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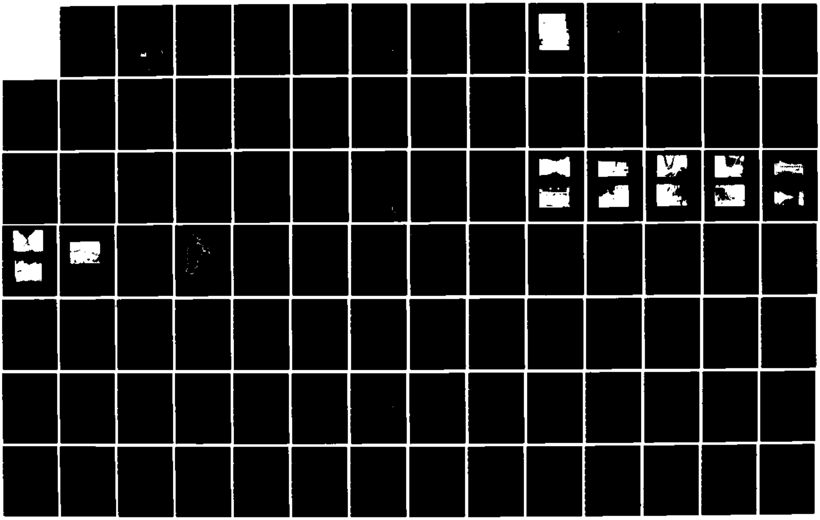

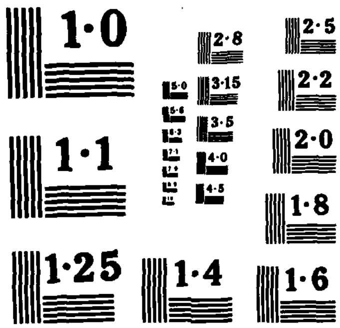


NATIONAL BUREAU OF STANDARDS
MICROCOPY RESOLUTION TEST CHART

KENNEBEC RIVER BASIN

MANCHESTER, MAINE

# COBBOSSEECONTEE LAKE DAM
# ME 00096

## STATE NO. 0418

# PHASE I INSPECTION REPORT
# NATIONAL DAM INSPECTION PROGRAM



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

NOVEMBER 1979

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

| REPORT DOCUMENTATION PAGE | | READ INSTRUCTIONS BEFORE COMPLETING FORM |
|---|---|---|
| 1. REPORT NUMBER<br>ME 0096 | 2. GOVT ACCESSION NO.<br>AD-A155 810 | 3. RECIPIENT'S CATALOG NUMBER |
| 4. TITLE (and Subtitle)<br>Cobbosseecontee Lake Dam<br>NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS | | 5. TYPE OF REPORT & PERIOD COVERED<br>INSPECTION REPORT |
| | | 6. PERFORMING ORG. REPORT NUMBER |
| 7. AUTHOR(s)<br>U.S. ARMY CORPS OF ENGINEERS<br>NEW ENGLAND DIVISION | | 8. CONTRACT OR GRANT NUMBER(s) |
| 9. PERFORMING ORGANIZATION NAME AND ADDRESS | | 10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS |
| 11. CONTROLLING OFFICE NAME AND ADDRESS<br>DEPT. OF THE ARMY, CORPS OF ENGINEERS<br>NEW ENGLAND DIVISION, NEDED<br>424 TRAPELO ROAD, WALTHAM, MA. 02254 | | 12. REPORT DATE<br>November 1979 |
| | | 13. NUMBER OF PAGES<br>58 |
| 14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) | | 15. SECURITY CLASS. (of this report)<br>UNCLASSIFIED |
| | | 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE |

16. DISTRIBUTION STATEMENT (of this Report)

APPROVAL FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Cover program reads: Phase I Inspection Report, National Dam Inspection Program; however, the official title of the program is: National Program for Inspection of Non-Federal Dams; use cover date for date of report.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

DAMS, INSPECTION, DAM SAFETY,
Kennebec River Basin
Manchester, Maine
Cobbosseecontee Stream

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The dam is a concrete capped stone masonry dam totaling 191 ft. long with a hydraulic height of 14 ft. The dam is in fair condition. There are a few major concerns which are listed in the report. The dam is large in size with a hazard potential of significant.

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

REPLY TO
ATTENTION OF:
NEDED

JUL 07 1980

Honorable Joseph E. Brennan
Governor of the State of Maine
State Capitol
Augusta, Maine 04330

Dear Governor Brennan:

Inclosed is a copy of the Cobbosseecontee Lake Dam Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Department of Agriculture cooperating agency for the State of Maine. In addition, a copy of the report has also been furnished the owner, Gardiner Water Power Company, Manchester, Maine 04351.

Copies of this report will be made available to the public, upon request, by this office under the Freedom of Information Act. In the case of this report the release date will be thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Department of Agriculture for your cooperation in carrying out this program.

Sincerely,

MAX B. SCHEIDER
Colonel, Corps of Engineers
Division Engineer

Incl
As stated

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT

| | |
|---|---|
| Identification No.: | ME00096 |
| Name of Dam: | Cobbosseecontee Lake Dam |
| Town: | Manchester |
| County and State: | Kennebec County, Maine |
| Stream: | Cobbosseecontee Stream |
| Date of Inspection: | September 18, 1979 |

## BRIEF ASSESSMENT

Cobbosseecontee Lake Dam is a concrete-capped stone masonry dam totaling 191 feet in length with a hydraulic height of 14 feet. The dam has a stoplog spillway and six low-level gated outlets. The dam impounds a reservoir with a maximum storage capacity of 67,000 acre-feet. The reservoir, including Lake Annabessacook, is 13 miles in length with a combined surface area of 6,960 acres, and is used for recreational purposes. The dam is located in southern Maine.

The dam is in fair condition. Concerns include the following: deterioration of the stone masonry sections of the dam, trees and brush growing in the earthfill section upstream and downstream of the stone masonry abutments; minor deterioration of the concrete, the wood timbers, and the stoplogs in the spillway; and trees overhanging the upstream approach channel.

The dam is of large size and significant hazard classification based on storage volume and potential for appreciable property loss in event of a breach. In accordance with Corps guidelines the test flood is the Probable Maximum Flood (PMF). The watershed consists of 126 square miles of moderately sloping terrain with several large storage areas. The test flood inflow was determined to be 31,500 cfs. After routing through Cobbosseecontee and Annabessacook Lakes, which have nearly the same normal water surface elevation, the routed outflow was reduced to 14,500 cfs at elevation 173.3' NGVD. The test flood analysis indicates that the dam would be overtopped by about 6.4 feet. The gated capacity of the dam, with all low-level outlets open and stoplogs in place, would be about 2,450 cfs which is 17 percent of the test flood outflow. A major breach at top of dam would probably not result in any loss of life but could cause appreciable property damage. (See Section 5 for details.)

The owner, the Town of Manchester, Maine, should implement the results of the recommendations and remedial measures given in Sections 7.2 and 7.3, respectively, within one year after receipt of this Phase I Inspection Report.

Warren A. Guinan
Project Manager
N.H. P.E. 2339

This Phase I Inspection Report on Cobbosseccontee Lake Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

ARAMAST MAHTESIAN, MEMBER
Geotechnical Engineering Branch
Engineering Division

CARNEY M. TERZIAN, MEMBER
Design Branch
Engineering Division

RICHARD DIBUONO, CHAIRMAN
Water Control Branch
Engineering Division





APPROVAL RECOMMENDED:

JOE B. FRYAR
Chief, Engineering Division

## PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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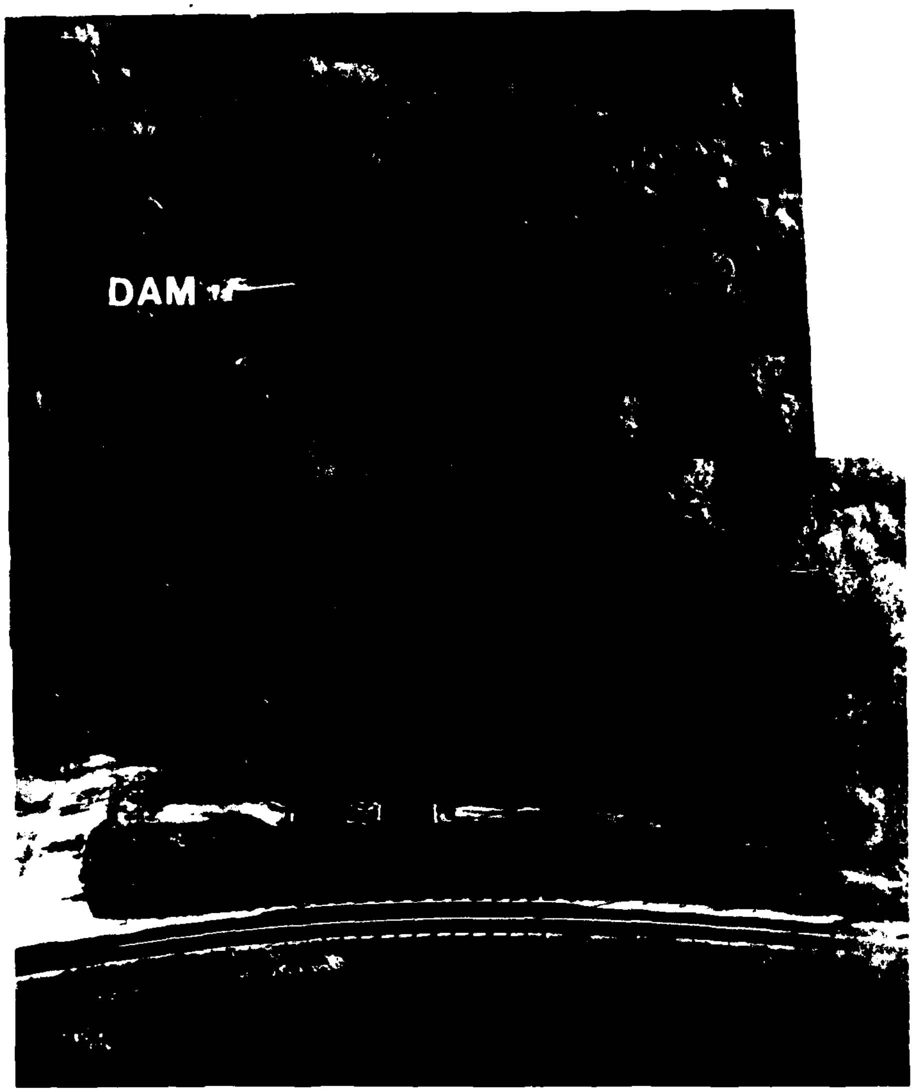
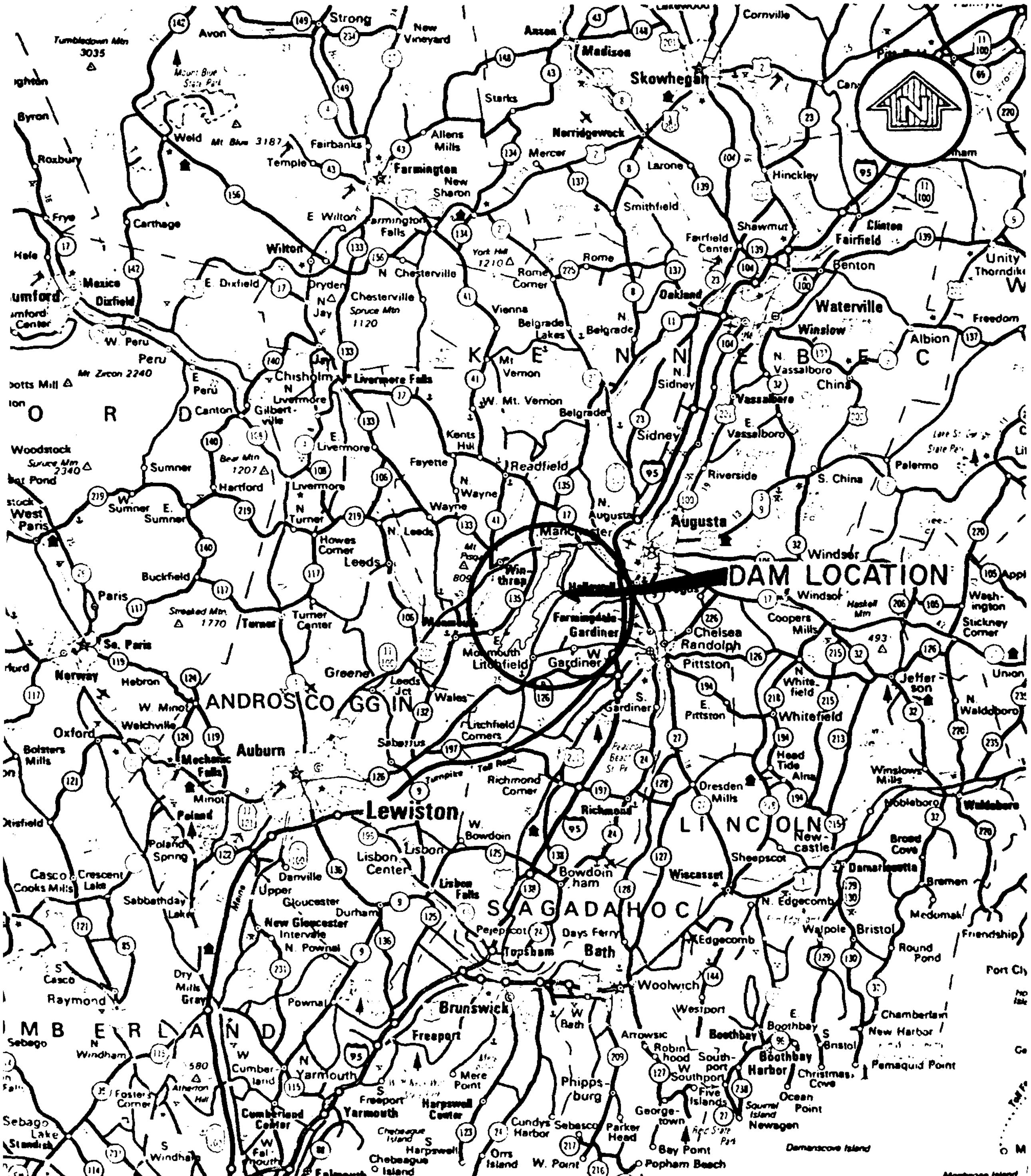



October 1979

Figure 1 - Overview of Cobbosseecontee Lake Dam. The dam is located in upper center of photo.






SCALE IN MILES

10 20

...ED ON 1979-1980 OFFICIAL
...ORTATION MAP STATE OF MAINE

| Anderson-Nichols & Co., Inc. CONCORD NEW HAMPSHIRE | U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MA. |
|---|---|

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

# LAKE COBBOSSEECONTEE DAM LOCATION MAP

COBBOSSEECONTEE STREAM MAINE

SCALE: SEE BAR SCALE

DATE: NOVEMBER 1979

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT
COBBOSSEECONTEE LAKE DAM

SECTION 1
PROJECT INFORMATION

1.1 General

a. Authority. Public Law 92-367, August 8, 1972 authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Anderson-Nichols & Company, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of New Hampshire. Authorization and notice to proceed were issued to Anderson-Nichols under a letter of August 28, 1979 from William E. Hodgson, Colonel Corps of Engineers. Contract No. DACW33-79-C-0050, as changed, has been assigned by the Corps of Engineers for this work.

b. Purpose

(1) To perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.

(2) To encourage and prepare the States to initiate quickly effective dam safety programs for non-Federal dams.

(3) To update, verify and complete the National Inventory of Dams.

1.2 Description of Project

a. Location. Cobbosseecontee Lake Dam is located in the Town of Manchester, Maine and impounds a reservoir of large size. After discharging at the damsite, Cobbosseecontee Stream flows southwesterly then shifts southeasterly through Pleasant Pond and then continues in a northeasterly direction until its confluence with the Kennebec River, a total distance of approximately 17.5 miles. The dam is shown on U.S.G.S. 15-Minute Quadrangle, Augusta, Maine with coordinates approximately at N44°16'42", W69°53'18", Kennebec County, Maine. (See Location Map page vii.)

b. Description of Dam and Appurtenances. Cobbosseecontee Lake Dam is a concrete-capped stone masonry dam totaling 191 feet in length with a hydraulic height of 14 feet. From the north abutment to the south abutment the dam consists of the following sections: a concrete-capped stone masonry section 33 feet long with earthfill against both the upstream and downstream faces; a stone masonry section about 47 feet long which houses six low-level gated outlets; a concrete stoplog spillway section about

0 feet long with two bays of stoplogs; and a concrete-capped tone masonry section about 71 feet long with earthfill against oth the upstream and downstream faces. The low-level outlets re each operated by a mechanical lifting device (rack and pinion) nd are housed inside a wooden gatehouse covered with corrugated heet iron. A wooden platform parallels the gatehouse and extends cross the stoplog spillway making the dam easily accessible.

c. Size Classification. Large (hydraulic height - 14 eet; storage - 67,000 acre-feet) based on storage $\geq$50,000 cre-feet as given in the Recommended Guidelines for Safety nspection of Dams. It should be noted, however, that this large torage which classifies this dam as large is not actually impounded y the dam structure. The dam impounds probably the top ten feet f the lake; the rest is dead storage which constitutes the natural ake. The total storage volume also includes storage of Lake nnabessacook, which is located about one mile upstream of obbosseecontee Lake. The two lakes are connected by a small hannel named Jug Stream. The U.S.G.S. Quadrangle Augusta, Maine hows the normal water surface elevations to be 166 and 165 feet bove NGVD of 1929 respectively. To avoid confusion in this Phase I nspection report in various portions of the pertinent data section iven in Section 1.3 and in the hydrologic/hydraulic analysis, the torage in these two lakes was treated as one body of water. The ctual location of the hydraulic control on Lake Annabessacook was ot verified during the field inspection; however, files obtained rom the Maine Department of Agriculture indicate the presence of concrete and rock structure about 6 feet in height. For all of he critical hydraulics in this dam safety evaluation the two lakes ct as a unit.

d. Hazard Classification. Significant hazard. A breach at op of dam would probably not result in any loss of life, but ould cause appreciable property damage to structures downstream. See details in Section 5.1 f.)

e. Ownership. The dam was originally owned by Gardiner ater Power Company. The dam is presently owned by the Town of anchester, Maine.

f. Operator. The current owner and operator of the dam is he Town of Manchester, Maine. Charles Wheeler, who lives near he dam, operates the dam. Phone: (207) 724-3434.

g. Purpose of Dam. The dam was constructed for use in onservation for water power in Gardiner. The impoundment is sed now for recreational purposes only.

h. Design and Construction History. The dam is thought to ave been built around 1900. No design or construction records ere found.

i. Normal Operating Procedures. Normal recreational pool s maintained below the crest of the stoplog spillway by use of he gated low-level outlets. The condition of the stoplogs and ates is checked every fall. At this time, all gates are operated o ensure they are functional. During high flows, Charles Wheeler operates the gates as he deems necessary.

..3 Pertinent Data

a. Drainage Area. The drainage area consists of 126 square miles (80,640 acres) of varied terrain. Several large storage areas are present in the upstream watershed. Lake Annabessacook has a surface area of 1536 acres with its normal water surface elevation only one foot higher than that of Cobbosseecontee Lake. Maranacook Lake has a surface area of about 1670 acres with its normal water surface elevation 44 feet above that of Lake Annabessacook. The normal surface area of Cobbosseecontee Lake and Lake Annabessacook combined is 6,960 acres which constitutes less than 9 percent of the watershed.

b. Discharge at Damsite.

(1) Outlet works - Five 4' x 4' gated outlets at invert elevation 155' NGVD and one 6' x 6' gated outlet at invert elevation 153' NGVD. Total gated capacity at recreational pool - 2,432 cfs @ 165' NGVD.

(2) The maximum discharge at damsite is unknown.

(3) Ungated spillway capacity at top of dam - not applicable

(4) Ungated spillway capacity at test flood elevation - not applicable

(5) Gated spillway capacity at top of dam -

(stoplogs in) - 15 cfs @ 166.9' NGVD
(stoplogs removed)- 1,085 cfs @ 166.9' NGVD

(6) Gated capacity at test flood elevation -

Stoplog spillway (stoplogs in) - 1,600 cfs @ 173.3' NGVD
Low-level outlets - 3,090 cfs @ 173.3' NGVD

(7) Total capacity at test flood elevation -

Stoplog spillway (stoplogs in) - 1,600 cfs @ 173.3' NGVD
Low-level outlets - 3,090 cfs @ 173.3' NGVD

(8) Total project discharge at test flood elevation - 14,500 cfs @ 173.3' NGVD

c. Elevation (feet above NGVD of 1929 formerly called Mean Sea Level (MSL); see (4) below.)

(1) Streambed at centerline of dam - 153

(2) Maximum tailwater - unknown

VISUAL INSPECTION CHECKLIST
PARTY ORGANIZATION

ROJECT Cobbosseecontee Dam, Me.

DATE Sept. 18, 1979

TIME 10:30

WEATHER Sunny, cool

W.S. ELEV. 165'NGVD U.S. 157.2'DN.S

ARTY:

. Warren Guinan (ANCo)
. Stephen Gilman (ANCo)
. Leslie Williams (ANCo)
. John Regan (ANCo)
. Terry Sapp (ANCo)
6. Janusz Czyzowski (ANCo)
7. Ronald Hirschfeld (GEI)
8. Alex Grier (ANCo)
9.
10.

| PROJECT FEATURE | INSPECTED BY | REMARKS |
|---|---|---|
| . Hydrology/Hydraulics | J. Regan/A. Grier | |
| . Structural Stability | S. Gilman | |
| . Soils & Geology | R. Hirschfeld | |
| . | | |
| . | | |
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# APPENDIX A

# VISUAL INSPECTION CHECKLIST

The owner should carry out the recommendations made by his engineer.

## 7.3 Remedial Measures

a. Operating and Maintenance Procedures. The owner should:

(1) Clear trees and brush from the embankments placed against both sides of the stone-masonry sections of the dam near the abutments, a zone 25 feet wide next to both sides of the downstream channel for a distance of 100 feet downstream from the dam, and a zone 25 feet wide next to both sides of the upstream channel between the dam and the highway bridge that crosses the channel. These areas should be maintained free of brush and trees.

(2) Replace the timbers and stoplogs in the spillway structure as needed.

(3) Replace the deteriorated portions of the wood railings as needed and paint all railings.

(4) Visually inspect the dam and appurtenant structures once a month.

(5) Engage a registered professional engineer to make a comprehensive technical inspection of the dam once every year after the recommendations made in 7.2 have been carried out.

(6) Establish a surveillance program for use during and immediately after heavy rainfall or snowmelt and also a downstream warning program to follow in case of emergency conditions to include the warning (now informal) for large releases from Lake Maranacook.

## 7.4 Alternatives

None.

## SECTION 7
## ASSESSMENT, RECOMMENDATIONS, AND REMEDIAL MEASURES

### 7.1 Dam Assessment

a. Condition. The visual examination indicates that Cobbosseecontee Dam is in fair condition. The major concerns with the integrity of the dam, if left uncorrected, are:

(1) Deterioration of the stone-masonry sections of the dam.

(2) Trees and brush growing on the earth fill that has been placed against the upstream and downstream sides of the stone-masonry sections of the dam near the abutments.

(3) Minor deterioration of the concrete and timbers in the stoplog spillway.

(4) Trees overhanging the upstream approach channel.

b. Adequacy of Information. The information available is such that the assessment of this dam must be based primarily on the results of the visual inspection and the hydrologic and hydraulic analyses.

c. Urgency. The owner should implement the recommendations in 7.2 and 7.3 within one year after receipt of this Phase I report.

d. Need for Additional Investigation. No additional investigation is needed for the purposes of this Phase I inspection.

