CELRH-EC-WM

05 Jan 2010
Schray/5604

Memorandum for Resource Managers and Water Control Manual holders

Subject: Modification of Huntington District Water Control Reporting Procedures.

1. Reference CELRH-EC-WM Memorandum to Kent Browning, dated 20 January 2004, Subject: Modification of Huntington District Water Control Reporting Procedures.

2. The referenced memorandum modifies certain reporting procedures. Since that memorandum was issued, improvements in technology have resulted in the National Weather Service providing detailed snow analyses data in graphical maps via the internet. This data satisfies Water Managements needs, and therefore an additional modification is necessary.

3. Modify Instructions to Dam Tender, Section 2 – Precipitation at Project, sub-section: Snow Depth and Moisture Content:

Replace the section in its entirety with the following:

"Report snow data to Water Management only when directed to do so. Measure and record the water content of the snow at least as often as indicated below.

(1) Each day when rain falls on existing snow cover

(2) Twice a week on Mondays and Thursdays when there is snow cover on the ground if condition (1) does not require more frequent measurement.

4. This change in reporting instructions does not modify the Project's requirement to store this data on site.

5. This memorandum shall be placed in the front of the Water Control Manual to document the change.

Timothy W. Curran, P.E.
Chief, Water Management Section

CELRH-EC-WM

11 June 2007
Schray/5604

Memorandum for Resource Managers and Water Control Manual holders

Subject: Modification of Huntington District Water Control Reporting Procedures.

1. Reference CELRH-EC-WM Memorandum to Kent Browning, dated 20 January 2004, Subject: Modification of Huntington District Water Control Reporting Procedures.

2. The referenced memorandum modifies certain reporting procedures, and this memorandum makes an additional change. Some Water Control Manuals have been revised with the new procedures the "Instructions to Resource Manager" or "Instructions to Dam Tender" section. Manuals that have not been revised should have the referenced memorandum placed in the front of the manual. Make handwritten changes to the memorandum or the Water Control Manual, as appropriate. This memorandum shall be placed in the front of the Water Control Manual to document the change.

3. Modify Instructions to Dam Tender, Section 4 – Regular Reports, sub-section: Weekly Precipitation Report, second and third sentences:

Replace the text "This report must be filled out and transmitted every Monday morning by 0800 hours. If Monday is a holiday, it shall be filled out on the next work day by 0800 hrs." with "This report is no longer required to be completed on a weekly basis. It shall only be filled out and submitted if required by special directive."

Timothy W. Curran, P.E.
Chief, Water Management Section

CELRH-EC-WM

26 April 2005
Hazelett/5186

MEMORANDUM FOR RECORD

From: Charlotte L. Hazelett

To: Joel Pokladnik, Project Manager, Dover Dam

Subject: Discharge Rating Table

1. Due to the Ohio USGS issuing an updated rating table, EC-WM has replaced the outflow rating table found in the Dover Dam Water Control Manual.

2. Please replace Rating No. 23, found on Plate No. 7-6, with the attached new Rating No. 26.

Charlotte L. Hazelett
CELRH-EC-WM

Attachments: As stated
Copies furnished: Muskingum Area Office

3/16/04
Clu

CELRH-EC-WM

20 January 2004
Schray/5604

Memorandum for Kent Browning, OR Water Management POC.

Subject: Modification of Huntington District Water Control Reporting Procedures.

1. Please distribute this memorandum to all Huntington District Flood Control Project Managers, direct them to place this memorandum in the front of the Water Control Manual, and make notes in the text which has been superseded.

2. As directed by the QC, EC-WM is implementing the recommendations of the Reservoir Reporting Process Action Team. As such, the following changes shall be made to the water control manuals and the associated processes:

The following sections are modified as noted.

Instructions to Dam Tender, Section 2 - Precipitation at Project, sub-section: Snow Depth and Moisture Content

Measure and report to EC-WM by 0900 hours the water content of the snow at least as often as indicated below.

(1) Each day when rain falls on existing snow cover

(2) Twice a week, on Mondays and Thursdays, when there is snow cover on the ground if condition (1) does not require more frequent measurements.

Instructions to Dam Tender, Section 2 - Precipitation at Ohio River Network Stations

Reports to the National Weather Service are carried out by agreement between the Project and the Weather Service and at their direction. The project is not required to gather or submit any additional data to Water Management beyond what is described previously in section 2 and what is detailed in section 4.

Sub-Sections a, b, and c are therefore no longer relevant except as to describe how to gather and provide data to the National Weather Service.

Instructions to Dam Tender, Section 4 - Regular Reports, sub-section: Weekly Report, ORH 14

This section is rescinded in its entirety and is replaced by sub-section: Historical Files.

Projects are required to maintain a permanent hard copy at the project of all water control data required for daily operation. This data shall be comprised of the information the project has historically gathered using the ORH 14 and 13 reports and shall be gathered at 0730 on days when the project is staffed, at other times as directed by the Schedule for Reading Gages and the Project Manager and when data is requested by Water Management Section. It shall include but not be limited to: Precipitation, Current Weather conditions, Lake Stage Levels, Outflow Stage Levels, Gate Settings, Gate Operations and time performed, Snowfall, Snow on the Ground, Total Moisture Content as directed in Section 2, and all Upstream and Downstream gauge readings which are utilized by project personnel for gate operation decision making.

This information may be maintained either on the historical reports or a new project developed format.

Instructions to Dam Tender, Section 4 - Regular Reports, sub-section: Daily Morning Report

This sub-section is modified to note that: Generation and transmission of the daily morning report (also call the intranet report which replaced the ORH-13 Daily report) is only required when requested by the Water Management Section. Automatic daily transmissions are no longer necessary.

Note: Atwood, Bolivar, Clendening, Piedmont, Tappan, and Tom Jenkins are still required to report all gate operations to EC-WM by phone. Extra emphasis will be placed on these phone calls as Water Management will no longer be able to look up the previous day's gate operations every morning.

Instructions to Dam Tender, Section 4 - Regular Reports, sub-section: Gate Operations Report

This sub-section is modified to note that: Generation and transmission of the gate operations report is only required when requested by the Water Management Section. Neither daily transmissions nor transmissions after every gate operation are necessary any longer.

Instructions to Dam Tender, Section 4 - Regular Reports, sub-section: Weekly Precipitation Report

This sub-section shall be added after the Water Quality Report sub-section.

A fourth report available from the Index Page is the Weekly Precipitation Report. This report must be filled out and transmitted every Monday morning by 0800 hours. If Monday is a holiday, it shall be filled out on the next work day by

0800 hours.

Upon accessing the Weekly Precip Report link on the Index Page, fill in the daily precipitation for the past week. When all data for the week is filled in, save the spread sheet and exit. This record will be saved for the entire year and can be viewed through the link used to modify it.

On days when the project is not staffed, place a "NS" in that day's field and report the combined day's precipitation in the next day when the project is staffed. I.e. If the project does not staff the weekend, place a "NS" in the field for Saturday and Sunday and report the 72 hour precipitation record on Monday morning.

Instructions to Dam Tender, Section 4 - Regular Reports, sub-section: Additional Comments

This sub-section shall be added after the Weekly Precipitation Report sub-section.

A fifth link available on the Index Page is the Additional Comments link. It shall be used when ever the Project has special information or questions that it wants to bring to the immediate attention of the Water Management team. Snow Moisture shall be reported using this link.

Upon accessing the Additional Comments link on the Index page, a blank email to the Water Management Team will be generated. Please note in the subject line, the nature of the issue and then provide supplemental data in the text block of the message. After the email has been completed click on the submit/send button to send the message.

Instructions to Dam Tender, Schedule for Reading Gages

The last sentence of the top paragraph "Stream gages and the precipitation gage (all gages) shall be read at least as often as shown in the table below", shall be replaced with: "Reading and recording of gages shall be carried out as defined under Schedule A except when gage levels/precipitation are such that the Resource Manager or their Acting anticipates that problems may result, at which point the relevant schedule B, C, or D shall be followed for reading and recording of all required gages. Transmission of project gage data will be at the request of EC-WM.

Modify the chart as follows:

SL, SO, and DCO shall be read in all schedules monthly as a check

Modify the footnotes as follows:

(1) When any one of the conditions listed under schedule A, B, C is exceeded and problems are anticipated, place the next higher schedule into effect. When conditions are such that would place schedules C or D into effect, notify by phone one of the Water Control personnel.

Timothy W. Curran, P.E.
Chief, Water Management Section

CF:EC-WH

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
502 EIGHTH STREET
HUNTINGTON, WEST VIRGINIA 25701-2070

20 December 2002

REPLY TO
ATTENTION OF:

Engineering & Construction Division
Water Resources Engineering Branch

MEMORANDUM FOR SEE DISTRIBUTION

SUBJECT: Updates for the Dover Lake Water Control Manual

1. Reference is made to Memorandum for Distribution dated 11 December 2002.

2. Paragraph 2 makes reference to Annex I, this should have been Exhibit B. Plate No. 7-6 has been re-labeled. Replace the revised attached sheets in the reference manual.

3. Place this page in the front of the manual.

Encl

ALFRED L. BRANCH, JR., P.E.
Chief, Engineering & Construction Division

CELRD-ET-W (2)
CELRH-OR
CELRH-OR-DOT (2)
CELRH-OR-MUR
CELRH-EC-WW (2)
CELRH-EC-WH

Engineering & Construction Division
Water Resources Engineering Branch

11 December 2002

MEMORANDUM FOR SEE DISTRIBUTION

SUBJECT: Updates for the Dover Lake Water Control Manual

1. EC-WW has identified outdated information in the referenced Water Control Manual.

2. Please replace the following pages with the attached pages: 7-4, 7-6, 7-10 (main text), and 1-2, 1-3 (Exhibit B), and Plate No. 7-6.

3. Place this page in the front of the manual.

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
502 EIGHTH STREET
HUNTINGTON, WEST VIRGINIA 25701-2070

11 December 2002

REPLY TO
ATTENTION OF:
Engineering & Construction Division
Water Resources Engineering Branch

MEMORANDUM FOR SEE DISTRIBUTION

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3. Place this page in the front of the manual.

Encl

ALFRED L. BRANCH, JR., P.E.
Chief, Engineering & Construction Division

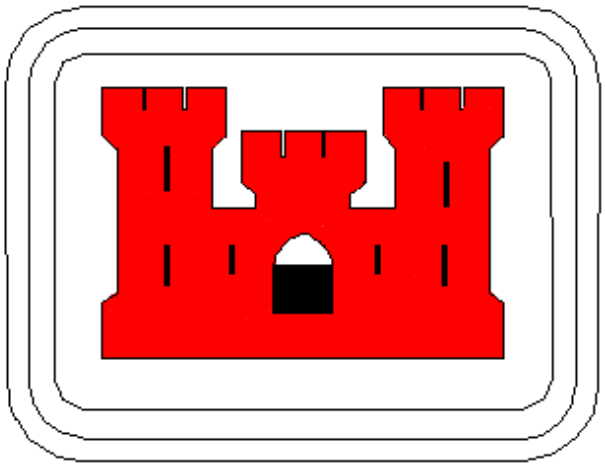
CELRD-ET-W (2)
CELRH-OR
CELRH-OR-DOT (2)
CELRH-OR-MUR
CELRH-EC-WW (2)
CELRH-EC-WH

WATER CONTROL MANUAL

DOVER LAKE – TUSCARAWAS RIVER

MUSKINGUM RIVER BASIN

OHIO



U.S. ARMY CORPS OF ENGINEERS

HUNTINGTON DISTRICT

HUNTINGTON, WEST VIRGINIA

JULY 2001

PHOTOGRAPH

PREFACE

This manual was developed under a contract between Advanced Technology Systems, Inc. and the U.S. Army Corps of Engineers, Pittsburgh District.

Contract No.: DACW69–00–D–0006

Delivery Order No. 7: Water Control Manual Development for Dover Lake

The manual was developed by:

Advanced Technology Systems, Inc.
639 Alpha Drive
Pittsburgh, PA
Phone:
Fax: [redacted]

All inquires concerning this manual should be directed to the U.S. Army Corps of Engineers, Huntington District, 502 8th Street, Huntington, WV 25701-2070.

NOTICE TO USERS OF THIS MANUAL

Regulations specify that this water control manual be published in a hard copy binder with loose–leaf form, and only those sections, or parts thereof, requiring changes will be revised and printed. Therefore, this copy should be preserved in good condition so that inserts can be made to keep the manual current. Changes to individual pages will carry the date of revision, which is the Division’s approval date.

REGULATION ASSISTANCE PROCEDURES

In the event that unusual conditions arise during non–duty hours, communication can be achieved by contacting, in the order listed, one of the following personnel. Their duty hour phone numbers are also listed.

CORPS OF ENGINEERS
Muskingum Area Office,
5336 State Route 800, NE
Dover, Ohio 44622-9610
[redacted], Operations Manager

Normal Work Hours, [redacted]

Night, Weekend
Holiday, NWS observers
Person-to-Person, at home
[redacted] (Operations Manager) [redacted]

KEY EMERGENCY CONTACTS
Huntington District Office, Water Resources Engineering Branch

Normal Work Hours, Nights,
Weekends, and holidays [redacted]
[redacted]

Party DISTRICT PERSONNEL	Telephone OFFICE	RESIDENCE	Radio CALL LETTERS
Water Resources Engineering Branch			WUE
[redacted] Chief, Water Control Section	[redacted]	[redacted] - unlisted	
[redacted] Water Control Section	[redacted]	[redacted]	
[redacted] Chief, Water Resources Engineering Branch	[redacted]	[redacted] - unlisted	

Pertinent telephone numbers which may be of value during a flood emergency are listed below

Other Agencies

U.S. geological Survey	Commercial	[redacted]
Columbus, OH	FTS	[redacted]
Nights, Weekends, Holidays		
[redacted]	Commercial	[redacted]
[redacted]	Commercial	[redacted]
National Weather Service	Commercial	[redacted]
Wilmington, Ohio		
Forecast Office	Commercial	
Hydrology Section	FTS	

WATER CONTROL MANUAL
DOVER DAM – TUSCARAWAS RIVER

U.S. ARMY CORPS OF ENGINEERS
HUNTINGTON DISTRICT
JULY 2001

TABLE OF CONTENTS

ANNEXES

LIST OF TABLES

LIST OF PLATES

LIST OF PLATES (continued)

Mean Sea Level Reference Datum

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

SI Units (Metric) Equivalents and Conversion

Length:
1 centimeter = 0.394 inches
1 meter = 3.28 feet
1 kilometer = 0.621 miles

Area:
1 square meter = 10.764 square feet
1 square kilometer = 0.386 square miles
1 hectare = 2.471 acres

Volume:
1 cubic meter = 35.31 cubic feet
1 cubic meter = 1.308 cubic yards
1 cubic meter = 0.81×10^{-3} acre feet

Flow:
1 cubic meter per second = 35.31 cubic feet per second

Temperature:
Degree Celsius = (Degree Fahrenheit - 32) x 5/9

DOVER LAKE

PERTINENT DATA

AUTHORIZATION. The Public Works Administration approved the project in December 1933, and the Muskingum Watershed conservancy District approved the official plan proposed by the Corps of Engineers on 19 November 1934.

LOCATION. The dam is in Tuscarawas County, Ohio, on the Tuscarawas River, a tributary of the Muskingum River, approximately 174 miles above the mouth of the Muskingum and about 3.5 miles northwest of Dover, Ohio.

STRUCTURAL DATA.

DAM.

Type:	Concrete Gravity
Maximum height:	83 feet
Height above natural streambed	71 feet
Crest Length:	824 feet
Crest Width:	25.5 feet
Base Width:	75± feet

SPILLWAY. Uncontrolled overflow ogee in channel section of dam. Crest elevation 916 feet; crest length 338 feet; surcharge 20.8 feet. The design discharge is 123,000 c.f.s.

OUTLET WORKS. Sluice – 18 grouped into 3 bays with 6 control gates each that discharge through short conduits into stilling basins

Size of Control Gates at Each Bay (feet)	7x7(Left	7x7(Center)	5x10(Right)
Invert Elevation of Gates at Each Bay (feet)	867(Left)	872(Center)	5x10(Right)

The maximum outlet discharge (at spillway elevation) with all gates open is 42,800 c.f.s.

OTHER STRUCTURES. Stilling Basin, divided into three sections, each at different elevation corresponding to the three bays of conduits in the spillway section. The basin is a conventional jump type with baffles. Other structures include Zoar Levee (to protect Zoar village), Somerdale Levee (to protect Somerdale), and Industrial Levees (3 small levees to protect industrial facilities).

HYDROLOGY.

Drainage Area Above Dam	1,404 square miles
Maximum Peak Discharge at Dam Site (1913-computed)	61,500 c.f.s.
Minimum Discharge Below Dam Site	6.5 c.f.s.

RESERVOIR	Elevation (Feet NGVD)	Capacity (Ac.ft)	Capacity (In.)	Area (Acres)	Backwater (Main Stem, Miles)
Streambed at Dam Site	860				
Minimum Pool	862				
Flood Control Pool	916	203,000	4.9	10,100	23.2
Total Storage	916	203,000	4.9		

MUSKINGUM RIVER BASIN
OHIO

PROJECT MANUAL
FOR
WATER CONTROL MANAGEMENT
DOVER DAM – TUSCARAWAS RIVER

SECTION I – INTRODUCTION

1-01 AUTHORIZATION

This manual is prepared according to instructions contained in Engineer Regulation 1110–2–240, *Water Control Management*, dated 30 April 1987; Engineer Manual 1110–2–3600, *Management of Water Control Systems*, dated 30 November 1987 and Engineer Regulation ER 1110–2–8156, *Preparation of Water Control Manuals*, dated 31 August 1995. ER 1110–2–8156 establishes a detailed outline for the contents and provides guidance for the narrative development.

1-02 PURPOSE AND SCOPE

The purpose of this manual is to describe the general plan for the regulation of Dover Dam in the Muskingum River Basin. The manual will serve two purposes: first, as documentation of this plan for water control, and second, as a reference source for higher authority and for office and field personnel responsible for water control management throughout the life of the project. The manual also contains background information necessary for understanding the objectives and application of the water management schedules, as well as results of optimal simulation of project operation for specific purposes and conditions.

1-03 RELATED MANUALS AND REPORTS

The following manuals and reports concerning Dover Dam or the Muskingum River projects have been previously completed.

	Title	Date
1.	Report on main river in the vicinity of the mouth (Navigation)	1879
2.	Report on main river (Navigation)	1884
3.	Report on main river (Navigation)	1886
4.	Report on main river, Zanesville to Dresden (Navigation)	1889
5.	Report on main river, Zanesville to Dresden (Navigation)	1895

6.	Report on main river, Zanesville to Coshocton (Navigation)	1902
7.	Report on main river in vicinity of the mouth (Navigation)	1905
8.	Report on main river and all tributaries (flood control)	1916
9.	Report on Mohican River and tributaries (flood control)	1931
10.	Comprehensive report on reservoirs in Mississippi River Basin	
11.	Ohio River 308 Report	
12.	Comprehensive flood control plan for Ohio and lower Mississippi Rivers	
13.	Official Plan for the Muskingum Watershed Conservancy District, Volumes I and II	October 1934 Amended April 1935 Revised June 1935
14.	Muskingum River 308 Report	December 1934 Revised January 1942
15.	Major Dams and Hydro-Projects in the Huntington, West Virginia and Zanesville, Ohio Engineer Districts	November 1937
16.	Analysis of Design	1938
17.	Analysis of Design – Addenda	1938
18.	History and Development of the Muskingum Watershed Conservancy District Project	March 1938 Revised March 1939 Revised July 1952
19.	Analysis of Hydrologic Data for Index Areas – Muskingum River Basin, Ohio	April 1942
20.	Flood Control Operation – Flood of December 1942 – January 1943 – Muskingum River Reservoirs, Ohio	February 1943
21.	Channel Capacity Investigation Muskingum River, Ohio	May 1944
22.	An Experience History of the Muskingum River Reservoir System	October 1951
23.	Instructions to the Damtender, Dover Dam	November 1953
24.	Water Inventory of the Muskingum River Basin and Adjacent Ohio River Tributary Area	1968
25.	Muskingum Area, Emergency Operation Plan	March 1970

26. Periodic Inspection, Dover Dam

Report No. 1	March 1970
Report No. 2	May 1976
Report No. 3	June 1981

27. Post-Flood Report, Muskingum River Basin, Ohio – Flood of July 1969 — April 1970

28. Muskingum River Basin, Ohio Basin Report — September 1973

29. Muskingum River Dams, Spillway Adequacy Study — April 1975

30. Muskingum River Basin, Ohio – Interim Feasibility Report for Water Resources Development — November 1975, Revised March 1976, Revised February 1977

31. Muskingum River Reservoirs General Plan of Reservoir Regulation — October 1976, Revised October 1984

32. Operations and Maintenance Manual — May 1978

33. Southeast Ohio Water Plan — September 1978

34. Dam Safety Training Program Manual, Dover Dam — April 1983

1-04 PROJECT OWNER

The United States Government is the owner of the Dover Lake Project, and the overall responsibility for the project is under the jurisdiction of the U.S. Army Corps of Engineers, Huntington District.

1-05 OPERATING AGENCY

The U.S. Army Corps of Engineers, Huntington District controls the operation, regulation, and maintenance of the Dover Lake project. In conformance with Ohio River Division Regulation 1110-2-27, dated 12 January 1976, the Huntington District Water Resources Engineering Branch has the primary responsibility for overall water control management of all District projects and associated reservoir activities; technical evaluations and performance of operations associated therewith; and for developing plans and manuals required for the various dams, such as Dover Dam.

The dam is attended continuously during normal business hours by the Damtender and his staff. The Damtender and the Operational Manager can be contacted as shown in **Table 1-1**.

Table 1-1

Project Office Points of Contact

Names and Addresses	Numbers
[redacted], Damtender 5153 State Route 800, NE Dover, OH 44622-9609	Work [redacted] Home Fax [redacted]
[redacted] Operations Manager	Work [redacted] Home

1-06 REGULATING AGENCIES

The regulation of the project is under the supervision of the Water Control section of the Water Resources Engineering Branch of the Huntington District. Any operations, which might deviate from the approved water control plan, as presented in this manual are coordinated with the Great Lakes and Ohio River Reservoir Control Center.

SECTION II – DESCRIPTION OF PROJECT

2-01 LOCATION

Dover Dam is located in Tuscarawas County, Ohio on the Tuscarawas River below the confluence of Tuscarawas River and Conotton Creek in the northeastern Ohio, as shown on **Plate 2-1**. The dam is located about 3.5 miles northeast of the city of Dover, and approximately 174 miles above the mouth of the Muskingum River. The general drainage map is shown on **Plate 2-2**.

2-02 PROJECT PURPOSES

a. General. Dover Reservoir is authorized for flood control and allied purposes in a comprehensive plan for the Muskingum and Ohio River Basins. Benefits from flood control serve not only local interests in the Tuscarawas River Basin, but also the overall Muskingum and Ohio River Basins.

b. Flood Control. The extent of flooding and resultant damages in the Tuscarawas River Basin before the construction of Dover Dam and the three additional upstream reservoirs was due primarily to the inadequate capacity of the stream channels and the extent of development in the overbank areas. Since most of the stream channels lack the capacity to carry the runoff from large storms, the towns and cities founded in the valleys are unprotected or so poorly protected that they suffered financial damage and loss of life from major floods. Extensive damages also resulted to agricultural communities.

Major flooding in the basin is likely to result from either summer or winter meteorological conditions. Summer rains usually result from thunderstorms and are usually confined to relatively small areas and are of short duration with high intensity. "Precipitation in late fall, winter and early spring generally results from the passage of a low pressure system over the basin, usually in a northeasterly direction. Occasional stagnation and stationary developments produce prolonged precipitation, which, historically, has caused the more severe flooding.

The storage capacity of Dover Reservoir between the design conservation pool and the spillway crest elevation is 203,000 acre-feet, or 4.9 inches of runoff from the uncontrolled drainage area above the dam. Regulation of this storage capacity provides substantial flood protection along the Tuscarawas River and also aids in providing flood protection along the Muskingum and Ohio Rivers.

The principal flood control benefits of Dover Reservoir are general benefits to agricultural areas and urban communities downstream along the Tuscarawas, Muskingum and Ohio Rivers through the coordinated operation of the Muskingum Basin Reservoirs. Along the

Ohio River, much industrial development is outside the floodwalls and levees. Accordingly, this development and many towns and cities suffer from floods of all stages. Dover Dam and other Muskingum Basin dams therefore help reduce the extent of flooding on the Ohio River.

c. Special Purposes. A wide range of people needs, involving water flow or stage within the sphere of project influence, become special purposes which are evaluated for translation into regulation. The expressed need may be for a low stage downstream to allow fording, construction work, or search for a drowning victim; a medium stage downstream for a sporting event such as canoeing; a high stage downstream to answer an emergency in the lake area; reservoir drawdown to meet an important construction need; or any of a multitude of other situations generating a request for special operation. Emergency needs are met as quickly as possible; however, requests for deviation from normal regulation must be evaluated with respect to the hydrometeorological outlook and with respect to the impact on other project purposes and must be coordinated with the Reservoir Control Center in the Division Office. After evaluation and coordination, the Chief of the Water Resources Engineering Branch either directs regulation to answer the need or denies the request.

2-03 PHYSICAL COMPONENTS

a. Dam. The dam is a concrete gravity type structure founded on limestone and silt shale. It has a maximum structural height of 83 feet and a crest length of 824 feet. Keywalls extend 20 feet into bedrock over most of the length of the dam, except for two monoliths, where the entire monolith foundation was lowered 20 feet because of a fault and severely fractured limestone discovered during construction. A grout curtain extends below the keywall and foundation drains extend from the foundation to the drainage gallery. **Plate 2-3** shows overview photographs, a plan view, and a typical section of the dam. Further details of the dam are shown on **Plates 2-4** and **2-5**. Additional pertinent dimensions, elevations, and data for the project are given in **Exhibit A** – Summary of Pertinent Data.

b. Spillway. A 338-foot long uncontrolled ogee spillway is located in the channel section of the dam, with the crest at elevation 916.0. Discharge from the spillway enters a stilling basin at the toe of the spillway. Details of the spillway and stilling basin are given on **Plates 2-4** and **2-6** respectively.

c. Outlet Works. The outlet works consist of 18 gated sluices through the spillway section of the dam. These sluices are arranged in groups of six, with each group having a different invert elevation. The lowest group is on the right, looking downstream, with the sluice inverts at elevation 862 and the sluices controlled by 5’ x 10’slide gates. The next higher group is on the left, where

the sluices are controlled by 7′ x 7′ slide gates and the invert elevation is 867. These sluice inverts for the central group are at the elevation 872. These sluices are also controlled by 7′ x 7′ slide gates.

The outlet works discharge into the spillway stilling basin, which is also separated by partial dividing walls into three sections corresponding to the three groups of sluices. The right section is at elevation 854, the left at elevation 860, and the central section at elevation 859. Each section has a series of baffle blocks and the two lower sections have an end sill which extends to elevation 860.

d. Operating Machinery.

(1) Slide Gates. The slide gates are hydraulically operated from a gallery through the dam. The gates are operated by individual oil cylinders with the oil pressure for gate operations provided by an electrically driven oil pump. The hydraulic controls are located in a pump chamber adjacent to the gate recesses with access provided by a stairway from the operating house to the tunnel floor. **Plate 2-4** shows the location of the gallery and the operating house. The operating house plan and elevations are shown on **Plate 2-7**.

The twelve 7′ x 7′ gates are designed to be either fully open or completely closed, while the six 5′ x 10′ gates can be operated to provide variable openings. An emergency gate exists for the 5′ x 10′ conduits, but not for the 7′ x 7′ conduits. Normally, due to their higher invert elevation, the pool level can be maintained at a level such that maintenance and repairs on these gates can be done in the dry. Stop log recesses have also been provided at the downstream end of each of the 5′ x 10′ conduits.

(2) Auxiliary Power Unit. The standby power unit consists of a diesel engine directly connected to a 30 kw alternating current generator, both mounted on a common base. The engine is water cooled and easily started by its battery. The power is sufficient for conceivable emergency needs.

2-04 RESERVOIR DESCRIPTION

The Official Plan for Dover Dam provided for a permanent lake at elevation 874.0 feet with a surface area of 350 acres. After the conservation pool level was attained in early 1940, it became apparent that industrial waste from a chemical plant in Barberton was causing severe pollution of the lake. It was also evident that the 1000 acre-feet conservation storage pool would rapidly silt up due to the large drainage area and the heavy sediment load carried by the Tuscarawas River. For these reasons, Dover has been operated as a dry reservoir since 1941.

At the maximum flood control pool (elevation 916), the reservoir has a surface area of 10,100 acres, a capacity of 203,000 acre-feet, and inundates portions of the Ohio counties of Stark, Tuscarawas and Carroll. At this elevation, two of the upstream dams, Atwood and Bolivar, lie within the Dover reservoir area while the stilling basin floor of the third upstream dam, Leesville, is inundated by one foot.

About 2 miles upstream of the dam, near the confluence with Conotton Creek, the Tuscarawas River leaves a broad, deeply filled pre-glacial valley and enters a narrow steep-walled valley of post-glacial origin, in which the dam site is located. In this relatively young, rock-cut valley, the stream flows essentially on bedrock. The valley walls in this area rise on steep slopes to an upland whose general elevation ranges from 1100 to 1200 feet. Above the Conotton Creek confluence, the Tuscarawas River flows in a southeasterly direction and Conotton Creek flows in a northwesterly direction. Just below the confluence, the Tuscarawas River turns abruptly and flows in a southwesterly direction to the dam site and beyond.

The drainage area follows the general direction of the Tuscarawas River and Conotton Creek upstream of their confluence. Thus the drainage area lies in a northwest-southeast direction and is basically parallel to the axis of the dam. The drainage area is given in **Plate 2-2**.

2-05 RELATED CONTROL FACILITIES

There are six levees which are part of the flood control system at Dover Dam. The largest one is located four miles north of the dam near Zoar Levee stretching 3,893 feet. Three of the levees are described below.

a. Somerdale Levee. The Somerdale Levee, which protects the town of Somerdale, Ohio, is located about 3 miles east of the dam. The levee is constructed of impervious material and consists of 4,070 feet of relocated railroad embankment. The top width is about 20 feet, the maximum height approximately 35 feet, and the maximum base width approximately 160 feet. The crest of the levee is at elevation 919.0

Appurtenant structures include 3 gated culverts with operating towers and two pipes with automatic flap gates through the levee. A general plan and typical section through one of the culverts is shown on **Plate 2-8.**

b. Zoar Levee. The Zoar Levee protects the town of Zoar, Ohio, and is located about 4 miles north of the dam. The levee is a rolled earthfill structure with an impervious core. It has a crest length of 3893 feet, a top width of 8 feet, and a maximum height of about 45 feet. The side slopes of the reservoir side are 3H:1V, and those of the landward side are 2.5H:1V. The embankment was

originally constructed to elevation 919.0, but was raised to elevation 928.5 in 1951. After considerable underseepage occurred at the levee during a flood in June 1947, sixteen pressure relief wells and 15 piezometers, each one located approximately midway between two relief wells, were constructed along the landward toe of the levee in 1948. Appurtenant structures include a diversion dam and channel to divert flows past the levee, a gated concrete culvert, and a pump station to provide additional flow diversion capability. A general plan and cross-section of the Zoar Levee are shown on **Plate 2-3**. Additional details on the concrete culvert are given in **Plates 2-9.**

c. Industrial Levee. Small industrial levees also protect the properties of Corundite Refractories, Inc. at Zoar, Ohio, the Fairfield Brick Company at Zoarville, Ohio, and the Norton Chemical Company near Mineral City, Ohio. Each levee is similar in construction to the Somerdale Levee and has a crest elevation of 919.0. The Corundite Refractories Levee has a maximum height of approximately 15 feet and has only one pipe with an automatic flap gate through the embankment. The other two levees have a maximum embankment height of approximately 25 feet. The Fairfield Brick Levee has two pipes with flap gates through the embankment and the Norton Chemical Levee has one pipe with a flap gate and one railroad stop log opening through the embankment.

2-06 REAL ESTATE ACQUISITION

In the acquisition of interest in the reservoir lands, several guiding principles were established by the Muskingum Watershed Conservancy District. Fee simple title was to be acquired for reservoir lands up to a line measured horizontally from the proposed conservation pool elevation 874 feet. Flowage easements were then to be acquired from the fee title line up to reservoir spillway level at elevation 916 feet. No properties were set up for easements unless some part of the property was located below spillway. Fee simple title was to be obtained in all cases whenever the cost of a flowage easement would approach the cost of fee title. In the actual taking of these lands, however, these criteria were modified somewhat according to local conditions at individual properties. In the Dover Reservoir area, 146.41 acres at the dam site, 66.57 acres at Zoar, 11.30 acres at Mineral City and 7.32 acres at Zoarville for a total of 231.60 acres were acquired in fee title. Flowage easements were acquired for 14,339.37 acres, which includes lands in the reservoir, the embankment at Somerdale and the industrial levee at Zoar.

2-07 PUBLIC FACILITIES

Since there is no conservation or minimum pool level, the project does not provide a sizeable body of water available for full recreational utilization by the public. However, there is one facility at the dam site consisting of a downstream access to the

tailwaters for fishermen, a parking lot, picnic tables and grills, drinking water and restrooms. There is also a nearby roadside park maintained by the State of Ohio.

SECTION III – HISTORY OF PROJECT

3-01 AUTHORIZATION

Dover Dam was constructed for flood control in cooperation with the Muskingum Watershed Conservancy District after approval by the Public Works Administration in 1933.

The Corps of Engineers initiated investigations following the execution of a contract between the United States of America and the Muskingum Watershed Conservancy District on 29 March 1934. The official plan was proposed by the COE and was approved by the Conservancy District on 19 November 1934.

The Flood Control Act, approved 11 August 1939, contained a provision that the dams and reservoirs be included in the Comprehensive Flood Control Plan for the Ohio River Basin. Operation and maintenance of the 14-reservoir system (which includes Dover Dam) have been the responsibility of the Corps of Engineers since that date.

3-02 GENERAL BACKGROUND HISTORY

The realization of the need for flood control and overall water management in the Muskingum River Basin grew as communities along the streams expanded and more and more acres of flood plains were occupied by man-made developments. The 1913 flood, which caused flood losses totaling $14 million in the basin, brought the problem into sharp focus, not only for the Muskingum Basin, but throughout Ohio. As a result, in 1914 the state legislature enacted the Conservancy Act of Ohio {Vol. 104-1914, Laws of Ohio). This Act authorizes the creation of conservancy districts, gives them the dominant right of eminent domain, establishes the procedure for financial administration for local participation, and authorizes them to enter into contracts with the state and Federal governments.

Subsequently, various organizations such as the Muskingum-Tuscarawas Improvement Association were formed to promote the development of an integrated program of water management for the entire Muskingum Basin. Through the efforts of this association, the Ohio Department of Public Works financed a study of the use and control of the waters of the Tuscarawas and Muskingum Rivers. The study revealed that it would be feasible to plan and execute a comprehensive flood control and water conservation program for the entire watershed, but that the costs were more than local interests could bear. The study also showed, however, that a comprehensive reservoir system on the Muskingum Basin would have a measurable effect in reducing flood crests and improving navigation on the Ohio River and thus suggested that Federal aid be sought for the project.

On June 3, 1933, the Muskingum Watershed Conservancy District was created under authority contained in the Ohio Conservancy Act to provide the legal machinery for carrying out a comprehensive project

for the Muskingum drainage area and to secure the necessary financial cooperation between the State of Ohio, the Federal Government, and the individual property owners and the communities of the District.

A preliminary plan was prepared, and in August 1933 the Conservancy District made application to the Federal Emergency Administration of Public Works for approval of the project and for aid in its construction and financing. The Federal Emergency Administration of Public Works approved the project in December 1933, and monies were allocated to the Corps of Engineers to aid in financing its construction. This approval was subject, however, to the execution of a contract between the United States of America and the Muskingum Watershed Conservancy District.

On 29 March 1934, the agreement between the Conservancy District and the Public Works Administration was signed and the work was begun immediately thereafter by the Corps of Engineers. Surveys and foundation investigations were made at approximately 150 tentative sites, and of these, 14 sites, one of which was Dover Dam, were selected which would provide the maximum degree of flood protection and the greatest conservation improvement consistent with available funds and legislative authority. The official plan was prepared by the Corps of Engineers and approved by the Conservancy District on 19 November 1934.

The Federal Government, through the Corps of Engineers, was directly responsible for the construction of the 14 reservoirs and relocations of railroads and other public utilities. The Ohio Highway Department, financially aided by the Federal Bureau of Public Roads, was responsible for the relocations of highways, roads and streets. The Conservancy District procured lands, easements and rights-of-way needed for the reservoirs, and was subsequently reimbursed for these expenditures by the Federal Government. The Conservancy District retains fee title to much of the project land. Fee title to the lands required specifically for construction of the 14 dams and appurtenant structures was conveyed to the United States. The United States acquired flowage easements over the remaining reservoir land from the Conservancy District and directly from property owners. The Flood Control Act, approved 11 August 1939, contained a provision that the dams and reservoirs be included in the comprehensive flood control plan for the Ohio River Basin. Operation and maintenance of the reservoir system have been the responsibility of the Corps of Engineers since that date. The Conservancy District, assisted by the National Park Service, prepared a master plan for comprehensive development of the areas surrounding the pools for recreation and conservation use.

Two reservoirs have been added to the Muskingum Basin system since the 1930’s. Dillon Lake was completed in 1961 and North Branch of Kokosing Lake was completed in 1972.

3-03 PLANNING AND DESIGN

The 16 flood control projects in the Muskingum Basin are all located in the Walhonding River, Tuscarawas River, Licking River and Wills Creek Basins. Dover Dam Reservoir is the key reservoir in the Tuscarawas River Basin. It was designed primarily for flood control with only a small conservation pool. Sufficient storage could not be obtained at this location, however, without excessive cost. Three additional reservoirs, Leesville, Atwood and Bolivar, were therefore constructed on upstream tributaries to provide additional flood control storage.

The total drainage area above Dover Dam is 1,404 square miles, of which 622 square miles are controlled by three upstream reservoirs. These reservoirs were designed to be constructed and operated such that the reservoirs would be filed to spillway level, but not beyond, by the runoff from the design storm, which was approximately 35% greater than the 1913 storm for the Dover Reservoir area. To this end, Dover Reservoir was designed to have a conservation pool of 1000 acre-feet and a flood control pool of 203,000 acre-feet, or 4.9 inches of runoff.

Several dikes were designed to protect various towns and factories against backwater from Dover Dam. These dikes were constructed at the towns of Zoar and Somerdale, and at the Corundite plant, the Fairfield Brick Company, and the Norton Chemical Company.

Two sites were originally considered for Dover Dam. The upper site was about 3.5 miles northeast of Dover on State Highway 8. The lower site was about one mile downstream of the upper site. Field reconnaissance and cross-sections taken at the lower site were sufficient to show the upper site to be more advantageous due to both cost and foundation conditions.

The narrow gorge and proximity of suitable rock foundations across the entire dam site dictated the selection of concrete gravity type dam. Earth-fill, buttress, multiple arch and various combinations thereof were investigated but discarded for either lack of suitable materials or foundation difficulties. The narrow box-like canyon precluded the use of a side channel spillway around any dam constructed and made a spillway structure located in the stream channel almost obligatory for any type dam considered. The concrete gravity structure was thus adopted as the most economical and suitable type structure for the site selected.

3-04 CONSTRUCTION

The contract for the construction of the dam was awarded to The Bates and Rogers Construction Company of Chicago, Illinois, with a notice to proceed given on 5 June 1935. The original completion date was set at 5 May 1937, but subsequent change orders resulted in extending the completion date to 29 November 1937.

The spillway section of the dam was constructed within cofferdams in two separate stages. The first stage cofferdam extended outward from the north bank of the river to include all of monolith 11. Work accomplished during this first stage, which encompassed the first two construction seasons, included the dam proper from monolith 1 through 11, both retaining walls, the stilling basin aprons and baffles, and the rolled embankment and rock fill behind the retaining walls. The upstream and downstream shore connections of the first cofferdam were pulled and water diverted through the conduits in August 1936. The second stage cofferdam was then constructed, allowing the construction of the remaining portion of the spillway section and the south abutment monoliths

When the foundation was exposed during construction, a fault of fairly major significance was observed cutting east to west across monoliths 14 and 15 and monolith 14 of the stilling basin. The limestone on the north side of the fault was found to be over thrust by several feet and much of the limestone was severely broken. Subsequent investigations also revealed the fault extended into the underlying shale. The foundations for the three monoliths were therefore lowered 20 feet and the keywall was eliminated in these monoliths. Extensive grouting was also required along both sides of the fault and under monoliths 12 and 13.

3-05 RELATED PROJECTS

Dover Dam is part of the flood control system for the Muskingum River Basin, as well as the Ohio River Basin. It is one of 16 reservoirs in the Muskingum River Basin and regulation procedures are therefore very closely coordinated with the other basin projects, particularly those located upstream in the Dover watershed. The reservoirs are operated so that the capacities up to flood stages of the downstream channels may be utilized as far as possible during periods of storm runoff and until the flood waters stored in the reservoirs have been emptied.

3-06 MODIFICATIONS TO REGULATIONS

As discussed in **Section 2-4**, the Official Plan for Dover Dam provided for a permanent lake at elevation 874.0 feet with a surface area of 350 acres. After the conservation pool level was attained in early 1940, it became apparent that industrial waste from a chemical plant in Barberton was causing severe pollution of the lake. It was also evident that the 1000 acre-feet conservation storage pool would rapidly silt up due to the large drainage area and the heavy sediment load carried by the Tuscarawas River. For these reasons, in 1941 it was decided to operate Dover as a dry reservoir. This policy has remained in effect.

3-07 PRINCIPAL REGULATION PROBLEMS

There is no identified regulation problem.

SECTION IV – WATERSHED CHARACTERISTICS

4-01 GENERAL CHARACTERISTICS

The drainage basin above Dover Dam lies in northeastern Ohio within the Counties of Medina, Summit, Wayne, Stark, Columbiana, Portage, Tuscarawas, Carroll and Harrison. The basin is irregular in shape but does have an overall elliptical appearance with the major axis lying parallel to the dam in a northeast-southeast direction. The maximum length of the basin is about 75 miles and the maximum width about 30 miles. The total drainage area is 1404 square miles of which 622 square miles are controlled by the three upstream reservoirs, Atwood, Leesville and Bolivar. The drainage map is given in **Plate 2-2**.

The Tuscarawas River rises in Stark County, Ohio, above the Portage Lakes region lying near Akron and North of Canton. From the source it flows in a westerly direction to Barberton where it turns and flows in a southerly direction to Dover Dam. The width between banks of the Tuscarawas River varies from less than 100 feet to over 500 feet. The banks are generally quite low, ranging in height from 2 to 3 feet to over 20 feet and averaging about 7 feet. The difference between the normal flow level and the flood flow level is about 18 feet at Dover.

The drainage areas and stream discharges for the Tuscarawas River and its tributaries within the influence of Dover Dam are listed in **Table 4-1**.

TABLE 4-1

Drainage Areas and Stream Flows – Tuscarawas River and Tributaries

Location	Miles Above Mouth	Area (sq.mi.)	Period of Record	Max. Stage (ft.)	Discharge (cfs)		
					Max.	Min.	Mean
Tuscrawas River at Clinton	101.1	174	1926-1978	17.00	2,700	10	148
Tuscarawas River at Massillon	86.0	518	1937-1983	16.43	10,700	57	441
Sandy Creek at Waynesburg	87.0	253	1938-1983	10.05	15,000	6.9	270
Nimishillen Creek at North Industry	85.5	175	1921-1983	11.29	8,600	3.6	184
McGuire Creek below Leesville	84.5	48.3	1938-1983	7.88	740	0	54
Indian Fork below Atwood Dam	76.5	70.0	1938-1975	19.00	1,610	0.1	72
Tuscarawas River below Dover Dam	60.3	1,405	1923-1983	15.51	26,400	6.5	1,430
Tuscarawas River at Newcomerstown	21.3	2,443	1921-1983	20.65	46,800	170	2,541

4-02 TOPOGRAPHY

The Dover Dam watershed lies within the Appalachian Plateau physiographic province. The northwestern portion lies in the glaciated plateau section while the southeastern portion lies in the unglaciated plateau section. The topographies of the glaciated and unglaciated sections exhibit marked differences, though the transition from one to the other is rather gradual. Terminal and lateral moraines are inconspicuous, and in many places it is not easy to establish the boundary from surface evidences.

The unglaciated portion is well dissected and presents a mature topography. It is a rugged, hilly country with broad, flat-bottomed valleys in which flood plains and terraces are prominent. It is apparent the many of the valleys are too wide to be the work of the streams that occupy them at the present time, and that they were cut by pre-glacial streams of far greater magnitude. The surface of the old plateau in this section, as indicated by the summits of the main ridge, stands approximately 1100 to 1200 feet above sea level.

The topography of the glaciated portion of the watershed is fairly well dissected near its border, and is made up of rolling hills and broad valleys. The relief is low to moderate due to the glacial erosion of the hills and the glacial deposits in the valley.

Tuscarawas River flows from its source at elevation 1180 to the mouth at Coshocton with a total fall of about 442 feet or 3.4 feet per mile. More than a half of this fall is in the headwaters as the stream drops 230 feet from its source to Barberton, a distance of 15 miles, or at a rate of 15.3 feet per mile. From Barberton to the dam the average slope is about 1.8 feet per mile. The Tuscarawas River streambed profile from above the Summit/Stark County line to its mouth at Coshocton is shown on **Plate 4-1**.

4-03 GEOLOGY AND SOILS

The consolidated rocks now appearing at the surface in the Dover Dam watershed are of sedimentary origin and belong to the Mississippi and Pennsylvania geologic systems. They dip to the southeast at the rate of about 20 feet to the mile.

The Mississippian formations, the oldest rocks outcropping in the areas, occur in the western portion of the watershed. They are made up of sandstones, shale, and coal, with a few thin beds of limestone.

The bedrock in the vicinity of Dover Dam is of the Allegheny and Pottsville series of the Pennsylvanian system. It consists of essentially horizontal beds of shale, sandstone, limestone and coal. Most of the dam is founded in the Lower Mercer limestone, a hard, dense, dark gray limestone which occurs at shallow depths below the river bed. The limestone layer at the site averages 4 feet in thickness and the surface undulates due to minor local flexures.

The unconsolidated materials in the watershed consist of glacial drift and till, outwash sands, gravel, and cobbles derived from glacial materials formed by disintegration of the bedrock. In the glacial area the valleys are deeply filled with glacial drift and poorly sorted glacio-fluvial sand, gravel and cobbles, over which is spread a thin blanket of flood plain silt and clay. The uplands in the glacial area are blanketed for the most part with a variable thickness of till. In the unglaciated area the valley fill materials are generally fine and consist of river deposited silt, clay and sand. The unglaciated uplands are blanketed with residual sandy clays which generally pass into bedrock at shallow depths.

4-04 EROSION AND SEDIMENT

The Official Plan for Dover Dam provided for a permanent lake at elevation 874.0 feet NGVD. After the conservation pool level was attained in early 1940, it became apparent that the conservation storage pool would rapidly silt up due to the large area and the heavy sediment load carried by the Tuscarawas River. This, coupled with severe pollution problem caused by an upstream chemical plant, resulted in the decision to operate Dover as a dry dam.

No sedimentation data are available specifically for the Dover Dam project, but since no seasonal pool is maintained at Dover Dam and since excessive sedimentation has not been experienced at either Atwood Lake or Leesville Lake, sedimentation behind Dover Dam is also not likely to be excessive.

4-05 CLIMATE

a. General. The climate of the Tuscarawas River Basin is essentially continental in nature and is characterized by moderate extremes of heat, cold, wetness and dryness. Frequent and rapid changes in weather occur due to the passage of fronts associated with general low-pressure areas. The prevailing wind direction is from the southwest. The average conditions for the Tuscarawas Basin are represented by the climatological data obtained at the Wooster, Millport and New Philadelphia stations. Temperature and precipitation data for these stations are listed in **Table 4-2**, page T4-1.

b. Temperature. The mean temperature is about 49.5°F which is close to the state average. The highest temperature of record for Wooster is 105° F and the lowest is –28° F. Maximum temperatures usually occur during July or August and minimum temperatures usually occur in January or February. Based on the station at Millport, the growing season, defined as the period where the minimum daily temperature is 32°F or higher, is approximately 134 days and extends from the middle of May to the end of September.

c. Precipitation. The average annual precipitation is 37.2 inches, which is slightly higher than the national average. The

monthly mean precipitation varies from 2.35 inches for February to 4.3 inches in July. The average annual snowfall is about 31.0 inches. Snowfall has been recorded at one or more stations in the basin for every month except June, July, and August.

The Tuscarawas River is drained by the Muskingum River to the Ohio River and extends generally north and south and therefore lies normal to the path of major storms that move across Ohio from west to east. Meteorological conditions likely to produce flooding in the basin develop into two types: the summer-type which occurs during the late spring and summer months and winter- or spring-type that occurs most frequently from January through March. Summer rains usually result from thunderstorms of conventional frontal activity.

They are usually confined to relatively small areas and are of short duration with high intensity rates that frequently cause local flash floods. Winter or spring storms generally consist of less precipitation but tend to be evenly distributed over a greater area and create more generalized flooding, since they result from the passage of a low-pressure system over the basin.

d. Evaporation and Wind. Since Dover Dam is operated as a dry reservoir, evaporation losses are not considered significant. The average annual evaporation loss for waterbodies in the Dover Dam area is approximately 31 inches, as estimated from Technical Paper No. 37, published by the National Weather Service from data obtained jointly by the Weather Service, the Corps of Engineers, and other organizations. Evaporation is greatest during the warm months, as approximately 76 percent of the annual evaporation in the Muskingum Basin occurs from May through October. During this period the average evaporation exceeds the average rainfall by about seven inches.

Prevailing winds in the area are from the south and southwest for most of the year; in February and March prevailing winds are from the northwest. The mean annual wind speed, based on data from the Akron-Canton Airport, is 9.9 miles per hour. The maximum mean monthly wind speeds average between 11 and 12 miles per hour during the period November through April; the minimum mean monthly wind speed is 7.4 miles per hour in August. Damaging windstorms are mostly associated with heavy thunderstorms, squall lines, or intense large area storms.

4-06 STORMS AND FLOODS

a. General. The earliest flood for the Tuscarawas River Basin for which authenticated records are available was that of February 1832. Records have also been found for two other major historical floods, those of April 1860 and February 1880. Generally, floods occur during any month or season, but are more likely to occur in

the winter or spring months. The greatest flood of record occurred in March 1913 with an estimated flow of 62,000 cfs at Dover Dam.

The flooding characteristics of the Tuscarawas River Basin, as a non-regulated basin and as regulated and controlled by the eight flood control reservoirs (Leesville, Atwood, Bolivar, Dover, Beach City, Tappan, Piedmont, and Clendening), can be partially described by comparing the highest annual historical floods. These are shown in **Table 4-3**, Tuscarawas River at Newcomerstown, Ohio, High Water Data, for the water years 1926 through 1982 at the Newcomerstown gaging station. All flows and gage heights are those that actually occurred. For clarity, the water year has been changed to the calendar year where appropriate.

Table 4-3

Tuscarawas River at Newcomerstown, Ohio

High Water Data

Date	Gage Height (feet)	Discharge (cfs)
26 Jan 1937	20.7	46,800
9 Aug 1935	21.3	41,700
17 Mar 1933	13.6	32,900
28 Feb 1929	13.5	29,400
28 Feb 1936	17.4	27,300
16 Jan 1930	11.4	23,200
23 Mar 1927	13.1	22,800
16 Dec 1928	12.9	22,300
15 Mar 1939	12.5	22,100
6 Mar 1940	12.5	22,000
18 Mar 1938	15.2	19,400
27 Jan 1952	11.7	18,100
26 Sept 1926	---	17,000
5 Mar 1963	11.2	17,000
22 Mar 1945	11.0	16,900
20 Jan 1932	9.1	16,800
15 Apr 1948	10.6	15,800
10 Mar 1964	10.6	15,600
31 Dec 1942	10.5	15,000
6 Apr 1934	8.3	14,800
8 Mar 1956	9.5	14,500
16 Feb 1950	10.4	14,200
5 Dec 1951	10.4	14,200
24 Feb 1975	10.2	13,800
16 Feb 1942	10.1	13,800
22 Jan 1959	10.1	13,700
9 Mar 1944	9.9	13,500
28 Jan 1949	9.7	13,500
13 Apr 1981	9.6	13,400

Table 4-3 (Continued)

Tuscarawas River at Newcomerstown, Ohio

High Water Data

Date	Gage Height (feet)	Discharge (cfs)
7 Jun 1947	9.9	13,200
20 Apr 1961	9.8	13,200
2 Mar 1946	9.5	13,000
31 Dec 1940	9.7	12,800
15 Mar 1946	9.2	12,500
8 Jul 1969	9.4	12,100
14 Feb 1966	9.0	12,000
5 Apr 1957	9.2	11,800
3 Jun 1980	8.8	11,800
1 Mar 1979	8.8	111,700
18 Feb 1976	9.1	11,600
5 Apr 1977	8.7	11,600
4 Apr 1974	9.1	11,500
28 Feb 1962	8.6	11,300
30 Mar 1960	8.8	11,200
4 Mar 1955	8.8	11,000
5 May 1958	8.8	11,000
23 Feb 1971	8.8	10,800
14 Mar 1967	8.3	10,700
28 May 1968	8.7	10,600
27 Jan 1965	8.2	10,400
18 Mar 1982	8.0	10,300
6 Apr 1931	6.4	10,200
17 Mar 1972	8.0	9,570
3 Apr 1970	8.1	9,470
17 Mar 1973	7.8	9,340
31 Mar 1954	7.6	8,710
25 May 1953	7.2	7,760

The nonregulated period is from 1926 through 1935, when construction of the Tuscarawas River Basin dams began. Construction of the dams was virtually complete in 1938 so the regulated period extends from 1939 to the present. The gaging station was moved on February 14, 1939 to a site approximately 1.5 miles downstream from the previous site, so a difference in gage heights is evident for similar discharges. The gage datum was 785.03 feet National Geodetic Vertical Datum (NGVD) prior to October 1934, 780.03 feet NGVD from then until February 13, 1939, and 780.00 feet NGVD after that until the present.

Flooding characteristics of the Tuscarawas-Muskingum River Basin can also be described by flow frequency curves. A detailed discussion of the discharge frequency and duration curves is presented in **Section 8-11**.

b. Storm and Flood of March 1913. The flood of March 1913 is the greatest flood of record for the Tuscarawas River. The flood was caused by excessive precipitation over a comparatively large area. Due to the mild winter, the ground was without snow cover, not frozen and already saturated from previous rains. In the Tuscarawas River Basin, the main storm began just before noon on March 23, became increasingly heavy the next two days, and continued on the 26th and in some portions of the basin on the 27th. The total rainfall during the five-day period, most of which fell in a period of 96 hours or less at individual points, averaged 6.55 inches over the Tuscarawas River Basin. The resulting flood crested at about 23.5 feet at Dover. The estimated high water profile resulting from this flood along the Tuscarawas River, from the mouth to approximately 100 miles upstream, is shown in **Plate 4-2**.

c. Storm and Flood of January 1937. A series of abnormally heavy rains in late December 1936 and most of January 1937 caused a major series of floods in the middle and lower portions of the Ohio River Valley. Tributary streams in the Tuscarawas Basin experienced successions of flood rises which moved out of the smaller rivers to accumulate in the larger rivers resulting in increasingly higher stages and discharges after each storm. The heavy general rainfall continued for almost an entire month and concluded with the heaviest storm from January 14 - 25 in which 7.93 inches fell over the Muskingum Basin. The partially completed flood control reservoirs helped decrease the peak stages and discharges by acting as retarding basins. The runoff to Dover Reservoir, which was under construction at the time, was 4.25 inches.

d. Storm and Flood on January 1959. The storm and flood of January 1959 is generally regarded as one of the highest of record throughout most sections of the Tuscarawas Basin. The conditions prior to the generalized rains on January 20th and 21st contributed greatly to the stages throughout the basin. Severe cold weather during December 1958 froze the ground to depths ranging from 6 to 18 inches. In addition, a storm occurring between January 14–17 deposited from 0.50 to 1.84 inches of precipitation over the basin. The ground was thus saturated, frozen and covered with varying amounts of snow, all of which greatly contributed to the high percentage of runoff encountered after the generalized rain began. Most of the flood producing rains fell between midnight on January 20 and noon on January 21. The runoff for Dover Reservoir was 2.85 inches and the maximum pool elevation was 901.65 feet NGVD.

e. Storm and Flood of July 1969. On the evening of July 4, 1969, severe thunderstorms with intense rainfall moved across northern Ohio. The storm centered along a line beginning just east of Toledo and extending through Ashland and Wooster to Uhrichsville. The average rainfall over the Muskingum River Basin upstream of Coshocton for the 18 hour period ending at 1:30 P.M. July 5 was 6.6 inches. Unofficial measurements ranged from 10-14 inches for the same period in the Wooster area. The intense rainfall and runoff

resulted in the rapid and severe inundation of much of the upper Muskingum River Basin. Many headwater and tributary streams overflowed with flood stages approaching or exceeding those recorded in previous major floods. The storm pattern was such that flooding was severe in areas upstream from existing reservoirs; however, the reservoirs were utilized efficiently to control downstream flows and significantly reduce damages.

f. Storm and Flood of February 1979. Antecedent conditions prior to moderate rainfalls near the end of February 1979 were mainly responsible for flooding conditions in the basin. Soils were frozen and snow cover persisted over most of the Muskingum Basin from early January to the onset of the major rainfall on February 25–26. Snowcover on the basin ranged from approximately 6 inches in the northern part of the basin to 20 inches at McConnelsville. Temperatures rose to above freezing for the first time in nearly 4 weeks on February 20 and combined with rainfalls of less than 0.5 inch on February 21–22, created rapid melting of snow and runoff and rising stages along the basin's streams. Continued thawing combined with heavier rainfalls of approximately 1.5 inches over the basin on February 25–26 produced heavy runoff and considerable flooding in the Muskingum River Basin. The basin reservoirs were utilized efficiently to reduce downstream flows and stages. It is estimated that the operation of the system reduced flood stages on the Muskingum River by 9.0 feet at Coshocton, 11.8 feet at Zanesville, and 6.2 feet at McConnelsville.

g. Storm and Flood of August 1980. Heavy rainfalls falling on saturated ground were mainly responsible for the flooding conditions experienced in many portions of the Muskingum River Basin in August 1980. The basin experienced average rainfalls approximately 150% of normal during June and July 1980. Widespread, intense thunderstorms produced the bulk of the basin's precipitation in August, with a large portion of the basin receiving more than 10 inches of rain during the month. The most notable storm occurred on August 10-11 in Guernsey, Belmont, Licking and Muskingum Counties. The Cambridge area received 7.5–8.0 inches of rain in about 18 hours, and most stations in these counties received at least 3.5 inches of rain from the storm. Wills Creek at Cambridge reached its highest peak since 1935, with property damage exceeding that of the 1913 flood due to economic development of the area. Heavy rainfalls exceeding 1- 2 inches were common throughout most of the basin during storms of August 2-6, August 9-12, August 17-19, and August 21–22. Operation of the Muskingum Basin dams reduced flood stages significantly during the month, especially downstream of Wills Creek Dam and Dillon Dam after the storm of August 10-11. It is estimated that flood stages were reduced by 13.2 feet on Wills Creek at Wills Creek, by 14.0 feet on the Licking River at Dillon Falls, and by 7.5 feet on the Muskingum River at Zanesville.

4-07 RUNOFF CHARACTERISTICS

The northwestern portion of the Dover Reservoir drainage area lies in a glaciated section of the Appalachian Plateau and is characterized by rolling hills and broad valleys which are conducive to a slower concentration of runoff. The southeastern portion of the drainage area lies in an unglaciated section of the plateau and is characterized by rugged, hilly country with broad valleys which are conducive to a faster concentration of runoff.

The major tributaries of the Tuscarawas River are Chippewa Creek, Sandy Creek and Conotton Creek upstream of Dover Dam, and Sugar Creek and Stillwater Creek below Dover Dam. Atwood and Leesville Reservoirs are located on tributaries of Conotton Creek and control 118 square miles of the 286 square miles drainage area. Bolivar Dam is located near the mouth of Sandy Creek and controls 504 square miles of the 506 square mile drainage area.

Basin runoff is highest during the winter months when storm rainfall may be augmented by snow melt and when frozen or saturated ground can result in infiltration rates that approach zero. Runoff is lowest during late summer and early fall when the ground is dry and losses are high. The mean annual runoff for the Tuscarawas River averages about 1.0 cfs per square mile of drainage area. **Table 4-4** presents the average normal, maximum and minimum monthly runoff from the watershed just below the Dover dam-site based on 60 years of record at the USGS gage.

Table 4-4

Monthly and Annual Runoff – Tuscarawas River Below Dam

Month	Normal Average Flow (cfs)	Maximum Flow (cfs)	Minimum Flow (cfs)
January	1873	8694	315
February	2235	6319	181
March	2914	5663	535
April	2199	4392	597
May	1656	4113	379
June	1190	4891	342
July	976	3925	251
August	703	4503	204
September	605	2900	188
October	583	2390	199
November	850	2722	201
December	1374	5090	226
Annual	**1430**	**2300**	**598**

4-08 WATER QUALITY

Geological considerations are important because rock type in the drainage area determines, to a great extent, the inorganic composition of the inflow and outflow waters. Approximately 2 miles upstream of the dam, the Tuscarawas River leaves a broad pre-glacial valley and flows through a narrow steep-walled postglacial gorge. In the valley area, the stream flows on bedrock of the Allegheny Formation and Pottsville Group of the Pennsylvania System. The strata consist of horizontal beds of shale, sandstone, limestone, and coal. Surface water is characteristic of the calcareous nature of the watershed.

