



US Army Corps
of Engineers®
St. Paul District

WATER CONTROL MANUAL

MISSISSIPPI RIVER NINE FOOT CHANNEL NAVIGATION PROJECT



LOCK AND DAM NO. 7

LA CRESCENT, MN

APPENDIX 7 OF THE MASTER WATER CONTROL MANUAL

UPDATED AUGUST 2002

WATER CONTROL MANUAL

**LOCK AND DAM No. 7
LA CRESCENT, MINNESOTA**

**UPPER MISSISSIPPI RIVER BASIN
MISSISSIPPI RIVER – NINE FOOT CHANNEL
NAVIGATION PROJECT**

**APPENDIX No. 7
of the
MASTER WATER CONTROL MANUAL**



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

AUGUST 2002

**Updated from
Reservoir Regulation Manual, June 1971
Operation of Navigation Pools, February 1943**

LOCK AND DAM No. 7
LA CRESCENT, MINNESOTA



Aerial View Looking Upstream – 1980's

5 Roller Gates and 11 Tainter Gates
Project Pool 639.0 feet (1912 Adjustment)

LOCK AND DAM No. 7
LA CRESCENT, MINNESOTA



Lock and Dam No. 7 Control House
Dedication Planned for September 2002

Lock Chamber and Miter Gates in Foreground

NOTICE TO USERS OF THIS MANUAL

This Water Control Manual complies with the latest US Army Corps of Engineers guidelines regarding management of water control systems and preparation of water control manuals. The St. Paul District prepared the *Preliminary Report on Operation of Navigation Pools* on 16 February 1943. This document provided the operational information for Lock and Dam Numbers 1 through 10. This was replaced by a Master Regulation Manual in September 1969. Appendices for each lock and dam were added during the years 1970 through 1972, with Appendix No. 7 being completed in June 1971. This manual is an update of Appendix No. 7. The manual is published in loose-leaf form to facilitate modifications. In the future, only those sections, or parts thereof, requiring changes will be revised and replaced.

EMERGENCY REGULATION ASSISTANCE PROCEDURES

In the event that unusual conditions arise (e.g. gate failure, excessive rainfall), the Lockmaster, Area Lockmaster, and Water Control should be notified as to the extent of the event. During normal water control duty hours (i.e. 0630 to 1730 hrs weekdays and 0630 to 1030 hrs weekends and holidays), contact with Water Control can be made at 651-290-5624 or 651-290-5474. On weekends and holidays, the Mississippi River Duty Regulator Pager number can be used. If communication with Water Control cannot be established, the following list can be used as a guide for establishing contact.

Water Control Regulation Assistance		
Scott R. Bratten	Primary Mississippi River Regulator scott.r.bratten@usace.army.mil	Duty: 651-290-5624 [REDACTED]
Duty Regulator	Mississippi River Duty Regulator; Pager and Fax	Pager: 612-660-8053 Fax: 651-290-5841
Dennis D. Holme	Physical Scientist dennis.d.holme@usace.army.mil	Duty: 651-290-5614 [REDACTED]
Theodore D. Pedersen	Water Control Gage Crew theodore.d.Pedersen@usace.army.mil	Duty: 651-290-5253 [REDACTED]
Ferris W. Chamberlin	Hydraulic Engineer ferris.w.chamberlin@usace.army.mil	Duty: 651-290-5619 [REDACTED]
Kenton. E. Spading	Hydraulic Engineer kenton.e.spading@usace.army.mil	Duty: 651-290-5623 [REDACTED]
Robert G. Engelstad	Chief, Water Control Section robert.g.engelstad@usace.army.mil	Duty: 651-290-5610 [REDACTED]
Michael R. Knoff	Chief, Hydraulics & Hydrology Br michael.r.knoff@usace.army.mil	Duty: 651-290-5600 [REDACTED]
John J. Bailen	Chief, Engineering Division john.j.bailen@usace.army.mil	Duty: 651-290-5303

**Lock and Dam No. 7
La Crescent, Minnesota**

**U.S. Army Corps of Engineers
St. Paul District –August 2002**

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PERTINENT DATA

Location: Lock and Dam No. 7 is located on the Mississippi River, 702.5 river miles above the mouth of the Ohio River, 11.8 river miles below Lock and Dam No. 6, and 23.3 river miles above Lock and Dam No. 8. The lock is on the right bank of the main channel of the Mississippi River, 4.6 river miles above the city of La Crosse, WI at approximate latitude 43° 52' 00" N and longitude 91° 18' 30" W.

Drainage Area: 62,340 square miles

Datum: MSL -1912 Adjustment

Fixed Height Dam

Type:	Earthen Dike
Total Length (including spillways):	9,000 feet
Crest Elevation:	649.0 feet
Top Width:	20 feet
Maximum Height:	27 feet

Fixed Crest Spillway

Type:	Concrete
Length:	1,000 feet
Crest Elevation:	639.0 feet
Low Flow Slots:	3 slots; 2.5 ft deep by 9.0 ft long

Moveable Dam

Roller Gates:	5 Gates	80 feet by 20 feet
Tainter Gates:	11 Gates	35 feet by 15 feet
Roller Gate Sill:	Elevation 619.0 feet	
Tainter Gate Sill:	Elevation 624.0 feet	

Lake Onalaska Dam

Type:	Fixed Crest Spillway Submerged Culverts
Total Length:	670 feet
Crest Elevation:	639.0 feet

Spillway Section

Type:	Concrete Capped Spillway
Length:	583 feet
Top Width:	20 feet
Side Slopes:	1V:3H Pool side; 1V:4H Tailwater side

Culvert Section

Type:	Submerged Box Culverts
Length:	87.0 feet (on centerline of dam)
Box Culverts:	4 culverts - 3 feet high 9 feet wide
Upstream Invert:	Elevation 629.0 feet
Downstream Invert:	Elevation 627.0 feet

French Lake Culvert

Type: 30-inch RCP

Lock

Main Lock Chamber:	110 feet by 600 feet
Top of Lock Walls:	Elevation 647.0 feet
Top of Upper Gate Sill (Main):	Elevation 621.0 feet
Top of Upper Gate Sill (Auxiliary):	Elevation 621.0 feet
Top of Lower Gate Sill:	Elevation 619.0 feet
Lock Floor:	Elevation 617.0 feet
Height of Upper Miter Gates (Main):	23.0 feet
Height of Upper Miter Gates (Aux.):	23.0 feet
Height of Lower Miter Gates:	25.0 feet

Pool

Normal (Project) Upper Pool:	Elevation 639.0 feet
Normal (Project) Lower Pool:	Elevation 631.0 feet
Total Pool Area (at Project Pool):	13,440 acres
Primary Control Point:	N/A (PCP falls within L&D 6)
Secondary Control Point:	Lock & Dam 7; Elevation 639.0 ft
Mid-Pool Gage Point:	Dakota, MN

- Notes:**
1. All elevations are Mean Sea Level (1912 adjustment).
 2. Roller gates are submergible to 3.0 feet below Project Pool (639.0 feet).
 3. Two tainter gates can be submerged to 2.0 feet below Project Pool.

I – INTRODUCTION

1-01. Authorization for Preparation of this Manual. Pursuant to the instructions from the Chief of Engineers dated 15 May 1942 and 29 August 1942, subject “Operation of Flood Control and Multiple-Purpose Reservoirs”, the methods and the technique used in operating the navigation pools on the Mississippi River in the St. Paul District was documented in February 1943. Authority to prepare regulation manuals for the locks and dams was granted by Engineering Regulation (ER) 1110-2-240, *Reservoir Regulation*, 1958. While ER 1110-2-240 has been updated and amended many times since the date of issuance, the document continues to give the Corps of Engineers authority to prepare what became known as “Water Control Manuals” by ER 1110-2-240, *Water Control Management*, 1982. This manual supercedes Lock and Dam 7 Regulation Manual dated June 1971 and was prepared in compliance with the guidelines presented in:

- a. Engineering Regulation, ER 1110-2-240, *Water Control Management*, 8 October 1982, amended 30 April 1987 and 1 March 1994.
- b. Engineering Manual, EM 1110-2-3600, *Management of Water Control Systems*, 30 November 1987.
- c. Division Regulation, DIVR 1110-2-240, *Water Control Management, Preparation of Water Control Plans and Manuals*, 1 January 1992.
- d. Engineering Regulation, ER 1110-2-8156, *Preparation of Water Control Manuals*, 31 August 1995.

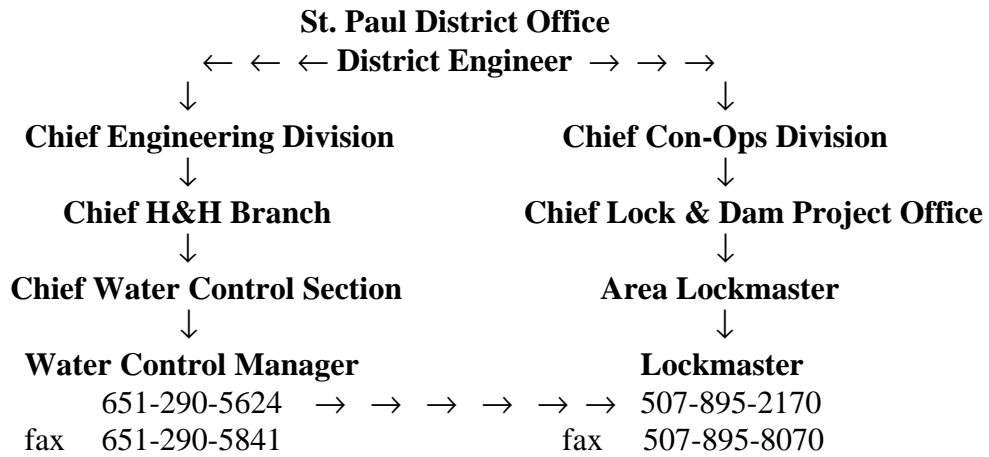
1-02. Purpose and Scope. The purpose of this manual is to provide guidance and instruction for project personnel and to serve as a reference source for others who may be involved with the regulation of this project. The manual is for daily use in Water Control Section activities for most foreseeable conditions and occurrences. The 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 Upper Mississippi River Lock and Dam system was authorized when Congress approved the nine-foot channel on 3 July 1930. Lock and Dam No. 7 was completed on 19 April 1937. A general scheme of operation was developed on 28 March 1935. The following is a list of related Manuals and Reports in chronological order.

- a. *Survey of Mississippi River Between Missouri River and Minneapolis*, Letter from The Secretary of War, 72 Congress, 1st Session, House Document No. 137, Part 1 – Report, 9 December 1931.
- b. *Report on General Scheme of Operation for the Dams of the 9-Foot Channel Project*, War Department, Office of the Chief of Engineers, 28 March 1935.
- c. *Preliminary Report on Operation of Navigation Pools*, War Department, US Engineer Office, St. Paul District, St. Paul, Minnesota, 16 February 1943.
- d. *Master Regulation Manual for Mississippi River Nine-Foot Channel Navigation Projects*, St. Paul District, Corps of Engineers, September 1969.
- e. *Mississippi River Nine-Foot Channel Navigation Project, Reservoir Regulation Manual, Appendix 7, Lock and Dam No. 7, La Crescent, Minnesota*, St. Paul District, Corps of Engineers, June 1971.
- f. *Creativity, Conflict & Controversy: A History of the St. Paul District, U.S. Army Corps of Engineers*, by Raymond H Merritt, 1979.
- g. *Upper Mississippi River, Land Use Allocation Plan, Master Plan for Public Use Development and Resource Management, Part I and Part II*, St. Paul District, Corps of Engineers, September 1983.
- h. *Emergency Plan for Lock and Dam 7 near La Crescent Minnesota*, St. Paul District, Corps of Engineers, August 1986.
- i. *Scour Protection for Locks and Dams 2-10, Upper Mississippi River*, Technical Report HL-87-4, Waterways Experiment Station, Corps of Engineers, Vicksburg, Mississippi, April 1987.
- j. *Commerce and Conservation on the Upper Mississippi River*, by John O. Anfinson, District Historian, St. Paul District, Corps of Engineers, 1990.
- k. *Design Analysis Report – Onalaska Dam Rehabilitation*, St. Paul District, Corps of Engineers, January 1991.
- l. *Gateways to Commerce*, The U.S. Army Corps of Engineers' 9-Foot Channel Project on the Upper Mississippi River, National Park Service, Rocky Mountain Region, 1992.
- m. *Authorized and Operating Purposes of Corps of Engineers Reservoirs*, U.S. Army Corps of Engineers, Washington D. C., July 1992.
- n. *Stilling Basin Report – Onalaska Dam Rehabilitation*, Progressive Consulting Engineers, Inc., March 1993.
- o. *Discharge Ratings for Tainter Gates and Roller Gates at Lock and Dam No. 7 on the Mississippi River, La Crescent, Minnesota*, US Geological Survey, Water Resource Investigation Report 95-4089, 1995.
- p. *Channel Maintenance Management Plan*, Upper Mississippi River Navigation System, St. Paul District, Corps of Engineers 1996.
- q. *Zebra Mussel Response Plan*, St. Paul District, Corps of Engineers, November 1997.
- r. *Locks and Dams Sounding Reports, Volume 2*, St. Paul District, Corps of Engineers, 1999.
- s. *2001 Annual Report – Water Quality Management Program*, St. Paul District, Corps of Engineers, January 2002.

1-04. Project Owner. The United States Government is the owner of Lock and Dam No. 7. The U.S. Army Corps of Engineers, St. Paul District, St. Paul Minnesota, is responsible for regulation of Lock and Dam No. 7.

1-05. Operating Agency. Lock and Dam No. 7 is regulated, operated, and maintained by the U.S. Army Corps of Engineers, St. Paul District. Regulation is the responsibility of Engineering Division, while operation and maintenance is the responsibility of Construction and Operations (Con-Ops) Division. The following chart shows the command structure for Lock and Dam No. 7.



The project is attended 24 hours a day, every day of the year. The Chief, Con-Ops Division and the Chief, Engineering Division are located in the St. Paul District Office, whereas the Lock and Dam Project Office is located in Fountain City, Wisconsin and the Area Lockmaster is stationed at Lock and Dam No. 9.

1-06. Regulating Agency. Regulation of Lock and Dam No. 7 is under the supervision of the Water Control Section as by the above command structure.

II – DESCRIPTION OF PROJECT

2-01. Location. Lock and Dam No. 7 is located on the Mississippi River, 702.5 river miles above the mouth of the Ohio River, 11.8 river miles below Lock and Dam No. 6, and 23.3 river miles above Lock and Dam No. 8. The lock is on the right bank of the river 4.6 river miles above the city of La Crosse, Wisconsin at approximate latitude 43° 52' 00" N and longitude 91° 18' 30" W. The project is bordered by La Crosse County on the Wisconsin side and Winona County on the Minnesota side. The project location is shown on **Plate 2-1**.

2-02. Purpose. Lock and Dam No. 7 is a unit of the Inland Waterway Navigation System of the Upper Mississippi River Basin. The system includes 29 locks and dams, which provide a “stairway of water” from Minneapolis, Minnesota to St. Louis Missouri. The primary purpose of the dams is to maintain a depth of nine feet for navigation. The authorized purposes for Lock and Dam No. 7 are navigation and recreation under Public Laws PL 71-250 and PL 78-534, respectively. Access and facilities are provided for recreation, but water is not controlled for that purpose.

2-03. Physical Components. Lock and Dam No. 7 consists of a main and uncompleted auxiliary lock, a movable dam section, a concrete fixed-crest spillway, an earthen dike, and the Onalaska Dam (**Figure 2-1**). The locks, moveable dam, and spillway are supported on timber pilings driven into sand and gravel and include steel sheet pile cutoff walls. The Onalaska Dam is supported by a cellular structure of steel sheet pile. The following describes the hydraulic feature of each component in detail.



Figure 2-1. Lock and Dam No. 7 (looking east).

- a. Lock.** Lock and Dam No. 7 has a main and an uncompleted auxiliary lock (Plate 2-1). The upper and lower miter gates of the main lock have a height of 23.0 feet and 25.0 feet, respectively. The respective sill elevations are 621.0 feet and 619.0 feet (1912 adjustment). A walkway is located atop the miter gates. It extends three feet above the top of miter gates (elevation 644.0 feet) to meet the top of lock walls (elevation 647.0 feet). While the main lock is fully functional, the auxiliary lock consists of only an upper gate bay. The miter gates on the auxiliary lock are 23 feet high with a sill elevation of 621.0 feet. The gates of the auxiliary lock have no machinery and therefore are inoperable. However, should an upper miter gate in the main lock become damaged, a miter gate from the auxiliary lock can be pulled to serve as a replacement. This operation requires assistance from Rock Island District because they have the equipment and expertise.

The main lock is 110 feet wide with a clear length of 600 feet. The filling and emptying of the lock chamber is controlled by tainter valves; two at the upstream (upper) end of the lock and two at the downstream (lower) end. During the filling or emptying process, the miter gates are closed thus sealing the lock chamber. For a filling operation, the upper tainter valves are opened allowing flow to enter the culverts (**Plate 2-2**, Section C-C). Flow then enters the lock chamber through ports along the lock wall (Section X-X) and the water level in the lock chamber rises until it equals the pool elevation. The upper tainter valves are then closed and the lower tainter valves are opened thus emptying the lock chamber. Under normal conditions, filling and emptying times are about five minutes.

Periodically, the lock chamber is flushed of sediment and debris. This is accomplished at the end of an emptying cycle. The upper miter gates and lower tainter valves are in the closed position, the lower miter gates are opened in the recessed position, and the upper tainter valves are operated to provide the flushing action.

Guidewalls are located upstream and downstream of the lock to provide a landing for down bound and up bound tows (**Plate 2-1**). The upper guide wall extends 521 feet upstream of the lock and the lower guide wall extends 504 feet downstream of the lock.

- b. Moveable Dam.** The moveable dam section extends from the auxiliary lock to the left bank of the main channel on French Island (see **Plate 2-1**). The moveable dam consists of five roller gates, 80 feet by 20 feet, and 11 tainter gates, 35 feet by 15 feet. The sill elevation of the roller gates is 619.0 feet (1912 adjustment), while the tainter gates sill elevation is 624.0 feet. The end sill elevations for the roller and tainter gates are 619.0 feet and 622.75 feet, respectively. The roller gates can be submerged up to three feet below normal pool (elevation 639.0 feet).

Each roller gate is equipped with an individual electrically operated hoist enclosed in an operating house located on the pier. The roller gates are driven from one end only. The travel rate of the gate is approximately 0.75 feet per minute. A position indicator, marked in increments of 0.1 feet, is attached to the hoist mechanism (**Figure 2-2**).



Figure 2-2. Roller Gate Position Indicator

An alternate position indicator, marked in increments of 0.5 ft, is attached to a shaft with a gear driven by the hoist mechanism (**Figure 2-3**).

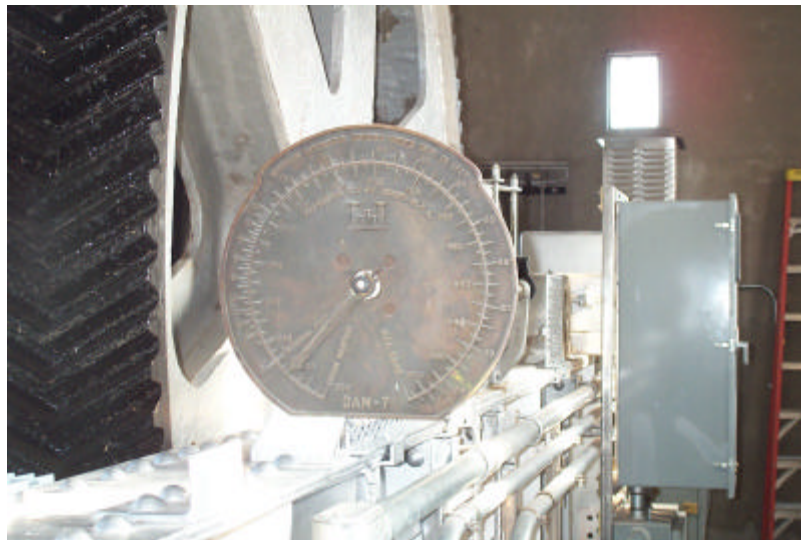


Figure 2-3. Alternate Roller Gate Position Indicator

Each tainter gate is individually operated by machinery consisting of an electrically operated central driving unit and two chain hoisting units. The electric controls consist of push buttons located on the deck rail. A position indicator is mounted on the pier about midway between the trunion and the gate surface (**Figure 2-4**). The indicator is marked in 0.1-foot increments. The tainter gates move at a rate similar to the roller gates. There are four bulkheads stored on site measuring 4 feet-2 inches by 37 feet-6 inches. The sill is at elevation 624.0 feet; therefore, the top of the bulkheads would be at elevation 640.67 feet (i.e. 640 feet-8 inches).



Figure 2-4. Tainter Gate Position Indicator

A service bridge, at elevation 668.5 feet, spans the entire length of the moveable dam and storage yard and provides for the operation of the crane. The 45-foot boom crane, with 25-ton capacity, was replaced in 1981. The new crane has a boom length of 60 feet and a capacity of 25 tons.

- c. **Channel Protection.** Immediately upstream and downstream of the moveable dam, the channel is protected by a stilling basin followed by stone protection.

Sections A-A and B-B of **Plate 2-2** show the original derrick stone protection. Over the years, scour upstream and downstream of the derrick stone caused some unraveling of the derrick stone. In 1983, riprap protection was extended upstream and downstream in the form of capstone and rockfill. **Plate 2-3** shows two transects of the added protection. The following gives a description of the riprap protection near the roller gates, tainter gates, lock, auxiliary lock, and storage yard.

(1) Roller Gates. Downstream protection originally consisted of derrick stone, 4 feet thick with a top of rock elevation of 617.0 feet (1912 adjustment). The derrick stone extended 25 feet downstream of the end sill. Upstream protection consisted of a 12 feet wide by 3 feet thick section of derrick stone with a top elevation of 618.0 feet. The scour holes that formed upstream and downstream of the derrick stone were filled between October 1982 and January 1983 by a horizontal capstone section 42 inches thick, underlain by a rockfill section a minimum of 30 inches thick. The capstone extends 55 feet downstream of the end sill and 25 feet upstream from the dam. The horizontal capstone was placed to the same elevation as the derrick stone at both the downstream (elevation 617.0 feet) and upstream (elevation 618.0 feet) locations.

(2) Tainter Gates. Downstream protection originally consisted of derrick stone 4 feet thick with a top of rock elevation of 620.75 feet (1912 adjustment). It extended 40 feet downstream of the end sill for the tainter gates. Upstream, the derrick stone section was 12 feet wide by 3 feet thick with a top of rock elevation of 623.0 feet. The scour hole upstream and downstream of the derrick stone was filled in 1983 by a horizontal capstone section 42 inches thick, underlain by a rockfill section a minimum of 30 inches thick. The downstream capstone of the two tainter gates closest to the roller gates was constructed similarly to the section downstream of the roller gates except that the top of capstone elevation

was 621.0 feet. The capstone and rockfill section for the next two tainter gates is in a transitional zone where the concrete apron width changes from 45 feet required for the roller gates down to 25 feet required for the tainter gates. The horizontal section of capstone was placed with a width ranging from 67 feet on the western side of the transition to 40 feet on the eastern side of the transition. The capstone extended an additional 30 feet downstream on a 1H:3V slope or on existing rockfill slopes that were flatter than 1H:3V. The capstone and rockfill sections for the remaining tainter gates between the transition and storage yard were constructed with the same geometry as the rock section at the end of the transition. Upstream, the capstone protection extends 25 feet from the dam. The horizontal capstone upstream of the dam was placed to the same elevation as the derrick stone (i.e. elevation 623.0 feet).

(3) Lock and Guidewalls. The original scour protection on the upstream side of the locks consisted of a 15-foot wide, 3-foot thick section of derrick stone with a top of rock elevation of 619.0 feet (1912 adjustment) placed around the upstream end of the intermediate and riverward lock walls. A 12-foot wide section of derrick stone protection was provided from the downstream end of the concrete paving on the partially completed auxiliary lock, downstream along the riverward side of the intermediate lock wall riverward of the 20-foot wide timber cribs, along the concrete apron on the downstream side of the landward lock, and 100 feet downstream along the lower guide wall. The derrick stone section was 3 feet thick downstream of the partially completed auxiliary lock and along the timber cribs adjacent to the intermediate lock wall and 2 feet thick along the downstream apron of the landward lock and along the lower guide wall. Soundings obtained in May 1943 revealed that the timber cribs at the base of the lower guide wall had been undercut by as much as 5 feet. In August 1943, 694 cubic yards of rock was placed along the lower guide wall. The rock was placed horizontally for a distance of 5 feet out from

the wall at elevation 616.0 feet then down on a 1V:2H slope riverward until it intersected the channel bed. In the early 1980's, a 30-inch thick layer of rock (+ 12-inch filter) was placed along the upper guide wall with a top elevation of 620.5 feet. The rock extended 20 feet horizontally out from the wall and then down on a 1V:2H slope riverward until it intersected the channel bed. Additionally downstream scour protection was also placed along the lock apron as well as along the entire length of the lower guide wall. Downstream of the lock apron the rock consisted of a 2-foot thick section of 2 to 3 ton stone, which extended horizontally a distance of 20 feet downstream of the end of the lock apron with a top of rock elevation the same as the apron elevation. Rockfill was placed beneath the upper layer of stone and extended downstream on a 1V:3H slope until it intersected the existing ground line. The scour protection placed downstream of the lower guide wall consisted of a rockfill section that extends 20 feet horizontally out from the wall at elevation 617.0 feet, then extended downward on a 1V:2H slope until it intersected the existing ground line. In the mid 1980's, additional scour protection was provided upstream and downstream of the partially completed auxiliary lock. At the upstream end of the auxiliary lock, a minimum 30 inch thick rockfill section was placed on existing ground and extended 130 feet upstream of the end of the sill with a base of rock elevation corresponding to the top of sill elevation. The rock slopes riverward for the side of the riverward lock wall at a 1V:3H slope until it intersects existing ground. On the downstream side of the auxiliary lock, rockfill was placed on existing ground with a top elevation of 615.0 feet. It extends horizontally a distance of 70 feet downstream from the end of the lock pavement and 50 feet riverward from the timber cribs adjacent to the riverward wall of the main lock. At the end of the horizontal section, the rockfill slopes riverward at 1V:3H until it intersects existing ground.

(4) Storage Yard. Original scour protection downstream of the storage yard consisted of riprap placed on a 1V:5.5H slope. Upstream scour protection consisted of riprap placed on a 1V:3H slope. In the late 1980's, the downstream bank of the storage yard failed and was subsequently repaired. Additional riprap was placed on the downstream bank in the late 1990's.

d. Earthen Dam and Fixed Crest Spillway. An earthen dam, 9,003 feet in length, extends from the end of the moveable dam section to the high ground on the west side of French Island, then resumes from high ground on the east side of French Island to terminate at the embankment of the railroad in the town of Onalaska, Wisconsin (**Plate 2-1**). The dam has a crest elevation of 649.0 feet (1912 adjustment), a top width of 20 feet, and a maximum height of 27 feet (**Plate 2-2**). The pool side slope is 1V:3H, while the tailwater slope is 1V:5.5H. The side slopes are protected by 12-inch riprap. Protection on the pool side slope extends to the dam crest, whereas protection on the tailwater slope extends to three feet above the lower project pool (i.e. $631.0 + 3.0 = 634.0$ ft).

Within the earthen dike is a fixed-crest concrete spillway (see **Plate 2-1**). The spillway is 1,000 feet in length and is located nearer the Minnesota end between the movable dam and the west side of French Island. The crest elevation is 639.0 feet (i.e. Project Pool Elevation). Three slots are cut into the spillway to provide aeration to the backwater areas upstream and downstream of the dam. The slots are 9.0 feet long by 2.5 feet deep.

A 30-inch RCP aeration culvert extends through the earthen dike upstream of French Lake near the earthen dike intersection with the west side of French Island. Flow is controlled by a slide gate.

e. Onalaska Dam. Located within the earthen dam on the eastern side of French Island is the 670-foot long Onalaska Dam. The dam is located between the

east side of French Island and the town of Onalaska, Wisconsin across the Black River channel. It consists of two sections; an overflow section and a culvert section (**Figure 2-5**). The crest of both sections is at elevation 639.0 feet (1912 adjustment) and is 20 feet wide. The overflow section is 583 feet in length. The pool side slope is 1V:3H and the tailwater slope is 1V:4H. The crest and side slopes are capped in concrete. The culvert section is 87 feet in length. There are four box culverts 3.0 feet high and 9.0 feet wide spaced throughout the section. The upstream invert is at elevation 629 feet, while the downstream invert is at elevation 627 feet. Flow through the culverts is controlled by stop logs.



Figure 2-5. Onalaska Dam (looking west)

Upstream of the dam is Lake Onalaska as shown in **Figure 2-6**. The dam can be seen in the lower portion of the aerial photo. In the northwest corner you can see a faint image of one the Corps of Engineers' man made islands. These are discussed in the next section.



Figure 2-6. Aerial View of Lake Onalaska

2-04. Related Control Facilities. There are no related control facilities in Pool No. 7. However, several “man-made” islands were created in Lake Onalaska in 1990 to reduce wind-induced erosion and promote growth of aquatic vegetation.



Figure 2-7. “Man-made” Islands in Pool 7 (Lake Onalaska)

2-05. Real Estate Acquisition. The Corps of Engineers acquired 14,328 acres of land and water area in fee for the Lock and Dam No. 7 project. Of this total, 6,988 acres are under the jurisdiction of the Corps of Engineers, and the balance, 7,340 acres, is under the jurisdiction of the Department of Interior. Of the Corps of Engineers lands, all but the 2 acres at the Lock and Dam site are under permit to the US Fish and Wildlife Service as part of the Upper Mississippi River Wildlife and Fish Refuge.

2-06. Public Facilities. The public facilities associated with Lock and Dam No. 7 are undergoing extensive renovations. The new facilities will include a comfort station, rehab of the elevated observation platform, picnic tables available for public use and a public parking area. The observation platform is located along the center of the lock chamber. Part of the planned renovations include the conversion of the old lock house into a museum. The comfort station is handicap accessible.

There is one major park adjacent to the pool, Trempealeau Landing, which is located in Wisconsin about 11.5 miles upstream of the dam and just downstream of Lock and Dam No. 6 (**Plate 2-4**). Lake Onalaska is located immediately upstream and to the northeast of Lock and Dam No. 7 and harbors numerous recreational facilities. Recreation facilities in Pool No. 7 are listed in **Table 2-1**. All of the facilities located downstream of river mile 709.0, are on Lake Onalaska except for Dakota Access and Dresbach Landing.

<p style="text-align: center;">Table 2-1 Pool No. 7 Recreation Facilities</p>								
River Mile	Name	Manager	Fee	Slips	Parking	Camp Sites	Toilets	Picnic Tables
714.0 L	Trempealeau Landing	WIDNR			50		Yes	
714.0 R	Sunset Bay	Private	Yes	20	10			
713.8 L	Larrys Landing	Private	Yes	10	10		Yes	
713.0 L	Second Lake Access	DNR/FWS			10			
712.9 L	Third Lake Access	WIDNR/FWS			20		Yes	Yes
712.8 L	Round Lake Landing	FWS			10			
712.8 L	Long Lake Landing	FWS			10			
711.9 L	Lone Tree Landing	FWS			3			
709.0 L	Lytle Canoe Access	WIDNR			8		Yes	
707.1 R	Dakota Access	MNDNR			8			
707.0 L	Brice Prairie Walk-in	WIDNR			30			
706.5 L	Cozy Corner Resort	Concession			5			
706.3 L	Brice Prairie Landing	Town of Onalaska			25		Yes	
705.0 L	Clearwater Resort	Concession			6			
704.8 R	Dresbach Landing	Dresbach			5		Yes	Yes
704.5 L	Northshore Landing	Concession	Yes		10	Yes	Yes	
704.5 L	Schafers Boat Livery	Concession		10	5		Yes	
704.5 L	Mosey Landing	Town of Onalaska			10		Yes	
704.3 L	La Crosse Sailing Club	Concession		60			Yes	Yes
704.0 L	Nelson Park	Town of Campbell			20		Yes	Yes
702.9 L	Fishermens Rd Landing	La Crosse Airport			6			
702.5 L	Upper Dike Landing	Town of Campbell			3			

III – HISTORY OF PROJECT

3-01. Authorization. The Lock and Dam No. 7 project was authorized on 3 July 1930 when the 71st Congress, second session, passed an act that modified the existing six-foot channel project in accordance with the plan for a comprehensive project to procure a channel of nine-foot depth, submitted in House Document No. 290. The nine-foot channel was to be achieved by construction of a system of locks and dams, supplemented by dredging.