### 7.2 Recommendations

The owner should engage a registered professional engineer to:

(1) Evaluate further the hydrology and hydraulics and design additional spillway capacity if needed.

(2) Design repairs for the stone-masonry sections of the dam.

(3) Design procedures for the removal of trees and brush from the embankments placed against both sides of the stone-masonry sections of the dam near the abutments.

(4) Design repairs for the deteriorated concrete in the spillway structure.

(5) Scrape and paint all rusted steel.

## SECTION 6
## STRUCTURAL STABILITY

### 6.1 Evaluation of Structural Stability

a. Visual Observations. The visual observation indicates several potential structural problems:

(1) Deterioration of the stone-masonry sections of the dam, as evidenced by the lack of mortar in some of the joints, will eventually result in structural problems if not corrected.

(2) Trees and brush are growing from the earthfill that has been placed against the upstream and downstream faces of the stone-masonry sections of the dam at the abutments. Growing roots of these trees may open up cracks in the stone-masonry wall. If a tree blows over and pulls out its roots, or if a tree dies and its roots rot, seepage and erosion problems might result.

(3) Minor deterioration of the concrete, the wood timbers, and stoplogs in the stoplog spillway, if not corrected, could eventually lead to structural problems with the stoplog section of the spillway.

(4) Trees overhanging the upstream approach channel, if undermined and toppled by flood flows, could plug the spillway.

b. Design and Construction Data. No design and construction data are available.

c. Operating Records. No operating records are available.

d. Post-Construction Changes. No record of post-construction changes is available.

e. Seismic Stability. This dam is in Seismic Zone 2 and, in accordance with the Phase I guidelines, does not warrant seismic analysis.

elevation 1.7 feet below the low chord. From this bridge to High Street bridge an increase in stage of 5.7 feet would result. This would flood five cottage structures with about one foot of water.

A stage discharge from Pleasant Pond, controlled by Gardiner Water District Dam, (See Appendix C - Figure 14.) was determined by use of the Corps of Engineers HEC-2 backwater computer program. It was determined that with a discharge of 3,250 cfs the elevation of Pleasant Pond would rise to 138.8' NGVD or 4.8 feet above normal level. This would cause backwater from the dam to the High Street bridge. The dam operators at Gardiner Water District Dam report no damage at elevation 138.1' NGVD (top of dam). The dam would be overtopped by 0.7 feet; damage would probably be minor. The 4.8-foot rise in Pleasant Pond would probably cause structural damage to cottages located on the shoreline; no loss of life is probable. Based on the above analysis, Cobbosseeconteee Lake Dam was classified Significant Hazard.

this CSM value to the drainage area resulted in a peak inflow value of 31,500 cfs. Routing of this value through the storage available in Cobbosseecontee Lake and Lake Annabessacook resulted in a test flood outflow of 14,500 cfs at elevation 173.3' NGVD. The test flood analysis indicates that the dam would be overtopped by about 6.4 feet. The gated capacity of the dam, with all low-level outlets open and stoplogs in place, would be about 2,450 cfs which is 17 percent of the test flood outflow.

f. Dam Failure Analysis. The impact of failure of the dam at top of dam was assessed using the Guidance for Estimating Downstream Dam Failure Hydrographs issued by the New England Division, Corps of Engineers. The analysis covered the reach from Cobbosseecontee Lake Dam to the Gardiner Water District Dam, a distance of 16.2 miles. The Gardiner Water District Dam impounds Pleasant Pond and is located 1.3 miles upstream from the confluence of Cobbosseecontee Stream with the Kennebec River in Gardiner, Maine.

A major breach of Cobbosseecontee Lake Dam would result in a discharge of 3,580 cfs. Antecedent discharge just prior to a breach, assuming normal operating conditions at the dam, would be about 740 cfs. The downstream hazard area would be affected as follows:

> From the dam to an unnamed mill pond about 2 miles downstream an increase in stage of 4.7 feet would result in addition to the 2.8 foot antecedent stage. No structures would be effected.
>
> The abandoned mill dam and pond section - the dam is controlled by a permanent opening and during the inspection little pondage was observed behind the dam. (See Appendix C - Figure 13.) A breach would result in an increase in stage of 3.4 feet in addition to the 2.9-foot antecedent stage. The total stage of 6.3 feet is below the top of the dam and would therefore not be overtopped by the initial breach wave. However, because of the extremely large volume of water coming out of Cobbosseecontee Lake, this pond area would fill up and then overtop the dam causing a flooding problem downstream.

An analysis was then performed to determine the approximate discharge coming out of the lake after the dam has breached. The Pond Road bridge would become the hydraulic control and would allow about 3,240 cfs to discharge into the downstream channel. This discharge was utilized to determine downstream flooding conditions.

Mill Pond Road will pass this discharge with the water surface

## SECTION 5
## HYDROLOGIC/HYDRAULIC

### 5.1 Evaluation of Features

a. General. Cobbosseecontee Dam is a concrete capped stone masonry structure which impounds a reservoir of large size. The six low-level outlets, which extend through the base of the dam, are operable with wooden gate stems and rack and pinion gate mechanisms. A gatehouse is situated over the gate mechanisms and is attached to a system of wooden beams attached to the top of the dam. The abutments of the dam extend into the natural soil. If the dam is overtopped these abutments could erode, endangering the dam stability. The reservoir level is controlled by stoplogs in the spillway section and by operation of the low-level gates. The watershed above the dam consists of 126 square miles of moderately sloping terrain. Several storage areas are present and are discussed in 5.1 e. below.

b. Design Data. No original hydrologic or hydraulic design data were found.

c. Experience Data. No flood history at the dam was discovered but an informal arrangement for warning of large releases to the lake from Maranacook Lake upstream was revealed by the operator.

d. Visual Observation. At the time of the inspection, no visual evidence was noted of damage to the dam caused by excessive discharges.

e. Test Flood Analysis. Cobbosseecontee Lake Dam is classified as being large in size having a hydraulic height of 14 feet and a maximum storage capacity of about 67,000 acre-feet; the dam was determined to have a significant hazard classification. Based on the Recommended Guidelines for Safety Inspection of Dams, a dam with a large size and significant hazard classification dictates use of the Probable Maximum Flood (PMF) as the test flood.

The PMF cannot be directly determined in a convenient manner. The dam is part of a complex hydrologic and hydraulic system consisting of Maranacook, Annabessacook, and Cobbosseecontee Lakes. When considering the behavior of this system of lakes during an extreme rainfall event, or combined rainfall - snowmelt event, it is necessary to consider the relative timing of the peak flows through each storage area. A complete analysis would include a detailed hydrologic or hydraulic routing of an assumed rainfall distribution through the system. This degree of detail is beyond the scope of the Phase I investigation.

Therefore, the COE guide curves were utilized to determine an approximate inflow. Because of the upstream storage area, the "Flat & Coastal" curve was used and resulted in a PMF inflow of 48,000 cfs. In order to assure a reasonable estimate, a regional equation was applied to this watershed. Using a Benson's regional equation, a lower value resulted. Analysis of the results indicate that a CSM value of 250 would be reasonable. Applying

## SECTION 4
## OPERATIONAL PROCEDURES

### 4.1 Procedures

No written operational procedures exist for Cobbosseecontee Lake Dam. Normal recreational pool is maintained below the crest of the stoplogs by use of the gated low-level outlets. During high flows, Charles Wheeler operates the gates as deemed necessary.

### 4.2 Maintenance of Dam

The owner, the Town of Manchester, Maine, is responsible for the maintenance of the dam.

### 4.3 Maintenance of Operating Facilities

No formal maintenance procedure was found. However, the condition of the stoplogs and gates is checked every fall. The gates are all operated to ensure that they are functional.

### 4.4 Description of Any Warning System in Effect

No written warning system exists for the dam. There is an informal arrangement for warning of large releases to the lake from Maranacook Lake.

### 4.5 Evaluation

A formal written operational and maintenance procedure should be developed to ensure problems encountered could be remedied within a reasonable amount of time.

At the north end of the low-level outlet section of the dam a stone masonry training wall extends downstream about 32 feet along the north side of the downstream channel. This wall is in fair condition.

At the south end of the stoplog spillway section a training wall, concrete in the lower part and stone masonry in the upper part, extends downstream about 33 feet along the south side of the downstream channel. The wall is in good condition. The six low-level outlets are controlled by hand-operated gates. Their operator mechanisms are well-lubricated and appear to be in good condition. The wood stoplogs which are 2" x 8" planks show some deterioration and have numerous concentrated leaks which appear to be at the joints between the stoplogs. A wooden service bridge extends across the dam from the north to the south abutments. (See Appendix C - Figure 9.) The wood deck is untreated and shows some deterioration. Also the 8" x 8" wood timbers supporting the deck are untreated and show deterioration as evidenced by the fungus growing on the wood.

d. Reservoir Area. The watershed above the reservoir is moderately to steeply sloping and partially wooded. About 900 feet upstream of the dam a highway bridge crosses the approach channel. (See Appendix C - Figure 10.) Trees overhang both banks of the approach channel between the highway bridge and the dam. (See Appendix C - Figure 11.) Many camps are located on the shoreline of Cobbosseecontee Lake. No evidence of significant sedimentation was observed.

e. Downstream Channel. The channel downstream of the dam is generally wide and unobstructed; trees overhang both banks of the channel. (See Appendix C - Figure 12.) The channel bottom is covered with cobbles and boulders.

## 3.2 Evaluation

Based on the visual inspection, Cobbosseecontee Dam is in fair condition.

The stone masonry sections of the dam are in fair condition, and mortar is missing from some of the joints. If deterioration of the stone masonry is not corrected, structural problems may result.

Trees and brush are growing from the earthfill that has been placed against the upstream and downstream faces of the stone masonry sections of the dam at the abutments. Growing roots of these trees may open up cracks in the stone masonry wall. If a tree blows over and pulls out its roots, or if a tree dies and its roots rot, seepage and erosion problems might result.

Minor deterioration of the concrete wood timbers and stoplogs in the stoplog spillway, if not corrected, could eventually lead to structural problems with the stoplog section of the spillway.

Trees overhanging the upstream approach channel, if undermined and toppled by flood flows, could plug the spillway.

## SECTION 3
## VISUAL INSPECTION

### 3.1 Findings

a. General. Cobbosseecontee Dam is a low dam which impounds a reservoir of large size. The watershed above the reservoir is moderately sloping and partially wooded with several storage areas. The downstream area is flat to rolling and partially wooded.

b. Dam. Cobbosseecontee Dam is a concrete-capped stone masonry dam with a hydraulic height of 14 feet, and a total of 191 feet in length. (See Appendix C - Figure 2.) From the north abutment to the south abutment the dam consists of a concrete-capped stone masonry section with earthfill against both the upstream and downstream faces, about 33 feet long; a stone masonry section which houses six gated low-level outlets, about 47 feet long (See Appendix C - Figure 3.); a concrete stoplog spillway section, about 40 feet long (See Appendix C - Figure 4.); and another concrete-capped stone masonry section with earthfill against both the upstream and downstream faces, about 71 feet long. (See Appendix C - Figure 5.)

The stone masonry is in fair condition; mortar in the joints is missing in some areas. The concrete cap on the stone masonry sections is in good condition. No leakage was visible on the downstream face of the stone masonry sections or at the toe of the earthfill against the downstream side of the stone masonry sections near the abutments. Tailwater made is impossible to observe whether any seepage was occurring underneath either the low-level outlet section or the stoplog spillway section of the dam.

On the earth berms against the stone masonry section of the dam near the north abutment a large willow tree and some brush are growing upstream of the crest and brush is growing downstream of the crest. (See Appendix C - Figure 6.)

On the earth berms against the stone masonry section of the dam near the south abutment, small trees and brush are growing on both sides of the crest.

c. Appurtenant Structures. The stoplog spillway consists of two bays, 16 feet long, and 13 feet long, respectively, separated by a concrete pier. (See Appendix C - Figure 4.) The concrete in the spillway apron and the central pier is in good condition with only minor surface erosion which is limited to loss or surface laitance. Minor erosion, up to a maximum of one inch, has occurred at the base of the central concrete pier. (See Appendix C - Figure 7.) Minor surface erosion has occurred at the upstream end of the north end of the spillway structure exposing the coarse aggregate. (See Appendix C - Figure 8.) The stoplogs are supported by 10 vertical 6" x 10" timbers, which are somewhat deteriorated and appear to be untreated, except for the top ends of the timbers.

## SECTION 2
## ENGINEERING DATA

### 2.1 Design

No design data were found for Cobbosseecontee Lake Dam.

### 2.2 Construction

No construction records were disclosed.

### 2.3 Operation

No engineering operational data were obtained.

### 2.4 Evaluation

a. Availability. No engineering data were available for Cobbosseecontee Lake Dam. Direct contact with the owner and a search of the files at the Maine Soil and Water Conservation Commission revealed only a limited amount of information.

b. Adequacy. The final assessments and recommendations of this investigation are based on the visual inspection and the hydrologic and hydraulic calculations.

c. Validity. No engineering data were obtained to validate.

(3) Height - 14' (structural and hydraulic)

(4) Topwidth - varied

(5) Sideslopes - varied

(6) Zoning - unknown

(7) Impervious core - unknown

(8) Cutoff - unknown

(9) Grout curtain - unknown

h. Diversion and Regulating Tunnel - not applicable (see j. below)

i. Spillway

(1) Type - stoplog spillway with two bays

(2) Length of weir - one 16' bay; one 13' bay

(3) Crest elevation - 161.4' NGVD (without stoplogs); 166.6' NGVD (with stoplogs)

(4) Gates - none

(5) U/S Channel - About 900 feet upstream of the dam is the Pond Road bridge. From this bridge to the dam is a relatively constricted channel averaging 170 feet in width. The banks are tree lined. Remains of the old Pond Road bridge are located just downstream of the new road crossing.

(6) D/S Channel - The channel immediately below the dam is narrow and rocky. Numerous trees overhang the discharge channel.

j. Regulating Outlets. There are six gated low-level outlets contained in a 47-foot section beginning 33 feet south of the north abutment of the dam. These outlets consist of five 4' x 4' gated outlets with invert elevation at 155' NGVD and one 6' x 6' gated outlet with invert elevation at 153' NGVD. These gates are operated to keep the normal pool level at about elevation 165' NGVD.

(3) Upstream gate inverts - 155 (4' x 4' gates)
153 (6' x 6' gate)

(4) Recreation pool - 165 (shown on U.S.G.S. Quad and assumed to be normal pool on day of inspection.)

(5) Full flood control pool - not applicable

(6) Spillway crest - 166.6 (top of stoplogs)
161.4 (stoplogs removed)

(7) Original design surcharge - unknown

(8) Top of dam - 166.9

(9) Test flood pool - 173.3

d. Reservoir Length (miles) Cobbosseecontee Lake and Lake Annabessacook

(1) Maximum pool - 13

(2) Recreation pool - 13

(3) Flood control pool - not applicable

e. Storage (acre-feet) Cobbosseecontee Lake and Lake Annabessacook

(1) Recreation pool - 50,750

(2) Flood control pool - not applicable

(3) Spillway crest pool - 63,500 (top of stoplogs)

(4) Top of dam - 67,000

(5) Test flood pool - 120,100

f. Reservoir Surface Area (acres) Cobbosseecontee Lake and Lake Annabessacook

(1) Recreation pool - 6,960

(2) Flood control pool - not applicable

(3) Spillway crest - 7,270

(4) Test flood pool - 8,560

(5) Top of dam - 7,330

g. Dam

(1) Type - concrete-capped stone masonry with stoplog spillway and six gated low-level outlets.

(2) Length - 191'

PERIODIC INSPECTION CHECKLIST

PROJECT Cobbosseecontee Dam, ME DATE Sept. 18, 1979

PROJECT FEATURE ______ NAME ______

DISCIPLINE ______ NAME ______

| AREA EVALUATED | CONDITION |
|---|---|
| OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE | |
| a. Approach Channel | |
| Slope Conditions | Good |
| Bottom Conditions | Not visible beneath water surface. |
| Rock Slides or Falls | None |
| Log Boom | |
| Debris | |
| Condition of Concrete Lining | Not visible |
| Drains or Weep Holes | None |
| b. Intake Structure | STOPLOG SPILLWAY |
| Condition of Concrete | Good-Minor surface erosion at concrete surface limited to loss of surface laitance; minor underming of concrete pier (1" maximum). |
| Stop Logs and Slots | |
| Wood Piers | 6x10 wood-evidence of deterioration at base of wood piers (stoplog supports); wood appears to be untreated. |
| Wood Stoplogs | untreated wood-2x8 nominal; logs are deteriorated and have numerous concentrated leaks which appear to be at joints. |

PERIODIC INSPECTION CHECKLIST

PROJECT Cobbosseecontee Dam, ME DATE Sept. 18, 1979

PROJECT FEATURE ______ NAME ______

DISCIPLINE ______ NAME ______

| AREA EVALUATED | CONDITION |
|---|---|
| OUTLET WORKS - CONTROL TOWER | |
| a. Concrete and Structural | |
| General Condition | Fair |
| Condition of Joints | None visible |
| Spalling | Surface erosion of concrete to a depth of ½". |
| Visible Reinforcing | None |
| Rusting or Staining of Concrete | Only at embedded items |
| Any Seepage or Efflorescence | None visible |
| Joint Alignment | Not applicable |
| Unusual Seepage or Leaks in Gate Chamber | Yes; source not visible |
| Cracks | None visible |
| Rusting or Corrosion of Steel | Only surface erosion |
| b. Mechanical and Electrical | |
| Air Vents | |
| Float Wells | |
| Crane Hoist | |
| Elevator-Hand operator(6 gates) | Well maintained and lubricated. |
| Hydraulic System | |
| Service Gates | |
| Emergency Gates | |
| Lightning Protection System | |
| Emergency Power System | |
| Wiring and Lighting System | |

PERIODIC INSPECTION CHECKLIST

PROJECT Cobbosseecontee Dam, ME DATE Sept. 18, 1979

PROJECT FEATURE ______ NAME ______

DISCIPLINE ______ NAME ______

| AREA EVALUATED | CONDITION |
|---|---|
| OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS | |
| a. Approach Channel | |
| General Condition | Good |
| Loose Rock Overhanging Channel | None |
| Trees Overhanging Channel | Some trees overhanging, but channel is wide. |
| Floor of Approach Channel | Not visible beneath water surface. |
| b. Weir and Training Walls | |
| General Condition of Concrete | |
| Rust or Staining | |
| Spalling | |
| Any Visible Reinforcing | |
| Any Seepage or Efflorescence | None |
| Drain Holes | |
| c. Discharge Channel | |
| General Condition | Good |
| Loose Rock Overhanging Channel | None |
| Trees Overhanging Channel | Some trees overhanging, but channel is generally wide and unobstructed. |
| Floor of Channel | Covered with boulders and cobbles. |
| Other Obstructions | None |

PERIODIC INSPECTION CHECKLIST

PROJECT Cobbosseecontee Dam, ME DATE Sept. 18, 1979

PROJECT FEATURE ______ NAME ______

DISCIPLINE ______ NAME ______

| AREA EVALUATED | CONDITION |
|---|---|
| OUTLET WORKS - SERVICE BRIDGE | |
| a. Super Structure | |
| Bearings | None |
| Anchor Bolts | Steel-leaded into wood; surface rusted. |
| Bridge Seat | |
| Longitudinal Members | 8x8 untreated wood; some surface deterioration observed |
| Underside of Deck | |
| Secondary Bracing | Wood timber used to support wood stoplog support; good condition |
| Deck | Wood plank - numerous areas of deterioration |
| Drainage System | Not applicable |
| Railings | Untreated wood; surface deterioration is limited |
| Expansion Joints | Not applicable |
| Paint | None |
| b. Abutment & Piers | |
| General Condition of Concrete | Good; minor undermining of concrete at base; some minor surface hairline cracks |
| Alignment of Abutment | No indication of movement |
| Approach to Bridge | Good |
| Condition of Seat & Backwall | Wood on mortar |

# APPENDIX B

# ENGINEERING DATA

APPLICATION FOR DAM REGISTRATION

Dam Registration Number 0418
Date Received SEP 1 1976
Fee Enclosed $10 on 3-2-77
Quad Sheet Name
Quad Sheet Number

**ation:**

nty: Kennebec

icipality: Manchester

e of Dam: Outlet

e of Impoundment: ?

**ership:**

ne of Owner: Town of Manchester

Name of Agent: Board of Selectmen
(if different from Owner)

lress of Owner: Manchester, Me

Address: Manchester Me

Lephone Number: 622-1894

Telephone Number: 622 1894

**scription of Dam**

pe: Locks +

nstruction Material: Concrete + Wood
(Concrete, wood, earth)

ar Originally built: ?

Year last major repair: 1973

ight: Locks + ?

Width: ?

illway type: Locks + ?

Spillway Width: ?

pounding Capacity: ?
(Acre-feet)

Drawdown available: 8'
(feet)

sh Passage available?: No

Installed Electrical Generating Cap: No

rposes for which stored water is used: Recreation

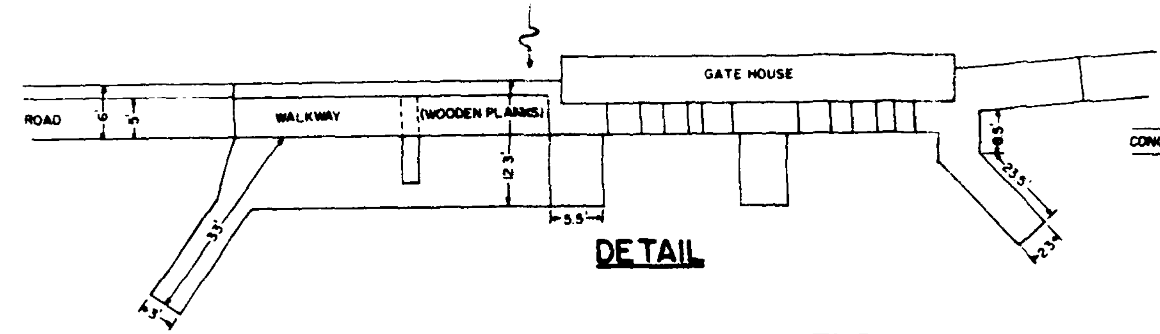
st recent inspection by Qualified Engineer (Date): 1973

me and Address of Engineer: ? Redington Robbin III
Civil Defense

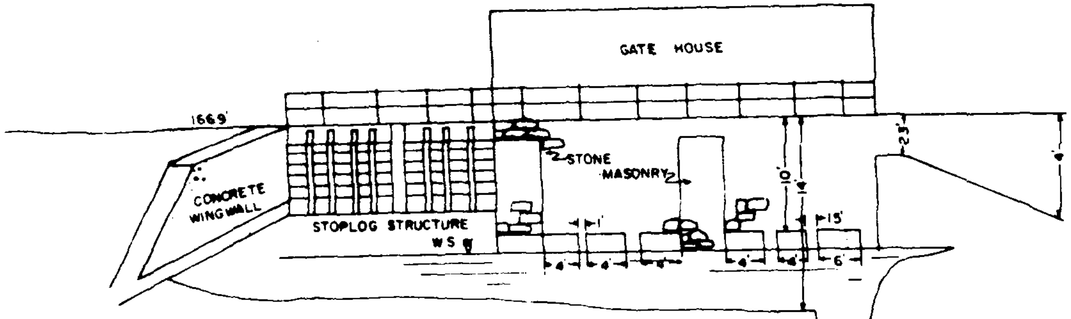
her Permits applicable: ?



