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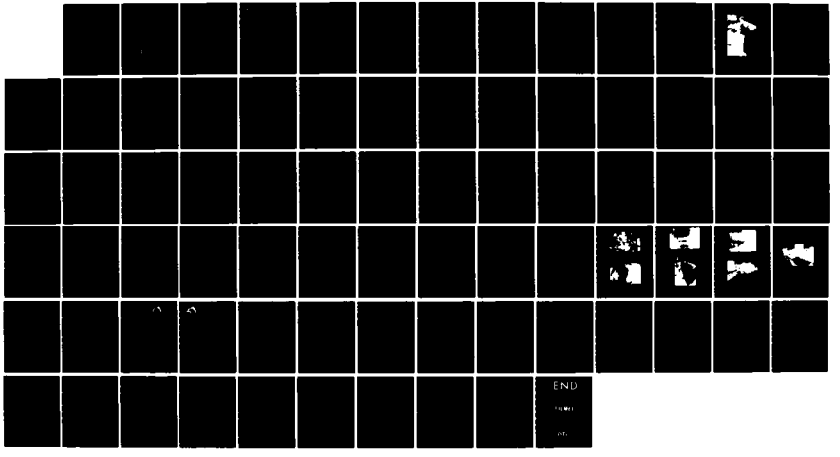
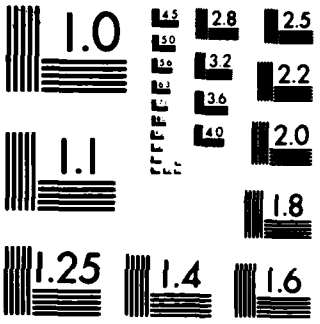
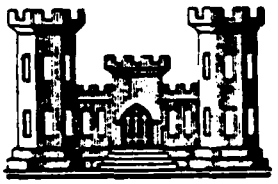




MOUSAM RIVER BASIN
SANFORD , MAINE

GOODALL-SANFORD DAM
ME-00185

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM



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

JUNE 1979

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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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)

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Mousam River Bsain
Sanford Maine
Mousam River

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

The dam is about 14 ft. high and 245 ft. long, and has a 213 ft. long uncontrolled free overfall spillway. The dam is assessed to be in fair condition. It is small in size with a high hazard potential. There are various remedial measures which should be implemented by the owner.

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

REPLY TO
ATTENTION OF:
NEDED

OCT 15 1979

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

Dear Governor Brennan:

Inclosed is a copy of the Goodall-Sanford 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 and the Department of Transportation, cooperating agencies for the State of Maine. In addition, a copy of the report has also been furnished the owner, Town of Sanford.

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, the Department of Agriculture and the Department of Transportation for your cooperation in carrying out this program.

Sincerely,

MAX B. SCHEIDER
Colonel, Corps of Engineers
Division Engineer

Incl
As stated

MOUSAM RIVER BASIN

SANFORD, MAINE

GOODALL-SANFORD DAM

ME-00185

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

NATIONAL DAM INSPECTION PROGRAM

PHASE I INSPECTION REPORT

ME-00185

GOODALL-SANFORD DAM

SANFORD

YORK COUNTY, MAINE

MOUSAM RIVER

December 5, 1978

BRIEF ASSESSMENT

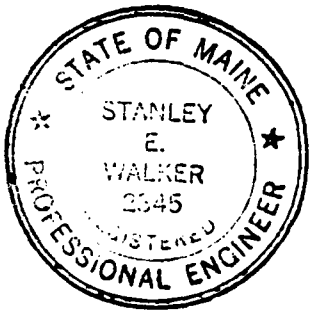
The Goodall-Sanford Dam is a concrete gravity structure. The dam is approximately 14 feet high and 245 feet long, and has a 213-foot long uncontrolled free overfall spillway.

Based on the visual inspection and reports of past operational performance, the Goodall-Sanford Dam is assessed to be in fair condition. Areas of major concern regarding the long-term safety of the dam include deterioration of the concrete at the gated outlet and process water headworks structures, leakage from beneath the east wingwall downstream of the dam, inadequate freeboard between the normal water surface elevation and low areas along the upstream concrete dikes, and the inability of the dam to pass the test flood without overtopping.

Based on the dam's small size and high hazard potential, the spillway test flood is one-half the probable maximum flood (1/2 PMF) which has a peak discharge of 8,500 cfs. The spillway discharge capacity is 26 percent of the test flood. The test flood outflow would overtop the west abutment by 1.6 feet and the east abutment by 0.6 feet.

The recommendations and remedial measures presented in Section 7 should be implemented within 12 months of receipt of this report by Owner. A qualified engineer should be retained to: 1) evaluate the hydrology of the watershed and hydraulics of the dam with respect to the need for increasing the total discharge capacity of the dam; 2) develop provisions for curtailing leakage through the east abutment; 3) develop recommendations for eliminating or relocating catwalks located across the river just downstream of the dam; and 4) develop provisions for curtailing leakage occurring through

the east abutment and to make recommendations to eliminate or relocate the catwalks downstream of the dam. Remedial measures include: 1) repair spalled and deteriorated concrete at the gated outlet and process water headworks structures; 2) remove trees from downstream channel; 3) repair badly corroded gate stems; 4) establish a formal warning system; 5) provide around-the-clock surveillance during heavy runoff periods; 6) institute a program of annual periodic technical inspection.



EDWARD C. JORDAN CO., INC.

Stanley E. Walker, P.E.
Project Officer

This Phase I Inspection Report on Goodall-Sanford 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.

Joseph A. McElroy

JOSEPH A. MCELROY, MEMBER
Foundation & Materials Branch
Engineering Division

Carney M. Terzian

CARNEY M. TERZIAN, MEMBER
Design Branch
Engineering Division

Joseph W. Finegan, Jr.

JOSEPH W. FINEGAN, JR., CHAIRMAN
Chief, Reservoir Control Center
Water Control Branch
Engineering Division

APPROVAL RECOMMENDED:

Joe B. Fryar

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 reasonable 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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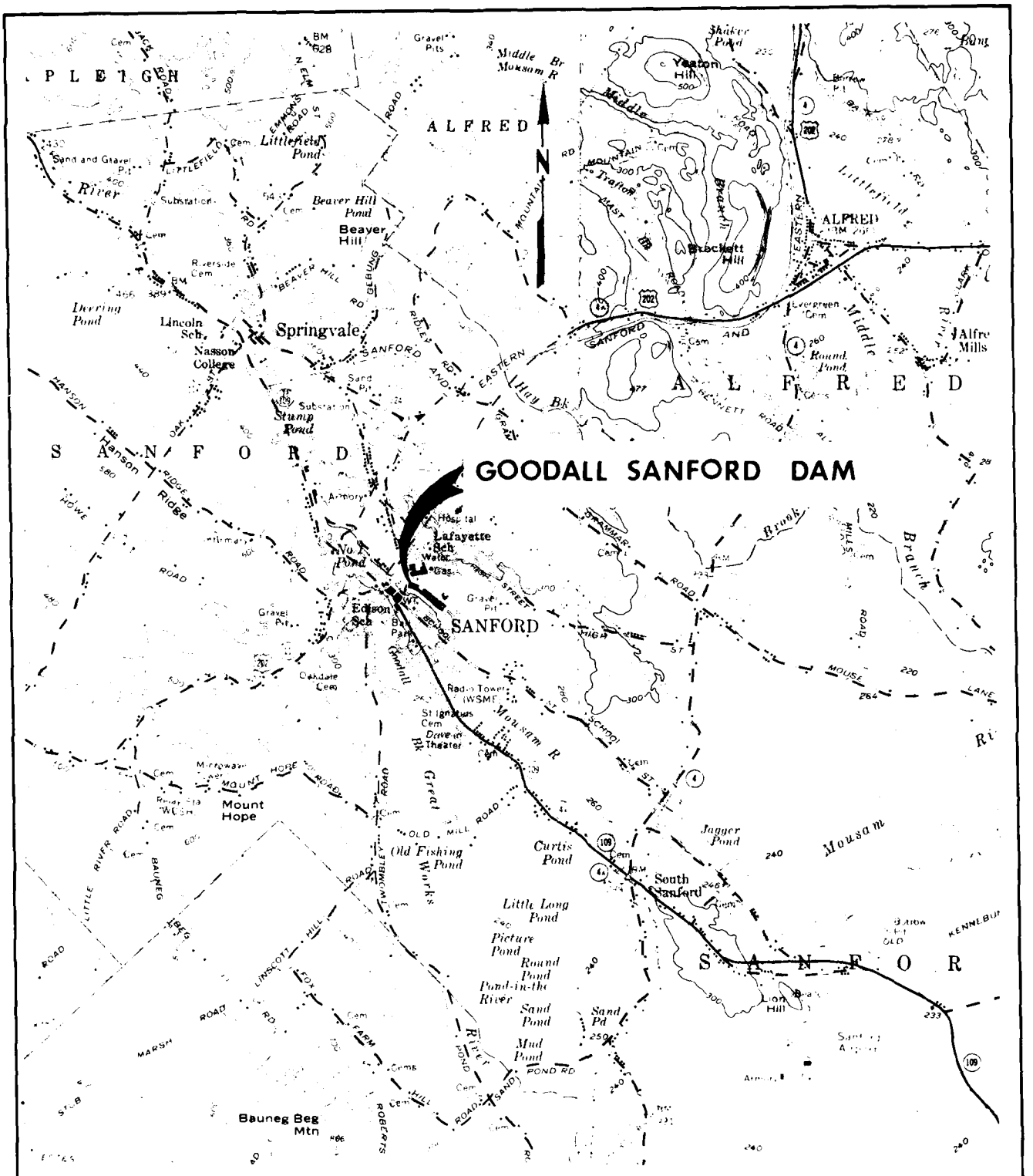


U.S. GEOLOGICAL SURVEY MAP
BERWICK, ME.- N.H. QUADRANGLE
KENNEBUNK, ME. QUADRANGLE

EDWARD C. JORDAN CO., INC. PORTLAND, MAINE	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

GOODALL SANFORD DAM
LOCATION MAP

MOUSAM RIVER ME.

207-53-15	SCALE AS SHOWN
	DATE APRIL 1978

PHASE I INSPECTION REPORT

GOODALL-SANFORD 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 asssigned the responsibility of supervising the inspection of dams within the New England Region. Edward C. Jordan Co., Inc. has been retained by the New England Division to inspect and report on selected dams in the states of Maine and New Hampshire. Authorization and notice to proceed were issued to Edward C. Jordan Co., Inc. under a letter of December 1, 1978 from Max B. Scheider, Colonel, Corps of Engineers. Contract No. DACW33-79-C-0017 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. The Goodall-Sanford Dam is located on the Mousam River in the town of Sanford, Maine, N 43°-26.5', W 70°-46.5'.

b. Description of Dam and Appurtenances. The Goodall-Sanford Dam is a concrete gravity structure. The dam is approximately 14 feet high and 245 feet long, and has a

213-foot long uncontrolled free overfall spillway. Located near the westerly abutment is a gated outlet works, and located at the easterly abutment is a process water headworks structure. Concrete dike walls extend upstream from both abutments.

Plan, profile and cross-section sketches are presented in Appendix B.

c. Size Classification. The Goodall-Sanford Dam has a maximum storage capacity of about 400 acre-feet and a height of 14 feet. According to Corps of Engineer's "Recommended Guidelines for Safety Inspection of Dams," a dam with storage capacity less than 1,000 acre-feet and a height less than 40 feet is classified as a small dam.

d. Hazard Classification. The Goodall-Sanford Dam is classified as a high hazard potential dam. The peak flow from the hypothetical failure of the dam was estimated to be about 6,500 cfs based on the guideline procedures provided by the Corps of Engineers. Failure of the dam would result in river stages of 8 to 9 feet between the two factory buildings which confine the river just below the dam. Considerable damage would be expected at the two buildings with the potential for loss of many lives. Several houses located approximately 1.5 miles downstream of the dam would be flooded to depths of 1 to 3 feet. Several highway bridges located within about 6000 feet of the dam would be overtopped.

e. Ownership.

Current Owner:	Town of Sanford Town Hall Sanford, Maine Tel: (207) 324-4121
Contact Person:	Anthony Hayes - Town Engineer
Previous Owner:	Goodall Mill Sanford, Maine
	Dates: Unknown

f. Operator.

Roy Moses
Sanford Highway Department
Sanford, Maine
Tel: (207) 324-2940

g. Purpose of Dam. This dam is presently used to provide process and fire protection water to Sutton's Mills and cooling water for York Heel of Maine Inc., located just downstream of the dam.

h. Design and Construction History. No design or construction data pertinent to this dam was disclosed.

i. Normal Operating Procedures. No formal operating procedure is followed. The town attempts to maintain an adequate reservoir volume to supply water to the mills located just downstream of the dam.

1.3 PERTINENT DATA

a. Drainage Area. The drainage area above the Goodall-Sanford Dam is approximately 41 square miles. Approximately 8 percent of the drainage area consists of surface water. The Emery Mills Dam, which impounds Mousam Lake, has a significant regulating effect on the discharge of the Mousam River. The drainage area above the Emery Mills Dam is approximately 29 square miles. The watershed above the Goodall-Sanford Dam is primarily forested, with the exception of the urbanized areas of Springvale and Sanford, Maine. Elevations in the basin vary from 1,230 feet to about 270 feet.

b. Discharge at Damsite. Releases for flood control or dam maintenance are made at the gated outlet works located near the west abutment and the uncontrolled spillway. The following discharges were estimated assuming a water surface at top of west wingwall (elev. 285.7 MSL), unless otherwise noted.

(1) Maximum capacity of gated outlet works (7 foot diameter gate), 520 cfs

(2) Maximum flood at damsite is unknown. The flood of March, 1936 produced a peak discharge of approximately 1,300 cfs at the damsite, according to U.S.G.S. Water Supply Paper 798.

