AD-A156 009 NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS SUCKER BROOK DAM (VT. (U) CORPS OF ENGINEERS WALTHAM MA NEW ENGLAND DIV FEB 80

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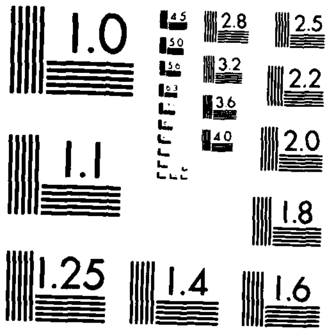
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TOWN OF SALISBURY
ADDISON COUNTY, VERMONT

SUCKER BROOK DAM
VT 00212

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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

FEBRUARY 1980

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1. REPORT NUMBER VT 00212	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Sucker Brook Dam NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS		5. TYPE OF REPORT & PERIOD COVERED INSPECTION REPORT
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) U.S. ARMY CORPS OF ENGINEERS NEW ENGLAND DIVISION		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS DEPT. OF THE ARMY, CORPS OF ENGINEERS NEW ENGLAND DIVISION, NEDED 424 TRAPELO ROAD, WALTHAM, MA. 02254		12. REPORT DATE February 1980
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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

DAMS, INSPECTION, DAM SAFETY,

Richelieu River BasinTown of Salisbury
Addison County, VT.
Sucker Brook

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

The dam is an earth embankment with two angle points along its axis, about 660 ft. long and 36 ft. high. The dam is in fair condition. There were some significant conditions which should be corrected.The spillway is inadequate to pass the test flood. It is small in size with a significant hazard potential. The owner should implement various recommendtions with in one year of receipt of the inspection report.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

RICHELIEU RIVER BASIN
TOWN OF SALISBURY
ADDISON COUNTY, VERMONT

SUCKER BROOK DAM
VT 00212

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

GORDON E. AINSWORTH & ASSOCIATES, INC.
Engineers, Surveyors and Planners
20 SUGARLOAF ST. SOUTH DEERFIELD, MASS. 01373

PROJECT NO. 21.06.79108

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For use of this form, see AR 340-15, the proponent agency is TAGCEN.

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NEDED-E (c)	Dam Safety Draft Report GEA

TO	FROM	DATE 10 JUN 80	CMT 1
Chief, Design Branch Chief, Geotechnical Engrg. Branch Chief, Water Control Br.	Chairman, Dam Safety Review Board		

Attached for your review are two copies of the Architect-Engineer's draft report for SUCKER BROOK Dam, Identity No. VT212. The review board meeting date for this report is 23 JUN 80. Please present your comments in writing under the format shown below. Please return one copy with your comments. Cost code for this rewiew is ABA06 0706 000000 (FY80)

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NATIONAL PROGRAM OF INSPECTION OF NON-FEDERAL DAMS
DRAFT REPORT REVIEW COMMENTS
SUCKER BROOK DAM, IDENTITY NO. VT 00212

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FROM THE CORPS OF ENGINEERS TO THE STATE

TO BE SUPPLIED BY THE CORPS OF ENGINEERS

NATIONAL DAM INSPECTION PROGRAM

PHASE I INSPECTION REPORT

Identification No.:	VT 00212
Name of Dam:	Sucker Brook Dam
Town:	Salisbury
County and State:	Addison County, Vermont
Stream:	Sucker Brook
Date of Inspection:	7 November 1979

BRIEF ASSESSMENT

1. Project Description

Sucker Brook Dam is an earth embankment, with two angle points along its axis, about 660 feet long by about 36 feet high. Included in the length of the dam is a 60-foot long spillway at the right abutment. Top width is about 10 feet, with an upstream slope of about 2.5H:1V and a downstream slope of about 2H:1V.

Normal pool elevation is maintained as much as 9 feet below the lower spillway crest by an outlet conduit starting from an intake structure and control tower, and running under the dam to a penstock at the downstream toe. The penstock carries all normal flow about 1.5 miles around a mountain to Silver Lake. The only spillway for the dam is a chute spillway at the right abutment, with two adjacent weir crests 4 feet different in elevation. The longer, lower weir crest is about 9 feet below the lowest point on the top of the dam.

2. Significant Findings and Assessment

The dam is in FAIR condition. Significant problems include several scarps near the upstream toeline about opposite the leftmost angle point of the dam; brush and small trees on the embankment slopes with some larger stumps on the downstream slope; cracking and undermining of the downstream end of the left concrete training wall of the spillway discharge channel; and what appears to be a significant amount of reservoir sedimentation that reduces total storage capacity and could hinder operation of the low level drain. Also, a hole was observed beneath the upstream extension of the left training wall of the original spillway (now covered with embankment) that could be a potential seepage path through the embankment.

3. Hydraulic and Hydrologic Findings

The spillway is INADEQUATE to pass the test flood without overtopping the dam. In accordance with recommended guidelines of the Corps of Engineers, the dam is classified as SMALL in size and as having a SIGNIFICANT hazard potential. Accordingly, a TEST FLOOD equal to ONE-HALF PMF (probable maximum flood) was judged as appropriate within the recommended range of the 100-year flood to one-half PMF. The test flood overtops the dam by a maximum of about 1.9 feet with duration of overtopping of about 5 hours. Peak inflow for the test flood is 7290 cfs. Peak outflow is unaffected by reservoir routing and is the same as peak inflow. Total project discharge capacity at the top of the dam is due to the two-level chute spillway plus the outlet penstock fully open, and is equal to 4280 cfs, or 59% of the test flood peak outflow.

4. Recommended Action

WITHIN ONE YEAR after their receipt of this Phase I Inspection Report, the Owner should implement the following recommendations:

a. Engage a registered engineer qualified in the design of dams to do such work as: investigate the cause of the scarps near the upstream toeline; determine whether the hole that was observed beneath the upstream extension of the left training wall of the original spillway passes through the dam; advise how to repair or rebuild the downstream end of the left training wall of the spillway discharge channel which is cracked and undermined; and perform a detailed hydraulic and hydrologic study to better assess spillway capacity.

b. Cut the brush and small trees from all slopes to a distance of about 20 feet downstream from the toeline.

c. Verify the depth of sediment in the reservoir. Clean out all sediment at least down to the level of the low level drain.

Additional recommendations and remedial measures that should be implemented by the Owner WITHIN ONE YEAR after their receipt of this Phase I Inspection Report are described in Section 7.

GORDON E. AINSWORTH & ASSOCIATES, INC.

Kenneth J. Male, P.E.