EPA uses an index of watershed indicators (IWI) to assess the health of aquatic resources in the watershed. The index ranges from 1 to 6 with 1 indicating a better water quality and lower vulnerability to stressors such as pollutant loadings and 6 indicating more serious water quality problems and a higher vulnerability to stressors.

The latest IWI score (calculated in 1999) for the Tuscarawas watershed was 4. This implies that the watershed has less serious water quality problems, with a higher vulnerability to pollutant loadings.

4-09 CHANNEL AND FLOODWAY CHARACTERISTICS

The regulation channel capacity or control flow in the Tuscarawas River below Dover Dam is 4832 cfs in the summer and 6026 cfs in the winter. The control flow in the Tuscarawas River is less in the summer than in the winter to accommodate farming in the flood plain. The rating is fairly stable at the site. Ratings are checked frequently by the USGS so that regulations personnel always have up-to-date ratings. Flood time of travel of Dover Dam discharge to the confluence with the Walhonding River at Coshocton is 30 hours and to the Ohio River at Marietta is an additional 42 hours.

The Tuscarawas River generally follows a meandering course through wide flat bottoms from its source to Massillon, through a comparatively narrow valley confined by steep hills from Massillon to Dover, and finally through a wide flat valley from Dover to its confluence with the Walhonding River. The flood plain widths average one-half mile, one-quarter mile, and one and one-quarter miles, respectively, through these three reaches. The stream width varies from less than 100 feet to over 500 feet. The valleys of the glaciated portion of the drainage area are deeply filled with drift and till outwash sands, gravel, and cobbles from glacial deposits; silts, clays and fine sands, from river deposits; and residual materials from rock disintegration. The valley fill materials in the unglaciated area are generally fine and consist of river deposited silt, clay, and sand.

Two key control stations at New Philadelphia and Newcomerstown control flood stage along the Tuscarawas River below Dover Dam. For

the Muskingum River, the control stations are located at Coshocton, Dresden, Zanesville and McConnellsville. For the Ohio River, Dover Dam operations are primarily based on stages at the gaging station on the Ohio River at Marietta, Ohio.

Heavy sediment load carried by the Tuscarawas River in the area below the dam coupled with the industrial waste from the chemical plant in Barberton made it apparent that it would encroach on the basin characteristics thereby cutting into its ability to release original control flows.

4-10 UPSTREAM STRUCTURES

The three major reservoirs upstream of Dover Lake are Leesville, Atwood and Bolivar Lakes. Of the total drainage area of 1404 square miles at Dover Dam, the three upstream reservoirs control 622 square miles.

4-11 DOWNSTREAM STRUCTURES

Dover Lake is one of 16 reservoirs in the Muskingum River Basin, which provides flood protection along the Tuscarawas River and Ohio River Basins. The locations of these reservoirs are shown on **Plate 2-1**.

4-12 ECONOMIC DATA

a. Population. The urbanized area is concentrated primarily along the northern perimeter of the Muskingum River Basin in Stark and Summit Counties and along the Tuscarawas and Muskingum Rivers. Population centers in the basin include Canton, Massillon, Wooster, Ashland, Dover-New Philadelphia, Mansfield, Newark, Zanesville and Marietta. **Table 4-5**, next page, shows the population of the Muskingum River Basin counties as determined by the 1960, 1970, 1980, and 1990 population censuses. It should be noted that the populations shown are the entire populations of the counties and several counties do not lie entirely within the basin. Also, the table does not include the populations of seven counties which contain small portions of the basin.

Most of the population increases have occurred in the counties in the northern portion of the basin. Licking County (Newark) and Washington County (Marietta) are the exceptions. The counties in the southern portion of the basin and especially the southeastern portion have experienced the least growth.

Table 4-5

Population of Muskingum River Basin Counties

County	Population				Percent Increase
	1990	1980	1970	1960	1960 to 1990
*Ashland	47,507	46,180	43,300	38,770	22.5
*Carroll	26,521	25,600	21,580	20,860	27.1
Coshocton	35,427	36,020	33,490	32,220	10.0
*Guernsey	39,024	42,020	37,670	38,580	1.2
*Harrison	16,085	18,150	17,010	18,000	-10.6
Holmes	32,849	29,420	23,020	21,590	52.1
Knox	47,473	46,300	41,800	38,810	22.3
*Licking	128,300	120,980	107,800	90,240	42.2
*Medina	122,354	113,150	82,720	65,320	87.3
*Morgan	14,194	14,240	12,380	12,750	11.3
Muskingum	82,068	83,340	77,830	79,160	3.7
*Noble	11,336	11,310	10,430	10,980	3.2
*Perry	31,557	30,130	27,430	27,860	13.3
*Richland	126,137	131,210	130,000	117,760	7.1
*Stark	367,585	378,820	372,210	340,350	8.0
*Summit	514,990	524,470	553,370	513,570	0.3
Tuscarawas	84,090	84,610	77,210	76,790	9.5
*Washington	62,254	64,270	57,160	51,690	20.4
Wayne	101,461	97,410	87,120	75,500	34.4
Total	**1,891,212**	**1,897,630**	**1,813,530**	**1,670,800**	**13.2**

*** Entire County is not within Muskingum River Basin.**

b. Agriculture. Approximately three-fourths of the land in Tuscarawas County and other western and northwestern counties of the Muskingum River Basin and about one-half of all the land in the basin is utilized for agricultural purposes, mainly cropland and pasture. In recent years there has been a steady conversion of agricultural lands to forest and industrial-urban development, but agricultural development is still occurring, primarily in the glaciated area and the wide stream valleys.

A great percentage of the land centered along the Muskingum River (Coshocton, Muskingum, Morgan, and Washington Counties) consists of woodland and extensive forest cover. Carroll County, where Atwood and Leesville Lakes are located, and the more rugged southeastern counties of the basin also have a high percentage of forest cover. A very small portion of these lands is controlled by government agencies. Commercial forest land amounts to about one-third of the state's total.

c. Industry. The industries in the Muskingum River Basin include the manufacturing of rubber, plastic, wood, glass, clay, and metal products; the extraction or mining of gas and oil, coal, clay, sandstone, limestone, dolomite, shale, and salt; and timbering.

The important manufacturing center in the basin is the City of Canton in Stark County. Fabricated metals, machinery, and rubber and plastic products account for the major portion of manufacturing in the area. In 1967, Stark County accounted for about one-fourth of the total value added by manufacturing in the basin; however, the late 1970's and early 1980's have shown a reduction in the manufacturing activity in the area due to the depression of the steel industry. Other important manufacturing centers in the Muskingum Basin include Mansfield, Newark and Zanesville.

The Muskingum River Basin is rich in mineral resources. Coal is the most important mineral resource and deposits are located in the eastern and southeastern portions of the basin. Harrison and Tuscarawas Counties are the leading producers in the area. There are many producing oil and gas wells in the basin. Clay mines in the basin account for about half of the clay produced in the state. Crushed sandstone is quarried in six counties, and limestone and dolomite are quarried extensively in many of the eastern counties of the basin. About one-fourth of the state's sand and gravel is produced in the basin. Tuscarawas, Stark and Perry Counties are the source of about 70 percent of the shale produced in Ohio. Salt brines rich in bromine, calcium, chlorine, magnesium, potassium and sodium are mined in the northern portion of the basin.

d. Flood Damages. Areas subject to flooding downstream of Dover Dam along the Tuscarawas and Muskingum Rivers consist of small farms, rural residences, and several communities. The larger communities downstream include Dover, New Philadelphia, Newcomerstown, Coshocton, Zanesville, McConnelsville, and Marietta.

Since their construction in the 1930's, the 14 original dams in the Muskingum River Basin reservoir system, of which Dover Dam is an integral part, have continued to significantly reduce flood damages in the basin. Based on estimates of flood damages for both the natural condition and as modified by the reservoir system, the 14 original dams have helped prevent an estimated $1.62 Billion in total damages from 1936 through September 30, 1995.

SECTION V – DATA COLLECTION AND COMMUNICATION NETWORKS

5-01 HYDROMETEOROLOGIC STATIONS

a. Facilities. Several stream and precipitation gaging stations, designed for the collection of hydrologic data, are located at strategic sites in and around the Tuscarawas River Basin. Data from these stations are necessary for execution of the water control plan.

(1) Streamflow Collecting and Reporting Facilities. Early stage-detection devices, i.e. staff sections and wire weight gages, are now used as primary references for setting modern measuring and recording instruments. Strip chart recorders provide a graphical record of stream stage and backup for Analog-to-Digital Recorder (ADR) devices. Shaft encoders are now being used to digitally record water levels. The data collection platforms have been installed at basin gages as listed in **Table 5-1**, page T5-2. The platforms store stage and precipitation data and every four hours transmit to the ORD computer downlink via the Geo-stationary Operational and Environmental Satellite. The Water Resources Engineering Branch Water Control System receives data automatically from the ORD water control system on an hourly basis. If necessary, the District can also access the data at other times by operator control.

A new type of data collection platform is now available which has the capability of reporting in response to a telephone query by computer, terminal or human. The query can be initiated at any time from the water control system, project office or the home of a selected individual during off-duty hours. In response to a human caller, the platform will respond with current information such as a stage with a synthesized voice. These DCP’s can also dump several readings to a computer terminal over a period of hours. These DCP’s are being installed at critical locations such as inflow, lake, outflow, and some control point stations.

(2) Precipitation Collecting and Reporting Facilities. Normal equipment is the 8-inch Standard Rain Gage with a metal support. All the above named stations have this standard gage except Massillon and New Philadelphia which use a tipping bucket gage. At ORN weather stations the measuring instrument, the standard 8-inch rain gage, is read and reported manually by telephone landline to the Muskingum Area Office. At the unattended stations, the “tipping bucket” measuring gage is interfaced to a data collection platform. The platform receives the signal electrically and transmits to the computer downlink via the satellite. The location of the hydrologic network stations are shown on the Basin Drainage Map as **Plate 5-1**, and data collection and communication equipment utilized at each are listed in **Table 5-2**, page T5-5.

b. Reporting. The two main data reporting are streamflow and precipitation data reporting. These are discussed as follows:

(1) Streamflow Reporting. Currently, morning reports from the Dover watershed projects, containing stage, precipitation, operational and temperature data, are received in the Reservoir Control Section as computer printouts from the water control system. They are received in the same format in which they are input at the Muskingum Area Office. Stage data are converted to flow and the values are used in the forecasting process. Frequency of reporting, and thus data collection, is dependent on the degree of urgency of weather and/or flooding conditions as specified in **Exhibit B**, Instructions to the Damtender. The frequency ranges from daily (5 days per week) at about 0730 hours under Normal Conditions to hourly under Major Flood Conditions when the lake level approaches or threatens spillway elevation.

(2) Precipitation Reporting. Weather service observers at Chippewa Lake, Marshallville, Louisville, Millport, Carrollton and Cadiz report by telephone to the Muskingum Area Office. The Muskingum Area Office in turn transmits the data to the District Water Control System and also relays the data to the NWS in Cleveland.

Usage of data from these reports and data exchanged with the NWS is as described below:

While primary dependence is on morning report information, the Water Resources Engineering Branch uses Weather Service data, available between 0900 and 0930 hours, in forecasting and computing average precipitation over the basin, area, and district. The data are used to fill in, by implication, for missing data and confirmation or refutation of doubtful readings. Weather Service coverage of areas lacking Corps' projects, when plotted on the District Isohyetal Map, provides a basis for better understanding of storm movement and aerial intensity, which contributes to improved water management decisions. Radar images on the NWS screen at Akron-Canton Airport provide valuable information for regulation and forecasting. The NWS Hydrologist analyzes for position, direction, speed, and estimated precipitation amounts in storms and relays this analysis by telephone on request. Ohio River and tributary stage and forecasts provided by the NWS are used to answer telephone calls from the public and particularly from local barging concerns.

A large portion of the total precipitation information received by NWS personnel comes through the cooperative ORN program. Complete district morning report data accessed from the Water Resources Engineering Branch mini-computer (water control system) are reorganized by NWS personnel into downstream format and inserted into the NWS Eastern data bank. The data are widely used by NWS elements such as those producing infiltration indices and short, medium and long range forecasts, and by the River Forecast Center in Cincinnati which produces Ohio River and tributary stage and flow

forecasts. The Cleveland office utilizes the data early in their mid-morning weather report including any updating of forecast which may be indicated.

Data from the unattended, tipping-bucket precipitation stations are collected and processed in the water control system along with stage data from the platform reported stream gages. The platform-satellite system described earlier in **Sub-section 5-01a** is the primary source of lake and outflow stage data at the Muskingum River Basin projects as well as stage data at the downstream control gages. Secondary sources of data are the morning and other reports from the Muskingum Area Office, which are transmitted over telephone lines directly to the water control system via computer terminals. Backup for these reports is via radio to the communication section operator-typist in the District Office.

Radio is also the primary mode of emergency backup communication between the District Office and the Area Office or projects; standard procedures require radios to be turned on at all times during working hours. During military emergency or national disaster, protected commercial telephone lines with Muskingum River Basin projects or special radio frequencies may be assigned by the Emergency Operations Manager.

c. Maintenance

(1) Streamflow Cooperative Program. The Corps of Engineers participates in the U.S. Geological Survey Federal-State Cooperative Water Resources Program under which the survey installs, rates and maintains the gages at locations desired by the cooperating entity, except at Corps' projects where the lake and outflow gages are originally installed by the Corps. Under this program, the Survey maintains the following stream gaging stations in the Muskingum River Basin pertinent to Dover Dam: Tuscarawas River at Massillon, Leesville Reservoir outflow gage, Dover Reservoir outflow gage, Tuscarawas River at Newcomerstown, Muskingum River at Coshocton, Muskingum River at Dresden, Muskingum River at Zanesville, Muskingum River at McConnelsville, and Ohio River at Marietta.

The Corps of Engineers also maintains several gages in the Muskingum River Basin independent of the stream cooperative program. Those pertinent to Dover Dam include the lake gages at Leesville, Atwood, Bolivar and Dover Reservoirs and the stream gage on the Tuscarawas River at New Philadelphia

The National Weather Service maintains gaging stations at some locations providing data from those via network connections; however, none of these is in the Dover watershed. The Corps of Engineers and the Weather Service cooperatively exchange stage information along with weather information as delineated in **Sub-section 5-01c(2)**.

(2) ORN Program. The Ohio River Reporting Network, a division-wide cooperative program with the National Weather Service, involves interchanges of information between the Weather Service and the Corps of Engineers which utilizes the respective installations and experience of the two agencies. The Weather Service recruits, trains, equips, and pays observers at Corps' requested locations and receives and records data from them. The Weather Service also provides weather and stream gage data, Ohio River and tributary forecasts, regular and requested special forecasts, radar, and other special reports on request. In addition to reimbursing NWS for direct costs incurred on the Corps' behalf, Huntington District provides NWS with all precipitation, snow cover, and stage information received in the Water Resources Engineering Branch from reservoir and other reports, three-day pool and outflow forecasts, and depth reports from the Corps of Engineers' Snow Cover Reconnaissance.

Precipitation station in and near the Dover Dam watershed are Chippewa Lake, Marshallville, Louisville, Massillon, Bolivar Dam, Beach City Lake, Millport, Carrollton, Dover Dam, New Philadelphia, Atwood Lake, Leesville Lake, Tappan Lake, and Cadiz.

5-02 WATER QUALITY STATIONS

There is no program design for water quality sampling, as it relates to daily management, at Dover Dam. The outlet works were not designed with water quality as one of its purposes.

a. Facilities. There is one water quality station established at Dover Dam and it is located on the Tuscarawas River about 400 feet below the dam.

b. Reporting. Water quality data collected at Dover Dam is collected on an as-needed basis and may be used to meet such objectives as:

(1) Establish baseline conditions and monitor subsequent changes;

(2) Identify water quality environmental problems;

(3) Study special problems or identify trends;

(4) Provide a database adequate for understanding project conditions and for coordination with state agencies in regard to implementing any needed watershed pollution control.

There is no definite data collection program for Dover Dam. Data collected are used for applications such as identification of trends indicating problem conditions and reporting existing conditions. Basic studies consist of 5 essential components:

(1) In-situ measurements to evaluate distribution of various properties.

(2) Wet chemistry and various types of solids for both immediate and long-term use.

(3) Indirect but rapidly obtainable indicators of productivity such as chlorophyll and carbon.

(4) Benthic organisms to monitor long-term quality of inflows and outflow.

(5) Other biological measurements such as plankton and seston.

Standard physical/ chemical tests and reasons for testing are presented in **Table 5-3**.

Table 5-3

Standard Physical / Chemical Tests

Type of Test	Test No.	Reasons for Testing
Calcium (Ca)	00916	Major Cations – Ionic Balance, Ratios and Relationships
Magnesium (Mg)	00927	
Sodium (Na)	00929	
Potassium (K)	00937	
SO_4	00945	Major Anions (Reasonably Expected) Ionic Balance, Ratios, and Relationships
CI	00940	
Nitrogen (N)		Nutrient Effects
Nitrate & Nitrite	00630	
Ammonia	00610	
Total Kjeldahl	00625	
Phosphorus		
Total	00625	
Filterable	00666	
Solids		Evaluate Buffer Capacity and Characterize
Total	00500	
Suspended	00530	
Dissolved	00515	
Hardness	00900	Evaluate Buffer Capacity and Characterize
Alkalinity	00410	
Iron		Important for Hypolimnetic and Outflow Evaluations During Stratification Periods
Total	01045	
Filterable	01046	
Manganese		
Total	01055	
Filterable	01056	

c. Maintenance. Operation and maintainance of the one water quality monitoring station is performed by the corps of engineers personel at Dover Dam. Parameters measured, frequency of collection, and numbers of data-collection-stations are determined by specific project conditions. Water quality data may be collected for one or more of the following reasons:

(1) Long term analysis

(2) Problem identification or solution

(3) Cause and effect relationships

(4) Mathematical modeling

(5) Predictive capability

5-03 SEDIMENT STATIONS

Sedimentation surveys were made at several representative Muskingum Basin reservoirs in 1945 and 1946 to establish indices of anticipated sedimentation rates in all the existing and future flood control reservoirs in the basin. The reservoirs selected for these surveys were Pleasant Hill, Senecaville, Charles Mill, and Tappan. These surveys showed the rate of storage depletion at these reservoirs to be insignificant at that time. Subsequent sedimentation surveys at these and other projects in the Muskingum River Basin indicate that, in general, the rate of sedimentation in the lakes is not excessive and is not detrimental to the operation of the projects for authorized purposes. No sedimentation data are available specifically for the Dover Dam project, but since no seasonal pool is maintained at Dover Dam and since excessive sedimentation has not been experienced at either Atwood Lake or Leesville Lake, sedimentation behind Dover Dam is also not likely to be excessive.

5-04 RECORDING HYDROLOGIC DATA

Data collection and communication within the Corps of Engineers have been accomplished largely by manual methods in the past. For example, precipitation data from the reservoir projects or the National Weather Service (NWS) have been reported by telephone, or stream gage readings have been obtained from telemarks via telephone lines and daily reports verbally submitted over the district radio network. During the last few years, however, several changes in data collection and communication have been made. The current hydrologic network system is illustrated in **Plate 5–1**.

Recently, the Water Resources Engineering Branch acquired a minicomputer to be used as a District Water Control System. Since that time, numerous changes in data collection have been effected with anticipated future improvements to take place as to data collection, analysis, and use.

All daily reservoir reports are now received through the water control system. Each Muskingum Basin project reports directly to the Muskingum Area Office at New Philadelphia, Ohio, via radio. The project report is then entered into the terminal offline and transmitted directly over telephone lines to the computer. The district radio network is used as backup, when needed.

Data from the NWS are now received by the water control system via network connection. Reservoir project data are also disseminated back to the NWS from the water control system.

In addition, data collection platforms (DCP's) have been installed throughout the district at various stream gaging and precipitation stations. Installations at various stations in the Muskingum River Basin are described in **Tables 5-1** (page T5-1) and **5-2** (page T5-4). The platforms transmit hydrometeorological data via the Geostationary Operational Environmental Satellite (GOES) to various receiving sites. The data are then obtained directly by the district water control system for processing. Some stream gaging stations are equipped with voice data collection platforms, which are capable of answering a telephone call and responding with the currently updated information by synthesized voice.

All data entered into the water control system are stored in a database and used by water control software programs, allowing more timely and efficient water management decisions and generation of required reports.

5-05 COMMUNICATION NETWORK

Communications between Dover Dam, the Muskingum Area Office, the District Office, etc., is carried out primarily by telephone. District radio network provides a backup when telephone service is interrupted. Data collection platforms (DCP's) are installed at stream gaging stations and precipitation stations for collection of hydrometeorological data. The DCP's can be accessed by phone and data retrieved by computer terminal at the area office or by synthesized voice. **Plate 5-2** graphically illustrates the communication network throughout the Muskingum River Basin.

5-06 COMMUNICATION WITH PROJECT

a. Regulating Office with Project Office. Telephone is the primary mode for most communication between the Water Resources Engineering Branch and the multipurpose projects and area offices and between projects and respective area offices. Lines of communication for the Tuscarawas-Muskingum River Basin are illustrated in **Plate 5-3**. District radio is used for secondary backup communication while mobile radio, State Police, courier, etc. are utilized during an emergency when neither the telephone nor district radio is operational. Inter project communication is mostly by radio with some telephone use for privacy. Water Control Section personnel use the telephone to request and receive

additional operations information and weather information and to give operational guidance and directives. The U.S. Postal Service is utilized for letter reports, other voluminous or detailed information, pictorial material, confirmation of Special Directives, and any other formal communication between the Water Control Section and the projects. Occasional visits to the projects afford an opportunity for office and project personnel to discuss ideas, problems, new procedures, etc.

b. Between Project Office and Others.

(1) District Staff. Major flood conditions may require daily or more frequent briefings for key staff members. During floods or other disasters when the Emergency Operations Center is in operation, Water Control Section personnel distribute copies of all reports received for critical and adjoining areas to the Center, District Engineer, Chief Engineer, and Executive Officer. Storm analysis and critical situations and operational information are provided to pertinent key staff as determined to be informational or necessary. The Public Affairs Office is kept advised to ensure proper public notification.

(2) Emergency Management Division. The Water Resources Engineering Branch has no regular communication with Emergency Management Division (EMD) except as mentioned above when the Emergency Operations Center is in operation. When storms occur in the district or high precipitation is shown on NWS Quantitative Precipitation Forecast, the Water Resources Engineering Branch telephones EMD to pass on the information. Frequently EMD personnel will visit the Water Resources Engineering Branch in person for further briefing. When EMD personnel learn of storms in or heading for the district, they visit the Water Control Section for evaluation and determination of impact. During these meetings, participants view Quantitative Precipitation Forecasts, other NWS forecasts and current information, District Isohyetal (precipitation) Maps, morning reports, etc.

(3) Great Lakes and Ohio River Division Water Management Branch. Telephone land lines and the U.S. Postal Service carry all normal communications between the Water Resources Engineering Branch and the Reservoir Control Center (RCC). Radio is used as backup in emergency situations. Telephone conversation communicates most items of short information and discussion while voluminous reports, confirmations, plans, blueprints and other pictorial material are sent by mail. A weekly report of reservoir holdouts, flood data and the Monthly Report are included in the “report” material mentioned above. When desired, pictorial, handwritten, electronic or printed material can be transmitted in a matter of minutes over land lines by facsimile machine or email. Personnel of the District Reservoir Control Section insert stage and flow information on weekdays into a computer file for accessing by RCC personnel. The first group of information so transferred is from ORH Form 2347A and consists of

pool elevations from the reservoir morning reports and discharge in cfs for all the district reservoirs. The second group of information, from LRD Form 85, consists of morning stage, 24-hour rainfall, and flow at District gages on the Ohio River and lowermost gages on main tributaries, and forecast flows in the tributaries for the next five days. The third and last item thus transmitted, ORH Form 2347B, is a 3-day forecast of pool elevations and discharges for the reservoirs. All other communication with RCC, other than mail correspondence, is by telephone. The Water Resources Engineering Branch briefs RCC personnel who call three times weekly, normally Monday, Wednesday, and Friday, for update on any and all special operations in the District. A Report of Deviation, revised Form 1018-R, may be requested by RCC on the occasion of special purpose operation at Dover Dam outside the approved plan of regulation. A copy of Form 1018-R is included as **Plate 5-4**.

(4) Operations Division Area Office. Administration of the Dover Dam project is placed under the Muskingum Area Office at Dover, Ohio. Normal communication between Water Control Section and the Area Office is by telephone, mail transfer of disposition forms, reports, maps, drawings and other pictorial material, and occasional visits by Branch personnel. Emergency communication is by radio.

(5) National Weather Service. Communication with National Weather Service (NWS) begins with cooperative arrangements for the ORN program discussed earlier in **Sub-section 5-01c(2)**. Under the program, observers were recruited at Chippewa Lake, Cadiz, Carrollton, Louisville, Marshallville, and Millport, which are in or near the Dover Dam-Tuscarawas River Basin. They telephone precipitation amounts to the Muskingum Area Office, which are included in the morning report to the District Water Control System and to the NWS in the Cleveland, Ohio.

The Division Office currently has a direct link with the NWS Automated Field Operating System (AFOS) and disseminates data from AFOS to the District Water Control System at least once an hour. Information formerly received from the NWS Weather Wire is also now received via the AFOS link in the Division Office.

(6) U.S. Geological Survey. Communication between the Water Resources Engineering Branch and U.S. Geological Survey (USGS) is varied and affected by the meshing of interests of the two entities. A large portion of he communication surrounds the stream cooperative program discussed in **Sub-section 5-01c(1)** and involves telephone discussions and mailed information on gage location, ratings, and rating extensions. Telephone requests are made by the Water Control Section for the USGS to repair a gage critical to regulation of reservoir in flood condition. Occasional meetings between USGS personnel and Water Resources Engineering Branch personnel are held as needed at convenient times and locations to discuss the program.

The USGS keeps flow records for the continental United States and at times, conducts studies of sediment carried by streams. These flow records and study results are available electronically to the Water Control System by accessing the USGS data bank or by mail in answer to spoken or written requests. The USGS compiles drainage areas and lengths of streams in a basin and binds them into paperback volumes.

(7) State and Local Agencies. The Water Control Section coordinates with the Ohio Department of Natural Resources about recreation and fish and wildlife enhancement in the Ohio Lakes and downstream areas, timing of spring filling and fall drawdown, probable height of a rise and, during an emergency, with the Department's representative in the Ohio Office of Emergency Services.

The Muskingum Watershed Conservancy District manages the recreational facilities at the projects having conservation pools. The Water Resources Engineering Branch coordinates with the Conservancy District concerning changes in the conservation pool levels.

(8) General Public and Commercial Interests. Water level warnings at Dover Reservoir are communicated by project personnel. This is discussed in **Section 5-08**.

5-07 PROJECT REPORTING INSTRUCTIONS

Weekly reports that provide gage readings for the lake and outflow are mailed to the District Office marked with ATTN: Water Control Section. Regular daily reports include the following information: precipitation, water levels at intake and outflow gages, gate positions, depth of snow cover, if any, beginning and ending times of precipitation with current weather, and water content of snow if previously requested. This information is provided to the Muskingum Area Office by fax or e-mail. The area office then assembles data from all projects and fax to the Water Control Section. After the daily information, the Water Control Section may request for extra reports. Extra reports may also be sent by fax or email to the Area Office. If some circumstance prohibits, such as the malfunction of electric power, attempts should be made via telephone.

Special report is also provided when an event occurs concerning the project that the Area Office and Water Control Section should have knowledge of or when a request is made by either of the two. Some examples of occasions or subjects for special reports are: (1) Extraordinary meteorological event such as tornado, blizzard, or heavy precipitation after 0730 hours (2) Gate positions and / or operations (3) flooding upstream or downstream (4) request for special operation originating from other than the Water Control Section (5) Catastrophe such as drowning (6) Air temperature if unusual and significant (7) Local weather forecast if unusual and significant. Special reports should be made at any time of day or night, including weekends and holidays or when request by the Water

Control Section. During office hours, special reports should be submitted by telephone. If this is impossible the District fax or e-mail should be utilized or any other appropriate means.

5-08 WARNINGS

Important public service messages of early significance concerning regulation of the lake are handled by the Public Affairs Office and disseminated via radio and / or television. Water level warnings at Dover Reservoir, **Table 5-4**, lists the communication by project personnel concerning high water situations. Warnings of unusual releases will be transmitted by project personnel in person or by telephone.

Table 5-4

High Water Notification

Project	Project Warned	Manner of Issuance	Criterion	Action Taken	Telephone Number
Dover Dam	None	Spoken In Person	When pool elevation nears 884.0 feet	Project personnel close gate at Zoar Levee and begin pumping operation.	
Dover Dam	None	Spoken In Person	When pool elevation nears 894.0 feet	Project personnel close 3 gates at Somerdale Levee and begin pumping operation.	
Dover Dam	Personnel at Norton Chemical Plant in Mineral City	Telephone	When pool elevation nears 903.0 feet	Project personnel install stop logs at railroad entrance at chemical plant drainage flap and insure that valve in levee is closed. Plant personnel monitor water accumulation in diversion ditch behind levee and are responsible for pumping out.	[redacted]
Dover Dam	Personnel at Corundite Refractories Plant in Zoar	Telephone	When pool elevation nears 905.0 feet	Project personnel insure that drainage flap valve in levee is closed. Plant personnel monitor water accumulation in diversion ditch behind levee and are pumping out.	[redacted]
Dover Dam	Personnel at Fairfield Brick Plant in Zoarville	Telephone	When pool elevation nears 908.0 feet	Project personnel insure that drainage flap valve in levee is closed. Plant personnel monitor water accumulation in diversion ditch behind levee and are responsible for pumping out.	[redacted]

SECTION VI – HYDROLOGIC FORECASTS

6-01 GENERAL

Hydrologic forecasts of lake elevations and streams flows in Tuscarawas River Basin are vitally important for Water Control Management as these forecast provide information which enable the optimal regulation of the projects. These forecast are conducted under low-flow, normal flow and flood flow conditions and are primarily developed by the Corps of Engineers and the National Weather Service on a daily basis.

a. Role of Corps.

(1) District Office. In accordance with ORDR 1110-2-27 dated 12 January 1976, Subject: Water Control Management Activities, the Water Control Section performs water control management activities for multi-purpose projects throughout the Huntington District. These activities include the preparation of forecasts for lake inflows, lake levels, project outflows, water quality and outflow temperature, and flows at downstream stations to ensure the safe and efficient operation of the district projects. River forecasts prepared by the Corps of Engineers are generally used for its own responsibilities and are not normally issued to the general public unless the National Weather Service is willing to make the release or agrees to such a release.

(2) Division Office. The Water Management Division at the Great Lakes and Ohio River Division Office utilizes the 5-day tributary forecasts prepared by the individual districts to derive its own 5-day flow forecasts for stations along the Ohio River.

b. Role of Other Agencies. The National Weather Service (NWS) has the official statutory responsibility for preparing forecasts of Ohio River stages and flows; and for transmitting data, forecasts, watches and warnings to users and the general public. NWS also collects and evaluates weather data from a variety of sources to prepare short and long-term weather forecasts.

6-02 FLOOD CONDITION FORECASTS

a. Requirements. Whenever “flood threat” conditions approach, as defined by the Schedule for Reading Gages, forecasting effort primarily focuses on area rainfall, downstream flood control points, and the lake elevation. The forecast is computed using one hour data and it normally takes one hour to complete the forecast of the Tuscarawas River Basin. The model is executed repeatedly during the flood event as additional data becomes available. The forecast data is used to predict the anticipated pool crest, downstream flood crests, necessary storage releases, and probable duration of flood period. The reservoir storage data used in the forecast model program is summarized in **Table 6-1**, next page. The control stages

and flows for the key stations at Tuscarawas, Muskingum and Ohio River are summarized in **Table 6-2** below. **Plate 6-1** shows the forecast area and reaches for Dover Lake. The drainage areas and stream discharges for the Tuscarawas River and its tributaries within the influence of Dover Dam are listed in **Table 6-3**, page 6-4. The basin configuration for the Dover Lake forecast area is shown on **Plate 6.2**.

TABLE 6-1

Dover Dam Lake Elevations and Storages

Pool	Surface Elevation NGVD	Area Acres	Backwater Stream Miles	Storage	
				Acre-feet	Inches Runoff
Year-Round Storage:					
Minimum	---	---	---	---	---
Flood Control Storage	916	10,100	23.2	203,000	4.9

Table 6-2

Control Stages And Flows At Key Stations

Station	River	Crop Season[1]		Non - Crop Season[2]		Cum. Travel Time, Dam to Station (hrs)
		Stage (feet)	Flow (cfs)	Stage (feet)	Flow (cfs)	
Dover outflow gage	Tuscarawas	6.5	4,832	7.5	6,026	--
New Philadelphia	Tuscarawas	6.5[3]	8,590	7.0	9,550	4
Newcomerstown	Tuscarawas	9.5	13,200	11.0	16,250	20
Coshocton	Muskingum	15.5	21,810	18.0	30,660	30
Dresden	Muskingum	16.0	23,420	18.5	32,000	41
Zanesville	Muskingum	19.5	38,200	21.5	48,000	45
McConnelsville	Muskingum	10.0	35,600	11.0	41,600	51
Marietta	Ohio	35.0	260,000	35.0	260,000	72[4]

1 16 April through 30 November
2 1 December through 15 April
3 Damage begins at 6.0 feet
4 Operational time prior to crest stage in excess of 35 feet

b. Methods. In order to achieve the most efficient water control management possible, a real-time computer model, developed by the Hydrologic Engineering Center (HEC), Davis, California, was adapted and calibrated for use in management of the Tuscarawas River Basin. The model uses real time data from the Corps of Engineer's satellite-platform network in and adjacent to the basin, in conjunction with the tables used to interpret this data. The modeling process includes reviewing and editing of all data, estimation of future flows, development and review of multiple lake outflow plans, and determining the optimal method of operation to decrease downstream flooding while still insuring the project viability.

A typical modeling sequence of events leading to water control management decisions is described as follows:

1. Satellite data, both stage and precipitation, are received from the LRD downlink, decoded and added to the resident database. This is done automatically each hour.

2. Observed precipitation and stage data are reviewed graphically to insure integrity. Any necessary corrections are made and any missing data are added when available from supplementary sources.

3. The precipitation-runoff model is executed based on observed data forecast. If precipitation is occurring at the time of forecast then future precipitation is considered in the model execution at the request of division.

4. The small basin hydrograph forecast are then reviewed and modified if necessary. The second part of the model is then executed to route, blend and combine flows. The flows are reviewed, the lake outflows modified if necessary, and the second part of the model is recomputed.

5. Step 3 is repeated to obtain subsequent forecasts that consider any additional precipitation (QPF), special regulation or other hypothetical analyses that may be required.

The real time modeling program makes extensive use of small-area unit hydrographs, infiltration rates, discharge rating tables, routing coefficients, and graphical review of flood hydrographs and profiles. The computer program assimilates the total precipitation over a 3-day time period and analyzes the storm in detail. By using predetermined basin rainfall infiltration rates and runoff percentages the program computes the antecedent rainfall, base flow, and storm runoff. By applying the computed storm runoff to the appropriate unit-hydrographs a computed hydrograph is developed. The computer then uses routing coefficients with routing and combining methods to rout the flood downstream and through Dover Lake. With this computer program and practical experience the Water Control Section is able to produce a reliable forecast for the

Tuscarawas River Basin. **Table 6-3** below, is an example of the various small areas above and below Dover Dam which small-area unit hydrographs are developed.

TABLE 6-3

Drainage Areas and Stream Flows – Tuscarawas River and Tributaries

Location	Miles Above Mouth	Area (sq.mi.)	Period of Record	Max. Stage (ft.)	Discharge (cfs)		
					Max.	Min.	Mean
Tuscrawas River at Clinton	101.1	174	1926-1978	17.00	2,700	10	148
Tuscarawas River at Massillon	86.0	518	1937-1983	16.43	10,700	57	441
Sandy Creek at Waynesburg	87.0	253	1938-1983	10.05	15,000	6.9	270
Nimishillen Creek at North Industry	85.5	175	1921-1983	11.29	8,600	3.6	184
McGuire Creek below Leesville	84.5	48.3	1938-1983	7.88	740	0	54
Indian Fork below Atwood Dam	76.5	70.0	1938-1975	19.00	1,610	0.1	72
Tuscarawas River below Dover Dam	60.3	1,405	1923-1983	15.51	26,400	6.5	1,430
Tuscarawas River at Newcomerstown	21.3	2,443	1921-1983	20.65	46,800	170	2,541

Stream and lake forecasting is accomplished with data stored and processed through the Ohio River Reporting Network. This network is a division-wide cooperative program with the National Weather Service, which involves interchanges of information between the Weather Service and the Corps of Engineers that utilize the respective installations and experience of the two agencies. All weather stations in the Tuscrawas River Basin are automated DCP stations. The Weather Service also provides weather and stream stage data, Ohio River and tributary forecasts, radar and other special reports on request. In addition to reimbursing NWS for direct costs on Corps behalf, the Huntington District provides NWS with all precipitation, snow cover, and stage information received in the Water Resources Engineering Branch from reservoir reports. Also included are three day pool and outflow forecasts, and depth reports from the Tuscarawas River Basin project areas. The extent and intensity of the ORN program is shown by the fact that in addition to the project morning report data, all data received by NWS in the Tuscarawas River Basin are from Corps financed satellite stations.

The data collection platforms mentioned above store stage and precipitation data and, every four hours, transmit to the LRD computer downlink via the GOES satellite. The Water Resources Engineering Branch Water Control System receives data automatically from the LRD water control system on an hourly basis. All the data entered into the Water Control System is stored in a database and

used by water control software programs, allowing more timely and efficient water management decisions and generation of required reports.

While primary dependence is on morning report information, Water Control Section personnel use Weather Service data, available between 0900 and 0930 hours, in forecasting and computing average precipitation over the basin, area, and District. The data is used to fill in, by implication, for missing data and for confirmation or refutation of doubtful readings. Weather Service coverage of areas lacking Corps projects, when plotted on the District Isohyetal Map, provides basis for better understanding of storm movement and areal intensity, which contributes to improved water management decisions. Radar images on the NWS screen at Charleston and Wilmington provide valuable information for regulation and forecasting. The NWS Hydrologist analyzes for position, direction, speed and estimated precipitation amounts in storms and relays this analysis by telephone on request. Ohio River and tributary stage and forecasts provided by the NWS are used to answer telephone calls from the public and particularly from local barging concerns. Data from NWS is received by the water control system via network connection. Project data is also disseminated back to NWS by the water control system.

6-03 CONSERVATION PURPOSE FORECASTS

a. Requirements. Dover Dam has no Conservation forecast requirement. As mentioned previously the dam is operated as a 'DRY' dam; all storage is used for flood control only. The normal run of the Tuscarawas River is passed on each day, therefore no additional storage is available for downstream drought requests. At the present time, operations for water temperature and quality are based on observations rather than forecast.

b. Methods. The daily outflow data from the Dam is interfaced with data from the Tuscarawas River basin reservoirs to produce a Muskingum River basin drought forecast. This passing of all normal inflow also provides downstream fish and wildlife habitat, recreation, and water supply.

6-04 LONG-RANGE FORECASTS

a. Requirements. Long range forecasts assist the Huntington District and the Great Lakes and Ohio River Division in water control management in the Tuscarawas River Basin. As mentioned previously Dover Dam is operated as a 'DRY' dam; all storage is used for flood control only. The normal run of the Dover River is passed on each day, therefore no additional storage is available for long-range downstream requests. The daily outflow data of Dover Dam is interfaced with data from the other Tuscarawas River basin reservoirs to produce a long range Muskingum River basin forecast. Long-range forecasts are required by the Division Headquarters Water

Management Branch (WMB) as they utilize it to inform the Mississippi Valley Division (MVD) of probable future conditions and to suggest specific items of water control management to the districts.

b. Methods. The Water Control Section produces a weekly 30-day forecast utilizing the same method as used for flood forecast. This forecast assumes no future rain. Lower than normal precipitation forecasts are produced by the National Weather Service.

6-05 DROUGHT FORECAST

a. Requirements. The Huntington District now uses the drought forecast of the National Weather Service. The Corps summer drought forecast was discontinued in lieu of the regular NWS forecast.

b. Methods. The long range and conservation forecast address all forecasting concerns that would be raised by a drought. No extra forecast activities are planned for this time.

c. Reference Documents. Many of the basic documents for drought forecast are in Water Resources Engineering Branch files for the Huntington District, Huntington, WV. These files contain records prepared by the Ohio Department of Natural Resources and the Ohio USGS for past drought periods, Water Availability Studies for the Tuscarawas River basin, and the Ohio River Basin Comprehensive Study, prepared by the Great Lakes and Ohio River Division, Cincinnati, Ohio. The national and state weekly drought forecasts are included with the Palmer Index summaries for the current and preceding drought periods. During a drought period the low-flow records and reference books are used to prepare weekly drought information bulletin for distribution to all concerned groups.

SECTION VII – WATER CONTROL PLAN

LEESVILLE LAKE

7-01. GENERAL OBJECTIVES

The plan of water control management and regulation reflects the optimal consideration of the project purpose, flood control, stated in Section 2-02. In developing the plan of regulation, the following general requirements were considered and evaluated in relation to the overall effective water control plan for the project, the Tuscarawas River Basin, the Muskingum River Basin and the Ohio River Basin:

1. Prevention or reduction of serious flood damages to the communities, crops and properties below the dam along the Tuscarawas River to the greatest extent consistent with safe operation of the project.

2. Maximum retention of flows which would add to flood crests on the Ohio River at Marietta, Ohio.

3. Establishment of maximum allowable discharge to avoid downstream damage during flood releases.

4. During minor rises, when releases are less than downstream channel capacity, limitation of release rates to less than the maximum flow that would have occurred if the project had not been constructed.

5. Sensitivity to reasonable requests for operational changes from the public or other agencies.

6. Concern for safety and well-being of humans, fish and wildlife, manmade structures and streambanks downstream of dam, which can be affected by discharge control.

7. Limitation of the rate of change of stage at the outflow station to a value no greater than that which would occur naturally.

8. Concern for the safety and well-being of humans, man-made structures, and stream banks downstream of the dam.

9. Concern for safety of humans and property at damsite and lake area when storing flood waters.

7-02 CONSTRAINTS

Constraints to regulation that are of special concern are those affecting fulfillment of the project purpose of flood control. Exercise of the flood control function can be inhibited by restrictions on storage of the design volume of water such as construction in the lake area and/or by inability to discharge

storage as quickly as planned, because of flood-plain encroachment. Compliance with a requested deviation as outlined in **Section 7-15** may become a constraint to regulation if some assumed factor, such as weather, developed differently from the way assumed.

Operational limitations for flood control are listed **Table 7-1**.

Table 7-1

Operational Limitations for Flood Control

	Pool Elevation Feet NGVD	Capacity Acre-feet - Gross
Streambed	860.0	Zero
Minimum pool	---	---
Maximum Flood Control Pool	916.0	203,000
Top of Dam	931.0	

Gate Change Maximum Rate – 1.0 feet per hour on Outflow gage.

Spillway Crest - 916.0 feet NGVD

Design Discharge - 123,000 cfs

7-03 OVERALL PLAN FOR WATER CONTROL

Dover Dam is regulated for the purposes of flood control only. All other activities are accommodated to the extent feasible. At the maximum flood control pool (elevation 916), Dover reservoir has a surface area of 10,100 acres and a capacity of 203,000 acre-feet or 4.9 inches in equivalent runoff. Regulation of this storage capacity provides flood protection along the Tuscarawas River and aids in providing flood protection along the Muskingum and Ohio Rivers.

The overall plan for water control, as it relates to Dover, is discussed in **Section 7-05**.

7-04 STANDING INSTRUCTIONS TO DAMTENDER

The Damtender and staff at Dover Dam operate the project in accordance with general instructions found in **Exhibit B** of this manual and Special Directives issued by the Water Control Section.

a. Regulations. The above-mentioned general instructions and Special Directives are written in accordance with the following regulations:

(1) EM 1110-2-3600, 25 May 1959, Subject: Reservoir Regulation.

(2) ER 1110-2-1400, DAEN-CWE-Y, 24 April 1970, Subject: Reservoir Control Centers.

(3) ER 1110-2-240, DAEN-CWE-Y, 8 October 1982, Subject: Reservoir Control Centers

(4) ORDR 1110-2-27, 12 January 1976, Subject: Water Control Management Activities.

(5) ER 1130-2-415, DAEN-CWE-Y, 28 October 1976, Subject: Water Quality Data Collection, Interpretation and Application Activities.

(6) ORDR 1110-2-26, 5 February 1979, ORDED-W, Subject: Water Quality Investigations and Control Activities.

(7) ER 1110-2-208, DAEN-CWE-Y, 30 July 1979, Subject: Water Control Management.

b. General Instructions. The general instructions apply at all times except when instructed by Special Directives which will be applicable for a specific operation or period of time. General instructions provide for routine reservoir regulation including the discharge limit at project initiative, details of gate operation technique, collection and transmission of hydrologic and streamflow data, reservoir regulation at the start of a flood before contact can be made with the District Office, and emergency regulation in the event all communications fail during a flood. These instructions are contained in **Exhibit B**, "Instructions to the Damtender". These instructions also establish text along with exhibits and schedules pertaining to use.

c. Special Directives. Special Directives are issued by telephone and confirmed by mail to record all substantive guidance given the project by Water Control Section pertaining to water control activities not covered by the general instructions. The following list of subjects or purposes of Special Directives is representative of types issued.

(1) Flood Control

(a) Outflow reduction for Muskingum Basin streams or Ohio River control.

(b) Release flood storage and adjustments in rate of release.

(c) Above channel capacity discharge when inflow hydrograph is greater than available storage capacity.

(2) Special Regulation for:

(a) Construction activities downstream affected by flow.

(b) Stream clean-up activities.

(c) Emergency – Drowning or pollutant spill.

(d) Stocking tailwaters – stable flow 24-48 hours.

(e) Complete closure for inspection on emergency or periodic basis.

(3) Change in general instructions.

(4) Any and all other pertinent operations as deemed necessary by Water Control Section.

7-05 FLOOD CONTROL

a. Requirements. The Muskingum River reservoir system, which includes Dover Dam, was designed to most economically meet needs for flood protection in the Muskingum and Ohio River Basins. With regards to flood control, the role of the Corps of Engineers is to decrease the peak flood stages, if possible below control or damage stage at gaged locations downstream of Dover Dam. These control stages are shown in **Table 7-2**. They were determined through channel capacity investigation which utilized topographic maps, aerial photos, and field inspections during high flow conditions. **Table 7-3**, next page, shows Dover impact elevations.

Table 7-2

Control Stages And Flows At Key Stations

Station	River	Crop Season[1]		Non - Crop Season[2]		Cum. Travel Time, Dam to Station (hrs)
		Stage (feet)	Flow (cfs)	Stage (feet)	Flow (cfs)	
Dover outflow gage	Tuscarawas	6.5	4,864	7.5	6,077	--
New Philadelphia	Tuscarawas	6.5[3]	7,563	7.0	8,379	4
Newcomerstown	Tuscarawas	9.5	13,580	11.0	16,690	20
Coshocton	Muskingum	15.5	23,800	18.0	33,310	30
Dresden	Muskingum	16.0	23,420	18.5	32,000	41
Zanesville	Muskingum	19.5	38,200	21.5	47,231	45
McConnelsville	Muskingum	10.0	35,100	11.0	41,290	51
Marietta	Ohio	35.0	260,000	35.0	260,000	72[4]

1 16 April through 30 November
2 1 December through 15 April
3 Damage begins at 6.0 feet
4 Operational time prior to crest stage in excess of 35 feet

Table 7-3 Dover Impact Elevations	
Elevation	**Impact**
881.3	Elevation of gate sill and hand gates at Zoar Levee
Above 895.5	Tuscarawas Co. Rd. 103, the access road to Bolivar Dam from Route 212, flooded
Above 897.6	Route 212, from Route 800 to the Zoar low spot flooded
Above 901.8	Route 800 at Ehlers Store, 0.5 miles northeast of RR underpass, flooded
Above 903.8	Water on new bridge at Zoar on Tuscarawas Co. Rd. 82
Above 908.0	Water on I-77 at the Wheeling and Lake Erie underpass
Above 912.0	Water on the bridge on I-77 at the county line Route 212 and railroad underpass flooded

b. Normal Plan. Dover Dam's plan of operation is to gather streamflow, precipitation and lake data from the data collection platform satellite network and the Dover Dam morning reports. It is one of 16 reservoirs in the Muskingum River Basin and regulation procedures are therefore very closely coordinated with the other basin projects, particularly those located upstream in the Dover watershed. Coordination of regulation is toward maintenance of a rough equivalence of degree of utilization of flood control storage capacity between the projects to maximize the ability of the reservoir system to meet potential flood threats in the Muskingum River Basin and along the Ohio River. Using the above data, Water Control Section personnel analyze current rainfall, soil and foliage conditions, and input them and the gaged streamflow and precipitation into the water control system. Lake and stage forecasts for downstream control gages listed in **Table 7-2** are then prepared using computer driven hydrologic models. These forecasts are supplemented by forecasts issued from NWS River Forecast Center in Wilmington, Ohio. These forecasts are used by Water Control Section to determine lake operation. At this time special directives are issued if necessary.

The reservoirs are operated so that the capacities up to flood stages of the downstream channels may be utilized as far as possible during periods of storm runoff and until the flood waters stored in the reservoirs have been emptied. In general, storage commences when the limits of channel capacity at any of the damage points below the dam sites are attained, and continuous until the stages at all control points fall below the danger point, taking into consideration the time of water travel.

Operation of Dover Dam is based on the following rules:

(1) All inflow is to be released up to that causing a stage at the outflow gage not to exceed 6.5 feet (4864 cfs) in the summer and 7.5 feet (6077 cfs) in the winter as listed in **Table 7-2**, page 7-4, except when critical flood conditions prevail or are predicted at downstream control points, or when Water Control Section has directed special operations.

(2) All inflow will be stored which would contribute to stages in excess of the designated control stages at key downstream stations as listed in **Table 7-2** unless the rate of rise in the pool level exceeds the values listed in **Table 7-4** or when spillway elevation 916 feet NGVD has been reached.

Table 7-4

Dover Reservoir – Limiting Rates of Rise

Range in Pool Elevation (feet NGVD)	Limiting Rate of Rise (ft./hr.)
905.0 – 906.5	0.25
906.5 – 908.5	0.20
908.5 – 910.5	0.15
910.5 - 912.5	0.10
912.5 – 915.0	0.05
915.0 – 916.0	0.02

(3) All inflow will be stored from 72 hours in advance of the predicted time of reaching a forecast crest stage in excess of 35 feet on the Ohio River at Marietta gage. When the stage at Marietta has crested and fallen one foot and continued recession is indicated, the outflow from Dover Dam will be gradually increased to channel capacity as permitted by conditions downstream from the dam.

(4) If the river stage at Marietta is not indicative of flooding conditions further downstream along the Ohio River, guidance from LRD Reservoir Control Center may suggest the storage of inflow in order to provide some benefit to these downstream areas. In such special cases, the Water Control Section will make a complete assessment of all current and anticipated hydrologic conditions in the Muskingum River Basin to devise an operational scheme which will benefit the downstream Ohio River areas and not prove detrimental to Muskingum River flood control objectives.

(5) The Water Control Section determines the release of accumulated flood storage following a complete evaluation of all hydrologic conditions which impact effective management of the project for optimal flood control benefits. The Branch will

evaluate each individual flood event, including consideration of percentage utilization of storage between the Muskingum Basin reservoirs and issue Special Directives for release of stored waters.

(6) The water control plan for major floods provides for increases in reservoir outflow when there are indications that available storage will be insufficient to completely control the flood. Any surcharge storage at Dover Dam would result in flood damage to property in the reservoir area, since the taking line for the acquisition of lands within the Dover Reservoir is at spillway crest elevation 916.0. In the event of surcharge storage, the damage to un-acquired property within the reservoir area above the spillway elevation would likely be greater than could be compensated for by the reductions in flood damages along the Tuscarawas, Muskingum, and Ohio Rivers. Since the storage capacity of Dover Reservoir is limited to 4.9 inches, it is proposed to operate the reservoir to prevent the pool from exceeding the spillway elevation of 916.0.

After the inflow hydrograph has been computed, the necessary outflow will be determined in order to use all the available storage. If the required discharge is equal to or greater than the downstream channel capacity, it is imperative that the outflow be increased, if physically possible, to the required value as soon as possible in order to avoid the necessity for releasing even greater flows at a later time. If the required outflow is considerably less than channel capacity, it may be desirable to reservoir releases to prevent sychronization of the outflow with peak delay flows from uncontrolled areas below the dam. Under the above circumstances, regulation of the reservoir will be governed by an analysis of current and forecast rainfall above the reservoir, and forecast conditions at downstream key control stations. Full consideration will be given to the effect of increased discharge from the reservoir, which would result from delaying the originally indicated outflow. The Water Control Section will direct these operations by Special Directives.

A regulation schedule has also been prepared from which the outflow rates during major floods can be determined from the rate of rise in the reservoir level and the available storage. This schedule is shown in **Plate 7-1**. This schedule was derived to enable project personnel to prevent the spillway level from being exceeded and causing excessive damage to lands within the reservoir area.

Area and capacity tables are given in **Plate 7-2** and percent storage utilization tables are given in **Plate 7-3.** The lower bay gate and the spillway rating curves are shown on **Plates 7-4 and 7-5** respectively. The outflow rating table for the gage below Dover Dam is given in **Plate 7-6**.

c. Emergency Plan. In the event that all communication is disrupted either between the Huntington District Office and the

Muskingum Area Office or between the Area Office and the Dover Dam Project Office, the District Office will try to establish communication directly with the Project Office. If the District Office cannot communicate with either the Project or Area Offices, the Water Control Section will utilize all available data, e.g. satellite platform data, to keep informed of project conditions and be prepared to resume regulation instructions when communication is restored. The Area Office Manager will then assume regulation in the interim if communication exists between the Area and Project Offices. Otherwise, the Damtender will assume regulation of the reservoir, following the measures described in **Exhibit B**, Instructions to Damtender. In addition, the Damtender will immediately make every effort to re-establish communications with the District Office.

The Instructions to Damtender directs project personnel to use the Emergency Operation Schedule, **Plate 1-3 of Exhibit B**. The Schedule contains the rates of rise curves to operate the project when communication with the District Office is disrupted more than two hours and the lake is rising. The curves indicate spillway gate openings to be used when the rate of rise in lake levels indicate that the available storage capacity of the project may be inadequate to fully control a given flood.

7-06 RECREATION - N/A

7-07 WATER QUALITY - N/A

7-08 FISH AND WILDLIFE - N/A

7-09 WATER SUPPLY - N/A

7-10 HYDROELECTRIC POWER - N/A

7-11 NAVIGATION - N/A

7-12 DROUGHT CONTINGENCY PLANS - SEE ANNEX I

7-13 FLOOD EMERGENCY PLANS

There is a stand-alone document on flood emergency operation plan for the Muskingum area.

7-14 OTHER PLAN

There is no additional regulation plan other than those that fall under deviation from normal regulation.

7-15 DEVIATION FROM NORMAL REGULATION

The Huntington District Engineer is occasionally requested to deviate from the normal regulation of Dover Dam. Approval and notification procedures are required when deviations from the normal

water control plan are necessary. Prior approval for major deviations are required from the Division Engineer except as noted below. Deviation requests normally fall into the following categories:

a. Definitions.

1. Major deviation. A change in normal operation of the project for a period greater than five days or elevation change of pool change greater than two feet. A major deviation is approved at the Branch and LRD Division level.

2. Minor deviation. A change of the normal operation that does not meet major deviation criteria. A minor deviation is approved at Water Resources Branch level based on authority of the Division.

b. Deviations.

1. Emergencies. Emergencies may fall under major or minor deviations. Normally they begin as minor deviations and if necessary are elevated to major deviations. The most common emergency that can be expected to occur is downstream drowning. Decreased flow may be needed while searching for a victim or increased flow to dislodge the body. Other common accidents occurring at the project are failure of the operation facilities, chemical spills, treatment plant failures and other temporary pollution problems. Water control actions necessary to abate the problem are taken immediately unless such action would create equal or worse conditions.

2. Minor Deviations. There are instances that create a temporary need for minor deviations from the normal regulation plan, although they are not considered emergencies. The following list contain most types of special regulations commonly requested: reduction of flow for construction work, major or minor reduction of flows to contain oil spill below dam and build pool level to stabilize the oil spill, and reduction of flow to recover car downstream.

3. Major deviation. Either increase or decrease in outflow may be requested by the governmental agencies, including state and local, or by higher authority with the Corps of Engineers. The following item represent types of major deviation commonly requested for Dover. Request to store three feet of water behind Dover Dam for two days to allow barge access to the dam structure for repairs.

c. Plan. Each condition should be analyzed on its merits. Required data on flood potential, watershed conditions, possible alternative measures, benefits to be expected and probable effects on project purpose, as mentioned above, shall be analyzed and presented by letter, telephone or fax to either the Great Lakes and

Ohio River Division LRD Office or Huntington Water Resources Branch Chief, along with recommendations for review and approval. Except in case of emergency, confirmation.

7-16 RATE OF RELEASE CHANGE

Regulation under normal conditions (not under Special Directive) may be determined by the Muskingum Area Office staff; however, releases shall not exceed a stage at the outflow gage of 4.2 feet (2427 cfs) in MIANO or 4.7 feet (2910 cfs) in DEMIA unless specifically directed by the Water Control Section. Dover Dam is regulated in such a manner that rate of release and resulting stream level does not change more than 1.0 foot per hour.

7-16 PUBLIC NOTIFICATION AND WARNING

News of impending gate opening operations is transmitted to persons downstream, primarily anglers, by means of the below project warning system which consists of a warning horn remotely controlled from the project office. At Dover, the horn is installed on the top of the dam, and is audible for a one mile radius. Important public service messages concerning regulation of the dam are handled by the Public Affairs Office and disseminated via radio, newspapers, and television.

The Damtender at Dover dam will keep informed and inform the Water Resources Engineering Branch of all developments upstream and downstream along the Tuscarawas River. Arrangements should be made with the Water Resources Engineering Branch for public notification of water release operations that are of an unusual nature or substantially different from the established release pattern whenever such releases might cause damage to equipment or facilities located downstream. The objective of this program is to afford those likely to be affected an opportunity to take appropriate remedial action in advance of the arrival of the releases to prevent damage to or loss of property. Warnings of any unusual releases will be transmitted downstream by project personnel in person and by telephone.

Pool level warnings are discussed in **Section 5-08**, and presented in **Table 5-4**.

SECTION VIII – EFFECT OF WATER CONTROL PLAN

8-01 GENERAL

The results of regulation for the authorized purpose of flood control are presented in the following paragraphs and in the plates referenced therein. Flood control benefits are discussed in **Section 8-02**. Regulation for various hypothetical design floods and for representative actual floods demonstrates the capability of the project to control and pass runoff from the drainage basin. The same capability, described in probability terms in sub-section 8-11b shows that the lake is likely to be filled to spillway elevation 916.0 feet NGVD once in 205 years.

8-02 FLOOD CONTROL

Dover Dam and the three reservoirs in its watershed control 1404 square miles or nearly 99% of the drainage area of the Tuscarawas River above the communities of Dover and New Philadelphia. Therefore, regulation of the project has been effective in reducing flood damages along the Tuscarawas River in these communities and in additional communities further downstream. The application of the adopted water control plan to two hypothetical floods (the Official Plan Flood and the Spillway Design Flood), two historical floods and four recent floods as they occurred are discussed in subsequent paragraphs.

a. Hypothetical Floods. Two hypothetical floods developed in the Analysis of Design – Dover Dam (revised 1938), consist of the following:

(1) Spillway Design Flood

(2) Official Plan Flood

b. Spillway Design Flood. The Spillway Design Flood (SDF) is the basis for determining the spillway capacity required to provide for the safety of the dam during the most critical flood over the basin. At the maximum lake level of 916 feet NVGD, approximately 203,000 acre-feet of storage capacity is available. The outflow discharged through the spillway would be approximately 123,000 cfs.

Current Corps of Engineers criteria specify that the SDF be based on the runoff from the probable Maximum Precipitation (PMP), as indicated in Hydrometeorological Reports 51 and 52. Probable Maximum Precipitation (PMP) is defined as the theoretically greatest depth of precipitation for a given duration that is physically possible over a particular drainage area at a certain time of year. The calculated SDF based on this data is routed through the reservoir, assuming a static full pool at the onset of the event.

The spillway at Dover Dam is currently undergoing an adequacy study. A plate showing the Spillway Design Flood characteristics and other information will be furnished when this study is completed.

c. Official Plan Flood. The maximum capacity of the outlets is fixed by the rate of flow that is required to be passed through the outlet works when operating the reservoir under an Official Plan Flood. The Official Plan flood believed to be the greatest flood that could occur in the Muskingum Watershed, assumes a rainfall of 10 inches over a period of 5 days with a runoff factor of 90 percent. The distribution of the rainfall during the 5 days is considered as proportionally the same as occurred during the 1913 flood for the Muskingum basin above Coshocton.