(3) East spillway section at top of dam - 2,065 cfs

(4) West spillway section at top of dam - 162 cfs

(5) Total project discharge at test flood (1/2 PMF) elevation 8,500 cfs at elev. 287.3

c. Elevation. The mean sea level elevation of the spillway crest is 283.2 ft. as given in U.S.G.S. Water Supply Paper No. 1671.

ITEM	ELEVATION (FEET ABOVE MSL)
Top of dam at west abutment	285.7
Low point of easterly concrete dike wall	285.1
Low point of westerly concrete dike wall	284.4
1/2 PMF pool	287.3
East spillway section	283.2
West spillway section	284.0
Full flood control pool	Not Applicable
Streambed at centerline of dam	272.5
Maximum tailwater	Unknown
Normal water surface (east spillway crest)	283.2
Invert of gated outlet	272.9
Approximate invert of water supply pipes in gate house at east abutment	274 ±

d. Reservoir Reach. The following lengths of the reservoir were estimated from U.S.G.S. maps and average streambed slopes.

ITEM	LENGTH (FEET)
Normal water surface pool (elev. 283.2 MSL)	5000
Top of dam (elev. 285.7 MSL)	5500

e. Storage.

ITEM	STORAGE (ACRE-FEET)
Normal water surface pool (elev. 283.2)	278
Top of west abutment (elev. 285.7)	413
Top of east abutment (elev. 286.7)	508
1/2 PMF pool	570

f. Reservoir Surface.

ITEM	SURFACE AREA (ACRES)
Normal water surface (elev. 283.2)	52
Top of west abutment (elev. 285.7)	72
Top of east abutment (elev. 286.7)	86
1/2 PMF pool	92

g. Dam.

Type - The dam is a concrete gravity structure.

Length - The length, including the process water headworks structure, is 245 feet.

Height - 14 feet from top of dam to river bed

Top Width - See plan and cross-sections in Appendix B.

Side Slopes - See plan and cross-sections in Appendix B.

Zoning - Unknown.

Impervious Core - N/A.

Cutoff - Concrete placed on bedrock.

Grout Curtain - Unknown

h. Diversion and Regulating Tunnel. Not applicable.

i. Spillway.

Type - The spillway is a broad crested uncontrolled free overfall weir.

Length - west section - 26 feet
east section - 187 feet

Crest Elevation - east section - 283.2 MSL
west section - 284.0 MSL

Gates - None.

Downstream Channel - The channel of the Mousam River just below the dam is steep and rocky. About 50 feet below the dam, a highway bridge constricts the channel to a width of 46 feet. Below the bridge, the river flows between two mills which form the river banks for a distance of about 300 feet. Several catwalks, connecting the two mills, cross the river in this reach (see photograph 3). Below the mills the bed material consists of sand, gravel and cobbles. The overbanks are flat to moderately sloping with a moderate growth of brush and small trees.

j. Regulating Outlets.

Invert elev. (MSL) - Outlet Gate 272.9

Size - Outlet Gate - 7-foot diameter

Description - Outlet gate consists of a vertical lift timber gate.

Control Mechanism - Outlet gate - manually operated hoisting equipment.

SECTION 2

ENGINEERING DATA

2.1 DESIGN

No original design data were available for Goodall-Sanford Dam. Some of the hydraulic and hydrologic data used in Appendix D was obtained from the Corps of Engineers Phase I Dam Inspection Reports completed for the Emery Mills Dam (October 1978), River Street Dam (October 1978), and the Mill Street Dam (October 1978), located upstream of the Goodall-Sanford Dam.

2.2 CONSTRUCTION

No engineering data were available regarding construction of the dam.

2.3 OPERATION

No engineering operational data were available.

2.4 EVALUATION

a. Availability. There are essentially no engineering data or plans available that would be useful in evaluating the integrity of the Goodall-Sanford Dam.

b. Adequacy. The lack of engineering data did not allow for a definitive review. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing design and construction data, but is based primarily on visual inspection, performance history and engineering judgment.

c. Validity. Not applicable.

SECTION 3

VISUAL INSPECTION

3.1 FINDINGS

a. General. The Goodall-Sanford Dam is located in a broad flat section of the Mousam River Valley. The dam is a concrete gravity structure with an uncontrolled free overfall spillway. It appears to be founded entirely on bedrock.

b. Dam.

(1) Structural - The dam is a concrete structure. See Appendices A, B and C for detailed inspection findings, drawings and photographs.

The inspection resulted in the following major findings:

(a) The dam appears true to line and grade. No evidence of horizontal movement or settlement was observed.

(b) The spillway sections of the dam appear to be in good condition. The concrete shows evidence of only minor erosion. The horizontal and vertical joints in the spillway are worn but appear tight and no leakage is occurring.

(c) The concrete in the process water headworks structure at the east abutment is in poor condition (see photographs 5 and 6). Severe spalling, exposing reinforcing steel, has occurred on the upstream faces. The downstream face shows severe surficial cracking indicating a potential lime-silica reaction within the concrete.

(d) The concrete in the control outlet section is in fair to poor condition (see photographs 1 and 2). Severe spalling has occurred particularly within the outlet conduit where joints are open and leakage is occurring.

(e) No seepage or leakage was observed along the downstream face of the dam. Leakage is occurring from beneath the east wingwall downstream of the dam. The source of this leakage could not be determined.

(2) Hydraulics - The reservoir water surface is primarily controlled by the free overfall spillway. A 7-foot diameter gated outlet, located near the west abutment, can be used to drain the impoundment if required. Although not operated during the field inspection, the gate works appeared in fair condition and are believed to be operable. The concrete of the outlet channel is deteriorated in some areas. Operation of the gated outlet at the present time would result in further damage to the outlet channel. Low concrete dike walls extend upstream of the dam on both the east and west shorelines. Three water supply inlets are operated from the gate house on the east abutment. The three pipelines supply process and cooling water to nearby factories. At the time of visual inspection, the reservoir level was about 0.05 feet above the east spillway crest.

c. Appurtenant Structures. The control outlet consists of a 7-foot diameter sluiceway closed by a vertical lift timber gate. The gate and operating mechanism appear to be in fair condition. The lifting stems on the gate are badly corroded but intact. During periods of high flow, there is not suitable access to the operating mechanism of the control outlet.

d. Reservoir Area. The reservoir shoreline is primarily urbanized except at the headwaters of the reservoir which is generally wooded. U.S. Route 202 crosses the reservoir approximately 600 feet upstream of the dam. The bridge causes a constriction of the reservoir at its crossing. With the exception of the Route 202 bridge, the approach to the spillway is clear and unobstructed. Ground slopes above the reservoir are slight to moderate and the potential for slope failures appeared minimal.

e. Downstream Channel. The channel of the Mousam River just below the dam is steep and rocky. About 50 feet below the dam, a highway bridge constricts the channel to a width of 46 feet. Below the bridge, the river flows between two mills which form the river banks for a distance of about 300 feet. The stream channel between the mill buildings is about 45 feet wide. Several catwalks, connecting the two mills, cross the river in this reach (see photograph 3). Below the mills, the bed

material consists of sand, gravel and cobble. The overbanks are flat to moderately sloping with a moderate growth of brush and small trees.

3.2 EVALUATION

Based on the visual inspection, the dam appears to be in fair condition. The concrete in the control outlet and process water headworks areas is in fair to poor condition with cracking and spalling evident. The catwalks crossing the downstream channel and connecting the mill buildings each side of the channel could collect debris and thus cause rapid flooding of street level areas within the mill buildings. As outlined in Section 7, rehabilitative construction and maintenance is necessary to assure the long-term safety of the structure.

SECTION 4

OPERATING PROCEDURES

4.1 PROCEDURES

The outlet gates are operated manually to control the reservoir surface elevation. The water supply inlets at the east abutment provide process and cooling water to the mills just downstream.

4.2 MAINTENANCE OF DAM

Reportedly, maintenance to the dam is performed on an as-needed basis. There are no maintenance records available.

4.3 MAINTENANCE OF OPERATING FACILITIES

The outlet gate and operating mechanism are generally in fair condition. However, the lifting stems on the gate are badly corroded. The gate reportedly is operated periodically to ensure that it remains operable.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

No warning system is known to be in effect.

4.5 EVALUATION

The Goodall-Sanford Dam operating equipment is generally in fair condition. Although no regularly scheduled program of maintenance is in effect, maintenance is reportedly performed on an as-needed basis. No formal warning system for either high water or structural distress is in effect at the dam.

SECTION 5

HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. General. The Goodall-Sanford Dam is a concrete gravity structure with a free overfall spillway running almost the entire length of the dam. Concrete dike walls extend upstream of the dam along both the east and west shorelines. The impounded water is primarily used for process and cooling water at nearby mills. The discharge of the Mousam River above the dam is affected by the regulation of Mousam Lake by the Emery Mills Dam. Water level is normally kept at or near spillway crest at the Goodall-Sanford Dam.

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

c. Experience Data. No information regarding specific overtopping events or other notable hydrologic occurrences were disclosed. Damage caused by previous overtopping events was not observed. As reported in U.S.G.S. Water Supply Paper No. 798, the flood of March, 1936 produced a discharge of 1,300 cfs on the Mousam River at Sanford, Maine.

d. Visual Observations. Water level at the Goodall-Sanford Dam can be regulated only by the gated outlet. The concrete of the gated outlet discharge channel is deteriorated (see photographs 1 and 2). The crest and downstream face of the spillway are in good condition. No significant scour was noted at the toe of the dam. Only about 2 feet of freeboard exists between normal water surface easterly of spillway crest and the top of the concrete dike walls along the east and west shores.

e. Test Flood Analysis. The Goodall-Sanford Dam is classified as having a high hazard potential. Based on Corps of Engineers' "Recommended Guidelines for Safety Inspection of Dams," the spillway test flood is one-half the probable maximum flood (PMF). Due to the amount of regulation upstream, the Mousam River is considered as having a low runoff potential. The drainage area above the Goodall-Sanford Dam is about 41 square miles. The

discharge of the Mousam River is regulated by the Emery Mills Dam on Mousam Lake. The drainage area above the Emery Mills Dam is about 30 square miles. Phase I Dam Safety Inspection Reports have been completed for three dams upstream of the Goodall-Sanford Dam, including the Emery Mills Dam. Using the results of the 1/2 PMF development for the upstream dams, the test flood inflow to the Goodall-Sanford Reservoir was estimated to be 8,500 cfs (see Appendix D). The surcharge storage capacity of the Goodall-Sanford Dam would not reduce the 1/2 PMF peak flow due to routing effects. The test flood would therefore overtop the west abutment (elev. 285.7) by 1.6 feet and the east abutment (elev. 286.7) by 0.6 feet. The low areas of the concrete dike walls would be overtopped by 2.9 feet. The spillway discharge capacity of the dam is approximately 26% of the 1/2 PMF peak flow.

f. Dam Failure Analysis. To determine the hazard classification of the Goodall-Sanford Dam, the potential impact of failure of the dam was assessed. The failure analysis relied upon the Corps of Engineers "rule of thumb" guidance. The hazard potential was determined by calculating peak discharge rates which might occur downstream of the dam due to a breach of the spillway section.

The flood peak at the dam from failure was estimated to be 6,500 cfs. It would take the reservoir 1 to 2 hours to empty. The peak flow would result in river stages of 8 to 9 feet between the two mills located just downstream of the dam. The possibility exists of clogging the stream channel between the mills due to debris catching on to the catwalks and catwalk support members. This would result in raising downstream water surfaces. Considerable damage would be expected at the mills and the potential for loss of life would be high. Just prior to failure, river stages between the two mills would be approximately 4 feet.

Some flooding would occur in a residential area located approximately 1.5 miles downstream of the dam in the area of School St. Approximately 5 dwellings would be flooded to depths of 1 to 3 feet. Prior to failure, with spillway discharging at full capacity, no flooding would be expected in this area.

Based on the information discussed above, the Goodall-Sanford Dam is judged to have a high hazard potential. Being a concrete gravity dam with an overfall spillway and concrete dike walls, the Goodall-Sanford Dam is considered to be generally resistant to deterioration by overtopping.

SECTION 6

STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations. Based on the visual observations, the Goodall-Sanford Dam appears to be in fair condition. The spillway sections appear to be in generally good condition but the gated outlet and process water headworks are in poor condition (see photographs 5 and 6). The concrete in these areas is severely spalled, joints are open, and surficial cracking is apparent. Leakage is occurring through joints in the gated outlet conduit. Leakage was also observed to be occurring from beneath the east wingwall downstream of the dam.

b. Design and Construction Data. No data concerning original design or construction of the Goodall-Sanford Dam was disclosed in this investigation.

c. Operating Records. None available.

d. Post-Construction Changes. Since its construction, reported to be in 1911, no modifications are known to have been made.

e. Seismic Stability. The dam is located in Seismic Zone No. 2 and in accordance with recommended Phase I guidelines, does not warrant seismic analysis.

SECTION 7

ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Condition. Based on the visual inspection and performance history, the Goodall-Sanford Dam is assessed to be in fair condition. The inspection identified the following major items of concern:

(1) Deterioration of concrete in gated outlet and process water headworks (see photographs 1, 2, 4, and 5).

(2) Leakage from beneath the east wingwall below the dam.

(3) The dam is not capable of passing the test flood (1/2 PMF) without overtopping. There is inadequate freeboard between the normal water surface elevation and the low areas of the concrete dikes to contain the test flood above the dam.

(4) Potential for collection of debris and rapid flooding of the immediate area at the catwalks across the downstream channel, connecting the mill buildings each side of the channel.

(5) Lack of suitable access to control outlet.

b. Adequacy of Information. The information available is such that the assessment of the condition of the dam must be based primarily on the visual inspection, the past operational performance of the dam, and engineering judgment.

c. Urgency. The recommendations and remedial measures outlined in 7.2 and 7.3 below should be implemented within 12 months after receipt of this report by the owner.

d. Need for Additional Investigation. Additional investigation is not considered necessary for the current assessment.