LICENSED PROFESSIONAL ENGINEER
KENNETH J. MALE
25004
UNIVERSITY OF THE STATE OF NEW YORK

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

THIS SHEET TO BE FURNISHED BY THE CORPS OF ENGINEERS

PREFACE

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

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

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conlimited to EL 1293 by intake opening, discharge capacity (limited by penstock) 100 cfs at top of dam @ EL 1311.2, 90 cfs at lower spillway crest @ EL 1302.

b) Low Level Drain
24-inch diameter, discharge invert in outlet conduit EL 1284, intake invert EL 1284 but draft limited to EL 1288 by baffle weir in intake structure, discharge capacity included in outlet conduit and not estimated separately.

c) Outlet Conduit Drain Pipe
20-inch diameter, intake invert EL 1284 ±, discharge invert unknown, discharge capacity not estimated.

2) Maximum Known Flood - unknown.

3) Ungated spillway capacity at top of dam (2 weirs at different elevations), 4180 cfs @ EL 1311.2.

4) Ungated spillway capacity at test flood pool, 5690 cfs @ EL 1313.1.

5) Gated spillway capacity at normal pool - N/A.

6) Gated spillway capacity at test flood pool - N/A.

7) Total spillway capacity at test flood pool, 5690 cfs @ EL 1313.1.

8) Total project discharge at top of dam, 4280 cfs @ EL 1311.2.

9) Total project discharge at test flood pool, 7290 cfs @ EL 1313.1.

c. Elevation (feet - NGVD)

All elevations in this report are based on drawings by Nepsco Services, Inc., which are included in Appendix B3, and are assumed to be in approximate feet above mean sea level NGVD (National Geodetic Vertical Datum of 1929).

1)	Natural Stream Bed at Toe of Dam - D/S	1275 ±
	- U/S	1280 ±
2)	Bottom of Cutoff	None
	a) Lowest Foundation Surface	1275 ±
	b) Core Wall	None

In September 1938 a flood caused severe damage to the spillway channel downstream of the dam necessitating its reconstruction. It was decided to relocate a new spillway founded on bedrock to the right of the old spillway. NEPSCO designed the new spillway, but the construction contractor for this work is unknown.

No other construction, modification, or major repair work is known to have occurred. Refer to Section 2 of this report for a complete discussion of the design, construction, and operation history.

i. Normal Operation Procedures

There are no known written operation and maintenance procedures for the dam. Maintenance personnel reportedly visit the dam weekly. Also, the Owner indicates that the dam is inspected annually by a private consultant. The water level in the reservoir presently is maintained as much as 9 feet below the spillway crest by the outlet conduit discharging into the penstock.

Refer to Section 4 of this report for a complete discussion of operation and maintenance procedures.

1.3 Pertinent Data

a. Drainage Area

1) Location - Central Vermont in northwestern foothills of Green Mountain National Forest.

2) River Basin - Sucker Brook to Lake Dunmore, then to Leicester River, to Otter Creek, to Lake Champlain, to Richelieu River.

3) Shape - Roughly square, 18,000 feet by 18,000 feet.

4) Area - 10.51 square miles, or 6726 acres.

5) Topography - Fairly steep wooded slopes averaging 5% to 20% slope. Elevations vary from EL 1293 to EL 3230.

b. Discharge at Dam Site (cfs)

1) Outlet Works

a) Outlet Conduit
3 feet-2 inches wide by 4 feet high through the dam followed by a 4-foot diameter penstock, discharge invert at penstock EL 1284, intake invert EL 1284 after gate well, but normal draft

e. Ownership

Since its construction, the dam has been and is still owned by:

Central Vermont Public Service Corporation (CVPS)
77 Grove Street
Rutland, Vermont 05701

Attention: Donald L. Rushford, Esq.
Vice President and General Counsel
(802) 773-2711

The dam and reservoir are located on Federally-owned land as part of the Green Mountain National Forest.

f. Operator

Day-to-day operation of the dam is the responsibility of:

J. Douglas Graham, Manager of Hydraulic Generation, CVPS
Edward Lurvey, General Hydraulic Foreman, CVPS

Both can be contacted at:

(802) 773-2711
(Same address as Owner)

g. Purpose of Dam

The dam diverts all the normal flow from Sucker and Dutton Brooks through a penstock to Silver Lake for later hydroelectric power generation as part of the Silver Lake Hydroelectric Development. (See Appendix D-1 and separate Phase I Inspection Report on Silver Lake Dam, VT 00196.) Water is not normally stored in Sucker Brook Reservoir. Major storage is provided upstream of the diversion dam on Sucker Brook by a much larger impoundment called Sugar Hill Reservoir. (See Appendix D-1 and separate Phase I Inspection Report on Sugar Hill Dam, VT 00176.)

h. Design and Construction History

The present Sucker Brook Dam was constructed in 1937 to replace an older concrete and rubble masonry dam at the same location, which had been in use for the same purpose for over 20 years. The present dam was designed by the New England Public Service Corporation (NEPSCO). Construction of the dam was performed by the Sanders Engineering Company under the direction of Frank H. Mason, NEPSCO Civil Engineer.

handwheel-operated rack gear mechanism exposed on top of the control tower. A rack structure and inclined intake opening on the upstream side of the control tower permit normal draft to about 9 feet below the lower spillway crest. A 24-inch diameter low level drain projecting upstream from the intake structure is limited to about 14 feet of draft below the lower spillway weir by a baffle weir in the intake structure. The invert of the low level drain and of the outlet conduit leaving the gate well is about 18 feet below the lower spillway crest.

The outlet conduit is a reinforced concrete box section 3 feet-2 inches wide by 4 feet high by about 100 feet long from the gate well through the dam to a 4-foot diameter penstock beginning just after the downstream toe. The foundation of the outlet conduit is reported to be rock at the upstream end and hard clay for the rest of its length. The penstock runs about 1.5 miles to Silver Lake. Connection to the penstock consists of a concrete transition to a round section, followed by a 47 3/4-inch diameter steel pipe section about 15 feet long with a 20-inch diameter drain pipe to the side, and then a short, partially-exposed corrugated metal pipe section to the penstock. The Owner indicates there are several such drain pipes from the penstock to the side along its route. The penstock was originally wood stave pipe, but it is thought to have been replaced in recent years with fully paved and coated, smooth-flow corrugated metal pipe.

c. Size Classification

In accordance with recommended guidelines (Reference 1), Sucker Brook Dam is classified as SMALL in size because its hydraulic height is 36 feet (within the 25 to 40-foot range) and its maximum storage capacity is 54 acre-feet (within the 50 to 1000 acre-foot range).

d. Hazard Classification

In accordance with recommended guidelines (References 1 & 18) involving loss of life and economic loss, Sucker Brook Dam is classified as having a SIGNIFICANT hazard potential. The dam itself is located in an isolated part of the Green Mountain National Forest and failure of the dam would cause little harm in this area. However, the increase in flow due to a dam failure would damage portions of Branbury State Park, increase damage to a highway bridge on Town Route 53 and to the road on either side of the bridge, and flood the first floors of about 8 houses along Lake Dunmore to a depth of less than 1 foot, with the moderate flow velocity of 7 fps probably damaging the homes. Total economic loss is judged appreciable. Loss of less than a few lives is judged possible. The dam failure analysis is developed in Section 5.5 of this report.