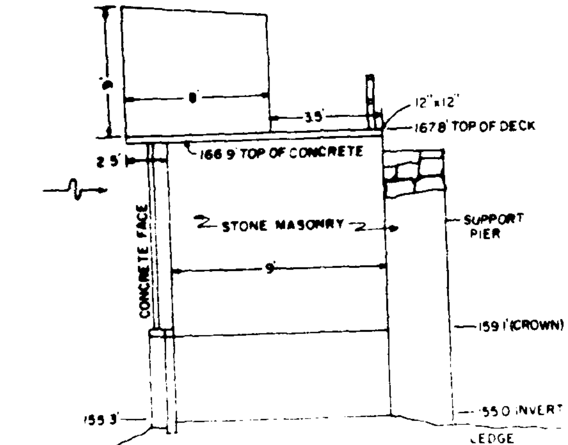
CC #14 For more information call Charles Wheeler
[illegible] Shop [illegible] Highway Dep



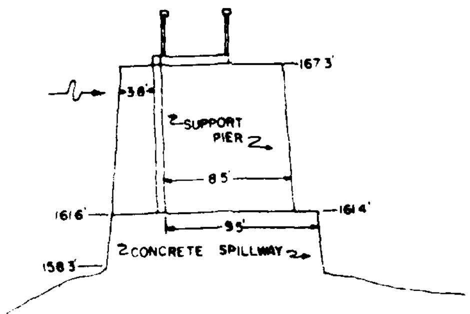

DETAIL



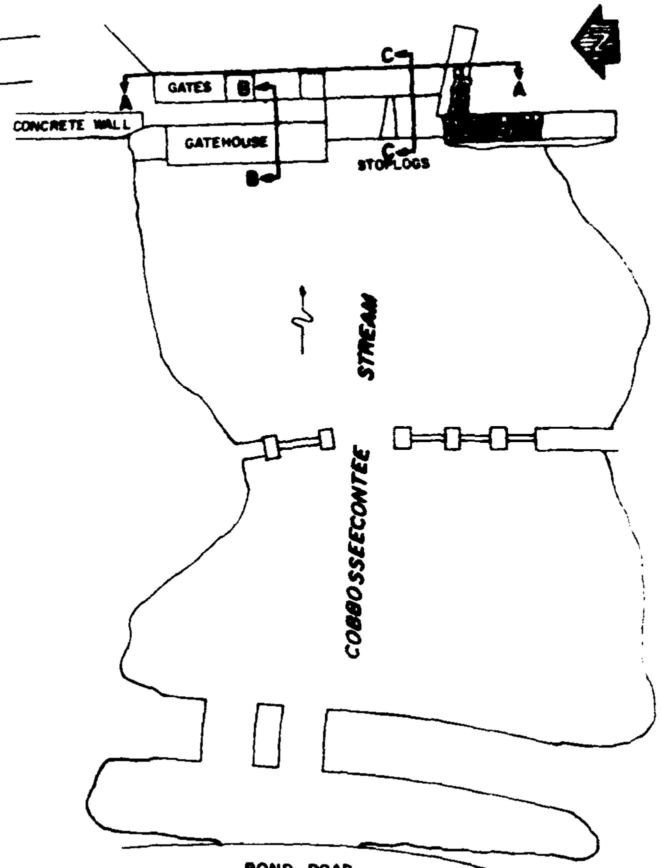

ELEVATION A-A




SECTION B-B




SECTION C-C




PLAN

| | |
|---|---|
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NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

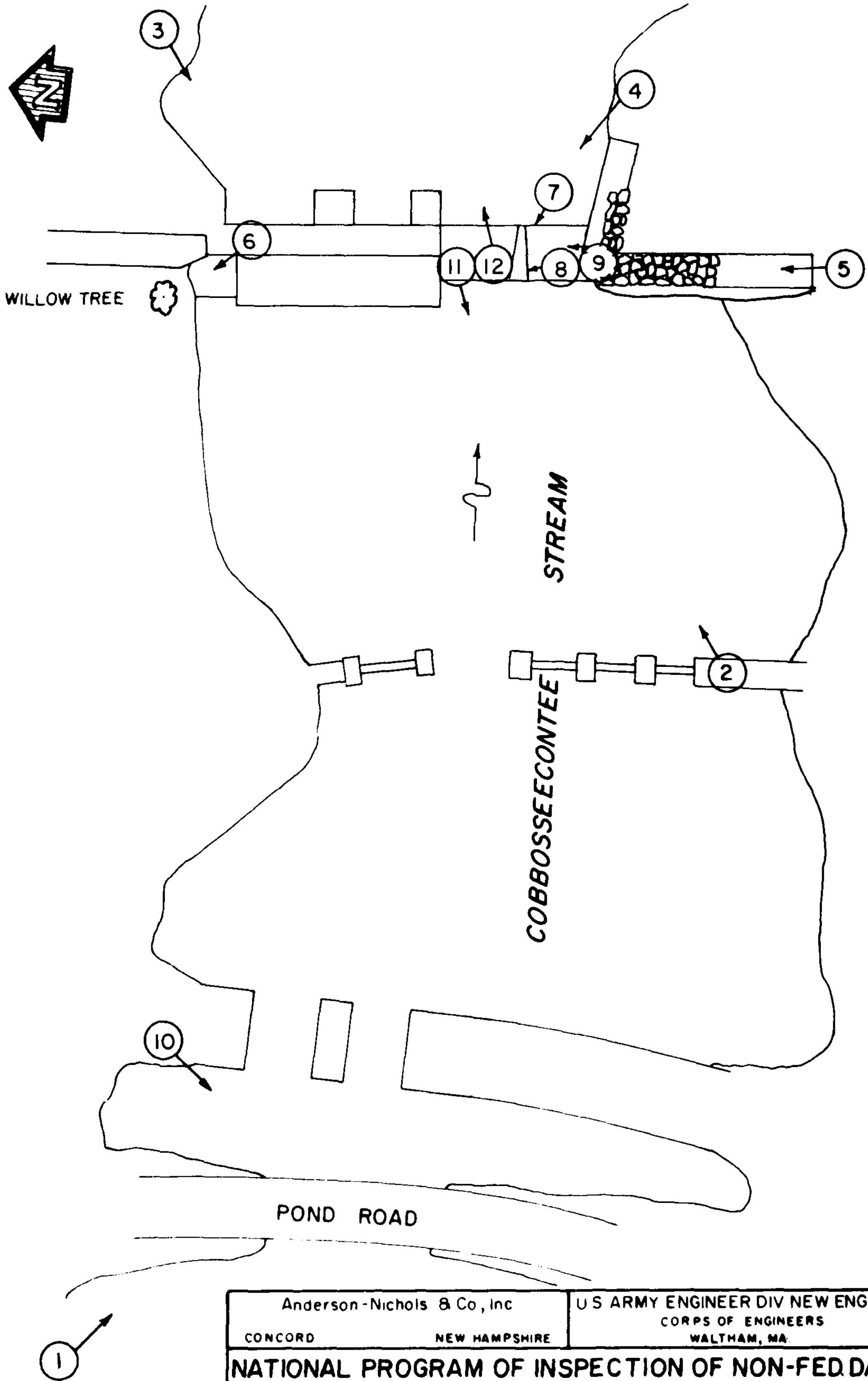
COBBOSSEECONTEE DAM

COBBOSSEECONTEE STREAM — MAINE

SCALE NOT TO SCALE
DATE NOVEMBER 1979

# APPENDIX C

# PHOTOGRAPHS




| Anderson-Nichols & Co, Inc<br>CONCORD NEW HAMPSHIRE | U S ARMY ENGINEER DIV NEW ENGLAND<br>CORPS OF ENGINEERS<br>WALTHAM, MA |
|---|---|

## NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

# PHOTO INDEX

**COBBOSSEECONTEE STREAM** **MAINE**

SCALE NOT TO SCALE

DATE NOVEMBER 1979

September 18, 1979
Figure 2 - View of the upstream face of the dam.

September 18, 1979
Figure 3 - Looking at the gatehouse and low-level outlets.

September 18, 1979

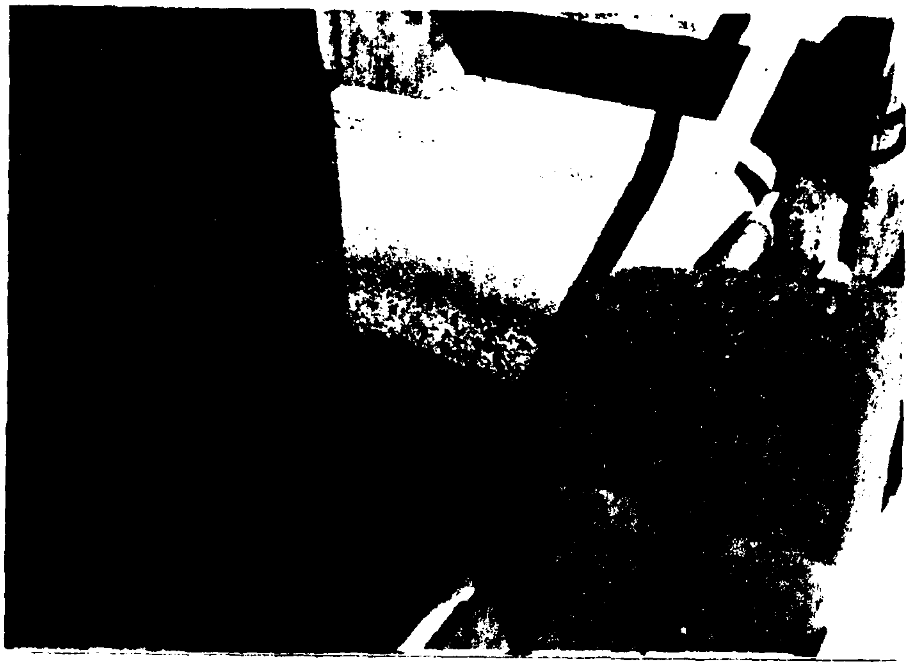
Figure 4 - View of downstream face of the stoplog spillway.

September 18, 1979

Figure 5 - Looking across the south abutment of the dam.

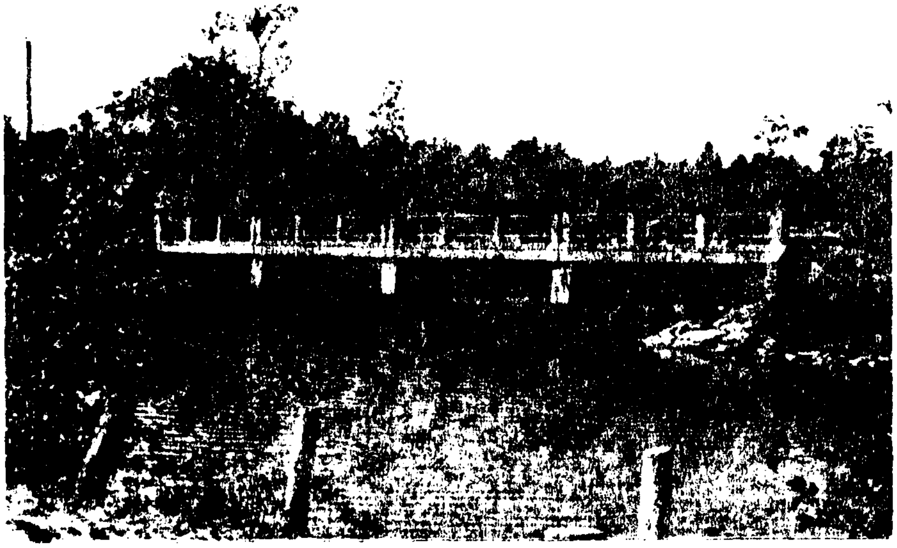
September 18, 1979
Figure 6 - View of the large willow tree near the north abutment.

September 18, 1979
Figure 7 - Looking inside the stoplog spillway bay. Note minor erosion at base of central pier.



September 18, 1979
Figure 8 - View of minor surface erosion at north end of stoplog spillway structure.

September 18, 1979
Figure 9 - Looking across the crest of the service bridge.



September 18, 1979
Figure 10 - Close-up view of the Pond Road bridge.

September 18, 1979
Figure 11 - Looking [illegible] approach channel from [illegible].

A) ELEV. 180 FT NGVD

$Q_{1,2,3,4,5} = 5(0.81)(16)\sqrt{64.4(23.5)} = 2521$ CFS

$Q_6 = (0.81)(36)\sqrt{64.4(23.5)} = 1135$ CFS

$Q_{S.W.} = (0.81)(29)(0.5)\sqrt{64.4(13)} = 340$ CFS

$Q_{T.O.\ Dam} = (2.7)(200)(12)^{3/2} = 22447$ CFS

$Q_{LEFT\ EMBK.} = \frac{1.49}{n} A R^{2/3} S^{1/2}$

$n = 0.12$
$S = 0.005$
$A = 5492$ FT$^2$
$WP = 858$ FT
$R = 6.4$ FT

$Q_{LEFT\ EMBK.} = \frac{1.49}{0.12}(5492)(6.4)^{2/3}(0.005)^{1/2} = 16585$ CFS

$Q_{RIGHT\ EMBK.} = \frac{1.49}{n} A R^{2/3} S^{1/2}$

$n = 0.12$
$S = 0.005$
$A = 1440$ FT$^2$
$WP = 252$ FT
$R = 5.7$ FT

$Q_{LEFT\ EMBK.} = \frac{1.49}{0.12}(1440)(5.7)^{2/3}(0.005)^{1/2} = 4030$ CFS

$Q_T = 47058$ CFS

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

AT ELEV. 175' NGVD

$Q_{1,2,3,4,5} = 5(0.81)(16)\sqrt{64.4(18.5)} = 2237$ CFS

$Q_6 = (0.81)(36)\sqrt{64.4(18.5)} = 1006$ CFS

$Q_{S.W.} = (0.81)(29)(\frac{1}{2})\sqrt{64.4(8)} = 267$ CFS

$Q_{TO\ DAM} = (2.7)(200)(7)^{3/2} = 10000$ CFS

$Q_{LEFT\ EMBK} = \frac{1.49}{n} A R^{2/3} S^{1/2}$

$S = 0.005$
$n = 0.12$
$A = 2080\ FT^2$
$WP = 528\ FT$
$R = \frac{2080}{528} = 3.9\ FT$

$Q_{LEFT\ EMBK.} = \frac{1.49}{0.12}(2080)(3.9)^{2/3}(0.005)^{1/2} = 4484$

$Q_{RIGHT\ EMBK.} = \frac{1.49}{n} A R^{2/3} S^{1/2}$

$n = 0.12$
$S = 0.005$
$A = 490\ FT^2$
$WP = 147\ FT$
$R = \frac{490}{147} = 3.3\ FT$

$Q_{RIGHT\ EMBK} = \frac{1.49}{0.12}(490)(3.3)^{2/3}(0.005)^{1/2} = 946$ CFS

$Q_T = 18940$ CFS

AT ELEV. 168 NGVD (TOP OF RIGHT ABUTMENT)

$$Q_{1,2,3,4,5} = 5(0.81)(16)\sqrt{64.4(11.4)} = 1756 \text{ CFS}$$

$$Q_6 = (0.81)(36)\sqrt{64.4(11.4)} = 790 \text{ CFS}$$

USE ORIFICE EQUATION FOR S.W.

$$Q_{SW} = 0.81(29)(0.5)\sqrt{64.4(0.75)} = 82 \text{ CFS}$$

$$Q_{(LEFT\ ABUTMENT)} = 2.9(98.5)(1/2)(1)^{3/2} = 143 \text{ CFS}$$

MANNING'S EQUATION IS USED TO CALCULATE THE FLOW OVER THE EMBANKMENTS

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$$

WHERE IN THIS CASE

$$^{*}n = 0.12$$

$$S = \frac{160-155}{900} = 0.005$$

$$A = 5 \text{ FT}^2$$

$$WP = 11 \text{ FT}$$

$$R = \frac{5}{11} = 0.45 \text{ FT}$$

$$Q_{(LEFT\ ABUTMENT)} = \frac{1.49}{0.12}(5)(0.45)^{2/3}(0.005)^{1/2} = 2.6 \text{ CFS}$$

$$Q_{TOTAL} = \underline{2774 \text{ CFS}}$$

* TAKEN FROM "OPEN CHANNEL HYDRAULICS" BY CHOW

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

AT ELEV. 161.6' NGVD

$Q_{1,2,3,4,5} = 5(0.81)(16)\sqrt{64.4(5.1)} = 1174$ CFS

$Q_6 = (0.81)(36)\sqrt{64.4(5.1)} = 528$ CFS

$Q_T = 1174 + 528 = 1702$ CFS

AT ELEV. 166.9' NGVD (TOP OF DAM)

$Q_{1,2,3,4,5} = 5(0.81)(16)\sqrt{64.4(10.4)} = 1677$ CFS

$Q_6 = (0.81)(36)\sqrt{64.4(10.4)} = 755$ CFS

$Q_T = 1677 + 755 = 2432$ CFS

AT ELEV. 167.4'

$Q_{1,2,3,4,5} = 5(0.81)(16)\sqrt{64.4(10.9)} = 1717$ CFS

$Q_6 = (0.81)(36)\sqrt{64.4(10.9)} = 772$ CFS

USE WEIR FLOW FOR SPILLWAY $Q = CLH^{3/2}$
WHERE *C = 3.5

$Q_{sw} = 3.5(29)(0.5)^{3/2} = 36$ CFS

$Q_{TOP\ OF\ DAM} = \frac{1}{2}(2.7)(98.5)(0.5)^{3/2} + \frac{1}{2}(2.7)(10)(.5)^{3/2}$
$= 47 + 5 = 52$

$Q_T = \underline{2577}$ CFS

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

## RATING CURVE CALCULATIONS

AT TIMES OF HIGH FLOW GATES ARE OPENED TO ACCOMMODATE THE PASSAGE OF WATER. HERE, IT IS ASSUMED THAT ALL GATES ARE OPEN.

THERE ARE FIVE 4'X4' GATES AND ONE 6'X6' GATE.

LOW-LEVEL OUTLETS:

ORIFICE EQUATION $Q = Ca\sqrt{2gh}$ IS USED TO CALCULATE THE DISCHARGE.

*C = 0.81

TOP OF DAM:

WEIR EQUATION $Q = CLH^{3/2}$ IS USED WITH *C = 2.9

AT ELEV. 155' NGVD $Q = 0$

AT ELEV. 157' NGVD

$Q_{1,2,3,4,5} = 5(0.81)(16)\sqrt{64.4(0.5)} = 368$ CFS

$Q_6 = (0.81)(36)\sqrt{64.4(0.5)} = 165$ CFS

$Q_T = 368 + 165 = \underline{533}$ CFS

AT ELEV. 158' NGVD

$Q_{1,2,3,4,5} = 5(0.81)(16)\sqrt{64.4(1.5)} = 637$ CFS

$Q_6 = (0.81)(36)\sqrt{64.4(1.5)} = 287$ CFS

$Q_T = 637 + 287 = \underline{924}$ CFS

$$Q_{100} = 1.38(126)^{0.9}(9.4)^{0.4}(15)^{-0.3}(6)^{1.1}(17)^{0.6}(1)^{1.2}$$

$$Q_{100} = 4577 \text{ CFS}$$

THIS REGIONAL EQUATION SHOWS THAT A CSM VALUE OF 380 IS TOO LARGE. ANALYSIS OF THESE RESULTS INDICATE THAT A CSM VALUE OF 250 WOULD BE REASONABLE. THEREFORE

PMF (TEST FLOOD) = 250 X 126 = 31500 CFS

$S_t$ = PERCENT OF SURFACE STORAGE AREA PLUS 0.5 PERCENT

I – T-YEAR 24-HOUR RAINFALL INTENSITY IN INCHES

t = AVERAGE JANUARY DEGREES BELOW FREEZING IN °F

O = OROGRAPHIC FACTOR

a, b, c, d, e, f, g = REGRESSION COEFFICIENT

FOR COBBOSSEECONTEE LAKE DAM:

$Q_T$ = 100-YEAR DISCHARGE

A = 126 $mi^2$

S = 9.4 FT/MI

$S_t$ = 15 PERCENT

*I = 6 INCHES

t = 17 °F

O = 1

FOR 100 YEAR DISCHARGE:

a = 1.38

b = 0.9

c = 0.4

d = - 0.3

e = 1.1

f = 0.6

g = 1.2

* OBTAINED FROM TECHNICAL PAPER NO. 40, RAINFALL FREQUENCY ATLAS OF THE U.S., PREPARED BY DAVID HERSHFIELD FOR ENGINEERING DIVISION, SCS, U.S. DEPT. OF AGRI., WASHINGTON, D.C. MAY 1961

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Subject ______________ Sheet No. ______ of ______

Date ______

Computed ______

Checked ______

JOB NO.

