper limit be reduced from 3.5 feet to 3.0 feet (also called the "Ordinary Operating Limits"). However, a minimum stage of 0.0 feet was not possible without a change in the regulations. The minimum stage was officially changed on December 29, 1944 (see **6.c. below**).

b. Exhibit C from a transcript of the minutes of a public hearing on the regulation of Gull reservoir held in Brainerd, Minnesota on 5 September 1945.

This table lists the operating levels that were in use at that time on the Headwaters reservoirs.

c. A letter from Major H. J. Manger, Acting St. Paul District Engineer, dated 25 January 1945, transmitting Secretary of War, Henry L. Stimson's December 29, 1944 revisions to allow for a lower minimum stage (0.0 feet) at Leech Lake Reservoir.

See **Paragraph 3-05** for a summary and **Exhibit D, Reference 6.a** for details.

EXHIBIT D

REFERENCE NO. 7

A copy of the Code of Federal Regulations, Title 33, Section 207.340, regarding the headwaters of the Mississippi River.

This document lists the latest regulations for the Mississippi River Headwaters reservoirs thru the 4 December 1936 regulations to include the later 29 December 1944 revision at Leech.

EXHIBIT D

REFERENCE NO. 8

a. A letter from D. P. Tierney, Valuation Engineer in Charge, Land Section, St. Paul District, dated 6 January 1945, which summarizes when the flowage rights for the Mississippi River Headwaters reservoirs where acquired.

b. A letter from J. Wesley Walters, Chief, Reservoirs and Permits Branch, St. Paul District, dated 28 July 1949, which summarizes the flowage rights for the Mississippi River Headwaters reservoirs.

See **Paragraph 2-05** for a summary of the flowage rights for all six of the Headwaters reservoirs. In many cases, an exact elevation cannot be assigned to the flowage rights as rights were obtained on: entire forty acre parcels; by condemnation of entire strips of land; and by other means. In some cases, the records are simply not clear on the subject or subsequent erosion has created problems.

This letter states that "the Government is restricted to a maximum stage of seven feet on Gull Reservoir.". However, Table 2 in the April 1963 (revised 17 Feb. 1968) Master Reservoir Regulation Manual indicates that the maximum stage on Gull is 11+ feet. The research conducted for this manual, by the Water Control Section and the District's Real Estate Division, could not find any evidence to support the 11+ feet. Sheet Nos. 1 through 18 titled "Land Acquisition, Gull Lake, June 1943", U.S. Army Engineer Office, St. Paul, Minn. File No. RE 2/94-1 through RE 2/94-18 indicates an "approximate flowage line shown by 1197 foot contour". An elevation of 1197 feet is a stage of seven feet referenced from the U.S. Engineer (USE) Datum in use at that time. This is equal to elevation 1194.75 feet in the 1929 NGVD that is in use now. Further support of the seven-foot figure is contained in the quit-claim deeds for the property surrounding Gull Lake, an example of which can be found in **Exhibit D, Reference 8.c.**

c. A letter from the United States Attorney, Department of the Justice, St. Paul, Minnesota, dated January 24, 1910 , which transmits a quit-claim deed for property on Gull Lake plus a copy of sheet No. 6 from the June 1943 Land Acquisition maps.

This document is provided here as evidence in support of a maximum stage of seven feet on Gull Lake reservoir. The listed "flowage elevation" of 1197 feet is a stage of seven feet referenced from the USE Datum in use at that time. This is equal to elevation 1194.75 feet in the 1929 NGVD that is in use now. In addition, a copy of sheet No. 6 from the June 1943 Land Acquisition maps for Gull Lake is attached, which also indicates a "flowage line" at elevation 1197 ft. (USE datum).

EXHIBIT D

REFERENCE NO. 9

A copy of Minnesota Statutes 1961, Sections 110.47 through 110.53, which lead to the subsequent Finding of Fact and Plan of Operation for the Headwaters reservoirs from the State of Minnesota (see Exhibit D, Reference Nos. 10 and 11).

EXHIBIT D

REFERENCE NO. 10

A Findings of Fact, Conclusion ORDER from Clarence Prout, Commissioner of Conservation, Department of Conservation, State of Minnesota, dated 19 April 1963.