Access to the dam is from Town Route 53 to the west via a trail road up the mountain inside the Green Mountain National Forest (see Drainage Area Map, Appendix D-1).

The popular name of the dam is Sucker Brook Diversion Dam. The official name is Sucker Brook Dam. The popular and official name of the impoundment is Sucker Brook Reservoir. The reservoir is aligned along a northwest - southeast axis with the dam located at the northwest end.

The dam is built across Sucker Brook, which is tributary to Lake Dunmore. The nearest downstream community is named Lake Dunmore, population estimated at 50, located about 3 river miles downstream from the dam on the western side of Lake Dunmore, roughly opposite the mouth of Sucker Brook. The community of Lake Dunmore is not an incorporated village but simply a group of houses and other structures located in the Town of Salisbury.

b. Description of Dam and Appurtenances

Sucker Brook Dam is a rolled earth embankment of "well graded hardpan" with a rockfill downstream toe and a riprapped upstream slope. There are two angle points in the axis of the dam as it crosses a natural stream channel just downstream of the confluence of two brooks. The dam is about 660 feet long (including the spillway) by about 36 feet high. Top width is about 10 feet, with an upstream slope of about 2.5H:1V and a downstream slope of about 2H:1V.

No impervious core or zoning are known. Although called for, no cutoff is known. The foundation of the embankment is largely on "clay hardpan" with the left side near the outlet works reportedly on bedrock.

At the right abutment there is an ungated chute spillway with two adjacent concrete weir crests 4 feet different in elevation. The 40-foot long weir is about 9 feet below the low point on the top of dam and the 20-foot long weir is about 5 feet below the same point. The chute discharge channel runs down along the right abutment and joins the natural stream channel about 500 feet downstream of the dam. The approach channel, concrete weirs, and the discharge channel for some distance downstream of the weirs are founded on solid bedrock. The left side (toward the dam) of the approach channel, of the weir, and of the discharge channel through the dam section are lined with a vertical concrete training wall. The right side is the naturally sloped hillside.

Near the left end of the dam there is a concrete intake structure and control tower in the embankment near the upstream toe. Inside there is a 3-foot by 4-foot gate well with a 4-foot wide by 5-foot high service slide gate controlled by a

NATIONAL DAM INSPECTION PROGRAM

PHASE I INSPECTION REPORT

NAME OF DAM: SUCKER BROOK DAM, ID NO. VT. 00212

SECTION 1

PROJECT INFORMATION

1.1 General

a. Authority

The National Dam Inspection Act, 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. Gordon E. Ainsworth and Associates, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of Vermont. Authorization and notice to proceed was issued to Gordon E. Ainsworth and Associates, Inc., under a letter from William E. Hodgson, Jr., Colonel, Corps of Engineers. Contract No. DACW33-80-C-0012 has been assigned by the Corps of Engineers for this work.

b. Purpose of Inspection

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

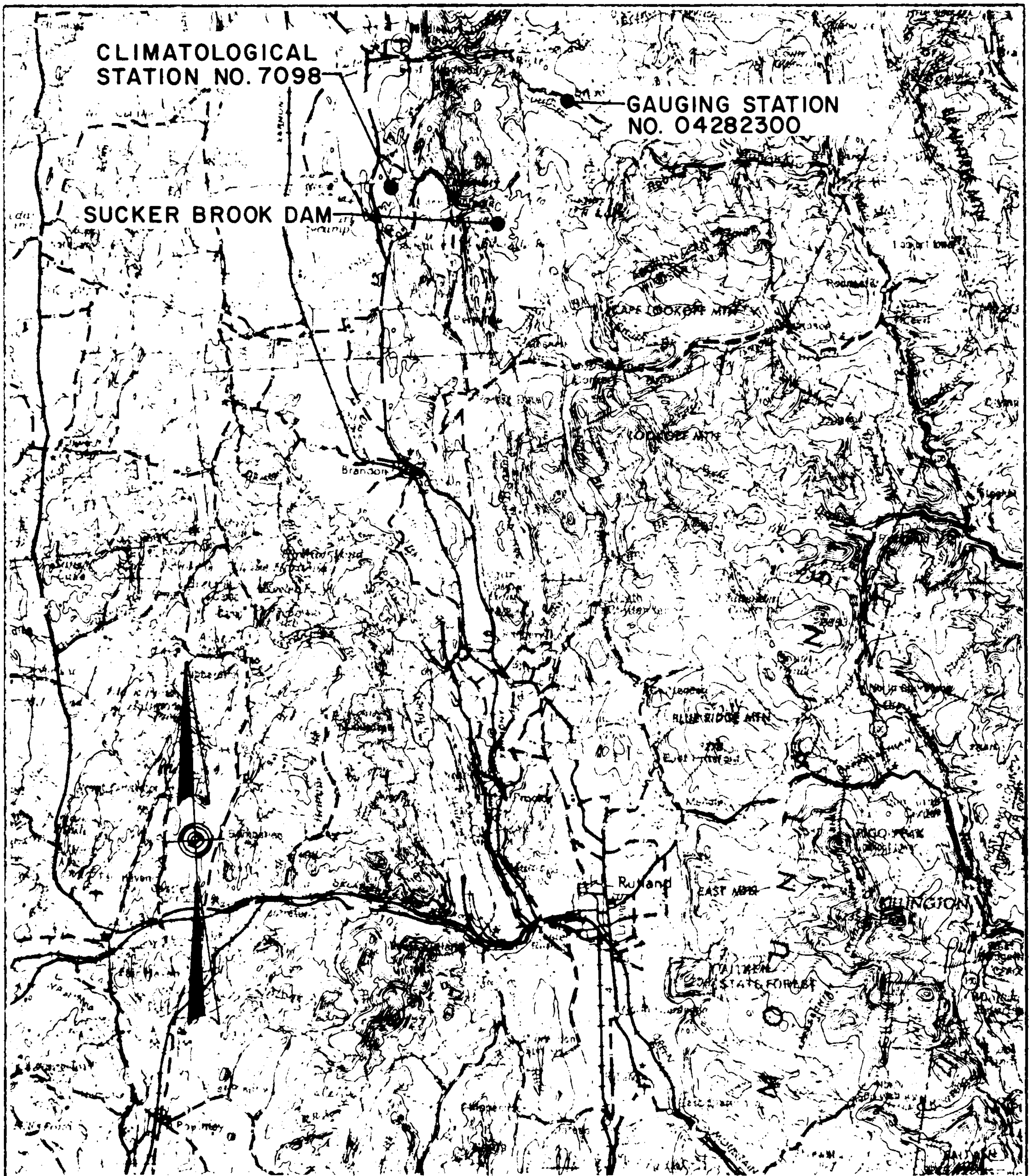
2) Encourage and assist the States to initiate quickly effective dam safety programs for non-Federal dams.