3-02. Planning and Design. The lock and dam system is necessary to provide a nine-foot channel during low to moderate flows. The dam is operated to accommodate river flow conditions. In normal operation, all gates are partially open to allow water through. As the river flow increases or decreases, the gate openings are increased or decreased accordingly. If there were no flow in the pool, the pool would be level throughout its entire length. This is the “project pool” level that ensures a nine-foot channel depth. When there is flow, there is a slope to the water surface. Typically the water surface is maintained at project pool elevation at a predetermined point, upstream of the dam, known as the “primary control point”. Its location is near the point of intersection of the “project pool” (flat pool level) and the “ordinary high water” profile. The ordinary high water mark can be considered “the point up to which the presence and action of the water is so continuous as to destroy the value of the land for agricultural purposes by preventing the growth of vegetation, constituting what may be termed any ordinary agricultural crop”. The government of the United States holds an easement to use the riparian lands up to the ordinary high water, in the public interest. Therefore, land inundated by the lock and dam above the ordinary high water profile was purchased in fee. This land lies between the primary control point and the dam.

Initial research on the nine-foot channel project showed a need for a lock and dam in the vicinity of La Crosse, Wisconsin. However, due to the damage that would

occur to the city of La Crosse, no site at or immediately below the city was feasible. Additionally, since the city and other conditions limited the pool elevation of Lock and Dam No. 8 below, it was necessary to construct Lock and Dam No. 7 as close to La Crosse as possible. Most of the channel upstream of La Crosse is sinuous and did not offer suitable sites for a lock. The final site for Lock and Dam No. 7 was chosen at the downstream end of Dresbach Slough, which was reopened to provide the upper approach to the lock. The design for Lock and Dam No. 7 provides for the project pool to be maintained at elevation 639.0 feet (1912 adjustment). The theoretical primary control point for Lock and Dam No. 7 is within the structure of Lock and Dam No. 6. Since the project pool elevation cannot be maintained at the primary control point, the pool is held in secondary control at Lock and Dam No. 7. Therefore, there is no drawdown as flow increases. The gates are simply raised to maintain the pool at the dam at elevation 639.0 ± 0.2 feet. As inflow continues to increase, eventually all the gates are raised above the water surface and open river conditions exist. When this condition occurs, the dam is said to be “out of control”.

The project design flood for Lock and Dam No. 7 was the flood of 1880. The design high water was elevation 645.35 feet with a flow rate of 190,000 cfs. The total number of gates required at each site was based on the allowable swellhead at extreme high water. For Lock and Dam No. 7, the swellhead was limited to less than one foot. This limitation required that the available floodway area be utilized to the greatest possible degree. As a consequence gate sills were set to the lowest possible elevation. The main channel at the lock and dam is narrow. The double locks occupy a large portion of the main channel and the five roller gates utilize much of the remaining space, leaving room for only 11 tainter gates. To obtain the required spillway area, a 1,000-foot-long concrete fixed crest spillway was constructed within the earthen embankment upstream of Round Lake. With the crest height set at the project pool elevation of 639.0 feet, there was little flow through the lake. Therefore, in 1967 three slots were cut into the concrete spillway to provide flow through the upstream and downstream

backwater areas helping to aerate the water for fish habitat. Each slot is 9.0 feet long and 2.5 feet deep. At project pool, they provide a total flow of 210 cfs. In addition, the earthen dike to the east of the concrete spillway cut off flow to French Lake. In 1994 a 30-inch RCP aeration culvert was placed through the dike near where it intersects with the west side of French Island. Flow through the culvert is controlled with a slide gate that is set to pass approximately 25 cfs during the summer months and 5 cfs during the winter months.

To maintain flow down the Black River, the Onalaska Dam was constructed. It is located at the east end of earthen dike where it ties into high ground at the railroad embankment (**Plate 2-1**). It is 670 feet long and consists of an overflow section and a culvert section (see **Figure 2-5**). Both sections have a crest elevation of 639.0 feet. The overflow section is 583 feet long with a pool side slope of 1V:3H and a tailwater side slope 1V:4H. The crest and side slopes were originally constructed of derrick stone and riprap. In 1994-1995, the stone was replaced with reinforced concrete and the channel riprap protection was extended downstream. Two sluiceways, 3.5 feet deep and 8 feet wide, that used to cut through the overflow section were also eliminated in the major rehab. Next to the overflow section is the culvert section. It is 87 feet in length. There were originally nine 3-foot by 4-foot box culverts spread out over its length. Flow through the box culverts was controlled by stop logs. Summer flow was regulated to approximately 1,500 cfs. The nine culverts were replaced with four 3-foot by 9-foot box culverts as part of the major rehab in 1994-95. The upstream and downstream inverts remained unchanged at elevation 629.0 feet and 627.0 feet respectively. While the flow area remained the same, a new stop log arrangement was required. The Wisconsin Department of Natural Resources through trial and error determined the number of stop logs required to produce approximately 1,000 cfs of flow for summer operation. The desired outflow for fish habitat during the winter months was 500 cfs. Again through trial and error, the WDNR determined that three additional stop logs placed in each of the outside culverts would

produce the desired effect. The stop logs are installed in late October and are removed following high water in the spring when river conditions permit.

3-03. Construction. The lock was put into operation on 19 April 1935. Construction of the lock began on 22 November 1933 and was completed on 1 April 1935. Construction of the dam began on 4 September 1935 and was completed on 7 April 1937. The earth dike was completed on 13 October 1936. The Onalaska Dam was completed 15 December 1936. Other structures related to the lock and dam included the stage recorder houses (completed 27 November 1936) and the temporary access road (completed 5 May 1938). The total cost of Lock and Dam No. 7 was set at \$5,805,000 in 1939.

3-04. Related Projects. Lock and Dam No. 7 is one part of the 29 locks and dams on the Mississippi River necessary to maintain the nine-foot navigation channel between Minneapolis, Minnesota and St. Louis, Missouri. Thirteen of the 29 locks and dams are located in the St. Paul District. These include Upper and Lower St. Anthony Falls and Lock and Dam No. 1 through No.10.

3-05. Modifications to Regulation.

a. 1948 Modification. The nine-foot channel depth was only important during the navigation season. Therefore, the pool could be drawn down over the winter months whenever it was considered necessary. By the 19 June 1948 amendment to the act of Congress dated 10 March 1934, entitled “An act to promote the conservation of wildlife, fish and game, and for other purposes”, drawdown of the pool was prevented. The amendment states the “...dam structures shall generally operate and maintain pool levels as though navigation was carried on throughout the year.”

b. 1973 Modification. The discharge through the dam was reevaluated in 1973. This resulted in a slight change in the discharge per foot of opening on the roller and tainter gates. Therefore, the Gate Regulation Schedule was revised.

Included in this revision was a redistribution of flow across the dam. The previous Gate Regulation Schedule had a more even flow distribution across the dam; however, to achieve that, the recommended tainter gate settings hugged the maximum allowable outflow velocity (4.5 feet per second). The new Gate Regulation Schedule, distributed flow across the dam based on a more equal distribution of outflow velocities.

- c. 1983 Modification.** In 1981 the Waterways Experiment Station began a study of the scour protection upstream and downstream of the Mississippi River dams and published their results in *Scour Protection for Locks and Dams 2-10, Upper Mississippi River*, Technical Report HL-87-4, April 1987. Since 1943, hydrographic surveys indicated that scour had occurred upstream and downstream of the dam. The purpose of the study was to develop a riprap design that would stabilize the existing conditions. Based on the preliminary results of the study, additional riprap protection was placed upstream and downstream of the dam in 1983. The riprap was designed to remain stable for the following condition; full open or half open single gate with normal pool and minimum tailwater. Before placement of the riprap, the maximum allowable gate openings were based on a flow velocity of 4.5 feet per second; however, for emergency purposes, it was permissible for flow velocities to go as high as 6.0 feet per second. Because of the additional channel stability, the maximum outflow velocity for routine gate movements was raised to 6.0 feet per second, and under emergency situations, this velocity may be exceeded for brief periods (i.e. 15 to 20 minutes). Therefore, a new Gate Regulation Schedule was developed showing the new maximum allowable gate openings.
- d. 1994 Modification.** The motors that operate the lock miter gates were raised in 1994. Before this, the motors were pulled when the pool reached elevation 643.5 feet. Since the motors were raised, the lock does not go out of operation until the pool is half a foot from the top of the lock wall or elevation 646.5 feet (1912 adjustment).

In 1994 a 30-inch RCP aeration culvert was placed through the dike near where it intersects with the west side of French Island to provide flow to French Lake. Flow through the culvert is controlled with a slide gate that is set to pass approximately 25 cfs during the summer months and 5 cfs during the winter months; however, it often becomes plugged with drifting weeds and becomes inoperable.

- e. **1995 Modifications.** Historically, winter regulation allowed a 0.3-foot drawdown at the lock and dam. The drawdown was for the purpose of providing for delays in gate operations due to icing conditions. The Water Level Management Task Force, which is a subcommittee of the River Resource Forum, request that drawdown be abandoned on a trial basis. Further more, they requested Water Control to operate on the high side of the band (i.e. 639.0 ± 0.3 feet) during winter regulation. The purpose being to keep as much volume of water as possible in the backwater areas to avoid or diminish dissolved oxygen depletion. Because of the plans success, the committee officially requested in the year 2000 that this be incorporated as a routine part of the operating plan.

Major rehabilitation of the Onalaska Dam resulted in a minor change in operation. Flow through the four culverts is controlled by stop logs. Through trial and error, the Wisconsin Department of Natural Resources has determined that the placement of three stop logs in each of the end bays reduces flow sufficiently for fish habitat during the winter months. The stop logs are placed by site personnel in late October and are removed following high water in the spring.

- f. **2002 Modification.** Outflow measurements for the roller and tainter gates were taken between October 1992 and October 1993. The results published by the US Geological Survey in 1995 showed a shift in the discharge per foot for the roller and tainter gates. The largest shifts occur at high head

differentials (>5 ft) for the roller gates and moderate head differentials (3 to 6 ft) for the tainter gates. A new Gate Regulation Schedule (**Table 7-4**) was developed based on these findings.

3-06. Principal Regulation Problems.

- a. French Lake Culvert.** In 1994 a 30-inch RCP was installed through the earthen dike at the west side of French Island. The purpose was to provide flow into French Lake. Operations were normal at first; however, the collection of weeds around the culvert inlet soon became a problem. To maintain the operability of the culvert requires periodic removal and disposal of the weeds. This is not a small task. The following photo shows the amount of weeds that collect along the shoreline. The pipe sticking up near the center of the photo marks the culvert entrance.



Figure 3-1. French Lake Aeration Culvert.

- b. Onalaska Dam.** The installation and removal of stop logs at the Onalaska Dam is also a regulation problem. Six stop logs are installed in late October and are removed following high water in the spring. The pool must be

lowered to below 639.0 feet to make the crest of the dam accessible by crane. The Lockmaster hires a crane for the placement and removal of the stop logs. The operation is very difficult.

- c. **Zebra Mussels.** A problem that could have a significant impact on future operations at the lock is the infestation of zebra mussels. Zebra mussel populations are present at all St. Paul District locks and dams on the Upper Mississippi River. It is possible that they may foul the gage wells, concrete surfaces, and untreated metal surfaces such as the lock miter gates. Masses of dead zebra mussels could accumulate in the gate recesses, hindering operation. When the lock was dewatered for inspection during the winter of 1994-1995, it was noted that zebra mussels had attached themselves in sporadic fashion along the lock culverts and other areas. The St. Paul District developed a “*Zebra Mussel Response Plan*” in November 1997. There were five methods for short-term control identified for locks and dams. The following tables show the possible problems and the recommended control techniques identified in the study.

Table 3-1 Zebra Mussel Control Techniques		
Code	Method	Description
A	Physical Removal	Removed by scraping, brushing, or high-pressure water or steam spraying.
B	Molluscicides	Primarily oxidizing biocides (chlorine) with possibility of periodic use of nonoxidizing biocides.
C	Thermal Treatments	Hot water, steam, or air injection periodically to kill adult and larval zebra mussels.
D	Dewatering Dislocation	Isolation of susceptible components from the river. Components removed from river if possible.
E	Replacement Components	Replacement components which can be easily removed should infestation occur.

**Table 3-2
Proposed Zebra Mussel Control Techniques for Locks and Dams**

Component	Potential Problem	Method
Lock Walls	Heavy encrustations can be expected. Structural damage limited to abrasion during cleaning.	A,D
Gages	Occlusion of the pipe leading from the well to the river. Encrustation of level markings.	A,B,C,D
Thermometers	Encrustations could reduce reliability of readings.	A
Miter Gates	Increased corrosion of metal surface, paint deterioration, and unbalanced loading.	A,D
Bulkhead Slots	Accumulation along the sealing surfaces.	A,D
Lock Culverts	Reduced flow area and increased roughness could cause increased emptying and filling times.	A,D
Roller Gates	Increased gate weight and corrosion.	A,D
Side Seals	Accelerated deterioration of seals.	A,D,C,E
Tracks, Chains, Cables	Accumulation could prevent movement of roller gates. Metal and paint deterioration.	A,D

IV – WATERSHED CHARACTERISTICS

- 4-01. General Characteristics.** The drainage area of Pool No. 7 totals 62,340 square miles in Minnesota and Wisconsin. At project pool elevation of 639.0 feet (1912 adjustment), the pool has a total surface area of 13,440 acres. Except for several small creeks, the only major tributary that flows into Pool No. 7 is the Black River with a total drainage area of 2,250 square miles. The Black River enters the pool from the Wisconsin side, just upstream of Lock and Dam No. 7.
- 4-02. Topography.** The Master Water Control Manual for Locks and Dams contains a description of the topography for the Upper Mississippi River basin. Presented here is a description of the topography for Black River. The Black River basin covers an area of about 2,250 square miles and enters the Mississippi River at river mile 708.7. It drains an area of 2,080 square miles above Galesville, Wisconsin, near its confluence with the Mississippi River, and 1,290 square miles above the Hatfield Dam near Black River Falls, Wisconsin. Upstream of Black River Falls, the river flows through a region of flat to gently rolling terrain in a previously glaciated area. The drainage network is young and mainly postglacial, and valleys are shallow. There are widespread swampy areas east of Black River Falls. Compared to the upper reaches of other river systems in the region, the slope of the Black River is relatively mild and uniform, at about 6 feet per mile. This is due to the presence of a crystalline bedrock substrate, which has limited downcutting. Downstream of Black River Falls, the river enters the unglaciated "driftless area", an area characterized by deeply cut valleys, or coulees, above which are areas of relatively uniform tableland. Here the river flows in a meandering manner through a thick alluvial fill at a slope of about 2 feet per mile to its confluence with the Mississippi River at La Crosse, Wisconsin near Mississippi River Mile 709. There are two impoundments on the Black River: Lake Arbutus, formed by the Hatfield Dam, and an unnamed impoundment formed by the Black River Dam in Black River Falls. Land use in the basin is

predominately agricultural, with some recreational use around Lake Arbutus and along parts of the main Black River channel.

4-03. Sediment. Part of the nine-foot navigation plan authorized by Congress included periodic dredging of sediment. There are seven sites within Pool No. 7 navigation channel that require periodic dredging. Also requiring periodic dredging is the lower approach to Lock No. 7 (Pool No. 8). Quantities and frequency of dredging for these areas is presented in **Paragraph 5-03**.

4-04. Climate. The National Weather Service maintains temperature and precipitation records for Lock and Dam No. 7. Temperature and precipitation data shown in the **Tables 4-1** and **4-2** respectively were taken from National Oceanic and Atmospheric Administration’s *Climatological Data Annual Summaries*, for La Crosse Airport, Wisconsin.

Table 4-1 30-Year Normal Monthly Temperature in Degrees Fahrenheit												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
14.4	19.9	32.8	47.7	59.5	68.5	73.5	70.8	61.8	50.2	35.6	20.3	46.3

Table 4-2 30-Year Normal Monthly Precipitation in Inches												
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
0.93	0.90	1.98	2.88	3.26	3.90	3.79	3.92	3.79	2.20	1.73	1.27	30.55

Pan evaporation data was collected at Lock and Dam No. 6, but stopped after 1997. The results are shown in **Table 4-3**. Pool evaporation was estimated by assuming a pan coefficient of 0.7.

Table 4-3 Pan and Pool Monthly Evaporation in Inches (Lock and Dam No. 6)								
	Apr	May	Jun	Jul	Aug	Sep	Oct	Period of Record
Pan Evaporation	0.26	3.35	3.92	5.15	4.66	2.88	0.65	(1983 – 1997)
Pool Evaporation	0.18	2.35	2.74	3.61	3.26	2.02	0.46	(1983 – 1997)

Wind speed and direction are recorded each morning at Lock and Dam No. 7. While this information is valuable for the regulation of the dam, it is of little value for presenting monthly highest wind speeds and directions. The *Climatic Atlas of the United States* (June 1968) contains monthly Fastest Mile information for La Crosse, Wisconsin. Fastest Mile wind speeds are defined as the fastest speed at which wind travels one mile measured over one month. Fastest Mile wind speeds are typically obtained from a short period of time, usually less than two minutes duration. The Fastest Mile wind speeds presented in the Atlas were modified to time-dependant (1-hour) average wind speeds using procedures presented in the US Army Corps of Engineers' *Shore Protection Manual* (1984).

Table 4-4 Highest Monthly Wind Speed and Direction in MPH												
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Direction	NNW	WNW	NNW	SSW	E	NNW	N	N	SSW	WNW	S	NNW
Fastest Mile	35	36	40	50	58	60	36	46	36	38	46	43
1-Hour	29.5	30.3	33.3	41.0	46.8	47.2	30.3	37.9	30.3	31.8	37.9	38.1

Because of the bluffs along the river, winds tend to be channeled either up river or down river. The wind blowing across the pool surface exerts a horizontal force on the water surface and induces a surface current in the general direction of the wind. The horizontal currents induced by the wind essentially cause water to “pile up” on the downwind side, resulting in a water level rise downwind and a

water level drop upwind. The change in water level is due to “wind setup”. The rise in water can be estimated by (EM 1110-2-1414):

$$S = (U^2 F) / (1400 D)$$

Where,

- S = Wind Setup (ft)
- U = Wind Speed (mph)
- F = Fetch Length (miles)
- D = Average Depth over Fetch (ft)

The above equation neglects the time required for the full wind setup to occur. The stronger the wind, the more time required. While it is recognized that the relationship is not linear, a rule of thumb has been developed that seems to work quite well for the lock and dam pools. For each ten miles per hour of wind speed, figure the change in the pool level to be 0.1 feet. Therefore, a northern wind at 20 mph would cause a 0.2 feet rise in the water surface at the dam, and conversely, a southern wind of 10 mph would result in a lowering of the water surface at the dam by 0.1 feet.

4-05. Storms and Floods. While an isolated storm over the Black River basin can have a significant impact on water levels in Pool No.7 during low flows, it is high inflows from upstream that produce flooding of the pool. After construction of the Lock and Dam in 1937, the first significant flood event did not occur until spring of 1951. On the 18th of April, the Mississippi River at La Crosse crested at 1.9 feet above flood stage with a gage height of 13.9 feet (elevation 640.25 ft - 1912 adjustment). This stage was exceeded the following year. On the 20th of April 1952, the La Crosse gage peaked at 15.3 feet (elevation 641.62 ft) with a peak pool gage elevation of 644.9 feet. Estimated discharge was 196,000 cfs. This remained the flood of record until 1965. **Table 4-5** gives a summary of peak elevations and discharges followed by a brief description of some of the larger events.

Table 4-5 Summary of Peak Stages/Elevations and Discharges					
Dakota, MN Approx. Mid-Pool		Lock and Dam No. 7			
Date	Elev. ft (1912)	Date	Pool ft (1912)	Tailwater ft (1912)	Discharge cfs
19-Apr-51	645.55	19-Apr-51	644.39	643.85	-
20-Apr-52	646.00	20-Apr-52	644.85	644.30	-
7-May-54	644.95	7-May-54	643.63	643.04	-
21-Apr-65	649.08	21-Apr-65	648.18	647.48	273,000
7-Apr-67	645.35	7-Apr-67	644.15	643.55	180,000
20-Apr-69	646.57	20-Apr-69	645.50	644.87	208,000
1-May-75	645.30	1-May-75	644.15	643.45	168,300
26-Jun-93	645.40	27-Jun-93	643.74	643.20	182,300
12-Apr-97	645.83	12-Apr-97	644.47	643.75	194,300
18-Apr-01	648.51	18-Apr-01	645.91	645.19	231,400

- a. **April - May 1965.** Because of the magnitude of the snow-water content on the ground, forecasts and warnings of floods were issued by the Weather Bureau (now the National Weather Service). An advisory on the flood potential in the Upper Mississippi River basin was published as early as the 19th of March 1965. The forecast predicted a stage of 14.5 feet at Winona, Minnesota (flood stage is 13.0 feet) and a stage of 13.5 feet at La Crosse, Wisconsin (flood stage is 12.0 feet) with normal precipitation and a snowmelt period of more than three days. This forecast meant that at Lock and Dam No. 7 a pool stage of 642.6 feet would be reached with a flow of 144,000 cfs. Also, the forecast cautioned that if rainfall of one inch should occur before or during the crest, the resulting peak stages would be near 1952 levels. Almost four inches of rain fell in the first two weeks of April. The Weather Bureau revised the forecast for Winona and La Crosse, predicting stages of 21.0 feet and 18.0 feet, respectively. The forecasted discharge of almost 270,000 cfs translated into a predicted elevation of 648.0 feet (1912 adjustment) at Lock

and Dam No. 7. Based on this, the earthen dike with a crest elevation of 649.0 feet was raised 2 feet to provide sufficient freeboard and the spillway abutments and Onalaska Dam abutments were protected by sandbags. Because the top of the lock walls are also at elevation 647.0 feet, the central control station had to be ringed with sandbags. The rapid increase of inflow began on the 1st of April when the discharge rose from 13,000 cfs on this date to 102,000 cfs on the 8th of April. By this time the head at the dam had been reduced to 0.40 foot and the gates were removed from the water. The motors that operate the lock miter gates were pulled on the 12th of April and the lock was out of operation until the 6th of May. The Mississippi River crested at elevation 660.82 feet (stage 20.7 ft) at Winona on the 20th of April and elevation 644.22 feet (stage 17.9 ft) at La Crosse on the 21st of April. This was 7.7 feet and 5.9 feet above flood stage, respectively and was nearly three feet higher than the peak stage of 1952. The pool at Lock and Dam No. 7 crested on the 21st of April at elevation 648.18 feet with a peak flow 273,000 cfs. The pool returned to secondary control (elevation 639.0 feet) on the 25th of May. In Pool No. 7, damages caused by the flood of 1965 totaled \$780,000 classified as follows: urban damages were \$309,000, agricultural damages were \$45,000, and transportation damages (railroads and highways) were \$426,000.

- b. April 1997.** The magnitude of the snow-water content on the ground indicated a high potential for flooding along the Upper Mississippi River. On the 13th of March, the National Weather Service outlook predicted a stage of 15.5 feet at La Crosse, Wisconsin. On the 13th of April, La Crosse crested at 15.01 feet (elevation 641.33 feet – 1912 adjustment). The pool at the dam crested on the 12th of April at elevation 646.3 feet. Peak discharge was 194,500 cfs. The motors that operate the lock miter gates were relocated to a higher elevation in 1994, which allowed the Lock No. 7 to remain open.

c. **April 2001.** The National Weather Service’s 2001 Spring Snowmelt Flood Outlook predicted minor to moderate flooding for Pool No. 7. This forecast was primarily due to the significant autumn precipitation the year before and the heavy winter snowfall. A less than ideal snowmelt followed by record breaking April precipitation resulted in producing the second highest flood stages in Pool No. 7. In the early morning of 18 April, the stage at La Crosse, Wisconsin peaked at 16.41 feet (elevation 642.73 ft – 1912 adjustment). On the 18th of April, the pool at Lock and Dam No. 7 peaked at elevation 645.91 feet with a discharge of 231,400 cfs. However, additional rainfall runoff resulted in a second crest of elevation 645.20 feet on the 30th of April. Although the lock may have remained in operation, the Coast Guard closed the river to navigation from the 9th of April to the 9th of May. By this time the pool had fallen to elevation 642.53 feet.

4-06. Runoff Characteristics. The mean annual discharge at Lock and Dam No. 7 is 33,300 cfs based on a period of record from 1959 to 1993. The following table shows the monthly average discharges.

Table 4-6 Monthly Average Flow in cfs – (Years 1959 to 1993)											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
16,800	17,100	35,200	68,500	55,300	43,400	34,600	23,700	26,800	28,300	28,800	21,000

The maximum discharge of 273,000 cfs occurred, at the dam, on 21 April 1965 (**Table 4-5**). The minimum discharge of 4,100 cfs occurred on 11 Dec 1961. A discharge frequency curve for the Mississippi River at the confluence with the Black River is shown on **Figure 8-1**. The following table shows the discharge-duration at the dam.

Table 4-7
Discharge-Duration at Lock and Dam No. 7
Percent Time At or Above Indicated Discharge (Years 1972-2000)

Discharge	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
180,000				0.9		0.2							
175,000				1.0		0.6							0.1
170,000				1.2	0.1	0.7							0.2
165,000				1.3	0.3	0.9	0.2						0.2
160,000				1.4	0.4	0.9	0.4						0.3
155,000				1.5	0.4	1.0	0.7						0.3
150,000				2.0	0.6	1.0	0.8						0.4
145,000				2.3	0.7	1.0	0.9						0.4
140,000				2.8	0.8	1.0	0.9		0.3				0.5
135,000			0.1	3.5	0.8	1.0	1.0		0.5	0.2			0.6
130,000			0.8	3.7	0.9	1.0	1.6		0.6	0.3			0.7
125,000			1.0	4.1	1.0	1.0	1.9		0.6	0.4			0.8
120,000			1.1	5.2	1.1	1.0	2.1		0.6	0.4			1.0
115,000			1.3	6.1	1.2	1.2	2.2		0.7	0.6			1.1
110,000			1.7	8.3	1.8	1.2	2.3		0.7	0.7			1.4
105,000			2.0	9.9	3.2	1.2	2.5		0.7	0.7			1.7
100,000			2.5	12.6	5.3	1.3	2.7		0.7	0.8			2.2
95,000			2.9	15.6	6.9	2.1	2.8		0.7	0.9			2.7
90,000			3.9	19.2	8.7	2.5	3.0	0.1	0.7	1.2			3.3
85,000			5.0	23.2	11.1	3.6	3.5	0.4	0.7	1.6			4.1
80,000			7.1	28.7	15.1	5.2	3.9	0.6	0.8	2.0			5.3
75,000			10.6	37.9	24.5	7.1	5.2	0.8	1.2	3.2	0.1		7.6
70,000			13.6	49.3	33.2	10.0	7.8	1.3	1.8	5.0	0.6		10.2
65,000		0.6	17.1	59.5	40.9	14.0	11.6	4.1	2.8	6.5	3.6		13.4
60,000		0.9	20.5	65.8	48.1	19.9	15.2	6.1	5.3	9.0	6.1		16.4
55,000		1.2	24.8	70.7	54.0	26.8	22.7	8.7	8.2	11.1	7.8	0.7	19.8
50,000		1.5	29.0	75.1	58.8	34.1	30.7	11.0	12.6	14.2	10.9	1.4	23.4
45,000		1.6	32.5	78.5	64.1	45.2	35.9	14.7	17.7	19.0	15.5	2.2	27.3
40,000	0.3	2.7	39.8	82.0	69.9	57.4	46.4	20.4	24.7	24.9	21.5	4.6	33.0
35,000	1.0	4.3	47.6	84.8	75.1	69.3	54.5	29.7	31.8	31.4	36.9	10.9	39.9
30,000	5.7	7.0	57.5	90.3	81.1	76.1	64.6	40.4	40.1	40.2	49.8	23.2	48.1
25,000	20.7	17.1	67.5	96.0	85.8	81.5	71.9	53.1	53.2	52.1	64.4	39.7	58.7
20,000	41.7	39.8	80.4	98.7	92.2	86.6	78.0	68.5	66.4	66.6	79.1	58.0	71.5
15,000	71.2	73.4	93.2	99.7	96.6	92.6	85.9	81.1	81.5	78.8	91.8	78.3	85.4
10,000	94.9	94.0	99.2	100.0	100.0	97.6	94.3	93.0	95.5	96.3	96.0	92.3	96.1
5,000	100.0	100.0	100.0	100.0	100.0	100.0	100.0	99.8	99.5	100.0	100.0	99.9	99.9
0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Construction of the lock and dam greatly influenced stage-duration curves throughout the pool. Based on a period of record from 1972 to 2000, the following three elevation-duration tables were developed for the pool, tailwater, and the mid-pool point at Dakota, Minnesota. The tables indicate the percent of time the water surface is at or above the indicated elevation (1912 adjustment). Gage zero for the pool and tailwater gages is elevation 600.00 feet. Gage zero for the Dakota gage is 631.56 feet.