This document contains recommendations from the Department of Conservation regarding the regulation of the Mississippi River Headwaters Reservoirs. The guidelines listed in Table D (low flow guidelines) and Table E (high flow guidelines) of this document were adopted by the Corps in the 17 February 1968 revision of the 1963 Headwaters Dams and Reservoirs, Master Reservoir Regulation Manual.

The St. Paul District has agreed informally to follow the guidelines in Tables D and E. Note that Lake Winnibigoshish's normal summer level was lowered one foot in 1975 (which changes some of the listed values for Winnibigoshish). This document is based in part on Minnesota Statutes 1961, Sections 110.47 through 110.53 (see **Exhibit D, Reference No. 9**). Recommendations from Gordon Wollan, Acting Director of Game and Fish, Department of Conservation (see **Para. 12 and 13 in Ref. 10**) are included in **Exhibit D, Reference No. 11**.

EXHIBIT D

REFERENCE NO. 11

a. A letter from Colonel W. B. Strandberg, District Engineer, Corps of Engineers, St. Paul, Minnesota, dated 18 December 1962, which discusses outflow rate-of-change guidelines proposed by the State of Minnesota for the Headwaters reservoirs.

It is assumed that the comments in this letter were considered, which resulted in the rate-of-change guidelines published in the 15 August 1963 Plan of Operation (see 11.b. discussion below).

b. A copy of the Plan of Operation, Mississippi Headwaters Reservoirs from Gordon Wollan, Acting Director of Game and Fish, Department of Conservation, State of Minnesota, dated 15 August 1963. See Exhibit D, Reference Nos. 9, 10 and 11.a.

This plan is referenced in Paragraph 13 of the Commissioners Order dated 19 April 1963 (see **Exhibit D, Reference No. 10**). It is not clear if the Corps agreed to informally follow any of the guidelines in this document. It is included here as the rate-of-change guidelines listed in the document were adopted for this manual (see **Table 7-5** in this manual) pending the outcome of detailed in-stream flow studies. The following is a description of the research that was done during the development of this manual, which led to the adoption of these rate-of-change guidelines.

The 1963 Headwaters Dams and Reservoirs, Master Reservoir Regulation Manual (Revised 17 February 1968) does not contain any guidelines for increasing or decreasing the outflow from the dams. A review of the literature, however, indicated the rate-of-change in the outflow was an important issue at the time. Discussions with experienced operators of the Headwaters dams indicated that, although all the sites are careful to adjust outflows in the interest of wildlife, three of the six reservoirs (Winni, Leech and Pine/Cross) have had, at one time or another, specific (but apparently unofficial) rate-of-change guidelines although no one could cite a published, official source. For example, Winnibigoshish and Leech used, for a period of time, a guideline that essentially stated: when conditions permit, any increase or decrease in discharge should be made so that the rate of outflow does not change more than 50 cfs per day, when the total change is to be less than 300 cfs, and 100 cfs per day if the change is to be more than 300 cfs. A change of 100 cfs every other day could be substituted for a change of 50 cfs per day.

The source of this information was traced to pages 63 and 66 of the report titled "Multiple Use Survey, Winnibigoshish and Leech Reservoirs". This report is not dated, however, it was received by the Corps on 25 August 1965 (see **Paragraph 1-03**). Although the guidelines on these pages were used by the Corps at one time, a further review of the correspondence between the District and the State of Minnesota (see **Exhibit D, Reference No. 11.a**), indicates that a 50 to 100 cfs per-day restrictions at Winnibigoshish and Leech was not acceptable. Instead, limiting the rise in the tailwater (e.g., no more than 0.5 ft. per day) was suggested as being more favorable to reservoir regulation, while still being acceptable to downstream interests. Concerns were also expressed about limits that were being proposed at that time at Gull and Sandy with no restriction at all being suggested for Sandy.

To confuse matters, the aforementioned "Multiple Use Survey" report also contains a copy of **Exhibit D, Reference No. 11.b.,** which contains a completely different set of rate-of-change guidelines. The report is not clear which of the two sets of guidelines were adopted (if any). These later guidelines (in **Ref. No. 11.b.**) however, correspond, for the most part, with the suggestions in the 18 December 1962 letter and as such were adopted, with minor additions and clarifications, for this manual (see **Table 7-5** in this manual). See also **Exhibit D, Reference No. 14.c.**

EXHIBIT D

REFERENCE NO. 12

a. A copy of Public Law 100-676, Section 21, November 17, 1988, Water Resources Development Act of 1988 (WRDA 1988) regarding the headwaters of the Mississippi River.

