

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

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

20 January 2004  
Schray/5604

3/16/04  
elle

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

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

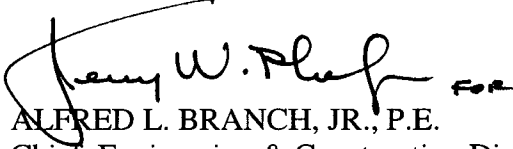
3 June 2002

MEMORANDUM FOR SEE DISTRIBUTION

SUBJECT: Water Control Manual for Kokosing River Lake

1. Please replace the existing Plate in subject manual with the revised Plate (attached).
2. Place this page in the front of the manual.

Encl

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

DISTRIBUTION:  
CELRD-ET-W (2)  
CELRH-OR  
CELRH-OR-NBN (2)  
CELRH-OR-MUR  
CELRH-EC-WW (2)  
CELRH-EC-WH



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

REPLY TO  
ATTENTION OF

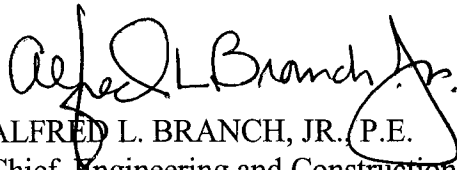
CELRH-EC-W (1110-2-1403a)

17 December 2001  
BROWN/gd/5530

MEMORANDUM FOR Commander, Great Lakes and Ohio River Division  
ATTN: CELRD-ET-W

SUBJECT: Water Control Manual for North Branch of Kokosing River/Lake

Forwarded herewith are two copies of the subject manual for your retention.

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

2 Encl

WATER CONTROL MANUAL  
NORTH BRANCH OF KOKOSING LAKE  
NORTH BRANCH OF KOKOSING RIVER

MUSKINHUM RIVER BASIN  
OHIO

NORTH BRANCH OF KOKOSING RIVER BASIN  
OHIO

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

PREPARED BY

CORPS OF ENGINEERS  
HUNTINGTON DISTRICT  
Water Resources Engineering Branch

November 2001



NORTH BRANCH KOKOSING RIVER LAKE

MUSKINGUM RIVER BASIN  
NORTH BRANCH KOKOSING RIVER  
NORTH BRANCH KOKOSING RIVER LAKE  
DAM AND SPILLWAY  
PLAN AND SECTION  
HUNTINGTON DISTRICT, HUNTINGTON, W. VA.  
Revised: 30 JUNE 1975

#### NOTICE TO USERS OF THIS MANUAL

Regulations require that this Water Control Manual be published in a hard backed 3-ring binder with the text in loose leaf form. In this way, only those sections or parts thereof requiring changes need be revised and printed. Therefore, this copy should be preserved in good condition in order that single page inserts can be made to keep the manual current. Changes to individual pages must carry the date of revision, which is the Great Lakes and Ohio River Divisions' approval date.

REGULATION ASSISTANCE PROCEDURES

In the event that unusual conditions arise during non-duty hours, communications can be achieved by contacting, in the order listed, one of the following.

DIRECTORY OF KEY PERSONNEL

Water Resources Engineering Branch	Home Telephone Number
[REDACTED] Chief, Water Control Section	*[REDACTED] *unlisted
[REDACTED] Water Control Section	[REDACTED]
[REDACTED] Water Control Section	[REDACTED]
[REDACTED] Chief, Water Resources Engineering Branch	*[REDACTED] *unlisted
Huntington District Office - Water Resources Engineering Branch Normal Work Hours 0700 to 1600 hrs	[REDACTED]
Nights, Weekends, and Holidays	Additional Extensions [REDACTED]

**Note: All the above numbers can be found on the Corps Intranet, including Cell Phone numbers. Located at <http://wcds-a/emergency.htm>**

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

Mohawk Dam Project Office  
Normal Work Hours  
Nights, Weekends,  
and Holidays  
Commercial [REDACTED]

Gate Operating Personnel	Home Telephone Number
[REDACTED] Commercial Commercial Commercial Commercial	[REDACTED]

DIRECTORY OF KEY EMERGENCY PERSONNEL  
OTHER AGENCIES

U. S. Geological Survey Columbus, Ohio Night, Weekend, Holiday	Commercial	[REDACTED]
[REDACTED]	Commercial	[REDACTED]
National Weather Service U.S. Forecast Office,	Commercial Commercial	[REDACTED]

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## UNIT CONVERSION

### *National Geodetic Vertical Datum*

All elevations in this manual use the 1929 National Geodetic Vertical Datum (1929 NGVD) unless otherwise specified, or 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 = 0.00081 acre-feet

#### Flow:

1 cubic meter per second = 35.31 cubic feet per second

#### Temperature:

Degree Celsius = (Degree Fahrenheit-32)x5/9

**SUMMARY OF PERTINENT DATA**

**NORTH BRANCH KOKOSING LAKE, OHIO**

**AUTHORIZATION:** The U.S. Congressional Flood control act of 1962.

**LOCATION OF DAM:** Knox County, Ohio. On North Branch Kokosing River, 2.2 miles northwest of Fredericktown.

**PURPOSES SERVED:** Flood control, recreation, fish and wildlife conservation.

**DAM:** Type-Earthfill, maximum height 70.5', total crest length 1,400'.

**SPILLWAY:** Uncontrolled type with a crest elevation of 1146.0, crest length 60'. Spillway design flood peak outflow, 13,500 cfs.

**OUTLET WORKS:** Reinforced concrete rectangular conduit, length 560', dimensions 3.5'x6.75', invert elevation 1101.

**OTHER STRUCTURES:** None

**DRAINAGE AREA ABOVE DAM:** 44.5 Square Miles.

**NET LAND USE:** Fee - 1,212 acres  
Easement 496 acres

**RESERVOIR DATA:** Streambed elevation at dam: 1098 feet NGVD.

<u>Pool</u>	Surface Elevation (NGVD)	Surface Area Acres	Backwater along Main Stream (Miles)	Capacity			
				Ac Ft (Thousands)		Inches of runoff	
				<u>Net</u>	<u>Gross</u>	<u>Net</u>	<u>Gross</u>
Year Round Storage:							
Minimum	1121	154	1.7	1.0	1.0	0.4	0.4
Flood Control Storage*	1146	1140		13.8	14.9	5.9	6.3
Total	1146	1140		14.9	14.9	6.3	6.3

\*At maximum pool level.

NORTH BRANCH KOKOSING RIVER BASIN  
OHIO  
PROJECT MANUAL  
FOR  
WATER CONTROL MANAGEMENT  
NORTH BRANCH LAKE - KOKOSING RIVER

SECTION I - INTRODUCTION

1-01. AUTHORIZATION OF WATER CONTROL MANUAL

This manual is prepared in accordance with Engineer Regulation 1110-2-240, Water Control Management, dated 30 April 1987; Engineer Regulation 1110-2-8156, Preparation of Water Control Manuals, dated 31 August 1995; Engineer Manual 1110-2-3600, Management of Water Control Systems, dated 30 November 1987; ER 1110-2-240, dated 8 October 1982; and ETL 1110-2-251, dated 14 March 1980, which provides for submission of regulation manuals in accordance with instructions contained in "Guide for Preparing Water Control Manuals" as prepared by SWD, dated October 1977.

1-02. PURPOSE, AND SCOPE OF WATER CONTROL MANUAL

The purpose of this manual is to furnish detailed schedules for the regulation of North Branch Kokosing Lake. The manual will serve two functions; first as documentation of the 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 additionally 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

	<u>Title</u>	<u>Date</u>
1.	Survey Report on Ohio River, House Document No. 306, 4th Congress, First Session	August 1935
2.	House Document No. 251, 78th Congress, 1st Session	1943
3.	Kokosing River Basin Survey Report, House Document 220, 87th Congress, 2nd Session.	August 1959

	<u>Title</u>	<u>Date</u>
4.	Design Memorandums:	
	Unnumbered - Sediment Range Layout	October 1964
	Supplement No. 1 to Unnumbered - Sediment Range Layout, Reconnaissance Report of the 1983 Sedimentation Reconnaissance	June 1984
	Supplement No. 2 to Unnumbered - Sediment Range Layout, Detailed Report of the 1987 Sedimentation Reconnaissance	December 1987
	No. 1 General Design	June 1966
	No. 2A Preliminary Master Plan	March 1967
	No. 2B Master Plan - Site Plan	March 1967
	No. 2C Master Plan - As Constructed	July 1973
	No. 3 Real Estate (Part 1, Dam Site and Construction Area)	January 1973
	No. 3 Real Estate (Part 2, Pool)	September 1967
	No. 5 Dam	January 1967
	No. 5A Outlet Works and Spillway	May 1968
	No. 5B Instrumentation	April 1968
	No. 6 Concrete Aggregates	April 1968
	No. 7 Relocations - Highways	September 1967
	No. 8 Relocations - Utilities	May 1969
5.	Environmental Impact Statement	June 1976
6.	Preliminary Project Manual For Water Control Management for North Branch Lake.	June 1972
7.	Periodic Inspection and Continuing Evaluation of Completed Civil Works Structures	*September 1968
	Periodic Inspections, North Branch Lake	
	Periodic Inspection Report No. 1	April 1972
	Periodic Inspection Report No. 2	April 1974
	Periodic Inspection Report No. 3	May 1976
	Periodic Inspection Report No. 4	June 1979
	Periodic Inspection Report No. 5	May 1981
	Periodic Inspection Report No. 6	May 1983
	Periodic Inspection Report No. 7	August 1988
	Periodic Inspection Report No. 8	August 1993
	Periodic Inspection Report No. 9	August 1998

<u>Title</u>	<u>Date</u>
8. Final Environmental Impact Statement	July 1974
9. Appendices to the Master Plan Appendix I - Statements of Other Agencies	February 1974
10. Operations and Maintenance Manual	January 1978
1/ Not Authorized	
* Month of Court Clearance	

1-04. PROJECT OWNER

The United States Government has full title, ownership, and fee control of all Huntington District, Corps of Engineers reservoir and lake lands, including North Branch Kokosing Lake, dam, and operating structures.

1-05. OPERATING AGENCY

The U. S. Army Corps of Engineers, Huntington District, Operations and Readiness Division, is responsible for and controls the operation, and maintenance of the North Branch of Kokosing Lake project. However, North Branch of Kokosing Lake is unique in that it is an unmanned self-regulated project, therefore, there are no operating personnel on duty at this project. The outlet works are uncontrolled, but, personnel from the downstream Mohawk Dam will attend the dam on a part time basis, including manually operating the release gate. Accordingly, any correspondence concerning North Branch Lake should be directed to Mohawk Dam.

1-06. REGULATING AGENCY

Any required regulation of North Branch of Kokosing Lake is under the supervision of the Water Control Section of the Water Resources Engineering Branch of the Huntington District, Corps of Engineers.

The operating and regulating responsibility is exercised under 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) ORDR 1110-2-27, 12 January 1976, Subject: Water Control Management Activities;

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

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

(6) ER 1110-2-208, DAEN-CWE-Y, 30 July 1979, Subject: Water Control Management; and

(7) ER 1110-2-240, DAEN-CWE-Y, 8 October 1982, Subject: Water Control Management.

## SECTION II - DESCRIPTION OF PROJECT

### 2-01. LOCATION

The North Branch dam site is located in the northwest corner of Knox County, Ohio, on the North Branch of Kokosing River, 9.1 miles above the mouth of North Branch, 38.6 miles above the mouth of the Kokosing river and approximately 2.2 miles northwest of Fredericktown.

A District map is included as **Plate No. 1-1** and a Kokosing River Basin map showing the regional location of the reservoir is included as **Plate No. 2-1**. The reservoir lake is shown as **Plate No. 2-2** and the general layout plan is shown on **Plate No 2-3**.

### 2-02. PROJECT PURPOSES

The North Branch of Kokosing Lake Project was authorized for flood control and allied purposes by the Flood Control Act of 1962, H.R. 13273, Public Law 87-874, 87th Congress, 2nd Session. The purposes include flood control, general recreation, and fish and wildlife conservation.

### 2-03. PHYSICAL COMPONENTS

a. Embankment. The embankment is primarily a rolled impervious earth section with a zone provided on the downstream side to permit use of the sandstones and poor quality shales from the spillway excavation and the overburden excavation from the left abutment of the dam. Between the impervious section and the random zone on the downstream side lies an inclined drain. **Plate No. 2-4** shows Dam and Dike location and Embankment cross section views. Detailed plan and section views of the Dike are shown in **Plate No. 2-5**. The North Branch Kokosing Reservoir is primarily for flood control purposes; therefore, reasonable leakage through, under or around the dam can be tolerated. Control of underseepage in the right abutment area is effected by a cutoff trench extending to the rock, and by a grout curtain. The cutoff trench and grout curtain are omitted in the left abutment area because of excessive depth of rock. An existing natural impervious blanket on the valley walls upstream from the dam, supplemented by an impervious blanket placed over exposed pervious materials in the valley floor is used to control underseepage in the left abutment area.

Pressure relief wells are provided at the downstream toe of the dam in the area not protected by positive cutoff. The entire upstream slope is protected from surface runoff and scour by 1.5 feet of rock slope protection, underlain by a 9 inch bedding layer. The downstream slope from streambed to elevation 1113.0 feet NGVD is similarly protected, but above elevation 1113.0 feet NGVD the downstream slope is protected by grass.

In the vicinity of the dam the overburden thickness varies from 15 feet at the right abutment to over 200 feet at the left abutment. The

steep bluff at the left abutment against which the embankment was placed was excavated to a 1 on 1.5 slope. The permanently exposed cut slopes upstream were excavated to a 1 on 4.5 slope and blanketed with impervious earth. The downstream cut slope was excavated to a 1 on 4 slope and covered with a reverse filter drain.

Principal dimensions of the embankment are as follows:

Crest Length	1,400 feet
Maximum Height (Elevation of top-1169 feet NGVD)	68.5 feet
Height Above Natural Streambed	71.5 feet
Crest Width	60 feet
Maximum Width at Toe of Slope	550 feet
Approximate Width at Natural Streambed	550 feet

b. Spillway. The spillway crest control at elevation 1146.0 feet consists of a broad-crested weir 60 feet wide with concrete lined vertical sides. The spillway channel extends approximately 300 feet upstream from the crest and has a bottom slope of -5.0 percent. Downstream of the crest the spillway has a bottom slope of 21.0 percent, terminating in a flip bucket. Spillway plan, profile, and sectional views are shown in **Plate No. 2-6**.

c. Outlet Works. The unregulated outlet works are located under the embankment near the right abutment. Plate No. 2-7 shows the intake structure in plan and sections. The outlet works consist of a weir type vertical shaft intake structure, a 3.5 foot by 6.75 foot rectangular concrete conduit embedded entirely in foundation rock, and a conventional jump type stilling basin. **Plate Nos. 2-7 and 2-8** show plan and profile views of the outlet works. **Plate No. 2-9** shows the plan and section details of the intake structure and outlet works. All North Branch Lake pertinent data are shown on **Exhibit No. A-1 and A-2**.

d. Operating Machinery. North Branch Kokosing Lake is basically a self-regulating project. The machinery for North Branch Kokosing Lake consists of a manually operated 24 inch square sluice gate for draining the reservoir. All other hydraulic features are unregulated.

2-04. RELATED CONTROL FACILITIES - N.A

2-05. REAL ESTATE ACQUISITION

Land acquisition was in accordance with the Ohio Joint Acquisition Policy. Acquisition policies during the acquisition program were based upon the fee acquisition of all lands required for the dam site and appurtenant structures, construction and borrow areas, and all lands lying below elevation 1121.0 feet. This elevation represented the minimum pool elevation for clearing of brush. A total of 67 acres were acquired, including 4 entire properties and 3 severed tracts. Flow easement was also acquired for 406 acres of lowland area subject to flooding below elevation 1149.0 feet NGVD.

In 1963 a phenomenal oil field was discovered near Mt. Gilead in Morrow County about 12 miles west of the project. Promotional propaganda in the local area flourished, although all wells in the

immediate project area were found to be dry. There were no other minerals in the project area of contributing value, however all outstanding mineral and oil leases in the project area were extinguished anyway.

## 2-06. RECREATION AND PUBLIC USE FACILITIES

Recreational utilization of the North Branch of Kokosing Lake is limited, although of some significance. Limited storage at the site resulted in the utilization of almost all the total available capacity for flood control storage.

TABLE NO. 2-1

RECREATION SITES AT NORTH BRANCH KOKOSING LAKE

NAME	STATUS
Dam Overlook Site	complete
Launching and Day Use Area	complete
Camping Area	complete
Upstream Fisherman's Access	complete
Below Dam Fisherman's Access	complete

Consequently, no seasonal pool was provided for recreational use. Listed above in **Table No. 2-1** are recreational sites in operational condition in the summer of 1983. Recreational site locations are shown on the Land Use Plan, **Plate No. 2-10**.

a. Corps Operated Sites. Mohawk Project personnel oversee the contract management of the following public use and recreation areas:

(1) Dam Overlook Site. The damsite is located on the North Branch Kokosing River approximately two miles northwest of Fredericktown, Ohio. The damsite and overlook consists of approximately 0.5 acres with paved parking, two bench seats, and a bulletin board.

(2) Launching and Day Use Area. This site consists of approximately ten acres developed for picnicking with 20 picnic units, two boat-launching lanes, parking for cars and for cars with trailers, and a vault-type restroom.

(3) Camping Area. This site consists of approximately ten acres developed for camping with 36 tent and trailer campsites, a vault-type restroom, and mooring bulkhead.

Note: A new water well was drilled near Sites 2 and 3 to upgrade the water supply system. The well provides water for those sites and eliminates the need for three pumps which were subject to flooding.

(4) Upstream Fisherman's Access. This site of approximately 0.5 acres is located upstream of the seasonal pool and provides canoe and small boat access to the reservoir headwaters. Facilities consist of a parking lot with trash receptacles.

(5) Below Dam Fisherman's Access. The site consists of approximately 1/4 acre of grassy area, which is kept mowed, extending about 100 feet along the lower end of the outlet channel down to the old streambed and along North Branch a short distance. Access is by automobile and parking is on the grass or up at the dam.

b. Other Sites. There are no other recreational facilities at present or planned for in the future.

## SECTION III - HISTORY OF PROJECT

### 3-01. AUTHORIZATION

The North Branch of Kokosing Lake Project was authorized for flood control by the Flood Control Act of 1962, H.R. 13273, Public Law 87-874, 87th Congress, 2nd Section.

Legislative authority includes the authorizing act: the Flood Control Act of 1944, as amended; the Fish and Wildlife Coordination Act of 1958; the Forest Conservation Act, as amended; the Federal Water Project Recreation Act; and the Water Resources Planning Act.

### 3-02. PROJECT PLANNING AND DESIGN

The combination of North Branch of Kokosing Lake, together with the existing flood control facilities that have been constructed in the basin by local interests, provide flood protection for the village of Fredericktown and substantially reduces flood damages along North Branch. To provide this protection it was necessary to include in the reservoir a minimum flood control storage capacity of 13,842 acre-feet.

This limits the outflow to acceptable levels for all floods of record and known history in the North Branch Basin. The reservoir may be filled to capacity near the end of certain floods and the outflow from the uncontrolled outlet works will be augmented by flows over the spillway. This occurs on the recession side of the hydrograph and presents no increased flood problems.

Because of the limited storage available at the North Branch site, almost all the storage is allocated for flood control use. Consequently, no seasonal pool is provided; the 154-acre lake formed by the minimum pool will be utilized for recreational purposes.

Recreational development is provided under authority of the 1944 Flood Control Act and in accordance with paragraph 3, Category d, of ENGCW-Y letter of 5 August 1965, subject "Implementation of the Federal Water Project Recreation Act (PL 89-72) in Previously Authorized Projects."

The U. S. Government provided for all initial development, and the State of Ohio will provide all further development of the initial facilities and any new areas.

Most of the upper North Branch Basin is used for agricultural purposes. Wooded areas cover only a small percentage of the basin. In the past, the stream has not appeared to carry a heavy silt load, however, no actual samples have been taken to determine the amount of sediment carried. Assuming that siltation in North Branch of Kokosing Lake would occur at the same rate as near-by reservoirs in the Muskingum River and adjacent basins, design calculations show that at the end of approximately 50 years about 1043 acre-feet of storage of storage would be necessary to offset the lost capacity to due to sediment. Based on this, after 50 years the minimum pool may be filled to such a point that less than a 5-foot average depth of water will be available for recreational use. Therefore, the economic life of the recreation facilities provided is assumed as 50 years.

### 3-03. CONSTRUCTION

Construction began in September 1964 with the foundation investigation for the dam site. Work on the dam, spillway section, and outlet works began in June 1970, with original completion date in June 1972. Construction was completed early with final acceptance in May 1972. Immediately after the contract was awarded, construction of the outlet works began; however, excavation of the spillway did not begin until the embankment foundation in the right abutment area was completed.

In June 1971 the road relocation program began, 1.89 miles of Knox County Route No. 6 and 0.63 miles of Middlebury Township Route 371 were relocated, with 1.78 miles of roads abandoned. No State roads were involved with project.

Utility relocation in the project area consisted of 16,150 lineal feet of telephone and 16,930 lineal feet of power lines. There were also 33,190 lineal feet of abandoned telephone and power lines with 2,035 lineal feet of power lines to remain subject to flooding.

No schools, railroads, pipe lines, or gravesites in the project area had to be abandoned. Original completion of the relocation project was for January 1972, but once again work was completed early with final acceptance coming in October 1971.

Construction of picnic, camping, and parking facilities at North Branch of Kokosing Lake began in March 1972 and was completed in April 1973 with final acceptance in November 1973.

The project was formally placed in operation in October 1973, although minimum pool elevation 1121.0 feet was reached April of 1972.

### 3-04. RELATED PROJECTS

As mentioned previously North Branch Kokosing Lake was added in 1969 to the series of fourteen original multi-purpose related projects in the Muskingum Basin all built at about the same time in the late 1930s. Four of these original projects were in the Walhonding Basin, with the upper three serving as tributary reservoirs to Mohawk Dam at Mohawk Station or Nellie. Much later North Branch of Kokosing Lake was added as a fifth reservoir to reduce flooding at Fredericktown, Ohio. All of the related Walhonding Reservoirs are reasonably close to Mohawk Dam, as shown on **Plate No. 2-1**. All the tributary projects are in a 20 mile semi-circle about Mohawk Dam; and all are operated in conjunction with the much larger Mohawk Dam at Nellie, about 28 air miles from North Branch Lake.

### 3-05. MODIFICATIONS TO REGULATIONS - N.A.

### 3-06. REGULATION PROBLEMS

There have been no significant regulation problems at North Branch Lake.

## SECTION IV - WATERSHED CHARACTERISTICS

### 4-01. GENERAL CHARACTERISTICS

a. Kokosing River Basin. The Kokosing River Basin is located in Central Ohio and covers portions of Knox, Morrow, Richland, Ashland and Coshocton Counties. The basin is roughly rectangular in shape, 32 miles long and 18 miles wide, and has an area of 484 square miles. The Kokosing River rises in Morrow County near the village of Williamsport and flows in a general southeasterly direction for 56.1 miles to its confluence with the Mohican River to form the Walhonding River. A general drainage basin map of the Kokosing - Walhonding River is included as **Plate No. 4-1**. Pertinent data for the Kokosing River Basin drainage areas are shown on **Table No. 4-1**, next page.

The North Branch of the Kokosing River is located in the northwest portion of the Kokosing River Basin. The North Branch Kokosing Basin has a drainage area of 98 square miles with 44.5 square miles of the basin lying above the dam site. About three miles below North Branch Lake, a very short distance above Fredericktown is the 31 square mile tributary junction of East Branch of North Branch. The North Branch Basin is roughly rectangular with the axis running in a northwest-southeast direction with drainage length of approximately 22 miles and maximum basin width of 7.2 miles. The North Branch of Kokosing heads in Morrow County about 2 miles southeast of Williamsport, about 3 miles from the source of the main Kokosing River, at approximately elevation 1375.0 feet NGVD and drains from there down to elevation 979.0 feet NGVD. North Branch flows in a southeasterly direction 20.4 miles to its confluence with Kokosing River 24.1 miles above the mouth of the Kokosing River, about 0.75 miles north of Mt. Vernon, Ohio.

b. North Branch Kokosing Basin. The lake lies within the northwest portion of Knox County, Ohio at the lower end (southeastern) of a relatively fan shaped drainage basin which lies in a northwest-southeast Direction. The watershed, of the North Branch of Kokosing lies wholly within the Till Plains Section of the Central Lowland physical province. Young till plains, morainic topography, and an absence of lakes characterize this physiographic section.

The shoreline of the permanent pool is relatively unbroken. A tributary stream, approximately 2,500 feet above the dam on the right descending bank, forms the only, cove of any significance. The lake narrows to within the stream ranks 12 miles above the dam site. The permanent pool elevation of 1,121 feet NGVD containing 154 acres is relatively shallow with an average depth of 12 feet and a maximum depth of 23.5 feet.

TABLE NO. 4-1

DRAINAGE AREAS OF KOKOSING RIVER  
AND PRINCIPAL TRIBUTARIES ABOVE DAM SITE

Stream	Location	Stream (miiles)	Drainage Area (sq. mi.)
Kokosing River	below mouth South Branch	47.7	36.5
Kokosing River	below Mile Run	45.7	75.1
Kokosing River	below mouth Granny Creek	43.2	99.7
<b>North Branch</b>			
<b>Kokosing River at Damsite</b>		<b>39.4</b>	<b>45.4</b>
East Branch			
Kokosing River	at mouth	28.08	30.6
North Branch			
Kokosing River	below East Branch	28.1	81.8
North Branch	near Fredericktown	26.2	88.1
Kokosing River			
North Branch			
Kokosing River	at mouth	0.0	96.7
Kokosing River	at Mount Vernon	20.0	202.0
Jelloway Creek	at mouth	0.0	74.0
Kokosing River	at Millwood	3.4	473.0
Kokosing River	at mouth	0.0	485.0
Mohican River	at mouth	0.0	1,004.0
Walhonding River	at Walhonding	23.4	1,489.0
Walhonding River	at Mohawk Dam	17.5	1,505.0

## 4-02. TOPOGRAPHY

The drainage basin of the North Branch of Kokosing River lies within the Till Plains section of the Central Lowlands physiographic province. This province is characterized by till plains morainic topography, and an absence of natural lakes. Total regional relief is about 150 feet. North Branch of Kokosing River rises about 15 miles southwest of Mansfield, Ohio, and flows in a southeasterly direction through a region of relatively low relief with flat crested hills and broad flood plains. The pattern of the stream is dendritic and it flows 22 miles from its head of drainage to its confluence with the Kokosing River near Mt. Vernon, Ohio. The stream fall from its source to its mouth is 396 feet for an average gradient of 18 feet per mile. The drainage basin above the dam site is generally fan-shaped and is about 10 miles long by 7 miles wide.

Topography of the basin is moderately steep with maximum relief of about 600 feet. The Kokosing River follows a meandering course through a broad valley from its headwaters downstream to Mt. Vernon. Between Mt. Vernon and Gambier the stream pattern is altered radically, and the river flows through a narrow gorge-like valley which was apparently formed during the recession of the Wisconsin glacier.

The stream profile is relatively steep, dropping from elevation 1300 feet NGVD at the headwaters to elevation 820 feet NGVD at the mouth, an average fall of 8.55 feet per mile. The stream gradient becomes somewhat flatter in the immediate vicinity of Mt. Vernon, where the average slope is about 6.0 feet per mile. Despite the relatively steep stream gradient in the headwater of the main stream and the tributaries, most of the highlands along the western boundary of the basin are marshy uplands of low relief, where the terrain has been affected by glacial action. The stream varies considerably in size, being only a few feet wide with shallow depths near the headwaters, and increasing to as much as 150 feet in width with 15-foot banks in its lower reaches.

The flood plain of North Branch varies in width from a few feet at its source to about 0.4 mile at its confluence with the Kokosing River. Lost Run is the largest named tributary above the dam site. It drains 6.2 square miles, 14 percent of the area, is about 5.2 miles long, and an average fall of 38.5 feet per mile. At Mt. Vernon, about midway of the stream course, the river averages from 100 to 125 feet in width and has banks about 8 to 10 feet high. The general stream bed profile of the North Branch of Kokosing River is shown on **Plate No. 4-2**.

#### 4-03. GEOLOGY and SOILS

The Kokosing River Basin lies in the glaciated portion of the Appalachian Plateaus physiographic province. This province is characterized by till plains morainic topography, and an absence of natural lakes. The North Branch Basin is underlain by sedimentary strata of the Mississippian system. The rock (siltstone, shale, and sandstone) are members of the Cuyahoga formation. This formation thickens towards the west at approximately 3 feet per mile and within the basin area consists of two members, the "Black Hand sandstone" and the "Cuyahoga siltstone and shale."

No significant faulting or folding is known to have occurred in the basin area. Two glacial stages, the Illinoian and the Wisconsin, are known from deposits to have passed over the basin in Knox County. Both the Illinoian and Wisconsin glaciers and glacial debris ranges from 25 to 100 feet in thickness. Both stages affected the drainage within the area and glacial drift deposits, mostly till, have been noted overlying the pre-Pleistocene Epoch bedrock surface.

These glacial deposits are usually composed of sorted debris or common till underlain by benticular beds of sands, silts and gravels. Rocks underlying the basin are shales, sandstones and limestone of the Waverly and Maxville series of the Mississippian age. The city of Mt. Vernon stands on terminal moraine of the Wisconsin glacier. The old Utica River, a tributary of the Deep Stage Newark River, flowed in a northerly direction past the western edge of the city. The rock floor of the old Utica River stands at about elevation 770 feet NGVD and the valley fill is approximately 225 feet in thickness. The rocks underlying the city are siliceous shales and sandstones of the Cuyahoga formation of the Waverly series.

The soils at the dam site are of varied geologic origins. The upper 10 to 15 feet of overburden located in the flood plain are recent alluvial deposits of the North Branch of Kokosing River. These soils are silts, clays and sands. The alluvium is underlain with coarse-grained soils including coarse gravels and cobbles. The right abutment soils are generally silts and sands to bedrock. Maximum overburden depth to bedrock along the dam axis is on the right abutment where the soils are granular, composed of sand, gravel and cobbles, and capped with a veneer of gravelly clay. All of these soils are formed in loam glacial till, and control of soil erosion is a major land management problem. Steepness of slope and erosion are the major management problems for the soils of this association.

#### 4-04. EROSION AND SEDIMENT YIELD

Most of the upper North Branch Basin is used for agricultural purposes and wooded areas cover only a small percent of the basin. There are periods during the year when large portions of the basin's soils are devoid of vegetation, thus creating the potential for serious erosion and sedimentation. This is especially true during the winter and early spring months, a time period which has produced several historical floods. Oil and gas are the only known minerals in the area which are considered to have commercial value. Exploration in the area has shown little or no potential, but companies plan to treat (fracture or acidize) the wells in an effort to salvage nominal production. The oil and gas potential could immediately change with the discovery of one good producing well and the geology composure of the area enhances this possibility. In the non-agricultural areas, erosion and siltation has been reduced as a result of the Muskingum Watershed Conservancy District's reforestation program. More than 12 million trees have been planted to date in the Muskingum River Basin by the MWCD, and more are planted every year.

The amount of sediment generated by a watershed depends on a number of factors including land use, physiography, rainfall and size and shape of the drainage basin. Rainfall dislodges soil particles from the earth, the first step in the erosion-sedimentation process. High intensity rainfalls with large-sized raindrops produce the highest concentrations of sediment. Steep sloping land and land with poor vegetation produces high erosion and sedimentation. Larger drainage basins generally produce less sediment per square mile from a given storm than smaller basins because of the variation in land uses and rainfall rates. And the shape of a drainage basin is an indicator of the amount of bottom land available for sediment deposition before it reaches the reservoir.

In the past, the stream has not appeared to carry a heavy sediment load; however, no actual samples were initially taken to determine the amount of sediment carried. However, several sedimentation surveys have been conducted at the nearby Pleasant Hill and Charles Mill Lakes, and none have ever indicated an excessive sedimentation rate. Therefore, there is no basis for any concern that any excess sedimentation rate would occur at North Branch Lake. Utilizing the data relative to the reservoirs in the basins adjacent to Kokosing River, and U.S. Department of Agriculture sedimentation data in "Miscellaneous

Publication No. 964", an estimate was compiled for the amount of sedimentation that might be expected to occur in North Branch Kokosing Lake. The best estimate was that a sedimentation rate of 0.22 acre-foot per square mile of controlled drainage area per year would be a representative value for North Branch Reservoir.

A sedimentation reconnaissance of the minimum pool of North Branch of Kokosing Lake was conducted in June 1983 with the mean date of resurvey being 9 June 1983. The reconnaissance was conducted at nine minimum pool locations, two of which coincided with ranges 1-A and 2-A across the minimum pool. These two ranges were both altered by construction activity within the normal pool, with range 1-A being modified more than 2-A. The volume of sediment estimated to be deposited below minimum pool elevation 1121.0 feet at the time of the 1983 reconnaissance was considered to be excessive from range 2-A downstream to the dam, and negligible from range 2-A upstream. The time of deposit was taken as the 11-year period between the time that storage began in July 1972 and the mean date of survey in June 1983. Following the 1983 sedimentation report the ranges were renumbered and three additional ranges were added. The sediment range index map is presented as **Plate No. 4-3**.

A resurvey of all thirteen sediment ranges located in the flood control pool area of North Branch of Kokosing Lake was conducted in December 1987 with the mean date of resurvey being 8 December 1987. The time of deposit was taken as the 15.47 year period from beginning of dam operation to the mean date of resurvey in December 1987. The volume of sediment estimated to be deposited in the lake at the time of the 1987 resurvey was 145 acre-feet, or 9.37 acre-feet per year, or 0.22 acre-foot per year per square mile of contributing drainage area. And about 77 percent of the total sediment deposited in the lake, at the time of the 1987 survey, was deposited in the minimum pool. Therefore, based on this sedimentation rate, the life expectancy of the minimum pool would extend to near year 2117.

The rate of sedimentation at North Branch of Kokosing Lake, indicated by the 1987 resurvey, does not appear to be detrimental to the effective operation and management of the project for authorized purposes at this time. Since this indicated rate is slightly less than the rate anticipated at the time of planning, it is recommended that the next resurvey be a reconnaissance of all ranges in the flood control pool area and all category "C" or downstream ranges. Sediment range end monuments that have been destroyed should be replaced as part of the next resurvey.

#### 4-05. CLIMATE

a. General. The climate of the North Branch Kokosing Basin is typical of the central temperate zone, having highly variable temperatures between the summer and winter seasons. The entire basin is affected by frontal airmass activity and is subject to both continental polar and maritime tropical airmasses. 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.

Meteorological data used in hydrologic studies for North Branch Kokosing Lake were available from 14 National Weather Service stations located adjacent to the drainage basin. **Table No. 4-2**, below, lists these stations along with their average annual precipitation and temperatures recorded. Average monthly, maximum, and minimum precipitation is listed in **Table No. 4-3**, next page, for two representative stations in the North Branch Kokosing River Basin area.

b. Temperature. Meteorological stations in the North Branch of Kokosing Basin have recorded temperatures varying from -29°F in February 1899 at Mansfield to 106°F in July 1930 at Newark. The average annual temperature is about 51°F. The growing season, or the period between the last killing frost of spring to the first killing frost of autumn, usually runs from mid-April to mid-October. Average monthly, maximum, and minimum temperatures are shown on **Table No. 4-4**, page 4-8, for two representative stations in the North Branch Kokosing River Basin.

c. Droughts. The most severe droughts on record for the basin occurred in 1930 and 1934.

TABLE NO. 4-2  
METEOROLOGICAL STATIONS IN OR NEAR  
NORTH BRANCH KOKOSING BASIN

Station	Watershed	Elevation		Period of Record	Temp. (F)	Average Annual	
		in Feet	NGVD			PPT Inches	Snow Fall Inches
Bangorville	Mohican River	1327	1882-1938	50.1	41.26	33.8	
Centerburg	Licking River	1220	1946-1972	49.9	42.59	30.2	
Coshocton	Muskingum River	760	1951-1980	50.9	39.56	29.1	
Fredericktown	Kokosing River	1145	1951-1980	48.8	38.56	31.3	
Galion	Scioto River	1170	1946-1969	-	36.81	35.5	
Gambier	Kokosing River	960	1940-1979	-	36.85	(1)	
Mansfield	Mohican River	1320	1937-1970	48.8	39.09	31.1	
Millersburg	Killbuck Creek	930	1951-1980	50.3	37.41	28.6	
Mt. Vernon	Kokosing River	1025	1892-1944	49.9	37.05	28.5	
Newark	Licking River	835	1951-1980	51.4	40.31	25.8	
Pleasant Hill	Clear Fork	1125	1936-1970	-	38.68	37.1	
Utica	Licking River	1005	1044-1970	-	37.90	30.5	
Westerville	Scioto River	811	1952-1966	51.7	34.18	26.	
Greer	Mohican River	921	1946-1970	-	30.90	(1)	

(1) Insufficient data available to determine value.

d. Precipitation. The normal annual precipitation of approximately 37 inches is nearly uniform over the North Branch Basin. Average monthly, maximum monthly, minimum monthly and maximum 24-hour precipitation data are listed in **Table No. 4-4**, page 4-8, for two representative stations.

TABLE NO. 4-3

## TEMPERATURE SUMMARY - MUSKINGUM RIVER BASIN

Station	Yrs. of Record*	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Annual
<u>Average Monthly and Annual Temperature, Degrees Fahrenheit</u>														
Fredericktown	42	24.5	26.8	36.9	48.5	58.7	67.8	71.2	69.6	62.9	52.0	40.0	28.9	49.0
Mansfield, 6W	49	24.3	26.8	36.1	47.7	57.8	66.4	70.0	68.4	62.1	51.7	39.8	28.7	48.3
<u>Maximum Monthly and Annual Temperature, Degrees Fahrenheit</u>														
Fredericktown	42	33.6	36.7	48.1	60.4	71.6	80.5	84.2	83.0	76.5	65.0	50.2	37.8	60.6
Mansfield, 6W	49	32.6	36.1	46.3	59.1	69.6	78.3	82.0	80.7	74.2	63.2	48.8	36.7	59.0
<u>Minimum Monthly and Annual Temperature, Degrees Fahrenheit</u>														
Fredericktown	45	14.8	16.4	26.1	36.0	45.9	55.0	58.1	56.1	48.9	38.3	29.7	19.8	37.1
Mansfield, 6W	49	15.7	18.0	26.3	36.0	46.0	54.6	58.2	56.6	50.0	40.0	30.8	20.9	37.8

\*Period of Record 1986

TABLE NO. 4-4

## PRECIPITATION SUMMARY - MUSKINGUM RIVER BASIN

Station	Yrs. of Record	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Annual
<u>Average Monthly and Annual Precipitation, Inches</u>														
Fredericktown	50	2.43	2.16	3.01	3.46	3.77	4.03	3.72	3.48	2.84	2.00	3.07	2.78	35.99
Centerburg	49	2.43	2.05	3.03	3.52	3.77	4.24	4.13	3.20	2.72	2.45	2.63	2.71	37.67
<u>Maximum Monthly and Annual Precipitation, Inches</u>														
Fredericktown	50	5.37	4.70	7.67	7.22	6.79	7.82	9.40	9.08	6.56	5.48	10.10	5.80	44.95
Centerburg	49	7.36	5.50	7.27	7.26	9.10	8.04	8.90	9.14	8.15	6.00	5.44	8.30	46.58
<u>Minimum Monthly and Annual Precipitation, Inches</u>														
Fredericktown	50	0.33	0.43	0.96	0.70	0.50	0.71	0.83	0.58	0.30	0.00	0.72	0.21	23.43
Centerburg	49	1.32	0.29	0.56	0.66	0.99	1.20	1.04	0.00	0.23	0.00	0.00	0.00	27.50
<u>Average Daily - Precipitation, Inches</u>														
Fredericktown	50	0.08	0.08	0.10	0.12	0.12	0.13	0.12	0.11	0.09	0.06	0.10	0.09	0.10
Centerburg	49	0.08	0.07	0.10	0.12	0.12	0.14	0.14	0.10	0.09	0.08	0.09	0.09	0.10
<u>Average Monthly and Annual Snowfall, Inches</u>														
Fredericktown	51	8.12	5.85	3.52	0.68	0.05	0.00	0.00	0.00	0.00	0.03	1.49	4.98	27.06
Centerburg	49	7.44	3.96	4.28	0.34	0.00	0.00	0.00	0.00	0.00	0.08	1.73	4.77	22.52

The North Branch Basin extends generally northwest to southeast. Consequently, the basin lies directly in the path of extensive meteorological disturbances, which in winter and spring generally travel from southwest to northeast. Storms likely to produce major flooding in the basin can be classified in two types: the summer-type and the winter-type. The summer-type storm usually occurs during the period from May through October with the greater probability of occurrence during June and July. Winter-type storms, which can occur in the period between December and April, are most likely to occur in March and April.

Summer type rains usually result from thunderstorms of conventional frontal activity with convectional or orographic origins. They are characterized by rainfall of high intensity, short duration, and relatively small areal extent.

Winter-type storms are differentiated from the summer-type storm by their less intensive and more evenly distributed rainfall of longer duration and wider areal extent. These storms are generally caused by cold air-masses, originating in the region of Alaska, which interact with warm moist air masses sweeping northward from the Gulf of Mexico and southern Atlantic Ocean. Occasional stagnation and stationary development produces prolonged precipitation. Snow cover, saturated or frozen ground, or combinations thereof, may greatly increase runoff rates and volume. The direction of travel of the storm system is usually northeastward.

Information on wind direction and speed is taken from "Climatic Atlas of the United States," June 1968, published by Environmental Science Services Administration of the U.S. Department of Commerce.

e. Evaporation and Wind. Evaporation losses occurring at North Branch of Kokosing Lake were calculated from NOAA Technical Report NWS 33, published by the National Weather Service from data obtained jointly by the Weather Service, Corps of Engineers and other organizations. Average values for monthly, seasonal, and annual evaporation losses from the lake are shown in **Table No. 4-5**, next page, Lake Evaporation Losses-Summary. The evaporation records at Wooster Experimental Station, Ohio, were used to determine the maximum seasonal (May-October) evaporation losses.

Annual average wind direction over the Kokosing River Basin is southwesterly. Southerly winds, however, prevail from July through October, change to southwesterly during November and December, and become near-westerly in January and February. The direction then gradually becomes and remains southwesterly during March, April, May and June. During the seasonal period of maximum evaporation, the lowest average windspeed, 4 mph, occurs in August and the highest, 7 mph, in May.

TABLE NO. 4-5

## NORTH BRANCH LAKE EVAPORATION LOSSES - SUMMARY

Average Annual Evaporation - inches 33.0 (1)		
Average Seasonal Evaporation (May-October) - inches 25.2(1)		
Average Monthly Evaporation Losses		
Month	Inches (1)	Ac-ft(2)
May	4.16	53.4
June	4.98	63.9
July	5.12	65.7
August	4.52	58.0
September	3.27	41.9
October	2.34	30.0
Seasonal Total	24.39	312.9

(1) Vertical distance

(2) 1-inch loss from minimum pool (elevation 1121.0, surface area 154 acres) = 12.83 acre-feet.

## 4-06. STORMS AND FLOODS

a. General. Floods in the basin are not limited to any specific month, although winter and spring floods are more frequent than summer floods. The occurrence of summer-type storms over the basin has produced local floods without affecting adjacent areas.

Most of the storms that occur in the Ohio River Basin travel from southwest to northeast and pass over, or just south of the Kokosing River Basin. These storms proceed down basin causing a pyramid of runoff and a resulting increase in flood heights.

Above Mt. Vernon, the basin is fan-shaped and largely agricultural with relatively few wooded areas, which tends to produce synchronization of flows and rapid runoff. Floods on North Branch above the dam site are generally of short duration, seldom remaining above flood stage more than one day.

Stream flow records on North Branch have been made for only a short period of time. Records for the stream flow station at Millwood, Ohio, on the Kokosing River have been published by the U.S. Geological Survey since 1921. Pertinent data relative to high Stages recorded at this station are listed in **Table No. 4-6**, next page.

b. Storm and Flood of March 1913. The flood of March 1913 in the Ohio Valley resulted from unprecedented, widespread rains over Ohio and Indiana falling at a time when conditions were favorable for runoff. During the five-day period, 23-27 march, the maximum rainfall recorded in the Muskingum Basin was 9.65 inches at Bangorville. This storm resulted in the greatest flood of record on the Muskingum River and most of its tributaries. The crest stage at the Mill Street gage at Millwood was estimated to be 29.0 feet. During the five-day period (23-27) March, the Kokosing River Basin above Mt. Vernon received an average rainfall depth of 9.60 inches and the runoff approximated 8.05 inches. The Kokosing River rose to unprecedented heights and was in flood stage at all points. At Mt. Vernon, 30 percent of the town was

inundated. The crest stage and flow at the Mt. Vernon gage were estimated to be 17.3 feet and 27,600 cfs, respectively. Approximately 50 residences were flooded and 3 persons lost their lives. Highway and railroad washouts were general and many bridges were destroyed. This was the most disastrous flood for the Kokosing River until January 1959.

TABLE No. 4-6  
KOKOSING RIVER AT MILLWOOD, OHIO  
HIGH - WATER DATA

		Date	Gage height, feet (1)	Discharge cfs	Duration days(2)
21	January	1959	34.00	75,900 (3)	1.3
25	March	1913	25.31	40,000 (4)	2.7
22	June	1937	21.43	27,500	1.1
4	July	1935	21.30	27,100	1.0
5	March	1963	20.76	25,600 (3)	1.8
10	March	1964	20.70	25,400 (3)	1.3
25	January	1937	20.67	25,300	0.9
15	January	1937	19.00	21,000	0.9
27	January	1952	18.68	20,200	0.9
29	June	1998		20,000 (4)	
14	February	1948	17.98	18,500	0.7
7	August	1935	17.98	18,500	0.5
24	March	1948	17.89	18,300	0.8
12	April	1948	17.54	17,500	1.0
28	May	1968	17.75	17,100 (3)	0.7
31	December	1990		17,000 (4)	
20	March	1927	17.09	16,500	1.5
7	March	1945	17.09	16,500	0.7
14	May	1933	17.00	16,300	0.4
10	February	1959	16.76	15,800 (3)	0.5
3	June	1947	16.67	15,600	0.5
21	April	1964	16.37	15,000 (3)	0.4
10	March	1943	16.33	14,900	0.4
21	January	1927	15.15	12,500	0.2
20	April	1940	15.15	12,500	0.2
3	March	1940	15.10	12,400	0.1
19	January	1929	14.90	12,000	0.1
30	January	1968	15.46	12,300 (3)	0.4
29	January	1970	15.50	11,400 (3)	0.3

1. First site, datum, and conditions, before discontinued in 1974.
2. Duration above bank overflow stage of 15.0 feet.
3. Flow as modified by existing East Branch-Knox Reservoir
4. East Branch-Knox Reservoir Estimated

c. Storm and flood of July 1935. Flooding of the Kokosing River and adjacent streams followed severe local thunderstorms of 3-4 July. The rainfall station at Bangorville recorded 1.56 inches on the 3rd, 4.35 inches on the 4th, 0.78 inches on the 5th, and 0.30 inches on the 6th. North Branch Basin received an average of about 5 inches during the storm period. The flood crested at 21.30 feet on the gage at Millwood with a corresponding flow of approximately 27,100 cfs.

