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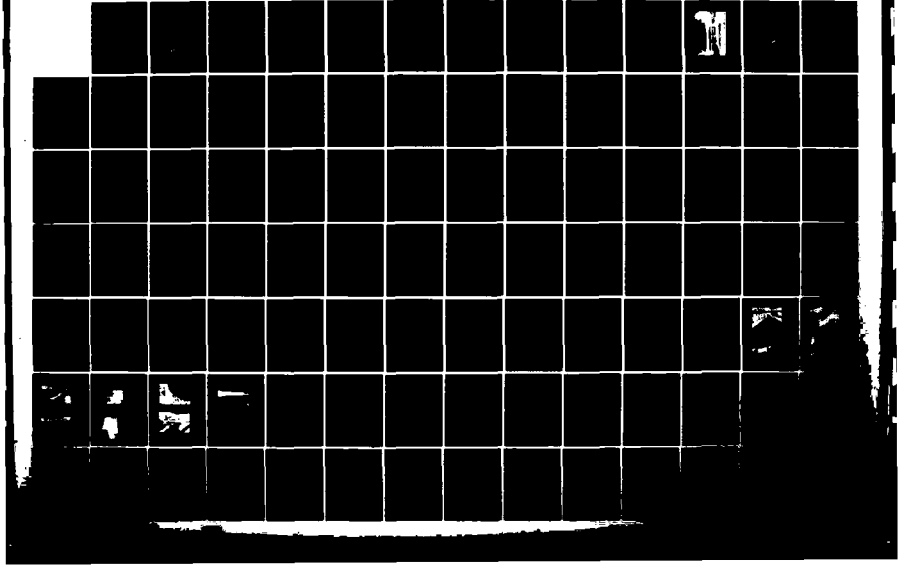
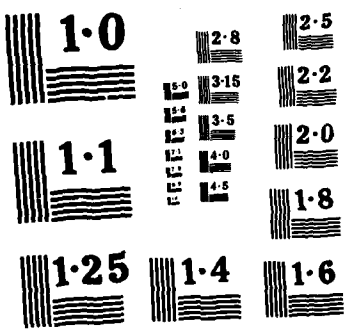
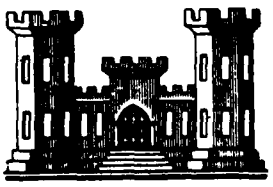




MERRIMACK RIVER BASIN
BRISTOL, NEW HAMPSHIRE

INTERNATIONAL PACKINGS CORPORATION
UPPER DAM
NH-00315

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM



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

APRIL 1979

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Merrimack Rsver Basin
Bristol, New Hampshire
Newfound River

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

The dam is a timber cribwork gravity dam with concrete abutment training walls. The dam is about 285 ft. long and 17.5 ft. high. The dam is considered to be in fair condition. Underseepage and deterioration of timber components are among a few major concerns. It is small in size with a significant hazard potential. The ½ PMF would overtop the dam by about three ft.

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INTERNATIONAL PACKINGS CORPORATION
UPPER DAM

NH-00315

MERRIMACK RIVER BASIN
BRISTOL, NEW HAMPSHIRE

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

NATIONAL DAM INSPECTION PROGRAM

PHASE I INSPECTION REPORT

NH-00315

INTERNATIONAL PACKINGS CORPORATION UPPER DAM

BRISTOL

GRAFTON COUNTY, NEW HAMPSHIRE

NEWFOUND RIVER

November 21, 1978

BRIEF ASSESSMENT

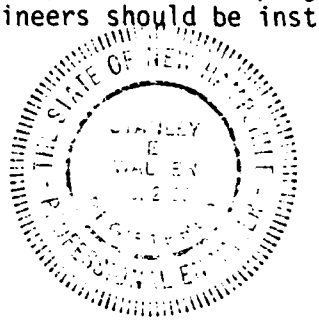
The International Packings Corporation Upper Dam is a timber cribwork gravity dam with concrete abutment training walls, an earth embankment section, and a stone masonry wingwall section. The dam has an overall length of about 285 feet and a height of about 17.5 feet.

Based on the visual inspection and reports of past operational performance, the International Packings Corporation Upper Dam is considered to be in fair condition. Major concerns regarding the safety of the dam include underseepage, deterioration of timber components, spalling and erosion of concrete, and lack of freeboard.

The International Packings Corporation Upper Dam is a small size dam classified as having a significant hazard potential. In accordance with Corps of Engineers' Recommended Guidelines for Safety Inspection of Dams, the test flood is one-half of the Probable Maximum Flood (PMF). The test flood is estimated to be 12,600 cfs. With stop logs removed, the spillway capacity of the dam, including the control outlet, is 40 percent of the test flood. The 1/2 PMF would overtop the dam by approximately three feet.

The recommendations and remedial measures outlined in Section 7 should be implemented within 12 months of receipt of this report by the owner. Recommendations include further evaluation and investigation of the effects of underseepage and the limited freeboard. Major maintenance items include repair of timber and concrete elements of the dam and repair of eroded embankment

slopes. A plan for around-the-clock surveillance during periods of anticipated high runoff and a formal warning system should be developed and implemented. A program of annual inspections by qualified engineers should be instituted.



EDWARD C. JORDAN CO., INC.

Stanley E. Walker, P. E.
Project Officer

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 investi-gation 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 Recommended Guidelines for Safety Inspection of Dams, 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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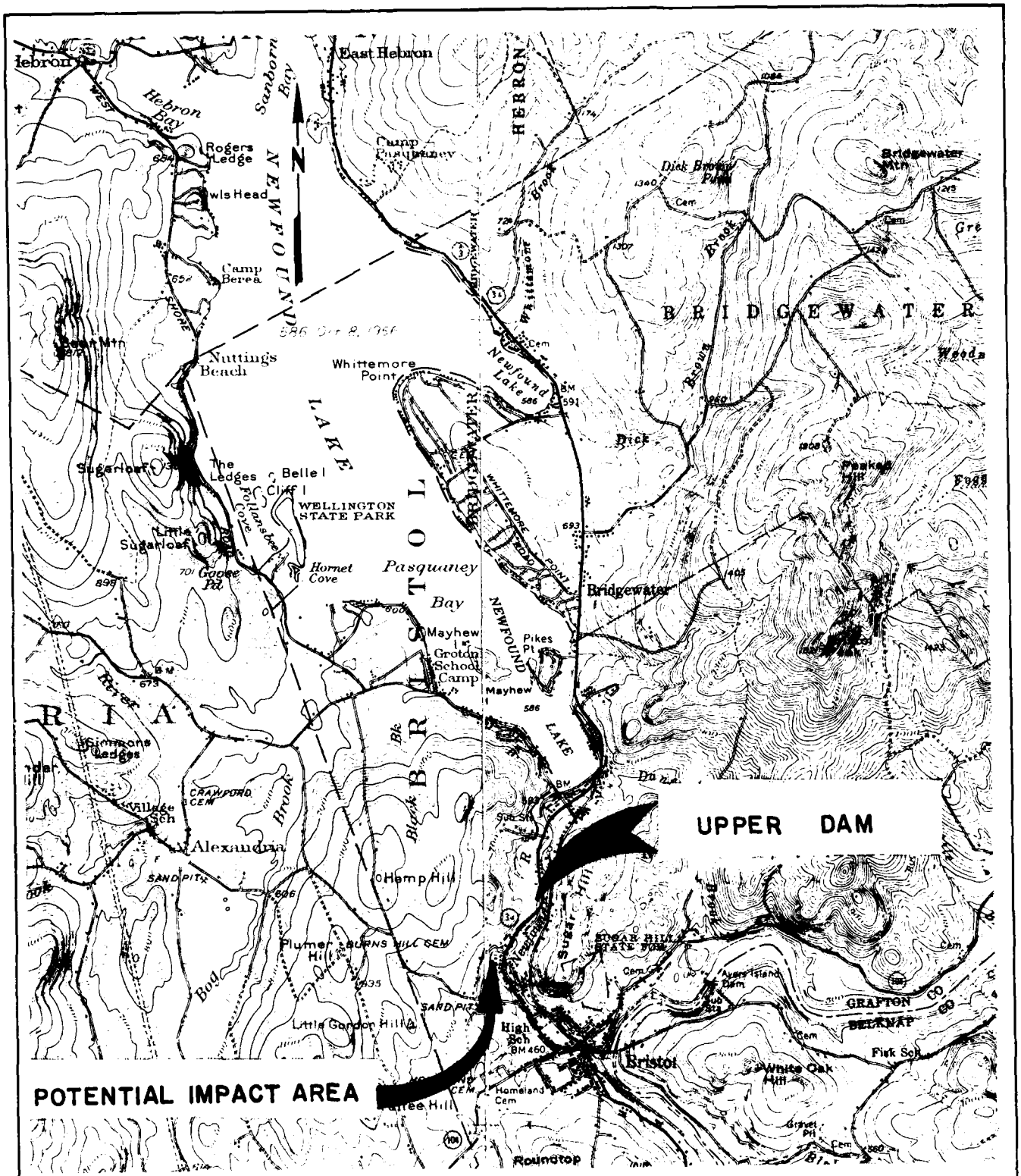


U.S. GEOLOGICAL SURVEY MAP

CARDIGAN, N.H. QUADRANGLE
HOLDERNESS, N.H. QUADRANGLE

0 1 2 3 MILES

NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

INTERNATIONAL PACKINGS CORP.
UPPER DAM
LOCATION MAP

NEWFOUND RIVER MAINE

20799 08		AS SHOWN
		MARCH 1979

PHASE I INSPECTION REPORT

INTERNATIONAL PACKINGS CORPORATION

UPPER 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. Edward C. Jordan Co., 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 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 expeditiously initiate 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 International Packings Corporation Upper Dam is located on the Newfound River in the town of Bristol, New Hampshire. N 43°-36.7', W 71-44.5'.

b. Description of Dam and Appurtenances. The International Packings Corporation Upper Dam is a timber cribwork structure with concrete abutment training walls, an earth embankment section, and a stone masonry wingwall section. The dam is apparently founded on soil and is situated in a broad section of the Newfound River Valley. It is a run-of-the-river dam with a small impoundment.

A powerhouse is located at the east end of the timber spillway. The structure is of concrete and brick construction, with the tailrace consisting partly of stone masonry. The powerhouse contains a single Leffel-type generator.

In the west embankment of the dam is a control outlet structure consisting of a concrete channel with two stop log bays. See Appendix B for sketches of the dam and appurtenances showing plan, profile, and typical cross-sections.

c. Size Classification. According to the Corps of Engineers Recommended Guidelines for Safety Inspection of Dams, the IPC Upper Dam is classified as a small size dam based on both its storage capacity (55 acre-feet) and height (17.5 feet).

d. Hazard Classification. The IPC Upper Dam is classified as having a significant hazard potential. The peak flow from hypothetical failure of the dam was estimated to be about 4,700 cfs based on procedures provided by the Corps of Engineers. Approximately 15 commercial, industrial, and residential buildings within a distance of about 1 mile downstream of the dam would incur some damage. No significant flooding would occur for a distance of about 1,600 feet below the dam because the channel of the Newfound River would be capable of transporting the peak discharge

with little overbank flow. Between about 1,600 feet and 4,700 feet downstream of the dam, flood depths of about 1 to 3 feet would occur. Flood depths at residences would be less than about 2 feet. There are only a few permanently habitable structures in the reach where flooding would occur. At distances greater than 4,700 feet downstream of the dam, the peak flow from failure would not cause significant flooding.

e. Ownership.

Current Owner: International Packings Corporation
Pleasant Street
Bristol, New Hampshire 03222

Previous Owner: Public Service Company of New Hampshire

Dates: Prior to 1962 or 1963; dates uncertain

f. Operator.

Roger L. Young, Plant Engineer
International Packings Corporation
Tel: 1-603-744-2281

g. Purpose of Dam. This dam is used intermittently to generate hydroelectric power to supplement the power requirements of the International Packings Corporation manufacturing facility in Bristol. The dam is used during periods when stream flow is adequate to operate the generating equipment. There is no regular schedule for this use.

h. Design and Construction History. The designer of the original structure is not known. Data pertinent to original or reconstruction design are not available. Information about original construction is also not available. According to New Hampshire Water Resources Board records, the Public Service Company of New Hampshire (or New Hampshire Power Co.) reconstructed the dam 1936; the records identify the engineer for this reconstruction as Paul Hatch of the New Hampshire Power Co.

Sometime during the period of 1965 to 1967, a major overhaul of the dam was performed by the International Packings Corporation. This construction included new stop log supports, a new service bridge, a steel I-beam and cable at the top of the stop log supports, new planking on the downstream apron, and a plywood facing on the upstream apron. No drawings for the renovation are available.

i. Normal Operating Procedure. The IPC Upper Dam stores water for on-site power production. A powerhouse is located on the east end of the dam. Power is generated on an intermittent basis at this dam, during seasonal periods when stream flows are above the minimum necessary to operate the equipment. During low and normal flows, stop logs are maintained near maximum height. In preparation for high flows, stop logs are manually removed to add capacity to the spillway. The stop logs of the control outlet structure are maintained at an elevation approximately 2-1/2 feet below top of dam. In anticipation of high flows or for conducting maintenance on the dam, stop logs are removed from the control outlet. The stop logs are not designed to automatically fail during overtopping conditions. Once overtopping of the dam occurred, it would be difficult to remove the stop logs because the service bridge would not be accessible.

1.3 PERTINENT DATA

a. Drainage Areas. The drainage area above the IPC Upper Dam is 95.8 square miles. The basin is primarily forested with slopes varying from moderate to steep. Elevations in the basin vary from 3,121 feet at Mount Cardigan to about 535 feet at the dam. About 7 percent of the entire drainage area consists of surface water at Newfound Lake, located about 0.6 miles upstream of the dam. A dam at the outlet of Newfound Lake regulates the discharge to the Newfound River. The drainage area above the Newfound Lake Dam is 95.0 square miles. Newfound Lake has a storage capacity of 38,800 acre-feet with water at the top of dam.

b. Discharge at Dam Site. Releases from the dam can be made through either the spillway stop log bays

or the controlled outlet. Water is also released through the powerhouse during periods of power generation. The following are estimated discharges at the dam site. Existing capacities assume water surface at top of dam (elev. 554.0 ft).

(1) Maximum flood at dam site is unknown. The flood of July, 1973 was estimated to be 3,500 cfs.

(2) Spillway capacity (with top of stop logs at elev. 551.9 ft) - 675 cfs.

(3) Spillway capacity (with all stop logs removed) - 3,670 cfs.

(4) Controlled outlet capacity (with top of stop logs at elev. 551.6 ft) - 150 cfs.

(5) Controlled outlet capacity (with all stop logs removed) - 1,390 cfs.

(6) Total project discharge at test flood (1/2 PMF) - 12,600 cfs at elev. 557.0 ft MSL with all stop logs removed.

c. Elevation. During the field inspection, no physical reference of the dam elevation to mean sea level was readily available. New Hampshire Water Resources Board records dating to 1939 indicate an elevation of the top of the west abutment of about 554.0 feet. Using this as an assumed datum, pertinent elevations at the International Packings Corporation Upper Dam site are as follows:

ITEM	ELEVATION ABOVE MSL
Streambed at centerline of dam	536.5 ±
Maximum tailwater	Unknown
Invert of controlled outlet	540.8
Normal pool (frequent high water mark)	552.7
Full flood control pool	Not applicable
Spillway crest (stop logs removed)	547.6
Design surcharge	Unknown
Top of dam (at abutment)	554.0
Test flood elevation (1/2 PMF)	557.0

d. Reservoir. The lengths of the normal water surface pool and the maximum pool were estimated from USGS maps and average streambed slopes.

ITEM	LENGTH (Feet)
Normal pool	1100
Maximum pool	1200

e. Storage.

ITEM	STORAGE (Acre-Feet)
Spillway crest	17
Top of dam	55
1/2 PMF flood pool	87

f. Reservoir Surface.

ITEM	SURFACE AREA (Acres)
Spillway crest	5.8
Top of dam	10.5
1/2 PMF pool	15.5

g. Dam.

Type - Timber cribwork structure with concrete abutment training walls, an earth embankment section, and a masonry wingwall section.

Length - Approximately 285 feet, including spillway, embankment and wingwall sections.

Height - Approximately 17.5 feet from top of abutment to center of streambed at tailwater.

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

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

Zoning - Unknown.

Impervious Core - The earth embankment section of the dam has a concrete or masonry core wall. The depth of this wall and its foundation are not known.

Cutoff - At the timber spillway, cutoff is accomplished by the sloped approach apron which is faced with plywood and sealed by muddy sediments.

Grout Curtain - Unknown.

h. Diversion and Regulating Tunnel. Not applicable.

i. Spillway.

Type - Timber cribwork with stop log bays.

Length of weir - 88.5 feet overall; 16 stop log bays @ 3.8 feet high by 5 feet high.

Crest Elevation - Approximately 547.6 feet (MSL) based on an assumed datum as discussed in Section 1.3C.

Gates - Manually removable stop logs.

Upstream Channel - The approach channel to the dam is clear and unobstructed. Four to six inches of accumulated silt was observed in the reservoir above the dam, but it is not likely that this would affect the operation of the spillway.

Downstream Channel - The downstream channel contains boulders, cobbles and gravel. Some scour is evident. Both sides of the channel are lined with trees and small brush.

j. Regulating Outlet. A control outlet structure is located in the westerly earth embankment. Pertinent data follows:

(1) Invert - Elev. 540.8 feet (MSL)

(2) Size - 2 stop log bays, each 5.5 ft wide by 13.2 ft high.

(3) Description - This structure is a concrete channel with flared wingwall entrance. (See plan, profile and cross-sections of dam in Appendix B). The structure is furnished with two stop log bays with manually removable stop logs.

(4) Control Mechanism - The control outlet hoisting equipment has deteriorated so that it is no longer useful. Operation of the outlet requires the manual removal or insertion of stop logs.

SECTION 2

ENGINEERING DATA

2.1 DESIGN

No original design data were available for the International Packings Corporation Upper Dam.

2.2 CONSTRUCTION

No engineering data relative to construction of the dam were available for the current study.

2.3 OPERATION

No operational data were available.

2.4 EVALUATION

a. Availability. No design, construction, or operational data pertinent to this structure were available for this study.

b. Adequacy. Because of the lack of engineering data, assessment of the International Packings Corporation Upper Dam must be based on visual inspection, past performance history, hydraulic and hydrologic computations, and engineering judgment.

c. Validity. No comparison can be made of existing conditions with original design and construction data.

SECTION 3

VISUAL INSPECTION

3.1 FINDINGS

a. General. The International Packings Corporation Upper Dam is a timber cribwork structure with concrete abutment training walls, an earth embankment section, and a masonry wingwall section. It appears to be founded on soil and is located in a broad section of the Newfound River valley. The dam is a run-of-the-river dam with a small impoundment. The cribwork section of the dam comprises the spillway; a controlled outlet is in the westerly embankment.

Detailed inspection findings are included in Appendix A. See also Appendix B for plan, profile and cross-sections of the structure, and Appendix C for photographs taken during the inspection.

b. Dam.

(1) Structural - The visual inspection revealed that the dam is in generally fair condition. The following are major findings of the inspection:

(a) There is no evidence of vertical movement indicating settlement of the timber structure. However, the steel I-beam which restrains the top of the stop log supports shows a downstream bow of 6 to 8 inches. The junctions between the timber portion of the dam and the concrete abutments we found to be good, but substantial seepage is occurring at these junctions.

(b) The embankment portions of the dam have settled in some areas, particularly the easterly end. Erosion has occurred along the downstream toe of the westerly embankment sections and overtopping apparently occurs frequently over the western-most section. Surface erosion is evident and small gullies have formed in this area.

(c) Substantial leakage is occurring through the timber section of the dam. Several small eroded depressions have developed along the upstream apron, although no distress related to undermining of the dam structure is evident.

(d) The wingwall between the spillway and the tailrace has settled and a crack has developed near the upstream end (see photograph 3). Undermining of the downstream end appears to be the cause of this distress.

(e) The timber deck and the downstream face of the spillway were found to be in poor condition (see photograph 1). Many of the planks are broken and badly worn. The downstream cribwork has lost a substantial amount of its stone fill, particularly near the east end. Most of the timber crib members appear to be in reasonably good condition, although some cracked logs were noted (see photograph 2).

(f) The stop log support columns, steel support beam and cable appear to be in good condition (see photograph 1). It was noted, however, that the support beam is bowed about 6 to 8 inches downstream.

(g) The surfaces of the concrete training walls at the spillway are spalled and eroded. Severe erosion of the concrete was noted at the downstream side of the controlled outlet flume (see photograph 9).

(h) The lifting hooks on some of the stop logs are broken, preventing easy removal of these stop logs.