SLOPE OF THE WATERSHED:

LENGTH OF MAIN CHANNEL = 24 mi

ELEV. DIFFERENCE = 380 − 154 = 226

$$\text{SLOPE} = \frac{226 \text{ FT}}{24 \text{ miles}} = 9.4 \text{ FT/mile}$$

$DA = 126\ Mi^2$
SIZE CLASSIFICATION : LARGE
HAZARD CLASSIFICATION : SIG
TEST FLOOD : PMF

CALCULATE PMF USING "PRELIMINARY GUIDANCE FOR ESTIMATING MAXIMUM PROBABLE DISCHARGES IN PHASE I DAM SAFETY INVESTIGATION, MARCH 1978"

USE FLAT & COASTAL CURVE (BECAUSE OF STORAGE IN THE DRAINAGE AREA)

AT $126\ Mi^2 \longrightarrow 380$ CSM

$$PMF = 380\ \frac{CFS}{Mi^2} \times 126\ Mi^2 = 47900\ CFS$$

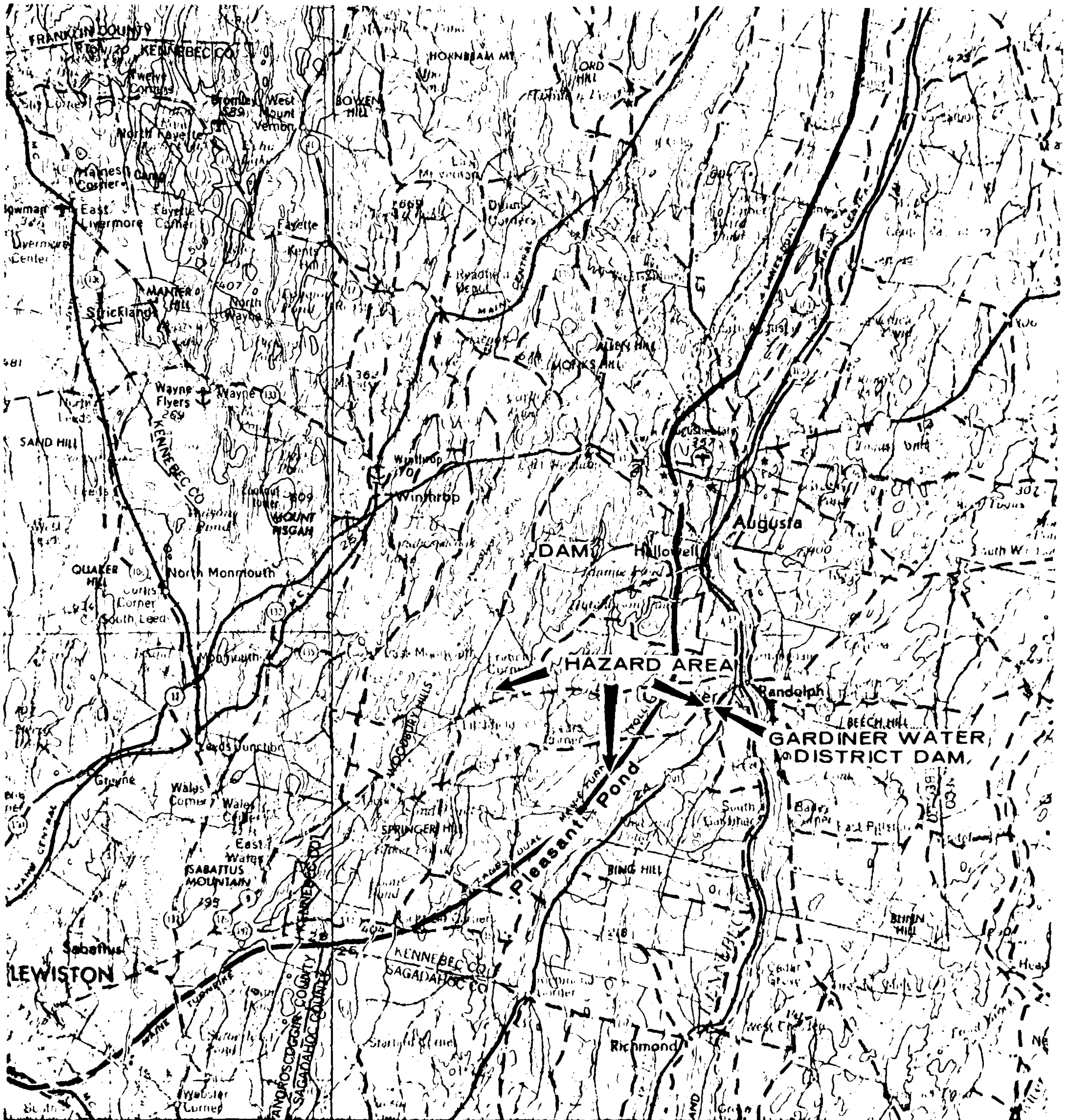
TAKE PEAK INFLOW = 48000 CFS

ANOTHER METHOD TO CALCULATE THE ESTIMATED "PMF" IS USE OF THE *BENSON'S EQUATION. THE EQUATION FOLLOWS

$$Q_T = a A^b S^c S_t^d I^e t^f O^g$$

WHERE $Q_T$ = T-YEAR ANNUAL PEAK DISCHARGE (CFS)
$A$ = DRAINAGE AREA
$S$ = MAIN CHANNEL SLOPE (FT/MILE)

* FACTORS INFLUENCING THE OCCURENCE OF FLOODS IN A HUMID REGION OF DIVERSE TERRAIN BY MANUEL A. BENSON




## NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

LAKE COBBOSSEECONTEE DAM
MANCHESTER, MAINE

# DOWNSTREAM HAZARD MAP

NOVEMBER 1979

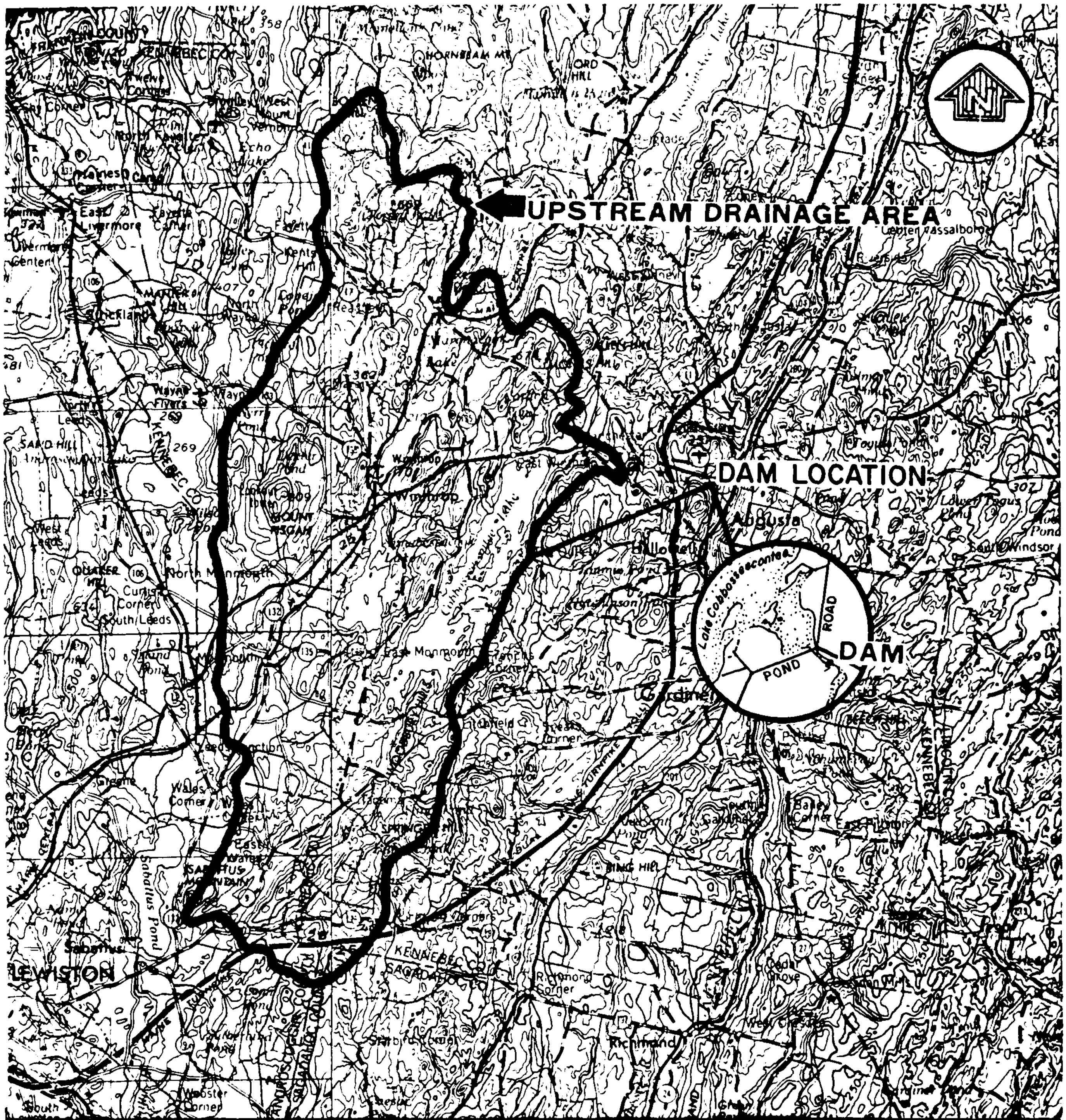
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

ANDERSON-NICHOLS & CO., INC CONCORD, NH

SCALE IN MILES

0 5 10

**MAP BASED ON U.S.G.S. 1:250,000 SERIES TOPOGRAPHIC MAPPING.** NL 19-10 LEWISTON, MAINE 1956. NL 19-11 BANGOR, MAINE, 1956 REVISED 1965.




**NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS**

LAKE COBBOSSEECONTEE DAM
MANCHESTER, MAINE

## REGIONAL VICINITY MAP

NOVEMBER 1979

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

ANDERSON-NICHOLS & CO., INC. CONCORD, N.H.

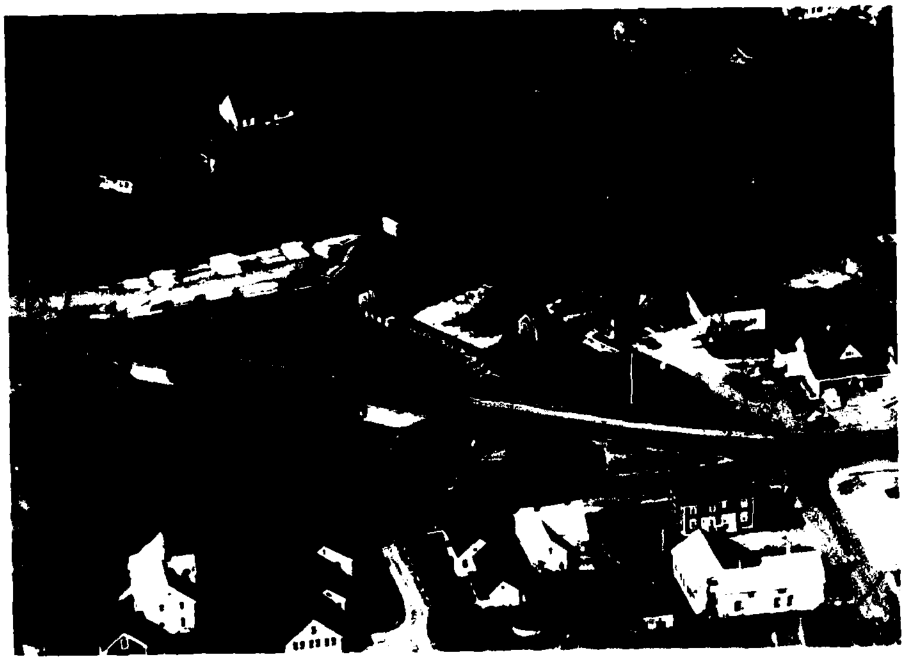
SCALE IN MILES

0 5 10

**MAP BASED ON U.S.G.S. 1:250,000 SERIES TOPOGRAPHIC MAPPING.** NL 19-10 LEWISTON, MAINE. 1956. NL 19-11 BANGOR, MAINE, 1956 REVISED 1965.

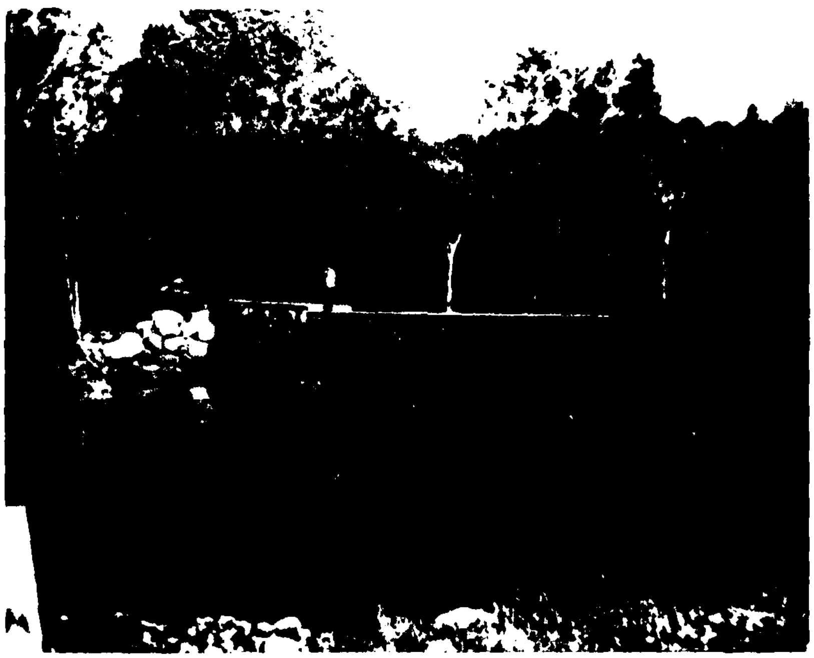
# APPENDIX D

# HYDROLOGIC AND HYDRAULIC COMPUTATIONS



October 1979
Figure 14 - Overview of the Gardiner Water District Dam which impounds Pleasant Pond.

September 18, 1979
Figure 12 - View of the downstream channel from the dam.



September 18, 1979
Figure 13 - View of the old mill dam located about 2.2 miles downstream.

Anderson-Nichols & Company, Inc.

Subject ______

Sheet No. ____ of ____
Date ____
Computed ____
Checked ____

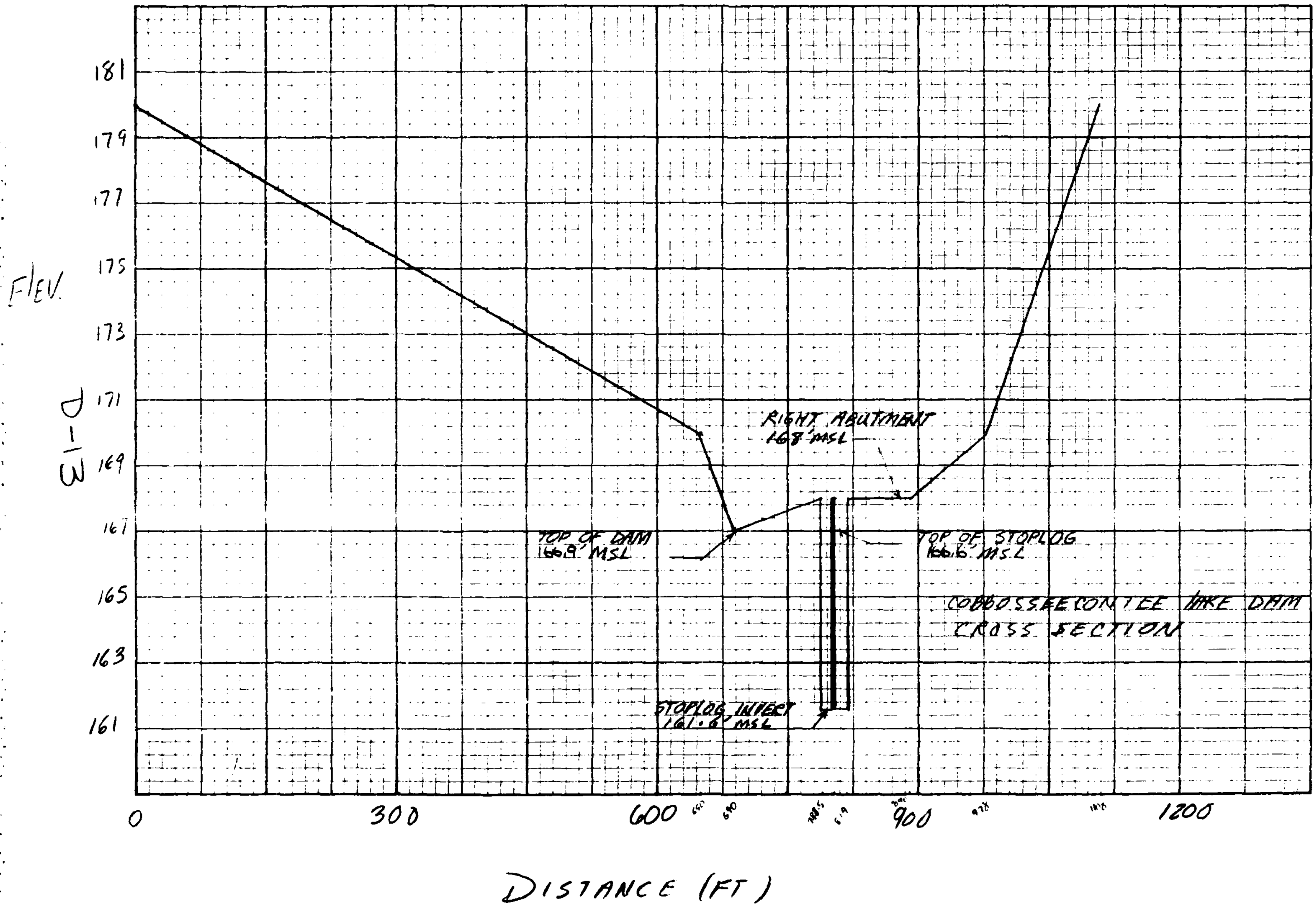
JOB NO.

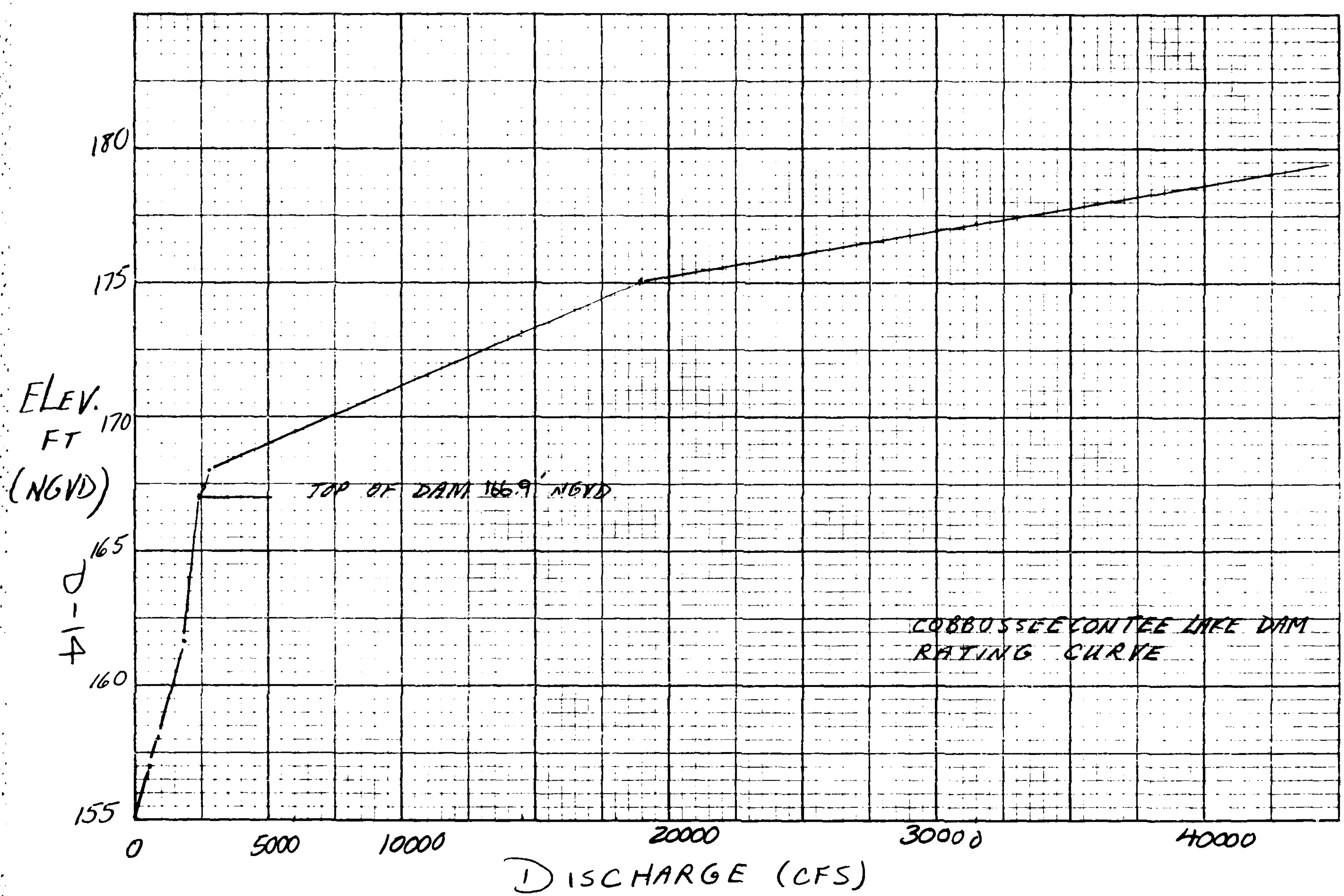
SQUARES 1/4 IN. SCALE

## RATING CURVE DATA

| ELEV. FT NGVD | DISCHARGE CFS |
|---|---|
| 155 | 0 |
| 157 | 533 |
| 158 | 924 |
| 161.6 | 1702 |
| 167 | 2432 |
| 167.4 | 2577 |
| 168 | 2774 |
| 175 | 18940 |
| 180 | 47058 |

D-13


ELEV.
181
179
177
175
173
171
169
167
165
163
161
0
300
600
650
690
788.5
819
900
978
1198
1200
DISTANCE (FT)
RIGHT ABUTMENT
168' MSL
TOP OF DAM
166.9' MSL
TOP OF STOPLOG
166.6' MSL
STOPLOG INVERT
161.6' MSL
COBBOSSEECONTEE LAKE DAM
CROSS SECTION


ELEV.
FT
(NGVD)
180
175
170
165
160
155
0
5000
10000
20000
30000
40000
DISCHARGE (CFS)
TOP OF DAM 166.9' NGVD
COBBOSSEECONTEE LAKE DAM
RATING CURVE

D-14

Anderson-Nichols & Company, Inc.

Subject ______ Sheet No. ____ of ____ Date ____ Computed ____ Checked ____

JOB NO.

SQUARES IN. SCALE 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

## STORAGE - ELEVATION DETERMINATION

BECAUSE LAKE ANNABESSACOOK u/s OF LAKE COBBOSSEECONTEE IS ONLY 1 FOOT HIGHER, IT MUST BE CONSIDERED IN STORAGE CALCULATION. HERE IT IS ASSUMED THAT THESE TWO LAKES ARE ONE, AND AT THE SAME ELEVATION.

AVERAGE DEPTH = 7 FT.