This flood occurred at a critical time during the growing season with resultant heavy damage to crops and fanning operations.

d. Storm and flood of June 1937. The local concentrated flood of June 1937 in central Ohio caused slightly higher stages on the Kokosing River than the record Ohio Valley flood of the previous January. Heavy general rains in the Muskingum, Scioto, and Sandusky River Basins, on 20-21 June, brought those streams and most of the tributaries above flood stage. In less than 24 hours, the Muskingum Basin received an average depth of 2.83 inches of rainfall, while the Mt. Vernon station recorded approximately 3.54 inches during the storm period. The rainfall averaged 3.31 inches of the Kokosing Basin above Mt. Vernon and resulted in approximately 2.61 inches of runoff. At Millwood the Kokosing River reached a stage of 18.10 feet, or 21.43 feet at present location. The estimated crest stage and discharge on the Kokosing River at Mt. Vernon was 15.59 feet and 15,750 cfs.

e. Storm and flood of January 1959. The greatest flood of record on the Kokosing River occurred during the period 21-24 January 1959. The storm period began on 14 January 1959 when approximately one inch of precipitation fell as snow. Sub-zero temperatures held this moisture on the ground until 19 January 1959 when, during a three-day period, approximately 5.0 inches of rain fell over the basin. Snow, changing to rain, fell on 19 January 1959. The rain increased in intensity on the 20th with nearly 4.0 inches falling on 21 January. The maximum stage of record, 18.19 feet, was reached on Kokosing River at Mt. Vernon on 21 January 1959, with a corresponding flow of 38,000 cfs. Downstream at Millwood the flow was estimated to be 75,000 cfs. Runoff amounted to approximately 5.1 inches from the drainage area above North Branch dam site.

f. Storm and Flood of July 1969. The floods of 4-8 July 1969 in north-central Ohio were caused by the most intense and widespread summer storm recorded in Ohio. On the evening of 4 July 1969, a line of thunderstorms moved into Ohio from Lake Erie, accompanied by heavy rains and strong winds. Following the first storms, an area of great atmospheric instability remained stationary for nearly 8 hours, and numerous storms with torrential rains moved southeastward through the area, which was located approximately 30 miles either side of a line from Toledo to Dennison. Within a period of 24 hours, an area of about 6,000 square miles in north-central Ohio received in excess of 4 inches of rainfall, and some small areas received as much as 14 inches of rainfall. The area north of Fredericktown had the heaviest precipitation, as Mohicanville Dam and Ashland received 9.67 inches and 8.99 inches of rainfall, respectively. Rainfall amounts of 10-14 inches were recorded near Wooster, just east of the basin.

g. Storm and Flood of February 1979. Subfreezing temperatures and a major snowcover persisted over the Muskingum River Basin during most of January and February 1979. Rising temperatures and rainfall during 21-24 February created thawing conditions and rapid snowmelt, producing flooding conditions in the Muskingum River Basin. At North Branch Lake, approximately 0.5 inch of rainfall combined with snowmelt from approximately 8 inches of snowfall on the basin to produce a major inflow into North Branch Lake. This flooding event was followed by a significant snowfall event of approximately 4-5 inches on 25-26

February. As temperatures rose in early March, this snowfall, which had a water equivalent of about 1.4 inches, melted and combined with minor rainfalls in early March to produce a secondary peak inflow into North Branch Lake.

h. Storm and Flood of February 1985. The flood of February 1985 was the result of rapid snowmelt combined with some minor rainfalls. The Muskingum River Basin experienced above-normal snowfalls and below normal temperatures during January, which created a significant snow cover over most of the basin from the second week of January into February. A large snowstorm on 12-13 February produced as much as 12 to 15 inches of snow in the southern half of the Muskingum River Basin. Mansfield and Ashland each received about 11 inches of snow from the storm, which increased snow depths to 18 inches at Ashland and 13 inches at Mansfield. The water equivalent of the snow pack at Mansfield by this time was 2.7 inches. A general thaw began over Ohio about 18 February, with temperatures rising into the upper 40's by 21 February and into the 60's on 23 and 24 February. Melting snow and ice combined with rainfalls of about 0.3-0.5 inch over the North Branch Lake during the period 22-25 February, and the resulting runoff produced flooding in the basin along with some ice jamming.

i. Storm and Flood of June-July 1998. The flood of 26 June to 8 July 1998 began in the very early hours of Saturday, 27 June 1998 as a series of thunderstorms with very heavy rain fell over areas of central Ohio. Many of these storms were cyclic or in sequence over the same areas for several hours producing 4-6 inch amounts of rain. The heaviest amounts of rainfall occurred in areas not controlled by the Corps of Engineers reservoir system. Since North Branch Lake was at the minimum pool level, the spillway releases at the beginning of the storms were near minimum flows. A second wave of heavy thunderstorms occurred early on Sunday 28 June 1998, over the same central Ohio area of the previous storm just 24 hours earlier. The second series of storms dropped another 4-6 inches over central Ohio to bring the past 36-hour total to 8-12 inches of rain. The extreme rainfall and flood was devastating with several deaths recorded, and a maximum pool of record was reached at North Branch Lake of 1143.13 feet NGVD on 29 June, utilizing 62.5 percent of the lake storage.

#### 4-07. RUNOFF CHARACTERISTICS

The northwestern portion of the Kokosing River 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 the border between the glaciated and 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 Kokosing River are Jelloway Creek, Schenck Creek, and North Branch of Kokosing River. The Mount Vernon gage is modified by North Branch Kokosing Lake that controls 44 square miles or 22 percent of the Mount Vernon drainage areas.

Throughout the Kokosing River Basin, infiltration losses are generally low due to the relatively shallow depth and high clay content of the soils. Basin runoff is highest during the late winter and early spring months. During this period, snow cover, saturated or frozen ground, in combination with rainfall, may greatly increase runoff rates and volumes. The runoff is lowest in the late summer and early fall when the ground is dry and infiltration rates are high. However, precipitation during these seasons may be quite heavy and of sufficient intensity to more than make up for the infiltration rates.

Variation of runoff characteristics within the Kokosing River Basin is mainly a function of topography. The Kokosing River Basin is located in the Indiana and Ohio Till Plains section. The topography of this area consists of gently rolling low relief, ground moraine, with bands of terminal moraine and outwash-filled valleys. The mean annual runoff for the Kokosing River averages about 1.0 cfs per square mile of drainage area. **Table No 4-7** below, presents monthly and annual average runoff for the Kokosing River watershed based on 45 years of record at the USGS gage at Mount Vernon, Ohio. The amount of runoff below the North Branch damsite would be about 22 percent in flow, but, the inches of runoff would be approximately the same.

Month	Normal Average flow		Maximum average flow		Minimum average flow	
	cfs	inches	cfs	inches	cfs	inches
January	281	1.60	1020	5.82	36.0	0.21
February	346	1.80	805	4.19	31.4	0.16
March	421	2.40	1068	6.09	129	0.74
April	379	2.09	845	4.67	122	0.67
May	269	1.54	820	4.68	53.0	0.30
June	200	1.10	909	5.02	29.1	0.16
July	152	0.87	636	3.63	25.0	0.14
August	81.2	0.46	438	2.50	18.0	0.10
September	65.3	0.36	587	3.24	16.7	0.09
October	64.0	0.37	275	1.57	15.1	0.09
November	143	0.79	635	3.51	20.4	0.11
December	240	1.37	979	5.59	23.0	0.13
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ANNUAL	225	15.13	325	21.85	78.7	5.89

#### 4-08. WATER QUALITY

a. Geology. 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. The strata consist of horizontal beds of shale, sandstone, limestone, and coal. Surface water is characteristic of the calcareous nature of the watershed.

Inflow water is characteristic of the calcareous nature of the watershed. Ionic concentrations and buffering capacity (alkalinity) are high. Nutrient levels are also high for both tributaries. Also, sulfate concentrations are relatively high, as are total salt concentrations and buffering capacity (alkalinity). Iron and manganese, possibly because of the calcareous nature of the basin and neutralization of acid drainage, are not present at problematic concentrations.

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 Kokosing watershed was 4. This implies that the watershed has less serious water quality problems, with a higher vulnerability to pollutant loadings.

Water quality data collected by the Corps of Engineers from 1974 to 1995 is limited, but indicates that water quality in the basin reflects watershed conditions.

b. Chemical. The chemical composition of water may be defined by grouping substances, which compose the dissolved solids. Relationships among groups of chemicals determine the type of water. In terms of major ions and descriptive parameters, water in North Branch Kokosing Lake is classified as calcium carbonate. This represents a balanced condition.

Impounded waters are in more or less dynamic states. The governing factor in water quality development is the temporal and spatial behavior of the density of this water. In most fresh water systems, water temperature is the predominant factor in determining density. Temperature variations in water masses are capable of creating strata of water of greatly different characteristics. Such differing characteristics have direct implications with regard to lake-releases. North Branch Kokosing Lake remains nearly isothermal during the winter months. In the spring, under normal conditions, the lake stratifies and remains so until September. At that time the lake mixes and becomes isothermal again.

c. Temperature Cycle A lake structure will typically cycle from a mixed condition (Temperature same from top to bottom) to a stratified or layered condition (Temperature changes with depth). This is the result of thermal energy from the atmosphere gained and lost during the year. During spring as air temperatures start to warm, so do surface water temperatures. This creates a surface layer called the epilimnion. Water temperatures near the bottom remain cool because they are not exposed to the sunlight or warmer air temperatures. This layer is called the hypolimnion. The layer in the middle is referred to as the metalimnion or transition layer. During fall when air temperatures start to cool, the water temperature at the surface also cools and mixes with water below at the same temperature. The process continues until water temperature in the epilimnion is the same as the hypolimnion and the lake is once again mixed. **Plate No. 4-4.**

d. Retention. North Branch Kokosing Lake remains nearly isothermal during the winter months. In the spring the lake stratifies and remains so until September. At that time the lake mixes and becomes isothermal again. The calculated average retention time is 8 days. This is an average number. Water remains in the lake longer in the summer during times of low-flow and shorter in the spring during times of high flow. Specific conductance does not indicate any density layers in the lake resulting in interflows through the lake during the summer months.

e. Dissolved Oxygen. Dissolved oxygen levels are extremely important in water quality characterization. They depend on the physical, chemical, and biological activities that occur in water. Dissolved oxygen saturation limits are directly related to temperature. Thermal stratification can result in zones that exhibit greatly different characteristics. In well-mixed epilimnetic waters, relatively high levels of dissolved oxygen occur and water is usually of acceptable quality. Water in the hypolimnion may become void of oxygen because of various oxygen demanding processes. Therefore, a concomitant decrease in water quality can occur after stratification becomes established. Concentrations of dissolved oxygen in North Branch Kokosing Lake remained constant throughout the water column after fall mixing completed, sometime in September, and remained so until around April when the lake would normally stratify. At that time, dissolved oxygen levels in the hypolimnion declined rapidly until anoxic conditions were reached. Dissolved oxygen remained above 5.0 mg/l in the epilimnion, declined rapidly in the metalimnion, and dropped to 0.0 mg/l in the hypolimnion. This meant that about 66% of the lake had oxygen levels above 5 mg/l. Dissolved oxygen is one of the key parameters for fishing and this represented the maximum amount of lake available for fishing during most of the stratification season. **Plate No. 4-5** shows typical dissolved oxygen concentrations during the summer months. Dissolved oxygen concentration of the inflow averaged 99% saturation. Average values in the tailwater averaged 93% saturation.

Concentrations of nutrients in a lake are an indicator of productivity. Low productivity results in fewer littoral plants and low density of phytoplankton, whereas highly productive lakes are characterized by littoral plants and abundant phytoplankton populations. The amount of productivity is directly related to the lake fishery. Sufficient quantities of phosphorous, nitrogen, and carbon are needed to have a productive lake. North Branch Kokosing Lake is considered productive with phosphorous as the limiting nutrient. Nutrients are transported with sediments. As water enters a lake, its velocity decreases and the sediments settle to the bottom. Because of this phenomena, it is common to see algal blooms at the upper end of a lake. Phosphorous concentrations averaged 0.19 mg/l in the inflow and 0.10 mg/l in the outflow which indicates that there was available phosphorous in the tailwaters.

f. pH. A measure of the hydrogen ion concentration is known as pH. It can be raised by adding a base or removing carbon dioxide from a solution such as in photosynthetic assimilation. By definition, pH ranges from 1 to 14 and a pH value of 7.0 is considered neutral. Average pH values found in the database for the inflow was around 7.6 while in the tailwater it was 7.9. The average numbers indicate

slightly basic conditions in the headwater and tailwater, which is a common condition for a watershed in a farming area. The increased nutrient supply allows for a higher rate of algal growth, which causes more photosynthetic activity, which removes more carbon dioxide. Long-term trends indicate no significant pattern in pH values over the entire watershed.

While pH is a measure of concentration, alkalinity is a measure of capacity. The capacity of a solution to neutralize acids or bases is called buffering capacity. Average alkalinity, a factor buffering pH, was around 226 mg/l CaCO<sub>3</sub> in the headwaters and 158 mg/l CaCO<sub>3</sub> in the tailwaters. These are high numbers and indicate a large buffering capacity to resist shifts in pH within the basin.

Water hardness is the sum of calcium and magnesium concentrations expressed in terms of mg/l calcium carbonate. It is largely a result of geological formations at the water source. Calcium and magnesium form an insoluble residue with soap and leave deposits on surfaces that come in contact with the water. The ring around a bathtub is a well-known example of these deposits. Detergents were introduced to reduce this problem. High hardness (hard water) results in high soap consumption as well as objectionable scale in heating vessels and pipes. Public acceptance of hardness varies. Many consumers will object to water harder than 150 mg/l calcium carbonate (Water Supply and Pollution control). Average water hardness at the main inflows was 231 mg/l calcium carbonate and was 195 mg/l calcium carbonate in the tailwater. This range is classified as very hard based on U.S. Geological Survey classifications.

g. Iron Concentration. Iron is an abundant element on the earth, but usually occurs as an insoluble form in water and at low concentrations. Concentrations of iron in the headwaters of North Branch Kokosing Lake averaged 200 ug/l which is well below a standard of 1000 ug/l. This average increased to 400 ug/l in the tailwaters, most likely due to the fact, that releases from the lake are unregulated for water quality. During the stratification season, iron levels remained below 1000 ug/l in the lake epilimnion and metalimnion, but exceeded 1000 ug/l in the hypolimnion **Plate No. 4-6**. This was the result of anaerobic conditions in the hypolimnion. Long-term trends indicated no significant changes in iron concentrations.

h. Manganese Concentrations. Concentrations of manganese in the headwaters were well below a standard of 1000 ug/l, averaging about 30 ug/l. During lake stratification, manganese levels were at 1000 ug/l in the hypolimnion **Plate No. 4-7**. The high concentrations of manganese in the hypolimnion were only slightly reflected in tailwater readings. This was the result of an outflow structure designed to release water from the lake surface. Average manganese levels in the tailwater area averaged 100 ug/l. Long-term trends indicated no significant change in manganese concentrations.

i. Productivity of Aquatic Habitats. In a freshwater community, algae are the primary producers. They serve as the basis of the food chain and are the primary food source for most aquatic animals. The quantity and types of algae present in a stream or lake is dependent upon many factors, such as temperature, oxygen, light, nutrients and flow. All freshwater algae contain the green pigment

chlorophyll. Therefore, measuring chlorophyll can monitor the productivity of aquatic habitats. Algal productivity was low in headwaters streams with an average chlorophyll concentration of 4.2 ug/l. Productivity on the lake was considered high with an average chlorophyll concentration of 62 ug/l.

#### 4-09. CHANNEL AND FLOODWAY CHARACTERISTICS

The channel capacity of the North Branch of Kokosing River immediately below the dam site is estimated to be 700 cfs. Encroachment on the natural flood zone of the Kokosing River, particularly around Mt. Vernon, has been the result of a general increase in commercial, industrial, agricultural, and recreational activities. Many houses, industrial plants, railroads and bridge abutments now occupy lands below the high waterline, and the cumulative effect of these obstructions increases flood stages along the Kokosing River. The town of Mt. Vernon has developed on both sides of the river and local programs for levee construction and channel rectification have further encroached upon the natural flood zone of the stream. The flow frequency graph for North Branch Kokosing Lake is shown in connection with a later section.

North Branch Kokosing River follows a meandering course over the 9.1 mile length between the dam site and its junction with Kokosing River.

It has generally stable banks and relatively low turbidity except after hard rains. The streambed is mostly sand and gravel and varies in width from about 20 feet at the dam site to 50 feet at the mouth. The valley width of North Branch Kokosing is about 1,120 feet at the damsite and expands to about 2,400 feet at the mouth.

#### 4-10. UPSTREAM STRUCTURES - N.A.

#### 4-11. DOWNSTREAM STRUCTURES

There are no downstream flood control structures on the Kokosing River, itself, however, on the adjacent East Branch of Kokosing River is the small state operated Knox Lake. Further downstream, about 9 miles below the junction of Kokosing and Mohican rivers at Walhonding, is Mohawk Dam, the huge earth filled flood control dam at Mohawk Junction or Nellie, Ohio. Mohawk Dam is the parent control structure for North Branch Lake.

#### 4-12. ECONOMIC DATA

a. Population. The North Branch Kokosing River Basin above North Branch Dam has an estimated 1980 population of 3,650 persons in a predominantly rural environment. Population centers are small, most of them numbering less than 50 persons. However, the adjacent town of Fredericktown, located just below the dam site had a 1990 census population of 2,443. North Branch Lake lies in two counties. Morrow and Knox, with a very small tip in Richland county. These two counties, Morrow and Knox had a population of 12,750 and 38,810, or a

total of 51,560 people in 1960. By 1990 the same two counties had grown to 14,194 and 47,473, or a total of 61,667 people; for a healthy increase of 19.6 percent in 30 years.

b. Industry and Agriculture. The chief forms of employment in the North Branch Kokosing River Basin are farming and mineral industries. Mineral industries include mining for coal, limestone, sand, sandstone, gravel, clay, and shale, and drilling for oil and natural gas. There are several producing oil and gas wells in the Kokosing River Basin.

There were 1153 farms in Morrow County, Ohio in 1977, totaling 188,000 acres or about 73 percent of the county, 53.3% of the farmers work 100 or more days away from the farm. Of the farms listed, 15.3% have sales totaling greater than \$40,000, while 51.6% have sales totaling over \$10,000.

c. Flood Damages. Frequency-damage computations for the North Branch of Kokosing and the Kokosing River extending down to the Mohawk Dam area show estimated average annual damages prevented by North Branch of Kokosing Lake to be \$248,500 for June 1966 price levels. These average annual amounts have been updated to \$1,178,000, respectively for October 1983; and further updated and escalated to March 2000 costs and conditions or, \$1,775,000 dollars.

Damages were updated to October 1983, and then March 2000 by considering escalation of construction costs between June 1966, October 1983, and March 2000, and a given annual growth rate in the flood plain between June 1966 and April 1974 when flood insurance requirements took effect. The annual growth rate used was 2.0 percent along the North Branch Kokosing River from North Branch Damsite down to the tiny pool of Mohawk Dam.

## SECTION V - DATA COLLECTION AND COMMUNICATIONS NETWORKS

### 5-01. HYDROMETEOROLOGICAL STATIONS

a. Facilities. Data Collection Platforms (DCPs) have been installed throughout the district at various strategic stream gaging and precipitation stations. Installations at stations in the Kokosing River Basin are described in **Table Nos. 5-1 and 5-2**, page number 5-3 and 5-4. The DCPs transmit hydrometeorological data, via the Geostationary Operational Environmental Satellite (GOES), to various receiver sites. The data is then obtained directly by the District Water Control System for processing.

Early-model 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 a backup for Analog-to-Digital Recorder (ADR) devices. Shaft encoders are now being used to digitally record water levels.

Some stream gaging stations have voice DCPs, capable of answering a telephonic call and responding with the current updated information by synthesized voice. Another type of DCP is now available that has the capability of reporting in response to a telephone query from a computer or terminal. The query can be initiated any time from the Water Control System, project office or the home of a selected individual during off-duty hours. The voice synthesizer gives stage as "level" to 0.1 feet when dialed. These DCP's can also dump to a computer terminal giving several readings over a period of hours. These DCPs are being installed at critical locations such as inflow, lake and outflow stations, along with some control point stations.

The USGS maintains three stations in the Kokosing River Basin: Kokosing River near Mt. Vernon, Kokosing River at Millwood, and Walhonding River at Coshocton. Gage locations are shown on **Plate No. 4-1**, Walhonding River Basin Map, and **Plate No. 5-1**, Hydrologic Network; and pertinent data about them are listed in **Table No. 5-1**, page 5-3, Stream Gage Data. **Plate Nos. 5-2 and 5-3** are Stage-Discharge Tables for North Branch Kokosing River at Fredericktown and Kokosing River at Mt. Vernon. **Plate Nos. 5-4 and 5-5** are revised Flow Frequency Curves for North Branch Kokosing River below the dam and at Mt. Vernon.

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. Data from NWS is also received by the water control system via network connection.

b. Reporting. The (DCP) platforms 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.

Water Control System. Stage data are converted to flow, and the values are used in the forecasting process. Frequency of reporting is dependent on the degree of urgency imposed by the weather and/or flooding conditions. The frequency ranges from daily (5 days per week) at about 0730 hours under Normal Condition to hourly under Major Flood Condition when the lake level approaches or threatens spillway elevation.

While primary dependence is on morning report information, Water Resources Engineering Branch personnel use National 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 Cleveland, Ohio 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.

Cell phones are the primary mode of emergency backup communication between the District Office and projects. Standard procedures require cell phones to be turned on at all times during working hours. During military emergency or national disaster, the Emergency Operations Manager may assign protected commercial telephone lines or special radio frequencies to Mohawk Lake.

The DCP-satellite system described above currently provides complete backup, through redundancy, of lake and outflow stage data collection and reporting. Precipitation data are similarly duplicated at the Mohawk Lake Project.

c. Maintenance. Routine daily first level maintenance for all mechanical streams gaging equipment in the Kokosing River Basin will be performed by the assigned project personnel. Advanced higher level maintenance, particularly for any electronic equipment malfunction, will be performed by a Corps trained technician. The headquarters for the advanced Corps trained instrument technician for the state of Ohio is located at Alum Creek Lake, Lewis Center, Ohio.

TABLE NO. 5-1

NORTH BRANCH OF KOKOSING BASIN  
STREAMGAGING - PERTINENT DATA

Stream And Station	Datum Elev. Ft/NGVD	Drainage Area Sq. Mi.	Date Established Year	Existing Station Facilities	Proposed Equipment	Method of Obtaining Data
North Branch Of Kokosing River at North Branch of disseminates Kokosing Lake Intake structure.	0	44.5	1972	Bubbler gage, strip chart, encoder and data collection  Platform (DCP)	- - -	DCP transmits via GOES satellite LRD downlink LRD WCS receives data downlink and hourly to LRD WCS.
Kokosing River* At Mt. Vernon computer  computer	984.16	202.0	1953	Strip chart for water stage recording, gage  Owned and operated by USGS.	Encoder DCP. Also tipping Bucket Precip.	USGS retrieves strip and inputs data into computer system. Corps for accesses data via Terminal.

\*Not in cooperative stream gaging program.

TABLE NO. 5-2

PRECIPITATION STATIONS IN AND NEAR  
NORTH BRANCH OF KOKOSING BASIN - PERTINENT DATA

RECORD FROM	STATION	EQUIPMENT	METHOD OF OBTAINING DATA	REPORTING CRITERIA
1972	North Branch of Kokosing Lake	Tipping Bucket gage, ADR and, DCP	DCP transmits via satellite to LRD downlink each 4 Hours. LRD WCS Receives from Downlink and disseminates hourly to LRD WCS.	Data collection interval 60 min.
1941	Fredericktown	Tipping Bucket gage, ADR and, DCP	DCP transmits via satellite to LRD downlink each 4 Hours. LRD WCS receives from downlink and disseminates hourly to LRD WCS.	Data collection interval 60 min.
1950	Centerburg	Tipping Bucket gage, ADR and,	DCP transmits via satellite to LRD downlink each 4 hours. LRD WCS receives from downlink and disseminates hourly to LRD WCS.	Data collection interval 60 min.

## 5-02. WATER QUALITY STATIONS

a. Facilities. A three station network was established at North Branch Lake for water-quality-sampling. All primary stations within the basin are described in **Table No. 5-3**, next page, and shown on **Plate No. 5-6**.

b. Reporting. There has been no program design for water quality sampling at North Branch of Kokosing Lake. The outlet works were not designed with water quality as one of its purposes; therefore, the discharge of water is not regulated for downstream quality. Samples collected within the watershed are for long-term applications.

c. Maintenance. Sediment and water samples are collected from North Branch Kokosing Lake about every 5 years. During emergency or under adverse conditions, water quality samples are collected on an as-needed basis. In all cases data are 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

Present sampling programs are oriented toward existing or potential effects and are structured to describe various factors that affect water quality.

Contact the Water Quality Section if any of the sampling equipment malfunctions.

<u>Station</u>	<u>Distance From the Dam</u>
NBN0001	0.8 Miles Below
NBN0002	0.1 Miles Above
NBN0003	4.6 Miles Above

Parameters measured, number of data collection stations, and frequency or number of collections, are determined by specific project conditions for that season. The water quality program design for North Branch Kokosing Lake was structured to describe the various factors affecting water quality on an as-needed basis. Data collected are used for applications such as identification of trends indicating problem conditions and reporting existing conditions. Basic studies consist one or more of the following 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 streams

(5) Other biological measurements such as plankton and seston

Standard physical/chemical tests and reasons for testing are presented in **Table No. 5-4**, next page.

TABLE NO. 5-4

Standard Physical/Chemical Tests

<u>Type of Test</u>	<u>Reason for Testing</u>
Calcium (Ca)	Major Cations - Ionic Balance, ratios and relationships
Magnesium (Mg)	
Sodium (Na)	
Potassium (K)	
Sulfate (SO <sub>4</sub> )	
Chloride (Cl)	Major Anions - Ionic Balance, ratios and relationships
Nitrogen (N)	Nutrient
Nitrate + Nitrite	
Ammonia	
Total Kjeldahl	
Total Organic Carbon (TOC)	Nutrient
Phosphorous (P)	Nutrient
Total Filterable	
Solids	Equivalent Ambient Values, Correlation with optical measurements
Total	
Suspended Dissolved	
Hardness	Evaluate buffer capacity and Alkalinity characteristics
Metals	Important for hypolimnetic and outflow evaluations during stratification
Iron (Fe)	
Manganese (Mn)	
Dissolved Oxygen	<u>in-situ</u> parameters used to evaluate conditions for project operation
Temperature	
pH	
Specific Conductance	

5-03. SEDIMENT STATIONS

a. Facilities. A summary of reservoir sediment deposition surveys made in the United States through 1960 was published by the U.S. Department of Agriculture in "Miscellaneous Publication No. 964." The information contained in this publication was used to estimate the amount of sedimentation, which might be expected to occur in North Branch Reservoir. Utilizing the data relative to the reservoirs in the Muskingum River and adjacent basins, it appeared that a siltation rate of 0.22 acre-feet per square mile of controlled drainage area per year would be a representative value for North Branch Reservoir. Accordingly, this value was used during the design stage of North Branch Reservoir for sedimentary planning.

b. Reporting. In order to monitor the rate of deposition of sediment in the lake, reconnaissance scope survey of selected ranges are conducted every five years unless an earlier survey is indicated by natural causes, such as a major flood or by increased sediment

producing activities in the basin. The first step for reporting and monitoring the sediment network was the certification and adoption of the sediment range network. Therefore, a letter report was submitted and approved in 1964, presenting a plan for the installation of sediment ranges at the North Branch of Kokosing River Lake. This 1964 letter report should be considered Design Memorandum (unnumbered), Sediment Range Layout, and this report on the revised sediment network was republished in 1978. This network consisted of eight categories "A" ranges upstream of the dam and two category "C" ranges downstream of the dam, which were numbered from one to ten. The original ground profiles along the original network of 10 sediment ranges at North Branch of Kokosing Lake were taken during the month of July 1966. The complete listing of the numbering and location of the sediment range network is listed in detail on **Table No. 5-5**, next page Sediment Range Location.

The re-survey of three sediment ranges downstream of the dam indicated no significant change in the channel change in this area. The original stream bottom profile for North Branch Reservoir and the upstream tributaries is shown on **Plate No. 4-2**.

c. Maintenance. Project personnel and the survey party members should regularly and periodically check the sediment range markers so the damaged monuments can be replaced and any obscuring undergrowth can be removed.

TABLE NO. 5-5

NORTH BRANCH OF KOKOSING LAKE  
SEDIMENT RANGE MONUMENT  
DESCRIPTIONS AND COORDINATES

<u>MONUMENT</u>	<u>ELEVATION</u>	<u>NORTHING</u>	<u>EASTING</u>	<u>BEARING</u>	<u>DISTANCE</u>
2 CL-1	1087.85	304343.20	1982736.93		
				S 25 28 26 W	288.87
2 CR-1	1092.13	304082.44	1982612.70		
1 CL-1	1101.38	304837.41	1980110.48		
				S 02 53 43 W	467.64
1 CR-1	1103.39	304360.39	1980086.36		
1 AL-1	1130.07	306389.38	1978492.83		
				S 26 01 42 W	1310.34
1 AR-1	1134.90	305212.18	1977917.80		
1.1AL-1	1146.22	307924.10	1978862.79		
				S 32 39 45 W	2683.29
1.1AR-1	1129.02	305664.99	1977414.56		
2 AL-1	1146.22	307924.10	1978862.79		
				S 65 07 55 W	3502.13
2 AR	1147.19	306451.12	1975684.90		
2.1 AL-1	1138.22	308236.00	1977537.00		
				S 103 14 22W	3104.71
2.1 AR-4	1144.67	308947.00	1974515.00		
3 AL	1136.69	310656.25	1975776.66		
				S 52 21 00 W	1444.35
3 AR-3	1147.32	309778.00	1974630.00		
4A-L	1147.12	313732.61	1975872.48		
				S 53 14 38 W	2145.64
4A-R	1154.04	312448.73	1974153.53		
5 AL-1	1141.46	315791.75	1973663.03		
				S 57 21 00 W	2173.05
5 AR	1159.78	314619.38	1971833.34		
6 AL-1	1150.68	317566.86	1972353.98		
				S 35 34 17 W	1727.61
6 AR-1	1151.54	316161.67	1971349.02		
7 AL	1143.46	308306.75	1975032.93		
				S 8 07 21 W	869.24
7 AR	1132.54	307446.35	1974910.10		
7.1 AL-1	1146.45	308539.12	1973773.84		
				S 12 21 00 E	1147.00
7.1 AR-1	1140.36	307418.66	1974019.17		
8 AL	1150.69	310743.67	1974138.00		
				S 17 24 21 W	1667.03
8 AR	1158.16	309153.20	1973639.40		

## 5-04. RECORDING HYDROLOGIC DATA

All data entered into the water control system are stored in a data base. Stream and precipitation data lists are stored in one hour increments. Project information is stored in one hour increments, and is also processed and stored on a one-day average value basis.

#### 5-05. COMMUNICATION NETWORK

Communication between North Branch Kokosing Lake or Mohawk Dam, the Muskingum Area Office, the District Office, etc., is carried primarily by telephone. The district cell phone network provides a backup when telephone service is interrupted. Data collection platforms (DCPs) are installed at stream gaging stations and precipitation stations for collection of hydrometeorological data. Many of the DCPs can be accessed by phone and data retrieved by the water control system, the microcomputer terminal at the project office or by listening to the synthesized voice. **Plate No. 5-8** graphically illustrates the radio communication network throughout the Huntington District; and **Plate No. 5-9** shows the Lines of Communication for the Walhonding River Basin.

#### 5-06. COMMUNICATION WITH PROJECTS

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 Walhonding River Basin are illustrated on **Plate No. 5-9**. District Cell Phones are used for secondary backup communication, while mobile radio, State Police, courier, etc. is utilized during an emergency when neither the telephone or district Cell Phones are operational. Inter-project communication is mostly by radio with some telephone for privacy. The 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 from projects to the Water Resources Engineering Branch, other voluminous or detailed information, pictorial material, confirmation of Special Directives, and any other formal communication between the Water Resources Engineering Branch and the projects. Occasional visits to the projects afford an opportunity for office and project personnel to discuss ideas, problems, new procedures, etc.

#### 5-07. PROJECT REPORTING INSTRUCTIONS

North Branch of Kokosing Lake is under the supervision of Mohawk Dam. Therefore, Mohawk Dam personnel will report any operational problems by telephone to the Water Resources Engineering Branch and the Technical Support Branch of Operations.

#### 5-08. WARNINGS

AS previously mentioned, North Branch of Kokosing Lake is basically self-regulating. However, if a sudden change in outflow release is planned, such as draining the lake, Mohawk Dam personnel are required to sound an alarm horn to warn the downstream recreation area users of the impending increase in outflow. The National Weather Service is responsible for issuing public flood watches in the Kokosing - Walhonding Basin. If the situation is grave enough, approaching emergency level, the Dam Safety Emergency Plan lists individuals to contact and warn of impending and sudden changes in dam operations.

## SECTION VI - HYDROLOGIC FORECASTS

### 6-01. GENERAL

Hydrologic forecasts of lake elevations and stream flows in North Branch of Kokosing Lake of the Kokosing River Basin are vitally important for Water Control Management as these forecast provide information, which enable the optimal regulation of the projects. The Water Control Section uses all available hydrologic and meteorologic data in forecasting efforts for the Kokosing - Walhonding River Basin. These forecast are conducted under low-flow, normal flow, and flood conditions and are primarily developed by the Corps of Engineers and the National Weather Service on a daily basis.

#### a. Corps of Engineers.

(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, 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.

The Huntington District provides NWS with all the precipitation, snow cover, observed stage information and three day pool and outflow forecasts received in the Water Resources Engineering Branch from reservoir reports and the three day pool and outflow forecasts for the Kokosing - Walhonding River Basin.

(2) Division Office. The Water Management Branch at the Great Lakes and Ohio River Division Office(LRD) 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. National Weather Service. The National Weather Service (NWS) has the official 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 basin forecast is computed using one-hour data and it normally takes one hour to complete the forecast of the Walhonding 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 No. 6-1** below.

The control stages and flows in forecasting the Kokosing River Basin are summarized in **Table No. 6-2**, below. The detailed drainage areas for the Kokosing River Basin are listed in **Table No. 6-3** on page 6-4. The Kokosing River basin configuration is shown on **Plate No. 6-2**.

TABLE NO. 6-1								
<u>NORTH BRANCH KOKOSING RIVER LAKE POOL ELEVATIONS AND STORAGES</u>								
Pool	Surface Elevation	NGVD	Area Acres	Backwater Stream Miles	Storage			
					Acre-feet Net	Gross	Inches Net	Gross runoff
Year-Round Storage:								
Minimum	1121		154	1.7	1,100	1,100	0.4	0.4
Flood Control Storage Year-Round*								
Winter	1146		1,140		13,800+	14,900	5.90	6.30
Summer	1146		1,140		13,800+	14,900	5.90	6.30
-----								
TOTAL	1146		1,140		13,800+	14,900	6.30	6.30
* At maximum pool elevation								
+ Between elevations 1121 and 1146								

b. Methods. A trained basin forecaster, assigned to the Muskingum - Walhonding River Basin, utilizes the Water Control System computer each day and couples the results from the model with knowledge and experience with the basin to produce the required daily forecasts. The computerized forecast is then made available for distribution to key interested parties and groups.

TABLE NO. 6-2		
<u>CONTROL STAGES AND TRAVEL TIMES</u>		
Station	Stream	Time of Travel Hours
North Branch	North Branch	
Lake Outflow Gage	Kokosing River	0.0
Mount Vernon	Kokosing River	3.0
Mohawk Dam	Walhonding River	15.0

A typical sequence of modeling 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. Stage data is converted to flow data using stage/flow rating tables. 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 up to the time of forecast. If precipitation is occurring at the time of forecast then future precipitation may be considered in the model execution by request of Division.

4. The small basin hydrograph forecasts 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.

In addition to the in-house forecast, and satellite network, radar images on the NWS screen at Jackson, Kentucky, and Wilmington, Ohio, provide valuable information for regulation and forecasting. The NWS also provides Ohio River and certain tributary stage forecasts that are used to answer telephone calls from the public and particularly from local river barging companies.

This 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 route the flood downstream and through North Branch of Kokosing Lake. With this computer program and practical experience the Water Control Section is able to produce a reliable forecast for the Kokosing River Basin.

**Table No. 6-3**, next page, is an example of the various small areas above and below North Branch of Kokosing Dam which small-area unit hydrographs are developed. **Plate No. 6-1** shows the basic forecast

areas for North Branch Lake, while **Plate No. 6-2** shows the North Branch Kokosing River network configuration.

The small area 3-hour adopted unit-hydrographs for the various Kokosing River - North Branch of Kokosing Lake forecast areas are shown on **Table No. 6-4**, page 6-5; and the Discharge Rating Tables for the key points in the Kokosing River Basin are shown on **Plate Nos. 5-2 and 5-3**.

TABLE NO. 6-3			
DRAINAGE AREAS OF KOKOSING RIVER AND PRINCIPAL TRIBUTARIES ABOVE DAM SITE			
<u>Stream</u>	<u>Location</u>	<u>Stream (miles)</u>	<u>Drainage Area (sq. mi.)</u>
Kokosing River	below mouth South Branch	47.7	36.5
Kokosing River	below Mile Run	45.7	75.1
Kokosing River	below mouth Granny Creek	43.2	99.7
<b>North Branch Kokosing River</b>	<b>at Damsite</b>	<b>39.4</b>	<b>45.4</b>
East Branch Kokosing River	at mouth	28.08	30.6
North Branch Kokosing River	below East Branch	28.1	81.8
North Branch Kokosing River	near Fredericktown	26.2	88.1
North Branch Kokosing River	at mouth	0.0	96.7
Kokosing River	at Mount Vernon	20.0	202.0
Jelloway Creek	at mouth	0.0	74.0
Kokosing River	at Millwood	3.4	473.0
Kokosing River	at mouth	0.0	485.0
Mohican River	at mouth	0.0	1,004.0
Walhonding River	at Walhonding	23.4	1,489.0
Walhonding River	at Mohawk Dam	17.5	1,505.0

Radar images on the NWS screen at Jackson, Kentucky, and Wilmington, Ohio, 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.

TABLE NO. 6-4

ADOPTED THREE-HOUR UNIT-HYDROGRAPHS FOR  
PRINCIPAL POINTS FOR NORTH BRANCH KOKOSING LAKE

Time Hours	Natural Unit Graph	Inflow Unit Graph	1-A Pool Head	#2 Around Pool	#3 Pool Area
3-hours	44.4	44.4	32.6	9.6	2.1
0	0	0	0	0	0
3	800	1020	1020	590	660
6	1840	3100	2300	1480	
9	2980	5700	3800	2080	
12	4080	5850	4860	1350	
15	4830	5000	3940	840	
18	4380	3800	2870	560	
21	3560	2900	2070	370	
24	2820	2200	1520	220	
27	2180	1750	1090	120	
30	1720	1350	890	70	
33	1370	1100	580	40	
36	1080	900	430	20	
39	850	700	320	10	
42	660	500	230		
45	500	370	170		
48	390	255	120		
51	300	200	80		
54	220	150	50		
57	160	130	30		
60	120	100	20		
63	70	80	10		
66	40	50			
69	20	30			
72	1	1			

6-03. CONSERVATION PURPOSE FORECASTS

a. Requirements. Conservation forecasts are executed in conjunction with the flood control forecast. They are executed on a daily basis for the next five days and on a weekly basis for the next 30 days. The main focus of the conservation forecast is to maintain seasonal pool at North Branch of Kokosing Lake in order to provide fish and wildlife habitat, recreation, and water supply.

b. Methods. The methods and procedures for nonflood streamflow projection are the same as mentioned previously for the flood forecasting except the concern of the modeler is the low-flow analysis. The repetitive process is utilized to operate the reservoir in order to provide downstream low-flow requirements and then to evaluate their impact on the lake pool.

#### 6-04. LONG RANGE FORECASTING

a. Requirements. Long-range forecasts assist the Huntington District and the Great Lakes and Ohio River Division in water control management in the Kokosing River Basin. Long-range forecast of a dry spring can allow earlier than normal filling during late winter or early spring to reach summer conservation pool levels in time for the beginning of the recreational season. If a drought is projected, conservation pool may be raised to store additional water for later release downstream. 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 forecast for the next 30-days utilizing the same method as used for flood forecast. This forecast assumes no future rain. Lower than normal precipitation forecast are produced by the National Weather Service.

#### 6-05. DROUGHT FORECASTS

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, West Virginia. 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 Kokosing 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 a weekly drought information bulletin for distribution to all concerned groups.

## SECTION VII - WATER CONTROL PLAN

### 7-01. GENERAL OBJECTIVES

In accordance with ER 1110-2-240 and ORDR 1110-2-27, the plan of water control management and regulation as discussed in the subsequent paragraphs reflects optimal consideration of each project purpose, namely flood control, lake and downstream recreation, fish and wildlife conservation, and water quality control. In developing the plan of regulation, the following general requirements were considered and evaluated in relation to the overall effective water control management plan for the project; the Kokosing, Walhonding, and Muskingum Rivers; and the Ohio River Basin.

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

b. Maximum retention or delay of flows that would add to flood crests on the Ohio River at Marietta, Ohio.

c. Maintenance of a minimum discharge to sustain downstream fisheries. Normally 1 cfs is considered to be adequate.

d. Maintenance of minimum pool at or near elevation 1121 feet NGVD to promote recreation, to support fishery, to provide minimum discharge as required, and for sediment reserve.

e. Delaying high discharge rates during flood periods.

f. Concern for the safety and well being of humans, fish and wildlife, man-made structures and streambanks downstream of the dam.

g. Concern for safety of humans and property at both damsite and recreation sites in the lake area.

### 7-02. MAJOR CONSTRAINTS

The various project purposes may at time strongly conflict, therefore the following priorities have been established; Flood control is the primary project purpose followed by low-flow, water quality fish and wildlife conservation, and recreation. The operational limitations are listed in **Table No. 7-1**, next page.

### 7-03. OVERALL WATER CONTROL PLAN

North Branch Kokosing Lake operates to reduce flooding on the Kokosing, Walhonding, Muskingum and Ohio Rivers; to provide consistent minimum releases, to improve downstream water quality, to provide habitat for fish and wildlife conservation, and to provide recreation within and below the lake.

TABLE NO. 7-1  
NORTH BRANCH KOKOSING LAKE  
PERTINENT DATA

Streambed	1098.0 NGVD	- zero	storage
Minimum Pool Level	1121.0 NGVD	1,043	acre-feet-Gross
Maximum Flood Control Pool	1146.0 NGVD	14,885	acre-feet-Gross
Spillway outflow	- 1148.0 NGVD	Outflow -	450 cfs
Maximum Surcharge Level	1166.0 NGVD	49,253	acre-feet-Gross
Spillway Maximum Flow	- 1166.0 NGVD	Outflow -	15,700 cfs
Top of Dam	1169.0 NGVD		
Minimum Continuous Outflow	-one cfs or stage of 4.75 feet on "O" gage		
Maximum low-flow system rate	- 430 cfs or 6.30 feet on "O" gage		

Historically, Flood damages occurring along the North Branch Kokosing River to Fredericktown primarily involve residences, utilities, highways, and commercial and extractive industries; with lesser amounts to agriculture. The most valuable agricultural products are from livestock, which sustained only slight damage from flooding. Greatest flood damages in the past have occurred to residences in the communities of Fredericktown, Mt. Vernon, and Millwood; as well as individual residences along the river and to small villages of less than 200 people. North Branch Lake drains 45 square miles and this constitutes 9.3 percent of the 485 square miles of the Kokosing River Basin. The method of self-regulation is used with a coordinated operation, to the fullest extent possible, with regulation of flood control projects on other tributaries of the Ohio River.

Most of the conflicting interests and purposes are resolved by practical planning and allocation of the lake storage volume into pools as listed on **Table No. 3-2**, page 3-10. The U.S. Public Health Service recommended a minimum year-round discharge from the lake of one cfs, and space was required for sediment storage and habitat for the expected large population of fisheries. Therefore, after proper study and authorization, a minimum pool at elevation 1121.0 feet above NGVD covering 154 acres was planned that would contain 1,043 acre feet of storage. This volume was allocated for recreation and water quality control and transferred from flood storage capacity. The difference in storage volume between maximum flood control elevation 1146.0 feet NGVD and the volume of the minimum pool 1121.0 feet NGVD is 13,840 acre feet of flood storage, equivalent to 5.83 inches runoff. This remaining storage is used for flood control

#### 7-04. STANDING INSTRUCTIONS TO DAMTENDER

The North Branch project is virtually self-regulating; however, the Mohawk Damtender (Resource Manager) and staff monitor and supervise the North Branch project in accordance with general instructions and Special Directives issued by the Water Control Section.

a. General Instructions. The general instructions apply at all times except when supersede by Special Directives that will be applicable for a specific operation or period of time. General instructions provide for routine self regulation, and collection and transmission of hydrologic and streamflow data in the event that all communications fail during a flood. These instructions are shown on exhibits, plates, curves, and schedules pertaining to their use.

b. Special Directives. Special Directives are issued normally

by telephone and confirmed by mail to record all substantive guidance concerning the project by the Water Control Section pertaining to water control activities not covered by the general instructions.

(1) Flood Control - Since the reservoir is self-regulating, no Special Directives are appropriate for this lake during a flood.

(2) Low-Flow - Adjustments of minimum flow in extremely dry weather to either avoid loss of pool, or to increase and guarantee downstream minimum flow is usually not an option at North branch Lake.

(3) Special regulations for:

- (a) Construction activities downstream affected by flow.
- (b) Stream clean-up activities.
- (c) Emergency - drowning or pollutant spill.
- (d) Special pool levels for fish spawning.
- (e) Stocking tailwaters - stable flow 24-48 hours.
- (f) Complete closure for inspection on an emergency or periodic basis.

(4) Change in general instructions.

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

(1) ER 11 10-2-1400, DAEN-CWE-Y 24 April 1970, Subject Reservoir Control Centers.

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

(3) ER 11 10-2-240, DAEN-CWE-Y, 24 April 1970, Subject: Reservoir Control Centers.

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

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

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

#### 7-05. FLOOD CONTROL

North Branch Reservoir was designed for flood protection along North Branch of Kokosing River to the head of the Mohawk Reservoir flood control pool. The discharge from the reservoir is regulated by an uncontrolled outlet weir, with small variation for pool level.

Damages occurring along North Branch of Kokosing to the Kokosing River, Kokosing River to the Muskingum River and along the Muskingum River to the Ohio River resulting from flooding are mainly to residences, utilities, highways and commercial and extractive industries, with lesser amounts to agriculture. The large majority of

dollar value of agricultural products are from livestock, which sustain only slight damage from flooding. In the past the largest storms of record have occurred during the winter months causing little or no harm to crops. Greatest flood damages in the past have occurred to residences in the communities of Fredericktown and Mt. Vernon; with flood damages also to individual residences along the river.

a. Requirements. Summer-type storms featuring intensive rainfall of relatively small areal extent can be destructive and result in local flooding despite the prevalence of conditions for water retention. Due to its proximity, Knox Lake, a State of Ohio water supply reservoir, works in conjunction with North Branch Reservoir in reducing flood stages in the Fredericktown area and below on the Kokosing River.

b. Normal Plan. North Branch of Kokosing Lake is the only authorized Corps of Engineers flood control reservoir in the Kokosing Basin, and is part of the flood control system of the entire Ohio River Basin. North Branch of Kokosing Lake serves as a retarding basin for Mohawk Dam; therefore, the North Branch outflow serves as input into Mohawk Reservoir. Coordination of regulation of Mohawk Lake 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 systems to meet potential flood threats in the basins and along the Ohio River below Huntington. Operation is also correlated with the operation of lakes on other Ohio River tributaries to the fullest extent possible while giving due consideration to local concerns and requirements.

Investigations of flood control storage requirements have been made with a view toward providing sufficient storage to effectively control not only recorded and historic floods, but also floods which might reasonably be expected to occur in the future. The results of these studies are presented in **Table No. 7-2**, next page.

Lake operation of North Branch Kokosing Lake is based on the following rules:

(1) All inflow, both routine and flood crest, will be passed over the unregulated weir. Weir flow fluctuates according to lake elevation above weir invert elevation 1121 feet NGVD. Exceptions may occur when the lake is below minimum weir elevation, or when the Water Control Section has directed special operations.

(2) The uncontrolled spillway will also pass accumulated flood storage above lake elevation 1146 feet NGVD, and the spillway flow will vary according to the pool level. This emptying is to prevent the possibility of a major flood occurring at a time when the lake is partly filled and overtopping the dam.

Storage allocations of approximately 13,842 acre-feet will limit outflow to acceptable levels for all floods of record and of known history in the North Branch Basin. This amount of storage will control and limit the outflow for the transferred storm of August 1935 to 980 cfs.

TABLE No. 7-2

REQUIRED STORAGE SPACE FOR VARIOUS FLOODS

<u>Flood or Storm</u>	Required storage to control flood acre feet	<u>Remarks</u>
Standard Project Flood	26,639	Summer-type Storm
Storm of January 1959	11,459	Flood of Record (max.)
August 1935	15,693	*Transferred Storm

\*Storm occurred over Cambridge, Ohio, and transposed to center over drainage area of project.

The area-capacity table for North Branch Kokosing Lake is shown in **Plate No. 7-1**, while the percent storage utilization table for North Branch of Kokosing Lake is shown as **Plate No. 7-2**. The reservoir would be filled near the end of the floods and outflow over the spillway would be released on the recession side of the hydrographs. In view of the preceding, the proposed storage allocations cited above are considered sufficient for flood control. **Plate No. 7-3** presents the spillway discharge rating-curve for North Branch of Kokosing Lake.

It is desirable to empty the lake of flood storage as quickly as possible, in view of the possibility of a major flood occurring at a time when the lake is partly filled. The time required to empty the flood control storage to pool elevation 1122.0 (elevation necessary to pass assumed inflow) is 15.8 days. The time required to evacuate 75 percent of the flood control storage has been computed to the 10.4 days on an emptying time curve for the project with the inflow constant at 90 cfs (2.02 cfs per square mile of drainage area) during the evacuation period. Because North Branch of Kokosing Lake is self-regulated, the drawdown times mentioned above cannot be changed. The outlet works discharge rating curve for North Branch Lake is shown on **Plate No. 7-4** and the emergency drawdown schedule is presented as **Plate No. 7-5**.

c. Emergency Plan. If a storm of floods producing magnitude occurs and communications fail, every effort, even to the extent of hiring a messenger, shall be made by the Mohawk Dam tender to contact the Area Office, or if the area office can not be contacted, the District Office, in order that the programs at all reservoirs may be coordinated. During prolonged dry seasons or droughts, a daily (Monday through Friday) inspection of the flow from the outlet works shall be made. If outflow ceases, contact the Muskingum Area Office, who will contact the Huntington District Water Resources Engineering Branch. The Water Control Section will issue special instructions for maintaining a small outflow rate. At North Branch Kokosing, a small 24-inch square sluice gate at sill elevation 1108.0 feet NGVD is available for emptying the reservoir. The dewatering gate discharge rating curve is presented as **Plate No. 7-6**.

Occasionally, periodic tunnel inspection will be required at the North Branch Project. At that time the Water Control Section will issue instructions to draw the pool down to a safe level to permit the tunnel inspection. The operation schedule to be issued will depend on the hydrologic conditions and the time required to perform the inspection. The operation will be performed by the Damtender of the Mohawk Project.

