



US Army Corps
of Engineers

Mississippi River Basin above Minneapolis Time of Travel Analysis

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Table of Contents

1. [General](#)
2. [Study Area](#)
3. [Hydrology](#)
4. [Flow Duration Curve](#)
5. [Hydraulics](#)
6. [Table 1: Annual Flow Duration Analysis](#)
7. [Table 2: 8-hour travel times to the St. Cloud, St. Paul, and Minneapolis Water Intakes](#)
8. [Table 3: Times of travel from Sauk River to the St. Cloud Water Intakes.](#)
9. [Table 4: Low Flow times of travel from tributaries to the St. Cloud, St. Paul, and Minneapolis Water Intakes.](#)
10. [Table 5: Medium Flow times of travel from tributaries to the St. Cloud, St. Paul, and Minneapolis Water Intakes.](#)
11. [Table 6: High Flow times of travel from tributaries to the St. Cloud, St. Paul, and Minneapolis Water Intakes.](#)
12. [Appendix](#)

General

This document describes the results of a hydrologic and hydraulic investigation conducted on the Mississippi River mainstem above Minneapolis, Minnesota. The purpose of this investigation was to determine the time of travel to various water intakes for high, medium, and low flow conditions for various key locations on the main stem of the Mississippi River above Minneapolis. This analysis was performed at the request of the River Defense Network (RDN), a multi-agency organization tasked with the protection of water supplies in the Upper Mississippi River Basin. A [companion study](#) was conducted by the United States Geological Survey (USGS) for tributaries of the Mississippi River for the region of interest.

Study Area

Although the River Defense Network extends from the Mississippi River [Headwaters to Minneapolis](#), it was determined that only the reach between [Royalton and Minneapolis](#) was required for analysis. This reach extends from river mile 956.5 to river mile 853.9, respectively.