NORMAL STORAGE (165') = 40000 + 10752 = 50752 ac-FT

TOTAL SURFACE AREA = 5711 + 1536 = 7247 ac

AREA OF ISLANDS = (0.04)(7247) = 290 ac

NET LAKE AREA = 6957 ac

USING FRUSTRUM OF PYRAMID EQUATION, AND PLANIMETERED AREAS DEVELOPE POINTS FOR STORAGE-ELEVATION CURVE.

$$V = \frac{1}{3} h \left(b_1 + b_2 + \sqrt{b_1 b_2}\right)$$

WHERE $h$ = ELEV. ABOVE NORMAL POOL (FT)

$b_1$ = NORMAL POOL SURFACE AREA (AC)

$b_2$ = ENLARGED S.A. (ac)

AT 180' ELEV. ⟹ SURFACE AREA = 9856 ac

$$V = \frac{1}{3}(15)\left(6957 + 9856 + \sqrt{(6957)(9856)}\right) = 125468 \text{ AC-FT}$$

TOTAL STORAGE = 125468 + 50752 = 176220 AC-FT

FROM THE ABOVE KNOWN STORAGE POINTS A STORAGE - ELEV. CURVE CAN BE DRAWN (P. )

Anderson-Nichols & Company, Inc.    Subject ______    Sheet No. ____ of ____
Date ____
Computed ____
JOB NO.    Checked ____

SQUARES 1/4 IN. SCALE 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

ROUTING CALCULATIONS

AT TEST FLOOD ELEV. (177.2') ⇒ STORAGE = 152000 AC-FT
NORMAL STORAGE = 50752 AC-FT
SURCHARGE STORAGE = 152000 − 50752 = 101248 AC-FT

$101248 \text{ AC-FT} \times \frac{1}{126 \text{ mi}^2} \times \frac{1 \text{ mi}^2}{640 \text{ ac}} = 1.25' = 15.1''$

$QP_2 = QP_1 \left(1 - \frac{STOR_1}{19''}\right)$

$QP_2 = 31500\left(1 - \frac{15.1}{19}\right) = 6466$ CFS

DETERMINE SURCHARGE HEIGHT TO PASS $QP_2$ = 6466 CFS
REFER TO RATING CURVE (P. )
AT 6466 CFS ⇒ ELEV. = 169.7'

REFER TO STORAGE-ELEV. CURVE (P. )
AT ELEV. 169.7' ⇒ STORAGE = 88000 AC-FT

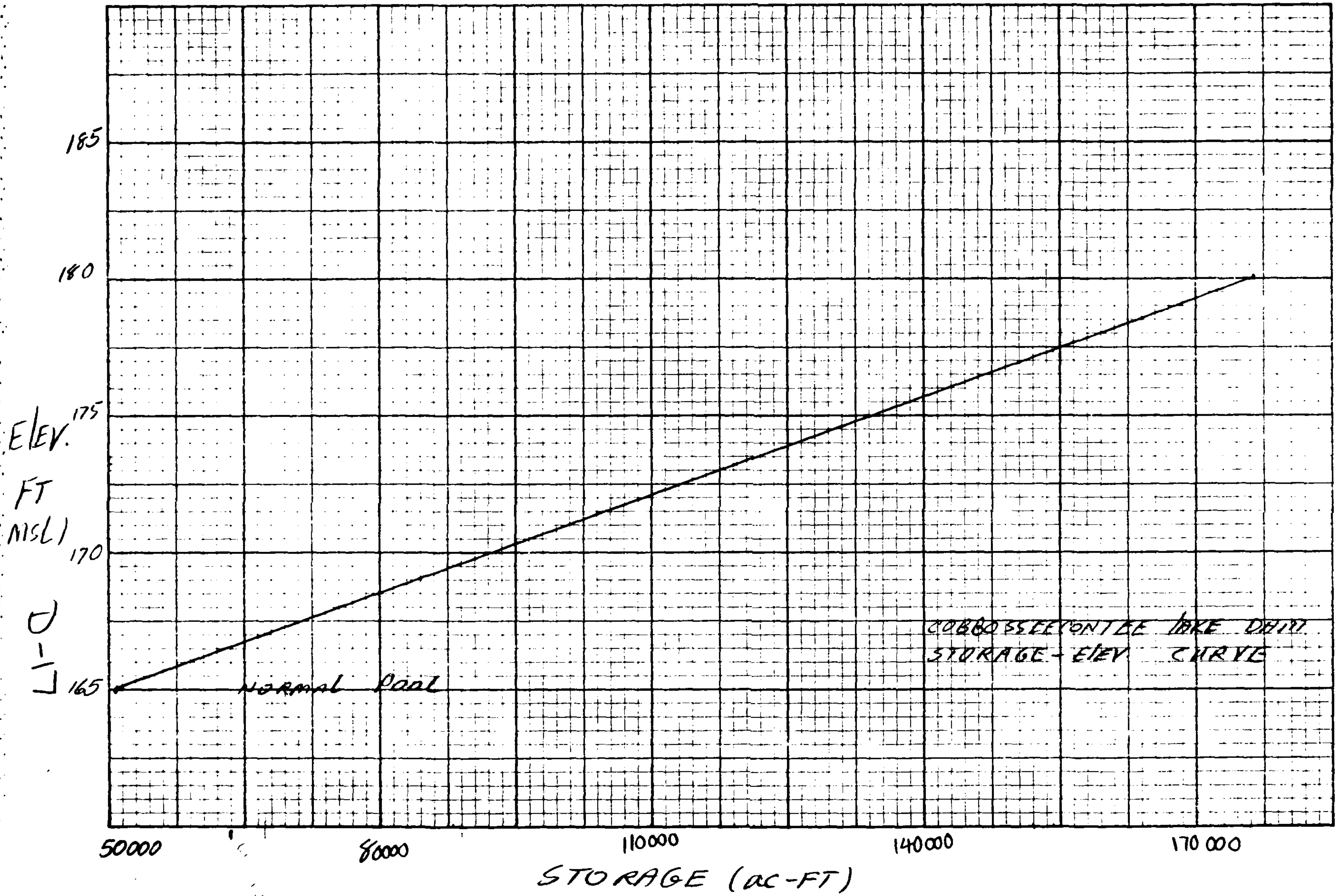
$(88000 - 50752) \text{ AC-FT} \times \frac{1}{126 \text{ mi}^2} \times \frac{1 \text{ mi}^2}{640 \text{ ac}} = 0.46' = 5.5''$

$(STOR)_1 = 15.1''$
$(STOR)_2 = 5.5''$
$(STOR)_{AVE.} = 10.3'' = 0.86'$

$(0.86 \text{ FT})(126 \text{ mi}^2)\left(\frac{640 \text{ ac}}{\text{mi}^2}\right) = 69350$ AC-FT

69350 + 50752 = 120102 AC-FT
FROM STORAGE-ELEV CURVE ⇒ ELEV. = 173.3'
FROM RATING CURVE ⇒ Q = 14500 CFS

TEST FLOOD DISCHARGE = **14500** CFS


185
180
175
170
165
ELEV. FT (MSL)
D-17
Normal Pool
COBBOSSEECONTEE LAKE DAM
STORAGE - ELEV CURVE
50000
80000
110000
140000
170 000
STORAGE (ac-FT)

Anderson-Nichols & Company, Inc.

JOB NO. 3273-14

Subject COBBOSSEECONTEE DAM INSPECTION

Sheet No. 1 of
Date 10/15/79
Computed AMG
Checked

I. BREACH ANALYSIS

TOP OF DAM EL. 166.9

INVERT AT GATE EL. 153.3

TAILWATER EL. 157.2

A. DETERMINATION OF BREACH FLOW

(1) $Q_{P_1} = \frac{8}{27} W_b \sqrt{g} (Y_0)^{3/2}$

$W_b$ - WIDTH OF BREACHED SECTION (DETERMINED WITH STRUCTURAL ENGINEER) SECTION MOST LIKELY TO FAIL IF BREACHED INCLUDES STOP LOG SECTION AND GATE SECTION TOTAL LENGTH STAT. 0+71 TO 1+52.5 OR 81.5 ft

$W_b$ SHOULD BE REDUCED BY THE WIDTH OF TWO PIERS WHICH WOULD WITHSTAND THE BREACH TOTAL PIER WIDTH 11 FEET

$W_b = 81.5 - 11 = 70.5$ ft.

$Y_0$ = EL. TOP OF DAM - EL. TAILWATER *

* NOTE: OUR ANALYSIS WILL NOT USE THE INVERT ELEVATION AS NO BREACH WAVE CAN AFFECT BELOW THE ANTICEDENT TAILWATER.

$Y_0 = 166.9 - 157.2 = 9.7$ ft

$Q_{P_1} = \frac{8}{27} (70.5 \text{ ft}) (\sqrt{32.2 \text{ ft/sec}^2}) (9.7 \text{ ft})^{3/2}$

$= 3580 \text{ ft}^3/\text{sec}$

I (CONTINUED)

A. DETERMINATION OF BREACH FLOW (CONTINUED)

(2) ANTICEDENT FLOW

ASSUME UPSTREAM WATER SURFACE AT TOP OF DAM - ELEVATION 166.9. ASSUME STOPLOGS AT SAME ELEVATION AS DAY OF INSPECTION EL. 166.6 ALSO ASSUME 1 6'X6' GATE FULLY OPEN (INVERT 153.0 CROWN 159.0)

USE WEIR EQUATION $Q = CLH^{3/2}$ OVER STOPLOG SECTION $C_w = 3.2$ FOR SHARP CRESTED WEIR $H/P \Rightarrow 0$ 9 OPENINGS 3.2 ft WIDE EACH

$L = 9 \times 3.2 = 28.8 \approx 29$ FT

$Q_{weir} = 3.2\,(29)(0.3)^{3/2} = 15$ cfs

USE ORIFICE EQUATION $Q = Ca\sqrt{2g\Delta H}$

$C = 0.81$ KING + BRATER p 4-32

$\Delta H = 166.9 - 157.2 = 9.7$ ft

$Q_{ORF} = 0.81\,(36\ ft^2)\sqrt{2(32.2\ ft/sec)(9.7\ ft)}$

$= 729\ ft^3/sec$

ANTICEDENT FLOW

$Q_T = Q_{weir} + Q_{ORF} = 15 + 729 = \underline{744}$ CFS

B. DETERMINATION OF DOWNSTREAM HAZARD

USING A TYPICAL CROSS-SECTION (P-4) TO REPRESENT THE REACH FROM THE TOE OF THE DAM TO THE POND ABOVE THE MILL DAM, A DISTANCE OF APPROXIMATELY 10,000 FEET, DEVELOP A STAGE DISCHARGE CURVE FOR THE REACH USING THE MANNING EQUATION

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$$

WHERE

$n$ = COMPOSITE ROUGHNESS COEFFICIENT
$A$ = AREA OF CROSS-SECTION
$R$ = HYDRAULIC RADIUS = A/WETTED PERIMETER
$S$ = SLOPE OF REACH

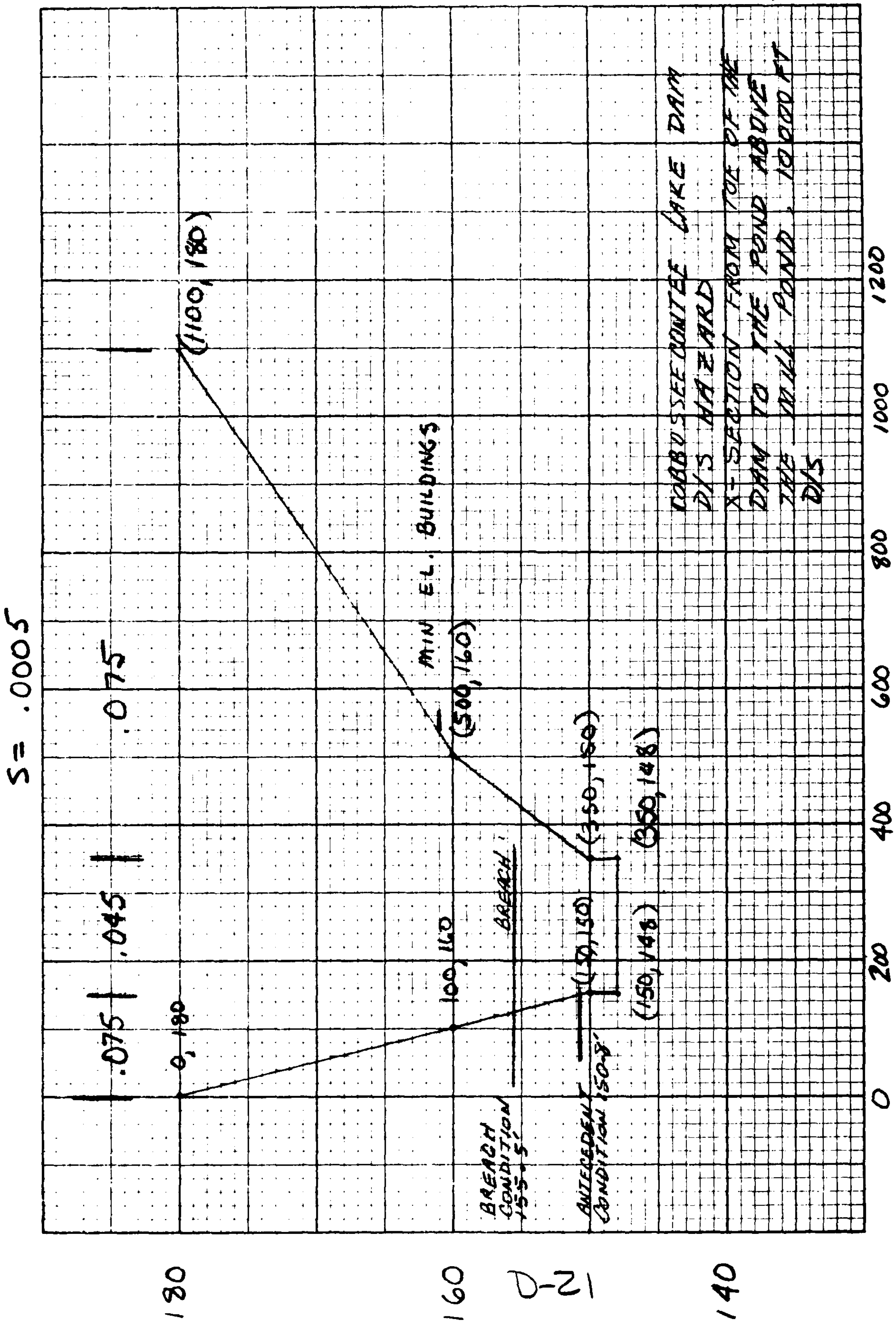
LENGTH OF REACH 10,000 FEET
TOE OF DAM – 153
ELEVATION OF POND – 148
SLOPE = .0005
'n' (CHANNEL) = .045 n (OVERBANK) = .075

POINTS DEFINING THE FOLLOWING STAGE-DISCHARGE CURVE (P-5) WERE GENERATED USING THE COMMODORE PET 2001 DESK COMPUTER. MANNING'S EQUATION WAS PROGRAMMED INTO THE COMPUTER USING THE DATA POINTS WHICH DEFINE THE CROSS-SECTION SHOWN ON PAGE 4.

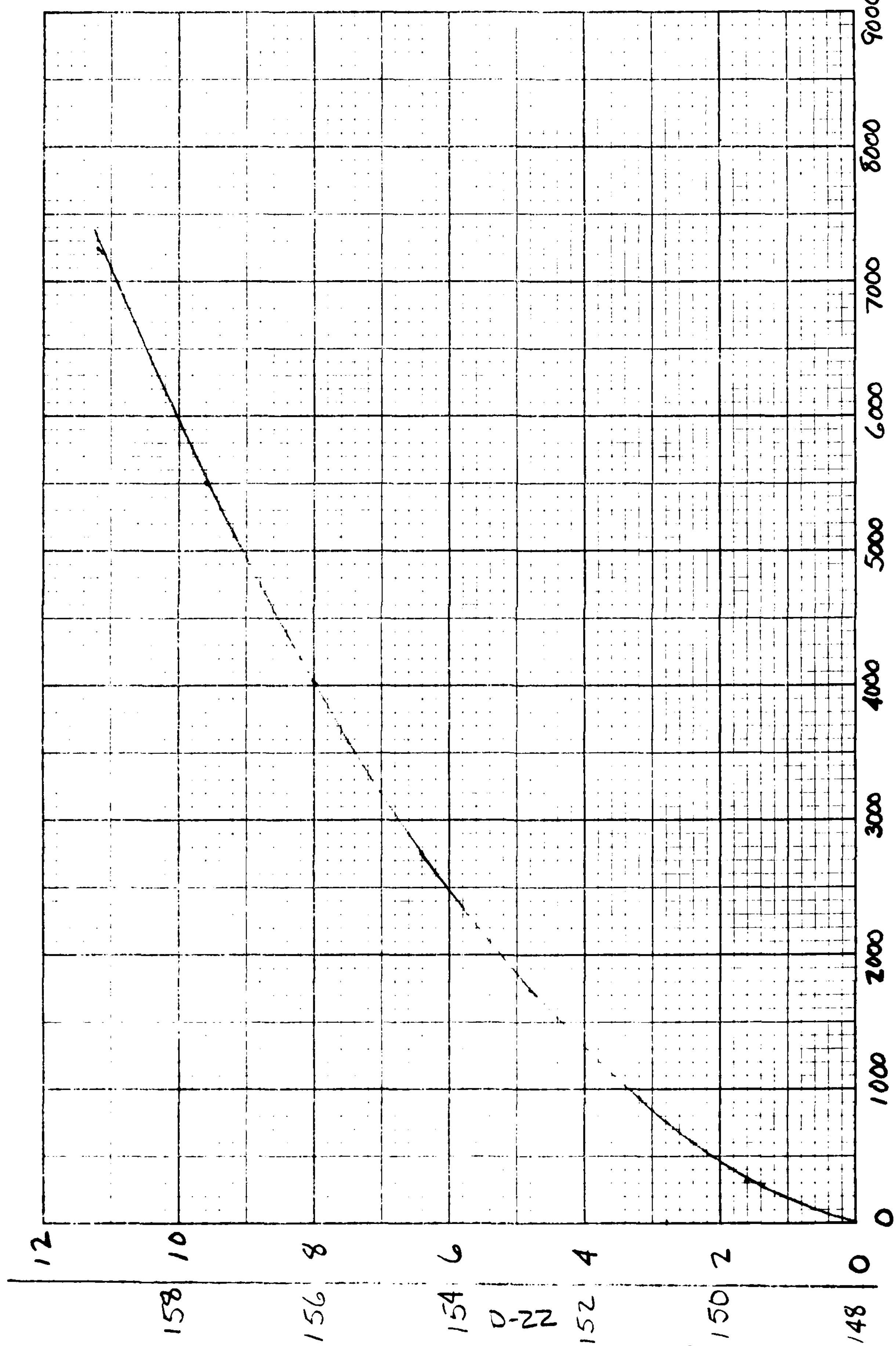
REFERING TO THE RATING CURVE ON PAGE 5
ANTICEDENT FLOW OF 740 cfs RESULTS IN A STAGE OF 2.8 FEET

TOTAL BREACH FLOW OF 3580 cfs RESULTS IN A STAGE OF 4.7 FEET WHICH IS BELOW THE LOWEST STRUCTURE ELEVATION WHICH IS 13 FEET ∴ NO HAZARD
THE INCREASE IN STAGE DUE TO BREACH – 1.9 Ft

COBBOSSEECONTEE
10/16/76
AMG
PAGE 4



10/16/79
AMG
PAGE 5



B. (CONTINUED)

USING A TYPICAL CROSS-SECTION FOR THE REACH OF THE LOWERED MILL POND (PAGE 7), A DISTANCE OF APPROXIMATELY 2000 ft. THE POND IS CONTROLLED BY A LOW DAM WHICH IS UNOPERATED WITH THE GATES REMOVED PERMANENTLY. THE ANTICEDENT FLOW WOULD SET THE WATER SURFACE OF THE REACH. THE MODEL OF CRITICAL POINTS AND STAGE DISCHARGE CURVE FOR GATE OPENINGS IN THE DAM ARE SHOWN ON PAGES 8 AND 9

LENGTH OF REACH - 2000 ft
SLOPE OF REACH - .0001
n = .075 EXTREME OVERBANK
n = .065 OVERBANK WHICH WAS INUNDATED BY MILL OPERATION
n = .05 CHANNEL

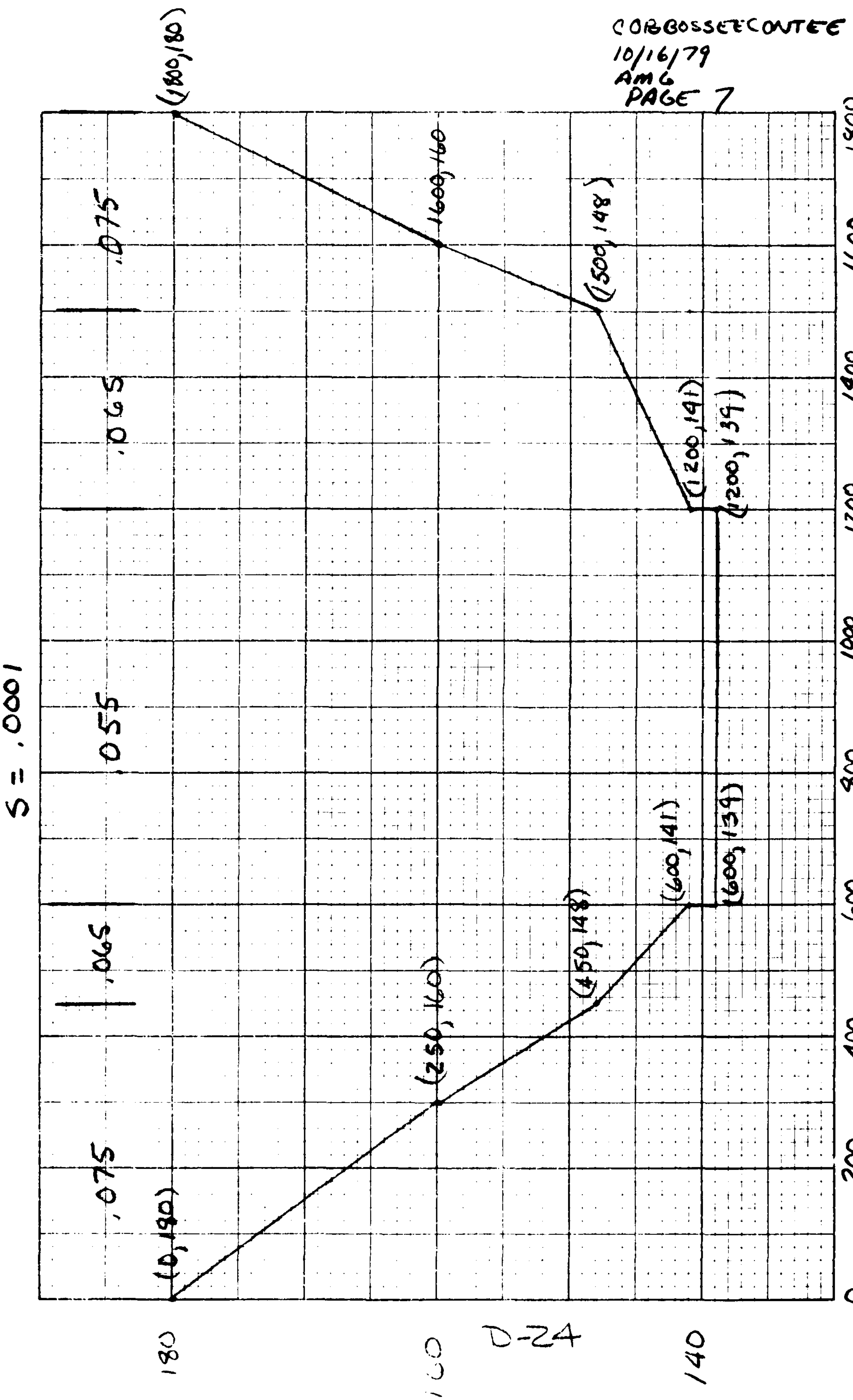
THE DATA USED TO DETERMINE THE REACH STAGE DISCHARGE CURVE (PAGE 10) WAS GENERATED USING THE COMMODORE PET 2001 DESK TOP COMPUTER PROGRAMMED WITH CRITICAL POINTS FROM THE CROSS-SECTION (PAGE 7) FOR THE POND REACH.

THE ANTICEDENT CONDITIONS (744 CFS) AT THE DAM SET THE STAGE FOR THE REACH AT 2.92 FEET (SEE PAGE 9)

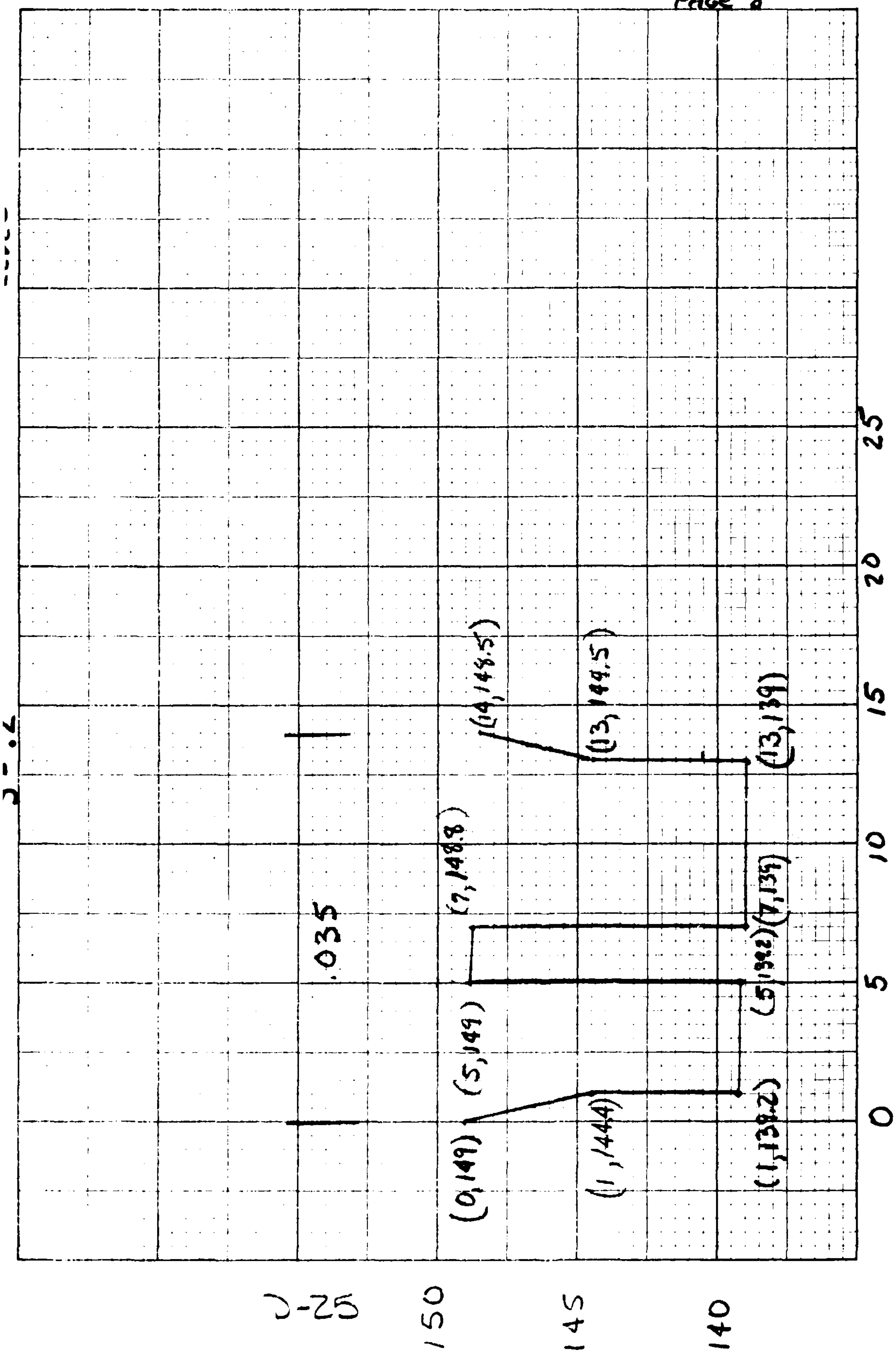
THE BREACH FLOW OF 3580 cfs ESTABLISHES THE STAGE OF 6.3 FEET.