7-06. RECREATION

No special releases have ever been made at North Branch Kokosing Lake for recreation; and the lake operation has never been modified for any fishing tournaments. North Branch Kokosing Lake is self-regulating, therefore, the lake normally hovers near weir elevation 1121 feet NGVD.

The observed recreation activities at North Branch Kokosing Lake have been hunting, boating swimming picnicking sightseeing, camping, and hunting. Fishing occurs all year with increased use with lake fill in the spring. All year boating becomes more significant with spring and the camp grounds open on May 1st, **Table No. 7-3**, below, lists the lake visits for these recreation uses for the calendar year 1998.

TABLE NO. 7-3		
PUBLIC USE OF RECREATION FACILITIES		
Facility	Activity	Visitor Participation
Boat Launch	Boating	96,500
	Fishing	69,300
overlooks, Information Center, Trails	Sightseeing	97,600
Beach	Swimming	63,800
Day Use Areas	Picnicking	36,800
	Fishing	25,600
Campgrounds	Camping	42,500
Managed Woodlands	Hunting	4,100
TOTAL		436,200

Unfortunately, summer pool elevations below the normal minimum elevation may occur during dry years due to tiny inflow and evaporation; and periodic rises above the minimum pool occur regularly due to seasonal flooding. Mohawk project personnel evacuate recreation areas when necessary and indicate increased discharge to down stream recreation users.

Rapid fluctuation in pool level can result in danger from newly inundated or exposed obstacles and potential snags near shore lines and cove areas. This may cause difficulty in launching and retrieving boats, and render camping and day use areas useless due to flooding of access roads, sanitary facilities, or grounds. For all recreation purposes it is desirable to keep the pool level as close to year-round pool elevation 1121 feet NGVD as possible.

## 7-07 WATER QUALITY

a. Corps Role. Responsibility for quality of impounded waters was assigned to the Corps of Engineers by Public Law 87-88, enacted by Congress on 20 July 1961. The Chief of Engineers delegated the responsibility to the various divisions as an ongoing function. Guidelines for water quality activities associated with water control management were established and described in ER 1130-2-415.

b. Water Quality Plan. Water Quality control at North Branch Kokosing Lake has one major aspect: flow augmentation for downstream needs.

(1) Flow Augmentation: Low-Flow augmentation is designed to provide pollution abatement at Fredericktown (see section 7-09 Water Supply for minimum flow requirements). The Federal Water Pollution Control Administration (currently the EPA) determined that a minimum flow of one cfs was the necessary flow at Fredericktown at all times.

(2) Temperature and Water Quality Sampling. The Ohio Department of Natural Resources, division of Fish and Game, has worked with the Corps to develop optimum outflow temperatures and desirable ranges of variation at North Branch Kokosing Lake.

## 7-08. FISH AND WILDLIFE CONSERVATION

In accordance with State Code, in 1983 the Ohio Department of Natural Resources (ODNR) accepted responsibility for fish and wildlife conservation at North Branch Lake. The ODNR shares the Corps conservation goal of the long term well-being of the populations of water and land species of plant and animal life common to the area and the maximum sustained enjoyment of these populations by the public.

The ODNR meets the conservation requirements in the lake and downstream by: stocking of the lake and downstream; imposing size limits as necessary; monitoring populations, reproductive success, and size distribution within species; providing a conservation officer at the lake to conduct creel surveys and fisherman interviews; and administering licensing regulations for sport fishermen.

The fisheries and wildlife are negatively impacted during spawning and reproduction by an unstable pool or by loss of pool. North Branch Kokosing Dam is self-regulated as described in 7-05b and 7-06, which fosters a stable pool during traditionally dry months. The self-regulating dam assists the ODNR and prevents negative impacts by providing a stable pool and outflow for 24-48 hours after lake and downstream stocking.

## 7-09. WATER SUPPLY

In accordance with National Environmental policies North Branch, Kokosing Lake is required to provide water to ensure flowing, oxygenated water for downstream fisheries and wildlife and water supply for the Fredericktown Water Company. Therefore, a guaranteed continuous minimum flow is a project requirement of North Branch Kokosing Lake. The discharge rate for aquatic environment and water supply maintenance of ONE cfs was selected after a study to determine the maximum rate that does not exceed the maximum acceptable drawdown in the driest year. This discharge is to be maintained at all times, even during closure for flood control.

- 7-10. HYDROELECTRIC POWER - N.A.
- 7-11. NAVIGATION - N.A.
- 7-12. DROUGHT CONTINGENCY PLAN - See ANNEX II
- 7-13. FLOOD EMERGENCY ACTION PLANS

Although the Huntington District has developed standard responses to floods in district, the District does not yet have a specific Flood Emergency Action Plan for North Branch Lake. However, inundation maps have been prepared and provided to the district Emergency Management Branch for use in developing an Emergency Plan for North Branch Lake and for contact with State and local authorities. The District responses are basically dependant on whether or not the integrity of the dam has been threatened. Also, the North Branch Lake inundation maps have been provided to State and local authorities for their use in developing evacuation plans for the affected areas.

a. Inundation Mapping. Inundation Maps have been prepared for North Branch Lake for the upstream and downstream spillway design flood with and without Dam failure. The maps were prepared in accordance with ER 1130-2-419 and show the time associated with the hypothetical flood wave. The inundation maps are to be stored in the Dam Safety Emergency Action Plan copies of which are located in OR-E-EC-GD, North Branch Kokosing Lake, and the individual maps are stored in EC-W.

b. Floods Without Dam Integrity Problems. In the course of a flood, which does not threaten the integrity of the dam, the lake operations will be governed as described in 7-05. The Emergency Operations Center(EOC) will respond, based on the Commanders initiative, to the situation as described in the Policies contained in Natural Disaster Procedures, ER 500-1-1, 11 March 1991, which can be found in the EOC. The EOC may ask for periodic updates of the river situation from the Water Control Section or this briefing may be carried out during the briefing for the Commander.

c. Floods With Dam Integrity Problems. When a condition occurs which requires the project to operate to protect the integrity of the Dam and has the potential to be or is a significant hazard to life and property, the observing personnel will elevate the awareness of the situation to the appropriate individuals and take the actions as described in 7-05-a-8 or in Annex B 1-07. Project personnel shall use the North Branch Lake Dam Safety Emergency Action Plan to determine what events will initiate this action and which individuals to contact.

The Water Control Section will be kept informed of the situation as a result of the reporting requirements. Water Control Personnel will contact the Dam Safety officer when the lake rise indicates that alert pool will be achieved or exceeded and will keep the National Weather Service informed of any abnormal operations of the project. The Dam safety Officer is responsible for convening the Dam Safety Committee who is responsible for convening the Crisis Management Team. The District Engineer, the commanding Officer, the head of the Crisis Management Team, will open the EOC if he determines it is necessary.

## 7-14. OTHER PLANS

Emergency Drawdown procedures are graphically illustrated on **Plate No. 7-5**. The directory of key Emergency Personnel is located on page iv, before the Table of Contents of this manual. North Branch Lake does not require an operational change to combat mosquitoes, routine debris, ice jams, or the lowering of the local ground water table. If necessary these and other items are addressed in paragraph 7-15.

## 7-15. DEVIATION FROM NORMAL REGULATION

The Huntington District Engineer is occasionally requested to deviate from the normal regulation of North Branch Lake. Approval and notification procedures are required when deviations from the normal water control plan are necessary. Prior approval for major deviations is required from the Division Engineer except as noted below. Deviation requests normally fall into the following categories.

### a. Definitions

Major Deviation: Changes the normal operation of the project for a period of time greater than 5 days and elevation changes greater than two feet. A Major Deviation requires approval of both the Branch and Division levels.

Minor Deviation: A change in the normal operation that is less than the Major Deviation criteria. A Minor Deviation is approved at the Branch level on the authority of the division.

### b. Types

1. Emergencies. The most common emergency that can be expected to occur at a project is a downstream drowning; decreased flow may be needed while searching for the victim or increased flow may be needed to dislodge the body. Other common accidents occurring at the project are failure of the operation facilities, chemical spills, treatment plan 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. Districts must inform their division office as soon as practicable. Prepare written confirmation of the deviation and description of the cause and furnish it to the division water control manager. Divisions may develop forms to facilitate the reporting of emergency deviations.

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. Requests for changes in release rates generally involve time periods ranging from a few hours to a few days. The following list contains most of the types of special regulations commonly requested: Legitimate interests, such as family to travel to and from home and burial processions on a road which traverses the Kokosing River streambed, may require reduction of flow for safe crossing. Construction work, major or minor, including pipeline changes or repair, boat dock work, or testing of a finished facility may have various and changing flow requirements.

Each request is evaluated on its own merits. Consideration must be given to upstream watershed conditions, potential flood threat, condition of the lake, and alternative measures that can be taken. In the interest of maintaining good public relations, requests generally are complied with, providing there are no foreseen adverse effects on the overall regulation of the project (or projects) for the authorized purposes. These minor deviations are appropriately coordinated by telephone with the Water Control Section which may, at the time of coordination, request written confirmation showing the conditions and deviation on ORD Form 1018-R revised. Written confirmation is then furnished to the Division Water Control Manager.

3. Major Deviations. Prior approval for major deviations is required from the Division Engineer as noted below. Either increase or decrease in outflow may be requested by other governmental agencies, including State and local, or by higher authority within the Corps of Engineers.

Each condition should be analyzed on its merits. Required data on flood potential, lake and watershed conditions, possible alternative measures, benefits to be expected and probable effects on other authorized and useful purposes, as mentioned above, are presented by letter, telephone or Facsimile to the Great Lakes and Ohio River Division LRD office, along with recommendations for review and approval. Except in case of emergency, confirmation of a major deviation is necessary from the Great Lakes and Ohio River Water Control Center before the Water Control Section may grant a request. In order for the Water Resources Engineering Branch and Division Office to gage the advisability of compliance with a request the Water Control Section must investigate upstream watershed conditions, potential flood threat, impact on other project purposes, conditions of the lake, and possible alternatives. The LRD decision and approval and/or rejection is then returned in like manner to the project. The following list contains most of the types of major deviations commonly requested.

(1) Anticipated drought periods may require maintenance of additional storage in the lake for later release into the river system for downstream benefit.

(2) Special pool level for fishery enhancement. Measures, such as holding a specific higher pool level during and after the spawning period to foster recruitment, may be requested by State Fisheries Biologists to benefit populations of certain species or the entire fishery.

(3) All requests for special releases from Corps lakes for recreation such as canoeing, whitewater, or, other special releases will be referred to the Huntington District, Water Control Section of the Engineering-Construction Division for evaluation.

(4) Slow drawdown from rises during annually designated 2-week to 3-week period in May in behalf of bass spawn. Special lake drawdown in fall for species adjustment.

#### 7-16. RATE OF RELEASE CHANGE

The North Branch Lake outflow is self-regulated, but, it is usually in such a manner that the rate of release does not fall below 1 cfs and the resulting stream level does not change more than 0.5 feet per hour.

#### 7-17. 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 horn. At North Branch Lake, the horn is installed approximately 1,000 feet below the dam and is audible within a one mile radius. The horn is activated by an assigned project worker from Mohawk Dam. Important public service messages of early significance concerning regulation of the lake are handled by the District Public Affairs Office and disseminated via radio and/or television. Warnings of any unusual releases will be transmitted downstream by project personnel in person and by telephone.

Notification of the public is enacted by the project, the Water Control Section, the National Weather Service, and by the district Public Affairs Office. These units utilize various types of mass media, telephone, radio, personal visitation, and the Weather Service dissemination system, depending on the type, urgency and target of the information. Information on planned additions to or changes in lake regulation such as for recreation or fishery enhancement are disseminated by the Public Affairs Office from detailed statements by the Water Control Section. Information of interest primarily to anglers, such as water condition of the lake and outflow, are disseminated by the project via an automatic telephone answering machine tape that is updated as necessary by project personnel. Daily reservoir and rainfall data are transmitted to the Weather Service via radio and/or telephone lines with the aid of computers and other data-handling equipment. This information appears along with other weather and stage information provided by the Weather Service to mass media and, county, State, and Federal agencies.

SECTION VIII - RESULTS OF THE WATER CONTROL PLAN

8-01. GENERAL

The effects of regulation for the authorized purposes of flood control, recreation, and fish and wildlife conservation are: a sharp reduction of flood damages along both the Kokosing, Walhonding, and Muskingum Rivers, and the Ohio River; an increase in the minimum observable flow below the project; and the development of the tourism industry and general recreation around North Branch Kokosing Lake.

8-02. FLOOD CONTROL

a. Spillway Design Flood.

The spillway design flood is the basis for determination of the spillway capacity required to provide safety of the dam during the most critical flood runoff over the basin. Estimates of this storm and flood were made in accordance with EM 1110-2-1405 and modified using procedures outlined in a letter from OCE to NED, 10 April 1964, subject, "Hop Brook Dam and Reservoir, Hop Brook, Housatonic River Basin, Connecticut, Design Memorandum No. 1 - Hydrology." Rainfall accounts obtained from Hydro-metrological Report No. 33, by the then United States Weather Bureau in April 1956 (now called the National Weather Service), were reduced by 15.5 percent and applied to the appropriate unit hydrographs to obtain the spillway design storm and flood for the reservoir. Graphical operation of this theoretical flood is shown on **Plate No. 8-1**.

Investigations of winter-type and summer-type probable storms and floods indicate that the summer-type storm is the most critical for drainage area above the dam site. Comparative data are given in **Table No. 8-1**, shown below, using data for the month of March for the winter type-storm and August for the summer-type storm.

TABLE NO. 8-1  
NORTH BRANCH KOKOSING RIVER  
WINTER AND SUMMER TYPE MAXIMUM  
PROBABLE STORMS AND FLOODS  
COMPARATIVE DATA

	Winter-type Storm	Summer-type Storm
Rainfall inches	11.06	25.35
Losses, inches	0.96	2.80
Rainfall excess, inches	10.10	22.55
Crest Natural flow, cfs	15,100	47,600
Crest Inflow, cfs	15,800	50,000
Hop-Brook Reduction-Inflow, cfs	5,615	19,000

The month of August was selected as the most critical storm-producing period. The average rainfall values for each 6-hour period of the 48

hour storm are shown in **Table No. 8-2**, below. The 6-hour values within each 24-hour period are arranged in the most critical order of occurrence for the basin.

Inflow hydrographs were also prepared representing greater concentrations of runoff but having the same volume as the provisional spillway design flood inflow hydrograph.

TABLE NO. 8-2			
NORTH BRANCH OF KOKOSING RIVER			
PROBABLE MAXIMUM PRECIPITATION AND RUNOFF			
Period No.	Rain Inches	Losses Inches	Excess Inches
1	0.42	0.42	0.00
2	0.46	0.46	0.00
3	0.55	0.42	0.13
4	0.59	0.30	0.29
5	0.85	0.30	0.55
6	3.45	0.30	3.15
7	17.64	0.30	17.34
8	1.39	0.30	1.09
Totals	25.35	2.80	22.55
R.O. Factor - 89.0%			

At the onset of the storm it was assumed that the flood storage between seasonal pool elevation and spillway crest elevation in the lake would be half utilized. This means that the pool would be at elevation 1138.5 feet NGVD, which is probably the worst condition of the pool that could happen in August. Initially, the inflow caused the pool level to rise until it approached elevation 1141 feet NGVD at hour 36. At this point, the pool would continue rising until the lake crested at elevation 1163.8 feet NGVD for hour 54 and then gradually receded to elevation 1121.0 feet NGVD.

**Plate No. 8-1** shows the basic operational hydrographs for North Branch Lake for runoff from the spillway design storm that was selected for the design of North Branch Reservoir. The SDF hydrograph has a peak natural flow of 47,600 cfs and a peak inflow of 50,000 cfs. The maximum pool level that would have been reached during this flood would be elevation 1163.8 feet NGVD which represents a rainfall excess of 22.55 inches and 36,000 acre-feet of storage being utilized above the flood control pool elevation of 1138 feet NGVD. The maximum outflow would have been 13,500 cfs at about hour 54.

When the Dam Safety Assurance program was initiated for the Huntington District in 1982 North Branch Kokosing spillway was informally evaluated by using the SDF reviewed in the previous paragraph using probable maximum rainfall shown in Hydrometeorological Report No. 33. However, the initial flood control pool was raised from half-pool, or elevation 1138.5 feet NGVD to elevation 1146.0 feet NGVD. The operation of the reservoir is similar but the pool reached a maximum elevation of 1166.5 feet NGVD at hour 58 with a maximum combined spillway and sluice discharge of 17,000 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. Additional criteria from the Ohio River and Great Lakes Division requires a preliminary rainfall equal to 37 percent of the basic storm. Probable Maximum Precipitation (PMP) is again 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. Because the North Branch Kokosing Lake was one of the more recently completed projects it has not been fully tested with a SDF based on Hydrometeorological Report 51 and 52 with the ORD-GL preliminary storm. However, it is currently on a list of new dams to be tested for hydrologic deficiency using the current Hydrometeorological 51 and 52 under the Dam Safety Assurance Program. When the dam safety assurance study for North Branch Lake based on both HMR-33 and HMR 51-52 is completed the detailed results and the operation hydrographs will be distributed to all concerned.

b. Standard Project Flood. The standard project flood constitutes a standard for design of structures that will provide a high degree of protection as determined by flood potentialities of the drainage area involved without regard to economic or physical limitations. This theoretical flood would result from a storm probably in July or August designed to equal the worst combination of meteorologic and hydrologic conditions considered reasonably characteristic of the area. It was determined from generalized rainfall criteria and procedures outlined in EM 1110-2-1411. The computerized operation of North Branch Kokosing Lake for the flood is shown in Plate No. 8-2. A review of summer-type storms indicated that a minimum infiltration rate of 0.05 inch per hour might be experienced and this value was adopted in determining the rainfall excess.

Based on studies of streamflow records for the Kokosing River, a base flow of 1 cfs per square mile was adopted. At the start of the flood the reservoir would have been regulated to maintain the minimum pool elevation 1121.0 feet NGVD with the outflow rate reaching channel capacity of 680 cfs at hour 68. The peak modified outflow would be of 5200 cfs would be reached by about hour 80 of the flood. The graphical operation of North Branch Kokosing Lake for the Standard Project Flood is shown on **Plate No. 8-2.**

The total rainfall for this storm would be about 15.46 inches with about 12.35 inches of rainfall excess. Maximum pool contents would be 22,210 acre-feet which includes 21,200 acre-feet of surcharge storage above elevation 1121 feet NGVD. The maximum pool elevation, 1152.27 feet NGVD would occur at hour 80 with maximum regulated discharge of 5200 cfs which is much less than the natural peak discharge of 30,100 cfs for a reduction due to the project of 24,900 cfs. Pertinent data for the Standard Project Flood is listed in **Table No. 8-3**, next page.

TABLE NO. 8-3

## NORTH BRANCH OF KOKOSING RIVER

## STANDARD PROJECT STORM AND FLOOD SUMMARY

Drainage Area	(square miles)	44.5
Rainfall	(inches)	15.46
Losses	(inches)	3.11
Rainfall Excess	(inches)	12.35
Natural Peak Discharge	(cfs)	30,100
Natural Peak Discharge	(cfs/sq. mi.)	576
Regulated Peak Discharge	(cfs)	5,200
Discharge Reduction	(cfs)	24,900
Flood Comparison:		
Max. flood of record (Jan 1959) in % of SPF		37.0%
Summer-type design flood in % of SPF		183.0%

c. Other Floods

(1) General. The historical floods which were selected for illustration of the water control plan were the floods of March 1913, June 1937, April 1948, and January 1959. **Table No. 8-4**, page 8-5, shows the effects of North Branch of Kokosing Lake regulation on the historic Kokosing River Basin floods.

(2) Storm and flood of March 1913. The flood of March 1913 in the Ohio Valley resulted from unprecedented, widespread rains over Ohio and Indiana falling at a time when conditions were favorable for runoff. During the five-day period, 23-27 March, the maximum rainfall recorded in the Muskingum Basin was 9.65 inches at Bangorville. This storm resulted in the greatest flood of record on the Muskingum River and most of its tributaries.

The crest stage at the U.S.G.S. gage at Millwood was estimated to be 29.0 feet. During the five-day period, 23-27 March, the Kokosing River Basin above Mt. Vernon received an average rainfall depth of 9.60 inches and the runoff approximated 8.05 inches. The Kokosing River rose to the unprecedented heights and was in flood stage at all points. At Mt. Vernon, 30 percent of the town was inundated. The crest stage and flow at the Mt. Vernon gage were estimated to be 17.3 feet and 27,600 cfs, respectively. Approximately 50 residences were flooded and 3 persons lost their lives. Highway and railroad washouts were general and many bridges were destroyed. This was the most disastrous flood within Kokosing River until January 1959.

None of the present day Muskingum system projects including East Branch-Knox Lake and North Branch Dam had been built at the time of this flood, however, the flood has been reconstituted for North Branch from old records. The flood reductions for the synthetic operation of North Branch Lake for the March 1913 flood are shown on **Table No. 8-4**, next page. If the same storm would reoccur today under similar conditions with the dam in place, the peak crest at Fredericktown would be reduced by about 4.02 feet. Lesser peak reductions would occur further downstream at Mt. Vernon and Millwood as shown on **Table No. 8-4**, next page. When the pool returned to near the year-round elevation level of 1121.0 feet NGVD North Branch Lake would revert to normal self regulation of releasing additional routine inflow.

TABLE NO. 8-4  
REDUCTIONS EFFECTED DURING SELECTED FLOODS  
OF NORTH BRANCH AND KOKOSING RIVER

Flood	Natural Stage (feet)	Modified Stage Due to Knox Lake, (feet)	Modified Stage Knox Lake + N. Branch Reservoir, (feet)	North Branch Reservoir Reduction (feet)
March 1913				
Fredericktown	1069.90	1069.24	1065.22	4.02
Mt. Vernon	17.37	17.14	16.15	0.99
Millwood	29.00	28.65	26.75	1.90
June 1937				
Fredericktown	1067.39	1066.19	1062.44	3.75
Mt. Vernon	15.59	15.22	14.08	1.14
Millwood	21.43	21.10	20.07	1.03
April 1948				
Fredericktown	1064.97	1063.80	1060.60	3.20
Mt. Vernon	13.12	12.50	11.16	1.34
Millwood	17.54	17.05	16.40	0.65
January 1959				
Fredericktown	1071.62	1070.50	1065.37	5.13
Mt. Vernon	18.40	18.19	17.46	0.73
Millwood	34.70	34.00	32.30	1.70

(3) Storm and flood of June 1937. Heavy general rains in the Muskingum, Scioto, and Sandusky River Basins, on 20-21 June, brought those streams and most of the tributaries above flood stage. In less than 24 hours, the Muskingum Basin received an average depth of 2.83 inches of rainfall, while the Mt. Vernon station recorded approximately 3.54 inches during the storm period. The rainfall averaged 3.31 inches of the Kokosing Basin above Mt. Vernon and resulted in approximately 2.61 inches of runoff. At Millwood the Kokosing River reached a stage of 18.10 feet, or 21.43 feet at present location. The estimated crest stage and discharge on the Kokosing River at Mt. Vernon was 15.59 feet and 15,750 cfs, respectively.

The original Muskingum Reservoir system was only partially completed for this flood, while East Branch-Knox Lake and North Branch Dam had not yet been considered. However, the North Branch flood has been reconstituted from old records. The flood reductions for the synthetic operation of North Branch Lake for the June 1937 flood are shown on **Table No. 8-4**, above. If the same storm would reoccur today under similar conditions with the dam in place, the peak crest at Fredericktown would be reduced by about 3.75 feet. Lesser peak reductions would occur further downstream at Mt. Vernon and Millwood as shown below on **Table No. 8-4**, above. When the North Branch pool returned to near the year-round elevation level of 1121.0 feet NGVD the lake would revert to normal self regulation of releasing additional routine inflow.

(4) Storm and flood of April 1948. The flood of April 1948 takes its place among the great floods on the Ohio, Muskingum and

Scioto Rivers. During the period 11-14 April, rainfall of unusual amounts was registered throughout the Muskingum Basin. Precipitation varied from 4.80 inches at Lowell, to 1.71 inches at Medina. The maximum 24-hour amount, 2.97 inches, was recorded at Millersburg.

Fredericktown in the Kokosing Basin, received 3.98 inches, 2.02 inches of which fell in 24 hours. Rainfall averaged 3.75 inches over the Kokosing Basin above Mt. Vernon and resulted in 3.20 inches of runoff. The Kokosing River went out of its banks and flooding of lowland area was widespread. The Kokosing River crested at 17.55 feet near Millwood and registered its sixth highest flood of record. The estimated crest stage and discharge on the Kokosing River at Mt. Vernon is 14.9 feet and 10,400 cfs, respectively.

The original Muskingum system was completed for this flood, but East Branch-Knox Lake and North Branch Dam had not yet been considered. However, the North Branch flood has been reconstituted from old records. The flood reductions for the synthetic operation of North Branch Lake for the April 1948 flood are shown on **Table No. 8-4**, previous page. If the same storm would reoccur today under similar conditions with the dam in place, the peak crest at Fredericktown would be reduced by about 3.20 feet. Lesser peak reductions would occur further downstream at Mt. Vernon and Millwood as shown on **Table No. 8-4**, previous page. When the pool returned to near the year-round elevation level of 1121.0 feet NGVD North Branch Lake would revert to normal self regulation of releasing additional routine inflow.

(5) Storm and flood of January 1959. The greatest flood of record on the Kokosing River occurred during the period 21-24 January 1959. The storm period began on 14 January when approximately one inch of precipitation fell as snow. Sub-zero temperatures held this moisture on the ground until the 19th of January when, during a three-day period, approximately 5.0 inches of rain fell over the basin. Snow, changing to rain, fell on 19 January. The rain increased in intensity on 20 January with nearly 4.0 inches falling on the 21st. The maximum stage of record, 18.19 feet, was reached on Kokosing River at Mt. Vernon on 21 January. This stage has a corresponding flow of 38,000 cfs. Runoff amounted to approximately 5.1 inches from the drainage area above North Branch dam site.

The original Muskingum system was completed for this flood, but East Branch-Knox Lake and North Branch Dam had not yet been constructed. However, the flood on North Branch has been reconstituted from old records. The flood reductions for the synthetic operation of North Branch Lake for the January 1959 flood are shown on **Table No. 8-4**, previous page. If the same storm would reoccur today under similar conditions with the dam in place, the peak crest at Fredericktown would be reduced by about 5.13 feet. Lesser peak reductions would occur further downstream at Mt. Vernon and Millwood as shown on **Table No. 8-4**, previous page. When the pool returned to near the year-round elevation level of 1121.0 feet NGVD North Branch Lake would revert to normal self regulation of releasing additional routine inflow.

(6) Flood of July 1969. The floods of 4-8 July 1969 in north-central Ohio were caused by the most intense and widespread summer storm recorded in Ohio. On the evening of 4 July 1969, a line of thunderstorms moved into Ohio from Lake Erie, accompanied by heavy rains and strong winds. Following the first storms, an area of great atmospheric instability remained stationary for nearly 8 hours, and numerous storms with torrential rains moved southeastward through the area, which was located approximately 30 miles either side of a line

from Toledo to Dennison. Within a period of 24 hours, an area of about 6,000 square miles in north-central Ohio received in excess of 4 inches of rainfall, and some small areas received as much as 14 inches of rainfall. The area north of Fredericktown had the of heaviest precipitation, as Mohicanville Dam and Ashland received 9.67 inches and 8.99 inches of rainfall, respectively. Rainfall amounts of 10-14 inches were recorded near Wooster, just east of the basin.

The original Muskingum system was fully operational for this flood. East Branch-Knox Lake was built, but North Branch Dam had not yet been completed. However, the flood on North Branch has been reconstituted from old records. The flood reductions for the synthetic operation of North Branch Lake for the July 1969 flood have been computed by the Water Resources Engineering Branch. If the same storm would reoccur today under similar conditions with the dam in place, the peak crest at Fredericktown would be reduced by several feet. Lesser peak reductions would occur further downstream at Mt. Vernon and Millwood. When the pool returned to near the year-round elevation level of 1121.0 feet NGVD North Branch Lake would revert to normal self regulation of releasing additional routine inflow.

(7) Flood of February 1979. Sub-freezing temperatures and a major snow cover persisted over the Muskingum River Basin during most of January and February 1979. Rising temperatures and rainfall during 21-24 February created thawing conditions and rapid snowmelt, producing flooding conditions in the Muskingum River Basin. At North Branch Lake, approximately 0.5 inch of rainfall combined with snowmelt from approximately 8 inches of snowfall on the basin to produce a major inflow into North Branch Lake. This flooding event was followed by a significant snowfall event of approximately 4-5 inches on 25-26 February. As temperatures rose in early March, this snowfall, which had a water equivalent of about 1.4 inches, melted and combined with minor rainfalls in early March to produce a secondary peak inflow into North Branch Lake.

All 16 projects of the Muskingum System, were operational for this flood. Both East Branch-Knox Lake and North Branch Dam were in operation for this flood. The Water Control Section has computed an inflow crest for North Branch Lake for this flood to be about 4,900 cfs and a pool crest of 1127.83 feet NGVD. The peak crest at Fredericktown was reduced by several feet, and lesser peak reductions occurred further downstream at Mt. Vernon and Millwood. When the pool returned to near the year-round elevation level of 1121.0 feet NGVD North Branch Lake would revert to normal self regulation of releasing additional routine inflow.

(8) Flood of February 1985. The flood of February 1985 was the result of rapid snowmelt combined with some minor rainfalls. The Muskingum River Basin experienced above-normal snowfalls and below normal temperatures during January, which created a significant snow cover over most of the basin from the second week of January into February. A large snowstorm on 12-13 February produced as much as 12 to 15 inches of snow in the southern half of the Muskingum River Basin. Mansfield and Ashland each received about 11 inches of snow from the storm, which increased snow depths to 18 inches at Ashland and 13 inches at Mansfield. The water equivalent of the snow pack at Mansfield by this time was 2.7 inches. A general thaw began over Ohio about 18 February, with temperatures rising into the upper 40's by 21 February and into the 60's on 23 and 24 February. Melting snow and ice combined with rainfalls of about 0.3 - 0.5 inch over the North

Branch Lake during the period 22-25 February, and the resulting runoff produced flooding in the basin along with some ice jamming.

All 16 Muskingum Basin projects plus Knox Lake were operational for this flood. The Water Control Section has computed the inflow for North Branch Lake for this flood to be about 1,900 cfs with a pool crest of 1133.03 feet NGVD. The peak crest at Fredericktown was reduced by several feet, and lesser peak reductions occurred further downstream at Mt. Vernon and Millwood. When the pool returned to near the year-round elevation level of 1121.0 feet NGVD North Branch Lake would revert to normal self regulation of releasing additional routine inflow.

(9) Flood of June-July 1998. The flood of 26 June to 08 July 1998 began in the very early hours of Saturday, 27 June 1998 as a series of thunderstorms with very heavy rain fell over areas of central Ohio. Many of these storms were cyclic or in sequence over the same areas for several hours producing 4-6 inch amounts of rain. The heaviest amounts of rainfall occurred in areas not controlled by the Corps of Engineers reservoir system. North Branch Lake was at the minimum pool level, and the spillway release at the beginning of the storms were near minimum flow. A second wave of heavy thunderstorms occurred early on Sunday 28 June 1998, over the same areas that had received very heavy rainfall just 24 hours earlier. The second series of storms dropped another 4-6 inches over central Ohio to bring the past 36-hour total to 8-12 inches of rain. The extreme rainfall and flood was so disastrous that several deaths were recorded.

All 16 Muskingum Basin projects plus Knox Lake were operational for this flood. The Water Control Section has computed the peak inflow for North Branch Lake for this flood to be about 4,400 cfs with a record pool crest of 1143.2 feet NGVD on 21 June with 62.5 percent of the lake storage being utilized. During the peak of the flood the pool was rising about 4 feet per hour. The peak crest at Fredericktown was reduced by several feet, and lesser peak reductions occurred further downstream at Mt. Vernon and Millwood. When the pool returned to near the year-round elevation level of 1121.0 feet NGVD North Branch Lake would revert to normal self regulation of releasing additional routine inflow.

#### 8-03. RECREATION

Recreational utilization of North Branch Kokosing Reservoir has been optimal. Due to the nature of the facility and its proximity to other state parks, North Branch Lake serves as an overflow camping area. Annual attendance figures for North Branch of Kokosing Lake are 55,800 visitor-days for general recreation and 13,620 visitor-days for fish and wildlife.

#### 8-04. WATER QUALITY

Because of the nature of a large body of water as described in section 4-08 there are a number of problems with the water quality of the lake. The temperature cycle results in the lake stratification with low dissolved oxygen, and high iron and manganese concentrations in the bottom of the lake; and higher than desired temperatures near the lake surface. The nutrient load also causes algae blooms in the head waters. All of these problem areas negatively impact the lake fishery, as only 40 percent of the summer lake storage is habitable.

There is no selective withdrawal facilities or plan for North Fork Of Kokosing Lake, however, despite the marginal chemical content of the lower layer of stored water, the released water improves the quality of the water downstream due to the increased flow during the dry summer months, and it insures that the river will not drop below a minimum desired habitable flow for fish, animals, and people.

#### 8-05. FISH AND WILDLIFE

Effects of water control management on fish and wildlife are those associated with:

a. Pool level fluctuations. Spawning season, usually from the third week in April through the third week in June, is a time when these fluctuations are critical. When the pool level builds up two feet or more during rainfall runoff and is returned to permanent pool elevation, 1121.0 feet NGVD, in from two to five days, spawning success suffers among black bass and other species. Black bass numbers reported by Ohio Department of Natural Resources, Fisheries Section, in their continuing study of fisheries in North Branch Lake, seem to reflect the often reported positive correlation between pool stability and spawning success. The correlation was noted particularly with regard to the largemouth variety which is the black bass species most caught in the lake. Rotenone treatment of a cove and electro fishing along several banks produces counts of largemouth bass along with other species. Numbers of young-of-the-year largemouth bass counted were always in rough proportion to the degree of stability of the pool, or in inverse proportion to the amount of variation in pool level. Thus, total largemouth bass counted by cove rotenone and electro fishing methods were 77 and 118 respectively in 1976 and 1980 when there was no appreciable variation. Conversely, in 1978 and 1979 when spawning-period pool rises were 7 feet, 2 feet, 2 feet, 3 feet and 4 feet spread over the two spawning seasons, counts of young-of-the-year largemouth bass were 39 and 43 respectively. In 1978 when the pool variation was 1.5 feet in late April, the count was 56 fishes.

The eggs and young of the year of ground-nesting birds, small mammals and reptiles are lost during a 10 foot pool rise, those closest to the lake during smaller rises. Such a rise also kills the herbaceous vegetation which is the food source of small mammals; however, losses of these animals are not as critical due to their fecundity. The State Wildlife Biologist for the Muskingum Basin stated that although these rises do reduce the carrying capacity, there has been little observable adverse effect of flood regulation on wildlife near the pool.

b. Stratification. Stratification effects on the lake fishery stem from the difference between values of temperature and concentration of dissolved oxygen in upper and lower levels in the water column discussed in sub-section 7-04. Low temperatures and concentrations occur at lower levels and high temperatures at upper levels. Fish species seek out their most desirable habitat. The Ohio Department of Natural Resources stocked walleye pike hoping they would thrive and reproduce; however they prefer cooler water than is available in the lake in summer with sufficient dissolved oxygen. Therefore they migrated out of the lake mostly through the outlet works - in search of more desirable habitat.

c. Permanent Pool. The walleye migration mentioned above has been a part of the fish losses from the lake through the outlet works. Many of the losses occur from the minimum pool during cold weather when they are lethargic and more likely to be drawn by a sudden current over the weir.

d. Reforestation. Major benefits to wildlife of Corps occupancy of lands purchased, but not submerged or utilized for recreation areas, were claimed for fire control efforts and the vegetation changes occurring during reversion of farm lands to forest. The District Forester stated the range to be healthy for forest animals. The 100 acres of low lands cropped and 100 acres brush-hogged are broken up into approximately 20 plots each and distributed for maximum effect. These plots and the approximate 57,000 seedling trees planted for browse and reforestation purposes are probably contributing to increases in small game, deer, and other animal populations. The State Wildlife Biologist in charge of the Muskingum Basin stated that grouse populations were good and deer populations seem to be improving.

e. Downstream Flow Fluctuations. Extremes of high and low flows downstream from the dam are not as great as before the project. One year frequency natural flow at the damsite has been estimated to be about 1,200 cfs; but, the lesser flushing action of outflow discharge for several days while releasing flood storage, for example 500 cfs when the pool is near elevation 1129 feet NGVD, has similar effects. In either case, temporarily, fish populations are displaced and food supplies diminished. The State Fisheries Biologist in charge stated his opinion that the major adverse effect of high discharges from the lake is the frustration of fishermen at the tailwaters because of the fast current pulling their lines downstream too quickly.

The capacity of the downstream fishery can be attributed to the more stable flows, both flood and drought, decreases in turbidity, increases in available food material (plankton and forage size fishes lost from the pool through the intake weirs, and presence of some catchable size game fishes similarly lost from the pool into the tailwaters. Because the project stabilizes flows by moderating storm impacts and because it functions to reduce turbidity downstream, the post-impoundment Muskingum River provides a better habitat during most spawning periods for forage and sport species. Additionally, plankton loss provides an increase in available food material for fry during this critical period in their life cycle, which probably increases both survival and growth rates of species spawned in this area.

f. Downstream Temperature. North Branch Lake is a self-regulated project, accordingly, there is very little adjustment of the downstream water temperature. The upper layer of better quality surface water passes through the outflow weirs. However, Outflow Temperature Regulation Curves were designed to approximate optimum temperatures for the warm water fishes common in near-by area streams; but, the only adjustment available is the low-flow emptying sluice in the bottom of the outlet works. The downstream habitat has been much more favorable than if fresh surface water were not released and outflow was limited to stale bottom discharge. The Ohio State Fisheries Biologist remarked that although they had not evaluated the downstream fishery, it was probably in better condition than before construction of the dam.

g. Access. The Fish and Wildlife Service report projected fisherman use of the downstream reach at 1,000 man/days per year after the project due to more stable water flows and better access. Greater use of the downstream reach during Corps ownership can be attributed to better access, trout stocking by the State and the capacity of the fishery to withstand the increased fishing pressure.

#### 8-06. WATER SUPPLY

The minimum flow requirement has a two fold effect on the lake. It significantly improves downstream flows, and during extreme low-flow times the fish and wildlife habitat is sustained. These minimum flows are year-round, and during the winter natural flow is normally adequate, but, during the dry summer months the inflow passing over the weir may be very small. The impacting of the lake recreation and fisheries is minimized by the stable amount of storage in the minimum pool.

8-07. HYDROELECTRIC POWER - N.A.

8-08. NAVIGATION - N.A.

8-09. DROUTH CONTINGENCY PLANS - N.A.

8-10. FLOOD EMERGENCY ACTION PLANS - N.A.

8-11. FREQUENCIES

a. Peak Inflow Probability or Natural Discharge Frequency and Duration at the Outflow Gage. The natural discharge-frequency curve for the North Branch Lake 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 several mainstream gaging stations, all in the Kokosing River 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.

Flow values for certain exceedence intervals from 1 year to 200 years are shown on **Table No. 8-5**, next page, Frequency Summary, at the North Branch Kokosing Lake Dam Site, All Seasons, Natural. North Branch Lake is a self-regulating project; therefore, the modified flows at the North Branch Lake outflow gage are determined by the reservoir outlet system, governed by the pool level; or the hydraulic head on the outlet weirs at elevation 1121 feet NGVD. If in the very rare event when the pool level would rise above the spillway elevation 1146 feet NGVD, the emergency spillway would then be activated.

Since March 1971, flows in Kokosing River have been regulated by North Branch Lake. 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 1971 through 1988. 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 Annual and Monthly Flow Duration below North Branch Lake.

TABLE NO. 8-5

FREQUENCY SUMMARY  
NORTH BRANCH KOKOSIUNG LAKE AT DAMSITE  
ALL SEASONS - NATURAL

Natural Condition		Modified Condition	
Exceedence Interval	Dis-charge	Exceedence Interval	Dis-charge
Years	CFS	Years	CFS
200	10,500	200	700
100	8,200	100	680
50	6,600	50	650
20	4,600	20	580
10	3,400	10	520
5	2,500	5	460
2	1,700	2	380
1	1,200	1	320

b. Pool Elevation Frequency and Duration. All significant flows for the period of record, 1937 to 1963, at Mount Vernon, Ohio, were tabulated and hydrographs reconstituted for the damsite or obtained by 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 frequency analysis method described in Beard's work mentioned in 8-10a above, the pool elevation frequency was estimated and is shown in Frequency of Filling, **Plate No. 8-4**. Deviation from the minimum elevation, 1121 feet NGVD, was plotted logarithmically as pool elevation versus the partial duration graphical frequency probability pattern. This gives the average probability of occurrence, which is usually referred to as the exceedence interval, of once in a number of years to which the pool may be expected to rise. Selected exceedence intervals with the respective maximum pool elevation expected to occur (on the average), once in that interval are listed in **Table No. 8-6**, below, Frequency Summary, North Branch Lake Pool Elevation Deviation.

TABLE NO. 8-6

FREQUENCY SUMMARY NORTH BRANCH LAKE  
POOL ELEVATION DEVIATION - ALL SEASONS

Exceedence Interval	Elevation	
	Years	Feet NGVD
225		1146.0
200		1145.8
100		1143.3
50		1140.5
20		1138.0
10		1135.4
5		1132.5
2		1129.0
1		1126.0

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 tabulated by elevation. The

total number of days tabulated for each elevation for all the floods of the period of record was divided by the number of years of record, 26, to obtain average number of days per year at or above the elevation. The "Average" curve in Duration of Filling, **Plate No. 8-5** was derived by plotting these average number of days values 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 for Period of Record."

c. Control Station - Mount Vernon, and Millwood. The natural frequency along the Kokosing River below North Branch Lake was estimated using nearly the same methods and techniques of data handling and calculation as were used for the North Branch Kokosing River at the damsite. The major difference was that a 50-year record existed for the downstream gages, making unnecessary the regional approach used for ungaged areas.

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 Natural and Modified Flow Frequency Curves. Flows for selected exceedence intervals from 1 year to 1000 years are included in **Table Nos. 8-7**(below) **and 8-8**, (page 8-14) Frequency Summary, Kokosing River at Mount Vernon and Millwood, Ohio, All Seasons - Natural Condition, are shown on this page.

TABLE NO. 8-7					
FREQUENCY SUMMARY					
KOKOSING RIVER AT MOUNT VERNON, OHIO					
ALL SEASONS					
Natural Condition			Modified Condition		
Exceedence Interval Years	Stage Feet	Dis-charge CFS	Exceedence Interval Years	Stage Feet	Dis-charge CFS
1,000	20.1	67,000	1,000	18.7	42,700
500	19.5	55,200	500	18.2	35,800
200	18.6	41,700	200	17.4	27,800
100	18.0	33,500	100	16.5	22,500
50	17.2	26,700	50	15.3	18,000
20	15.6	19,000	20	13.2	12,700
10	14.1	14,700	10	11.0	9,800
5	12.2	11,200	5	8.8	7,400
2	8.9	7,500	2	7.0	4,450
1	7.7	5,300	1	6.0	3,300

TABLE NO. 8-8

FREQUENCY SUMMARY  
KOKOSING RIVER AT MILLWOOD, OHIO  
ALL SEASONS

Natural Condition			Modified Condition		
Exceedence Interval Years	Stage Feet	Dis- charge CFS	Exceedence Interval Years	Stage Feet	Dis- charge CFS
1,000	38.5	98,000	1,000	35.8	84,000
500	35.5	82,200	500	32.8	70,500
200	31.2	63,700	200	29.2	54,800
100	28.5	51,900	100	26.5	44,700
50	25.7	41,900	50	24.0	36,000
20	22.5	31,000	20	21.3	27,000
10	20.1	23,700	10	19.2	20,500
5	18.1	18,200	5	17.2	16,000
2	15.6	12,300	2	14.6	10,500
1	13.7	8,700	1	12.8	7,600

In order to estimate modified frequencies, representative floods from the record prior to beginning operation of the North Branch project were routed through the lake and reductions routed to the downstream gages. These were applied to the actual (natural) and the resulting modified peaks noted. Reductions of Kokosing River flows effected by the North Branch project since March 1971 were routed to the downstream gages and added to the actual (modified) flows to produce the natural. The peak modified flow for each event was plotted against the peak natural flow for the event. The most representative smooth curve, to be known as the "Correlation Curve," was drawn among the points, the upper end of the curve being defined by the natural and modified of the Standard Project Flood.

Any point on the proper Correlation Curve gives, for the peak natural flow specified, the probable peak flow to be experienced at the Mount Vernon and Millwood gage because of North Branch Lake control of Kokosing River flows; and exceedence intervals of modified flows are the same as those of the corresponding natural flows. Flows for selected intervals are listed in **Table Nos. 8-7**, page 8-13 and **Table No. 8-8**, above, Frequency Summary, Kokosing River at Mount Vernon and Millwood, Ohio, All Season - Natural and Modified Conditions.

SECTION IX - WATER CONTROL MANAGEMENT

9-01. RESPONSIBILITIES AND ORGANIZATION

(1) 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, as shown on the Organization Chart **Plate No. 9-1**, under the discretionary authority of the Chief of Engineers. Some modifications in project operation are permitted under congressional enactments subsequent to original project authorization; regardless, North Branch of Kokosing Lake is fully owned and operated by the U.S. Government under the supervision of Mohawk Dam. The Huntington District, Corps of Engineers is the operating agency under administrative control of the Muskingum Area office within Operations Division.

(2) 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.

(3) 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 Great Lakes and Ohio River 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 Water Control Center is responsible for administration of the Division Engineer's policy for water control management.

(4) Huntington District. The District Engineer has 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 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 Resources Engineering Branch is further 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, is 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 regulation plans. The communication mode for the advisory is commensurate with the urgency of the situation and is transmitted before the district implements a plan of action. An organizational chart is shown on **Plate No. 9-1**, for Water Control Management in the Kokosing - Walhonding River Basin. As shown on the chart, the Recreational-Resource Management Branch and the Muskingum Area Office are responsible for supervision of the operation and maintenance of the dam and operations area at North Branch of Kokosing Lake. While North Branch Lake is basically self-regulating, the Mohawk project damtender (Resource Manager) manually regulates the project in accordance with general instructions and Special Directives issued by the Water Control Section. Special Directives are issued and signed by the Chief, Water Control Section, for dissemination to the Mohawk damtender as necessary to efficiently regulate the project for optimal water control management of all project purposes.

During normal operations, the Water Control Section of the Water Resources Engineering Branch are 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 Resources Engineering Branch personnel are responsible for the following activities in regard to water control management:

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

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

(3) Providing liaison personnel to support Emergency Operations 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.

a. Instruction to Damtender. During a FLOOD EMERGENCY SITUATION Exhibit B of the manual describes the responsibilities of the Corps Of Engineers project personnel at downstream Mohawk Dam. 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 ER's.

b. Other Federal Agencies. The National Weather Service and the U.S. Geological Survey cooperate and coordinate activity with the Water Control Section in regard to accumulation of rainfall and streamflow data, as well as river forecasts and discharge measurements. The Corps of Engineers is required by the Fish and Wildlife Coordination Act (48 Stat. 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.

c. Local and State Agencies. No local or state agency has funding or operational responsibilities in the Huntington District multipurpose reservoirs except in leased recreational areas. 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 the 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. The State has undertaken fish management at the project lakes and the Corps of Engineers cooperates in the lake level manipulation and maintenance of downstream flow requirements to enhance fisheries management.

d. Private Organizations. There are no private interests presently involved with North Branch of Kokosing Lake.

#### 9-02. INTERAGENCY COORDINATION AND COOPERATION

a. Press Releases. 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 Office 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. Many such varied articles are printed in Castle Comments, the District newspaper; and Engineer Update, the newspaper from the Corps of Engineers. Both are unofficial monthly publications for Corps' employees and retirees of all ages.

b. National Weather Service. An agreement between the National Weather Service (NWS) and The Corps of Engineers provides for collection and dissemination of current precipitation data for the Ohio River Basin. By joint agreement, the NWS installs, maintains and operates all stations in the Ohio River Network, except those operated by the Corps of Engineer personnel at flood-control and navigation projects. Where there is a mutual need for the data, station costs are shared by both the NWS and the Corps of Engineers. Costs of stations required 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 described in paragraph 6-02b, NWS provides a range

of 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, many other Federal, State, and private agencies and individuals interested 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 with the Corps, described in paragraph 6-20a, provides the Water Control Section with a system for obtaining reliable stage and flow information, which is necessary for efficient water control management.

The annual program 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. The Huntington District Water Control Section cooperates fully with the Ohio Department of Natural Resources about fish and wildlife enhancement in the Ohio lakes and downstream areas, by making special efforts to maintain constant pool elevations during April, May, and June for spawning benefit. Additional coordination is used for proper timing of spring filling and fall drawdown, and probable height of both lake level manipulation during flooding and expected project outflow.

The Ohio Department 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.

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 Department of Natural Resources and the U.S. Fish and Wildlife Service.

The Ohio Division of Forestry at Columbus, all project lake Corps Personnel, and project lake state park personnel cooperate in fire-fighting activities to suppress fires that threaten or are burning on project lands. Project personnel cooperate 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 Department of Natural Resources personnel through much of the year.

e. Other State, Federal, Local or Private Agencies. The Corps of Engineers receives requests for information, aid, or cooperation from many parties or groups. All legitimate responsible requests from Federal, State, local, or private organizations or from groups that coordinate with ODNR receive appropriate attention and consideration. Accuracy of information transmitted and the proper level or amount 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 Corps areas of responsibility and expertise.