Table 4-8
Elevation-Duration, Lock and Dam No. 7 Tailwater
Percent of Time At or Above Indicated Elevation (Years 1972 to 2000)

Elev.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
643.0				0.9	0.3	0.3							0.1
642.5				1.6	0.5	0.8	0.1						0.2
642.0				2.3	0.7	1.0	0.6		0.3				0.4
641.5			0.5	2.6	0.8	1.0	0.8		0.6	0.3			0.6
641.0			1.1	3.8	1.0	1.0	1.0		0.7	0.4			0.8
640.5			1.5	5.6	1.3	1.0	1.7		0.7	0.5			1.0
640.0			2.1	7.8	2.7	1.2	2.1		0.7	0.7			1.4
639.5			2.6	11.3	4.3	1.4	2.3		0.7	0.8			1.9
639.0			2.9	16.2	6.7	2.2	2.6		0.7	1.3			2.7
638.5			4.1	21.9	9.8	2.9	3.0	0.4	0.8	1.6			3.7
638.0			5.9	27.6	14.5	4.1	4.1	0.6	0.9	2.3			5.0
637.5			7.1	33.0	19.1	5.4	5.3	0.8	1.0	2.9			6.2
637.0			9.3	38.2	26.0	7.0	6.8	0.8	1.2	3.6			7.8
636.5		0.9	12.2	45.6	32.0	9.9	8.9	1.3	1.7	4.6	0.6		9.8
636.0		1.1	14.9	53.9	37.6	12.2	11.6	3.1	2.4	5.6	2.0		12.1
635.5		1.1	18.2	62.5	46.5	18.1	15.4	5.6	4.1	7.1	4.2	1.0	15.3
635.0		1.3	22.7	66.9	52.1	24.0	20.6	7.9	6.1	10.3	7.0	2.0	18.5
634.5	0.1	2.1	27.1	72.4	56.6	31.3	27.1	10.1	10.9	12.1	10.0	4.6	22.1
634.0	1.1	4.0	33.0	77.4	61.0	42.9	34.0	12.9	15.8	16.5	13.8	9.3	26.9
633.5	7.5	6.5	41.3	79.6	65.0	54.0	40.0	17.1	21.6	21.5	19.5	16.5	32.6
633.0	18.1	16.6	51.4	83.0	72.4	62.8	48.9	23.1	28.7	28.0	28.5	25.0	40.6
632.5	31.8	26.5	63.0	87.7	77.8	72.2	57.8	33.9	35.6	35.8	44.9	36.3	50.4
632.0	50.3	49.4	78.1	93.2	84.7	79.4	68.7	46.1	47.8	50.6	60.8	49.4	63.2
631.5	76.6	81.7	92.1	98.1	92.4	90.5	80.5	71.2	72.0	72.4	81.7	73.5	81.8
631.0	98.2	98.9	99.6	100.0	99.6	99.2	98.4	97.4	97.5	99.1	98.5	94.8	98.4
630.5	99.9	100.0	100.0	100.0	100.0	100.0	99.9	100.0	100.0	100.0	100.0	99.3	99.9
630.2	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 4-9
Elevation-Duration for Dakota, Minnesota
Percent of Time At or Above Indicated Elevation (Years 1972 to 2000)

Elev.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
645.5				0.7		0.1							
645.0				1.2	0.4	0.6							0.2
644.5				1.9	0.5	1.1	0.5		0.2				0.4
644.0				2.6	0.7	1.1	0.8		0.7	0.2			0.5
643.5			0.8	3.8	0.9	1.1	1.0		0.7	0.4			0.7
643.0			1.3	5.4	1.3	1.2	2.0		0.7	0.6			1.0
642.5			1.9	8.3	2.8	1.2	2.2		0.7	1.4			1.6
642.0			3.0	12.5	5.4	1.9	2.5		0.8	2.3			2.4
641.5		0.7	4.7	19.1	8.9	2.9	3.2	0.2	0.9	2.9		0.9	3.7
641.0		1.2	9.0	28.7	17.6	5.4	5.8	0.5	1.1	3.6	0.1	1.8	6.3
640.5	0.4	1.6	18.6	47.2	30.5	12.0	13.8	4.1	3.2	5.4	2.4	4.2	12.1
640.0	5.1	4.9	36.6	69.8	49.2	27.4	29.6	10.9	9.4	12.2	9.6	15.7	23.6
639.5	32.6	29.6	62.4	85.5	74.7	64.4	57.8	33.8	32.0	30.7	38.7	40.5	48.8
639.0	95.3	97.3	98.7	99.4	99.3	98.7	97.9	96.4	95.8	94.4	96.9	93.1	97.0
638.5	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	99.9	100.0	100.0	100.0
638.4	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 4-10
Elevation-Duration, Lock and Dam No. 7 Pool
Percent of Time At or Above Indicated Elevation (Years 1972 to 2000)

Elev.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
644.0				0.7	0.2								
643.8				0.9	0.3								0.1
643.6				0.9	0.3	0.2							0.1
643.4				1.2	0.4	0.5							0.2
643.2				1.7	0.4	0.7							0.2
643.0				1.7	0.6	0.8	0.1						0.3
642.8				2.1	0.6	0.9	0.3						0.3
642.6				2.4	0.7	0.9	0.6		0.1				0.4
642.4				2.5	0.8	1.0	0.7		0.3				0.4
642.2			0.3	2.5	0.9	1.0	0.8		0.6	0.1			0.5
642.0			0.7	3.1	0.9	1.0	0.8		0.6	0.2			0.6
641.8			0.8	3.5	1.0	1.0	0.9		0.6	0.3			0.7
641.6			1.1	3.9	1.1	1.0	0.9		0.7	0.3			0.8
641.4			1.2	4.5	1.1	1.0	1.0		0.7	0.4			0.8
641.2			1.5	5.2	1.2	1.0	1.1		0.7	0.4			0.9
641.0			1.6	6.1	1.5	1.0	1.8		0.7	0.6			1.1
640.8			1.8	6.7	1.9	1.0	1.9		0.7	0.6			1.2
640.6			2.1	7.7	2.7	1.2	2.0		0.7	0.7			1.4
640.4			2.2	8.6	3.2	1.2	2.1		0.7	0.7			1.6
640.2			2.5	10.1	3.8	1.2	2.2		0.7	0.8			1.8
640.0			2.7	12.2	4.6	1.4	2.3		0.7	0.8			2.1
639.8			3.0	14.1	5.5	1.8	2.5		0.7	0.9			2.4
639.6			3.7	16.3	6.7	2.3	2.7		0.9	1.1			2.8
639.4			5.3	19.7	7.7	3.2	3.3	0.2	1.3	1.9	0.2	0.9	3.7
639.2	7.9	8.1	22.1	32.3	16.8	14.6	14.9	12.4	12.3	12.2	11.7	13.9	15.0
639.0	49.9	50.4	60.3	67.0	56.0	57.5	63.5	62.3	61.8	62.9	62.2	59.2	59.5
638.8	89.0	88.2	92.3	94.8	91.9	92.2	96.2	95.0	94.9	93.6	92.6	88.5	92.5
638.6	99.4	96.7	99.3	99.7	99.0	99.1	99.9	99.4	99.7	97.6	98.6	98.5	98.9
638.4	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

At a flat pool elevation of 639.0 feet (project pool), the storage volume in Pool No. 7 is 74,200 acre-feet. There is no drawdown at the dam. That is, elevation 639.0 ± 0.2 feet is held at the dam until all the gates are raised clear of the water. For the purpose of computing the storage volume in Pool No. 7, the pool was divided into two reaches; Dakota to the tailwater of Lock and Dam No. 6 and Dakota down to Lock and Dam No. 7 (**Table 4-11**). The total storage is the sum of the storage in the two reaches. Assuming an elevation of 639.0 feet at the dam, elevation 641.0 at Dakota, MN, and elevation 644.0 at the tailwater of Lock and Dam No. 6, the approximate volume of Pool No. 7 would be 103,000 acre-feet. A flow rate of approximately 51,900 cfs would result in a daily exchange in storage. A relationship of storage to discharge is shown on **Plate 4-1**.

Table 4-11
Storage Volume of Pool No. 7 in 1,000 Ac-Ft
Between Dakota, MN and Lock and Dam No. 6

TW Elev. Dam 6	Elevation at Dakota, MN – 1912 Adjustment																			
	650	649	648	647	646	645	644	643	642	641	640	639	638	637	636	635	634	633	632	631
654	168	157	146																	
653	162	152	142	132																
652	157	148	139	128	119															
651		141	132	124	114	106														
650			128	119	111	102	93													
649				114	106	98	90	81												
648					101	93	85	77	69											
647						89	82	74	66	59										
646							77	70	62	56	49									
645								66	59	52	46									
644									56	49	44	39								
643									52	47	42	37	33							
642									49	44	39	35	31	28						
641										40	36	32	29	26	24					
640											33	30	27	24	22	20				
639												27	24	22	20	18	17			
638													22	20	18	17	15	14		
637														19	17	15	14	12	11	
636															15	14	12	11	10	9
635																13	12	10	9	8
634																	11	9	8	8
633																		8	7	7

Table 4-11 continued
Storage Volume of Pool No. 7 in 1,000 Ac-Ft
Between Dakota, MN and Lock and Dam No. 7

Pool Elev. Dam 7	Elevation at Dakota, MN – 1912 Adjustment																					
	648	647	646	645	644	643	642	641	640	639	638	637	636	635	634	633	632	631	630	629	628	
646	118	115	112																			
645	113	109	106	102																		
644	107	103	100	96	93																	
643		98	94	90	87	84																
642			89	85	81	78	74															
641				79	76	72	69	65														
640					70	66	63	59	56													
639						61	57	54	50	48												
638							52	48	45	42	39											
637								47	43	40	37	34	31									
636									38	35	32	29	26	24								
635										30	27	25	23	21								
634											24	22	20	18	16							
633												19	17	15	14	12						
632													14	13	12	11	10					
631														11	10	9	9	8				
630															9	8	8	7	7			
629																8	7	6	6	5	5	
628																	6	5	5	5	4	4

4-07. Water Quality. The St. Paul District does not collect water quality information for Pool No. 7. However, as an element of the Environmental Management Program (EMP), the Corps of Engineers oversees the Long Term Resource Monitoring Program (LTRMP) of the Upper Mississippi River System. The LTRMP was implemented to provide decision makers with the information needed to maintain the Upper Mississippi River System as a viable multiple-use large river ecosystem. The LTRMP is being implemented by the US Geological Survey (USGS) in cooperation with the states of Illinois, Iowa, Minnesota, Missouri, and Wisconsin with guidance and overall program responsibility by the Corps of Engineers. Recent studies conducted by agencies in Pool No. 7 included an Elevation Survey of Dredge Cuts by the USGS, Terrestrial Vegetation Survey of Rosebud Island by the St. Paul District and US Fish and Wildlife Service and water quality monitoring of Long Lake by the Wisconsin Department of Natural Resources.

4-08. Channel and Floodway Characteristics. The top of the lower lock sill elevation at Lock and Dam No. 6 is elevation 626.5 feet and the top of the upper lock sill elevation at Lock and Dam No. 7 is elevation 621.0 feet. Therefore, there is a 5.5-foot drop in sill elevation along the pool, which has a length of 11.8 miles as measured along the navigation channel. The navigation channel is 300 feet in width in the straight stretches, and varies from 300 feet to 550 feet in the bends. The line of navigation is shown on **Plates 2-4, 2-5 and 2-6.**

4-09. Upstream Structures. Lock and Dam No. 6 is located 11.8 miles upstream of Lock and Dam No. 7. The lock and dam system continues upstream to the Upper St. Anthony Falls lock and dam located in Minneapolis, Minnesota.

4-10. Downstream Structures. Lock and Dam No. 8 is located 23.3 miles downstream of Lock and Dam No. 7. The lock and dam system continues downstream to Lock and Dam No. 27 in St. Louis, Missouri; however, St. Paul District terminates with Lock and Dam No. 10.

4-11. Economic Data. Pool No. 7 lies on the Minnesota-Wisconsin border. Winona County lies on the western side and La Crosse County and a portion of Trempealeau County lie on the eastern side. Based on the US Census Bureau, county populations have increased slightly.

Table 4-12 County and City Populations Near Pool No. 7				
	1990	2000	Difference	Change
County				
Winona, MN	47,828	49,985	2,157	4.5 %
Trempealeau, WI	25,263	27,010	1,747	6.9 %
La Crosse, WI	97,904	107,120	9,216	9.4%
City				
Winona, MN	25,399	27,669	2,270	8.9%
Trempealeau, WI	1,039	1,319	280	26.9%
Onalaska, WI	11,284	14,839	3,555	31.5%
La Crosse, WI	51,003	51,818	805	1.6%

The following table gives a break down of the employment by industry. The data were taken from the US Census Bureau's 1997 Economic Census.

Table 4-13 Employment by Industry – Counties on Pool No. 7 (1997)			
Industry	Winona	Trempealeau	La Crosse
Manufacturing	7,115	4,678	10,171
Wholesale Trade	682	215	3,217
Retail Trade	2,506	1,017	9,005
Real Estate, Rental, Leasing	129	49	774
Professional, Scientific, Tech Services	569	177	1,531
Admin & Support, Waste Management	567	114	2,384
Education Services	10	7	46
Health Care & Social Services	705	207	1,013
Arts, Entertainment & Recreation	134	33	500
Accommodations & Food Services	1,725	713	5,533
Other Services	296	168	1,271
Totals	15,038	7,578	35,445

V - DATA COLLECTION AND COMMUNICATION NETWORKS

5-01. Hydrometeorological Stations.

- a. **Facilities.** The regulation and proper operation of the dam site requires the collection and evaluation of several hydraulic and hydrologic parameters. The Corps of Engineers (COE), US Geological Survey (USGS), and the National Weather Service (NWS) are involved in the data collection network. Inflow to Pool No. 7 from Dam 6 is computed as part of the regulation program, using pool and tailwater elevations, and the gate settings. When the gates are raised clear of the water, a rating table is used. About seven miles downstream of Lock No. 6 is the Dakota gage. It is located on the right bank of Mississippi River approximately 1,500 feet upstream of the railroad station at Dakota, Minnesota (**Figure 5-1**).



Figure 5-1. Dakota, MN Stream Gage

The main tributary to the pool is the Black River, which enters the Mississippi River about seven miles upstream of the lock and dam. The Galesville gage is located on the left bank of the Black River approximately 7 miles upstream of the confluence. It is about 1,000 feet upstream of US Highway 53 Bridge and is 4.5 miles southeast of Galesville, Wisconsin. **Exhibit B** contains the USGS rating table for the Black River gage. The equipment at Dakota and Galesville are owned by the COE, however the gage near Galesville is maintained by the USGS through a cooperative agreement. The COE operates and maintains the pool and tailwater gages at the lock. The gage houses are located on the upper and lower guidewalls about 500 feet from the lock chamber (**Figure 5-2**). Each gage house has a well with a float and tape system that reports elevation to the Stevens PAV-C Recorder located in the central control station (**Figure 5-3**). Staff gages are mounted outside the gage houses and serve as backup or are used for verification of the tape in the well. The locations of these gage sites are shown on **Plate 5-1**.



Figure 5-2. Pool (left) and Tailwater (right) gage houses



Figure 5-3. Stevens PAV-C Pool and Tailwater Elevation Recorders

A water temperature sensor, reading in degrees Fahrenheit, is located in the upper ladder recess. A standard eight-inch precipitation gage is located to the south of the Central Control Station adjacent to the parking lot (**Figure 5-4**). The site is equipped with a measuring rod for snow depth and a snow-tube and scale for determining snow-water content. An anemometer is located on the roof of roller gate Pier No. 1. The National Weather Service has a Fisher-Porter automatic weighing, punched tape, binary decimal recording gage installed at the site (**Figure 5-4**).



Figure 5-4. Corps' Rain Gage and NWS's Rain Gage.

**Table 5-1
Hydrometeorological Stations**

Location	Data Type	Equipment	Notes
Mississippi River at Dakota, Minnesota	Water Surface Elevation & Precipitation	Sutron 8210 Data Recorder GOES Telemetry Voice Modem	Gage Zero: 600.00 (1912) Maintained by Corps NWS ID: DKTMS
Black River nr Galesville, WI	Water Surface Elevation	Campbell CR10 Data Recorder GOES Telemetry Voice Modem	Gage Zero: 658.43 (1929) Flood Stage: 12.0 ft (NWS) Co-Op Gage NWS ID: GALW3
Lock & Dam No. 7 Upper Guide Wall	Pool Elevation	Stevens PAV-C Recorder Staff Gage	Continuous Strip Chart record of pool elevations.
Lock & Dam No. 7 Lower Guide Wall	Tailwater Elevation	Stevens PAV-C Recorder Staff Gage	Continuous Strip Chart record of TW elevations.
Lock & Dam No. 7	Snow Depth & Water Content	Snow Rod, Snow Tube, Scale	Maintained by Corps Gage Crew.
Lock & Dam No. 7 Pier No. 1 Roof	Wind Speed & Direction	Anemometer	Maintained by site personnel.
Lock & Dam No. 7 Upper Ladder Recess	Water Temperature	Water Temperature Sensor	Electronically transmitted to lock house.
Lock & Dam No. 7	Precipitation	Standard 8-inch Rain Gage	Recorded daily.
Lock & Dam No. 7	Precipitation	Fischer-Porter - Weighted Punch Tape	NWS Gage.

b. Reporting. The information needed to regulate the lock and dam is provided to Water Control, via computer by dam personnel, daily at 0630-hours. While morning data is collected between 0600 and 0630-hours, it is archived as 0800-hours. Records are then kept at four-hour intervals (i.e. 0800-hr, 1200-hr, 1600-hr, etc). Each morning lock and dam operators call the gage observer who reads the wire weight on the La Crosse River at West Salem, Wisconsin. They also call the voice modems on the Mississippi River at Brownsville, Minnesota and La Crosse, Wisconsin. These stages/elevations are part of the 0630-hour data report. While the La Crosse River is tributary to Pool No. 8,

the call to the West Salem gage is made by Lock and Dam No. 7 staff because it is a local call. For this same reason, calls to the gages at La Crosse and Brownsville, located in Pool No. 8, are made by Lock and Dam No. 7 staff. Pool and tailwater readings, as well as individual gate settings for the roller and tainter gates, are entered in four-hour increments beginning with the previous day's 0800-hour reading. The Stevens PAV-C strip charts are mailed to Water Control at least once a year where they are then periodically archived on microfilm. Wind speed and direction along with air temperature are entered into the computer at eight-hour intervals, beginning with the 0800-hour reading (actual reading taken between 0600 and 0630-hours). Precipitation total for last 24 hours is measured each morning along with water temperature and reported as an 0800-hour reading. The maximum and minimum air temperatures for the last 24 hours are recorded at 1900-hours daily (reported as 2400-hour reading). During the winter months, percent of ice coverage over the lower pool and upper tailwater, ice thickness, snow depth, and snow-water content (all in inches) are recorded once a week on Sundays. The snow-water content is determined by instructions contained in the National Weather Service Observing Handbook No. 2.

- c. **Maintenance.** The equipment at the four gage sites located at (1) La Crosse River at West Salem, Wisconsin, (2) Mississippi River at Dakota, Minnesota, (3) Mississippi River at Brownsville, Minnesota, and (4) Mississippi River at La Crosse, Wisconsin are property of the Corps of Engineers; however, the Brownsville gage is maintained by the USGS on a periodic basis. The Water Control Gage Crew provides emergency backup. Operation and maintenance of the pool and tailwater gages are the responsibility of the Gage Crew. Dam personnel maintain the Stevens Pav-C strip chart recorders with the Gage Crew used as a backup if necessary. The anemometer, water temperature sensor, and standard precipitation gage are maintained by site personnel; however should the precipitation gage become damaged, a new one would be mailed to the site from Water Control. The Fischer-Porter precipitation gage

is maintained by the National Weather Service. Repair of the snow survey equipment is the responsibility of the Water Control Gage Crew.

5-02. Water Quality Stations. There are no Corps of Engineers' water quality stations in Pool No. 7; however, site personnel may be asked on occasion to assist district office personnel or other federal or state agencies in the collection of water samples and/or water quality measurements in the project area.

5-03. Sediment Stations. Suspended sediment data was collected at the Black River gage from October 1964 to August 1994. Since then, there has been no routine sampling in Pool No. 7 or its tributaries; however, routine dredging of sediment is part of the nine-foot navigation plan. There are several sites in Pool No. 7 that require periodic dredging due to sedimentation. Dredging is the responsibility of the St. Paul District's Fountain City Boat Yard located at Fountain City, Wisconsin. As soon as the ice leaves the river, hydrographic surveys are made to get an early indication of channel conditions. After spring high water, surveys of the historic problem spots are performed. Equipment is lined up and a priority list is made. **Table 5-2** gives a summary of dredging in Pool No. 7 and in the lower lock approach since 1970.

Table 5-2 Summary of Dredging Activity – 1970 through 2000					
Cut Name	River Mile	Avg. Vol. Per Year (yd³)	Avg. Vol. Per Job (yd³)	Freq. of Dredging	Last Year Dredged
Lower Approach LD 6	714.0 to 714.3	3,822	19,745	19%	1998
Richmond Island	711.4 to 712.3	4,136	32,053	13%	1982
Winters Landing	707.4 to 709.3	23,150	39,870	58%	1998
Dakota	706.1 to 706.6	7,318	20,623	35%	1997
Dresbach	704.0 to 705.3	10,340	22,895	45%	1999
Lower Dresbach Island	703.0 to 703.7	4,531	14,047	32%	2000
Upper Approach LD 7	702.5	848	13,147	6%	1989
Lower Approach LD 7	702	390	12,089	3%	1973

5-04. Recording Hydrologic Data. Pool and tailwater elevations, roller and tainter gate settings, La Crosse River at West Salem stage and discharge, and the Mississippi River at Dakota, La Crosse and Brownsville stages are entered on log sheets. Up until 2001, log sheets were mailed to Water Control where they were periodically archived on microfilm. Log sheets are now stored electronically and are available on the Water Control web site at www.mvp-wc.usace.army.mil. Earlier log sheets have been entered such that the electronic file begins 1 January 1993. Water Control Section maintains electronic files of hourly stage/elevation data for the gages located at Dakota, Minnesota, La Crosse, Wisconsin, and Brownsville, Minnesota beginning 1 December 1997. All daily data received by Water Control Section from the dam site is compiled and archived using Hydraulic Engineering Center's Data Storage System (HEC-DSS) and is accessible from the Water Control web site. The US Geological Survey (USGS) is responsible for maintaining a discharge record for the Brownsville gage. The data are archived in the USGS WATSTORE database in Reston, Virginia and are available from the annual publications of the USGS Water-Data Report, Water Resources Data, Minnesota. The daily record of max-min temperature, precipitation, weather characteristics, river stages and general remarks are recorded on National Weather Service (NWS) Form B-91. This form is mailed at the end of each month, along with the punched tape from the Fischer-Porter gage, to the NWS in La Crosse, Wisconsin.

5-05. Communication Network. The communication network consists of computer terminal, T1 line, telephone, pager, facsimile, FM radio, voice modem, satellite, and the US Postal Service. Computer communication is done via e-mail, and "sig-na-term" which allows remote access to the Water Control network. When the computer is down, the transfer of data is by facsimile and telephone or FM radio. During non-duty hours on weekends and holidays, dam personnel can contact the river regulator by calling the pager number (612-660-8053). The gage sites at Dakota, Minnesota, La Crosse, Wisconsin, and Brownsville, Wisconsin send stage/elevation data hourly via satellite to Water Control. In addition, all three

gages send hourly cumulative precipitation. This information is made available to the dam site from the Water Control web site; www.mvp-wc.usace.army.mil. All three gages have a voice modem and can be contacted by telephone for immediate stage information. A T1 line ensures communication between Water Control and the Mississippi River Valley Division Office (MVD) in Vicksburg, Mississippi. Bulk items like Stevens PAV-C strip charts are delivered to Water Control through the postal service.

5-06. Communication with Project.

- a. Regulating Office with Project Office.** Dam site personnel input and transmit their data, via computer, to Water Control every day by 0630-hours. Water Control issues orders to Lock and Dam No. 7 every morning at approximately 0800-hours during the navigation season and around 0730-hours during the non-navigation season. Orders are typically delivered via e-mail; however, FM radio is available as backup, with the telephone serving as backup to the radio. Should the dam site have computer problems, such that the transfer of data is not possible, a facsimile is then sent to Water Control (651-290-5841). The Water Control river manager then enters the information into the Regulation Program and Information Management (IM) is notified of the computer problem. Communication with the project after orders are delivered is typically by telephone.

- b. Between Project Office and Others.** The general public has access to river level and discharge data by calling Water Control's "Corps of Engineers River Information Service" at 651-290-5861. This service provides a recording of daily stages and discharges along the Mississippi River. In addition, the Water Control web site at www.mvp-wc.usace.army.mil also provides river information to the general public. From here the public can access current water surface elevations and discharges for the Mississippi River as well as the daily log sheets for the locks and dams. Notifications of severe weather or

impending unusual conditions are handled through local law enforcement, civil defense authorities, and the National Weather Service.

5-07. Project Reporting Instructions. The project staff reports hydrologic and climatic conditions to Water Control every morning. The lock operator may make gate changes required to remain within the pool band issued by Water Control provided it is less than 10 percent of the total flow. If the pool goes out of the band after 0400-hours, no gate changes are to be made by project staff until Water Control issues its morning orders. Gate changes to aid work efforts (e.g. painting) are to be coordinated with Water Control. Problems with machinery that operate the gates are to be reported to Water Control Section and Construction-Operations Division.

5-08. Warnings. In the event the lock operator makes a gate change to remain within the pool band issued by Water Control, Lock No. 7 personnel should notify Lock No. 8 of the cut or opening that was made. In the event of a gate failure, communications must be established as quickly as possible with the Water Control Section and the Construction-Operations Division. The installation of any bulkheads must be coordinated with Water Control.

VI – HYDROLOGIC FORECASTS

6-01. General. During periods of low flow, the gates at the dam are regulated to pass inflow under pooled conditions, while during high flow they are raised free of the water surface and except for a slight swellhead due to the effect of the piers and the embankment, the dam offers little obstruction to the flow. The storage capacity created by the dam is relatively small as compared with the volume of flow and since the dam is out of operation at high discharges, the use of the dam to control floods is not possible. The lock goes out of operation at elevation 646.5 feet (1912 adjustment) at which time water is within half a foot of the top of the lock wall. The timing and elevation of the crest is important for planning sand bagging operations and forecasting when the lock will go out of operation. Additionally, the timing of the receding limb of the hydrograph aids in estimating when the lock will go back into service. In 1997, the St. Paul District developed an unsteady-flow model of the Mississippi River. The Mississippi Basin Model System utilizes the computer program UNET for forecasting purposes.

a. Role of the Corps. The St. Paul District previously relied solely on the National Weather Service (NWS) for Mississippi River forecasts. However, the NWS only forecasts for designated sites along the Mississippi River. The nearest forecast site to Lock and Dam No. 7 is La Crosse, Wisconsin. Also, the NWS forecast typically is only a five-day forecast with a projected crest height and date. The District saw a need for a model to forecast not only the time and elevation of the crest at the dam for planning sand bag operations, but also the receding limb for forecasting when the lock may go back into operation. In 1997, the District developed such a model. It is called the Mississippi Basin Model System (MBMS) and utilizes the unsteady flow program UNET. The river regulator in the Water Control Section runs the MBMS model every morning. For the flood events of 1997 and 2001, the model provided excellent predictions of when the crest would occur and when the lock would be placed back into operation. This was of great use in planning sand bagging efforts,

work scheduling, and keeping the towing industry abreast of the flooding situation.

b. Roles of Other Agencies. The National Weather Service (NWS) electronically provides the District forecasted flow hydrographs of the major tributaries to the Mississippi River by 0830-hours daily. Water Control Section inputs these hydrographs into the Mississippi Basin River System model and makes a run. The results are then electronically transferred to the NWS River Forecast Center in Chanhassen, Minnesota by 0930-hours. The NWS uses the UNET results and the results from their Mississippi River forecast model to provide stage forecasts at various points along the Mississippi River. The closest forecast site for Pool No. 7 is the control point for Lock and Dam No. 8 at La Crosse, Wisconsin.

6-02. Flood Condition Forecasts. Since 1997, St. Paul District has been using the Mississippi Basin Modeling System (MBMS) to forecast flood conditions at Lock and Dam No.7. The system utilizes UNET, which is an unsteady flow computer program. UNET was modified to simulate navigation dams according to operating rules. While the program allows the operating rules to vary according to the season, it does not account for gate operation. At the time of this manual update, work was still being performed on the program LDGATE, which would account for gate operation. Therefore, model results are limited while the dam is in a regulated condition. Flow and stage data are required to provide the boundary conditions that drive the model. Observed stages are updated daily. The model is dependent upon forecasted tributary inflow. The National Weather Service electronically mails the five-day forecasted stage hydrographs for the major tributaries to Water Control by 0830-hours daily. The hydrographs typically include the 24-hour quantitative precipitation forecast (QPF). Water Control extrapolates the tributary stage hydrographs to 30-days. Forecasts beyond 5-7 days are very approximate due to unknowns such as additional rainfall. The MBMS model is run in Water Control every day between the hours of 0830 and

0930. The 30-day forecast as well as more in depth information concerning the MBMS model are available on the Water Control web site; www.mvp-wc.usace.army.mil.

6-03. Long-Range Forecasts. The Mississippi Basin Modeling System (MBMS) is used for making long-range forecasts. It is run everyday at about 0930-hours. The model forecasts elevation and discharge for the locks and dams and control points 30-days out. However, as previously noted, the five-day tributary inflow provided by the National Weather Service only includes the 24-hour quantitative precipitation forecast (QPF). Therefore, judgment is required when looking at long-rang forecasts.

6-04. Drought Forecast. The lock and dam system operates as “run of the river”. That is, whatever flow enters the pool is passed on. Therefore, during low flow periods, the project pool elevation is maintained. This pool elevation is maintained provided there is sufficient inflow to meet withdrawal needs and pool evaporation. There is no drought-forecasting model other than the MBMS previously discussed.

VII - WATER CONTROL PLAN

7-01. General Objectives. The general objective of the water control plan is to maintain a minimum depth of nine feet along the navigation channel of Pool No. 7, without inducing higher stages during flood events. Project pool elevation for Lock and Dam No. 7 is 639.0 ± 0.2 feet (1912 adjustment). A control point is normally established near the intersection of the ordinary high water line and the project pool elevation. For Pool No. 7, the “primary control point” would be located within the structure of Lock and Dam No. 6. Since the project pool elevation cannot be maintained at the primary control point, the pool is held in secondary control at Lock and Dam No. 7. Maintaining project pool elevation at this location during periods of low flows ensures a minimum channel depth of nine feet; however, periodic dredging is still required.

The dam has minor localized impacts during flood events. The required spillway area at the dam was designed such that when all the gates are out of the water, the swellhead produced by the piers and embankment is less than one foot. Long before flood stage is reached, all the gates are raised above the water surface so that natural open river conditions exist during the flood period.

7-02. Constraints.

a. Pool Levels. For low to moderate discharges, the pool is maintained at elevation 639.0 ± 0.2 feet (1912 adjustment) at Lock and Dam No. 7. This is “project pool” or “normal pool” for Lock and Dam No. 7 and was mandated by the 79th Congress (1st Session, House Document No. 137, 9 December 1931). Normally, as discharges increase, there is a “drawdown” in the water surface elevation at the dam while the “primary control point” is maintained. Because there is no primary control point for Lock and Dam No. 7, the water surface at the dam is maintained at 639.0 ± 0.2 feet until all the gates are raised clear of the water and “open river conditions” exist.

- b. Maximum Outflow Velocity.** Downstream scour protection limits outflow velocities from the roller and tainter gates. The original design plan set maximum outflow velocities at 4.5 feet per second for standard operating procedures with an allowance to go to 6.0 feet per second for an emergency situation. In 1983, additional riprap was placed upstream and downstream of the dam. Since this time, routine maximum gate openings have been computed based on a maximum outflow velocity of 6.0 feet per second. However, it should be noted that during flood events, flow velocities exceed 8.0 feet per second with no disturbance of the riprap occurring. Therefore, the design velocity of 6.0 feet per second may be exceeded for short periods of time (15 to 20 minutes) during emergency operations (e.g. barge incident, passing of debris).
- c. Open River Conditions.** The dam is “out of control” when the gates are raised clear of the water surface and “open river conditions” exist. This typically happens when the differential head is less than one foot and the discharge is around 89,000 cfs. When gates are put back in the water, the total gate openings are 70 feet on roller gates and 110 feet on tainter gates.
- d. Closure of the Lock to Navigation.** Prior to 1994, the lock would close to navigation when high water dictated the removal of the miter gate motors. This occurred when the upper pool reached elevation 643.5 feet (1912 adjustment). As part of the major rehabilitation work in 1994, the motors were raised; therefore, the lock can now technically remain open to navigation provided water is not spilling over the upper miter gates of the main lock at elevation 647.0 feet. While this is the physical constraint, closure will often happen before the water level gets this high due to wave action over the miter gates. For this reason, the lock closes when the pool elevation is within half a foot from the top of the lock wall or elevation 646.5 feet. However, it is not unusual for the Coast Guard to close the river to navigation before this elevation is reached.

The lock is also closed when ice is too thick to permit tow traffic. As winter approaches, the lock remains open as long as towboats and barges can travel. Water temperatures are monitored to predict lock closure. When temperatures approach the low 30's, ice can form overnight and can impact the entire pool. In late February, early March, the ice becomes thin enough for some tow traffic and the lock is opened. The ice thickness on Lake Pepin (Pool No. 4) is monitored weekly. When the ice is down to about six inches of blue ice, tow traffic can soon be expected. **Table 7-1** shows some of the recent history of opening and closing dates for Lock and Dam No. 7.

Table 7-1 Spring Opening and Fall Closing Dates					
Year	Opening Date	Closing Date	Year	Opening Date	Closing Date
1972	22 Mar	12 Dec	1987	09 Mar	01 Dec
1973	16 Mar	06 Dec	1988	19 Mar	01 Dec
1974	13 Mar	14 Dec	1989	27 Mar	24 Nov
1975	20 Mar	14 Dec	1990	12 Mar	29 Nov
1976	03 Mar	06 Dec	1991	21 Mar	24 Nov
1977	21 Mar	10 Dec	1992	08 Mar	02 Dec
1978	03 Apr	30 Nov	1993	20 Mar	27 Nov
1979	30 Mar	08 Dec	1994	18 Mar	30 Nov
1980	25 Mar	05 Dec	1995	12 Mar	29 Nov
1981	07 Mar	04 Dec	1996	22 Mar	28 Nov
1982	23 Mar	08 Dec	1997	20 Mar	26 Nov
1983	03 Mar	17 Dec	1998	08 Mar	17 Dec
1984	02 Mar	1 Dec	1999	08 Mar	14 Dec
1985	17 Mar	07 Dec	2000	03 Mar	29 Nov
1986	21 Mar	05 Dec	2001	03 Mar	

- e. **Maximum Number of Gates Closed.** At times it is necessary to close one or more gates for maintenance purposes. All gate closures shall be coordinated with the river regulation desk at the Water Control Section. The maximum number of gates allowed to be closed will be at the discretion of Water Control based on conditions as they exist. The following table was prepared based on outlet velocities of 4.5 feet per second. The table assumes **either**

roller gates **or** tainter gates are being closed. Any mixing of roller gate and tainter gate closures would require additional evaluation by Water Control.