THE INCREASE IN STAGE CAUSED BY THE BREACH IS 3.4 FEET AS THERE ARE NO STRUCTURES IN THE REACH THERE IS NO HAZARD

COBBOSSEECONTEE
10/16/79
AMG
PAGE 7



COBBOSSEECONTEE
10/16/79
AMG
PAGE 8



1 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

$^{2}_{3} = .29 \qquad \frac{V_1^2}{2g} \Rightarrow 0$

$Q = K_N b_2 \sqrt{2g}\left(Y_3 - \theta \frac{V_3^2}{2g}\right)\sqrt{h_3 + \beta \frac{V_1^2}{2g}}$

$Q = .91\,(60\,ft)\sqrt{64.4\,ft/sec^2}\,(9.74\,ft - (.3)\,.29\,ft)\sqrt{h_3}$

$h_3 = \frac{2500\ ft^3/sec}{4230\ ft^{5/2}/sec}$

$h_3 = .35\ ft$

W. S. EL. U/S FACE
164.74 + .35 = 165.09

LOSS CONTRACTION $= .3\left[\frac{\left(\frac{2500}{A_{u/s}}\right)^2}{64.4}\right] = .3\frac{\left(\frac{2500}{590}\right)^2}{64.4} = .09$

LAKE WATER SURFACE

165.09 + .09 = 165.18 (1.16)

FOR FLOW 3000 Cfs

AT BREACH SECTION FROM RATING CURVE
WS = 155 + 9.10 = 164.1

LOSS DUE TO CONTRACTION
$A_{BREACH} = 637 \quad V = \frac{3000}{637} = 4.71 \quad \frac{V^2}{2g} = .344$
$A_{POND} = 1000 \quad V = \frac{3000}{1000} = 3.0 \quad \frac{V^2}{2g} = .140$

$H_L = .3(.344 - .140) = .061$

W.S. = 164.10 + .061 = 164.16

2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

LOSS DUE TO CONTRACTION FROM OLD BRIDGE TO NEW BRIDGE (NO EXPANSION DUE TO HYDRAULIC PROXIMITY OF BRIDGES)

$$\frac{V_{OLD}^2}{2g} = \frac{\left(\frac{2500}{A_{U/S\,FACE}}\right)^2}{2g}$$

$A_{U/S\,FACE}$ BASED ON DEPTH

NEW W.S. EL. = 163.75 + .75
= 164.50

A @ EL. 164.5 = 300 ft²

$$\frac{V_{OLD}^2}{2g} = \frac{\left(\frac{2500\ cfs}{300 ft^2}\right)^2}{2(32.2\ ft/sec^2)} = 1.08\ ft$$

$$\frac{V_{NEW}^2}{2g} = \frac{\left(\frac{2500}{A_{NEW}}\right)^2}{2g}$$

$A_{NEW\ D/S\ FACE}$ → ASSUME (.4 ft) HEAD LOSS TO EL. 164.9 A = 580 ft²

$$= \frac{\left(\frac{2500}{580}\right)^2}{64.4} = .29\ ft$$

ΔA OK

$H_{L\ CONTRACTION}$ = .3 (1.08 − .29) = .24 ft ≈ .4

WATER SURFACE AT D/S FACE BRIDGE

164.50 + .24 = 164.74 ft.

USING NAGLER FORMULA FOR LOSS THROUGH BRIDGE SEE P. 19 FOR EQUATION + COEFFICIENTS

ASSUME $B_3 = b_2$ $\sigma = 1$ $b_2 = 60 ft$ (AVG)

$y_3 = 9.74$ $K_N = .91$ FROM TABLE p 503 CHOW

3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

$$h_3 + \beta \frac{V_1^2}{2g} = \frac{Q^2}{(C)^2}$$

$$\beta \frac{V_1^2}{2g} = \frac{Q^2}{(C)^2} - h_3$$

$$V_1^2 = \left(\frac{Q^2}{(C)^2} - h_3\right)\frac{2g}{\beta}$$

$$V_1 = \sqrt{\left(\frac{Q^2}{(C)^2} - h_3\right)\frac{2g}{\beta}} = \frac{Q}{Y_1 B_1} = \frac{Q}{(Y_3+h_3)\beta_1}$$

$$V_1 = \frac{2500 \text{ ft}^3/\text{sec}}{(8.75+h_3)\,100\text{ ft}} = \left[\left\{\left[\frac{2500 \text{ ft}^3/\text{sec}}{(.9)\,40\text{ ft}\sqrt{2(32.2)\text{ft}/\text{sec}^2}\,(8.75\text{ ft} - (.14\text{ ft})3)^{3/2}}\right]^2 - h_3 \text{ ft}\right\}\frac{64.4 \text{ f}/\text{sec}^2}{2.05}\right]^{1/2}$$

$$\frac{Q}{C} = .9937, \quad \left(\frac{Q}{C}\right)^2 = .9875$$

$$\left(\frac{25}{8.75+h_3}\right)^2 \frac{1}{31.4} = .988 - h_3$$

$$\frac{19.9}{(8.75+h_3)^2} = .988 - h_3$$

TRY $.5 = h_3$

$.23 \neq .488$

$h_3 = .65$

$.225 \neq .338$

$h_3 = .8$

$.22 = .188$

D-37

$$Q = K_N\, b_2 \sqrt{2g}\left(y_3 - \theta \frac{V_3^2}{2g}\right)\sqrt{h_3 + \beta \frac{V_1^2}{2g}}$$

EQ. 17-28 p501 CHOW OPEN CHANNEL HYDRAULICS

$K_N$ = NAGLER COEFFICIENT DEPENDENT ON DEGREE OF CHANNEL CONTRACTION

$b_2$ - WIDTH OF CONTRACTED SECTION ASSUMING RECTANGULAR CHANNEL

$y_3$ - DEPTH DOWNSTREAM OF BRIDGE

$\theta$ — ADJUSTMENT FACTOR USUALLY 0.3 UNLESS SMALL CONTRACTION EFFECT OR HIGH TURBULENCE

$h_3$ - HEADLOSS

$\beta$ - COEFFICIENT VARYING WITH CONVEYANCE RATIO

$\sigma$ - CONVEYANCE RATIO $\frac{b_2}{B_3}$ IF RECTANGULAR

$\sigma = \frac{40}{140} = .28 \quad \therefore \beta = 2.05$ SEE p502 FIG. 17-33 IBID

$y_3 = 8.75$

$b_2 = 40$

$K_N = .90$ ASSUMED FROM TABLE p503

$\frac{V_3^2}{2g} = .14$ * SEE PAGE PREVIOUS

REARRANGE EQ.

$$Q^2 = \left[K_N\, b_2 \sqrt{2g}\left(y_3 - \theta \frac{V_3^2}{2g}\right)\right]^2 \left(h_3 + \beta \frac{V_1^2}{2g}\right)$$

CLEARING CONSTANTS

2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

LOSS DUE TO EXPANSION IN OLD BRIDGE SECTION

$\frac{V_{POND}^2}{2g} = .14$

ASSUME HEAD LOSS .4 ft ∴ WATER SURFACE = 163.5 $AREA_{BRIDGE} = 260$

$\frac{V_{B_1}^2}{2g} = \frac{\left(\frac{2500 cfs}{260}\right)^2}{64.4} = \frac{(9.6)^2}{64.4} = 1.44$

$H_L = .5(1.44 - .14) = .5(1.30) = .65 ft$

$\Delta H_L = .25 ft$ ΔAREA WILL BE MINOR USE .65

AT D/S FACE OF BRIDGE W.S = 163.1 + .65
= 163.75

LOSS THROUGH OLD BRIDGE

$K = 1.25$

$y = 8.75$ $A = 270$ $V = \frac{2500}{270} = 9.3$

$\frac{V^2}{2g} = 1.33$

$\omega = \frac{V^2/2g}{y} = \frac{1.33}{8.75} = .15$

$\left(\alpha = \frac{175}{320} = .55\right)$ (?)

$H'_{L\,BRIDGE} = 2(1.25)[1.25 + 10(.15) - .6][.55 + 15(.55)^4]\,1.33$

$= 2(1.25)\ (2.15)\ (1.89)\,1.33$

TRIAL AND ERROR DETERMINATION OF LAKE OUTFLOW

EQUATIONS

$$H_L = K_1 \left( \frac{V_2^2}{2g} - \frac{V_1^2}{2g} \right)$$

K CONTRACTING = .3

$K_1$ EXPANDING = .6

p. 185 APPLIED HYDRAULICS IN ENGINEERING
MORRIS + WIGGERT

LOW FLOW BRIDGE WITH PIERS
YARNELL'S EQUATION

$$H = 2K(K + 10\omega - 0.6)(\alpha + 15\alpha^4)\frac{V^2}{2g}$$

H = HEAD LOST THROUGH BRIDGE
K = PIER SHAPE COEFFICIENT
ω = RATIO OF VELOCITY HEAD TO DEPTH DOWNSTREAM
α = OBSTRUCTED AREA / TOTAL UNOBSTRUCTED AREA
V = VELOCITY DOWNSTREAM FROM BRIDGE IN FPS

CALCULATING FORMULA FOR HEC-2 COMPUTER ROUTING

FOR Q = 2500 cfs

AT BREACHED SECTION FROM RATING CURVE
W.S. 155 + 8.0 = 163

LOSS DUE TO CONTRACTION

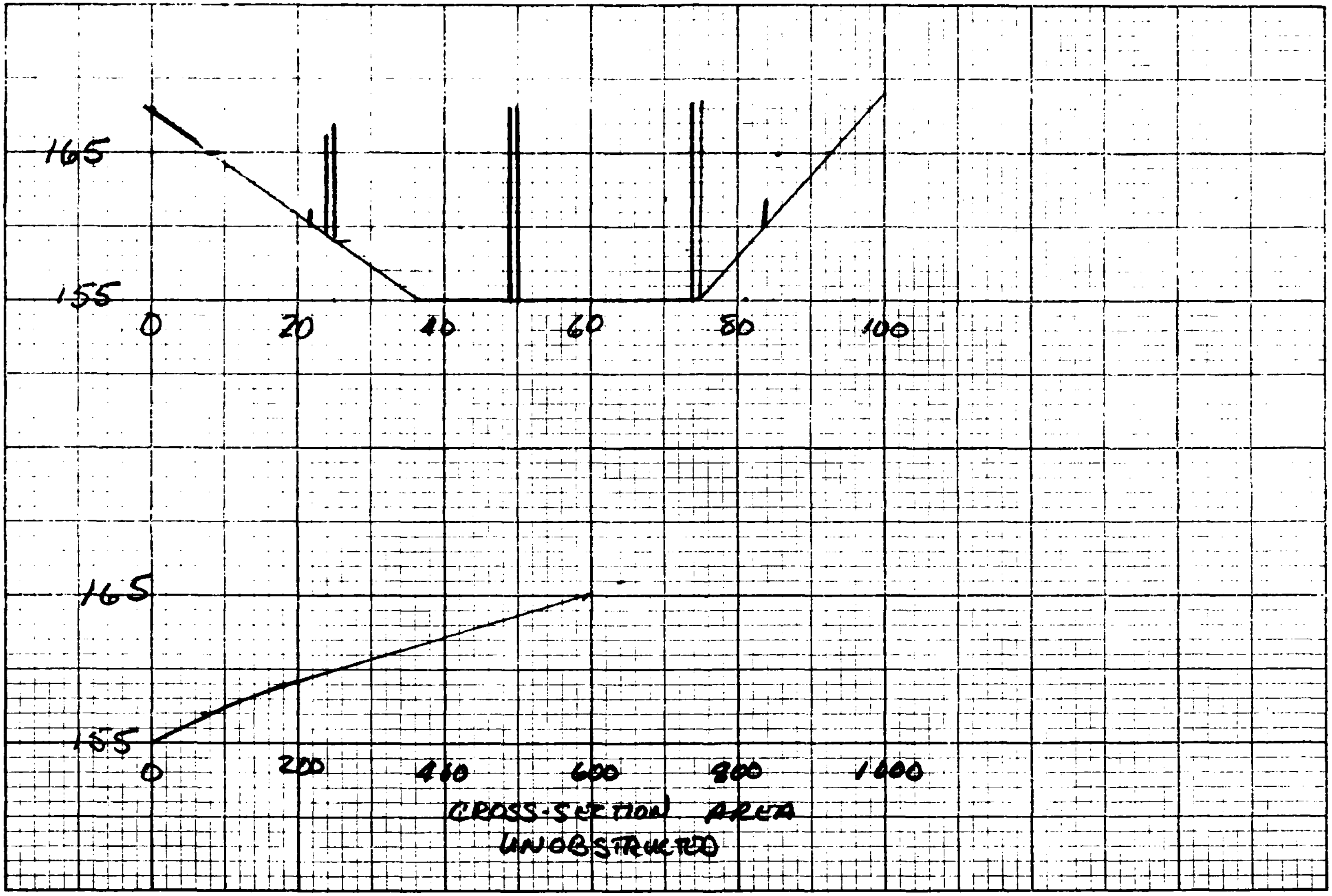
$A_{BREACH}$ = 560 ft² $V_{BR} = \frac{2500}{560} = 4.46$ $\frac{V^2}{2g} = .31$