In certain cases, such as potential downstream flooding concerns or emergency complications involving regulation of North Branch of Kokosing Lake, the District Emergency Operations Manager coordinates with the Ohio Disaster Services Agency. An 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 Operation 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, the Tennessee Valley Authority, six Federal Agencies, and two regional commissions, which are Ohio River Oriented. The Group meets three times yearly 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 publics varied interests in reservoir regulation and accordingly perfecting that regulation to the maximum extent possible.

Water Resources Engineering Branch personnel sends 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, MEETINGS AND ORGANIZATIONS

Agreements among the Corps of Engineers, the U.S. Geological Survey, and the National Weather Service are mentioned and outlined in paragraphs 6-02a and b. An annual meeting is held with each of the State branches of the Geological Survey cooperating 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 Ohio Department of Natural Resources to be administered by the Division of Forestry. The understanding includes cooperative warning and suppression of fires on or threatening Corps owned lands, Ohio Department of Natural Resources maintenance of a standard cache of fire-fighting tools at the project, and payment by the Corps of extinguishment costs incurred by the Ohio Department of Natural Resources.

The Great Lakes and Ohio River Division Water Management Division holds a quarterly meeting of the Reservoir Operations Coordinating Group. The meeting is normally 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 meeting is to exchange information and views on regional water recourse 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 North Branch Lake and acts in a consultative capacity to both governmental and private interests in the basin. The commission members are representatives of Federal and State leaders in Water Resources. The commissions purpose is to provide a forum for the Ohio River border 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, 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 New York, Ohio, Indiana, Illinois, Pennsylvania, West Virginia, Kentucky, and Virginia are represented on this commission.

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

d. Ohio Department of Natural Resources(ODNR). Through its several divisions, the ODNR regulates water appropriation and all activities with direct impact on public streams and lakes in the state of Ohio.

e. 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 this committee is to review guidelines, develop and implement functional drought contingency plans, and to keep the CDMC informed on drought status and drought related topics and issues.

f. Corps Drought Management Committee(CDMC). The CDMC is composed of 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 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 Division uses guidelines from this committee in developing and justifying deviations from approved water management plans and procedures.

g. Interagency Drought Management Committee(IDNMC). The IIDMC is composed of local, state, and Federal agency directors 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 Committee Agency, U.S. Fish and Wild Life 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 Districts 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. HUNTINGTON DISTRICT REPORTS

**Table No. 9-1**, back of section contains a listing of the various Periodic and Special reports provided by the District Water Control Section.

a. Periodic.

(1) Daily. Districts are required to report current hydrologic data daily as prescribed by the Division Office. A daily report is prepared five days per week by the Water Control Section of Water Control Section and, when staffing is provided, as under flooding conditions, on Saturdays, Sundays and holidays. It is 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 Great Lakes and Ohio River Division water control system. The transmission includes morning lake elevation, rate and temperature of outflow, and 3-day forecast of lake 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 report items are prepared in accordance with ORDER 1110-2-20, CHORD-ED-W lt, 10 Jul 69, CHORD-ED-W lt, 23 Jan 67, and ORDER 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 storms or river conditions and properly quoted NWS forecasts are permissible. 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 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 a full week ending with the current week. All of the key gage points are reported for North Branch of Kokosing Lake, Kokosing River Basin, and Ohio River Basin. The main stem points are located at Mt. Vernon, Coshocton, Zanesville, and Marietta, Ohio.

During any flood, drought or other emergency involving reservoirs, the Ohio River or other streams in the District, the Water resources Engineering Branch provides all available information to the District Engineer, Chief of Engineers and interested elements as frequently as necessary.

(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 the 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.

(4) Quarterly Reservoir Operations. Each District provides a quarterly review of meteorological influences and water control management activities to each of the four yearly meetings of the Reservoir Operations Coordinating Group. Huntington District personnel of the Water Control Section summarize and compare weather experienced with long-term normals and actual streamflows 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.

(5) Annual. The Division Engineer is required by ORDR 1110-2-27 and CEORD-ED-W Ltr, 30 September 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, ADP use, 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. An annual Division Water Quality report is required by ORDR-2-26. The report is submitted in two parts. The first part addresses the divisions 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. An Annual Water Quality Report by Districts to LRD includes narrative and tabular summaries of water quality activities and conditions in the Districts. The District report contains a synopsis of activities, specific cases of interest, improvements during the year, and plans for future emphasis. The tabular portion includes an overview of water quality activities, an overview of water quality conditions, specific water quality control 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 submitted by 1 December of each year.

b. Special Reports.

(1) Flood Emergency Operations Reports. 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 Report of Reservoir Effects. Information on the operation of the affected reservoirs is gathered in accordance with ER 500-1-1. This report provides details on antecedent meteorologic and hydrologic conditions, description of the performance of the dam and appurtenant works, detailed analysis of the operating procedures, and effects of reservoir operation on the Kokosing River and the Ohio River. Reservoir effects include evaluation of the stage reductions at key stations, estimates of damages prevented by the projects, and precipitation maps will be included in the post-flood reports required by ER 500-1-1. Conclusions are discussed with regard to adequacy of operating technique, performance of structures, and benefits derived from operations during the flood. The outline of a typical post flood report is given below.

- I- Authority, Purpose And Scope
- II- Basin Description
  - Basin Flood Control works
  - 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 are 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 reported. Information on the Water Control Data Systems and associated Communications Category of the Plant Replacement and Improvement Program is submitted with the annual budget. Reporting is 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 submits 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 is determined by the urgencies of situations as they occur. The reports are 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 Situation. During major droughts or extreme low-flow conditions, narrative summaries of the situation should be furnished to alert the Chief of Engineers regarding the possibility of serious runoff deficiencies that are likely to precipitate actions associated with Corps of Engineers reservoirs.

(6) Master Plans. Division water control managers will develop Master plans for water control data systems and significant revisions thereto. They are 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 are maintained current and are updated as necessary to meet needs.

Modified master plans are 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 allows adequate time for OCE review and approval prior to annual budget submittals.

(7) Miscellaneous. Any additional or pertinent reports required from higher authority will be promptly compiled and transmitted.

TABLE NO. 9-1

HUNTINGTON DISTRICT REPORTS  
WATER RESOURCES ENGINEERING BRANCH

PERIODIC REPORTS - Computer reports keyed to forms formerly completed by hand as follows:

Daily - Computer reports of observed and forecast stages and flows including:

-Morning reservoir pool elevation, outflow, outflow temperature and three-day pool and outflow forecast.

-24-hour rainfall, morning stage, flow and five-day flow forecasts at Ohio River tributary gage points.

Weekly Reservoir effects at Ohio River tributary gage points.

Monthly Records of District reservoirs available on request.

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, when and as requested.

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, relevant NWS zone forecasts and special bulletins, and computer generated isohyetal maps of the District.

Reports on reservoir operations to OCE during flood emergencies including inflow, outflow, pool elevation, predicted crest, and maximum storage utilization to date.

Post-flood reports.

Budget requests for water control management activities to OCE.

Snowmelt runoff and flood potential reports to OCE.

Narrative summaries of major drought or low-flow conditions likely to require special regulation of District reservoirs.

Master plans for water control data systems and significant revisions thereto are submitted to HQDA (DAEN-CWE-HY) Washington, DC 20314, for review and approval of engineering.

**PERTINENT DATA**

**NORTH BRANCH KOKOSING LAKE, OHIO**

**LOCATION OF DAM:** Knox County, Ohio. On North Branch Kokosing River, 2.2 miles northwest of Fredericktown, Ohio.

**AUTHORITY:** Flood control act of 1962.

**PURPOSES SERVED:** Flood control, recreation, fish and wildlife conservation.

**DAM:** Type-Earthfill, maximum height 70.5', total crest length 1,400'.

**SPILLWAY:** Uncontrolled type with a crest elevation of 1146.0, crest length 60'. Spillway design flood peak outflow, 13,500 cfs.

**OUTLET WORKS:** The rectangular 14.5 foot by 21.5 foot concrete inlet tower rises 34 feet above the stream bed rock of 1093 elevation NGVD. This inlet tower connects to a reinforced concrete rectangular conduit, length 560', dimensions 3.5'x6.75', invert elevation 1101. A pair of 4 foot long outlet weirs in the top of the intake tower at elevation 1121 feet NGVD provide the sole regulation of the project.

**OTHER STRUCTURES:** None

**DRAINAGE AREA ABOVE DAM:** 44.5 Square Miles.

**RESERVOIR DATA:** Streambed elevation at dam: 1098 feet NGVD.

<u>Pool</u>	<u>Surface Elevation</u> (Ft above NGVD)	<u>Surface Area</u> (Acres)	<u>Backwater along Main Stream</u> (Miles)	<u>Capacity</u>			
				<u>Ac Ft</u> (Thousands)		<u>Inches of runoff</u>	
				<u>Net</u>	<u>Gross</u>	<u>Net</u>	<u>Gross</u>
Year Round Storage:							
Minimum	1121	154	1.7	1.0	1.0	0.4	0.4
Flood Control Storage*	1146	1140	4.0	13.8	14.9	5.9	6.3
Total	1146	1140	4.0	14.9	14.9	6.3	6.3

\*At maximum pool level.

**PERTINENT DATA(cont'd)**

**NORTH BRANCH KOKOSING LAKE, OHIO**

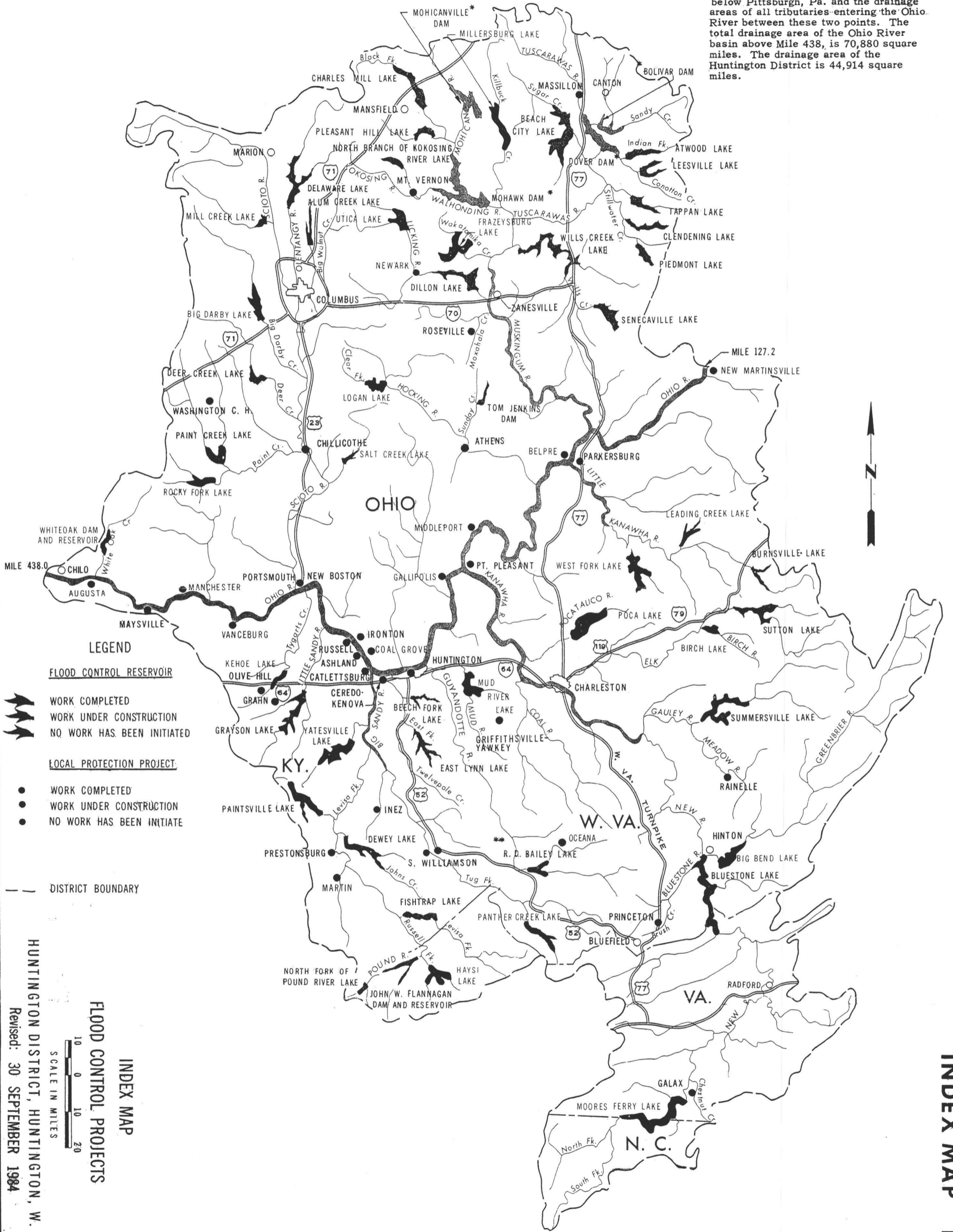
**NET LAND USE**: Fee - 1,212 acres  
Easement 496 acres

**STATUS**: The Project is complete.

<b><u>COST</u></b> : Construction	\$6,221,000
Operation and Maintenance through 30 Sep 1988	1,643,030
Estimated recreation (code 711) funds	45,000
Expended through 30 Sep 1981	45,200

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 areas 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.



**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

--- DISTRICT BOUNDARY

**INDEX MAP**  
**FLOOD CONTROL PROJECTS**

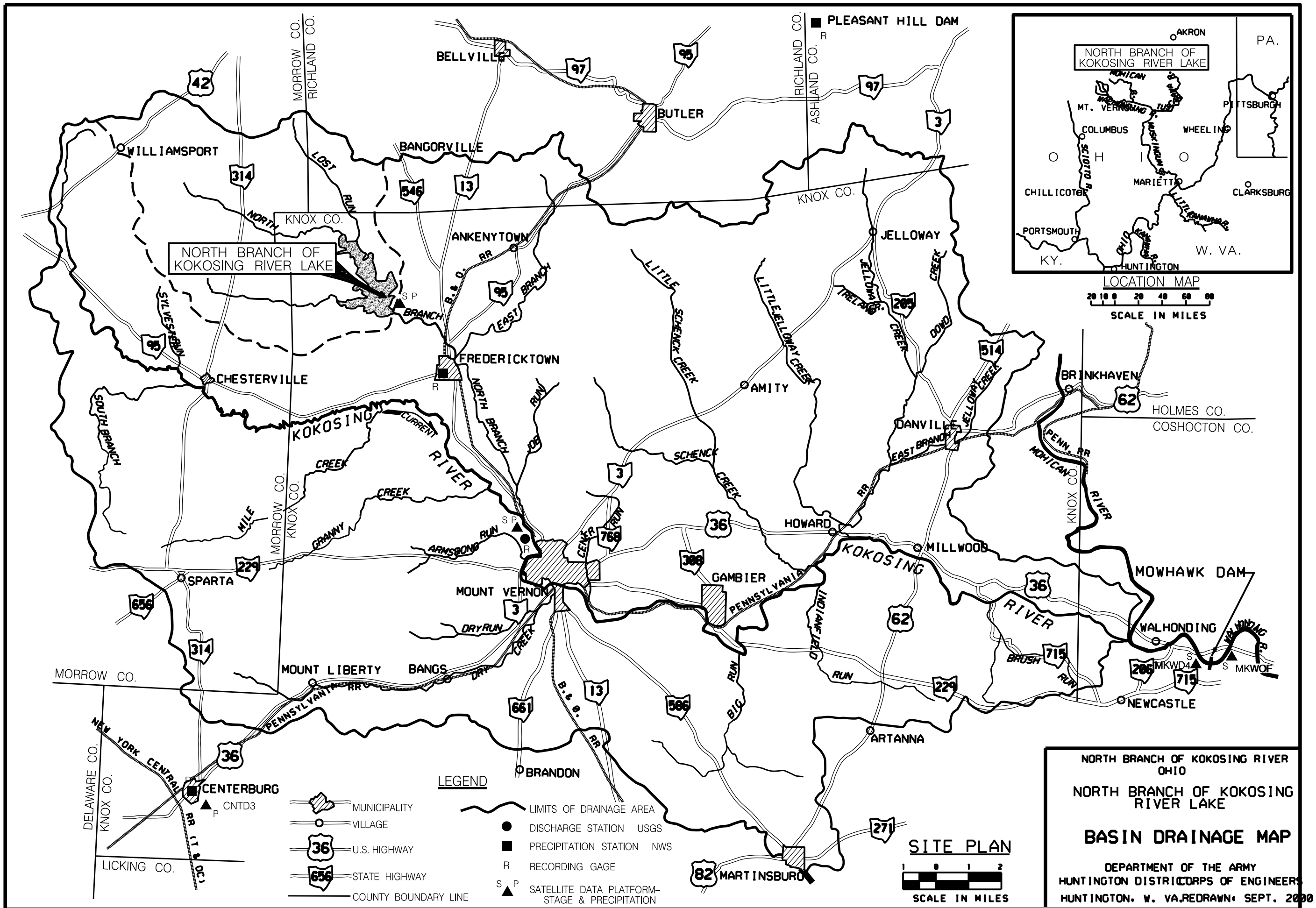


HUNTINGTON DISTRICT, HUNTINGTON, W. VA.  
Revised: 30 SEPTEMBER 1984

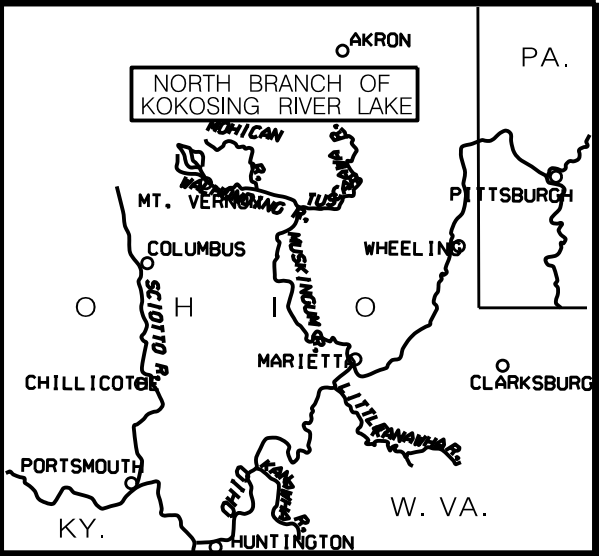
Plate No. 1-1

INDEX MAP F/C1

\*Dry dam, with flood control pool outlined.  
\*\*Completed project where further improvements are in progress or authorized.



NORTH BRANCH OF KOKOSING RIVER LAKE



LOCATION MAP

SCALE IN MILES

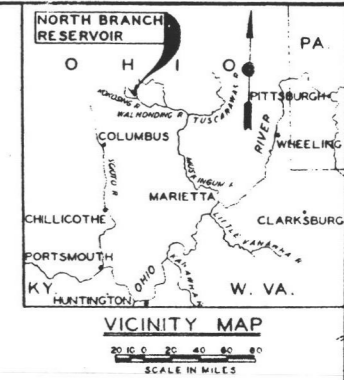
LEGEND

- MUNICIPALITY
- VILLAGE
- U.S. HIGHWAY
- STATE HIGHWAY
- COUNTY BOUNDARY LINE
- LIMITS OF DRAINAGE AREA
- DISCHARGE STATION USGS
- PRECIPITATION STATION NWS
- RECORDING GAGE
- SATELLITE DATA PLATFORM-STAGE & PRECIPITATION

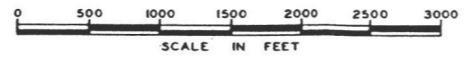
SITE PLAN



NORTH BRANCH OF KOKOSING RIVER  
OHIO  
NORTH BRANCH OF KOKOSING  
RIVER LAKE  
**BASIN DRAINAGE MAP**  
DEPARTMENT OF THE ARMY  
HUNTINGTON DISTRICT CORPS OF ENGINEERS  
HUNTINGTON, W. VA. REDRAWN: SEPT. 2000



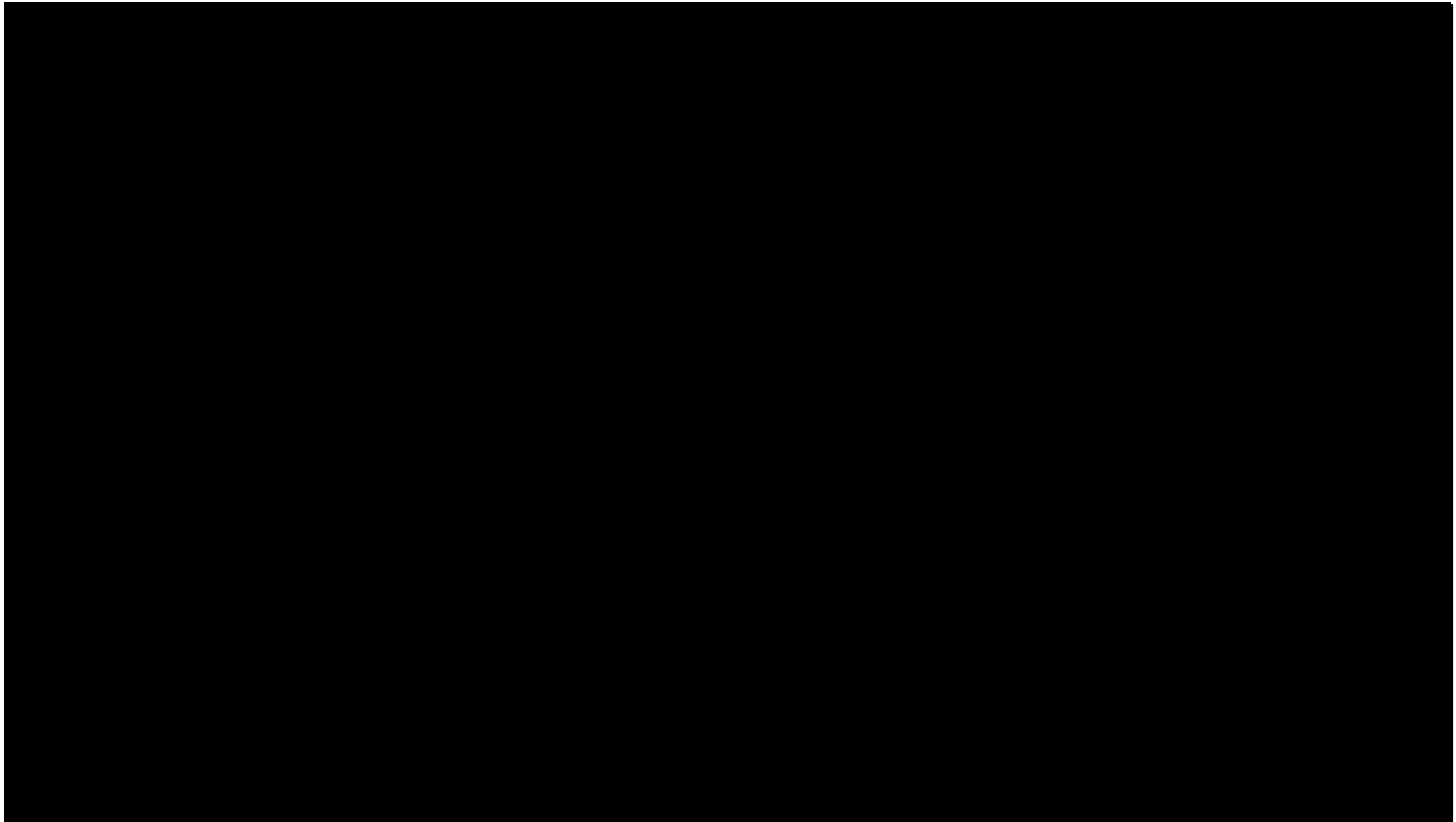
- LEGEND**
- MAXIMUM FLOOD CONTROL POOL EL. 1146.0
  - PERMANENT POOL EL. 1121.0
  - COUNTY ROAD (PAVED)
  - COUNTY ROAD (GRAVELED)
  - TOWNSHIP ROAD (ALL GRAVELED)
  - CEMETERY
  - CHURCH



MUSKINGUM RIVER BASIN  
NORTH BRANCH RESERVOIR  
NORTH BRANCH KOKOSING RIVER, OHIO

**RESERVOIR MAP**

U. S. ARMY ENGINEER DISTRICT, HUNTINGTON  
CORPS OF ENGINEERS  
HUNTINGTON, W. VA.  
OCTOBER 1964

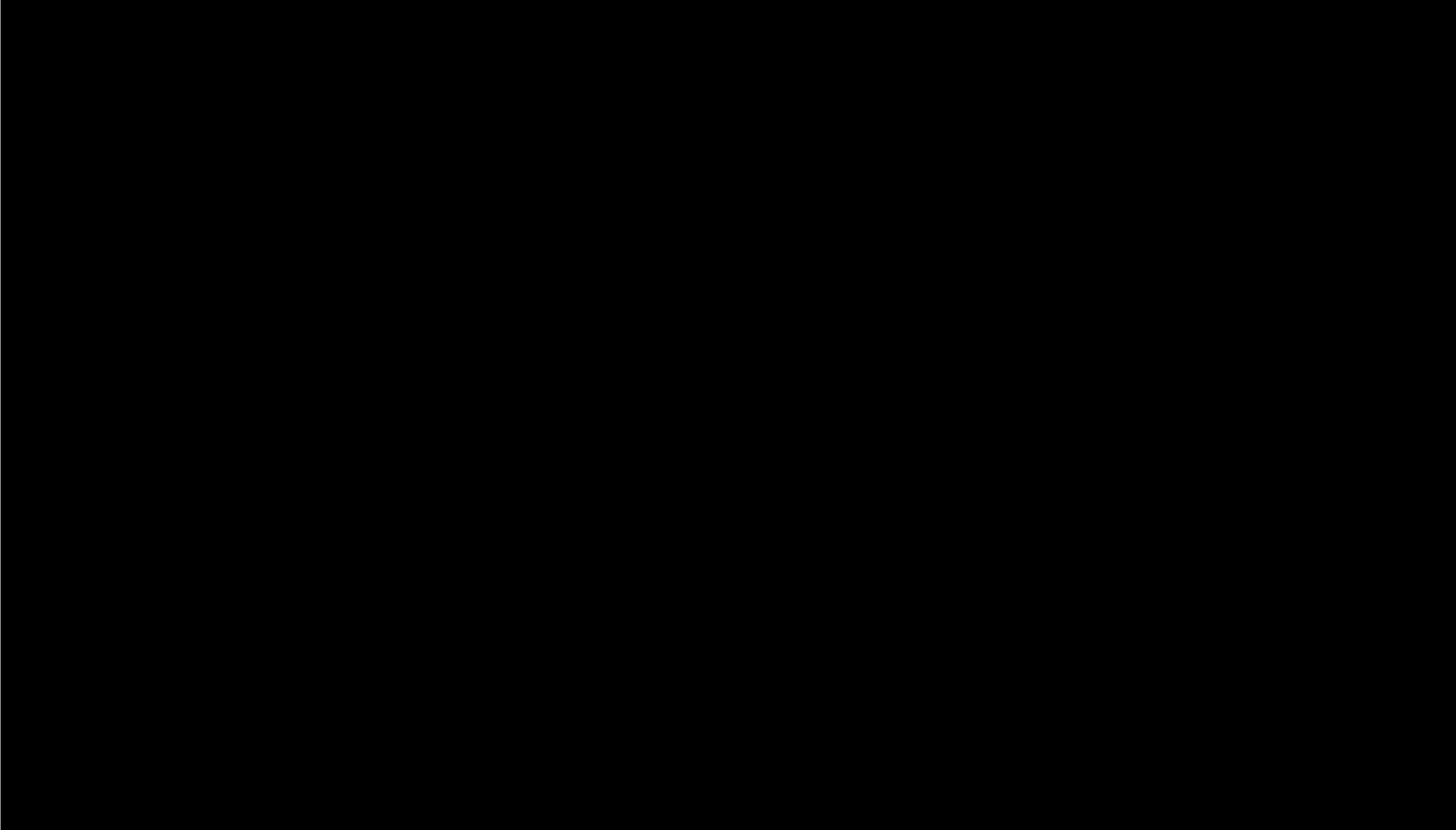


KOKOSING RIVER  
OHIO  
NORTH BRANCH OF KOKOSING  
DAM AND RESERVOIR

GENERAL PLAN

DEPARTMENT OF THE ARMY  
HUNTINGTON DISTRICT CORPS OF ENGINEERS  
HUNTINGTON, W. VA. REDRAWN: SEPT. 2000

RESERVED

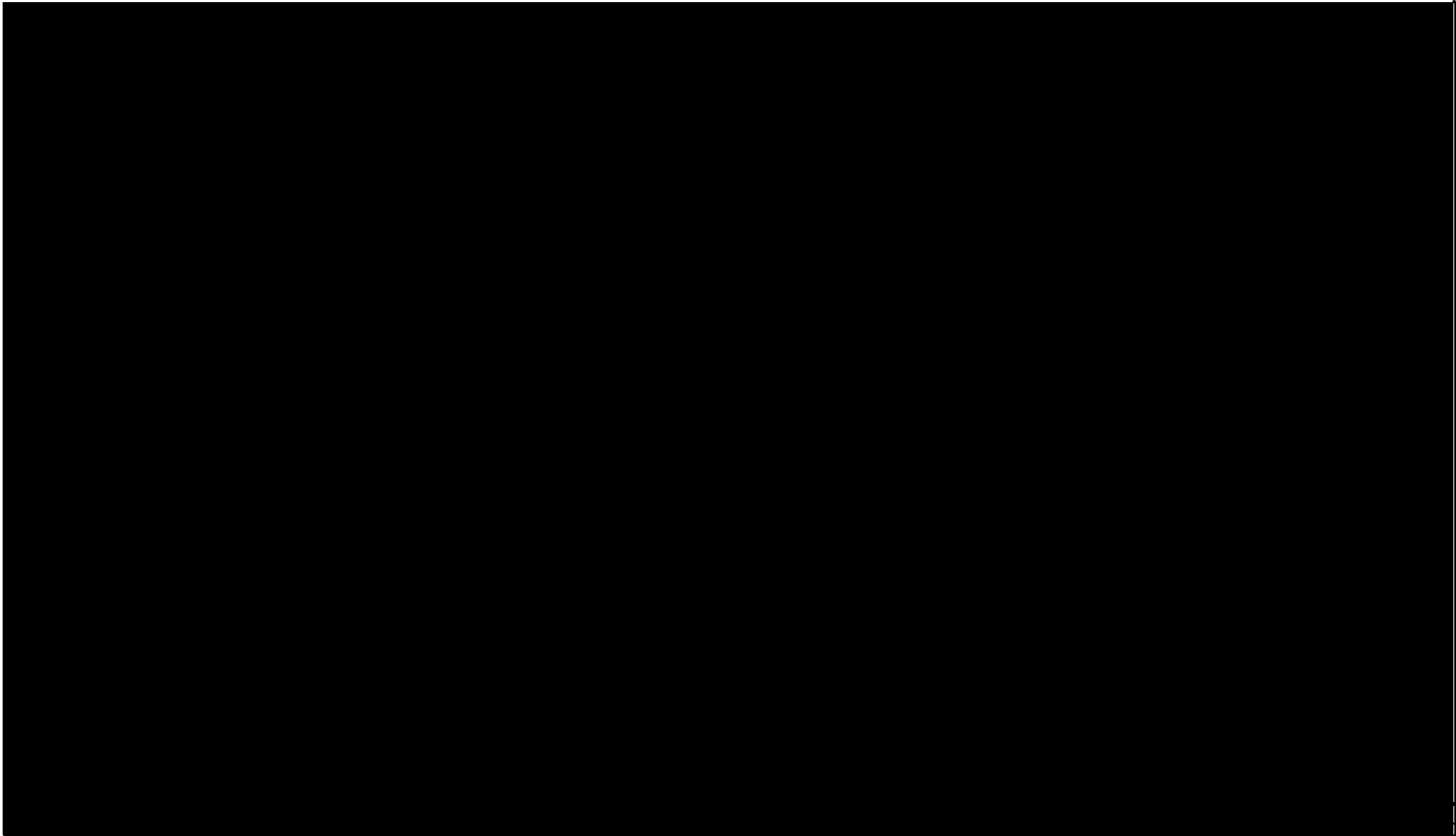


KOKOSING RIVER  
OHIO  
NORTH BRANCH OF KOKOSING  
DAM AND RESERVOIR

DAM  
DIKE - PLAN AND SECTIONS

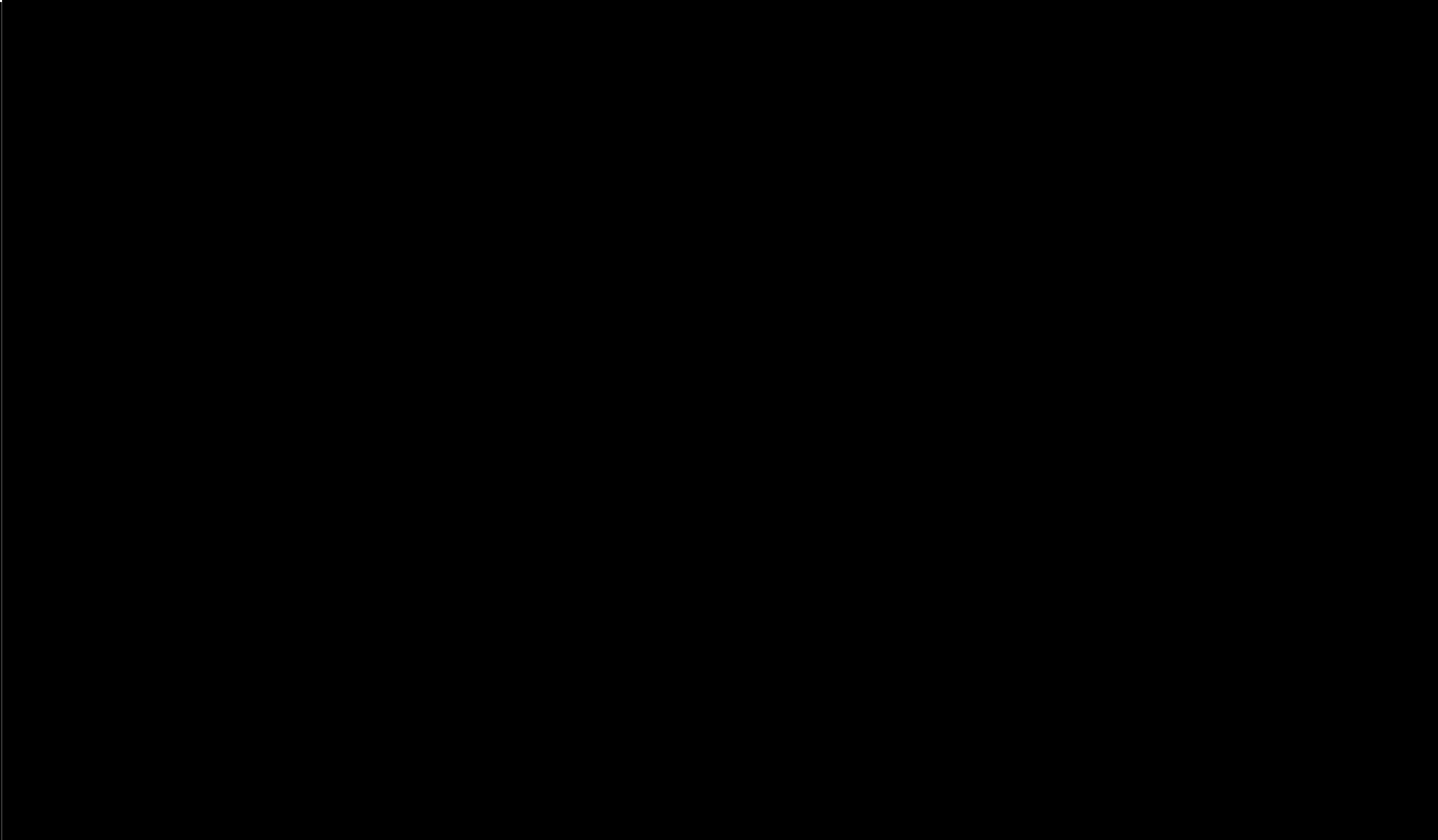
DEPARTMENT OF THE ARMY  
HUNTINGTON DISTRICT CORPS OF ENGINEERS  
HUNTINGTON, W. VA. REDRAWN SEPT. 2000

DE:



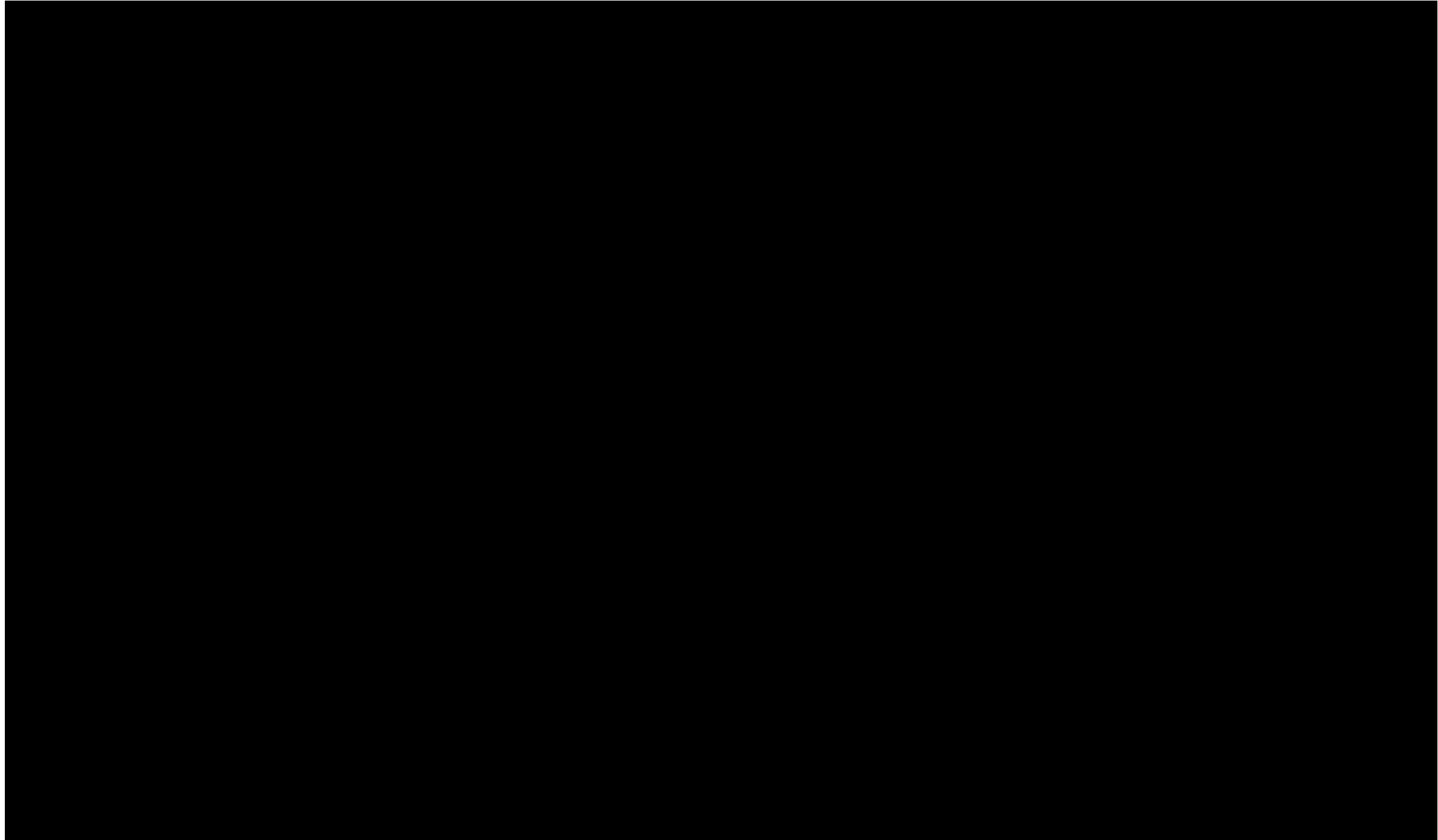
NORTH BRANCH OF KOKOSING RIVER  
OHIO  
NORTH BRANCH OF KOKOSING  
DAM AND RESERVOIR  
**DAM  
EMBANKMENT DETAILS**  
DEPARTMENT OF THE ARMY  
HUNTINGTON DISTRICT CORPS OF ENGINEERS  
HUNTINGTON, W. VA. REDRAWN: SEPT. 2000

DESCRIPTION



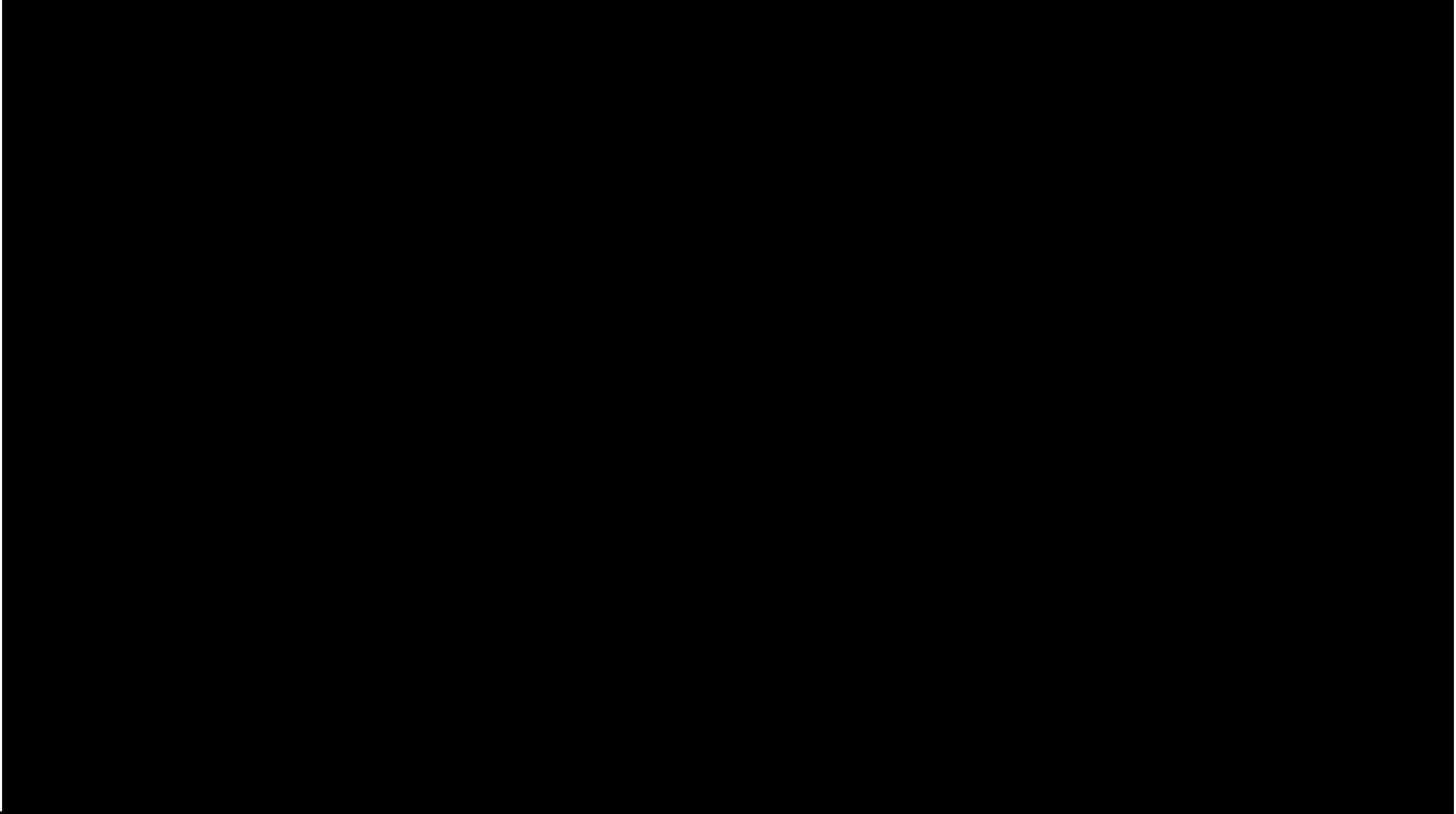
DESCRIPTION

KOKOSING RIVER  
OHIO  
NORTH BRANCH OF KOKOSING  
DAM AND RESERVOIR  
**SPILLWAY**  
**PLAN, PROFILE AND SECTIONS**  
  
DEPARTMENT OF THE ARMY  
HUNTINGTON DISTRICT CORPS OF ENGINEERS  
HUNTINGTON, W. VA., REDRAWN, SEPT. 2000



DESCRIPTION

KOKOSING RIVER  
OHIO  
NORTH BRANCH OF KOKOSING  
DAM AND RESERVOIR  
**OUTLET WORKS  
PLAN AND PROFILE  
SHEET NO. 1**  
DEPARTMENT OF THE ARMY  
HUNTINGTON DISTRICT CORPS OF ENGINEERS  
HUNTINGTON, W. VA. REDRAWN: SEPT. 2000



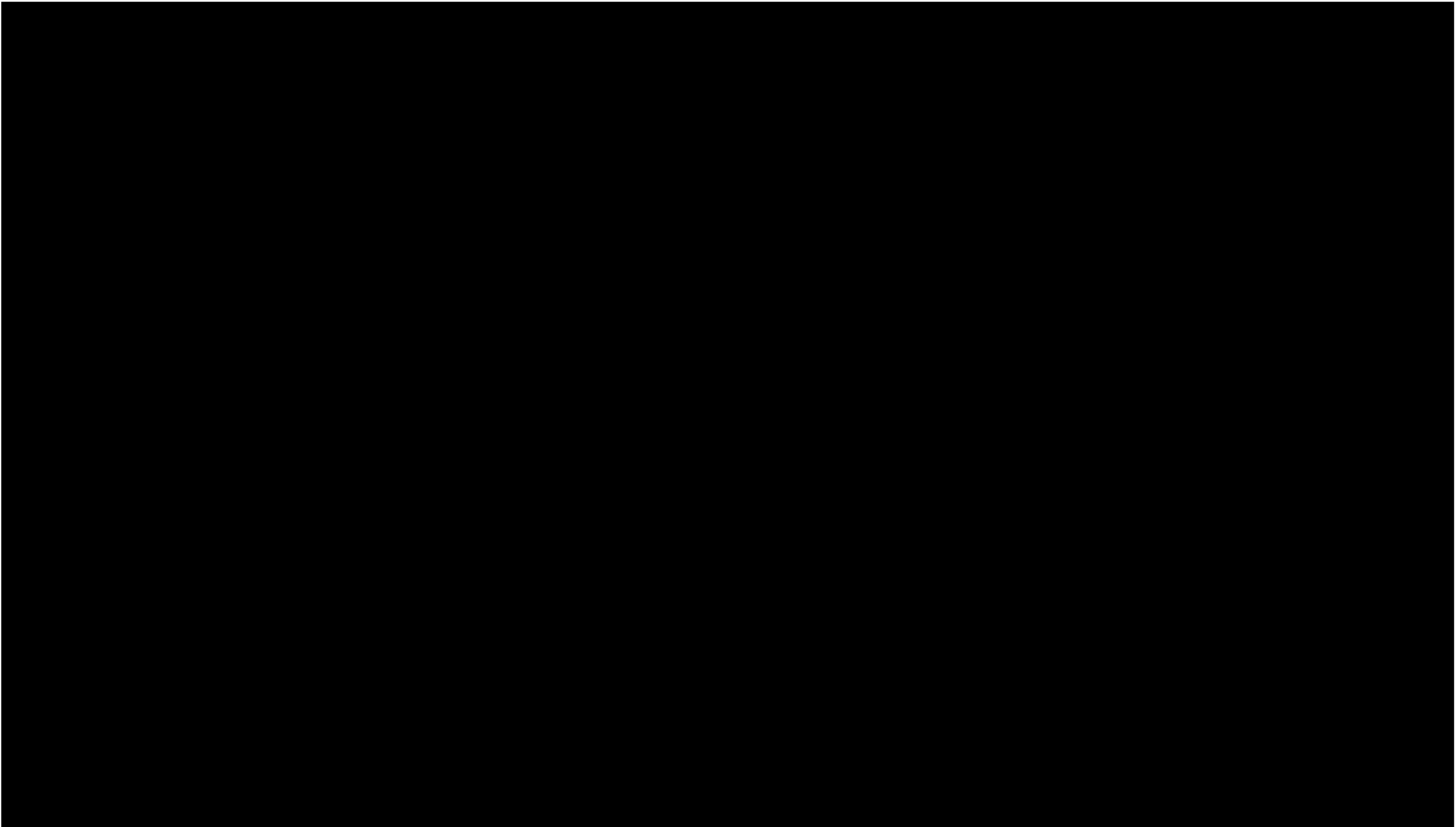
DESCRIPTION

KOKOSING RIVER  
OHIO

NORTH BRANCH OF KOKOSING  
DAM AND RESERVOIR

PLAN AND PROFILE  
SHEET NO.2

DEPARTMENT OF THE ARMY  
HUNTINGTON DISTRICT CORPS OF ENGINEERS  
HUNTINGTON, W. VA. REDRAWN: SEPT. 2000



NORTH BRANCH OF KOKOSING RIVER  
OHIO

NORTH BRANCH OF KOKOSING  
RIVER LAKE







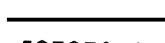




OUTLET WORKS  
INTAKE STRUCTURE  
PLAN AND SECTIONS

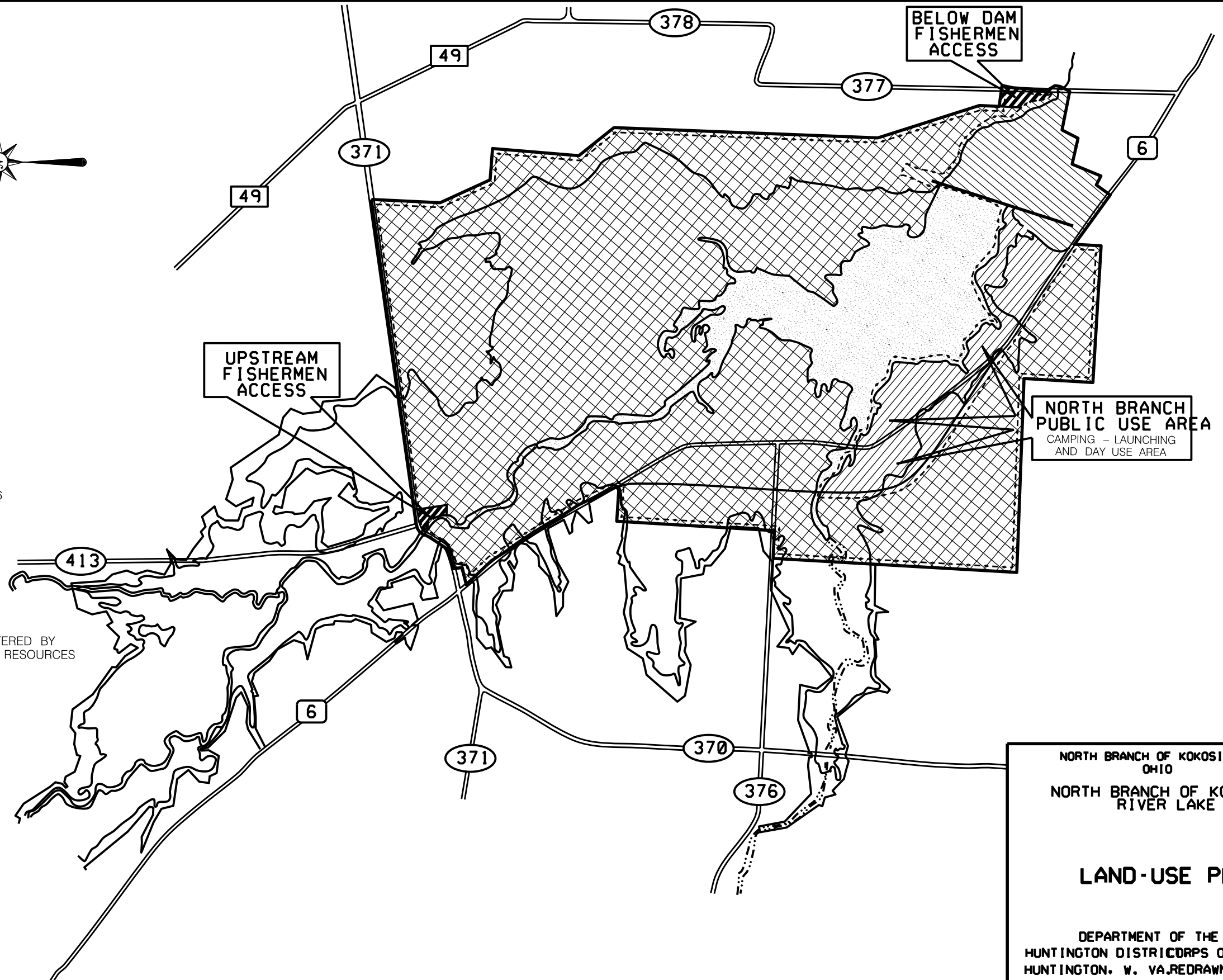
DEPARTMENT OF THE ARMY  
HUNTINGTON DISTRICT CORPS OF ENGINEERS  
HUNTINGTON, W. VA. REDRAWN: SEPT. 2000