The goal of this law is to require the Secretary of the Army to notify Congress when the specified operating limits (both high and low) where going to be exceeded. The referenced "contingency plan" is included below as **Reference 12.b.**

b. A copy of the Reservoir Regulation Contingency Plan for the Mississippi River Headwaters Reservoirs prepared to comply with the Water Resources Development Act of 1988 (WRDA 1988), Public Law 100-676, Section 21 of November 17, 1988 (see Reference 12.a.).

Note: Selected pages are included here. The information used to write this document was extracted from draft copies of the Water Control Manual (dated approx. 1986). The draft manuals contained errors which also appear in the Contingency Plan. Pokegama's upper notification limit should be elev. 1278.42 ft. (not 1276.42) and the dam should be wide open at 1278.42 ft. (not 1277.92). Sandy's upper notification limit should be elev. 1221.31 ft. (not 1218.31). Pine's upper notification limit should be elev. 1235.30 ft. (not 1234.82) due to the dam safety rehabilitation. Revised wording has been submitted for inclusion in WRDA 2003. Before that becomes law, the District will have to ask MVD for a deviation to operate outside of the WRDA 1988 limits.

EXHIBIT E

STAGE-DISCHARGE TABLES

GULL LAKE DAM AND RESERVOIR

EXHIBIT E

STAGE-DISCHARGE TABLES

Table E-1

Table E-1

Table E-1

Table E-1

Table E-1

Table E-2

Table E-2

Table E-2

Table E-2

Table E-3

Table E-3

Table E-3

Table E-4

Table E-4

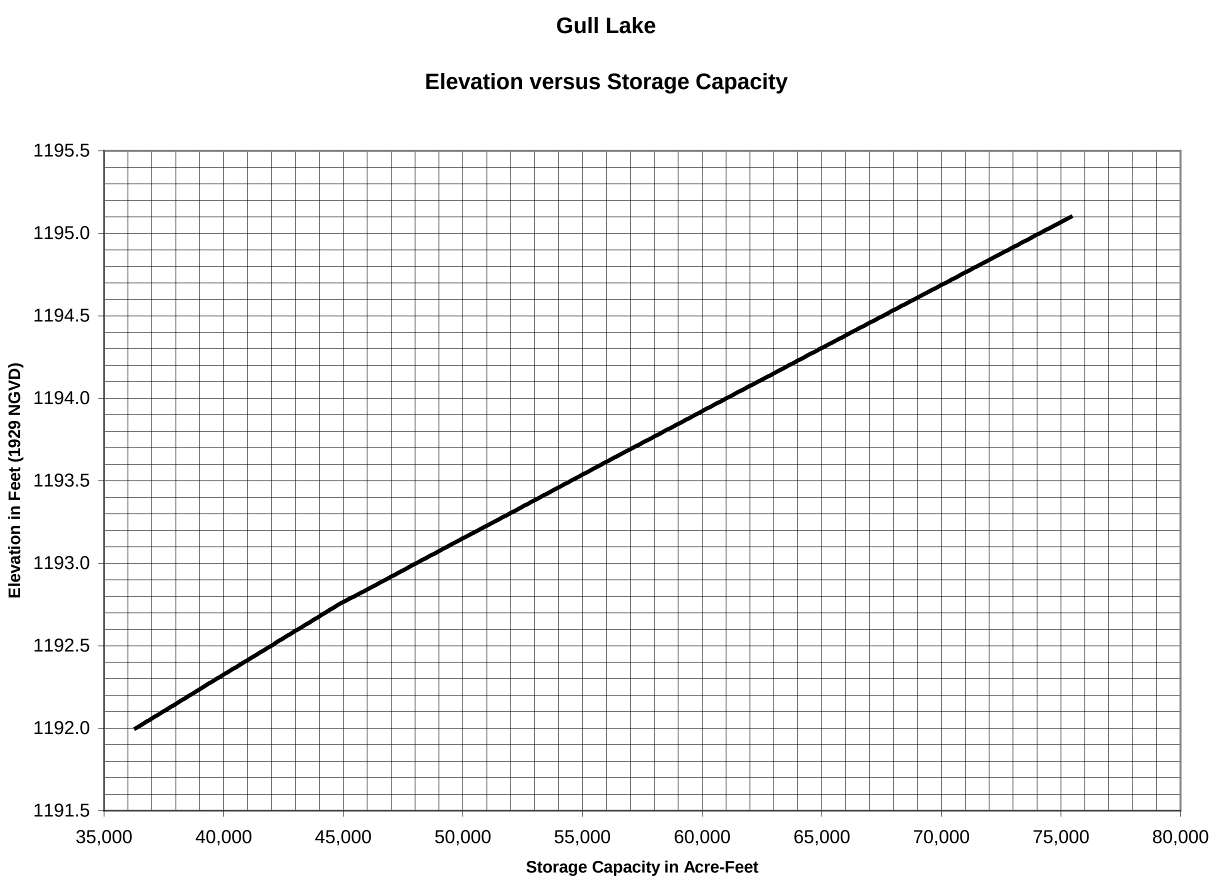
Table E-4

Table E-4

EXHIBIT F

ELEVATION - STORAGE CURVE / TABLE
AREA CAPACITY CURVE

GULL LAKE DAM AND RESERVOIR



The original data for this graph and table was published in the report titled "Area Capacity Table Reevaluation for the Mississippi River Headwater Study" dated August 1983.

GULL LAKE DAM AND RESERVOIR

ELEVATION IN FEET (1929 NGVD) WITH STORAGE CAPACITY IN ACRE-FEET

	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
1192.0	36325	36438	36551	36664	36777	36890	37003	37116	37229	37342