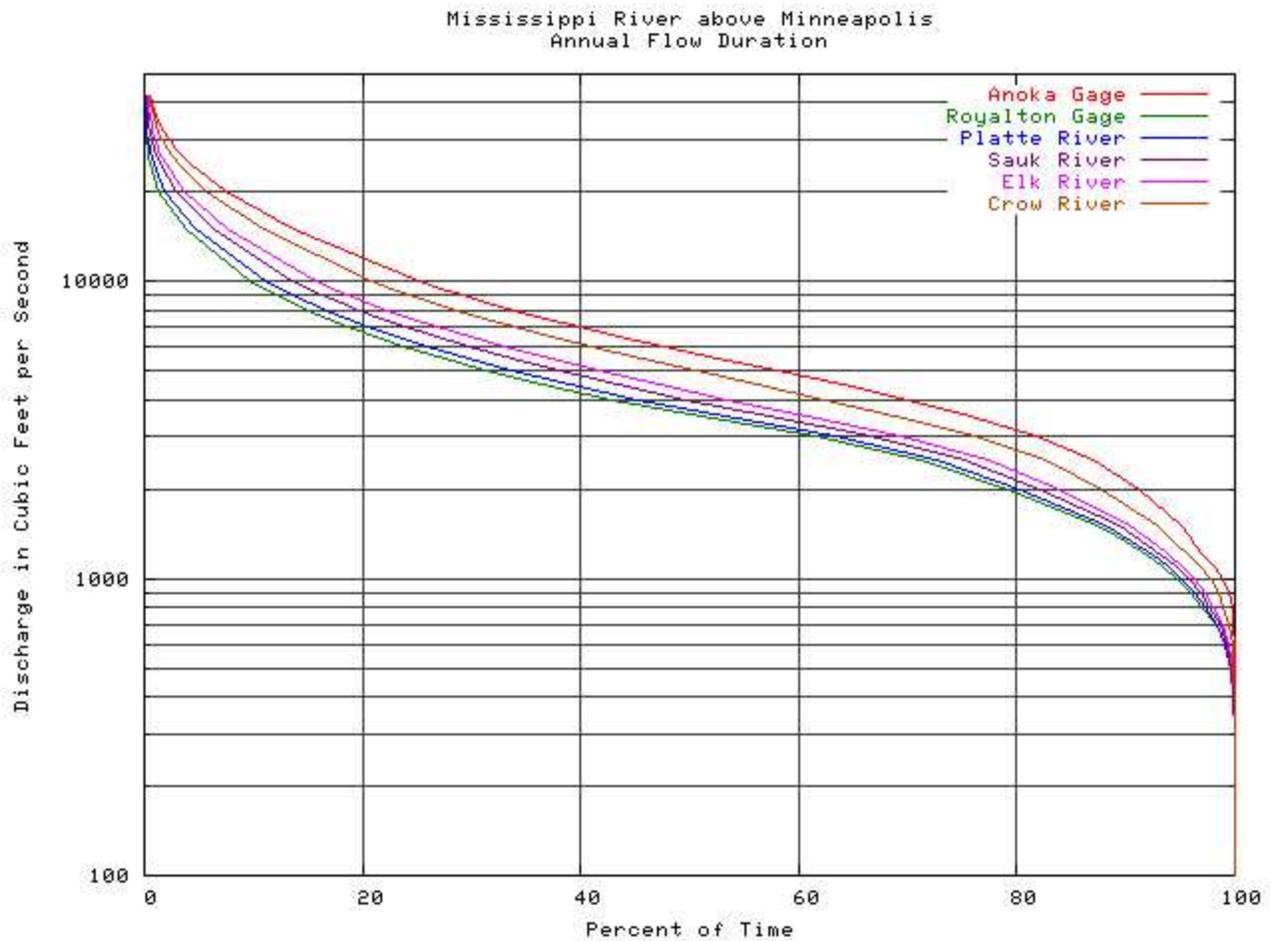
Hydrology

Discharges were developed what the River Defense Network has defined as high, medium, and low flow conditions. For the purposes of this study, these flows are defined as follows:

- High Flow: Flow rates which are exceeded 10-percent of the time.
- Medium Flow: Flow rates which are exceeded 50-percent of the time.
- Low Flow: Flow rates which are exceeded 90-percent of the time.

Annual flow duration curves for USGS gaging stations at [Anoka](#) and [Royalton](#) were computed from the daily flow records at each site. The period of record at Anoka is from June 1931 through October 2003 and the period of record at Royalton is from April 1924 through October 2003. The flow duration at the confluences of tributaries between the gages was interpolated using drainage area. Results of the flow duration analysis are available in [tabular](#) and [graphical](#) formats.

A graph showing the annual flow duration discharges developed at Royalton, Anoka, and the Platte, Sauk, Elk, and Crow rivers is shown below.



A table showing the annual flow duration discharges developed at Royalton, Anoka, and the Platte, Sauk, Elk, and Crow rivers is shown below.

Table 1

Mississippi River above Minneapolis Annual Flow Duration Analysis					
Location	Drainage Area in square miles	River Mile	Percentage of time discharge is exceeded at these locations		
			90 Percent	50 Percent	10 Percent
USGS Gage at Royalton	11435	956.5	1,340 CFS	3,570 CFS	9,880 CFS
Confluence with Platte River	12180	947.4	1,370 CFS	3,710 CFS	10,900 CFS
Confluence with Sauk River	13490	930.0	1,460 CFS	3,980 CFS	12,500 CFS

Confluence with Elk River	14615	884.8	1,530 CFS	4,280 CFS	13,600 CFS
Confluence with Crow River	17315	879.6	1,780 CFS	5,050 CFS	15,900 CFS
USGS Gage at Anoka	19600	864.8	2,150 CFS	5,760 CFS	17,950 CFS

Hydraulics

Times of travel were computed using the Riverine Emergency Management Model (REMM) previously developed for the study area. REMM contains an option to compute travel times for discharges observed during the 1998 drought. These discharges were replaced with the discharges developed for high, medium, and low flow conditions. The model was then run with these discharges and the travel times were computed. The travel times shown are in days, hours, and minutes (days, hh:mm). River mileages are measured from the confluence of the Ohio and Mississippi Rivers above Cairo, Illinois.