DESCRIPTIC



**LEGEND**

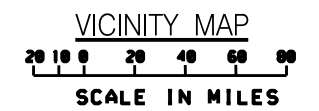
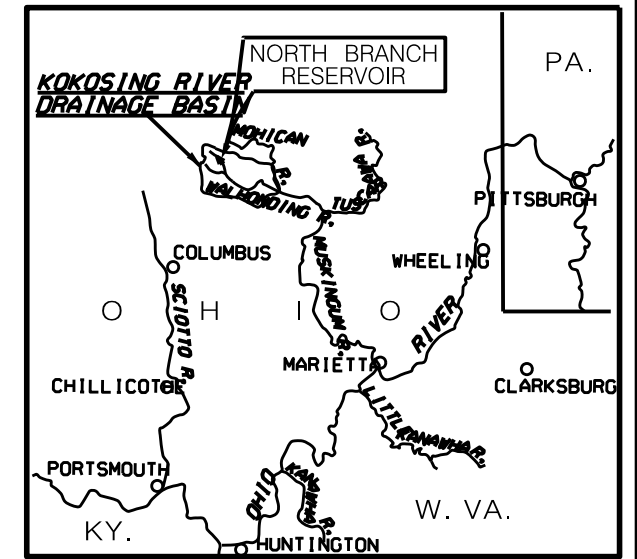
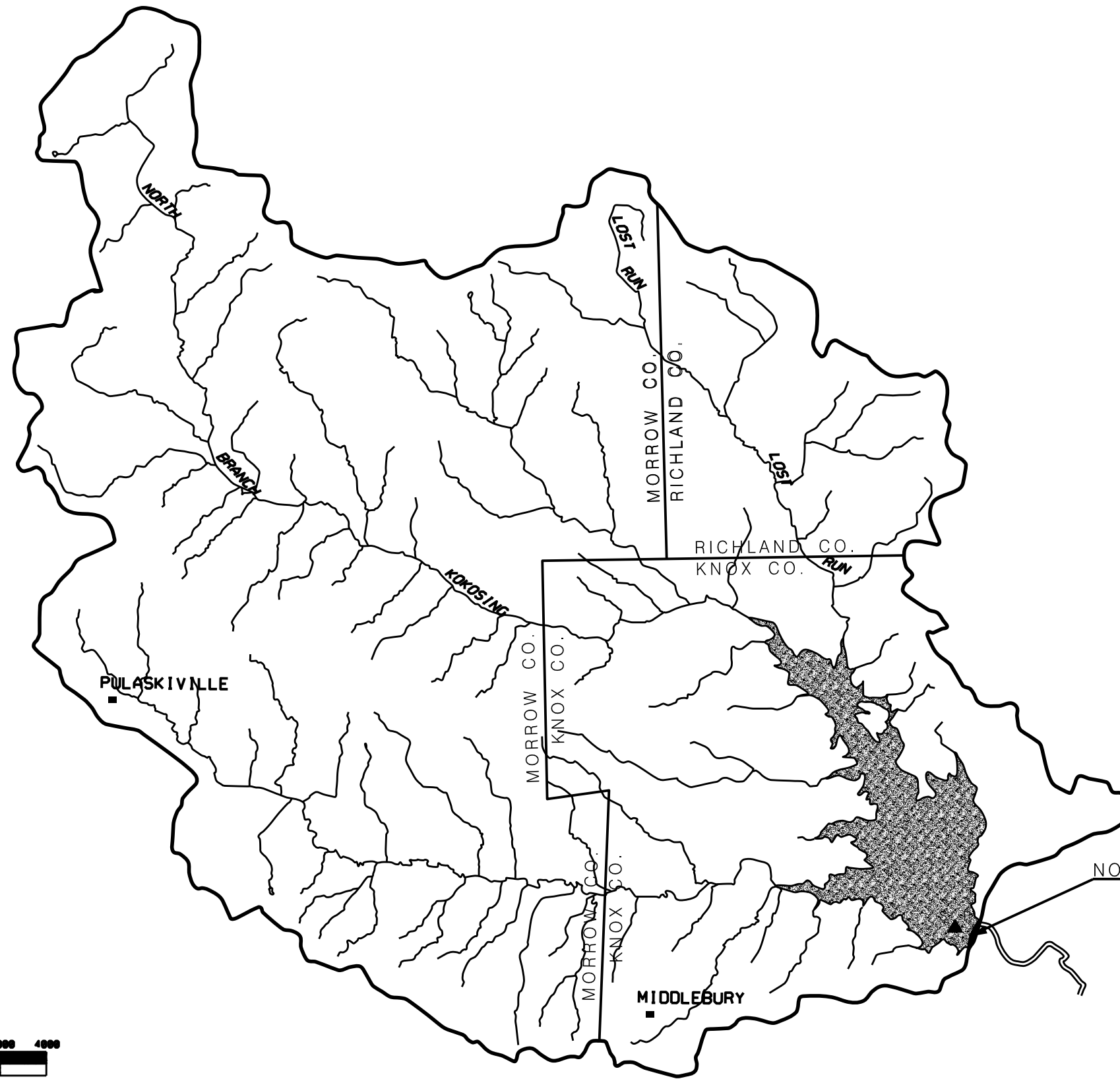
-  GOV'T. PROPERTY LINE
-  EASEMENT LINE
-  FLOOD CONTROL POOL - EL. 1146
-  MINIMUM POOL - EL. 1121
-  COUNTY ROAD
-  TOWNSHIP ROAD
-  RELOCATED ROAD
-  LAND & WATER AREAS ADMINISTERED BY OHIO DEPARTMENT OF NATURAL RESOURCES
-  FISH & WILDLIFE MANAGEMENT
-  RECREATION AREAS
-  OPERATION AREA & OVERLOOK



NORTH BRANCH OF KOKOSING RIVER  
OHIO  
NORTH BRANCH OF KOKOSING  
RIVER LAKE

**LAND-USE PLAN**

DEPARTMENT OF THE ARMY  
HUNTINGTON DISTRICT CORPS OF ENGINEERS  
HUNTINGTON, W. VA. REDRAWN: SEPT. 2000



**LEGEND**

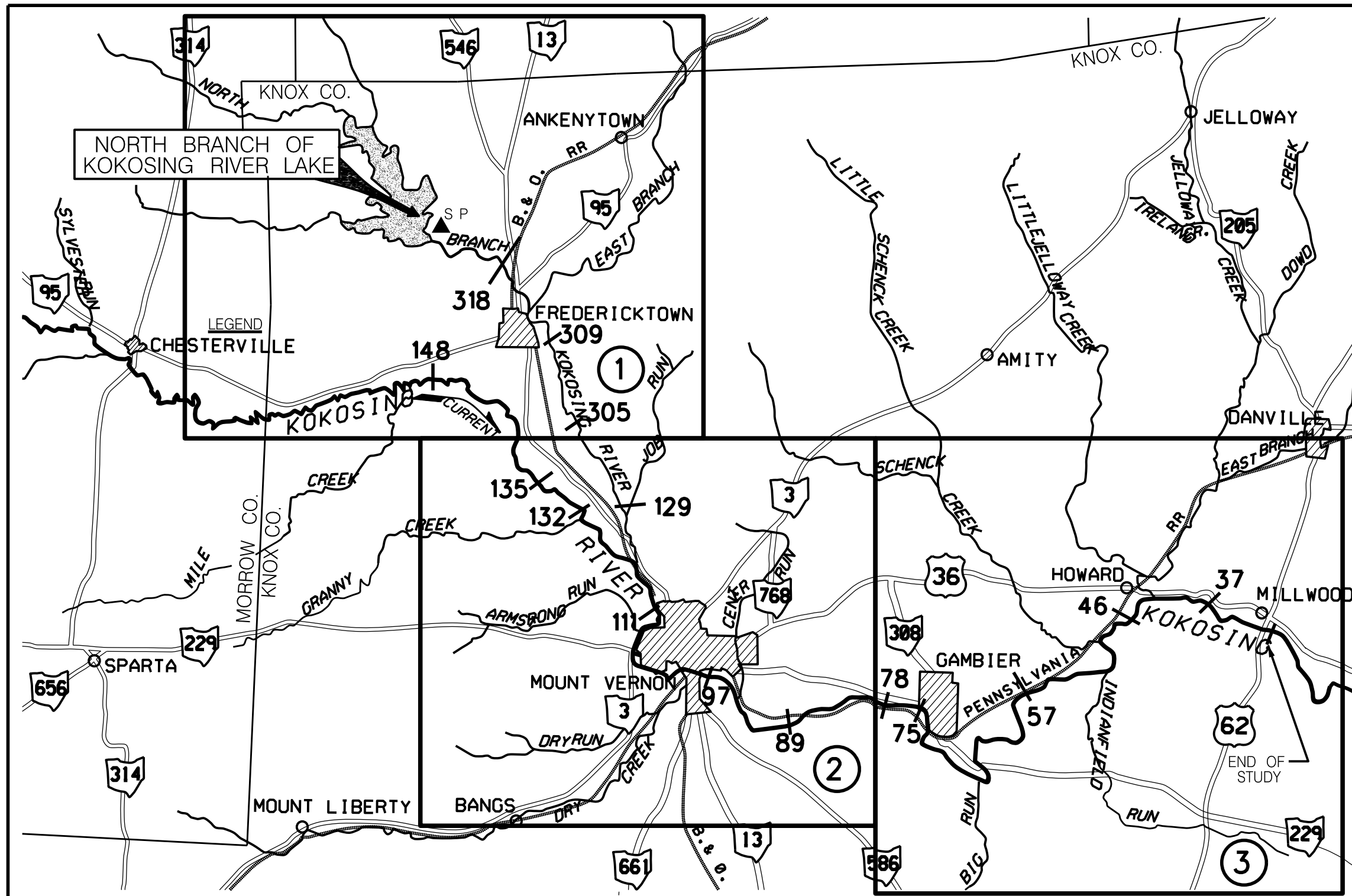


**NORTH BRANCH OF KOKOSING RIVER  
OHIO**

**NORTH BRANCH RESERVOIR**

DRAINAGE AREA MAP

DEPARTMENT OF THE ARMY  
HUNTINGTON DISTRICT CORPS OF ENGINEERS  
HUNTINGTON, W. VA. REDRAWN: SEPT. 2000



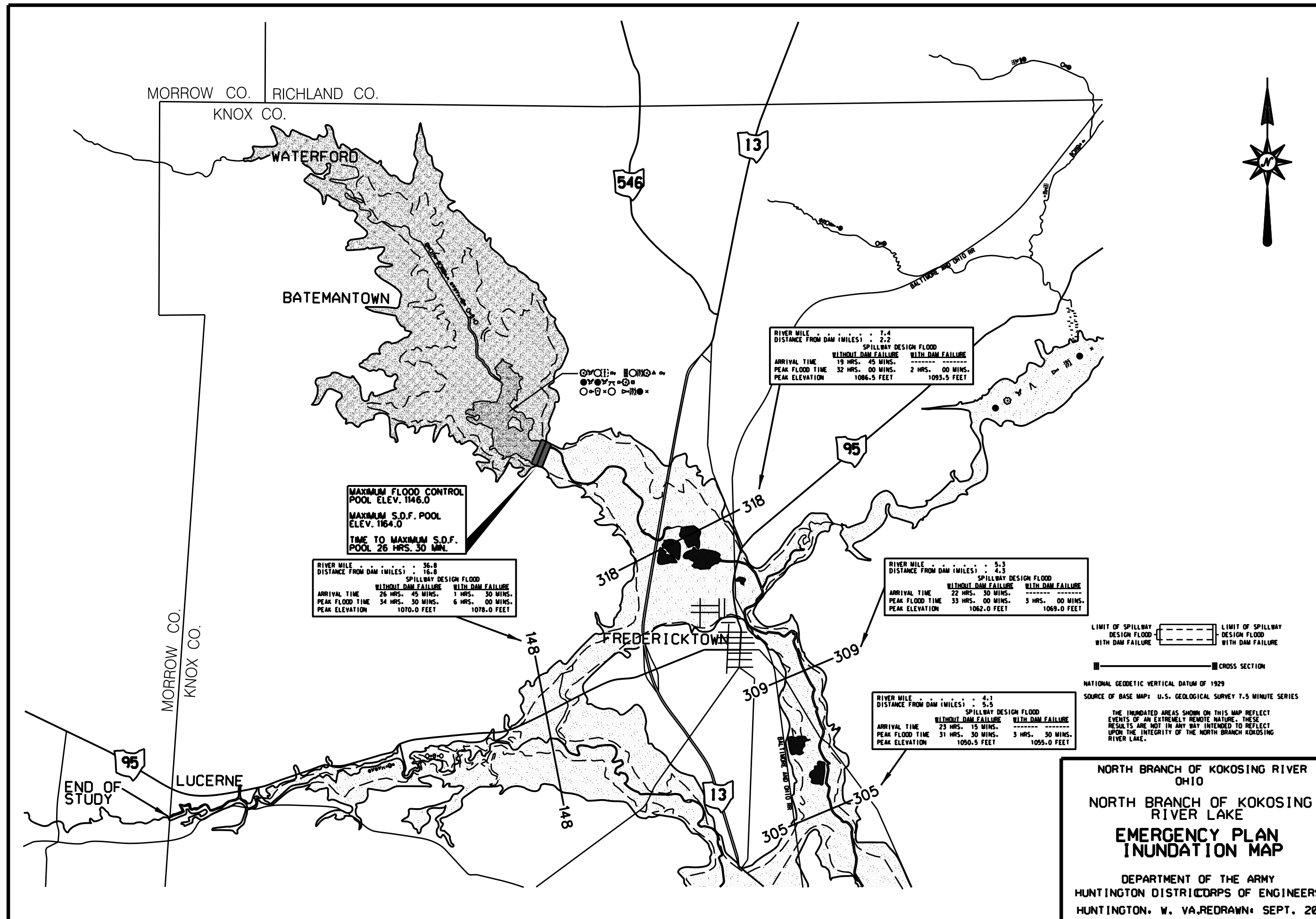
CROSS SECTION DATA

SPILLWAY DESIGN FLOOD									
PLATE NUM	SECT. NUM	RIVER NUM	DISTANCE FROM DAM MILE	WITHOUT DAM FAILURE			WITH DAM FAILURE		
				ARRIVAL TIME	PEAK FLOOD TIME	PEAK ELEV	ARRIVAL TIME	PEAK FLOOD TIME	PEAK ELEV
1	148	36.8	16.8	26 HRS 45 MINS	34 HRS 30 MINS	1070.0	1 HRS 30 MINS	6 HRS 00 MINS	1078.0
1	305	4.1	5.5	23 HRS 15 MINS	31 HRS 30 MINS	1050.5	-----	3 HRS 30 MINS	1055.0
1	309	5.3	4.3	22 HRS 30 MINS	33 HRS 00 MINS	1062.0	-----	3 HRS 00 MINS	1069.0
1	318	7.4	2.2	19 HRS 45 MINS	32 HRS 00 MINS	1086.5	-----	2 HRS 00 MINS	1093.5
2	89	24.0	15.2	27 HRS 30 MINS	50 HRS 00 MINS	974.5	00 HRS 30 MINS	13 HRS 00 MINS	987.5
2	97	25.8	13.4	27 HRS 30 MINS	49 HRS 00 MINS	985.5	00 HRS 30 MINS	12 HRS 00 MINS	996.0
2	111	28.6	10.6	26 HRS 45 MINS	43 HRS 00 MINS	1005.0	-----	9 HRS 30 MINS	1010.5
2	129	1.3	8.3	27 HRS 30 MINS	33 HRS 30 MINS	1020.5	1 HRS 45 MINS	5 HRS 30 MINS	1024.5

SPILLWAY DESIGN FLOOD									
PLATE NUM	SECT. NUM	RIVER NUM	DISTANCE FROM DAM MILE	WITHOUT DAM FAILURE			WITH DAM FAILURE		
				ARRIVAL TIME	PEAK FLOOD TIME	PEAK ELEV	ARRIVAL TIME	PEAK FLOOD TIME	PEAK ELEV
2	132	31.5	11.5	30 HRS 15 MINS	40 HRS 00 MINS	1026.5	2 HRS 00 MINS	8 HRS 30 MINS	1034.5
2	135	32.6	12.6	27 HRS 30 MINS	39 HRS 00 MINS	1038.5	-----	7 HRS 30 MINS	1046.0
3	37	9.9	29.3	41 HRS 30 MINS	61 HRS 00 MINS	896.0	13 HRS 00 MINS	20 HRS 00 MINS	905.5
3	46	12.2	27.0	41 HRS 00 MINS	59 HRS 00 MINS	903.5	12 HRS 30 MINS	19 HRS 30 MINS	910.5
3	57	15.6	23.6	36 HRS 00 MINS	55 HRS 00 MINS	923.5	9 HRS 30 MINS	16 HRS 00 MINS	929.5
3	75	20.8	18.4	31 HRS 30 MINS	51 HRS 00 MINS	955.0	4 HRS 15 MINS	13 HRS 30 MINS	962.5
3	78	21.8	17.4	31 HRS 00 MINS	50 HRS 30 MINS	962.0	4 HRS 00 MINS	13 HRS 00 MINS	972.0

NORTH BRANCH OF KOKOSING RIVER  
OHIO  
NORTH BRANCH OF KOKOSING RIVER LAKE  
**EMERGENCY PLAN INDEX MAP**  
DEPARTMENT OF THE ARMY  
HUNTINGTON DISTRICT CORPS OF ENGINEERS  
HUNTINGTON, W. VA. REDRAWN: SEPT. 2000



MORROW CO. RICHLAND CO.  
KNOX CO.

WATERFORD

BATEMANTOWN

546

13

RIVER MILE	7.4	
DISTANCE FROM DAM (MILES)	2.2	
SPILLWAY DESIGN FLOOD		
ARRIVAL TIME	WITHOUT DAM FAILURE	WITH DAM FAILURE
PEAK FLOOD TIME	19 HRS. 45 MINS.	32 HRS. 00 MINS.
PEAK ELEVATION	1086.5 FEET	1093.5 FEET

95

MAXIMUM FLOOD CONTROL  
POOL ELEV. 1146.0  
MAXIMUM S.D.F. POOL  
ELEV. 1164.0  
TIME TO MAXIMUM S.D.F.  
POOL 26 HRS. 30 MIN.

RIVER MILE	36.8	
DISTANCE FROM DAM (MILES)	16.8	
SPILLWAY DESIGN FLOOD		
ARRIVAL TIME	WITHOUT DAM FAILURE	WITH DAM FAILURE
PEAK FLOOD TIME	26 HRS. 45 MINS.	34 HRS. 30 MINS.
PEAK ELEVATION	1070.0 FEET	1078.0 FEET

318

RIVER MILE	5.3	
DISTANCE FROM DAM (MILES)	4.3	
SPILLWAY DESIGN FLOOD		
ARRIVAL TIME	WITHOUT DAM FAILURE	WITH DAM FAILURE
PEAK FLOOD TIME	22 HRS. 30 MINS.	33 HRS. 00 MINS.
PEAK ELEVATION	1062.0 FEET	1069.0 FEET

FREDERICKTOWN

309

RIVER MILE	4.1	
DISTANCE FROM DAM (MILES)	5.5	
SPILLWAY DESIGN FLOOD		
ARRIVAL TIME	WITHOUT DAM FAILURE	WITH DAM FAILURE
PEAK FLOOD TIME	23 HRS. 15 MINS.	31 HRS. 30 MINS.
PEAK ELEVATION	1050.5 FEET	1055.0 FEET

MORROW CO.  
KNOX CO.

LUCERNE

END OF STUDY

148

13

305

LIMIT OF SPILLWAY DESIGN FLOOD WITH DAM FAILURE

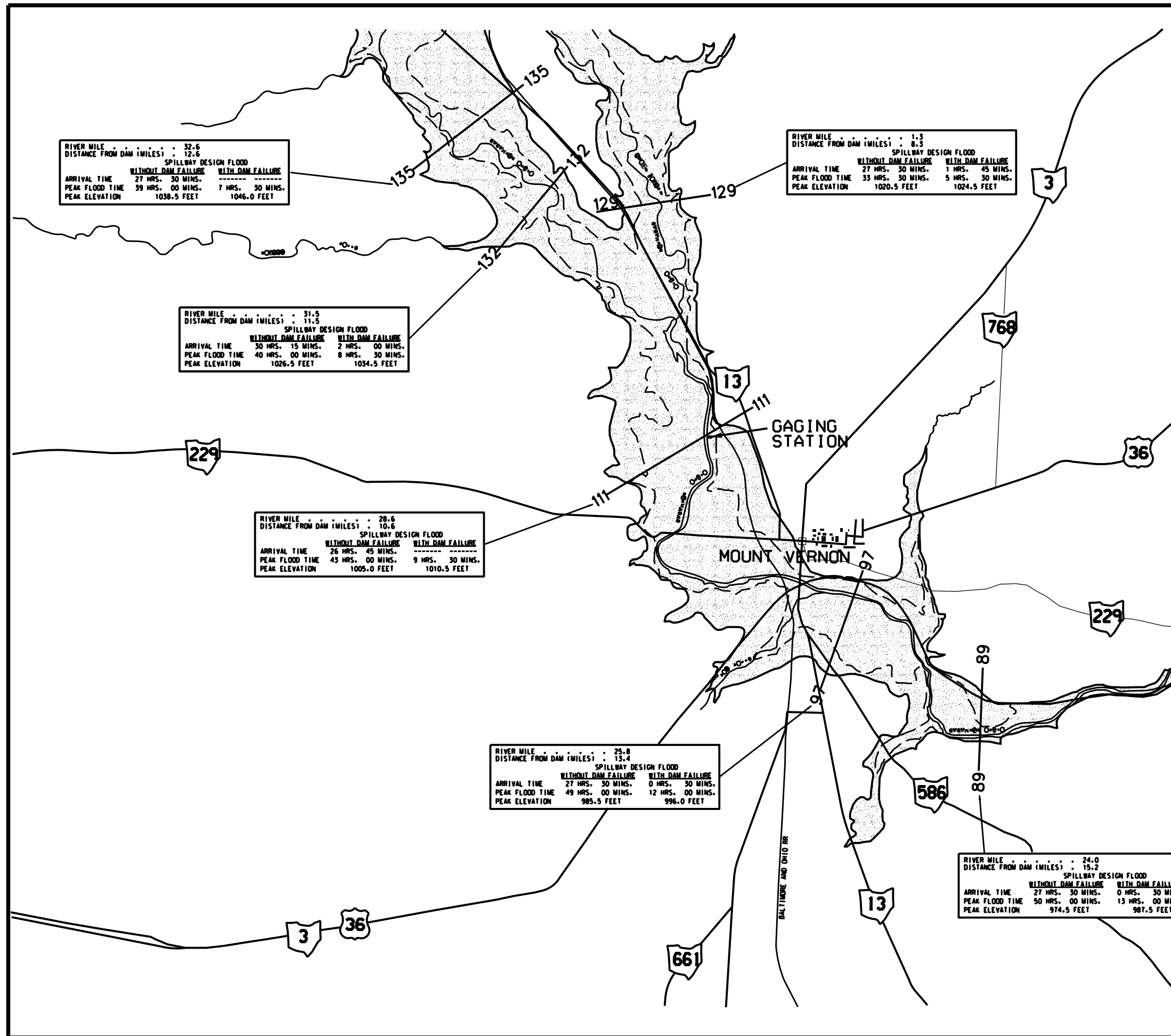
CROSS SECTION

NATIONAL GEODETIC VERTICAL DATUM OF 1929  
SOURCE OF BASE MAP: U.S. GEOLOGICAL SURVEY 7.5 MINUTE SERIES

THE INUNDATED AREAS SHOWN ON THIS MAP REFLECT EVENTS OF AN EXTREMELY REMOTE NATURE; THESE RESULTS ARE NOT IN ANY WAY INTENDED TO REFLECT UPON THE INTEGRITY OF THE NORTH BRANCH KOKOSING RIVER LAKE.

**NORTH BRANCH OF KOKOSING RIVER OHIO**  
**NORTH BRANCH OF KOKOSING RIVER LAKE**  
**EMERGENCY PLAN INUNDATION MAP**

DEPARTMENT OF THE ARMY  
HUNTINGTON DISTRICT CORPS OF ENGINEERS  
HUNTINGTON, W. VA. REDRAWN: SEPT. 2000



RIVER MILE	: 32.6	
DISTANCE FROM DAM (MILES)	: 12.6	
SPILLWAY DESIGN FLOOD		
	WITHOUT DAM FAILURE	WITH DAM FAILURE
ARRIVAL TIME	27 HRS. 30 MINS.	7 HRS. 30 MINS.
PEAK FLOOD TIME	39 HRS. 00 MINS.	1046.0 FEET
PEAK ELEVATION	1038.5 FEET	

RIVER MILE	: 31.5	
DISTANCE FROM DAM (MILES)	: 11.5	
SPILLWAY DESIGN FLOOD		
	WITHOUT DAM FAILURE	WITH DAM FAILURE
ARRIVAL TIME	30 HRS. 15 MINS.	2 HRS. 00 MINS.
PEAK FLOOD TIME	40 HRS. 00 MINS.	8 HRS. 30 MINS.
PEAK ELEVATION	1026.5 FEET	1034.5 FEET

RIVER MILE	: 28.6	
DISTANCE FROM DAM (MILES)	: 10.6	
SPILLWAY DESIGN FLOOD		
	WITHOUT DAM FAILURE	WITH DAM FAILURE
ARRIVAL TIME	26 HRS. 45 MINS.	0 HRS. 30 MINS.
PEAK FLOOD TIME	43 HRS. 00 MINS.	9 HRS. 30 MINS.
PEAK ELEVATION	1005.0 FEET	1010.5 FEET

RIVER MILE	: 25.8	
DISTANCE FROM DAM (MILES)	: 13.4	
SPILLWAY DESIGN FLOOD		
	WITHOUT DAM FAILURE	WITH DAM FAILURE
ARRIVAL TIME	27 HRS. 30 MINS.	0 HRS. 30 MINS.
PEAK FLOOD TIME	49 HRS. 00 MINS.	12 HRS. 00 MINS.
PEAK ELEVATION	985.5 FEET	996.0 FEET

RIVER MILE	: 1.3	
DISTANCE FROM DAM (MILES)	: 8.3	
SPILLWAY DESIGN FLOOD		
	WITHOUT DAM FAILURE	WITH DAM FAILURE
ARRIVAL TIME	27 HRS. 30 MINS.	1 HRS. 45 MINS.
PEAK FLOOD TIME	33 HRS. 30 MINS.	5 HRS. 30 MINS.
PEAK ELEVATION	1020.5 FEET	1024.5 FEET

RIVER MILE	: 24.0	
DISTANCE FROM DAM (MILES)	: 15.2	
SPILLWAY DESIGN FLOOD		
	WITHOUT DAM FAILURE	WITH DAM FAILURE
ARRIVAL TIME	27 HRS. 30 MINS.	0 HRS. 30 MINS.
PEAK FLOOD TIME	50 HRS. 00 MINS.	13 HRS. 00 MINS.
PEAK ELEVATION	974.5 FEET	987.5 FEET

LIMIT OF SPILLWAY DESIGN FLOOD WITH DAM FAILURE (dashed line)  
 LIMIT OF SPILLWAY DESIGN FLOOD WITH DAM FAILURE (solid line)

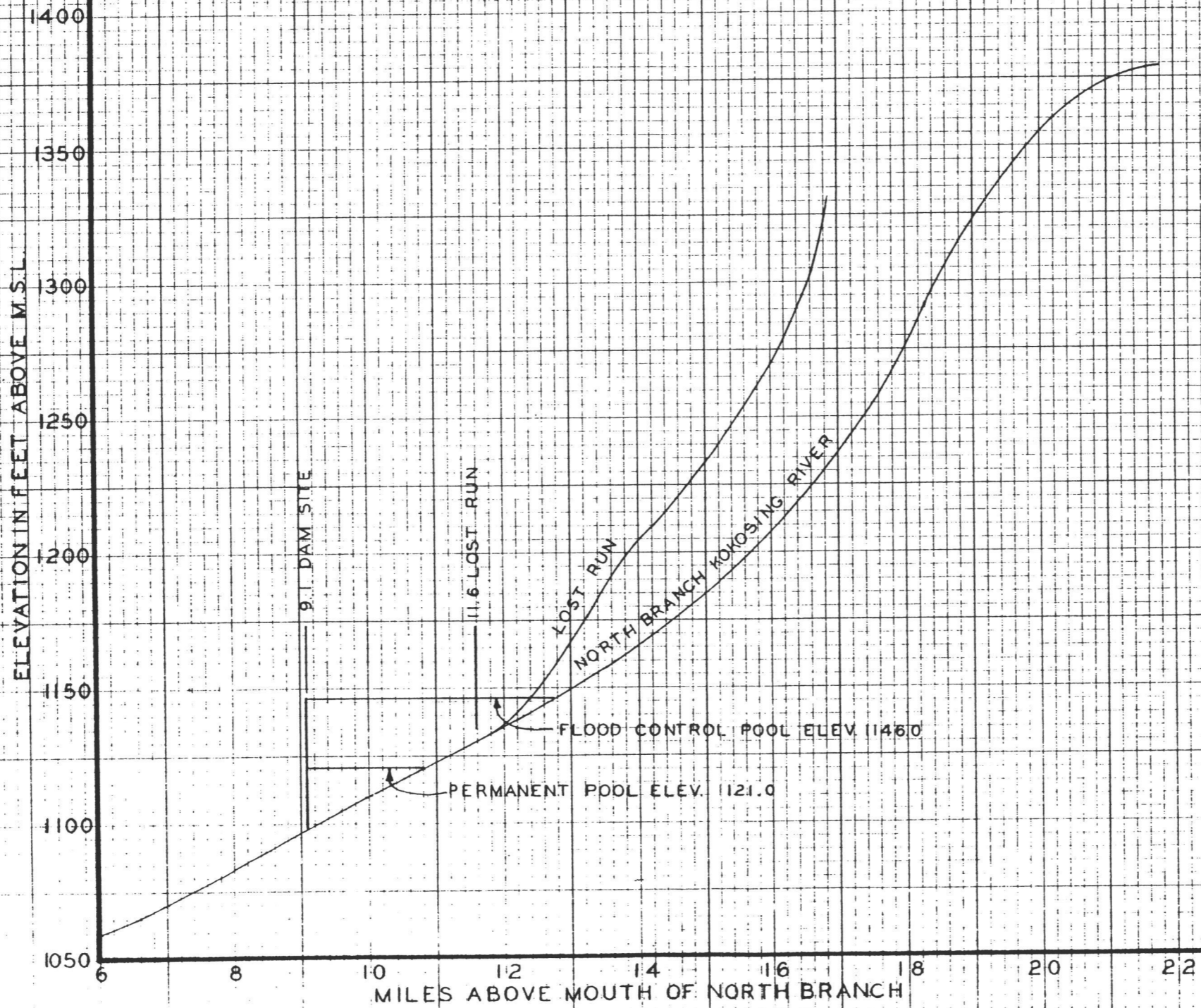
CROSS SECTION (line with vertical bars)

NATIONAL GEODETIC VERTICAL DATUM OF 1929  
 SOURCE OF BASE MAP: U.S. GEOLOGICAL SURVEY 7.5 MINUTE SERIES

THE INUNDATED AREAS SHOWN ON THIS MAP REFLECT EVENTS OF AN EXTREMELY REMOTE NATURE. THESE RESULTS ARE NOT IN ANY WAY INTENDED TO REFLECT UPON THE INTEGRITY OF THE NORTH BRANCH KOKOSING RIVER LAKE.

**NORTH BRANCH OF KOKOSING RIVER**  
**OHIO**  
**NORTH BRANCH OF KOKOSING RIVER LAKE**  
**EMERGENCY PLAN INUNDATION MAP**  
 DEPARTMENT OF THE ARMY  
 HUNTINGTON DISTRICT CORPS OF ENGINEERS  
 HUNTINGTON, W. VA. REDRAWN: SEPT. 2000

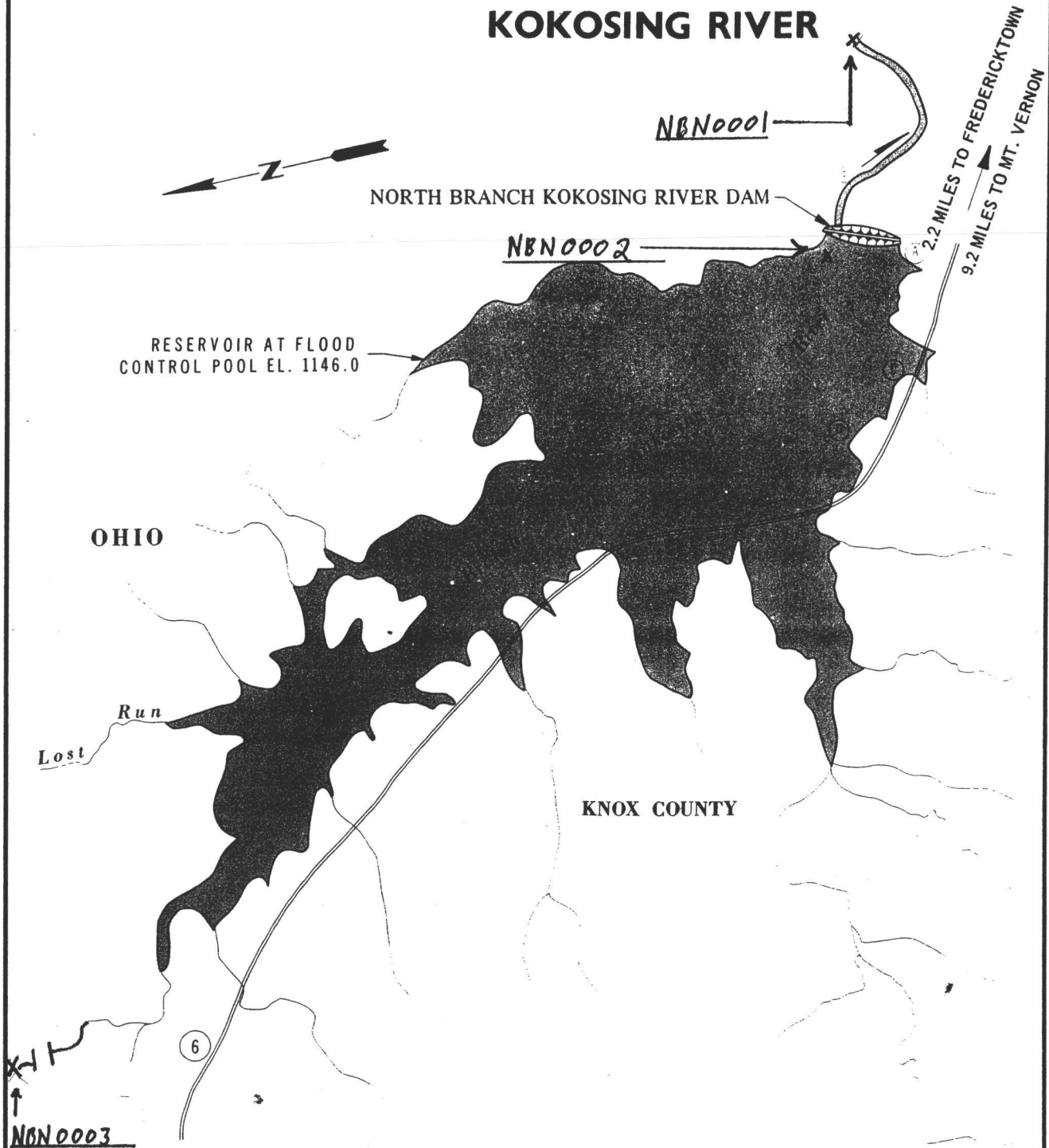




KOKOSING RIVER  
OHIO  
NORTH BRANCH RESERVOIR PROJECT  
STREAM PROFILE  
SCALE AS SHOWN  
U. S. ARMY ENGINEER DISTRICT, HUNTINGTON  
CORPS OF ENGINEERS  
HUNTINGTON, W. VA. APRIL 1965

# NORTH BRANCH KOKOSING RIVER

F/C 76-C



RESERVOIR AT FLOOD  
CONTROL POOL EL. 1146.0

OHIO

Lost Run

KNOX COUNTY

## PUBLIC USE GUIDE

- OVERLOOK
- FISHERMAN ACCESS & PICNIC AREA
- BOAT RAMP & PICNIC AREA
- CAMPING AREA

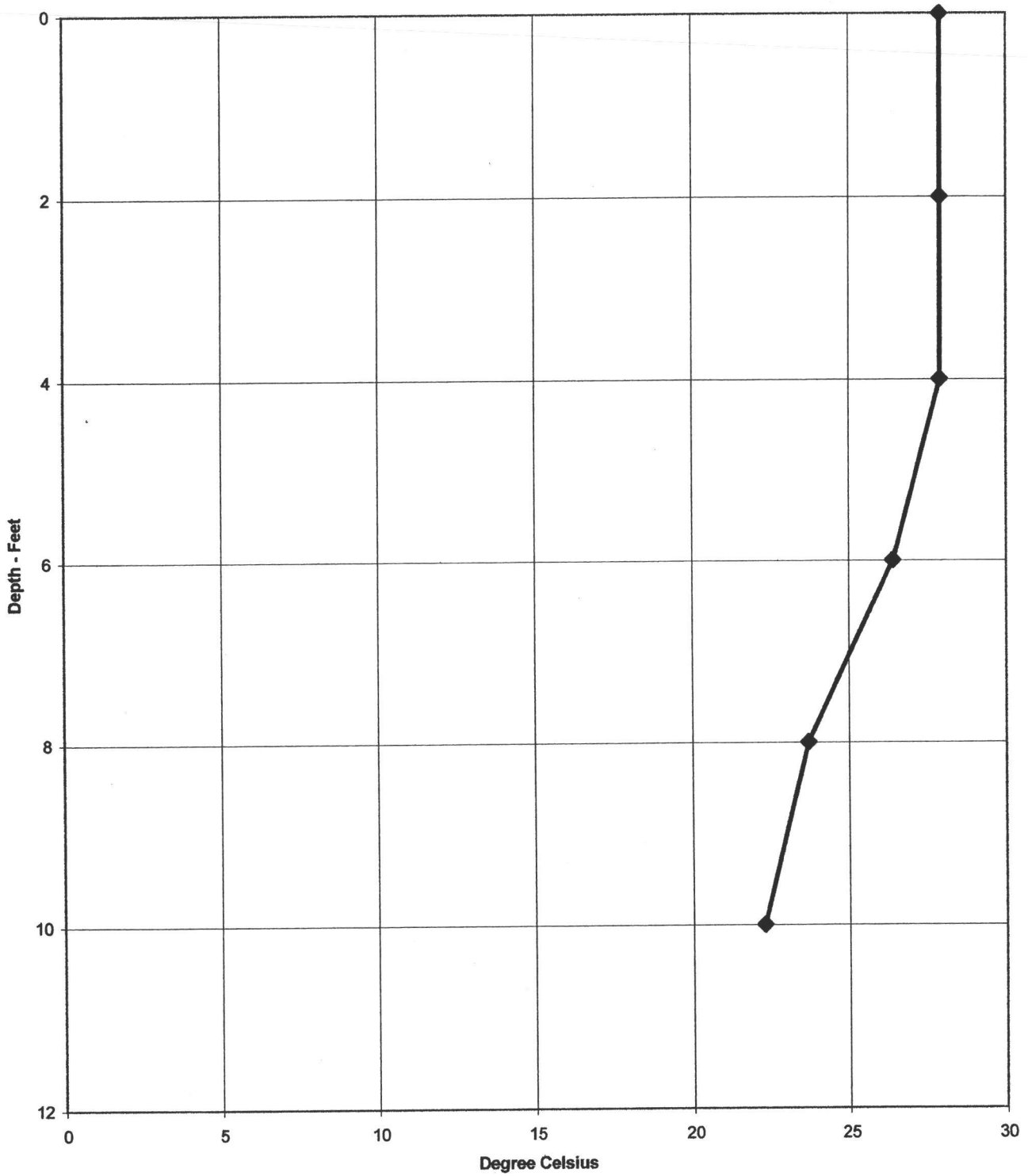
MUSKINGUM RIVER BASIN  
NORTH BRANCH KOKOSING RIVER  
NORTH BRANCH KOKOSING RIVER LAKE

Scale In Feet

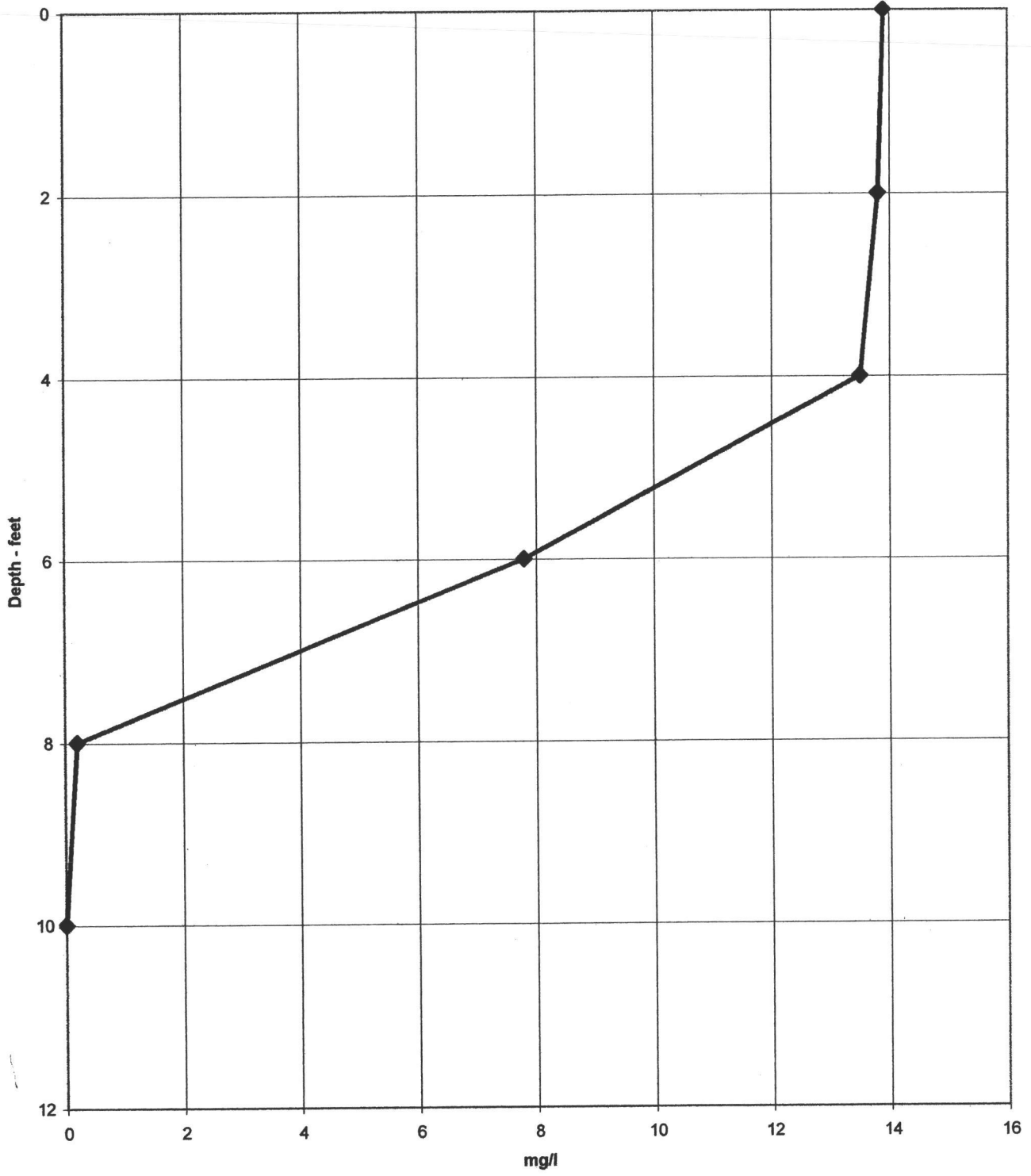


HUNTINGTON DISTRICT, HUNTINGTON, W. VA.  
Revised: 30 JUNE 1974

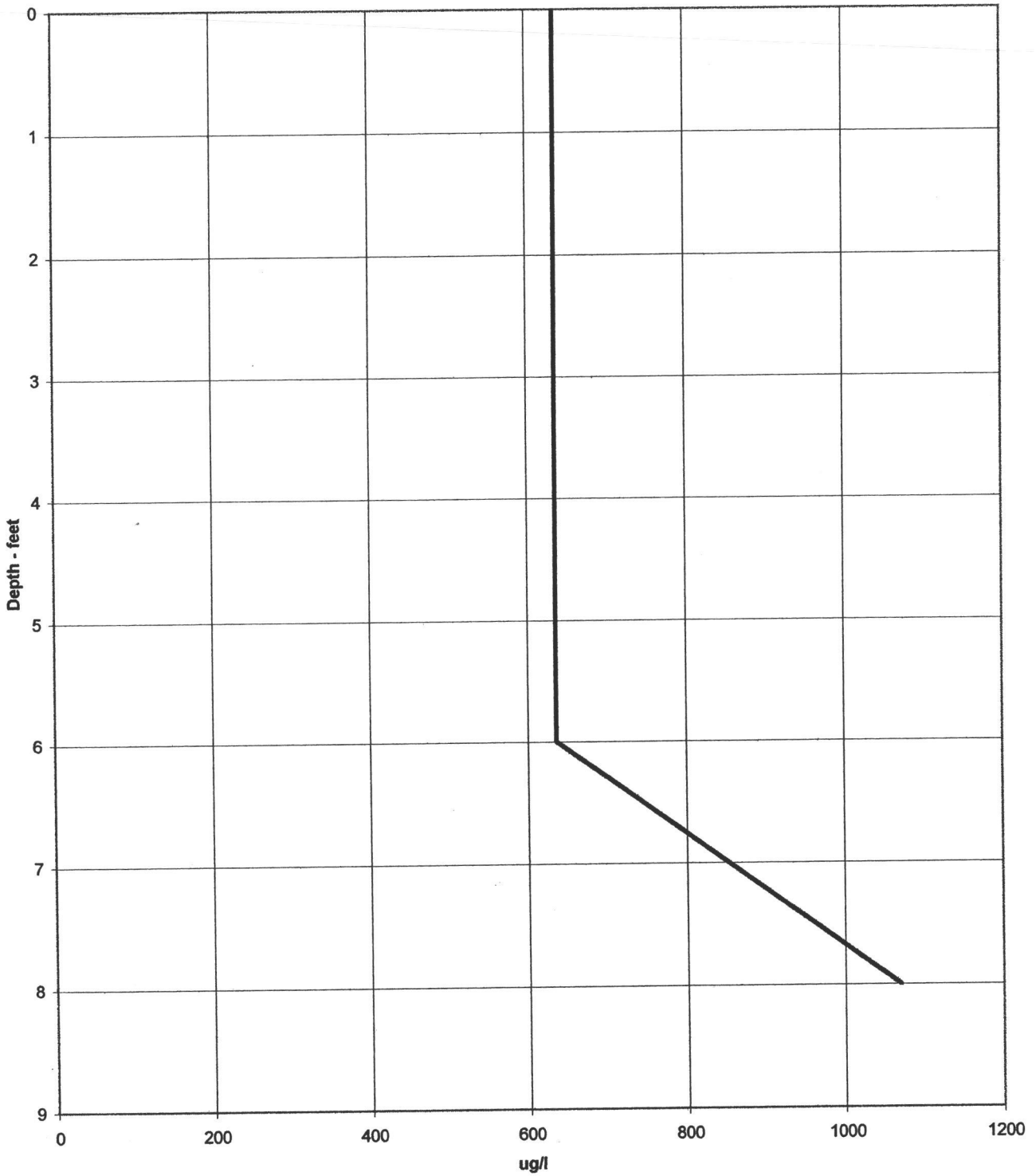
North Branch Kokosing Lake  
Water Temperature  
October 22, 1995