Table 7-2
Maximum Number of Gates Allowed to be Closed

<u>Flow (cfs)</u>	<u>No. of Roller Gates Closed</u>	<u>Flow (cfs)</u>	<u>No. of Tainter Gates Closed</u>
Below 19,000	5	Below 28,000	11
19,000 – 25,000	4	28,000 – 30,000	10
25,000 – 32,000	3	30,000 – 32,000	9
32,000 – 40,000	2	32,000 – 35,000	8
40,000 – 50,000	1	35,000 – 37,000	7
Above 50,000	0	37,000 – 40,000	6
		40,000 – 43,000	5
		43,000 – 46,000	4
		46,000 – 50,000	3
		50,000 – 53,000	2
		53,000 – 57,000	1
		Above 57,000	0

7-03. Overall Plan for Water Control.

- a. General Plan.** The navigation channel of Pool No. 7 is 300 feet wide along the straight reaches of the river and varies from 300 feet to 550 feet in the bends. The primary purpose of Lock and Dam No. 7, combined with periodic dredging, is to maintain a minimum depth of nine feet throughout the navigation channel without inducing higher stages during flood events. During flows of less than 89,000 cfs, the water surface elevation at Lock and Dam No. 7 is maintained at “project pool” elevation of 639.0 ± 0.2 feet (1912 adjustment). There is no “primary control point” in Pool No. 7; therefore the pool is maintained in secondary control at the dam. As discharges increase, gates are opened at the dam to maintain project pool at the dam. As discharges continue to rise to around 89,000 cfs, the differential head is reduced to less than one foot and it is no longer possible to maintain secondary control. At this time the gates are raised above the water surface and the dam is said to be “out of control” or in “open river conditions”. On the recession limb of the hydrograph, the gates are put back into the water to

maintain secondary control. The operating curves shown on **Plate 7-1** were updated based on historical flow and the new Gate Regulation Schedule presented in **Table 7-4**. The following table approximates the control conditions at the lock and dam.

Table 7-3 Control Conditions at Lock and Dam No. 7			
Control Conditions	Approximate Discharge	Dakota Gage Elevation	Lock and Dam 7 Pool Elevation
Primary	N/A	N/A	N/A
Secondary	< 89,000 cfs	< 641.5 ft	639.0 ft
Open-River	> 89,000 cfs	> 641.5 ft	> 639.0 ft

Also, part of the general plan includes flow over the concrete spillway section and the Onalaska Dam as well as flow through the Onalaska Dam culverts and the aeration culvert upstream of French Lake. The concrete spillway section has an elevation 639.0 feet and is 1,000 feet long. There are three slots 9-feet long and 2.5-feet deep cut through the spillway. These slots provide flow into Round Lake. At project pool and tailwater, the slots provide a discharge of 270 cfs based on the following equation. The rating curves for the spillway are shown on **Plate 7-2**. Note that flow through the slots is not included in the rating curves.

$$\begin{aligned}
 Q &= CLH^{3/2} & \text{Where, } C &= \text{Weir coefficient (2.8)} \\
 Q &= 2.8 (9.0 - 1.0) (2.5)^{3/2} & L &= L - (2 K_a H_e) \\
 Q &= 90 \text{ cfs (for each slot)} & L &= 9 - [(2)(0.2)(2.5)] = 8.0 \\
 & & H &= H_e = 2.5 \text{ ft}
 \end{aligned}$$

The Onalaska Dam provides flow down the Black River. It has a crest elevation of 639.0 feet, is 670 feet long, and has four submerged box culverts on the east end. The rating curve for flow over the Onalaska Dam is shown on **Plate 7-3**. Flow through the submerged culverts at the Onalaska Dam is controlled by stop logs and not represented in the rating curves. Prior to rehab of the structure, flow was regulated to around 1,500 cfs. Rehab of the

structure in 1994-95 replaced the nine 3 feet by 4 feet box culverts, with four 3 feet by 9 feet culverts. While the flow area remained the same, a new stop log configuration had to be developed. Based on trial and error, the Wisconsin Department of Natural Resources partially blocked off the two outer culverts such that the total outflow would be approximately 1,000 cfs. It was determined that this discharge was too high for fish habitat downstream during the winter months. Again, based on trial and error, the Wisconsin Department of Natural Resources determined that three additional stop logs at the entrance of each of the end culverts would provide the reduced flow necessary. This discharge is a little over 500 cfs. **Plate 7-4** shows the discharge relationship based total outflow from the dam. The stop logs are installed in late October and are removed when river conditions permit following spring runoff.

Flow to French Lake is maintained by a 30-inch reinforced concrete pipe (RCP) and is controlled by a slide gate. This, like the Onalaska Dam culverts, is adjusted in the fall and following spring runoff. The gate is opened to pass approximately 25 cfs during the summer and 5 cfs during the winter. **Plate 7-5** shows a family of outflow curves based on different heads.

- b. Computed Discharge.** Discharges are computed as part of the “River Program”. Outflows were determined on a per foot opening basis for various heads. Flows through the dam are then computed based on the differential head and the gate settings. At high discharges when the gates are out of the water, discharges are computed based on the tailwater-rating curve. To prevent a discontinuity between the computed outflows and the tailwater-rating curve, computed outflows are transitioned to meet the tailwater rating.

Discharge ratings for the gates were originally developed based on laboratory tests on a hydraulic model. A Gate Regulation Schedule was developed based on gate discharge, maximum outflow velocity of 4.5 feet per second, and an

effort to equally distribute flow across the dam. In 1973, the US Geological Survey measured outflows in the prototype. This resulted in a new relationship in the per foot discharge for the roller and tainter gates. The analysis also showed a slight change in the tailwater rating. These changes were presented in a new Gate Regulation Schedule (revised June 1973). Included with the change in per foot discharge, was a reevaluation of the flow distribution across the dam. Flow was now to be distributed based on balancing outflow velocities. This schedule remained unchanged until 1983 when riprap was placed upstream and downstream of the dam. Based on this, the maximum outflow velocity was raised to 6.0 feet per second and hence the maximum gate openings were changed on the Gate Regulation Schedule to reflect this.

In 1995, the St Paul District contracted with the US Geological Survey (USGS) to verify the measurements taken in 1973. The discharge measurements were made using a Price type AA current meter suspended with a Columbus sounding weight. Flow equations were developed for different head conditions. Some adjustments were required to produce a smooth curve. A comparison of the 1973 and 1995 results are shown on **Plate 7-6**. The 1995 results indicate similar discharge measurements at low head for the roller gates and slightly higher discharge for the tainter gates. At high head differentials, the USGS measurements showed similar discharge in the tainter gates and lesser discharge in the roller gates. The Gate Regulation Schedule was updated to reflect the change in discharge per foot opening of the gates. The distribution of flow was based on equalizing the outflow velocities. For example, consider a flow of 51,000 cfs and a respective head across the dam of 4.8 feet with a tailwater elevation of 634.2 feet. The discharge per foot opening for roller and tainter gates are 1,085 cfs and 611 cfs, respectively. By setting the roller gates at a total opening of 27.0 feet ($27.0 \times 1,085 = 29,300$ cfs) and the tainter gates at 35.5 feet ($35.5 \times 611 = 21,700$ cfs) gives a total discharge of 51,000 cfs ($29,300 + 21,700$). Outflow velocities are calculated

based on $Q=VA$, where Q is the discharge in cfs, V is the flow velocity in fps, and A is the flow area in sq ft. Q is the discharge through one gate. Area is the gate width, plus one pier width, times the depth of flow over the end sill. Roller gates are 80 feet long with a pier width of 15 feet. Tainter gates are 35 feet long with a pier width of 8 feet. The respective end sill elevations for roller and tainter gates are 619.0 feet and 622.75 feet. Flow velocities are;

Roller Gate

$$Q = VA$$

$$(27 \text{ ft}/5 \text{ roller gates}) 1,085 \text{ cfs} = V (80 \text{ ft} + 15 \text{ ft}) (634.2 \text{ ft} - 619.0 \text{ ft})$$

$$V = 4.06 \text{ ft}/\text{sec}$$

Tainter Gate

$$Q = VA$$

$$(35.5 \text{ ft}/11 \text{ tainter gates}) 611 \text{ cfs} = V (35 \text{ ft} + 8 \text{ ft}) (634.2 \text{ ft} - 622.75 \text{ ft})$$

$$V = 4.01 \text{ ft}/\text{sec}$$

To complete the update of the Gate Regulation Schedule to reflect the change in per foot discharge, also requires a change in the maximum allowable gate openings. Maximum allowable gate openings are based on flow velocity at the end sill downstream of the gates. Again, let's consider a discharge of 51,000 cfs and a differential head of 4.8 feet with a tailwater elevation of 634.2 feet. Based on $Q = VA$, where Q is the discharge per foot, times the maximum allowable gate opening, V is the maximum allowable flow velocity of 6.0 feet per second, and A is the flow area over the end sill for one gate, the following maximum allowable gate openings were determined.

Roller Gate

$$Q = VA$$

$$1,085 \text{ cfs (max gate opening in ft)} = 6.0 \text{ fps} (80 \text{ ft} + 15 \text{ ft}) (634.2 \text{ ft} - 619.0 \text{ ft})$$

$$\text{Max Gate Opening} = 8.0 \text{ ft}$$

Tainter Gate

$$Q = VA$$

$$611 \text{ cfs (max gate opening in ft)} = 6.0 \text{ fps} (35 \text{ ft} + 8 \text{ ft}) (634.2 \text{ ft} - 622.75 \text{ ft})$$

$$\text{Max Gate Opening} = 4.8 \text{ ft}$$

Table 7-4 shows the new Gate Regulation Schedule.

**Table 7-4
Gate Regulation Schedule
5 Roller Gates and 11 Tainter Gates**

Total Discharge cfs	Total Gate Opening in Feet		Elevation in Feet 1912 Adjustment		Head In Feet	Discharge (cfs) per Foot of Opening		Discharge (cfs)		Max Allowable Opening of a Gate	
	Rollers	Tainters	Pool	TW		Rollers	Tainters	Rollers	Tainters	Rollers	Tainters
10,000	4.5	5.5	639.0	631.1	7.90	1287	773	5,800	4,250	5.4	2.8
11,000	5.0	6.0	639.0	631.2	7.84	1286	772	6,450	4,650	5.4	2.8
12,000	5.5	6.5	639.0	631.2	7.78	1285	770	7,050	5,000	5.4	2.8
13,000	6.0	7.0	639.0	631.3	7.72	1284	768	7,700	5,400	5.5	2.9
14,000	6.5	7.5	639.0	631.3	7.66	1283	766	8,350	5,750	5.5	2.9
15,000	7.0	8.0	639.0	631.4	7.60	1282	765	8,950	6,100	5.5	2.9
16,000	7.5	8.5	639.0	631.4	7.56	1281	763	9,600	6,500	5.5	2.9
17,000	8.0	9.0	639.0	631.5	7.52	1280	761	10,250	6,850	5.6	3.0
18,000	8.5	9.5	639.0	631.5	7.48	1279	759	10,850	7,200	5.6	3.0
19,000	9.0	10.0	639.0	631.6	7.44	1278	757	11,500	7,550	5.6	3.0
20,000	9.5	10.5	639.0	631.6	7.40	1277	755	12,150	7,950	5.6	3.0
21,000	10.0	11.0	639.0	631.6	7.36	1275	753	12,750	8,300	5.7	3.0
22,000	10.5	11.5	639.0	631.7	7.32	1273	752	13,350	8,650	5.7	3.1
23,000	11.0	12.0	639.0	631.7	7.28	1271	750	14,000	9,000	5.7	3.1
24,000	11.5	12.5	639.0	631.8	7.24	1269	748	14,600	9,350	5.7	3.1
25,000	12.0	13.0	639.0	631.8	7.20	1267	746	15,200	9,700	5.8	3.1
26,000	12.5	14.0	639.0	631.9	7.12	1263	742	15,800	10,400	5.8	3.2
27,000	12.5	15.0	639.0	632.0	7.04	1259	738	15,750	11,050	5.9	3.2
28,000	13.5	15.0	639.0	632.0	6.96	1255	734	16,950	11,000	5.9	3.3
29,000	14.0	16.0	639.0	632.1	6.88	1252	729	17,550	11,650	6.0	3.3
30,000	14.0	17.5	639.0	632.2	6.80	1248	725	17,450	12,700	6.0	3.4
31,000	14.5	18.0	639.0	632.3	6.72	1244	721	18,050	13,000	6.1	3.4
32,000	15.0	18.5	639.0	632.4	6.64	1238	717	18,550	13,250	6.2	3.5

**Table 7-4 – Continued
Gate Regulation Schedule
5 Roller Gates and 11 Tainter Gates**

Total Discharge cfs	Total Gate Opening in Feet		Elevation in Feet 1912 Adjustment		Head In Feet	Discharge (cfs) per Foot of Opening		Discharge (cfs)		Max Allowable Opening of a Gate	
	Rollers	Tainters	Pool	TW		Rollers	Tainters	Rollers	Tainters	Rollers	Tainters
33,000	16.0	18.5	639.0	632.4	6.56	1233	713	19,750	13,200	6.2	3.5
34,000	16.0	20.0	639.0	632.5	6.48	1227	709	19,650	14,150	6.3	3.6
35,000	17.0	20.0	639.0	632.6	6.40	1222	704	20,750	14,100	6.3	3.6
36,000	17.5	21.0	639.0	632.7	6.30	1216	699	21,300	14,650	6.4	3.7
37,000	18.0	22.0	639.0	632.8	6.20	1208	693	21,750	15,250	6.5	3.7
38,000	18.5	23.0	639.0	632.9	6.10	1201	688	22,200	15,800	6.6	3.8
39,000	19.5	23.0	639.0	633.0	6.00	1194	682	23,300	15,700	6.7	3.9
40,000	20.0	24.0	639.0	633.1	5.90	1187	677	23,750	16,250	6.8	3.9
41,000	20.5	25.0	639.0	633.2	5.80	1180	671	24,200	16,750	6.9	4.0
42,000	21.0	26.0	639.0	633.3	5.70	1172	665	24,600	17,300	7.0	4.1
43,000	22.0	26.5	639.0	633.4	5.60	1163	659	25,600	17,450	7.1	4.2
44,000	22.5	27.5	639.0	633.5	5.50	1154	653	25,950	17,950	7.2	4.2
45,000	23.0	29.0	639.0	633.6	5.40	1144	648	26,300	18,800	7.3	4.3
46,000	23.5	30.0	639.0	633.7	5.30	1134	642	26,650	19,250	7.4	4.4
47,000	24.0	31.5	639.0	633.8	5.20	1124	636	27,000	20,050	7.5	4.5
48,000	25.0	32.0	639.0	633.9	5.10	1115	630	27,900	20,150	7.6	4.6
49,000	25.5	33.5	639.0	634.0	5.00	1105	623	28,200	20,900	7.7	4.7
50,000	26.5	34.0	639.0	634.1	4.90	1096	617	29,050	21,000	7.9	4.7
51,000	27.0	35.5	639.0	634.2	4.80	1085	611	29,300	21,700	8.0	4.8
52,000	28.0	36.0	639.0	634.3	4.70	1076	605	30,100	21,750	8.1	4.9
53,000	29.0	37.0	639.0	634.4	4.60	1066	598	30,900	22,150	8.2	5.0
54,000	29.5	38.5	639.0	634.5	4.50	1055	592	31,100	22,800	8.4	5.1
55,000	30.5	39.5	639.0	634.6	4.40	1045	585	31,850	23,100	8.5	5.2

**Table 7-4 – Continued
Gate Regulation Schedule
5 Roller Gates and 11 Tainter Gates**

Total Discharge cfs	Total Gate Opening in Feet		Elevation in Feet 1912 Adjustment		Head In Feet	Discharge (cfs) per Foot of Opening		Discharge (cfs)		Max Allowable Opening of a Gate	
	Rollers	Tainters	Pool	TW		Rollers	Tainters	Rollers	Tainters	Rollers	Tainters
56,000	31.5	40.5	639.0	634.7	4.30	1034	579	32,550	23,450	8.7	5.3
57,000	32.5	41.5	639.0	634.8	4.20	1023	572	33,250	23,750	8.8	5.4
58,000	33.0	43.5	639.0	634.9	4.10	1012	565	33,400	24,600	9.0	5.5
59,000	34.5	44.0	639.0	635.0	4.00	1001	558	34,550	24,550	9.1	5.7
60,000	35.0	46.0	639.0	635.1	3.90	989	551	34,600	25,350	9.3	5.8
61,000	36.0	47.5	639.0	635.2	3.80	977	544	35,200	25,850	9.4	5.9
62,000	37.0	49.0	639.0	635.3	3.70	966	537	35,750	26,300	9.6	6.0
63,000	38.0	50.5	639.0	635.4	3.60	953	530	36,250	26,750	9.8	6.2
64,000	39.5	51.5	639.0	635.5	3.50	942	522	37,200	26,900	10.0	6.3
65,000	40.5	53.0	639.0	635.6	3.40	929	515	37,650	27,300	10.2	6.4
66,000	41.5	54.5	639.0	635.7	3.32	919	509	38,150	27,750	10.3	6.6
67,000	42.5	56.5	639.0	635.8	3.24	909	503	38,650	28,400	10.5	6.7
68,000	44.0	57.5	639.0	635.9	3.16	899	497	39,550	28,550	10.7	6.8
69,000	45.0	59.0	639.0	636.0	3.08	888	490	40,000	28,900	10.9	7.0
70,000	46.0	61.5	639.0	636.1	3.00	878	484	40,350	29,750	11.0	7.1
71,000	47.0	64.5	639.0	636.2	2.88	861	474	40,450	30,600	11.3	7.3
72,000	48.5	67.0	639.0	636.3	2.76	844	464	40,900	31,100	11.6	7.5
73,000	50.5	69.0	639.0	636.4	2.64	826	454	41,750	31,350	12.0	7.7
74,000	52.5	71.0	639.0	636.5	2.52	809	444	42,450	31,500	12.3	8.0
75,000	54.0	74.5	639.0	636.6	2.40	790	433	42,700	32,250	12.7	8.3
76,000	56.0	77.5	639.0	636.7	2.28	771	422	43,200	32,700	13.1	8.5
77,000	58.0	81.0	639.0	636.8	2.16	752	411	43,600	33,300	13.5	8.8
78,000	60.5	84.5	639.0	637.0	2.04	732	399	44,300	33,750	14.0	9.2

**Table 7-4 – Continued
Gate Regulation Schedule
5 Roller Gates and 11 Tainter Gates**

Total Discharge cfs	Total Gate Opening in Feet		Elevation in Feet 1912 Adjustment		Head In Feet	Discharge (cfs) per Foot of Opening		Discharge (cfs)		Max Allowable Opening of a Gate	
	Rollers	Tainters	Pool	TW		Rollers	Tainters	Rollers	Tainters	Rollers	Tainters
79,000	63.0	88.0	639.0	637.1	1.92	712	388	44,850	34,100	14.5	9.5
80,000	65.5	92.5	639.0	637.2	1.80	690	375	45,200	34,700	15.0	9.9
81,000	68.5	96.0	639.0	637.3	1.70	672	365	46,050	35,050	15.5	10.3
82,000	71.0	100.5	639.0	637.4	1.60	653	354	46,400	35,600	16.1	10.7
83,000	74.0	105.0	639.0	637.5	1.50	634	343	46,900	36,000	16.6	11.1
84,000	77.5	110.0	639.0	637.6	1.40	614	331	47,550	36,450	17.3	11.6
85,000	81.5	115.0	639.0	637.7	1.30	593	319	48,300	36,700	18.0	12.1
86,000	85.5	121.0	639.0	637.8	1.20	571	307	48,800	37,150	18.8	12.7
87,000	90.0	128.0	639.0	637.9	1.10	548	294	49,300	37,600	Out	13.3
88,000	95.0	136.5	639.0	638.0	1.00	524	280	49,750	38,250	Out	14.0
89,000	Out of Control – All gates raised clear of water. Gates put back in at 70 ft Roller Gates and 110 ft Tainter Gates.										

Note: Revisions to the Operating Curves (Plate 7-1) and the new Discharge-Per-Foot vs. Head Curves (Plate 7-6) allowed for the point at which the dam goes “out of control” to increase from 82,000 cfs to 89,000 cfs.

c. Regulation Procedure. Each morning at 0645-hours, the Water Control manager prints the Regulation Sheets containing all the input from the lock and dam sites. Regulation for Lock and Dam No. 7 begins at Lock and Dam No. 4. Gate changes at Lock and Dam No. 4 directly influence action needed at Dam No. 5, which in turn directly influences Dam No. 5A, and so on down to Lock and Dam No. 7. After regulating Lock and Dam No. 6, inflow to Pool No. 7 is determined. Inflow consists of outflow from Lock and Dam No. 6, inflow from the Black River, and any miscellaneous inflow. Inflow from Lock and Dam No. 6 is computed as part of the daily regulation. Inflow from the Black River will appear on the Regulation Sheet from input by site personnel (see Standing Instructions to Lockmaster). Miscellaneous inflow will vary seasonally but for simplicity it is assumed to be a constant 500 cfs. This may be modified if precipitation has occurred in the last 24-hours. As a general rule, for each inch of rainfall that has fallen in past 24-hours, an additional 600 cfs is added to the miscellaneous inflow. Inflow is totaled and the 24-hour change is noted. Also noted are the change in outflow and any gate changes made in the past 24-hours. Next the rate of fall or rise of the pool is calculated. This is done at the dam and Dakota. Note the changes. Allow for wind at the dam. That is, adjust the pool elevation, up or down, 0.1 foot per 10 mph of wind (see Section 4-04). Estimate the needed change in discharge to maintain the proper pool band. To aid in this assessment, it has been determined that a change in outflow of 700 cfs over a 24-hr period of time will result in about a one tenth of a foot change in the overall pool elevation. This value was computed based on the effective project pool area of 13,440 acres. Once the needed change in discharge is determined, the Gate Regulation Schedule is used to distribute flow and hence set gate changes. The gate change information is e-mailed to the lock site and the St. Paul District's intranet at approximately 0800-hours each day. The orders are typically one of four types; (1) no change, (2) no change at present, (3) open a given amount, or (4) cut a given amount. A "no change at present" order is followed by an "if statement". For example, "if the pool falls to elevation

The following steps walk through the regulation procedure for this particular day. This is intended only as an example.

Step 1. Determine inflow to Pool 7.

Computed inflow from LD 6 was 18,400 cfs.

LD 6 orders were to open up 1,600 cfs to 20,000 cfs.

The Black River is at 1,200 cfs.

Miscellaneous inflow is 500 cfs.

Rainfall was 0.75 inches, so add 450 cfs to inflow.

Total Inflow = 22,150 cfs (up 1,450 cfs from yesterday).

Step 2. Note change in outflow.

Up 1,000 cfs due to pool elevation change.

Step 3. Note change in pool elevation.

Pool is up 0.25 feet at the dam.

Pool is up 0.20 feet at Dakota.

Wind is 8 mph out of the north.

Therefore, about 0.1 ft of increase at dam is due to wind.

Step 4. Estimate needed change in discharge.

Inflow is up 1,450 cfs from yesterday (due to rain and the 1 ft opening at LD 6 between midnight and 0400-hrs).

The pool has increased 0.25 ft – 0.1 ft (due to wind) = 0.15 ft and is on the high side.

Need to increase outflow, as a minimum, the increased outflow at LD 6 (1,600 cfs). Also need to reduce pool elevation 0.15 ft.

Pool elevation will decrease 0.1 foot per 700 cfs in 24 hours; therefore, need to increase outflow approximately 1,000 cfs to reduce pool by 0.15 ft.

We want to open 1,600 cfs + 1,000 cfs = 2,600 cfs for a total outflow of 20,500 cfs

Step 5. Set gate change.

The Gate Regulation Schedule shows ideal gate settings for 21,000 cfs to be 10.0 ft on RG and 11.0 ft on TG.

We are presently at 4.0 on RG and 11.0 on TG.

Therefore, the entire gate opening will be on the Roller Gates.

A one-foot opening on RG's would increase outflow 1,300 cfs.

Therefore,

“Open 2.0 ft on RG. Increases flow 2,600 to 20,500.”

Step 6. Set the pool band.

The pool is a little high (i.e. target at dam is 639.0 ft) and is impacted by the wind. Therefore,

“Hold elevation 639.0 ± 0.2 feet.”

“Allow for wind on the high side.”

d. Winter Regulation. Each year in early winter, the tainter gates are set at predetermined heights and are allowed to freeze in place. In late November,

Water Control makes an estimate of the anticipated minimum base flow for the winter months. The estimate is based on the average flow from 1 October through 15 November and the minimum winter flow rate curve. The curve was developed using historic discharge information for the gage site at Winona, Minnesota. “Average October Flow” and “Average November Flow” were plotted against the “Minimum Winter Flow”. Curves were drawn through the lowest data points. A composite curve was then developed. By entering the average flow for the period 1 October through 15 November, the anticipated minimum base flow can be selected from the curve. To determine where to set the tainter gates, we must first consider the roller gates. Because we are using the minimum base flow rate, we must consider minimum submerged roller gate settings. Roller gates can be submerged from 0.5 feet to 3.0 feet. Discharge rates for submerged roller gates are shown in the following table.

Table 7-5 Discharge Rates for Submerged Roller Gate – cfs (June 1971)							
Pool Elevation	Head Feet	Depth of Submerged Gate					
		0.5 ft	1.0 ft	1.5 ft	2.0 ft	2.5 ft	3.0 ft
639.0	8.0	250	560	920	1330	1800	2010
	7.0	240	540	890	1280	1740	1970
638.9	8.0	230	530	880	1280	1740	1940
	7.0	220	510	840	1230	1680	1900
638.8	8.0	220	500	830	1230	1680	1870
	7.0	200	480	800	1180	1620	1830
638.7	8.0	200	470	800	1180	1620	1790
	7.0	190	450	760	1140	1560	1750
638.6	8.0	190	450	760	1130	1560	1720
	7.0	180	430	730	1090	1500	1680
638.5	8.0	170	430	730	1090	1500	1650
	7.0	160	410	700	1050	1440	1610
638.4	8.0	-	410	700	1050	1450	1590
	7.0	-	390	670	1000	1400	1540
638.3	8.0	-	390	670	1010	1400	1520
	7.0	-	370	640	960	1340	1480
638.2	8.0	-	370	640	970	1350	1470
	7.0	-	350	610	-	1300	1420

Discharge rates for submerged roller gates are computed down to 0.5 feet submergence; however, roller gates are typically not submerged less than one foot due to ice interference. Therefore, the total discharge for all roller gates at one-foot submergence is deducted from the estimated minimum base flow. This flow is then used to determine tainter gate settings. While two of the tainter gates can be submerged to 2.0 feet below project pool elevation, they are operated only in the raised position due to icing problems. The recommended tainter gate settings are sent to the Lockmaster for evaluation. The Lockmaster assesses the Water Control recommendations and makes the final decision on tainter gate settings before freeze up. Before ice begins to form on the pool, the roller gates are placed in a submerged position. Adjusting roller gates in the submerged position makes the necessary changes in discharge. When the roller gates are at an extreme setting and additional change in outflow is needed, a tainter gate, or tainter gates, must be freed up. The tainter gates have side seal heaters but the heaters are seldom sufficient to free the tainter gates from ice. Usually considerable time is spent steaming and chopping before an ice bound tainter gate becomes moveable.

Throughout the winter, the tainter valves in the lock walls on the upstream side are kept open four feet each and the ones on the downstream side are just cracked open. The purpose is to maintain a flow through the lock chamber to prevent the formation of ice.

On the weekends and holidays, the second shift and third shifts are limited to one person at the dam site. There is a one half hour over lap in the morning between 0730 and 0800-hours. Therefore, Water Control makes an effort to get orders out by 0730-hours. Due to the limited staff at the site and the difficulty in moving the submerged roller gates, the tolerance for stage deviation is increased to plus or minus three tenths of a foot. That is, the pool is typically maintained at elevation 639.0 ± 0.3 feet. A high pool level during the winter reduces oxygen depletion in the backwater areas, which benefits fish

habitat. Therefore, Water Control operates on the high side of the band during winter months.

- 7-04. Standing Instructions to Lock and Dam No. 7 Staff.** Lock and dam personnel are to update and send via computer by 0630-hours, the last 24-hour data readings needed for regulation. This data includes pool and tailwater elevations, discharges, gate settings, precipitation, air temperature, wind speed and direction, water temperature, maximum and minimum air temperatures, stages at La Crosse and Brownsville, and stage and discharge for the La Crosse River at West Salem. During the winter months, the data sent in includes percent of pool ice coverage, ice thickness, snow depth, and snow water equivalent. Log sheets with this data are maintained at the site.

Each morning lock and dam personnel call the voice modems at the gages located at La Crosse and Brownsville on the Mississippi River. Additionally, lock and dam personnel call a gage reader at West Salem, Wisconsin who manually reads the La Crosse River gage (note: the only equipment at this site is a wire weight gage on the bridge near the old gage house). Discharges are obtained from the latest rating table provided by the US Geological Survey (USGS). This information appears on the regulation sheet for inflow to Pool No. 8. Lock and Dam No. 6 calls the Black River gage each morning and inputs the stage and discharge based on the latest USGS rating table (see **Exhibit B**). Lock personnel also measure the water temperature and precipitation every morning. Pool elevations, tailwater elevations, discharges, and gate settings are recorded in 4-hour intervals beginning with the previous days 0800-hour records. Air temperature, and wind speed and direction are recorded every 8-hours beginning with the 0800-hour reading. All of the morning's readings are taken between 0600 and 0630-hours but are entered as 0800-hour readings. Maximum and minimum air temperatures are measured at 1900-hours but are entered as a 2400-hour reading.

Discharges at the dam are calculated internally on 4-hour intervals based on pool and tailwater elevations and the gate settings. Total discharge includes flow through the roller and tainter gates (**Plate 7-6**), flow over the 1,000-foot concrete spillway (**Plate 7-2**), flow over the 670-foot Onalaska Dam (**Plate 7-3**), and flow through the submerged culverts in the Onalaska Dam (**Plate 7-4**). When the gates are all raised clear of the water, a tailwater rating is used.

During the winter months, every Sunday the snow depth is measured and a snow-water equivalent is determined. Also an estimate is made as to the percent the pool and tailwater are covered with ice and holes are drilled in the pool and tailwater to determine ice thickness. These data are sent to Water Control via a remote computer terminal.

At 0645-hours everyday, the Water Control regulator analyzes the field data and at around 0800-hours, the daily orders for gate movements are sent to the site via e-mail. On weekends and holidays during the winter operations, orders are sent by 0730-hours due to limited staffing at the dam site. Gate changes are then made as soon as possible. If Water Control has notified the site that they will contact them again at 1400-hours, site personnel will have the noon and present pool and tailwater elevations as well as any other pertinent information (e.g. wind speed and direction) available at that time.

Normal duty hours for Water Control are 0630 to 1500-hours during the week, and 0630 to 0930-hours on weekends and holidays. During the course of non-duty hours site personnel may make gate changes as necessary to stay within the pool band prescribed. The site is limited however to changes up to ten percent of the 1600-hour discharge. If a gate change greater than this is necessary, site personnel should contact the river regulator at home. If the need for a gate change becomes necessary at 0400-hours, no gate change will be made. Water Control will provide the necessary gate change and band limit with the morning's orders. The following is a list of Water Control personnel with river responsibilities. The

first contact should be the person who issued the last orders. If that person is not available, contact should be made in the order listed below. The weekend pager number is 612-660-8053.

Table 7-6 Water Control Personnel Telephone Numbers		
Name	Home Telephone No.	Office Telephone No.
Scott Bratten	651-436-6135	651-290-5624
Dennis Holme	651-483-4003	651-290-5614
Ted Pedersen	651-487-7874	651-290-5253
Ferris Chamberlin	651-653-7981	651-290-5619
Kenton Spading	651-488-8893	651-290-5623
Bob Engelstad	651-459-6343	651-290-5610

Lock personnel contacting Water Control personnel at home should have pool and tailwater readings, wind speed and direction, amount of precipitation since last report, latest discharge calculations, and all gate changes made since the morning gate change.

If lock personnel have any questions regarding the Water Control order, they are to contact the regulator via telephone (651-290-5624) and the question will be resolved. During computer outages, log sheets will be faxed to Water Control Section (651-290-5841) and orders will be given via telephone or FM radio.

In the event of a gate failure or any occurrence that will require the installation of the bulkheads, communications must be established as quickly as possible with Water Control Section and Construction and Operations (Con-Ops) Division. Under full head conditions at the dam, the force is too great to allow the installation of the bulkheads. Therefore, the operating head must be reduced. Water Control will coordinate gate movements with site personnel in preparation for installation and removal of the bulkheads.