1192.1	37455	37568	37681	37794	37907	38020	38133	38246	38359	38472
1192.2	38585	38698	38811	38924	39037	39150	39263	39376	39489	39602
1192.3	39715	39828	39941	40054	40167	40280	40394	40508	40622	40736
1192.4	40850	40964	41078	41192	41306	41420	41532	41644	41756	41868
1192.5	41980	42092	42204	42316	42428	42540	42654	42768	42882	42996
1192.6	43110	43224	43338	43452	43566	43680	43792	43904	44016	44128
1192.7	44240	44352	44464	44576	44688	44800	44932	45064	45196	45328
1192.8	45460	45592	45724	45856	45988	46120	46248	46376	46504	46632
1192.9	46760	46888	47016	47144	47272	47400	47529	47658	47787	47916
1193.0	48045	48174	48303	48432	48561	48690	48819	48948	49077	49206
1193.1	49335	49464	49593	49722	49851	49980	50111	50242	50373	50504
1193.2	50635	50766	50897	51028	51159	51290	51419	51548	51677	51806
1193.3	51935	52064	52193	52322	52451	52580	52709	52838	52967	53096
1193.4	53225	53354	53483	53612	53741	53870	53999	54128	54257	54386
1193.5	54515	54644	54773	54902	55031	55160	55289	55418	55547	55676
1193.6	55805	55934	56063	56192	56321	56450	56581	56712	56843	56974
1193.7	57105	57236	57367	57498	57629	57760	57891	58022	58153	58284
1193.8	58415	58546	58677	58808	58939	59070	59199	59328	59457	59586
1193.9	59715	59844	59973	60102	60231	60360	60491	60622	60753	60884
1194.0	61015	61146	61277	61408	61539	61670	61801	61932	62063	62194
1194.1	62325	62456	62587	62718	62849	62980	63110	63240	63370	63500
1194.2	63630	63760	63890	64020	64150	64280	64411	64542	64673	64804
1194.3	64935	65066	65197	65328	65459	65590	65721	65852	65983	66114
1194.4	66245	66376	66507	66638	66769	66900	67031	67162	67293	67424
1194.5	67555	67686	67817	67948	68079	68210	68341	68472	68603	68734
1194.6	68865	68996	69127	69258	69389	69520	69651	69782	69913	70044
1194.7	70175	70306	70437	70568	70699	70830	70961	71092	71223	71354
1194.8	71485	71616	71747	71878	72009	72140	72271	72402	72533	72664
1194.9	72795	72926	73057	73188	73319	73450	73581	73712	73843	73974
1195.0	74105	74236	74367	74498	74629	74760	74891	75022	75153	75284
1195.1	75415									