The computed inflow crest for the Official Plan Flood was 56,400 cfs. All inflow was passed. The maximum pool elevation attained was 916.16 feet NGVD. The hydrograph of the Official Plan Flood at the Dover Dam site together with the reservoir operation curve is shown in **Plate 8-1**.

d. Other Floods. The historical floods which were selected for illustration of the water control plan are the floods of March 1913 and January 1937. Also selected were the floods of January 1959, July 1969, February 1979, and August 1980 which illustrate floods actually regulated according to the water control plan. The flood of March 1913 was caused by widespread heavy rains which resulted in record stages along the Tuscarawas River. The flood of January 1937, which occurred when the Muskingum River Basin Reservoir system was under construction, stemmed from a series of severe storms and resulted in record stages along the Ohio River below Parkersburg, WV. The flood of January 1959 resulted from generalized rains with high runoff due to the saturated, frozen and snow-covered ground. A line of thunderstorms, which occurred in the upper Muskingum Basin, caused the flood of July 1969. The flood of February 1979 was caused by antecedent snowmelt and moderate rainfall falling on snow-covered and frozen ground. The flood of August 1980 resulted from a series of locally intense random thundershowers falling on saturated ground and already rain-swollen streams.

Peak flood stage and discharge reductions due to the Muskingum River Basin flood control structures are given in **Table 8-1** (page T8-8) **and 8-2** (page T8-9) respectively, for the above-mentioned floods at various locations downstream of Dover Dam.

(1) Flood of March 1913. The flood of March 1913 was caused by excessive precipitation over a comparatively large area enabling great volumes of water to be dumped into the streams throughout the Tuscarawas River Basin. The rain was exceptionally heavy through the northern sections of Ohio, amounting to 10 inches or more in some areas. Since the winter had been mild, the ground was without snow, not frozen and already saturated from the heavy

rains of January and the first portions of March. In the Tuscarawas Basin, the main storm began just before noon on 23 March, became increasingly heavy the next two days, and continued on the 26th and in some portions of the basin on the 27th. Total rainfall during the five days, most of which occurred in a 96-hour period or less at individual locations, averaged 6.55 inches over the Dover Dam drainage area. The resulting flood attained record stages which still stand along the Tuscarawas River.

Neither Dover Dam nor any of the other flood control dams in the Muskingum Basin was built at the time, but the flood has been reconstituted. The computed inflow crest was 61,200 cfs, with a modified inflow due to the upstream reservoirs of 38,000 cfs. In the reconstituted operation at Dover Dam, all inflow was passed until the morning of 24 March, when all gates were closed to minimize further flooding downstream. The gates were kept closed until noon of the 26th, when outflow was initiated and gradually increased about 500 cfs per hour until a discharge of 12,300 cfs was reached. The reservoir emptied within a few days. The maximum pool elevation attained was 915.96 feet NGVD. The results of regulation of the flood at Dover Dam and New Philadelphia by the Muskingum River flood control structures are shown on **Plates 8-2** and **8-3**. The hydrographs shown in these plates labeled "natural" represent the flow conditions without the flood control projects, and those labeled "modified" represent the flow conditions with the projects. For the hydrographs shown at Dover Dam, the outflow hydrograph represents the regulated outflow from Dover Dam. The hydrographs shown for other regulated floods are also labeled as such.

(2) Flood of January 1937. A series of abnormally heavy rains, centered largely in the middle and lower portions of the Ohio River Valley, began late in December 1936 and continued through most of January 1937. These rains caused a series of floods along the Ohio River that were greater than any known flood in the area. The Tuscarawas Basin, which was situated to the northeast of the center of maximum precipitation, experienced less severe flooding. Tributary streams experienced successions of flood rises which moved out of the smaller rivers to accumulate in the larger rivers and caused increasingly higher stages and discharges in them. The heavy general rainfall continued with the heaviest rainfall of the period in the storm of 14 to 25 January in which 7.93 inches fell over the Muskingum Basin and produced damaging floods. The flood control reservoirs in the Muskingum System were partially completed and helped to decrease the peak stages and discharges downstream by acting as automatic retarding basins.

Dover Dam was under construction when the flood occurred but the flood was reconstituted. The computed natural crest was 27,200 cfs and the computed modified inflow was 14,300 cfs. The runoff for Dover Reservoir was 4.25 inches. The flood operation outflow was limited to 5200 cfs until early 21 January when all the gates were closed. The gates were reopened on 26 January to 2000 cfs and then

to 6800 cfs on 28 January. This flow was maintained for several days until the reservoir emptied. The maximum pool elevation obtained was about 888 feet NGVD. Results of regulation of this flood similar to those given for the 1913 flood are given in **Plates 8-4** and **8-5**.

(3) Flood of January 1959. The flood of January 1959 is generally regarded as one of the highest of record along most tributaries in the Tuscarawas River Basin. The conditions prior to the generalized rains of 20 and 21 January contributed greatly to the flood stages throughout the basin. Severe cold weather during December 1958 caused the ground to freeze to depths ranging from 6 to 18 inches. In addition, a storm occurring between 14-17 January deposited from 0.50 to 1.84 inches of precipitation over the basin. The ground was thus saturated, frozen and covered with varying amounts of snow, all of which greatly contributed to the high percentage of runoff encountered after the generalized rain began. Most of the flood producing rains fell between midnight on 20 January and noon on 21 January.

The flood was reconstituted and the computed natural crest was 35,800 cfs and the modified inflow was 15,000 cfs. The runoff for Dover Reservoir was 2.85 inches. The sluice gates were closed at Dover Dam early in the afternoon on 21 January and the inflow was stored until late on 24 January, when the outflow was increased to over 7000 cfs and maintained until later in February when the reservoir was emptied. The maximum pool elevation obtained for Dover Dam was 901.65 feet NGVD. Results of regulation of this flood are given in **Plates 8-6 and 8-7**.

(4) Flood of July 1969. On the evening of 4 July 1969, severe thunderstorms with intense rainfall moved across northern Ohio. The storm centered along a line beginning just east of Toledo and extended through Ashland and Wooster to Urichsville. The average rainfall over the Muskingum Basin upstream of Coshocton for the 18-hour period ending at 1:30 P.M. on 5 July was 6.6 inches. Unofficial measurements ranged from 10 to 14 inches for the same period in the Wooster area. The intense rainfall and runoff resulted in the rapid and severe inundation of much of the Muskingum River Basin. Many headwater and tributary streams overflowed with flood stages approaching or exceeding those recorded in previous major floods.

The storm pattern was such that flooding was severe in areas upstream from existing reservoirs; however, the reservoirs were utilized efficiently to control downstream flows and significantly reduce damages. At the onset, all inflow was passed until the morning of 5 July when all gates were closed. The gates remained closed until noon on 10 July when outflow was initiated and gradually increased until an outflow gage height of 6.5 feet was reached. Later that day the outflow was reduced to a gage height of 4.0 feet and remained at that level until the morning of 11 July when the outflow was gradually increased to reach a gage height of

6.5 feet. On the afternoon of 14 and 15 July, the outflow was again gradually increased to reach a gage height of 7.0 and 7.8 feet respectively. A smaller storm occurring on 18-20 July forced the reduction of outflow from the morning of 20 July until the morning of 22 July. On the evening of 27 July it again became necessary to reduce the outflow to gage height of 4.0 feet in order to reduce flow at Newcomerstown. Normal operations were resumed on the afternoon of 28 July. The maximum reservoir elevation obtained during the flood was 905.0 feet NGVD, the highest level recorded at Dover Dam during its period of record. Results of regulation of this flood are given in **Plates 8-8** and **8-9**.

(5) Flood of February 1979. Subfreezing temperatures and a major snow-cover persisted over the Muskingum River Basin during most of January and February 1979. Rising temperatures and light rainfall on 21-22 February created thawing conditions that persisted until moderate rainfall on 25-26 February, combined with rapid snowmelt, created flooding conditions in the Muskingum River Basin. Rainfalls averaged only approximately 1.5 inches but combined with snowmelt from 6-20 inches of snow-cover on the basin.

Outflow at Dover Dam increased gradually to approximately 5200 cfs on 24 February, and then was cut back to approximately 500 cfs to reduce the flow at Newcomerstown and store runoff at Dover. Runoff was stored at Dover Dam until the peak inflow passed late on 26 February. Outflow was then increased gradually to a range of 5000-6000 cfs on 27 February. The pool at Dover Dam reached a maximum level of approximately 895.0 feet NGVD above mean sea level during this flood. Results of regulation of this flood are given in **Plates 8-10 and 8-11**.

(6) Flood of August 1980. Heavier than normal rainfall over the Muskingum River Basin during June and July 1980 created saturated soil conditions in many areas. Subsequent widespread and intense thunderstorm activity in August thus resulted in substantial runoff, causing major rises in river levels during the month. Rainfalls of 1 to 2 inches were common from storms occurring on 2-6 August, 9-12 August, 17-19 August and 21-22 August. The most notable rainfall occurred on 10-11 August in Guernsey, Belmont, Licking, and Muskingum Counties, as the Cambridge area received approximately 8.0 inches in 18 hours, and most areas in the 4 counties received at least 3.5 inches.

A series of inflow peaks recorded at Dover Dam during the month of August, with the highest inflow peak being approximately 6510 cfs on 19 August. Dover Dam was generally operated to pass most of the inflow, but some inflow from the major rises was stored. The peak pool level reached at Dover Dam during these storms was elevation 889.64 feet NGVD above mean sea level on 24 August. For the various storms experienced during August, it is estimated that peak flood stages were reduced by 2.1 to 4.5 feet at Dover and 0.5 to 3.7 feet at Newcomerstown due to the regulation of the Muskingum River Basin

dams. Results of regulation of this flood are given in **Plates 8-12** and **8-13**.

8-03 RECREATION - N/A

8-04 WATER QUALITY

There are certain water quality problems associated with dry dams such as Dover. Sediment buildup is a common problem when water is impounded for a small time and then released. Other water quality problems can be directly related to problems in the watershed.

8-05 FISH AND WILDLIFE - N/A

8-06 WATER SUPPLY - N/A

8-07 HYDROELECTRIC POWER - N/A

8-08 NAVIGATION - N/A

8-09 DROUGHT CONTINGENCY PLAN

Upon approval of NEPA documentation, the drought contingency plan will be furnished for enclosure in the water control manuals.

8-10 EMERGENCY DRAWDOWN

Since the Dover Dam project has been operational, no emergency drawdown has occurred. Dover Dam is currently operated as a "Dry Dam" where the normal run of the Tuscarawas River is passed through the dam. In the event that emergency drawdown is necessary, drawdown from the maximum flood control pool elevation 916 feet NGVD to the reference pool elevation 874 feet NGVD can be accomplished in 20 days assuming a constant inflow of 1,000 cfs and winter channel capacity releases of 6,026 cfs. During the growing season when the channel capacity releases are limited to 4,832 cfs, the time required for the same drawdown is 26.4 days. The minimum time required to draw down the reservoir from the maximum control level to the reference pool level is about 3.4 days with all gates fully open and assuming the same inflow of 1,000 cfs. An emergency drawdown schedule for Dover Dam is shown on **Plate 8-14**.

Should emergency drawdown become necessary, various procedures such as surveillance of the dam or notification of key personnel may be placed into effect, depending on the cause and its severity. Detailed information concerning these emergency actions are found in the Flood Emergency Plan for Dover Dam.

8-11 FREQUENCIES

a. Natural Discharge-Frequency and Duration at the Outflow Gage. The natural discharge-frequency curve for the Tuscarawas

River at the Dover Dam outflow gage was developed on a regional basis in accordance with methods outlined in “Statistical Methods in Hydrology”, by Leo R. Beard, dated January 1962, and Bulletin 17A, “Guidelines for Determining Flood Flow Frequency”, published by the United States Water Resources Council and dated March 1976. A log Pearson Type III distribution was fitted to the annual event series at gaging stations in the Muskingum Basin. This enabled generalized relationships to be derived which relate frequency curve characteristics, mean, standard deviation and skew to individual basin factors. These data were utilized to make flow frequency estimates for the project drainage area.

The curve derived by plotting probable maximum flow to be expected at the dam-site against exceedence interval in years is shown as **Plate 8-15**. Similar plot for New Philadelphia gaging station is shown on **Plate 8-16**. Flow values for certain exceedence intervals from 1 year to 1000 years are given in **Table 8-3**.

Table 8-3

Frequency Summary

Tuscarawas River At Dover Dam Outflow Gage

All Seasons – Natural

Exceedence Interval (Years)	Discharge (cfs)
1000	84,000
500	70,900
200	54,700
100	48,500
50	40,700
20	31,700
10	25,700
5	20,800
2	15,300
1	12,000

Since 1937, flows in Tuscarawas River have been regulated by Dover Dam. A computer study of the duration of flow at the outflow gage was conducted using the U.S. Geological Survey record of flow past the gage for the period March 1937 through 1979. Percent of total elapsed time during which the flow was at or above certain selected values was calculated. These flow values were then plotted against the percent of time as calculated for the full year and for each month to produce the Annual and Monthly Flow Duration curves for the Tuscarawas River below Dover Dam as shown on **Plate 8-17**.

b. Pool Elevation Duration and Frequency. All significant flows for the period of record on the Tuscarawas River were tabulated and hydrographs reconstituted for the dam-site or obtained by discharge-drainage area ratio. The hydrographs were routed through the lake following the approved plan of water control and the peak pool elevation noted. Using the graphical analysis method described in Beard's work mentioned in **Sub-section 8-06a** above, the pool elevation frequency was estimated and is shown in Frequency of Filling, **Plate 8-18**. Deviation from the reference elevation, 874 feet NGVD, was plotted as pool elevation probable of occurrence on the average once in a number of years, which is the exceedence interval, against the interval. Selected exceedence intervals with the respective maximum pool elevation expected to occur on the average once in that interval are listed in **Table 8-4**.

Table 8-4

Frequency Summary

Dover Dam Pool Elevation Deviation – All Seasons

Exceedence Interval (Years)	Elevation (feet)
205	916.0
150	913.2
100	911.4
50	907.8
20	902.8
10	899.8
5	896.4
2	890.0
1	887.0

Pool elevation hydrographs produced when the above floods were routed through the lake were measured for amplitude (duration in days) at certain specified elevations and these were tabulated by elevation. The total number of days tallied for each elevation for all floods of the period of record was divided by the number of years of record (27) to obtain the average number of days per year at or above that elevation. The "Average" curve in Duration of Filling, **Plate 8-19**, was derived by plotting these values of the average number of days against the respective elevations. Amplitudes at specific elevations of the curve with the highest peak were plotted against the elevations to obtain the "maximum Number of Days per Period of Record."

c. Key Control Points. The natural frequency was estimated at several control stations along the Tuscarawas and Muskingum Rivers using similar methods and techniques of data handling and calculations as were used for the Tuscarawas River at the dam-site. These control stations are located at Dover Dam and at New Philadelphia, Newcomerstown, Coshocton, Dresden, Zanesville, McConnelsville and Marietta.

Actual Peaks occurring at each of the gaging stages since the Muskingum Basin projects went into operation were increased by the routed lake reductions to produce natural flows. For each gage the maximum natural flows expected to occur, on the average, once in a certain period of years, which is the exceedence interval, were plotted against the respective intervals to produce the "Natural" curve of Flow Frequency Curves, All Seasons, **Plates 8-15** and **8-16**. Flows for selected exceedence intervals from 1 year to 1000 years are included in **Table 8-5**, page T8-10.

In order to estimate modified frequencies at each gage, representative floods from the record prior to beginning operation of the Muskingum Basin projects were routed through the reservoirs and reductions routed to the gaging stations. These were applied to the actual (natural) and the resulting modified peaks noted. Reductions of flows effected by the Muskingum Basin projects since they were placed in operation were routed to the gaging stations and added to the actual (modified) flows to produce the natural. At each gaging station the peak modified flow for each event was plotted against the peak natural flow for each event. The most representative smooth curve, to be known as the "Correlation Curve," was drawn among the points. Any point on the Correlation Curve gives, for the peak natural flow specified, the probable peak flow to be experienced at that gaging station because of the control of the Tuscarawas and Muskingum Rivers by the Muskingum Basin projects. The exceedence intervals of the modified flows are the same as those of the corresponding natural flows. Therefore, the intervals of selected natural flows were plotted against their corresponding modified flows to produce the "modified" curve given on **Plates 8-15** and **8-16**.

Studies of the flow durations at the various gaging stations were performed using the U.S. Geological Survey records of flow at each gaging station. The percent of total elapsed time during which the flow was at or above certain specified values were calculated by computer. These flow values were then plotted against the respective percent of time, as calculated for the entire year and for each month, to produce the Annual and Monthly Flow Duration curves at the dam-site shown in **Plate 8-17**.

8-12 OTHER STUDIES

a. Examples of Regulation. After the decision was made to operate Dover as a dry reservoir, no additional studies were performed regarding the regulation of Dover Dam.

b. Channel and Floodway Improvement. In 1985, the Water Resources Engineering Branch performed a dam break study for Dover Dam. Flood waves were determined for failure of the dam during the Spillway Design Flood (SDF) and with the reservoir level at spillway elevation 916 feet NGVD. Flood waves were also determined for the SDF without failure. The study provided estimated wave heights and arrival times at several locations downstream of Dover Dam as well as maps of the areas inundated during the SDF with and without failure.

SECTION IX – WATER CONTROL MANAGEMENT

9-01 RESPONSIBILITIES AND ORGANIZATION

a. Corps of Engineers. General authorities for allocation and regulation of reservoir storage in projects owned and operated by the Corps of Engineers are contained in legislative authorization acts and referenced project documents. These public laws and project documents usually contain provisions for development of water control plans, and appropriate revisions thereto, under the discretionary authority of the Chief of Engineers. Some modifications in project operation are permitted under congressional enactments subsequent to original project authorization. Dover Dam is owned and operated by the U.S. Government. The Huntington District, Corps of Engineers is the operating agency for the project, with the administrative control under the Muskingum Area office within Operations Division. An organizational chart is shown on **Plate 9-1** for Water Control Management at Dover Dam.

b. OCE Role in Water Control Activities. OCE will establish policies and guidelines applicable to all field offices and for such actions as are necessary to assure a reasonable degree of consistency in basic policies and practices in all Division areas. Assistance will be provided to field offices during emergencies and upon special request.

c. Great Lakes and Ohio River Division. The Division Engineer has primary responsibility and authority for direct action with respect to ALL PHASES of reservoir regulation, including: (a) basic policies, criteria, and concepts that determine operating plans; (b) technical evaluations; (c) field operation; and (d) review and approval of reservoir regulation plans and manuals and related activities. The Division Office will coordinate water control management activities associated with interdistrict, interdivision, and interagency water resource needs. As established in accordance with ER 1110-2-1400, the Great Lakes and Ohio River Division Reservoir Control Center is responsible for administration of the Division Engineer’s policy for water control management.

d. Huntington District. District Engineers have the primary responsibility for (a) general management of reservoir regulation activities within their respective areas; (b) technical evaluations and performance of operations associated therewith; and (c) developing plans and manuals required for reservoirs and interrelated systems within their respective district area. The Water Control Section, within the Engineering and Construction Division, is the responsible element for all water control activities which include the following reservoir project functions:

(a) Flood control.

(b) Regulation of flows for water supply and water quality control.

(c) Navigation - stage regulation.

(d) Hydropower.

(e) Recreation.

(f) Fish and wildlife enhancement.

(g) Alleviation of sediment and erosion problems affected by reservoirs.

Water control plans include coordinated reservoir regulation schedules for project/system operation and such additional provisions as may be required to collect, analyze and disseminate basic data, prepare detailed operating instructions, assure project safety and carry out regulation of projects in an appropriate manner. Water control plans will be developed to conform with objectives and specific provisions of project authorizing legislation and applicable Corps of Engineers' projects. They will include any applicable authorities established after project construction. The water control plans will be prepared giving appropriate consideration to all applicable Congressional Acts relating to operation of Federal facilities, i.e., Fish and Wildlife Coordination Act (P.L. 85-624), Federal Water Project Recreation Act - Uniform Policies (P.L. 89-72), National Environmental Policy Act of 1969 (P.L. 91-190), and Clean Water Act of 1977 (P.L. 95-217). Thorough analysis and testing studies will be made as necessary to establish the optimum water control plans possible within prevailing constraints.

Water Resources Engineering Branch is delegated the responsibility to coordinate the operation of specific projects with Federal and State agencies, local entities, and the general public. The Division Engineer, ATTN: CELRD-EC-W, will be advised, as soon as possible, of any coordination activities which may require a study, public hearing, or revision in operating plans. Districts are required to alert the Division Engineer, ATTN: CELRD-EC-W, of any significant deviations from routine daily regulation plans, The communication mode for the advisory should be commensurate with the urgency of the situation and transmitted before a plan of action is implemented by the district. As shown on **Plate 9-1**, the Natural Resource Management Branch and the Muskingum Area office are responsible for supervision of the operation and maintenance of Dover Dam. The Damtender at Dover Dam will regulate the project in accordance with general instructions and Special Directives issued by the Water Control Section. General instructions are included in Instructions to Damtender, **Exhibit B** of this manual. Special Directives are issued and signed by the Chief, Water Control Section, for dissemination to the Damtender as necessary to efficiently regulate the project for optimal water control management for all project purposes.

During normal operations, the Water Control Section is involved in the following activities pertaining to water control management:

(1) Routine regulation of the lakes and dissemination of pertinent data.

(2) Investigations and refinement of regulation procedures such as analysis of past floods, channel investigations, improvement of forecasting, and planning programs with other agencies.

(3) Training personnel in flood control duties with visits to projects and instructing Water Resources Engineering Branch personnel from other sections.

(4) Development and application of mathematical modeling to complex reservoir systems.

(5) Operation of the Branch hydrologic data collection and water control management system, including computers and field equipment.

(6) Developing and conducting effective public information programs to inform and educate the public regarding Corps of Engineers' water control management activities.

(7) Preparing and submitting reports on lake regulations such as daily reports, weekly reports, monthly reports, annual reports, weekly briefings, and post flood reports.

(8) Preparing and updating water control manuals for individual projects and master manuals for basins.

During flood or other emergencies, Water Control Section personnel are responsible for the following activities in regard to water control management:

(1) Evaluation and dissemination of current and forecast hydrologic, hydraulic and meteorological data.

(2) Presentation of storm and flood analysis to the District Engineer and pertinent staff members.

(3) Providing liaison personnel to support Emergency Operation Center when it is operational.

(4) Regulation of all projects and systems in accordance with approved plans.

(5) Furnishing information to others such as reports to higher authority, status to Emergency Operations Center and data to Public Affairs Office.

During a FLOOD EMERGENCY SITUATION, the lines of communication between the various office elements are shown on **Plate 9-2**. Details and responsibilities of other elements are indicated in the overall

district plan in the Emergency Operations Center Plan and ER 500-1-1, ER 500-2-1 and all annexes to these two ER's.

During normal non-flood periods, water control management activity is accomplished by personnel of the Water Control Section. During flood conditions and other emergencies, assistance of other Water Resources Engineering Branch personnel may be required to maintain effective water control management within the Huntington District. The area affected and magnitude of the flood will determine the number of people engaged in each particular activity and assigned to each sub-basin or major river basin. A typical organizational chart for Water Resources Engineering Branch for a major flood covering several basins is shown on **Plate 9-3**.

The National Weather Service and project personnel are provided with a list of names of Water Resources Engineering Branch personnel and home telephone numbers with instructions to contact them during off-duty hours if unusual conditions occur or a project is in a particular reporting schedule. During emergency conditions or flood regulation, Water Resources Engineering Branch staff are available from 18 to 24 hours daily, depending on the magnitude of a particular event. At each project, responsible personnel will be on duty or on call at all times.

The Huntington District also works in cooperation with other Federal, State, local and private organizations and agencies. These relationships are described in detail in the following paragraphs and illustrated in **Plate 9-4**.

e. Other Federal Agencies. The National Weather Service and the U.S. Geological Survey cooperate and coordinate activities with the Water Resources Engineering Branch in regard to accumulation of rainfall and streamflow data, as well as river forecasts and discharge measurements. The Corps is required by the Fish and Wildlife Coordination Act (48 Stat. 401 as amended) to coordinate all plans affecting Fish and Wildlife with the U.S. Fish and Wildlife Service. The Service is required to present the plans to the relevant State agency, in this case the Ohio Department of Natural Resources, for their comments and recommendations. The Service then presents a combined report to the Corps including its comments and recommendations and those of the Ohio Department of Natural Resources.

f. Local and State Agencies. No local or state agency has funding or operational responsibilities in the Huntington District multipurpose reservoirs except in leased recreation areas. The Muskingum Watershed Conservancy District holds fee title to much of the project land and manages the recreational facilities at the projects having conservation pools. The State of Ohio constitutionally holds in trust all wild animal life in the state on both public and private lands, and all aquatic life in public waters. The State Department of Natural Resources, as mandated by

State Code, has responsibility for conservation of fish and wildlife and for boating safety at the project lakes. The Game Protection Division of the Department of Natural Resources enforces hunting regulations and licenses on the reservoir lands.

g. Private Coordination. Under flood conditions the plant personnel of Fairfield Brick Company, Norton Chemical Company and Corundite Refractories are responsible for monitoring the water accumulation behind the levee and pumping out the water as necessary.

9-02 INTERAGENCY COORDINATION

a. Local Press and Corps Bulletins. Huntington District Office and the National Weather Service, coordinate in forecasting flood stages. Local press is provided with information of flood forecasts as furnished by the National Weather Services (officially responsible for issuing flood warnings). This information will be supplemented by the Corps with available information on observed conditions and with technical advise to enable local interests, within the limits of their capabilities, to obtain optimum flood protection, and to perform rescue and relief functions.

The Public Affairs Office in the Huntington District releases various other items to the press for public dissemination. Some of these are in the public interest such as drawdown announcements or notification of a change in or opening of a new facility or service at a reservoir. Some releases are to enlist public cooperation and some, such as reports of flood damages saved by regulation of certain reservoirs, are to inform the public of the benefits derived from Corps-built projects.

b. National Weather Service. An agreement between NWS and the Corps of Engineers provides for collection and dissemination of current precipitation data for the Ohio River Basin. By joint agreement, NWS installs, maintains and operates all stations in the Ohio River Network, except those operated by Corps of Engineers' personnel at flood-control and navigation projects. Where there is a mutual need for the data, station costs are shared by both NWS and the Corps of Engineers. Costs of stations that are required only for reservoir regulation are borne entirely by the Corps of Engineers. In either case, an annual transfer of funds from the Corps of Engineers to NWS is made to cover the required expenditures. As briefly described in **Sub-section 5-01c**, NWS provides a range of weather information and forecasts under the program as well as Ohio River and tributary stage information and forecasts. The Corps reciprocates, providing NWS with all precipitation, snow cover and stage information from reservoir and other reports, pool level and outflow forecasts and depth reports from the District Snow Cover Reconnaissance.

c. U.S. Geological Survey. The Cooperative Stream Gaging Program was established about 1940 through cooperative arrangements between the Corps of Engineers and the USGS in order that sufficient stream flow water would be available to meet special needs in connection with the Corps water resources responsibilities. This is in keeping with the Chief of Engineers policy of fully utilizing the facilities and services of other Federal Agencies in obtaining many types of basic data. Accordingly, arrangements were made for the Geological Survey to operate specific stations for the Corps on an advance of funds basis. Although the Corps of Engineers requires the basic data, other Federal, State, and private agencies and individuals use the water data. The data are published by the survey assuring maximum availability and use of all data.

The Geological Survey coordination and cooperation agreement with the Corps is formulated by the Water Resources Engineering Branch in collaboration with appropriate District Chiefs of the Geological Survey. The Corps of Engineers and the local representative of the U.S. Geological Survey determine the necessary stations to provide the data for publication and the Corps is requested to furnish an estimate of the costs of installing and/or operating each station. The District Engineer forwards the selected program through the Division Engineer to the Chief of Engineers. Any supplemental instructions of a current nature necessary in connection with preparation of the report are issued annually by the Chief of Engineers.

d. Ohio Department of Natural Resources. Functional agreements, meetings, and contacts with various divisions of the Department of Natural Resources are discussed below. They are important to operation of the project in accordance with project purposes and with the recommendations of the Ohio Division of Natural Resources and the U.S. Fish and Wildlife Service.

The Ohio Division of Natural Resources maintains an Office of Corps Liaison for the purpose of coordinating special releases from Corps Lakes for recreational or other purposes. This office receives all requests for special regulation and, after examining the request and appending to it any ODNR comments, sends the request to the District Office. Using the Corps based guidance policies and criteria a determination is then made, and this decision is then sent back to the ODNR to coordinate with the organization making the request.

The Ohio Department of Forestry at Columbus, all project lake Corps Personnel, and project lake state park personnel cooperates in fire-fighting activities to suppress fires that threaten or are burning on project lands. Project personnel cooperates by taking training in fire suppression techniques, reporting such fires to the ODNR District Forester, fighting the fires before State personnel arrive and by assisting their suppression efforts after arrival.

The Parks and Recreation Division will enforce the Boating safety and water regulations, while hunting and fishing licensure procedure

enforcement is by the Division of Wildlife. There is frequent day-to-day contact between project personnel and Ohio Division of Natural Resources personnel through much of the year.

e. Other Federal, State, or Local Agencies. The Corps of Engineers receives requests for information, aid or cooperation from many parties. All responsible requests from Federal, State, local or private organizations or from groups who coordinate with the ODNR receive appropriate attention and consideration. Accuracy of information transmitted and responsible character of aid or cooperation given is commanded by District policy. Huntington District reacts quickly in disaster situations, allocating material and man power when needs are in the Corps' areas of responsibility and expertise. In certain cases, such as potential downstream flooding concern or emergency complication involving regulation of Dover Dam, the District Emergency Operations Manager coordinates with the Ohio Disaster Services Office in Columbus. Another example of cooperation with a State entity is an occasion when the Corps studies damages and reconstruction costs due to a flood or other disaster for the Office of the Governor to use in applying for Federal assistance.

In accord with the Corps of Engineers statutory responsibility for operation of its reservoirs in the public interest, the Great Lakes and Ohio River Division Engineer organized the Reservoir Operations Coordinating Group for the Ohio River Basin as a vehicle for perceiving, interpreting, and prioritizing that interest. The Group is composed of the twelve basin States, Tennessee Valley Authority, six Federal agencies and two regional commissions which are Ohio River oriented. The Group meets quarterly and provides a mechanism for a two-way communication through various levels of government and among various agencies of government and other organizations, which serve the public. Meetings of the Group have the stated mission of bringing focus to the public's varied interests in reservoir regulation and accordingly perfecting that regulation to the maximum extent possible.

Water Control Section personnel will send to each meeting a report which summarizes hydrologic and meteorologic situations in the district for the preceding three month or six month period highlighting pertinent events, flood control activity, and special operations by each project.

9-03 INTERAGENCY AGREEMENTS

Agreements between the Corps of Engineers and U.S. Geological Survey (USGS) and National Weather Service are mentioned above and outlined in **Section 5-01**. An annual meeting is held with each of the State branches of the USGS in conjunction with the stream gage installation and maintenance work the USGS performs in the Stream Gaging Program. The Corps and Weather Service mutually agree upon

scheduling of meetings concerning the Ohio River Network on an as-needed basis.

In the interest of fire protection for visitors, employees, property, and animal and plant life, the District executed a memorandum of understanding covering all Corps' reservoir projects in Ohio with the Department to be administered by its Division of Forestry. The understanding includes cooperative warning and suppression of fires on or threatening Corps' owned lands, Department maintenance of a standard cache of fire-fighting tools at the project, Department training of project personnel on a need basis at the project, and payment by the Corps of extinguishments costs incurred by the Department.

Great Lakes and Ohio River Division Reservoir Control Center holds a quarterly meeting of the Reservoir Operations Coordinating Group. The meeting is attended by representatives of Federal, Regional and State agencies and commissions, along with Corps representatives of District and Division reservoir regulation elements. The purpose of the meetings is to exchange information and views on regional water resource concerns.

9-04 COMMISSIONS, RIVER AUTHORITIES, COMPACTS, AND COMMITTEES

a. Ohio River Basin Commission (ORBC). This commission has an active interest in the operation of the Dover Lake and acts in a consultative capacity to both governmental and private interests in the basin. The commission consists of Federal and State representatives in Water Resources. Its purpose is to provide a forum for the Ohio River states to study, discuss, and develop regional policies and positions on common interstate issues concerning water and related land issues.

b. Ohio River Valley Water Sanitation Commission (ORSANCO). This commission, which was created in 1948, coordinates the water quality programs of member states, and promulgates regulations to prevent and mitigate water quality problems on the Ohio River and its tributaries. The states of West Virginia, Pennsylvania, Illinois, Indiana, Kentucky, New York, Ohio, and Virginia are represented on this commission.

c. Ohio Fish and Wildlife Service (OFWC). This commission has interest in water related issues as they affect fishery resources and boating opportunities in the State.

d. District Drought Monitoring Committee (DDMC). This is an existing committee consisting of Huntington District Corps of Engineers personnel from the Planning, Operation and Readiness, and Engineering and Construction Divisions; the Office of Counsel; and the Public Affairs Office. The purpose of the committee is to review guidelines, develop and implement functional drought

contingency plans, and keep the CDMC informed on drought status and drought related topics and issues.

e. Corps Drought Management Committee (CDMC). The CDMC is composed of personnel from the Corps' office. The purpose of the committee is to represent the broad range of Federal interests and to establish and direct the water management policy for the Huntington District during a drought. Where possible, the Chief of the Engineering and Construction Division uses guidance from this committee in developing and justifying deviations from approved water management plans and procedures.

f. Inter-agency Drought Management Committee (IDMC). The IDMC is composed of local, State, and Federal agency heads that have the authority to represent all user water needs within the Muskingum River basin. Federal members include the Huntington District Commander who serves as the Chairman, and agency heads or their designees from the Federal Emergency Management Agency, U. S. Fish and Wildlife Service, Environmental Protection Agency, National Weather Service, U. S. Geological Survey, and Soil Conservation Service. State members include department heads or their designees from the Ohio Department of Environmental Protection and the Ohio Emergency Management Agency. Local members include representatives from the area counties. The purpose of the committee is to review the status of the District's lake storage and operations, review drought related water needs and requests, develop proposed action plans for meeting consolidated and coordinated user needs, and set priorities and define actions on these needs.

9-05 NON-FEDERAL HYDROPOWER - N/A

9-06 REPORTS

Table 9-1, page 9-14, contains a listing of the various Periodic and Special reports provided by Huntington District Water Control Section.

a. Periodic.

(1) Daily. Districts are required to report current hydrologic data daily as prescribed by the Division Office. All periodic daily reports are prepared five days per week by the Water Control Section of Water Resources Engineering Branch and, when staffing is provided, as under flooding conditions, on Saturdays, Sundays and holidays. They are prepared as detailed in sub-section 8-03 and inserted into a computer file. After review, the report is sent over a leased line to the LRD water control system. The transmission includes morning lake elevation, rate and temperature of outflow, and a 3-day forecast of lake elevations and outflow for all reservoir projects. Ohio River morning stages and 24-hour rainfall, morning stage and flow and 5-day flow forecast for Ohio River tributary gage points complete the transmission and the

report. The reported items are prepared in accordance with ORD ER 1110-2-20, CEORD-ED-W lt, 10 Jul 69, CEORD-ED-W lt, 23 Jan 67, and ORD ER 1110-2-17.

Daily or more frequent briefings of the District Engineer and Chief Engineer containing pertinent hydrologic and meteorologic information are made during flood or other emergencies.

In carrying out water control activities, Corps of Engineers personnel must recognize and observe the legal responsibility of the National Weather Service (NWS) and the National Oceanic and Atmospheric Administration (NOAA) for issuing weather forecasts and flood warnings, including river discharges and stages. River forecasts prepared by the Corps of Engineers in the execution of its responsibilities should not be released to the general public, unless the NWS is willing to make the release or agrees to such dissemination. However, release to interested parties of factual information on current stroms or river conditions and properly quoted NWS forecasts is permissable. District offices are encouraged to provide assistance to communities and individuals regarding the impact of forecasted floods. Typical advice would be to provide approximate water surface elevations at locations upstream and downstream of the NWS forecasting stream gages. Announcement of anticipated changes in reservoir release rates as far in advance as possible to the general public is the responsibility of the Corps of Engineers water control managers for projects under their jurisdiction.

(2) Weekly. Each week a list of 24-hour reservoir effects at tributary gage points is transmitted to LRD. The list, which gives flows in cfs held out from or added to the natural flow, shows the data for an entire week ending with the current week. The gage points reported for the Muskingum Basin is at McConnelsville, Ohio, on the Muskingum River. An example of the list is shown in **Plate 9-5**.

(3) Monthly. Engineer Regulation No. 1110-2-240, dated 8 October 1982, requires that a monthly record of reservoirs operated by the District be promptly prepared by Water Control Section, according to 33 CFR 208.11, and maintained in tabular form readily available for transmittal to the Chief of Engineers or others on request. An example of the monthly report is shown in **Plate 9-6**.

(4) Reservoir Operations. Each District provides a review of meteorological influences and water control management activities to each of the meetings of the Reservoir Operations Coordinating Group. Meetings are held three times each year. Huntington District personnel of the Water Control Section summarize and compare weather experienced with long-term normals and actual stream flows to mean annual values. They describe seasonal features of operation such as spring filling, summer outflow temperature control or fall drawdown, frozen lakes and effect of river ice on

navigation, in addition to any significant flood control operations and damages prevented. An example of the reservoir operations report is shown in **Plate 9-7**.

(5) Annual. The Division Engineer is required by ORDR 1110-2-27 and ORDED-W Ltr, 30 Sep 1977 to submit to OCE for approval an annual report on reservoir regulation activities of significance during the fiscal year ending and programs proposed for the year following. This report summarizes the water control activities throughout the Ohio River Basin. Therefore, District input is mandatory. The following documentation of District programs and activities is requested by 1 November of each year:

(a) A brief summary highlighting the significant accomplishments attributed to each reservoir during the preceding fiscal year.

(b) Reservoir regulation manual submission schedule.

(c) Concise reports on major accomplishments concerning personnel, training, model application, data reporting and analysis, and general improvements in reservoir regulation activities.

By executive order 12088, the President ordered the head of each Executive Agency to be responsible for ensuring that all necessary actions are taken for prevention, control, and abatement of environmental pollution with respect to Federal facilities and activities under control of the Agency. Annual Division Water Quality Reports are required by ORDR-2-26. The report is submitted in two parts. The first part addresses the Division Water Quality management plan while the second part presents specific project information. A major objective of this report is to summarize information pertinent to overall water management responsibilities. As Annual Water Quality Report by Districts to ORD includes narrative and tabular summaries of water quality activities and conditions in the Districts. The report contains a synopsis of activities, specific cases of interest, improvements during the year, and plans for future emphasis. The tabular portions include an overview of water quality objectives, an overview of water quality conditions, specific water quality actions in coordination with the Water Control Section, aimed at identification or solution of problems and problems requiring special studies with schedules for executing the studies. The annual water quality report is to be submitted by 1 December of each year.

b. Special Reports.

(1) Reports on Reservoir Operations During Flood Emergencies. Information on reservoir operations to be included in reports submitted to the Chief of Engineers during flood emergencies in accordance with ER 500-1-1 include rate of inflow and outflow in cfs, reservoir levels, predicted maximum level and anticipated date,

and percent of flood control storage utilized to date. Maximum use should be made of computerized communication facilities in reporting project status to DAEN-,CWO-E/CWE-HY in accordance with the requirements of ER 500-1-1.

(2) Post-Flood Summaries of Reservoir Effects. Reservoir effects including evaluation of the stage reductions at key stations, estimates of damages prevented by projects, and precipitation maps will be included in the post-flood reports required by ER 500-1-1. **Plate 9-8** shows the tabular and graphic output used to calculate stage reductions at the following gaging stations pertinent to Dover Dam: Tuscarawas River at Dover and New Philadelphia. The outline of a typical post-flood report is given below:

I - Authority, Purpose And Scope

II - Basin Description
Impact of Flood

III - General Precipitation
Storms and Reservoirs

IV - Damages and Flooding

V - Antecedent Rainfall
Storm Rainfall and Runoff

VI - General Method of Operation
Emergency and Standing Instructions
Flood Control Operations during Storms
Special Operations
Operations during Release Period
Results of Operation
Flood Damages Eliminated

VII - Computer Programs Utilized
Special Flood Activity

(3) Fiscal year budget requests. Fiscal year budget requests for water control management activities will be prepared and submitted to the Office of the Chief of Engineers in accordance with requirements established in Engineer Circular on Annual Budget Requests for Civil Works Activities. The total annual costs of all activities and facilities that support the water control functions (excluding physical operation of projects, but including flood control and regulation of navigation projects subject to 33 CFR 208.11) are to be reported. Information on the Water Control Data Systems and associated Communications Category of the Plant Replacement and Improvement Program will be submitted with the annual budget. Reporting will be in accordance with an Engineer

Regulation and the annual Engineer Circular on Civil Works Operations and Maintenance, General Program.

(4) The Chief of Engineers. The Chief of Engineers and staff require information to respond to inquiries from members of Congress and others regarding runoff potentials. Therefore, the Division Engineer will submit a snowmelt runoff and flood potential letter report covering the snow accumulation and runoff period, beginning generally in February and continuing monthly, until the potential no longer exists if necessary. Dispatch of supplemental reports will be determined by the urgencies of situations as they occur. The reports will be forwarded as soon as hydrologic data are available, but not later than the 10th of the month. For further information on reporting refer to ER 500-1-1.

(5) Major drought situations. During major drought situations or low-flow conditions narrative sill-arise of the situation should be furnished to alert the Chief of Engineers regarding the possibility of serious runoff deficiencies that are likely to call for actions associated with Corps of Engineers' reservoirs.

(6) Master plans. Master plans for water control data systems and significant revisions thereto will be prepared by Division water control managers and submitted to HQDA (DAEN-CWE-HY) Washington, DC 20314, for review and approval of engineering aspects. Engineering approval does not constitute funding approval. After engineering approval is obtained, equipment in the master plan is eligible for consideration in the funding processes described in ER 1125-2-301 and Engineering Circulars on the Annual Budget Request for Civil Works Activities. Master plans will be maintained current and will be updated as necessary to meet needs. Modified master plans should be submitted by 1 February if revisions are required to include equipment not previously approved or for changes in scope or approach. Submittal by the February date will allow adequate time for OCE review and approval prior to annual budget submittals.

(7) Miscellaneous. Any additional or pertinent reports which might be required from higher authority.

Table 9-1

Huntington District Reports By Water Resources Engineering Branch

Periodic Reports

Frequency	Report
Daily	ORH Form 2347A - Morning reservoir pool elevation and discharge.
	ORD Form 85 - 24-hour rainfall, morning stage, flow and five-day flow forecast at Ohio River tributary gage points.
	- ORH Form 2347B - Three-day pool and outflow forecast.
Weekly	Reservoir effects at Ohio River tributary gage points. Oral presentation of current reservoir and stream information and current-and forecast weather information applicable to water control management.
Monthly	Record of District reservoirs available on request.
Quarterly	Review of meteorological influences on water control management activities to-Reservoir Operations Coordinating Group.
Annually	Summary of significant reservoir regulation activities for the year and of programs proposed for the following year.
Special Reports	
Daily or more frequent briefing of District Engineer and Chief Engineer during flood or other emergencies containing hydrologic, meteorologic, and operational information.	
Information relevant to flooded area or situation to the Emergency Operations Center (when functioning) such as pertinent data about the area, copies of reservoir morning and extra reports, relay of any verbal reports, and relevant NWS Weather Wire zone forecasts and special bulletins.	
Reports on reservoir operations to OCE during flood emergencies including inflow, outflow, pool elevation, predicted crest, and maximum storage utilization to date.	
Post-flood summaries of reservoir effects.	
Budget requests for water control management activities to OCE.	
Snow-melt runoff and flood potential letter report to OCE.	
Narrative summaries of major drought or low-flow conditions likely to call for regulations of District reservoirs.	
Master plans for water control data systems and significant revisions thereto are submitted to HQDA (DEAN-CWE-HY) Washington, DC 20314, for review and approval of engineering.	

TABLE 4-2

Climatic Summary – Tuscarawas River Basin

Condition	Station	Years of Record	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
Normal Monthly and Annual Precipitation (Inches)	Wooster	103	2.84	2.32	3.27	3.02	3.74	3.94	4.09	3.47	3.15	2.29	2.56	2.52	37.21
	Millport	91	2.82	2.31	3.33	3.23	3.60	3.89	4.25	3.25	3.04	2.49	2.58	2.63	37.42
	New Philadelphia	45	2.94	2.35	3.44	3.64	3.78	4.18	1.08	3.42	2.86	2.44	2.63	2.55	38.31
Normal Monthly and Annual Temperature (ºF)	Wooster	99	26.4	28.2	37.2	48.0	58.4	67.5	71.5	69.7	63.5	51.9	40.3	30.1	49.4
	Millport	89	26.6	27.4	37.4	47.8	58.0	66.5	70.5	69.0	62.8	51.4	39.9	29.7	48.9
	New Philadelphia	23	24.5	26.9	38.2	48.2	59.0	68.0	71.8	70.5	63.7	51.4	41.5	30.8	49.5
Normal Monthly and Annual Snowfall (Inches)	Wooster	92	8.9	7.4	5.3	1.6	0.1	--	--	--	--	0.2	2.6	6.7	32.8
	Millport	90	7.9	6.7	5.4	1.4	0.1	--	--	--	--	0.1	2.8	6.3	30.7
	New Philadelphia	45	9.1	7.2	5.0	0.8	--	--	--	--		0.1	2.0	6.2	30.4

Table 5-1

Dover Dam

Tuscarawas-Muskingum River Basins Stream Gaging Network – Pertinent Data

Stream and Station	Zero Gage Elevation Feet m.s.l.	Drainage Area Sq. Mi.	Date Established Month/Year	Existing Station Facilities	Method of Obtaining Data
Tuscarawas River at Massilon, OH	916.0	518	10/37	Analog –to-digital recorder, called ADR, Data collection platform (shortened to DCP). Other gages include an electric reference tape, called tape, staff, and a tipping bucket precipitation gage	DCP transmits to downlink via satellite and data disseminated to Water Resources Engineering Branch minicomputer, hereafter called water control system.
McGuire Creek of Conotton Creek at Leesville Lake	928.0	48.3	4/38	Stevens continuous recorder, called strip chart, DCP. Other gages include a tape and staff.	Project personnel view strip chart and include readings in regular and extra reports. DCP transmits via satellite to downlink and data disseminated to water control system.
McGuire Creek of Conotton Creek below LeesvilleLake	915.0	48.3	10/38	Strip chart, ADR, DCP. Other gages include a tape and staff.	Project personnel view remoted readout and include readings in regular and extra reports. DCP transmits via satellite to downlink and data disseminated to water control system.
Indian Fork of Conotton Creek at Atwood Lake	890.0	69.9	6/38	Manometer, strip chart, DCP, Other gages include a staff.	Project personnel view strip chart and include readings in regular and extra reports. DCP transmits via satellite to downlink and data disseminated to water control system.
Indian Fork of Conotton Creek below Atwood Lake	884.0	69.9	6/38	Strip chart, ADR. Other gages include a tape.	Project personnel view remoted readout and include readings in regular and extra reports.
Sandy Creek of Tuscarawas River at Bolivar Dam	895.0	504	6/38	Manometer, strip chart, DCP. Other gages include a staff.	Project personnel view strip chart and include readings in regular and extra reports. DCP transmits via satellite to downlink and data disseminated to water control system.

Table 5-1 (Continued)

Dover Dam

Tuscarawas-Muskingum River Basins Stream Gaging Network – Pertinent Data

Stream and Station	Zero Gage Elevation Feet m.s.l.	Drainage Area Sq. Mi.	Date Established Month/Year	Existing Station Facilities	Method of Obtaining Data
Sandy Creek of Tuscarwas River below Bolivar Dam	897.0	504	6/38	Staff gage.	Project personnel view staff gage and include readings regular and extra reports.
Tuscarawas River at Dover Dam	858.0	1404	6/38	Manometer, strip chart, DCP. Other gages include a staff.	Project personnel view strip chart and include readings in regular and extra reports. DCP transmits via satellite to downlink and data disseminated to water control system.
Tuscarawas River below Dover Dam	861.51	1405	10/23	ADR, voice DCP. Other gages include a tape and a tipping bucket precipitation gage.	Project personnel call DCP and include readings in regular and extra reports. DCP transmits via satellite to downlink and data disseminated to water control system
Tuscarawas River at New Philadelphia, OH	850.0	1806	/62	Strip Chart, voice DCP. Other gages include a tape, wire weight and tipping bucket precipitation gage.	Area office personnel call DCP and include readings in regular and extra reports DCP transmits via satellite to downlink and data disseminated to water control system
Tuscarawas River at Newcomerstown, OH	780.0	2443	9/21	ADR, voice DCP. Other gages include a tape and tipping bucket precipitation gage.	Area office personnel call DCP and include readings in regular and extra reports DCP transmits via satellite to downlink and data disseminated to water control system

Table 5-1 (Continued)

Dover Dam

Tuscarawas-Muskingum River Basins Stream Gaging Network – Pertinent Data

Stream and Station	Zero Gage Elevation Feet m.s.l.	Drainage Area Sq.Mi.	Date Established Month/Year	Existing Station Facilities	Method of Obtaining Data
Muskingum River near Coshocton, OH	725.0	4859	7/36	ADR, voice DCP. Other gages include a tape, wire weight and tipping bucket precipitation gage	Area office personnel call DCP and include readings in regular and extra reports DCP transmits via satellite to downlink and data disseminated to water control system
Muskingum River at Dresden, OH	693.15	5993	9/21	ADR, voice DCP. Other gages include a tape.	Project personnel call DCP and include readings in regular and extra reports. DCP transmits via satellite to downlink and data disseminated to water control system
Muskingum River at Zanesville, OH	667.0	6844	10/60	Manometer, strip chart, ADR, voice DCP. Other gages include a staff and tipping bucket precipitation gage	Area office personnel call DCP and include readings in regular and extra reports DCP transmits via satellite to downlink and data disseminated to water control system
Muskingum River at McConelsville, OH	650.31	7422	10/21	Manometer, strip chart, ADR, voice DCP. Other gages include tipping bucket precipitation gage.	Area office personnel call DCP and include readings in regular and extra reports DCP transmits via satellite to downlink and data disseminated to water control system
Ohio River near Marietta, OH	567.12	35600	10/68	Strip chart, ADR, voice DCP. Other gages include a tape, staff and tipping bucket precipitation gage	DCP transmits via satellite to downlink and data disseminated to water control system

Table 5-2

Precipitation Stations In and Near Tuscarawas River – Dover Dam Basin – Pertinent Data

Record From	Station	Equipment	Method of Obtaining Data	Reporting Criteria
1/95	Chippewa Lake	8-inch Standard Rain Gage (SRG)	Observer calls Muskingum Area Office about 0730 hours. Additional reports (including weekends and holidays) also called in to area office personnel or to office recorder	0.5 inch precipitation collected in 24 hours prior to 0700 or in 12 hours prior to 1900. Any subsequent precipitation reported each 12 hours until told to stop or after first report is zero. Each report is of precipitation since previous 0700 reading.
4/46	Marshallville	8-inch SRG	Observer calls Muskingum Area Office about 0730 hours. Additional reports (including weekends and holidays) also called in to area office personnel or to office recorder	0.5 inch precipitation collected in 24 hours prior to 0700 or in 12 hours prior to 1900. Any subsequent precipitation reported each 12 hours until told to stop or after first report is zero. Each report is of precipitation since previous 0700 reading.
9/46	Louisville	8-inch SRG	Observer calls Muskingum Area Office about 0730 hours. Additional reports (including weekends and holidays) also called in to area office personnel or to office recorder	0.5 inch precipitation collected in 24 hours prior to 0700 or in 12 hours prior to 1900. Any subsequent precipitation reported each 12 hours until told to stop or after first report is zero. Each report is of precipitation since previous 0700 reading.
5/84	Massillon	Tipping bucket gage with heater and data collection platform	Platform transmits via satellite to receiver each 4 hours. Water control system retrieves data.	Data Collection interval 60 minutes.

Table 5-2 (Continued)

Precipitation Stations In and Near Tuscarawas River – Dover Dam Basin – Pertinent Data

Record From	Station	Equipment	Method of Obtaining Data	Reporting Criteria
4/38	Bolivar Dam	8-inch SRG	Project personnel read gage and include reading in morning report. Extra reports by telephone to area office.	Daily at 0730 amount of precipitation collected in previous 24 hours. Extra at 1330 if 0.5 inch or more collected after 0730
3/38	Beach City Lake	8-inch SRG	Project personnel read gage and include reading in morning report. Extra reports by telephone to area office.	Daily at 0730 amount of precipitation collected in previous 24 hours. Extra at 1330 if 0.5 inch or more collected after 0730
7/92	Millport	8-inch SRG	Observer calls Muskingum Area Office about 0730 hours. Additional reports (including weekends and holidays) also called in to area office personnel or to office recorder	0.5 inch precipitation collected in 24 hours prior to 0700 or in 12 hours prior to 1900. Any subsequent precipitation reported each 12 hours until told to stop or after first report is zero. Each report is of precipitation since previous 0700 reading.
10/40	Carrollton	8-inch SRG	Observer calls Muskingum Area Office about 0730 hours. Additional reports (including weekends and holidays) also called in to area office personnel or to office recorder	0.5 inch precipitation collected in 24 hours prior to 0700 or in 12 hours prior to 1900. Any subsequent precipitation reported each 12 hours until told to stop or after first report is zero. Each report is of precipitation since previous 0700 reading.
4/38	Dover Dam	8-inch SRG	Project personnel read gage and include reading in morning report. Extra reports by telephone to area office.	Daily at 0730 amount of precipitation collected in previous 24 hours. Extra at 1330 if 0.5 inch or more collected after 0730

Table 5-2 (Continued)

Precipitation Stations In and Near Tuscarawas River – Dover Dam Basin – Pertinent Data

Record From	Station	Equipment	Method of Obtaining Data	Reporting Criteria
12/36	New Philadelphia	Tipping bucket gage with heater and data collection platform	Platform transmits via satellite to receiver each 4 hours. Water control system retrieves data.	Data Collection interval 60 minutes.
4/38	Atwood Lake	8-inch SRG	Project personnel read gage and include reading in morning report. Extra reports by telephone to area office.	Daily at 0730 amount of precipitation collected in previous 24 hours. Extra at 1330 if 0.5 inch or more collected after 0730
4/38	Leesville Lake	8-inch SRG	Project personnel read gage and include reading in morning report. Extra reports by telephone to area office.	Daily at 0730 amount of precipitation collected in previous 24 hours. Extra at 1330 if 0.5 inch or more collected after 0730
4/38	Tappan Lake	8-inch SRG	Project personnel read gage and include reading in morning report. Extra reports by telephone to area office.	Daily at 0730 amount of precipitation collected in previous 24 hours. Extra at 1330 if 0.5 inch or more collected after 0730
9/30	Cadiz	8-inch SRG	Observer calls Muskingum Area Office about 0730 hours. Additional reports (including weekends and holidays) also called in to area office personnel or to office recorder	0.5 inch precipitation collected in 24 hours prior to 0700 or in 12 hours prior to 1900. Any subsequent precipitation reported each 12 hours until told to stop or after first report is zero. Each report is of precipitation since previous 0700 reading.