$A_{POND}$ = 840 ft² $V_{POND} = \frac{2500}{840} = 2.98$ $\frac{V^2}{2g} = .14$

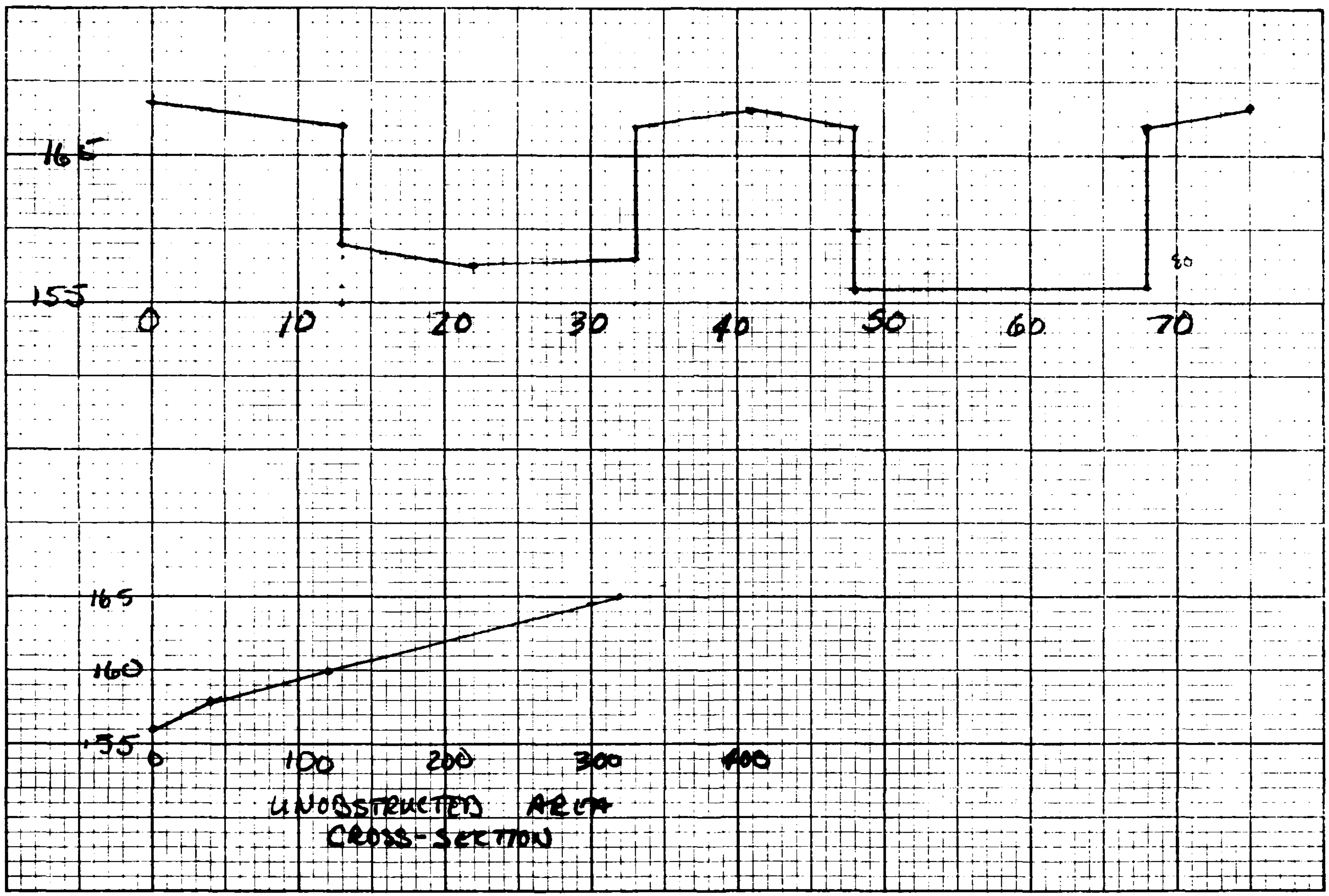
$H_L = .3(.31 - .14) = .051$

W.S. = 163 + .051 ⇒ USE 163.1

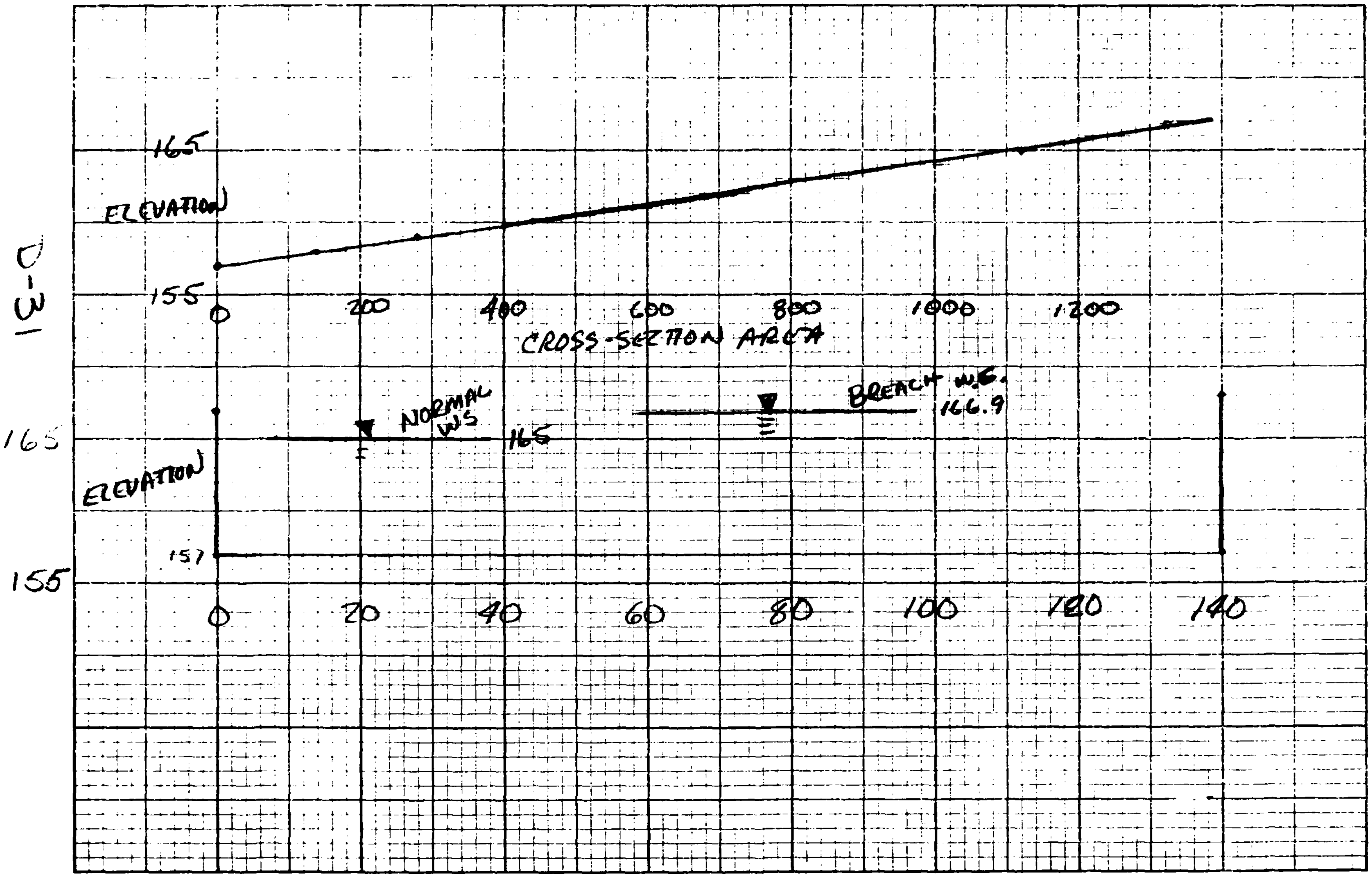
NEW BRIDGE OF POND ROAD

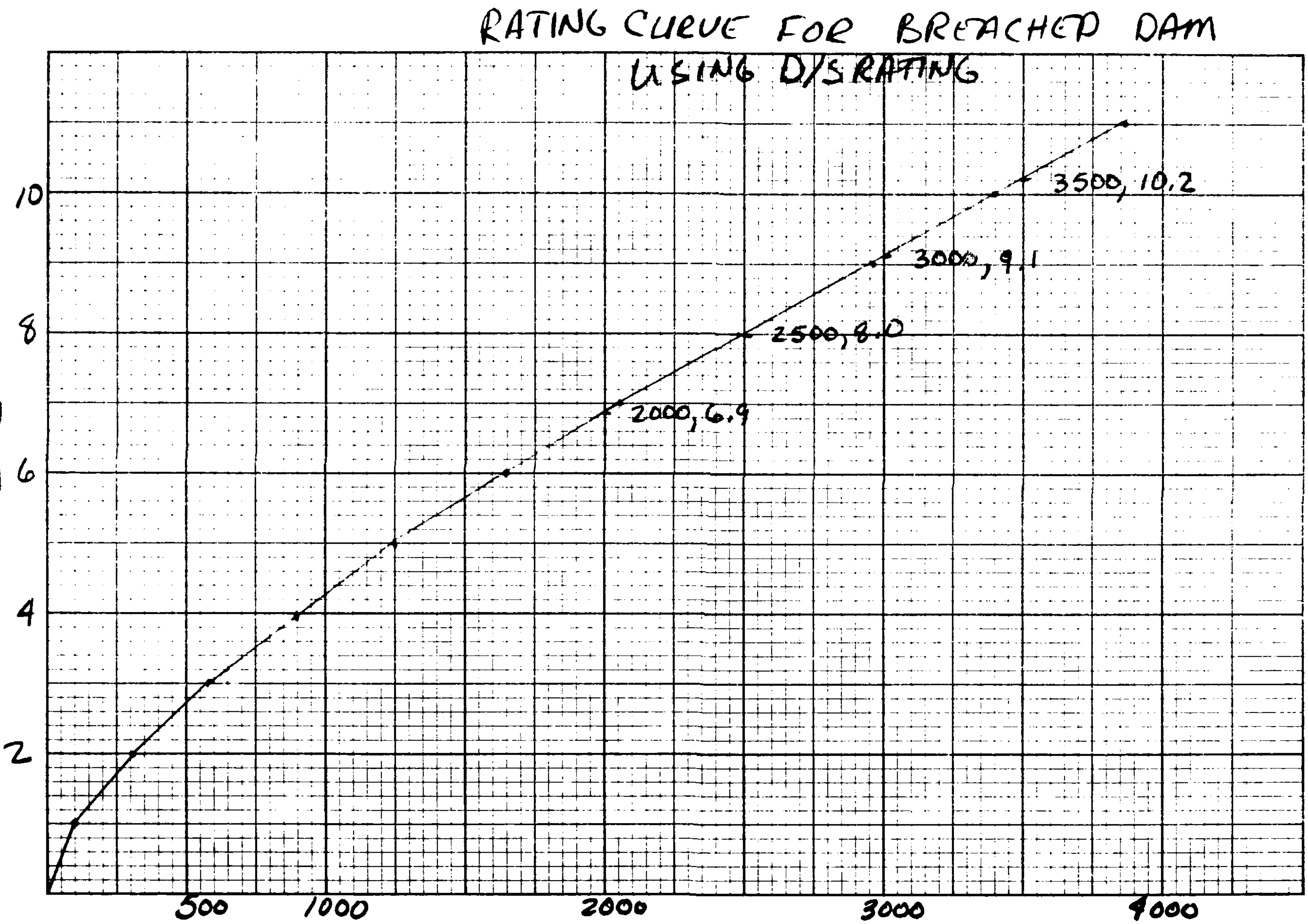


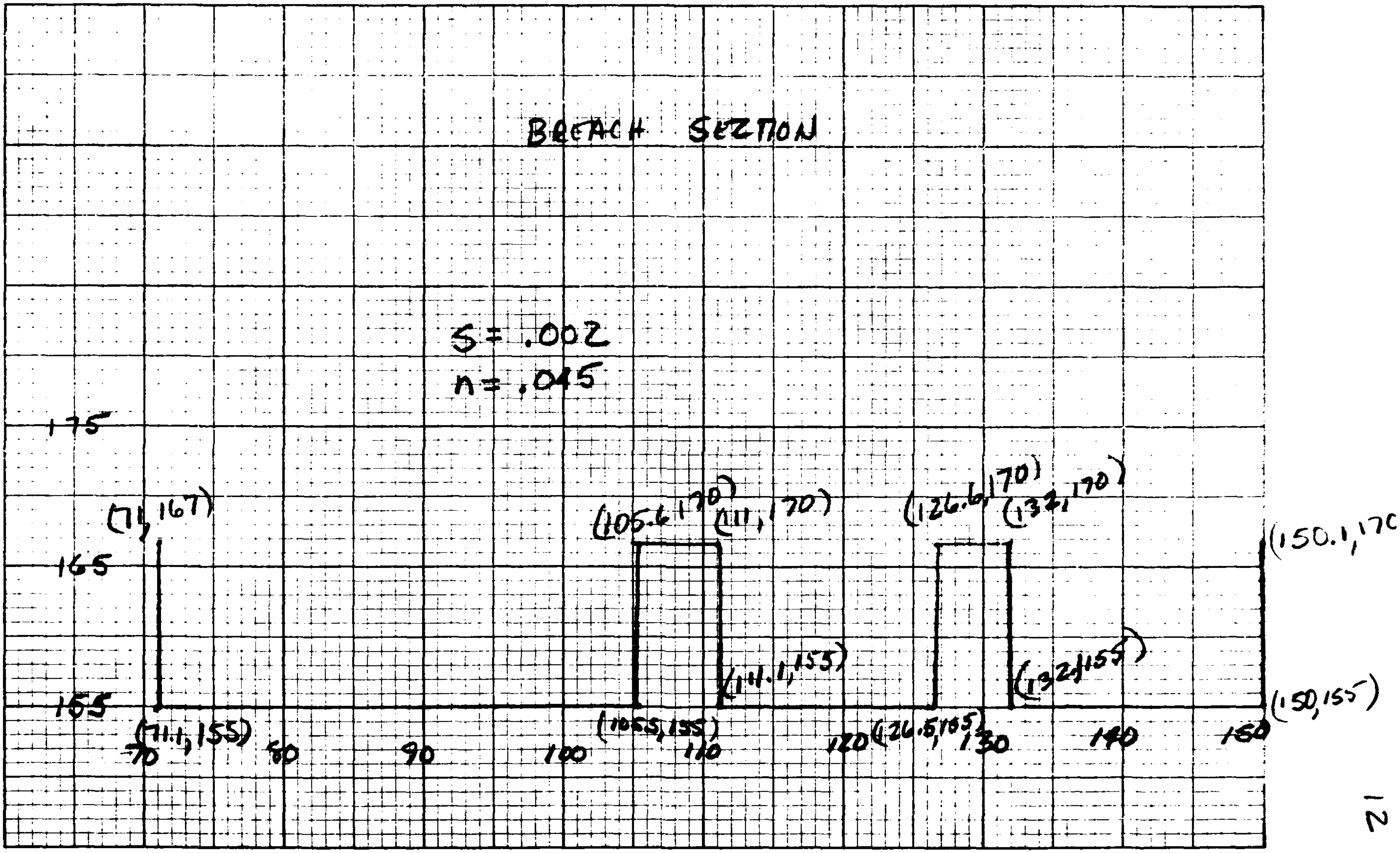
# OLD POND ROAD BRIDGE



# POND SECTION




RATING CURVE FOR BREACHED DAM
USING D/S RATING
3500, 10.2
3000, 9.1
2500, 8.0
2000, 6.9
10
8
6
4
2
500
1000
2000
3000
4000


BREACH SECTION
S = .002
n = .045
175
165
155
(71, 167)
(71.1, 155)
(105.6, 170)
(111, 170)
(111.1, 155)
(105.5, 155)
(126.6, 170)
(132, 170)
(132, 155)
(126.5, 155)
(150.1, 170)
(150, 155)
70
80
90
100
110
120
130
140
150

B. (CONTINUED)

THE BREACH WAVE WOULD BE FULLY DAMPED BY THE MILL DAM AS THE STAGE IN THE UPSTREAM REACH OF 6.3 FEET IS BELOW THE DAM SPILLWAY CREST WHICH IS AT A STAGE OF 9 FEET. THE BREACH WAVE WOULD STOP AND A MORE NORMAL HYDROGRAPH, SIMILAR TO A FLOOD WOULD RESULT BELOW THE MILL DAM.

---

DETERMINATION OF DOWNSTREAM HAZARD BELOW MILL DAM

FLOW MUST BE ESTABLISHED BASED ON MAXIMUM OUTFLOW FROM LAKE THROUGH BREACHED SECTION OF DAM AND UPSTREAM BRIDGES

**STEP 1**

ESTABLISH RATING CURVE THROUGH OPENING IN DAM BASED ON CROSS-SECTION AND SLOPE OF REACH.

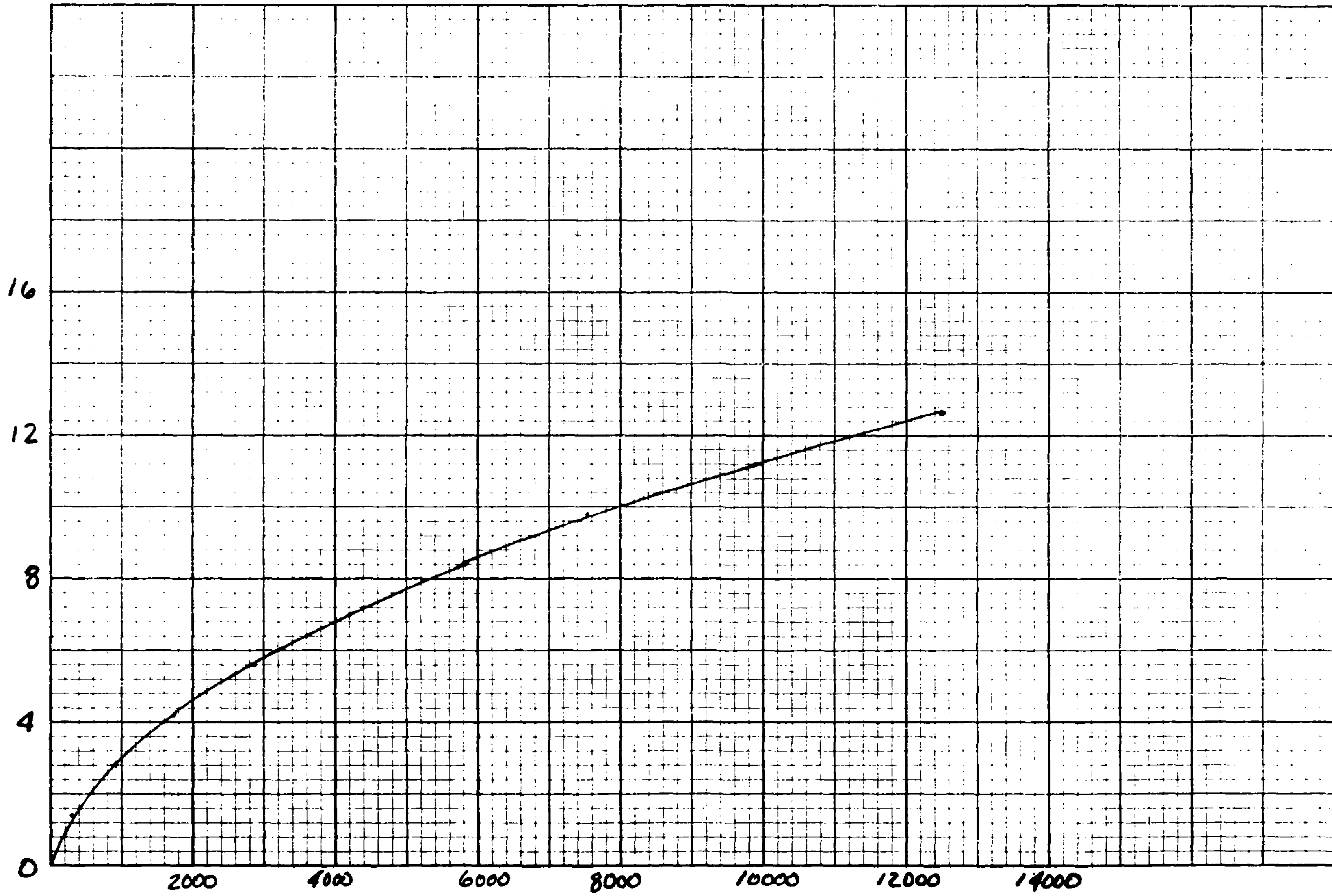
**STEP 2**

BASED ON DOWNSTREAM RATING CURVE DETERMINE LOSSES THROUGH BRIDGES BASED ON EXPANSION CONTRACTION AND YARNELLS EQUATION. ESTABLISH FLOW VERSES WATERSURFACE ON POND

**STEP 3**

DETERMINE FLOW FROM LAKE TO PLEASANT POND.

STAGE DISCHARGE CURVE
SECT 2 CHANNEL 'n' .05
SLOPE .0001




COBBOSSEECONTEE
10/16/79
AMG
PAGE 10

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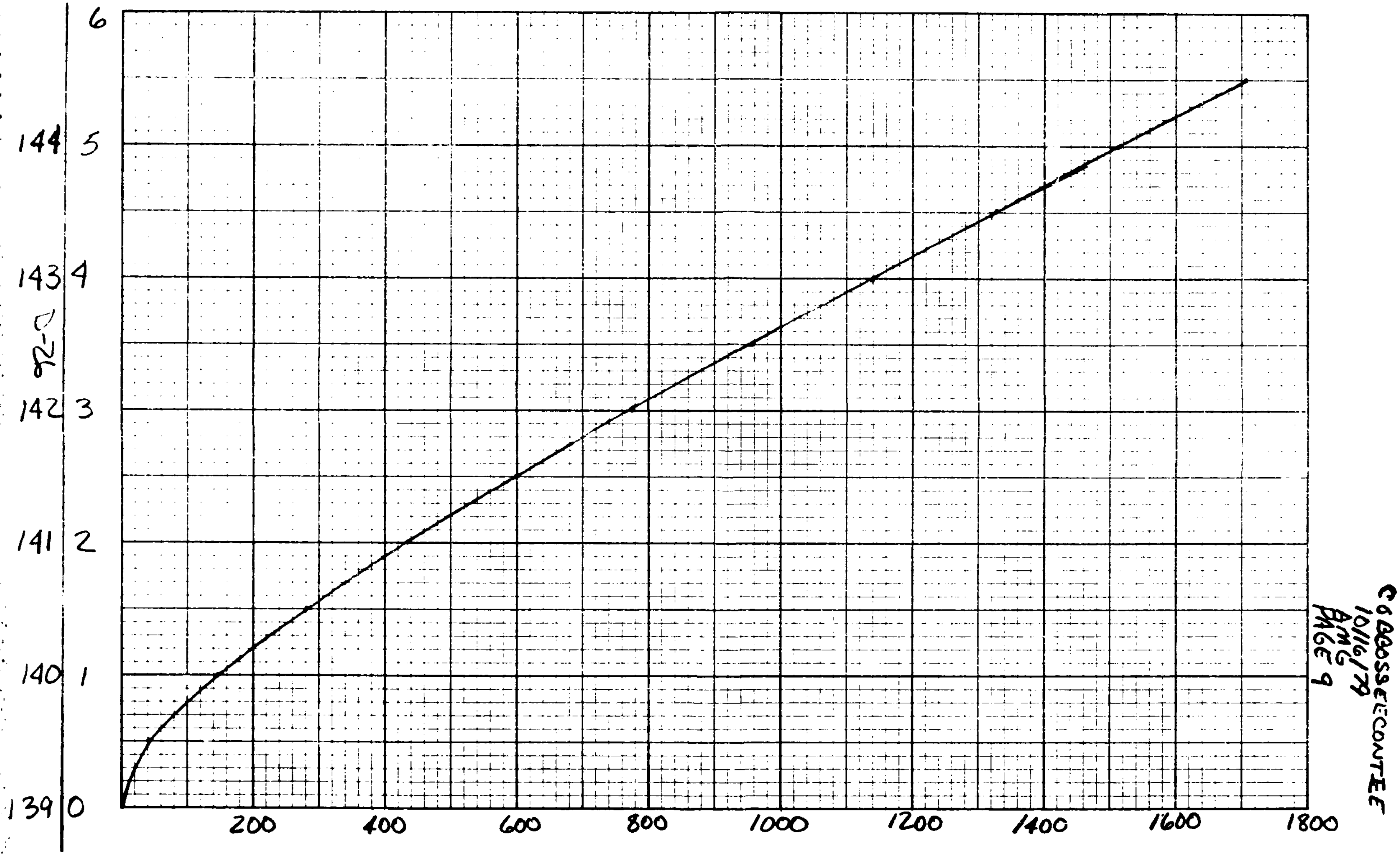
STAGE DISCHARGE CURVE
SECT 3



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Subject: COBBOSS DAM INSPECT

Sheet No. 23 of

Date 11/23/79

Computed AMG

Checked

JOB NO. 3273-14

SQUARES 1/4 IN. SCALE

LOSS FROM EXPANSION FROM OLD BRIDGE

ASSUME .7 ft HEAD LOSS ∴ A = 315 (p 15)

$$\frac{V^2}{2g} = \frac{\left(\frac{3000}{315}\right)^2}{64.4} = 1.41$$

$$H_L = .5(1.41 - .14) = .63 \text{ ft}$$

W.S. @ D/S FACE = 164.16 + .63 = 164.79

USING NAGLER EQ: SEE p. 19

$$Y_3 = 9.79$$

$$\left(\frac{Q}{(Y_3+h_3)B_1}\right)^2 = \left(\frac{Q^2}{C^2} - h_3\right)\frac{2g}{\beta}$$

$$\left(\frac{3000}{(9.79+h_3)100}\right)^2 \frac{2.05}{64.4} = \left\{\frac{3000}{.9(40)\sqrt{64.4}\,[9.79 - .14(3)]}\right\}^2 - h_3$$

$$\left(\frac{3000}{2816}\right)^2 - h_3$$

$$\frac{28.7}{(9.79+h_3)^2} = (1.0?)^2 - h_3 = 1.13 - h_3$$

TRY .85

$$\frac{28.7}{(9.79+.85)^2} = 1.13 - .85$$

$$.25 = .28$$

TRY .9

$$.25 = .23$$

OK

W.S. U/S FACE OLD BRIDGE

164.79 + .9 = 165.69

Q = 3000 cfs

LOSS DUE TO CONTRACTION FROM NEW TO OLD BRIDGE

$V_{OLD} = \frac{3000}{350} = 8.57 \qquad \frac{V^2}{2g} = 1.14$

$V_{NEW} = \frac{3000}{640} = 4.69 \qquad \frac{V^2}{2g} = .34$

$H_L = .3(1.14 - .34) = .24$

W.S. @ D/S FACE NEW BRIDGE = 165.69 + .24 =
= 165.93

LOSS THROUGH NEW BRIDGE SEE P. 22

$h_3 = \left[\frac{3000}{.91(60)\sqrt{64.4}\,(10.93 - .3(.34))}\right]^2$

= .40

W.S. @ U/S FACE NEW BRIDGE = 165.93 + .40
= 166.33

$H_L$ CONTRACTION $= .3\left[\frac{\left(\frac{3000}{650}\right)^2}{64.4}\right] = .10$

LAKE WATER SURFACE

166.33 + .1 = 166.43 (165.46)

FOR FLOW 2000 cfs

FROM RATING CURVE @ BRENCH SECTION

W.S. EL 155 + 6.9 = 161.9

Anderson-Nichols & Company, Inc.

Subject COBBOSS DAM

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JOB NO. 3273-14

SQUARES 1/4 IN. SCALE 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 2

$Q = 2000$

LOSS DUE TO CONTRACTION

$A_{BREACH} = 483 \quad V_{BRE} = \frac{2000}{483} = 4.14 \quad \frac{V^2}{2g} = .266$

$A_{POND} = 720 \quad V_{POND} = \frac{2000}{720} = 2.78 \quad \frac{V^2}{2g} = .120$

$H_L = .3(.266 - .12) = .044$

W.S. = 161.9 + .04 = **161.9**

---

LOSS DUE TO EXPANSION AT OLD BRIDGE

ASSUME HEAD LOSS .6' $\quad A = 225 ft^2$

$V = \frac{2000}{225} = 8.89 \quad \frac{V^2}{2g} = 1.23$

$H_L = .5(1.23 - .12) = .$

W.S. 161.9 + .6 = **162.5**

USING NAGLER FORMULA SEE P. 19

$Y_3 = 7.5 \quad B_1 = 100 \quad K_N = .90 \quad \theta = .3$

$\beta = 2.05 \quad G = \frac{40}{140} = .28$

BALANCING TRIAL + ERROR

$$\left(\frac{Q}{(Y_3 + h_3)B_1}\right)^2 = \left(\frac{Q^2}{C^2} - h_3\right)\frac{2g}{\beta}$$

$$\left(\frac{2000}{(7.4 + h_3)100}\right)^2 = \left\{\left[\frac{2000^2}{.9(40)\sqrt{64.4}\,[7.4 - .3(.12)]}\right] - h_3\right\}\frac{64.4}{2.05}$$

$$\frac{12.7}{(7.4 + h_3)^2} = (.941 - h_3)$$

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Subject COBBOSS DAM

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SQUARES 1/4 IN. SCALE

TRY $h_3 = .7$ $\frac{12.7}{7.4}$

.193 = .241

TRY $h_3 = .76$

.191 = 1.81

USE .8 ∴ W.S. 162.5 + .8 = **163.3**

LOSS DUE TO CONTRACTION FROM NEW TO OLD BRIDGE

$V_{OLD} = \frac{2000}{285} = 7.00$ $\frac{V^2}{2g} = .765$

$V_{NEW} = \frac{2000}{520} = 3.85$ $\frac{V^2}{2g} = .230$

$H_L = .3(.765 - .230) = .16$

W.S. D/S FACE NEW BRIDGE 163.3 + .2 = **163.5**

LOSS THROUGH NEW BRIDGE see p22

$$h_3 = \left[\frac{2000}{.91(60)(64.4)(8.5 - .3(.23))}\right]^2$$

$= .293$

W.S. U/S FACE 163.5 + .3 = 163.8

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SQUARES 1/4 IN. SCALE

LOSS DUE TO CONTRACTION

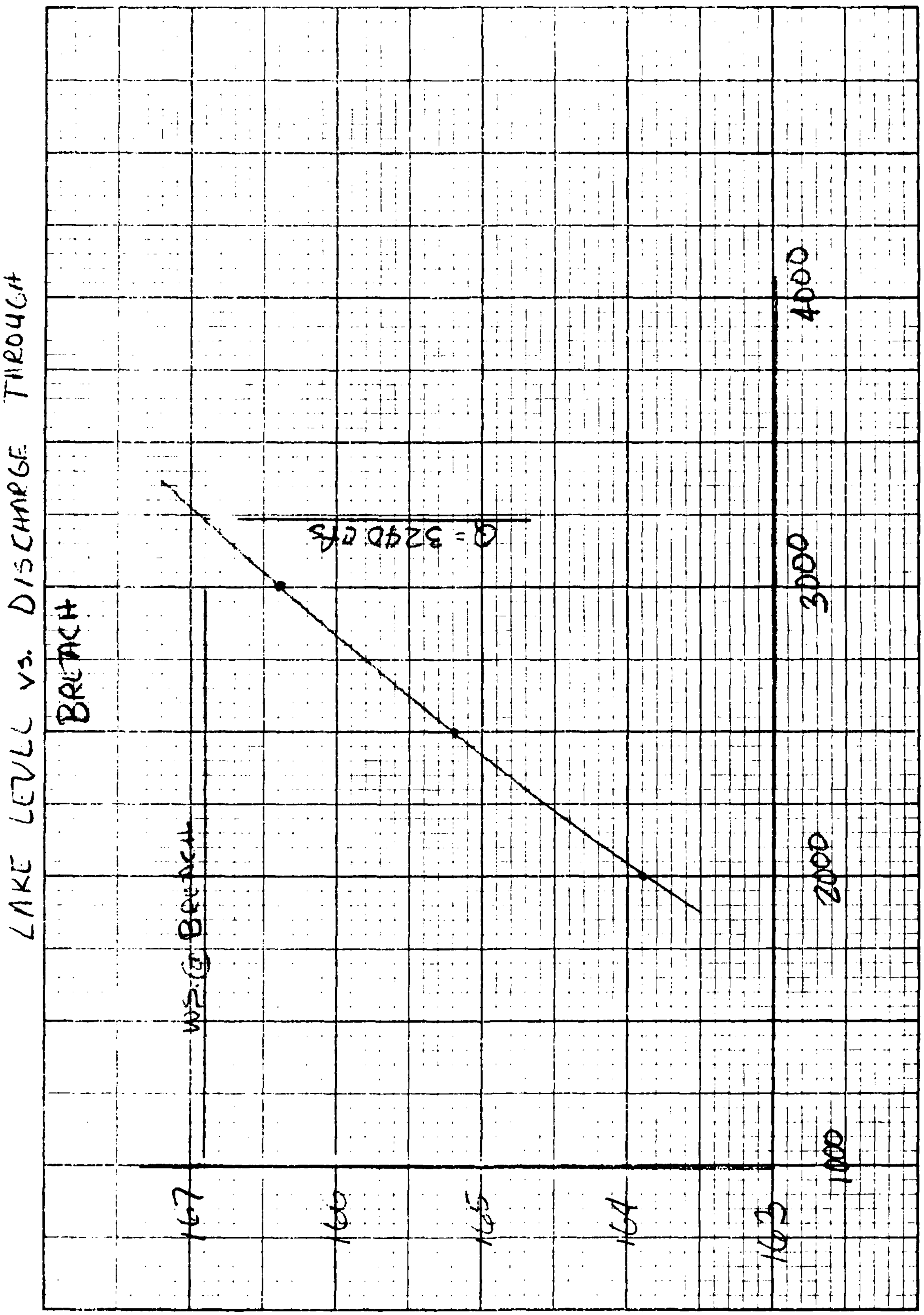
$$h_L = .3\left[\frac{\left(\frac{2000}{520}\right)^2}{64.4}\right] = .069 \quad \text{USE } .1$$

LAKE ELEVATION 163.8 + .1 = 163.9

∴ FOR Q = 2000 cfs LAKE EL. = 163.9

Q = 2500 LAKE EL = 165.2

Q = 3000 LAKE EL = 166.4


LAKE LEVEL vs. DISCHARGE THROUGH BREACH
W.S. @ BREACH
Q = 3240 cfs
167
166
165
164
163
1000
2000
3000
4000

DOWNSTREAM FLOODING DUE TO EXTENSIVE OUTFLOW FROM BREACHED DAM NOT BREACH

LOSS THROUGH BRIDGE #1 DOWNSTREAM OF MILL POND BASED ON FRICTION LOSS (PAGE 30)

WATER SURFACE 143.3 BELOW BRIDGE LOW CHORD (145.) NO STRUCTURES EFFECTED

REACH #3 FROM BRIDGE #1 BELOW MILL POND TO HIGH STREET BRIDGE IS REPRESENTED BY CROSS-SECTION PAGE 31.