(2) Hydraulics - At the time of the visual inspection (November 14, 1978), the reservoir was empty and the entire flow of the river (estimated to be 2 to 5 cfs) was passing through and beneath the spillway section (see photographs 6 and 11). Above the frequent high water mark, only about 16 inches of freeboard exists to the top of the dam. About 24 inches

of freeboard was noted between the top of the stop logs and the embankment sections (see photograph 10). Evidence of overtopping of the embankment was observed.

Hydraulic control of the reservoir is provided by the spillway stop logs, the controlled outlet, and to a certain extent, the power tunnel. All stop logs must be manually removed or inserted. The invert of the control outlet is approximately at the low point of the reservoir, allowing drainage of the reservoir if required.

c. Appurtenant Structures. A powerhouse with operational generating equipment exists in the easterly portion of the dam. This structure was found to be in generally good repair, although leakage was noted in the ceiling of the tailrace.

A controlled outlet with stop log bays is located in the westerly embankment of the dam (see photographs 6, 7 and 8). This discharges to an earth channel below the embankment. This structure is in fair condition, but the hoisting equipment for the stop logs is deteriorated and unusable so that the stop logs must be manually removed. Severe deterioration of the concrete on the outlet side of the structure was observed.

d. Reservoir Area. No evidence of landslides in the reservoir area was observed during the inspection. Due to the flatness of the valley floor surrounding the reservoir, the potential for slope failure around the reservoir appeared minimal. There is a low-lying area along the reservoir shoreline approximately 100 feet upstream of the controlled outlet. There was some accumulated sediment within the reservoir basin, but it was not sufficient to obstruct the approach channel to the spillway or the controlled outlet. There are no buildings along the reservoir shoreline. The reservoir area is shown in Photographs 6, 10 and 11.

e. Downstream Channel. The downstream channel (photograph 4) shows no signs of significant scour below the spillway or controlled outlet. The channel bed is composed primarily of cobbles and boulders. The

banks are cluttered with small trees and brush. The channel just below the dam appeared sufficient to transport moderate to high flows without flooding. The channel below the controlled outlet appeared sufficient to transport the full capacity of the outlet.

3.2 EVALUATION

Based on the visual inspection findings, the dam appears to be in fair condition. Some deterioration of the timber and concrete elements of the dam has occurred. Very little freeboard exists above normal pond level. Apparently, overtopping of portions of the embankment occasionally occurs. Substantial leakage is occurring through and beneath the timber section of the dam, which could lead to continued deterioration of the spillway and its foundation. As outlined in Section 7, rehabilitative measures are necessary to assure the long-term safety of the structure.

SECTION 4

OPERATING PROCEDURES

4.1 PROCEDURES

The International Packings Corporation Upper Dam impounds water for on-site power production. Spillway stop logs are reportedly maintained near maximum height during low and normal flows, to provide water at sufficient head to the powerhouse. In preparation for high flows, stop logs are reportedly removed to increase spillway capacity. The stop logs of the controlled outlet are maintained at an elevation approximately 2-1/2 feet below the top of the dam. In anticipation of high flows or for conducting maintenance of the dam, the controlled outlet is opened. Apparently, operating records are not kept for this dam.

4.2 MAINTENANCE OF DAM

Maintenance of the dam appears to be on an as-needed basis. Once a year, according to the plant engineer at International Packings Corporation, the pond is drained for inspection and maintenance. There are no maintenance records.

4.3 MAINTENANCE OF OPERATING FACILITIES

As reported by the plant engineer, the generation equipment and trash screen are checked once or twice a day when power is being generated. The stop logs and their supports on the spillway and in the controlled outlet are kept in generally good condition, although some stop log lift hooks were missing or broken at the time of inspection. Hoisting equipment at the controlled outlet is dilapidated and unusable.

Routine maintenance appears to be limited to the once-a-year inspection and repair. No maintenance records for operating facilities are kept.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

There is no automatic warning system or remote monitoring system in effect. In cases of impending excess runoff, the New Hampshire Water Resources Board (which

operates a dam upstream at Newfound Lake) contacts the International Packings Corporation.

4.5 EVALUATION

The once-a-year maintenance program appears sufficient to keep the stop logs and generating equipment in generally fair repair. However, the older cribwork, plank and plywood facing, and concrete sections of the dam are in need of attention. A more thorough on-going maintenance program is warranted. Records of maintenance and operation activities should be kept.

While there is no formal operating procedure, adjustments in the stop logs are reportedly made in anticipation of high flows. The New Hampshire Water Resources Board operates a dam upstream at Newfound Lake and notifies the International Packings Corporation of major adjustments to outflow from the lake.

The lack of a warning system or some form of remote monitoring of the dam is of concern, in that the dam has very little freeboard and is subject to overtopping during high flow conditions. Personnel who operate the dam are located about two miles from the structure at the International Packings Corporation plant.

SECTION 5

HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. General. The International Packings Corporation Upper Dam is a run-of-the-river dam constructed for low head hydroelectric power generation. The dam consists of a stop log spillway constructed above a timber crib base, earth embankment, and masonry wingwalls. A stop log controlled outlet is located in the westerly embankment. A trash rack is located upstream of the inlet to the powerhouse. The flow of the Newfound River is regulated by the operation of the Newfound Lake Dam located about 0.6 miles upstream of this dam. The New Hampshire Water Resources Board owns and operates the Newfound Lake Dam.

b. Design Data. Design data were not available.

c. Experience Data. There are no published hydrologic data for the Newfound River Basin. However, for the last three years the New Hampshire Water Resources Board has maintained a record of the discharges from Newfound Lake. The maximum flow in these records is 1,280 cfs occurring on April 5, 1976. According to personnel of the New Hampshire Water Resources Board, no significant damage occurred downstream of Newfound Lake during this release.

A flood flow of about 3,500 cfs (estimated by the owner) in the summer of 1973 did not overtop nor submerge the IPC Upper Dam. All stop logs had been removed in anticipation of the flood.

d. Visual Observations. Water level at the IPC Upper Dam may be controlled by either the spillway or the controlled outlet at high and normal flows. At very low flows, leakage through the dam and powerhouse controls the reservoir level. All stop logs must be manually operated. The invert of the controlled outlet is approximately at the low point of the reservoir. The bottom half of the trash rack upstream of the powerhouse inlet was littered

with debris. The natural channels downstream of the spillway and the controlled outlet were generally clear of debris and showed no signs of significant scour. Concrete on the downstream side of the controlled outlet structure showed signs of severe erosion.

e. Test Flood Analysis. The International Packings Corporation Upper Dam is a small size dam classified as having a significant hazard potential. Using the Corps of Engineers Recommended Guidelines for Safety Inspection of Dams, the test flood for evaluating spillway capacity is one-half the Probable Maximum Flood (PMF).

Flow at the dam is regulated by Newfound Lake Dam. The drainage area above the IPC Upper Dam was determined from USGS maps to be 95.8 square miles. The drainage area above Newfound Lake Dam is 95.0 square miles. The watershed is classified as mountainous. Elevations range from 3,121 feet (MSL) at Mount Cardigan to about 580 feet at the Newfound Lake Dam and 537 feet at the IPC Upper Dam. The PMF flow into Newfound Lake was estimated to be 114,000 cfs using the Corps of Engineers "Preliminary Guidance for Estimating Maximum Probable Discharges."

The PMF and the 1/2 PMF were routed through Newfound Lake using the Corps of Engineers computer model, HEC-1. The routed PMF was computed to be 28,720 cfs and the routed 1/2 PMF was computed to be 12,120 cfs (see Appendix D).

The intervening drainage area between Newfound Lake Dam and the IPC Upper Dam is about 0.8 square miles. The 1/2 PMF inflow from this part of the drainage area was estimated to be 480 cfs. The reservoir of the IPC Upper Dam has no significant surcharge storage capacity. Therefore, the 1/2 PMF discharge at the Dam is estimated to be 12,600 cfs. The PMF discharge at the Dam would be about 29,700 cfs.

The spillway and controlled outlet have a combined discharge capacity of approximately 5,060 cfs with all stop logs removed and water surface elevation at the top of the dam. This capacity amounts to 40 percent of the test flood (1/2 PMF). The test flood would overtop the dam by about 3.0 feet.

At full spillway capacity, a high tailwater condition would exist at the dam and some flooding would likely occur downstream. Although insufficient to pass the test flood, the spillway is not considered seriously inadequate according to the Corps of Engineers guidelines of ETL 1100-2-234. Failure from overtopping would not significantly increase the downstream hazard potential above that existing just before overtopping failure. The dam's timber crib section is considered to be in fair structural condition and would be expected to remain stable under overtopping conditions. The earth embankment section of the dam would be less resistant to overtopping. Overtopping could cause serious erosion to the embankment.

f. Dam Failure Analysis. The dam failure analysis relied upon the "rule of thumb" guidance outlined in an attachment to ETL 1100-2-234. The hazard potential was determined by analyzing downstream dam failure hydrographs using cross-sections derived from USGS maps and the field inspection. The peak flood flow from failure would be about 4,700 cfs which would create a flood wave of approximately 10 feet at the dam. It would take the reservoir approximately 17 minutes to empty. At the Route 3A bridge located approximately 500 feet downstream of the dam, the peak would be reduced to 4,240 cfs with a stage of 7.2 ft beneath the bridge. At a distance of 1,600 feet below the dam, the peak flow would be reduced to 3,500 cfs, corresponding to a stage of 8.2 feet. The channel below the dam to this point would be able to transport these flows without significant bank overflow. At the IPC Lower Dam located about 3,200 feet below the IPC Upper Dam, the peak would be reduced to 2,700 cfs. Some flooding would occur in the area at and above the IPC Lower Dam. Flood depths would average 1 to 2 feet and would cause damage to about 15 buildings in that area. Only a few residences are located in the affected area. The flow would be at flood stage for less than ten minutes based on a general flood initiation discharge of 2,000 to 2,500 cfs. It is estimated that at a distance greater than 4,700 feet below the dam, the peak would be below general flood levels.

SECTION 6

STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations. Based on the visual observations, the International Packings Company Upper Dam appears to be in fair condition. The timber members in the cribwork of the dam appear to be in fair condition. The stop logs and their supports appear to be in reasonably good condition. Some stone fill has been lost from the cribwork. The timber planking on the downstream face and apron is in poor condition. Many planks are broken or badly worn. Substantial seepage and leakage is occurring through and beneath the timber spillway section of the dam. This leakage will likely cause further deterioration of the structure unless it is curtailed. Apparently, portions of the embankment are occasionally overtopped during high flow conditions. These sections are reasonably resistant to erosion, but continued overtopping could cause serious erosion.

b. Design and Construction Data. No data concerning the original design or construction of the dam were available for this investigation.

c. Operation Records. None available.

d. Post-Construction Changes. According to New Hampshire Water Resources Board records, the dam underwent substantial reconstruction in 1936. Details of this reconstruction are not known. Sometime during the period of 1965 to 1967, the International Packings Corporation performed another reconstruction of the structure. New stop log bays, a new service bridge, a steel I-beam and cable for support of the stop log uprights, new planking on the tail apron, and plywood facing on the upstream apron were installed. Drawings of this renovation are not available.

The newer timber uprights and stop logs remain in generally good condition. Some replacement members have been installed. The plywood facing on the up-

stream apron and the planks on the downstream apron have deteriorated considerably. The older cribwork timbers show some signs of deterioration, with some surficial rotting, splitting at the ends, and occasional cracking. Some stone has been displaced from the cribs. Considerable spalling and erosion of concrete has occurred in some areas. The concrete wingwall between the spillway and tailrace has developed a major structural crack.

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. The visual inspection indicates that the International Packings Corporation Upper Dam is in fair condition. Major concerns relative to the dam's physical condition are identified as follows:

(1) Seepage is taking place under the cribwork structure as evidenced by eroded depressions at the upstream face.

(2) Deterioration of timber in the spillway structure has occurred, especially the planks on the downstream face and apron.

(3) A considerable amount of stone has been displaced from the cribwork.

(4) There is very little freeboard between the top of the stop logs and the tops of the embankments. There is also very little clearance between the spillway stop logs and the service bridge.

(5) The concrete walls of the controlled outlet are seriously spalled and eroded, especially downstream of the stop log bays.

(6) Substantial leakage through the bulkhead above the tailrace under the powerhouse is occurring.

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

c. Urgency. The recommendations and remedial measures outlined below should be implemented within 12 months of 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

It is recommended that further evaluation of the underseepage and limited freeboard be made by qualified engineers, and that recommendations for mitigation of these conditions be formulated and implemented. It is also recommended that a qualified engineer evaluate the possibility of modifying the existing spillway to allow for automatic release of stop logs if overtopping of the dam occurred.

7.3 REMEDIAL MEASURES

a. Operating and Maintenance Procedures. The annual inspection and maintenance program by International Packings Corporation personnel should be continued. This program should be supplemented by on-going maintenance of the dam, with records kept of all maintenance and operation activities.

The following specific maintenance and operating procedures should also be implemented:

(1) Repair spalled concrete throughout the structure.

(2) Refill the cribwork with stone where loss has occurred.

(3) Replace deteriorated timber, particularly the deteriorated planking and plywood on both the upstream and downstream faces of the structure.

(4) Curtail the leakage that is taking place through the ceiling of the powerhouse tailrace.

(5) Cut trees and brush on embankment sections of the dam and remove root systems and rehabilitate embankment.

(6) Repair eroded portions of the discharge channel below the controlled outlet and the embankment upstream of that structure.

(7) Repair areas of localized settlement between the masonry walls along the easterly embankment and monitor this area for any future settlement.

(8) Repair or replace stop log lift hooks as needed.

(9) Provide and implement written procedures for the operation of the dam under various flow conditions.

(10) Provide for 24-hour surveillance of the structure during impending high runoff conditions.

(11) Develop a plan for a formal warning system which could be used in the event of an emergency.

(12) Provide for annual inspection of the facility by qualified engineers.

7.4 ALTERNATIVES

An alternative to implementing the recommendations and remedial measures outlined above would be the removal of the dam. Such removal of the dam should be under the direction of a qualified engineer, with consideration given to potential release of accumulated sediments and other potential environmental impacts which could result from removal of the structure.

Another alternative would be the permanent removal of stop logs from the spillway crest and controlled outlet to minimize the dam's hazard under low flow conditions. Removal of these stop logs as an interim measure until the above outlined recommendations and remedial measures are being implemented should also be considered.

VISUAL INSPECTION CHECKLIST
PARTY ORGANIZATION

PROJECT International Packings Corp.
Upper Dam

DATE 11/21/78

TIME AM

WEATHER Cold, snow

W.S. ELEV. 540.8 U.S. 534+ DN.S.

PARTY:

1. Stephen Cole
2. John Devine
3. David Nyman
4. Timothy Noonan
5. Daniel Lane
6.
7.
8.
9.
10.

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.	Geotechnical	Cole	
2.	Structural	Cole, Nyman, Devine	
3.	Hydrology/Hydraulics	Devine	
4.	Civil	Devine	
5.	Survey	Noonan, Lane	
6.	Photography	Nyman, Devine	
	Inspection Review	C. Horstmann, S. Walker	
	11/30/78		

NOTE: See Supplementary Inspection Notes Following Checklist

INSPECTION CHECKLIST

PROJECT International Packings Corp. Upper Dam — DATE 11/21/78

PROJECT FEATURE Embankment — NAME Cole

DISCIPLINE Geotechnical — NAME

AREA EVALUATED	CONDITIONS
DAM EMBANKMENT	
Crest Elevation	554±
Current Pool Elevation	540.8 (11/21/78); 552 (11/30/78)
Maximum Impoundment to Date	Overtopped
Surface Cracks	None observed
Pavement Condition	Turf, bushes, trees
Movement or Settlement of Crest	Several depressions evident, particularly east section
Lateral Movement	None
Vertical Alignment	Appears low compared to spillway - stop log crest
Horizontal Alignment	Okay
Condition at Abutment and at Concrete Structures	Good
Indications of Movement of Structural Items on Slopes	Downstream retaining wall, south wing - deflected downstream
Trespassing on Slopes	None
Sloughing or Erosion of Slopes or Abutments	Erosion of upstream face of east sections erosion, overtop - west section
Vegetation	Grass, bushes, trees

AREA EVALUATED	CONDITIONS
DAM EMBANKMENT (cont.)	
Rock Slope Protection - Riprap Failures	Erosion downstream banks below tailrace and spillway
Unusual Embankment or Downstream Seepage	None
Piping or Boils	None
Foundation Drainage Features	Drains - 4" from retaining walls - east wing
Toe Drains	None
Instrumentation System	None

INSPECTION CHECKLIST

PROJECT International Packings Corp. Upper Dam — DATE 11/21/78

PROJECT FEATURE Outlet Works — NAME Cole, Nyman

DISCIPLINE Geotechnical, Structural Hydrology/Hydraulics — NAME Devine

AREA EVALUATED	CONDITION
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	OUTLET WORKS IN WEST EMBANKMENT
a. Approach Channel	
Slope Conditions	Good
Bottom Conditions	Silted but not obstruction
Rock Slides or Falls	None
Log Boom	None
Debris	None
Condition of Concrete Lining	None
Drains or Weep Holes	None
b. Intake Structure	
Condition of Concrete	Fair - some spall and erosion
Stop Logs and Slots	None, stop logs located at control gate

INSPECTION CHECKLIST

PROJECT International Packings Corp. Upper Dam — DATE 11/21/78

PROJECT FEATURE Control Tower — NAME Cole, Nyman

DISCIPLINE Geotechnical, Structural Hydrology/Hydraulics — NAME Devine

AREA EVALUATED	CONDITION
OUTLET WORKS - CONTROL TOWER	
a. Masonry and Structural	
General Condition	Fair
Condition of Joints	Okay
Spalling	Some minor spall
Visible Reinforcing	None
Rusting or Staining of Concrete	None
Any Seepage or Efflorescence	None
Joint Alignment	Okay
Unusual Seepage or Leaks in Gate Chamber	N/A
Cracks	None
Rusting or Corrosion of Steel	None
b. Mechanical and Electrical	
Air Vents	N/A
Float Wells	N/A
Gate Hoist	Stop log hoist deteriorated, not usable
Elevator	N/A

AREA EVALUATED	CONDITIONS
OUTLET WORKS - CONTROL TOWER (cont.)	
Hydraulic System	N/A
Service Gates	Stop logs, slots okay
Emergency Gates	Logs fair
Lightning Protection System	N/A
Emergency Power System	N/A
Wiring and Lighting System	N/A

INSPECTION CHECKLIST

PROJECT International Packings Corp. Upper Dam — DATE 11/21/78

PROJECT FEATURE Transition Conduit — NAME Cole, Nyman

DISCIPLINE Geotechnical, Structural Hydrology/Hydraulics — NAME Devine

AREA EVALUATED	CONDITION
OUTLET WORKS - TRANSITION AND CONDUIT	
General Condition of Concrete	Poor
Rust or Staining on Concrete	Some lime stain
Spalling	Severe
Erosion or Cavitation	Some erosion near bottom of side walls
Cracking	None
Alignment of Monoliths	Okay
Alignment of Joints	Okay - joints, walls to floor worn open, steel exposed
Numbering of Monoliths	N/A

PERIODIC INSPECTION CHECKLIST

PROJECT International Packings Corp. Upper Dam — DATE 11/21/78

PROJECT FEATURE Outlet Structure/Channel — NAME Cole, Nyman

DISCIPLINE Geotechnical, Structural Hydrology/Hydraulics — NAME Devine

AREA EVALUATED	CONDITION
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	
General Condition of Concrete	Poor
Rust or Staining	None
Spalling	Severe spall, near bottom of walls
Erosion or Cavitation	Erosion of walls at bottom
Visible Reinforcing	At joint, wall-floor
Any Seepage or Efflorescence	At westerly toe
Condition at Joints	Poor, floor to wall
Drain holes	None
Channel	
Loose Rock or Trees Overhanging Channel	Trees both sides of channel
Condition of Discharge Channel	Fair, erosion of banks evident

INSPECTION CHECKLIST

PROJECT International Packings Corp. Upper Dam — DATE 11/21/78

PROJECT FEATURE Spillway — NAME Cole, Nyman

DISCIPLINE Geotechnical, Structural Hydrology/Hydraulics — NAME Devine

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	None
Floor of Approach Channel	Silted, no obstruction or debris
b. Weir and Training Walls	Timber weir
General Condition of Concrete	Fair
Rust or Staining	Some rust and lime stain
Spalling	Some spall and erosion
Any Visible Reinforcing	None
Any Seepage or Efflorescence	None
Drain Holes	None
c. Discharge Channel	
General Condition	Good
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	Trees both sides of channel
Floor of Channel	Boulders, cobbles, gravel, some scour evident
Other Obstructions	None

NOTE: Timber weir in fair condition, some deteriorated members, stone mill in cribs gone in some areas.