In addition to operating the roller and tainter gates, lock personnel are also responsible for the operation of the submerged culverts in the Onalaska Dam. In late October, the Lockmaster will coordinate hiring a crane for placement of stop logs in the two outside bays of the four box culverts. Three stop logs will be placed in each bay. The number of stop logs may be adjusted by the Wisconsin Department of Natural Resources. Following spring high water when the pool is below 639.0 feet, the Lockmaster will make the necessary coordination to have the stop logs removed.

The slide gate on the 30-inch RCP located upstream of French Lake is also operated by lock personnel. The slide gate is set to pass 25 cfs in the summer and 5 cfs in the winter. A family of rating curves is shown on **Plate 7-5** to aid in determining the proper gate setting. Periodic removal of weeds may be necessary to insure operation of the culvert (see **Figure 3-1**).

7-05. Flood Control. Lock and Dam No. 7 has no flood control benefits. It is operated strictly for navigation. While it may seem possible that the pools be drawn down over the winter months to provide storage for spring runoff, this plan has no merit for two reasons. First the Anti-Drawdown Act of 1934, which was amended in 1948 to prevent any drawdown of the pools. Secondly, the storage volume that would be made available in the pool is insignificant in comparison to the flood flow volume. The pool would be filled in a matter of hours and would have no impact on the peak flood stage.

7-06. Recreation. The major recreation features for Lock and Dam No. 7 is fishing, hunting and boating. Construction of the lock and dam inundated the numerous wing dams that were constructed as part of the six-foot channel project. The wing dams as well as some of the backwater areas provide excellent fish and game habitat. As for recreational boating, there were over 9,000 recreation boat lockages in the year 2000. **Table 7-7** shows a comparison of recreational to towboat lockages.

Table 7-7 Commercial & Recreational Lockages at Lock No. 7					
Year	Towboats & Barges	Recreation Boaters	Other Lockages	Total Lockages	Percent Recreation
1991	1,591	12,551	192	14,334	88%
1992	1,579	11,310	155	13,044	87%
1993	1,010	6,685	108	7,803	86%
1994	1,170	12,381	137	13,688	90%
1995	1,440	13,441	194	15,075	89%
1996	1,537	11,107	159	12,803	87%
1997	1,406	12,686	174	14,266	89%
1998	1,553	12,528	357	14,438	87%
1999	1,688	12,049	273	14,010	86%
2000	1,568	9,612	123	11,303	85%

7-07. Water Quality. The Corps of Engineers has not performed any water quality analysis in Pool No. 7. However, as an element of the Environmental Management Program (EMP), the Corps of Engineers oversees the Long Term Resource Monitoring Program (LTRMP) of the Upper Mississippi River System. The LTRMP was implemented to provide decision makers with the information needed to maintain the Upper Mississippi River System as a viable multiple-use large river ecosystem. The LTRMP is being implemented by the US Geological Survey (USGS) in cooperation with the states of Illinois, Iowa, Minnesota, Missouri and Wisconsin with guidance and overall program responsibility by the Corps of Engineers. Recent studies conducted by agencies in Pool No. 7 included an Elevation Survey of Dredge Cuts by the USGS, Terrestrial Vegetation Survey of Rosebud Island by the St. Paul District and US Fish and Wildlife Service, and water quality monitoring of Long Lake by the Wisconsin Department of Natural Resources.

7-08. Fish and Wildlife. Until 1967, during low to moderate flows, there was no flow into Round Lake located downstream of the 1,000-foot concrete spillway. In

1967, three slots, 9.0 feet long and 2.5 feet deep, were cut into the concrete spillway. When the pool is project level, the slots provide a constant flow of 270 cfs into Round Lake. This aids fish habitat by aerating the water upstream and downstream.

In 1994 a 30 inch RCP aeration culvert was installed in the earthen dike portion of the dam located upstream of French Lake near the west side of French Island. The flow is controlled with a slide gate and is typically set to approximately 25 cfs during the summer months and 5 cfs during the winter months

Major rehabilitation of the Onalaska Dam in 1995 resulted in a minor change in operation. Flow through the four culverts is controlled by stop logs. Through trial and error, the Wisconsin Department of Natural Resources determined that the placement of three stop logs in each of the end bays reduces flow sufficiently for fish habitat during the winter months. The stop logs are placed by site personnel in late October and are removed following high water in the spring.

The lock and dam was constructed for the purpose of navigation; therefore, during the winter months when navigation was no longer possible, it was advantageous to draw the pool down a considerable amount (e.g. fewer gate changes). However, the 1934 “Anti-Drawdown Act”, as amended in 1948, prevented any winter drawdown of the pool such that the “...dam structures shall generally operate and maintain pool levels as though navigation was carried on throughout the year.” Because of the time lost in moving gates due to icing conditions, drawdown was limited 0.3 feet at the lock and dam. This was the standard operating procedure until 1995, when the Water Level Management Task Force, which consists of various state and Federal agencies, requested that the pool be maintained on the high side of the band (i.e. near 639.3 feet). A higher stage in the backwater areas reduces the oxygen depletion and thereby improves fish habitat. Therefore, Water Control operates on the high side of the band during the winter months.

7-09. Water Supply. The city of Onalaska, Wisconsin, Dakota, Minnesota and the village of Trempealeau, Wisconsin obtain their water from wells. Pool No. 7 does not provide water supply.

7-10. Hydroelectric Power. There is no hydroelectric power at Lock and Dam No. 7.

7-11. Navigation. The primary purpose of Lock and Dam No. 7 is to provide navigation. The lock is 110 feet wide and 600 feet long. Barges are typically 35 feet wide and 195 feet long. Towboats are of similar size. There are many ways in which the barges and towboat may be oriented. Tows oriented such that the overall length exceeds the lock chamber will require a double lockage. The maximum number of barges allowed in a double lockage is 17. This orientation consists of five rows of three barges with two empty “hip” barges straddled along the sides of the towboat. The first nine barges enter the lock chamber and are broken free of the remainder. The tow haulage unit moves these through the lock and they are then tied to the guidewall. The towboat with the remaining eight barges passes through the lock and is rejoined with the nine other barges. Filling and emptying time for the lock under normal conditions is five minutes. Lockage time for a double lockage depends on the experience of the deck hands breaking and making couplings, number of loaded and empty barges, wind speed and direction, flow conditions, and whether it is an up bound or down bound tow. A down bound tow will take longer due to outdraft conditions at the dam. On average, a single lockage takes approximately 30 minutes, while a double lockage takes about 1.5 to 2 hours.

7-12. Flood Emergency Action Plans. The Emergency Action Plan is a stand-alone document entitled *Emergency Plan for Lock and Dam 7 near La Crescent, Minnesota*, August 1986. The plan addresses emergencies related to above normal reservoir water levels and/or rapid release of large volumes of water past the dam. It covers identification of impending or existing emergencies and notification of other parties concerning impending or existing emergencies.

Potential causes of an emergency affecting the operation or safety of Lock and Dam No. 7 include excess seepage, sabotage, extreme storm, failure of earthen dike, and failure due to scouring.

There are several protective measures taken at Lock and Dam No. 7 when a flood occurs. For example, when the pool level is forecasted to go above elevation 645.0 feet (1912 adjustment) the dike section between the spillway and French Island is protected with plastic to prevent wave damage. The following table gives a brief summary of the steps to be taken at the dam. Note that the flood emergency action procedures will be updated in 2002 as the new Central Control Station and other updated facilities will change the required actions and/or its associated pool elevation.

**Table 7-8
Flood Emergency Actions at the Dam**

<u>Pool Elevation</u>	<u>Action Taken</u>
642.0 feet	Control seepage in Central Control Station. Start pumping miter gate machinery recesses. Protect fuel storage tanks.
645.0 feet	Control Station, shop, and pole building are sandbagged. Diversion dike esplanade to tainter valve #2. Miter gate limit switches protected.
646.0 feet	Tainter gate limit switches protected. Grating secured.
646.5 feet	Lock is closed to navigation.
647.0 feet	Lower haulage motor protected. Miter gate handrails removed. Septic system protected.
650.0 feet	Upper haulage motor protected.

7-13. Other. During a flood event, debris is passed beneath the gates as they are typically raised clear of the water. During ice breakup, ice is passed over the submerged roller gates.

7-14. Deviation from Normal Regulation. Project pool elevation is mandated by congress. The pool is maintained at elevation 639.0 ± 0.2 feet as long as the dam

is in control. During low flows, the pool is not to be intentionally raised above or lowered below this elevation; however, temporary deviations are permitted. Because these deviations are unplanned and are only temporary, while actions are being taken to correct the situation, these exceptions do not require notification to be sent to the Division Office. The Division Office (MVD) must be notified when the deviation is intentional and for a prolonged period of time. A written request describing cause and effect will be sent to the Division Water Control Manager for approval. The District Commander or Chief of Engineering Division may deviate from the approved plan in an emergency situation. The District will inform MVD as soon as possible. This will include a written confirmation of the deviation and description of the cause.

7-15. Rate of Release Change. The only guideline for rate of release change is the “ten percent rule” (**Section 7-04**, page 7-19, last paragraph). During Water Control’s non-duty hours, lock and dam personnel may only make a gate change to remain within the band such that it does not exceed ten percent of the total flow. There are no other guidelines for rate of release change. Operation of the dam is basically run-of-the-river. Therefore, rate of release change is typically nature driven.

VIII – EFFECT OF WATER CONTROL PLAN

- 8-01. General.** The effect of the water control plan for Lock and Dam No. 7 is to maintain a nine-foot depth in the navigation channel of Pool No. 7. Lock and Dam No. 7 is just one piece of the lock and dam system that provides navigation from St. Louis, Missouri to Minneapolis, Minnesota. Navigation on the Upper Mississippi River progressed from a four-foot deep channel in 1866, to a four and one-half foot channel in 1878, to a six-foot channel in 1907, and finally, to a nine-foot channel in the 1930's. A more complete description of this development is available in the Master Water Control Manual for the Locks and Dams.
- 8-02. Flood Control.** The locks and dams provide no flood control benefits. They were constructed strictly for navigation purposes. The dam operates on a run-of-the-river principal. As discharge increases, the gates are opened. At around 89,000 cfs the gates are raised clear of the water surface. Therefore, for flood events, the only impact on the flow line is the swellhead at the dam, which is less than one foot.
- 8-03. Recreation.** The project is not regulated for recreation purposes; however, it does provide recreational benefits. The three recreation qualities associated with Pool No. 7 are fishing, hunting and boating. Project pool inundated the wing dams, constructed as part of the six-foot navigation project, and created backwater areas, which provide good fish and waterfowl habitat. While Lock and Dam No. 7 provides the necessary depths for the towing industry, it also is a benefit to recreational boating. The more stable water surface provides a more suitable environment for docks and marinas. There were over 9,000 recreation boat lockages in the year 2000.
- 8-04. Fish and Wildlife.** Part of the Upper Mississippi River Wildlife and Fish Refuge is located in Pool No. 7 and includes all but the navigation channel. The Refuge was established in 1924 to preserve the Upper Mississippi River for fish,

migratory birds, other wildlife and people. The Refuge includes acreage acquired by the US Fish and Wildlife Service and land acquired during the 1930's by the US Army Corps of Engineers for the construction of the 9-foot navigation channel. Today, the refuge consists of about 200,000 acres of wooded islands, forest, prairie, marsh, and water extending 261 miles southward from Wabasha, Minnesota to just above Rock Island, Illinois. The refuge still remains relatively untouched by modern civilization.

8-05. Navigation. The Upper Mississippi River Nine-Foot Channel Project originated in the 1920's when it was promoted as a way to alleviate the Nation's worsening farm crisis. It was also aimed at allaying the inequities in commercial rail and water freight rates. The project was authorized by the Rivers and Harbors Act of 1930. The project was not without its controversy. For example, railroads claiming damage to their right-of-ways and conservationists fearing its effects on the environment. Ultimately, the economic benefits overrode all other concerns. After completion of the project, river traffic increased from 2,400,000 tons in 1939 to 68,400,000 in 1976. **Table 8-1** shows the recent history of tonnage commodities at Lock and Dam No. 7. For more historical information concerning the Nine-Foot Channel Project, see the Master Water Control Manual for the Locks and Dams.

Table 8-1 Lock and Dam No. 7 Tonnage – Commodities									
Year	Coal	Petrol Product	Chemical Products	Crude Material	Manu Goods	Farm Products	Equip Mach	Misc Product	Total Tonnage
1991	1,143,000	719,400	1,446,500	782,500	477,000	10,315,500	3,000	21,400	14,908,300
1992	897,300	281,600	1,700,900	832,000	442,400	10,366,200	16,500	21,500	14,558,400
1993	973,400	171,000	1,748,200	747,800	307,000	5,123,200	15,200	34,900	9,120,700
1994	1,241,900	260,900	2,159,700	860,500	462,000	6,660,800	3,000	60,200	11,709,000
1995	735,600	548,800	1,768,000	963,500	488,500	8,304,600	27,700	128,700	12,965,400
1996	857,800	453,700	1,739,500	976,100	248,100	9,595,400	9,800	71,600	13,952,900
1997	903,400	587,300	1,583,300	1,240,100	319,400	8,452,400	37,300	127,500	13,230,700
1998	1,019,000	896,200	1,785,200	1,049,700	536,900	8,825,900	13,800	58,900	14,185,600
1999	1,053,800	642,000	1,542,200	1,034,400	675,300	10,797,800	18,600	93,300	15,857,400
2000	911,957	618,514	1,877,505	1,040,591	577,613	9,541,606	13,800	225,033	14,806,619

8-06. Frequencies. The Corps of Engineers developed a discharge-frequency relationship in 2002 for the Upper Mississippi River at the Black River confluence, which is located approximately two miles upstream of the Dakota, Minnesota gage site. The Black River confluence is about five miles downstream of Lock and Dam No. 6, and about six miles upstream of Lock and Dam No. 7.

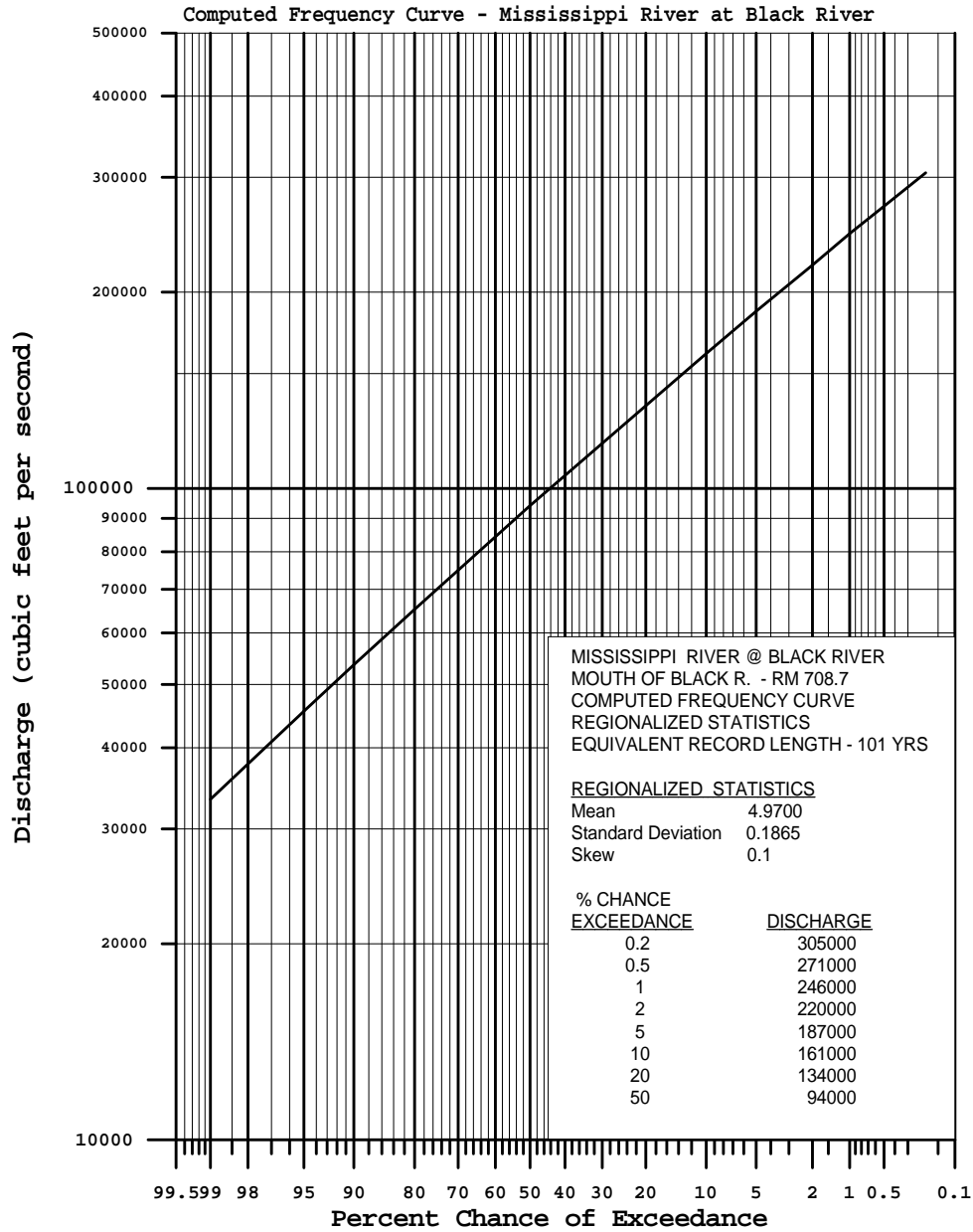


Figure 8-1. Mississippi River at Black River – Discharge/Frequency

The frequency curve displayed in **Figure 8-1** represents peak flow relationships for the Mississippi River at the Black River confluence at river mile 708.7. The frequency curve was derived from regionalized statistics for the mean and standard deviation, based on the drainage area relationships of the Mississippi River at the mouth of the Black River.

Construction of the dam was completed in April 1937. By June, project pool elevation was achieved. The following shows a history of the pool elevation. The high elevations represent flood events and the lows represent a temporary drawdown at the dam. The pool is maintained at elevation 639.0 ± 0.2 feet (1912 adjustment) at the dam. Prior to the Anti-Drawdown Law, as amended by Congress in 1948, the pools were sometimes drawn down well below the project pool elevation during the winter months. The greatest drawdown occurred in January 1944 when the pool was drawn down to elevation 630.65 feet.

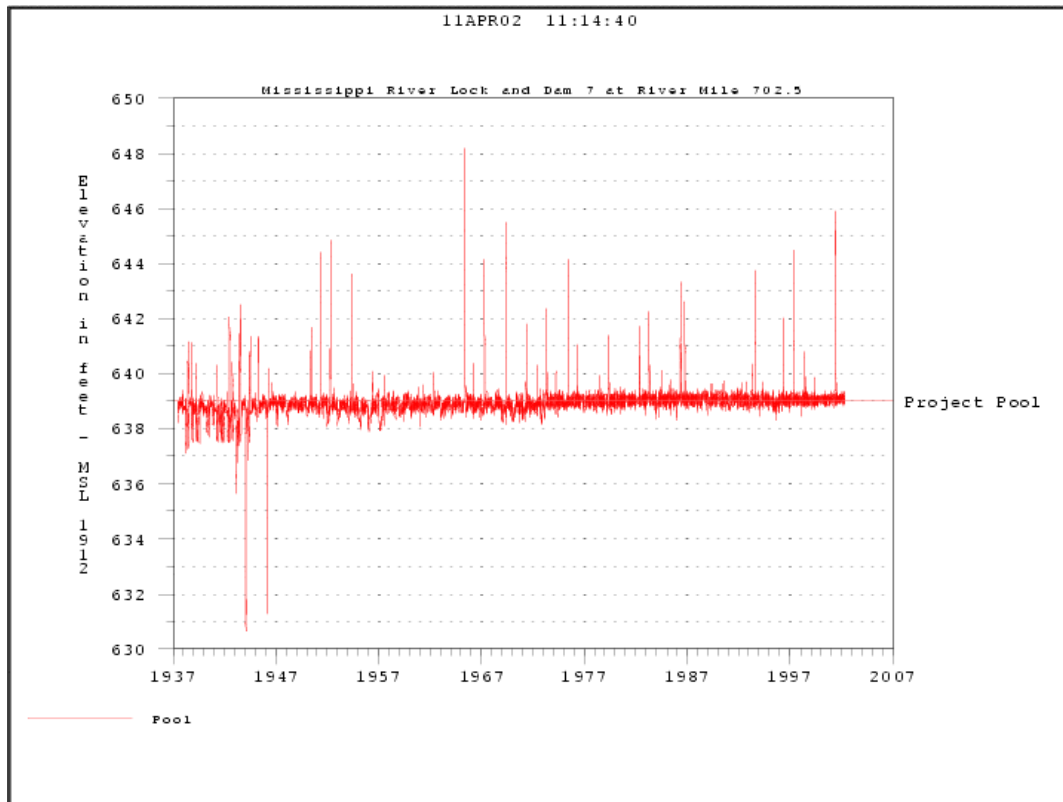


Figure 8-2. History of Pool Elevation

Water surface profile frequencies were developed in 1979 for Pool No. 7. The following figure shows how these profiles compare with historic floods. Note that the flood of 2001 was not documented at the time of this report.

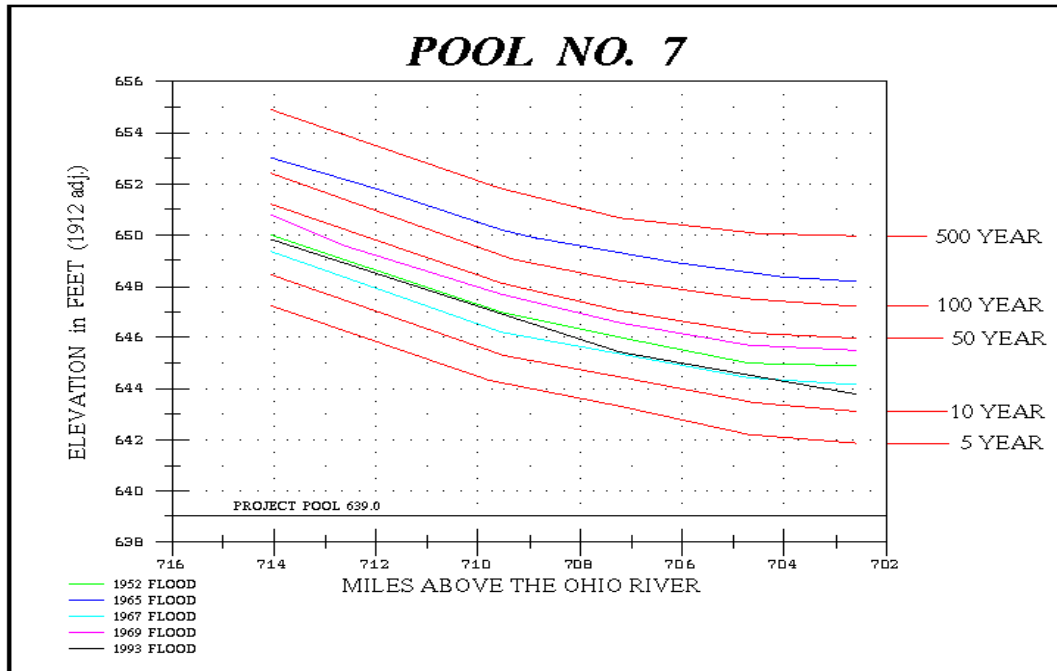
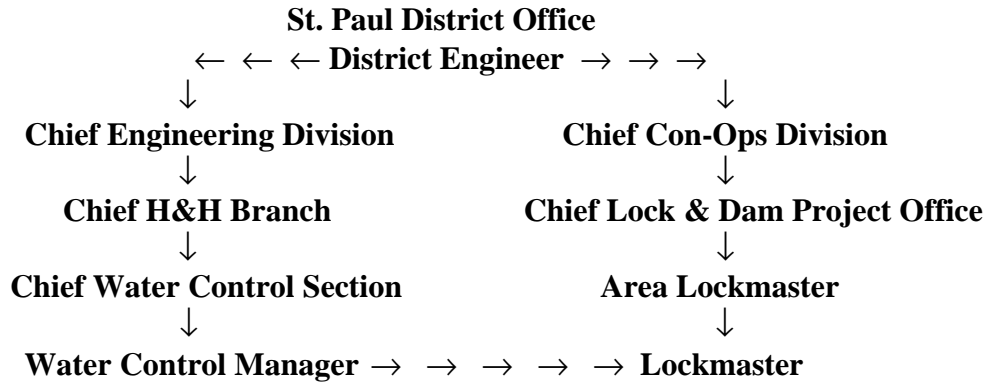


Figure 8-3. Water Surface Profiles - Flood Frequencies and Historic Flood

IX – WATER CONTROL MANAGEMENT

9-01. Responsibilities and Organization.

- a. Corps of Engineers.** The Corps of Engineers is the owner, operator, and regulator for Lock and Dam No. 7. The St. Paul District, Water Control Section has direct day-to-day responsibility for gate adjustments at the dam. Construction and Operations Division is responsible for operation and maintenance of the lock and the dam. The following shows the working relationship for the locks and dams within the St. Paul District.



- b. Other Federal Agencies.** During high water, the National Weather Service (NWS) forecasts stage heights for Lock and Dam 7 (La Crescent) and for the City of La Crosse, Wisconsin. Water Control Section provides the NWS with the daily output from the Mississippi Basin Modeling System to aid them in making their forecast. The US Geological Survey (USGS) maintains the Black River near Galesville, Wisconsin gage site. Daily discharge values are printed annually in the USGS *Water Resources Data – Wisconsin* report. Daily discharge values can also be obtained from their web site at wi.water.usgs.gov. The US Fish and Wildlife Service (USFWS) maintains the Mississippi River Wildlife and Fish Refuge that includes Lake Onalaska, which is located in Pool No.7.

9-02. Interagency Coordination.

- a. Local Press and Corps Bulletins.** Information concerning regulation of Lock and Dam No. 7 is provided by the St. Paul District's Public Affairs Office (PAO) to the local news media in response to their requests. In addition, Construction and Operations Division coordinates with PAO to provide News Releases regarding the opening or closing of the lock to navigation.
- b. National Weather Service.** The National Weather Service (NWS) provides the St. Paul District a "Work 10" file daily by 0830-hours. The file contains the five-day forecast for tributaries to the Mississippi River lock and dam system. The five-day forecast includes the 24-hour quantitative precipitation forecast. These hydrographs are input to Mississippi Basin Modeling System which is an unsteady flow model utilizing the computer program UNET. After the model is run, the output is sent to the NWS by 0930-hours. The NWS uses this information to forecast stages along the Mississippi River, which includes Winona, Minnesota in Pool No. 6 and La Crosse Wisconsin in Pool 8. During flood events the NWS will include additional forecast locations at the locks and dams including Lock and Dam No. 7 (La Crescent).
- c. US Geological Survey.** To maintain the vast network of stream gages for operation of the locks and dams in the St. Paul District would be a costly undertaking. Because of the existing infrastructure of the US Geological Survey (USGS), the St Paul District enters into a cooperative agreement each year with the USGS to maintain many of the gages on the Mississippi River and its tributaries. As for gages logged by Lock and Dam No. 7 personnel, the USGS only maintains the gage located on the Mississippi River at Brownsville, Minnesota. All other gages are maintained by the St. Paul District. The St. Paul District owns all the gage equipment. The USGS publishes the daily discharges for the Brownsville gage site annually as part of

their *Water Resources Data – Minnesota*. Data are also available from their web site; <http://wwwmn.cr.usgs.gov>.

- d. US Fish and Wildlife Service.** The St. Paul District, in coordination with the US Fish and Wildlife (USFWS), constructed the Habitat Rehabilitation and Enhancement Project in Lake Onalaska, which is within the portion of the Mississippi River Wildlife and Fish Refuge located in Pool No. 7. The project consisted of a combination of dredging and island creation. Dredging was performed in a fishery wintering area near Rosebud Island to increase the flow of oxygenated water. A portion of the dredge spoil was used to create three artificial islands to help reduce wave action in the lake. The reduced wave action helps promote growth of aquatic vegetation and provide predator-free waterfowl nesting areas. The dredge cut near Rosebud Island initially caused excessive flows resulting in unfavorable velocities and cold temperatures during the winter months. Flow modifications at the Onalaska Dam were initiated following the reconstruction of the spillway in 1994-95. Winter flows have been reduced, resulting in improved velocity and thermal conditions.
- e. River Resources Forum.** The River Resources Forum and the subcommittee, Water Level Management Task Force, shares information and provides recommendations to the Corps of Engineers on river management. Participants include the US Fish and Wildlife Service, US Geological Survey, US Environmental Protection Agency, National Park Service, US Coast Guard, US Department of Transportation, Minnesota Department of Natural Resources, Wisconsin Department of Natural Resources, Minnesota Department of Transportation, Wisconsin Department of Transportation, and representatives of the commercial navigation industry.

9-03. Reports. “Water Log Sheet” is the name for the daily log of river and dam conditions. These are kept at the site. Nation Weather Service (NWS) Form B-

91 contains pertinent weather information at the lock site. This form and the tape from the Fisher-Porter rain gage are mailed to the NWS in La Crosse, Wisconsin on the first of each month. The “Stevens Strip Charts” are sent to Water Control section at a minimum of once a year.

EXHIBIT A
SUPPLEMENTARY PERTINENT DATA

General Information

Location: Mississippi River Mile 702.5
Lat 43° 52' 00"N Long 91° 18' 30" W
La Crescent, Minnesota
11.8 river miles below Lock and Dam No. 6
23.3 river miles above Lock and Dam No. 8

Type of Project: Lock and Dam for Navigation Purposes

Project Owner: US Army Corps of Engineers

Operating Agency: St. Paul District; Construction-Operations Division
24 hrs a day, 7 days a week

Regulating Agency: St. Paul District; Water Control Section

Completion Date: April 1937

Hydrology

Drainage Area: 62,340 square miles

Design Flood: Flood of 1880
Design High Water: Elevation 645.35 ft
Design Discharge: 190,000 cfs

Minimum Flow: Of Record: 1934 Discharge 3,000 cfs
Post Const: 11 Dec 1961 Discharge 4,100 cfs

Maximum Flow: 21 Apr 1965: Discharge 273,000 cfs

Avg Annual Flow: Years 1959-1993: Discharge 33,300 cfs

Max Monthly Flow: April 1965: Discharge 162,460 cfs

Max Daily Flow: 21 April 1965: Discharge 266,000 cfs

Key Locations: Mississippi River @ TW of Lock and Dam No. 6
Mississippi River @ Dakota, Minnesota
Black River @ Galesville, Wisconsin

Data Recorded at Dam: Pool & Tailwater Elevations (4-hr)
 Roller Gate Discharge (4-hr)
 Tainter Gate Discharge (4-hr)
 Spillway Discharge (4-hr)
 Onalaska Culvert Discharge (4-hr)
 Tainter Valve Discharge (4-hr, winter only)
 Total Discharge (4-hr)
 Gate Openings (4-hr)
 Wind Speed & Direction (8-hr)
 Air Temperature (8-hr)
 Pool No. 8 Control Pt Elevation at La Crosse (daily)
 Elevation at Brownsville (daily)
 Elevation at Dakota (daily)
 La Crosse River Stage & Discharge (daily)
 Water Temperature (daily)
 Max-Min Air Temperature (daily)
 Precipitation (daily)
 Snow Depth & Water Content (weekly)
 Pool & Tailwater Ice Coverage (weekly)
 Pool & Tailwater Ice Thickness (weekly)

Precipitation Gages: Lock & Dam No. 6 and 7
 Mississippi River @ Dakota, Minnesota
 Mississippi River @ La Crosse, Wisconsin
 Black River near Galesville, Wisconsin
 Black River @ Black River Falls, Wisconsin

Snow Survey: At LD No. 7 (weekly by site personnel)
 Black River Basin (late Feb by Gage Crew)
 Black River Falls, Wisconsin
 Neillsville, Wisconsin
 Abbotsford, Wisconsin
 Medford, Wisconsin

Physical Features

Moveable Dam: Roller Gates: 5 Gates 80 feet by 20 feet
 Tainter Gates: 11 Gates 35 feet by 15 feet
 Roller Gate Sill: Elevation 619.0 ft
 Tainter Gate Sill: Elevation 624.0 ft
 Roller Gate End Sill: Elevation 619.0 ft
 Tainter Gate End Sill: Elevation 622.75 ft
 Roller Gate Submergence: 3 feet below PP
 Bulkheads: Roller Gates: 6 @ 4'-2" by 85'-0.5"
 Tainter Gates: 4 @ 4'-2" by 37' - 6"
 Top of Bridge Deck: Elevation 668.42 ft

Lock:	Main Lock Chamber:	110 ft by 600 ft
	Top of Lock Walls:	Elevation 647.0 ft
	Top of Upper Gate Sill (main):	Elevation 621.0 ft
	Top of Upper Gate Sill (aux):	Elevation 621.0 ft
	Top of Lower Gate Sill (main):	Elevation 619.0 ft
	Lock Chamber Floor:	Elevation 617.0 ft
	Height of Upper Miter Gates (main):	23.0 feet
	Height of Upper Miter Gates (aux):	23.0 feet
	Height of Lower Miter Gates (main)	25.0 feet
	Lift:	8.0 feet
	Upper Guidewall Length:	521 feet
	Lower Guidewall Length:	504 feet
	Freeboard @ Project Pool:	8 feet
	Average Filling/Emptying Time:	5 minutes
	Average Double Lockage Time:	1.5 to 2.0 hours

Earthen Dam:	Length (including spillways):	9,000 feet
	Crest Elevation:	649.0 feet
	Top Width:	20 feet
	Maximum Height:	27 feet
	Pool Side Slope:	1V:3H
	Tailwater Slope:	1V:5.5H
	Slope Protection:	12 inch riprap
		To crest on pool side.
		To elevation 634.0 ft on tailwater side.