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

1.2 Description of Project

a. Location

Referring to the Location and Vicinity Maps at the beginning of this report, Sucker Brook Dam is located in central Vermont in the Town of Salisbury, Addison County, about 3 miles east of the community of Salisbury. The dam at its maximum section is at Latitude 43 degrees - 54.1 minutes North, Longitude 73 degrees - 2.5 minutes West.



APPROX. SCALE IN MILES

0 2 4 8 12

DATUM - N.G.V.D. 1929, 100' CONTOUR INTERVAL

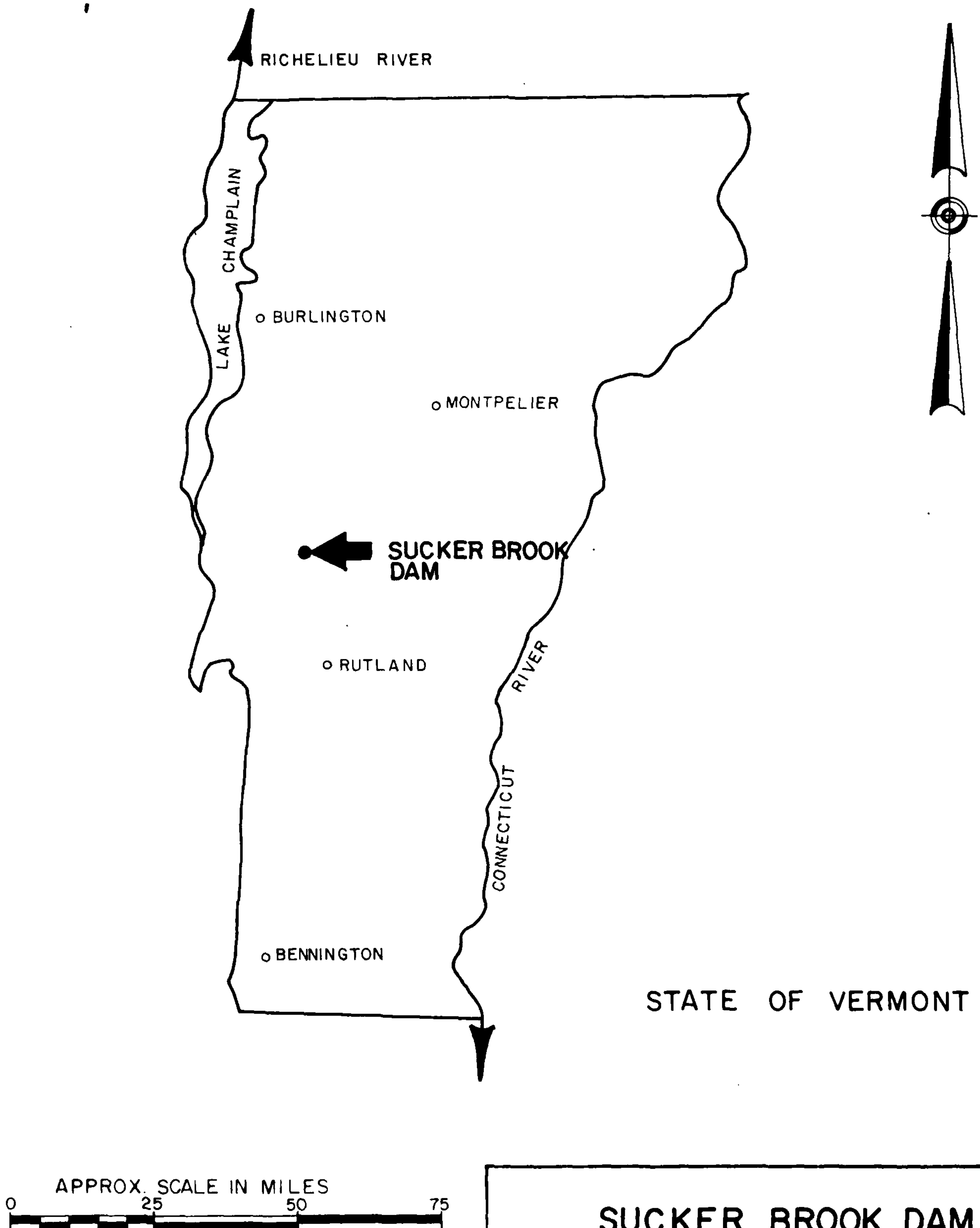
BASE MAP - 1:250,000 U.S.G.S. TOPO MAP

GLEN FALLS, N.Y., VT, N.H.
1956, LIMITED REVISION 1967

SUCKER BROOK DAM VICINITY MAP

GORDON E. AINSWORTH & ASSOCIATES INC.

20 SUGARLOAF ST SOUTH DEERFIELD MASS 01373



SUCKER BROOK DAM LOCATION MAP

GORDON E. AINSWORTH & ASSOCIATES INC.

20 SUGARLOAF ST SOUTH DEERFIELD MASS 01373

Overview Photo - Sucker Brook Dam - 11/30/79

APPENDICES

TABLES

SUCKER BROOK DAM

PHASE I INSPECTION REPORT

TABLE OF CONTENTS

ditions, 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 will be detected.

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

The Phase I Investigation does not include an assessment of the need for fences, gates, no-trespassing signs, repairs to existing fences and railings and other items which may be needed to minimize trespass and provide greater security for the facility and safety to the public. An evaluation of the project for compliance with OSHA rules and regulations is also excluded.