INSPECTION CHECKLIST

PROJECT International Packings Corp. Upper Dam DATE 11/21/78

PROJECT FEATURE Service Bridge NAME Cole

DISCIPLINE Structural NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - SERVICE BRIDGE	
a. Superstructure	
Bearings	Okay
Anchor Bolts	Okay
Bridge Seat	Fair, timber somewhat deteriorated
Longitudinal Members	Good
Under Side of Deck	Good
Secondary Bracing	Okay
Deck	Okay
Drainage System	N/A
Railings	Good
Expansion Joints	N/A
Paint	Okay, railing only
b. Abutment & Piers	
General Condition of Concrete	Okay
Alignment of Abutment	Good
Approach to Bridge	Okay
Condition of Seat & Backwall	Okay

SUPPLEMENTARY INSPECTION NOTES

INTERNATIONAL PACKINGS CORPORATION UPPER DAM

BRISTOL, NEW HAMPSHIRE

APPENDIX A

The International Packings Corporation Upper Dam is a timber cribwork structure with concrete abutment training walls, an earth embankment section, and a stone masonry wingwall section. It appears to be founded on soil and is located in a broad section of the Newfound River valley. The dam is a run-of-the-river dam with a small impoundment. The cribwork section of the dam forms the spillway; a control outlet is located in the westerly earth embankment of the dam.

1. CONCRETE AND STONE MASONRY STRUCTURES

a. Concrete Surfaces. In general, the concrete surfaces were found to be in fair condition. Some areas of serious erosion and spalling were observed. In some areas reinforcing is exposed through the concrete.

Stone Masonry Surfaces. The stone masonry sections of the dam are reasonably tight; however, portions laid in mortar show signs of cracking and loose mortar. In other areas the masonry appears quite open.

b. Structural Cracking. A large structural crack was observed in the tailrace wingwall between the powerhouse and the spillway of the dam. This crack appears to be directly related to settlement of the downstream end of the pier and is open as much as 4 inches at the top. No other structural cracking was noted.

c. Movement, Horizontal and Vertical Alignment. The concrete and masonry sections of the dam appear to be reasonably true to line and grade, with the exception of the apparent settlement of the tailrace wingwall as noted above.

d. Junctions. The junctions between the earth embankment and the concrete portions of the dam, particularly the wingwalls and training walls, were found

to be in good condition. No seepage or settlement was observed at any of these junctions. Junctions between the concrete portions of the dam and the timber portions of the dam also appear to be in good condition. However, substantial seepage and leakage occurs at the junctions.

e. Drains - Foundation Joint and Face. Downstream of the powerhouse, in the east training wall above the tailrace, are three 4-inch drains. No seepage was observed from these drains, but they appear to be clear. A 4-inch diameter drain was also found downstream of the powerhouse coming out of the east embankment of the dam. This drain was flowing with approximately 2 gpm. No other drains were observed in or below the structure. (Note: Similar flow was observed on November 30, 1978, with pond at normal pool level.)

f. Water Passages in or Below the Structure. The interior surfaces of the penstock or intake to the powerhouse were found to be in good condition. Little or no erosion was observed. The tailrace below the generator was observed to be in generally good condition with little erosion of the concrete surfaces. However, leakage in the ceiling of the tailrace was noted. The floor of this tailrace is concrete and was found to be in good condition. The westerly wingwall of the dam was also found to be in generally good condition with little or no erosion evident. The sidewalls of the controlled outlet, located in the westerly embankment of the dam, were found to be in fair to poor condition. Serious erosion of the concrete in this structure has occurred downstream of the stop logs and also above the stop logs on the westerly side.

g. Seepage or Leakage. Leakage (150 gpm $\pm$) was observed to be coming through the ceiling of the tailrace. No other seepage or leakage through concrete portions of the dam was noted.

h. Monolith Joints, Construction Joints. In general, all the joints in the concrete portions of the dam were found to be in good condition and no signs of leakage, seepage, or movement were observed.

i. Foundation. With the exception of the tailrace wingwall located downstream of the powerhouse and spillway, there is no indication of foundation problems. It appears that the dam is founded on soil, but there is no evidence of settlement or foundation distress. The tailrace wingwall has settled as much as 4 to 5 inches on the downstream end, apparently due to undermining or scour.

j. Abutments. The concrete end walls of the spillway show no signs of instability.

2. EMBANKMENT STRUCTURES

The embankment portions of the dam consist of the east wingwall (faced with stone masonry), an earth section between the spillway and the controlled outlet and another section west of the controlled outlet.

a. Settlement. It was noted that some areas of localized settlement have occurred in the easterly wingwall of the dam east of the powerhouse. These areas are depressions approximately 6 to 8 inches deep and 4 to 6 feet in diameter. No general settlement was noted in this area, however. The embankment section between the spillway and the controlled outlet was found to be in good condition. No settlement was observed. This is also true for the area west of the controlled outlet.

b. Slope Stability. The east wingwall of the dam is retained on the upstream side by stone masonry and on the downstream side by a concrete wall. The upstream wall was found to be in good condition and true to line and grade. The downstream concrete wall is tilted out at the top as much as 4 inches downstream. There appears to be no serious instability at this time. The upstream slope of the embankment between the spillway and controlled outlet appears to be in good condition with no sign of instability. The downstream slope shows signs of erosion, but the slope appears to be stable. The embankment west of the controlled outlet has very flat slopes and appears stable, although an eroded area was found about 50 feet westerly of the outlet structure.

c. Seepage. No seepage was observed downstream of the embankment portions of the dam. The embankments are tree covered in most areas. No animal burrows were found. It should be also noted that the reservoir water level at the time of inspection (November 21, 1978) was very low and therefore seepage would not be readily apparent. No evidence of past seepage was noted. (Note: Some minor seepage through the embankment west of the controlled outlet was observed on November 30, 1978 when the pond was at normal pool elevation.)

d. Drainage Systems. Drain lines were observed coming out of the embankment retaining wall at the powerhouse. These drains were found to be clear. One 4-inch drain was also observed to be coming out of the east embankment and was flowing approximately 2 to 3 gpm. No other drainage systems were found in the embankment sections.

e. Slope Protection. The upstream slope of the easterly embankment is protected by stone masonry walls. The other portions of the embankment have no formal slope protection or rip-rap. The toe of the downstream slope of the embankment near the controlled outlet was found to be seriously eroded by the channel in several areas. The embankment west of the controlled outlet apparently has been overtopped and eroded gullies were noted on the downstream slope.

3. TIMBER CRIBWORK IN GENERAL

The spillway structure is a stone filled timber cribwork. Planks cover the downstream apron and planks and plywood cover the upstream face of the spillway. Above the cribwork are timber columns with stop logs. The service bridge over the spillway is also constructed of timber. A steel beam and cable have been installed on the downstream side of the top of the timber columns to add support to them.

a. General Condition of Timber. The timber members of the cribwork were found to have some surficial deterioration or rot; however, the members appear to be generally sound. The ends of many crib members were split. It was also noted that stone has been displaced from some of the downstream

cribs, leaving several of the cribs only about one-half full of stone. Many of the planks on the downstream apron were found to be deteriorated, broken or missing. Planks on the upstream face of the spillway were also found to be in poor condition. Repair has been made with plywood in several areas, but the plywood was also found to be seriously deteriorated. The stop logs and their supporting columns were found to be in generally good condition.

b. Movement. There is no evidence of vertical movement indicating settlement of the timber section of the dam. However, the cable-supported steel I-beam which restrains the tops of the stop log supports shows a downstream bow of 6 to 8 inches. The junctions between the timber portions of the dam and the concrete abutments were found to be good. Substantial seepage is occurring at these junctions. There is no substantial movement between the timber and the concrete at these junctions.

c. Seepage. Substantial leakage is occurring into the upstream apron of the timber section of the dam. Several small eroded depressions have developed along the upstream toe. However, no distress related to undermining of the dam structure is evident.

4. SPILLWAY STRUCTURES

a. Control Gates and Operating Machinery. The spillway and controlled outlet are controlled by timber stop logs. The stop logs must be manually lifted from the support slots. Several of the hooks on the stop logs have been broken or lost. The stop logs are in generally good condition with little sign of deterioration.

b. Unlined Saddle Spillways. There appear to be several unlined saddle spillways located northwest of the control outlet. This area appears to have been overtopped several times. There are signs of erosion downstream of the crest of this embankment.

c. Approach and Outlet Channels. The spillway approach and outlet channels were found to be clear and unobstructed. The upstream channel has 4 to 6 inches

of accumulated silt, but this would not be likely to effect the operation of the spillway.

d. Stilling Basin. The stilling basin below the spillway consists of a timber apron over the downstream cribwork and also the channel of the stream. Many of the planks of the apron were found to be deteriorated, broken, or missing. The channel shows signs of some minor scour. Undermining of the dam is not evident.

5. OUTLET WORKS

The outlet works consist of a control outlet with two stop log bays located in the west embankment. The outlet discharges to a channel below this embankment section.

a. Intake Structure. The intake of the controlled outlet works consists of concrete abutment wingwalls. The concrete was found to be spalled and eroded. This area is clear of debris and generally unobstructed.

b. Operating and Control Gates. The controlled outlet is regulated by two stop log bays. A hoist over for removal of the stop logs has deteriorated and is unusable. Therefore, stop logs must be manually lifted from the slots. A few of the lifting hooks on the stop logs have broken.

c. Conduits, Sluices and Water Passages. The interior surface of the controlled outlet was found to be in poor condition. The concrete side walls were found to be severely spalled and eroded with reinforcing steel exposed in several areas. The floor of the controlled outlet is concrete and was found to be in good condition.

d. Stilling Basin. The stilling basin below the outlet works consists of an unlined channel. Some scour and erosion has occurred in this channel immediately downstream of the outlet works and also along the toe of the embankment section of the dam.

e. Approach and Outlet Channels. The approach channels were found to be clear and unobstructed. The out-

let channels were generally unobstructed, but many trees overhang the channel banks.

f. Drawdown Facilities. Primary hydraulic control of the reservoir is provided by the spillway and controlled outlet. Complete drainage of the reservoir can be accomplished using the controlled outlet. The inlet to the powerhouse could be used to drawdown the reservoir water surface, but is considered a secondary hydraulic control structure. Its primary purpose is power generation and not control of the water surface.

6. INSTRUMENTATION

None.

7. RESERVOIR

a. Shoreline. No major active or inactive landslide areas were observed. There is a low area in the shoreline located 50' upstream of the controlled outlet.

b. Sedimentation. There is a minor accummulation of sediment in the reservoir area, especially near the inlet to the controlled outlet. The sediment accummulation is not sufficient at this time to impede flow to the outlet or spillway or significantly decrease reservoir storage capacity. The watershed is primarily forested and rural. Newfound Lake probably provides some settling of sediment.

c. Potential Upstream Hazard Area. The small amount of freeboard existing between the normal water surface and embankment crests creates a potential for flooding along Route 3A at and upstream of the dam.

d. Watershed Runoff Potential. The drainage area is primarily forested and rural. Discharge from Newfound Lake (located 0.6 miles above IPC Upper Dam) is closely regulated by the N.H. Water Resources Board.

8. DOWNSTREAM CHANNEL

The channel immediately downstream of the dam, for about 1,600 feet, appears to have sufficient capacity to trans-

port moderate to high flows without significant flooding. The Newfound River channel is generally steep and composed of boulder-cobble bed material. The banks are cluttered with small trees and brush in some reaches. No serious scour problems were noted downstream of the dam.

9. OPERATION AND MAINTENANCE FEATURES

a. Reservoir Regulation Plan. Although no formal plan is available, International Packings Corporation representatives indicated that at low to moderate discharges from Newfound Lake, stop logs are currently maintained near maximum height. In anticipation of high flows, stop logs are manually removed to add capacity to the spillway and controlled outlet.

b. Maintenance. In general, it appears that maintenance to the dam is on an as-needed basis. An ongoing maintenance program does not appear to be in effect, although once a year, the reservoir is reportedly drained for inspection and repair of the dam. Maintenance of planking and other deteriorated members of the timber portion of the dam is presently needed. The embankment sections show signs of erosion needing repair.

c. Operation of Generating Equipment. The generating equipment was not in use at the time of inspection on November 21, 1978 or a follow-up visit on November 30. The equipment is reportedly used during periods when stream flow is consistently above the minimum needed to operate the generator. The log book at the powerhouse has apparently not been kept up to date.

APPENDIX B

ENGINEERING DATA

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

Appendix	Description
B-1	General Project Data
B-2	Past Inspection Reports

APPENDIX B-1

GENERAL PROJECT DATA

I. The following material relative to the International Packings Corporation Upper Dam is on file at the firm's Bristol, N.H. plant:

   A. Miscellaneous information relating to generating equipment.

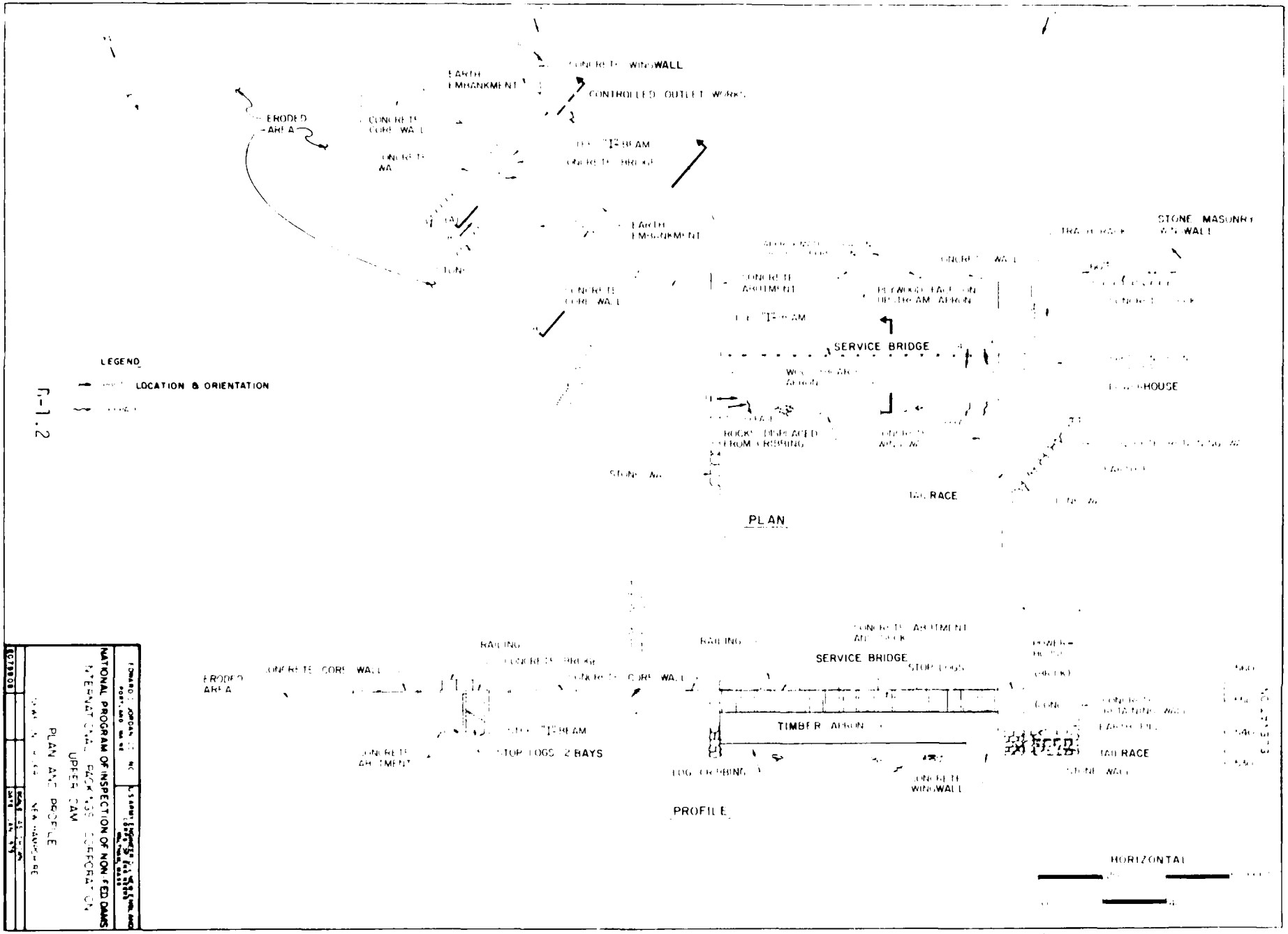
II. The following material is available at the office of the New Hampshire Water Resources Board, 37 Pleasant Street, Concord, N.H.:

   A. Periodic Inspection Reports, copies of which are attached as Appendix B-2 of this report.

   B. Photographs taken of dam at various times during the period 1934 to present.

   C. Miscellaneous correspondence and survey data.

III. The following sketches show plan, profile, and cross-sections of the dam and were developed from limited stadia survey performed during visual inspection, field notes taken by inspection team members, and photographs taken during the visual inspection. The drawings are referenced to an approximate MSL datum based on information in the past inspection reports on file with the N.H. Water Resources Board.



LEGEND

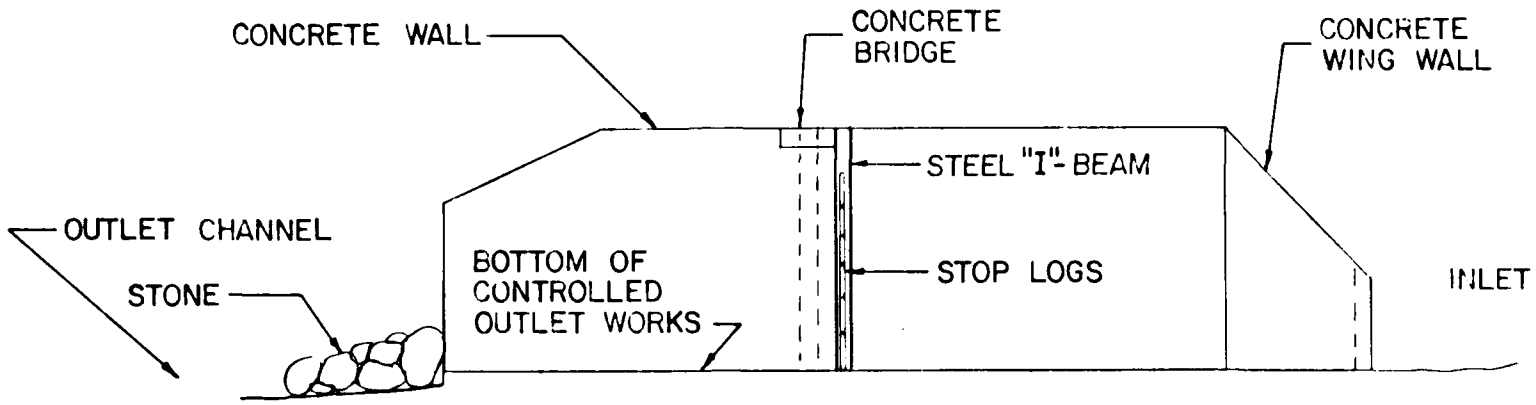
LOCATION & ORIENTATION

F-1.2

NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

PLAN AND PROFILE

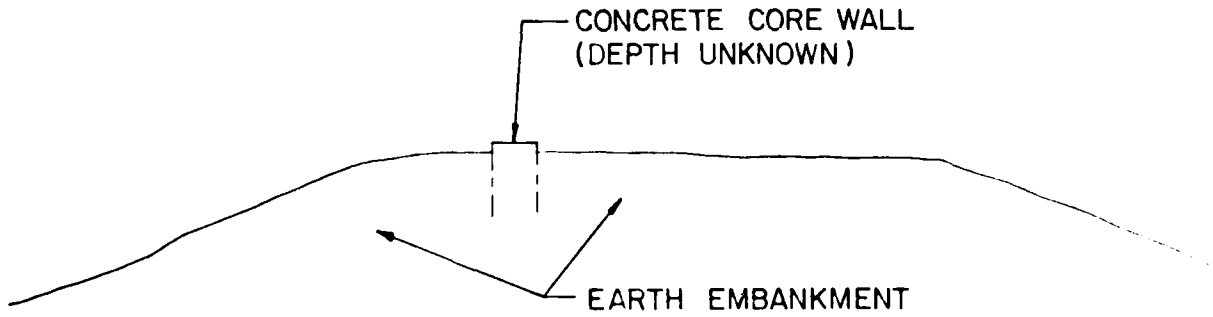
UPPER DAM



SECTION A

(COMPILED FROM PHOTOS & FIELD NOTES)