Concrete Spillway:	Length:	1,000 feet
	Crest Elevation:	639.0 feet
	Slots in Spillway:	3 @ 9 ft long x 2.5 ft deep
	Flow @ Project Pool:	270 cfs

Onalaska Dam:	Total Length:	670 feet
	Spillway Crest Elevation:	639.0 feet
	Length of Overflow Section:	583 feet
	Side Slope Upstream:	1V:3H
	Side Slope Downstream:	1V:4H
	Length of Culvert Section:	87.0 feet
	Box Culverts:	4 barrels – 3 ft by 9 ft
	Control:	Stop Logs
	Upstream Invert Elevation:	629.0 feet
	Downstream Invert Elevation:	627.0 feet
	Summer Discharge:	1,100 cfs
	Winter Discharge:	650 cfs

French Lake Culvert:	Type:	30-inch RCP
	Control:	Slide Gate
	Summer Discharge:	25 cfs
	Winter Discharge:	5 cfs

Pool:	Normal (Project) Upper Pool:	Elevation 639.0 ft
	Normal (Project) Lower Pool:	Elevation 631.0 ft
	Total Pool Area (at Project Pool):	13,440 ac
	Effective Pool Area (at Project Pool):	13,440 ac
	Primary Control Point:	None
	Secondary Control Point:	Elevation 639.0 ft
	Mid Pool Point:	Dakota, MN
	Length in River Miles:	11.8 miles
	Navigation Channel Width;	
	Straight Reaches:	300 feet
	Curved Reaches:	300-550 feet
	Most Frequent Dredge Site:	Winters Landing

1

U.S. DEPARTMENT OF THE INTERIOR - U.S. GEOLOGICAL SURVEY - WATER RESOURCES

STATION NUMBER 05382000 **BLACK RIVER NEAR GALESVILLE, WI** SOURCE AGENCY USGS STATE 55 COUNTY 063

LATITUDE 440337 LONGITUDE 0911714 NAD27 DRAINAGE AREA 2080 CONTRIBUTING DRAINAGE AREA DATUM 658.43 NGVD29

Date Processed: 2005-03-11 08:24 By rjwaschb Rating for Discharge, IN cfs RATING ID: 48.0

Created by dlolson on 02-13-2004 @ 11:19:30 CST, Updated by rjwaschb on 04-05-2004 @ 11:49:31 CDT

Remarks: SAME AS RTG. NO. 46 ABOVE 10.5FT

OFFSET: 1.00

EXPANDED RATING TABLE

Gage height, feet	Discharge IN cfs (STANDARD PRECISION)										DIFF IN Q PER .1 UNITS
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
2.20	200*	204	208	212	216	219	224	228	232	236	40.0
2.30	240*	245	250	254	259	264	269	274	280	285	50.0
2.40	290*	295	299	304	309	313	318	323	328	333	48.0
2.50	338	343	348	353	358	363	369	374	379	385	52.0
2.60	390*	396	401	407	413	418	424	430	436	442	58.0
2.70	448	454	460	466	472	478	485	491	497	504	62.0
2.80	510*	517	523	530	536	543	550	557	564	571	68.0
2.90	578	585	592	599	606	613	620	628	635	643	72.0
3.00	650*	657	663	670	677	684	691	697	704	711	68.0
3.10	718	725	732	739	747	754	761	768	775	783	72.0
3.20	790*	797	804	812	819	826	834	841	848	856	73.0
3.30	863	871	878	886	894	901	909	917	924	932	77.0
3.40	940*	948	955	963	971	979	987	995	1000	1010	80.0
3.50	1020	1030	1030	1040	1050	1060	1070	1080	1080	1090	80.0
3.60	1100*	1110	1120	1120	1130	1140	1150	1150	1160	1170	80.0
3.70	1180	1190	1190	1200	1210	1220	1230	1240	1240	1250	80.0
3.80	1260*	1270	1280	1280	1290	1300	1310	1320	1330	1340	80.0
3.90	1340	1350	1360	1370	1380	1390	1400	1400	1410	1420	90.0
4.00	1430*	1440	1450	1460	1470	1480	1490	1500	1500	1510	90.0
4.10	1520	1530	1540	1550	1560	1570	1580	1590	1600	1610	100
4.20	1620*	1630	1640	1650	1660	1670	1680	1690	1700	1710	100
4.30	1720	1730	1740	1750	1760	1770	1780	1790	1800	1810	100
4.40	1820*	1830	1840	1850	1860	1870	1880	1900	1910	1920	110
4.50	1930	1940	1950	1960	1970	1980	2000	2010	2020	2030	110
4.60	2040*	2050	2060	2070	2080	2090	2100	2120	2130	2140	110
4.70	2150	2160	2170	2180	2190	2200	2220	2230	2240	2250	110
4.80	2260*	2270	2280	2300	2310	2320	2330	2340	2350	2370	120
4.90	2380	2390	2400	2410	2430	2440	2450	2460	2480	2490	120
5.00	2500*	2510	2520	2540	2550	2560	2570	2580	2590	2610	120
5.10	2620	2630	2640	2650	2670	2680	2690	2700	2720	2730	120
5.20	2740*	2750	2770	2780	2790	2800	2820	2830	2840	2860	130
5.30	2870	2880	2890	2910	2920	2930	2950	2960	2970	2990	130
5.40	3000*	3010	3030	3040	3050	3060	3080	3090	3100	3120	130

Gage height, feet	Discharge IN cfs										DIFF IN Q PER .1 UNITS
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
5.50	3130	3140	3150	3170	3180	3190	3210	3220	3230	3250	130
5.60	3260*	3270	3290	3300	3310	3320	3340	3350	3360	3380	130
5.70	3390	3400	3410	3430	3440	3450	3470	3480	3490	3510	130
5.80	3520*	3530	3550	3560	3570	3580	3600	3610	3620	3640	130
5.90	3650	3660	3680	3690	3700	3710	3730	3740	3750	3770	130
6.00	3780*	3790	3810	3820	3830	3840	3860	3870	3880	3900	130
6.10	3910	3920	3940	3950	3960	3970	3990	4000	4010	4030	130
6.20	4040*	4050	4070	4080	4090	4100	4120	4130	4140	4160	130
6.30	4170	4180	4200	4210	4220	4230	4250	4260	4270	4290	130
6.40	4300*	4310	4330	4340	4350	4360	4380	4390	4400	4420	130
6.50	4430*	4440	4460	4470	4480	4490	4510	4520	4530	4540	130
6.60	4560	4570	4580	4600	4610	4620	4630	4650	4660	4670	130
6.70	4690	4700	4710	4720	4740	4750	4760	4780	4790	4800	130
6.80	4820	4830	4840	4860	4870	4880	4890	4910	4920	4930	130
6.90	4950	4960	4970	4990	5000	5010	5030	5040	5050	5070	130
7.00	5080*	5090	5110	5120	5140	5150	5160	5180	5190	5200	140
7.10	5220	5230	5250	5260	5270	5290	5300	5320	5330	5340	140
7.20	5360	5370	5390	5400	5420	5430	5440	5460	5470	5490	140
7.30	5500	5510	5530	5540	5560	5570	5590	5600	5610	5630	140
7.40	5640	5660	5670	5690	5700	5720	5730	5740	5760	5770	150
7.50	5790	5800	5820	5830	5850	5860	5880	5890	5900	5920	140
7.60	5930	5950	5960	5980	5990	6010	6020	6040	6050	6070	150
7.70	6080	6100	6110	6130	6140	6160	6170	6190	6200	6220	150
7.80	6230	6240	6260	6270	6290	6300	6320	6330	6350	6360	150
7.90	6380	6400	6410	6430	6440	6460	6470	6490	6500	6520	150
8.00	6530	6550	6560	6580	6590	6610	6620	6640	6650	6670	150
8.10	6680	6700	6710	6730	6750	6760	6780	6790	6810	6820	160
8.20	6840	6850	6870	6880	6900	6920	6930	6950	6960	6980	150
8.30	6990	7010	7030	7040	7060	7070	7090	7100	7120	7140	160
8.40	7150	7170	7180	7200	7210	7230	7250	7260	7280	7290	160
8.50	7310	7320	7340	7360	7370	7390	7400	7420	7440	7450	160
8.60	7470	7480	7500	7520	7530	7550	7560	7580	7600	7610	160
8.70	7630	7650	7660	7680	7690	7710	7730	7740	7760	7780	160
8.80	7790	7810	7820	7840	7860	7870	7890	7910	7920	7940	170
8.90	7960	7970	7990	8000	8020	8040	8050	8070	8090	8100	160
9.00	8120*	8140	8160	8170	8190	8210	8230	8250	8260	8280	180
9.10	8300	8320	8340	8350	8370	8390	8410	8430	8450	8460	180
9.20	8480	8500	8520	8540	8560	8570	8590	8610	8630	8650	190
9.30	8670	8680	8700	8720	8740	8760	8780	8800	8810	8830	180
9.40	8850	8870	8890	8910	8930	8940	8960	8980	9000	9020	190

Gage height, feet	Discharge IN cfs										DIFF IN Q PER .1 UNITS
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
9.50	9040	9060	9080	9100	9110	9130	9150	9170	9190	9210	190
9.60	9230	9250	9270	9280	9300	9320	9340	9360	9380	9400	190
9.70	9420	9440	9460	9480	9490	9510	9530	9550	9570	9590	190
9.80	9610	9630	9650	9670	9690	9710	9730	9750	9770	9780	190
9.90	9800	9820	9840	9860	9880	9900	9920	9940	9960	9980	200
10.00	10000*	10000	10000	10000	10100	10100	10100	10100	10100	10100	200
10.10	10200	10200	10200	10200	10200	10200	10300	10300	10300	10300	100
10.20	10300	10300	10300	10400	10400	10400	10400	10400	10400	10500	200
10.30	10500	10500	10500	10500	10500	10600	10600	10600	10600	10600	100
10.40	10600	10700	10700	10700	10700	10700	10700	10800	10800	10800	200
10.50	10800*	10800	10900	10900	10900	10900	11000	11000	11000	11000	300
10.60	11100	11100	11100	11100	11200	11200	11200	11200	11300	11300	200
10.70	11300	11300	11400	11400	11400	11400	11500	11500	11500	11500	300
10.80	11600	11600	11600	11700	11700	11700	11700	11800	11800	11800	200
10.90	11800	11900	11900	11900	11900	12000	12000	12000	12100	12100	300
11.00	12100	12100	12200	12200	12200	12200	12300	12300	12300	12400	300
11.10	12400	12400	12400	12500	12500	12500	12500	12600	12600	12600	300
11.20	12700	12700	12700	12700	12800	12800	12800	12800	12900	12900	200
11.30	12900	13000	13000	13000	13000	13100	13100	13100	13200	13200	300
11.40	13200	13200	13300	13300	13300	13400	13400	13400	13400	13500	300
11.50	13500*	13500	13600	13600	13600	13700	13700	13700	13800	13800	400
11.60	13900	13900	13900	14000	14000	14000	14100	14100	14100	14200	300
11.70	14200	14200	14300	14300	14400	14400	14400	14500	14500	14500	400
11.80	14600	14600	14700	14700	14700	14800	14800	14800	14900	14900	300
11.90	14900	15000	15000	15100	15100	15100	15200	15200	15200	15300	400
12.00	15300	15400	15400	15400	15500	15500	15600	15600	15600	15700	400
12.10	15700	15700	15800	15800	15900	15900	15900	16000	16000	16100	400
12.20	16100	16100	16200	16200	16300	16300	16300	16400	16400	16500	400
12.30	16500	16500	16600	16600	16700	16700	16700	16800	16800	16900	400
12.40	16900	16900	17000	17000	17100	17100	17100	17200	17200	17300	400
12.50	17300*	17300	17400	17400	17500	17500	17500	17600	17600	17600	400
12.60	17700	17700	17800	17800	17800	17900	17900	17900	18000	18000	400
12.70	18100	18100	18100	18200	18200	18300	18300	18300	18400	18400	300
12.80	18400	18500	18500	18600	18600	18600	18700	18700	18800	18800	400
12.90	18800	18900	18900	19000	19000	19000	19100	19100	19200	19200	400
13.00	19200	19300	19300	19400	19400	19400	19500	19500	19600	19600	400
13.10	19600	19700	19700	19800	19800	19800	19900	19900	20000	20000	400
13.20	20000	20100	20100	20200	20200	20200	20300	20300	20400	20400	500
13.30	20500	20500	20500	20600	20600	20700	20700	20800	20800	20800	400
13.40	20900	20900	21000	21000	21000	21100	21100	21200	21200	21300	400

Gage height, feet	Discharge IN cfs (STANDARD PRECISION)										DIFF IN Q PER .1 UNITS
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
13.50	21300*	21400	21400	21500	21500	21600	21700	21700	21800	21800	600
13.60	21900	22000	22000	22100	22200	22200	22300	22300	22400	22500	600
13.70	22500	22600	22700	22700	22800	22800	22900	23000	23000	23100	700
13.80	23200	23200	23300	23400	23400	23500	23600	23600	23700	23800	600
13.90	23800	23900	23900	24000	24100	24100	24200	24300	24300	24400	700
14.00	24500	24500	24600	24700	24700	24800	24900	24900	25000	25100	700
14.10	25200	25200	25300	25400	25400	25500	25600	25600	25700	25800	600
14.20	25800	25900	26000	26000	26100	26200	26300	26300	26400	26500	700
14.30	26500	26600	26700	26800	26800	26900	27000	27000	27100	27200	800
14.40	27300	27300	27400	27500	27500	27600	27700	27800	27800	27900	700
14.50	28000	28100	28100	28200	28300	28400	28400	28500	28600	28700	700
14.60	28700	28800*	28900	29000	29100	29300	29400	29500	29600	29700	1200
14.70	29900	30000	30100	30200	30300	30500	30600	30700	30800	30900	1200
14.80	31100	31200	31300	31400	31600	31700	31800	31900	32100	32200	1200
14.90	32300	32400	32600	32700	32800	33000	33100	33200	33300	33500	1300
15.00	33600*	33800	33900	34100	34300	34400	34600	34800	34900	35100	1700
15.10	35300	35500	35600	35800	36000	36200	36300	36500	36700	36900	1800
15.20	37100	37200	37400	37600	37800	38000	38100	38300	38500	38700	1800
15.30	38900	39100	39300	39500	39600	39800	40000	40200	40400	40600	1900
15.40	40800	41000	41200	41400	41600	41800	42000	42200	42400	42600	2000
15.50	42800*	43000	43100	43300	43500	43700	43800	44000	44200	44400	1700
15.60	44500	44700	44900	45100	45300	45400	45600	45800	46000	46200	1800
15.70	46300	46500	46700	46900	47100	47300	47400	47600	47800	48000	1900
15.80	48200	48400	48600	48800	49000	49200	49300	49500	49700	49900	1900
15.90	50100	50300	50500	50700	50900	51100	51300	51500	51700	51900	2000
16.00	52100*	52300	52400	52600	52800	53000	53200	53300	53500	53700	1800
16.10	53900	54000	54200	54400	54600	54800	54900	55100	55300	55500	1800
16.20	55700	55900	56000	56200	56400	56600	56800	57000	57200	57300	1800
16.30	57500	57700	57900	58100	58300	58500	58700	58900	59100	59200	1900
16.40	59400	59600	59800	60000	60200	60400	60600	60800	61000	61200	2000
16.50	61400*	61600	61800	61900	62100	62300	62500	62700	62900	63000	1800
16.60	63200	63400	63600	63800	64000	64200	64400	64500	64700	64900	1900
16.70	65100	65300	65500	65700	65900	66100	66300	66400	66600	66800	1900
16.80	67000	67200	67400	67600	67800	68000	68200	68400	68600	68800	2000
16.90	69000	69200	69400	69600	69800	70000	70200	70400	70600	70800	2000
17.00	71000*										

UNITED STATES DEPARTMENT OF INTERIOR - GEOLOGICAL SURVEY - WATER RESOURCES DIVISION

PAGE 1
TYPE: LOG

05382000
BLACK RIVER NEAR GALESVILLE, WI
OFFSET: 1.00
EXPANDED RATING TABLE
DATE PROCESSED: 11-24-1998 @ 09:33 BY bkholmst
DD: 4
TYPE: 001
RATING NO: 47.0
START DATE/TIME: 12-01-94 (0001)

BASED ON _____ DISCHARGE MEASUREMENTS, NOS _____, AND _____, AND IS _____ WELL DEFINED BETWEEN _____ AND _____ CFS
COMP BY _____ DATE _____ CHK. BY _____ DATE _____
SAME AS RTG. NO. 46 ABOVE 10.5FT

GAGE HEIGHT (FEET)	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	DIFF IN Q PER TENTH FT
1.60	376	382	388	394	400	406	412	418	424	424	60.0
1.70	430*	440	445	451	456	461	466	471	476	476	51.0
1.80	481	491	496	501	506	511	516	521	526	526	50.0
1.90	531	541	546	551	556	560	565	570	575	575	49.0
2.00	585*	590	596	601	606	611	616	621	627	627	52.0
2.10	632	642	647	652	658	663	668	673	678	678	51.0
2.20	683	693	698	704	709	714	719	724	729	729	51.0
2.30	734*	744	749	755	760	765	771	776	781	781	52.0
2.40	786	797	802	807	812	817	823	828	833	833	52.0
2.50	838	849	854	859	864	869	875	880	885	885	52.0
2.60	890*	901	907	913	919	924	930	936	942	942	57.0
2.70	947	959	965	970	976	982	988	993	999	999	53.0
2.80	1000	1020	1020	1030	1030	1040	1050	1050	1060	1060	60.0
2.90	1060	1070	1080	1090	1090	1100	1100	1110	1110	1110	60.0
3.00	1120*	1130	1140	1150	1150	1160	1170	1170	1180	1180	70.0
3.10	1190	1200	1210	1210	1220	1230	1230	1240	1250	1250	60.0
3.20	1250	1270	1270	1280	1290	1300	1300	1310	1320	1320	70.0
3.30	1320	1330	1340	1350	1360	1360	1370	1380	1380	1380	70.0
3.40	1390	1400	1410	1420	1430	1430	1440	1450	1450	1450	70.0
3.50	1450*	1470	1480	1490	1500	1500	1510	1520	1530	1530	80.0
3.60	1540	1540	1560	1570	1570	1580	1590	1600	1610	1610	70.0
3.70	1610	1620	1630	1640	1650	1660	1670	1680	1680	1680	80.0
3.80	1690	1700	1710	1720	1730	1740	1750	1760	1760	1760	80.0
3.90	1770	1780	1790	1800	1810	1820	1830	1840	1840	1840	80.0
4.00	1850*	1860	1870	1880	1890	1900	1910	1920	1930	1930	90.0
4.10	1940	1940	1960	1970	1980	1990	2000	2010	2010	2010	80.0
4.20	2020	2030	2040	2050	2060	2070	2080	2090	2100	2100	90.0
4.30	2110	2120	2130	2140	2150	2170	2170	2180	2190	2190	90.0
4.40	2200	2210	2220	2230	2240	2250	2260	2270	2280	2280	90.0
4.50	2290	2300	2310	2320	2330	2340	2350	2370	2370	2370	90.0
4.60	2380	2390	2400	2410	2420	2430	2440	2460	2470	2470	100
4.70	2480	2490	2500	2510	2520	2530	2540	2550	2560	2560	90.0
4.80	2570	2580	2590	2600	2610	2620	2630	2650	2650	2650	90.0
4.90	2660	2670	2680	2690	2700	2710	2720	2740	2750	2750	100

EXHIBIT B

05382000
BLACK RIVER NEAR GALESVILLE, WI
OFFSET: 1.00
DATE PROCESSED: 11-24-1998 @ 09:33 BY bkholmst
DD: 4 TYPE: 001 RATING NO: 47.0
START DATE/TIME: 12-01-94 (0001)

SAME AS RTG. NO. 46 ABOVE 10.5FT

GAGE HEIGHT (FEET)	DISCHARGE IN CUBIC FEET PER SECOND										DIFF IN Q PER TENTH FT
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
5.00	2760*	2770	2780	2790	2800	2810	2820	2830	2840	2850	100
5.10	2860	2870	2880	2890	2900	2910	2920	2930	2940	2950	100
5.20	2960	2970	2980	2990	3000	3010	3020	3030	3040	3050	100
5.40	3170	3180	3190	3200	3210	3220	3230	3240	3250	3260	100
5.50	3270	3280	3290	3300	3310	3320	3340	3350	3360	3370	110
5.60	3380	3390	3400	3410	3420	3430	3440	3450	3460	3470	100
5.70	3480	3490	3510	3520	3530	3540	3550	3560	3570	3580	110
5.80	3590	3600	3610	3620	3640	3650	3660	3670	3680	3690	110
5.90	3700	3710	3720	3730	3740	3760	3770	3780	3790	3800	110
6.00	3810*	3820	3830	3850	3860	3870	3880	3890	3910	3920	120
6.10	3930	3940	3960	3970	3980	3990	4000	4020	4030	4040	120
6.20	4050	4070	4080	4090	4100	4110	4130	4140	4150	4160	130
6.30	4180	4190	4200	4210	4230	4240	4250	4260	4280	4290	120
6.40	4300	4310	4330	4340	4350	4360	4380	4390	4400	4420	130
6.50	4430	4440	4450	4470	4480	4490	4500	4520	4530	4540	130
6.60	4560	4570	4580	4590	4610	4620	4630	4650	4660	4670	130
6.70	4690	4700	4710	4720	4740	4750	4760	4780	4790	4800	130
6.80	4820	4830	4840	4850	4870	4880	4890	4910	4920	4930	130
6.90	4950	4960	4970	4990	5000	5010	5030	5040	5050	5070	130
7.00	5080*	5090	5110	5120	5140	5150	5160	5180	5190	5200	140
7.10	5220	5230	5250	5260	5270	5290	5300	5320	5330	5340	140
7.20	5360	5370	5390	5400	5420	5430	5440	5460	5470	5490	140
7.30	5500	5510	5530	5540	5560	5570	5590	5600	5610	5630	140
7.40	5640	5660	5670	5690	5700	5720	5730	5740	5760	5770	150
7.50	5790	5800	5820	5830	5850	5860	5880	5890	5900	5920	140
7.60	5930	5950	5960	5980	5990	6010	6020	6040	6050	6070	150
7.70	6080	6100	6110	6130	6140	6160	6170	6190	6200	6220	150
7.80	6230	6240	6260	6270	6290	6300	6320	6330	6350	6360	150
7.90	6380	6400	6410	6430	6440	6460	6470	6490	6500	6520	150
8.00	6530	6550	6560	6580	6590	6610	6620	6640	6650	6670	150
8.10	6680	6700	6710	6730	6750	6760	6780	6790	6810	6820	160
8.20	6840	6850	6870	6880	6900	6920	6930	6950	6960	6980	150
8.30	6990	7010	7030	7040	7060	7070	7090	7100	7120	7140	160
8.40	7150	7170	7180	7200	7210	7230	7250	7260	7280	7290	160

05382000 BLACK RIVER NEAR GALESVILLE, WI DATE PROCESSED: 11-24-1998 @ 09:33 BY bkholmst DD: 4 TYPE: 001 RATING NO: 47.0
 OFFSET: 1.00 START DATE/TIME: 12-01-94 (0001)

SAME AS RTG. NO. 46 ABOVE 10.5FT

GAGE HEIGHT (FEET)	DISCHARGE IN CUBIC FEET PER SECOND (STANDARD PRECISION)										DIFF IN Q PER TENTH FT
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
8.50	7310	7320	7340	7360	7370	7390	7400	7420	7440	7450	160
8.60	7470	7480	7500	7520	7530	7550	7560	7580	7600	7610	160
8.70	7630	7650	7660	7680	7690	7710	7730	7740	7760	7780	160
8.80	7790	7810	7820	7840	7860	7870	7890	7910	7920	7940	170
8.90	7960	7970	7990	8000	8020	8040	8050	8070	8090	8100	160
9.00	8120*	8140	8160	8170	8190	8210	8230	8250	8260	8280	180
9.10	8300	8320	8340	8350	8370	8390	8410	8430	8450	8460	180
9.20	8480	8500	8520	8540	8560	8570	8590	8610	8630	8650	190
9.30	8670	8680	8700	8720	8740	8760	8780	8800	8810	8830	180
9.40	8850	8870	8890	8910	8930	8940	8960	8980	9000	9020	190
9.50	9040	9060	9080	9100	9110	9130	9150	9170	9190	9210	190
9.60	9230	9250	9270	9280	9300	9320	9340	9360	9380	9400	190
9.70	9420	9440	9460	9480	9490	9510	9530	9550	9570	9590	190
9.80	9610	9630	9650	9670	9690	9710	9730	9750	9770	9780	190
9.90	9800	9820	9840	9860	9880	9900	9920	9940	9960	9980	200
10.00	10000*	10000	10000	10000	10100	10100	10100	10100	10100	10100	200
10.10	10200	10200	10200	10200	10200	10200	10300	10300	10300	10300	100
10.20	10300	10300	10300	10400	10400	10400	10400	10400	10400	10500	200
10.30	10500	10500	10500	10500	10500	10600	10600	10600	10600	10600	100
10.40	10600	10700	10700	10700	10700	10700	10700	10800	10800	10800	200
10.50	10800*	10800	10900	10900	10900	10900	11000	11000	11000	11000	300
10.60	11100	11100	11100	11100	11200	11200	11200	11200	11300	11300	200
10.70	11300	11300	11400	11400	11400	11400	11500	11500	11500	11500	300
10.80	11600	11600	11600	11700	11700	11700	11700	11800	11800	11800	200
10.90	11800	11900	11900	11900	11900	12000	12000	12000	12100	12100	300
11.00	12100	12100	12200	12200	12200	12200	12300	12300	12300	12400	300
11.10	12400	12400	12400	12500	12500	12500	12500	12600	12600	12600	300
11.20	12700	12700	12700	12700	12800	12800	12800	12800	12900	12900	300
11.30	12900	13000	13000	13000	13000	13100	13100	13100	13200	13200	300
11.40	13200	13200	13300	13300	13300	13400	13400	13400	13400	13500	300
11.50	13500*	13500	13600	13600	13600	13700	13700	13700	13800	13800	400
11.60	13900	13900	13900	14000	14000	14000	14100	14100	14100	14200	300
11.70	14200	14200	14300	14300	14400	14400	14400	14500	14500	14500	400
11.80	14600	14600	14700	14700	14700	14800	14800	14800	14900	14900	300
11.90	14900	14900	15000	15100	15100	15100	15200	15200	15200	15300	400

GAGE HEIGHT (FEET)	DISCHARGE IN CUBIC FEET PER SECOND (STANDARD PRECISION)										DIFF IN Q PER TENTH FT
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
12.00	15300	15400	15400	15400	15500	15600	15600	15600	15600	15700	400
12.10	15700	15700	15800	15800	15900	15900	16000	16000	16000	16100	400
12.20	16100	16100	16200	16200	16300	16300	16400	16400	16400	16500	400
12.30	16500	16500	16600	16600	16700	16700	16800	16800	16800	16900	400
12.40	16900	16900	17000	17000	17100	17100	17200	17200	17200	17300	400
12.50	17300*	17300	17400	17400	17500	17500	17600	17600	17600	17600	400
12.60	17700	17700	17800	17800	17800	17900	17900	18000	18000	18000	400
12.70	18100	18100	18100	18200	18200	18300	18300	18400	18400	18400	300
12.80	18400	18500	18500	18600	18600	18700	18700	18800	18800	18800	400
12.90	18800	18900	18900	19000	19000	19100	19100	19200	19200	19200	400
13.00	19200	19300	19300	19400	19400	19500	19500	19600	19600	19600	400
13.10	19600	19700	19700	19800	19800	19900	19900	20000	20000	20000	400
13.20	20000	20100	20100	20200	20200	20300	20300	20400	20400	20400	500
13.30	20500	20500	20500	20600	20600	20700	20700	20800	20800	20800	400
13.40	20900	20900	21000	21000	21100	21100	21200	21200	21200	21300	400
13.50	21300*	21400	21400	21500	21500	21600	21700	21700	21800	21800	600
13.60	21900	22000	22000	22100	22200	22200	22300	22300	22400	22500	600
13.70	22500	22600	22700	22700	22800	22800	23000	23000	23000	23100	700
13.80	23200	23200	23300	23400	23400	23500	23600	23600	23700	23800	600
13.90	23800	23900	23900	24000	24100	24100	24200	24300	24300	24400	700
14.00	24500	24500	24600	24700	24700	24800	24900	24900	25000	25100	700
14.10	25200	25200	25300	25400	25400	25500	25600	25600	25700	25800	600
14.20	25800	25900	26000	26000	26100	26200	26300	26300	26400	26500	700
14.30	26500	26600	26700	26800	26800	26900	27000	27000	27100	27200	800
14.40	27300	27300	27400	27500	27500	27600	27700	27800	27800	27900	700
14.50	28000	28100	28100	28200	28300	28400	28400	28500	28600	28700	700
14.60	28700	28800*	28900	29000	29100	29300	29400	29500	29600	29700	1200
14.70	29900	30000	30100	30200	30300	30500	30600	30700	30800	30900	1200
14.80	31100	31200	31300	31400	31600	31700	31800	31900	32100	32200	1200
14.90	32300	32400	32600	32700	32800	33000	33100	33200	33300	33500	1300
15.00	33600*	33800	33900	34100	34300	34400	34600	34800	34900	35100	1700
15.10	35300	35500	35600	35800	36000	36200	36300	36500	36700	36900	1800
15.20	37100	37200	37400	37600	37800	38000	38100	38300	38500	38700	1800
15.30	38900	39100	39300	39500	39600	39800	40000	40200	40400	40600	1900
15.40	40800	41000	41200	41400	41600	41800	42000	42200	42400	42600	2000