Table 2

Location	8 Hour Travel Time Begins at River Mile		
	Low Flow	Medium Flow	High Flow
St Cloud Water Intake at River Mile 928.4	932.67 (4.27 miles)	933.35 (4.95 miles)	936.00 (7.60 miles)
St Paul Water Intake at River Mile 862.8	866.55 (3.75 miles)	867.75 (4.95 miles)	874.91 (12.1 miles)
Minneapolis Water Intake at River Mile 858.6	862.40 (3.80 miles)	866.51 (7.91 miles)	871.10 (12.5 miles)

Table 3

Time of Travel Estimate from the Confluence of the Sauk River 1.6 miles upstream of the St Cloud Water Intake			
Current	Low Flow (hh:mm)	Medium Flow (hh:mm)	High Flow (hh:mm)
Surface	04:50	02:29	00:55
Average	04:56	02:33	01:06
Bottom	05:08	02:42	01:30

Table 4: Low Flow Times of Travel

Tributary to the Mississippi River	Times of Travel to the St Paul Water Intakes			Times of Travel to the Minneapolis Water Intakes		
	Surface Current (hh:mm)	Average Current (hh:mm)	Bottom Current (hh:mm)	Surface Current (hh:mm)	Average Current (hh:mm)	Bottom Current (hh:mm)
Elk Rive/r	3 days, 16:03	3 days, 16:12	3 days, 16:19	4 days, 00:53	4 days, 01:02	4 days, 01:10
Crow River	3 days, 04:36	3 days, 04:45	3 days, 04:53	3 days, 13:27	3 days, 13:36	3 days, 13:44
Rum River	2 days, 02:39	2 days, 02:48	2 days, 02:55	2 days, 11:29	2 days, 11:38	2 days, 11:46
Elm Creek	2 days, 00:57	2 days, 01:06	2 days, 01:14	2 days, 09:48	2 days, 09:57	2 days, 10:05
Coon Creek	04:12	04:13	04:13	13:03	13:04	13:04
Rice Creek				06:55	06:55	06:55

Table 5: Medium Flow Times of Travel

Tributary to the Mississippi River	Times of Travel to the St Paul Water Intakes			Times of Travel to the Minneapolis Water Intakes		
	Surface Current (hh:mm)	Average Current (hh:mm)	Bottom Current (hh:mm)	Surface Current (hh:mm)	Average Current (hh:mm)	Bottom Current (hh:mm)
Elk River	1 day, 09:40	1 day, 13:00	1 day, 16:04	1 day, 13:49	1 day, 17:54	1 day, 22:55
Crow River	1 day, 05:21	1 day, 07:46	1 day, 09:57	1 day, 09:30	1 day, 12:40	1 day, 16:49
Rum River	19:32	20:13	21:37	23:40	1 day, 01:07	1 day, 04:29
Elm Creek	18:54	19:30	20:51	23:02	1 day, 00:24	1 day, 03:43
Coon Creek	02:10	02:35	03:33	06:19	07:29	10:24
Rice Creek				03:11	03:46	05:18

Table 6: High Flow Times of Travel

	Times of Travel to the St Paul Water Intakes	Times of Travel to the Minneapolis Water Intakes

Mississippi River						
	Surface Current (hh:mm)	Average Current (hh:mm)	Bottom Current (hh:mm)	Surface Current (hh:mm)	Average Current (hh:mm)	Bottom Current (hh:mm)
Elk River	12:03	14:23	20:34	14:06	16:47	1 day, 00:05
Crow River	10:07	12:05	17:34	12:10	14:29	21:05
Rum River	06:08	07:18	11:18	08:10	09:42	14:49
Elm Creek	05:53	07:01	10:54	07:56	09:25	14:26
Coon Creek	01:06	01:18	01:53	03:09	03:42	05:24
Rice Creek				01:34	01:50	02:42

Appendix

- Upper Mississippi River Basin [above Minneapolis](#) (JPEG Graphic Image)
- Map of the [Study Area](#) (JPEG Graphic Image)
- Annual Flow Duration Curve at [Royalton](#) (PNG Graphic Image)
- Annual Flow [Duration Curve](#) at Royalton (PostScript)
- Annual Flow Duration Curve at [Anoka](#) (PNG Graphic Image)
- Annual Flow [Duration Curve](#) at Anoka (PostScript)
- Annual Flow Duration [Curve](#) for all six locations (PNG Graphic Image)
- Annual Flow Duration Curve for all [six locations](#) (PostScript)
- [Flow Duration](#) Analysis Table
- Low, Medium, and High Flow [Duration](#)Table