7.2 RECOMMENDATIONS

An engineering evaluation of the watershed hydrology and dam hydraulics should be undertaken to determine the need for

increased discharge capacity and need for increasing the height of the existing concrete dike walls to provide sufficient freeboard. The findings of that evaluation should be implemented as found necessary.

A qualified engineer should be engaged to develop provisions for curtailing leakage occurring through the east abutment and to make recommendations to eliminate or relocate the catwalks downstream of the dam.

The need and appropriate construction details for a facility to provide access to the gated outlet during high flow should be evaluated and developed by a qualified engineer and implemented as found necessary.

7.3 REMEDIAL MEASURES

a. Operating and Maintenance Procedures. A program of regular inspection and maintenance of the dam should be implemented and recorded. The following specific maintenance and operating procedures should be implemented:

(1) Repair the spalled and deteriorated concrete in the gated outlet and process water headworks.

(2) Remove trees in downstream channel.

(3) Repair or replace badly corroded gate stems.

(4) Provide around-the-clock surveillance during periods of anticipated high runoff.

(5) Develop a formal warning system and implement its use in the event of an emergency.

(6) Have inspections of the dam made by qualified engineers once every year.

7.4 ALTERNATIVES

None.

APPENDIX A

VISUAL INSPECTION CHECKLIST

AND

SUPPLEMENTARY INSPECTION NOTES

VISUAL INSPECTION CHECKLIST
PARTY ORGANIZATION

PROJECT Goodall-Sanford Dam DATE 12/5/78

TIME A.M.

WEATHER Partly cloudy, cool

W.S. ELEV. U.S. DN.S.

PARTY:

1. Stephen Cole
2. John Devine
3. Scott Decker
4. John Kimble
5. Charles Goodwin
6.
7.
8.
9.
10.

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.	Geotechnical	Cole	
2.	Structural	Cole, Devine, Decker	
3.	Hydraulics/Hydrology	Devine	
4.	Civil	Decker	
5.	Survey	Kimble, Goodwin	
6.	Photography	Decker, Devine	
7.			
	Review Inspection	S. Walker, C. Horstmann	
	12/5/78	No significant differences noted during inspection of 12/5/78.	

NOTE: See Supplementary Inspection Notes Following Checklist

INSPECTION CHECKLIST

PROJECT Goodall-Sanford Dam DATE 12/5/78

PROJECT FEATURE Embankment NAME Cole

DISCIPLINE Geotechnical NAME

AREA EVALUATED	CONDITIONS
DAM EMBANKMENT	
Crest Elevation	
Current Pool Elevation	
Maximum Impoundment to Date	
Surface Cracks	
Pavement Condition	NOT APPLICABLE No Embankment
Movement or Settlement of Crest	
Lateral Movement	
Vertical Alignment	
Horizontal Alignment	
Condition at Abutment and at Concrete Structures	
Indications of Movement of Structural Items on Slopes	
Trespassing on Slopes	
Sloughing or Erosion of Slopes or Abutments	
Vegetation	

AREA EVALUATED	CONDITIONS
DAM EMBANKMENT (cont.)	
Rock Slope Protection - Riprap Failures	
Unusual Embankment or Downstream Seepage	NOT APPLICABLE No Embankment
Piping or Boils	
Foundation Drainage Features	
Toe Drains	
Instrumentation System	

INSPECTION CHECKLIST

PROJECT Goodall-Sanford Dam DATE 12/5/78

PROJECT FEATURE Intake Channel/Structure NAME Cole, Devine

DISCIPLINE Structural, Geotechnical Hydraulics/Hydrology NAME Decker

AREA EVALUATED	CONDITION
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	
a. Approach Channel	
Slope Conditions	Concrete retaining walls
Bottom Conditions	Substantial silt, no debris
Rock Slides or Falls	None
Log Boom	None at major outlet, log above process water outlet structure
Debris	None
Condition of Concrete Lining	N/A
Drains or Weep Holes	N/A
b. Intake Structure	
Condition of Concrete	Spalled and cracked
Stop Logs and Slots	None
Debris Screen	None

INSPECTION CHECKLIST

PROJECT Goodall-Sanford Dam DATE 12/5/78

PROJECT FEATURE Control Tower NAME Cole, Devine

DISCIPLINE Structural/Geotechnical NAME Decker
Hydrology/Hydraulics

AREA EVALUATED	CONDITION	
OUTLET WORKS - CONTROL TOWER	Control Outlet	Process Water Headworks
a. Concrete and Structural		
General Condition	Spalled	Spalled
Condition of Joints	Fair	Fair
Spalling	Severe	Severe
Visible Reinforcing	None	Yes
Rusting or Staining of Concrete	Lime stain	Lime stain and rust
Any Seepage or Efflorescence	None	None
Joint Alignment	Okay	Okay
Unusual Seepage or Leaks in Gate Chamber	N/A	N/A
Cracks	Surficial	Surficial
Rusting or Corrosion of Steel	None	None
b. Mechanical and Electrical		
Air Vents	N/A	N/A
Float Wells	N/A	N/A
Gate Hoist	Gate works good	Hoist for inlet screens
Elevator	N/A	N/A

AREA EVALUATED		CONDITIONS
OUTLET WORKS - CONTROL TOWER (Cont.)	Control Outlet	Process Water Headworks
Hydraulic System	N/A	N/A
Service Gates Emergency Gates	Timber gate okay	3 valves, 36", 24", 30" good
Lightning Protection System	N/A	N/A
Emergency Power System	N/A	N/A
Wiring and Lighting System	N/A	N/A

INSPECTION CHECKLIST

PROJECT Goodall-Sanford Dam DATE 12/5/78

PROJECT FEATURE Conduit NAME Cole, Devine

DISCIPLINE Geotechnical, Structural Hydraulics/Hydrology NAME Decker

AREA EVALUATED	CONDITION
OUTLET WORKS - TRANSITION AND CONDUIT	Control Outlet
General Condition of Concrete	Spalled, cracked, open joints
Rust or Staining on Concrete	Lime stain, some rust
Spalling	Severe spalling
Erosion or Cavitation	Erosion of spalled area
Cracking	Along joints, sides of conduit
Alignment of Monoliths	Horizontal joints open 1" ±
Alignment of Joints	Okay
Numbering of Monoliths	N/A
	Heavy leakage into conduit through cracks and joints.
	Could not inspect conduit below process water headworks.

PERIODIC INSPECTION CHECKLIST

PROJECT Goodall-Sanford Dam DATE 12/5/78

PROJECT FEATURE Outlet Structure/Channel NAME Cole

DISCIPLINE Geotechnical, Structural Hydrology/Hydraulics NAME Devine, Decker

AREA EVALUATED	CONDITION
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	
General Condition of Concrete	Spalled, cracked, open joints
Rust or Staining	Some staining
Spalling	Severe
Erosion or Cavitation	Only of spalled areas
Visible Reinforcing	None
Any Seepage or Efflorescence	None
Condition at Joints	Poor, open somewhat
Drain holes	None
Channel	No scour
Loose Rock or Trees Overhanging Channel	None
Condition of Discharge Channel	Bridge restriction downstream

INSPECTION CHECKLIST

PROJECT Goodall-Sanford Dam DATE 12/5/78

PROJECT FEATURE Spillway NAME Cole

DISCIPLINE Geotechnical, Structural Hydrology/Hydraulics NAME Decker, Devine

AREA EVALUATED	CONDITION
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
a. Approach Channel	
General Condition	Good - Note: Bridge restriction upstream
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	None
Floor of Approach Channel	Some silt, no debris
b. Weir and Training Walls	
General Condition of Concrete	Fair to good
Rust or Staining	None observed
Spalling	Minor
Any Visible Reinforcing	None
Any Seepage or Efflorescence	None observed
Drain Holes	One 4" pipe near east end of spillway
c. Discharge Channel	
General Condition	Bedrock, island w/trees in channel
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	On island
Floor of Channel	Bedrock, no scour
Other Obstructions	Bridge downstream

SUPPLEMENTARY INSPECTION NOTES

GOODALL-SANFORD DAM
SANFORD, MAINE

APPENDIX A

1. CONCRETE STRUCTURES IN GENERAL

a. Concrete Surfaces. The concrete surfaces of the Goodall-Sanford Dam range from fair to very poor. Around the process water headworks and the gated outlet section of the dam, deep spalling has occurred (see photographs 1, 2, 4, and 5). At the process water headworks, the spalling has progressed to a point where reinforcing steel is exposed and the wingwalls of this section are considered to be in very poor condition. The surface of the spillway shows evidence of some erosion and minor spalling. In other areas of the dam, particularly the wingwalls, there is substantial cracking and substantial lime stain and some rust stain. The surficial cracking appears to be related to a lime silica reaction in the concrete.

b. Structural Cracking. There appear to be no major structural cracks in the dam structure. It is noted above that substantial surficial cracking has occurred in many areas.

c. Movement, Horizontal and Vertical Alignment. The entire dam structure, including the wingwalls, appear to be true to line and grade. No evidence of horizontal or vertical movement was noted.

d. Junctions. The junctions between the abutments and the wingwalls and the embankment behind the wingwalls were found to be in good condition with no evidence of settlement or seepage.

e. Drains. One 4-inch diameter drain was found at the toe of the spillway section on the easterly end of the dam near the process water headworks. It was found to be open and flowing about 100 gpm.

f. Water Passages. The surface of the spillway was found to be in generally good condition with some erosion and minor spalling of the concrete surface. The interior surface of the gated outlet conduit is in very poor condition. The concrete has a very soft texture and there are areas deeply spalled. Also, joints at each side of this conduit are open and leakage is occurring through the westerly side of the conduit.

g. Seepage or Leakage. No seepage or leakage was observed along the downstream face of the dam. Some leakage (about 20 gpm) was observed beneath the downstream wingwall at the east end of the dam. The source of this leakage could not be determined.

h. Monolith Joints & Construction Joints. The spillway section of the dam and the gated outlet section was apparently placed in at least four lifts. The horizontal joints were found to be open somewhat with erosion along the joints. The vertical joints in the spillway section of the dam were also in good condition with no signs of movement or leakage. Some erosion and wear has occurred along these joints.

i. Foundation. The dam appears to be founded entirely on bedrock. No undermining at the toe of the dam was evident and no foundation distress was evident.

j. Abutments. No evidence was found in the visual inspection to indicate instability or weathering of the abutments. The abutments appear to be founded directly on bedrock and no movement or evidence of substantial seepage or leakage was evident.

2. EMBANKMENT STRUCTURES

The only embankment at the Goodall-Sanford Dam is behind the concrete wingwalls which run upstream from the abutments of the dam. The embankment behind both wingwalls was found to be in good condition with no evidence of settlement or instability.

3. SPILLWAY STRUCTURES

The spillway at the Goodall Dam is a concrete weir which extends from the process water headworks to the west abutment, being interrupted only by the gated outlet structure.

a. Control Gates and Operating Machinery. The spillway at the Goodall-Sanford Dam is uncontrolled.

b. Unlined Saddle Spillways. None.

c. Approach and Outlet Channels. The approach channel to the spillway is clear and unobstructed. A highway bridge, located about 800 feet upstream of the dam, restricts the channel. There is some evidence of minor silting upstream of the spillway, however, no debris was apparent (see photograph 5). The outlet channel from the spillway is the bedrock channel downstream of the dam. The bedrock is high near the midpoint of the spillway and in this area there are many trees and brush (see photograph 7). The wingwalls downstream of the dam constrict the channel substantially to the two bridges located approximately 150 feet downstream from the spillway.

4. GATED OUTLET WORKS

The gated outlet works consist of a 7-foot diameter conduit which is gated by a vertical lift timber gate.

a. Intake Structure. The concrete around the inlet structure appears to have spalled and is somewhat deteriorated. The inlet appears to be clear and unobstructed.

b. Operating and Emergency Control Gates. The hoisting equipment for the gated outlet appears to be in good condition except the gate stems, which show a substantial amount of corrosion at the water line. It was reported by the dam operator that the gate has been frequently operated in the past, however, the gate was not operated during inspection. The downstream face of the gate was inspected and was found to have some surficial deterioration. Little or no leakage was occurring.

c. Conduits, Sluices and Passageways. The interior surface of the outlet conduit consists of a steel pipe extending approximately four feet from the gate face and a concrete conduit beyond that. The interior surface of this conduit is severely spalled and has two open joints, one of which is leaking at approximately 50 gpm. Some erosion of the concrete has occurred, particularly in areas where spalling has started.

d. Stilling Basin. The stilling basin downstream of the

outlet sluiceway consists of the bedrock channel. No serious erosion or scour could be seen.

e. Approach and Outlet Channels. The approach channel to the gated outlet appears to be clear and unobstructed. The outlet channel also appears to be clear and unobstructed, except for the bridges downstream.

f. Drawdown Facilities. The gated outlet appears to be capable of providing complete drainage of the pond during low to average flows.

5. RESERVOIR

a. Shoreline. The potential for slope failure or earth slides appeared minimal. The reservoir shoreline is primarily urbanized with the exception of the headwaters area which is wooded. U.S. Route 202 crosses the reservoir approximately 600 feet above the dam. The bridge causes a constriction of the reservoir.

b. Sedimentation. The extent of sedimentation in the reservoir could not be observed during the field inspection. However, sediment accumulation does not appear to impede flow to the spillway.

c. Potential Upstream Hazard. A house located near the dam in the west bank would be flooded to a depth of about 5 feet during the test flood. The basement of the house is above the spillway crest.

d. Watershed Runoff Potential. No significant changes in watershed runoff potential are expected to occur in the near future.

6. DOWNSTREAM CHANNEL

The channel of the Mousam River just below the dam is steep and rocky. About 50 feet below the dam, a road bridge constricts the channel to a width of 46 feet. Below the bridge, the river flows between two mills which form the river banks for a distance of about 300 feet. Several catwalks, connecting the two mills, cross the river in this reach (see photograph 3). Below the mills, the bed material consists of sand, gravel and cobble. The overbanks are flat to moderately sloping with a moderate growth of brush and small trees.