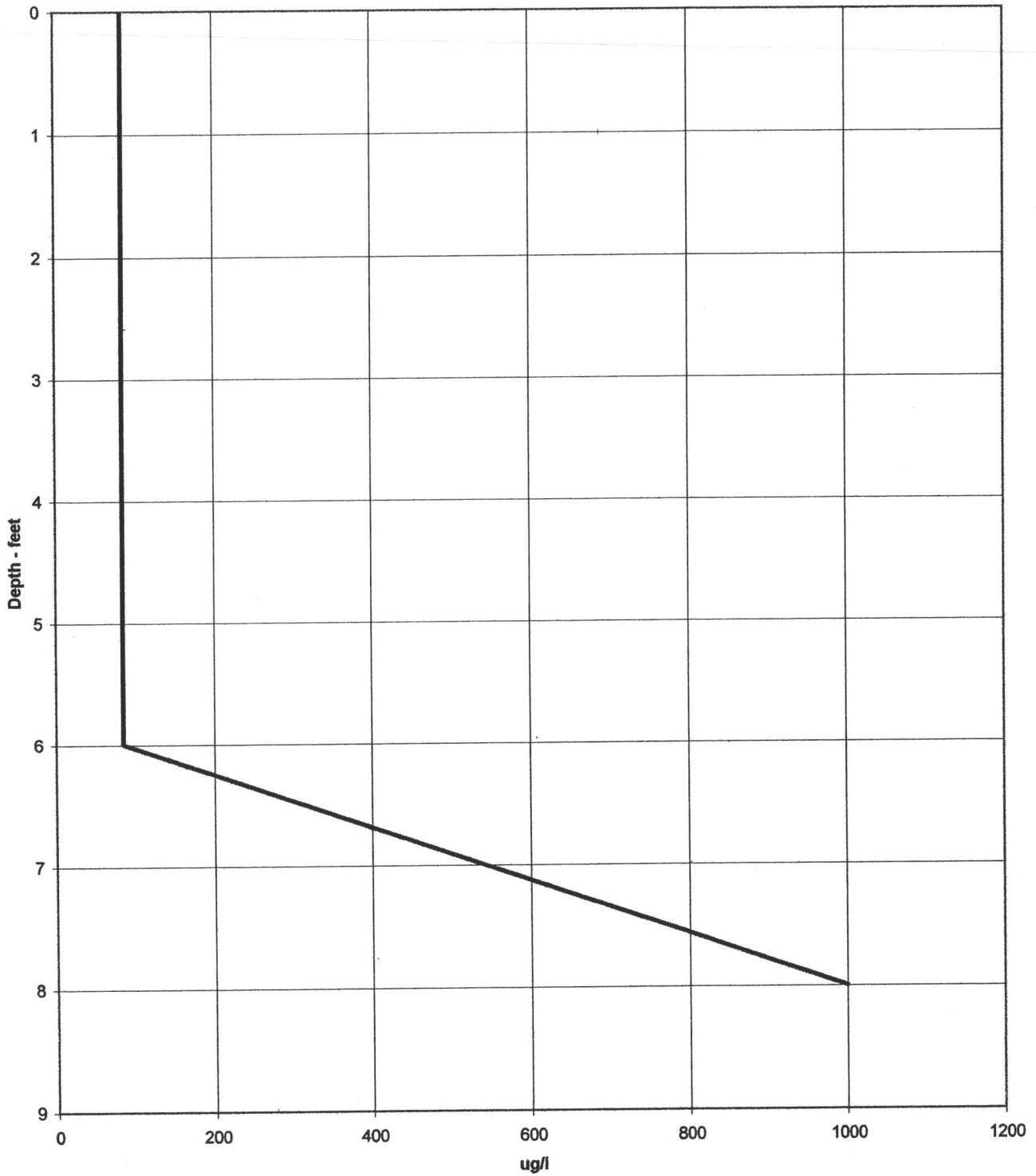
North Branch Kokosing Lake  
Dissolved Oxygen  
October 22, 1995

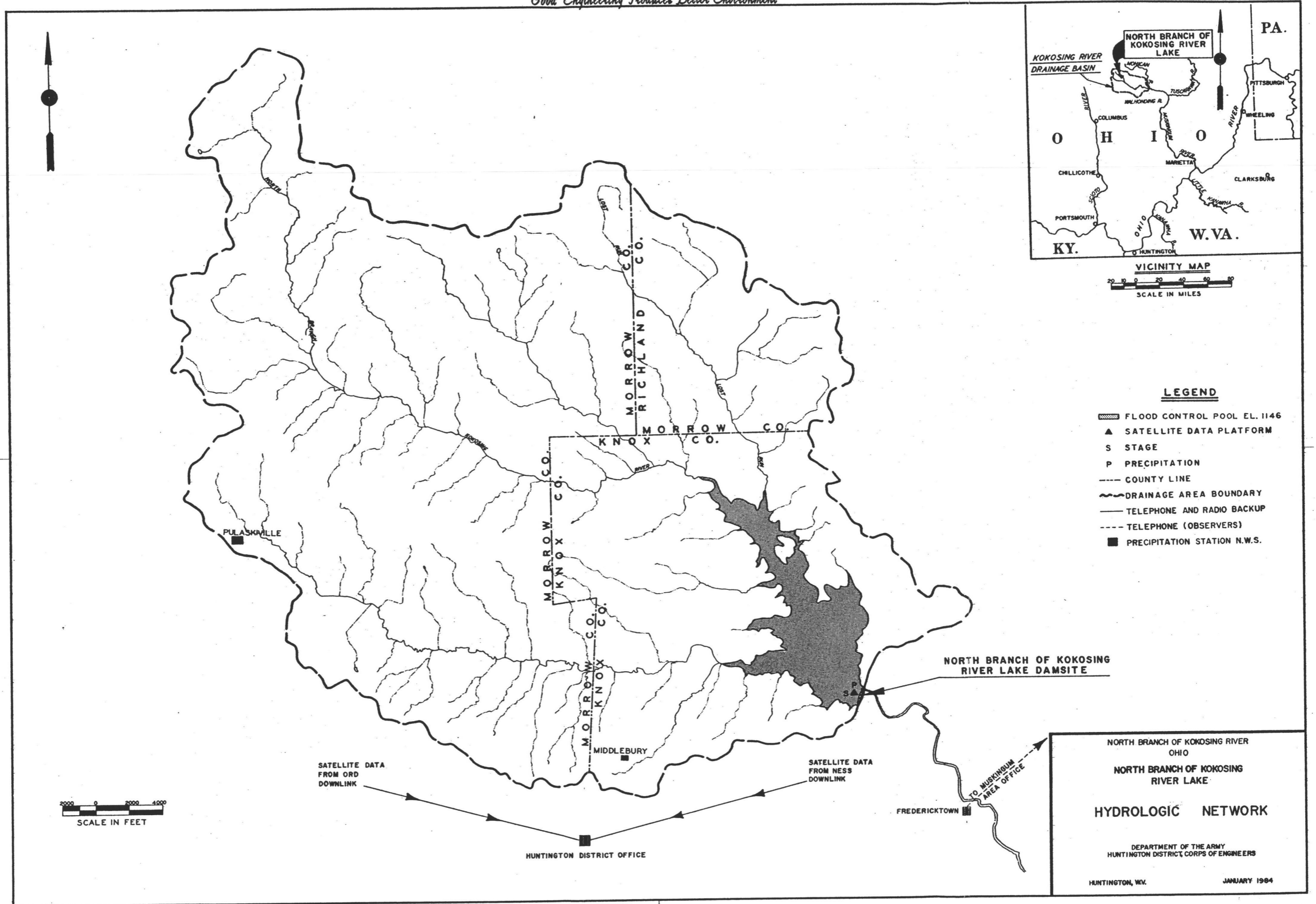


North Branch Kokosing Lake  
Total Iron  
October 22, 1995



North Branch Kokosing Lake  
Total Manganese  
October 22, 1995





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

EXPANDED RATING TABLE DATE PRINTED 03-08-78

03136400 N B KOKOSING R NR FREDERICKTOWN OH

TYPE LOG(SCALE OFFSET = 2.00) RATING NO 15

BASED ON \_\_\_\_\_ DISCHARGE MEASUREMENTS, NO. \_\_\_\_\_, AND \_\_\_\_\_, AND IS \_\_\_\_\_ WELL DEFINED BETWEEN \_\_\_\_\_ AND \_\_\_\_\_  
 \*COMP BY \_\_\_\_\_ DATE \_\_\_\_\_  
 \*CKD. BY \_\_\_\_\_ DATE \_\_\_\_\_

GAGE HEIGHT IN FEET	DISCHARGE IN CUBIC FEET PER SECOND (EXPANDED PRECISION)											DIFF IN Q PER TENTH GH
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09		
2.10	.620	.756	.907	1.07	1.25	1.44	1.65	1.87	2.11	2.36	2.61	2.01
2.20	2.63	2.91	3.21	3.52	3.85	4.19	4.55	4.92	5.31	5.71	6.11	3.50
2.30	6.13	6.55	7.01	7.47	7.95	8.45	8.96	9.49	10.0	10.6	11.1	5.0
2.40	11.2	11.8	12.4	13.0	13.6	14.3	14.9	15.6	16.3	17.0	17.6	6.6
2.50	17.8	18.5	19.3	20.1	20.9	21.6	22.5	23.4	24.1	25.1	25.9	8.2
2.60	26.0	26.8	27.7	28.6	29.5	30.4	31.3	32.2	33.2	34.1	35.1	9.1
2.70	35.1	36.1	37.1	38.1	39.1	40.1	41.2	42.2	43.3	44.4	45.4	10.4
2.80	45.5	46.6	47.7	48.8	50.0	51.2	52.3	53.5	54.7	55.9	57.1	11.7
2.90	57.2	58.4	59.7	60.9	62.2	63.5	64.8	66.1	67.5	68.8	70.1	13.0
3.00	70.2	71.5	72.9	74.3	75.7	77.1	78.6	80.0	81.5	83.0	84.5	14.2
3.10	84.4	85.9	87.5	89.0	90.5	92.1	93.6	95.2	96.8	98.4	100.0	15.6
3.20	100.0	101.6	103.2	104.8	106.4	108.0	109.7	111.3	113.0	114.7	116.4	16.4
3.30	116.4	118.1	119.8	121.5	123.3	125.0	126.6	128.2	129.8	131.5	133.1	16.5
3.40	133.1	134.8	136.4	138.1	139.8	141.5	143.1	144.8	146.6	148.3	150.0	16.4
3.50	150.0	151.8	153.5	155.3	157.1	158.9	160.7	162.6	164.4	166.2	168.1	18.1
3.60	168.1	169.9	171.8	173.7	175.5	177.4	179.3	181.2	183.1	185.1	187.0	18.8
3.70	187.0	188.9	190.9	192.9	194.8	196.8	198.8	200.8	202.8	204.8	206.8	19.6
3.80	206.8	208.8	210.9	212.9	215.0	217.0	219.1	221.2	223.3	225.4	227.5	20.6
3.90	227.5	229.6	231.7	233.9	236.0	238.1	240.3	242.5	244.6	246.8	249.0	21.5
4.00	249.0	251.1	253.3	255.4	257.6	259.6	261.8	264.1	266.3	268.3	270.5	21.6
4.10	270.6	272.8	275.1	277.3	279.5	281.6	284.0	286.1	288.5	290.8	293.0	22.4
4.20	293.0	295.3	297.6	299.8	302.1	304.5	306.8	309.1	311.5	313.8	316.1	23.1
4.30	316.1	318.5	320.9	323.1	325.6	328.0	330.4	332.8	335.1	337.6	340.0	23.8
4.40	340.0	342.3	344.6	347.0	349.3	351.6	354.0	356.3	358.6	361.1	363.4	23.4
4.50	363.4	365.8	368.1	370.6	373.0	375.4	377.8	380.1	382.6	385.0	387.5	24.1
4.60	387.5	389.9	392.3	394.8	397.1	399.6	402.1	404.6	407.1	409.6	412.1	24.6
4.70	412.1	414.6	417.1	419.6	422.1	424.6	427.2	429.7	432.2	434.8	437.3	25.1
4.80	437.3	439.9	442.4	445.0	447.5	450.1	452.7	455.3	457.9	460.5	463.1	25.8
4.90	463.1	465.7	468.3	470.9	473.5	476.2	478.8	481.5	484.1	486.8	489.4	26.4
5.00	489.5	492.1	494.8	497.5	500.2	502.8	505.5	508.2	510.9	513.7	516.4	26.9
5.10	516.4	519.1	521.8	524.6	527.3	530.0	532.8	535.5	538.3	541.1	543.9	27.4
5.20	543.8	546.5	549.4	552.2	555.0	557.8	560.6	563.4	566.2	569.0	571.9	28.1
5.30	571.9	574.7	577.5	580.4	583.2	586.1	588.9	591.8	594.7	597.5	600.4	28.5
5.40	600.4	603.3	606.2	609.1	612.0	614.9	617.8	620.7	623.7	626.6	629.5	29.1
5.50	629.5	632.5	635.4	638.4	641.3	644.3	647.2	650.2	653.2	656.2	659.1	29.7
5.60	659.2	662.2	665.2	668.2	671.2	674.2	677.2	680.2	683.2	686.3	689.3	30.1
5.70	689.3	692.4	695.4	698.5	701.5	704.6	707.7	710.7	713.8	716.9	720.0	30.7
5.80	720.0											

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

EXPANDED RATING TABLE DATE PRINTED 03-08-78

03136400

N B KOKOSING R NR FREDERICKTOWN OH

TYPE LOG (SCALE OFFSET = 2.00) RATING NO 15

BASED ON \_\_\_\_\_ DISCHARGE MEASUREMENTS, NO. \_\_\_\_\_, AND \_\_\_\_\_, AND IS \_\_\_\_\_ WELL DEFINED BETWEEN \_\_\_\_\_ AND \_\_\_\_\_

\*COMP BY \_\_\_\_\_ DATE \_\_\_\_\_  
\*CKD. BY \_\_\_\_\_ DATE \_\_\_\_\_

FROM \_\_\_\_\_ TO \_\_\_\_\_, FROM \_\_\_\_\_ TO \_\_\_\_\_

DIFF IN Q  
PER  
FOOT GH

GAGE HEIGHT IN FEET	DISCHARGE IN CUBIC FEET PER SECOND (EXPANDED PRECISION)										DIFF IN Q PER FOOT GH
	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9	
2.00		.620	2.63	6.13	11.2	17.8	26.0	35.1	45.5	57.2	178.8
3.00	70.2	84.4	100.0	116.4	133.1	150.0	168.1	187.0	206.8	227.5	240.5
4.00	249.0	270.6	293.0	315.1	340.0	363.4	387.5	412.1	437.3	463.1	240.5
5.00	489.5	515.4	543.8	571.9	600.4	629.5	659.2	689.3	720.0		

UNITED STATES DEPARTMENT OF INTERIOR - GEOLOGICAL SURVEY - WATER RESOURCES DIVISION  
 EXPANDED RATING TABLE  
 DATE PROCESSED: 03-27-1990 @ 13:07 BY JMKLINGLER

PAGE 1  
 TYPE: LOG RLR

03136500  
 KOKOSING R AT MOUNT VERNON OH  
 OFFSET: .00

DD: 2 TYPE: 001 RATING NO: 0036  
 START DATE/TIME: 06-14-89 (1500)

BASED ON DISCHARGE MEASUREMENTS, NOS AND AND IS WELL DEFINED BETWEEN AND CFS  
 COMP BY DATE CHK. BY DATE

GAGE HEIGHT (FEET)	DISCHARGE IN CUBIC FEET PER SECOND (EXPANDED PRECISION)										DIFF IN Q PER TENTH FT
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
.20	8.200*	9.284	10.45	11.70	13.04	14.47	15.98	17.59	19.30	21.10	14.80
.30	23.00*	24.33	25.74	27.16	28.62	30.10	31.62	33.17	34.75	36.36	15.00
.40	38.00*	39.67	41.36	43.09	44.84	46.63	48.45	50.29	52.17	54.07	18.00
.50	58.00*	59.94	61.92	63.92	65.95	68.00	68.06	70.19	72.33	74.49	20.88
.60	76.68	78.90	81.14	83.41	85.71	88.03	90.38	92.75	95.15	97.58	23.32
.70	100.0	102.5	105.0	107.5	110.1	112.7	115.3	117.9	120.5	123.2	25.90
.80	125.9	128.6	131.4	134.2	137.0	139.8	142.6	145.5	148.4	151.3	28.40
.90	154.3	157.2	160.2	163.2	166.3	169.3	172.4	175.5	178.7	181.8	30.70
1.00	185.0*	188.2	191.4	194.7	197.9	201.2	204.5	207.8	211.2	214.6	33.00
1.10	218.0	221.4	224.8	228.3	231.8	235.3	238.8	242.4	246.0	249.6	33.20
1.20	253.2	256.8	260.5	264.2	267.9	271.6	275.4	279.2	283.0	286.8	37.40
1.30	290.6	294.5	298.3	302.2	306.2	310.1	314.1	318.1	322.1	326.1	39.50
1.40	330.1	334.2	338.3	342.4	346.5	350.7	354.9	359.1	363.3	367.5	41.70
1.50	371.8	376.0	380.3	384.7	389.0	393.4	397.7	402.1	406.6	411.0	43.70
1.60	415.5	419.9	424.4	428.9	433.5	438.0	442.6	447.2	451.8	456.5	45.60
1.70	461.1	465.8	470.5	475.2	480.0	484.7	489.5	494.3	499.1	504.0	47.70
1.80	508.8	513.7	518.6	523.5	528.4	533.4	538.4	543.4	548.4	553.4	49.70
1.90	558.5	563.5	568.6	573.7	578.8	584.0	589.2	594.3	599.5	604.8	51.50
2.00	610.0*	615.3	620.6	625.9	631.3	636.6	642.0	647.4	652.8	658.3	53.70
2.10	663.7	669.2	674.7	680.2	685.7	691.3	696.9	702.4	708.0	713.7	55.60
2.20	719.3	725.0	730.7	736.4	742.1	747.8	753.6	759.4	765.2	771.0	57.50
2.30	776.8	782.7	788.5	794.4	800.3	806.2	812.2	818.2	824.1	830.1	59.40
2.40	836.2	842.2	848.2	854.3	860.4	866.5	872.6	878.8	884.9	891.1	61.10
2.50	897.3	903.5	909.8	916.0	922.3	928.6	934.9	941.2	947.6	953.9	63.00
2.60	960.3	966.7	973.1	979.6	986.0	992.5	999.0	1005	1012	1019	64.70
2.70	1025	1032	1038	1045	1051	1058	1065	1071	1078	1085	67.00
2.80	1092	1098	1105	1112	1119	1126	1132	1139	1146	1153	68.00
2.90	1160	1167	1174	1181	1188	1195	1202	1209	1216	1223	70.00
3.00	1230*	1237	1245	1252	1259	1267	1274	1281	1289	1296	74.00
3.10	1304	1311	1319	1326	1334	1341	1349	1356	1364	1372	75.00
3.20	1379	1387	1395	1402	1410	1418	1426	1433	1441	1449	78.00
3.30	1457	1465	1473	1480	1488	1496	1504	1512	1520	1528	79.00
3.40	1536	1544	1552	1560	1568	1576	1585	1593	1601	1609	81.00
3.50	1617	1625	1634	1642	1650	1659	1667	1675	1683	1692	83.00
3.60	1700	1709	1717	1725	1734	1742	1751	1759	1768	1776	85.00
3.70	1785	1794	1802	1811	1819	1828	1837	1845	1854	1863	87.00
3.80	1872	1880	1889	1898	1907	1915	1924	1933	1942	1951	88.00
3.90	1960	1969	1978	1987	1996	2005	2014	2023	2032	2041	90.00

UNITED STATES DEPARTMENT OF INTERIOR - GEOLOGICAL SURVEY - WATER RESOURCES DIVISION  
 EXPANDED RATING TABLE  
 DATE PROCESSED: 03-27-1990 @ 13:07 BY JHKLINGLER

PAGE 2  
 TYPE: LOG

03136500  
 KOKOSING R AT MOUNT VERNON OH  
 OFFSET: .00

DO: 2 TYPE: 001 RATING NO: 0036  
 START DATE/TIME: 06-14-89 (1500)

GAGE HEIGHT (FEET)	DISCHARGE IN CUBIC FEET PER SECOND (EXPANDED PRECISION)										DIFF IN G PER TENTH FT
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
4.00	2050*	2058	2067	2075	2084	2092	2101	2109	2118	2127	85.00
4.10	2155	2164	2172	2181	2190	2198	2207	2216	2224	2233	87.00
4.20	2222	2230	2239	2248	2257	2265	2274	2283	2292	2301	88.00
4.30	2310	2318	2327	2336	2345	2354	2363	2372	2381	2390	89.00
4.40	2399	2408	2417	2426	2435	2444	2453	2462	2471	2480	90.00
4.50	2489	2498	2508	2517	2526	2535	2544	2553	2563	2572	92.00
4.60	2581	2590	2600	2609	2618	2628	2637	2646	2656	2665	93.00
4.70	2674	2684	2693	2703	2712	2721	2731	2740	2750	2759	95.00
4.80	2769	2778	2788	2797	2807	2817	2826	2836	2845	2855	96.00
4.90	2865	2874	2884	2894	2903	2913	2923	2932	2942	2952	97.00
5.00	2962	2971	2981	2991	3001	3011	3020	3030	3040	3050	98.00
5.10	3060	3070	3080	3090	3100	3109	3119	3129	3139	3149	99.00
5.20	3159	3169	3179	3189	3199	3209	3219	3229	3239	3249	101.0
5.30	3261	3270	3280	3291	3301	3311	3321	3331	3342	3352	102.0
5.40	3362	3372	3383	3393	3403	3414	3424	3434	3445	3455	103.0
5.50	3465	3476	3486	3497	3507	3518	3528	3538	3549	3559	105.0
5.60	3570	3580	3591	3602	3612	3623	3633	3644	3654	3665	106.0
5.70	3676	3686	3697	3708	3718	3729	3740	3750	3761	3772	107.0
5.80	3783	3793	3804	3815	3826	3836	3847	3858	3869	3880	108.0
5.90	3891	3902	3912	3923	3934	3945	3956	3967	3978	3989	109.0
6.00	4000*	4012	4023	4035	4047	4058	4070	4082	4093	4105	117.0
6.10	4117	4128	4140	4152	4164	4176	4187	4199	4211	4223	118.0
6.20	4231	4243	4255	4267	4279	4291	4303	4315	4327	4339	120.0
6.30	4355	4367	4379	4391	4403	4415	4427	4439	4451	4463	121.0
6.40	4478	4490	4502	4514	4526	4538	4550	4562	4574	4586	122.0
6.50	4598	4610	4623	4635	4647	4660	4672	4685	4697	4709	124.0
6.60	4722	4734	4746	4758	4770	4783	4795	4807	4819	4831	125.0
6.70	4847	4859	4872	4884	4896	4910	4923	4935	4947	4961	127.0
6.80	4977	4989	5002	5014	5026	5038	5050	5062	5074	5086	128.0
6.90	5102	5114	5127	5140	5152	5164	5176	5188	5200	5212	129.0
7.00	5231	5244	5257	5270	5283	5296	5309	5323	5336	5349	131.0
7.10	5368	5381	5394	5407	5420	5433	5446	5459	5472	5485	132.0
7.20	5498	5511	5524	5537	5550	5563	5576	5589	5602	5614	134.0
7.30	5628	5641	5654	5667	5680	5693	5706	5719	5732	5745	136.0
7.40	5762	5775	5788	5801	5814	5827	5840	5853	5866	5879	137.0
7.50	5899	5912	5926	5940	5954	5967	5981	5995	6009	6022	137.0
7.60	6036	6050	6064	6078	6092	6106	6119	6133	6147	6161	139.0
7.70	6175	6189	6203	6217	6231	6245	6259	6273	6287	6301	140.0

Plate No. 5-3  
 Sheet 2 of 5

UNITED STATES DEPARTMENT OF INTERIOR - GEOLOGICAL SURVEY - WATER RESOURCES DIVISION  
EXPANDED RATING TABLE

PAGE 3  
TYPE: LOG

DATE PROCESSED: 03-27-1990 @ 13:07 BY JHKLINGLER

03136500  
KOKOSING R AT MOUNT VERNON OH  
OFFSET: .00

DD: 2 TYPE: 001 RATING NO: 0036  
START DATE/TIME: 06-14-89 (1500)

GAGE HEIGHT (FEET)	DISCHARGE IN CUBIC FEET PER SECOND (EXPANDED PRECISION)										DEPTH (FEET)
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
7.80	6315	6330	6344	6358	6372	6386	6400	6414	6429	6443	142.0
7.90	6427	6441	6456	6470	6484	6498	6512	6526	6540	6554	143.0
8.00	6600	6614	6628	6642	6655	6669	6683	6697	6711	6725	139.0
8.10	6739	6753	6767	6781	6795	6809	6823	6837	6851	6865	140.0
8.20	6879	6893	6908	6922	6936	6950	6964	6978	6992	7007	142.0
8.30	7021	7035	7049	7063	7078	7092	7106	7121	7135	7149	142.0
8.40	7163	7177	7191	7205	7219	7233	7247	7261	7275	7289	144.0
8.50	7307	7321	7335	7349	7363	7377	7391	7405	7419	7433	145.0
8.60	7432	7446	7460	7474	7488	7502	7516	7530	7544	7558	146.0
8.70	7598	7613	7628	7642	7657	7672	7686	7701	7716	7731	147.0
8.80	7745	7760	7775	7790	7805	7820	7834	7849	7864	7879	149.0
8.90	7891	7906	7921	7936	7951	7966	7981	7996	8011	8026	149.0
9.00	8043	8058	8073	8088	8103	8118	8133	8148	8163	8178	151.0
9.10	8194	8209	8224	8239	8254	8269	8284	8299	8314	8329	152.0
9.20	8346	8361	8376	8391	8407	8422	8437	8453	8468	8483	155.0
9.30	8499	8514	8529	8545	8560	8575	8591	8606	8622	8637	154.0
9.40	8653	8668	8684	8699	8715	8730	8746	8761	8777	8792	155.0
9.50	8808	8823	8839	8854	8870	8886	8901	8917	8933	8948	156.0
9.60	8964	8980	8995	9011	9027	9043	9058	9074	9090	9106	157.0
9.70	9121	9137	9153	9169	9185	9200	9216	9232	9248	9264	159.0
9.80	9280	9296	9312	9328	9343	9359	9375	9391	9407	9423	159.0
9.90	9439	9455	9471	9487	9503	9520	9536	9552	9568	9584	161.0
10.00	9600	9617	9634	9650	9667	9684	9701	9718	9735	9751	168.0
10.10	9768	9785	9802	9819	9836	9853	9870	9887	9904	9921	170.0
10.20	9938	9955	9972	9989	10010	10020	10040	10060	10070	10090	172.0
10.30	10110	10130	10140	10160	10180	10190	10210	10230	10250	10260	170.0
10.40	10280	10300	10320	10330	10350	10370	10380	10400	10420	10440	170.0
10.50	10450	10470	10490	10510	10520	10540	10560	10580	10590	10610	180.0
10.60	10630	10650	10660	10680	10700	10720	10730	10750	10770	10790	170.0
10.70	10800	10820	10840	10860	10870	10890	10910	10930	10950	10960	180.0
10.80	10980	11000	11020	11030	11050	11070	11090	11110	11120	11140	180.0
10.90	11160	11180	11200	11210	11230	11250	11270	11280	11300	11320	180.0
11.00	11340	11360	11370	11390	11410	11430	11450	11470	11480	11500	180.0
11.10	11520	11540	11560	11570	11590	11610	11630	11650	11660	11680	180.0
11.20	11700	11720	11740	11760	11770	11790	11810	11830	11850	11870	180.0
11.30	11880	11900	11920	11940	11960	11980	11990	12010	12030	12050	190.0
11.40	12070	12090	12110	12120	12140	12160	12180	12200	12220	12240	180.0

UNITED STATES DEPARTMENT OF INTERIOR - GEOLOGICAL SURVEY - WATER RESOURCES DIVISION  
EXPANDED RATING TABLE

PAGE 4  
TYPE: LOG

03136500  
KOKOSING R AT MOUNT VERNON OH  
OFFSET: .00

DATE PROCESSED: 03-27-1990 @ 13:07 BY JHKLINGLER

DD: 2 TYPE: 001 RATING NO: 0036  
START DATE/TIME: 06-14-89 (1500)

GAGE HEIGHT (FEET)	DISCHARGE IN CUBIC FEET PER SECOND (EXPANDED PRECISION)											DIFF IN C PER TENTH FT
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09		
11.50	12250	12270	12290	12310	12330	12350	12370	12380	12400	12420	12420	190.0
11.60	12440	12460	12480	12500	12520	12530	12550	12570	12590	12610	12610	190.0
11.70	12630	12650	12670	12690	12700	12720	12740	12760	12780	12800	12800	190.0
11.80	12820	12840	12860	12880	12890	12910	12930	12950	12970	12990	12990	190.0
11.90	13010	13030	13050	13070	13080	13100	13120	13140	13160	13180	13180	190.0
12.00	13200*	13220	13240	13260	13270	13290	13310	13330	13350	13370	13370	190.0
12.10	13390	13400	13420	13440	13460	13480	13500	13520	13530	13550	13550	180.0
12.20	13570	13590	13610	13630	13650	13670	13680	13700	13720	13740	13740	190.0
12.30	13760	13780	13800	13820	13830	13850	13870	13890	13910	13930	13930	190.0
12.40	13950	13970	13980	14000	14020	14040	14060	14080	14100	14120	14120	190.0
12.50	14140	14160	14170	14190	14210	14230	14250	14270	14290	14310	14310	190.0
12.60	14330	14350	14370	14380	14400	14420	14440	14460	14480	14500	14500	190.0
12.70	14520	14540	14560	14580	14600	14610	14630	14650	14670	14690	14690	190.0
12.80	14710	14730	14750	14770	14780	14810	14830	14850	14870	14890	14890	190.0
12.90	14900	14920	14940	14960	14980	15000	15020	15040	15060	15080	15080	200.0
13.00	15100	15120	15140	15160	15180	15200	15220	15240	15260	15270	15270	190.0
13.10	15290	15310	15330	15350	15370	15390	15410	15430	15450	15470	15470	200.0
13.20	15490	15510	15530	15550	15570	15590	15610	15630	15650	15670	15670	200.0
13.30	15690	15710	15730	15750	15770	15790	15810	15830	15850	15870	15870	200.0
13.40	15890	15910	15930	15950	15970	15990	16010	16030	16050	16070	16070	200.0
13.50	16090	16110	16130	16150	16170	16190	16210	16230	16250	16270	16270	200.0
13.60	16290	16310	16330	16350	16370	16390	16410	16430	16450	16470	16470	200.0
13.70	16490	16510	16530	16550	16570	16590	16610	16630	16650	16670	16670	200.0
13.80	16690	16710	16730	16750	16770	16790	16810	16830	16850	16870	16870	210.0
13.90	16900	16920	16940	16960	16980	17000	17020	17040	17060	17080	17080	200.0
14.00	17100*	17130	17170	17200	17240	17270	17310	17340	17380	17410	17410	350.0
14.10	17450	17480	17520	17560	17590	17630	17660	17700	17730	17770	17770	350.0
14.20	17800	17840	17880	17910	17950	17980	18020	18050	18090	18130	18130	360.0
14.30	18160	18200	18240	18270	18310	18360	18380	18420	18450	18490	18490	370.0
14.40	18530	18560	18600	18640	18670	18710	18750	18780	18820	18860	18860	360.0
14.50	18890	18930	18970	19010	19040	19080	19120	19160	19190	19230	19230	380.0
14.60	19270	19310	19360	19400	19420	19460	19490	19530	19570	19610	19610	380.0
14.70	19630	19680	19720	19760	19800	19840	19870	19910	19950	19990	19990	380.0
14.80	20030	20070	20110	20160	20180	20220	20260	20300	20340	20380	20380	390.0
14.90	20420	20450	20490	20530	20570	20610	20650	20690	20730	20770	20770	390.0
15.00	20810	20850	20890	20930	20970	21010	21050	21080	21120	21160	21160	390.0
15.10	21200	21240	21280	21320	21360	21400	21440	21490	21530	21570	21570	410.0
15.20	21610	21650	21690	21730	21770	21810	21850	21890	21930	21970	21970	400.0

Plate No. 5-3  
Sheet 4 of 5

UNITED STATES DEPARTMENT OF INTERIOR - GEOLOGICAL SURVEY - WATER RESOURCES DIVISION  
EXPANDED RATING TABLE

PAGE 5  
TYPE: LOG

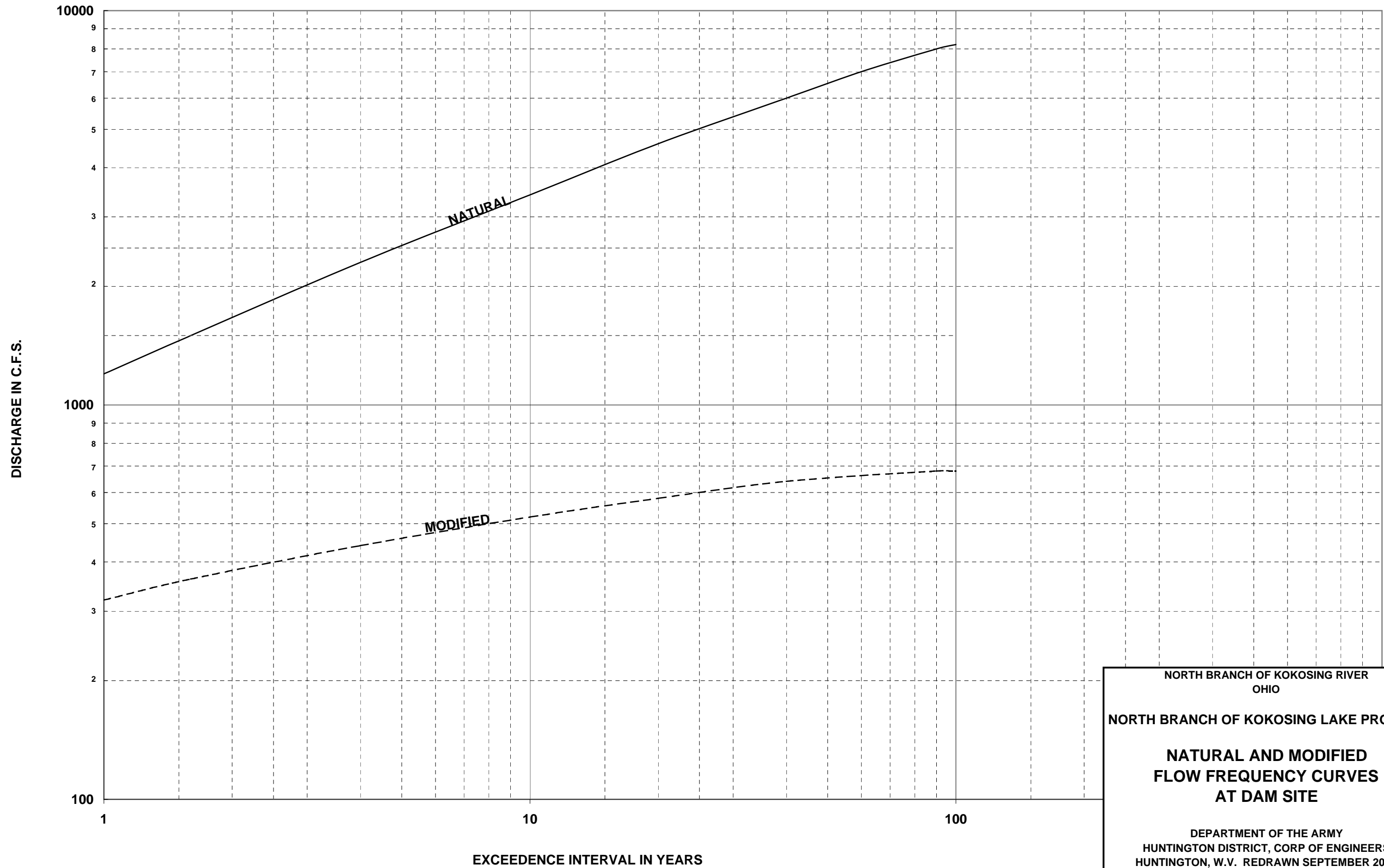
03136500  
KOKOSING R AT MOUNT VERNON OH  
OFFSET: .00

DATE PROCESSED: 03-27-1990 @ 13:07 BY JHKLINGLER

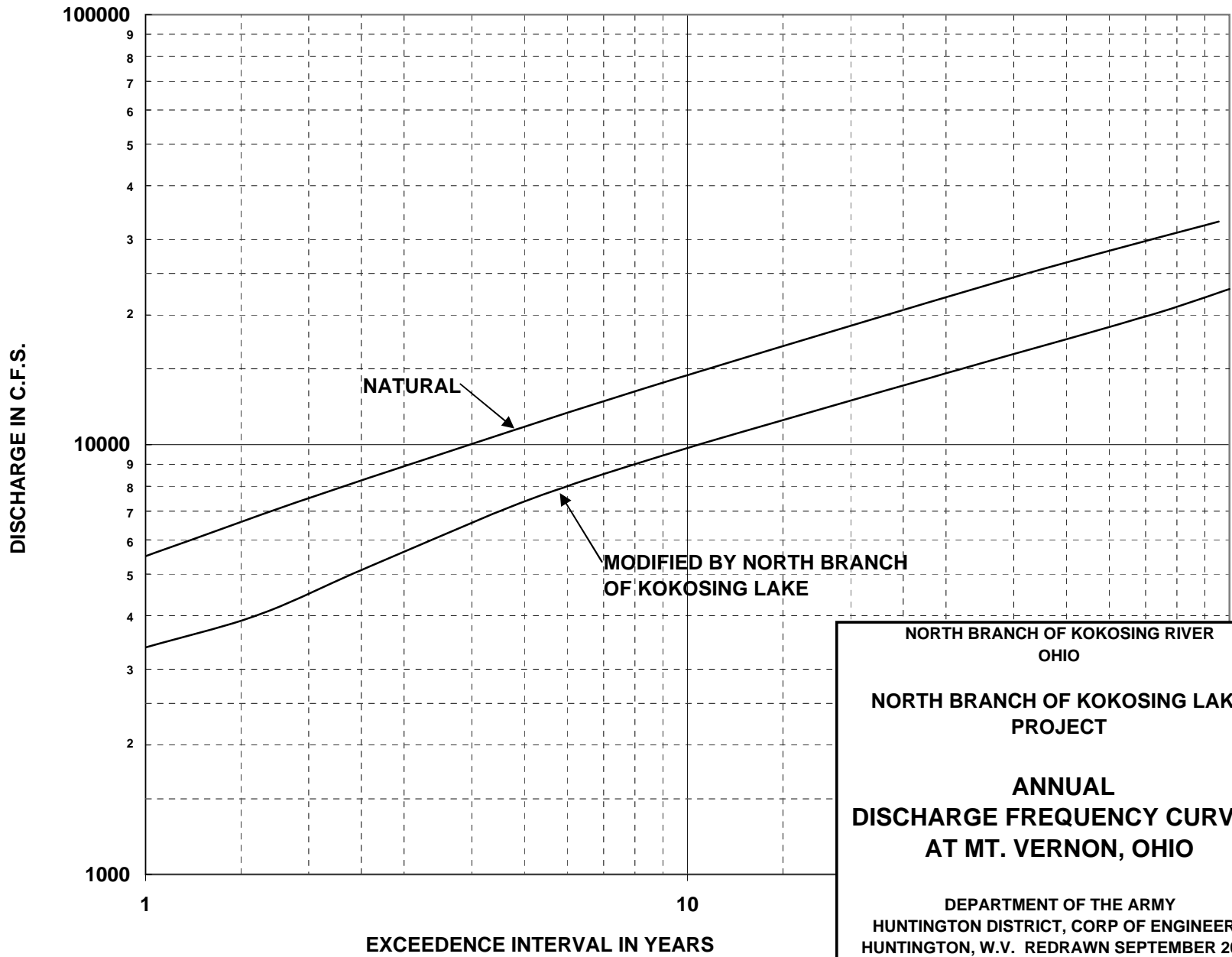
DD: 2 TYPE: 001 RATING NO: 0036  
START DATE/TIME: 06-14-89 (1500)

GAGE HEIGHT (FEET)	DISCHARGE IN CUBIC FEET PER SECOND (EXPANDED PRECISION)											DIFF. IN FEET TENTH FT
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09		
15.30	22010	22050	22090	22140	22180	22220	22260	22300	22340	22380	22380	410.0
15.40	22420	22470	22510	22550	22590	22630	22670	22720	22760	22800	22800	420.0
15.50	22860	22910	22950	22970	23010	23050	23090	23140	23180	23220	23220	420.0
15.60	23260	23310	23350	23390	23430	23480	23520	23560	23600	23650	23650	430.0
15.70	23690	23730	23780	23820	23860	23900	23950	23990	24030	24080	24080	430.0
15.80	24120	24160	24210	24250	24300	24340	24380	24430	24470	24510	24510	440.0
15.90	24950	25000	25050	25090	25130	25180	25220	25270	25310	25360	25360	440.0
16.00	25000	25050	25100	25150	25200	25250	25300	25360	25410	25460	25460	510.0
16.10	25510	25560	25610	25660	25720	25770	25820	25870	25920	25970	25970	520.0
16.20	26030	26080	26130	26180	26230	26290	26340	26390	26440	26500	26500	520.0
16.30	26550	26600	26660	26710	26760	26810	26870	26920	26970	27030	27030	530.0
16.40	27080	27130	27190	27240	27290	27350	27400	27460	27510	27560	27560	540.0
16.50	27620	27670	27730	27780	27840	27890	27950	28000	28050	28110	28110	540.0
16.60	28160	28220	28270	28330	28380	28440	28500	28550	28610	28660	28660	560.0
16.70	28720	28770	28830	28880	28940	29000	29050	29110	29160	29220	29220	560.0
16.80	29280	29330	29390	29450	29500	29560	29620	29670	29730	29790	29790	570.0
16.90	29850	29900	29960	30020	30070	30130	30190	30250	30310	30360	30360	570.0
17.00	30420	30480	30540	30600	30650	30710	30770	30830	30890	30950	30950	580.0
17.10	31000	31060	31120	31180	31240	31300	31360	31420	31480	31540	31540	590.0
17.20	31590	31650	31710	31770	31830	31890	31950	32010	32070	32130	32130	600.0
17.30	32190	32250	32310	32370	32440	32500	32560	32620	32680	32740	32740	610.0
17.40	32800	32860	32920	32980	33040	33110	33170	33230	33290	33350	33350	610.0
17.50	33410	33480	33540	33600	33660	33720	33790	33850	33910	33970	33970	630.0
17.60	34040	34100	34160	34220	34290	34350	34410	34480	34540	34600	34600	630.0
17.70	34670	34730	34790	34860	34920	34980	35050	35110	35180	35240	35240	630.0
17.80	35300	35370	35430	35500	35560	35630	35690	35760	35820	35890	35890	650.0
17.90	35850	35920	35980	36050	36110	36180	36250	36310	36370	36440	36440	650.0
18.00	36500	36570	36640	36700	36770	36830	36900	36970	37030	37100	37100	670.0
18.10	37270	37330	37400	37470	37530	37600	37670	37740	37800	37870	37870	670.0
18.20	37940	38010	38070	38140	38210	38280	38340	38410	38480	38550	38550	680.0
18.30	38620	38690	38750	38820	38890	38960	39030	39100	39170	39230	39230	680.0
18.40	39300	39370	39440	39510	39580	39650	39720	39790	39860	39930	39930	700.0
18.50	40000											