3) Maximum Tailwater — Unknown

4) Normal Pool (site inspection 11/7/79) — 1293 ±

5) Full Flood Control Pool — N/A

6) Spillway Crest (ungated chute spillway)
   - lower weir — 1302
   - upper weir — 1306

7) Design Surcharge — Unknown

8) Top of Dam - low point — 1311.2
   - high point — 1312.3
   - design — 1312

9) Test Flood Surcharge — 1313.1

d. Reservoir (length in feet)

1) Normal Pool — 300 ±

2) Flood Control Pool — N/A

3) Spillway Crest Pool (lower weir) — 500 ±

4) Top of Dam — 700 ±

5) Test Flood Pool — 800 ±

e. Storage (acre-feet)

1) Normal Pool — 5

2) Flood Control Pool — N/A

3) Spillway Crest Pool (lower weir) — 21

4) Top of Dam — 54

5) Test Flood Pool — 63

f. Reservoir Surface (acres)

1) Normal Pool — 1.1

2) Flood Control Pool — N/A

3) Spillway Crest Pool (lower weir) — 3.0

4) Top of Dam — 4.5

5) Test Flood Pool — 5.0

g. <u>Dam</u>

1) Type - Earth.

2) Length - 660 feet including spillway.

3) Height - Hydraulic Height - 36 feet.
- Structural Height - 36 feet.

4) Top Width - About 10 feet.

5) Side Slopes - Upstream - About 2.5H:1V.
- Downstream - About 2H:1V.

a) Approximate Volume of Dam - 30,000 cubic yards.

6) Zoning - None known. Design called for pervious upstream and downstream shells. But description by Barrows during construction indicates dam is homogeneous "clay hardpan" with rockfill downstream toe and riprap upstream.

7) Impervious Core - See Zoning.

8) Cutoff - None known. Concrete cutoff was called for in locations where embankment was founded on rock.

9) Grout Curtain - None.

10) Other - Foundation of embankment is largely on "clay hardpan" and spillway is on bedrock. Left side of embankment near outlet is on bedrock.

h. <u>Diversion and Regulating Tunnel</u> - N/A

i. <u>Spillway</u>

1) Type - Chute, with two adjacent concrete overflow weir control sections at different elevations, founded on rock.

2) Length of Weirs - lower weir - 40 feet.
- upper weir - 20 feet.

3) Crest Elevation - w/o flashboards
lower weir - 1302
upper weir - 1306
- w/ flashboards - N/A

4) Gates - None.

5) Upstream Channel - Natural bedrock-bottom approach section with reinforced concrete training wall on left side of control section and natural hillside on right.

6) Downstream Channel - About a 500-foot long chute, founded partly on rock, along right abutment with a natural bottom narrowing in width away from spillway. Left training wall is reinforced concrete along dam section, right side is natural hillside.

7) General - No comment.

j. <u>Regulating Outlets</u>

1) <u>Low Level Drain</u>

a) Invert - Intake EL 1284, Discharge EL 1284. Baffle weir in intake structure permits draft only to EL 1288.

b) Size - 24-inch diameter.

c) Description - Steel pipe stub about 25 feet long from upstream toe of dam to intake structure, with the intake structure discharging through the gate well into outlet conduit under dam.

d) Control Mechanism - None itself. Control provided by outlet conduit slide gate in gate well.

e) Other - No comment.

2) <u>Outlet Conduit</u>

a) Invert - Intake EL 1284 after gate well, Discharge EL 1284. Rack structure and intake opening just upstream of gate well permit normal draft to about EL 1293. Draft to EL 1288 by low level drain limited by baffle weir.

b) Size - 3 feet-2 inches wide by 4 feet high.

c) Description - Reinforced concrete box section about 100 feet long from gate well through dam section. At downstream toe, there is a concrete transition section from rectangular box to a 47 3/4-inch diameter steel pipe section about 15 feet long. This steel pipe is then joined with a short, partially-exposed corrugated metal pipe section to a 4-foot diameter penstock about 1.5 miles long to Silver Lake. The penstock discharges at about EL 1270 into an open channel just short of Silver Lake. Penstock was originally wood stave pipe, but it is thought to have been replaced in recent years with fully paved and coated, smooth-flow corrugated metal pipe.

d) Control Mechanism - 4-foot wide x 5-foot high slide gate in the gate well at the upstream end, which is controlled by a handwheel-operated rack gear mechanism on top of the control tower directly above.

e) Other - No comment.

3) <u>Outlet Conduit Drain Pipe</u>

a) Invert - Intake EL 1284 ±, Discharge invert unknown.

b) Size - 20-inch diameter.

c) Description - Steel pipe from bottom of 47 3/4-inch diameter steel pipe section (between outlet conduit and penstock) discharging into the stream channel downstream of the dam to the right of the penstock.

d) Control Mechanism - A normally-closed cover or bulkhead accessible through a manhole in the top of the 47 3/4-inch diameter steel pipe section.

e) Other - No comment.

SECTION 2

ENGINEERING DATA

2.1 Design Data

The present Sucker Brook Dam was designed in about 1937 for the current owner, Central Vermont Public Service Corporation (CVPS), by the New England Public Service Corporation (NEPSCO), to replace an older concrete and rubble masonry dam which had been in use for over 20 years. NEPSCO was thought to be the present New England Power Service Corporation, located at 25 Research Drive, Westborough, Massachusetts 01581, telephone (617) 366-9011. They were contacted, but they indicated that they could find no data on the dam. Subsequently, it was learned that they are not the successors to NEPSCO. The present business status and location of NEPSCO is unknown.

The only available data covering the design and construction of the dam is included in Appendix B3. It consists of copies of a letter (starting on Appendix B3-9) and a report (starting on Appendix B3-11) on construction. This material was prepared by H.K. Barrows, Consulting Engineer of Boston, in 1937 during and just after the completion of construction. A CVPS petition to the Vermont Public Service Commission for authority to construct the dam contains some additional data and is included starting on Appendix B3-1. Included with this petition were a drainage area map (see Appendix B3-5) as well as some design plans, sections, and details (see Appendices B3-6 through 8). The order approving the dam construction from the Vermont Public Service Commission is included as Appendix B3-18.

No other design data or drawings were available. The construction specifications were not available.

2.2 Construction Data

a. Initial Construction

Construction of the dam for CVPS was completed in 1937. The dam was constructed by the Sanders Engineering Company under the direction of Frank H. Mason, NEPSCO Civil Engineer. The resident engineer and superintendent are identified on Appendix B3-16. The present business status and location of Sanders Engineering is unknown.

Background data on the original construction is contained in the letter, report, and CVPS petition discussed in Section 2.1. The original construction included an embankment with a maximum reported height of approximately 40 feet at design top EL 1312, an embankment length of about 400 feet, a concrete spillway with a 150-foot long crest at EL 1306, and an outlet conduit through the dam to a wood stave penstock. The old concrete and rubble masonry dam was left in place about 50 to 100 feet upstream of the embankment.