WATER SURFACE RISE FOR REACH #3 WOULD RESULT IN DAMAGE TO COTTAGE STRUCTURES. FIRST FLOOR COVERED WITH WATER MINIMAL DEPTH.

HIGH STREET (BRIDGE #2) SEE P 32

LOSS DUE TO EXPANSION CONTRACTION ONLY

U/S AND D/S CROSS SECTIONS ASSUMED SAME SIZE AND SHAPE

$A_{BRIDGE} = 770 \quad V = \frac{3240}{770} = 4.2 \quad \frac{V^2}{2g} = .275$

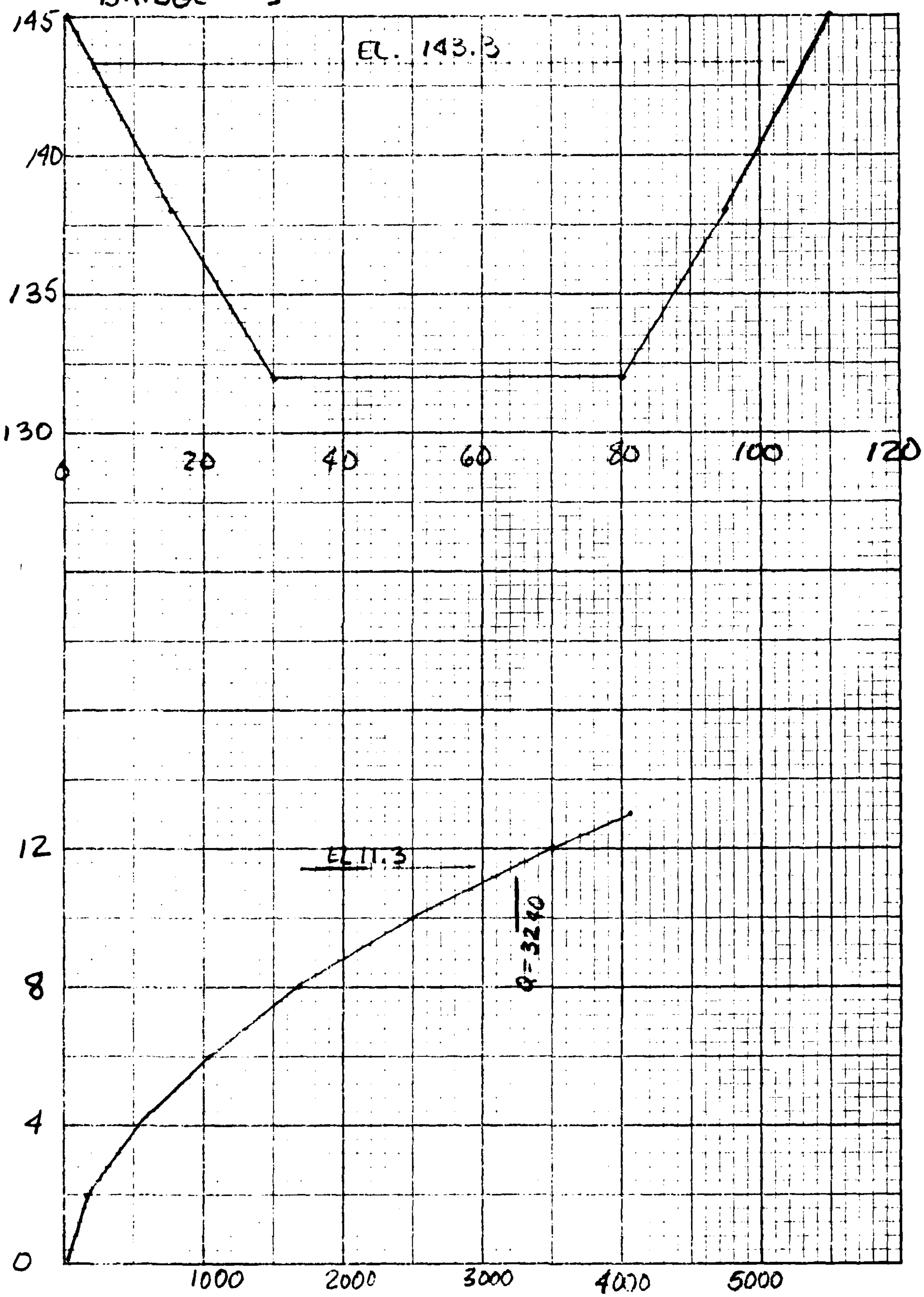
$A_{POND} = 250 \times 11$

$= 2750 \quad V = \frac{3240}{2750} = 1.18 \quad \frac{V^2}{2g} = .022$

$H_L = .3(.275 - .022) + .5(.275 - .022)$

$= .20$ ft INSIGNIFICANT

BRIDGE #1


EL. 143.3
145
140
135
130
0
20
40
60
80
100
120
EL 11.3
Q=3240
12
8
4
0
1000
2000
3000
4000
5000

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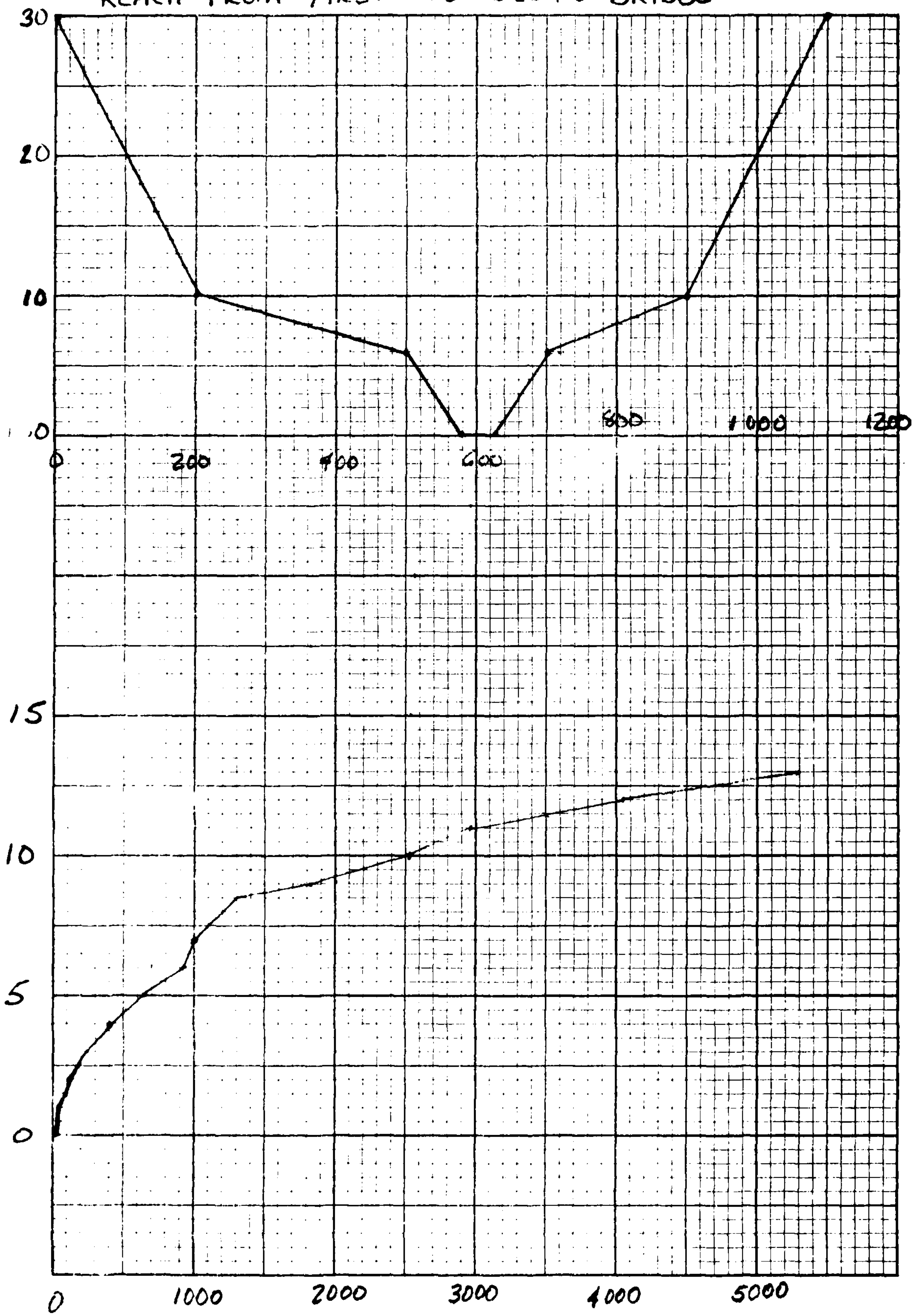
REACH FROM FIRST TO SECOND BRIDGE



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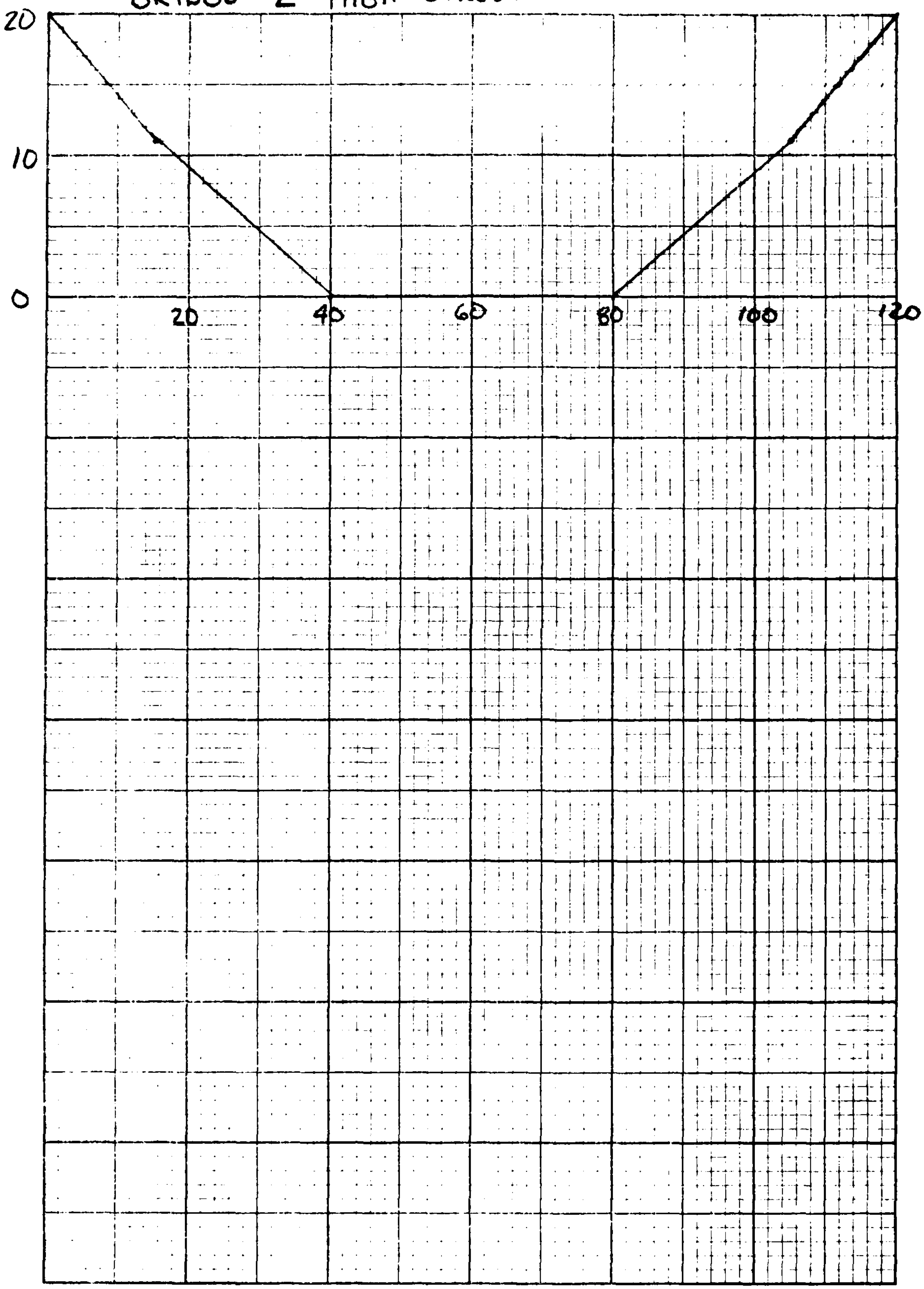
BRIDGE #2 HIGH STREET



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REACH #4 FROM HIGH STREET (BRIDGE #2) TO LEWISTON ROAD (BRIDGE #3)

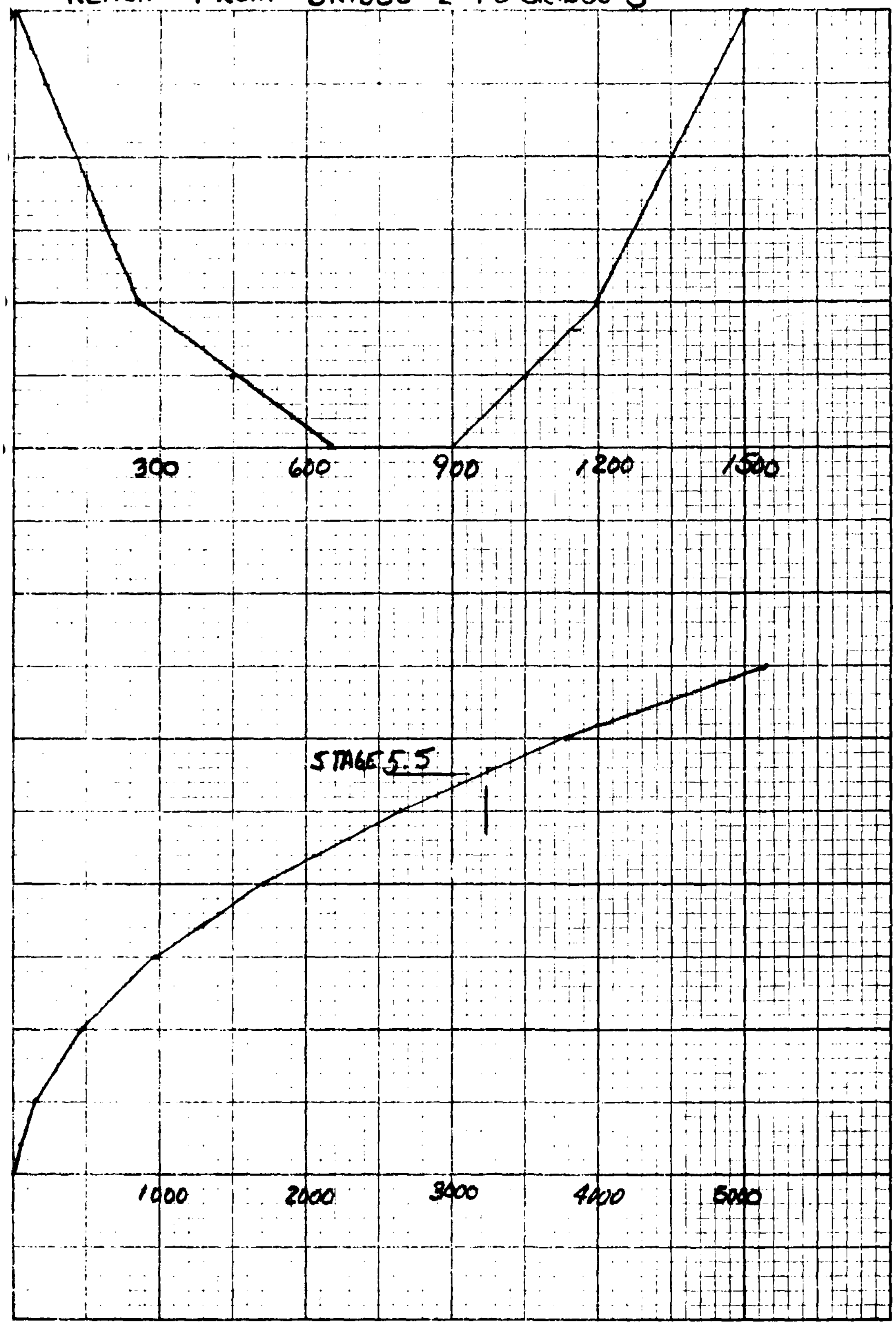
REPRESENTATIVE CROSS-SECTION PAGE 34

Q=3240 STAGE 5.5 INCREASE IN DEPTH .5ft NO DAMAGE
SECTION WOULD BE FLOODED HIGHER BY BACK WATER FROM PLEASANT POND
EL. 138.8 STAGE = 8.8' SEE PAGE 35

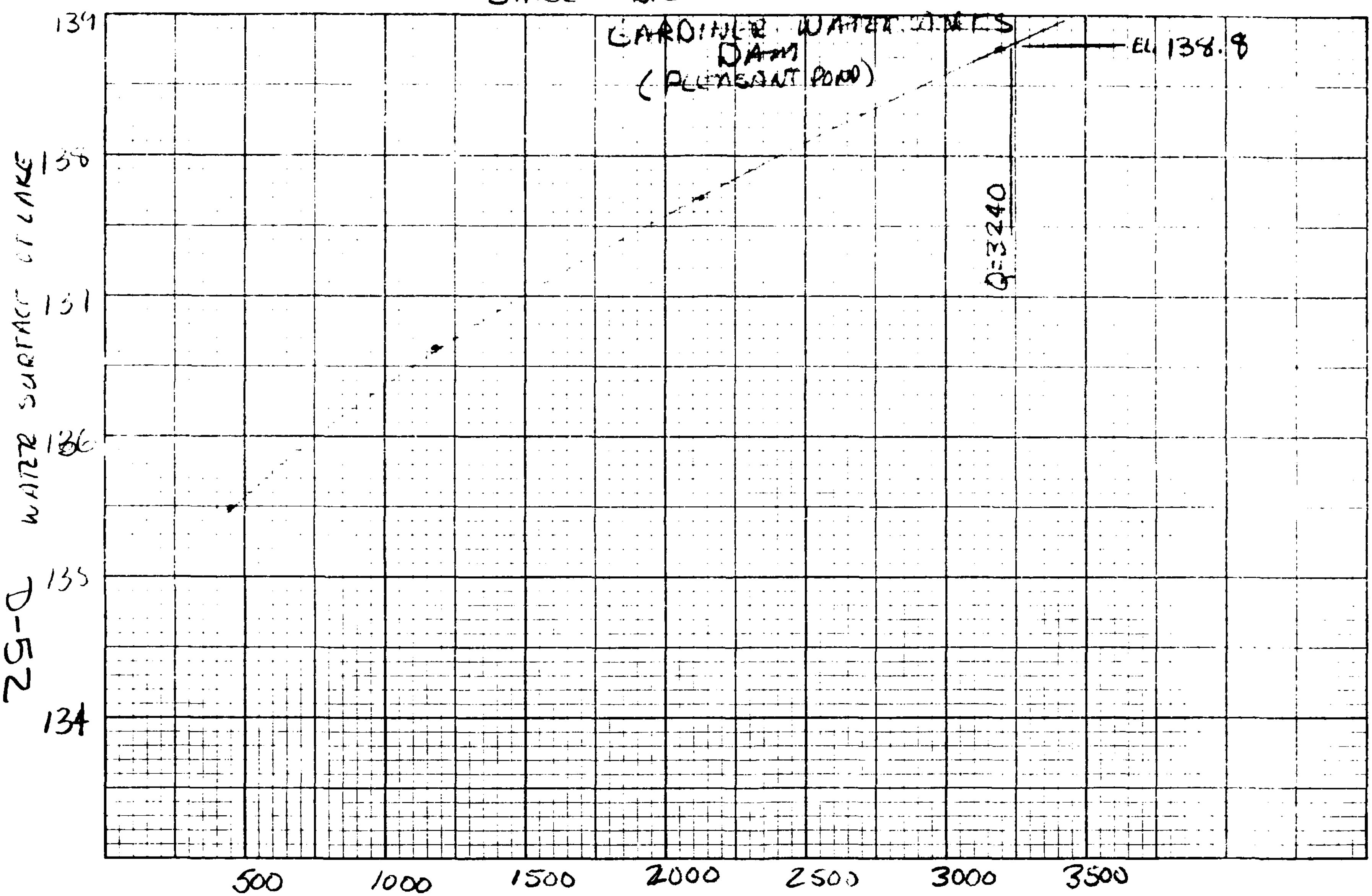
STAGE DISCHARGE FROM PLEASANT POND GARDINER WATER WORKS DAM HAS BEEN DETERMINED BY USE OF HEC-2 BACKWATER MODELING OF OUTLET, WATER SURFACE AS SHOWN WOULD BE 138.8.

DAM OPERATORS AT GARDINER WATER WORKS DAM REPORT NO DAMAGE AT W.S. EL. 138.1 (TOP OF DAM)
IT IS ASSUMED AN ADDITIONAL .7 FEET WILL CAUSE ONLY MINIMAL DAMAGE

REACH FROM BRIDGE 2 TO BRIDGE 3



STAGE DISCHARGE CURVE FOR

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APPENDIX E

INFORMATION AS
CONTAINED IN THE NATIONAL
INVENTORY OF DAMS