B-1.3



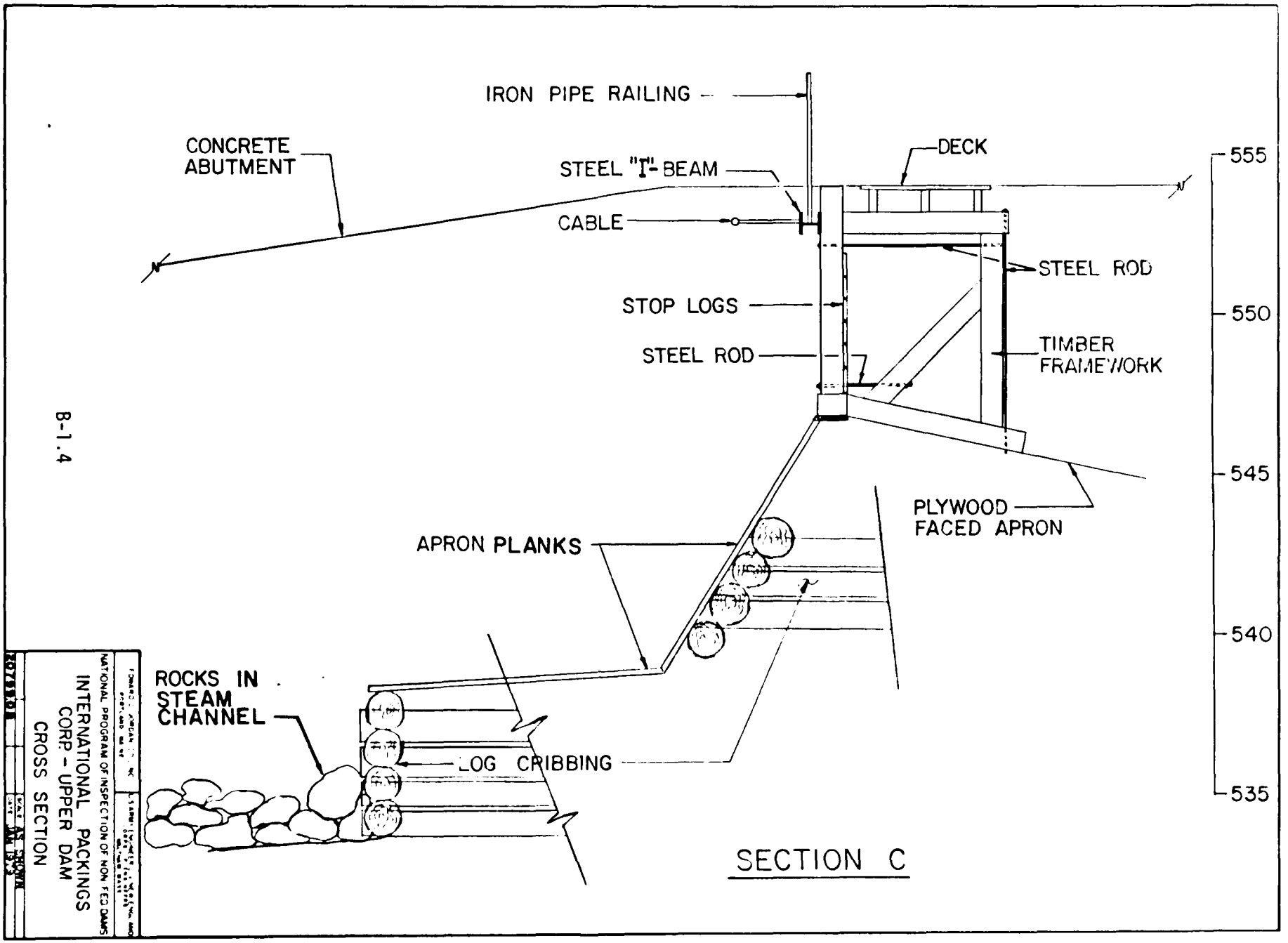
NOTE:
SECTIONS ARE SCHEMATIC, NOT TO SCALE

SECTION B

(COMPILED FROM PHOTOS & FIELD NOTES)

INTERNATIONAL PACKINGS CORP – UPPER DAM
CROSS SECTION

NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS



B-1.4

INTERNATIONAL PACKINGS CORP. - UPPER DAM
CROSS SECTION
NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

APPENDIX B-2

PAST INSPECTION REPORTS

Attached are copies of inspection reports pertaining to the International Packings Corporation Upper Dam and on file with the New Hampshire Water Resources Board in Concord, New Hampshire.

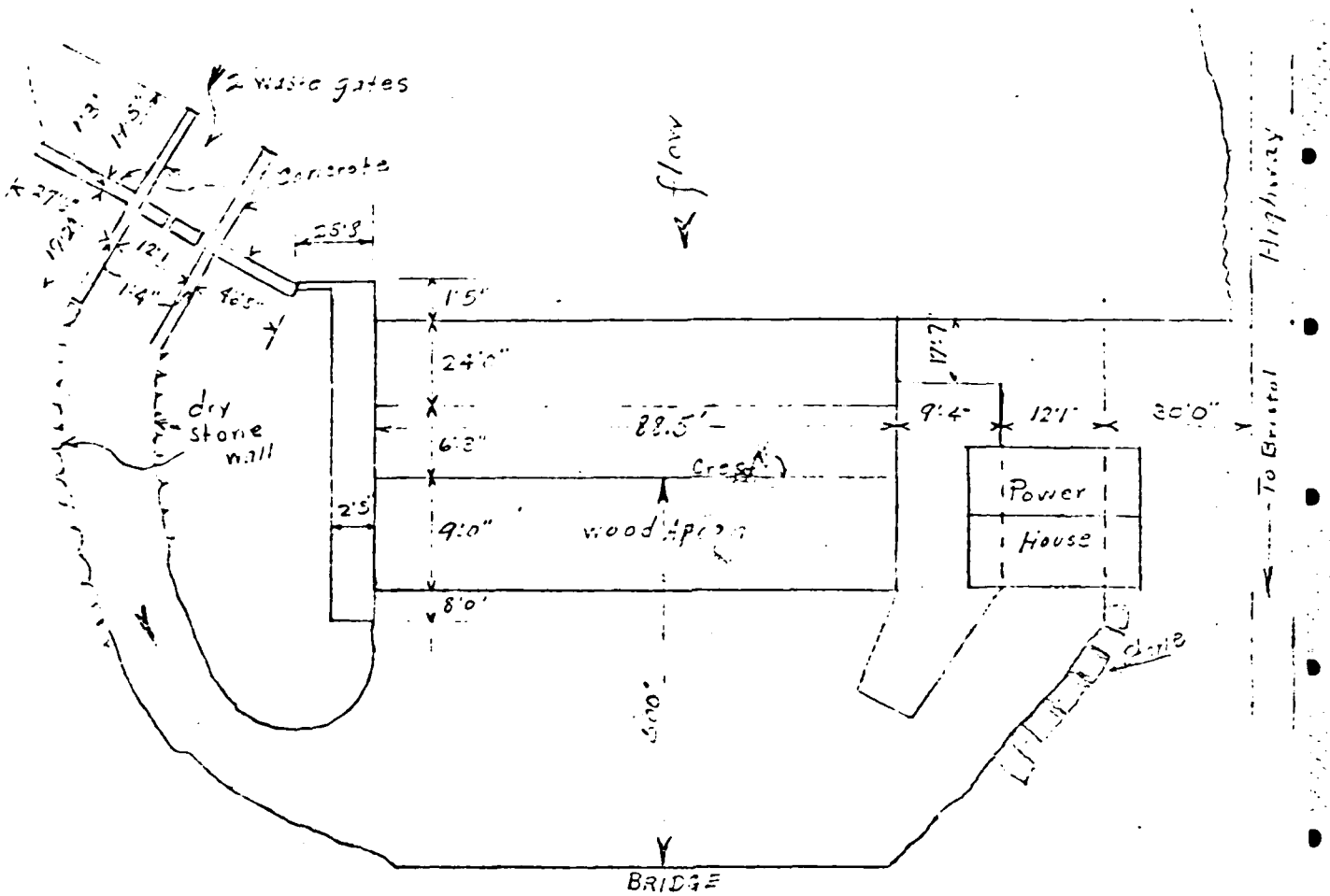
EW HAMPSHIRE
ATER RESOURCES
BOARD
ONCORD, N. H

PROJECT ... FILE ...

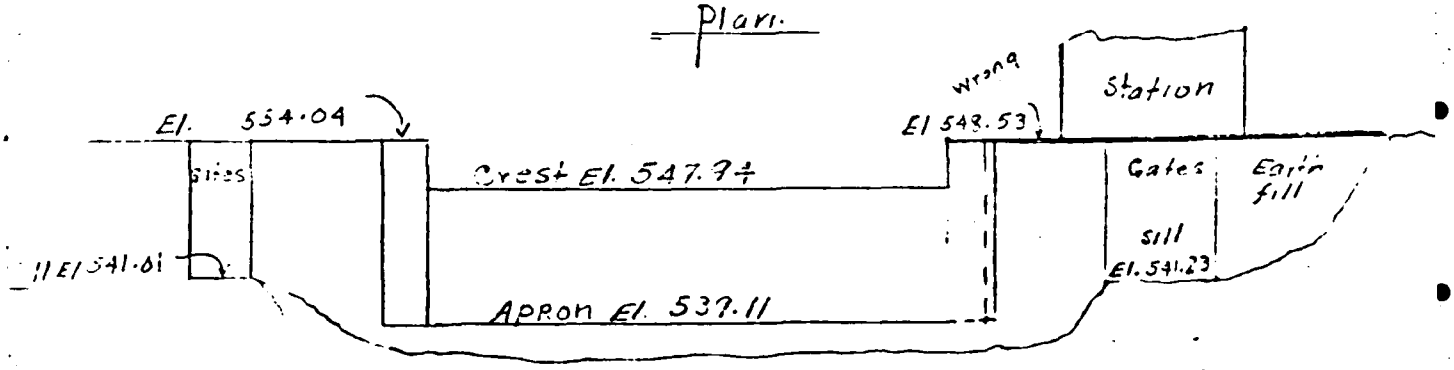
SUBJECT ... ACC ...

... Public Service Co. ...

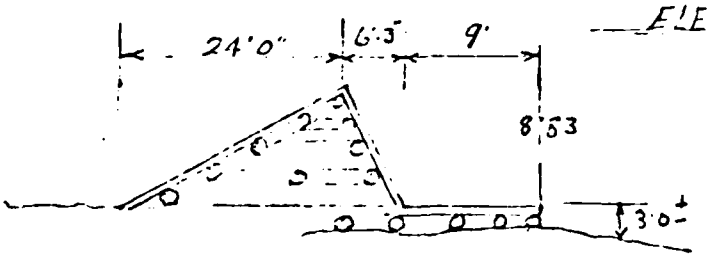
COMPUTER ... CHECKER ... CONT FROM ACC ... CONT ON ACC ... SUMMARY ON ACC ... DATE ...



Plan.



ELEVATION



B-2.2

IDC Upper Dam

NEW HAMPSHIRE WATER RESOURCES BOARD

INSPECTION REPORT

Town: BRISTOL Dam Number: 31,03

Name of Dam, Stream and/or Water Body: NEWFOUND RIVER

Owner: IPC Telephone Number:

Mailing Address: BRISTOL

Max. Height of Dam: 18' Pond Area: 3-5 ACRES Length of Dam: 250'

FOUNDATION: EARTH

OUTLET WORKS: ~~2 GATES~~ 88.5' SPILLWAY

8"x8" H BEAM W/ 1" CABLE SUPPORTS STOP LOG BA-

APRON NEEDS NEW BOARDS

2-6' STOPLOG BAYS (RT SIDE) REPLACED 2-5' GATES

CLEAN TRASH RACK

ABUTMENTS: U/S & D/S

CONCRETE U/S WING ON RT STOPLOG SECTION NEEDS PAT

REMARKS → PLYWOOD OVER U/S BOARD APRON

LARGE CRACK LT D/S WING BET SPILL + ~~GATES~~ WHEEL HOUSE

LT ABUT SPALLED

~~EMBANKMENT~~: LOG CRIB W/ STONE FILL

D/S SIDE OF TURBINE BUILDING SPALLED

Item No. 11.0 5

SPILLWAY: Length: 88.5' Freeboard: (6') 1.5' w/STOPLOGS IN

SEEPAGE: Location, estimated quantity, etc.

LEAKAGE UNDER D/S APRON ENTIRE LENGTH OF DAM

MOST SUBSTATIAL LEAKAGE @ LT ABUT 40 CFS OR MORE

Changes Since Construction or Last Inspection:

1972 - STEEL BEAM, STOPLOG SUPPORTS, CATWALK, STEEL CABLE

WASTE GATES @ RT END KNOW STOP LOGS

Tail Water Conditions:

FREE FLOWING

Overall Condition of Dam: FAIR

Contact With Owner: YES

Date of Inspection: 10/19/78 Suggested Reinspection Date

Class of Dam: NON-MENACE

Signature Kenneth A Thomas

Date 10/19/78

COMMENTS:

(1) PATCH SPALLING
- (a) STOP LOG WING WALLS
- (b) LT ABUT NEAR POWER HOUSE
- (c) D/S SIDE OF POWER HOUSE

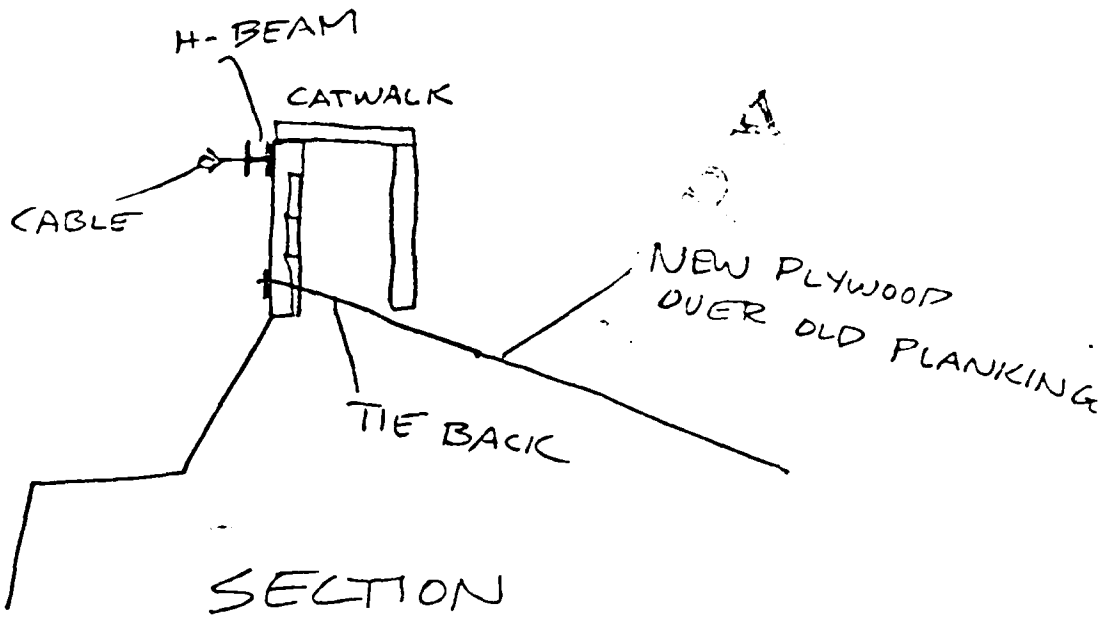
(2) A FEW LARGE TREES NEAR RT ABUT.

(3) CLEAN TRASH RACK

(4) LARGE CRACK in D/S WING WALL BETWEEN SPILLWAY & POWERHOUSE RACEWAY

Section of Dam (Show Plan, Elevation & Cross Sections)

SEE DRAWING IN FILE



SECTION

WATER RESOURCES BOARD
37 Pleasant Street
Concord, N.H. 0330
TELEPHONE 271-34

October 23, 1973

International Packing Corp.
Bristol,
New Hampshire 03222

Dear Sirs:

Under the provisions of RSA Chapter 482, Sections 8 through 15, the New Hampshire Water Resources Board is authorized to inspect all dams in the State which by reason of their physical condition, height and location may be a menace to the public safety.

The dam structure (No. 31.03 & 07) located Bristol, New Hampshire-Newfound River was inspected on October 19, 1973 and as a result of this inspection, certain discrepancies were found which should require corrective measures in order to protect the integrity of the structure. (See attached sheet.)

Your dam has been classified by the Board as a non-menace dam and with this classification, the State will not insist that the item(s) noted on the attached be corrected, but it is advisable that corrective measures be voluntarily initiated to protect the integrity of the structure.

Should you make the repairs and/or maintenance items on the attached sheet in the waters of the State, you will need a permit from the Special Board. Applications can be obtained by writing or calling the Special Board Office, 37 Pleasant Street, Concord, New Hampshire 03301, telephone no. 271-2147.

Please feel free to call or write if you have any questions regarding the evaluation of your structure.

Sincerely,

George McGee Sr.

George J. McGee, Sr.,
Chairman

GJM:paf
Enc.

cc:

B-2.7

IPC-Upper Dam

Dam No. 31.03 Newfound River inspected on October 19, 1978

Visual Discrepancies (31.03 Upper Dam)

1- Spalled concrete should be repaired at the following locations:

a- The wing walls at the stop log section on the right canal,

b- The left abutment near the powerhouse,

c- The downstream side of the powerhouse.

2- The large crack in the downstream wing wall between the spillway and powerhouse should be repaired.

3- There are a few large trees growing very near the concrete and stone appurtenances which should be cut and treated to prevent regrowth. The roots of trees displace stones, crack concrete and increase seepage through earthen embankments.

Dam No. 31.07 Newfound River inspected on October 19, 1978

Visual Discrepancies (31.07 Lower Dam)

1- The right spillway abutment is badly spalled and should be patched or completely refaced.

2- The left abutment at the head gates is extremely deteriorated and should be reconstructed.

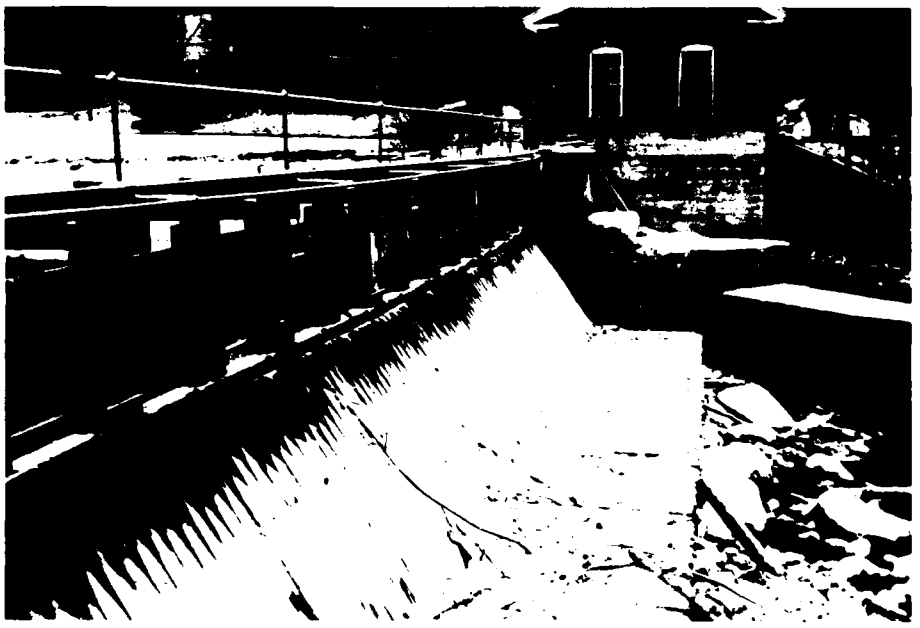
3- There are two trees growing at the downstream end of the left abutment which should be cut and chemically treated to prevent regrowth.