7. OPERATING AND MAINTENANCE FEATURES

a. Reservoir Regulation Plan. No formal plan was disclosed.

b. Maintenance. It appears that maintenance is done to the dam on an as-needed basis. The operating equipment for the outlet gate appears to be in generally good condition, except the gate stem which has a substantial amount of corrosion at the normal water line. Little or no maintenance has been done to the concrete surfaces of the structure. These areas of the dam are presently in need of maintenance.

APPENDIX B

ENGINEERING DATA

This appendix lists the engineering data collected either from project records or other sources of data developed as a result of the visual inspection. The contents of this appendix are listed below.

Appendix	Description
B1	General Project Data

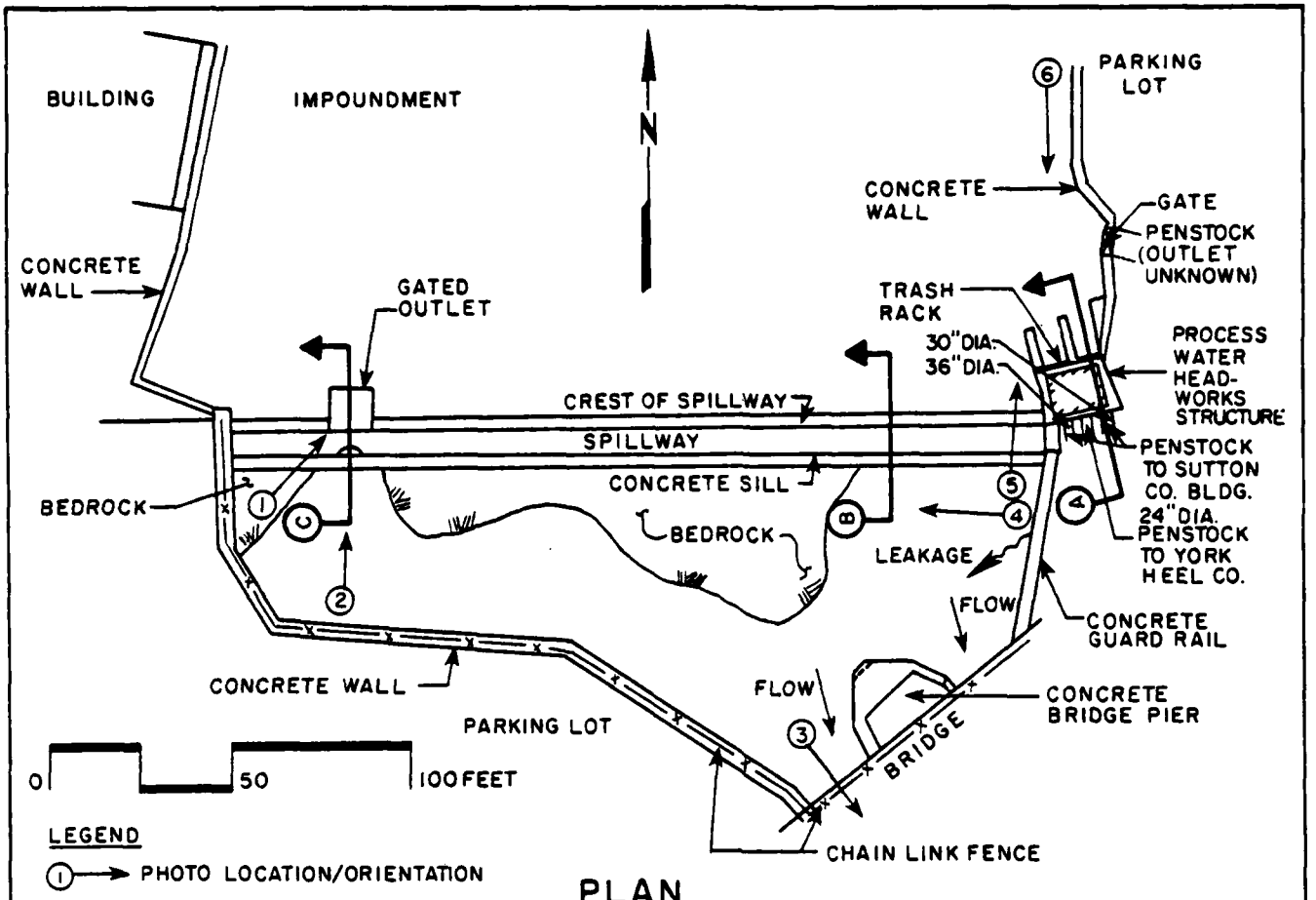
APPENDIX B-1

GENERAL PROJECT DATA

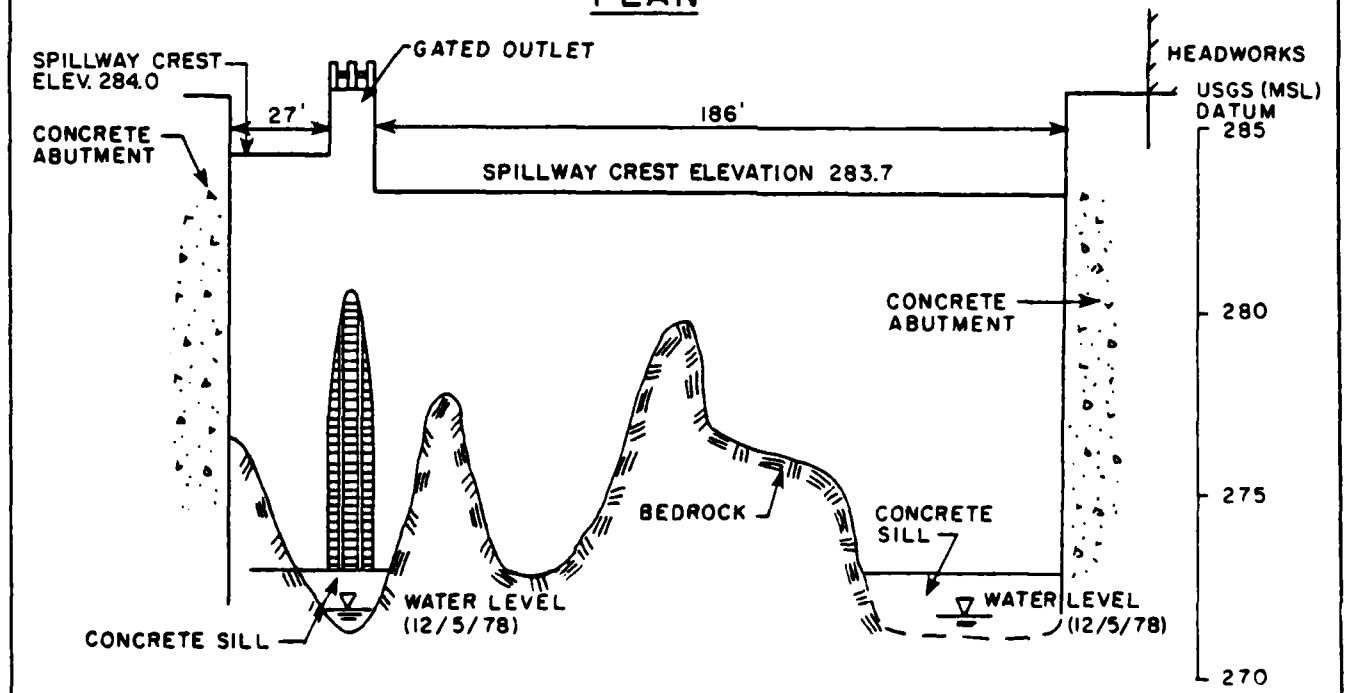
The following material is available at the office of the U.S. Army Corps of Engineers, 424 Trapelo Road, Waltham, Massachusetts.

A. Copy of the Corps of Engineers "National Dam Inspection Program, Phase I Inspection Reports," for Emery Mills Dam, October, 1978, and River Street Dam, 1978.

The following plan, profile and cross-sections of the dam were developed from a limited stadia survey performed during visual inspection, field notes taken by inspection team members, and photographs taken during the visual inspection. Approximate U.S.G.S. elevations based on mean sea level were calculated by noting the dam's location on a U.S.G.S. topographic map.



PLAN



DOWNSTREAM PROFILE

EDWARD C. JORDAN CO., INC. PORTLAND, MAINE	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

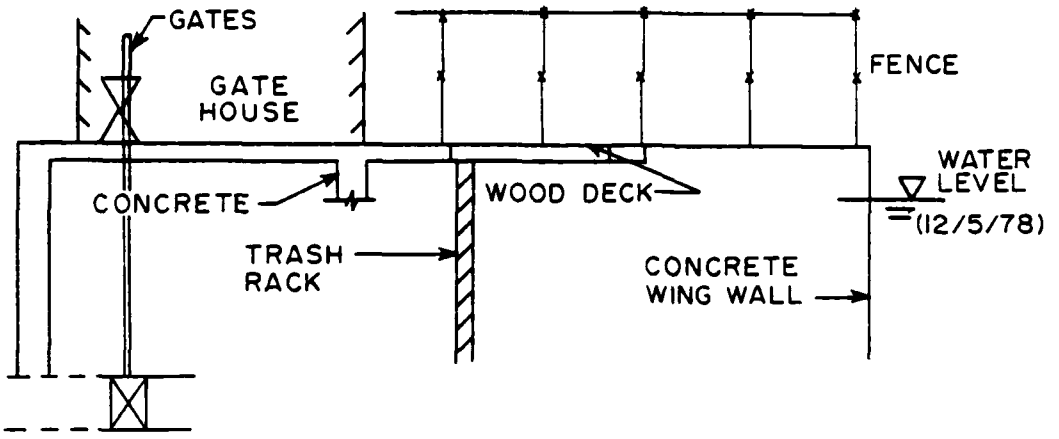
NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

GOODALL DAM
PLAN & PROFILE

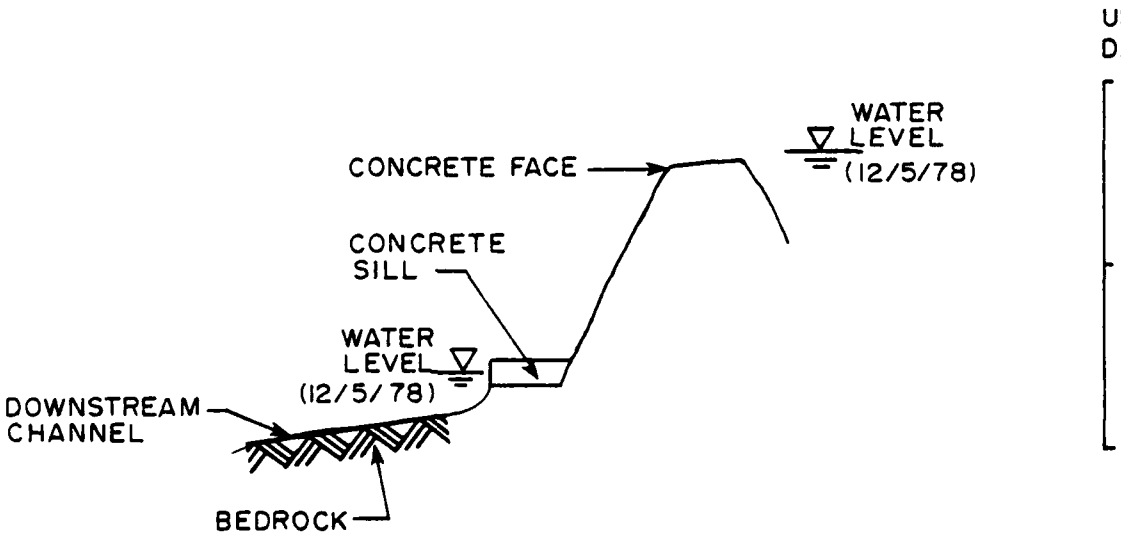
MOUSAM RIVER ME.

SCALE AS SHOWN
DATE APRIL 1979

20799-19



SECTION A



SECTION B

EDWARD C. JORDAN CO., INC. PORTLAND, MAINE	U.S. ARMY ENGINEER DIV., NEW ENGLAND CORPS OF ENGINEERS 424 TRAPELO ROAD WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