No other records on the original construction of the dam are known.

b. Modifications

In September 1938 a flood occurred which "caused the spillway channel below the dam to be so badly washed as to necessitate" reconstruction and relocation of the channel and the spillway. A letter by H.K. Barrows in November 1939 (see Appendix B3-19) describes the damage which occurred, the new design, and the construction of the spillway improvement.

The new spillway was designed by NEPSCO in 1939. Construction was completed by November 1939 under the direction of NEPSCO engineers. However, the construction contractor for this work is unclear. On Appendix B3-21, a "Mr. Merry" is identified as "Contractor", but it is not evident whether he was the actual contractor or just the superintendent.

The new spillway construction resulted in addition of a second bend point and lengthening of the embankment to its present total of about 600 feet. The new spillway consisted of two adjacent concrete weirs located to the right of the old spillway (now embankment), with crests 40 and 20 feet long at EL 1302 and EL 1306, respectively. The lower weir had 4-foot high pin-type flashboards when it was constructed originally, but they have been subsequently removed and their supports have been cut off at the weir crest. One design plan of the new spillway by NEPSCO was included with Barrows' Report of November 1939 and is included as Appendix B3-23.

The original wood stave penstock about 1.5 miles long to Silver Lake is thought to have been replaced in recent years with fully paved and coated, smooth-flow corrugated metal pipe.

No records of any other modifications to the dam are known.

c. Repairs and Maintenance

No records of any repairs to the dam are known.

d. Pending Remedial Work

The Owner has no plans for any pending remedial work.

2.3 Operation Data

a. Inspections

Only one inspection report was available and it is included starting on Appendix B3-24. The report was prepared by Stephen H. Haybrook, on behalf of the State of Vermont, on April 17, 1951. It contains some general data, a historical brief, and a description of the dam. It was stated in the report that the "dam appears in a good condition" but that "the discharge channel may be subjected to erosion in flood time but the safety of the dam from such a condition would not be affected." The report contains the concluding statement that "there is no appreciable change in the stability of this dam since its construction."

The Owner indicates that the dam is inspected annually by the firm of Kleinschmidt and Dutting, Engineering Consultants, 70 Main Street, Pittsfield, Maine 04967, telephone (207) 487-3328. However, the Owner did not make the results of those inspections available for review.

b. Performance Observations

There is no instrumentation in the dam. Other than observations made during the inspection previously discussed in Section 2.3.a, there are no other known performance observations.

c. Water Levels and Discharges

There are no known records of routine water levels and discharges from the dam.

d. Past Floods

Other than the brief account of the September 1938 flood in Barrows' report on spillway improvement (see Appendix B3-19), there are no other known records of past floods at the dam.

e. Previous Failures

There are no known previous failures of the dam.

2.4 Evaluation

a. Availability

As listed on Appendix B1, various engineering data and records are available in the files of the Dam Safety Engineer of the Vermont Department of Water Resources, of the Vermont Public

Service Board, and of Vermont Public Records. This data was reviewed, and copies of the records significant to the dam are included in chronological order in Appendix B3. Discussion of the data starts at the beginning of this section of the report. The Owner was unwilling to make their annual inspection reports or other data on file available. The Owner did make one drawing available for review during the field inspection, but the Owner would not allow it to be photographed and would not release it for subsequent review.

b. Adequacy

Available data consisted of a letter and two reports on construction of the dam and relocation and construction of the new spillway 2 years later, including poor copies of four various design/construction drawings, together with one report of an inspection some years later. Such data as the design calculations, construction specifications, detailed data on the foundation and embankment soils, and detailed operation and performance data were not available. The lack of such in-depth engineering data does not permit a comprehensive review. Therefore, the adequacy of this dam could not be assessed with respect to reviewing design, construction, and operation data.

c. Validity

Based on field observation and checking, the limited data available generally appears valid. Some exceptions noted are:

1) Original data in Appendix B3 indicate that the dam crest was intended to be at EL 1312, 10 feet higher than the lower spillway crest. Field measurements (see Appendix B2) show that the crest is non-level with the low point at EL 1311.2, 9.2 feet above the lower spillway crest. Also, original data indicate a maximum embankment height of 40 feet. From present analysis it appears that the structural height of the embankment is only about 36 feet to the actual low point of the dam crest, or about 37 feet to the design crest at EL 1312.

2) Existing engineering data indicate a total drainage area of 8.7 to 9.0 square miles and a drainage area tributary to Sugar Hill Reservoir of 2.3 to 2.5 square miles (see Appendices B3-3, B3-11, and B3-24). As discussed later in Section 5.1, present measurement yields about 10.51 square miles total (as much as about 21% more than reported) and 2.97 square miles to Sugar Hill Reservoir (as much as about 29% more than reported).

SECTION 3

VISUAL INSPECTION

3.1 Findings

a. General

Sucker Brook Dam was inspected on November 7, 1979. The inspection party (see Appendix A-1) was accompanied by two representatives of the Owner: Mr. J. Douglas Graham, Manager of Hydraulic Generation, and Mr. Edward Lurvey, General Hydraulic Foreman. Also present was Mr. Peter Barranco, Jr., Dam Safety Engineer of the Vermont Department of Water Resources. The weather was drizzly and overcast and the temperature was about 45° F. The water surface was very low at about EL 1293, about 9 feet below the lower spillway crest. The Visual Inspection Checklist is included as Appendix A, while selected photos taken during the inspection are included in Appendix C. Appendix C-1 is a photo index map. The Overview Photo at the beginning of the report as well as a couple of the photos in Appendix C are aerial photos taken from a helicopter on November 30, 1979.

b. Dam

In plan view this dam contains two bends, or angle points (see Overview Photo and Appendix C-1). At the rightmost angle point there exists a concrete wall which appears to pass entirely through the embankment transversely. Photo C-2A (extreme left center) shows the upstream end of the wall. The crest of the dam extends above the top of the wall about 3 to 4 feet. Photo C-2B is a detail of the upstream end which extends into the reservoir behind the dam. A large hole was found immediately to the right and underneath the upstream end of this wall. The hole is about 8-inch diameter and extends into the ground at least 2 feet. It is possible that this hole is the upstream end of a hole that passes through the dam along this wall. Inspection of the potential downstream exit points of any such hole revealed the presence of heavy riprap in those areas.

Inspection of the upstream end of this wall during periods of high water is indicated. It may be possible to observe small whirlpools above the hole if significant flow is occurring. Also, dye could be added above the hole to determine whether it moves downward into the hole.