P. S. - Please contact Mr. McGee by telephone (271-3406) to arrange for purchase of cinders.

APPENDIX C

PHOTOGRAPHS

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



1

VIEW OF SPILLWAY STRUCTURE SHOWING CONDITION OF TAIL APRON; POWER HOUSE IN BACKGROUND

2

LOG CRIBBING BENEATH TAIL APRON. NOTE ROCKS DISPLACED FROM CRIB WORK

3

CONCRETE WING WALL ADJACENT TO TAIL RACE; NOTE CRACKING

4

VIEW [illegible]

5

HIGHWAY BRIDGE DOWNSTREAM FROM DAM

6

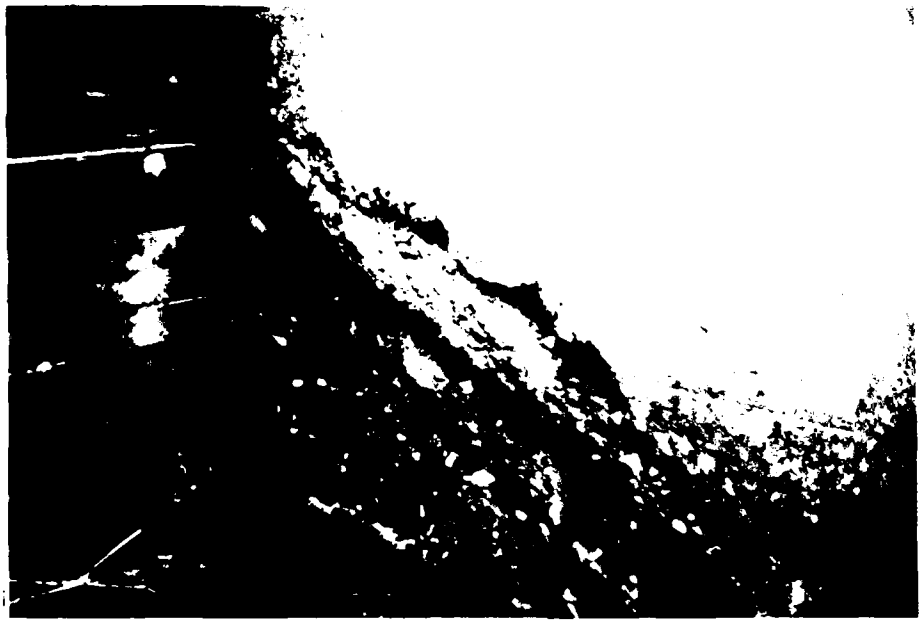
VIEW OF UPSTREAM FACE OF DAM. INLET TO CONTROL OUTLET STRUCTURE IS AT RIGHT.

7

INLET TO CONTROL OUTLET STRUCTURE

8

CONTROL OUTLET GATE
AND BRIDGE AS SEEN
FROM DISCHARGE END



9

VIEW OF DISCHARGE CHANNEL OF CONTROL OUTLET SHOWING EROSION OF CONCRETE

10

VIEW OF UPSTREAM FACE OF DAM FROM CONTROL OUTLET. HIGHWAY CAN BE SEEN IN BACKGROUND AT LEFT; NOTE LACK OF FREEBORAD OVER TOP OF DAM.

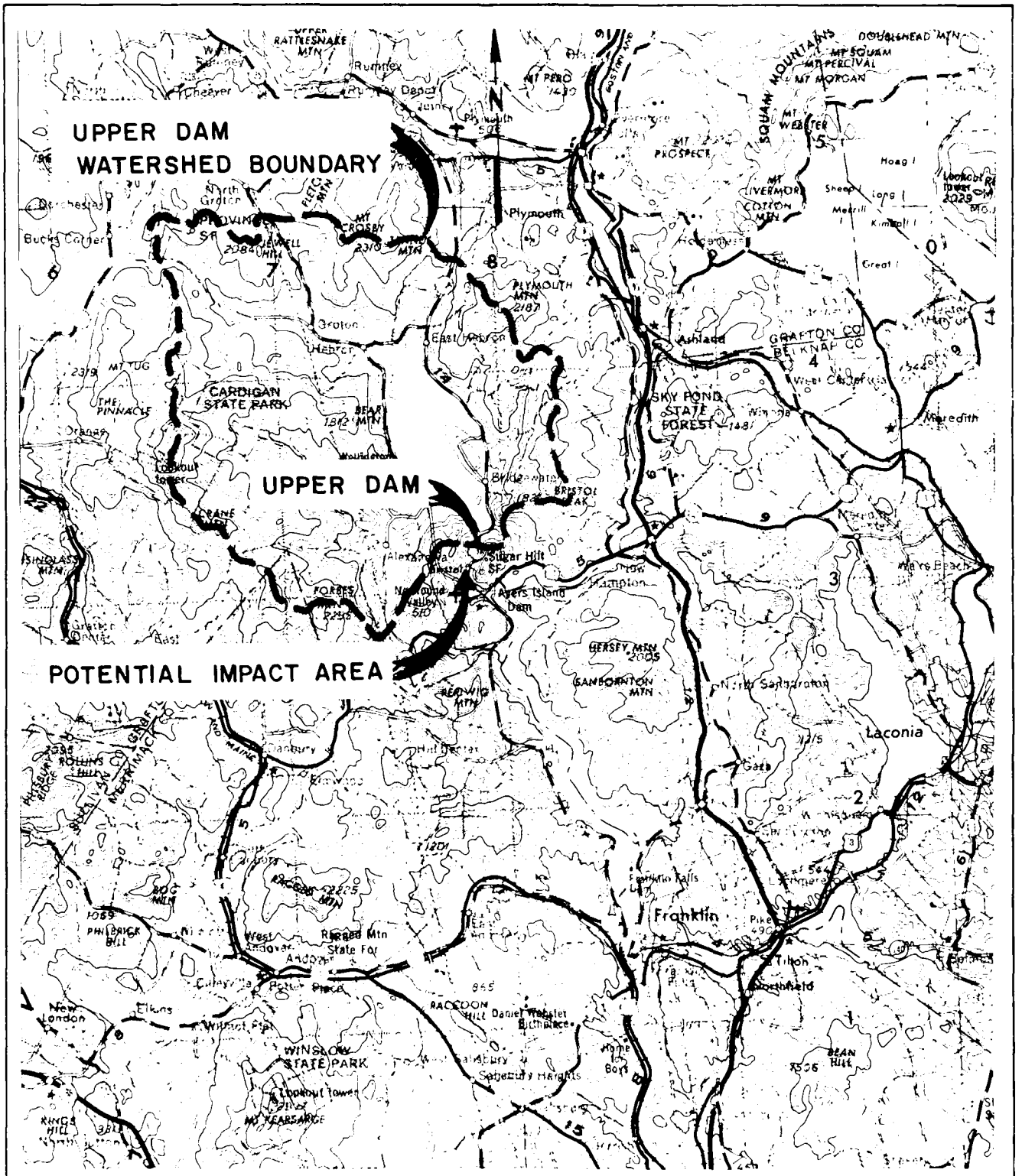
11

VIEW UPSTREAM FROM NEAR POWER HOUSE; RESERVOIR IS AT LOW WATER DUE TO CONTROL OF FLOW FROM NEWFOUND LAKE

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

Hydrologic computations pertinent to this investigation are attached. The following figure shows the Newfound River watershed at the International Packings Corporation Upper Dam.



U.S. GEOLOGICAL SURVEY MAP

CARDIGAN , N.H. QUADRANGLE
HOLDERNESS , N.H. QUADRANGLE
PLYMOUTH , N.H. QUADRANGLE
RUMNEY , N.H. QUADRANGLE

0 5 10 15 MILES

INTERNATIONAL PACKINGS CORP.
UPPER DAM
DRAINAGE AREA MAP
NEWFOUND RIVER N.H.
AS SHOWN
20799108 MARCH 1979

PROJECT		JOB NO.
N.H. DAM INSPECTION PROGRAM		
IPC UPPER DAM	CHK BY	DATE

Test Flood Analysis

All flow at the IPC Upper Dam is controlled by the Newfound Lake Dam. The drainage area above Newfound Lake Dam is 95.0 square miles. The drainage area above the IPC Upper Dam is 95.8 square miles.

The PMF + ½ PMF flood flows are to be routed through Newfound Lake. The routed flow will then be added to the contribution from the remaining drainage (0.8 mi^2) to determine the peak discharge of the PMF and ½ PMF. The fact that the peaks will be out of sync due to routing is not considered.

Slope of the longest channel = 140 ft/mile
Terrain is hilly to mountainous

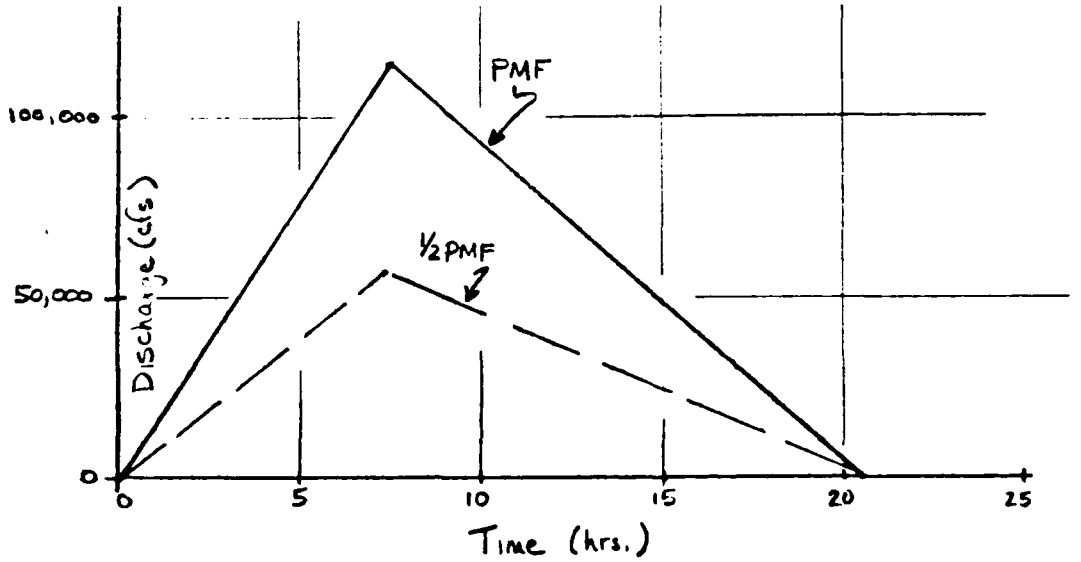
- Using 'Mountainous' curve of Guide Curves
  PMF = 1,200 csm × 95.0 mi^2 = 114,000 cfs (to be routed)
  ½ PMF = 57,000 cfs (to be routed)

- Storage Routing (using HEC-1)
  a) Inflow hydrograph
  Time to peak:
  19" of runoff from 95 mi^2 = 96,267 A-F (total area under hydrograph)

$$96{,}267 = \frac{1}{2}(114{,}000) \times B$$

$$B = 20.4 \text{ hours (total time of runoff)}$$

Time to peak = 20.4 ÷ 2.67 = 7.6 hours ≅ 7.5 hours



PROJECT	COMP BY	JOB NO.
	[illegible]	20799-03
	CHK BY	DATE
		2-19-[illegible]

B) Storage - Discharge Relationship Data on Newfound Lake:

Newfound Lake is presently owned and operated by the New Hampshire Water Resources Board. The primary purpose of the dam is for lake level control for recreation on Newfound Lake. A minimum release to the Newfound River is provided. During the winter months, normal operating procedure provides for maintenance of the lake level at 4.2 ft with respect to the USGS water surface elevation gage located at the dam. During the summer month, normal operating procedure provides for maintenance of the lake level at 6.5ft (storage = 35,470 ac.-ft.). For the initial storage volume in the HEC-1 routing subroutine, we input 35,470 acre-feet.

An area-capacity table for Newfound Lake is included in this Appendix.

- capacity at full pond elevation of 589.1 ft = 38,800 A-F
- area at full pond elev = 4,100 acres
- capacity at elev 588.4' (6.5' on USGS reservoir elevation gage) = 35,470 A-F
- there is a storage capacity of about 13,200 acre-feet below reservoir level of 1.3'
- area at elevation 600 ft = 5,500 acres (from USGS quad)
  interval capacity = $\left(\frac{5500+4100}{2}\right) \times 10.9'$ = 52,320 A-F

  total capacity at 600 ft = 91,120 A-F
- area at elevation 620 ft = 7,350 acres (from USGS quad)
  interval capacity = $\left(\frac{5500+7350}{2}\right) \times 20'$ = 128,500 A-F

  total capacity = 219,620 A-F

NEWFOUND LAKE STORAGE
IN
CUBIC FEET PER SECOND

STORAGE DATA - NEWFOUND LAKE

USGS GAGE Elev. Ft.	Tenths of Feet										Ave.	Inc
	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	Diff.	Run
1.00	0	0	0	119 1/	322	532	735	938	1141	1344	200	5.1
2.00	1554	1757	1967	2170	2380	2590	2793	3003	3213	3423	210	4.4
3.00	3633	3843	4053	4263	4473	4690	4900	5110	5327	5537	210	3.6
4.00	5745	5971	6181	6398	6615	6832	7049	7259	7483	7700	220	2.8
5.00	7917	8134	8351	8568	8792	9009	9233	9450	9674	9891	220	1.9
6.00	10115	10339	10563	10780	11004	11228	11459	11683	11907	12131	220	1.1
7.00	12362	12586	12810*	13041	13272	13496	13727	13958	14182	14413	230	0.2
8.00	14644	14874	15104	15334	15564	15794	16024	16254	16484	16714	230	0.6
9.00	16944	17184	17424	17664	17904	18144	18384	18624	18864	19104	240	1.5
10.00	19344	19584	19824	20064	20304	20544*					240	2.5
												3.0

D-4

IPC Upper Dam

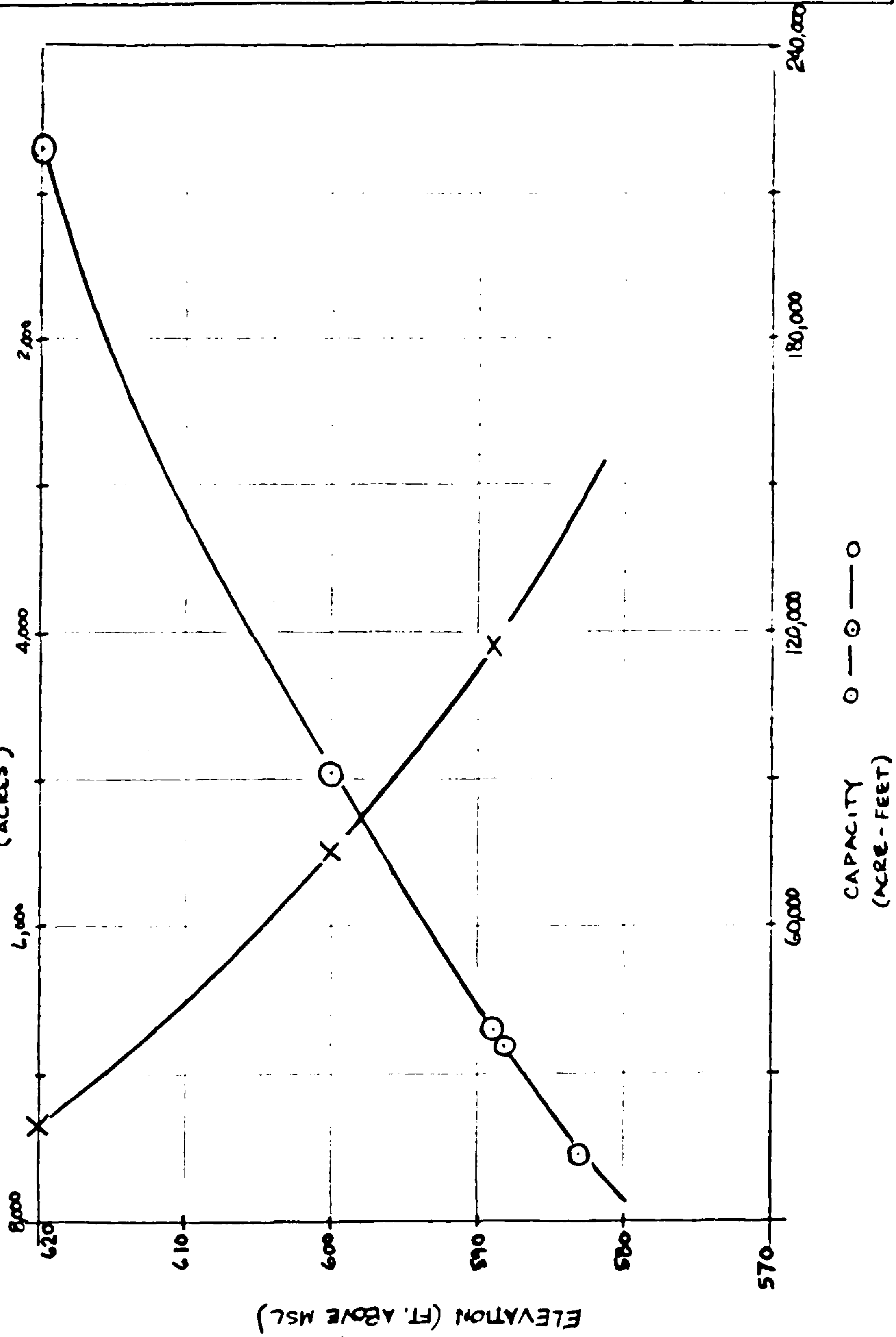
Gross D.A. 95.05 Sq. Mi.
Surface Area 4106 Acres
Full Pond Elev. 7.24 USGS Gage
Gate Sill Elev. -2.15
Zero of Gage 581.88 USGS Gage
Dam Gage Elev. 7.24 USGS = 108"
1" Runoff = 2535 cfs = 1.16' on Lake

Based on USGS Capacity Table dated 11/25/42
Computed by V.A.K. - 4/4/74

1/ Note: Storage is given in cfs-days. There is storage below elevation 1.3' on gage; approximately 13,200 acre-feet. Discharge from the spillway is controlled by a sandbar upstream of the dam. The sandbar control is at some elev. - 2.3' (see 2')

EDWARD C. JORDAN CO., INC.

PROJECT	COMP BY	JOB NO.
IPC UPPER DAM [illegible] CURVE - [illegible] LAKE	JSD	[illegible]
	CHK BY	DATE 2-19-[illegible]



NEWFOUND LAKE
AREA - CAPACITY CURVES

PROJECT	COMP BY	JOB NO.
	FED	20774-08
	CHK BY	DATE
		2-[illegible]-93

B) Storage - Discharge Relationship

Newfound Lake Dam and Spillway:
The top of dam at Newfound Lake is at elevation 592.4'. The dam is 110' long. There are three distinct spillway sections. Weir "A" consists of 3 stop log sections measuring 12.7 ft high by 4.0 ft wide. Floor elevation of weir "A" is about 579.7 ft. Weir "B" also consists of 3 stop log sections measuring 12.7 ft high by 6 ft wide. Floor elevation of weir "B" is 579.7 ft. A sand bar upstream of the dam impedes flow below elevation 584.2 ft (~2.3 ft on USGS gage on reservoir). It is assumed there is no discharge with reservoir water surface elevation ≤ 584.2 ft.

Weir "C" consists of 6 bay spillways measuring 7.2 ft wide by 6.2 ft high. Floor elevation of weir "C" is 586.2 ft.

C) Summary of storage - discharge data

Elev (ft)	Storage (A-F)	Discharge (cfs)
583.2	4,000	0
581.2	6,000	0
582.2	10,000	0
583.2	13,000	0
584.2	18,000	0
585.2	23,000	1,018
586.2	28,000	1,308
587.2	31,000	1,735
588.2	35,000	2,232
589.2	40,000	2,923
590.2	45,000	3,649
591.2		
592.2		
593.2	58,000	6,980
534.2		
595.2	67,000	10,310

Elev. (Ft.)	Storage (A-F)	Discharge (cfs)
598.2	82,000	16,009
600.2	94,000	20,117
605.2	117,000	35,697
610.2	146,000	52,928
615.2	171,000	71,192
620.0	220,000	89,763

PROJECT	COMP BY	JOB NO.
Rating Curve - [illegible] Lake Dam [illegible]	[illegible]	[illegible]
	CHK BY	DATE
		[illegible]

ASSUME FLOW IS GOVERNED BY $Q = CLH^{3/2}$ AND SPILLWAY ACTS AS A BROAD-CRESTED WEIR OR WEIR WITH TRAPEZOIDAL CROSS-SECTION.

Upstream sand bar impedes discharge below elevation 584.2 ft (2.3 ft on USGS reservoir elevation gage). Top of dam elevation = 592.4 ft. Discharge at 584.2 ft = 0.0 cfs. Bottom of bay spillways = 586.2 ft. Elevation of gate sill = 579.7 ft. Q_S is discharge through a single [illegible]

Elevation (ft)	Discharge through weir "A" [1] (cfs)					Discharge through weir "B" [2] (cfs)				
	H	C [3]	L	Q_S	Q_T	H	C [3]	L	Q_S	Q_T
584.7	5.0	2.63	4	118	353	5.0	2.63	6		529
585.2	5.5				407	5.5				611
	6.0				464	6.0				696
586.2	6.5				523	6.5				785
	7.0				585	7.0				877
587.2	7.5				648	7.5				972
	8.0				714	8.0				1,071
588.2	8.5				782	8.5				1,173
	9.0				852	9.0				1,278
589.2	9.5				924	9.5				1,386
	10.0				998	10.0				1,497
590.2	10.5				1,074	10.5				1,611
	11.0				1,151	11.0				1,727
591.2	11.5				1,231	11.5				1,846
	12.0				1,312	12.0				1,968
592.2	12.5				1,395	12.5				2,092
592.4	12.7				1,428	12.7				2,143
593.2	13.5				1,565	13.5				2,348
594.2	14.5				1,743	14.5				2,614
595.2	15.5				1,926	15.5				2,889
596.2	16.5				2,115	16.5				3,173
597.2	17.5				2,310	17.5				3,466
598.2	18.[illegible]				2,511	18.5				3,766
599.2	19.5				2,718	19.5				4,076
600.2	20.5				2,929	20.5				4,394
601.2	21.5				3,146	21.5				4,719
602.2	22.5				3,368	22.5				5,053
603.2	23.5				3,595	23.5				5,393
604.2	24.5				3,827	24.5				5,741

PROJECT	COMP BY	JOB NO.
	CHK BY	DATE 12-20-78

Flow through Weirs "A" and "B" (cont.)