Table 8-1

Peak Flood Stage Reduction (feet) by Muskingum Basin Reservoirs

Flood Date	Below Dover Dam		Tuscarawas River at New Philadelphia		Tuscarawas River at Newcomerstown		Muskingum River at Newcomerstown		Muskingum River at Dresden		Muskingum River at Zanesville		Muskingum River at McConnelsville	
	Nat	Mod	Nat	Mod	Nat	Mod	Nat	Mod	Nat	Mod	Nat	Mod	Nat	Mod
March 1913	23.1	10.7			20.5	13.8	29.6	19.5	45.0	28.6	52.4	30.5	33.0	17.3
January 1937	16.5	8.2	13.3	6.9	17.0	11.0	22.4	13.9	33.0	21.3	38.0	21.5	22.5	13.0
January 1959	18.3	8.3	14.9	7.7	17.1	9.8	24.1	13.6	33.8	18.9	39.6	21.0	22.0	11.8
July 1969	13.3	8.1	15.0	8.6	16.8	9.0	25.0	14.4	33.0	20.1	35.0	19.1	19.9	10.1
February 1979	14.7	6.7	11.3	6.1	14.2	8.2	19.0	10.0	26.6	16.5	30.0	18.2	17.7	11.5
August 1980														
1st Rise	8.1	6.0	7.0	5.5	9.8	8.8	17.1	16.0	23.7	18.8	26.3	18.8	16.6	12.8
2nd Rise	10.5	6.0	9.7	5.5	12.5	8.8	15.0	13.4	17.8	15.5	17.2	15.8	9.3	8.6
3rd Rise	8.4	6.0	8.0	5.6	9.1	8.6	17.7	14.9	19.9	16.7	21.5	17.8	13.4	11.0

Table 8-2

Peak Flood Discharge Reduction (1000 cfs) by Muskingum Basin Reservoirs

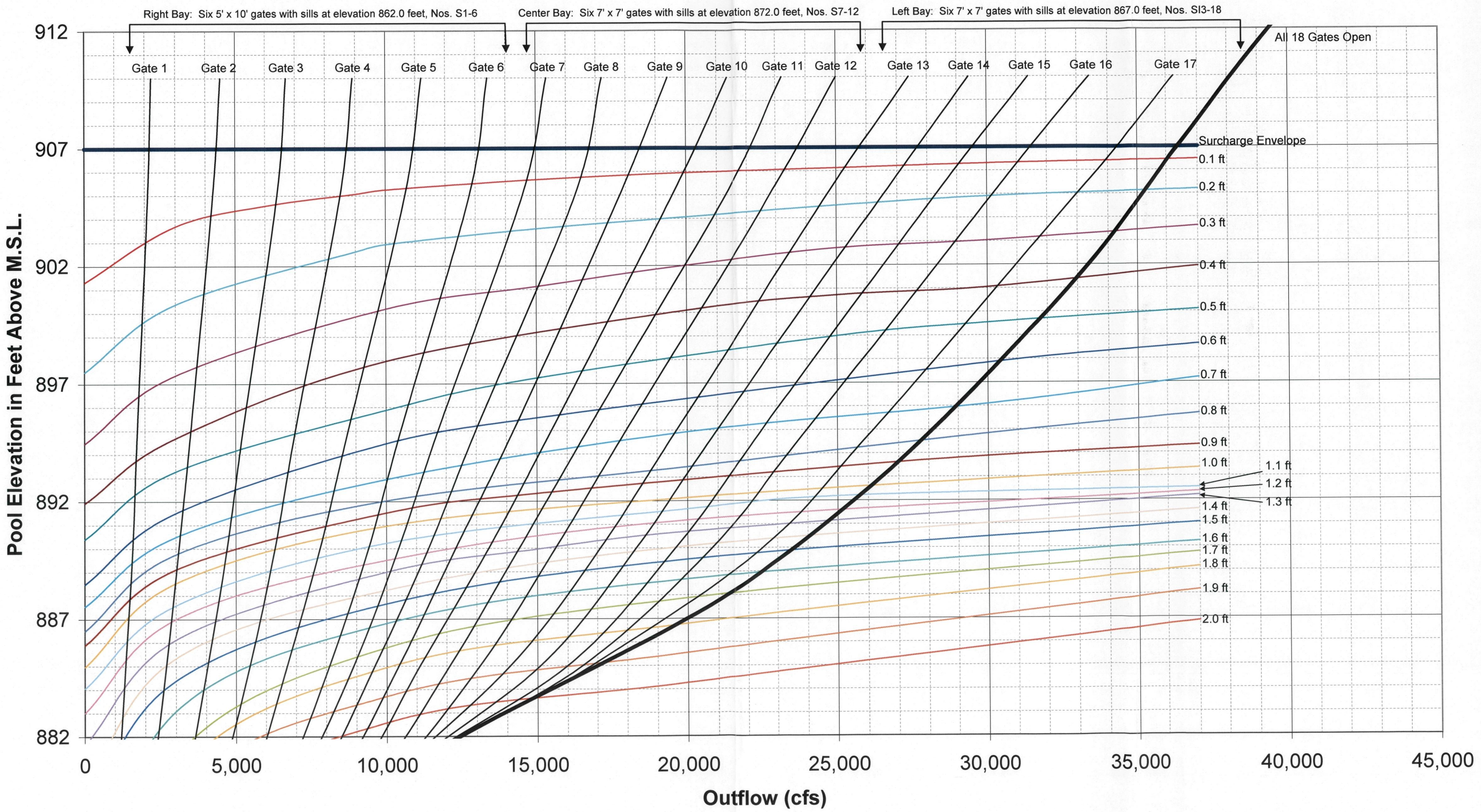
Flood Date	Below Dover Dam		Tuscarawas River at New Philadelphia		Tuscarawas River at Newcomerstown		Muskingum River at Newcomerstown		Muskingum River at Dresden		Muskingum River at Zanesville		Muskingum River at McConnelsville	
	Nat	Mod	Nat	Mod	Nat	Mod	Nat	Mod	Nat	Mod	Nat	Mod	Nat	Mod
March 1913	61.2	12.3	79.7	16.0	84.4	27.8	203.0	80.2	228.0	87.7	251.5	82.2	272.0	95.2
January 1937	27.2	6.7	35.3	9.3	50.0	16.8	92.7	33.6	107.0	44.0	125.0	45.5	132.0	56.0
January 1959	36.0	7.1	51.6	11.0	51.8	13.8	108.0	32.5	117.8	39.5	140.5	86.3	133.0	82.0
July 1969	19.0	3.4	52.8	13.4	50.0	12.1	119.3	46.1	111.0	38.1	112.2	36.8	109.6	35.6
February 1979	16.1	5.8	22.4	8.9	30.3	10.9	52.1	20.4	68.3	27.3	89.3	35.2	91.0	45.4
August 1980														
1st Rise	7.2	4.2	9.4	6.9	14.4	10.9	27.5	23.4	49.5	33.5	71.0	35.8	81.8	53.2
2nd Rise	11.6	4.3	16.5	7.1	22.0	10.9	20.6	15.7	30.4	22.0	30.5	26.1	30.5	27.2
3rd Rise	8.2	3.9	11.6	7.1	12.4	10.5	29.5	20.0	38.0	26.5	48.5	32.5	48.5	41.2

Table 8-5

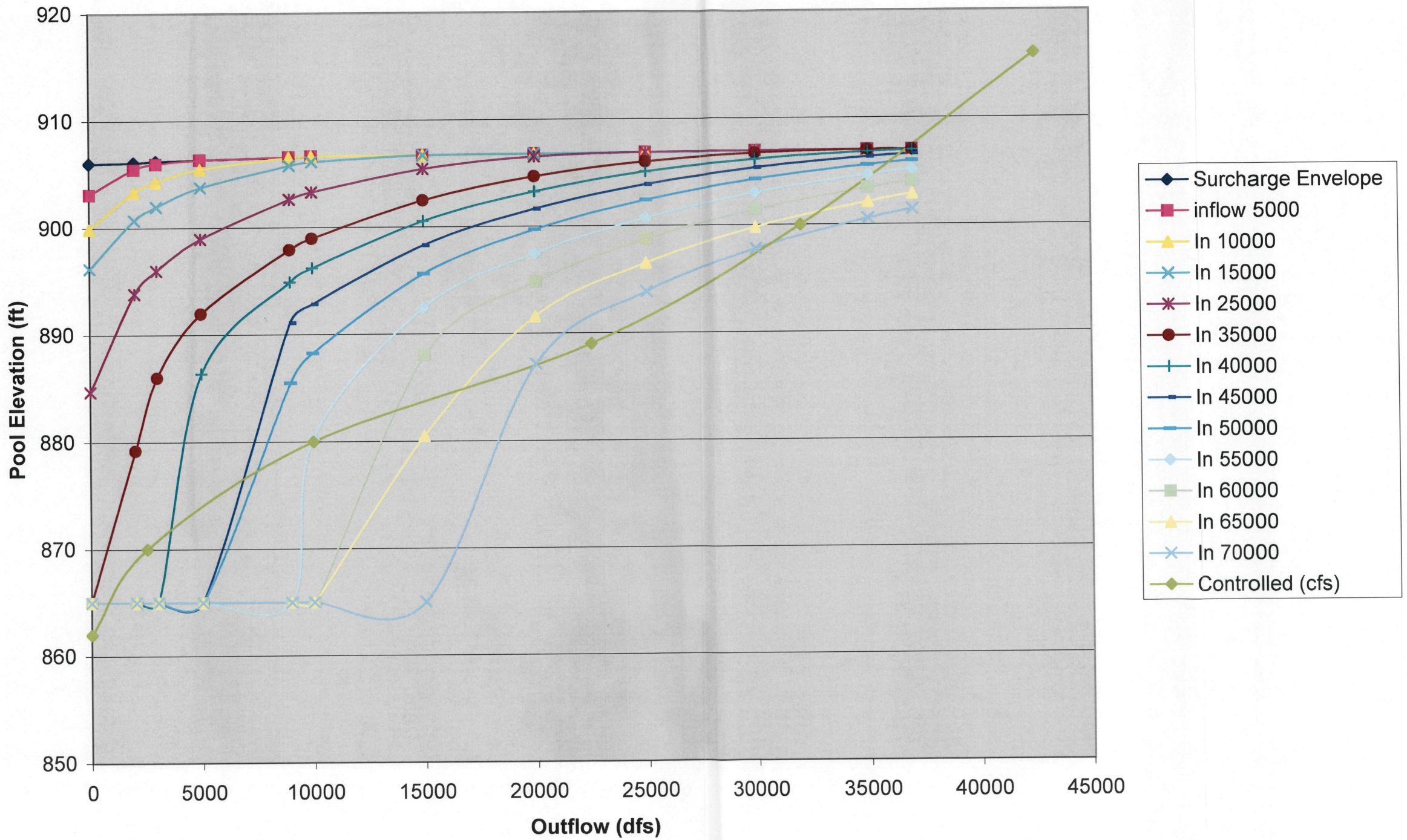
Frequency Summary Tuscarawas, Muskingum, and Ohio Rivers Below Dover Dam – All Seasons

Exceedence Interval Years	New Philadelphia		Newcomerstown		Coshocton		Discharge in cfs at Dresden		Zanesville		McConnelsville		Marietta	
	Nat.	Mod.	Nat.	Mod.	Nat.	Mod.	Nat.	Mod.	Nat.	Mod.	Nat.	Mod.	Nat.	Mod.
1000	97,000	32,000	137,000	66,000	300,000	147,000	310,000	131,400	320,000	122,000	345,000	148,000	755,000	585,000
500	85,000	24,400	118,000	50,100	253,000	107,200	265,000	101,600	274,000	97,700	297,000	115,100	708,000	537,000
200	70,000	17,300	94,600	33,100	196,000	74,200	212,000	78,000	222,000	78,000	243,000	91,200	646,000	480,000
100	65,500	14,100	79,500	24,100	161,000	60,600	178,000	64,500	188,000	68,000	207,000	77,700	598,000	440,000
50	51,500	11,800	66,300	18,100	132,000	51,500	148,000	53,700	158,000	59,500	175,000	65,500	548,000	402,000
20	40,500	10,000	51,500	15,000	100,000	42,000	112,000	43,100	124,000	50,500	137,000	54,100	481,000	355,000
10	33,300	9,600	42,800	15,000	79,200	35,600	92,400	38,000	100,000	45,400	111,000	47,500	429,000	320,000
5	27,000	9,500	33,500	15,000	63,800	31,900	74,000	34,000	81,000	43,400	90,000	45,000	377,000	285,000
2	20,300	9,500	25,000	15,000	46,000	28,800	55,000	30,800	60,000	43,400	66,000	45,000	305,000	242,000
1	16,000	9,500	19,200	15,000	36,000	27,700	43,000	29,100	48,000	43,400	51,500	45,000	248,000	205,000

Dover Dam
Interim Emergency Operations Schedule (Max Pool 907.0 ft)



Interim Office Reg Sch for Major Floods IOE 907



Pool ELV Ft	**Dover** Capacity Inches	Remaining Capacity Inches
895.0	1.16	2.19
895.5	1.22	2.13
896.0	1.28	2.07
896.5	1.35	2.01
897.0	1.41	1.94
897.5	1.48	1.88
898.0	1.54	1.81
898.5	1.61	1.75
899.0	1.67	1.68
899.5	1.75	1.61
900.0	1.82	1.53
900.5	1.89	1.46
901.0	1.96	1.39
901.5	2.00	1.36
902.0	2.03	1.32
902.5	2.16	1.20
903.0	2.28	1.07
903.5	2.36	0.99
904.0	2.44	0.91
904.5	2.53	0.83
905.0	2.61	0.74
905.5	2.70	0.65
906.0	2.79	0.56
906.5	2.88	0.47
907.0	2.97	0.38
907.5	3.07	0.29
908.0	3.16	0.19
908.5	3.26	0.10
909.0	3.35	0.00

DOVER DAM

TUSCARAWAS - MUSKINGUM RIVER BASINS

PERTINENT DATA

LOCATION OF PROJECT

The dam is located in Tuscarawas County, Ohio, on the Tuscarawas River, a tributary of the Muskingum River, approximately 174 miles above the mouth of the Muskingum and about 3.5 miles northwest of Dover, Ohio.

TYPE OF PROJECT

Flood Control.

AUTHORITY

The Muskingum Watershed Conservancy District was created on 3 June 1933, for the purpose of developing a plan for flood control, water conservation, and water use in the Muskingum River Basin. A general plan was prepared, and application for approval of the project system and a request for financial cooperation was filed with the Federal Emergency Administration of Public Works in August 1933. The Public Works Administration approved the project system in December 1933 and allocated funds to the Corps of Engineers in financing the construction of the projects.

The Corps of Engineers initiated investigations following the execution of a contract between the United States of America and the Muskingum Watershed Conservancy District on 29 March 1934. The official plan was proposed by the COE and was approved by the Conservancy District on 19 November 1934.

The Flood Control Act, approved 11 August 1939, contained a provision that the dams and reservoirs be included in the Comprehensive Flood Control Plan for the Ohio River Basin. Operation and maintenance of the 16-reservoir system (which includes Dover Dam) have been the responsibility of the Corps of Engineers since that date.

PURPOSES

The project was initially authorized for reduction of flood heights on the Tuscarawas and Muskingum Rivers. As noted in the paragraph above, the project was later included in the Comprehensive Ohio River Flood Control Plan.

DOVER DAM

PERTINENT DATA (Cont'd)

DRAINAGE	**(Square Miles)**
Tuscarawas River at Clinton	174
Tuscarawas River at Massillon	518
Sandy Creek at Waynesburg	253
Nimishillen Creek at mouth	188
Sandy Creek above Nimishillen Creek	293
Sandy Creek at mouth (Bolivar Dam)	504
McGuire Creek at Leesville Lake	48
Conotton Creek above McGuire Creek	92.4
Indian Fork at Atwood Lake	70
Conotton Creek above Indian Fork	167
Conotton Creek at mouth	286
Tuscarawas River at Dover Dam	1,404
Tuscarawas River at mouth	2,596
Muskingum River at mouth	8,051

STREAMFLOW DATA	**(Cubic feet per second)**
Average annual flow just below dam site	1,430
Maximum peak discharge at dam site (1913-computed)	61,500
Minimum discharge just below dam site	6.5

RESERVOIR DATA	**Elevations (Feet NGVD)**
Streambed at dam site	860
Minimum pool	---
Flood control pool	916
Spillway design flood	---

CAPACITIES	**Acre Feet**	**Inches Runoff**
Minimum pool	---	---
Flood control pool	203,000	4.9
Total storage	203,000	4.9

	Surface Areas (Acres)
Flood control pool	10,100

	Backwater along Main Stream (Miles)
Flood control pool	23.2

DOVER DAM

PERTINENT DATA (Cont'd)

DAM

Type - Concrete Gravity	
Maximum height, feet	83
Height above natural streambed, feet	71
Crest length, feet	824
Crest width, feet	25.5
Base width, feet	75±

SPILLWAY

Type - Uncontrolled overflow ogee in channel Section of dam	
Crest length, feet	338
Crest elevation, feet NGVD	916
Design discharge, cubic feet per second	123,000
Surcharge, feet	20.8

OUTLET WORKS

There are 18 sluices through the spillway section of the dam. The sluices are grouped into 3 bays with 6 control gates each that discharge through short conduits into stilling basins at the toe of the dam. Each bay has a different invert elevation and each discharge into a correspondingly different stilling basin elevation. The bays are designated left-center-right (L-C-R) looking downstream, and the gates are numbered consecutively beginning with Number I on the left side also facing downstream.

Number of control gates	18
Size of control gates, feet	
6 - left bay	7x7
6 - center bay	7x7
6 - right bay	5xl0
Invert elevation of control gates, ms!	
6 - left bay	867
6 - center bay	872
6 - right bay	862
Maximum outlet discharge, cfs	
At spillway elevation - all gates open	42,800

DOVER DAM

PERTINENT DATA (Cont'd)

STILLING BASIN

Each of the 18 conduits discharges flows between flared training walls down a stepped apron then through the baffle system of the stilling basin into the original channel. The stilling basin is divided into three sections, each at a different elevation corresponding to the 3 bays of conduits in the spillway section. The two end sections are confined along the riverbank by heavy retaining walls, while the middle section is separated by intermediate walls.

	Elevation (NGVD)
Type - Conventional jump type with baffles	
Left section	860
Center section	859
Right section	854
Row of Baffles	
Left section	3
Center section	3
Right section	2
Width, feet	
All 3 sections	338
Length, feet	
Each section	±100

OTHER STRUCTURES

Zoar Levee - Protects Zoar Village, 4 miles north of dam. Levee is earth fill, 3,893 feet in length, maximum height 45 feet to elevation 928.5 feet NGVD. Appurtenant works include four roadway ramps, a diversion dam and channel, a gated concrete culvert and a pump station.

Somerdale Levee - Protects town of Somerdale, 3 miles east of dam. Railroad embankment 4,070 feet long constructed of impervious material to elevation 919 feet NGVD forms levee, with 3 gated culverts with automatic drains.

Industrial Levees - Three small levees protect industrial facilities at Zoar, Zoarville, and at Mineral City.

U.S. ARMY ENGINEER DISTRICT, HUNTINGTON
CORPS OF ENGINEERS
HUNTINGTON, WEST VIRGINIA

TUSCARAWAS RIVER
OHIO

PROJECT MANUAL
FOR
WATER CONTROL MANAGEMENT
DOVER DAM - TUSCARAWAS RIVER

INSTRUCTIONS TO DAMTENDER
DOVER DAM
2001

EXHIBIT B

INSTRUCTIONS TO DAMTENDER

DOVER DAM – TUSCARAWAS RIVER

U.S. ARMY CORPS OF ENGINEERS

HUNTINGTON DISTRICT

MAY 2001

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DOVER DAM

SECTION I - GENERAL OPERATION INSTRUCTIONS

1-01 GENERAL

Follow instructions given in this section under one or more of the sections at all times, except when other operations are required by Special Directive issued by Water Control Section of the Huntington District Office and normally directed through the Muskingum Area Office. In the event contact cannot be made with proper personnel of the Area Office, the Water Control Section personnel will issue Special Directives directly to the project.

a. The project is to be operated to allow free flow of the river at all times except when flow restriction or complete closure is necessary for downstream flood control.

b. Instructions contained in Special Directives will be applicable for a specific operation or for a stated period of time. After the instructions specified have been executed, resume operation in accordance with the following general instructions.

1-02 GATE REGULATION TECHNIQUE

a. General. Facilities provided for water control include 18 sluice gates on three levels arranged in three bays of six gates each and an uncontrolled spillway for relief from excessive floods. Sluice gates are designated S-1 through S-18 from left to right facing downstream. Gates S-13 through S-18 are designed for opening to any desired height whereas S-1 through S-12 are designed for operation only in fully open or fully closed position.

Under normal conditions (see **Plate 3-1**) during DEMIA*, gates are left open to allow free flow of the river through the dam. However, during MIANO* left and center bays are kept closed at all times because of the greater possibility of flash flooding from a summer-type storm which might occur when the project is unattended. Such an occurrence could cause flooding downstream with all gates open before arrangements could be made to man the project. When gates are closed for downstream control, they are to be closed in the following order unless instructed otherwise by Special Directive: Gates S13-18, S6-1, S7, S12, S8, S11, S9 and finally S10. They are to be opened in reverse order. Gates are operated in opening and closing so as to limit the rate of change in stage at the outflow "D" gage, to a maximum of 1.0 foot per hour. This rate of change in stage is approximate to the natural rate and is not to be exceeded except under Special Directive from Water Control

* Acronyms for mid-April through November and December to mid-April

Section or, in emergency conditions, under provisions of **Section 1-05**.

Plate 1-1 (at the end of this section) shows approximate stage and discharge to be reached on the Outflow "D" gage under various conditions of lake level and openings of gates in the right bay, gates S13-18. Using these tables as a guide, the approximate gate openings required to attain a designated stage at the Outflow gage can be determined. When the flow at the Outflow gage has stabilized after setting the gates as determined by the tables, only a minor adjustment of the gates should be necessary to attain the designated stage. **Plate 1-2** gives the same information for gates in left and center bays, Gate Numbers S1-12.

b. Sluice Gates. All the gates are hydraulically operated slide gates. Those in the left and center bays are 7.0’ x 7.0’ and in the right bay, 5.0’ x 10.0’. Invert elevations in feet above mean sea level are respectively 857.0, 872.0, and 862.0 of gates in left, center and right bays.

1-03 ROUTINE OPERATION

Under normal DEMIA conditions, the gates are to be maintained in fully open position, subject to Special Directive, in order to allow free flow of the river through the dam. However, during MIANO left and center bays are kept closed.

Regulation under normal conditions (not under Special Directive) may be determined by the Dover Dam staff; however, releases shall not exceed a stage at the outflow gage of 4.2 feet (2440 cfs) in MIANO or 4.7 feet (2910 cfs) in DEMIA unless specifically directed by the Water Control Section. After rainfall or when there is a general stream rise, guidance presented in the following paragraphs shall be used to maintain proper project conditions.

1-04 OPERATION FOR DOWNSTREAM CONTROL

During reservoir regulation activity, a maximum stage at the outflow gage of 6.5 feet (4860 cfs) during MIANO and 7.5 feet (6070 cfs) during DEMIA can be maintained without causing any appreciable damage along Tuscarawas River downstream from the dam to the confluence with Sugar Creek. These channel capacity discharges must be covered by Special Directive. Similarly, no appreciable damage occurs in the reach along Sugar Creek to the Tuscarawas River and down Tuscarawas River to the gage at New Philadelphia when maximum stages of 6.5 and 7.0 feet on the New Philadelphia gage are maintained in MIANO and DEMIA periods, respectively. When significant rainfall occurs over the uncontrolled drainage areas along Tuscarawas River and Sugar Creek, discharges will be regulated from Dover Dam so as not to add to or cause flooding at downstream control stations. The control stages and flows for the key stations at Tuscarawas, Muskingum and Ohio River are summarized in **Table 1-1** below.

Table 1-1

Control Stages And Flows At Key Stations

Station	River	Crop Season[1]		Non - Crop Season[2]		Cum. Travel Time, Dam to Station (hrs)
		Stage (feet)	Flow (cfs)	Stage (feet)	Flow (cfs)	
Dover outflow gage	Tuscarawas	6.5	4,832	7.5	6,026	--
New Philadelphia	Tuscarawas	6.5[3]	8,590	7.0	9,550	4
Newcomerstown	Tuscarawas	9.5	13,200	11.0	16,250	20
Coshocton	Muskingum	15.5	21,810	18.0	30,660	30
Dresden	Muskingum	16.0	23,420	18.5	32,000	41
Zanesville	Muskingum	19.5	38,200	21.5	48,000	45
McConnelsville	Muskingum	10.0	35,600	11.0	41,600	51
Marietta	Ohio	35.0	260,000	35.0	260,000	72[4]

1 16 April through 30 November
2 1 December through 15 April
3 Damage begins at 6.0 feet
4 Operational time prior to crest stage in excess of 35 feet

Operation for the Ohio River at Marietta, Ohio is based on stage forecasts and water travel time from the project to Marietta. Special Directives will be issued by Water Control Section for operation of Dover Dam for Ohio River Control. Releases are timed so as not to add to the crest at Marietta or other stations downstream along the Ohio River.

1-05 OPERATION DURING COMMUNICATIONS FAILURE

During flood periods, make every effort to contact personnel of the Area Office and failing that, the Water Resources Engineering Branch. Possibly other projects can help reach the District Office. If both radio and telephone facilities fail, solicit cooperation of local radio and T.V. stations, amateur and citizens band radio operators, or of the State Police. The emergency procedure outlined below shall be followed during periods when the Water Resources Engineering Branch cannot be contacted either through the Area Office or otherwise.

a. If a Special Directive from the Water Control Section was in effect prior to communications failure, follow the operating instructions contained in the Special Directive until:

(1) The specific operation given in the Directive has been completed, or

(2) Twenty-four hours have elapsed since last contact with the Water Control Section either through the Area Office or otherwise, or

(3) Sufficient rainfall or snow melt occurs which causes the lake gage or streams in the vicinity to rise rapidly.

b. Whenever any of the foregoing conditions, (1), (2) or (3) occurs, or if not under Special Directive and either of conditions (2) or (3) applies, follow operating instructions contained in sections 1-03, 1-04, or 1-05c, whichever is applicable.

1-06 EMERGENCY OPERATION

a. Emergency Operation Schedule Instructions contained here involve the Emergency Operation Schedule, **Plate 1-3** and take precedence over all preceding instructions. The Emergency Operation Schedule is provided for use by the Damtender for a rare flood event and complete failure of communication with Water Control Section either through the Area Office or otherwise.

Whenever the lake level is above elevation 883.0 feet and rising, a constant check shall be made on the rate of rise of the lake level. Read the lake gage every hour on the hour and calculate the rise in lake level for the previous hour.

Enter the rate-of-rise curves of the Emergency Operation Schedule with the rise and current lake level and read the Sluice Gate Position at the bottom of the Schedule. Look in the table to the right of the curves for necessary sluice gate settings opposite the Sluice Gate Position. Should the required settings be greater than the current gate settings, contact the Water Control section immediately for operating instructions.

In the event of failure of normal means of communication (radio and telephone), continuous and vigorous effort shall be made to contact the Water Control Section as described above. Authorization is hereby given to operate the project in accordance with the Emergency Operation Schedule (**Plate 1-3**) when there is a three-hour or greater delay in establishing contact with the Water Control section, from the time that the curves indicate gate settings greater than those being maintained in accordance with other instructions. In such emergency situations, follow the procedures described below, continuing efforts to contact Water Control Section before and after each operation for guidance in use of the rate-of-rise curves.

(1) Emergency operation shall be based on the last readings taken and no attempt shall be made to make up for any missed operation steps. The required gate settings shall be executed as soon as they have been determined from the Emergency Operation Schedule, **Plate 1-3**.

(2) One hour after the previous reading, the lake gage shall be read again, the new rate of rise computed and the required gate settings executed as determined from the Emergency Operation Schedule.

(3) Continue the hourly computations and gate settings until the lake level crests.

(4) If the lake level crests above spillway elevation 916.0, maintain the current gate settings until the lake level recedes to elevation 916.0; then gradually close the gates as necessary to maintain the lake level at that elevation until ordered by Special Directive to begin drawdown operation.

(5) If the lake level crests below spillway elevation of 916.0, gradually close the gates as necessary to maintain the crest lake level until ordered by Special Directive to being drawdown operation.

(6) If a second rise occurs while out of communication with Water Control Section, resume operation in accordance with rate-of rise curves and instructions printed in the Emergency Schedule.

1-07 PUBLIC NOTIFICATION OF UNUSUAL RELEASES

Operation of reservoir projects during major floods has, on occassion, resulted in water releases being made which damaged privately owned equipment or facilities located downstream and caused claims or damage suits to be filed against the Government. To minimize the possibility of such claims or suits, Dover Dam Damtender must stay informed and inform Water Control Section of all developments along Tuscarawas River between the dam and the USGS gage at New Philadelphia, Ohio.

If required by unusual release patterns, obtain directions through the Area Office, from Water Control Section, who will coordinate the release with Public Affairs Office for public notification procedures. Unusual release patterns include closure for flood control, maintenance, inspection, or construction purposes, and emergency, above channel capacity discharges. Notification of large releases is to afford those likely to be affected an opportunity to take remedial measures in advance of the release.

DISCHARGE TABLES FOR GATES OF RIGHT BAY – S13-18

(Six 5′x10′ gates with sills at elevation 862)

Note: Values in "F" columns are numbers of fully open gates used for discharge.
Values in "P′ columns are partial openings of one gate used for discharge.
"M" means more than six gates required for discharge from elevation

Stage at	Gate Openings for Discharge at Lake Elevation																							
"D"Gage	Discharge	867		870		875		880		885		890		895		900		905		910		916	
Feet	c.f.s.	F	P	F	P	F	P	F	P	F	P	F	P	F	P	F	P	F	P	F	P	F	P
1.30	270	1	1.7		4.0		2.7		2.3		2.0		1.8		1.6		1.5		1.4		1.3		1.3
1.71	500	2	2.9	1	2.1		5.6		4.3		3.8		3.3		3.1		2.8		2.7		2.6		2.4
1.87	600	3	1.0	1	3.9		7.0		5.4		4.6		4		3.6		3.3		3.1		3.0		2.9
2.00	690	3	3.0	2	0.1		8.8		6.1		5.3		4.7		4.3		3.9		3.8		3.5		3.2
2.17	800	4	1.4	2	1.6	1	0.5		7.2		6.1		5.4		4.9		4.6		4.2		4.0		3.8
2.31	900	5	0.0	2	3.1	1	1.5		8.2		6.9		6.1		5.5		5.1		4.8		4.6		4.2
2.45	1000	5	0.9	2	5.6	1	2.5		8.3		7.6		6.7		6.1		5.7		5.3		5.0		4.7
2.59	1100	6	0.2	3	1.0	1	3.6	1	0.0		8.4		7.4		6.7		6.1		5.8		5.5		5.2
2.72	1200	M		3	2.5	1	5.0	1	0.8		9.1		8.0		7.2		6.8		6.3		5.9		5.7
2.98	1400	M		4	0.6	1	7.9	1	2.6	1	0.3		9.2		8.3		7.8		7.2		6.8		6.5
3.23	1600	M		4	3.6	2	1.0	1	4.4	1	1.7	1	0.1		9.3		8.8		8.1		7.7		7.3
3.47	1800	M		5	1.2	2	3.1	1	6.2	1	3.2	1	1.4	1	0.2		9.6		9.0		8.5		8
3.70	2000	M		5	4.5	2	5.6	1	8.2	1	4.9	1	2.8	1	1.3	1	0.3		9.8		9.2		8.8
4.04	2300	M		M		3	0.5	2	0.8	1	7.1	1	5.0	1	3.2	1	2.0	1	0.7	1	0.3		9.7
4.37	2600	M		M		3	3.7	2	3.4	1	9.4	1	6.9	1	5.2	1	3.8	1	2.3	1	1.7	1	0.9
4.80	3000	M		M		4	0.0	2	7.2	2	2.1	1	9.3	1	7.2	1	5.9	1	4.6	1	3.8	1	2.7
5.29	3500	M		M		4	5.6	3	1.7	2	5.9	2	2.3	1	9.9	1	8.4	1	6.9	1	6.2	1	5.1
5.75	4000	M		M		5	2.6	3	6.3	2	9.6	2	5.7	2	2.8	2	0.6	1	9.1	1	8.3	1	7.3
6.20	4500	M		M		6	0.0	4	0.8	3	3.1	2	8.9	2	5.4	2	3.4	2	0.9	2	0.0	1	9
6.50	4860	M		M		M		4	4.0	3	5.9	3	0.8	2	8.0	2	5.5	2	3.4	2	1.8	2	0.3
6.62	5000	M		M		M		4	5.4	3	1.0	3	1.6	2	8.7	2	6.1	2	3.6	2	2.5	2	0.9
7.04	5500	M		M		M		5	0.0	4	0.4	3	5.1	3	1.3	2	8.8	2	6.2	2	5.0	2	3.2
7.50	6070	M		M		M		5	5.1	4	4.8	3	8.7	3	4.6	3	1.2	2	9.2	2	7.6	2	5.8
7.84	6500	M		M		M		5	9.3	4	8.0	4	1.2	3	7.1	3	3.8	3	0.1	2	9.2	2	7.7

PLATE NO. 1-1

DISCHARGE TABLES FOR GATES OF LEFT AND CENTER BAYS

(Gates operated either fully open or fully closed)
"M" means more than 6 gates required for discharge at elevation

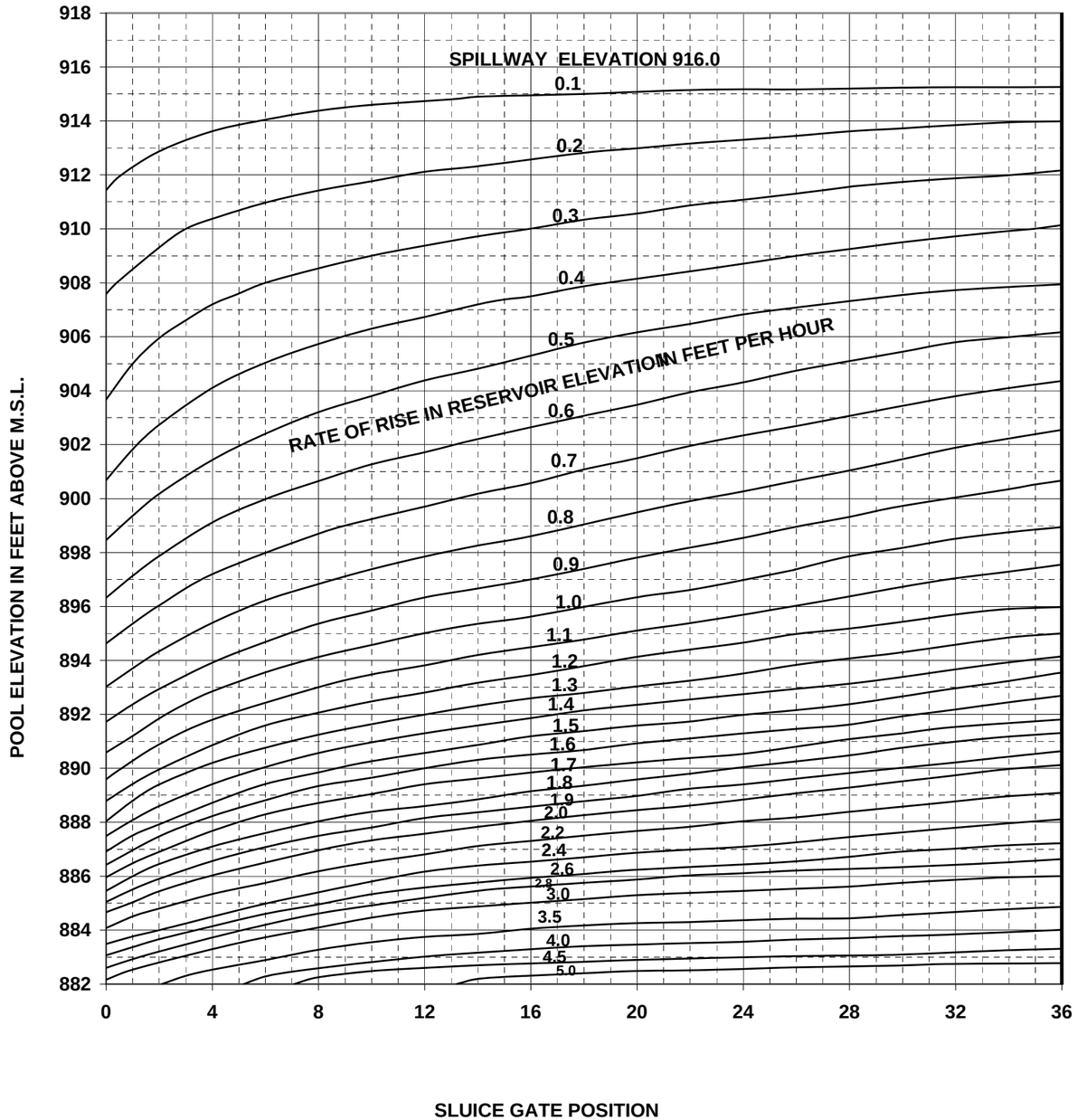
LEFT BAY: Six 7′x7′ gates with sills at elevation 867.0 feet, Nos. SI-6

Stage at "D" Gage (feet)	Discharge c.f.s.	Gates Required Open for Discharge at Lake Elevation										
		868	870	875	880	885	890	895	900	905	910	916
2.00	690	M	6	2	1	1	1	1	1	1	1	1
2.17	800	M	M	2	1	1	1	1	1	1	1	1
2.45	1000	M	M	2	2	1	1	1	1	1	1	1
3.10	1500	M	M	4	2	2	1	1	1	1	1	1
3.70	2000	M	M	5	3	2	2	2	2	1	1	1
4.26	2500	M	M	6	3	3	2	2	2	2	2	2
4.80	3000	M	M	M	4	3	3	2	2	2	2	2
5.29	3500	M	M	M	5	3	3	3	2	2	2	2
5.75	4000	M	M	M	5	4	3	3	3	3	2	2
6.62	5000	M	M	M	6	5	4	4	3	3	3	3
7.45	6000	M	M	M	M	6	5	4	4	4	3	3

CENTER BAY: Six 7′x7′ gates with stlIs at elevation 872.0 feet. Nos. S7-12

		875	880	885	890	895	900	905	910	916
2.00	690	6	2	1	1	1	1	1	1	1
2.17	800	M	2	1	1	1	1	1	1	1
2.45	1000	M	3	2	1	1	1	1	1	1
3.10	1500	M	4	2	2	2	1	1	1	1
3.70	2000	M	5	3	2	2	2	2	1	1
4.26	2500	M	6	3	3	3	2	2	2	2
4.80	3000	M	M	4	3	3	2	2	2	2
5.29	3500	M	M	5	3	3	3	2	2	2
5.75	4000	M	M	5	4	4	3	3	2	2
6.62	5000	M	M	6	5	5	4	3	3	3
7.45	6000	M	M	M	6	6	4	4	4	3

PLATE NO. 1-2



SLUICE GATE NUMBER

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
0	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
1	C	C	C	C	C	C	C	C	C	C	C	C	5	C	C	C	C	C
2	O	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
3	O	C	C	C	C	C	C	C	C	C	C	C	5	C	C	C	C	C
4	O	O	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
5	O	O	C	C	C	C	C	C	C	C	C	C	5	C	C	C	C	C
6	O	O	O	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
7	O	O	O	C	C	C	C	C	C	C	C	C	5	C	C	C	C	C
8	O	O	O	O	C	C	C	C	C	C	C	C	C	C	C	C	C	C
9	O	O	O	O	C	C	C	C	C	C	C	C	C	C	C	C	C	C
10	O	O	O	O	O	C	C	C	C	C	C	C	C	C	C	C	C	C
11	O	O	O	O	O	C	C	C	C	C	C	C	5	C	C	C	C	C
12	O	O	O	O	O	O	C	C	C	C	C	C	C	C	C	C	C	C
13	O	O	O	O	O	O	C	C	C	C	C	C	5	C	C	C	C	C
14	O	O	O	O	O	O	O	C	C	C	C	C	C	C	C	C	C	C
15	O	O	O	O	O	O	O	C	C	C	C	C	5	C	C	C	C	C
16	O	O	O	O	O	O	O	O	C	C	C	C	C	C	C	C	C	C
17	O	O	O	O	O	O	O	O	C	C	C	C	5	C	C	C	C	C
18	O	O	O	O	O	O	O	O	O	C	C	C	C	C	C	C	C	C
19	O	O	O	O	O	O	O	O	O	C	C	C	5	C	C	C	C	C
20	O	O	O	O	O	O	O	O	O	O	C	C	C	C	C	C	C	C
21	O	O	O	O	O	O	O	O	O	O	C	C	5	C	C	C	C	C
22	O	O	O	O	O	O	O	O	O	O	O	C	C	C	C	C	C	C
23	O	O	O	O	O	O	O	O	O	O	O	C	5	C	C	C	C	C
24	O	O	O	O	O	O	O	O	O	O	O	O	C	C	C	C	C	C
25	O	O	O	O	O	O	O	O	O	O	O	O	5	C	C	C	C	C
26	O	O	O	O	O	O	O	O	O	O	O	O	O	C	C	C	C	C
27	O	O	O	O	O	O	O	O	O	O	O	O	O	5	C	C	C	C
28	O	O	O	O	O	O	O	O	O	O	O	O	O	O	C	C	C	C
29	O	O	O	O	O	O	O	O	O	O	O	O	O	O	5	C	C	C
30	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	C	C	C
31	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	5	C	C
32	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	C	C
33	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	5	C
34	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	C
35	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	5
36	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O

C SLUICE – GATE CLOSED

O FULL SLUICE GATE OPENINGS

5 PARTIAL SLUICE GATE OPENINGS IN FEET

OPERATING INSTRUCTIONS

1. SEE SEPARATE INSTRUCTIONS AS TO WHEN RESERVOIR MAY BE OPERATED WITHOUT SPECIFIC INSTRUCTIONS MUSKIGUM AREA OFFICE.

2. READ THE "LAKE" GAGE EVERY HOUR AND COMPUTE THE RISE IN POOL ELEVATION DURING THE PRECEDING HOUR.

3. ADJUST THE GATE SETTINGS EACH HOUR ON THE BASIS OF THE RATE OF RISE AND THE CURRENT RESERVOIR ELEVATION AS INDICATED BY THE CURVES. OBTAIN THE SLUICE GATE POSITION FROM THE SET OF CURVES AND OBTAIN SLUICE GATE OPENINGS FROM THE CHART. [SLUICE GATE NOS. 1-12 MUST ALWAYS BE EITHER FULLY OPENED OR COMPLETELY CLOSED. GATES 13-18 MAY BE PARTIALY OPENED TO OBTAIN THE DESIRED DISCHARGE FOR OTHER THAN EVEN NUMBERED SLUICE GATE POSITIONS]

4. WHEN THE RESERVOIR LEVEL EXCEEDS SPILLWAY ELEVATION AND THEN STARTS TO FALL, MAINTAIN THE CURRENT GATE SETTINGS UNTIL THE POOL RECEDES TO SPILLWAY ELEVATION 916.0

5. HOLD THE POOL AT SPILLWAY ELEVATION 916.0 OR AT MAXIMUM LEVEL ATTAINED, IF BELOW SPILLWAY ELEVATION UNTIL ORDERED BY SPECIAL DIRECTIVE TO BEGIN DRAWDOWN OPERATION.

6. IF A SECOND RISE OCCURS WHILE THE POOL IS BEING HELD AT MAXIMUM LEVEL, RESUME OPERATION IN ACCORDANCE WITH RATE OF RISE CURVES AND ABOVE INSTRUCTIONS.

TUSCARAWAS RIVER
OHIO

DOVER RESERVOIR PROJECT

EMERGENCY OPERATION SCHEDULE

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON, W.V. REDRAWN OCTOBER 1999

SECTION II - COLLECTION OF HYDROMETEOROLOGIC DATA

2-01 PRECIPITATION AT DOVER DAM

a. General. Obtain precipitation data by direct observation of the rain gage at the damsite. Instructions for preparation and transmission of hydrologic reports are contained in **Section IV**.

b. Official Precipitation Gage. The standard National Weather Service (non-recording) rain gage at the damsite is designated as the gage for official use.

c. Regular Readings. Measure and discard precipitation contained in the standard gage about 0730 hours daily. Observe and record the times of beginning and ending of precipitation. The times of beginning and ending may be read from the recorder chart of the recording precipitation gage when “unknown" or "during night." Instructions for the preparation and transmission of precipitation reports are contained in **Section IV**. These instructions are for Corps of Engineers purposes and are not to be considered as superseding observation instructions received from the National Weather Service.

d. Recording Precipitation Gage. Check the recording precipitation gage about 0730 hours daily. Remove punched tape record monthly, marking record and unused portions with date and time and mail the record to NWS Columbus in the envelope provided. Install new roll of tape as needed. Empty collector bucket as needed after between 10" and 15" has been collected and add two quarts of antifreeze oil if between I October and 1 May.

e. Extra and Special Readings. Take extra readings of the precipitation gage whenever required by Schedule for Reading Gages, **Plate 3-1**, and special readings when requested by Water Control section through the Area Office. When taking these readings, do not empty the gage at any time except the regular time. Report the total which has fallen since the regular time of reading, even though a portion of it may have been reported in a previous extra reading. The regular reading on the morning following any extra readings should always include the amounts reported in the extra readings. Instructions pertaining to the transmission of extra and special precipitation readings are contained in **Section IV**.

f. Satellite Platform Stations. Two precipitation stations, Dover Outflow "D" gage, and New Philadelphia are equipped with data collection platforms (DCP’s) which have voice modems, **Table 2-1**, next page. These answer a human telephone caller by synthesized voice. After a few seconds of high pitched tone, the voice gives the latest reading and time of reading of each parameter reported by the platform. Precipitation is called "rain" and stream stage, "level." The message ends with battery voltage and time of the reading. One should note that time given by the platform is Greenwich Mean Time (GMT). To convert to Eastern Daylight or Eastern Standard Time, subtract four or five hours, respectively.

Table 2-1

Precipitation Platform Communication Information

Lovation/ Gage	Equip	Voice	Channel No.	Update Interval	Data Transmitted	Frequency of Transmission
Dover outflow gage	1/	v			P, S	4 Hours
New Philadelphia	1/	v			P, S	4 Hours

1/ Precipitation equipment same at all platform reported stations: Tipping-bucket gage and platform.
P Precipitation in inches
E Elevation in feet NGVD
S Stream stage in feet above gage zero
T Temperature in degrees Fahrenheit
V "Voice platform answers telephone query with synthesized voice in addition to transmitting via satellite

g. Snow Depth and Moisture Content. During the winter, make regular measurement of snowfall and snow depth about 0730 hours daily when relevant. Measurements of the water content of the snow on the ground are required in order to determine the amount of water which may run off during a warm spell or with any wind and rainfall which may occur. To determine the water content of the snow, obtain a representative snow sample at an undisturbed location by forcing the outside container of the rain gage through the snow to the ground surface. Then, using a shovel or thin sheet of metal to hold the snow cover within the container, remove the container from the ground. The water content of the sample can be measured by placing the outside container in a vessel of warm water, and then pouring the melted snow into the inside container of the gage for a reading with the measuring stick. On no account should the vessel containing the snow be exposed to extreme heat because of the possibility of loss by evaporation. Measure water content of the snow at least as often as indicated below.

(1) Each day when any new snowfall occurs.

(2) Each day when rain falls on existing snow cover.

(3) Twice a week when there is snow cover if neither condition (1) nor (2) requires more frequent measurements.

(4) By special request from Water Control Section.

SECTION III - COLLECTION OF STREAMFLOW DATA

3-01 GENERAL.

Obtain lake and river (above and below dam) stage data by reading the counter at the Lake gage and by telephoning the voice platform at the outflow station. If there is trouble with the outflow reading, visit the gage site and read the tape or staff gage. The necessary frequency for reading the gages at the project and for obtaining reports from the telemetered stations is set forth in the Schedule for Reading Gages, **Plate 3-1**, which appears at the end of this section. Instructions regarding the transmission of regular, extra, and special reports of gage readings are contained in **Section IV**.

3-02 GAGES PERTINENT TO REGULATION OF DOVER DAM.

a. Gage Listings. Information about gages of importance to operation of the project appears in **Table 3-1**, next page.

b. Reading and Recording Gage Heights. All gage readings must be listed in the records in order that complete data on the operation of the project will be available. Record lake gage readings in terms of elevation NGVD, but record all other gages in feet above gage datum as set forth in the Schedule for Reading Gages, **Plate 3-1**. Gage NGVD datums are listed in **Table 3-1**.

3-03 TELEPHONE GAGES

In order to facilitate collection of stage information, data collection devices called Hydrologger's, capable of responding to telephone calls, were installed at the outflow station and New Philadelphia. To obtain reports from these gages by telephone, call the station telephone numbers. After a few seconds of high-pitched tone, the Hydrologger will repeat with synthesized voice the unit identification and the latest reading of each parameter reported by the platform, each followed by the time of the reading. Stage is called "level," and precipitation "rain." The message ends with the request, "Enter Command," at which time the call may be concluded by hanging up the phone. One should note that the time given by the Hydrologger is Greenwich Mean Time (GMT). To convert to Eastern Daylight or Eastern Standard Time, subtract four or five hours, respectively.

TABLE 3-1

PERTINENT GAGE DATA

Gage	Location	Code Symbol	Eqpt.	Reference Gages		Recorder	Datum of Gage[1/]
				Staff	Other		
Lake	Control house	I	DCP	SI	1/TI	RI	858.00
Outflow	2 mi below Dam, above Dover	D	DCP,H	2/	TD, WD	RD*	861.51

Inflow	Massillon	M	DCP	SM	-	RM*	916.00
Downstream	New Philadelphia South Side	N	V	SN	TN	RN	850.00

1/ Feet above Mean Sea Level
2/ Staff missing; TD is primary reference
* ADR (analog-to-digital recorder)
V Voice platform
S Staff gage
T Electric tape gage
DCP Standard platform
TI Manometer gate at lake station, in Control House
W Wire weight on bridge below Outflow gage
H Hydrologger

The telephone numbers of these gages are classified as "restricted" in order to avoid indiscriminate calls by unauthorized persons. The necessary frequency for obtaining reports from the telemetered gages is set forth in the Schedule for Reading Gages, **Plate 3-1.** Instructions pertaining to transmission of regular, extra, and special reports of gage readings are contained in **Section IV.** Telephone numbers and code symbols assigned to the gages to be called by project or Area Office personnel are listed in **Table 3-2.**

TABLE 3-2

STREAM GAGE TELEPHONE NUMBERS

Gage	Symbol	Tel Number	Device
Dover Outflow	DOTOF	[redacted]	Hydrologger
New Philadelphia	NPTD6	[redacted]	Hydrologger

3-04 DATA COLLECTION.

Project personnel read the official project rain gage and times of beginning and ending from the recording gage; and gage snow depth if relevant. Personnel read the upstream water surface elevation by visiting the control house on top of the dam and viewing the counter of the manometer. Personnel telephone the outflow gage Hydrologger for the current outflow stage as described in 3-03 above. These values are recorded in the level book and subsequently transmitted to the Muskingum Area Office via computer or fax. Area Office personnel combine information from each project and submit a daily report to the District Water Control System via intranet.

SCHEDULE FOR READING GAGES
DOVER DAM

The regular stream gages, TI or RI and DT or RD, must always be read and recorded immediately before each gate operation except when they have been read in the last hour with no intervening gate operation. They must also be read within one hour after completion of any operation. However, when the gates are heing operated practically continuously, the gages need not be read before and after each individual operation; but readings at one-hour intervals including the readings before the first and after the last operation will be sufficient. if the recorders are operating properly, the above gage heights may be read from the charts at the time of the next reading. Stream gages and the precipitation gage shall be read at least as often as shown in the table below.

	SCHEDULE A(l)		SCHEDULE B(l)		SCHEDULE C(l)		SCHEDULE D (1)	
	Normal Conditions		Flood Threat		Flood Condition		Major Flood Condition	
COMDITIONS	**MIANO***	**DEMIA****	**MIANO***	**DEMIA****	**MIANO***	**DEMIA****	**MIANO***	**DEMIA****
Lake gage elevation	Below 883	Below 883	883-898	883-898	898-912	898-912	Above 912(4)	Above 912(4)
Stage at outflow gage	Below 5.0(5)	Below 5.8(5)	5.0-5.8(5)	5.8-6.7(5)	5.8-6.5(5)	6.7-7.5(5)	Above 6.5(5)	Above 7.5(5)
Precipitation within								
24 hours (6)	Less than 0.75	Less than 0.50	0.75-1.25	0.50-1.00	1.25-2.50	1.00-2.50	More than 2.50	More than 2.50

READ GAGES

TI and DT	At 0730 & 1330(2)	At 0730 & 1330	At 0730, 1330, 1930 & 0130	At 3 hour intervals (3)
RT and RD Marts	Readings for 0730, 1330, 1930 & 0130(4)	Readings for 0730,1330, 1930 & 0130(4)	Readings for 0730, 1330, 1930 & 0130(4)	Readings for 0730, 1330, 1930 & 0130(4)

Precipitation Gage	Daily at 0730	Daily at 0730 & 1330	At 0730, 1330, 1930 & 0130	At 3 hour intervals
SI, WD, and TD	Twice Weekly(as check)	Twice weekly(as check)	Twice weekly(as check)	Twice weekly(as check)

(1) When any one of the conditions listed under schedule A, B or C is exceeded, place the next higher schedule into effect immediately and notify designated personnel of the Muskingum Area Office by person-to-person telephone call. If unable to make contact, similarly call Water Resources Engineering Branch personnel listed In paragraph 4-03c.

(2) Take readings on work days regularly and at other times by special arrangement.

(3) Whenever the water level at the lake gage is between elevation 912 and 916 and rising, or at elevation 916 or above, read the lake gage and outflow gage hourly.

(4) The 1330, 1930, and 0130 readings on weekdays and all readings for Saturday and Sunday may be obtained from the chart at the time of the next scheduled reading of visual pages. If necessary to obtain the readings desired, roll the chart back and, after taking readings, return to the proper position-all according to Instructions contained in **Plate 3-2**.

(5) All stages at the outflow gage above 4.2 feet in MIANO and above 4.7 feet in DEMIA must be authorized by Water Resources Engineering Branch.

(6) If precipitation has occurred since the morning reading and amounted to 0.20" in winter or 0.50" in summer, or if snowmelt has occurred sufficiently to cause a rise in lake or outflow, read the lake gage, outflow gage, and rain gage at 1330 hours and transmit the information to the Muskingum Area Office.

Once a particular schedule is in effect, follow that schedule for a minimum of 24 hours before placing a lower schedule into effect or until such time that conditions require the use of a higher schedule. The foregoing table lists the minimum number of gage readings required. Record all gage readings made in addition to those required by the foregoing table.

*MIANO - 16 April through 30 November
**DEMIA - I December through 15 April

CHART HANDLING INSTRUCTIONS

Obtaining Weekend and Holiday Readings
From Stevens Strip Chart Recorders

STEVENS TYPE AP, TYPE A-71 OR A-35 RECORDER

1. First lift the lid or remove dust cover.
2. Lift pan from chart and secure pen in bolder off paper position.
3. Facing Stevens recorder grasp knurled knob on the take up roll located in the rear of the recorder and to the left of the recorder paper. Turn knurled knob clockwise until enough paper is showing to obtain sufficient readings being careful paper does not come in ‘contact with pen.
4. Record weekend and Holiday readings.
5. After sufficient readings have been obtained, grasp knurled knob, turn counterclockwise until slack is out of paper. Lower pen back on chart. If pen is off more than I hour, reset for correct time. To-raset, grasp the knurled disc which is located on the right-hand side of the recorder just beneath the knurled knob of the supply cylinder. Pull the disc out to the right and rotate it until the paper is free. Advance paper until chart shows the correct time. Rotate the knurled disc to its normal location and push back in place to the left.
6. If you reset for time, make notation on chart.

STEVENS PAV-C OR CAV-C RECORDER

1. Face recorder and open recorder door.
2. Remove pen from chart by turning pen arm positioning screw clockwise.
3. Run the chart upward by moving and turning the knurled disk on the right end of the take up roller, upward, until enough record is showing to obtain readings. Be careful paper doesn’t come in contact with pen.
4. Record weekend and Holiday readings.
5. After readings are obtained,run the chart downward by turning the knurled disk on the right end of the take up roll, downward, until paper slack is removed and pen time is correct. Hold the chart in place; at the same time place a finger mder the spiral spring belt, lift outward from the wall slig htly stretching the belt, then release. Paper will stay taut.
6. Place pen back on the chart by turning pen arm positioning screw counterclockwise
7. If pen is off more than 1 hour, reset for time. To reset, run chart downward until Den shows correct time on the chart. Holding chart in place lift outward spiral Spring belt, stretching slightly, then release belt.
8. If you reset for time, make a notation on chart. Include in notation time, date, stage from counter, etc.

SECTION IV - INSTRUCTIONS FOR COMPLETION AND TRANSMISSION OF REPORTS

4-01 REGULAR REPORTS

a. Weekly Report, ORH Form 14. To reduce the probability of error in transcribing data from other forms, enter gage readings through the week on a copy of Form 14. Lake and outflow gage readings will be obtained for every six hours (0130, 0730, 1330 and 1930) during periods when the project is attended and recorded on the form. The Schedule for Reading Gages, **Plate 3-1**, defines conditions for taking more frequent readings of gages. After entering each of the readings on the form, check the accuracy of the readings as recorded. If doubt arises, investigate to the extent necessary to be certain of the readings. During normal conditions, if the 1930 and 0130 readings have not been recorded on the form, take them from the recorder charts when taking the 0730 Project Report readings. After any period in which the project was not attended, obtain all missing readings from the recorder charts and record on Form 14. See **Plate 3-2** for instructions on how to turn back charts to obtain missed readings and the proper method to reset the gage after doing so. On Monday morning, or Tuesday if the project was not attended on Monday, record any missed readings along with the 0730 readings. Check the accuracy of the data on the typed original compared to the handwritten form. Mail the original typed form to the District Office marked "Attention Water Resources Engineering Branch." Begin a new Form 14. A sample Form 14, **Plate 4-1**, is included at the end of this section.

b. Daily Morning Report. The regular morning readings at the project, including precipitation, readings of the lake "L" gage, outflow "0" gage, gate positions, river stages and gate operations shall be recorded each day. After recording, the data will be transmitted via the Internet to the District INTRANET System for the Water Resources Engineering Branch by approximately 0800 hours on each day in which the project is attended. The proper manner of reporting the data is shown in a printout of a Project Data Input Form found at the end of this section as **Plate 4-2**.

Transmit reports for Saturdays, Sundays, and Holidays on which the project is attended as on regular work days. Transmit reports for unattended days after transmission of the current report for the first working day, which follows.

In each regular or extra Daily Morning Report, also include any telephonic readings made since the previous Project Information report.

If conditions are such that the daily report cannot be transmitted to the District Intranet System by 0830 hours, transmit the report by telephone or fax to Water Resources Engineering Branch, then enter the data into the computerized report form when it becomes available.

Instructions relative to arrangement and transmission of the Daily Morning report are as follows:

(1) Logging On. Open the web browser (Microsoft Internet Explorer or Netscape Navigator) to the address http://wcds-a.orh.usace.army.mil/DOT/index.htm. This Index Page contains links to information pertaining to Dover Dam. Each project has a specific set of report forms. Report forms for one project cannot be substituted for another project. When submitting data for gate operations follow the link for Gate Operations. There is currently no water quality stratification function at Dover Lake, hence the water quality data report page is not currently in use. When the data submission page has been accessed, indicate if this is a new or a revised report and then check the date/time group. The Beech Fork Lake assigned PASSWORD is required for submission. Follow the example on **Plate 4-2.**

(2) Three reports can be accessed from the Index Page: The Daily Project Report (also called the Morning Report), the Gate Operations Report and the Water Quality Report (not currently used). Click on the picture or on the Report name to access a report.

(3) When the Project Report Page has been accessed, indicate if this is a new or a revised report. Check the date/time group.

(4) The first table, Current Project Info, is used to record general information about the project at the time of the report.

(5) Column 1 - Station Abbreviation. This column identifies the lake station. The first three letters comprise the abbreviation of the station name and the last letter and figure is a key to its location on the District Isohyetal Map. This five-digit group constitutes the abbreviation for the station and should always be used. These station names have been coded into the web page and cannot be changed at the project. If there are any difficulties in relation to this, please contact the Water Control Branch.

(6) Column 2 - Precipitation. Record the amount of precipitation (to the nearest 1/100 inch) since the last report.

(7) Column 3 - Lake Elevation. Use this column for reporting the lake "L" gage, in feet above NGVD, to the nearest hundredth foot. Please include decimal points.

(8) Column 4 - Outflow Stage. Use this column for reporting the stage at the "0" gage, to the nearest hundredth foot. This is the stage reading of the gage.

(9) Column 5 - Flow. This column can be used for recording the outflow if it becomes necessary. At this point, this field is unavailable.

(10) Columns 6 and 7 - Snow and Water Equivalent. Report the depth of snow cover and its water content in these columns. Where a station does not make this report or no precipitation has been reported, send 0.00. Record the snow depth in inches to the nearest hundredth. Indicate a trace by OOT. Report the figures for snowfall and snow cover since the previous report.

(11) Columns 8 - Weather Description. The drop down menu in this column is used to report the weather conditions at the time of the Project Report Observation.

(12) The second table, Current Gate Settings, is used to record gate settings at the time of the report.

(13) Columns 2 through 7 are used for recording the openings of gated sluices through the spillway section of the dam. This table arranges these sluices in groups of six, with each group having a diffent invert elevation on a different row. Row 1 is used for the right sluice gates R1 through R6, row 2 is used for the center sluice gates C7 through C12, and row 3 is used for the left sluice gates L13 through L18. Each gate opening is reported to the nearest tenth of a foot. For example, 4.8 feet is reported as 048 and 6.0 feet as 060. Transmission of the openings for each gate shall consist of a 3-digit number. Report these settings as OPN for fully open and 000 for fully closed.

(14) The third table, Additional Station information, is used to record data from downstream gages for permanent record.

(15) Report precipitation and stage information for Dover Outflow (DOTOF) and New Philadelhia (NPTD6) in the appropriate fields.

(16) The fourth table, Additional Comments, gives an unlimited field to record any comments relevant to the Project report which have not been covered in the previous tables.

(17) Password. Each project has a unique password needed to submit the report the WCDS-A system. If this password is missing or incorrect, attempts to submit the Project Report will be unsuccessful. Use the ‘back arrow’ on the browser to get back to the Project Report Page to attempt to submit the form with the correct password. While the information being submitted is not classified, the password should be protected to keep unauthorized personnel from gaining access to mil computer systems. Questions about the password should be directed to the Water Control Section.

(18) After all the project information has been recorded, click on the "Submit" button to send the report to WCDS-A or "Clear Form" to clear all the information out of the form and start over.

(19) If the password was correct, a SHEF compatible report will be sent back to the computer terminal. Information can be checked before the final submission. If there is any incorrect data on the report, use the browser’s "back button" to return to the Project Report Page to correct the information.

This report can be accessed through the Dover Dam Lake web page (http://wcds-a.orh.usace.army.mil.dbases/briefing/dot.htm) under Project Reports or through a link to ‘Project Reports’ on the Index Page. The reports are stored as ASCII text and may be printed to keep as a hard copy.

(20) The second report accessed from the Index Page is the Gate Operations Report. This report is used to record information about gate operations. Each gate operation should be recorded at the time it occurs. If several gate operations are performed within a short period of time, up to 6 (six) gate operations may be reported on a single form. Choose the Gate ID from a drop down menu. Transmit all gate valve operations since the previous report and transmit with each morning or extra report. List them in chronological order after the Water Supply Data. Enter the data on the report in the following manner with the first entry for a new report. An unlimited field is also provided to make any additional comments. As in the Project Report, a password is necessary to submit the gate Operation Report to the WCDSA computer. The same password is used to the Project Report and the Gate Operations Report (see Para. 4.01.17). If the report is submitted with the proper password, a confirmation screen will be transmitted back to the terminal. If the information is correct, click on the 'Correct' button at the top of the page. The information will be entered into a permanent record.

This record can be viewed through the Dover Dam Lake web page at (http://wcds-a.orh.usace.army.mil/dbases/dot/reports/gateop.txt). See the example in **Plate 4-2**.

(21) The third report available from the Index Page is the Water Quality Report (this is not currently used for Dover lake). This report is used during the seasons in which the lake is subject to stratification. Monitoring begins when a special directive is sent by Water Control Section at the request of Water Quality Section. Report Water Quality data in accordance with the special directive. Monitoring ends when the lake is no longer stratified. Water Quality Section will request Water Control Section issue a special directive ending monitoring when it is no longer necessary.

(22) The first table in the Water Quality Report has fields referring to conditions at the time the water quality sampling was performed. Record the date and time, the lake elevation in feet to the nearest hundredth, and the weather conditions.

(23) The second table is used to record water quality data at the outflow gage on the surface. Record the water temperature in degrees Celsius, the Dissolved Oxygen (D.O.) content in mg/ml, the water condition, turbidity in n.tu and pH.

(24) The third table is used to record water quality at various depths. The first column records the depth water depth, from the surface, in meters. This field is populated for the convenience of the data transcriber, but can be changed if conditions warrant. The second column records the water temperature in degrees Celsius. The third records the Dissolve Oxygen (D.O.) content in mg/ml. The fourth column records the water condition. The fifth column records turbidity in n.tu. The sixth column records the pH. Not all of these readings will be taken at every recording session at every depth.

(25) Below the table recording the water conditions, there is an unlimited field to provide additional comments.

(26) As in the Project Report, a password is necessary to submit the Water Quality Report to the WCDS-A computer. The same password is used to the Project Report and the Water Quality Report (see Para. 4.01.17). If the report is submitted with the proper password, a confirmation screen will be transmitted back to the terminal. If the password was correct, a SHEF compatible report will be sent back to the computer terminal. If there is any incorrect data on the report, use the browser's "back button" to return to the Project Report Page to correct the information. If the information is correct, click on the "Correct" button at the top of the page. The information will be entered into a permanent record.

This record can be viewed through the Dover Dam web page at (http://wcds-a.orh.usace.army.mil/dbases/dot/reports/waterqual.txt). This arrangement is illustrated in **Plate 4-3** at the end of this section.

4-02 EXTRA REPORTS

Always transmit extra reports, as indicated by the Schedule for Reading gages, **Plate 3-1**, to INTRANET over the project computer terminal in the same way as the regular Project Information report. If project personnel are unable to transmit the report over the computer terminal, telephone the report in to Water Control Section. Failing this attempt, telephone the report to one of the Water Resources Engineering Branch personnel in the order listed below in paragraph 4-03c.

4-03 SPECIAL REPORTS

a. Reporting Criteria. Special reports include any report not regularly scheduled or indicated by the Schedule for Reading Gages. A special report should be made when an event occurs concerning the project that the Area Office and Water Control section should have knowledge of or when requested by either the Area Office or Water Control Section.

b. Special Report Data. The following types of occurrences or information are examples of occasions for or subjects of special reports.

(1) Extraordinary meteorological event such as a tornado or blizzard, or heavy precipitation after 0730 hours.

(2) Gate positions and/or operations.

(3) Flooding upstream or downstream.

(4) Request for special operation originating from other than Water Resources Engineering.

(5) Catastrophe such as drowning.

(6) Air temperature if unusual and significant.