On the downstream side of the dam about 30 feet left from the above-described wall and behind the vehicles shown in Photo C-3A, about 10 to 20 feet downstream from the apparent toeline, three 6-inch diameter holes were found in the ground. These appeared to be animal holes. One of these holes had numerous rocks in the bottom. It seems that topsoil had been placed over rockfill and that the topsoil had locally eroded into the larger openings. There was no reason to suspect that these holes were connected in any way with the upstream side of the dam.

Near the upstream toeline of the dam, opposite the person on the crest in Photo C-3B (near the left angle point in the dam), several small scarps have developed. The location of the scarps is also shown in Photo C-4A where the person in the orange raincoat is standing. These scarps are 6 to 18 inches high and extend for a longitudinal distance of about 15 feet. One scarp is about 3 feet downstream and another about 6 feet downstream from the toeline. The material in the reservoir bottom and in these scarps is highly organic. They appear to be localized slumps caused by placement of fill over peaty organic soil that seems to form part of the bottom of the reservoir.

The downstream slope of the dam is shown in Photos C-5A and C-5B, which overlap to display a continuous view of the slope. The slope is covered with brush about 6 feet in height, and stumps up to 8-inch diameter are found sporadically throughout. A few bare spots were found on the slope, but no significant erosion has occurred. On the downstream portion of the slope, up to about 15 feet above the downstream toeline, rock cover exists which now has been substantially overgrown. Some of the rock cover is seen at the lower left in Photo C-5A. Another view of the downstream slope, looking from right to left, is given in Photo C-4B. The rock cover is evident in most of the photo.

Riprap covers the entire upstream face. Some of the riprap is shown in Photo C-6B. In many locations the riprap is covered with loam and brush, and it is, therefore, difficult to see without close inspection. There was no way to judge whether a properly graded filter was placed beneath the riprap.

The original plans (1937) indicate that riprap was placed on the entire upstream face, but no mention was made of filter material. The hardpan in the embankment, against which the riprap was placed, was noted to be "well graded."

Leakage was observed exiting from the rock cover at the downstream toeline at a rate of about 4 gpm. The seepage was clear. The discharge channel and some ponded water downstream are shown in Photo C-6A.

c. Appurtenant Structures

1) Intake Structure and Control Tower

The intake structure and control tower are one and the same concrete structure located just upstream of the dam near the left end (see Overview Photo). The actual intake is an inclined port just upstream of the control tower covered by a large wooden trash rack structure (see Photo C-7A). The inspection checklist for the intake is on Appendix A-4. The inspection checklist for the control tower is on Appendix A-5. Only the outside of the intake structure and control tower were inspected. The inside was not readily accessible and was also partially submerged. For similar reasons, the 24-inch diameter low level drain pipe projecting upstream from the bottom of the intake structure was not inspected. As discussed later in Section 3.1.d, the inlet to this low level drain may be buried by sediment.

From what was readily visible, the intake structure and wooden trash rack are in fair to good condition. As seen in Photo C-7A, leaves and trash had collected against the rack structure and were causing some flow obstruction. The low water level and the partially exposed reservoir bottom, that appears like a bog, aggravate this condition. The inclined steel trash rack shown directly over the intake by the design/construction drawings (see Appendix B3-8) was not noted during the inspection.

The outside of the concrete control tower is in good condition, except for deterioration at the support seat for the service bridge (see Photo C-8A) and for a vertical crack on the left side of the tower (see Photo C-8B). Deterioration on the right side of the support seat was about as advanced as that shown on the left side by Photo C-8A, except that the loose concrete had not fallen off yet. The vertical crack on the left side of the tower starts at a railing post socket on top and appeared to narrow toward the base. No leakage was observed, since the water level inside the tower was lower than the ground at the base of the tower.

On top of the control tower there is a handwheel-operated rack gear control mechanism (see Photo C-7B), which operates the service slide gate in the gate well directly underneath. The handwheel was secured with a padlocked chain and was not operated, but the entire mechanism appeared in serviceable condition. The service gate appeared to be fully open during the inspection.

The lower horizontal pipe railing on top of the control tower toward the intake was not secured on its left end. Welds are broken and a section of railing is missing at this point. (Just visible in Photo C-7A.)

2) Service Bridge

The service bridge is a wood-decked walkway supported on open web beams spanning about 20 feet from a point just upstream of the dam crest to a seat on the control tower. (See Photos C-3B, C-4A, and C-7A.) The inspection checklist is on Appendix A-9.

The concrete seat on the control tower is deteriorated, as seen in Photo C-8A and already discussed in the previous section. The wooden deck planking appeared sound except for one or two planks near the control tower. Some other planks felt loose. The deck planking appeared to be bare wood.

3) Outlet Conduit

The outlet conduit consists of a concrete box section 3 feet-2 inches wide by 4 feet high running from the gate well in the bottom of the control tower through the dam to a 4-foot diameter penstock starting just downstream of the downstream toe. The penstock runs about 1.5 miles to Silver Lake. The outlet conduit was not inspected, because access was very difficult and it appeared to be almost completely full of water. The connection between the outlet conduit and the penstock is partially exposed at the downstream toe and is visible in Photos C-4B and C-9A.

4) Spillway and Discharge Channel

The chute type spillway is at the right abutment of the dam (see Overview Photo). The spillway consists of a short approach section, two adjacent concrete weirs at different elevations, and a long chute discharge channel. The inspection checklist is on Appendix A-8.

Photo C-9B shows the approach channel. The floor of the channel is natural bedrock and is obscured, but not significantly obstructed, by grass and weeds.

Photo C-10A shows the lower spillway weir. The remains of the pin-type flashboard supports that have been cut off are visible. At the left in Photo C-10B can be seen the upper spillway weir. Both spillway weirs were in good condition.

The left training wall of the spillway is visible in Photos C-10A, C-10B, and C-11B. Next to the approach section and the weir, the training wall is in good condition. Downstream of the weir on the left of the discharge channel there are several problems. First, there is spalling at two construction joints, one near the first break in slope of the wall top downstream of the weir and the other about 30 feet from the downstream end of the wall. The joint near the first break in slope is shown in Photo C-11A, which is typical of the condition at the other joint further downstream.

Second, there is significant efflorescence and hairline cracking in the training wall for about 10 feet downstream of the second break in slope downstream of the weir. This is just visible in Photo C-10A to the right of a small evergreen tree growing next to the wall.

Third, at the downstream end of the wall shown in Photo C-11B, there is a transverse crack and the wall is tilted slightly into the discharge channel. The bottom of the wall is undermined at the end, as seen in Photo C-12A. This wall requires maintenance to prevent accelerated deterioration.