GOODALL DAM

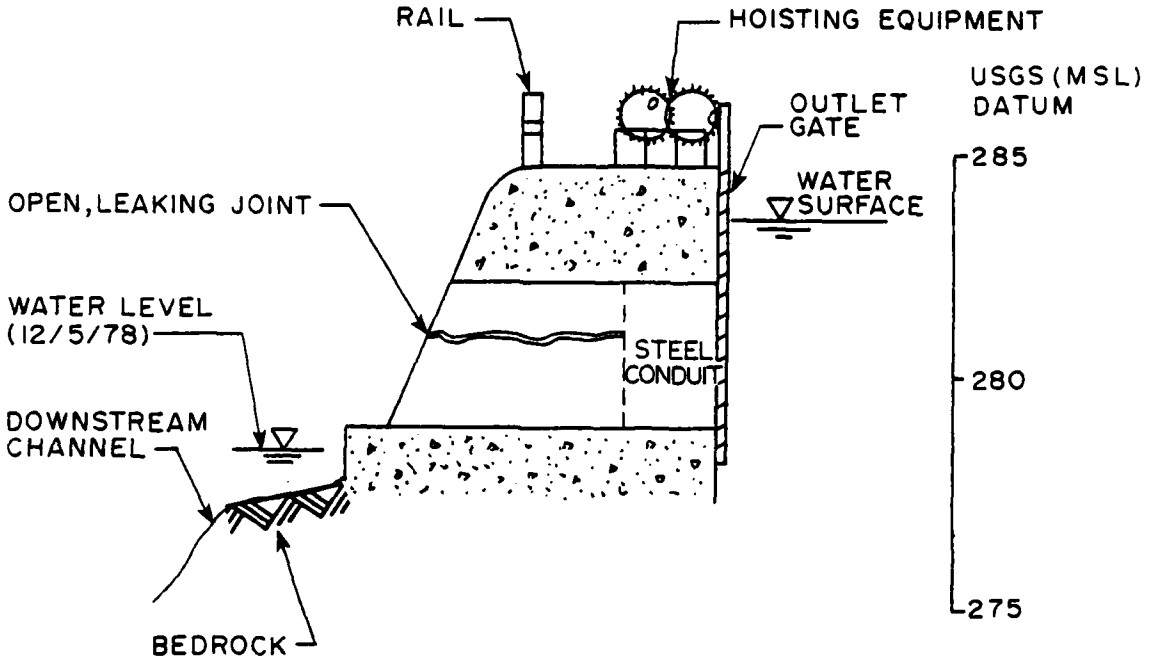
X-SECTIONS

MOUSAM RIVER MAINE

SCALE AS SHOWN

DATE APRIL 1979

20799-19



SECTION C

EDWARD C. JORDAN CO., INC.
PORTLAND, MAINE

U.S. ARMY ENGINEER DIV. NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

GOODALL DAM
X - SECTION

MOUSAM RIVER MAINE

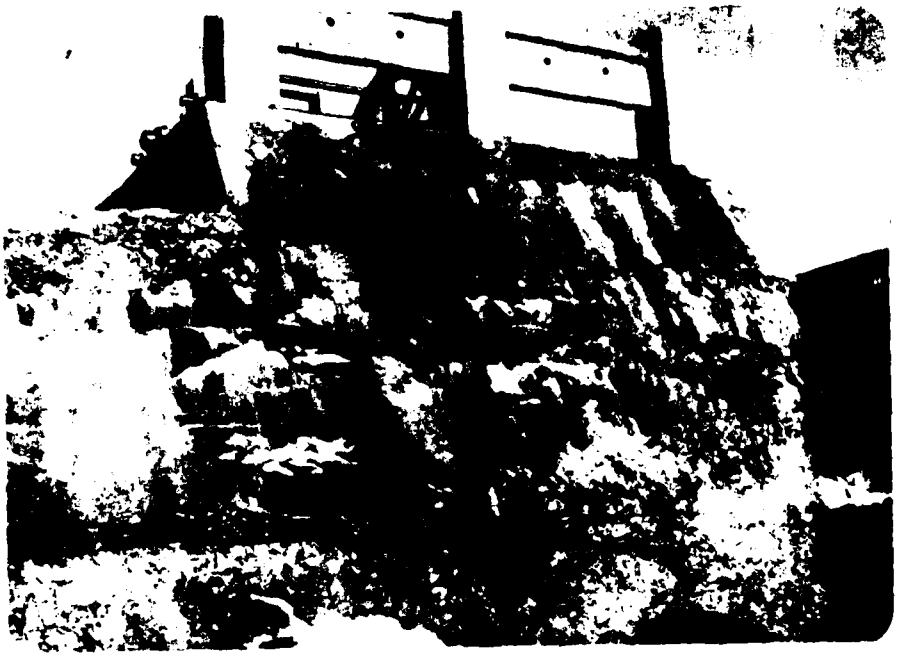
SCALE AS SHOWN
DATE APRIL 1979

20799-19

APPENDIX C

PHOTOGRAPHS

The following are photographs referenced in this report. See Sheet B-1 for photograph locations and orientations.

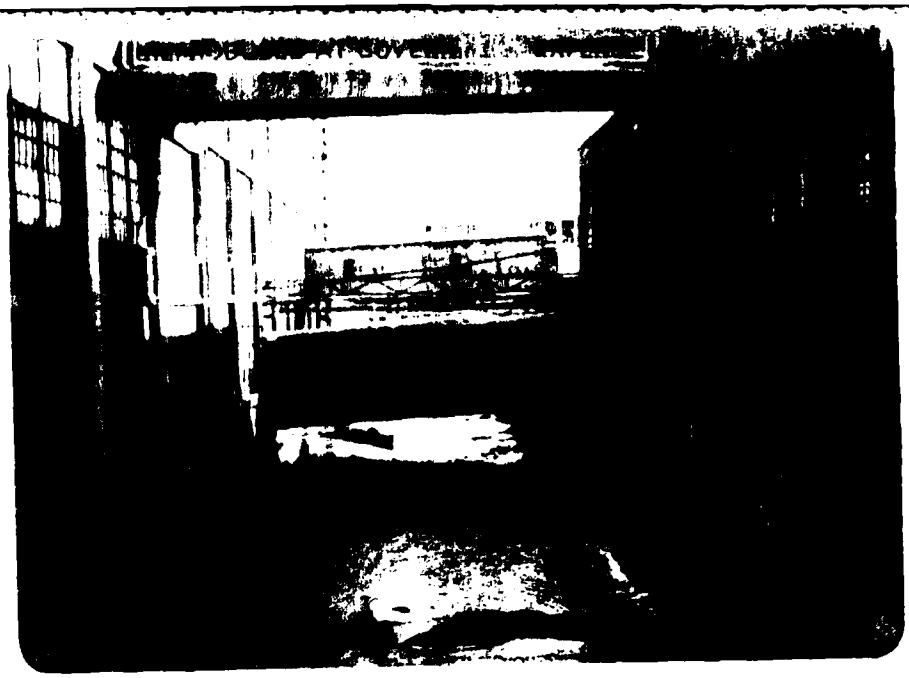


1

OUTLET GATEWORKS

2

OUTLET GATE



3

DOWNSTREAM CHANNEL RESTRICTION

4

DOWNSTREAM FACE

5

UPSTREAM VIEW

6

GATED HEADWORKS

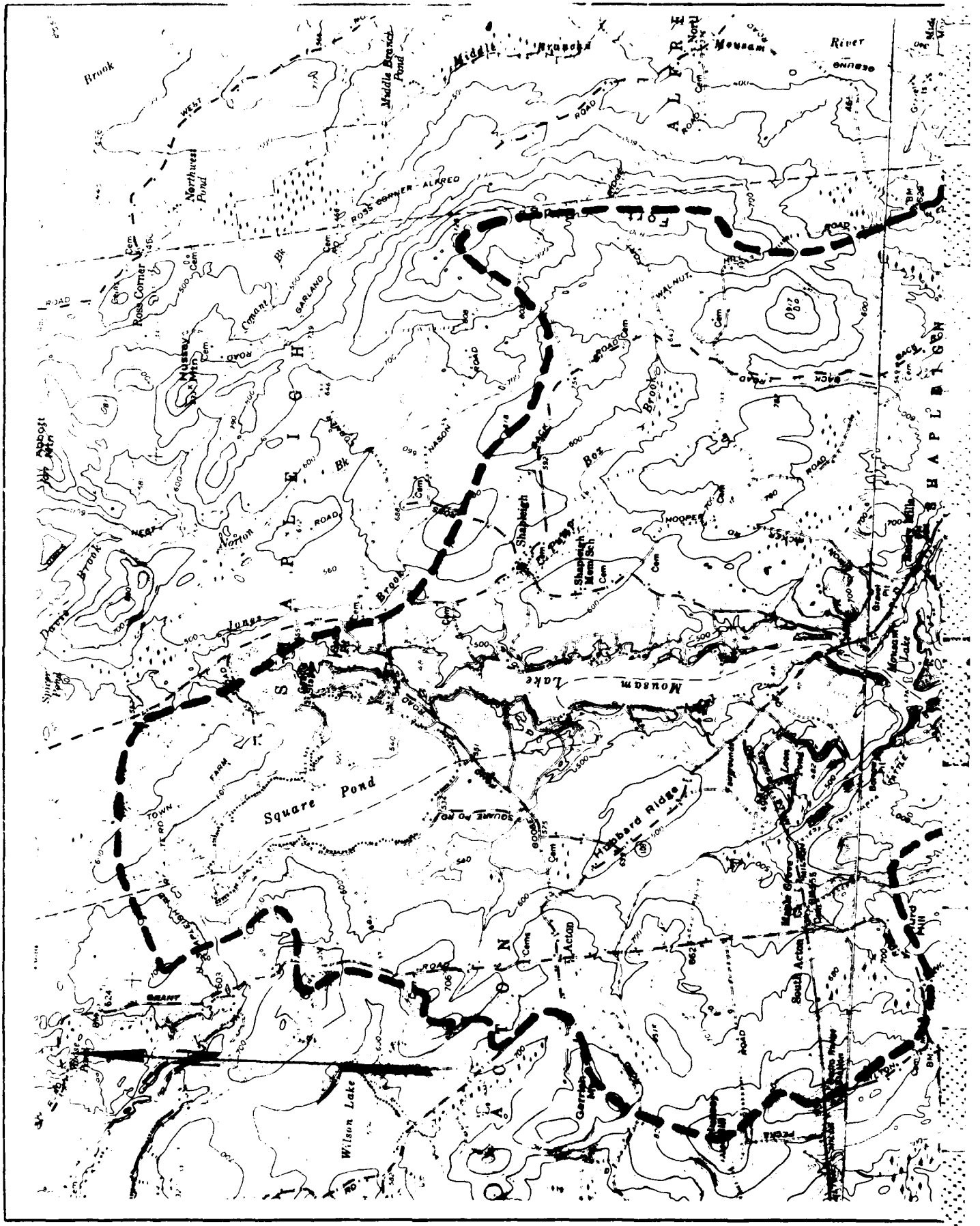
7

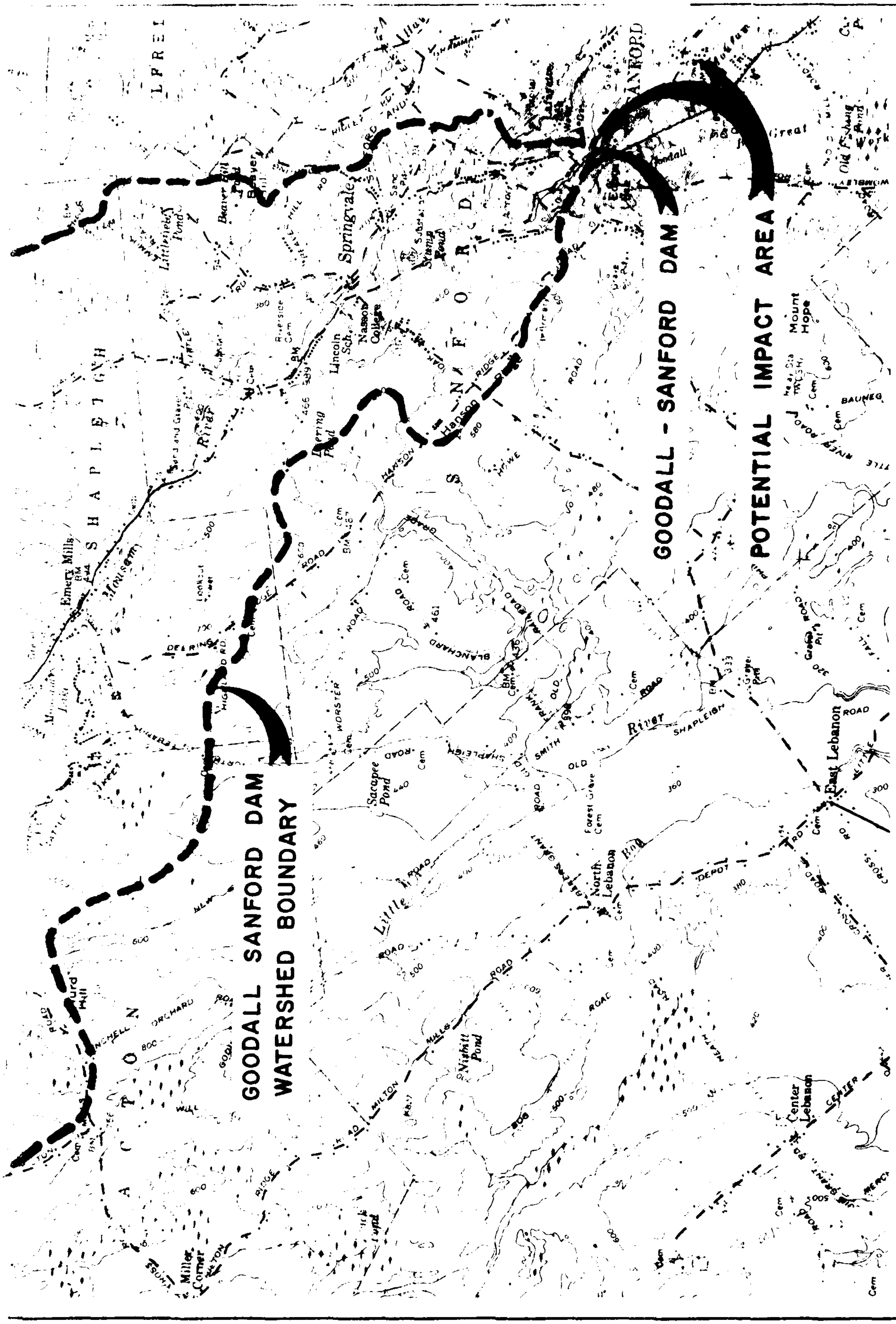
VIEW OF DOWNSTREAM CHANNEL

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

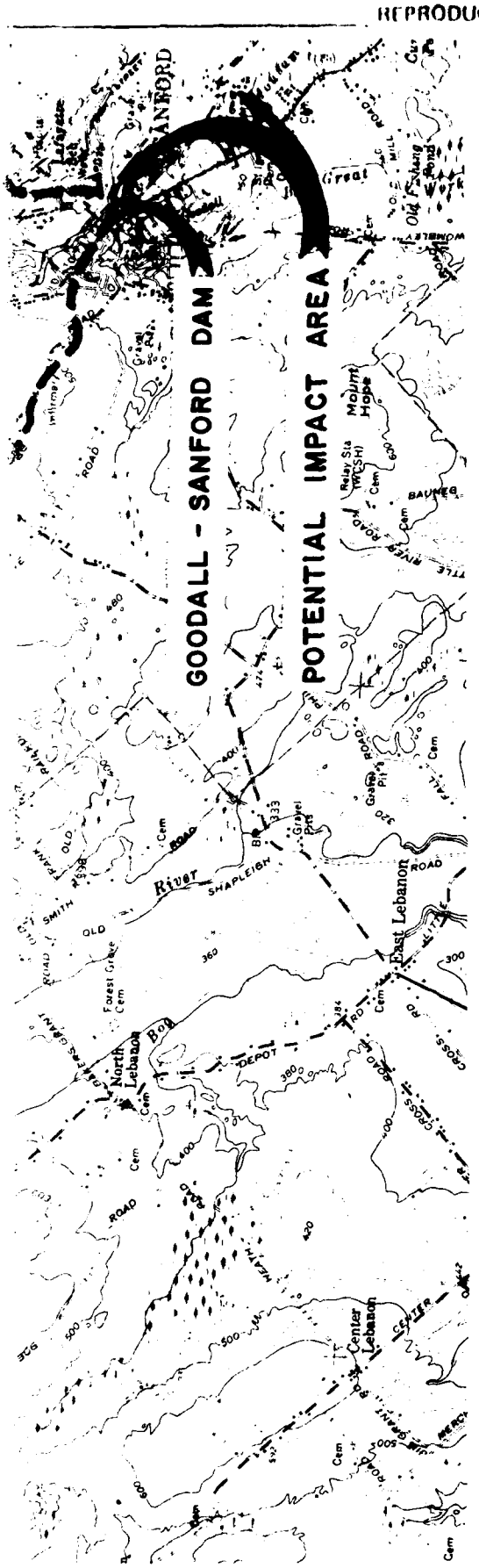
Hydrologic computations pertinent to this investigation are attached. The following figure shows the Mousam River watershed at the Goodall-Sanford Dam.