(7) Local weather forecast.

c. Transmission of Special Report. All.special reports should be made at any time of day or night, including weekends and holidays, or when requested by Water Control Section. During office hours, submit them by telephone; however, if it is impossible by telephone, utilize the District radio network or cell phone. When making telephone calls after hours or during weekends or holidays, unless advised that the Water Control Section will be on duty, place a personto-person call to one of the following Water Resources Engineering Branch personnel, in the order listed:

CORPS OF ENGINEERS	
Water Resources Engineering Branch Personnel	**Home Phone Number**
[redacted] Chief, Water Control Section	[redacted] *unlisted
[redacted] Water Control Section	[redacted]
[redacted] Chief, Water Resources Engineering Branch	[redacted] *unlisted

Pertinent telephone numbers which may be of value during flood emergency are listed below:

Huntington District Office **Water Resources Engineering Branch**	
Normal Work Hours 0700 to 1600 hrs	[redacted]
Night, Weekend, Holiday	Additional Extensions: [redacted]
Muskingum Area Office	
Name	**Phone Number**
[redacted]	[redacted]
[redacted]	[redacted]
Dover Dam Proiect Office	
[redacted]	

Gate Operating Personnel	
Name	**Phone Number**

[redacted]	[redacted]
[redacted]	[redacted]

Other Agencies	
Name	**Phone Number**
U.S. Geological Survey, New Philadelphia, Ohio	[redacted]
Night, Weekend, Holiday [redacted]	[redacted]
N.W.S. Forecast Office Cleveland, Ohio Hydrology Section	[redacted] [redacted]

4-04 CELL PHONE AS STANDBY COMMUNICATION

Keep the cell phone turned on at all times when anyone is on duty at the project office, including overtime periods, since Area Office and District Office operators are sometimes on duty outside of regular office hours. Also, messages may be relayed through other projects.

4-05 LETTER REPORTS

a. General. All letter reports pertaining to water control management will be addressed to the District Engineer, Attention: Water Resources Engineering Branch (CELRH-W).

b. Downstream Channel Conditions. At the request of the Area Office or Water Resources Engineering Branch, inspection of critical areas downstream from the dam will be made for conditions listed below to observe encroachment on the channel, indiscreet utilization of low-lying areas, and flooding conditions, as follows:

(1) During flood periods when maintaining the maxi allowable (for the season) stage on the "0" gage, downstream to the New Philadelphia south gage including all points of potential flooding in between.

(2) If workload permits during or immediately following periods of unusual storage releases to the points mentioned in (1) above.

(3) If complaints of flooding are received, notify Area Office immediately; then make an inspection of the specific area as soon as practicable.

(4) At any other times, as requested by the Water Resources Engineering Branch, and under (3) above, the essential items to note and report are: (a) persons or communities involved; (b) nature of complaint; and (c) extent and depth of flooding. Make a letter report, containing pictures, cross sections or sketches of the findings as soon as practicable. If immediate action appears necessary, make a brief initial report via telephone to the Water Resources Engineering Branch.

c. Lake Area Conditions. During periods of flood storage, inspections shall be made within the storage area. Essential items to look for and observe are bank slippage and effects of wind and wave erosion.

d. Functioning of the Dam. Functioning of the dam shall be observed at all times, including performance of gates, valves machinery and outlet structure and the presence of any leakage. During flood storage periods when the lake level reaches or exceeds the Alert Elevation, 898 feet NGVD for Dover Dam, daily observations are made and reported under provisions of the Dam Operations Management Policy in addition to the normal weekly observations made under the policy. At these or other times requested by Water Resources Engineering Branch for a particular use, forward a copy of such observations as soon as practicable to Water Resources Engineering Branch as a letter report.

RESERVOIR WEEKLY REPORT						STATION Dover Dam			
						WEEK ENDING @ 0730 25 May 87			
GAGE RECORDS						**GATE OPERATING RECORD**			
DATE	TIME		GAGES			GATE NO.	AMT. OF OPENING		PURPOSE
	START	END	TI	DT			INITIAL	FINAL	
18 May	1330		865.85	863.48					
	1930		866.03	863.56					
19 May	0130		866.99	863.73					
	0730		868.67	864.50					
	1330		868.25	864.37					
	1930		868.60	864.42					
20 May	0130		868.57	864.48					
	0730		868.19	864.37					
	1330		867.85	864.24					
	1930		867.50	864.19					
21 May	0130		868.00	864.09					
	0730		869.54	864.72					
	1330		869.21	864.81					
	1930		869.20	964.91					
22 May	0130		868.60	864.80					
	0730		868.25	864.57					
	1330		867.93	864.41					
	1930		867.75	864.25					
23 May	0130		867.75	864.18					
	0730		867.50	864.10					
	1330		867.25	864.00					
	1930		867.00	863.90					
24 Mqy	0130		866.87	863.83					
	0730		866.74	863.72					
	1330		866.59	863.72					
	1930		866.40	863.85					
25 May	0130		866.28	863.61					
	0730		866.17	863.98					
CHECK READINGS						**FINAL POSITION OF GATES**			
Date	Time		SI	TI	RI	1-6 Open			
21 May	0730		869.60	869.54	869.54	Left & Center 0-0			
25 May	0730		N/A	866.17	866.17				
Date	Ti me	DT	WD	TD	RD				
21 May	0730	864.72	864.72	864.72	864.72	**SIGNATURE**			
25 May	0730	863.58	863.58	863.58	863.58				

PLATE NO. 4-1

DOVER LAKE

PROJECT INFORMATION

USE THE MOUSE OR TAB TO MOVE BETWEEN FIELDS
ENTER WILL SUBMIT THE FORM

This file is a New submission.

DATE	TIME
10 Jul 2001	0730

CURRENT PROJECT INFO

COE ID	PRECIP (IN)	POOL ELEV (FT-MSL)	TAIL WATER STAGE (FT)	FLOW (KCFS)	SNOW DEPTH (IN)	WATER EQUIVILENT (IN)	WEA COND
DOTC6	0	870.0	850.0	0	0.0	0.0	0 Unchange

CURRENT GATE SETTINGS

GATE	R1	R2	R3	R4	R5	R6
SETTING	10.0	10.0	10.0	10.0	10.0	10.0
GATE	C7	C8	C9	C10	C11	C12
SETTING	Closed	Closed	Closed	Closed	Closed	Closed
GATE	L13	L14	L15	L16	L17	L18
SETTING	Closed	Closed	Closed	Closed	Closed	Closed

ADDITIONAL STATION INFORMATION

COE ID	PRECIP (IN)	STAGE (FT)
NPTD6		

DOVER LAKE

GATE OPERATIONS

This file is a New submission.

GATE ID	VALUE		DATE	TIME	
	Start	End		Start	End
R1	0.0	0.0	10 Jul 2001	0700	0705

ADDITIONAL COMMENTS

PLEASE ENTER THE DOVER PASSWORD:

Submit These Gate Operations

Clear Form

CLICK HERE TO RETURN TO DOVER LAKE HOME PAGE (WILL NOT SAVE DATA)

DOVER LAKE

Lake Quality Report

THIS PAGE IS NOT CURRENTLY IN USE AT DOVER LAKE

USE THE MOUSE OR TAB TO MOVE BETWEEN FIELDS
THE ENTER KEY WILL SUBMIT THE DATA

This file is a New submission.

DATE	TIME	LAKE ELEV (FT)	WEATHER
10 Jul 2001	0730	885.00	0 Unchanged

DEPTH (M)	TEMP (C)	D.O.	COND	TURB	pH
OUTFLOW					

DEPTH (M)	TEMP (C)	D.O.	COND	TURB	pH
0.0					
1.0					
2.0					
3.0					
4.0					
5.0					
6.0					
7.0					
8.0					

UPON APPROVAL OF NEPA DOCUMENTATION, THE DROUGHT CONTINGENCY PLAN WILL BE FURNISHED FOR ENCLOSURE IN THE WATER CONTROL MANUALS.

THE HUNTINGTON DISTRICT INCLUDES THE REACH OF THE OHIO RIVER BETWEEN RIVER MILE 127.2 (NEW MARTINSVILLE W. VA.) AND MILE 438.0 (3.5 MILES DOWNSTREAM FROM CHILO, OHIO) BELOW PITTSBURGH, PA. AND THE DRAINAGE AREA OF ALL TRIBUTARIES ENTERING THE OHIO RIVER BETWEEN THESE TWO POINTS. THE TOTAL DRAINAGE AREA OF THE OHIO RIVER BASIN ABOVE MILE 438. IS 70,880 SQUARE MILES. THE DRAINAGE AREA OF THE HUNTINGTON DISTRICT IS 44,914 SQUARE MILES.

MILLERSBURG LAKE
MOHICANVILLE DAM
TUSCARAWAS RIVER
BLACK FK.
71
KILBUCK CR.
SUGAR CR.
CHARLES MILL LAKE
MANSFIELD
MASSILLON
CANTON
*BOLIVAR DAM
DOVER DAM
PLEASANT HILL LAKE
BEACH CITY LAKE
SANDY CR.
MOHICAN R.
NORTH BRANCH OF KOKOSING R.
KOKOSING LAKE
MARION
INDIAN FK.
ATWOOD LAKE
LEESVILLE LAKE
DELAWARE LAKE
ALUM CREEK LAKE
ALUM CREEK
MT. VERNON
MOWHAWK DAM *
77
SCIOTO R.
OLENTANGY R.
BIG WALNUT CR.
WALHONDING R.
TUSCARAWAS R.
STILLWATER R.
HUTTON CR.
TAPPAN LAKE
MILL CREEK LAKE
UTICA LAKE
TICKNOR FK.
WILLS CREEK LAKE
CLENDENING LAKE
TOWNSHIP R.
FRAZYSBURG LAKE
PIEDMONT LAKE
COLUMBUS
NEWARK
DILLON LAKE
MILE 127.2
BIG DARBY LAKE
ZANESVILLE
OHIO
ROSEVILLE
SENECAVILLE LAKE
DARBY CR.
CLEAR FK.
MUSKINGHAM R.
NEW MARTINSVILLE
71
DEER CREEK LAKE
LOGAN LAKE
MAYAHALA CR.
DEER CR.
WASHINGTON C.H.
HOCKING R.
SUNDAY CR.
TOM JENKINS DAM
OHIO RIVER
PAINT CREEK LAKE
CHILLICOTHE
ATHENS
BELPRE
WILLOW ISLAND
PARKERSBURG
PAINT CR.
23
SALT CREEK LAKE
SCIOTO R.
LITTLE KANAWHA R.
ROCKY FORK LAKE
CAPT. ANTHONY MELDAHL
BELLEVILLE
MIDDLEPORT
WHITE OAK CR.
KANAWHA R.
LEADING CREEK LAKE
CHILO
WHITEOAK DAM AND RESERVOIR
PT. PLEASANT
RACINE
WEST FORK LAKE
BURNSVILLE LAKE
MANCHESTER
PORTSMOUTH
NEW BOSTON
MILE 438.0
AUGUSTA
OHIO RIVER
GREENUP
GALLIPOLIS
KANAWHA R.
79
SUTTON LAKE
MAYSVILLE
TYGARTS CR.
WINFIELD
POCATALICO R.
POKA LAKE
VANCEBURG
IRONTON
COAL GROVE
KEHOE LAKE
RUSSELL
ASHLAND
HUNTINGTON
ELK R.
BIRCH LAKE
BIRCH R.
64
CATLETTSBURG
119
64
OLIVE HILL
CEREDO
KENOVA
MUD RIVER LAKE
CHARLESTON
MARMET
GRAHN
KY
GRAYSON LAKE
GAULEY R.
SUMMERSVILLE LAKE
GREENBRIER RIVER
GRIFFITHSVILLE
TAWKEY
WAYNE
LONDON
W. VA.
YATESVILLE LAKE
EAST FK. TWELVEPOLE CR.
EAST LYNN LAKE
GUYANDOTTE R.
MEADOW R.
RAINELLE
PAINTSVILLE LAKE
INEZ
BEACH FORK LAKE
TURNPIKE
COAL R.
NEW R.
DEWEY LAKE
OCEANNA
HINTON
PRESTONBURG
MARTIN
S. WILLIAMSON
R.D. BAILEY LAKE
77
BIG BEND LAKE
JOHNS CR.
TUG FK.
BLUESTONE CR.
FISHTRAP LAKE
PRINCETON
BLUESTONE LAKE
BLUEFIELD
BRUSH
LEVISA FK.
RUSSELL FK.
POUND R.
NORTH FORK OF POUND RIVER LAKE
HASI LAKE
PANTHER CREEK LAKE
RADFORD
JOHN W. FLANNAGAN DAM AND RESERVOIR
NEW R.
VA.
GALAX
MOOREFIELD LAKE
CHESTNUT CK.
NORTH FK.
SOUTH FK.
N.C.

10 0 10 20
SCALE IN MILES

LEGEND

FLOOD CONTROL RESERVOIR
- WORK COMPLETED
- WORK UNDER CONSTRUCTION
- NO WORK HAS BEEN INITIATED

LOCAL PROTECTION PROJECT
- WORK COMPLETED
- WORK UNDER CONSTRUCTION
- NO WORK HAS BEEN INITIATED

LOCKS AND DAMS
- WORK COMPLETED
- DISTRICT BOUNDARY

* DRY DAM, WITH FLOOD CONTROL POOL OUTLINED.

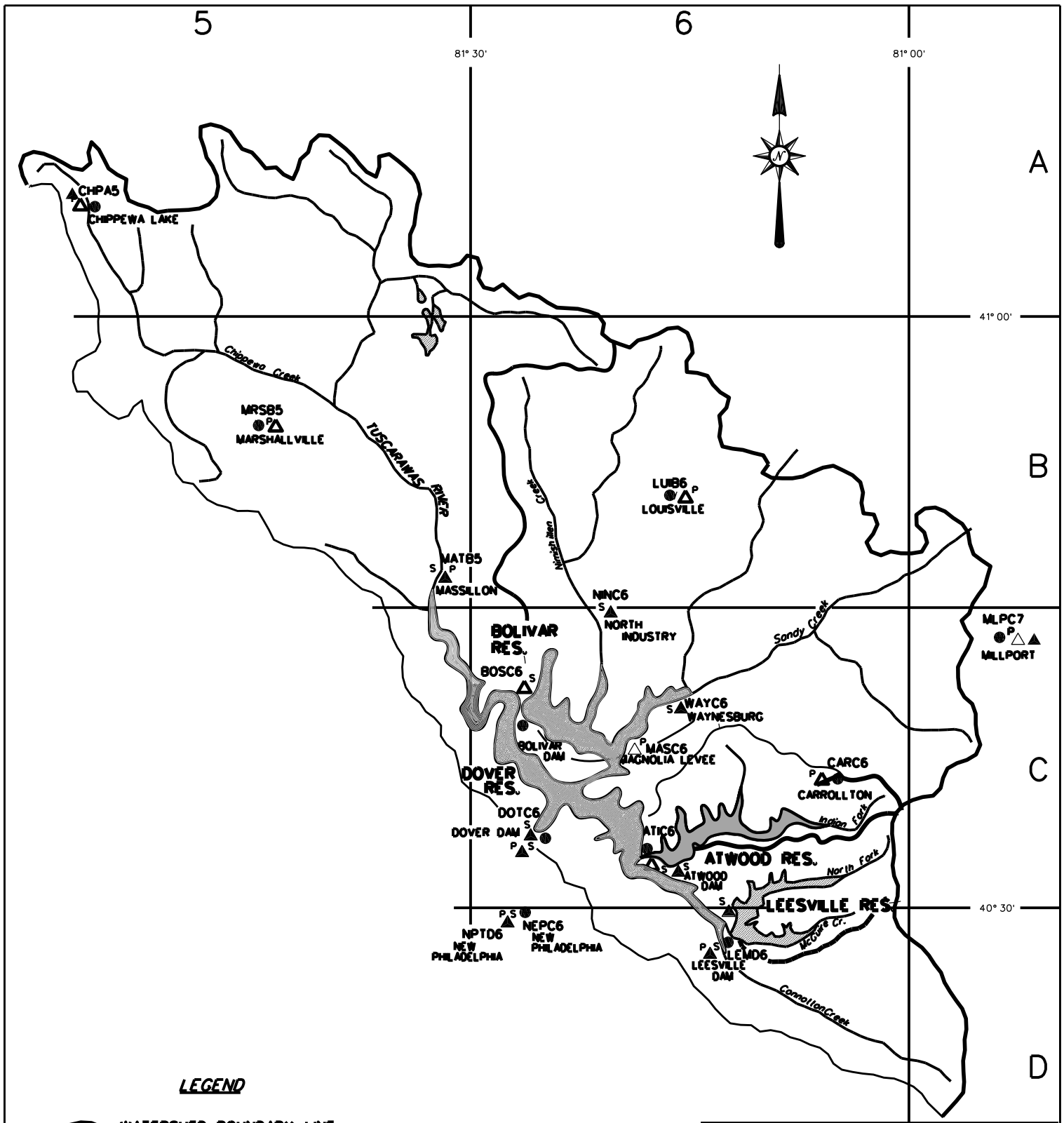
** COMPLETED PROJECT WHERE FURTHER IMPROVEMENTS ARE IN PROGRESS OR AUTHORIZED.

DISTRICT BOUNDARY

TUSCARAWAS RIVER
OHIO

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON, W. VA. REDRAWN: MAY, 2001

PLATE NO. 2-1



LEGEND

- WATERSHED BOUNDARY LINE
- RESERVOIR, SPILLWAY ELEVATION
- REPORTING PRECIPITATION STATION
- P PRECIPITATION
- S STAGE
- ▲ SATELLITE DATA PLATFORM
- △ SATELLITE DATA PLATFORM PLANNED

TUSCARAWAS RIVER
OHIO

DOVER DAM

DRAINAGE AREA MAP

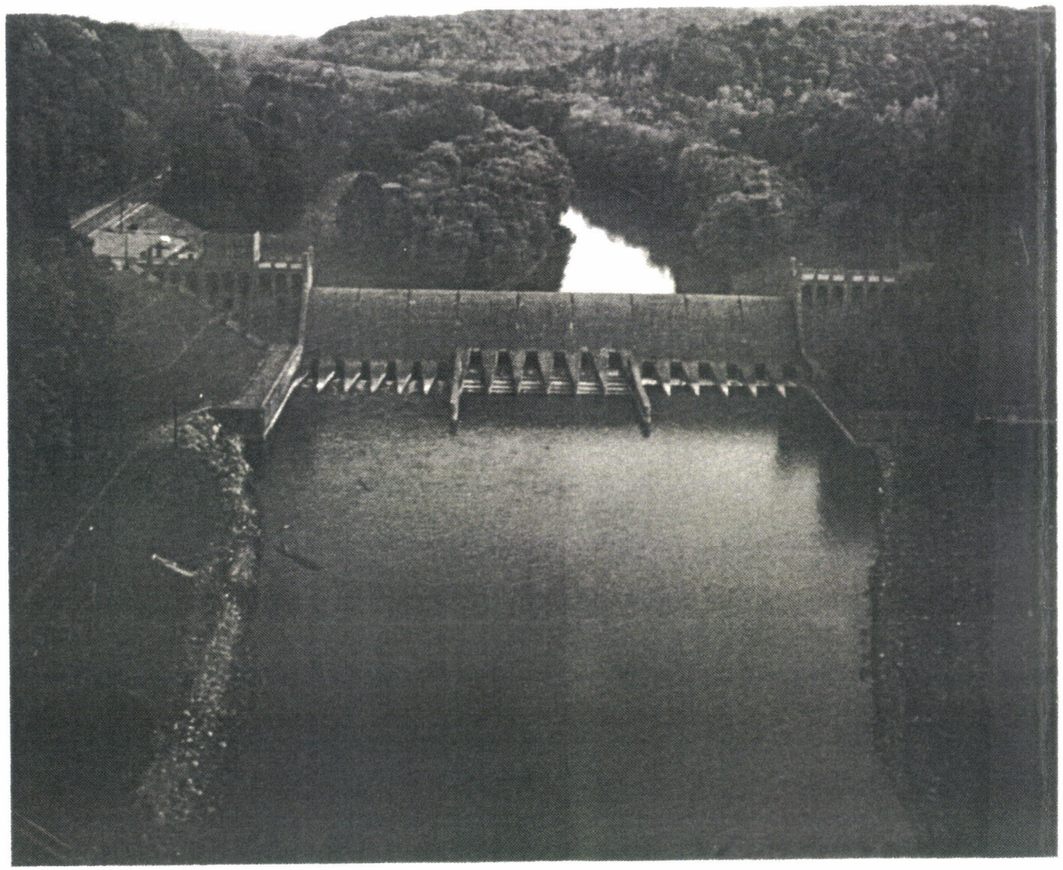
DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON, W. VA. REDRAWN: OCT. 1999

PLATE 2-2

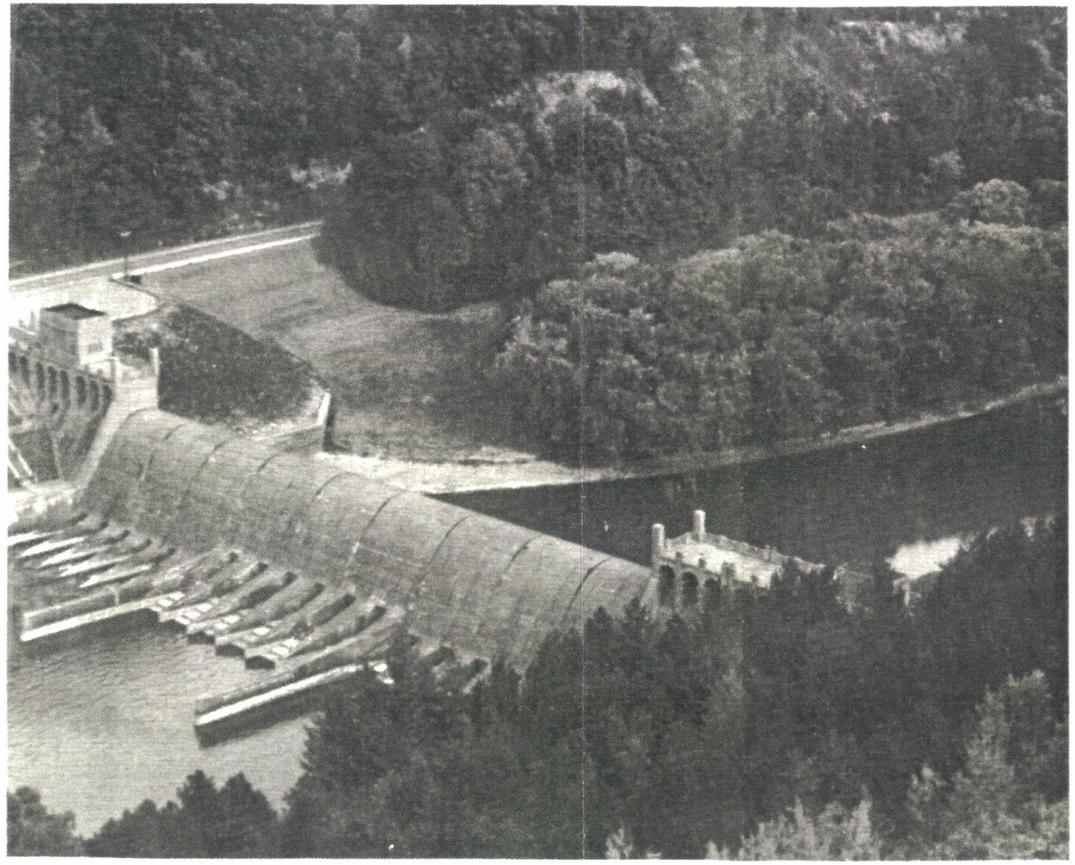
CORPS OF ENGINEERS

U. S. ARMY

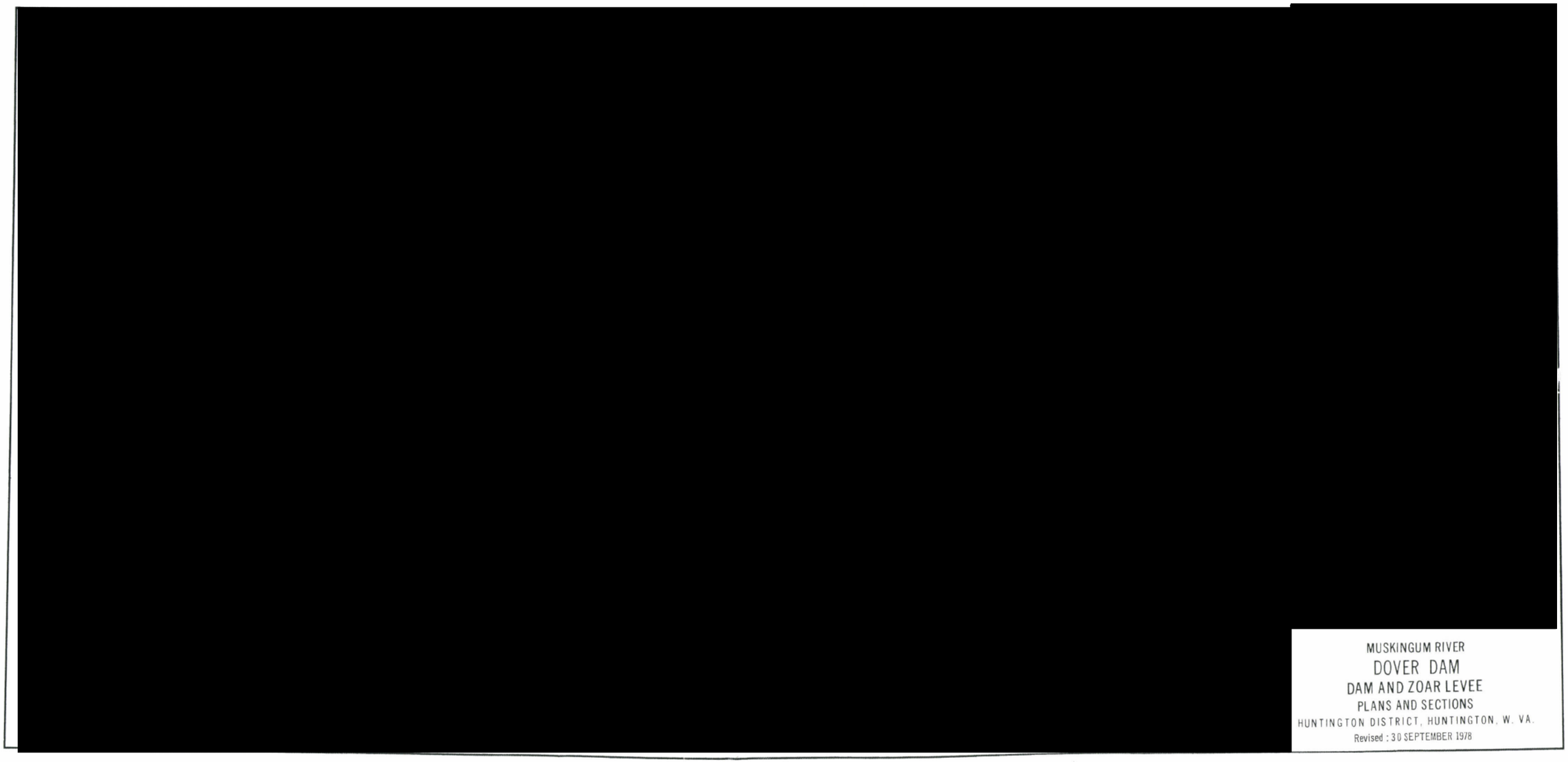
DOVER F/C 8



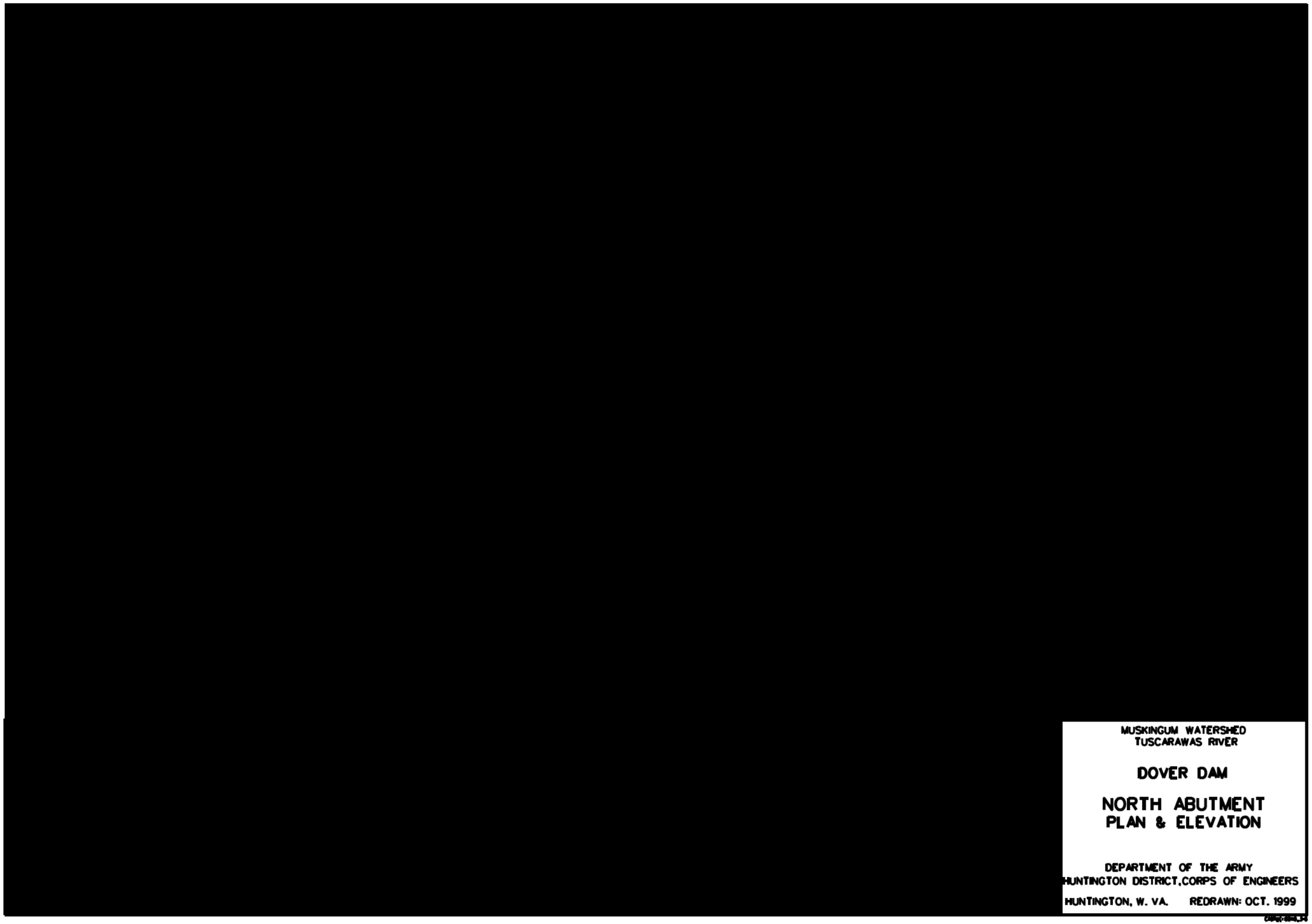
OVERALL VIEW, LOOKING UPSTREAM



DOWNSTREAM SIDE OF DAM



MUSKINGUM RIVER
DOVER DAM
DAM AND ZOAR LEVEE
PLANS AND SECTIONS
HUNTINGTON DISTRICT, HUNTINGTON, W. VA.
Revised : 30 SEPTEMBER 1978



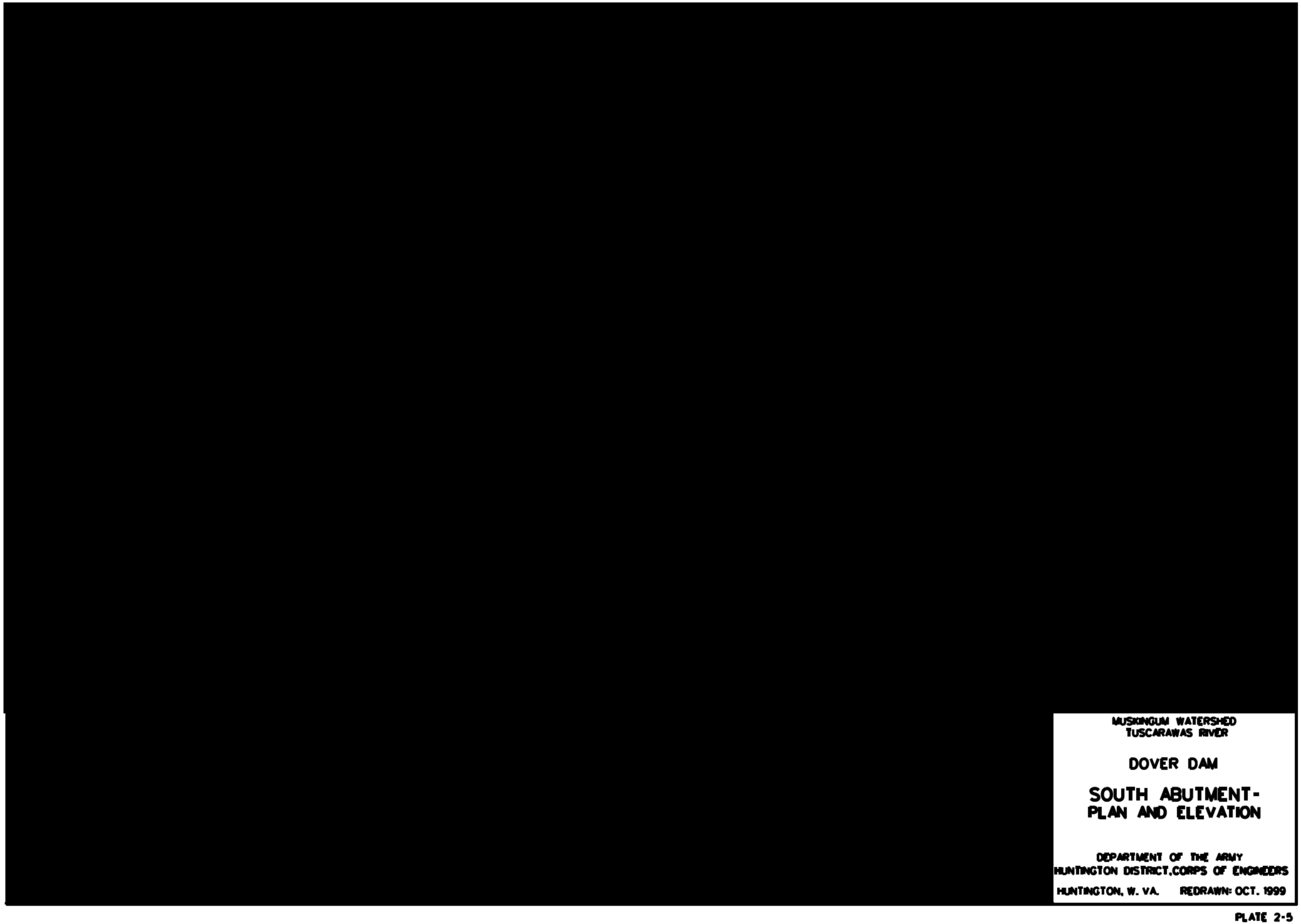
MUSKINGUM WATERSHED
TUSCARAWAS RIVER

DOVER DAM

NORTH ABUTMENT
PLAN & ELEVATION

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON, W. VA. REDRAWN: OCT. 1999

PLATE 2-4



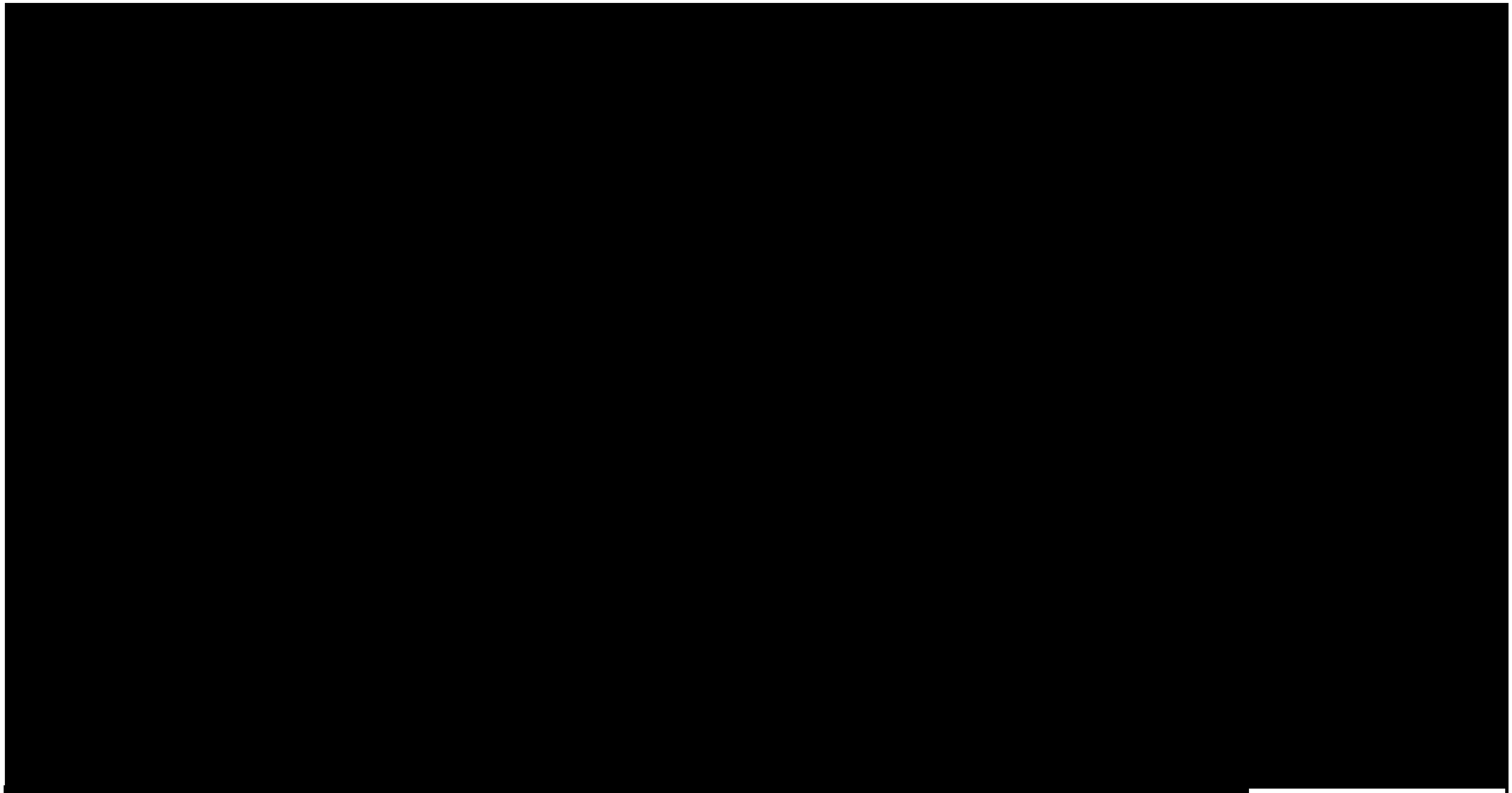
MUSKINGUM WATERSHED
TUSCARAWAS RIVER

DOVER DAM

SOUTH ABUTMENT-
PLAN AND ELEVATION

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON, W. VA. REDRAWN: OCT. 1999

PLATE 2-5



MUSKINGUM WATERSHED
TUSCARAWAS RIVER

DOVER DAM

STILLING BASIN GENERAL PLAN

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON, W. VA. REDRAWN: OCT. 1999

PLATE 2-6

[redacted]

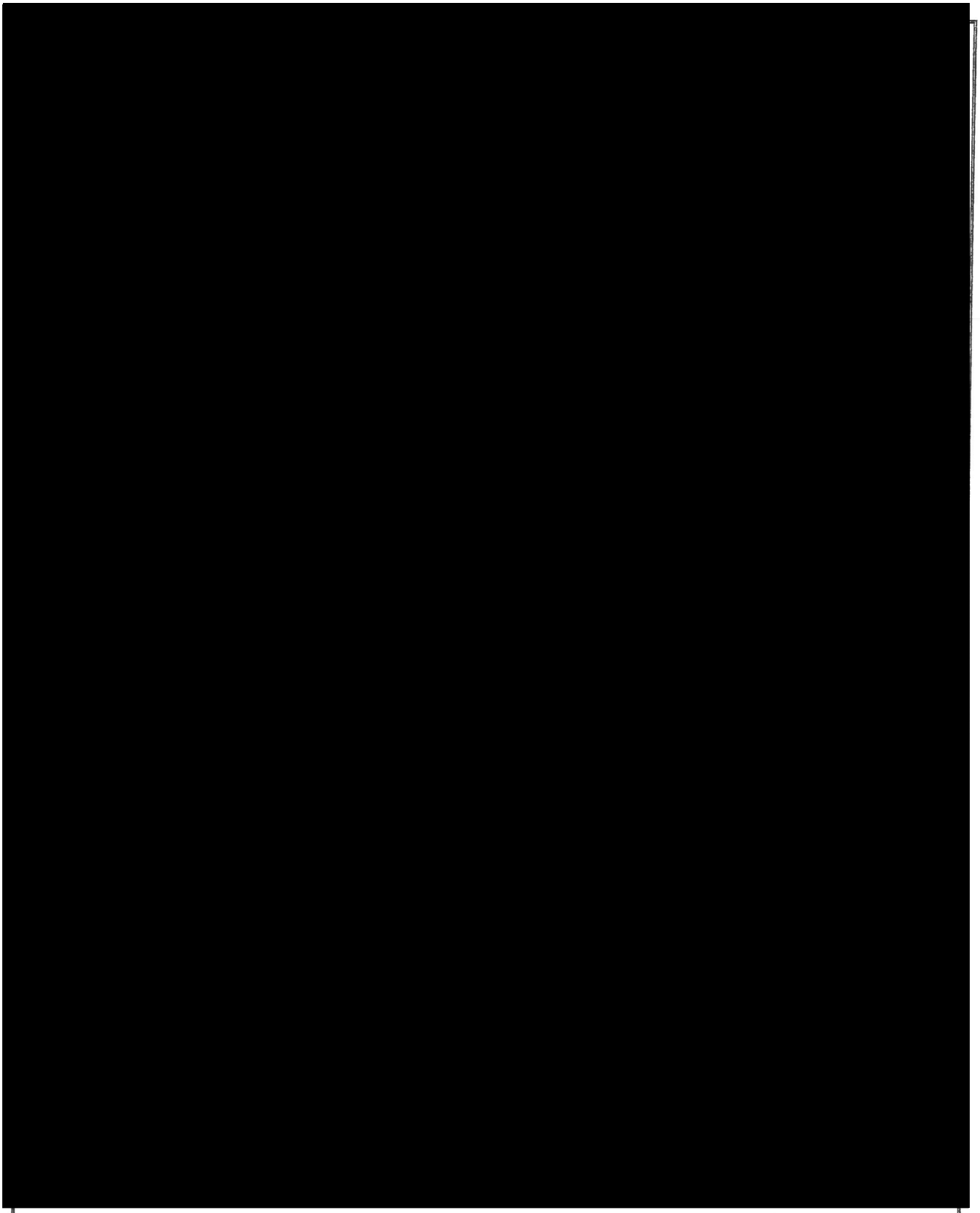
MUSKINGUM WATERSHED
TUSCARAWAS RIVER

DOVER DAM

OPERATING HOUSE - PLAN AND ELEVATIONS

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON, W. VA. REDRAWN: OCT. 1999

PLATE 2-7



MUSKINGUM RIVER

DOVER DAM

SOMERDALE LEVEE

PLAN AND SECTION

HUNTINGTON DISTRICT, HUNTINGTON, W. VA.

Revised: 30 JUNE 1970

PLATE NO. 2-8

MUSKINGUM WATERSHED
ZOAR, OHIO

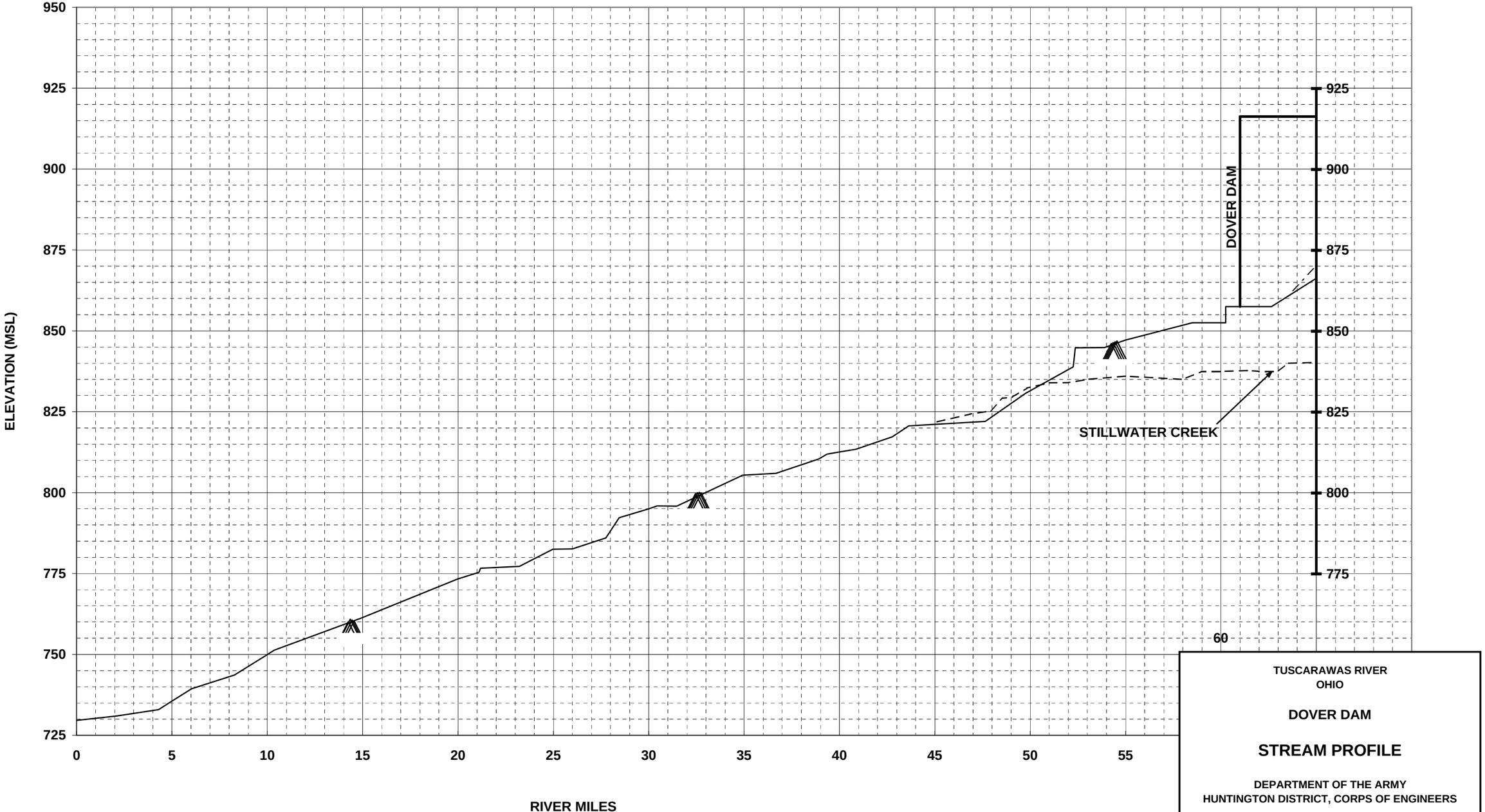
DOVER RESERVOIR

SECTION & DETAILS
INLET STRUCTURE - STA. 27+45

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS

HUNTINGTON, W. VA. REDRAWN: OCT. 1999

PLATE 2-9



TUSCARAWAS RIVER
OHIO

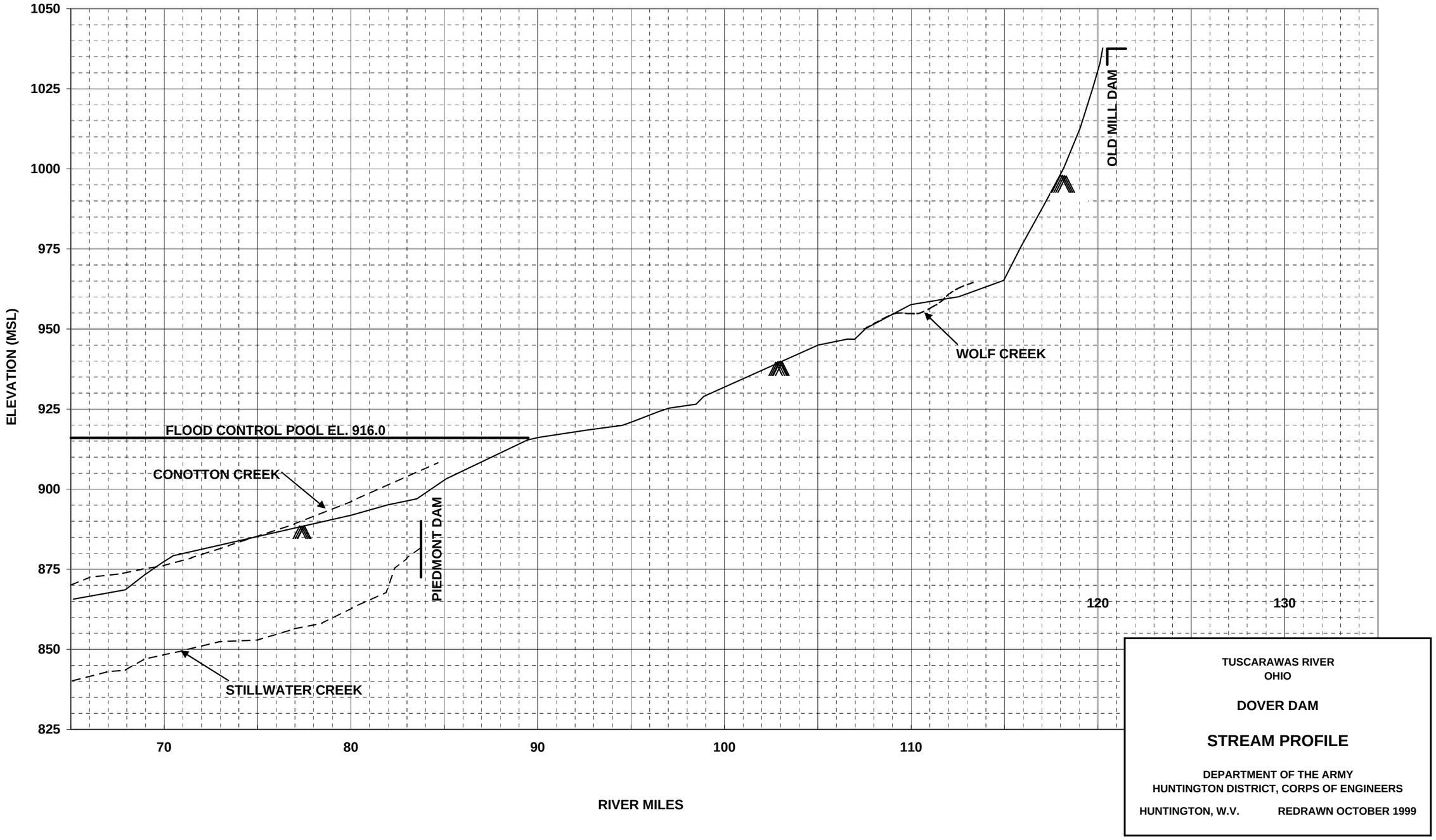
DOVER DAM

STREAM PROFILE

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS

HUNTINGTON, W.V. REDRAWN OCTOBER 1999

Plate 4-1 a



TUSCARAWAS RIVER
OHIO

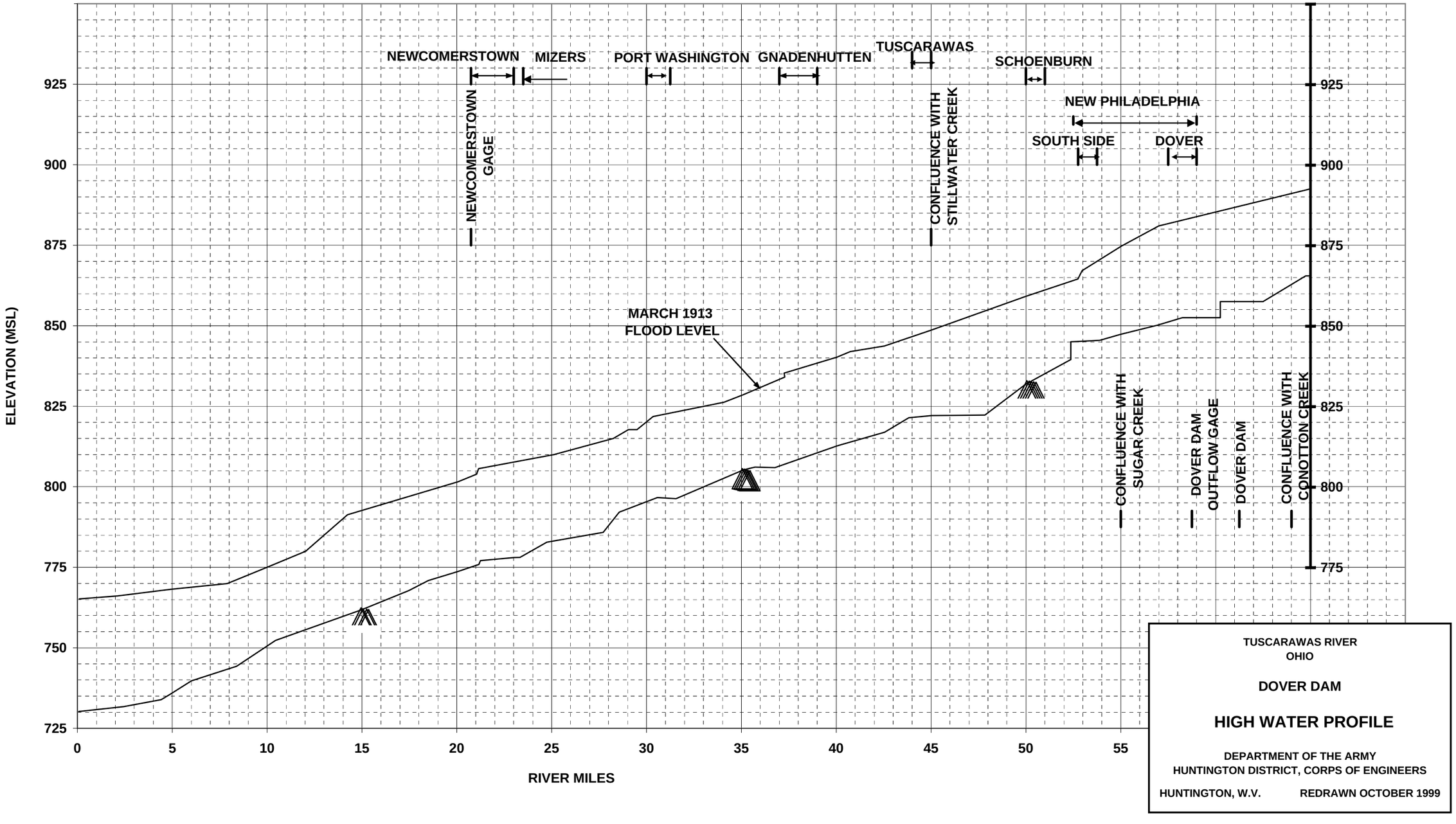
DOVER DAM

STREAM PROFILE

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS

HUNTINGTON, W.V. REDRAWN OCTOBER 1999

Plate 4-1 b



TUSCARAWAS RIVER
OHIO

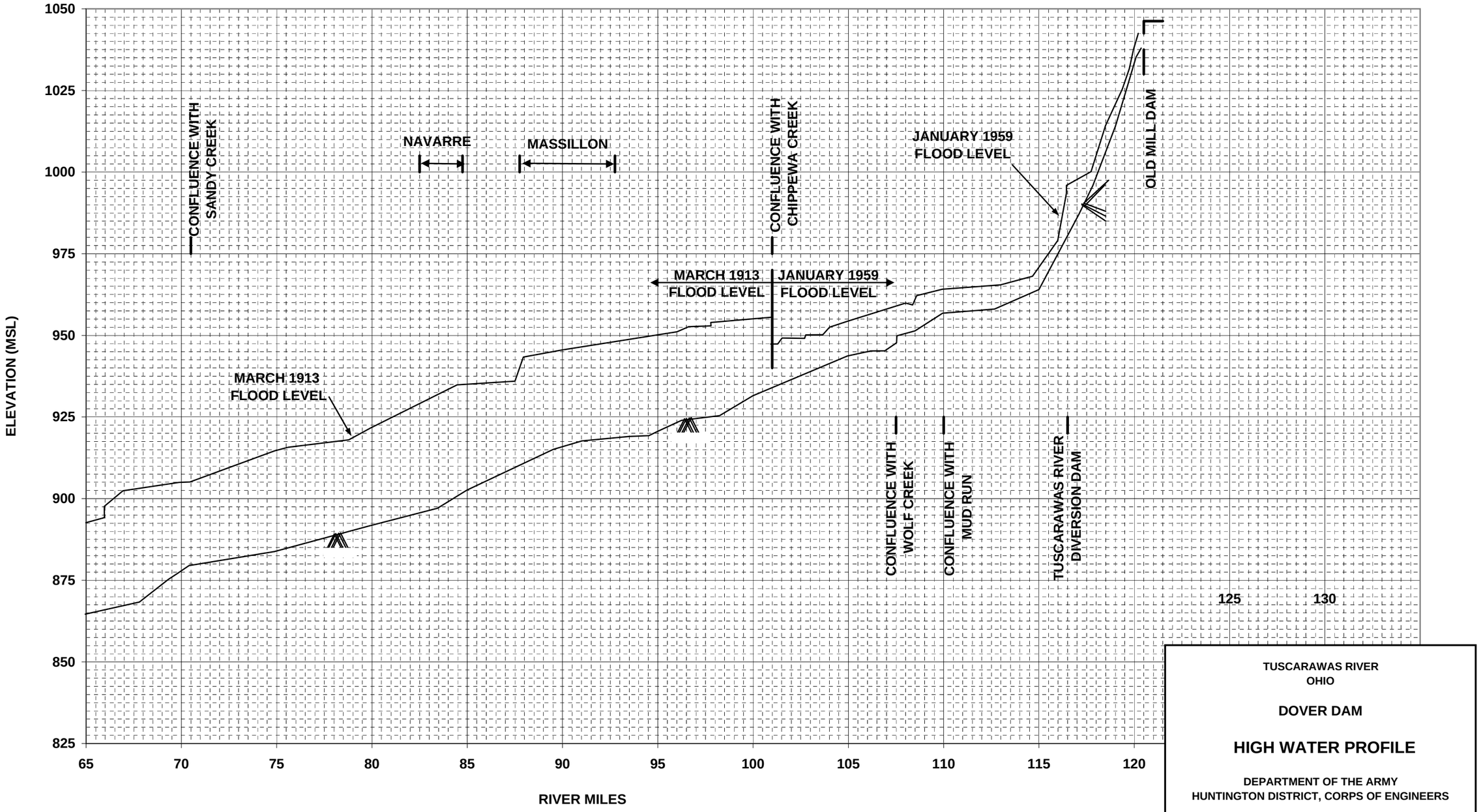
DOVER DAM

HIGH WATER PROFILE

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS

HUNTINGTON, W.V. REDRAWN OCTOBER 1999

Plate 4-2 a



TUSCARAWAS RIVER
OHIO

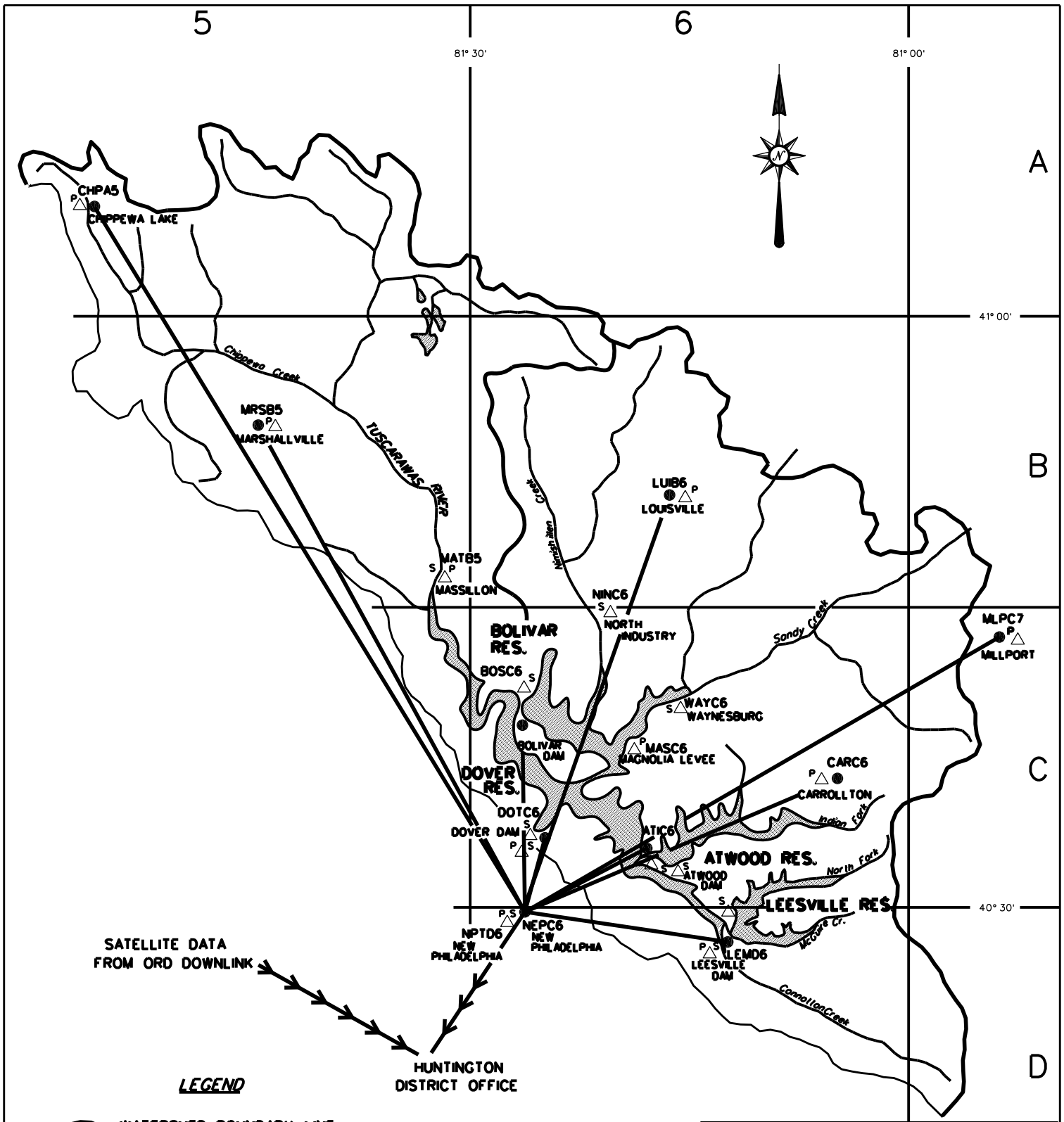
DOVER DAM

HIGH WATER PROFILE

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS

HUNTINGTON, W.V. REDRAWN OCTOBER 1999

Plate 4-2 b



TUSCARAWAS RIVER
OHIO

DOVER DAM

HYDROLOGIC NETWORK

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON, W. VA. REDRAWN: OCT. 1999

Plate 5-1

THE HUNTINGTON DISTRICT INCLUDES THE REACH OF THE OHIO RIVER BETWEEN RIVER MILE 127.2 (NEW MARTINSVILLE W. VA.) AND MILE 438.0 (3.5 MILES DOWNSTREAM FROM CHILO, OHIO) BELOW PITTSBURGH, PA. AND THE DRAINAGE AREA OF ALL TRIBUTARIES ENTERING THE OHIO RIVER BETWEEN THESE TWO POINTS. THE TOTAL DRAINAGE AREA OF THE OHIO RIVER BASIN ABOVE MILE 438. IS 70,880 SQUARE MILES. THE DRAINAGE AREA OF THE HUNTINGTON DISTRICT IS 44,914 SQUARE MILES.