Elevation (Ft)	H	C	L_A	L_B	Q_A	Q_B
605.2	25.5	2.63	4	6	4,064	6,096
606.2	26.5				4,305	6,458
607.2	27.5				4,551	6,827
608.2	28.5				4,802	7,203
609.2	29.5				5,057	7,585
610.2	30.5				5,316	7,974
611.2	31.5				5,580	8,369
612.2	32.5				5,847	8,771
613.2	33.5				6,119	9,179
614.2	34.5				6,395	9,593
615.2	35.5				6,675	10,010
616.2	36.5				6,960	10,439
617.2	37.5				7,247	10,871
618.2	38.5				7,539	11,309
619.2	39.5				7,835	11,752
620.0	40.3				8,074	12,111

PROJECT	COMP BY	JOB NO.
RATING CURVE - Newfound Lake Dam Spillway	TCD	[illegible]
	CHK BY	DATE
		12-20-78

BAY SPILLWAYS - Total of 6 bays w/ dimensions of 7.2' wide by 6.2' high
Bottom of bay elevation = 536.2'

Elevation (Ft)	Discharge through weir "C" 4/ (cfs) H	C	L	Q_s	Q_T
536.7	0.5	2.61	7.2		40
587.2	1.0	2.67			115
587.7	1.5	2.66			211
	2.0	2.68			327
588.7	2.5	2.72			465
	3.0	2.73			613
589.7	3.5	2.76			781
	4.0	2.79			964
590.7	4.5	2.88			1,188
591.2	5.0	3.07			1,483
591.7	5.5	3.32			1,850
592.2	6.0	"			2,108
592.4 (TOP OF DAM) 5/	6.2	"			2,214
593.2	7.0				2,656
594.2	8.0				3,245
595.2	9.0				3,872
596.2	10.0				4,536
597.2	11.0				5,233
598.2	12.0				5,962
599.2	13.0				6,723
600.2	14.0				7,513
601.2	15.0				8,332
602.2	16.0				9,179
603.2	17.0				10,053
604.2	18.0				10,953
605.2	19.0				11,878
606.2	20.0				12,828
607.2	21.0				13,802
608.2	22.0				14,800
609.2	23.0				15,820
610.2	24.0				16,863
612.2	26.0				19,014
614.2	28.0				21,250
616.2	30.0				23,567
618.2	32.0				25,963
619.2	33.0				27,189
620.0	33.8				28,184

1/ Weir "A" is the stop log spillway section closest to the right abutment looking upstream. There are 3 individual sections w/ dimensions of 4' wide by 10½' high. Q_s represents flow through a single section, Q_T is the total flow through the weir

2/ Weir "B" is the middle stop log spillway section consisting of three individual sections with maximum dimensions of 6' wide by 10½' high. Q_s represents flow through a single section. Q_T is the total flow through the weir

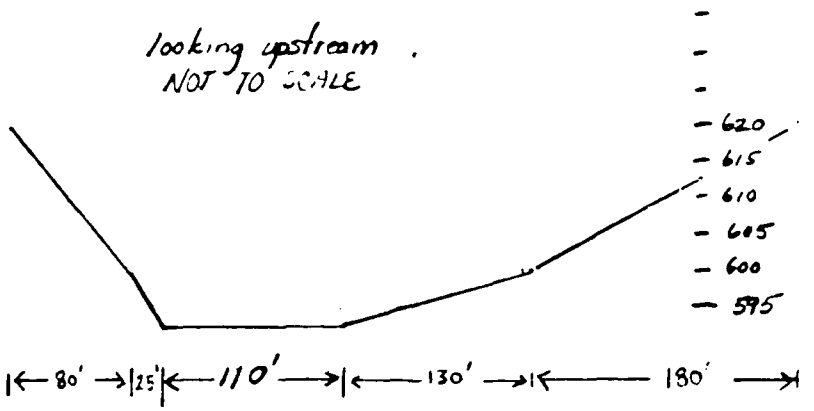
3/ 'C' values from Brater & King "Handbook of Hydraulics", Table 5-3, pg 5-46.

4/ Weir "C" is the bay spillway section which consists of 6 bays

PROJECT	COMP BY	JOB NO.
RATING CURVE - Hereford Dam	CD	207[illegible]
Dam Overflows	CHK BY	DATE
		12-20-79

Cross-section at dam (top of dam at 592.4, length = 120')

looking upstream
NOT TO SCALE



Dam overflow:
Dam width already accounted for in weirs "A" + "B" + "C" = 73.2 ft - remainder of dam acts as a broadcrested weir upon overflow (110' - 73.2' = 36.8 ft)
Overflow over dam discharge determined below:

Elevation (ft)	H	C	L	Q
592.4	0		36.8	0
593.4	1.0	2.63	36.8	97
594.4	2.0			274
595.4	3.0			503
596.4	4.0			774
597.4	5.0			1,082
598.4	6.0			1,422
599.4	7.0			1,793
600.4	8.0			2,190
601.4	9.0			2,613
602.4	10.0			3,060
603.4	11.0			3,531
604.4	12.0			4,023
605.4	13.0			4,537
606.4	14.0			5,070
607.4	15.0			5,623
608.4	16.0			6,194
609.4	17.0			6,784
610.4	18.0			7,391
612.4	20.0			8,657
614.4	22.0			9,987
616.4	24.0			11,379
618.4	26.0			12,831
620.0	27.6			14,033

Overtank flow estimate

$Q = \frac{1.486}{n} A R^{2/3} S^{1/2}$

at elev 600', $A = \frac{1}{2}(25')(7.6) + \frac{1}{2}(7.6)(130')$

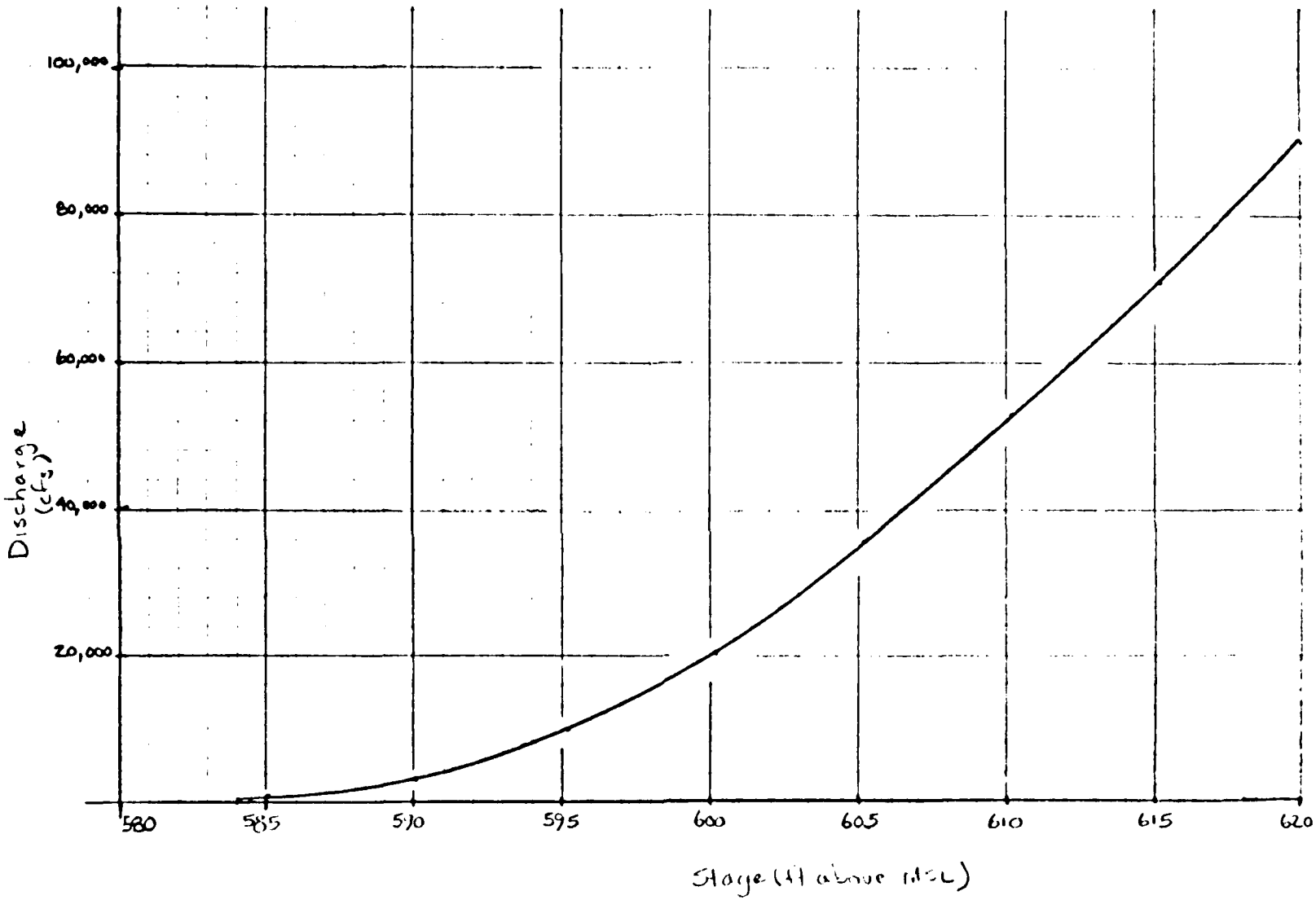
$A = 589\ ft^2$
$P = 130 + 26 = 156$
$R = 3.776 \quad R^{2/3} = 2.424$
$S = .0095$ (from USGS map)
$S^{1/2} = .097$
$n = .065$
$Q = 3,166$ cfs

at elev 620', $A = 589 + \frac{1}{2}(20)(80) + \frac{1}{2}(180)(20) = 3189$

$P = 156 + 181 + 82 = 419$
$R = 7.610 \quad R^{2/3} = 3.869$
$S^{1/2} = .097$
$Q = 27,361$ cfs

Assume a linear rating curve for overflow

STAGE - DISCHARGE CURVE : NEWFOUND LAKE DAM



CHK BY

DATE 2-13-73

VERSION DATED JAN 1973
ED AUG 74
NO. 01

ROUTING OF PMF AND 1/2 PMF FLOODS
THRU NEWFOUND LAKE

C.O.E. DAM INSPECTION PROGRAM
ROUTING OF PMF THRU NEWFOUND LAKE FOR STUDY OF IPC DAMS
JOB NO. 20799-07 AND 08

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
12	2	30	0	0	0	0	2	4	0

JOPER	NWT
3	0

SUB-AREA RUNOFF COMPUTATION

1/2 PMF INFLOW HYDROGRAPH TO NEWFOUND LAKE

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
100	0	0	0	0	0	1

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
-1	0	95.00	0.00	0.00	0.00	0.000	0	0	0

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTING THRU NEWFOUND LAKE

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
100	1	0	0	0	0	1

ROUTING DATA

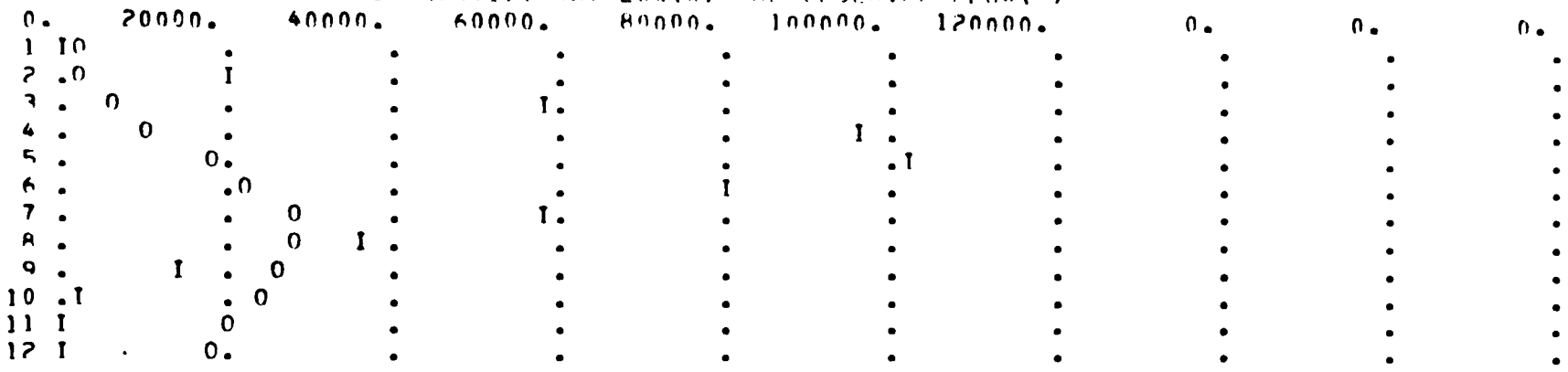
QLOSS	CLOSS	AVG	IRES	ISAME
0.0	0.000	0.00	1	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA
0	0	0	0.000	0.000	0.000	35470.

AGE=	23000.	40000.	58000.	67000.	82000.	94000.	117000.	146000.	171000.	22000
LOW=	1018.	2923.	6980.	10310.	16009.	20117.	35687.	52928.	71192.	8976

STATION 100

INFLOW(I), OUTFLOW(O) AND OBSERVED FLOW(*)



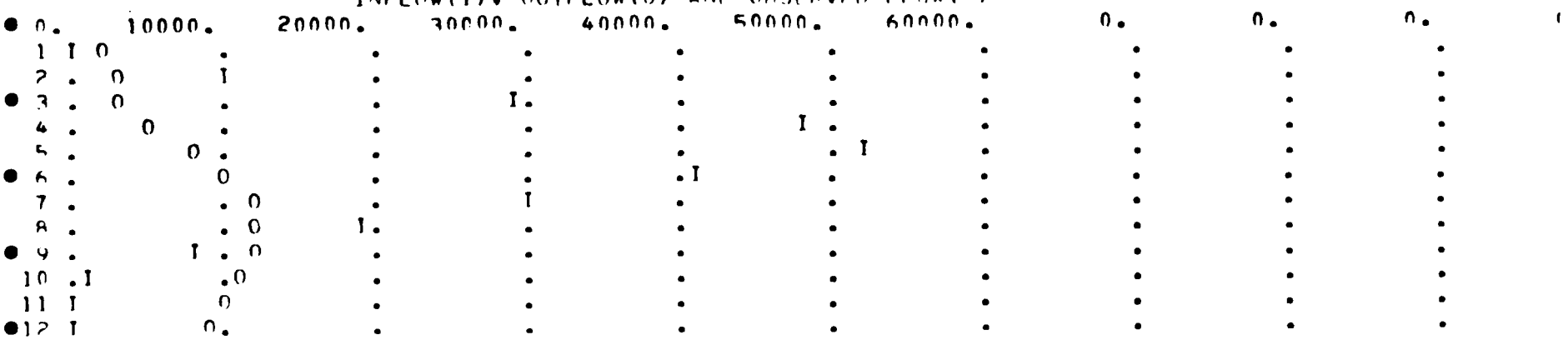
IPC Upper Dam

RUNOFF SUMMARY. AVERAGE FLOW

		PEAK	6-HOUR	24-HOUR	72-HOUR	AREA
HYDROGRAPH AT	100	114000.	102867.	51557.	38668.	95.00
ROUTED TO	100	28722.	28170.	21839.	17224.	95.00

STATION 100

INFLOW(I), OUTFLOW(O) AND OBSERVED FLOW(*)



RUNOFF SUMMARY, AVERAGE FLOW

		PEAK	6-HOUR	24-HOUR	72-HOUR	AREA
HYDROGRAPH AT	100	57000.	51519.	26064.	19548.	95.00
ROUTED TO	100	12117.	11949.	9905.	8112.	95.00

PROJECT	COMP BY	JOB NO.
	CHK BY	DATE

Spillway Capacity of I.P.C. Upper Dam

A) Service Spillway
- consists of 16 ports measuring 3.8 ft. wide by 5.0 ft. high (maximum height of stop logs)
- distance from spillway crest to top of dam = 6.4 ft (average spillway crest at 94.0 ft. using survey datum)
- elevation of top of dam = 100.4 ft. using survey datum, and 554.0 ft according to old drawing of dam

Survey datum elev. (ft) [1]	Mean sea level elev (ft.) [2]	H	C [3]	L	Q_s [4]	Q_T [5]
94.0 [6]	547.6	0			0	0
95.0	548.6	1.0	3.41	3.8	12.9	208
95.5	549.1	1.5	3.57	"	25.3	399
96.0	549.6	2.0	3.65	"	40	627
96.5	550.1	2.5	3.70	"	56	889
97.0	550.6	3.0	3.72	"	73	1,175
97.5	551.1	3.5	3.72	"	93	1,481
98.0	551.6	4.0	3.73	"	113	1,815
98.4	552.0	4.4	"	"	131	2,093
99.0	552.6	5.0	"	"	159	2,536
99.5	553.1	5.5	"	"	182	2,925
100.0	553.6	6.0	"	"	209	3,333
100.4	554.0 [7]	6.4	"	"	230	3,672
101.0	554.6	7.0	"	5.5 [8]		5,133
102.0	555.6	8.0	"	"		6,272
103.0	556.6	9.0	"	"		7,434
104.0	557.6	10.0	"	"		8,765
106.0	559.6	12.0	"	"		11,522
108.0	561.6	14.0	"	"		14,519
110.0	563.6	16.0	"	"		17,739

[1] Refer to drawing of dam profile
[2] Elevation referenced to mean sea level = survey datum + 453.6 ft.
[3] Values from King & Brater, "Handbook of Hydraulics", Table 5-11, pg 5-53
[4] Discharge through a single port
[5] $Q_T = 16\ Q_s$
[6] Average spillway crest
[7] Top of dam
[8] Account for absence of any stop log guides or walkway supports.

PROJECT	COMP BY	JOB NO.
	[illegible]	[illegible]
	CHK BY	DATE
	[illegible]	1-1-79

c) Controlled Outlet Structure
- consists of two parts measuring 5½' wide by 13.2 ft high
- distance from crest to top of dam = 13.2 ft
- elevation of crest = 87.2' using survey datum and 540.8' USGS M.S.L.
- assume C = 2.63 for all values of H

Survey datum elevation	Elevation	H	C	L → includes both parts	Q
87.2'	540.8'	0	2.63	11.0	0
	541.8	1.0	"	"	29
	542.8	2.0	"	"	82
	543.8	3.0	"	"	150
	544.8	4.0	"	"	231
	545.8'	5.0	"	"	323
	546.8	6.0	"	"	425
	547.8	7.0	"	"	536
	548.8	8.0	"	"	655
	549.8	9.0	"	"	781
97.2	550.8	10.0	"	"	915
	551.8	11.0	"	"	1,055
		12.0	"	"	1,203
		13.0	"	"	1,356
100.4	554.0	13.2	"	"	1,387
	554.8	14.0	"	"	1,515
	556.8	16.0	"	"	1,852
	558.8	18.0	"	"	2,209
107.2	560.8	20.0	"	"	2,588

c) 8' wide deck between powerhouse and spillway section
- will act as a broad-crested weir upon overtopping

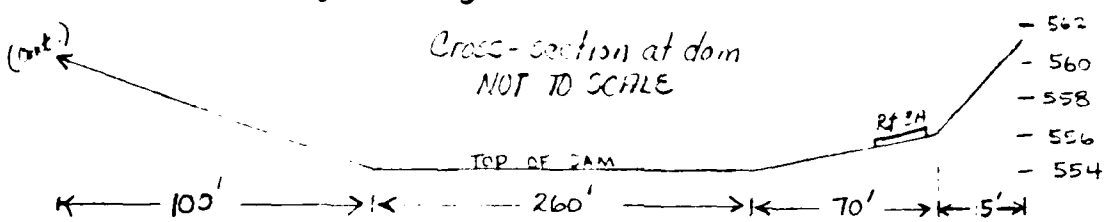
Elevation	H	C [1]	L	Q
554.0	0		8'	0
555.0	1	2.68	8'	21
556.0	2	2.65	"	60
557.0	3	2.66	"	111
558.0	4	2.70	"	173
559.0	5	2.79	"	250
560.0	6	2.88	"	339
561.0	7	2.88	"	427

[1] King & Brater, Table 5-3, pg 5-46, C values for H=6 and H=7ft are estimated

PROJECT	COMP BY	JOB NO.
	[illegible]	2074[illegible]-[illegible]
	CHK BY	DATE
		-12-79

D) Discharge over dam through non-spillway section

The IPC Upper Dam is constructed on the Newfound River in a narrow, yet flat valley section. Vertical distance between the top of dam and Route 3A is approximately 1 to 2 feet. The highway centerline is approximately 50 ft. from reservoir water line near the dam. East of the highway, hills with an approximate slope of 1 vertical : 3 horizontal begin to rise. At the west end of the dam, the ground slopes down to the emergency spillway channel, then back up again. From top of bank to top of bank, the emergency spillway channel is approximately 30 ft wide and is about 12 ft high. For computation of discharge over dam, it is assumed that the emergency spillway acts independently of over-the-dam flow. The valley section is drawn below. The controlled outlet channel is drawn as part of the dam. Dam overflow will occur over the 50 foot east wingwall which is included in the drawing as part of the dam. Dam overflow is assumed to be governed by Mannings equation.