U.S. GEOLOGICAL
BERWICK , ME.
NEWFIELD , ME.

NATIONAL PROGRAM OF
GOODALL -
DRAINAGE
MOUSAM RIVER



U.S. GEOLOGICAL SURVEY MAP

BERWICK, ME. QUADRANGLE
NEWFIELD, ME. QUADRANGLE

EDWARD S. JORDAN CO., INC. PORTLAND, MAINE	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

GOODALL - SANFORD DAM
DRAINAGE AREA MAP

MOUSAM RIVER ME.

SCALE AS SHOWN
DATE APRIL 1978

PROJECT	COMP BY	JOB NO.
GOODALL - SANFORD DAM HYDRAULICS	JHF & JJD	20799-19
	CHK BY BTB	DATE 2-13-79

DISCHARGE CAPACITY AT DAM :

TIE TO MEAN SEA LEVEL DATUM - MAIN SPILLWAY CREST AT SURVEY DATUM = 100.0 FT = 283.2 FT MSL (OBTAINED FROM USGS WATER SUPPLY PAPER No. 1671).

A. MAIN SPILLWAY (EAST SPILLWAY SECTION) - NON-GATED FREE OVERFALL SPILLWAY WITH BREADTH ≅ 3.0 FT., ASSUME SPILLWAY IS A BROAD-CRESTED WEIR. "C" VALUES FROM KING & BRATER "HANDBOOK OF HYDRAULICS", TABLE 5-3, SIXTH EDITION

	MEAN SEA LEVEL ELEV.	SURVEY DATUM ELEV	H	C	L	Q
CREST	283.2	100.0	0		186	0
	284.0	100.8	0.8	2.67	"	355
	285.0	101.8	1.8	2.68	"	1,204
	286.0	102.8	2.8	2.87	"	2,501
			3.8	3.03	"	4,175
	288.0	104.8	4.8	3.32	"	6,494
			5.8	3.32	"	8,626
	290.0	106.8	6.8	3.32	"	10,950
	291.0	107.8	7.8	3.32	"	13,452

B. SPILLWAY SECTION AT WEST END OF DAM - SAME AS ABOVE ✕ WITH BREADTH ≅ 3.0 FEET

	MEAN SEA LEVEL ELEV	SURVEY DATUM ELEV	H	C	L	Q
CREST	284.0	100.8	0		27	0
	285.0	101.8	1.0	2.65	"	72
	286.0	102.8	2.0	2.72	"	208
				2.92	"	410
	288.0	104.8	4.0	3.07	"	663
				3.32	"	1,002
	290.0	106.8	6.0	"	"	1,317
	291.0	107.8	7.0	"	"	1,660

PROJECT	COMP BY	JOB NO.
GOODALL- SANFORD DAM HYDRAULICS	JHF & JJD	20799 - 19
	CHK BY BTB	DATE 2-13-79

C. EAST WINGWALL SECTION WITH CREST AT ELEV 285.1 FT MSL (SURVEY DATUM = 101.9 FT) - BROAD CRESTED WEIR WITH BREADTH = 1.5 FT

	MSL ELEV	SURVEY ELEV	H	C	L	Q
CREST	285.1	101.9	0		20	0
	286.0	102.8	0.9	2.71	"	46
			1.9	3.05	"	160
	288.0	104.8	2.9	3.32	"	328
		105.8	3.9	"	"	511
	290.0		4.9	"	"	720
	291.0	107.8	5.9	"	"	952

D. EAST WINGWALL SECTION WITH CREST AT ELEV 285.3 FT MSL - BROAD CRESTED WEIR WITH BREADTH = 1.5 FT

	MSL ELEV	SURVEY ELEV	H	C	L	Q
CREST	285.3	102.1	0		217	0
	286.0	102.8	0.7	2.66	"	338
		103.8	1.7	3.07	"	1,477
	288.0		2.7	3.30	"	3,177
		105.8	3.7	3.32	"	5,127
	290.0		4.7	"	"	7,340
	291.0	107.8	5.7	"	"	9,804

E. EAST WINGWALL SECTION AT 286.3 FT

MSL ELEV	SURVEY ELEV	H	C	L	Q
286.3	103.1	0		15	0
287.0	103.8	0.7	2.66	"	23
288.0		1.7	3.07	"	102
	105.8	2.7	3.30	"	220
290.0		3.7	3.32	"	354
291.0	107.8	4.7	3.32	"	507

PROJECT	COMP BY	JOB NO.
GOODALL - SANFORD DAM HYDRAULICS	SSD & JHF	20799-19
	CHK BY BTB	DATE 2-15-79

F. EAST WINGWALL SECTION WITH CREST ELEV AT 286.7 FT (BREADTH=1.5)

MSL ELEV	SURVEY ELEV	H	C	L	Q
286.7	103.5	0		50	0
287.0	103.8	0.3	2.63	"	22
288.0		1.3	2.89	"	214
	105.8	2.3	3.12	"	544
290.0		3.3	3.32	"	995
291.0	107.8	4.3	3.32	"	1,480

G. WEST WINGWALL SECTION WITH CREST ELEV AT 284.4 FT (BREADTH= 1.5 FT)

MSL ELEV	SURVEY ELEV	H	C	L	Q
284.4	101.2	0		20	0
285.0	101.8	0.6	2.64	"	25
286.0		1.6	3.07	"	124
	103.8	2.6	3.28	"	275
288.0		3.6	3.32	"	453
	105.8	4.6	"	"	655
290.0		5.6	"	"	880
291.0	107.8	6.6	"	"	1,126

H. WEST WINGWALL SECTION WITH CREST ELEV AT 285.7 FT (BREADTH = 1.5 FT)

MSL ELEV	SURVEY ELEV	H	C	L	Q
285.7	102.5				0
286.0	102.8	0.3	2.63	65	29
	103.8	1.3	2.89	"	278
288.0		2.3	3.12	"	707
	105.8	3.3	3.32	"	1,294
290.0		4.3	"	"	1,924
291.0	107.8	5.3	"	"	2,633

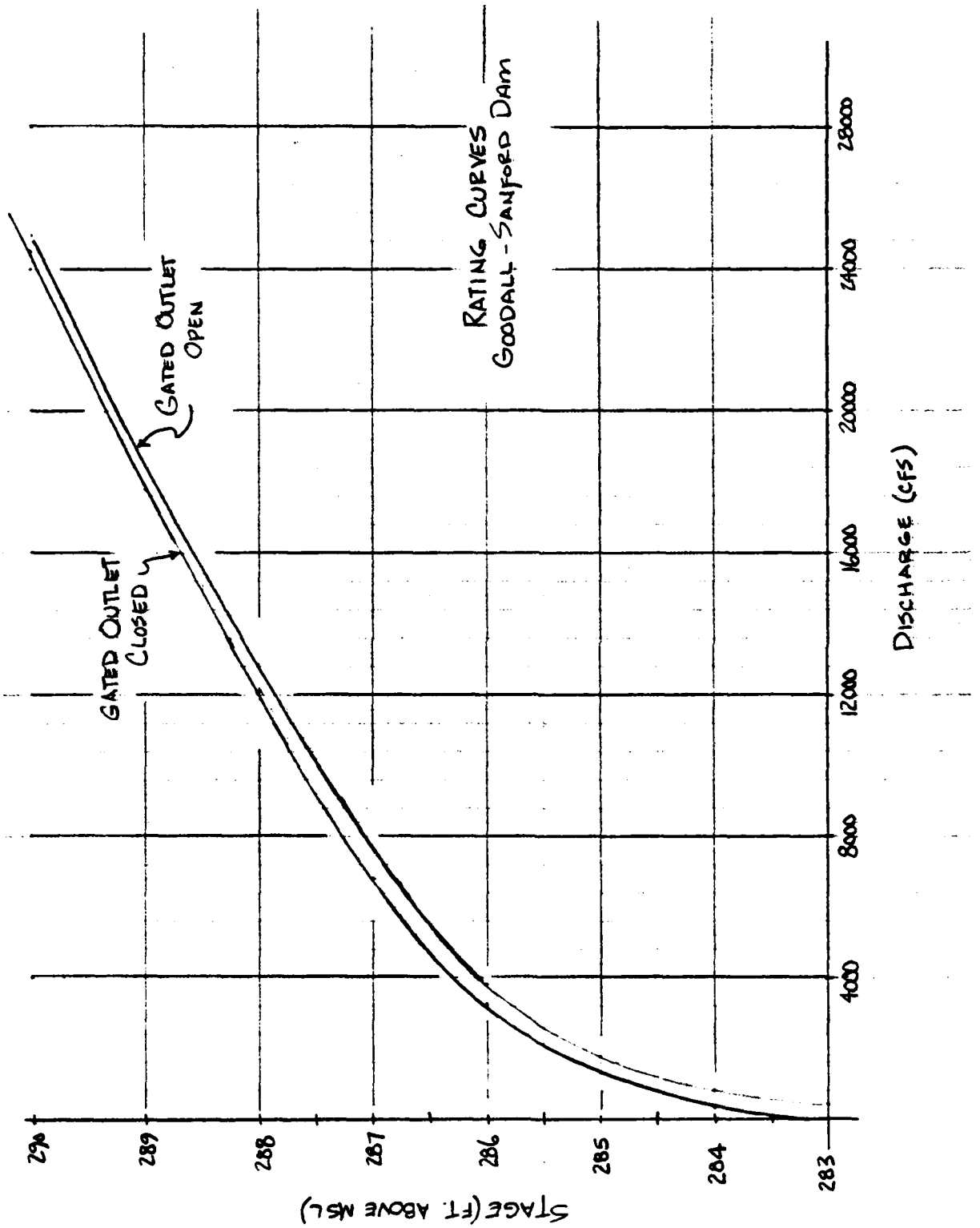
PROJECT	COMP BY	JOB NO.
GOODALL - SANFORD DAM HYDRAULICS	JJD/JHF	20799-19
	CHK BY BTB	DATE 2-16-79

I. GATED OUTLET WORKS (NEAR WEST END OF DAM) - 7 FT DIAMETER AT UPSTREAM FACE, INVERT AT ELEV ~272.9 FT, ASSUME OUTLET DISCHARGES AS A SUBMERGED ORIFICE

	MSL ELEV	SURVEY ELEV	C	A	H	Q
	280.9	97.7	0.7	38.5	1	216
	281.0	97.8	"	"	1.1	227
	282.0	98.8	"	"	2.1	313
	283.0		"	"	3.1	381
	284.0	100.8	"	"	4.1	438
	285.0		"	"	5.1	488
	286.0	102.8	"	"	6.1	534
TOP OF GATE STRUCT.	286.3	103.8	"	"	6.4	547

DISCHARGES GIVEN ABOVE ASSUME OUTLET 1 IS FULLY OPENNED. THE GATE WORKS ARE OPERABLE BUT NOT USED TO PASS FLOOD FLOWS. THERE ARE THREE SMALL DIAMETER (4" AND 6") PIPES AT THE GATE HOUSE ON THE EAST ABUTMENT. THESE PIPES DELIVER PROCESS, WATER TO NEARBY FACTORIES AND ARE NOT CONSIDERED AND COOLING USABLE FOR FLOOD CONTROL.