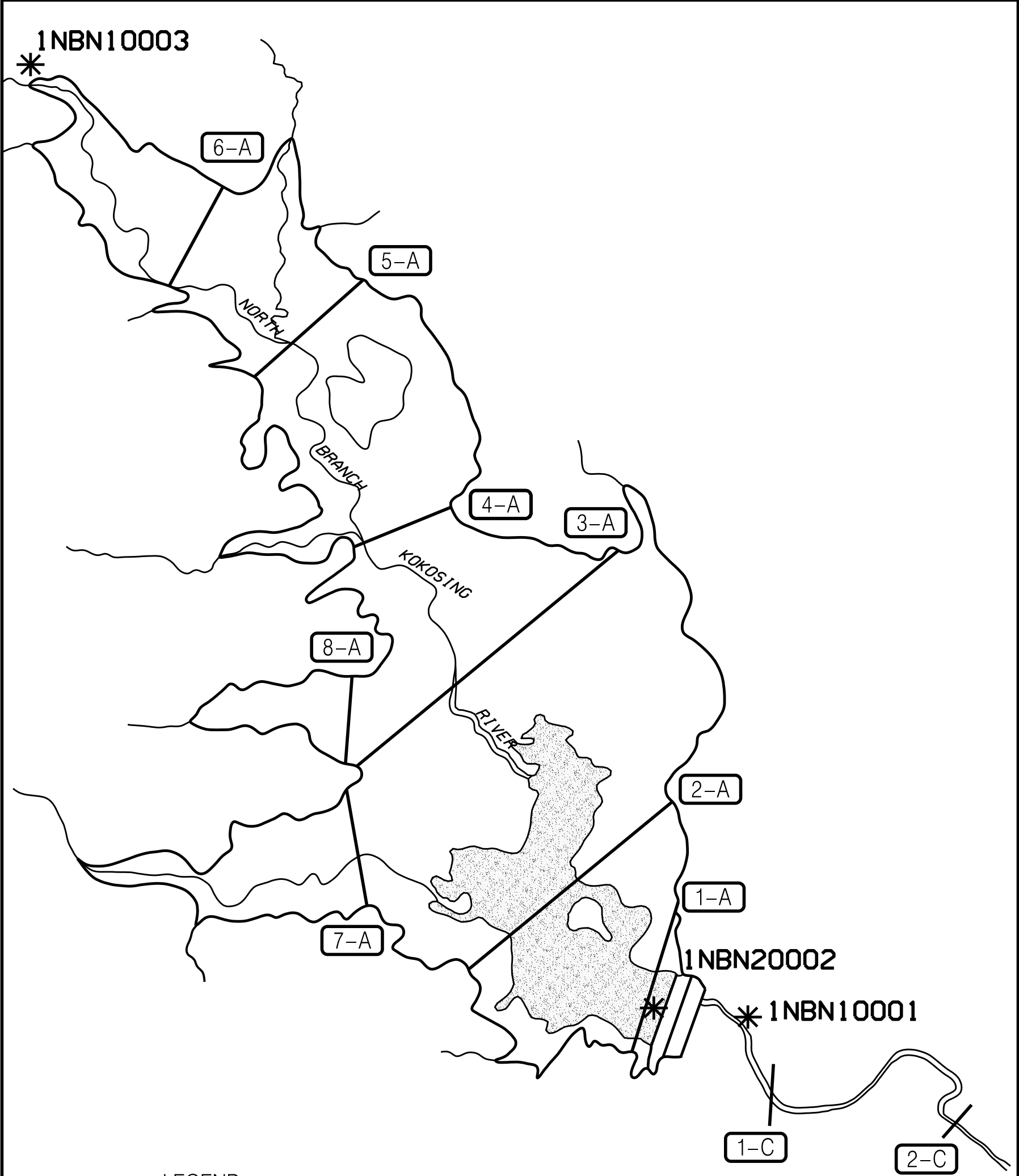
Plate No. 5-3  
Sheet 5 of 5





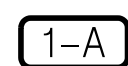
NORTH BRANCH OF KOKOSING RIVER  
 OHIO  
  
 NORTH BRANCH OF KOKOSING LAKE PROJECT  
  
**NATURAL AND MODIFIED  
 FLOW FREQUENCY CURVES  
 AT DAM SITE**  
  
 DEPARTMENT OF THE ARMY  
 HUNTINGTON DISTRICT, CORP OF ENGINEERS  
 HUNTINGTON, W.V. REDRAWN SEPTEMBER 2000



**NORTH BRANCH OF KOKOSING RIVER**  
**OHIO**  
  
**NORTH BRANCH OF KOKOSING LAKE**  
**PROJECT**  
  
**ANNUAL**  
**DISCHARGE FREQUENCY CURVES**  
**AT MT. VERNON, OHIO**  
  
 DEPARTMENT OF THE ARMY  
 HUNTINGTON DISTRICT, CORP OF ENGINEERS  
 HUNTINGTON, W.V. REDRAWN SEPTEMBER 2000



**LEGEND**

-  FLOOD CONTROL POOL  
ELEVATION - 1146
-  NORMAL POOL  
ELEVATION - 1121
-  SEDIMENT RANGE

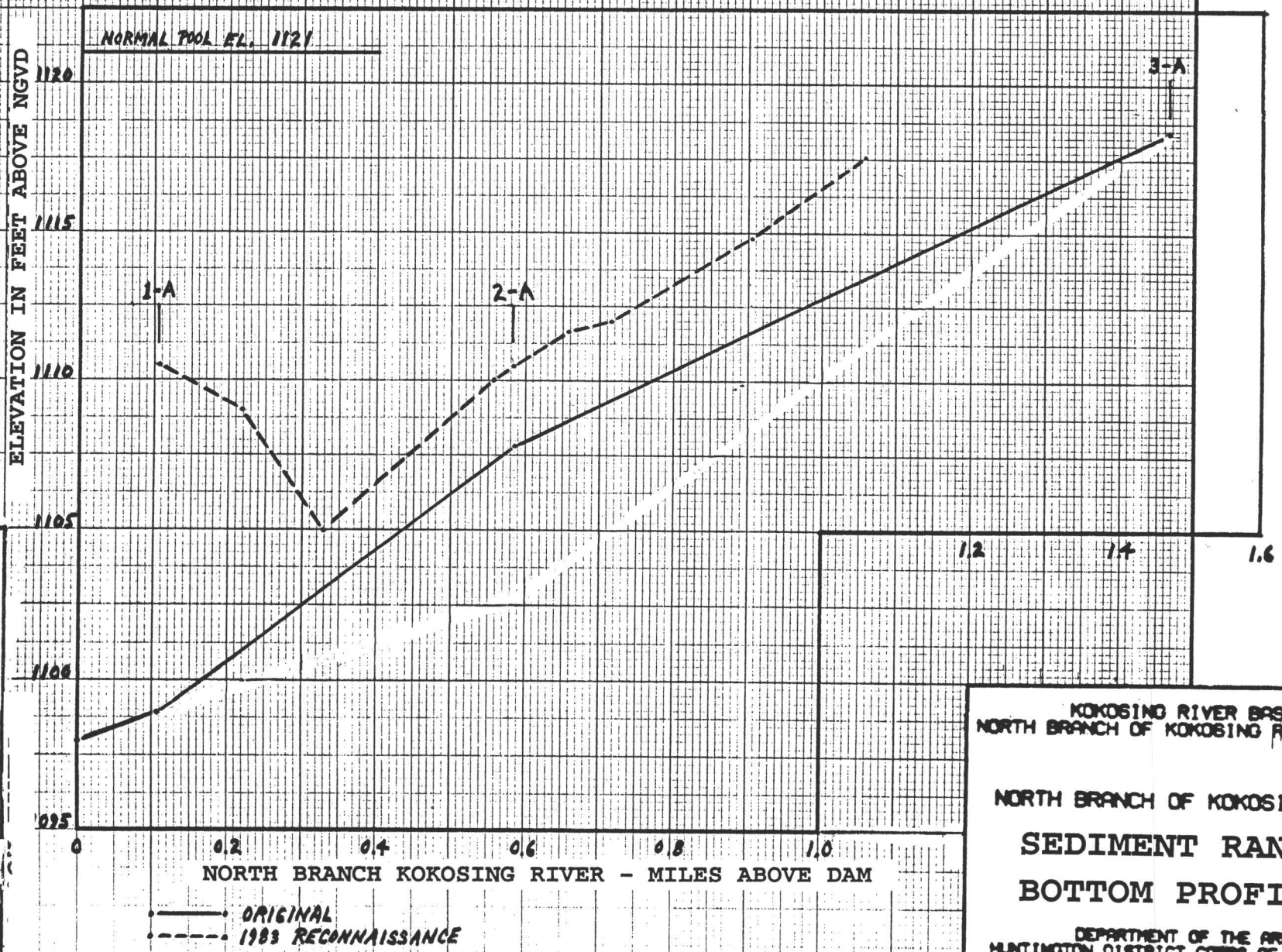
NOTE:  
1NBN1003 IS 4.56 MILES ABOVE THE DAM

**NORTH BRANCH OF KOKOSING RIVER  
OHIO**

**NORTH BRANCH OF KOKOSING  
RIVER LAKE**

SEDIMENT RANGES AND  
WATER QUALITY  
SAMPLING STATIONS

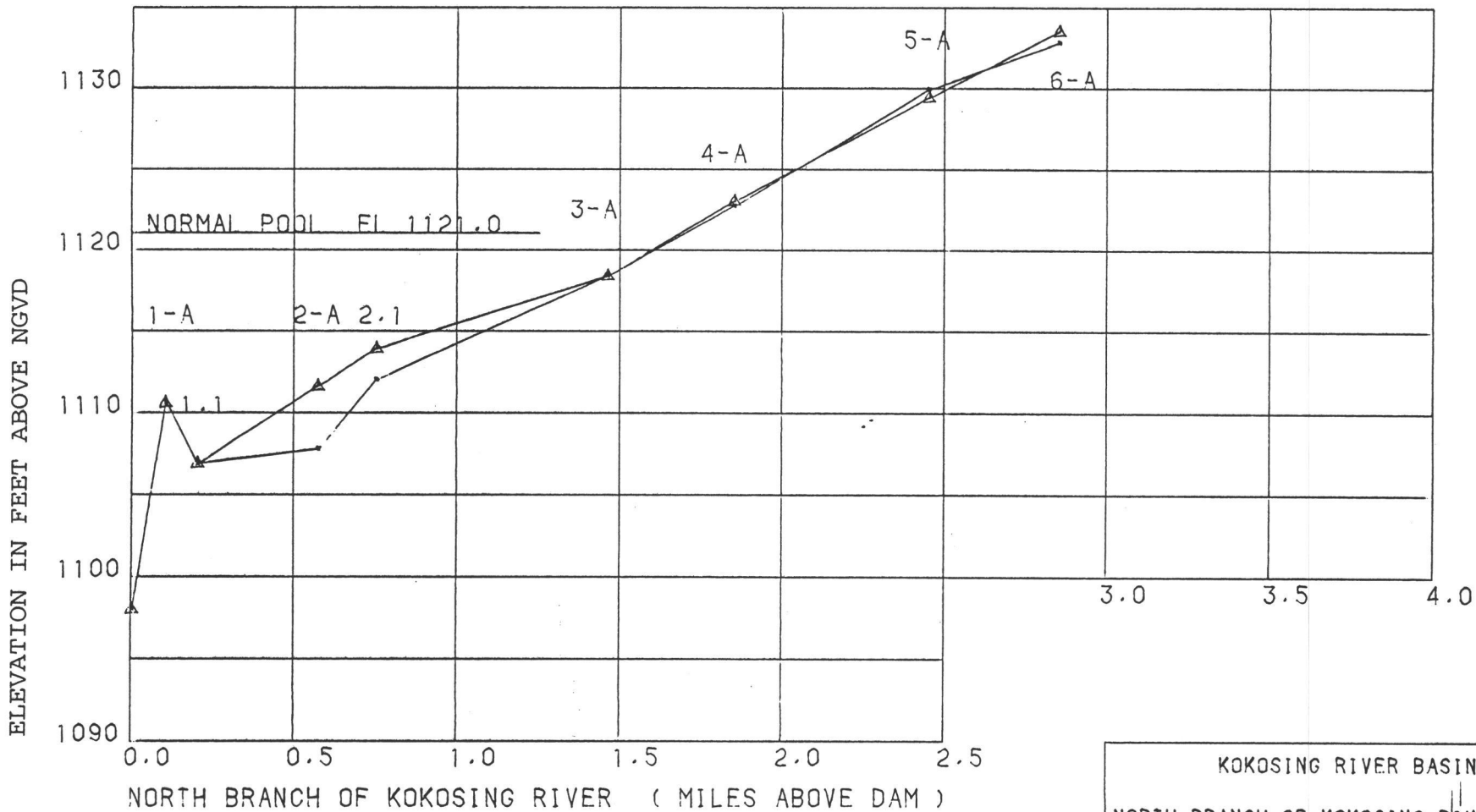
DEPARTMENT OF THE ARMY  
HUNTINGTON DISTRICT CORPS OF ENGINEERS  
HUNTINGTON, W. VA. REDRAWN: SEPT. 2000



KOKOSING RIVER BASIN  
NORTH BRANCH OF KOKOSING RIVER, OHIO

**NORTH BRANCH OF KOKOSING LAKE  
SEDIMENT RANGE  
BOTTOM PROFILE**

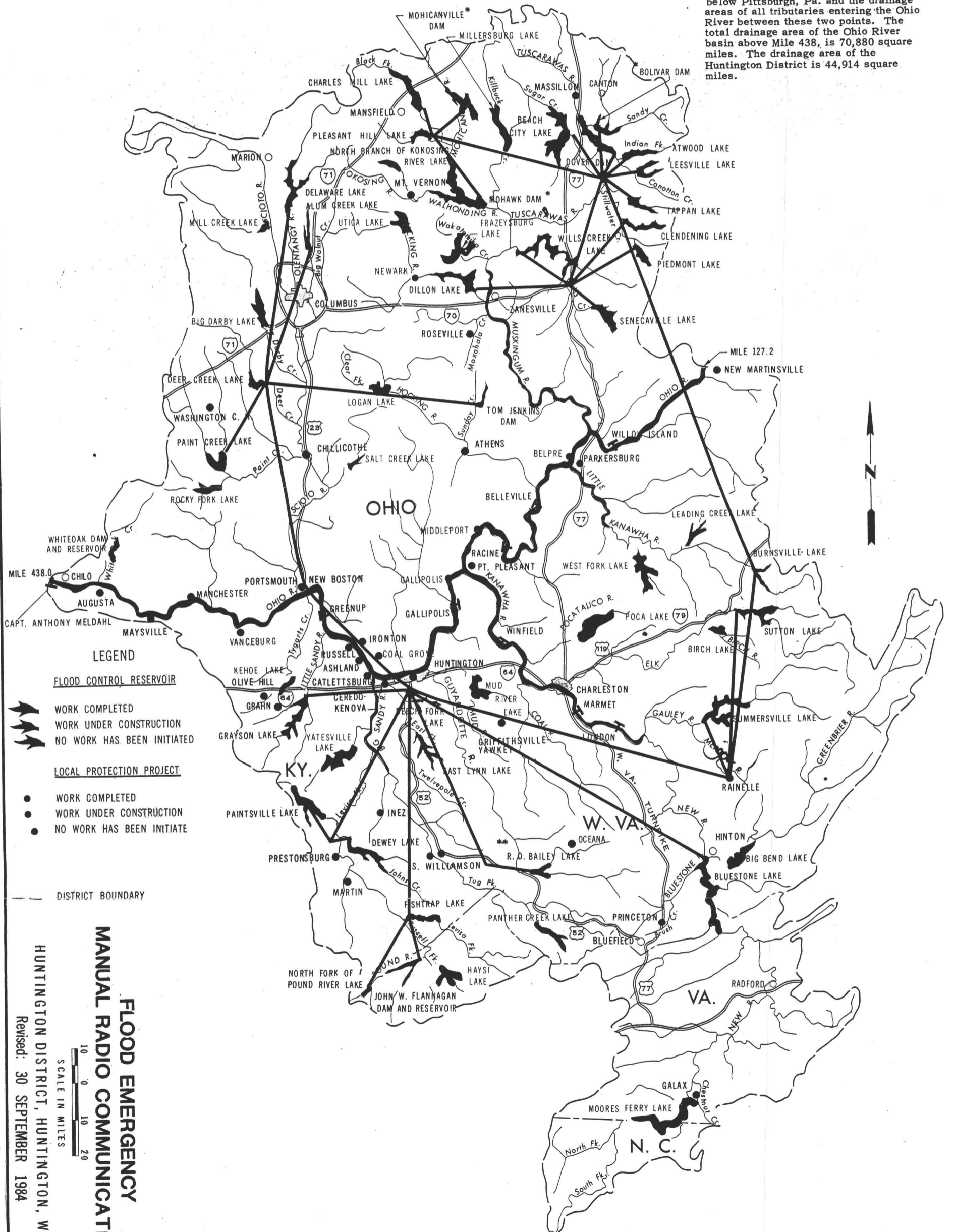
DEPARTMENT OF THE ARMY  
MUNTINGTON DISTRICT CORPS OF ENGINEERS  
MUNTINGTON, W. VA.  
MAY 1984



KOKOSING RIVER BASIN  
 NORTH BRANCH OF KOKOSING RIVER, OHIO  
 NORTH BRANCH OF KOKOSING LAKE  
 SEDIMENT RANGE  
 BOTTOM PROFILE

DEPARTMENT OF THE ARMY  
 HUNTINGTON DISTRICT CORPS OF ENGINEERS  
 HUNTINGTON, W. VA. JUNE 1992

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 areas 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.



**FLOOD EMERGENCY  
MANUAL RADIO COMMUNICATION**

HUNTINGTON DISTRICT, HUNTINGTON, W. VA.

Revised: 30 SEPTEMBER 1984

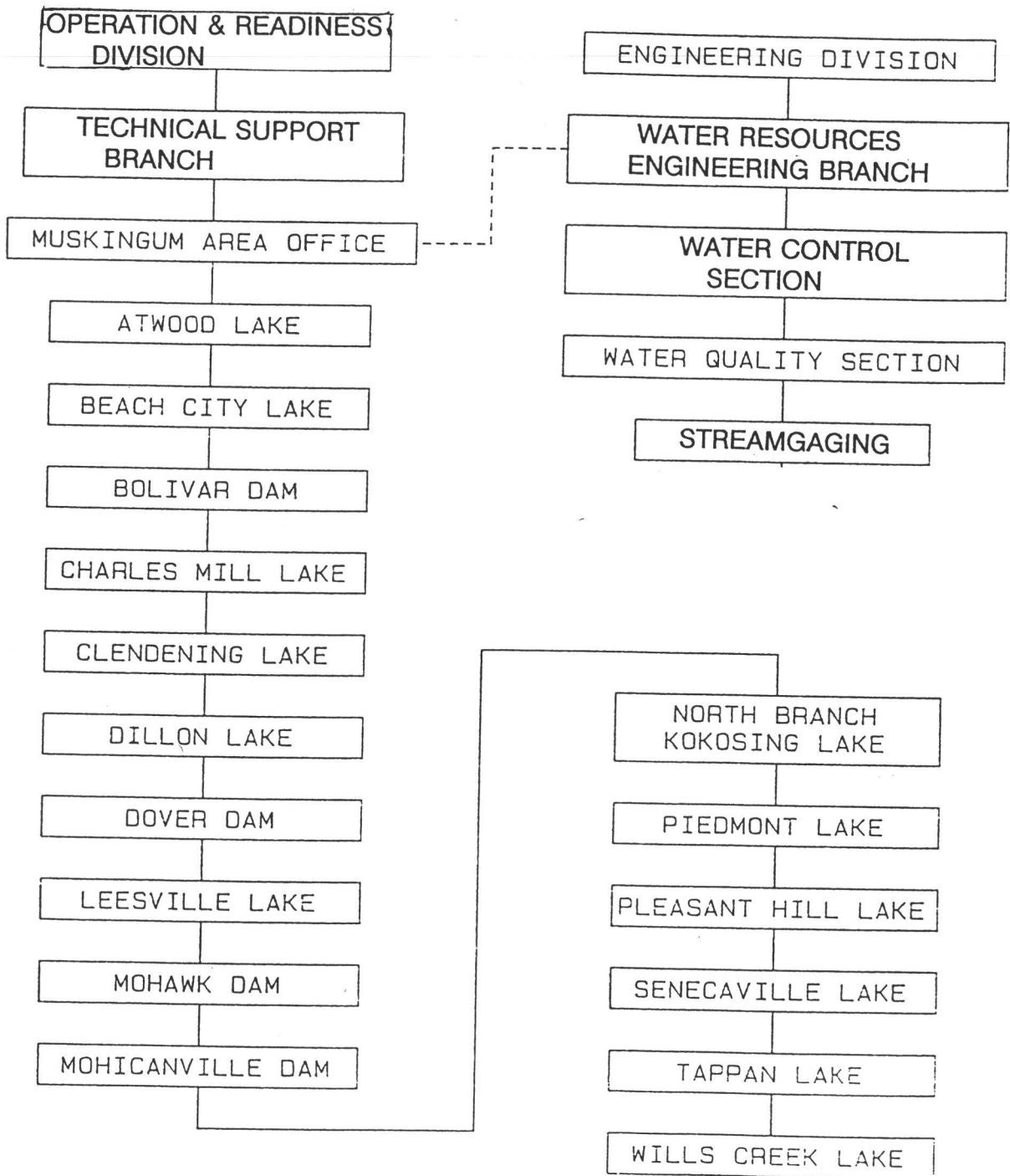
Plate No. 5-8

- 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
  - DISTRICT BOUNDARY

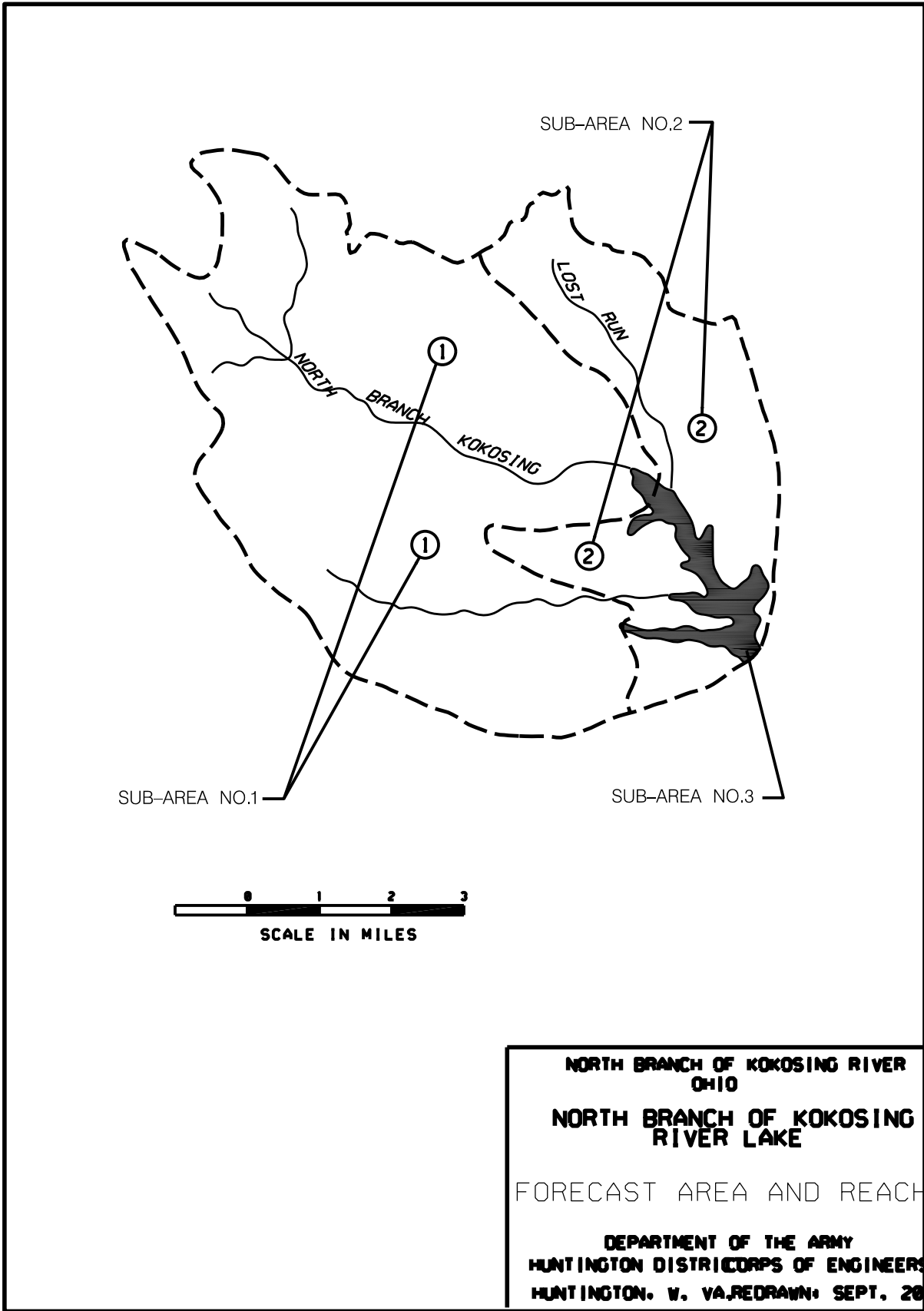


\*Dry dam, with flood control pool outlined.  
\*\*Completed project where further improvements are in progress or authorized.

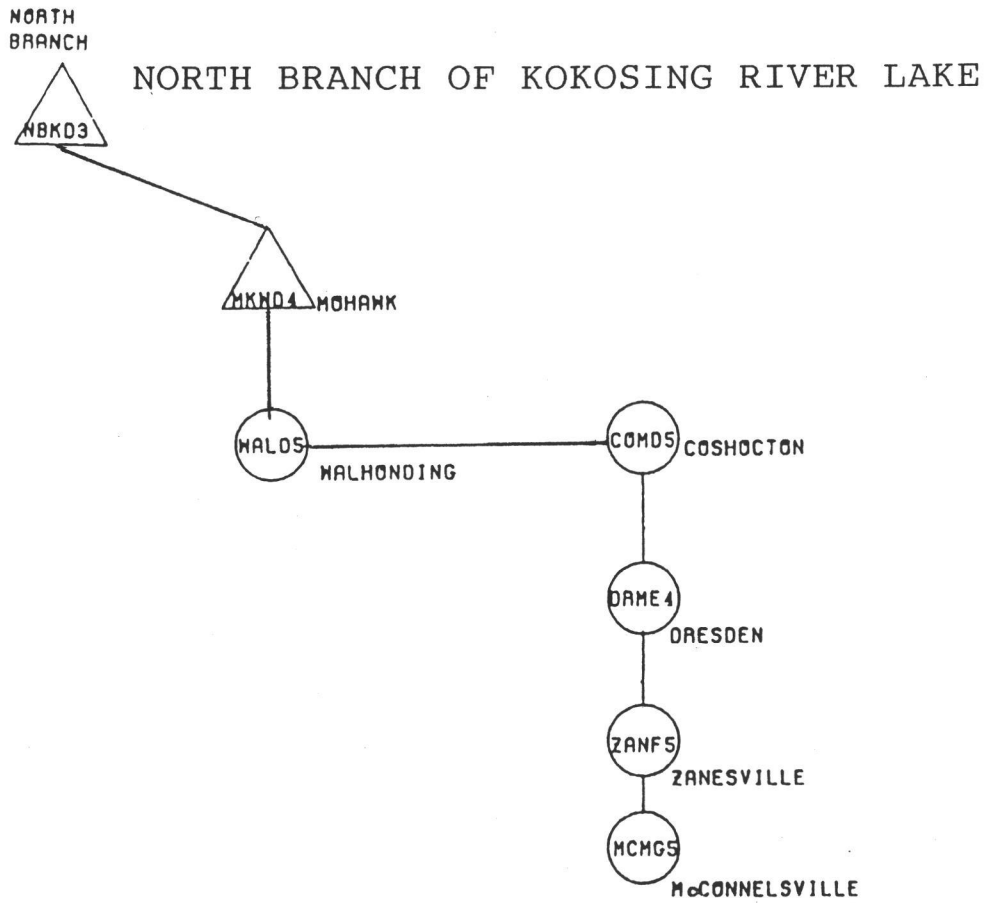
WATER CONTROL MANAGEMENT  
MUSKINGUM RIVER BASIN  
NORMAL ORGANIZATION



WATER CONTROL MANAGEMENT  
NORMAL ORGANIZATION



NORTH BRANCH OF KOKOSING RIVER LAKE  
MUSKINGUM RIVER  
BASIN NETWORK CONFIGURATION



NORTH BRANCH KOKOSING  
RIVER RESERVOIRS  
AREA AND CAPACITY TABLES

Drainage Area 44.5 sq. mi.

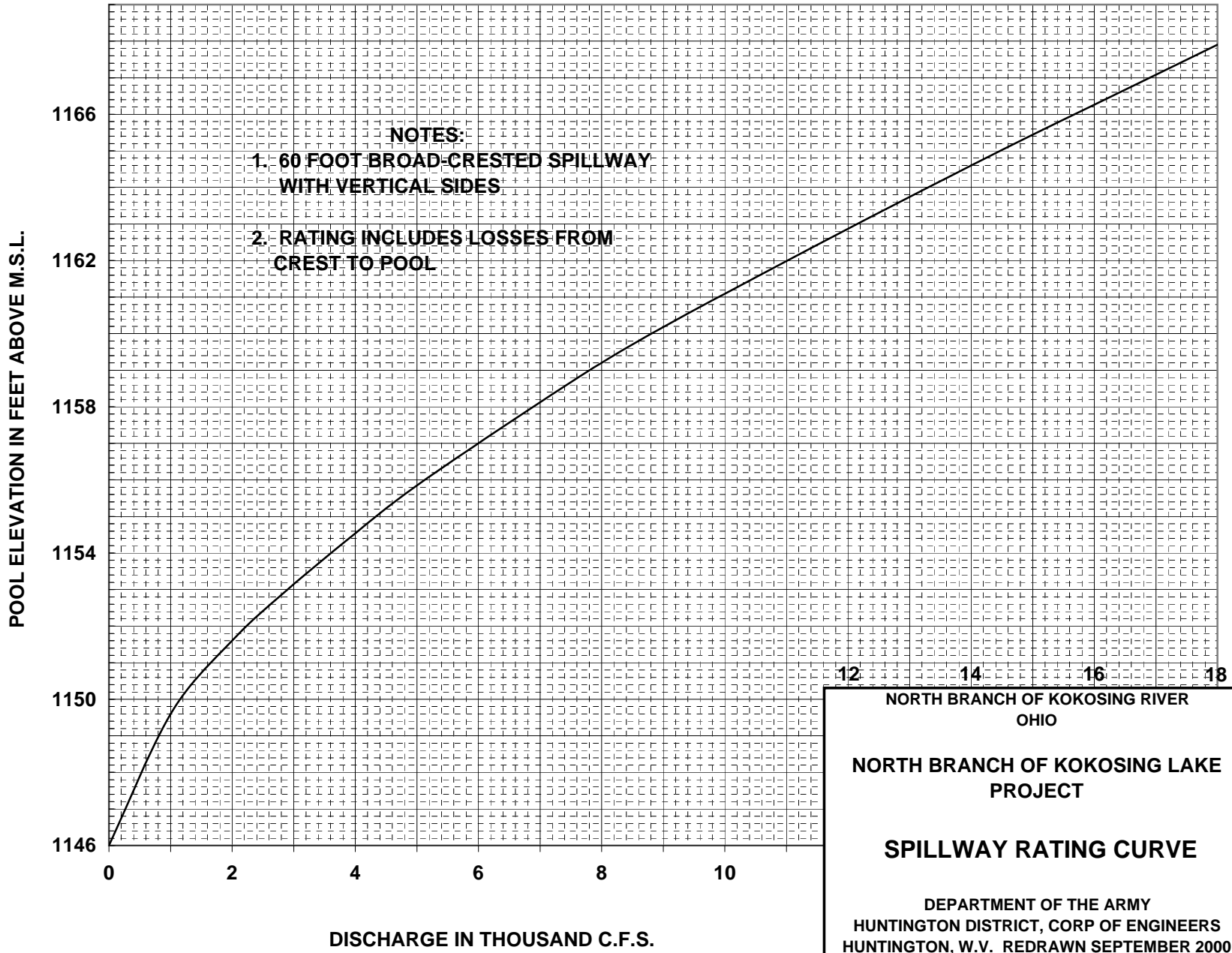
1 in. Runoff = 2373 Ac. Ft.

Pool El.	Capacity			Area Acres	Pool El.	Capacity			Area Acres
	Ac. Ft.	Inches				Ac. Ft.	Inches		
1098.0	0	.00		0	1136.0	6310	2.66		601
1099.0	1	.00		1	1137.0	6932	2.92		644
1100.0	2	.00		3	1138.0	7599	3.20		690
					1139.0	8315	3.50		741
1101.0	6	.00		4	1140.0	9083	3.83		795
1102.0	11	.00		7					
1103.0	19	.01		9	1141.0	9906	4.17		852
1104.0	29	.01		12	1142.0	10787	4.55		909
1105.0	43	.02		15	1143.0	11725	4.94		967
					1144.0	12721	5.36		1024
1106.0	59	.02		18	1145.0	13774	5.80		1082
1107.0	79	.03		22					
1108.0	103	.04		26	1146.0	14885	6.27		1140
1109.0	131	.06		31	1147.0	16053	6.76		1197
1110.0	164	.07		36	1148.0	17278	7.28		1253
					1149.0	18557	7.82		1306
1111.0	203	.09		41	1150.0	19889	8.38		1358
1112.0	248	.10		48					
1113.0	299	.13		55	1151.0	21272	8.96		1408
1114.0	357	.15		61	1152.0	22707	9.57		1461
1115.0	422	.18		69	1153.0	24195	10.19		1516
					1154.0	25741	10.85		1575
1116.0	494	.21		77	1155.0	27347	11.52		1637
1117.0	576	.24		87					
1118.0	668	.28		99	1156.0	29015	12.23		1700
1119.0	775	.33		115	1157.0	30747	12.96		1764
1120.0	899	.38		113	1158.0	32543	13.71		1828
					1159.0	34404	14.50		1893
1121.0	1043	.44		154	1160.0	36329	15.31		1958
1122.0	1208	.51		176					
1123.0	1396	.59		199	1161.0	38319	16.15		2023
1124.0	1606	.68		221	1162.0	40375	17.01		2089
1125.0	1839	.77		245	1163.0	42497	17.91		2154
					1164.0	44683	18.83		2219
1126.0	2095	.88		269	1165.0	46935	19.78		2285
1127.0	2377	1.00		294					
1128.0	2684	1.13		322	1166.0	49253	20.75		2350
1129.0	3021	1.28		351	1167.0	51635	21.76		2415
1130.0	3387	1.43		382	1168.0	54082	22.79		2479
1131.0	3785	1.60		415					
1132.0	4217	1.78		449					
1133.0	4684	1.97		485					
1134.0	5188	2.19		522					
1135.0	5729	2.41		461					

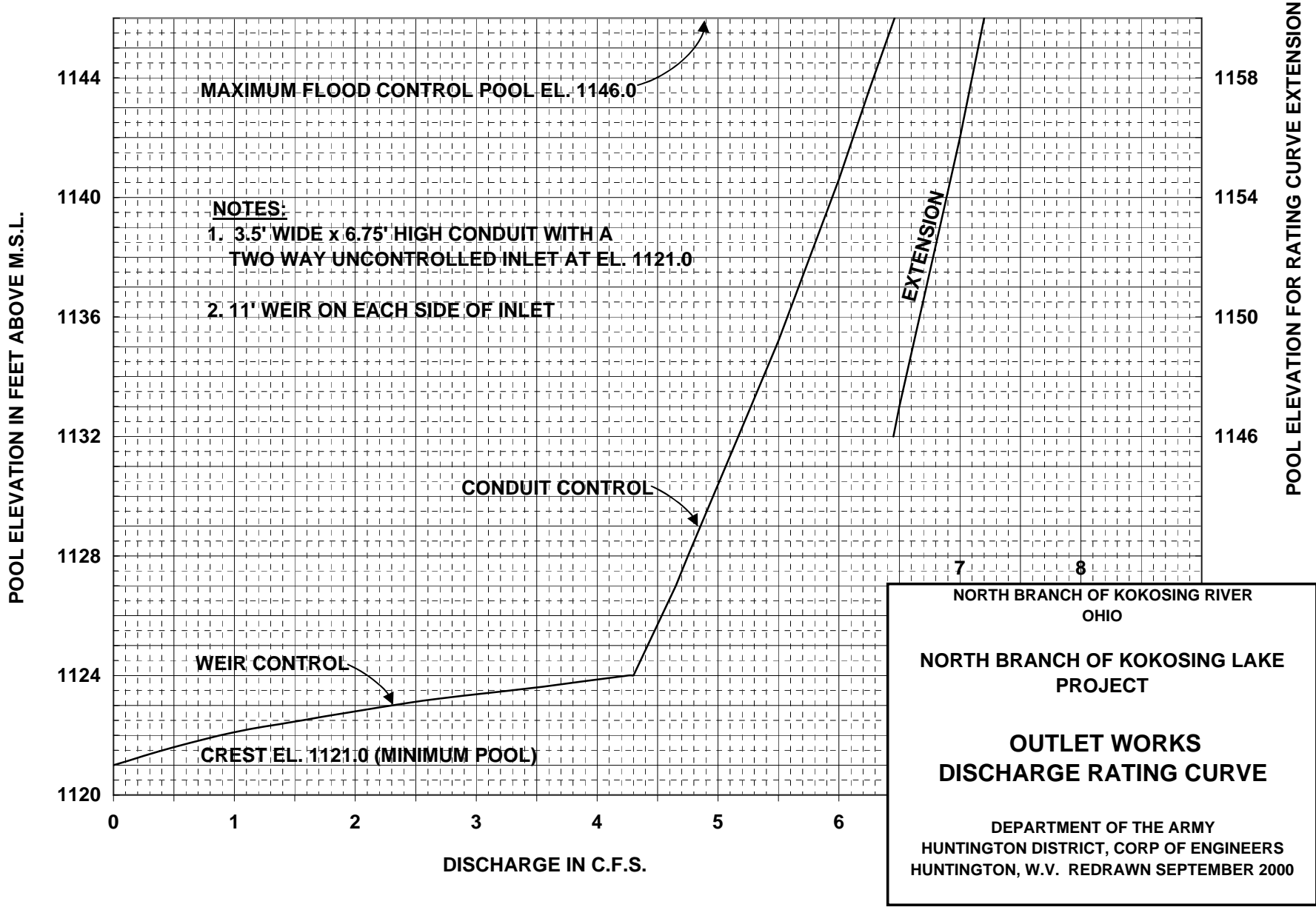
NORTH BRANCH KUKOSING LAKE

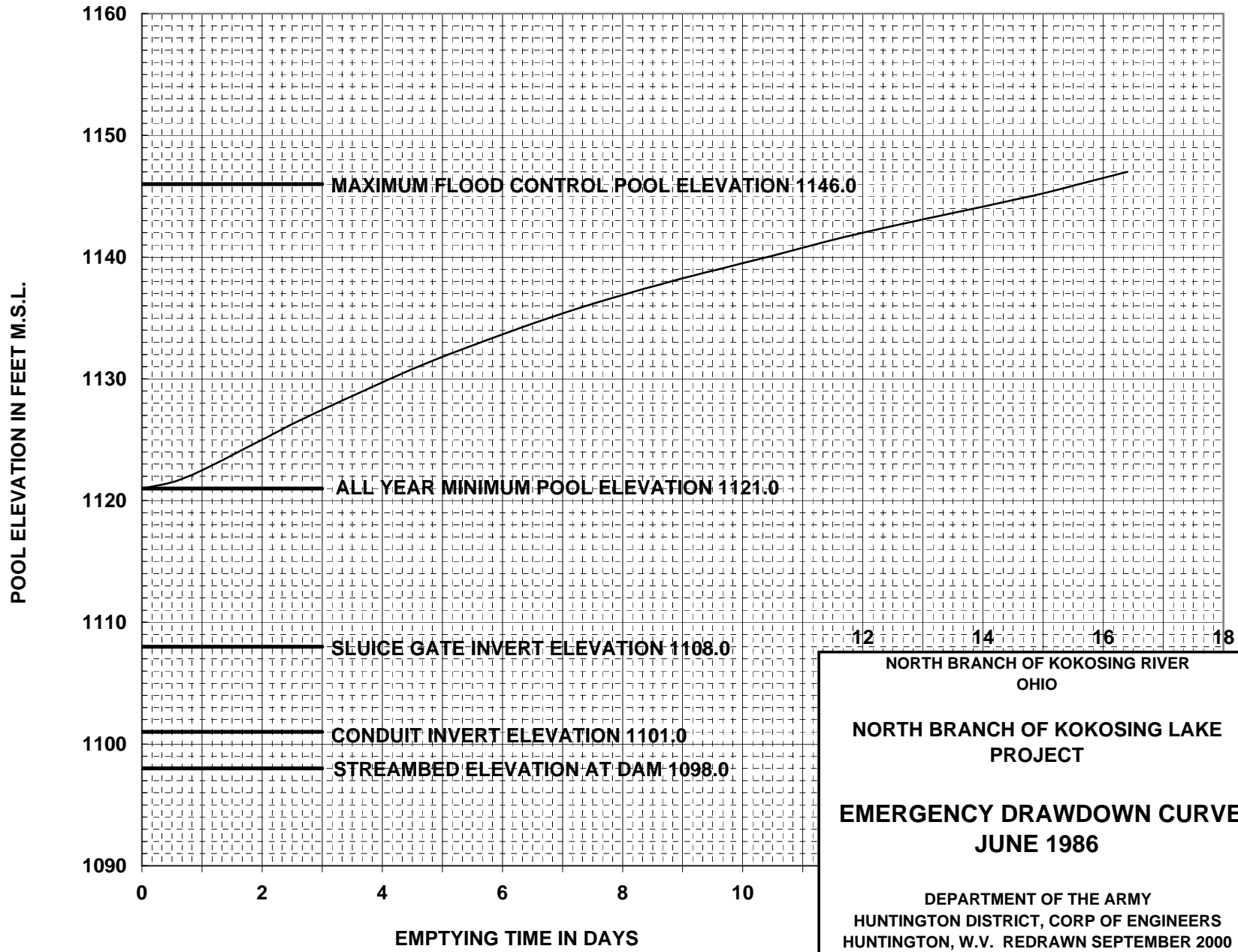
PERCENT STORAGE UTILIZATION - ALL-YR

ELEV	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1121	0.00	0.11	0.23	0.34	0.46	0.58	0.70	0.82	0.94	1.07
1122	1.19	1.32	1.45	1.58	1.72	1.85	1.99	2.13	2.27	2.41
1123	2.55	2.69	2.84	2.99	3.14	3.29	3.44	3.59	3.75	3.91
1124	4.07	4.23	4.39	4.55	4.72	4.89	5.06	5.23	5.40	5.57
1125	5.75	5.93	6.11	6.29	6.47	6.65	6.84	7.02	7.21	7.41
1126	7.60	7.80	7.99	8.19	8.39	8.60	8.80	9.01	9.21	9.42
1127	9.64	9.85	10.06	10.28	10.50	10.72	10.94	11.17	11.39	11.62
1128	11.85	12.09	12.32	12.56	12.80	13.05	13.29	13.54	13.79	14.04
1129	14.29	14.54	14.80	15.06	15.32	15.58	15.85	16.12	16.39	16.66
1130	16.93	17.21	17.49	17.77	18.05	18.34	18.63	18.92	19.21	19.51
1131	19.81	20.11	20.41	20.72	21.03	21.34	21.65	21.97	22.28	22.61
1132	22.93	23.25	23.58	23.91	24.25	24.58	24.92	25.26	25.61	25.95
1133	26.30	26.65	27.01	27.37	27.73	28.09	28.45	28.82	29.19	29.57
1134	29.94	30.32	30.70	31.09	31.47	31.86	32.25	32.65	33.05	33.45
1135	33.85	34.26	34.67	35.08	35.49	35.91	36.33	36.76	37.18	37.62
1136	38.05	38.48	38.92	39.36	39.81	40.25	40.71	41.16	41.62	42.08
1137	42.54	43.01	43.48	43.95	44.43	44.91	45.39	45.88	46.37	46.86
1138	47.36	47.86	48.36	48.87	49.38	49.90	50.42	50.94	51.47	52.00
1139	52.53	53.07	53.61	54.15	54.70	55.26	55.81	56.37	56.94	57.51
1140	58.08	58.66	59.23	59.82	60.41	61.00	61.60	62.20	62.80	63.41
1141	64.03	64.64	65.27	65.89	66.53	67.16	67.80	68.44	69.09	69.74
1142	70.40	71.05	71.72	72.38	73.05	73.73	74.41	75.09	75.78	76.47
1143	77.17	77.87	78.57	79.28	79.99	80.71	81.43	82.16	82.89	83.62
1144	84.36	85.10	85.85	86.60	87.35	88.11	88.87	89.64	90.41	91.19
1145	91.97	92.75	93.54	94.34	95.13	95.93	96.74	97.55	98.36	99.18
1146	100.00	100.82	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00



NORTH BRANCH OF KOKOSING RIVER  
 OHIO  
  
 NORTH BRANCH OF KOKOSING LAKE  
 PROJECT  
  
**SPILLWAY RATING CURVE**  
  
 DEPARTMENT OF THE ARMY  
 HUNTINGTON DISTRICT, CORP OF ENGINEERS  
 HUNTINGTON, W.V. REDRAWN SEPTEMBER 2000





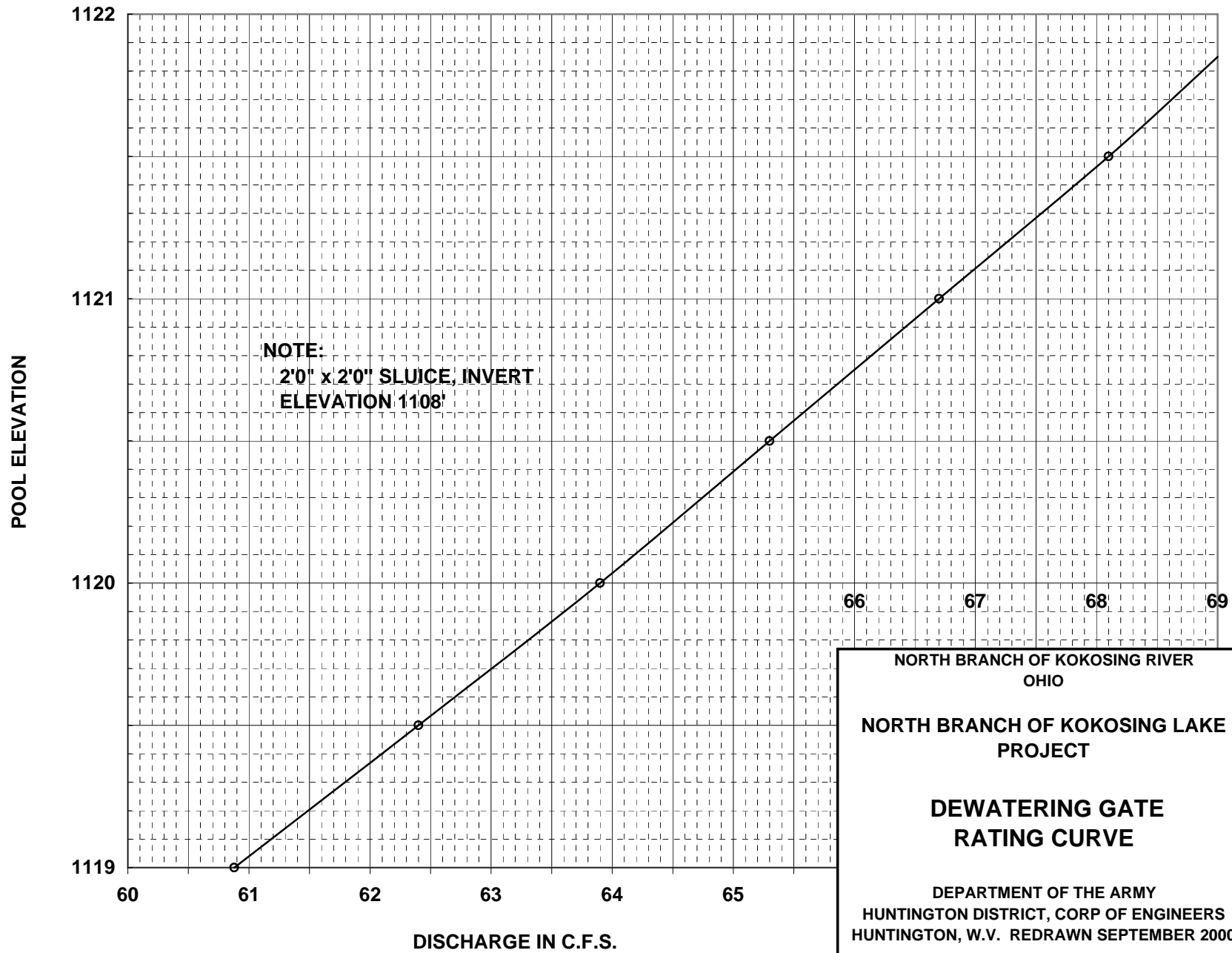
12      14      16      18

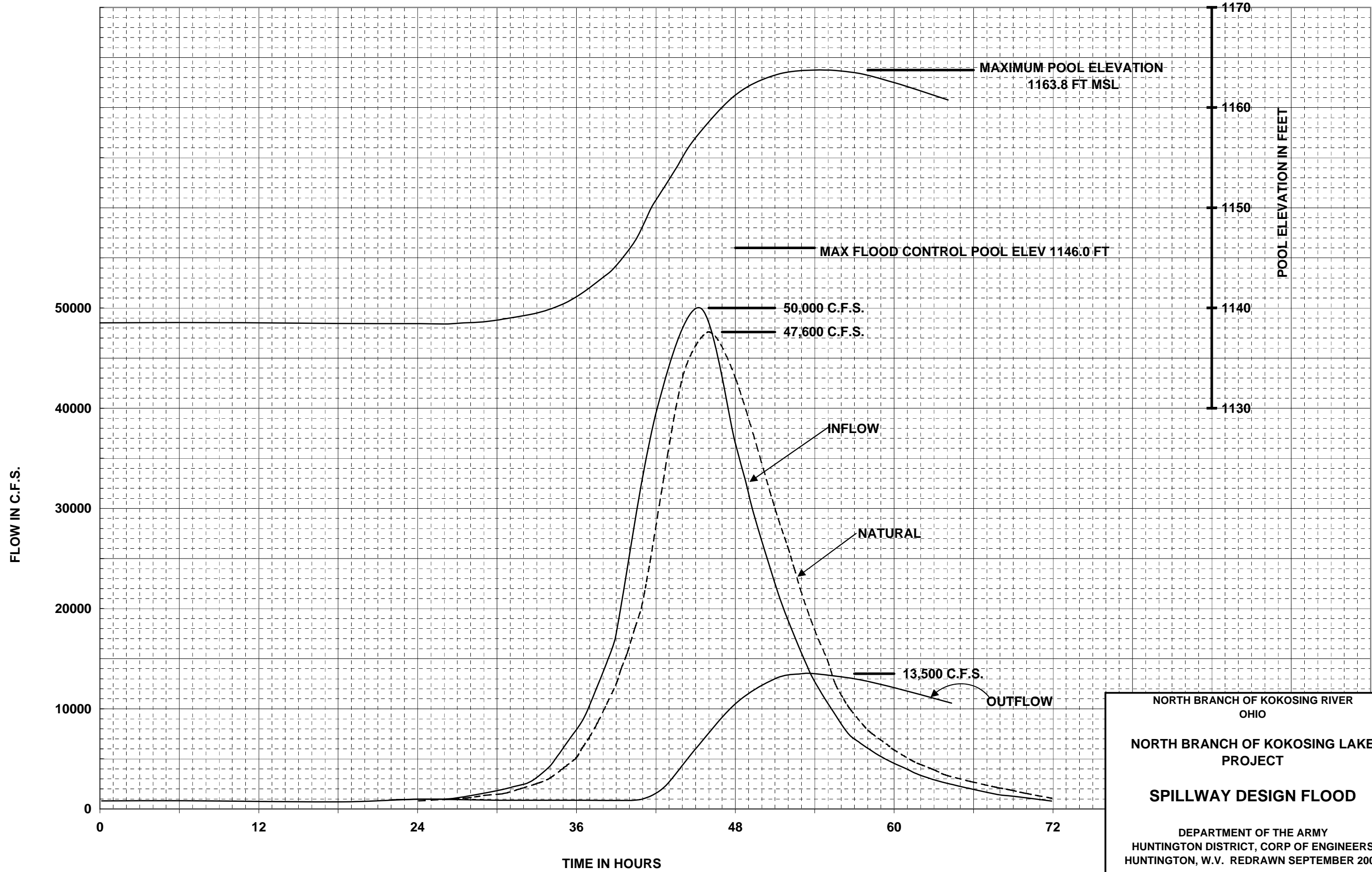
NORTH BRANCH OF KOKOSING RIVER  
OHIO

NORTH BRANCH OF KOKOSING LAKE  
PROJECT

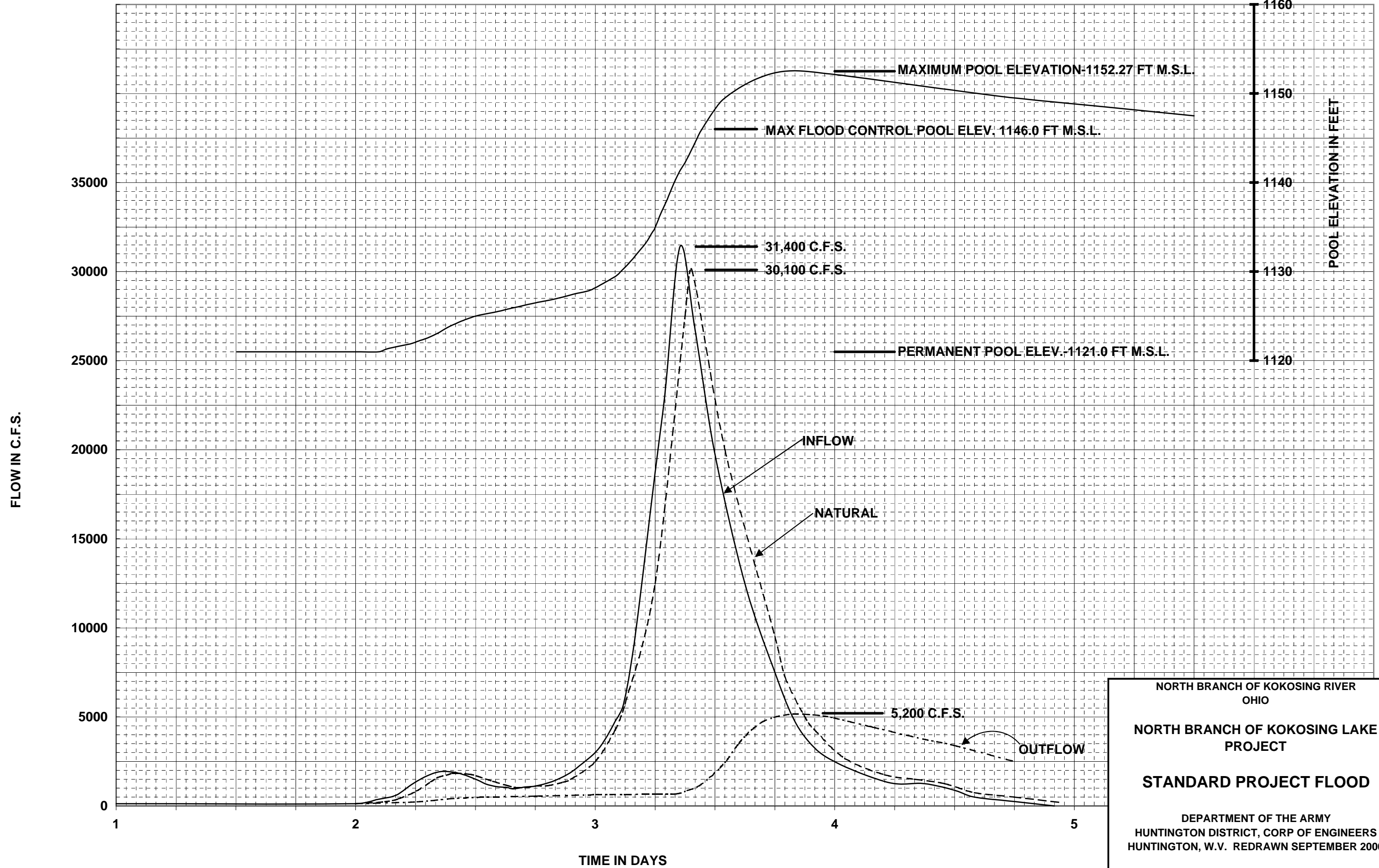
**EMERGENCY DRAWDOWN CURVE  
JUNE 1986**