EXHIBIT G

MISSISSIPPI HEADWATER REGULATION WORKSHEET

GULL LAKE DAM AND RESERVOIR

Mississippi Headwater Regulation Worksheet

Project	Summer Band Center	Normal Drawdown	Lake levels / outflows/inflows 2days ago	yesterday	this a.m.	Min. release/ change/day	Quantitative Precipitation Forecasts 24-hr	48-hr	72-hr	Mean Areal Precipitation Last 24 hours	Date: Wind Direction & Speed effect: 0.1' per 10mph to dam (+	away (-)
							Damtender release preference			Coordinated release order		
Pokegama	1273.17 to 1273.67	1270.42				sum of W&L						
Jeff ##055 or 218-326-6128	1273.42		/	/	/	20-30%	USGS Grand Rapids Q = ______			prec.____	S 180deg	N 360deg
Winnibigoshish	1297.94 to 1298.44	1296.94				100						
Jeff ##055 or 218-326-6128	1298.19		/	/	/	200				prec.____	WNW 270-315	ESE 90-135
Leech	1294.50 to 1294.90	1293.8				100						
Timm/Jason##054 or 218-654-3145	1294.7		/	/	/	100				prec.____	SWW 225-315	E/NE 45-135
Red Lake	1174.00	1173.50				75	SAUM5 =		AVERAGE(Pool, SAUM5, & WSKM5) =			
Timm/Jason##054 or 218-654-3145	Highlanding/8.75		/	/	/	any	WSKM5 =			prec.____		
Sandy	1216.06 to 1216.56	1214.31				20						
Jeff/Terry##056 or 218-426-3482	1216.31		/	/	/	20-30%				prec.____	E/SE 90-135	W 270deg
Cross/Pine	1229.07 to 1229.57	1227.32				30						
Ray ##052 or 218-692-2025	1229.32		/	/	/	60				prec.____	WNW 270-315	E/SE 45-135
Gull	1193.75 to 1194.00	1192.75				20						
Greg ##060 or 218-829-2797	1193.88		/	/	/	20-30%				prec.____	N	S

Aitkin =		(FS = 12.0)
WILM5 =		(MAX 81.50)
DAYM5 =		(MIN 71.50)
Mud Lake Dam Pool =		
Mud Lake Dam Tail =		

Mud Lake Dam Operation Plan : winter = 1279, spring = 1279.5, summer = hold stable, fall = 1280, 1282or higher can cause floating bog problems, 1282 or higher erosion begins on County Road 139

Knutson Dam Pool =	
Knutson Dam Tailwater =	
Knutson Dam Q =	

Knutson summer pool 1301.4 to 1301.7

Operating Limits 1300.25 to 1302.25

Consider:

* Grand Rapids low flow trigger = 400 cfs, no more than 10% change in flow in 2 hrs.@ Pokeg & Winni.
* Leech Lake, pool needs to be atleast 94.40 by 1 May (thur 1 OCT)or sailboats start to have problems at Walker Bay.
* 5 days following March 1 minimum temp at Grand Rapids greater than 32 degrees, peak at Aitkin occurs 10-14 days later.
* Ideally reduce Winnibigoshish & Leech discharge 10 > 15 days before NWS forcast peak at Atkin.
* Maximum Winnibigoshish & Leech winter Q =2200 c.f.s.
* Take Pokegama back to 1271.0 if DAYM5 is less than 71.50
* Travel times :

* Winni > Pokeg about 3 days	* Sandy > Aitkin about 1 day
* Leech > Pokeg about 3 days	* Red Lake Dam > Highlanding about 1.5 days
* Pokeg > Aitkin about 3 days	* Red Lake Dam > Crookston about 5.5 days

* Winni - Fish Spawn - target reservoir 1297.44 to 1297.75 by 25 APR, 1297.75 top of stripping boards.(hard to do)
* Gull - discharge goal of 100 - 200 cfs for opening week-end.
* Sandy - Fish Spawn - Hold middle of S.B. middle April to 1 May so spawn does not dry out.
* Normal ice-out about 20 April (from 1 April to 10 May)
* Normal pool for ice-out : Winni < 1297.94, Leech < 1294.5, Pokeg < 1272.6
* Normal pool for ice-out : Sandy < 1214.8, Cross < _______, Gull < 1193.5
*Wild Rice harvest is usually completed by the middle of SEP.