TYPE: LOG

05382000

BLACK RIVER NEAR GALESVILLE, WI

OFFSET: 1.00

EXPANDED RATING TABLE

DATE PROCESSED: 11-24-1998 @ 09:33 BY bkholmst

DD: 4

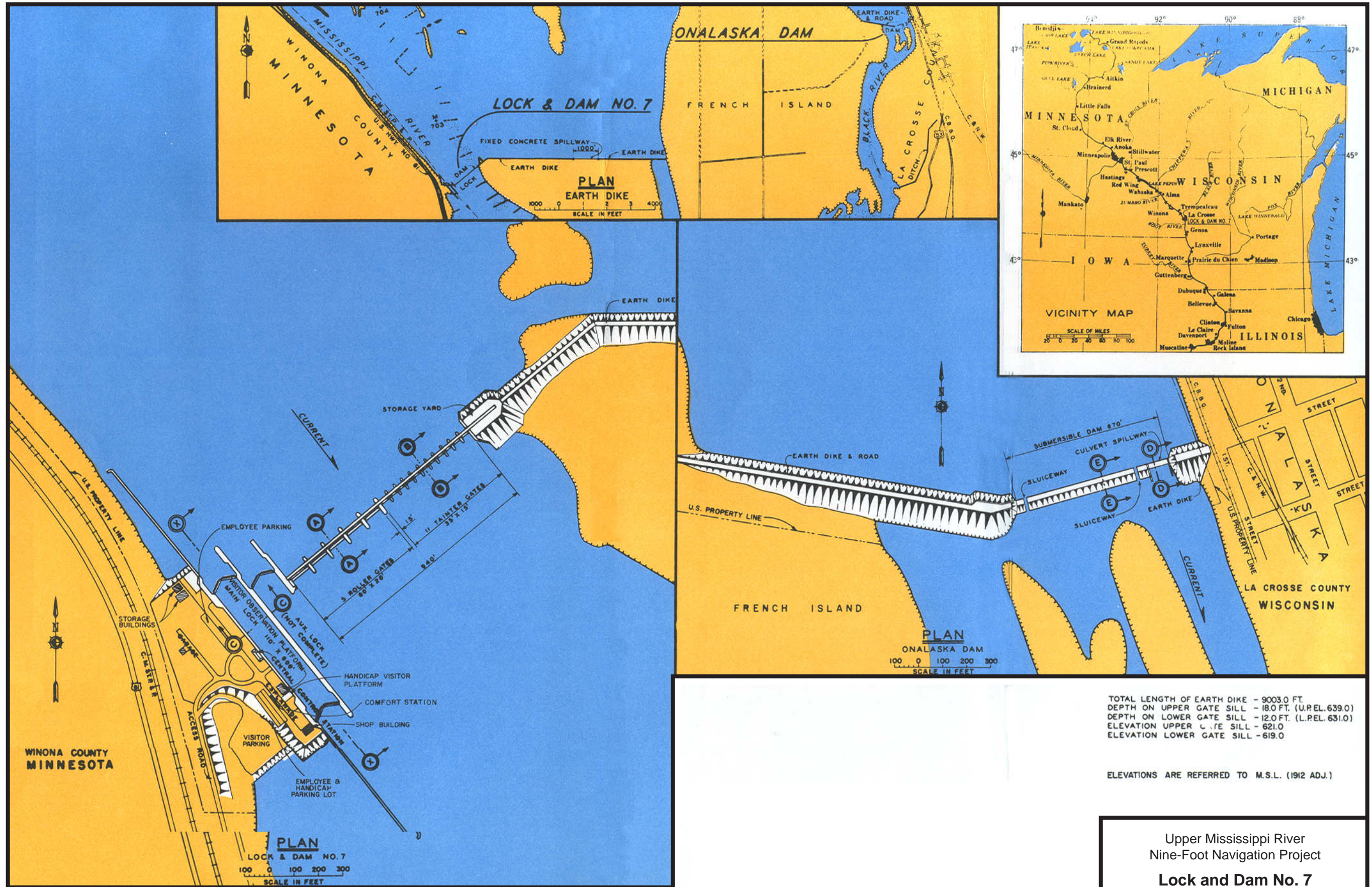
TYPE: 001

RATING NO: 47.0

START DATE/TIME: 12-01-94 (0001)

SAME AS RTG. NO. 46 ABOVE 10.5FT

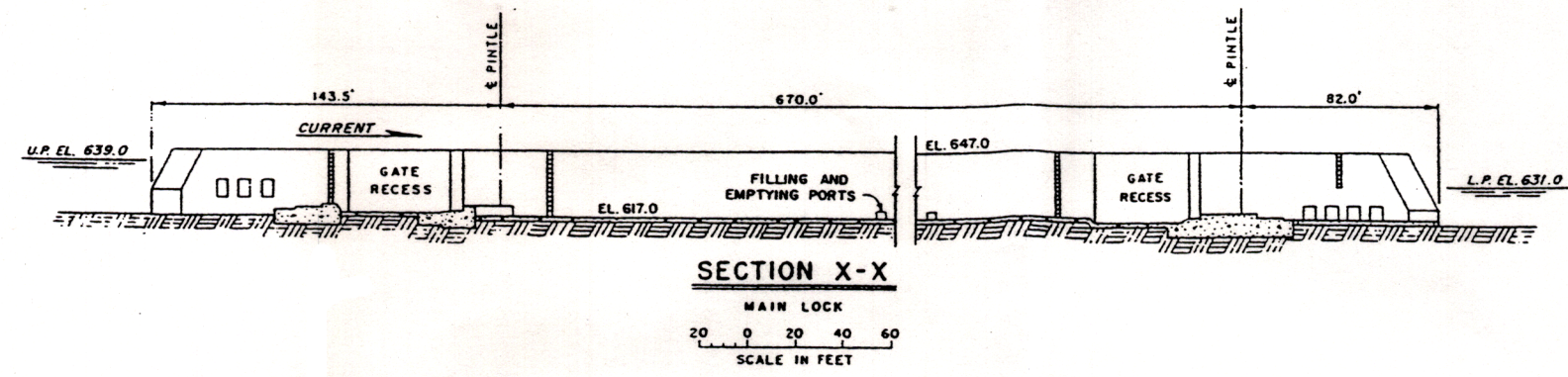
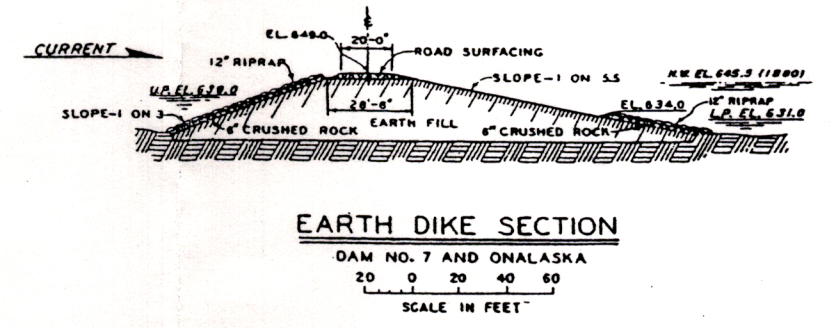
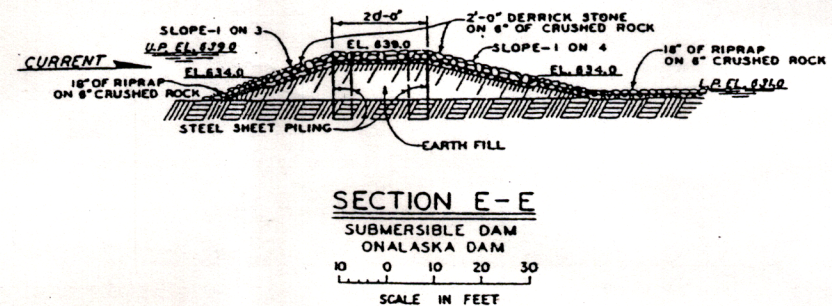
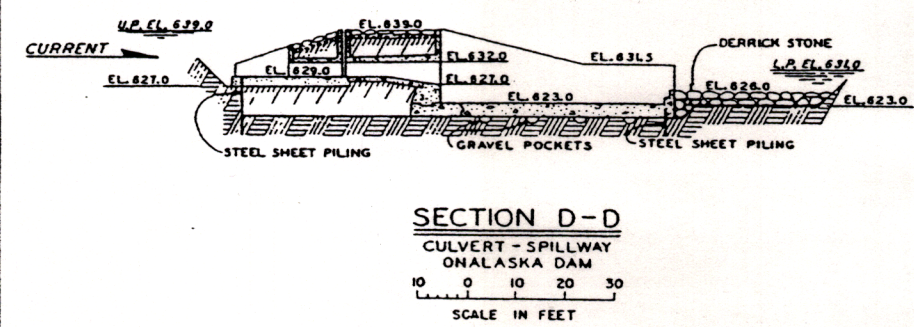
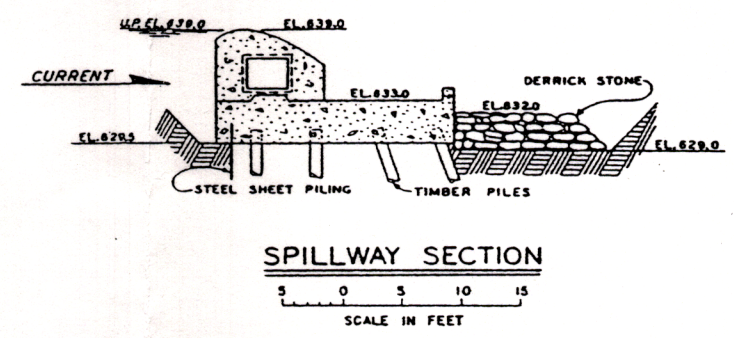
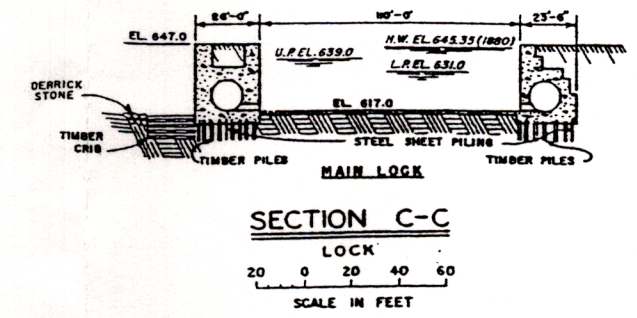
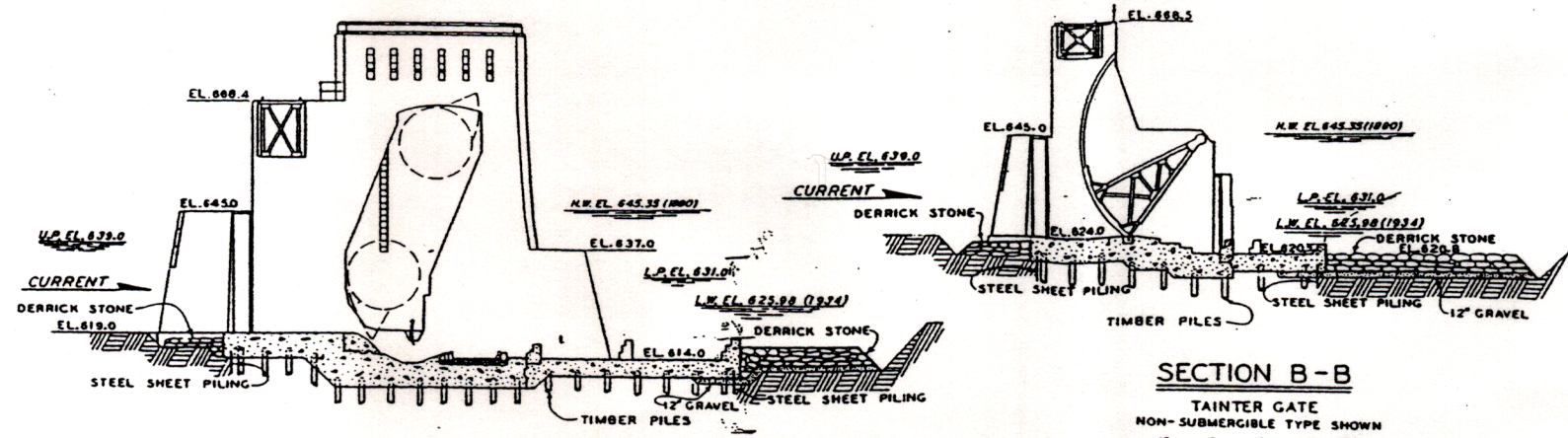
GAGE HEIGHT (FEET)	DISCHARGE IN CUBIC FEET PER SECOND										DIFF IN Q PER TENTH FT
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
15.50	42800*	43000	43100	43300	43500	43700	43800	44000	44200	44400	1700
15.60	44500	44700	44900	45100	45300	45400	45600	45800	46000	46200	1800
15.70	46300	46500	46700	46900	47100	47300	47400	47600	47800	48000	1900
15.80	48200	48400	48600	48800	49000	49100	49300	49500	49700	49900	1900
15.90	50100	50300	50500	50700	50900	51100	51300	51500	51700	51900	2000
16.00	52100*	52300	52400	52600	52800	53000	53200	53300	53500	53700	1800
16.10	53900	54000	54200	54400	54600	54800	54900	55100	55300	55500	1800
16.20	55700	55900	56000	56200	56400	56600	56800	57000	57200	57300	1800
16.30	57500	57700	57900	58100	58300	58500	58700	58900	59100	59200	1900
16.40	59400	59600	59800	60000	60200	60400	60600	60800	61000	61200	2000
16.50	61400*	61600	61800	61900	62100	62300	62500	62700	62900	63000	1800
16.60	63200	63400	63600	63800	64000	64200	64400	64500	64700	64900	1900
16.70	65100	65300	65500	65700	65900	66100	66300	66400	66600	66800	1900
16.80	67000	67200	67400	67600	67800	68000	68200	68400	68600	68800	2000
16.90	69000	69200	69400	69600	69800	70000	70200	70400	70600	70800	2000*
17.00	71000*										



TOTAL LENGTH OF EARTH DIKE - 9003.0 FT.
 DEPTH ON UPPER GATE SILL - 18.0 FT. (U.REL. 639.0)
 DEPTH ON LOWER GATE SILL - 12.0 FT. (L.REL. 631.0)
 ELEVATION UPPER GATE SILL - 621.0
 ELEVATION LOWER GATE SILL - 619.0

ELEVATIONS ARE REFERRED TO M.S.L. (1912 ADJ.)

Upper Mississippi River
 Nine-Foot Navigation Project
**Lock and Dam No. 7
 Project Location Map**
 U.S. Army Corps of Engineers
 St. Paul District - St. Paul, MN
 30 September 1992

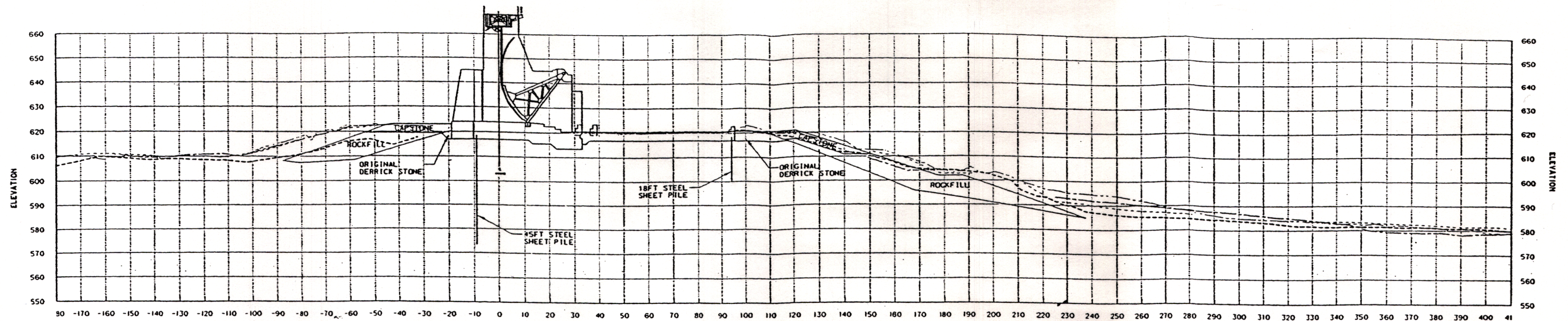


ELEVATIONS ARE REFERRED TO M.S.L. (1912 ADJ.)

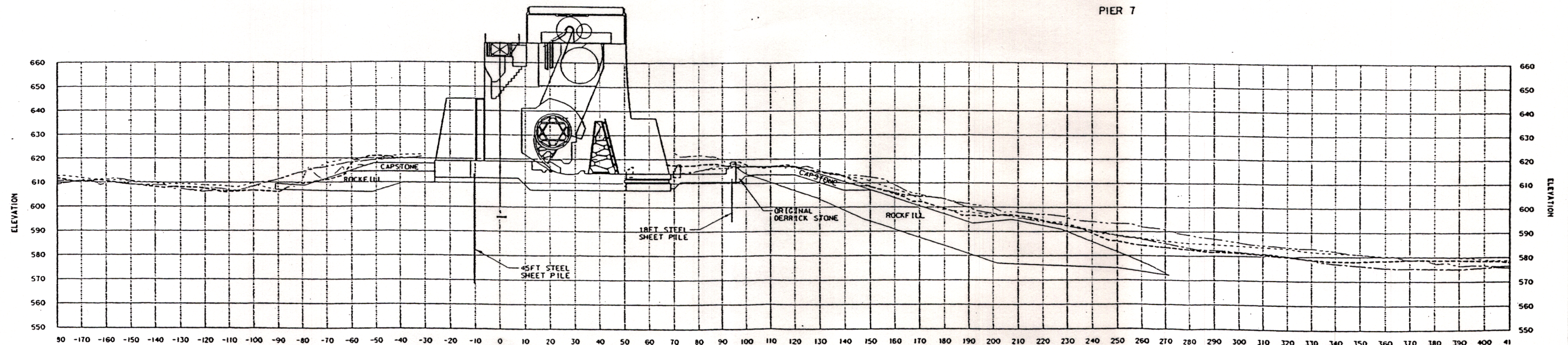
Upper Mississippi River
Nine-Foot Navigation Project

Lock and Dam No. 7
Cross-Sections

U.S. Army Corps of Engineers
St. Paul District - 30 Sep 1977



PIER 7



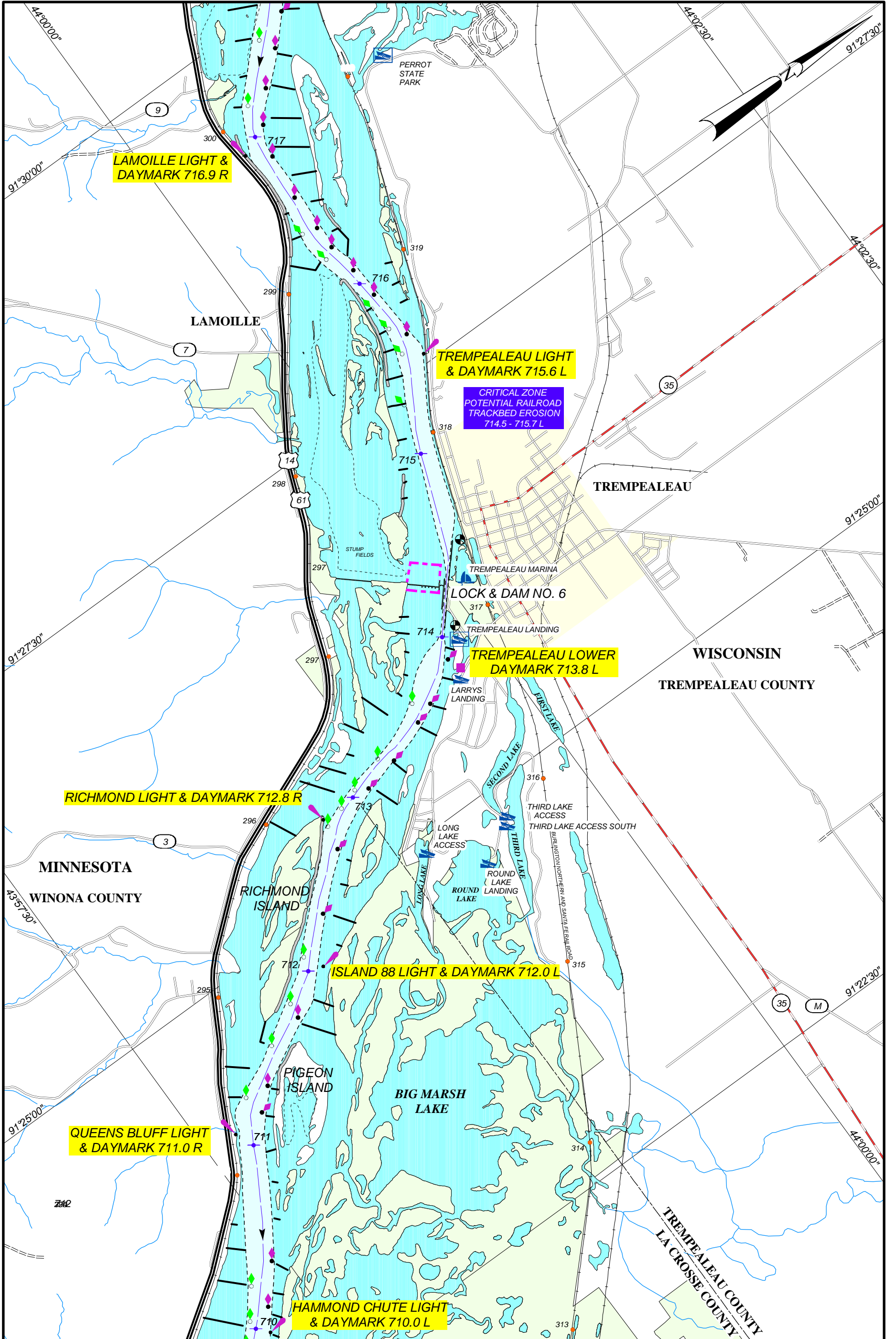
PIER 6

KEY	
---	1999
---	1998
---	1997
---	1996

Upper Mississippi River
 Nine-Foot Navigation Project

**Scour Protection
 Upstream and Downstream of Dam
 Capstone and Rockfill Placed in 1983**

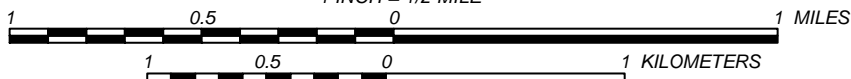
U.S. Army Corps of Engineers
 St. Paul District - St. Paul, MN



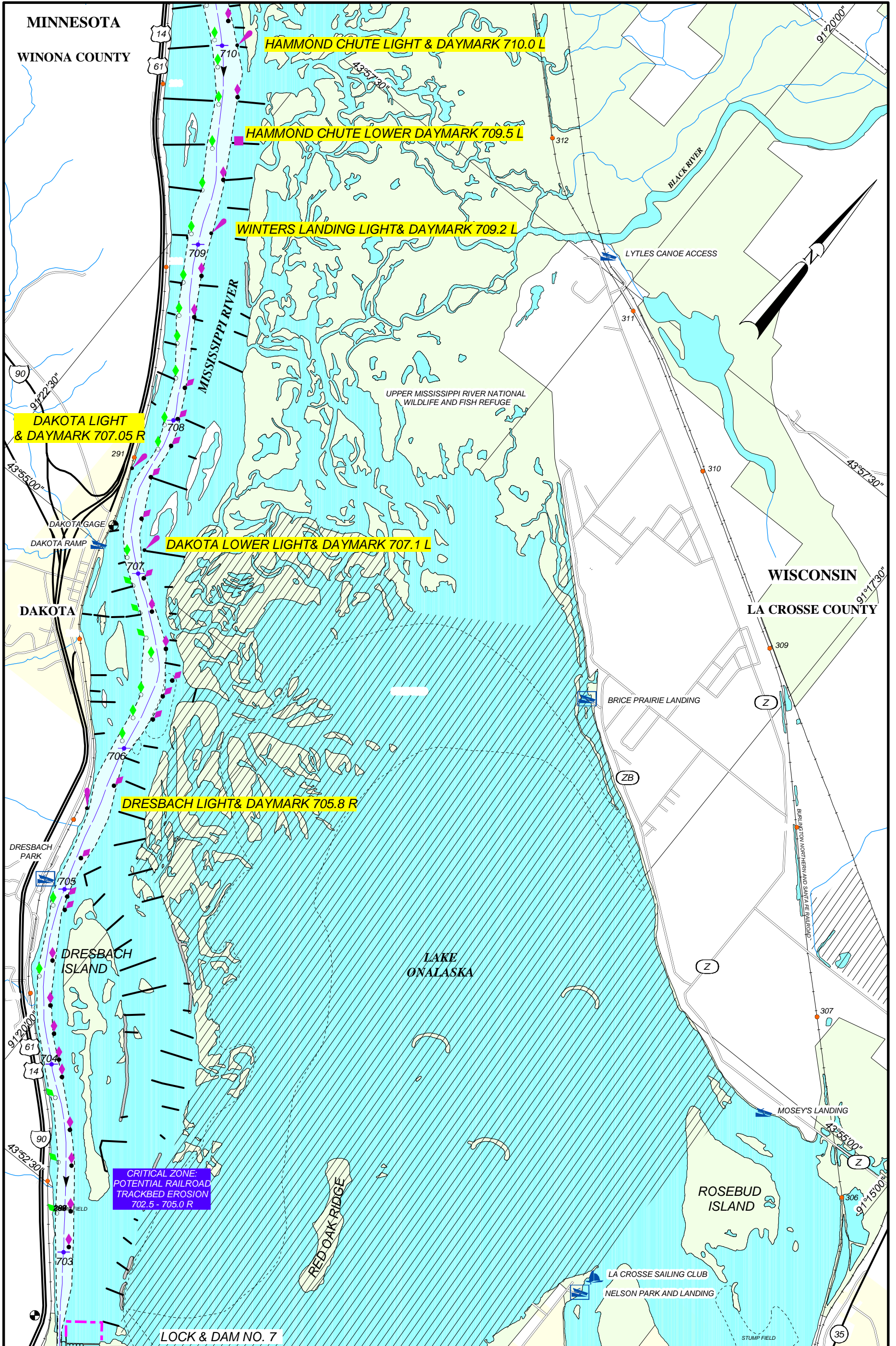
2001

BUOY POSITIONS ON CHARTS ARE APPROXIMATE, SEE NOTICE ON LEGEND NO. 1

SCALE 1:31,680
1 INCH = 1/2 MILE



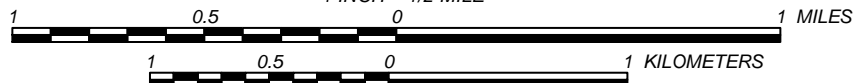
Upper Mississippi River
 Nine-Foot Channel Navigation Project
Navigation Chart
River Mile 710 to 717
 U.S. Army Corps of Engineers
 St. Paul District - St. Paul, MN



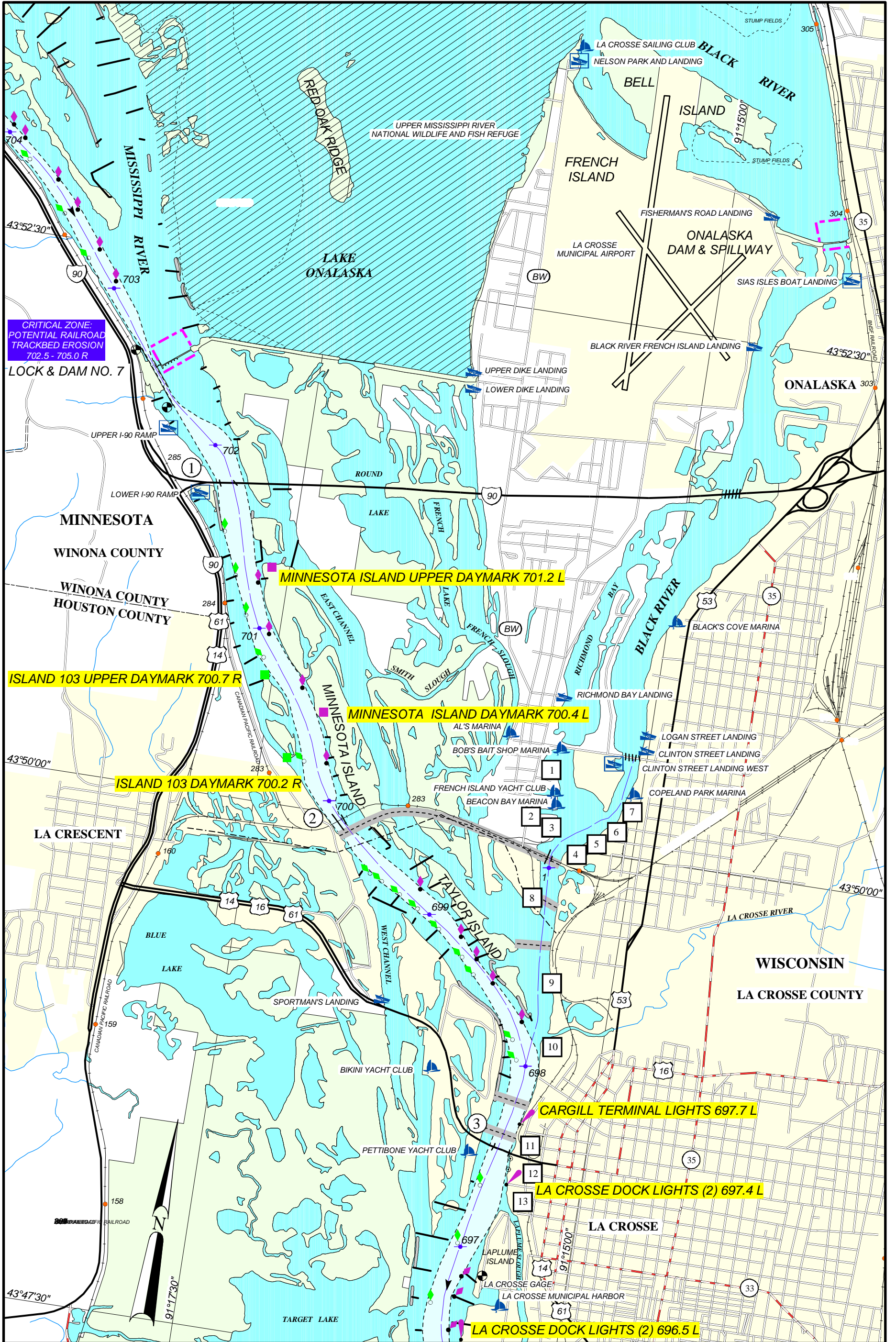
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BUOY POSITIONS ON CHARTS ARE APPROXIMATE, SEE NOTICE ON LEGEND NO. 1

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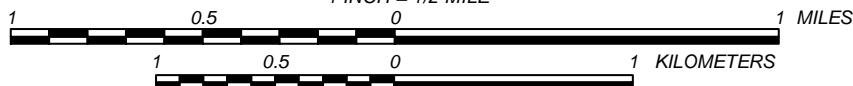
Upper Mississippi River
 Nine-Foot Channel Navigation Project
Navigation Chart
River Mile 703 to 710
 U.S. Army Corps of Engineers
 St. Paul District - St. Paul, MN



2001

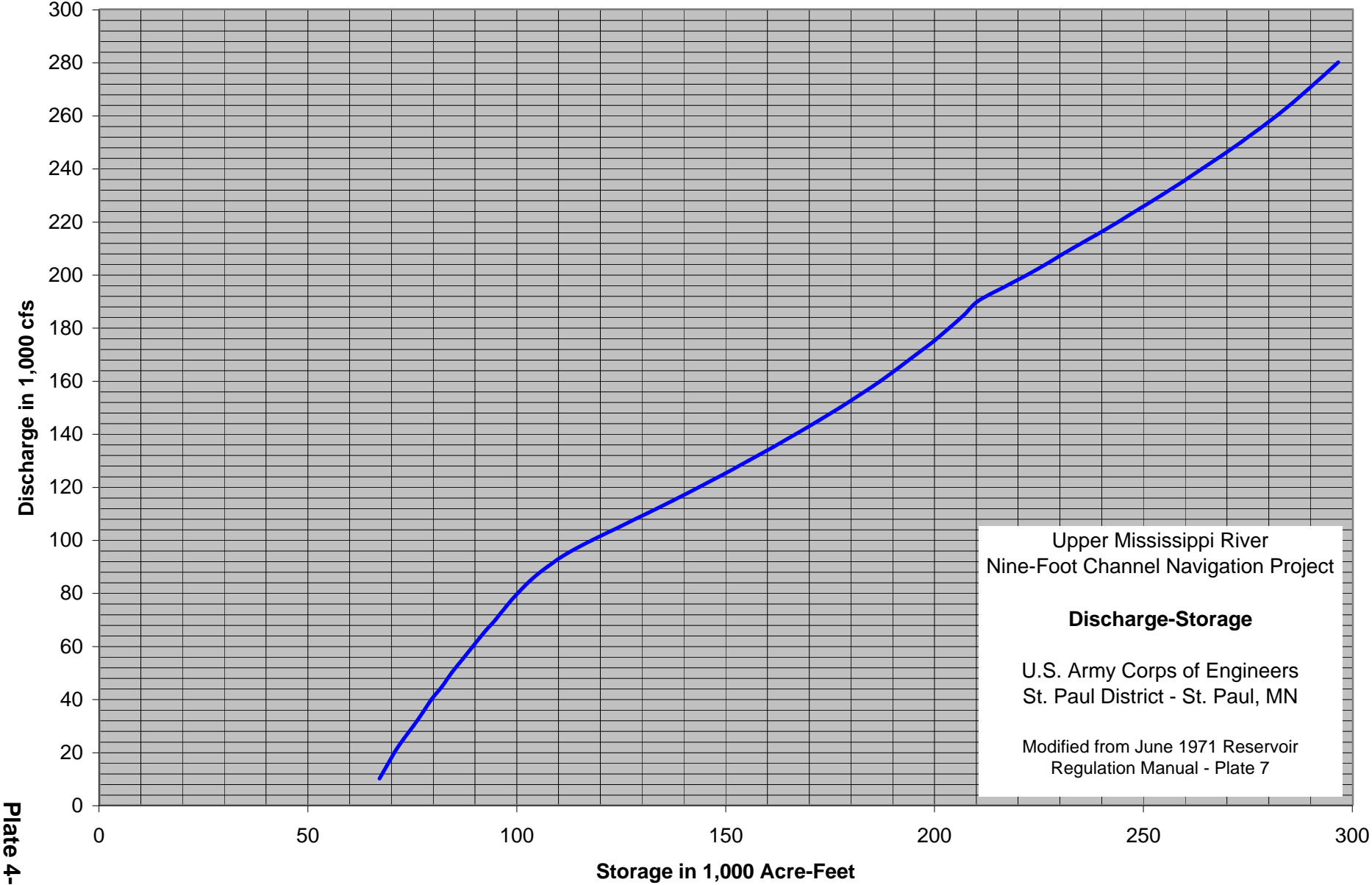
BUOY POSITIONS ON CHARTS ARE APPROXIMATE, SEE NOTICE ON LEGEND NO. 1

SCALE 1:31,680
1 INCH = 1/2 MILE



Upper Mississippi River
 Nine-Foot Channel Navigation Project
Navigation Chart
River Mile 697 to 704
 U.S. Army Corps of Engineers
 St. Paul District - St. Paul, MN