Looking upstream

Length of powerhouse = 18' (no flow through powerhouse)

At elev = 555 ft :

$A = (50 \times 1) + (1 \times 35 \times .5) + (1 \times 16.7 \times .5) = 76\ ft^2$

$P = 50 + 35 + 16.7 = 102\ ft \qquad R = .745 \qquad R^{2/3} = .822 \qquad S = .015$

$\eta = .050 \qquad \therefore Q = 227\ cfs$

At elev = 556 ft :

$A = 76 + 50 + 16.7 + 35 + 26 = 204\ ft^2$

$P = 102 + 35 + 16.7 = 153.7\ ft, \quad R = 1.327, \quad R^{2/3} = 1.208, \quad S = .015$

$\eta = .045, \therefore Q = 997$

η is lower to account for road surface in x-section

At elev = 557 ft :

$A = 204 + 154 + 8.3 + 1.5 = 368\ ft^2$

$P = 153.7 + 16.7 + 3.2 = 173.6, \quad R = 2.166, \quad R^{2/3} = 1.674, \quad S = .015$

$\eta = .045, \therefore Q = 2,491$

PROJECT	COMP BY	JOB NO.
	KD	20799-03
	CHK BY	DATE
		1-12-79

At elevation 558 :

$A = 376 + 171 + 8.3 + 1.5 = 557\ ft^2$

$P = 173.6 + 16.7 + 3.2 = 193.5$, $R = 2.920$, $R^{2/3} = 2.043$, $S = .015$

$\eta = .045$, $\therefore Q = 4,602$ cfs

At elevation 559 :

$A = 565 + 191 + 8.3 + 1.5 = 766\ ft^2$

$P = 193.5 + 16.7 + 3.2 = 213.4$, $R = 3.627$ $R^{2/3} = 2.361$, $S = .015$

$\eta = .045$, $\therefore Q = 7,314$ cfs

At elevation = 560 :

$A = 774 + 212 + 8.3 + 1.5 = 996\ ft^2$

$P = 213.4 + 16.7 + 3.2 = 233.3$, $R = 4.309$, $R^{2/3} = 2.648$

$\eta = .045$, $\therefore Q = 10,666$ cfs

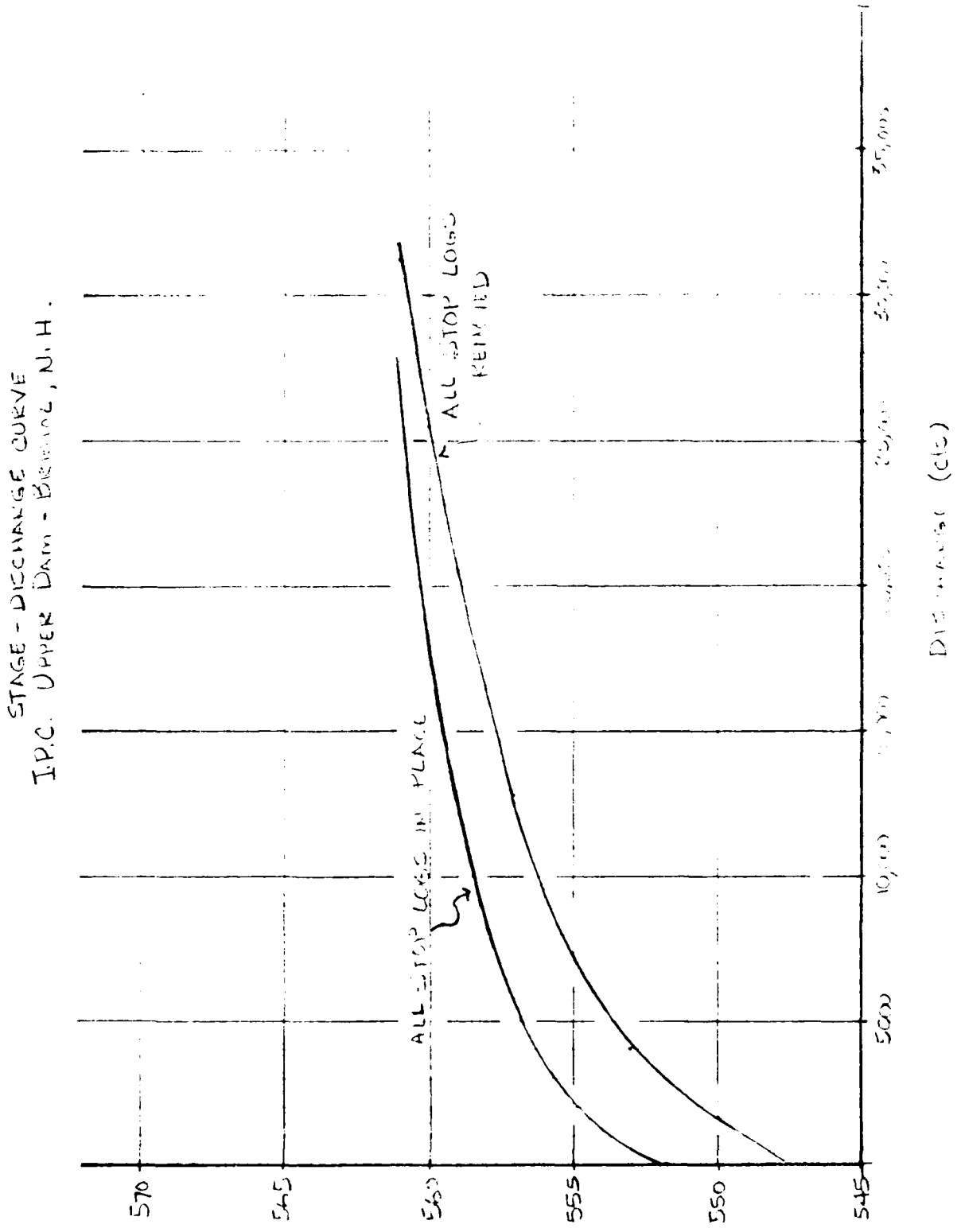
At elev = 561 :

$A = 1,004 + 232 + 8.3 + 1.5 = 1,246\ ft^2$

$P = 233.3 + 16.7 + 3.2 = 253.2$ ft , $R = 4.921$, $R^{2/3} = 2.893$, $S = .015$

$\eta = .045$, $\therefore Q = 14,579$

PROJECT	COMP BY	JOB NO.
IPC [illegible] DAM	[illegible]	[illegible]
STAGE - [illegible] CURVE	CHK BY	DATE
	[illegible]	[illegible]



	CHK BY	DATE 1-12-79

Dam & Reservoir Data - IPC Upper Dam

Elevations:

Item	Survey datum	USGS
1. Top of dam	100 ±	554.5'
2. Top of ogee-by service spillway	98.3'	552.7'
3. Crest of ogee-by service spillway	94.1	547.7'

Area assumptions:

1. USGS map gives a surface area at normal operating level (taken as high water mark) which is 16" below top of dam

Survey datum	USGS	Area
99.1	552.7	8.1 ac.

Capacity assumptions:

1. To determine capacity at elev 552.7', take 1/2 height of dam

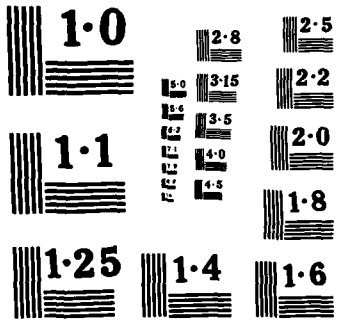
552.7'

540.8' (approx. upstream elev. of dam)

Elevation	Area	Capacity
540.8'	0	0
552.7'	8.1 ac	49 ac.-ft.
560.0	21.2 ac	155 " "
580.0	62 ac	987 " "

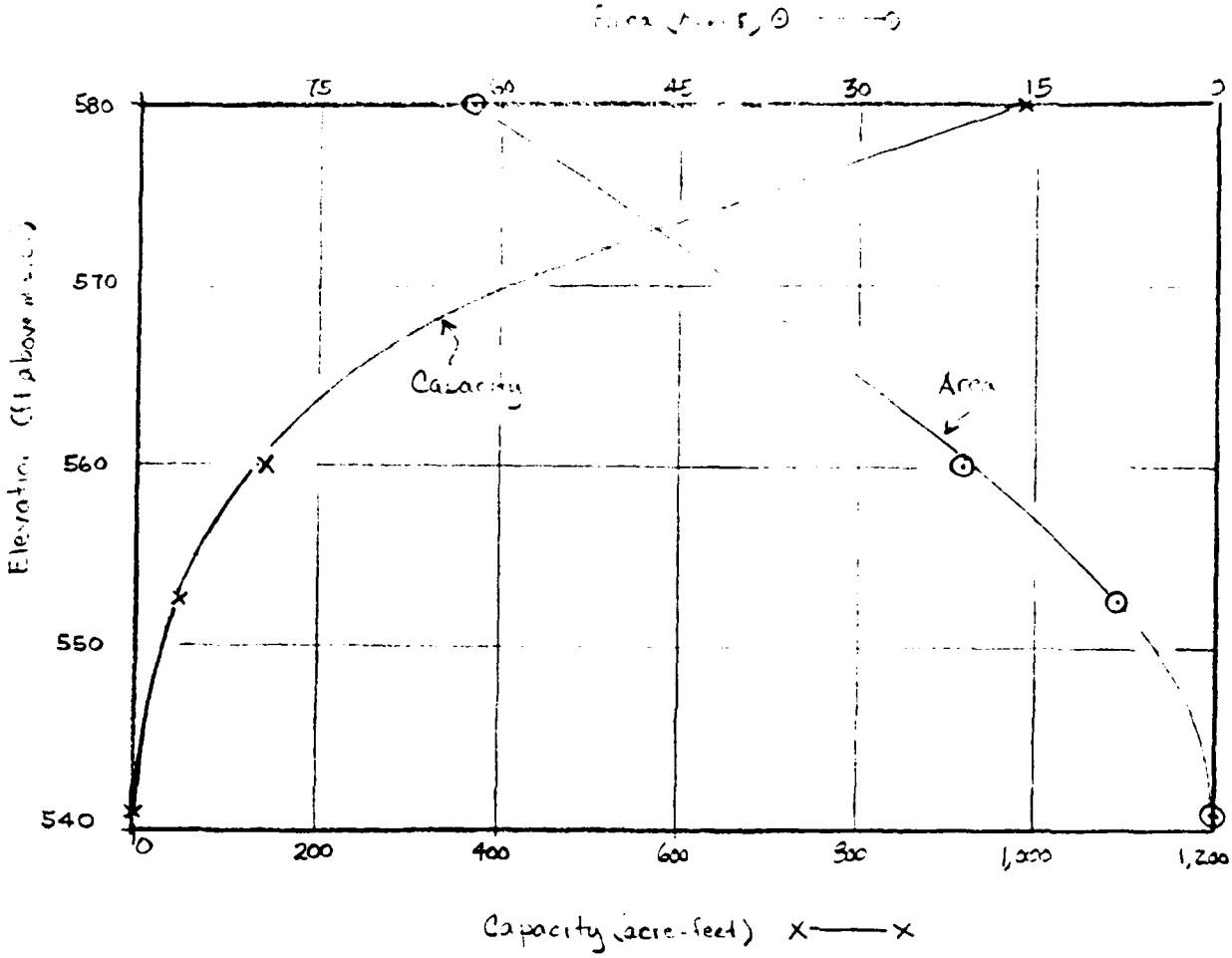
AD-A156 389 NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS 2/2
INTERNATIONAL PACKING..(U) CORPS OF ENGINEERS WALTHAM
MA NEW ENGLAND DIV APR 79

UNCLASSIFIED F/G 13/13 NL



NATIONAL BUREAU OF STANDARDS
MICROCOPY RESOLUTION TEST CHART

PROJECT	COMP BY	JOB NO.
IPC Upper Dam Study Area Capacity Curves - IPC Upper Dam	JC	25-77-05
	CHK BY	DATE 1-12-77



PROJECT

CHK BY	DATE

	0	
548.0	3	
[illegible]	7	
550.0	12	
[illegible]	18	2,823
[illegible]	25	3,978
553.0	34	[illegible]
Top of dam 554.0	38	5,957
555.0	47	7,385
556.0	58	[illegible]
557.0	70	[illegible]
558.0	83	16,158
559.0	98	20,006
560.0	117	25,502
561.0	135	31,252

1/ Surcharge storage determined with respect to spillway crest (elev = 547.6 ft.)

When water level is at top of dam, some overflow would be occurring along the west bank of the reservoir shoreline about 50 ft. upstream of the emergency spillway. Flow through the low area would be a maximum of 200 second-feet with water at top of dam.

PMF peak inflow = 28,722 cfs + contribution from intervening drainage
= 29,682 cfs
(cont. from intervening drainage = 0.8 mi² × 1200 csm = 960 cfs

½ PMF peak inflow = 12,117 + 480 = 12,597 cfs

Effect of surcharge storage:

@ PMF flow, Q_{pl} = 29,682 cfs and surcharge elevation = 560.7 ft.

$STOR_1 = \frac{130 \text{ A-F}}{60{,}800 \text{ ac}} \times \frac{12}{1} = .026''$ and $\frac{.026}{19} \Rightarrow 0$

@ ½ PMF flow, Q_{pl} = 12,597 and surcharge elev = 557.0 ft

$STOR_1 = \frac{70}{60{,}800} \times \frac{12}{1} = .014''$ and $\frac{.014}{9.5} \Rightarrow 0$

∴ PMF = 29,680 cfs and overtops dam by 6.7 ft.
½ PMF = 12,597 cfs " " " by 3.0 ft.

PROJECT

CHK BY	DATE

WHEN WATER SURFACE ELEVATION IS AT TOP OF DAM AND THERE IS NO NORMAL OPERATION PROCEDURE (OTHER THAN TOP OF DAM LEVEL MAINTENANCE INSPECTION) :

SERVICE SPILLWAY : $H = 2.1$ FT, $C = 3.65$, $L = 16 \times 3.5 = 60.8$ FT, $\therefore Q = 675$ CFS

CONTROLLED OUTLET : $H = 2.4$ FT, $C = 3.60$, $L = 11$ FT $\therefore Q = 151$ CFS

TOTAL Q = 826 CFS

FLOW AT FREQUENT HIGH WATER MARK (HWM,
FREQUENT HWM IS 16" BELOW TOP OF DAM AT SURVEY DATUM
ELEV = 99.1 $\therefore H = 0.8$ FT, $C = 3.41$, $L = 60.8$ FT, $Q = 148$ CFS
SERVICE SPILLWAY

CONTROL OUTLET, $H = 1.2$ FT, $C = 3.47$, $L = 11$ FT, $Q = 50$ CFS

TOTAL Q = 198 CFS

[illegible]	[illegible]	[illegible]
[illegible]	CHK BY	DATE

Dam Failure Analysis

(1) Storage at time of failure = 55 [illegible]

(2) Peak [illegible] outflow, Q_{p1}

$$Q_{p1} = \frac{8}{27} W_b \sqrt{g} \; Y_0^{3/2}$$

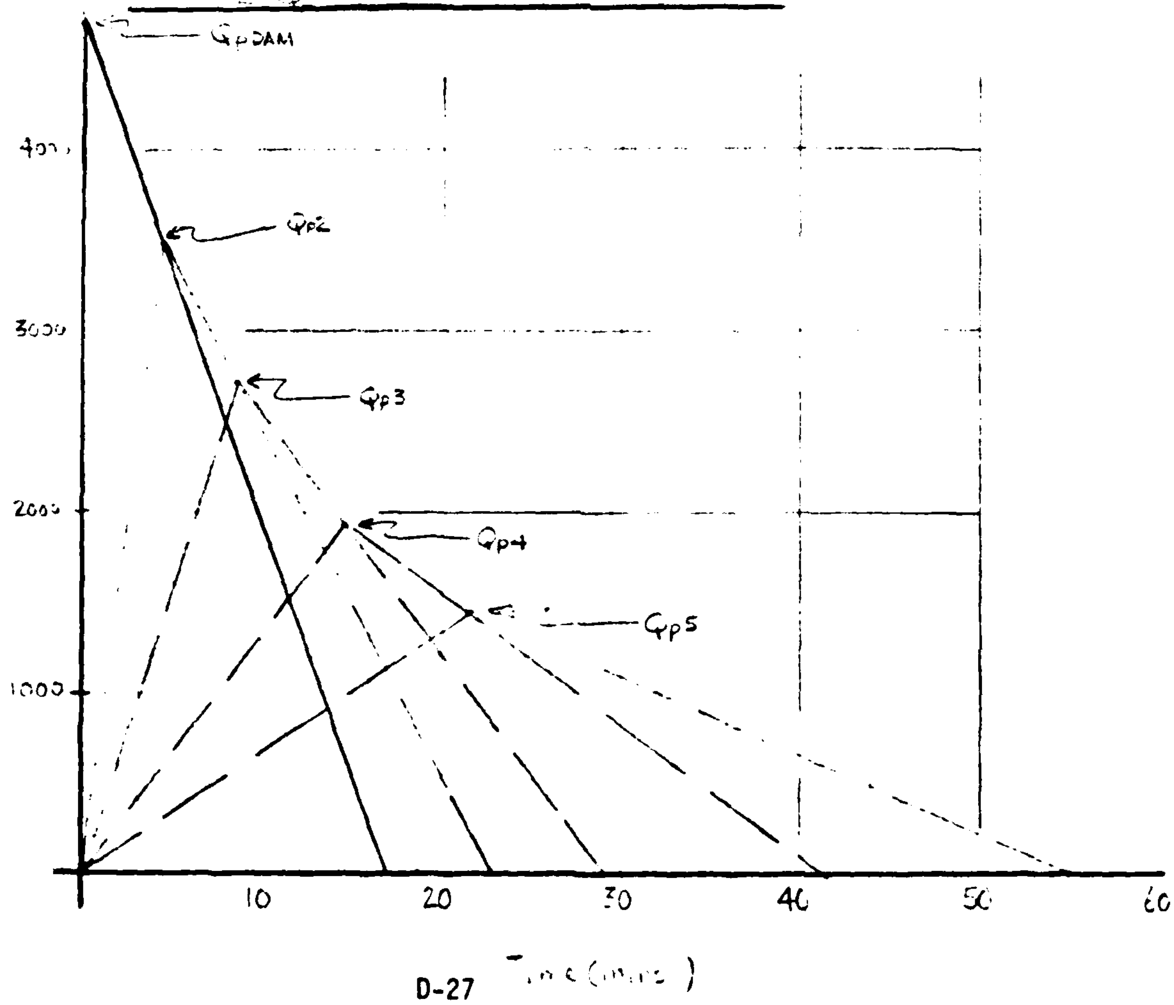
$$= \frac{8}{27} (40)(32.2)^{1/2} (15.4)^{3/2}$$

$$= 4{,}0?? \text{ cfs}$$

Y_0 = [illegible] 15.4 ft. 35.0 is the est[illegible] of the energy [illegible] [illegible] below the exit [illegible]. W_b = 40 ft – [illegible] the [illegible] between [illegible] [illegible] occurs.