DEPARTMENT OF THE ARMY  
HUNTINGTON DISTRICT, CORP OF ENGINEERS  
HUNTINGTON, W.V. REDRAWN SEPTEMBER 2000

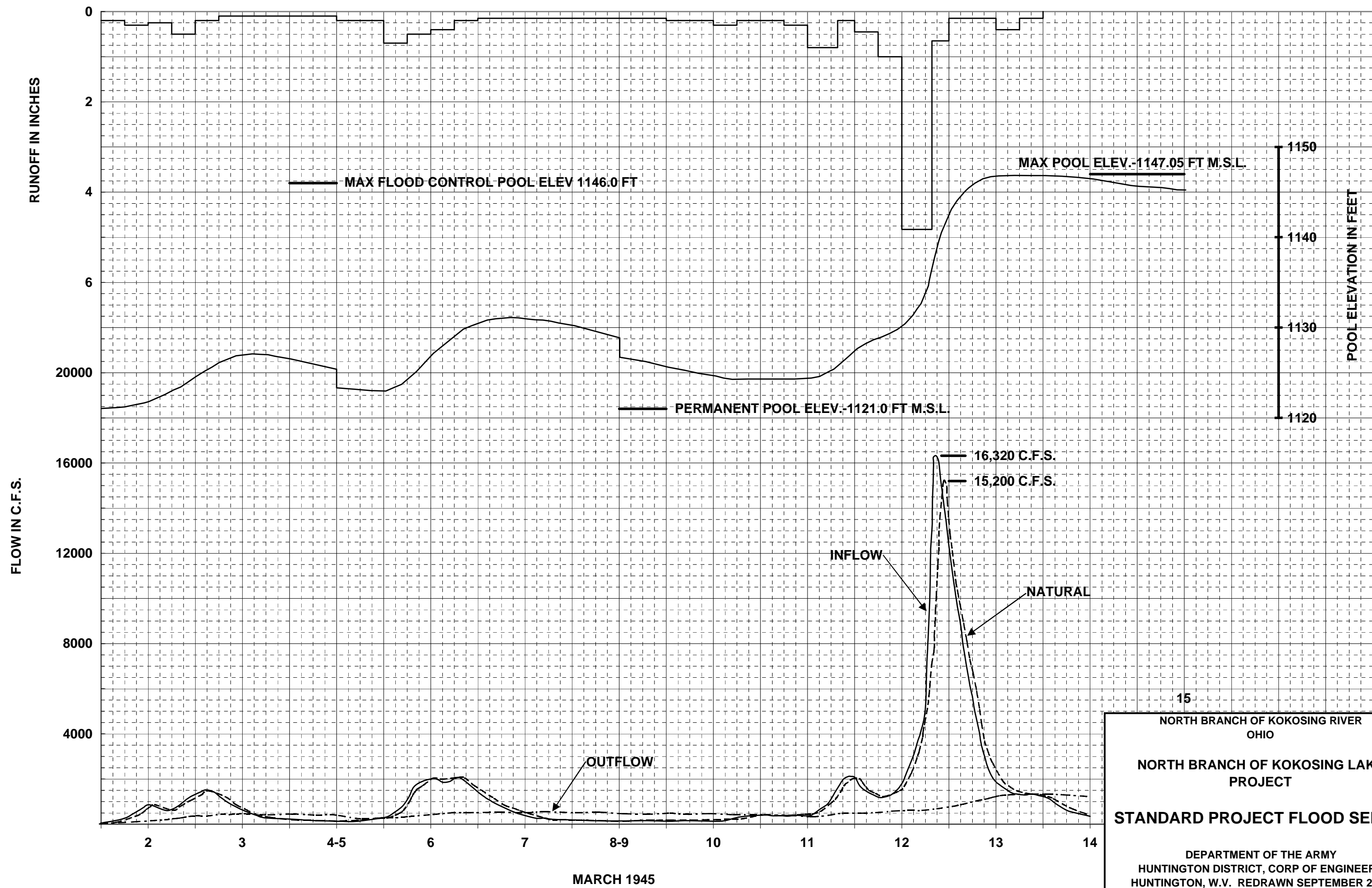




NORTH BRANCH OF KOKOSING RIVER  
 OHIO  
  
 NORTH BRANCH OF KOKOSING LAKE  
 PROJECT  
  
**SPILLWAY DESIGN FLOOD**  
  
 DEPARTMENT OF THE ARMY  
 HUNTINGTON DISTRICT, CORP OF ENGINEERS  
 HUNTINGTON, W.V. REDRAWN SEPTEMBER 2000



NORTH BRANCH OF KOKOSING RIVER  
 OHIO  
**NORTH BRANCH OF KOKOSING LAKE  
 PROJECT**  
**STANDARD PROJECT FLOOD**  
 DEPARTMENT OF THE ARMY  
 HUNTINGTON DISTRICT, CORP OF ENGINEERS  
 HUNTINGTON, W.V. REDRAWN SEPTEMBER 2000



NORTH BRANCH OF KOKOSING RIVER  
 OHIO  
  
 NORTH BRANCH OF KOKOSING LAKE  
 PROJECT  
  
**STANDARD PROJECT FLOOD SERIES**  
  
 DEPARTMENT OF THE ARMY  
 HUNTINGTON DISTRICT, CORP OF ENGINEERS  
 HUNTINGTON, W.V. REDRAWN SEPTEMBER 2000

**DOLLAR BENEFITS 100,000**

1      2      3      4      5      6      7      8      9      10      11      12

**FLOOD CONTROL**  
1

1,178,032

**GENERAL RECREATION**  
2

122,800

2. BASED ON MONTHLY ESTIMATES-  
NOVEMBER 1982 THROUGH OCTOBER 1983

1. AREAS ABOVE MOHAWK  
MAXIMUM FLOOD CONTROL POOL

**FISH & WILDLIFE  
RECREATION**  
2

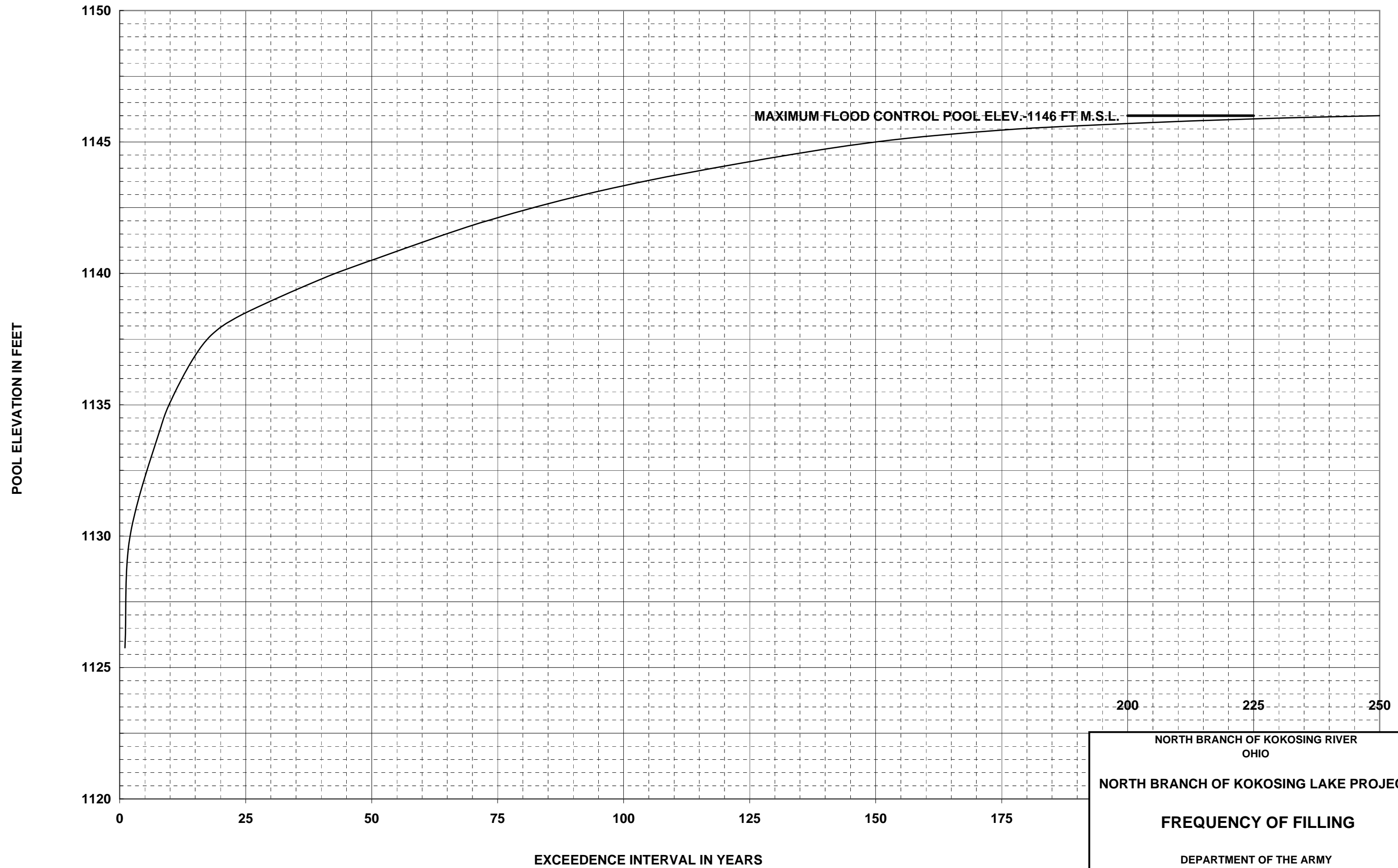
39,500

NORTH BRANCH OF KOKOSING RIVER  
OHIO

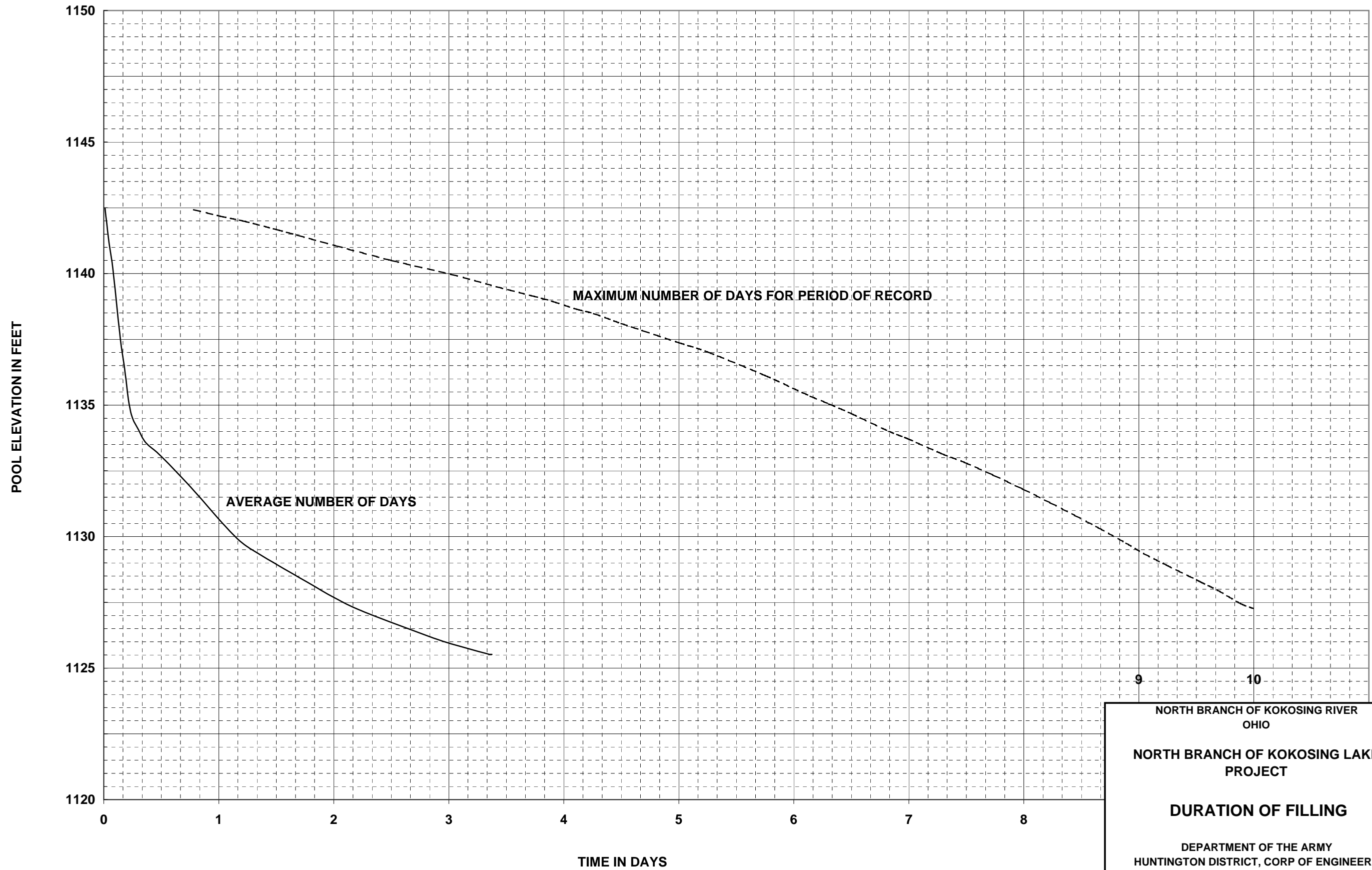
NORTH BRANCH OF KOKOSING LAKE  
PROJECT

**DOLLAR BENEFITS**

DEPARTMENT OF THE ARMY  
HUNTINGTON DISTRICT, CORPS OF ENGINEERS  
HUNTINGTON, W.V. REDRAWN SEPTEMBER 2000

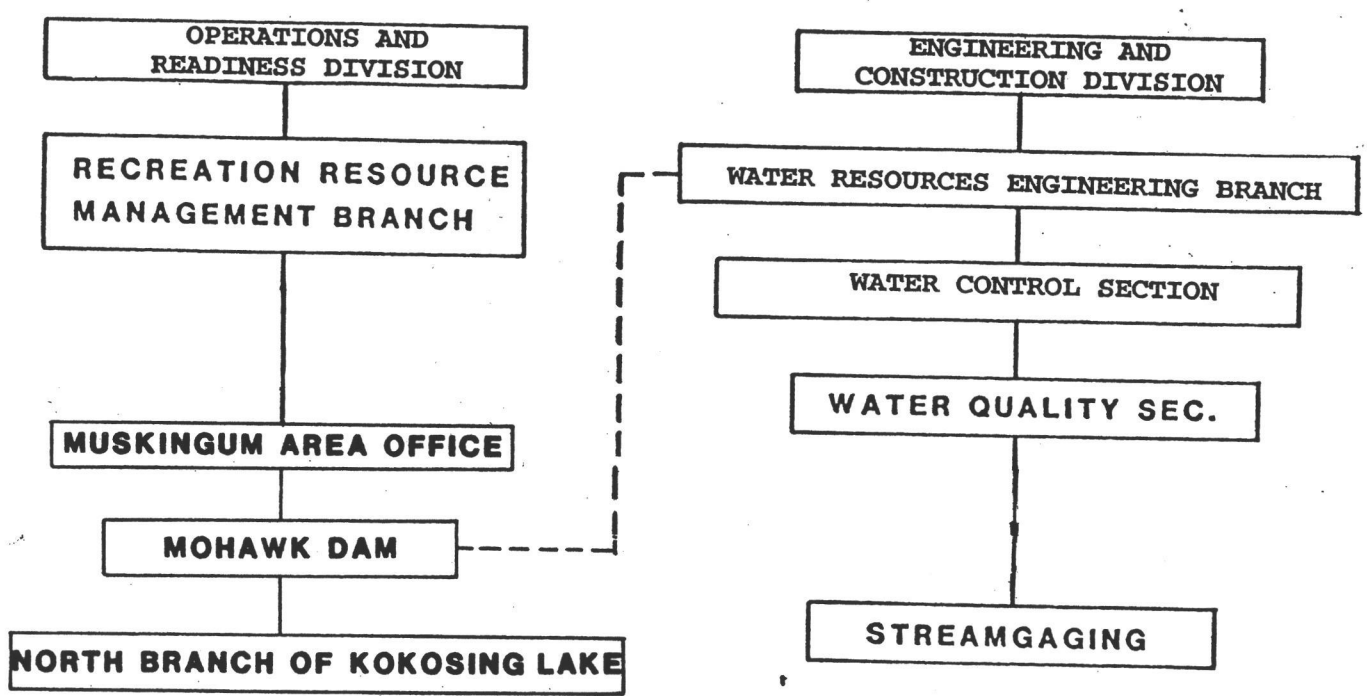


NORTH BRANCH OF KOKOSING RIVER  
 OHIO  
**NORTH BRANCH OF KOKOSING LAKE PROJECT**  
**FREQUENCY OF FILLING**  
 DEPARTMENT OF THE ARMY  
 HUNTINGTON DISTRICT, CORP OF ENGINEERS  
 HUNTINGTON, W.V. REDRAWN SEPTEMBER 2000



**NORTH BRANCH OF KOKOSING RIVER**  
 OHIO  
**NORTH BRANCH OF KOKOSING LAKE**  
 PROJECT  
  
**DURATION OF FILLING**  
  
 DEPARTMENT OF THE ARMY  
 HUNTINGTON DISTRICT, CORP OF ENGINEERS  
 HUNTINGTON, W.V. REDRAWN SEPTEMBER 2000

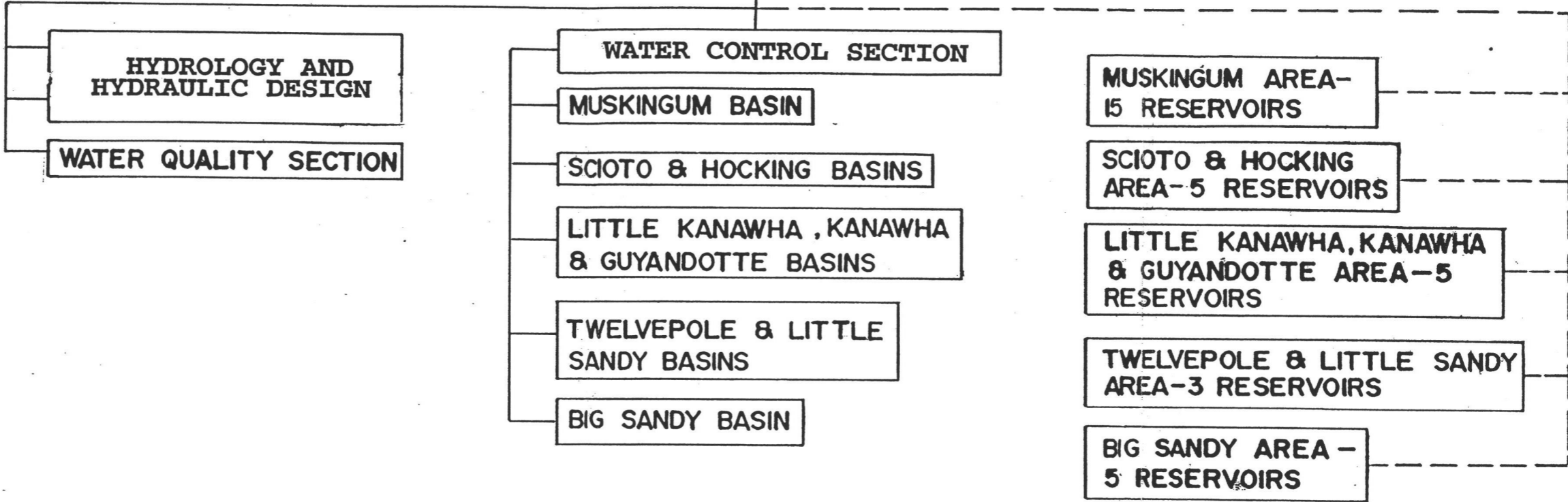
**NORTH BRANCH OF KOKOSING LAKE  
WATER CONTROL MANAGEMENT  
NORMAL ORGANIZATION**



**WATER CONTROL MANAGEMENT  
NORMAL ORGANIZATION**

WATER RESOURCES ENGINEERING BRANCH  
FLOOD EMERGENCY ORGANIZATION

CHIEF, WATER RESOURCES ENGINEERING BRANCH



WATER RESOURCES ENGINEERING BRANCH  
FLOOD EMERGENCY ORGANIZATION  
SHEET 1 OF 2

WATER RESOURCES ENGINEERING BRANCH  
FLOOD EMERGENCY ORGANIZATION

CHIEF, WATER RESOURCES ENGINEERING BRANCH

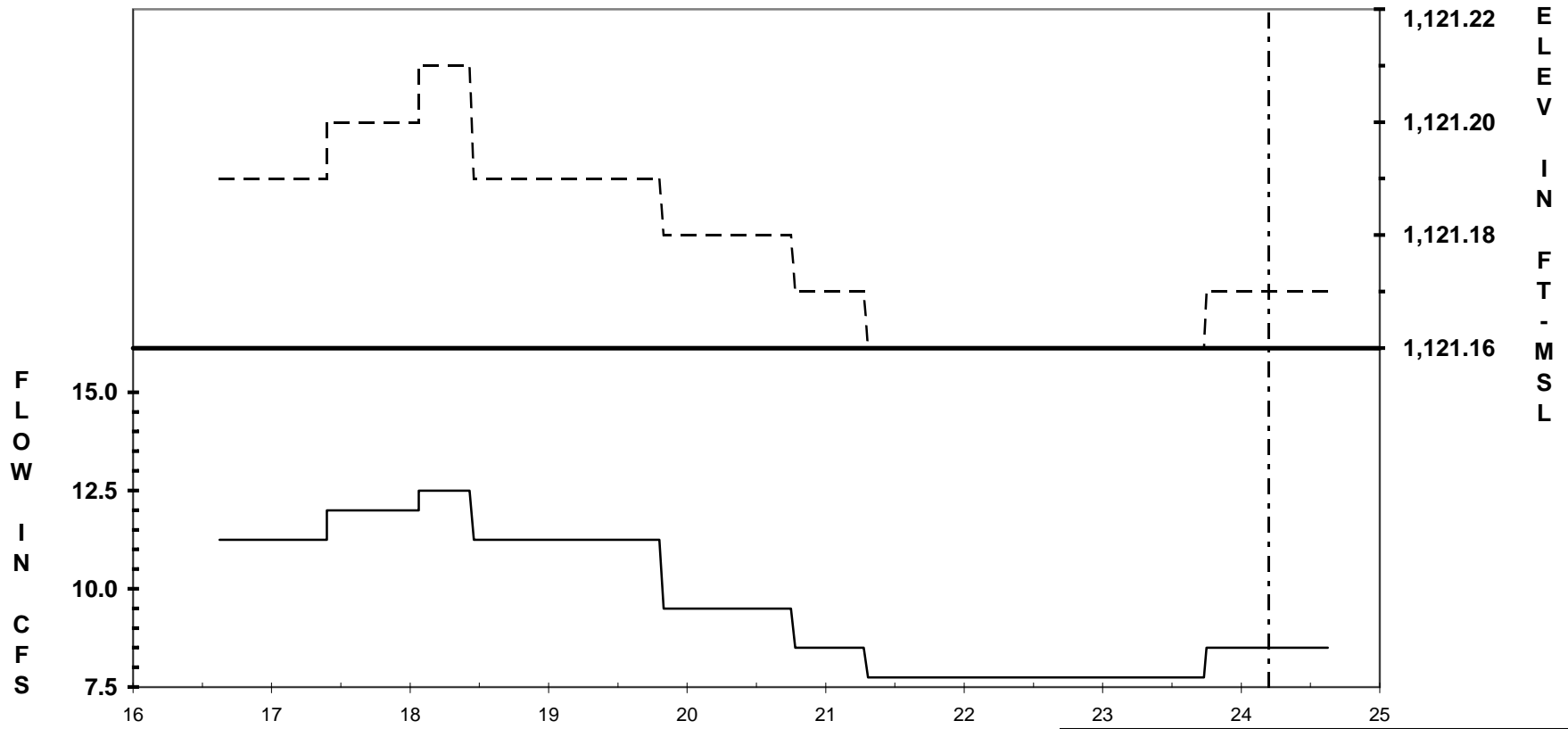
CHIEF, WATER CONTROL SECTION

MOHAWK DAM

NORTH BRANCH OF KOKOSING LAKE

WATER RESOURCES ENGINEERING BRANCH  
FLOOD EMERGENCY ORGANIZATION

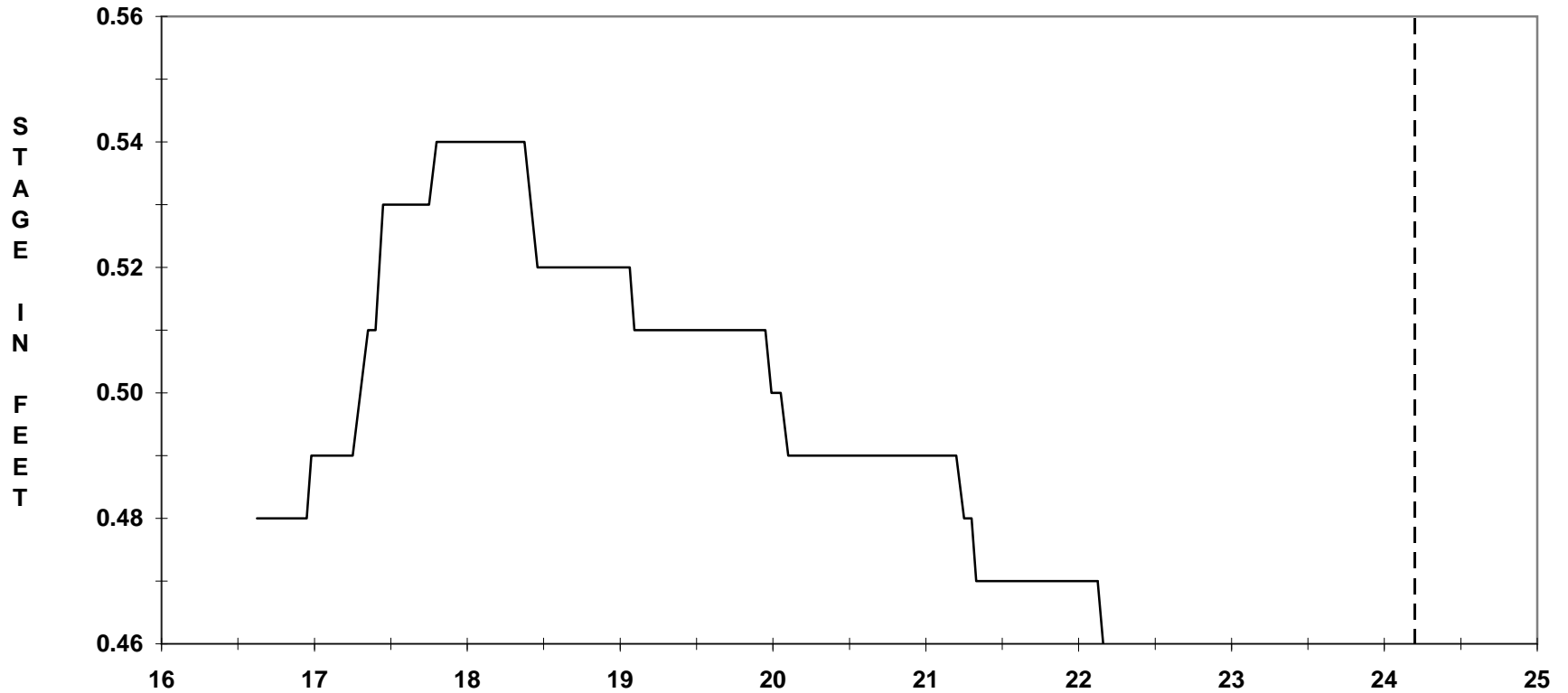
SHEET 2 OF 2



NOVEMBER 1987

— NBKOF OBS. FLOW  
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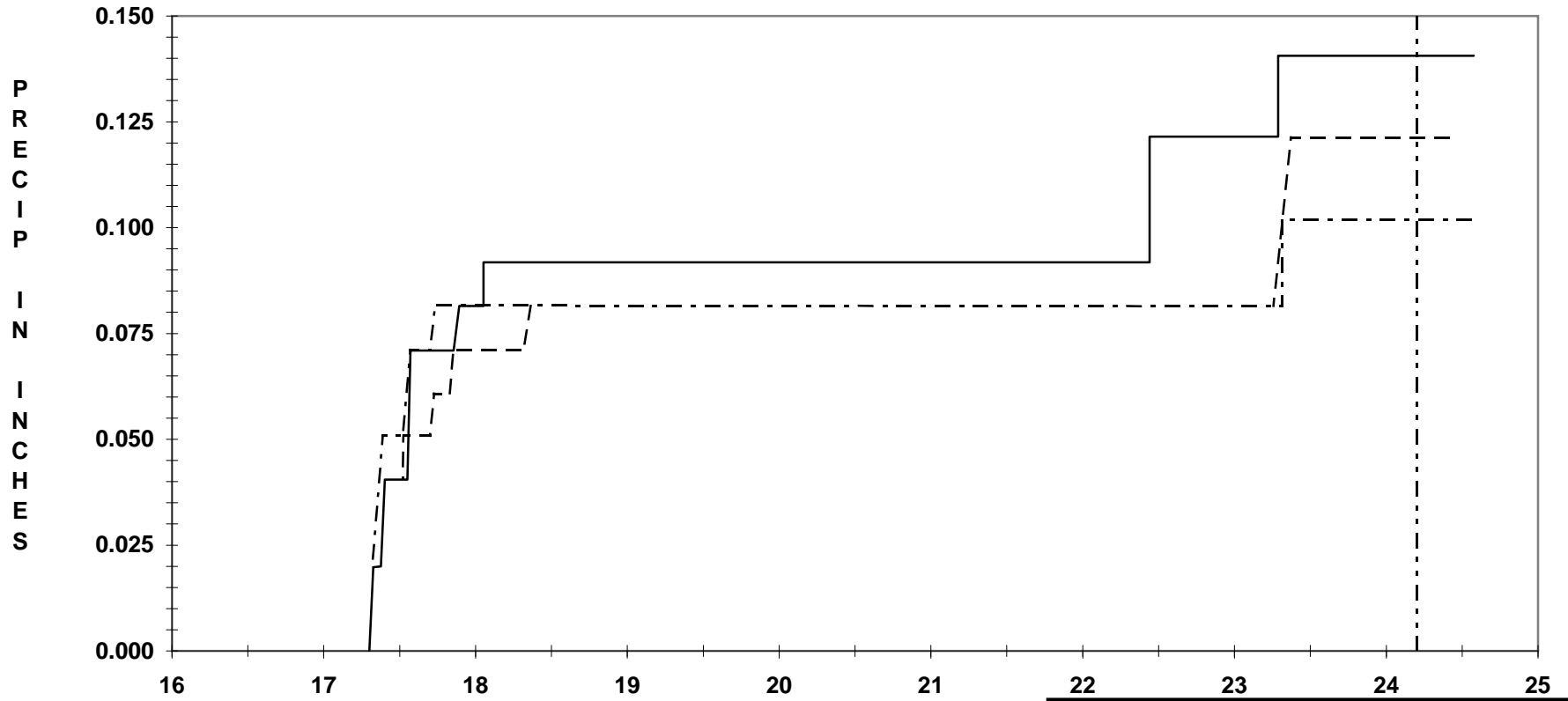
NORTH BRANCH OF KOKOSING RIVER  
 OHIO  
 NORTH BRANCH OF KOKOSING LAKE PROJECT  
**OBSERVED LAKE DATA  
 MUSKINGUM**  
 DEPARTMENT OF THE ARMY  
 HUNTINGTON DISTRICT, CORPS OF ENGINEERS  
 HUNTINGTON, W.V. REDRAWN SEPTEMBER 2000



NOVEMBER 1987

— MTVD4 OBS STAGE

**NORTH BRANCH OF KOKOSING RIVER**  
**OHIO**  
**NORTH BRANCH OF KOKOSING LAKE PROJECT**  
  
**OBSERVED STAGE DATA**  
**MUSKINGUM**  
  
 DEPARTMENT OF THE ARMY  
 HUNTINGTON DISTRICT, CORPS OF ENGINEERS  
 HUNTINGTON, W.V. REDRAWN SEPTEMBER 2000

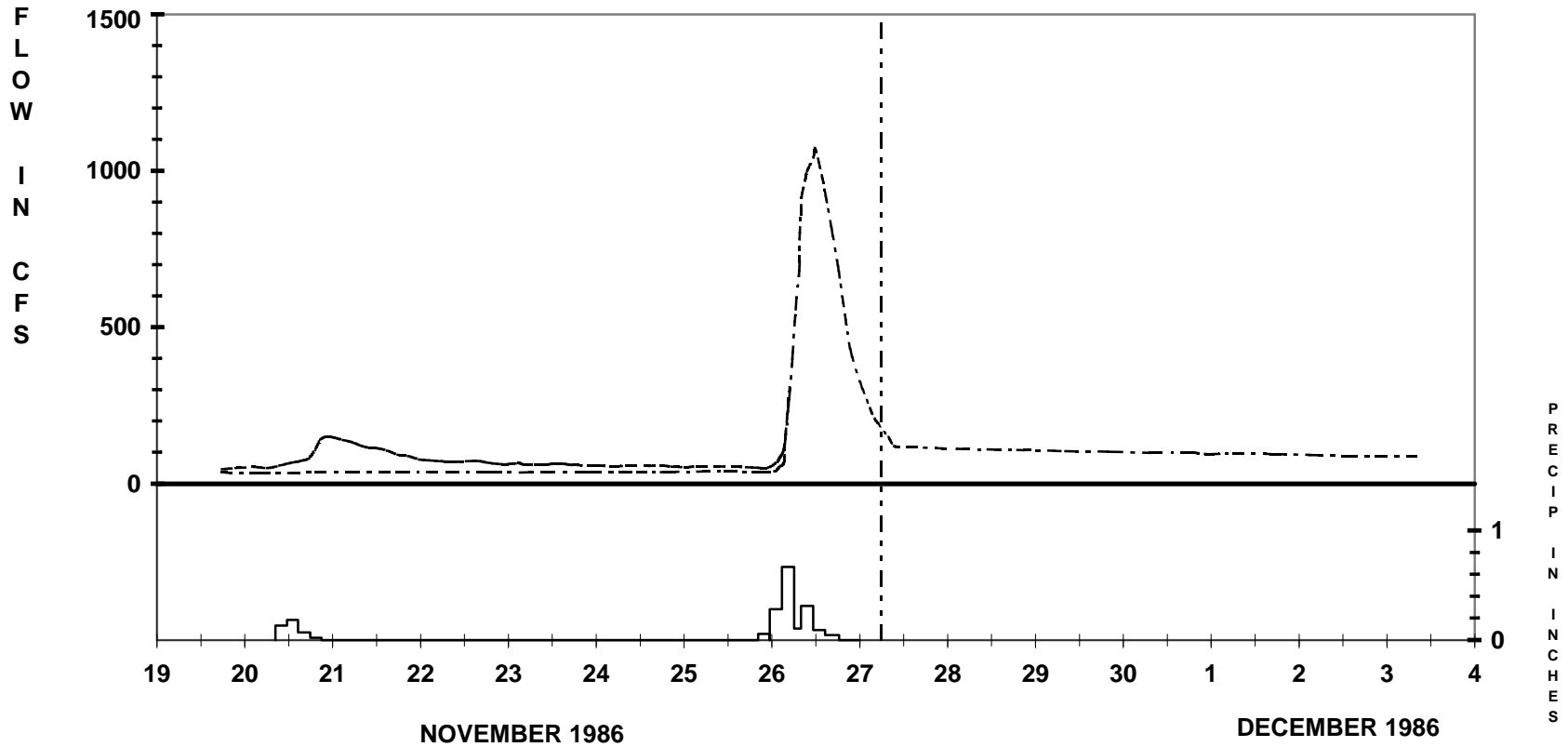


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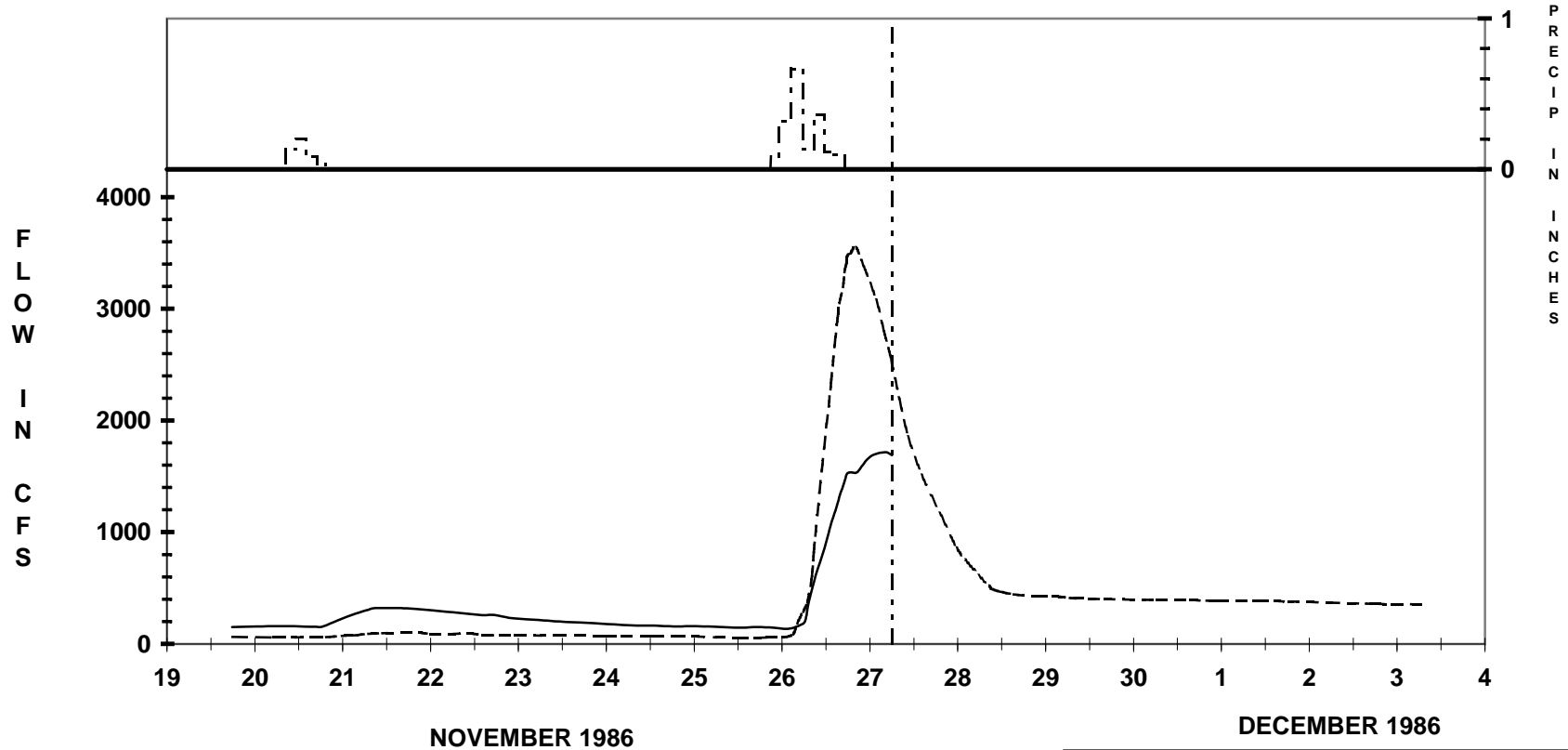
**NORTH BRANCH OF KOKOSING RIVER**  
**OHIO**  
**NORTH BRANCH OF KOKOSING LAKE PROJECT**  
**OBSERVED PRECIPITATION DATA**  
**MUSKINGUM**  
  
 DEPARTMENT OF THE ARMY  
 HUNTINGTON DISTRICT, CORPS OF ENGINEERS  
 HUNTINGTON, W.V. REDRAWN SEPTEMBER 2000

NOVEMBER 1987



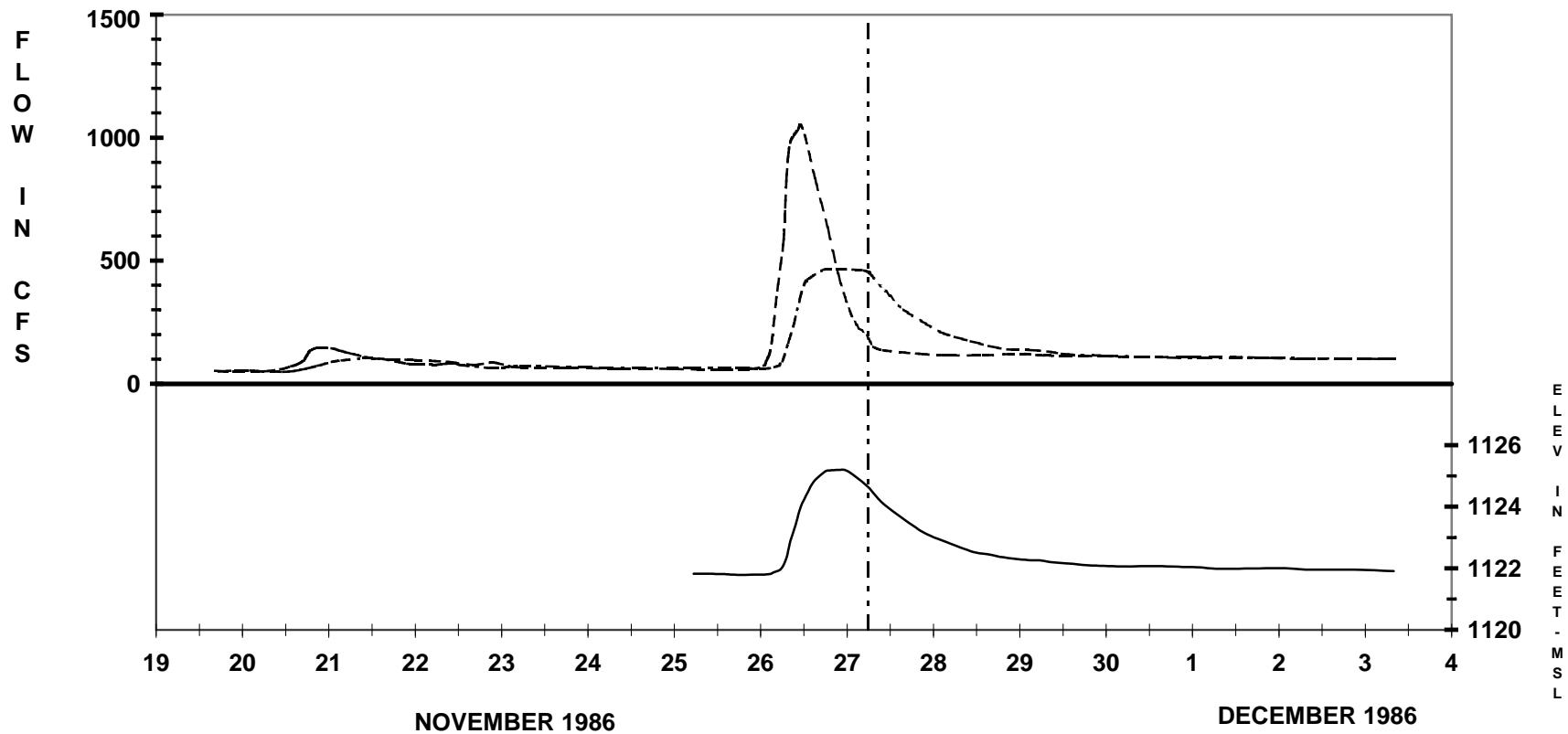
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NORTH BRANCH OF KOKOSING RIVER  
 OHIO  
  
 NORTH BRANCH OF KOKOSING LAKE  
 PROJECT  
  
**ESTIMATED INFLOW-NORTH BRANCH  
 MUSKINGUM**  
  
 DEPARTMENT OF THE ARMY  
 HUNTINGTON DISTRICT, CORPS OF ENGINEERS  
 HUNTINGTON, W.V. REDRAWN SEPTEMBER 2000



——— MTVD4 OBS FLOW  
 - - - MTVD4 HO6ACB FLOW  
 - . - . MTVD4 H06A PRECIP-INC

**NORTH BRANCH OF KOKOSING RIVER**  
**OHIO**  
  
**NORTH BRANCH OF KOKOSING LAKE**  
**PROJECT**  
  
**FLOW FORECAST-MT. VERNON**  
**MUSKINGUM**  
  
 DEPARTMENT OF THE ARMY  
 HUNTINGTON DISTRICT, CORPS OF ENGINEERS  
 HUNTINGTON, W.V. REDRAWN SEPTEMBER 2000



——— NBKD3 H06AFB ELEV  
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 - . . - NBKOF H06AFB FLOW

NORTH BRANCH OF KOKOSING RIVER  
 OHIO  
 NORTH BRANCH OF KOKOSING LAKE  
 PROJECT  
 NORTH BRANCH LAKE FORECAST  
 MUSKINGUM  
 DEPARTMENT OF THE ARMY  
 HUNTINGTON DISTRICT, CORPS OF ENGINEERS  
 HUNTINGTON, W.V. REDRAWN SEPTEMBER 2000