PROJECT	COMP. BY	JOB NO.
GOODALL - SANFORD DAM HYDRAULICS	JJD	20799-19
	CHK. BY BTB	DATE 4-10-79



D-5 Goodall-Sanford Dam

PROJECT	COMP BY	JOB NO.
GOODALL - SANFORD DAM AREA - CAPACITY DATA	JD & JHF	20799-19
	CHK BY BTB	DATE 2-16-79

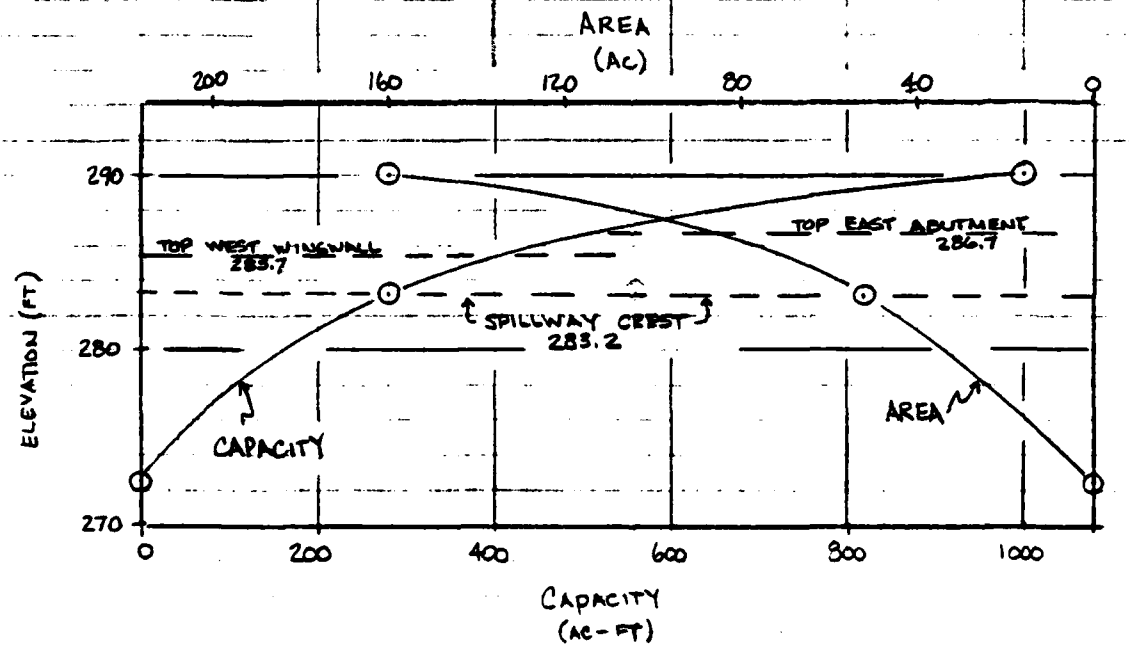
THE STORAGE OF GOODALL - SANFORD DAM CONSISTS ENTIRELY OF IMPOUNDED WATER.

AREA - CAPACITY DATA :

TIE TO MEAN SEA LEVEL DATUM - FROM ELEVATION DATA GIVEN IN USGS WATER SUPPLY PAPER NO. 1671, THE ELEV OF THE CREST OF THE MAIN SPILLWAY IS 283.2 FT MSL (100.0 FT ON SURVEY DATUM)

HEIGHT OF DAM FROM SPILLWAY CREST (ELEV 283.2 FT) TO DOWNSTREAM STREAMBED = 10.7 FT

MSL ELEV	AREA (AC.)	AVG. AREA (AC.)	ELEV. INTERVAL (FT)	ΔVOL (AC-FT)	VOL (AC-FT)
272.5	0				0
		26	10.7	278	
283.2	52				278
		106	6.8	721	
290.0	159				999



PROJECT	COMP BY	JOB NO.
GOODALL - SANFORD DAM TEST FLOOD ANALYSIS	JHF & JJD	20799-19
	CHK BY BTB	DATE 2-16-79

TEST FLOOD ANALYSIS

DRAINAGE AREA - 40.6 SQUARE MILES

HAZARD CLASSIFICATION - HIGH HAZARD
SIZE CLASSIFICATION - SMALL
TEST FLOOD - PMF
DESCRIPTION - FLAT

THE FOLLOWING "PHASE I DAM SAFETY INSPECTION REPORTS" HAVE BEEN COMPLETED FOR DAMS ON THE MOUSAM RIVER UPSTREAM OF THE GOODALL - SANFORD DAM:

DAM	DRAINAGE AREA (MI^2)
EMERY MILLS DAM	29.3
MILL STREET DAM	37.8
RIVER STREET DAM	39.3

THE ROUTED 1/2 PMF AT THE OUTLET OF THE RIVER STREET DAM = 7,930 CFS
CONTRIBUTION TO 1/2 PMF FROM ADDITIONAL DRAINAGE AREA ≅ 600 CFS
TOTAL 1/2 PMF = 8,530 CFS

THE ROUTED PMF AT THE OUTLET OF THE MILL STREET DAM = 14,540 CFS
CONTRIBUTION TO PMF FROM ADDITIONAL DRAINAGE AREA = 2,520 CFS
(RIVER ST. DAM DOES NOT REDUCE PMF DUE TO SURCHARGE STORAGE)

TOTAL PMF = 17,060 CFS

PROJECT	COMP BY	JOB NO.
GOODALL - SANFORD DAM TEST FLOOD ANALYSIS	JJD	20799-19
	CHK BY BTB	DATE 2-16-79

ELEVATION - DISCHARGE - STORAGE TABLE

MSL ELEV. (FT)	SURCHARGE STORAGE (A-F)	DISCHARGE AT DAM (CFS) [1]
283.2	0 [2]	0
284.0	40	355
285.0	100	1,300
286.0	160	3,246
287.0	260	6,820
288.0	370	12,138
289.0	500	17,861
290.0	720	24,480

AT ELEV 285.7 FT ; DAM DISCHARGE = 2,660 CFS , SURCHARGE STOR. = 135 A-F

AT ELEV 286.7 FT : DAM DISCHARGE = 5,750 CFS , SURCHARGE STOR. = 230 A-F

PMF INFLOW = 17,060 CFS

SURCHARGE HEIGHT TO PASS PMF = 5.66 FT (EL 288.9)

VOLUME OF SURCHARGE :

$$STOR_1 = 487 \text{ AC-FT} \times \frac{1}{40.6} \times \frac{1}{640} \times 12 = .22 \text{ INCHES}$$

$$Q_{p2} = 17{,}060\left(1 - \frac{.22}{19}\right) = 16{,}860$$

∴ EFFECT OF SURCHARGE STORAGE IS INSIGNIFICANT

1/2 PMF INFLOW = 8,530 CFS

HEIGHT TO PASS = 287.3 FT (4.1 FT)

$$STOR_1 = \frac{293}{40.6} \times \frac{12}{640} = .14 \text{ IN.} \longrightarrow \frac{.14}{9.5} = .0147$$

∴ EFFECT OF SURCHARGE STORAGE IS INSIGNIFICANT

---

[1] ASSUME GATED OUTLET WORKS CLOSED.

[2] STORAGE AT SPILLWAY CREST = 278 AC-FT

PROJECT	COMP BY	JOB NO.
GOODALL - SANFORD DAM TEST FLOOD ANALYSIS	JJD	20799-19
	CHK BY BTB	DATE 2-16-79

PMF DATA

(1) PMF OUTFLOW AT DAM ≅ 17,000 CFS
(2) PMF ELEV AT DAM = 288.9 FT
(3) OVERTOPPING DATA :
  A) WEST ABUTMENT OVERTOPPED BY 3.2 FT.
  B) EAST ABUTMENT OVERTOPPED BY 2.2 FT.
  C) LOW POINT OF WEST WINGWALL - 4.5 FT
  D) " " " EAST " - 3.8 FT
(4) SPILLWAY CAPACITY AT TOP OF DAM (EL 285.7) = 2,230 CFS (~13 % PMF)

½ PMF DATA

(1) ½ PMF OUTFLOW AT DAM = 8,530 CFS
(2) ½ PMF ELEV AT DAM = 287.3 FT
(3) OVERTOPPING DATA
  A. WEST ABUTMENT — 1.6 FT
  B. EAST ABUTMENT — 0.6 FT
  C. LOW POINT OF WEST WINGWALL — 2.9 FT
  D. " " " EAST " — 2.2 FT
(4) SPILLWAY CAPACITY AT TOP OF DAM (EL 285.7) = 26% OF ½ PMF

PROJECT	COMP BY	JOB NO.
GOODALL - SANFORD DAM DAM FAILURE ANALYSIS	JJD	20799-19
	CHK BY BTB	DATE 2-16-79

DAM FAILURE ANALYSIS

ASSUME WATER SURFACE ELEVATION AT THE TOP OF THE WEST WINGWALL (EL. 285.7 FT.)

ASSUME FAILURE OF THE DAM AT THE MAIN SPILLWAY SECTION. BASED ON CONVERSATIONS AMONG ENGINEERS INVOLVED IN THE INSPECTION, FAILURE WIDTH WOULD PROBABLY NOT EXCEED 60 FT. IN ADDITION, THE BRIDGE LOCATED ~ 500' UPSTREAM OF THE DAM IS 64 FT. LONG AND THIS WOULD LIMIT FLOW TO THE DAM AT FAILURE WIDTHS GREATER THAN 64 FT.

(1) STORAGE AT TIME OF FAILURE = 413 AC.-FT

(2) FAILURE OUTFLOW, Q

$$Q = \frac{8}{27} W_b \sqrt{G}\, Y_o^{3/2} = \quad W_b = 60 \text{ FT}, \quad Y_o = 13.2 \text{ FT}$$

$$= 4{,}838 \text{ CFS}$$

(3) FLOW FROM REMAINDER OF SPILLWAY (ONLY INCLUDES DISCHARGE THROUGH SPILLWAY SECTIONS AND NOT OVER WINGWALLS BECAUSE FLOW OVER WINGWALLS MAY NOT REENTER DOWNSTREAM CHANNEL)

$$Q = \frac{(213-60)(2280)}{213} \cong 1{,}638 \text{ CFS}$$

(4) PEAK FAILURE OUTFLOW, Q_{pl}

$$Q_{pl} = 4{,}838 + 1{,}638 = 6{,}476 \text{ CFS}$$

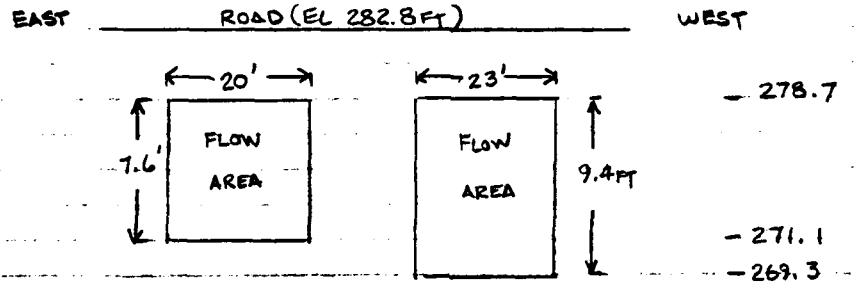
(5) TIME FOR RESERVOIR TO EMPTY, T

$$T = \frac{12.1\, S}{1/2\, Q_{pl}} = \frac{12.1(413)}{1/2(6476)} = 1.5 \text{ HOURS}$$

FLOW OVER THE CONCRETE DIKE WALLS WILL FLOOD LOW AREAS IN VICINITY OF DAM, AND PROBABLY NOT REENTER THE MOUSAM RIVER CHANNEL AS A CONTINUOUS FLOW.

PROJECT	COMP BY	JOB NO.
GOODALL-SANFORD DAM DAM FAILURE ANALYSIS	JJD	20799-19
	CHK BY BTB	DATE 2-16-79

CROSS-SECTION #1
(LOCATED AT BRIDGE ABOUT 50 FT BELOW DAM)
NOT TO SCALE



(1) BY MANNINGS EQUATION : ($\eta = .025$, $S = .015$)

A) AT ELEV 278.0 FT, $A = 333$, $P = 74$, $R = 4.5$, $\therefore Q = 6,540$ CFS

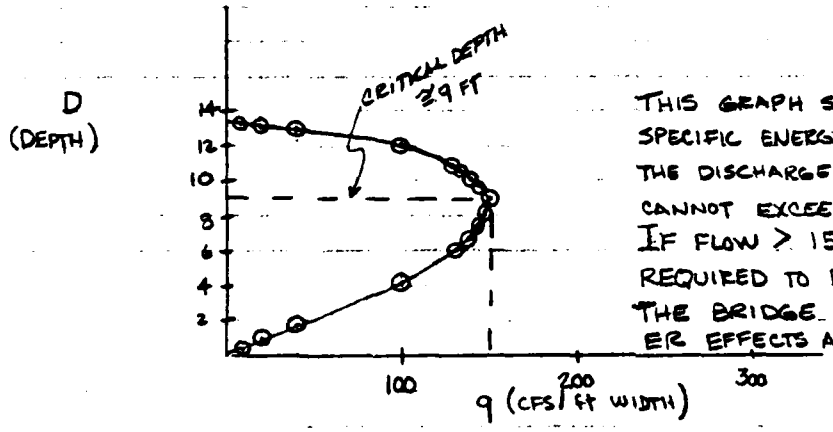
IF $Q = 6,540$ CFS, $V = 19.6$ FPS (LOOKS EXTREMELY HIGH, MANNINGS PROBABLY DOES NOT APPLY)

(2) TRY SPECIFIC ENERGY APPROACH OF RAPIDLY VARIED FLOW :

A) ASSUME H_E (SPECIFIC ENERGY) = 13.2 FT-LBS/LB OBTAINED FROM (285.7 − 272.5) = 13.2 FT

USING CONSTANT-ENERGY RELATION AND $H_E = D + \frac{q^2}{2g D^2}$

WITH D = DEPTH, q = CFS/FT WIDTH, g = ACC. OF GRAV :



THIS GRAPH SHOWS THAT FOR A SPECIFIC ENERGY OF 13.2 FT-LBS/LB THE DISCHARGE PER FOOT OF WIDTH CANNOT EXCEED 150 CFS/FT WIDTH. IF FLOW > 150 CFS/FT WIDTH ARE REQUIRED TO PASS FLOW FROM FAILURE, THE BRIDGE WILL PRODUCE BACKWATER EFFECTS AND CAUSE ORIFICE FLOW AT THE CULVERTS

PROJECT	COMP BY	JOB NO.
GOODALL - SANFORD DAM DAM FAILURE ANALYSIS	JJD	20799-19
	CHK BY BTB	DATE 2-16-79

TOTAL WIDTH OF CULVERTS = 43 FT

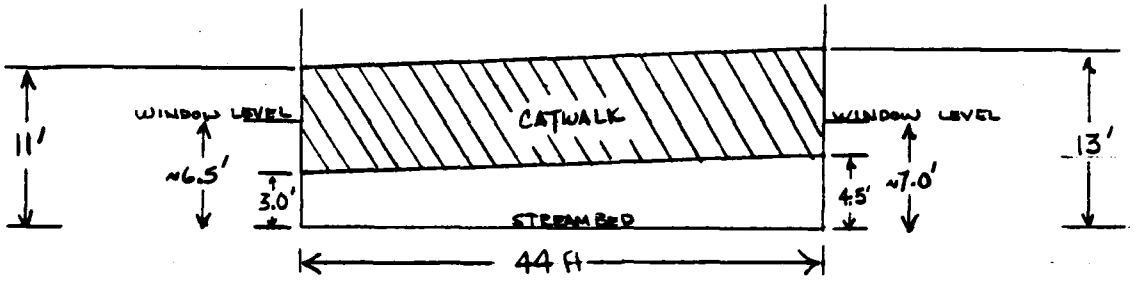
PEAK FLOW FROM FAILURE = 6,500 CFS

$\therefore$ q REQUIRED = 6,500/43 = 151 CFS/FT OF WIDTH

BOTH OPEN CHANNEL FLOW METHODS AGREE CLOSELY, THEREFORE, ASSUME PEAK FLOW FROM FAILURE CAN PASS UNDER BRIDGE UNDER OPEN CHANNEL FLOW CONDITIONS.