(3) Time for reservoir to empty, T

$$T = \frac{12.1\,S}{{}^{1}\!/\!_{?}\,Q} = \;?\text{ mins} \approx 17 \text{ minutes}$$



IPC Upper Dam

PROJECT

CHK BY | DATE

Cross-section #1 (approx 500' downstream of dam)

$S = 55$ A-F

$q_{p1} = 4,674$ trial stage = 7.6 ft

$V_1 = \left(\frac{452 \times 500}{43,560}\right) = 5.2$ A-F

$q_{p2} = 4,674\left(1 - \frac{5.2}{55}\right) = 4,232$ cfs

$V_2 = \frac{424 \times 500}{43,560} = 4.9$ A-F

$V_{Ave} = 5.1$ A-F

$Q_1 = 4,674\left(1 - \frac{5.1}{55}\right) = 4,240$ cfs

Stage $\cong$ 7.2 ft

Cross-section #2 (approx 1100 ft downstream of dam)

$Q_1 = 4,240$ cfs

trial stage = 529.3 (9.3 ft)

$V_1 = \left(\frac{389 + 425}{2}\right) \times 1100 \times \frac{1}{43,560} = 10.3$ A-F

$q_{p2} = 4,240\left(1 - \frac{10.3}{55}\right) = 3,448$ cfs

$V_2 = \left(\frac{320 + 372}{2}\right) \times \frac{1100}{43,560} = 8.7$ A-F

$V_{Ave} = 9.5$ A-F

$Q_2 = 4,240\left(1 - \frac{9.5}{55}\right) = 3,508$ cfs (Stage = 9.2 ft)

Cross-section #3 (at IPC Lower Dam - about 3200 feet below dam)

$Q_2 = 3,508$ cfs

trial stage = 98.1 ft (at IPC Lower Dam X-section)

$V_1 = \left(\frac{323 + 480}{2}\right) \times \frac{1600}{43560} = 14.7$ A-F

$q_{p2} = 3,508\left(1 - \frac{14.7}{55}\right) = 2,568$ cfs

$V_2 = \left(\frac{300 + 243}{2}\right) \times \frac{1600}{43,560} = 10.0$ A-F

$V_{AVE} = 12.4$

$Q_3 = 2,717$ cfs

PROJECT	COMP BY	JOB NO.
	CHK BY	DATE

Cross-section #4 (2700 ft below dam - same as cross-section #2 of IPC lower dam)

$Q_3 = 2,717$ cfs
trial stage = 4.3'

$V_1 = \left(\frac{307 + 940}{2}\right) \times \frac{1500}{43,560} = 21.5$ A-F

$q_{p2} = 2,717\left(1 - \frac{21.5}{55}\right) = 1,656$

$V_2 = \left(\frac{217+689}{2}\right) \times \frac{1500}{43,560} = 15.6$ A-F

$V_{Ave} = 18.6$ A-F

$Q_4 = 2,717\left(1 - \frac{15.6}{55}\right) = 1,946$ cfs

Stage = 4.1'

Cross-section #5 (5700 ft below dam - same as X-sect #3 of IPC lower dam)

$Q_4 = 1,946$
trial stage = 5.3 ft.

$V_1 = \left(\frac{804 + 1154}{2}\right) \times \frac{1000}{43560} = 22.5$ A-F

$q_{p2} = 1,946\left(1 - \frac{22.5}{55}\right) = 1,151$ cfs

$V_2 = \left(\frac{754 + 489}{2}\right) \times \frac{1000}{43560} = 14.3$ A-F

$V_{Ave} = 18.4$ A-F

$Q_5 = 1,946\left(1 - \frac{14.3}{55}\right) = 1,440$ cfs

It is estimated that flood stage in this reach occurs at flows of 2,000 to 2,500 second-feet. At sections below cross-section 4, discharge drops below the general flood level in the reach. Duration of the ~~flow~~ flow above flood stage is less than 10 minutes in any reach. This should lessen the impact of any flooding which might occur. Approximately the same area should be impacted as is under the IPC Lower Dam failure analysis. The flood depths would be slightly higher for an IPC Upper Dam failure. However, because of the very short duration of the event and the relatively low depths of flooding, the IPC

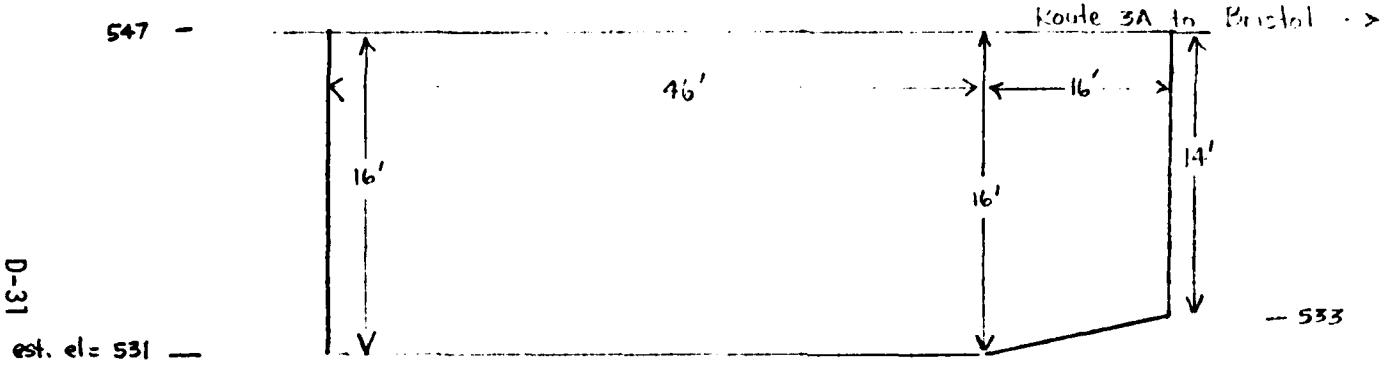
	CHK BY	DATE

Upper Dam is classified as [illegible] hazard potential.

The Upper Dam presents no significant risk to the structure and should be [illegible] during overtopping conditions.

Cross-Section #1
X - section at bridge
(~500 ft. downstream of dam)

NOT TO SCALE
Looking downstream



D-31

IPC Upper Dam

WSE	η [1]	1.486/η	A	P	R	$R^{2/3}$	S	$S^{1/2}$	Q
531									
532	.050	29.7	50	55	.909	.938	.011	.105	146
533	"	"	108	64	1.688	1.417	"	"	477
534	"	"	170	66	2.576	1.879	"	"	996
535	"	"	232	68	3.411	2.264	"	"	1,638
536	"	"	294	70	4.200	2.600	"	"	2,383
537	"	"	356	72	4.944	2.899	"	"	3,218
538	"	"	418	74	5.649	3.135	"	"	4,087
539	"	"	480	76	6.316	3.443	"	"	5,109
540	"	"	542	78	6.949	3.637	"	"	6,068

[1] Assume Mannings η = .050 for stream reach below IPC Upper Dam.

PROJECT

COMP BY

CHK BY

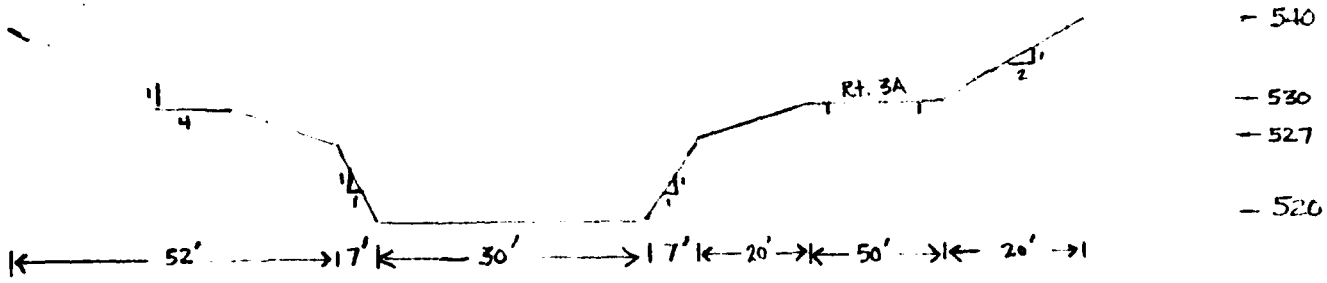
JOB NO.

DATE

Cross - section #2
(approx. 1600 ft. downstream of dam)

From field inspection - bottom channel width = 30 ft, height from river bed to road ≅ 10'

NOT TO SCALE
Looking downstream



D-32

Top of Dunning Dam

WSE	η	$1.486/\eta$	A	P	R	$R^{2/3}$	S	$S^{1/2}$	Q
521	.050	29.7	31	32.8	.945	.963	.015	.122	108
522	"	"	64	35.6	1.798	1.478	"	"	343
523	"	"	99	38.5	2.571	1.876	"	"	673
524	"	"	136	41.3	3.293	2.212	"	"	1,090
525	"	"	175	44.1	3.969	2.504	"	"	1,588
526	"	"	216	46.9	4.606	2.766	"	"	2,165
527	"	"	259	49.8	5.201	2.999	"	"	2,814
528	"	"	308	60.5	5.091	2.956	"	"	3,299
529	"	"	368	71.2	5.169	2.986	"	"	3,982
530	"	"	438	82.0	5.341	3.052	"	"	4,844
531	"	"							
532	"	"							

PROJECT

COMP SY

CHK BY

JOB NO.

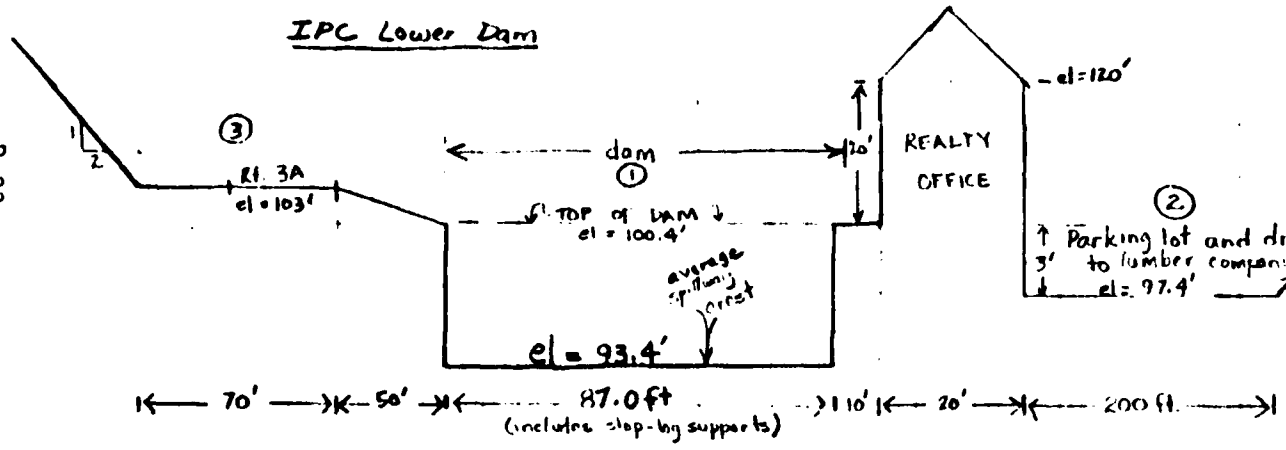
DATE

X-section #3 (of I.P.C Lower Dam)
NOT TO SCALE

Looking downstream

NOTE: Elevations were taken from survey during inspection and are not meant to express actual elevations.

IPC Lower Dam



elev (ft.)	Q (cfs)
94.4	270
95.4	828
96.4	1,566
97.4	2,412
98.4	4,029
99.4	6,464
100.4	9,665

Flow at top of dam:

① service spillway flow = 5,600 cfs

② $Q = 1.486/n\ A R^{2/3} S^{1/2}$ with $n = .065$, $S = 3/150 = .020$

$A = 600 + 9 = 609\ ft^2$, $P = 205.2$, $R = 2.968$, $R^{2/3} = 2.065$

$Q = 4,065$

Total Q @ top of dam = 9,665 cfs

	Discharge from non-spillway section								Spillway discharge	Total discharge
ELEV	1.486/n	A	P	R	$R^{2/3}$	S	$S^{1/2}$	Qns.	Qs	Qt
103	22.9	1,226	268	4.575	2.756	.020	.141	10,910	8,986	19,896
104	22.9	1,589	350	4.540	2.739	.020	.141	14,053	10,427	24,480
105	22.9	1,928	354	5.446	3.095	.020	.141	19,267	11,937	31,204
106										

ECT

COMP BY

CHK BY

JOB NO.

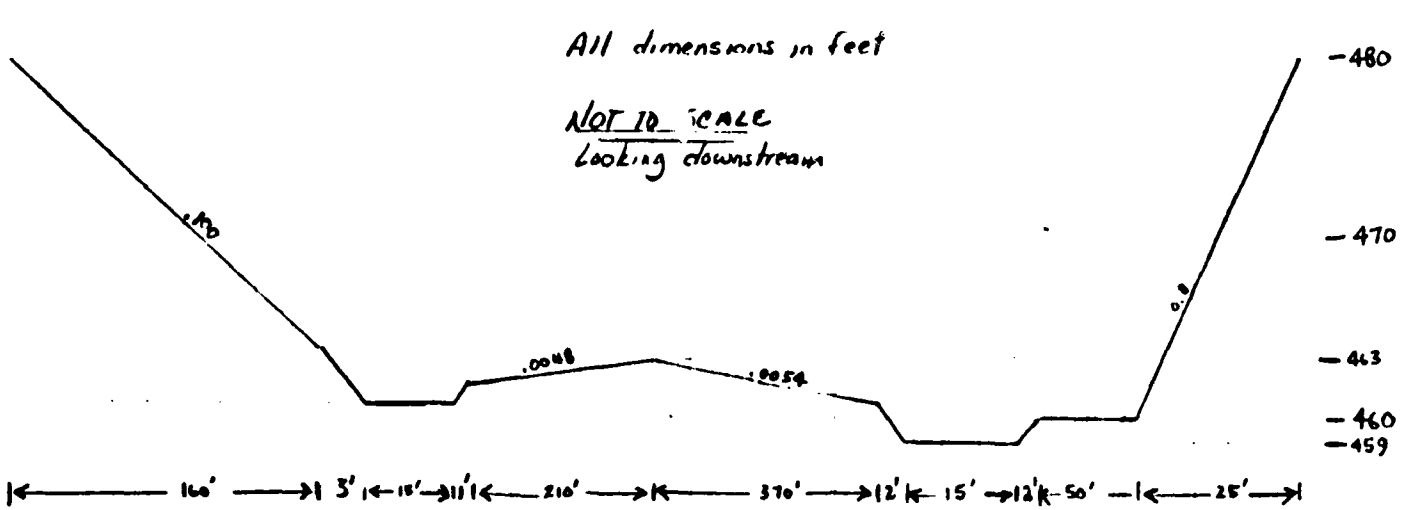
DATE

EDWARD E. JORDAN CO., INC.

cross-section #4 (from USGS quad)
(approx 4700' downstream of dam)

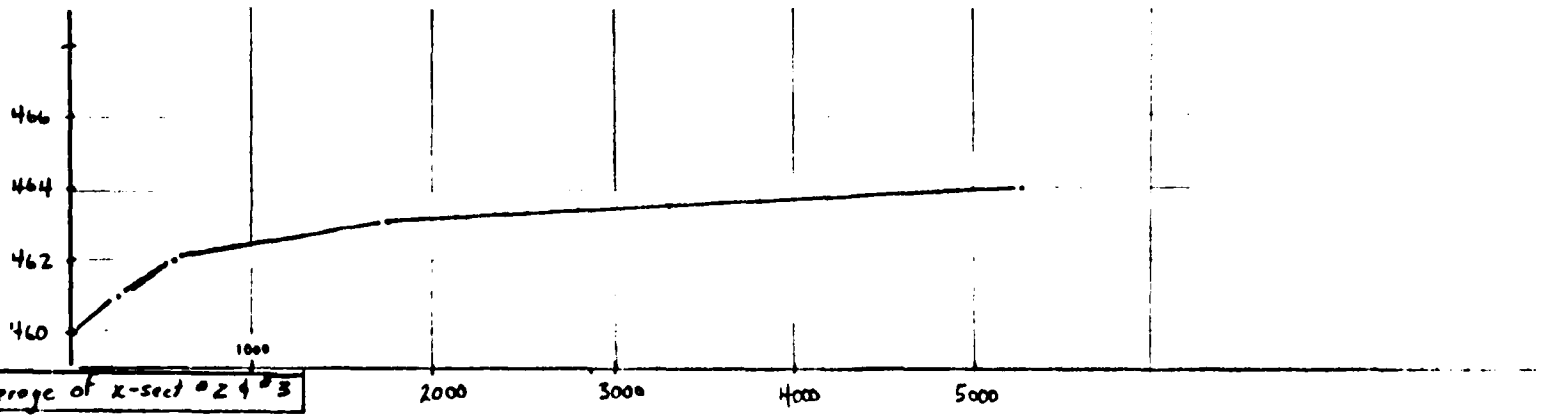
All dimensions in feet

NOT TO SCALE
Looking downstream



D-34

WSE	n	1.486/n	A	P	R	$R^{2/3}$	S [1]	$S^{1/2}$	Q
460	.055	27.0	16.5	18.7	.882	.920	.0099	.099	3.8
461	.055	"	85.6	71.7	1.193	1.125	.0099	.099	257
462	.065	22.9	265	276	0.960	0.973	.0099	.099	584
463	.065	22.9	736	671	1.097	1.064	.0099	.099	1,775
464	.065	22.9	1,416	674	2.100	1.640	.0099	.099	5,263



[1] Average of x-sect #2 & #3

PROJECT

COMP BY

CHK BY

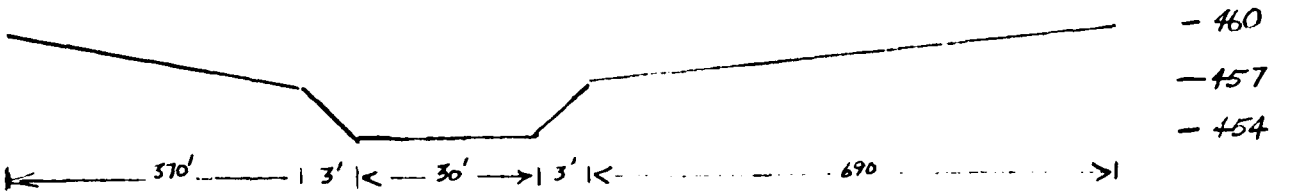
JOB NO.

DATE

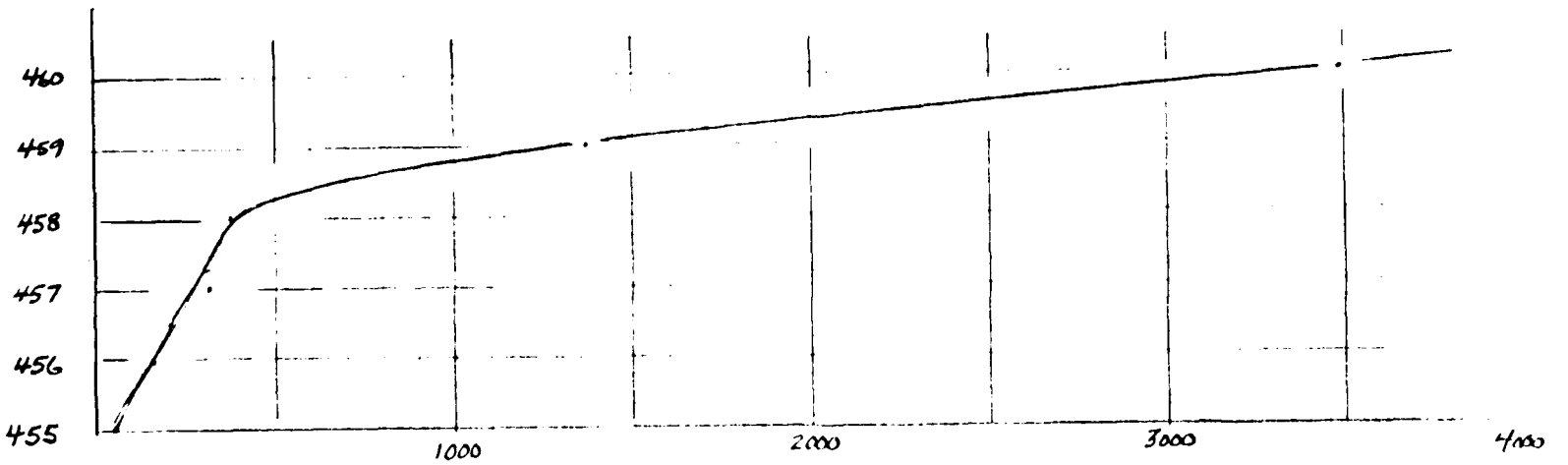
Cross-section #5
(about 5700 ft below dam)
All dimensions in feet

NOT TO SCALE

Looking downstream



wse	n	1.486/n	A	P	R	R^2/3	S	S^1/2	Q
455	.055	27.0	31	32.8	.945	.963	.0038	.061	49
456	.055	27.0	64	35.7	1.793	1.476	.0038	.061	156
457	.055	27.0	99	38.5	2.571	1.877	.0038	.061	306
458	.065	22.9	312	392	0.796	0.859	.0038	.061	374
459	.065	22.9	878	745	1.178	1.116	.0038	.061	1369
460	.065	22.9	1798	1098	1637	1.389	.0038	.061	3488



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PROJECT

COMP BY

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JOB NO.

DATE

EDWARD C. JORDAN CO., INC.

APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS

END

FILMED

8-85

DTIC