**Discharge - Storage Curve
Pool 7**

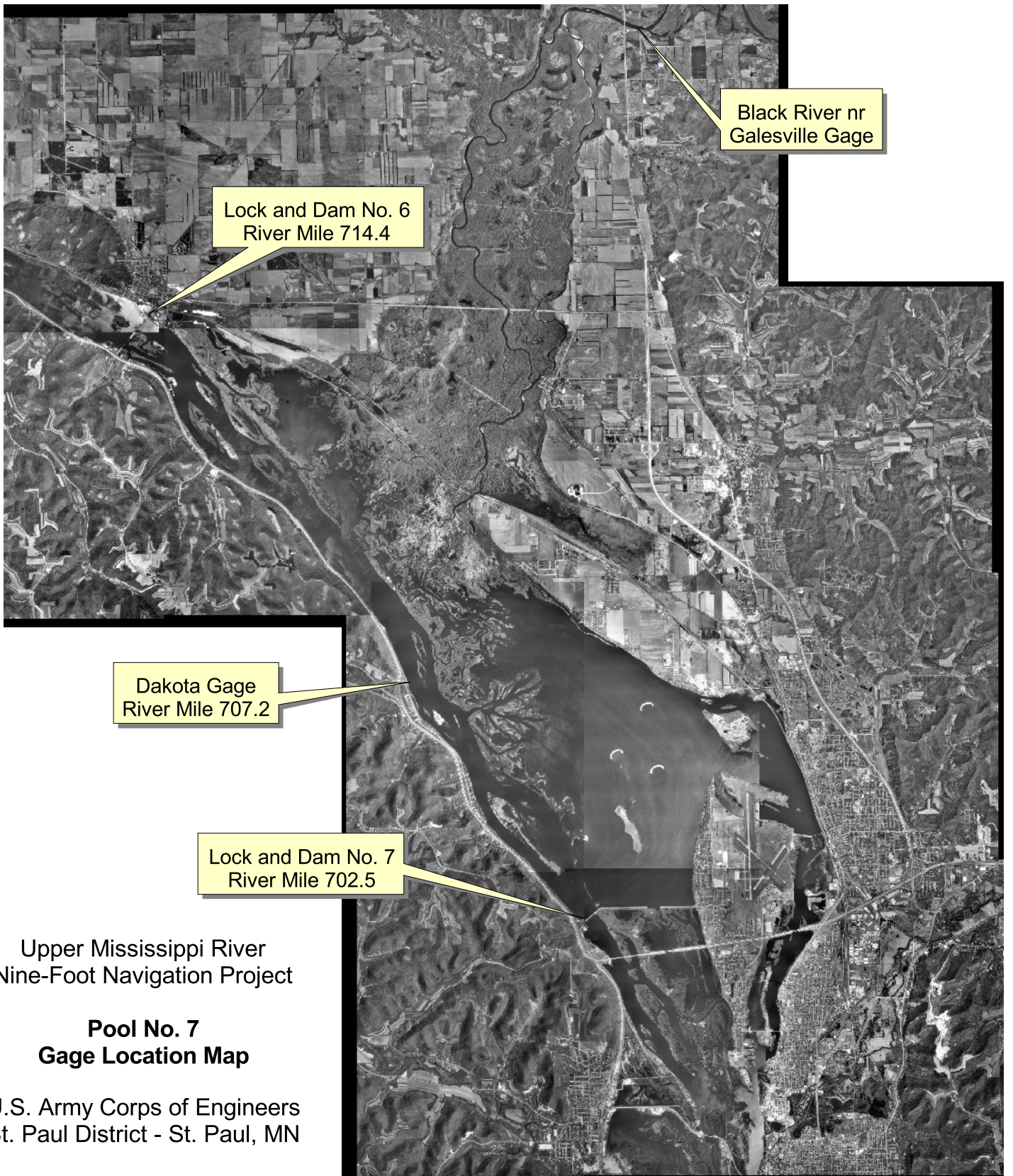


Upper Mississippi River
Nine-Foot Channel Navigation Project

Discharge-Storage

U.S. Army Corps of Engineers
St. Paul District - St. Paul, MN

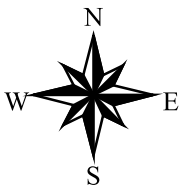
Modified from June 1971 Reservoir
Regulation Manual - Plate 7



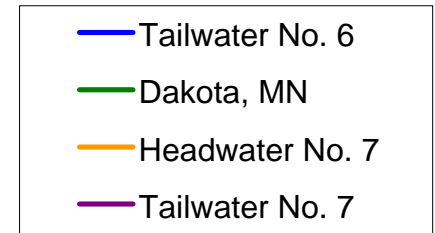
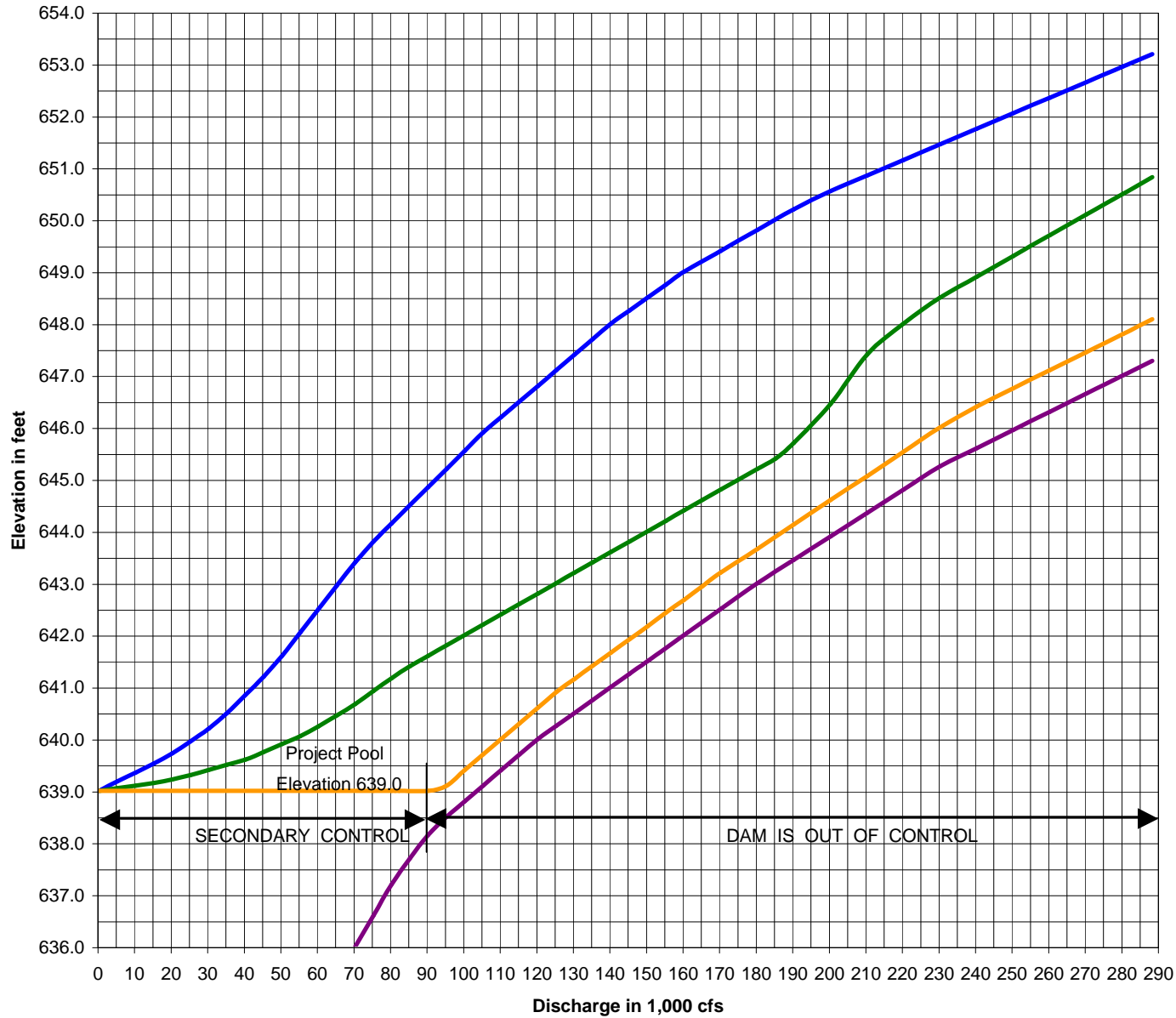
Upper Mississippi River
Nine-Foot Navigation Project

**Pool No. 7
Gage Location Map**

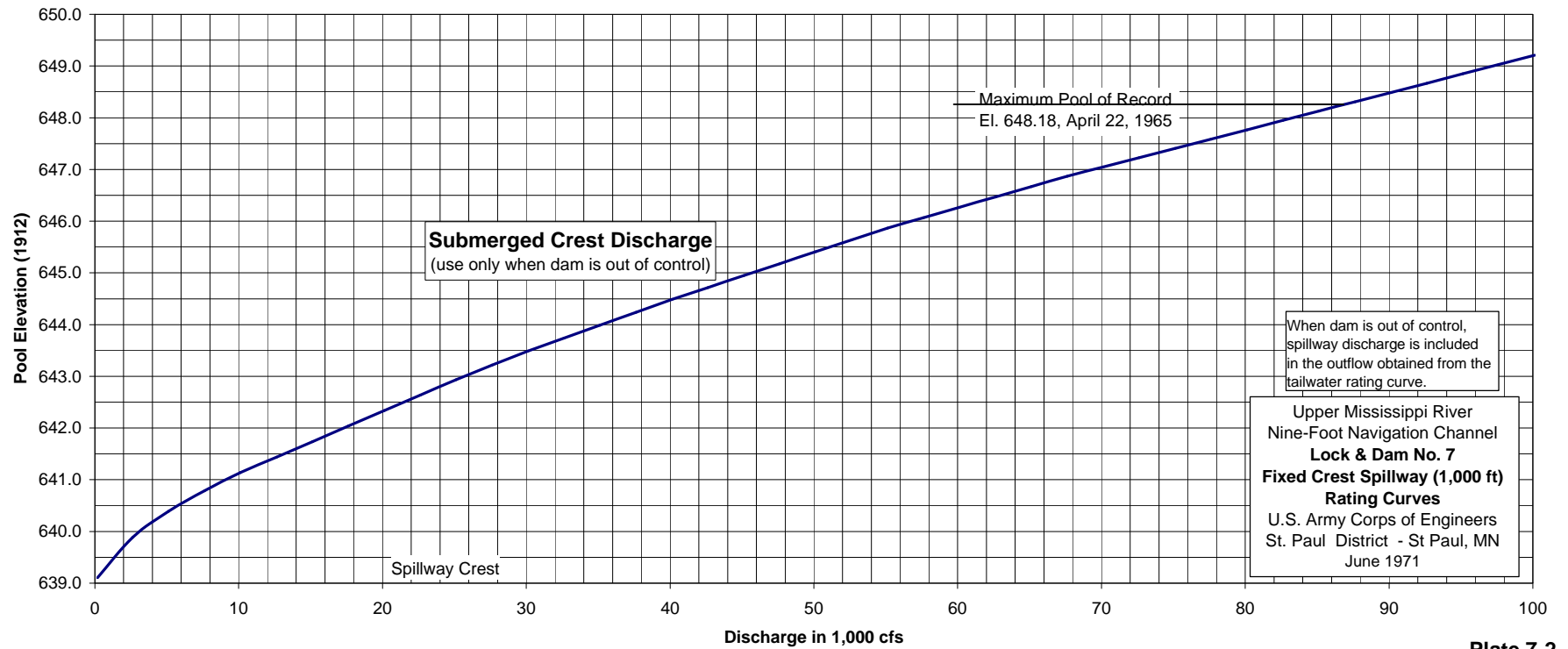
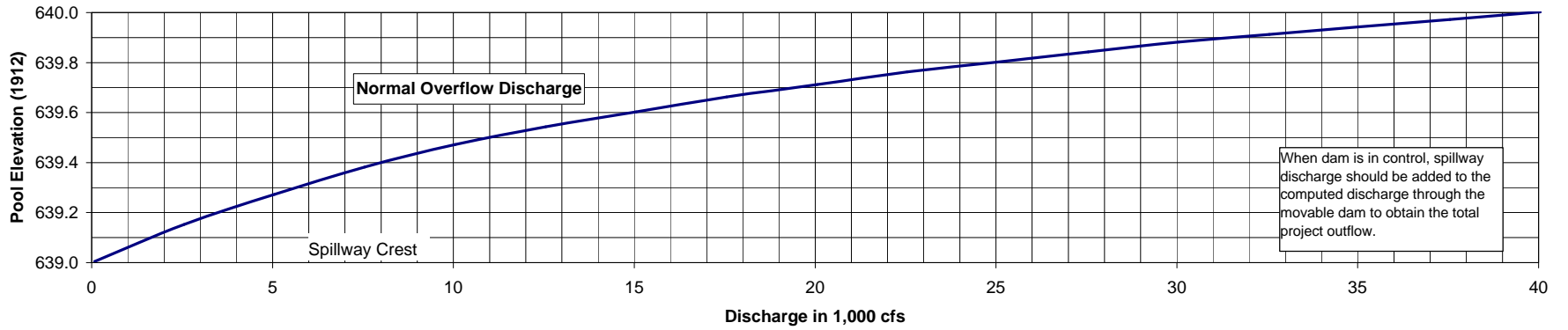
U.S. Army Corps of Engineers
St. Paul District - St. Paul, MN

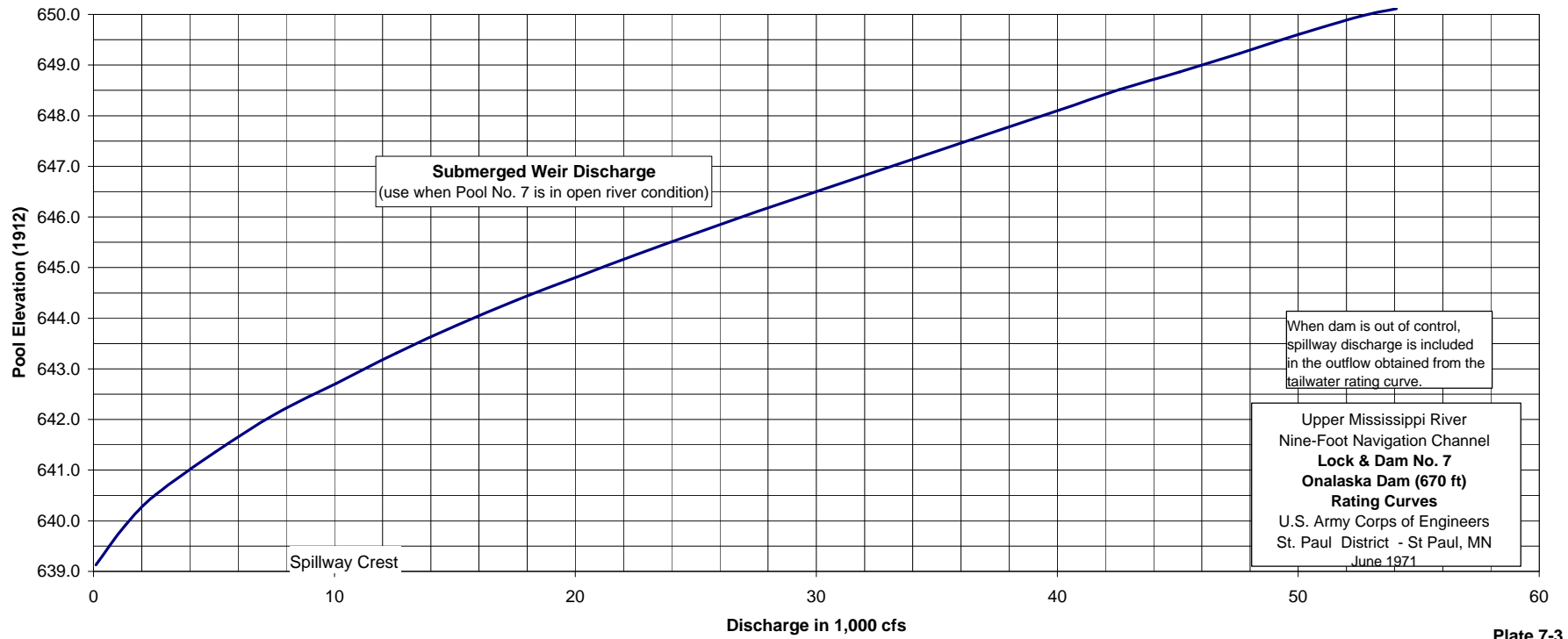
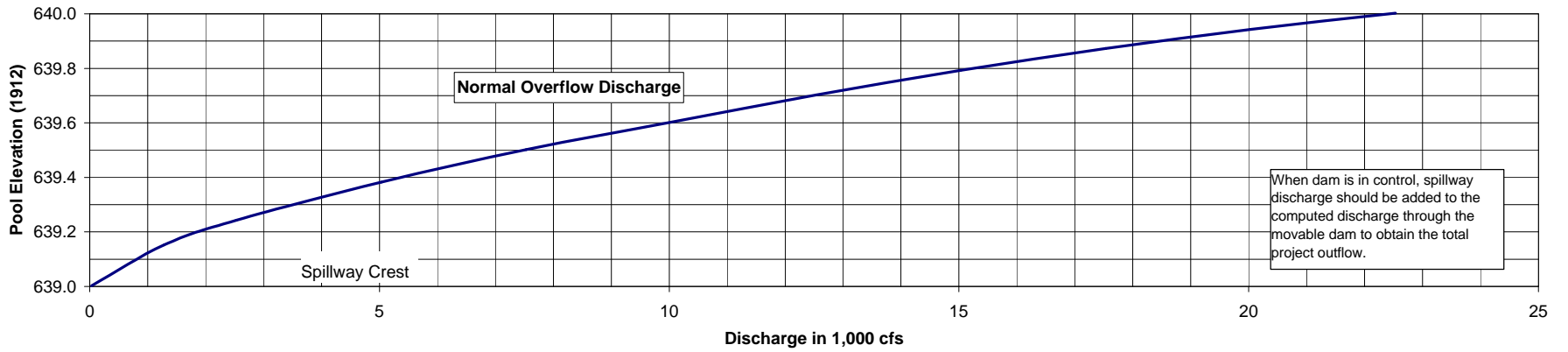


LOCK & DAM NO. 7 OPERATING CURVES



Upper Mississippi River
 Nine-Foot Navigation Channel
Lock & Dam No. 7
Operating Curves
 U.S. Army Corps of Engineers
 St. Paul District - St Paul, MN
 March 2002





Upper Mississippi River
 Nine-Foot Navigation Channel
Lock & Dam No. 7
Onalaska Dam (670 ft)
Rating Curves
 U.S. Army Corps of Engineers
 St. Paul District - St Paul, MN
 June 1971

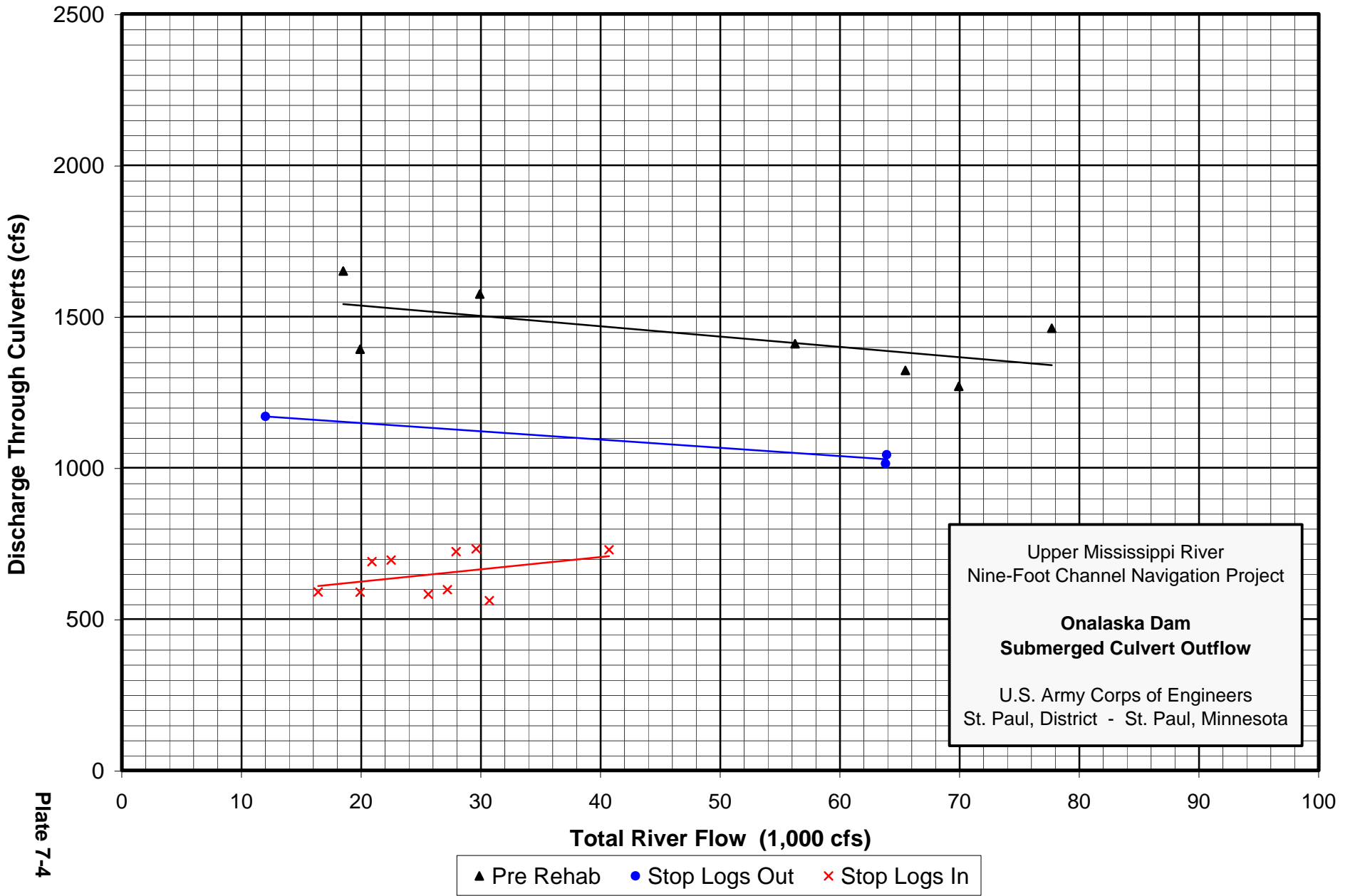
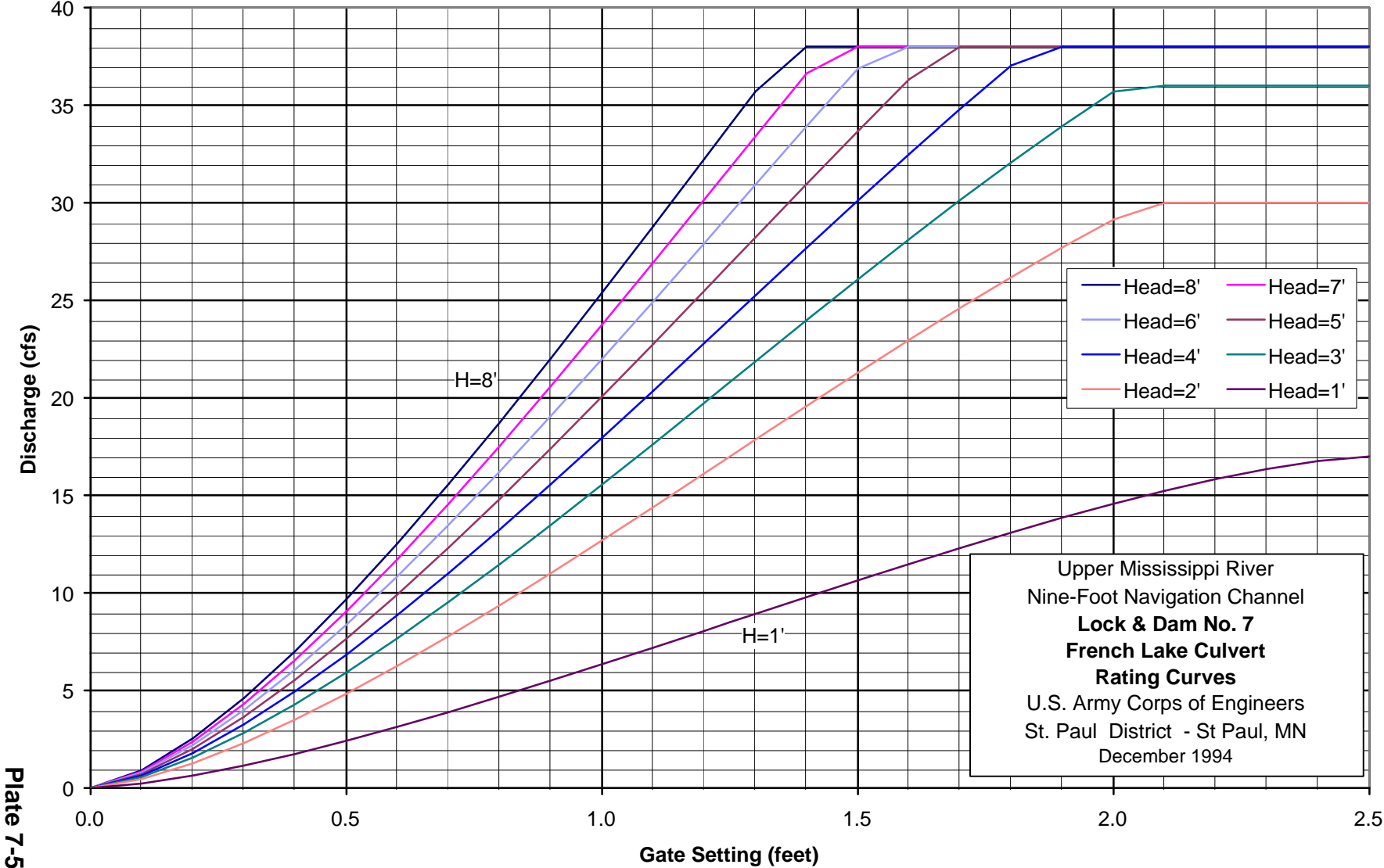
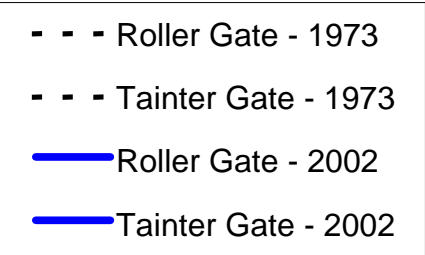
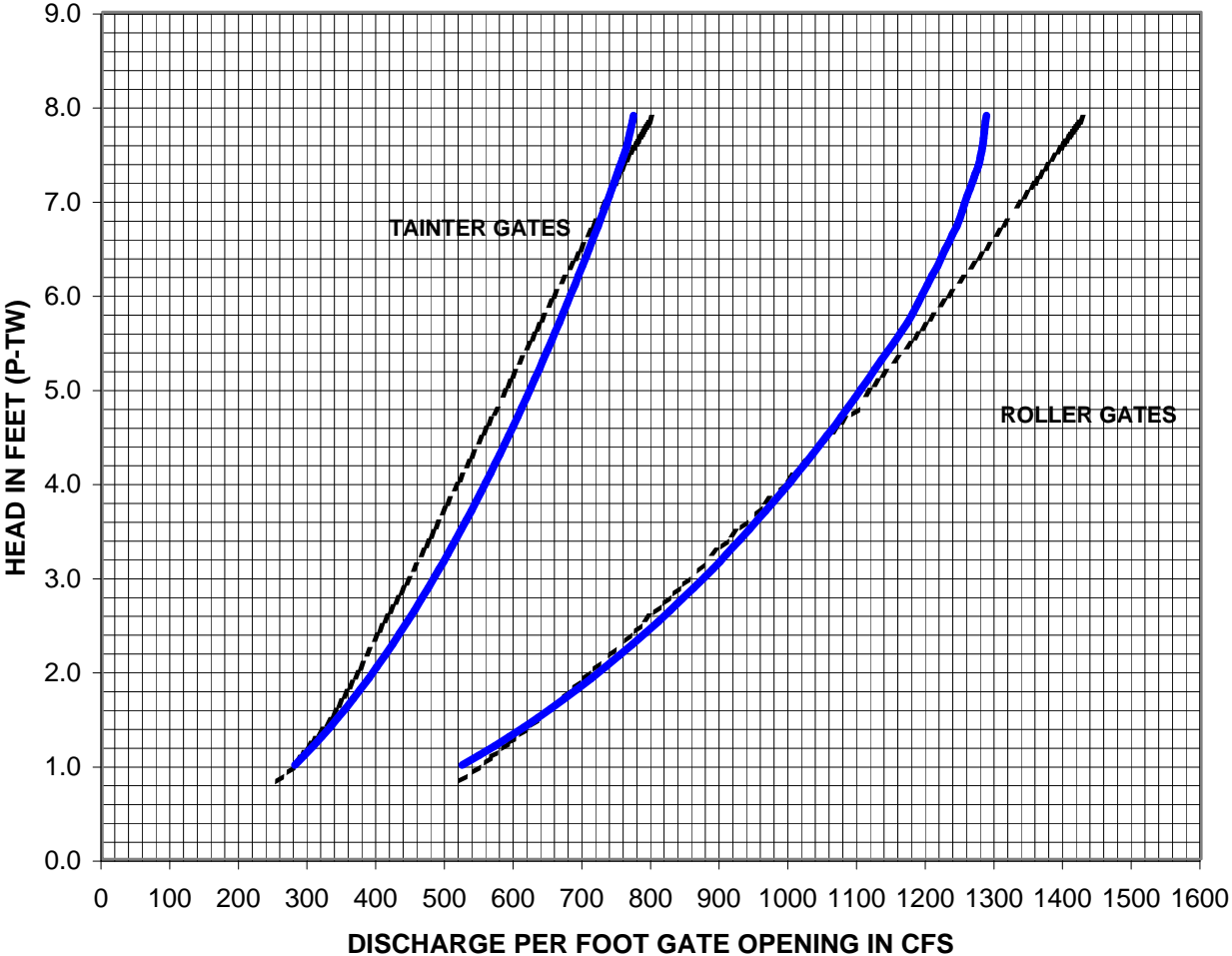


Plate 7-4

French Lake Culvert Rating Curves



LOCK AND DAM NO. 7 ROLLER AND TAITNER GATE DISCHARGE



Upper Mississippi River
Nine-Foot Channel Navigation Project

**Lock and Dam No. 7
Roller & Tainter
Gate Discharge**

U.S. Army Corps of Engineers
St. Paul District - St. Paul, MN
March 2002