MILLERSBURG LAKE
MOHICANVILLE DAM
TUSCARAWAS RIVER
BLACK FK.
CHARLES MILL LAKE
MANSFIELD
KILBUCK CR.
SUGAR CR.
MASSILON
CANTON
BOLIVAR DAM
DOVER DAM
PLEASANT HILL LAKE
MOHICAN R.
BEACH CITY LAKE
SANDY CR.
INDIAN FK.
ATWOOD LAKE
MARION
NORTH BRANCH OF KOKOSING
KOKOSING R.
LAKE
LEESVILLE LAKE
DELAWARE LAKE
ALUM CREEK LAKE
MOWHAWK DAM
MT. VERNON
WALHONDING R.
CUTTON CR.
TAPPAN LAKE
SCIOTO R.
OLENTANGY R.
BIG WALNUT CR.
TUSCARAWAS R.
CLENDENING LAKE
MILL CREEK LAKE
UTICA LAKE
WILLS CREEK LAKE
WAKATOMIKA R.
TOWNER
FRAZYSBURG LAKE
PIEDMONT LAKE
COLUMBUS
NEWARK
DILLON LAKE
ZANESVILLE
MILE 127.2
BIG DARBY LAKE
OHIO
ROSEVILLE
SENECAVILLE LAKE
NEW MARTINSVILLE
DARBY CR.
DEER CR.
CLEAR FK.
MAXAHALA CR.
MUSKINGHAM R.
DEER CREEK LAKE
LOGAN LAKE
WASHINGTON C.H.
OHIO RIVER
TOM JENKINS DAM
HOCKING R.
SUNDAY CR.
PAINT CREEK LAKE
PAINT CR.
CHILLICOTHE
ATHENS
BELPRE
WILLOW ISLAND
PARKERSBURG
SALT CREEK LAKE
SCIOTO R.
LITTLE KANAWHA R.
ROCKY FORK LAKE
BELLEVILLE
CAPT. ANTHONY MELDAHL
MIDDLEPORT
WHITE OAK CR.
KANAWHA R.
LEADING CREEK LAKE
CHILO
WHITEOAK DAM AND RESERVOIR
PT. PLEASANT
WEST FORK LAKE
BURNSVILLE LAKE
MANCHESTER
PORTSMOUTH
NEW BOSTON
RACINE
SUTTON LAKE
MILE 438.0
AUGUSTA
OHIO RIVER
GREENUP
GALLIPOLIS
TYGARTS R.
KANAWHA R.
LOCATAL CR.
MAYSVILLE
WINFIELD
POKA LAKE
VANCEBURG
IRONTON
COAL GROVE
BIRCH LAKE
KEHOE LAKE
RUSSELL
ASHLAND
HUNTINGTON
ELK R.
BIRCH R.
GREENBRIER RIVER
CATLETTSBURG
CHARLESTON
OLIVE HILL
CEREDO
KENOVA
MARMET
MUD RIVER LAKE
GRAHN
KY
GAULEY R.
SUMMERSVILLE LAKE
GRAYSON LAKE
GRIFFITHSVILLE
KAWKEY
LONDON
W. VA.
SANDY R.
EAST FK.
TUG FK.
YATESVILLE LAKE
LEVISA FK.
BIG SANDY R.
TWELVEPOLE CR.
EAST LYNN LAKE
GUYANDOTTE R.
MEADOW R.
RAINELLE
PAINTSVILLE LAKE
BEACH FORK LAKE
COAL R.
TURNPIKE
NEW R.
INEZ
OCEANNA
HINTON
DEWEY LAKE
PRESTONBURG
R.D. BAILEY LAKE
BIG BEND LAKE
MARTIN
S. WILLIAMSON
JOHNS CR.
TUG FK.
BLUESTONE R.
FISHTRAP LAKE
PRINCETON
BLUESTONE LAKE
BLUEFIELD
BRUSH
RUSSELL FK.
LEVISA FK.
POUND R.
NORTH FORK OF POUND RIVER LAKE
HAST LAKE
PANTHER CREEK LAKE
RADFORD
JOHN W. FLANNAGAN DAM AND RESERVOIR
NEW R.
VA.
GALAX
CHESTNUT CK.
MOORES FEERY LAKE
NORTH FK.
SOUTH FK.
N.C.

10 0 10 20
SCALE IN MILES

LEGEND

FLOOD CONTROL RESERVOIR
- WORK COMPLETED
- WORK UNDER CONSTRUCTION
- NO WORK HAS BEEN INITIATED

LOCAL PROTECTION PROJECT
- WORK COMPLETED
- WORK UNDER CONSTRUCTION
- NO WORK HAS BEEN INITIATED

LOCKS AND DAMS
- WORK COMPLETED
- DISTRICT BOUNDARY

* DRY DAM, WITH FLOOD CONTROL POOL OUTLINED.

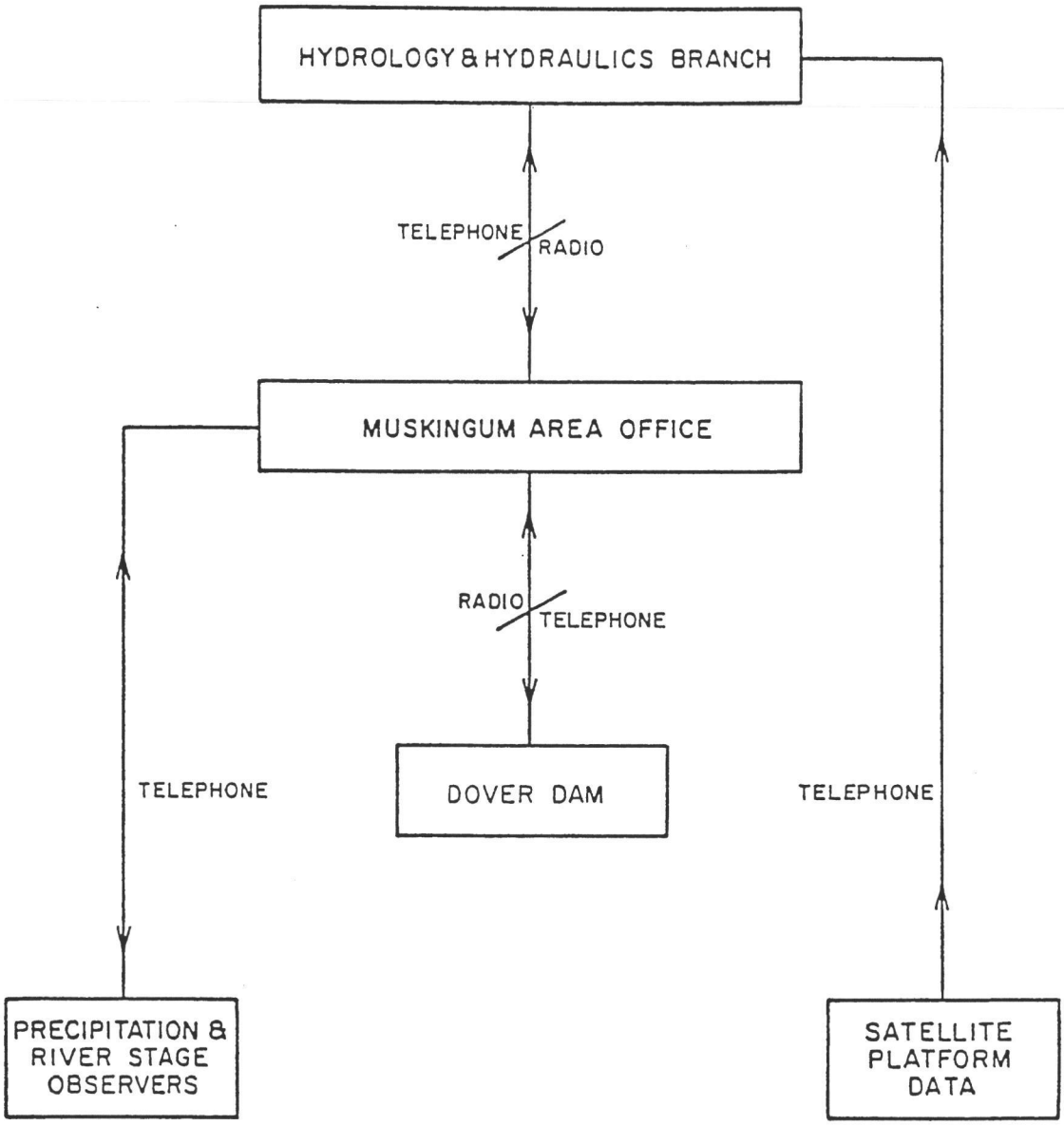
** COMPLETED PROJECT WHERE FURTHER IMPROVEMENTS ARE IN PROGRESS OR AUTHORIZED.

TUSCARAWAS RIVER
OHIO

FLOOD EMERGENCY MANUAL RADIO COMMUNICATION

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON, W. VA. REDRAWN, MAY, 2001

PLATE NO. 5-2



LINES OF COMMUNICATION

TUSCARAWAS-MUSKINGUM

RIVER BASINS

PLATE NO 5-3

Mail to: Ohio River Division
ATTN: ORDED-WR

RECORD OF DEVIATION FROM APPROVED
WATER CONTROL PLAN

DATE _____

DEVIATION _____
(Lake, Reservoir, or System)

1. This is to confirm the following verbal request from

_____ to _____ via
(Name) (Office Symbol) (Name) (Office Symbol)

telephone for approval of a deviation from the approved water control plan.

2. _____

_____

_____

_____

_____

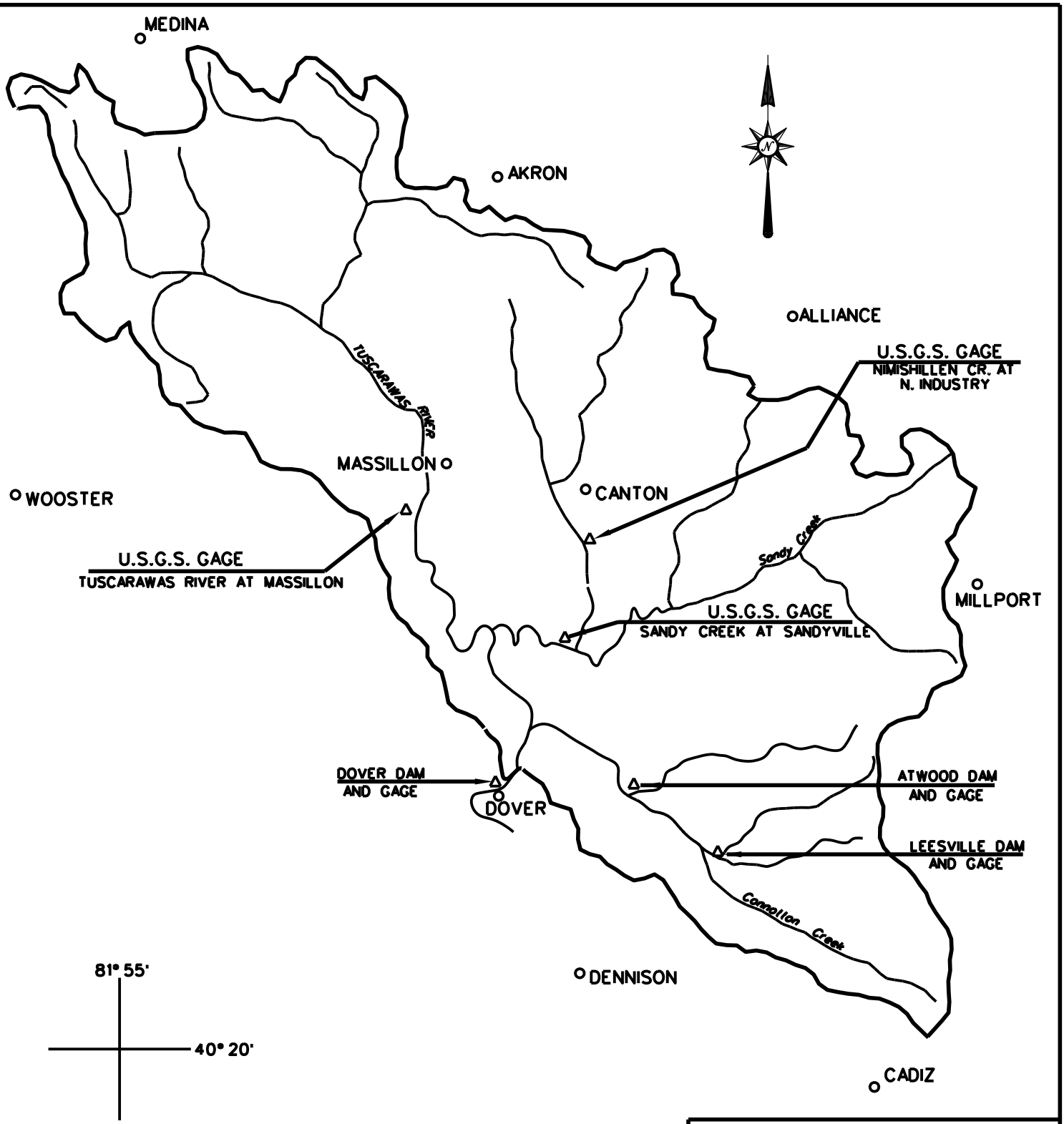
_____

_____

_____

_____

_____



TUSCARAWAS RIVER
OHIO

DOVER DAM

FORECAST AREA REACHES

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON, W. VA. REDRAWN: OCT. 1999

PLATE 6-1

DOVER LAKE-MUSKINGUM RIVER BASIN
BASIN CONFIGURATION

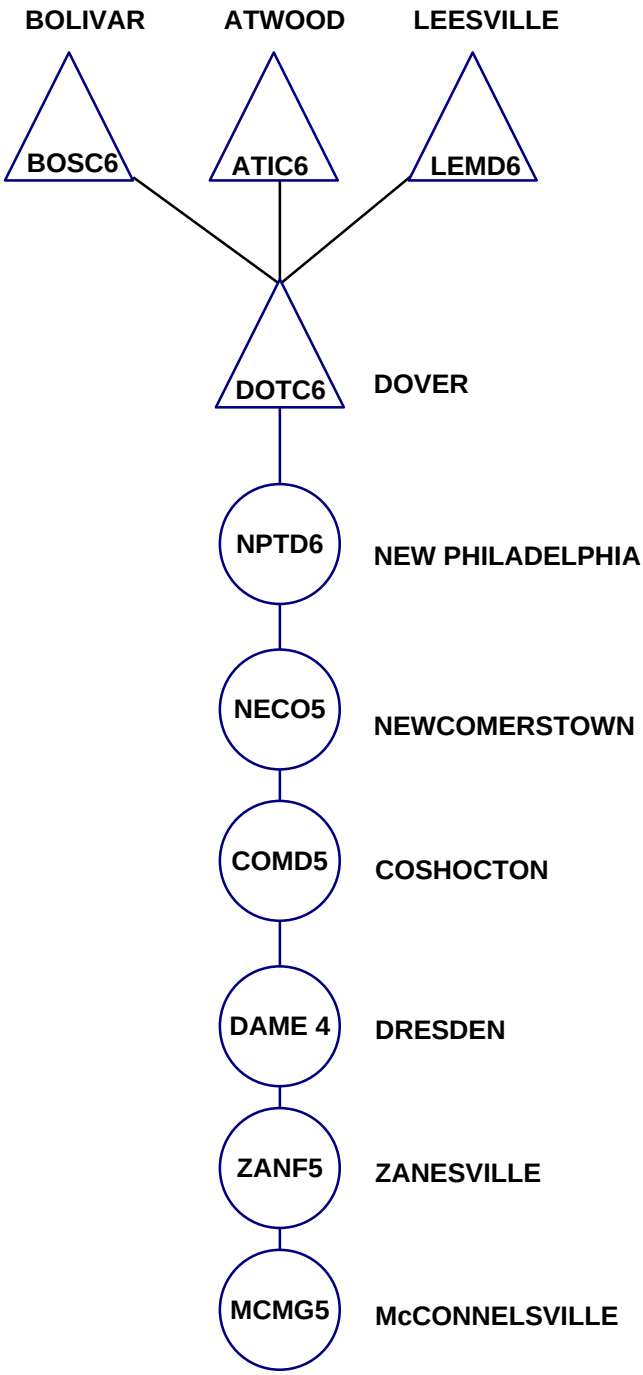
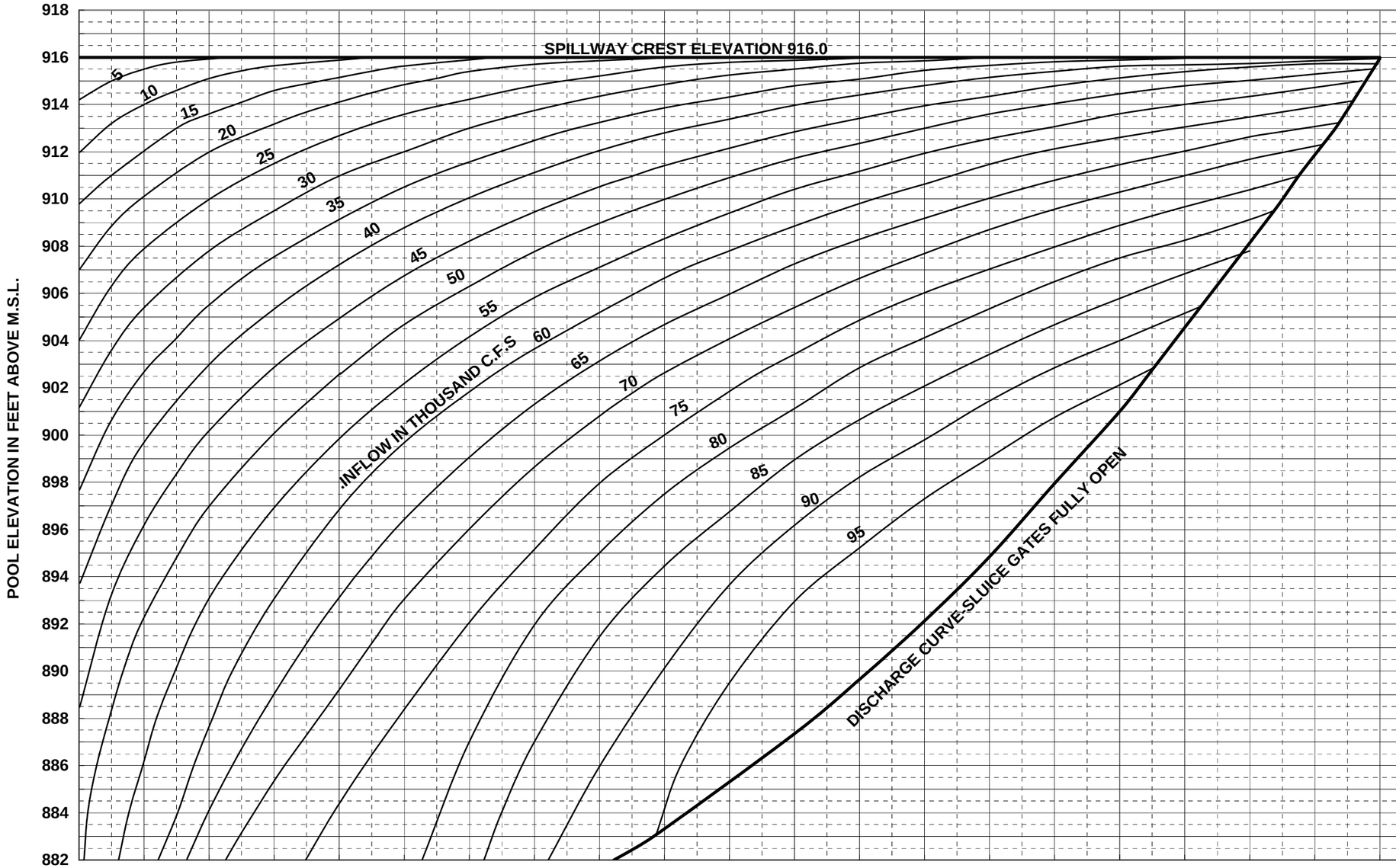


Plate 6-2



OPERATING INSTRUCTIONS

1. FOLLOW REGULAR FLOOD CONTROL REGULATION UNTIL LARGER RELEASES ARE REQUIRED BY THIS SCHEDULE.

2. ADJUST THE OUTFLOW EACH HOUR ON THE BASIS OF THE AVERAGE INFLOW FOR THE PRECEDING HOUR AND THE CURRENT RESERVOIR ELEVATION AS INDICATED BY THE CURVE.

3. IF THE RESERVOIR ELEVATION CRESTS ABOVE SPILLWAY ELEVATION OF 916.0, MAINTAIN CURRENT GATE OPENINGS UNTIL THE ELEVATION HAS RECEDED TO SPILLWAY ELEVATION.

4. MAINTAIN POOL ELEVATION AT SPILLWAY LEVEL OR AT MAXIMUM ATTAINED ELEVATION, IF BELOW SPILLWAY LEVEL, UNTIL TIME TO DRAW POOL DOWN BY RELEASING THE MAXIMUM ALLOWABLE SEASONAL DISCHARGE RATE.

TUSCARAWAS RIVER
OHIO

DOVER RESERVOIR PROJECT

OFFICE REGULATION SCHEDULE FOR MAJOR FLOODS

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON, W.V. REDRAWN OCTOBER 1999

DOVER RESERVOIR, TUSCARAWAS RIVER

AREA AND CAPACITY TABLES

DRAINAGE:
UNCONTROLLED = 782 SQ.MI.
CONTROLLED = 622 SQ.MI.
TOTAL = 1404 SQ.MI.

1 INCHE OF RUNOFF = 41,707 AC. FT. (UNCONTROLLED)

POOL ELEV.	CAPACITY		AREA IN ACRES	POOL ELEV.	CAPACITY		AREA IN ACRES
	AC. FT.	INCHES			AC. FT.	INCHES	
865	0	0.00	0	903	95,000	2.28	6,750
866	5	0.00	10	904	101,900	2.44	6,980
867	27	0.00	35	905	109,000	2.61	7,200
868	65	0.00	40	906	116,300	2.79	7,440
869	110	0.00	50	907	123,800	2.97	7,660
870	182	0.00	95	908	131,600	3.16	7,900
871	297	0.01	135	909	139,600	3.35	8,130
872	462	0.01	195	910	147,900	3.55	8,380
873	692	0.02	265	911	156,400	3.75	8,630
874	1,000	0.02	350	912	165,200	3.96	8,900
875	1,390	0.03	428	913	174,200	4.18	9,150
876	1,880	0.05	550	914	183,500	4.40	9,440
877	2,500	0.06	690	915	193,100	4.63	9,750
878	3,260	0.08	830	916	203,000	4.87	10,100
879	4,170	0.10	1,000	917	213,300	5.11	10,500
880	5,260	0.13	1,180	918	224,000	5.37	10,900
881	6,540	0.16	1,360	919	235,100	5.64	11,300
882	8,000	0.19	1,580	920	246,600	5.91	11,700
883	9,690	0.23	1,800	921	258,500	6.20	12,100
884	11,600	0.28	2,020	922	270,800	6.49	12,500
885	13,700	0.33	2,260	923	283,500	6.80	12,900
886	16,100	0.39	2,480	924	296,600	7.11	13,300
887	18,700	0.45	2,690	925	310,100	7.44	13,700
888	21,500	0.52	2,920	926	324,100	7.77	14,100
889	24,500	0.59	3,140	927	338,400	8.11	14,500
890	27,800	0.67	3,400	928	353,100	8.47	14,900
891	31,300	0.75	3,690	929	368,200	8.83	15,300
892	35,200	0.84	3,990	930	383,700	9.20	15,700
893	39,300	0.94	4,270	931	399,700	9.58	16,200
894	43,700	1.05	4,560	932	416,100	9.98	16,600
895	48,400	1.16	4,840	933	432,900	10.38	17,000
896	53,400	1.28	5,080	934	450,200	10.79	17,500
897	58,600	1.41	5,350	935	467,900	11.22	18,000
898	64,100	1.54	5,590	936	486,100	11.66	18,400
899	69,800	1.67	5,850	937	504,700	12.10	18,900
900	75,700	1.82	6,080	938	523,900	12.56	19,400
901	81,900	1.96	6,310	939	543,500	13.03	19,800
902	88,400	2.28	6,540	940	563,600	13.51	20,400

PLATE NO 7-2

DOVER

PERCENT STORAGE UTILIZATION— ANNUAL

ELEV	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
860	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
861	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
862	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
863	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
864	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
865	-0.00	-0.00	-0.00	-0.00	-0.00	0.00	0.00	0.00	0.00	0.00
866	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01
867	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03
868	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.05
869	0.05	0.06	0.06	0.06	0.07	0.07	0.07	0.08	0.08	0.09
870	0.09	0.09	0.10	0.10	0.11	0.11	0.12	0.13	0.13	0.14
871	0.15	0.15	0.16	0.17	0.17	0.18	0.19	0.20	0.21	0.22
872	0.23	0.24	0.25	0.26	0.27	0.28	0.29	0.30	0.32	0.33
873	0.34	0.35	0.37	0.38	0.40	0.41	0.43	0.44	0.46	0.48
874	0.49	0.51	0.53	0.55	0.56	0.58	0.60	0.62	0.64	0.66
875	0.68	0.71	0.73	0.75	0.77	0.80	0.82	0.85	0.87	0.90
876	0.93	0.95	0.98	1.01	1.04	1.07	1.10	1.13	1.16	1.20
877	1.23	1.27	1.30	1.34	1.37	1.41	1.45	1.49	1.53	1.57
878	1.61	1.65	1.69	1.73	1.77	1.82	1.86	1.91	1.96	2.01
879	2.05	2.10	2.15	2.21	2.26	2.31	2.37	2.42	2.48	2.53
880	2.59	2.65	2.71	2.77	2.83	2.90	2.96	3.02	3.09	3.15
881	3.22	3.29	3.36	3.43	3.50	3.57	3.64	3.71	3.79	3.86
882	3.94	4.02	4.10	4.18	4.26	4.34	4.43	4.51	4.60	4.69
883	4.77	4.86	4.95	5.05	5.14	5.23	5.33	5.42	5.52	5.62
884	5.71	5.81	5.91	6.01	6.11	6.21	6.32	6.42	6.53	6.64
885	6.75	6.86	6.98	7.09	7.21	7.33	7.45	7.57	7.69	7.81
886	7.93	8.05	8.18	8.31	8.43	8.56	8.69	8.82	8.95	9.08
887	9.21	9.35	9.48	9.62	9.75	9.89	10.03	10.17	10.31	10.45
888	10.59	10.73	10.88	11.02	11.16	11.31	11.46	11.61	11.76	11.91
889	12.07	12.23	12.39	12.55	12.71	12.87	13.03	13.20	13.36	13.53
890	13.69	13.86	14.02	14.19	14.36	14.53	14.71	14.88	15.06	15.24
891	15.42	15.61	15.80	15.98	16.18	16.37	16.56	16.75	16.95	17.14
892	17.34	17.54	17.73	17.93	18.13	18.33	18.53	18.74	18.94	19.15
893	19.36	19.57	19.78	19.99	20.21	20.43	20.64	20.86	21.08	21.30
894	21.53	21.75	21.98	22.21	22.44	22.67	22.90	23.13	23.37	23.60
895	23.84	24.08	24.33	24.57	24.82	25.06	25.31	25.56	25.81	26.06
896	26.31	26.56	26.81	27.06	27.31	27.57	27.82	28.08	28.34	28.60
897	28.87	29.13	29.40	29.67	29.94	30.21	30.48	30.75	31.03	31.30
898	31.58	31.85	32.13	32.41	32.69	32.97	33.25	33.53	33.82	34.10
899	34.38	34.67	34.95	35.24	35.53	35.82	36.11	36.40	36.70	36.99
900	37.29	37.59	37.89	38.19	38.50	38.80	39.11	39.41	39.72	40.03

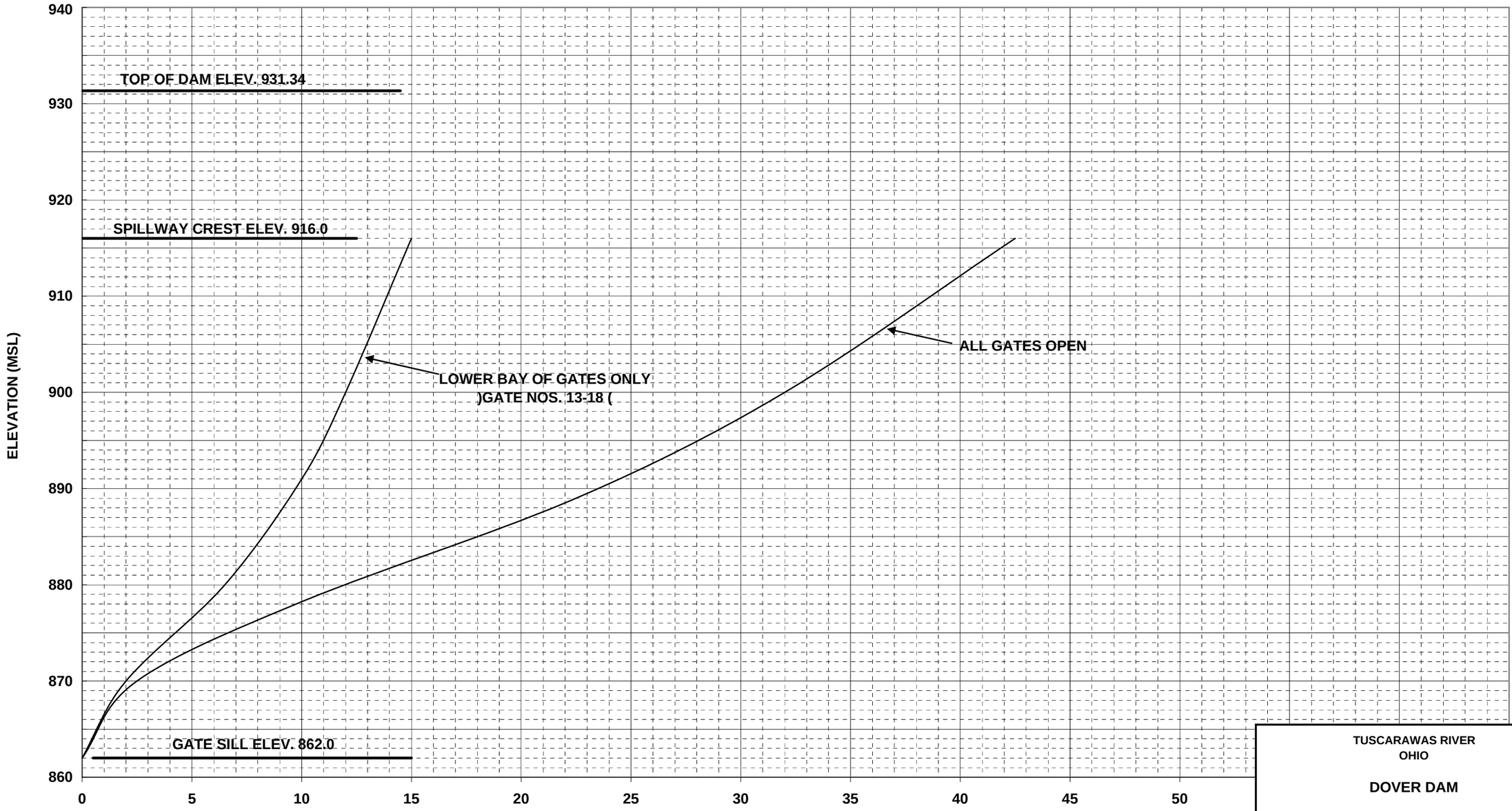
PLATE NO. 7-3 (1 OF 2)

DOVER

PERCENT STORAGE UTILIZATION - ANNUAL

ELEV	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
901	40.35	40.66	40.98	41.30	41.62	41.94	42.26	42.58	42.90	43.22
902	43.55	43.87	44.19	44.51	44.83	45.15	45.48	45.81	46.14	46.47
903	46.80	47.13	47.47	47.81	48.15	48.49	48.83	49.17	49.51	49.85
904	50.20	50.54	50.89	51.24	51.58	51.93	52.28	52.64	52.99	53.34
905	53.70	54.05	54.41	54.76	55.12	55.48	55.84	56.20	56.56	56.93
906	57.29	57.65	58.02	58.38	58.75	59.12	59.49	59.86	60.24	60.61
907	60.99	61.37	61.75	62.13	62.51	62.89	63.28	63.67	64.05	64.44
908	64.83	65.22	65.60	66.00	66.39	66.78	67.18	67.57	67.97	68.37
909	68.77	69.17	69.58	69.99	70.39	70.80	71.21	71.62	72.03	72.44
910	72.86	73.27	73.68	74.10	74.52	74.93	75.35	75.77	76.20	76.62
911	77.05	77.47	77.90	78.34	78.77	79.20	79.63	80.07	80.51	80.94
912	81.38	81.82	82.26	82.69	83.14	83.58	84.02	84.47	84.92	85.36
913	85.81	86.27	86.72	87.17	87.63	88.09	88.54	89.01	89.47	89.93
914	90.40	90.86	91.33	91.80	92.27	92.74	93.21	93.69	94.17	94.64
915	95.12	95.60	96.08	96.57	97.05	97.54	98.03	98.52	99.01	99.50
916	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

PLATE NO. 7-3 (2 OF 2)



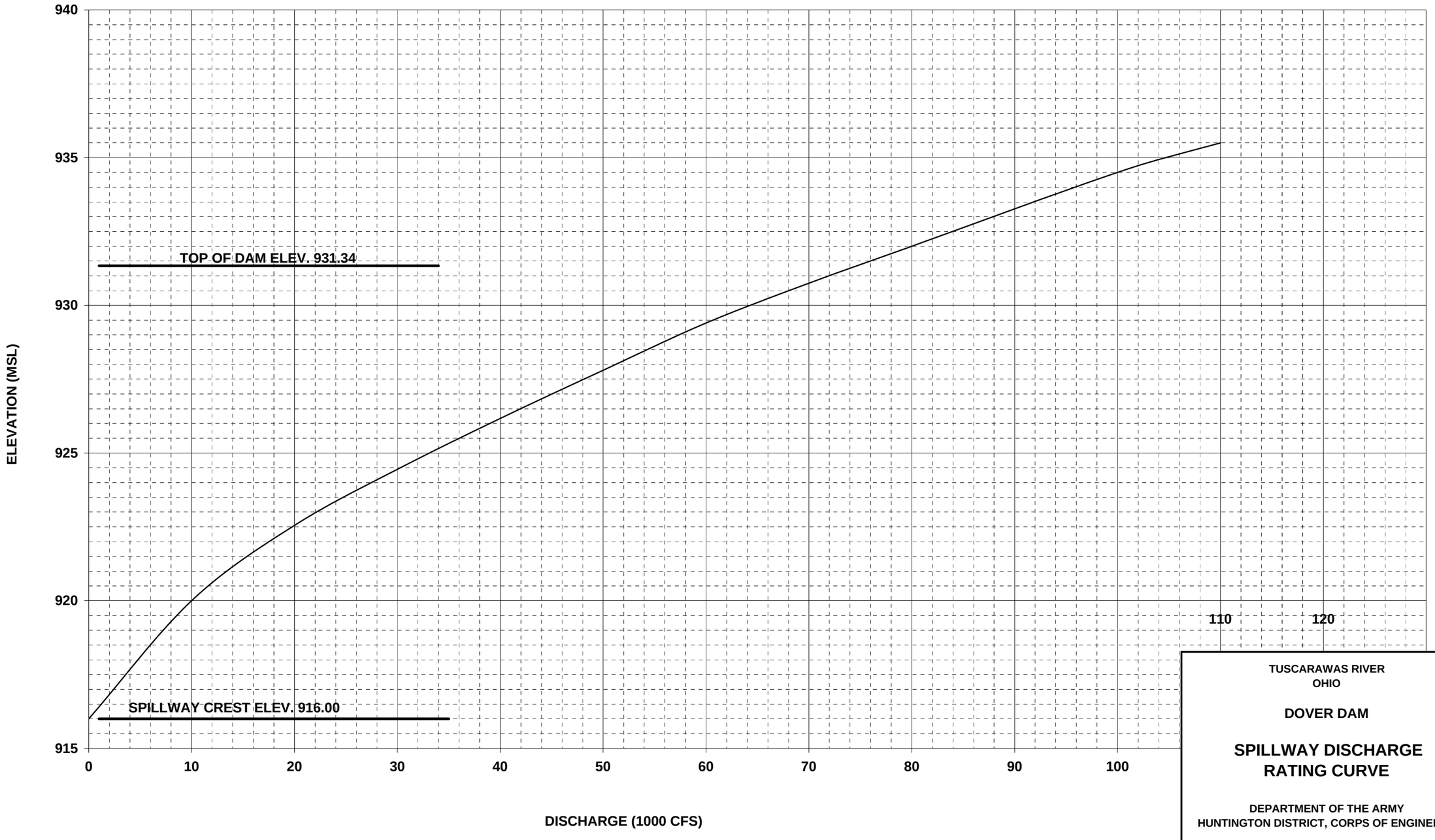
TUSCARAWAS RIVER
OHIO

DOVER DAM

GATE RATING CURVES

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS

HUNTINGTON, W.V. REDRAWN OCTOBER 1999



TUSCARAWAS RIVER
OHIO

DOVER DAM

SPILLWAY DISCHARGE RATING CURVE

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS

HUNTINGTON, W.V. REDRAWN OCTOBER 1999

U.S. DEPARTMENT OF THE INTERIOR - U.S. GEO CAL SURVEY - WATER RESOURCES

ION NUMBER 03122500 Tuscarawas River below Dover Dam nea OH SOURCE AGENCY USGS STATE 39 COUNTY 157
LAT 403147 LONGITUDE 0812548 NAD27 DRAINAGE AREA 1405.00 RIBUTING DRAINAGE AREA 1405. DATUM 861.51 COE1912
Date Processed: 2005-02-18 09:49 By srfrum
Rating for Discharge Final Data, IN cfs
RATING ID: 26 TYPE: stage-discharge EXPANSION: logarithmic STATUS: working
Created by srfrum on 02-18-2005 @ 08:57:00 EST, Updated by srfrum on 02-18-2005 @ 09:49:10 EST
Remarks:

OFFSET: 0.50

EXPANDED RATING TABLE

Gage height, feet	Discharge IN cfs (STANDARD PRECISION) .00	.01	.02	.03	.04	.05	.06	.07	.08	.09	DIFF IN Q PER .1 UNITS
1.00	133*	137	141	145	149	153	157	162	166	170	41.0
1.10	174	179	183	187	192	196	201	205	210	214	45.0
1.20	219	224	228	233	238	243	248	252	257	262	48.0
1.30	267	272	277	282	287	292	297	303	308	313	51.0
1.40	318	323	329	334	339	345	350	356	361	366	54.0
1.50	372*	377	383	388	393	399	404	410	415	421	54.0
1.60	426	432	437	443	449	454	460	466	471	477	57.0
1.70	483	489	494	500	506	512	518	524	530	536	58.0
1.80	541	547	553	559	565	572	578	584	590	596	61.0
1.90	602	608	614	621	627	633	639	646	652	658	62.0
2.00	664	671	677	684	690	696	703	709	716	722	65.0
2.10	729	735	742	748	755	762	768	775	781	788	66.0
2.20	795	801	808	815	822	828	835	842	849	856	68.0
2.30	863	869	876	883	890	897	904	911	918	925	69.0
2.40	932	939	946	953	960	967	974	981	989	996	68.0
2.50	1000	1010	1020	1020	1030	1040	1050	1050	1060	1070	80.0
2.60	1080	1080	1090	1100	1100	1110	1120	1130	1130	1140	70.0
2.70	1150	1160	1160	1170	1180	1190	1190	1200	1210	1220	70.0
2.80	1220	1230	1240	1250	1260	1260	1270	1280	1290	1290	80.0
2.90	1300	1310	1320	1330	1330	1340	1350	1360	1360	1370	80.0
3.00	1380*	1390	1390	1400	1410	1420	1420	1430	1440	1450	70.0
3.10	1450	1460	1470	1470	1480	1490	1500	1500	1510	1520	80.0
3.20	1530	1530	1540	1550	1560	1560	1570	1580	1580	1590	70.0
3.30	1600	1610	1610	1620	1630	1640	1640	1650	1660	1670	70.0
3.40	1670	1680	1690	1700	1700	1710	1720	1730	1730	1740	80.0
3.50	1750*	1760	1770	1770	1780	1790	1800	1800	1810	1820	80.0
3.60	1830	1840	1840	1850	1860	1870	1880	1880	1890	1900	80.0
3.70	1910	1920	1920	1930	1940	1950	1960	1960	1970	1980	80.0
3.80	1990	2000	2000	2010	2020	2030	2040	2040	2050	2060	80.0
3.90	2070	2080	2080	2090	2100	2110	2120	2130	2130	2140	80.0
4.00	2150*	2160	2170	2170	2180	2190	2200	2210	2210	2220	80.0
4.10	2230	2240	2240	2250	2260	2270	2280	2280	2290	2300	80.0
4.20	2310	2320	2320	2330	2340	2350	2360	2360	2370	2380	80.0
4.30	2390	2400	2400	2410	2420	2430	2440	2440	2450	2460	80.0
4.40	2470	2480	2490	2490	2500	2510	2520	2530	2530	2540	80.0
4.50	2550*	2560	2570	2570	2580	2590	2600	2610	2620	2620	80.0
4.60	2630	2640	2650	2660	2670	2670	2680	2690	2700	2710	90.0
4.70	2720	2720	2730	2740	2750	2760	2770	2770	2780	2790	80.0
4.80	2800	2810	2820	2820	2830	2840	2850	2860	2870	2870	80.0
4.90	2880	2890	2900	2910	2920	2930	2930	2940	2950	2960	90.0

PLATE 7-6 (1 of 3)

U.S. DEPARTMENT OF THE INTERIOR - U.S. GEO CAL SURVEY - WATER RESOURCES

ON NUMBER 03122500 Tuscarawas River below Dover Dam near OH SOURCE AGENCY USGS STATE 39 COUNTY 157
LAT 403147 LONGITUDE 0812548 NAD27 DRAINAGE AREA 1405.00 RIBUTING DRAINAGE AREA 1405. DATUM 861.51 COE1912
Date Processed: 2005-02-18 09:49 By srfrum
Rating for Discharge Final Data, IN cfs
RATING ID: 26 TYPE: stage-discharge EXPANSION: logarithmic STATUS: working
Created by srfrum on 02-18-2005 @ 08:57:00 EST, Updated by srfrum on 02-18-2005 @ 09:49:10 EST
Remarks:

OFFSET: 0.50

EXPANDED RATING TABLE

Gage height, feet	Discharge IN cfs (STANDARD PRECISION) .00	.01	.02	.03	.04	.05	.06	.07	.08	.09	DIFF IN Q PER .1 UNITS
5.00	2970	2980	2990	2990	3000	3010	3020	3030	3040	3040	80.0
5.10	3050	3060	3070	3080	3090	3100	3100	3110	3120	3130	90.0
5.20	3140	3150	3160	3170	3170	3180	3190	3200	3210	3220	90.0
5.30	3230	3230	3240	3250	3260	3270	3280	3290	3300	3300	80.0
5.40	3310	3320	3330	3340	3350	3360	3360	3370	3380	3390	90.0
5.50	3400*	3410	3420	3420	3430	3440	3450	3460	3460	3470	80.0
5.60	3480	3490	3500	3510	3510	3520	3530	3540	3550	3550	80.0
5.70	3560	3570	3580	3590	3590	3600	3610	3620	3630	3630	80.0
5.80	3640	3650	3660	3670	3680	3680	3690	3700	3710	3720	80.0
5.90	3720	3730	3740	3750	3760	3770	3770	3780	3790	3800	90.0
6.00	3810	3810	3820	3830	3840	3850	3860	3860	3870	3880	80.0
6.10	3890	3900	3910	3910	3920	3930	3940	3950	3950	3960	80.0
6.20	3970	3980	3990	4000	4000	4010	4020	4030	4040	4050	80.0
6.30	4050	4060	4070	4080	4090	4100	4100	4110	4120	4130	90.0
6.40	4140	4150	4150	4160	4170	4180	4190	4200	4200	4210	80.0
6.50	4220*	4230	4240	4250	4260	4270	4280	4290	4300	4310	100
6.60	4320	4330	4330	4340	4350	4360	4370	4380	4390	4400	90.0
6.70	4410	4420	4430	4440	4450	4460	4470	4480	4490	4500	100
6.80	4510	4520	4530	4540	4550	4560	4570	4580	4590	4600	100
6.90	4610	4620	4630	4630	4640	4650	4660	4670	4680	4690	90.0
7.00	4700	4710	4720	4730	4740	4750	4760	4770	4780	4790	100
7.10	4800	4810	4820	4830	4840	4850	4860	4870	4880	4890	100
7.20	4900	4910	4920	4930	4940	4950	4960	4970	4980	4990	100
7.30	5000	5010	5020	5030	5040	5050	5060	5070	5080	5090	100
7.40	5100	5110	5120	5130	5140	5150	5160	5170	5180	5190	100
7.50	5200*	5210	5220	5240	5250	5260	5270	5280	5290	5310	120
7.60	5320	5330	5340	5350	5370	5380	5390	5400	5410	5430	120
7.70	5440	5450	5460	5470	5490	5500	5510	5520	5530	5550	120
7.80	5560	5570	5580	5590	5610	5620	5630	5640	5650	5670	120
7.90	5680	5690	5700	5710	5730	5740	5750	5760	5780	5790	120
8.00	5800*	5810	5820	5830	5850	5860	5870	5880	5890	5900	120
8.10	5920	5930	5940	5950	5960	5980	5990	6000	6010	6020	110
8.20	6030	6050	6060	6070	6080	6090	6100	6120	6130	6140	120
8.30	6150	6160	6180	6190	6200	6210	6220	6240	6250	6260	120
8.40	6270	6280	6290	6310	6320	6330	6340	6350	6370	6380	120
8.50	6390	6400	6410	6430	6440	6450	6460	6470	6490	6500	120
8.60	6510	6520	6540	6550	6560	6570	6580	6600	6610	6620	120
8.70	6630	6640	6660	6670	6680	6690	6710	6720	6730	6740	120
8.80	6750	6770	6780	6790	6800	6820	6830	6840	6850	6860	130
8.90	6880	6890	6900	6910	6930	6940	6950	6960	6980	6990	120

PLATE 7-6 (2 of 3)

U.S. DEPARTMENT OF THE INTERIOR - U.S. G AL SURVEY - WATER RESOURCES

TION NUMBER 03122500 Tuscarawas River below Dover Dam near r OH SOURCE AGENCY USGS STATE 39 COUNTY 157
LATITUDE 403147 LONGITUDE 0812548 NAD27 DRAINAGE AREA 1405.00 CONTRIBUTING DRAINAGE AREA 1405. DATUM 861.51 COE1912
Date Processed: 2005-02-18 09:49 By srfrum
Rating for Discharge Final Data, IN cfs
RATING ID: 26 TYPE: stage-discharge EXPANSION: logarithmic STATUS: working
Created by srfrum on 02-18-2005 @ 08:57:00 EST, Updated by srfrum on 02-18-2005 @ 09:49:10 EST
Remarks:

OFFSET: 0.50

EXPANDED RATING TABLE

Gage height, feet	Discharge IN cfs (STANDARD PRECISION) .00	.01	.02	.03	.04	.05	.06	.07	.08	.09	DIFF IN Q PER .1 UNITS
9.00	7000*	7010	7030	7040	7060	7070	7090	7100	7120	7130	140
9.10	7140	7160	7170	7190	7200	7220	7230	7250	7260	7280	150
9.20	7290	7300	7320	7330	7350	7360	7380	7390	7410	7420	150
9.30	7440	7450	7470	7480	7500	7510	7530	7540	7560	7570	150
9.40	7590	7600	7610	7630	7640	7660	7670	7690	7700	7720	140
9.50	7730	7750	7760	7780	7790	7810	7820	7840	7850	7870	160
9.60	7890	7900	7920	7930	7950	7960	7980	7990	8010	8020	150
9.70	8040	8050	8070	8080	8100	8110	8130	8140	8160	8170	150
9.80	8190	8210	8220	8240	8250	8270	8280	8300	8310	8330	150
9.90	8340	8360	8380	8390	8410	8420	8440	8450	8470	8480	160
10.00	8500*										

"*" indicates a rating descriptor point

Rating Type: Rating Type: stage-discharge

ID	Starting Date	Ending Date	A	Comments
26	10-01-2004 @ 01:00:00 EDT	-----	W	

PLATE 7-6 (3 of 3)

U.S. DEPARTMENT OF THE INTERIOR - U.S. GE AL SURVEY - WATER RESOURCES

ATION NUMBER 03129000 Tuscarawas River at Newcomerstown O EAM SOURCE AGENCY USGS STATE 39 COUNTY 157
LATITUDE 401541 LONGITUDE 0813633 NAD27 DRAINAGE AREA 2443.00 NTRIBUTING DRAINAGE AREA 2443. DATUM 780.00 COE1912
Date Processed: 2005-04-04 14:01 By srfrum
Rating for Discharge FROM DCP, IN cfs
RATING ID: 28 TYPE: stage-discharge EXPANSION: logarithmic STATUS: approved
Created by chawkins on 10-25-2004 @ 08:26:11 EDT, Updated by hshindel on 02-03-2005 @ 10:34:06 EST
Remarks:

OFFSET: 0.50

EXPANDED RATING TABLE

Gage height, feet	Discharge IN cfs (STANDARD PRECISION) .00	.01	.02	.03	.04	.05	.06	.07	.08	.09	DIFF IN Q PER .1 UNITS
0.80	350*	356	363	369	375	381	387	393	399	404	60.0
0.90	410*	417	424	431	439	446	453	459	466	473	70.0
1.00	480*	487	494	501	508	515	522	529	536	543	70.0
1.10	550*	558	566	574	582	590	598	606	614	622	80.0
1.20	630*	639	648	657	666	675	684	693	702	711	90.0
1.30	720*	729	738	747	756	765	774	783	792	801	90.0
1.40	810*	821	832	843	854	865	876	887	898	909	110
1.50	920*	931	942	953	963	974	985	996	1010	1020	110
1.60	1030	1040	1050	1060	1070	1080	1100	1110	1120	1130	110
1.70	1140*	1150	1160	1180	1190	1200	1210	1230	1240	1250	120
1.80	1260	1280	1290	1300	1310	1330	1340	1350	1370	1380	130
1.90	1390	1400	1420	1430	1440	1460	1470	1480	1490	1510	130
2.00	1520*	1530	1540	1560	1570	1580	1590	1610	1620	1630	120
2.10	1640	1660	1670	1680	1690	1710	1720	1730	1740	1760	130
2.20	1770	1780	1790	1810	1820	1830	1840	1860	1870	1880	120
2.30	1890	1910	1920	1930	1940	1960	1970	1980	2000	2010	130
2.40	2020	2030	2050	2060	2070	2090	2100	2110	2120	2140	130
2.50	2150*	2160	2180	2190	2200	2210	2230	2240	2250	2270	130
2.60	2280	2290	2310	2320	2330	2350	2360	2370	2380	2400	130
2.70	2410	2420	2440	2450	2460	2480	2490	2500	2520	2530	130
2.80	2540	2560	2570	2580	2600	2610	2620	2640	2650	2660	140
2.90	2680	2690	2700	2720	2730	2740	2760	2770	2780	2800	130
3.00	2810	2820	2840	2850	2870	2880	2890	2910	2920	2930	140
3.10	2950	2960	2970	2990	3000	3020	3030	3040	3060	3070	130
3.20	3080	3100	3110	3120	3140	3150	3170	3180	3190	3210	140
3.30	3220	3240	3250	3260	3280	3290	3300	3320	3330	3350	140
3.40	3360	3370	3390	3400	3420	3430	3440	3460	3470	3490	140
3.50	3500*	3510	3530	3540	3560	3570	3590	3600	3620	3630	150
3.60	3650	3660	3670	3690	3700	3720	3730	3750	3760	3780	140
3.70	3790	3810	3820	3840	3850	3870	3880	3890	3910	3920	150
3.80	3940	3950	3970	3980	4000	4010	4030	4040	4060	4070	150
3.90	4090	4100	4120	4130	4150	4160	4180	4190	4210	4220	150
4.00	4240	4250	4270	4280	4300	4310	4330	4340	4360	4370	150
4.10	4390	4400	4420	4430	4450	4460	4480	4490	4510	4520	150
4.20	4540	4550	4570	4590	4600	4620	4630	4650	4660	4680	150
4.30	4690	4710	4720	4740	4750	4770	4780	4800	4810	4830	160
4.40	4850	4860	4880	4890	4910	4920	4940	4950	4970	4980	150
4.50	5000*	5020	5030	5050	5060	5080	5090	5110	5120	5140	160
4.60	5160	5170	5190	5200	5220	5230	5250	5270	5280	5300	150
4.70	5310	5330	5340	5360	5380	5390	5410	5420	5440	5450	160

U.S. DEPARTMENT OF THE INTERIOR - U.S. G CAL SURVEY - WATER RESOURCES

ATION NUMBER 03129000 Tuscarawas River at Newcomerstown EAM SOURCE AGENCY USGS STATE 39 COUNTY 157
LAT E 401541 LONGITUDE 0813633 NAD27 DRAINAGE AREA 2443.00 NTRIBUTING DRAINAGE AREA 2443. DATUM 780.00 COE1912
Date Processed: 2005-04-04 14:01 By srfrum
Rating for Discharge FROM DCP, IN cfs
RATING ID: 28 TYPE: stage-discharge EXPANSION: logarithmic STATUS: approved
Created by chawkins on 10-25-2004 @ 08:26:11 EDT, Updated by hshindel on 02-03-2005 @ 10:34:06 EST
Remarks:

OFFSET: 0.50

EXPANDED RATING TABLE

Gage height, feet	Discharge IN cfs (STANDARD PRECISION) .00	.01	.02	.03	.04	.05	.06	.07	.08	.09	DIFF IN Q PER .1 UNITS
4.80	5470	5490	5500	5520	5530	5550	5570	5580	5600	5610	160
4.90	5630	5650	5660	5680	5690	5710	5730	5740	5760	5770	160
5.00	5790	5810	5820	5840	5850	5870	5890	5900	5920	5930	160
5.10	5950	5970	5980	6000	6010	6030	6050	6060	6080	6090	160
5.20	6110	6130	6140	6160	6180	6190	6210	6220	6240	6260	160
5.30	6270	6290	6310	6320	6340	6350	6370	6390	6400	6420	170
5.40	6440	6450	6470	6490	6500	6520	6530	6550	6570	6580	160
5.50	6600*	6620	6630	6650	6670	6680	6700	6720	6730	6750	170
5.60	6770	6780	6800	6820	6830	6850	6870	6880	6900	6920	160
5.70	6930	6950	6970	6980	7000	7020	7030	7050	7070	7080	170
5.80	7100	7120	7140	7150	7170	7190	7200	7220	7240	7250	170
5.90	7270	7290	7300	7320	7340	7360	7370	7390	7410	7420	170
6.00	7440	7460	7470	7490	7510	7530	7540	7560	7580	7590	170
6.10	7610	7630	7640	7660	7680	7700	7710	7730	7750	7760	170
6.20	7780	7800	7820	7830	7850	7870	7880	7900	7920	7940	170
6.30	7950	7970	7990	8010	8020	8040	8060	8070	8090	8110	180
6.40	8130	8140	8160	8180	8200	8210	8230	8250	8270	8280	170
6.50	8300*	8320	8330	8350	8360	8380	8390	8410	8430	8440	160
6.60	8460	8470	8490	8510	8520	8540	8550	8570	8590	8600	160
6.70	8620	8630	8650	8660	8680	8700	8710	8730	8740	8760	160
6.80	8780	8790	8810	8820	8840	8860	8870	8890	8900	8920	160
6.90	8940	8950	8970	8980	9000	9020	9030	9050	9060	9080	160
7.00	9100	9110	9130	9140	9160	9180	9190	9210	9220	9240	160
7.10	9260	9270	9290	9300	9320	9340	9350	9370	9380	9400	160
7.20	9420	9430	9450	9460	9480	9500	9510	9530	9550	9560	160
7.30	9580	9590	9610	9630	9640	9660	9670	9690	9710	9720	160
7.40	9740	9750	9770	9790	9800	9820	9840	9850	9870	9880	160
7.50	9900*	9920	9940	9950	9970	9990	10000	10000	10000	10100	200
7.60	10100	10100	10100	10100	10100	10200	10200	10200	10200	10200	200
7.70	10300	10300	10300	10300	10300	10300	10400	10400	10400	10400	100
7.80	10400	10500	10500	10500	10500	10500	10500	10600	10600	10600	200
7.90	10600	10600	10700	10700	10700	10700	10700	10700	10800	10800	200
8.00	10800	10800	10800	10900	10900	10900	10900	10900	10900	11000	200
8.10	11000	11000	11000	11000	11100	11100	11100	11100	11100	11100	200
8.20	11200	11200	11200	11200	11200	11300	11300	11300	11300	11300	100
8.30	11300	11400	11400	11400	11400	11400	11500	11500	11500	11500	200
8.40	11500	11500	11600	11600	11600	11600	11600	11700	11700	11700	200
8.50	11700	11700	11700	11800	11800	11800	11800	11800	11900	11900	200
8.60	11900	11900	11900	11900	12000	12000	12000	12000	12000	12100	200
8.70	12100	12100	12100	12100	12200	12200	12200	12200	12200	12200	200

U.S. DEPARTMENT OF THE INTERIOR - U.S. G CAL SURVEY - WATER RESOURCES

TATION NUMBER 03129000 Tuscarawas River at Newcomerstown REAM SOURCE AGENCY USGS STATE 39 COUNTY 157
LA E 401541 LONGITUDE 0813633 NAD27 DRAINAGE AREA 2443.00 NTRIBUTING DRAINAGE AREA 2443. DATUM 780.00 COE1912
Date Processed: 2005-04-04 14:01 By srfrum
Rating for Discharge FROM DCP, IN cfs
RATING ID: 28 TYPE: stage-discharge EXPANSION: logarithmic STATUS: approved
Created by chawkins on 10-25-2004 @ 08:26:11 EDT, Updated by hshindel on 02-03-2005 @ 10:34:06 EST
Remarks:

OFFSET: 0.50

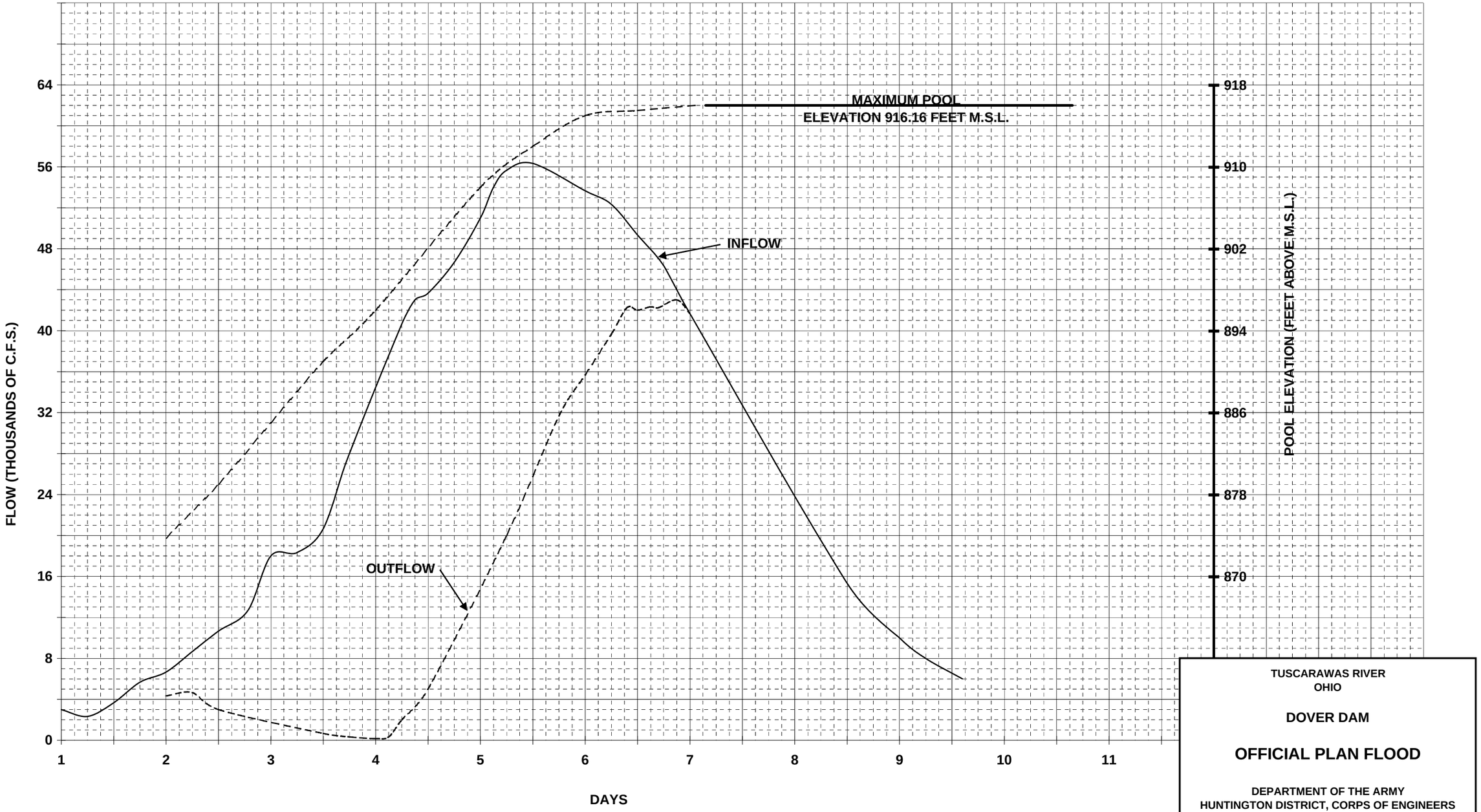
EXPANDED RATING TABLE

Gage height, feet	Discharge IN cfs (STANDARD PRECISION) .00	.01	.02	.03	.04	.05	.06	.07	.08	.09	DIFF IN Q PER .1 UNITS
8.80	12300	12300	12300	12300	12300	12400	12400	12400	12400	12400	100
8.90	12400	12500	12500	12500	12500	12500	12600	12600	12600	12600	200
9.00	12600	12700	12700	12700	12700	12700	12700	12800	12800	12800	200
9.10	12800	12800	12900	12900	12900	12900	12900	13000	13000	13000	200
9.20	13000	13000	13000	13100	13100	13100	13100	13100	13200	13200	200
9.30	13200	13200	13200	13300	13300	13300	13300	13300	13400	13400	200
9.40	13400	13400	13400	13400	13500	13500	13500	13500	13500	13600	200
9.50	13600	13600	13600	13600	13700	13700	13700	13700	13700	13700	200
9.60	13800	13800	13800	13800	13800	13900	13900	13900	13900	13900	200
9.70	14000	14000	14000	14000	14000	14100	14100	14100	14100	14100	100
9.80	14100	14200	14200	14200	14200	14200	14300	14300	14300	14300	200
9.90	14300	14400	14400	14400	14400	14400	14500	14500	14500	14500	200
10.00	14500	14600	14600	14600	14600	14600	14600	14700	14700	14700	200
10.10	14700	14700	14800	14800	14800	14800	14800	14900	14900	14900	200
10.20	14900	14900	15000	15000	15000	15000	15000	15100	15100	15100	200
10.30	15100	15100	15200	15200	15200	15200	15200	15200	15300	15300	200
10.40	15300	15300	15300	15400	15400	15400	15400	15400	15500	15500	200
10.50	15500*	15500	15500	15600	15600	15600	15600	15700	15700	15700	200
10.60	15700	15800	15800	15800	15800	15900	15900	15900	15900	15900	300
10.70	16000	16000	16000	16000	16100	16100	16100	16100	16200	16200	200
10.80	16200	16200	16300	16300	16300	16300	16400	16400	16400	16400	200
10.90	16400	16500	16500	16500	16500	16600	16600	16600	16600	16700	300
11.00	16700	16700	16700	16800	16800	16800	16800	16900	16900	16900	200
11.10	16900	17000	17000	17000	17000	17000	17100	17100	17100	17100	300
11.20	17200	17200	17200	17200	17300	17300	17300	17300	17400	17400	200
11.30	17400	17400	17500	17500	17500	17500	17600	17600	17600	17600	300
11.40	17700	17700	17700	17700	17800	17800	17800	17800	17900	17900	200
11.50	17900*										

"*" indicates a rating descriptor point

Rating Type: Rating Type: stage-discharge

ID	Starting Date	Ending Date	A	Comments
28	10-01-2003 @ 00:05:00 EDT	09-30-2004 @ 23:59:59 EDT	A	
28	10-01-2004 @ 00:00:00 EDT	-----	W	



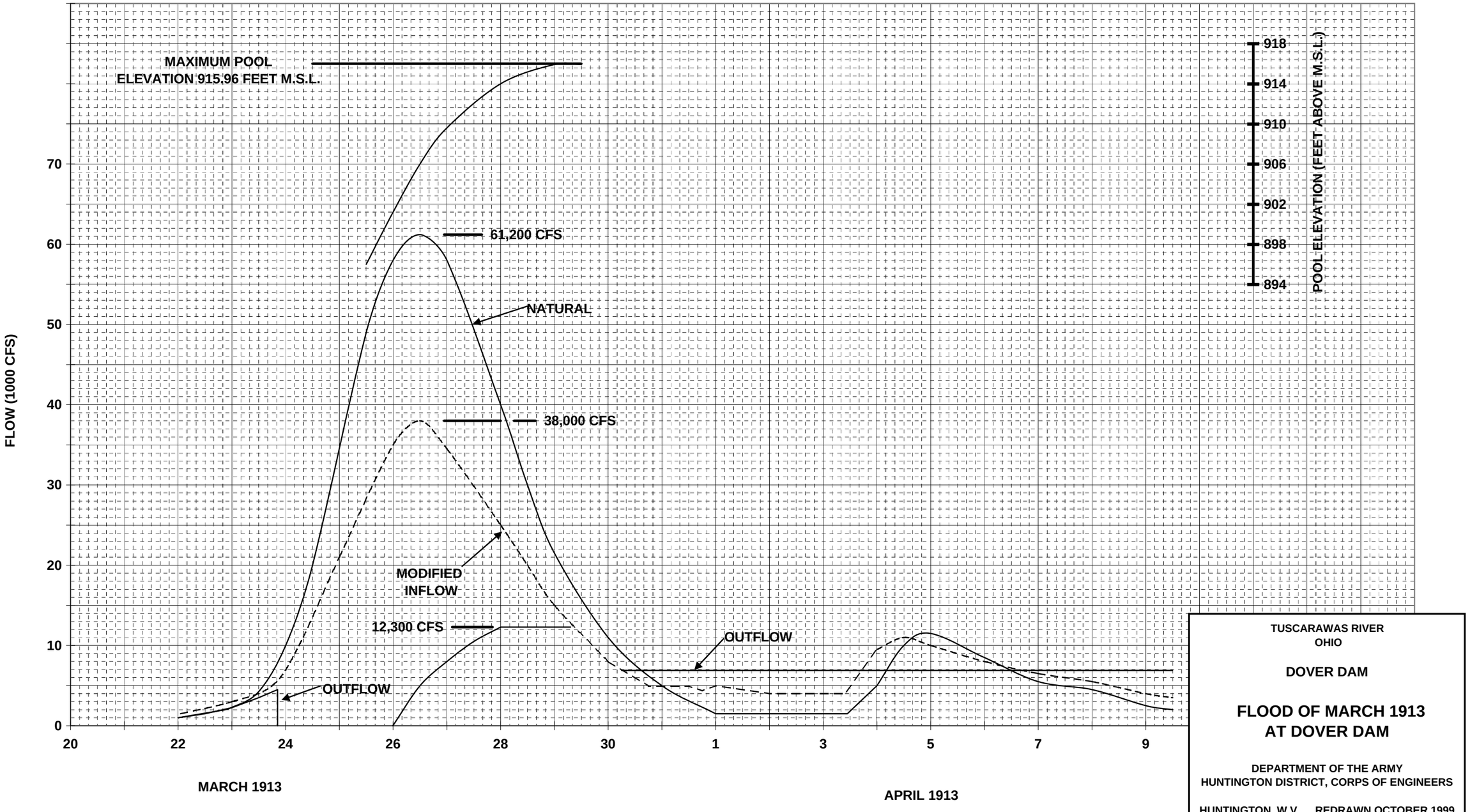
TUSCARAWAS RIVER
OHIO

DOVER DAM

OFFICIAL PLAN FLOOD

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS

HUNTINGTON, W.V. REDRAWN OCTOBER 1999



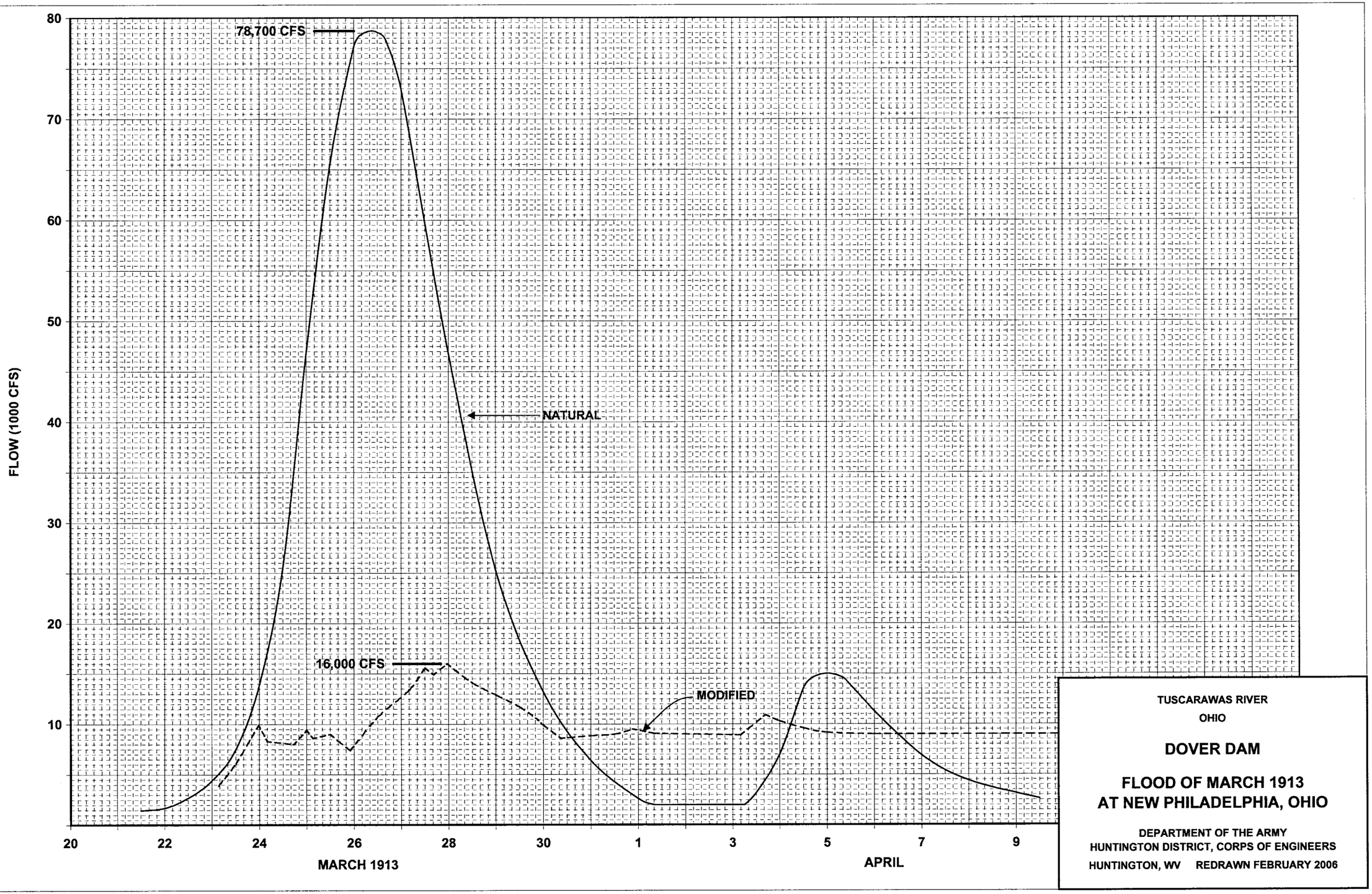
TUSCARAWAS RIVER
OHIO

DOVER DAM

FLOOD OF MARCH 1913 AT DOVER DAM

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS

HUNTINGTON, W.V. REDRAWN OCTOBER 1999



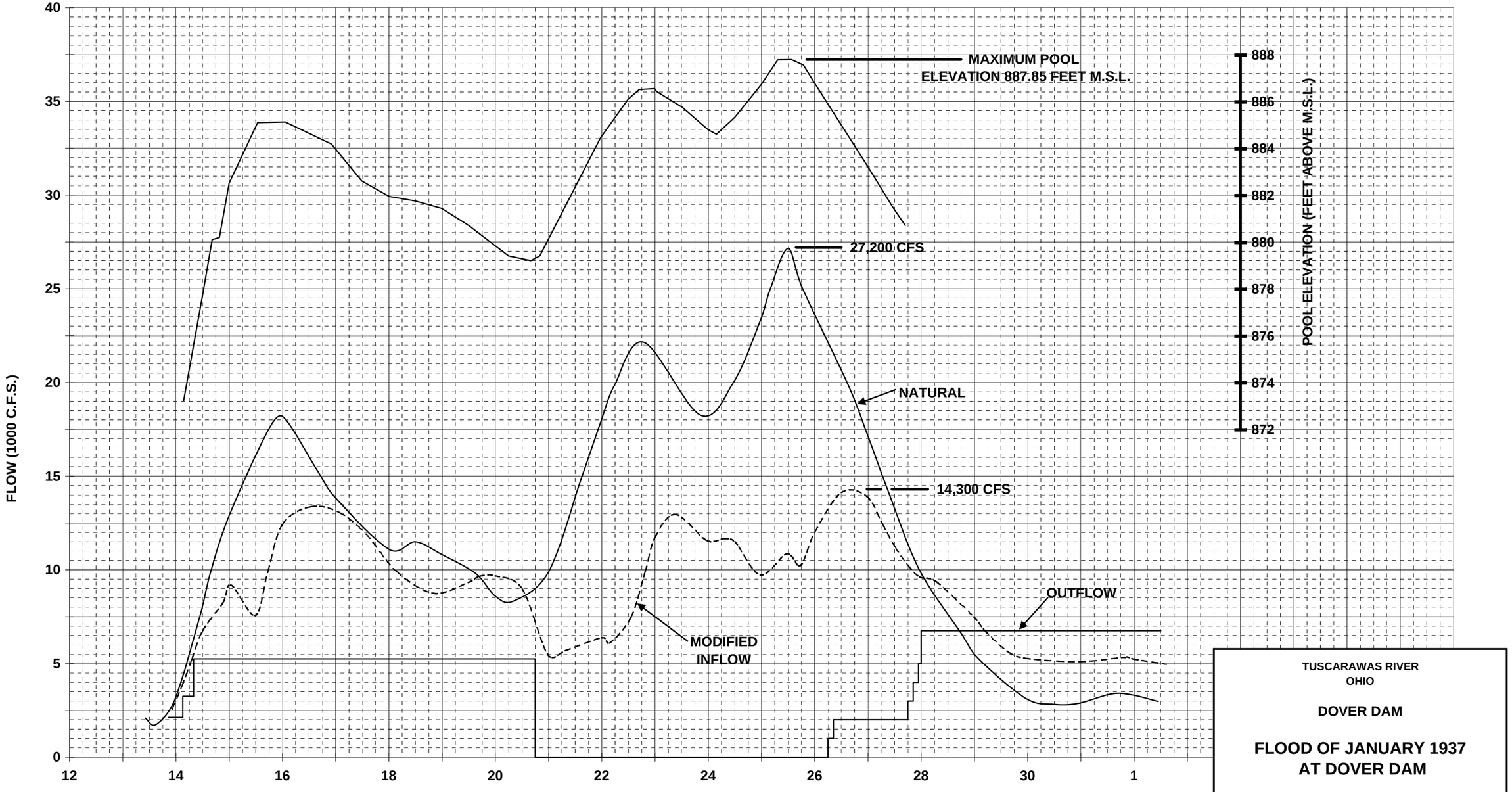
TUSCARAWAS RIVER
OHIO

DOVER DAM

FLOOD OF MARCH 1913
AT NEW PHILADELPHIA, OHIO

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON, WV REDRAWN FEBRUARY 2006

PLATE NO. 8-6



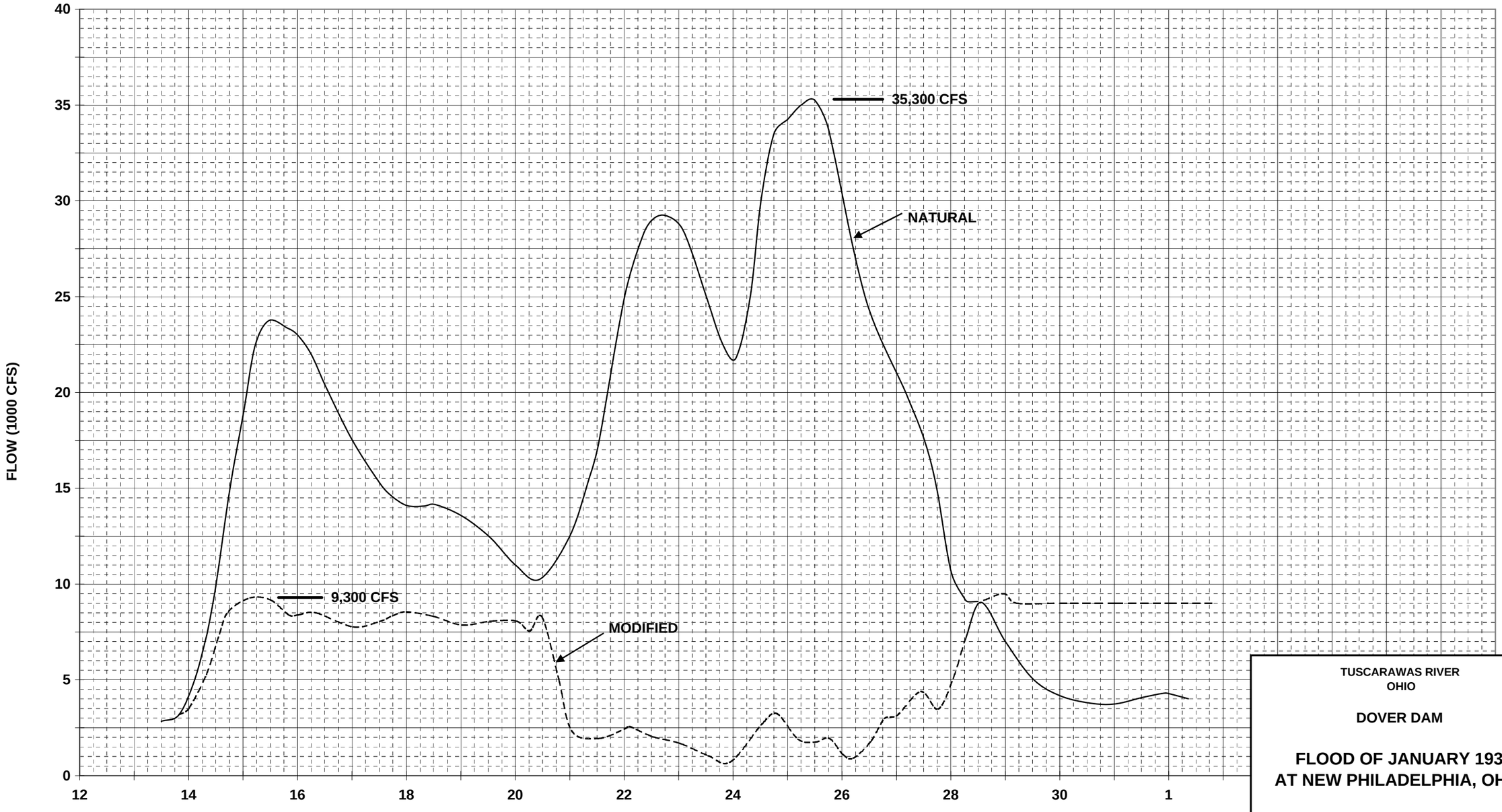
TUSCARAWAS RIVER
OHIO

DOVER DAM

FLOOD OF JANUARY 1937
AT DOVER DAM

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS

HUNTINGTON, W.V. REDRAWN OCTOBER 1999



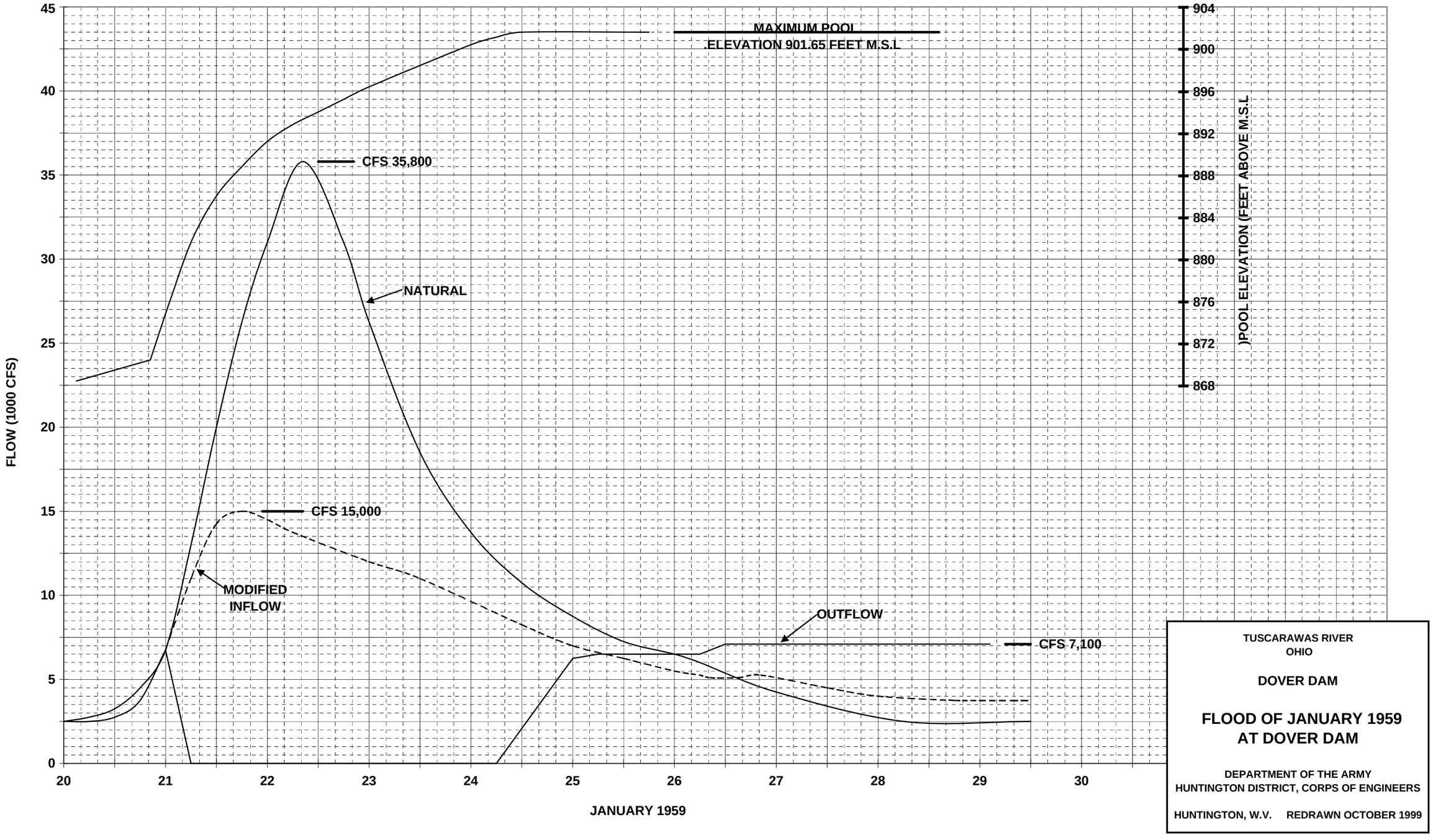
TUSCARAWAS RIVER
OHIO

DOVER DAM

FLOOD OF JANUARY 1937
AT NEW PHILADELPHIA, OHIO

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS

HUNTINGTON, W.V. REDRAWN OCTOBER 1999



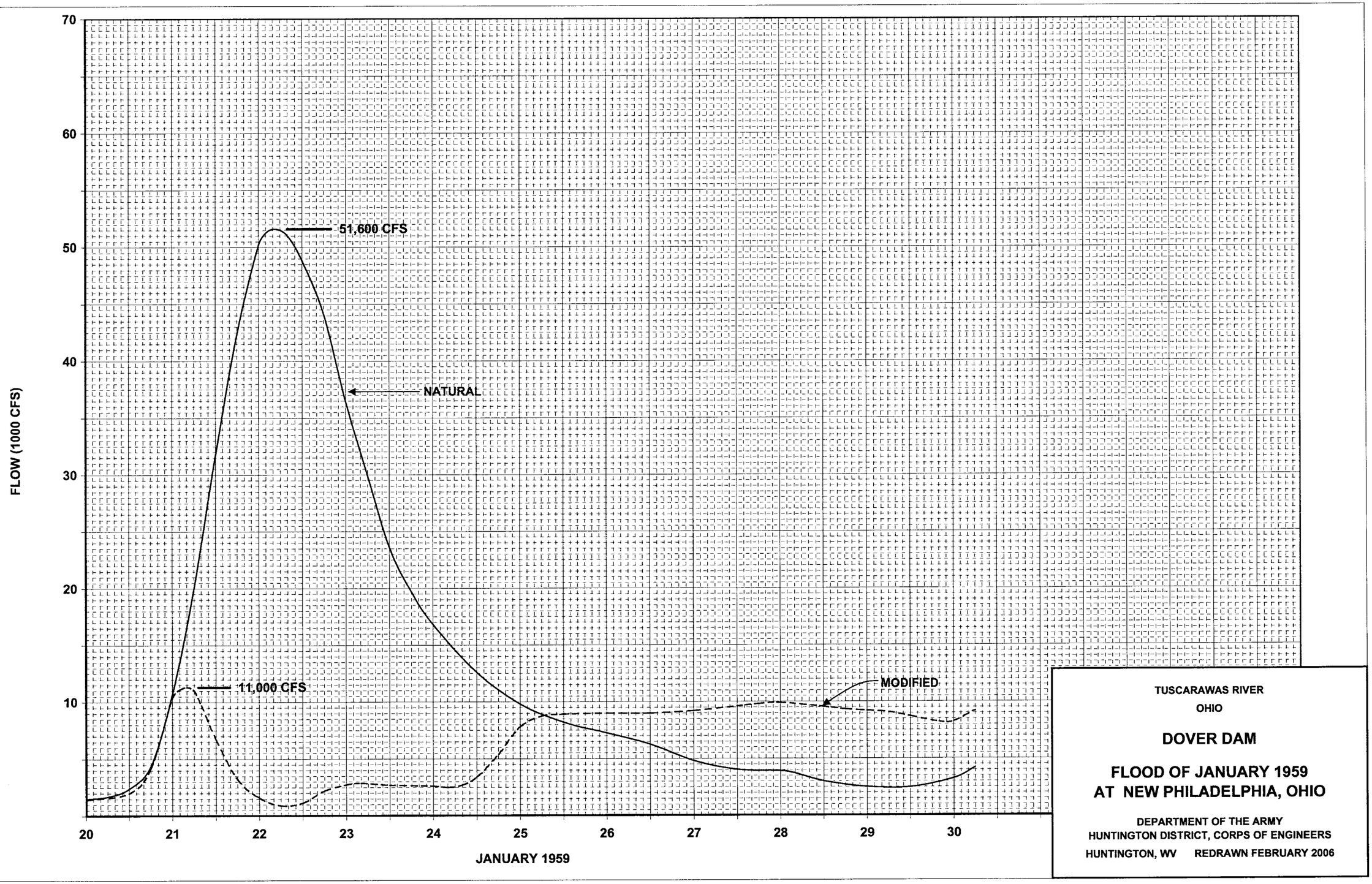
TUSCARAWAS RIVER
OHIO

DOVER DAM

FLOOD OF JANUARY 1959
AT DOVER DAM

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS

HUNTINGTON, W.V. REDRAWN OCTOBER 1999



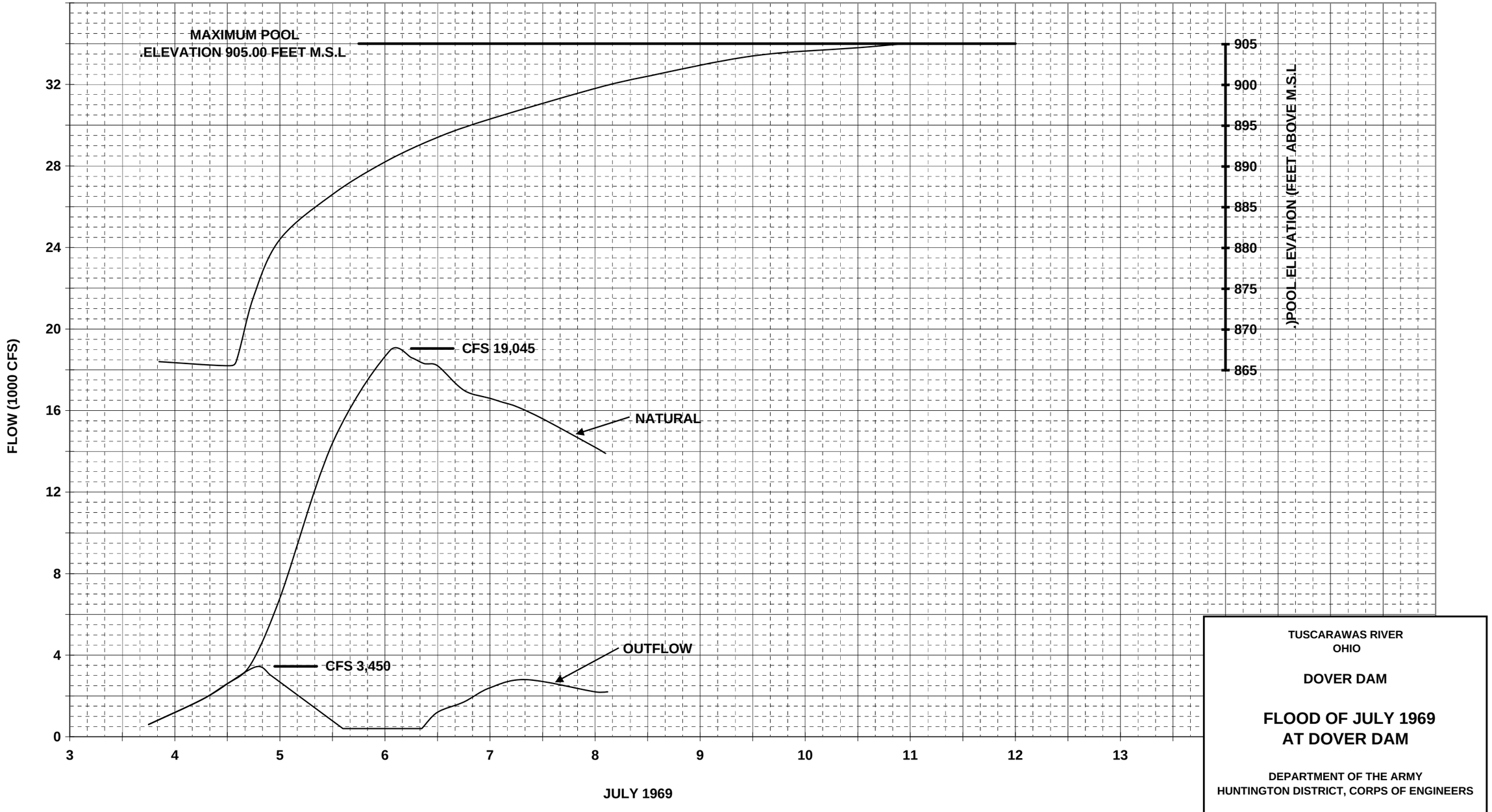
TUSCARAWAS RIVER
OHIO

DOVER DAM

FLOOD OF JANUARY 1959
AT NEW PHILADELPHIA, OHIO

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON, WV REDRAWN FEBRUARY 2006

PLATE NO. 8-12



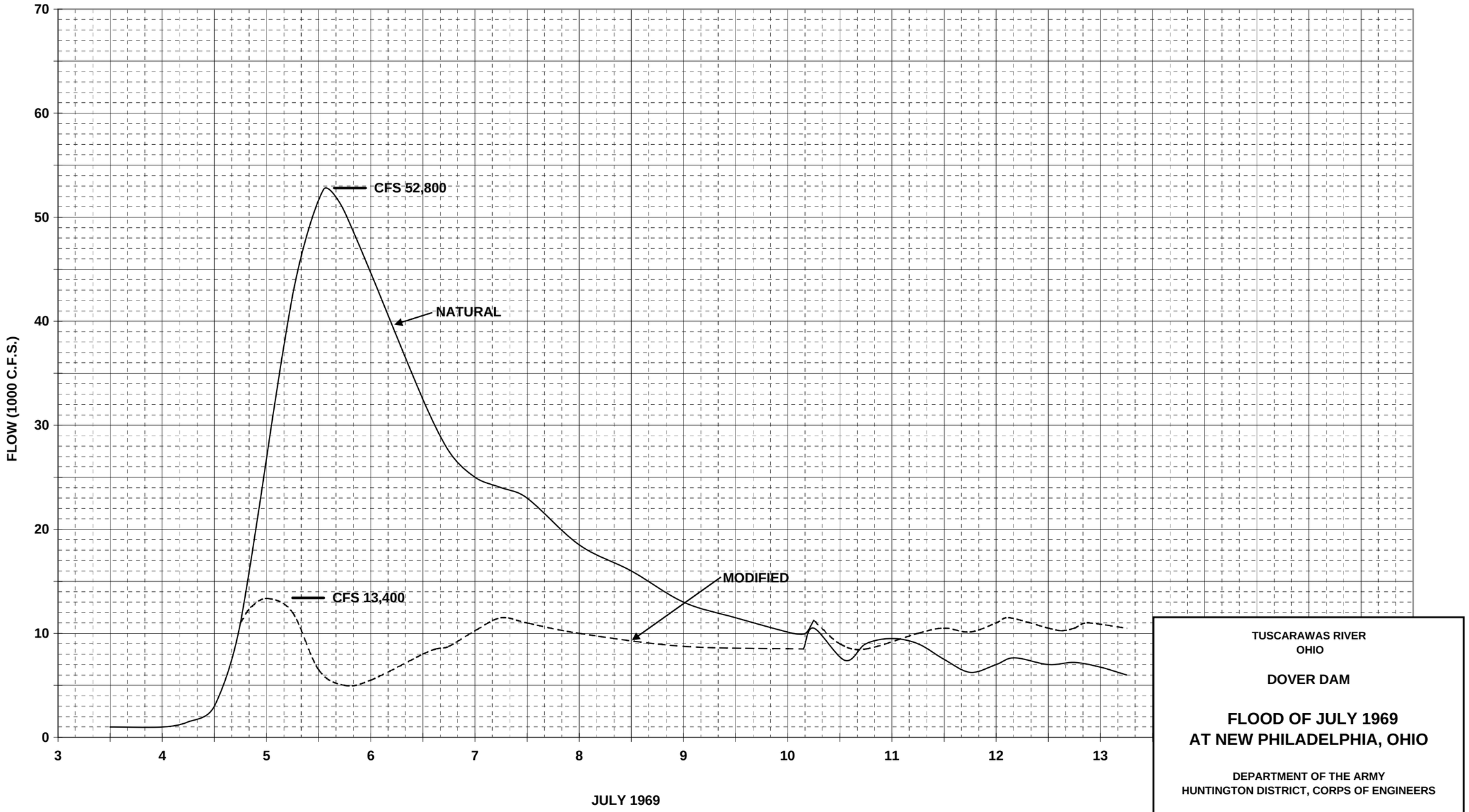
TUSCARAWAS RIVER
OHIO

DOVER DAM

FLOOD OF JULY 1969
AT DOVER DAM

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS

HUNTINGTON, W.V. REDRAWN OCTOBER 1999



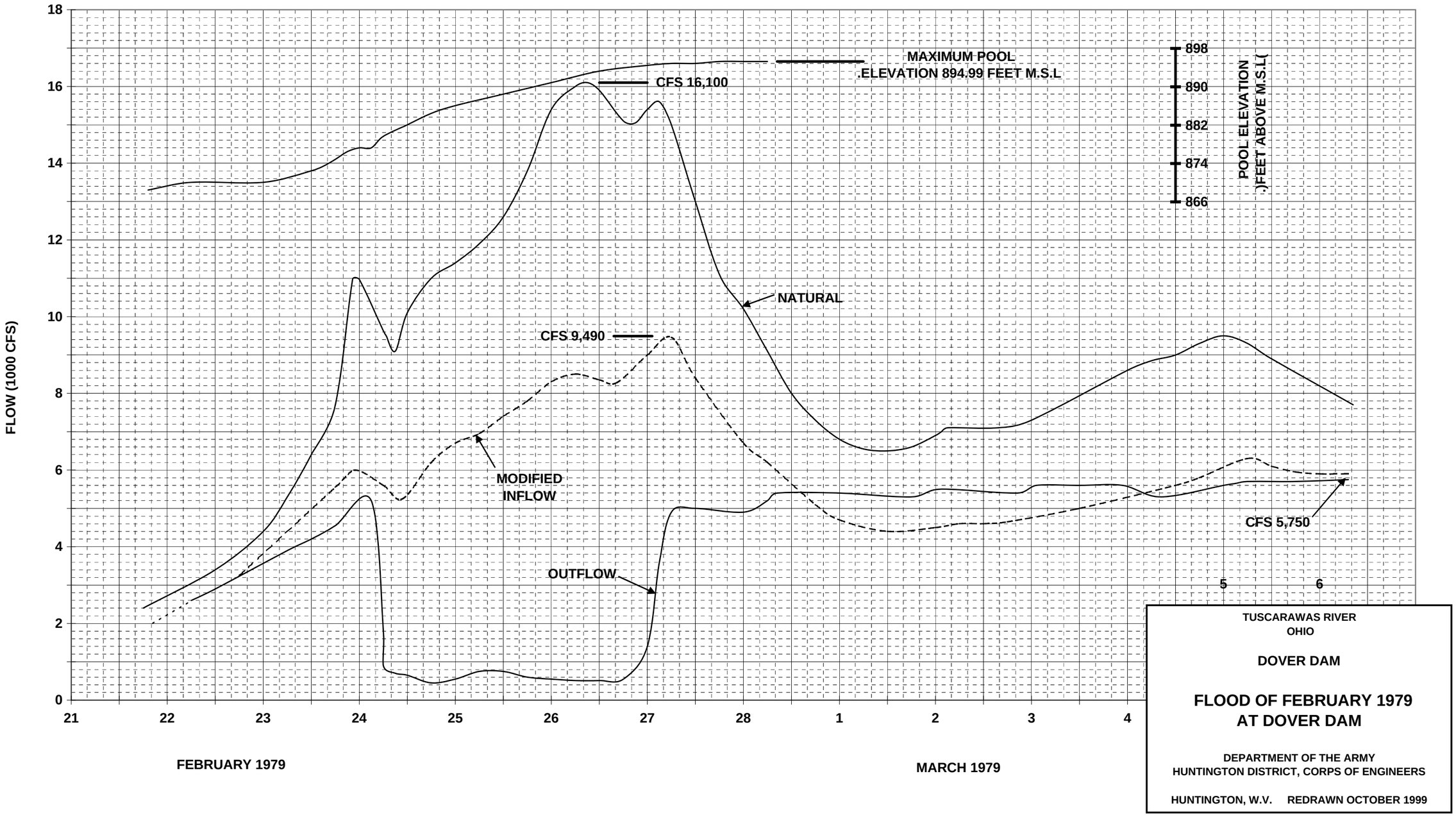
TUSCARAWAS RIVER
OHIO

DOVER DAM

FLOOD OF JULY 1969
AT NEW PHILADELPHIA, OHIO

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS

HUNTINGTON, W.V. REDRAWN OCTOBER 1999



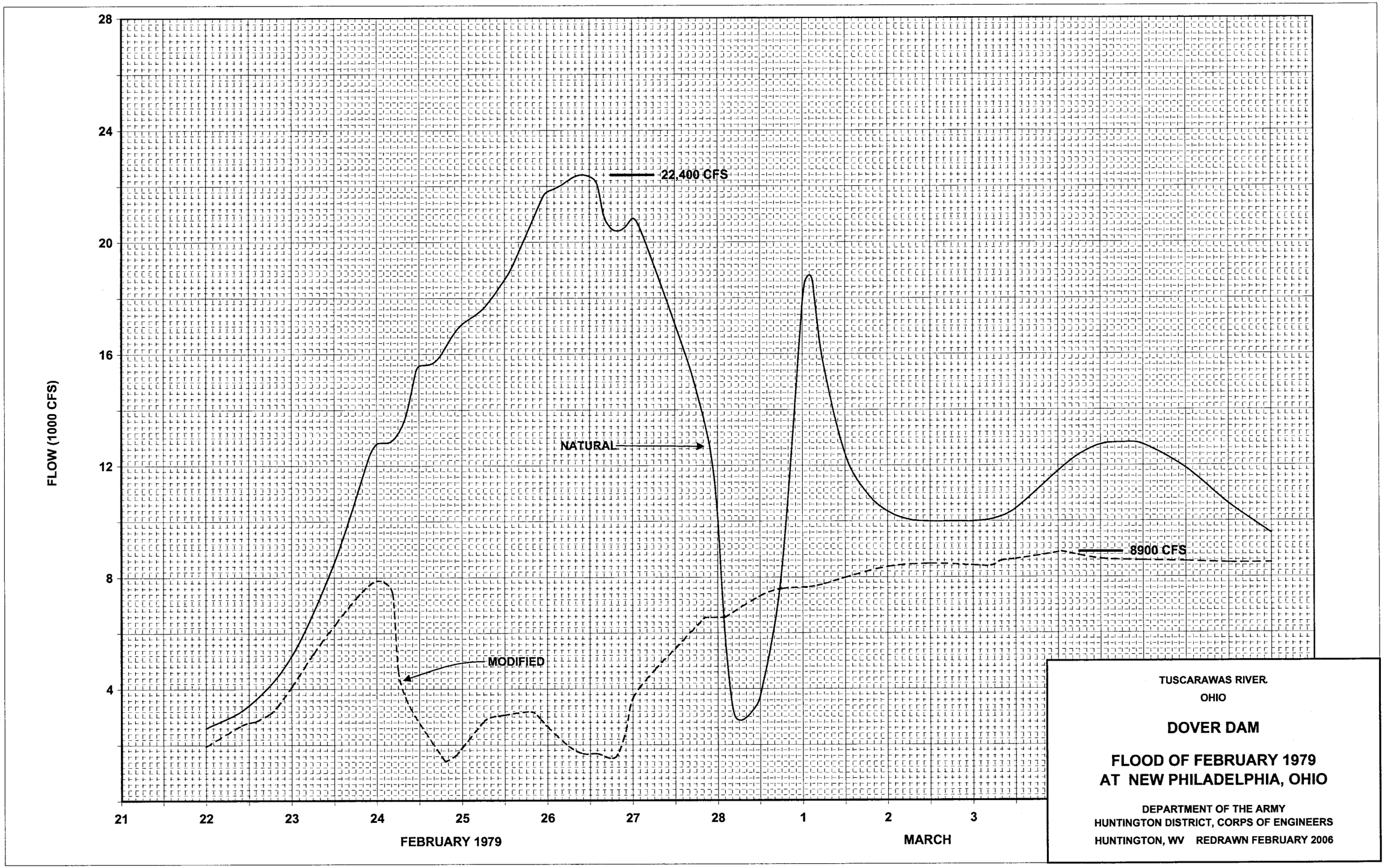
TUSCARAWAS RIVER
OHIO

DOVER DAM

FLOOD OF FEBRUARY 1979
AT DOVER DAM

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS

HUNTINGTON, W.V. REDRAWN OCTOBER 1999



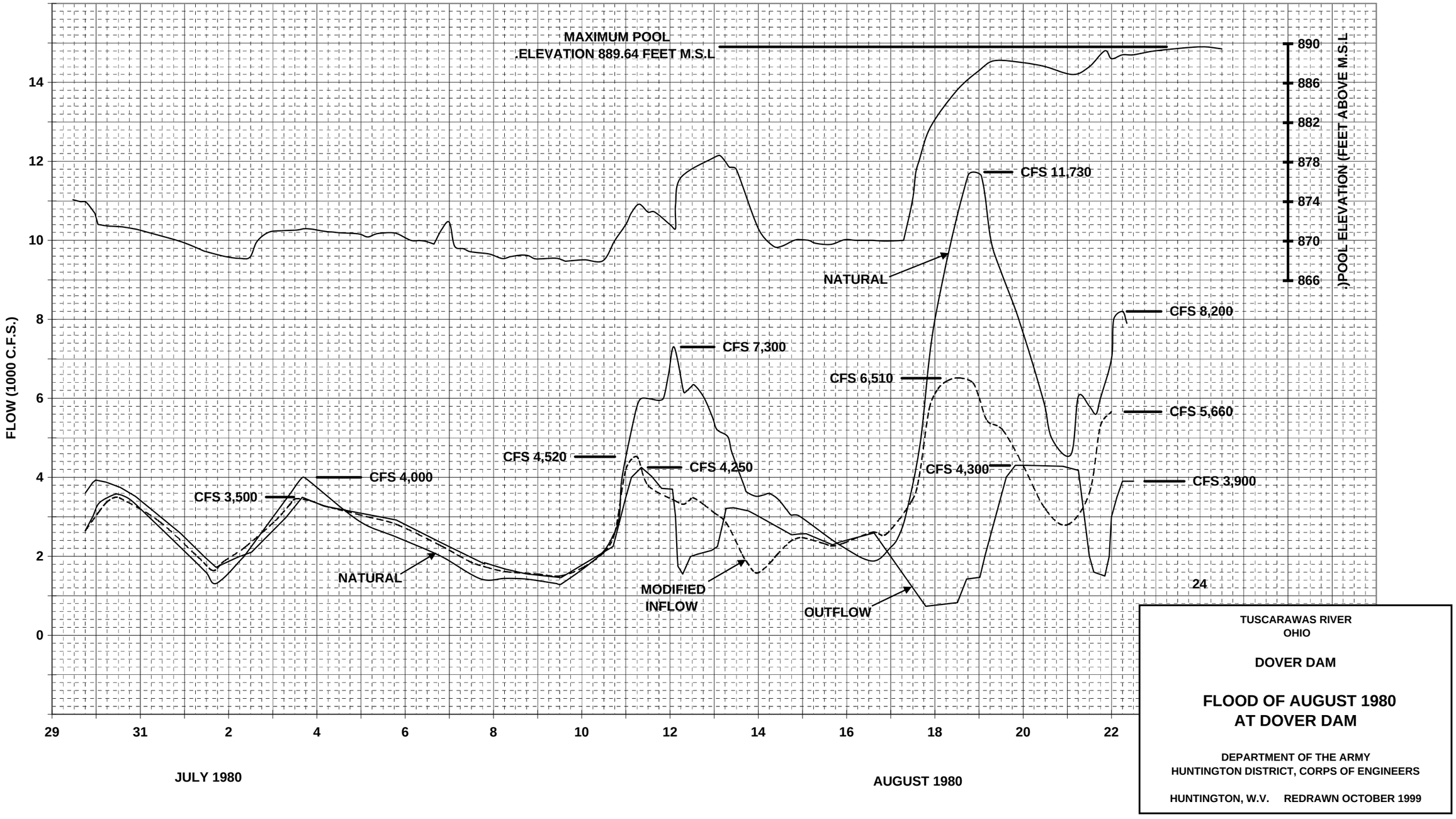
TUSCARAWAS RIVER
OHIO

DOVER DAM

FLOOD OF FEBRUARY 1979
AT NEW PHILADELPHIA, OHIO

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON, WV REDRAWN FEBRUARY 2006

PLATE NO. 8-14



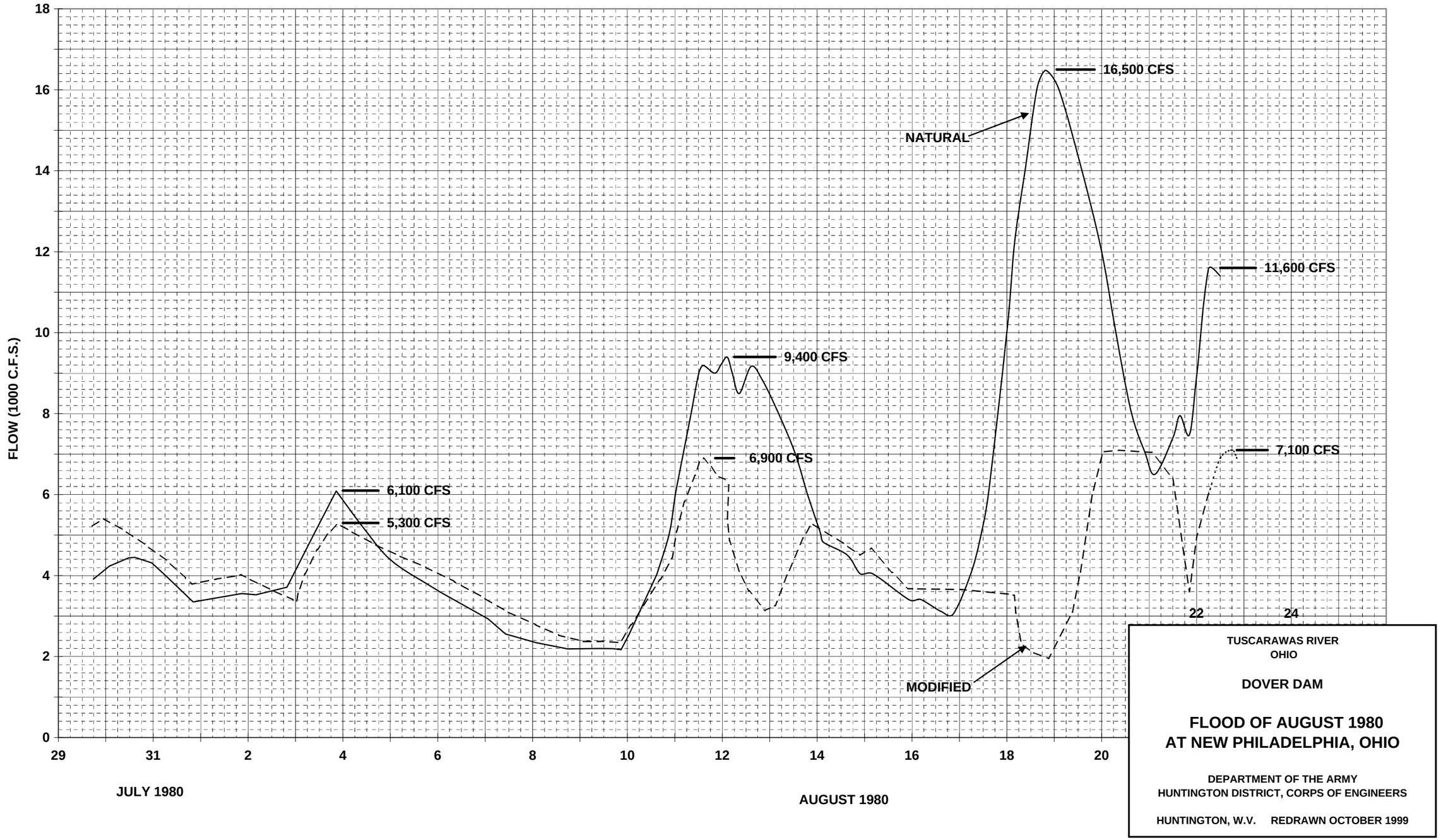
TUSCARAWAS RIVER
OHIO

DOVER DAM

FLOOD OF AUGUST 1980
AT DOVER DAM

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS

HUNTINGTON, W.V. REDRAWN OCTOBER 1999



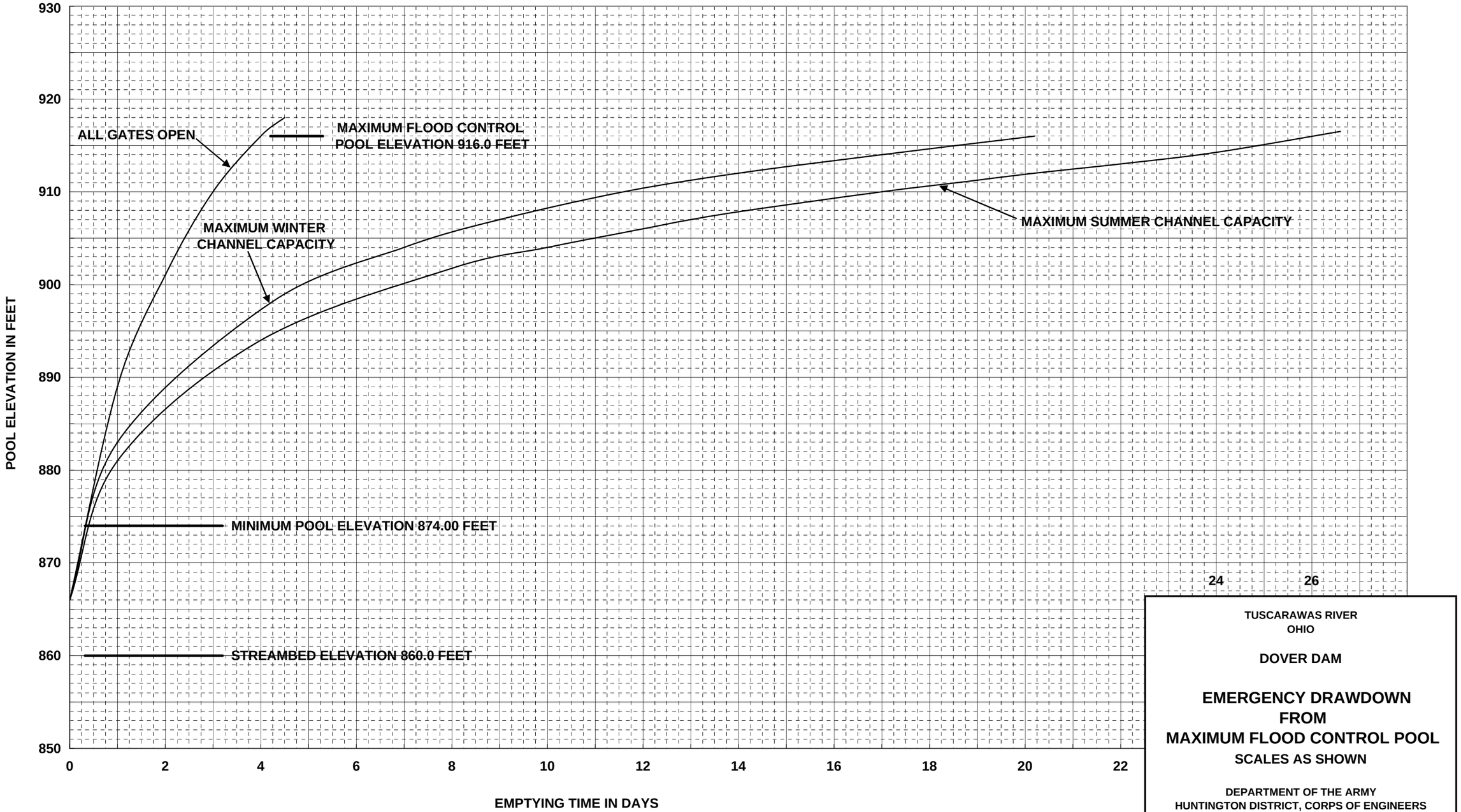
TUSCARAWAS RIVER
OHIO

DOVER DAM

FLOOD OF AUGUST 1980
AT NEW PHILADELPHIA, OHIO

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS

HUNTINGTON, W.V. REDRAWN OCTOBER 1999



TUSCARAWAS RIVER
OHIO

DOVER DAM

EMERGENCY DRAWDOWN FROM MAXIMUM FLOOD CONTROL POOL

SCALES AS SHOWN

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS

HUNTINGTON, W.V. REDRAWN OCTOBER 1999

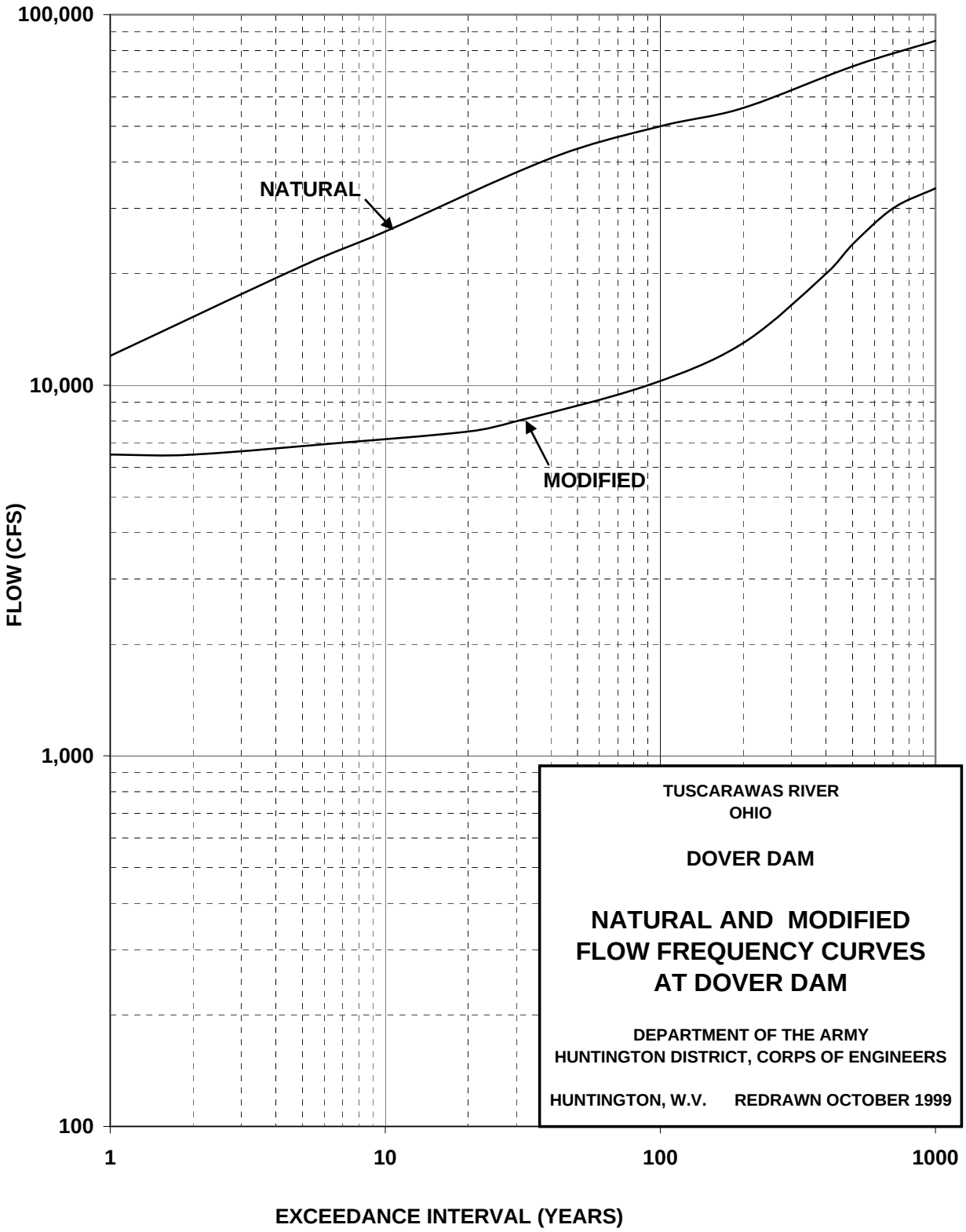

100,000
10,000
1,000
100
NATURAL
MODIFIED
FLOW (CFS)
1
10
100
1000
EXCEEDANCE INTERVAL (YEARS)
TUSCARAWAS RIVER
OHIO
DOVER DAM
NATURAL AND MODIFIED
FLOW FREQUENCY CURVES
AT DOVER DAM
DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON, W.V. REDRAWN OCTOBER 1999