PROJECT	COMP. BY	JOB NO.
GOODALL - SANFORD DAM DAM FAILURE ANALYSIS	JJD	20199 - 19
	CHK. BY BTB	DATE 2-16-79

CROSS - SECTION #2
(AT CATWALK LOCATED ~ 250 FT BELOW DAM)



STREAMBED AT APPROX. ELEVATION OF 268 FEET MSL

NOTE: CATWALK SIDES AND ROOF ARE CONSTRUCTED OF THIN SHEET METAL AND IS SUPPORTED BY 12" AND 8" STEEL "I" BEAMS. FLOOD WATERS IMPACTING THE CATWALK WOULD PROBABLY SEVERELY DAMAGE AND WASH OUT THE SHEET METAL PORTIONS OF THE STRUCTURE.

CHECK OPEN-CHANNEL FLOW [1] ($n = .035$, $S = .015$)

STAGE (Ft)	AREA (Ft²)	WETTED PERIM.	HYDRAULIC RADIUS	SLOPE	1.486/n	Q (CFS)
2	88	48	1.83	.015	42.5	682
4	176	52	3.38	"	"	2,047
6	264	56	4.71	"	"	3,821
8	352	60	5.87	"	"	5,892
10	440	64	6.88	"	"	8,175

PRIOR TO FAILURE, STAGE ≯ 4 ft.
AFTER FAILURE, STAGE ≯ 8 ft (ABOVE WINDOW LEVELS)

ORIFICE FLOW ($C = 0.6$, $A = 165$ ft²)

ELEV	Q	ELEV	Q
275	1,256	279	2,025
277	1,685	281	2,316

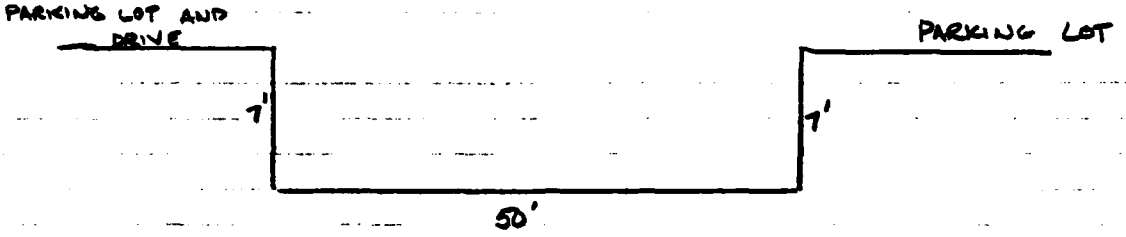
FLOW PRIOR TO FAILURE WOULD SUBMERGE AND PROBABLY WASH OUT CATWALK.

[1] ASSUME CATWALKS ARE WASHED OUT (SHEET METAL PORTIONS), ∴ OPEN-CHANNEL FLOW WOULD RESULT

PROJECT	COMP BY	JOB NO.
GOODALL - SANFORD DAM	JJD	20799-19
DAM FAILURE ANALYSIS	CHK BY BTB	DATE 7-19-79

CROSS-SECTION #3
(LOCATED ~ 500 FT BELOW DAM)
(LOOKING DOWNSTREAM)

CROSS-SECTION CONSISTS OF A 50 FT LONG DAM OR WATER CONTROL STRUCTURE. STRUCTURE CAN BE CONSIDERED AS BROAD-CRESTED WEIR WITH BREADTH = 3.0 FT

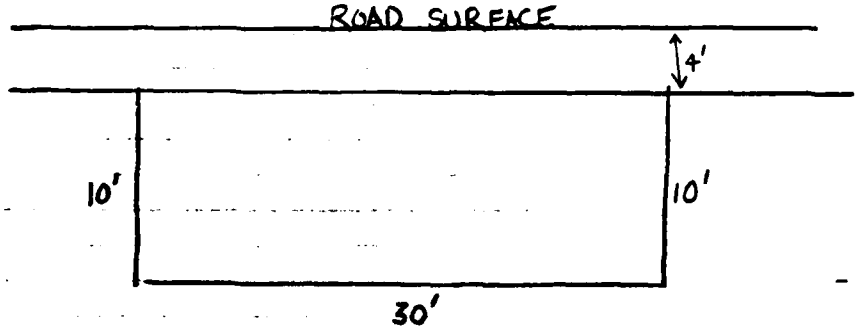


H	C	L	Q
4	3.07	50	1,228
5	3.32	"	1,855
6	"	"	2,439
7	"	"	3,074
8	"	"	3,756
9	"	"	4,482
10	"	"	5,250
12	"	"	6,900

WITH H > 7 FT., WATER WOULD BEGIN TO OVERFLOW THE CHANNEL INTO THE PARKING LOT AND PARKING LOT DRIVEWAY.

PROJECT	COMP BY	JOB NO.
GOODALL - SANFORD DAM DAM FAILURE ANALYSIS	JSD	20799-19
	CHK BY BTB	DATE 2-16-79

CROSS-SECTION #4
(LOCATED APPROX 2,500 FT BELOW DAM AT BRIDGE CROSSING)



$n = .035$, $S = .0077$ (AVG. OF UPSTREAM AND DOWNSTREAM REACHES)

CAPACITY UNDER BRIDGE ASSUMING OPEN CHANNEL FLOW:

$A = 300$, $P = 50$, $R = 6.00$, $\therefore Q = 3{,}690$ CFS

$\therefore$ PEAK FLOW FROM FAILURE WILL NOT PASS UNDER BRIDGE UNDER OPEN CHANNEL FLOW CONDITIONS, FLOW PRIOR TO FAILURE WOULD

FOR ORIFICE FLOW:

$C = 0.6$

$A = 300$

$H = 4$

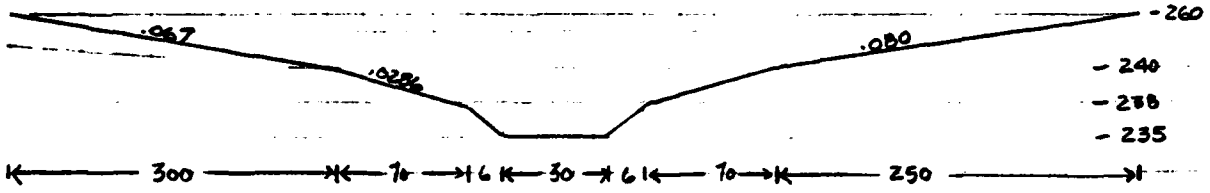
$\therefore Q = CA\sqrt{2gH} = 2890$ CFS

BRIDGE WILL BE OVERTOPPED

NO SIGNIFICANT CHANNEL STORAGE ABOVE BRIDGE SECTION

PROJECT	COMP BY	JOB NO.
GOODALL - SANFORD DAM DAM FAILURE ANALYSIS	JJD	20799-19
	CHK BY BTB	DATE 2-16-79

CROSS-SECTION #5
(~1.2 MILES BELOW DAM, ABOVE SCHOOL ST)
(LOOKING UPSTREAM)
ELEVATIONS ARE APPROXIMATE



OVERALL "n" = .060
S = .00095 (20'/4 MILES)

W.S. ELEV	1.486/n	A	P	R	S	Q
238	24.8	108	43	2.51	.00095	152
240	"	332	183	1.81	"	375
245	"	1,590	321	4.95	"	3,494
247	"	2,284	376	6.07	"	5,743
248	"	2,672	403	6.63		7,199

S = 413 AC-FT
q_1 = 6,500 CFS TRIAL STAGE = 247.5 FT (12.5 FT)

$$V_1 = \frac{(6300 - 2500)(2478)}{43{,}560} = 216 \text{ AC-FT} \quad (\sim 50\% \text{ OF S})$$

$$q_2 = 6{,}500\left(1 - \frac{216}{413}\right) = 3{,}100 \text{ CFS}$$

$$V_2 = \frac{(1430)(3{,}800)}{43{,}560} = 125 \text{ AC-FT}$$

V_{AVE} = 171 AC-FT

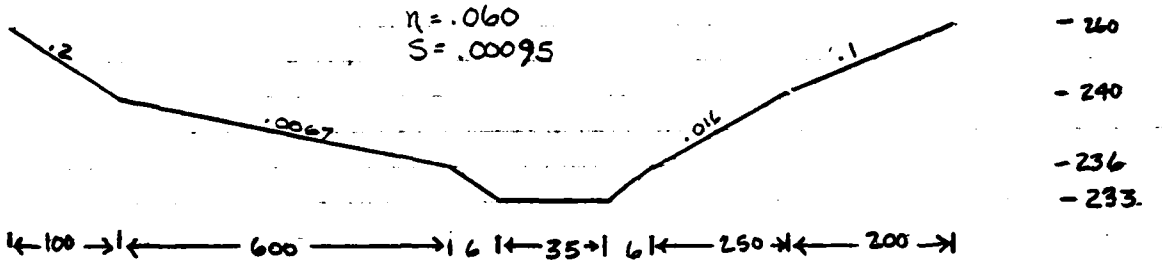
$$Q_5 = 6{,}500\left(1 - \frac{171}{413}\right) = 3{,}809 \text{ CFS}$$

STAGE = 10.3 FT (245.3 FT)

PROJECT	COMP BY	JOB NO.
GOODALL - SANFORD DAM DAM FAILURE ANALYSIS	JJD	20799 - 19
	CHK BY BTB	DATE 2-16-79

CROSS - SECTION #6
(~1.5 MILES BELOW DAM, BELOW SCHOOL ST)

LOOKING UPSTREAM
$n = .060$
$S = .00095$



W.S. ELEV	1.486/n	A	P	R	S	Q
236	24.8	123	48	2.56	.00095	176
238	"	642	473	1.36	"	600
240	"	2,011	898	2.24	"	2,617
241	"	2,916	913	3.19	"	4,830
etc						

$S = 413$ AC-FT
$q_1 = 3,809$ CFS TRIAL STAGE = 240.5 FT (7.5 FT)

$$V_1 = \frac{(1,694 + 2,464)}{2}\left(\frac{1600}{43,560}\right) = 76 \text{ AC-FT}$$

$$q_2 = 3809\left(1 - \frac{76}{413}\right) = 3,108 \text{ CFS}$$

$$V_2 = \frac{(1,430 + 2212)}{2}\left(\frac{1600}{43,560}\right) = 67 \text{ AC-FT}$$

$V_{AVE} = 72$ AC-FT

$$Q_6 = 3809\left(1 - \frac{72}{413}\right) = 3,145 \text{ CFS}$$

STAGE = 7.2 FT (EL 240.2 FT)

SEVERAL HOUSES IN THIS AREA WOULD BE FLOODED TO DEPTHS OF 1 TO 3 FEET. THERE IS NO HAZARD BELOW THIS SECTION.

APPENDIX E

Information as Contained in the National Inventory of Dams

INVENTORY OF DAMS IN THE UNITED STATES

STATE	IDENTITY NUMBER	DIVISION	STATE	COUNTY	CONGR DIST.	STATE	COUNTY	CONGR DIST.	NAME	LATITUDE (NORTH)	LONGITUDE (WEST)	REPORT DATE DAY | MO | YR
ME	185	NED	ME	031	01				GOODALL-SANFORD	4326.5	7046.5	01JUN79

POPULAR NAME	NAME OF IMPOUNDMENT

REGION	BASIN	RIVER OR STREAM	NEAREST DOWNSTREAM CITY-TOWN-VILLAGE	DIST FROM DAM (MI.)	POPULATION
01	04	MOUSAN RIVER	SANFORD	0	17500

TYPE OF DAM	YEAR COMPLETED	PURPOSES	STRUCTURAL HEIGHT (FT.)	HYDRAULIC HEIGHT (FT.)	IMPOUNDING CAPACITIES MAXIMUM (ACRE-FT.)	IMPOUNDING CAPACITIES NORMAL (ACRE-FT.)
PGCT		O	14	12	508	278

DIST	OWN	FED R	PRV/FED	SCS A	VER/DATE
NED	N	N	N	N	

REMARKS
23-WATER STORAGE (PROCESS AND FIRE)

D/S HAS	SPILLWAY CREST LENGTH	SPILLWAY TYPE	SPILLWAY WIDTH (FT.)	MAXIMUM DISCHARGE (FT.)	VOLUME OF DAM (CY)	POWER CAPACITY INSTALLED (MW)	POWER CAPACITY PROPOSED (MW)	NAVIGATION LOCKS NO.	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)
1	245	U	213	2227												

OWNER	ENGINEERING BY	CONSTRUCTION BY
TOWN OF SANFORD		

REGULATORY AGENCY			
DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE

INSPECTION BY	INSPECTION DATE DAY | MO | YR	AUTHORITY FOR INSPECTION
EDWARD C JORDAN CO INC	05DEC78	PUBLIC LAW 92-367 8AUG1972

REMARKS

END

FILMED

7-85

DTIC