Plate 8-15

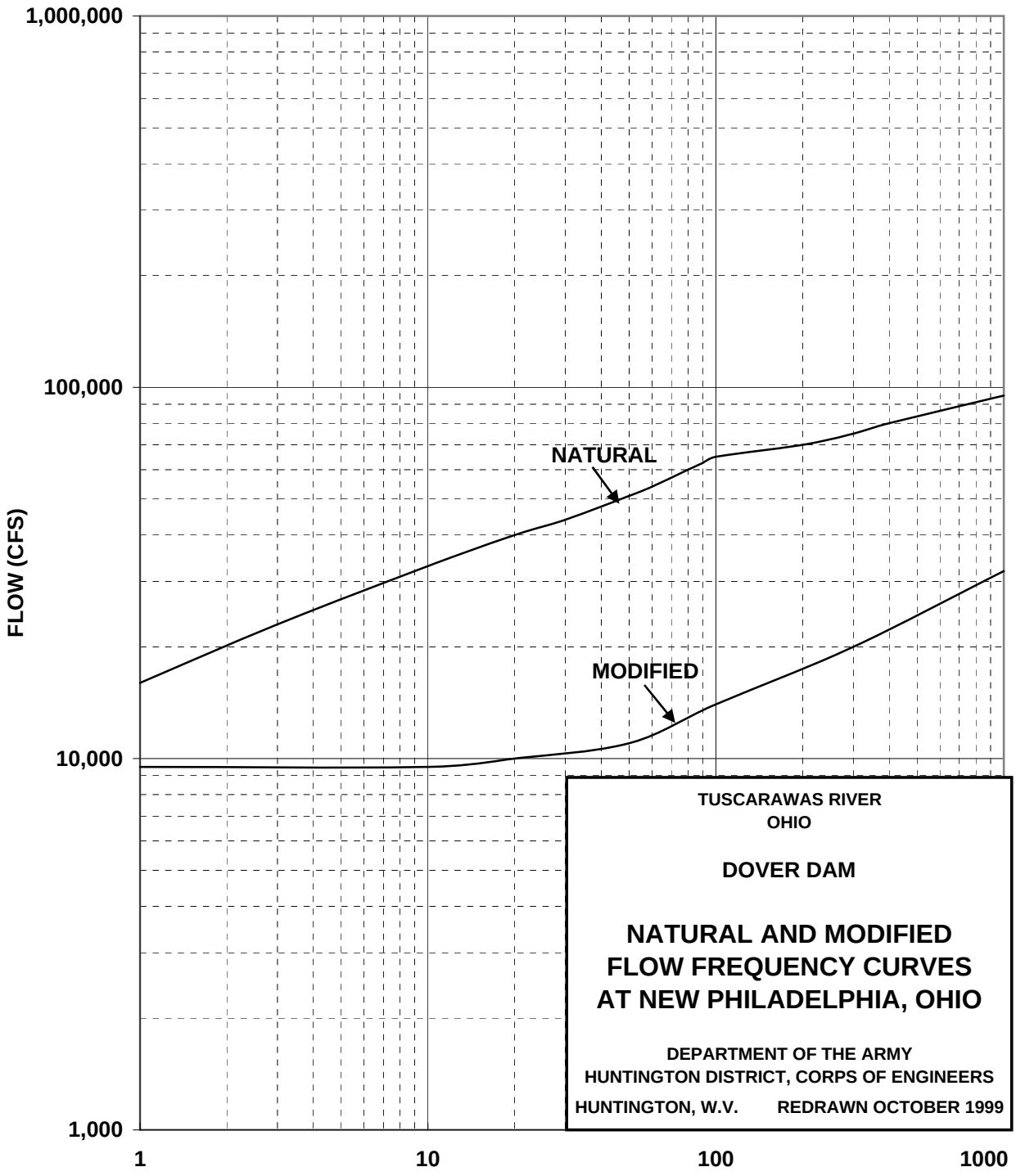
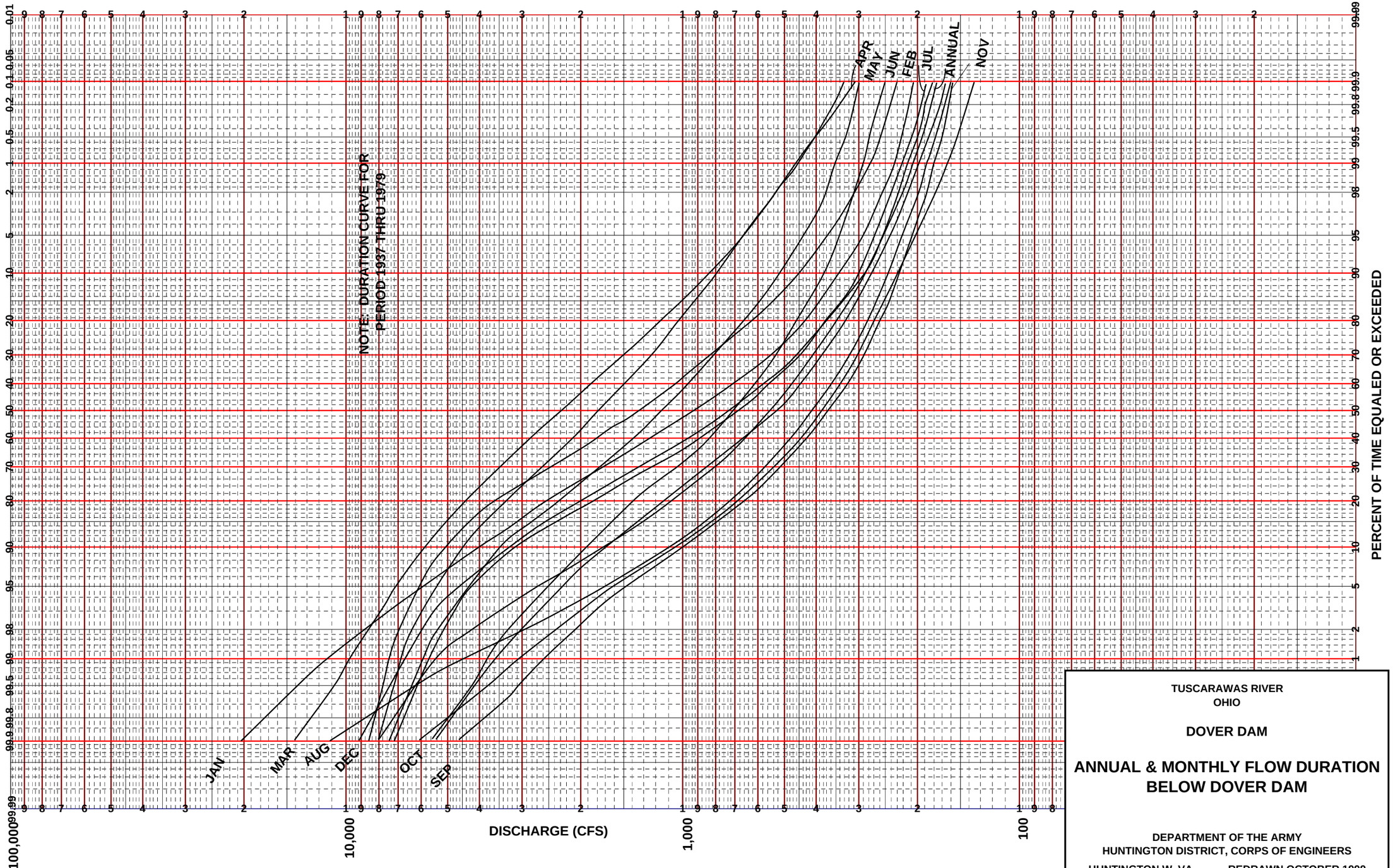

1,000,000
100,000
10,000
1,000
FLOW (CFS)
NATURAL
MODIFIED
1
10
100
1000
EXCEEDANCE INTERVAL (YEARS)
TUSCARAWAS RIVER
OHIO
DOVER DAM
NATURAL AND MODIFIED
FLOW FREQUENCY CURVES
AT NEW PHILADELPHIA, OHIO
DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON, W.V.
REDRAWN OCTOBER 1999

Plate 8-16

PROBABILITY X FOUR 3½ INCH LOGARITHMIC CYCLES

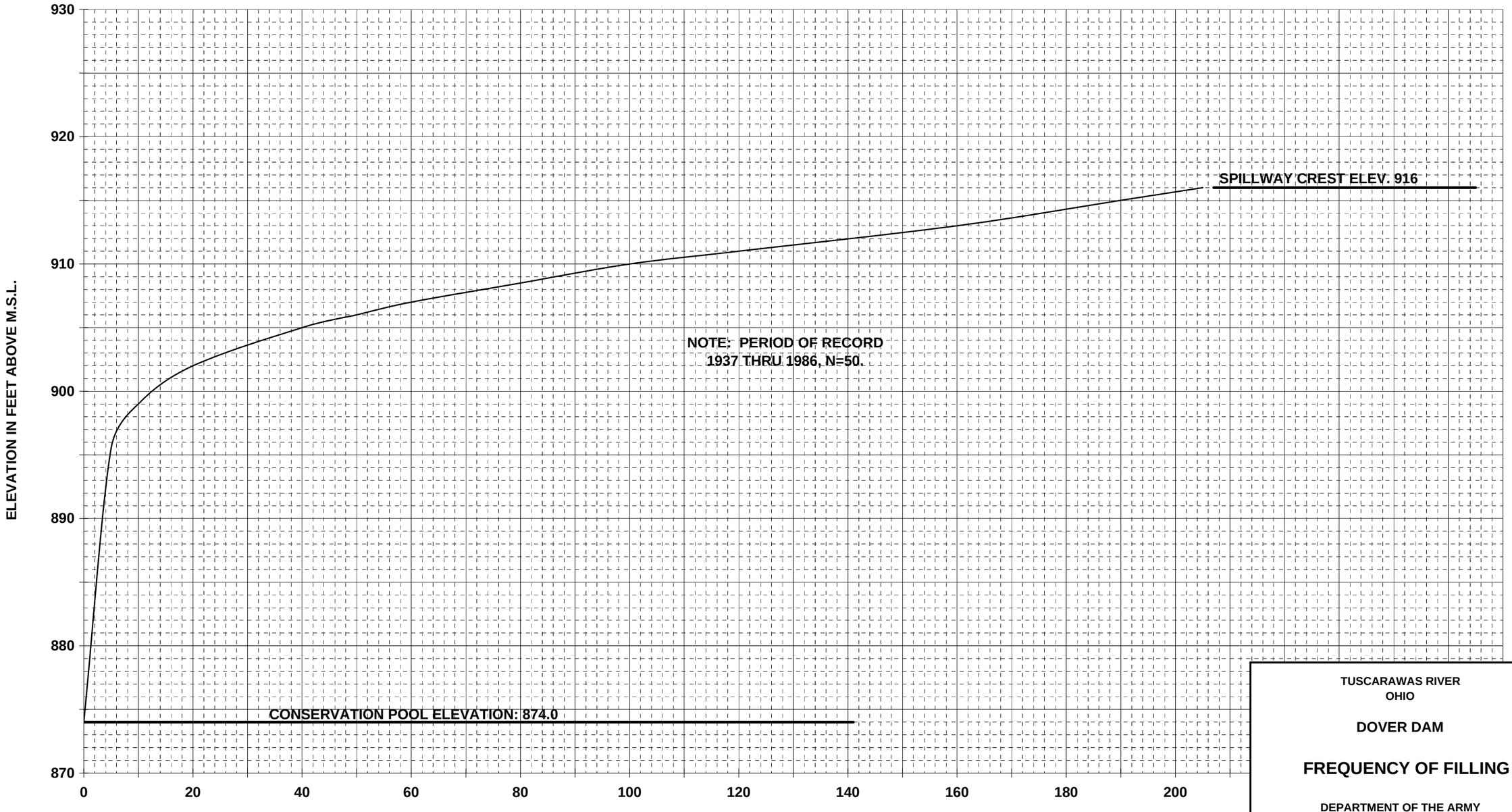


TUSCARAWAS RIVER
OHIO

DOVER DAM

ANNUAL & MONTHLY FLOW DURATION BELOW DOVER DAM

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
HUNTINGTON W. VA. REDRAWN OCTOBER 1999



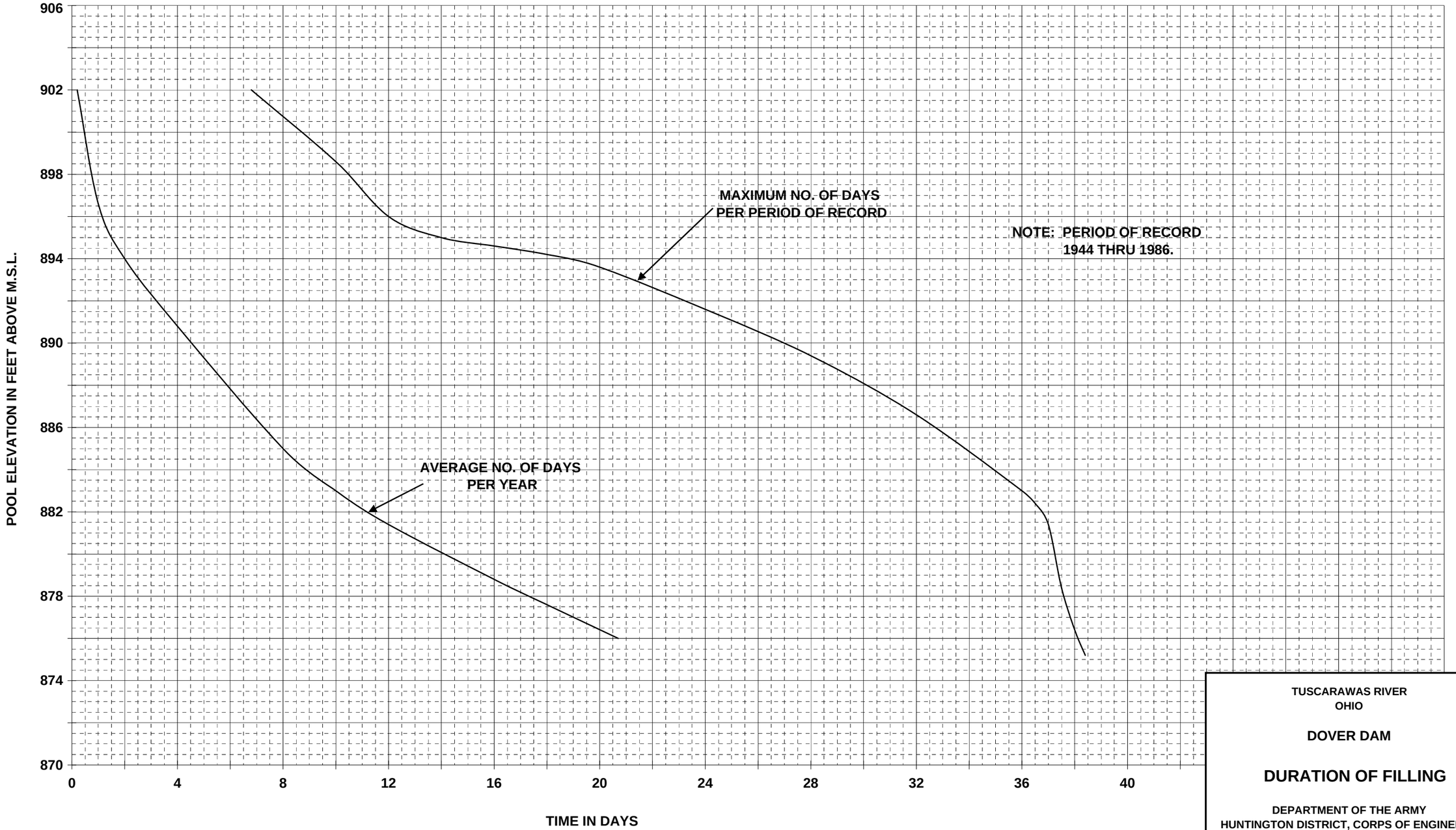
TUSCARAWAS RIVER
OHIO

DOVER DAM

FREQUENCY OF FILLING

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS

HUNTINGTON, W.V. REDRAWN OCTOBER 1999



TUSCARAWAS RIVER
OHIO

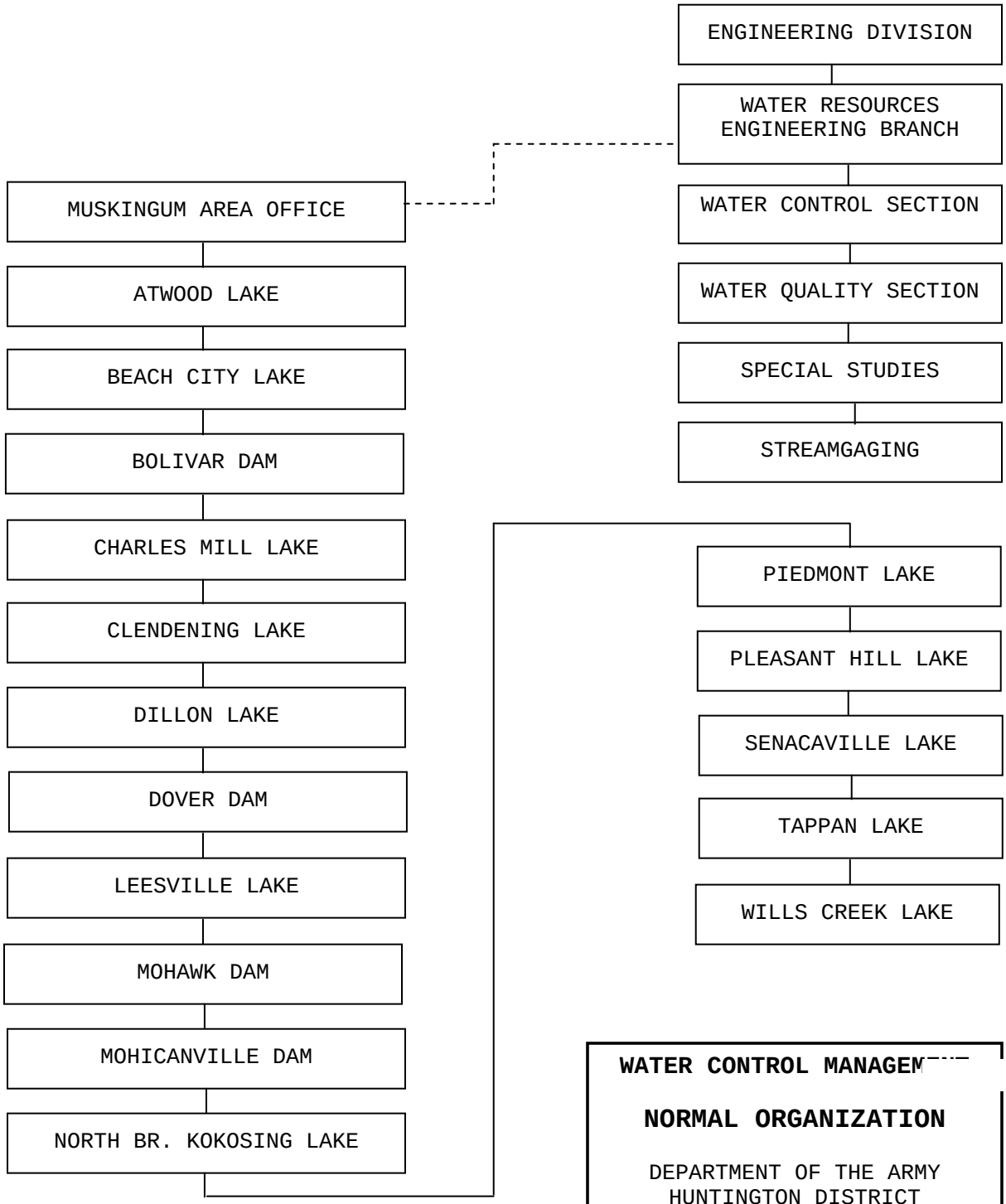
DOVER DAM

DURATION OF FILLING

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS

HUNTINGTON, W.V. REDRAWN OCTOBER 1999

WATER CONTROL MANAGEMENT
MUSKINGUM RIVER BASIN
NORMAL ORGANIZATION



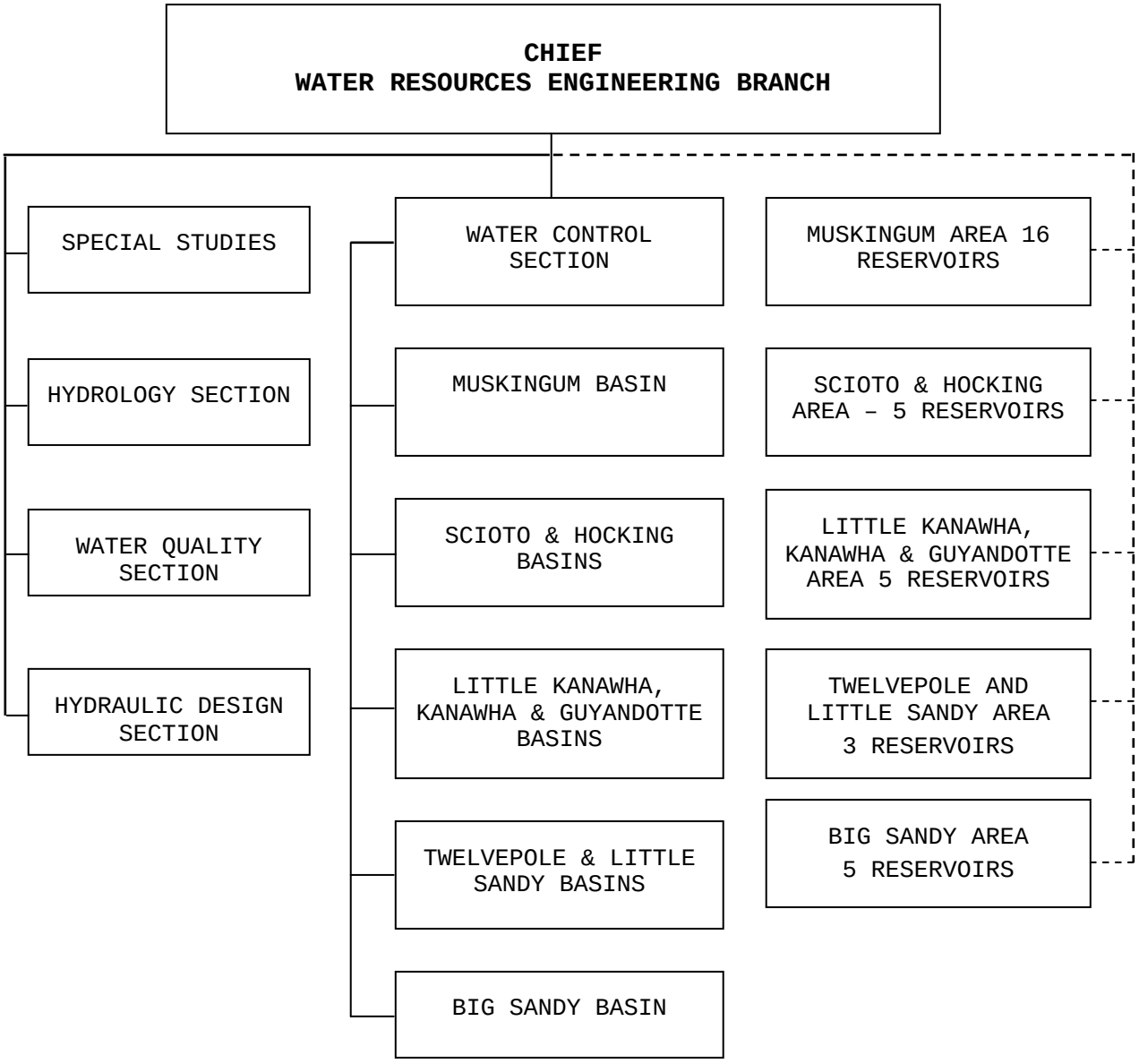
WATER CONTROL MANAGEMENT

NORMAL ORGANIZATION

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT
CORPS OF ENGINEERS,
HUNTINGTON, W.V.

PLATE NO 9-1

WATER RESOURCES ENGINEERING BRANCH
FLOOD EMERGENCY ORGANIZATION

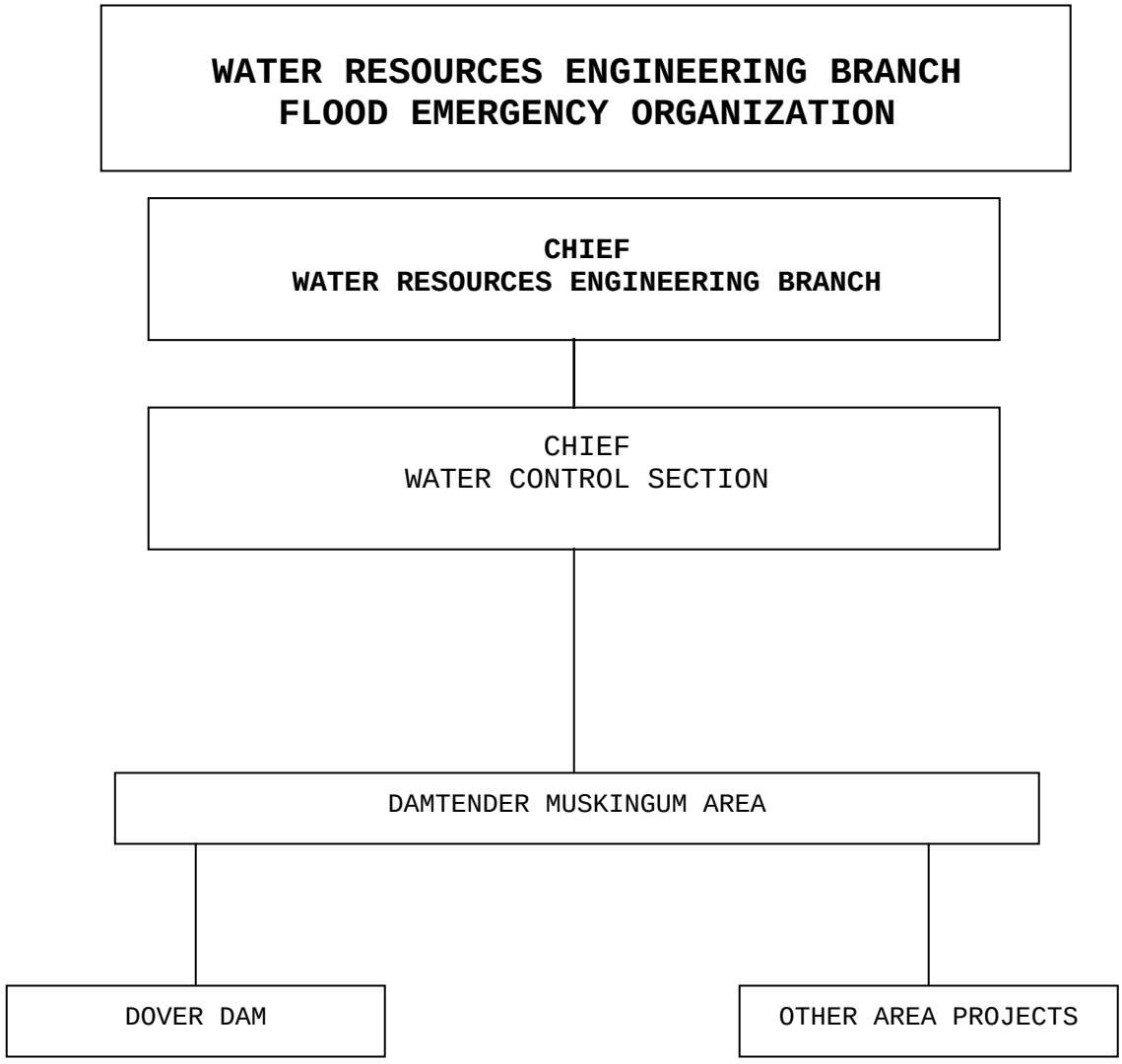


FLOOD EMERGENCY ORAGNIZATION

LINES OF COMMUNICATION

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT
CORPS OF ENGINEERS, HUNTINGTON, W.V.
MAY 2001

PLATE NO 9-2

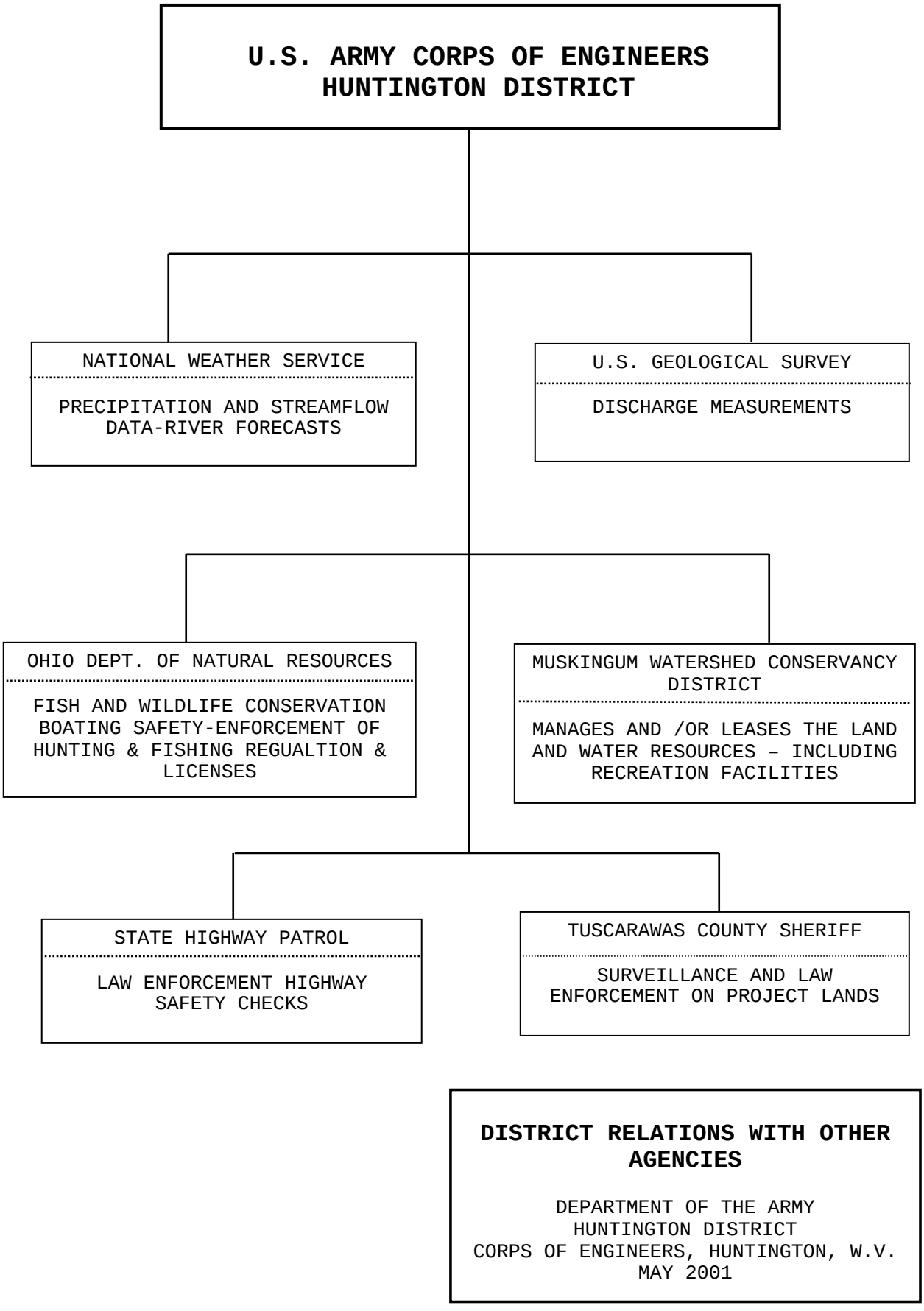


FLOOD EMERGENCY ORAGNIZATION

TYPICAL ORGANIZATIONAL CHART

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT
CORPS OF ENGINEERS, HUNTINGTON, W.V.
MAY 2001

PLATE NO 9-3



DISTRICT RELATIONS WITH OTHER AGENCIES

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT
CORPS OF ENGINEERS, HUNTINGTON, W.V.
MAY 2001

PLATE NO 9-4

HUNTINGTON DISTRICT 24HR RES EFFECTS 11 JAN THRU 13 FEB 1985

DATE	ATH	CHK	GRL	WAY	HIG	LOS	MCC	PAL	BRL
1-11	11.	393.	-514.	-74.	11.	-148.	-672.	-23.	174.
1-12	4.	815.	-571.	40.	134.	-99.	-628.	-36.	134.
1-13	-0.	488.	-301.	5.	110.	95.	-406.	-27.	-29.
1-14	-3.	-823.	55.	5.	-13.	296.	-209.	16.	-53.
1-15	-2.	-247.	168.	-36.	27.	70.	-150.	-11.	53.
1-16	-0.	975.	97.	31.	82.	-19.	-518.	-2.	89.
1-17	-0.	-458.	72.	27.	-100.	-5.	-316.	23.	-25.
1-18	-0.	683.	101.	37.	24.	-50.	-40.	4.	66.
1-19	1.	-95.	96.	3.	4.	155.	57.	43.	-27.
1-20	4.	-192.	97.	-2.	40.	213.	27.	-14.	72.
1-21	-3.	-599.	55.	-46.	-127.	131.	-312.	-22.	78.
1-22	-7.	-470.	-19.	4.	-184.	-11.	-10.	-17.	1.
1-23	-7.	539.	-96.	-17.	-12.	-56.	104.	-25.	-68.
1-24	3.	499.	-93.	3.	84.	117.	-133.	6.	28.
1-25	3.	892.	-82.	13.	73.	293.	-218.	4.	-154.
1-26	6.	-392.	-92.	9.	57.	301.	-130.	4.	33.
1-27	10.	-992.	-97.	1.	18.	11.	-101.	11.	19.
1-28	2.	-159.	-99.	-7.	11.	187.	-33.	-2.	-234
1-29	1.	384.	12.	1.	-12.	200.	-7.	-21.	-55.
1-30	3.	-317.	-0.	0.	-12.	138.	-62.	12.	68.
1-31	4.	699.	14.	-19.	-11.	-2.	-108.	25.	40.
2 -1	8.	66.	917.	276.	6.	-16.	-71.	-7.	-3.
2 -2	16.	-1963.	829.	111.	4.	347.	-9.	64.	358.
2 -3	18.	5129.	-150.	-568.	-27.	1733.	-42.	414.	5239.
2 -4	16.	-2120.	-791.	53.	-31.	4322.	-9.	-48.	2514.
2 -5	10.	-4496.	-927.	115.	-3.	2178.	81.	-289.	-903.
2 -6	13.	2088.	-14.	-83.	34.	13.	121.	-213.	-2191.
2 -7	13.	503.	526.	-28.	29.	-1823.	87.	-33.	-2707.
2 -8	-2.	-152.	243.	-62.	9.	160.	85.	-24.	-1610.
2 -9	-52.	-435.	48.	125.	-9.	1204.	132.	37.	-681.
2-10	-28.	1337.	-4.	24.	-17.	673.	114.	-14.	-108.
2-11	-30.	-121.	7.	10.	-17.	130.	103.	3.	-69.
2-12	-25.	-419.	3.	-98.	10.	358.	59.	0.	4.
2-13	29.	-2341.	360.	30.	32.	422.	121.	92.	65.

PLATE NO. 9-5

MONTHLY RESERVOIR OPERATION REPORT
MOHAWK DAM
MUSKINGUM RIVER BASIN
GROSS D. A. 1504 SQ. MILES
OHIO RIVER DIVISION HUNTINGTON DISTRICT
OCT 1984 FINAL

MON	DAY	MEAN DAILY FLOWS (CFS) INFLOW	NATURAL	DISCHARGE	REDUCTIONS CFS	POOL ELEV EOD	STORAGE AC-FT	24 HR PROJ PRECIP - IN
OCT	1	326.	332.	326.	6.	800.89	125.	0.06
OCT	2	341.	332.	341.	-9.	800.89	125.	0.00
OCT	3	341.	347.	341.	6.	800.89	125.	0.00
OCT	4	316.	321.	318.	2.	800.82	121.	0.00
OCT	5	300.	304.	301.	2.	800.78	119.	0.00
OCT	6	292.	294.	293.	1.	800.76	118.	0.21
OCT	7	303.	299.	304.	-5.	800.73	117.	0.34
OCT	8	330.	323.	331.	-8.	800.69	115.	0.07
OCT	9	355.	349.	353.	-4.	800.79	120.	0.00
OCT	10	352.	357.	346.	11.	801.04	132.	0.00
OCT	11	326.	330.	327.	2.	801.00	130.	0.00
OCT	12	310.	316.	311.	4.	800.97	129.	0.00
OCT	13	298.	301.	299.	2.	800.94	127.	0.00
OCT	14	290.	292.	292.	-0.	800.89	125.	0.00
OCT	15	290.	290.	290.	-0.	800.89	125.	0.16
OCT	16	287.	288.	287.	0.	800.89	125.	0.00
OCT	17	287.	287.	287.	0.	800.89	125.	0.05
OCT	18	284.	285.	284.	1.	800.89	125.	0.00
OCT	19	278.	279.	278.	0.	800.89	125.	0.00
OCT	20	278.	278.	278.	0.	800.89	125.	0.24
OCT	21	283.	281.	283.	-2.	800.89	125.	0.27
OCT	22	361.	331.	359.	-28.	800.98	129.	0.34
OCT	23	431.	422.	433.	-11.	800.89	125.	0.00
OCT	24	409.	415.	409.	6.	800.89	125.	0.00
OCT	25	362.	376.	362.	13.	800.89	125.	0.06
OCT	26	338.	343.	338.	4.	800.91	126.	0.15
OCT	27	331.	332.	329.	2.	800.97	129.	0.00
OCT	28	338.	333.	337.	-5.	801.00	130.	0.40
OCT	29	1138.	865.	1003.	-138.	804.69	399.	0.00
OCT	30	984.	1094.	1041.	52.	803.39	284.	0.00
OCT	31	777.	829.	799.	29.	802.81	241.	0.00

PLATE NO. 9-6 (1 OF 2)

MONTHLY RESERVOIR OPERATION REPORT
MOHAWK DAM
MUSKINGUM RIVER BASIN
GROSS D. A. 1504 SQ. MILES
OHIO RIVER DIVISION HUNTINGTON DISTRICT
OCT 1984 FINAL

MAXIMUM 6-HR EVENTS (3 HIGHEST)

MON	DATE	TIME	POOL	STORAGE	AVG DISCHARGE	NATURAL	PERCENT UTILIZATION SUM	PERCENT UTILIZATION WIN
OCT	29	1930	805.57	488.	1431.	1395.	0.2	0.2
OCT	30	130	804.69	399.	1180.	1247.	0.1	0.1
OCT	30	730	804.05	340.	1073.	1120.	0.1	0.1

MON	DATE	TIME	AVG DISCHARGE	NATURAL	POOL	STORAGE	PERCENT UTILIZATION SUM	PERCENT UTILIZATION WIN
OCT	29	1930	1431.	1395.	805.57	488.	0.2	0.2
OCT	29	1330	1393.	1119.	802.89	247.	0.1	0.1
OCT	30	130	1180.	1247.	804.69	399.	0.1	0.1

MON	DATE	TIME	NATURAL	AVG DISCHARGE	POOL	STORAGE	PERCENT UTILIZATION SUM	PERCENT UTILIZATION WIN
OCT	29	1930	1395.	1431.	805.57	488.	0.2	0.2
OCT	30	130	1247.	1180.	804.69	399.	0.1	0.1
OCT	30	730	1120.	1073.	804.05	340.	0.1	0.1

PERTINENT DATA

WINTER POOL	799.20	0
SUMMER POOL	799.20	0
FULL POOL	890.00	285000

OUTLET CAPACITY 43200 CFS

PLATE NO. 9-6 (2 OF 2)

(#05/ED-H-10)

Reservoir Operations in the Huntington District

by

Robert E. Bame

Below is a summary of temperature and precipitation data for selected stations for the previous four months.

STATION		Average Temperature Observed Degrees F	Average Temperature Departure from Normal	Precipitation Observed Inches	Precipitation Departure from Normal
AKRON-CANTON, OH	Jun 87	69.8	+2.0	3.83	+0.56
	Jul 87	74.4	+2.8	2.58	-1.16
	Aug 87	70.6	+0.2	3.96	+0.65
	Sep 87	63.4	-0.4	2.11	-0.85
COLUMBUS, OH	Jun 87	72.7	+2.5	3.60	+0.06
	Jul 87	76.6	+2.8	3.89	-0.12
	Aug 87	74.3	+1.9	2.96	-0.74
	Sep 87	66.9	+1.1	1.53	-1.23
CHARLESTON, WV	Jun 87	73.5	+2.5	3.38	-0.41
	Jul 87	77.0	+2.5	4.23	-1.13
	Aug 87	77.0	+3.3	3.56	-0.59
	Sep 87	67.1	-0.5	3.89	+0.88

The weather during June was warm with varying precipitation. Temperatures averaged about 2.5°F above normal. Precipitation was above normal in northern Ohio, near normal in central Ohio and below normal in southern Ohio and the Huntington District portion of Kentucky and West Virginia. Streamflows were above normal in the Scioto Basin and near normal in eastern Ohio and West Virginia. Streamflows in eastern Kentucky were below normal.

The weather during July was warm with widely varying precipitation. Temperatures averaged about 2.5°F above normal. The bulk of the month's precipitation was produced by widely scattered heavy thunderstorms and occurred during the first half of the month. Precipitation was above normal in central Ohio and below normal in eastern Ohio, West Virginia and eastern Kentucky. Streamflows were normal in the Scioto and Muskingum River Basins and in the normal range in the remainder of the district. Streamflow trend was downward during the month.

The weather during August was hot and dry. Temperatures averaged about 2°F above normal. Precipitation occurred during scattered summertime showers and was below normal, except in eastern Ohio and central West Virginia, where above normal rainfall occurred. Streamflows continued to be below normal during the month.

The weather during September varied significantly. Normal to slightly above normal rainfall was reported in the mountains of West Virginia and Virginia, while the remainder of the district drainage basins reported below normal precipitation. Near normal temperatures were reported in the mountains of West Virginia and Virginia, while above normal temperatures prevailed over the remainder of the district. Streamflows were above normal in the eastern mountains of the district and remained below normal for the rest of the district.

The weather during the first half of October has been cool with near normal precipitation. The district drainage area north of the Ohio River has averaged 1.8 inches of rainfall, while the drainage area south of the Ohio River has averaged 1.2 inches.

SPECIAL OPERATIONS

1. Thirteen district projects are obtaining weekly temperature and dissolved oxygen profiles this summer. These projects are Alum Creek, R. D. Bailey, Beech Fork, Burnsville, Deer Creek, Dillon, East Lynn, Fishtrap, Grayson, Paint Creek, Paintsville, Summersville and Sutton Lakes. Eleven of these projects are operating for desired outflow temperatures and high quality discharges.

2. Alum Creek Lake project maintained a discharge rate of 8 cfs from 23 July through 6 August and from 21 August through 26 August. The additional discharges of 3 cfs above minimum were made, as requested, by the Westerville Water Company.

3. R. D. Bailey Lake project began drawdown to winter level of elevation 1012.0 feet on 8 September. The lake level will be lowered to winter level by 26 October. This will allow U.S. Army Divers opportunity to inspect the concrete face of dam and therefore complete the periodic inspection of the project. The rate of fall of the lake level was slowed on 11 September to allow the lake marina operator opportunity to remain open through Sunday, 20 September.

4. Bluestone Lake project was completely closed for 3 hours on 1 July to allow inspection of the outlet works and debris removal from the trash racks. An outflow rate of 4,500 cfs was maintained for 2 hours on 9 August to aid activities of the West Virginia Water Festival. An outflow rate of 900 cfs was maintained for 3 hours on 23 August to aid in a body recovery activity in the Thurmond, West Virginia area.

5. Burnsville Lake project began drawdown to winter level of elevation 776.0 feet on 1 October.

6. Deer Creek Lake project began drawdown to winter level of elevation 796.0 feet on 1 October.

7. Delaware Lake project is maintaining prescribed outflow rates from 1 July through 31 October in order to maintain an acceptable aquatic environment in the Olentangy River below the project. An outflow rate of 5. cfs was maintained for 7 hours on 18 July to allow emergency repair to a water line which crosses the Olentangy River below the project. On 1 August, Delaware Lake project released 510 cfs for 9 hours, to allow canoeing in the Olentangy River, by Columbus Council of American Youth Hostels.

8. Dewey Lake project maintained minimum discharge of 10 cfs for 3 hours on 16 July to aid downstream construction activity.

9. Fishtrap Lake project began drawdown to winter level of elevation 725.0 feet on 8 September.

10. John W. Flannagan Dam and Reservoir was completely closed for 3 hours on 26 June to allow an inspection of the outlet tunnel. This project supplemented low flows in Levisa Fork and Big Sandy Rivers from 31 July through 12 August; 15 August through 28 August and from 3 to 7 September. On 13 September, John W. Flannagan Dam and Reservoir released 1,350 cfs for 3 hours to allow Pike County Kentucky Officials opportunity to research whitewater potential of Russell Fork. This project maintained a release of 1,350 cfs for 6 hours on 17 and 18 October, respectively, to allow kayaking on Russell Fork.

11. Grayson Lake project maintained a discharge of 5 cfs for 2 hours on 29 September to aid construction of an access road into the outlet channel near the outflow gage. On 6 and 7 October, Grayson Lake project maintained 3 cfs for 3 and 5 hours, respectively, to allow repair of outlet channel. This project was completely closed for 7 hours on 8 October for the periodic inspection.

12. Dover Dam was completely closed for 3 hours on 22 September to allow stilling basin inspection.

13. Paint Creek Lake project supplemented low flows in Paint Creek from 23 July until 3 September when ODNR released required augmentation flows from Rocky Fork Lake project so that Paint Creek Lake level could be stabilized at its current level of elevation 794.8 feet for Labor Day weekend recreational activities. Augmentation releases from Paint Creek Lake project resumed on 9 September and has continued until the present, except for a 2 hour release of

10 cfs on 28 September to allow stilling basin inspection. The Paint Creek Lake level is 5.8 feet below seasonal level as of 15 October.

14. Paintsville Lake project pool level was maintained between elevation 710.0 feet and Water Quality Control pool level of elevation 709.0 feet through June and July. During this time period a minimum release of 25 cfs was maintained. Beginning on 1 August, a minimum release of 10 cfs has been maintained, except for trout stocking periods, when 25 cfs is maintained for 72 hours after the stocking.

15. Summersville Lake project maintained an outflow rate of 2,440 cfs for 4 hours on 11 June to allow filming of a whitewater documentary. Summersville Lake project supplemented low flows in the Kanawha River at Charleston, West Virginia, from 23 July through 7 September. Summersville Lake level drawdown has been modified this fall to provide whitewater rafting opportunities on the Gauley River during September and early October, as well as fishing opportunities during the second and third weeks of October. Whitewater releases of 2,400 cfs for 6 hours were made on 12, 13, 19, 20, 26, 27, 28 and 29 September, 2, 3, 4, 5, 9, 10, 11 and 12 October and releases of 2,400 cfs for 4 hours were made on 30 September, 1, 6, 7 and 8 October. Releases of 200 cfs for fishing activities are being made on 13 through 26 October.

16. Sutton Lake project supplemented low flows in the Kanawha River at Charleston, West Virginia from 23 July through 7 September and on 24-25 September. Drawdown of the lake level officially began on 8 September,

however, discharge of storage for drawdown purposes did not begin until 7 October.

FLOOD CONTROL ACTIVITIES

A cold front moving north across North Central Ohio created a very unstable airmass on 29 June. Thunderstorms formed with heavy rain occurring along this front beginning late on 29 June with lighter rain continuing until 2 July. Rainfall amounts in excess of 5 inches were recorded during this storm event. Two Huntington District Lake projects set new pools of record as Alum Creek Lake level crested at elevation 893.32 feet on 4 July with 36.7 percent of available flood storage being utilized and North Branch of Kokosing Lake level crested at elevation 1137.57 feet on 2 July with 45.3 percent of available flood storage being utilized.

Flood storage accumulated in the Muskingum River Reservoirs due to this storm event. Reservoir effects are listed below:

Station	Control Stage	Natural Crest	Observed Crest	Reduction In feet
Tuscarawas Rv at New Philadelphia	6.5	8.8	6.0	2.8
Muskingum Rv at Coshocton	15.5	20.3	13.8	6.5
Muskingum Rv at Dresden	16.0	20.9	14.4	6.5
Muskingum Rv at McConnellsville	10.0	11.1	7.4	3.7

An estimated $13,491,000 of damages were prevented by the Muskingum River projects during this event.

Flood storage accumulated in the Scioto River Reservoirs due to this storm event. Reservoir effects are listed below:

Station	Control Stage	Natural Crest	Observed Crest	Reduction In feet
Scioto River at Circleville, OH	14.0*	24.0	16.4	7.6
Scioto River at Higby, OH	13.5	19.2	11.7	7.5

An estimated $6,249,000 of damages were prevented by the Scioto River projects during this event.

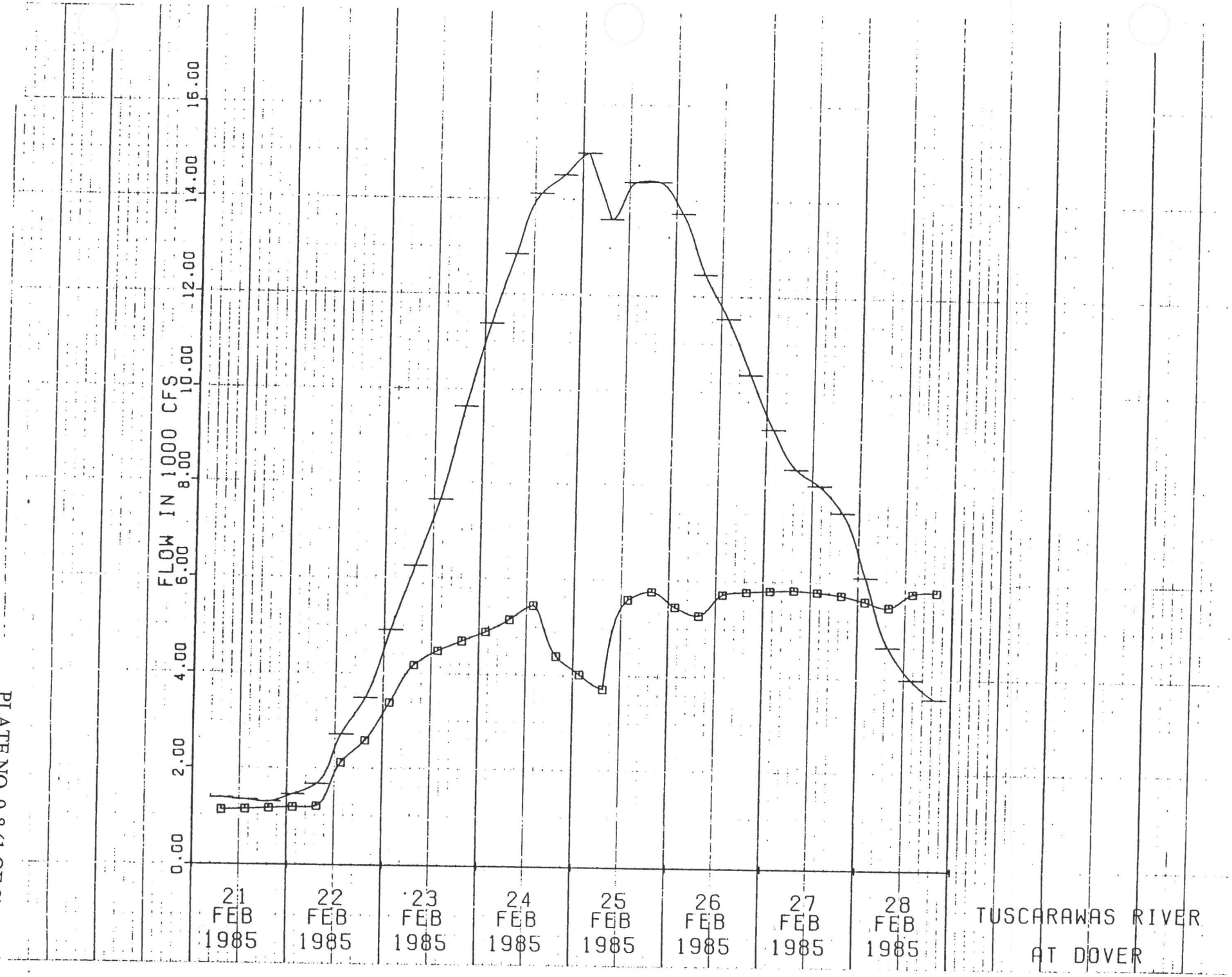


PLATE NO. 9-8 (1 OF 2)

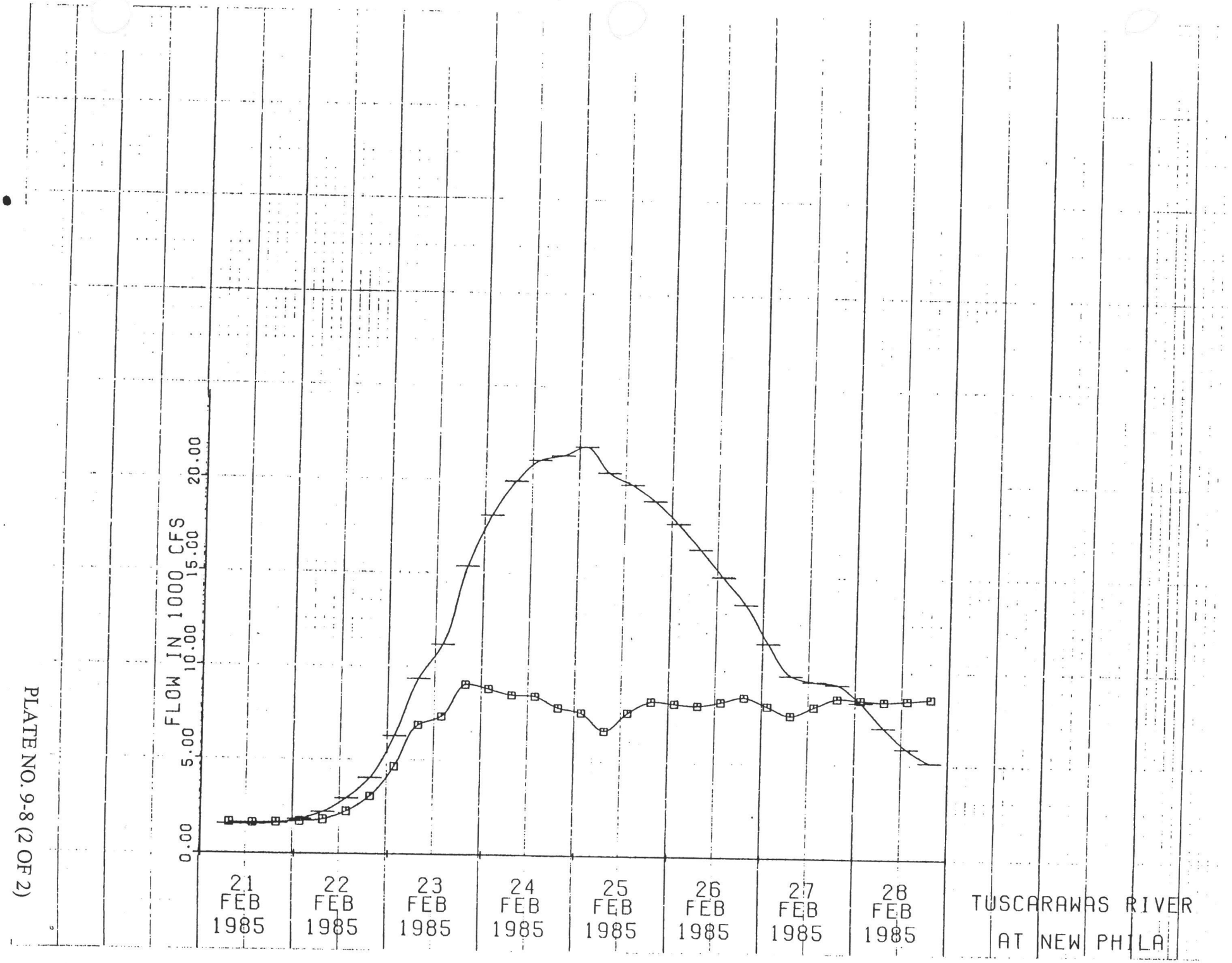
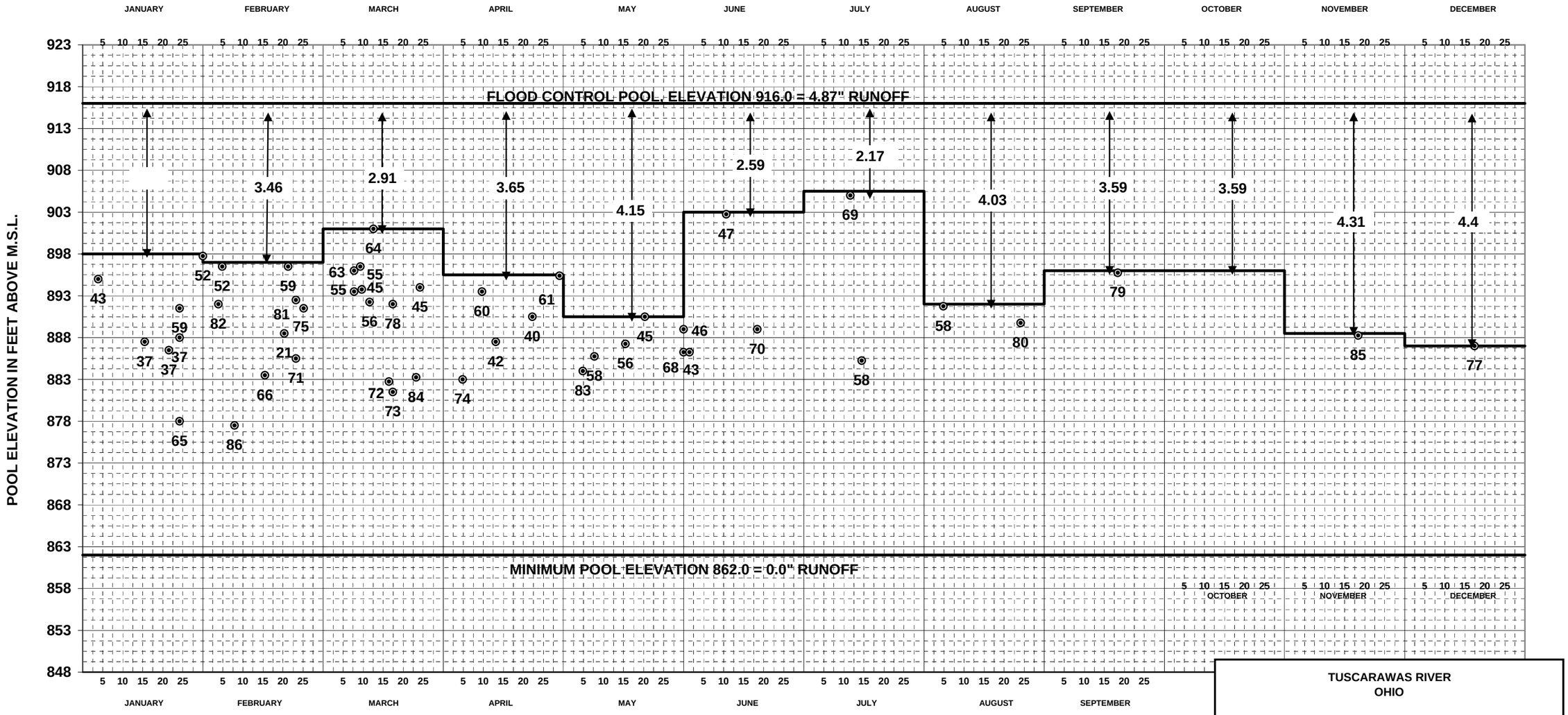


PLATE NO. 9-8 (2 OF 2)



NOTES

(1) DRAINAGE AREA = 1404 SQ. MI.
(2) ONE INCH RUNOFF = 41,707 AC FT.
(3) PERIOD OF RECORD: 1944-1987
(4) O CREST POOL ELEVATION OF A RISE AND YEAR (1947) IN WHICH IT OCCURED

TUSCARAWAS RIVER
OHIO

DOVER DAM

RESERVOIR UTILIZATION ENVELOPE FLOOD CONTROL

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS

HUNTINGTON, W.V. REDRAWN OCTOBER 1999