There were several logs lodged in the discharge channel just downstream of the weir (see Photo C-10B). Also, there were small evergreen trees and brush growing on the left side next to the training wall (see Photo C-11B).

d. Reservoir Area

It appears that there is well over several feet of sedimentation in the bottom of the reservoir. The design/construction drawings in Appendix B3 indicate that the lowest part of the bottom is about at EL 1280 just upstream and to the right of the intake structure and control tower, at about the natural confluence of Sucker Brook and Dutton Brook. Part of the bottom was visible above the water in this area during the November 7 inspection (see Photo C-3B) and during the aerial photo trip on November 30 (see Overview Photo). The water elevation is judged to be about the same on both occasions and about at EL 1293, slightly above the invert of the intake port (water visible through the racks spilling into the intake in Photo C-7A). This suggests that sedimentation may be built up to as much as 13 feet deep with an average level perhaps several feet lower at about EL 1290. Such a sediment level would bury the inlet of the 24-inch diameter low level drain, which has a top elevation of about EL 1296, located about 25 feet upstream of the intake structure. (Area visible in Overview Photo and Photo C-7B). The inlet of the low level drain was not readily evident from shore during the field inspection, and the reservoir bottom was too soft to allow approaching the suspected location of the inlet.

There does not appear to be any potential hazard due to backwater flooding of the reservoir. Also, other than Sugar Hill Dam located about 2.7 miles upstream on Sucker Brook (see Appendix D-1), no features were observed that might cause excessive alteration of the drainage area or increased inflow. (See separate Phase I Inspection Report for Sugar Hill Dam, VT

00176.) No potential landslide areas were noted around the reservoir.

e. Downstream Channel

All the normal flow from Sucker Brook Reservoir (i.e., all the normal flow of Sucker Brook and Dutton Brook) is diverted through a 4-foot diameter penstock about 1.5 miles long around a mountain to Silver Lake located to the southwest (see Appendix D-1). The beginning of the penstock is shown in Photo C-9A. Any release from the drain pipe at the start of the penstock or seepage from the dam would follow approximately the old natural stream channel of Sucker Brook (visible to the right of the penstock in Photo C-9A and in the vicinity of ponded water in Photo C-6A). About 500 feet downstream of the dam, the spillway discharge channel joins Sucker Brook from the right (see Overview Photo).

From the dam to Lake Dunmore, a distance of about 2 stream miles, Sucker Brook is generally a rocky, sometimes steep channel that is heavily wooded on both sides. For a map of the downstream channel, refer to the Drainage Area Map, Appendix D-1, which also indexes photos that cover the downstream area.

About 0.6 of a mile downstream of the dam (just below Sta 26+00), Voters Brook joins Sucker Brook. About 1 mile downstream (almost to Sta 56+00), an unnamed tributary joins Sucker Brook from the north. Also, approximately at this point any flow from Silver Lake would join Sucker Brook from the south.

About 1.6 miles downstream (Sta 85+00), Sucker Brook runs under a bridge on Town Route 53 (formerly a State highway, see Photo C-12B). Before reaching the bridge, Sucker Brook drops down from the mountains over so-called Lana Falls. Photo C-13A is an aerial overview looking upstream, which shows the mountains in the background and the low-lying area on the shores of Lake Dunmore in the foreground.

Photo C-13B is a closer aerial view of the mouth of Sucker Brook where it flows into Lake Dunmore, and the adjacent low-lying houses and hazard area.

3.2 Evaluation

The hole that was observed beneath the upstream extension of the left training wall of the original spillway should be investigated to see if it passes through the dam and is a potential seepage path. Observation during periods of high water together with dye testing should be tried.

TABLE 5.2

SUCKER BROOK DAM

DAM FAILURE ANALYSIS

CONDITIONS — Top of Dam Elev. 1311.2 (lowest point of non-level top)
Spillway Crest Elev. 1302
Total Project Discharge Capacity less
Diversion Flow at Top of Dam = 4180 cfs ±
due to two spillways. Outlet works closed.

	Approx. Peak Flow (cfs)	Time to Peak Flow (hours	Approx. Max. Water Surface			
			Elev. (feet)	Depth (feet)	Top Width (feet)	Avg. Vel. (fps)
PRIOR FLOW AT TOP OF DAM						
Inflow = Outflow = Total Project Discharge Capacity less Diversion Flow at Top of Dam						
Start Routing at Top of Dam						
Dam	4180	--	1311.2	27.2	--	--
Sta 26+00	4180	--	1125.3	5.3	--	28
Sta 80+00	4180	--	644.1	4.1	--	38
Sta 85+00 Hwy Bridge	4180	--	600.6	2.6	--	12
Sta 93+00 Houses	4180	--	580.5	2.5	--	7
BREACH AT TOP OF DAM						
Inflow = zero						
Start Routing at Top of Dam						
Start Breach W.S. at Top of Dam						
Time of Failure = 0.00 hour						
Breach Time = 0.023 hour						
Breach Width = 100 feet						
Breach Depth = 27.2 feet						
Trapezoid, 0.5H:1V side slopes						
Dam	28,000	0.02	1311.2	27.2	--	--
Sta 3+00	--	--	--	--	--	--
Sta 26+00	16,600	0.03	1130.1	10.1	70	40
Sta 56+00	11,100	0.05	899.5	4.5	200	25
Sta 72+00	10,000	0.07	809.5	9.5	50	37
Sta 80+00	10,000	0.07	646.1	6.1	60	46
Sta 85+00 Hwy Bridge	10,000	0.07	601.2	3.2	570	14
Sta 93+00 Houses	7,600	0.10	581.1	3.1	910	7

points. It must be done by judging the calculated quantity, depth, width, and velocity of flow against the real channel cross section as it exists.

b. Results of Analysis

The results of the dam failure analysis using the HEC-1 DB program are summarized in Table 5.2. PRIOR FLOW AT TOP OF DAM establishes initial conditions downstream due to steady state total project discharge capacity, less diversion flow, at the top of dam with no dam breach. The computer input and selected pages of the computer outut start on Appendix D-32. In Table 5.2 only the results at the more important stations are summarized.

BREACH AT TOP OF DAM is a major sudden failure of the dam under the conditions previously discussed in Section 5.5.a. Results are summarized in Table 5.2 for all stations, with the computer input and selected pages of the computer output starting on Appendix D-37.

From the computer listing and plot of the breach hydrograph on Appendices D-39 and D-40, note that the standard calculation interval selected (1 minute = 0.017 hours) was short enough to permit the interpolated breach hydrograph at the standard time interval to closely approximate the computed breach hydrograph. Only the interpolated breach hydrograph is routed downstream.

Appendix D-41 is a computer plot of the complete outflow hydrograph during and after the breach.

c. Hazard Evaluation

For a sudden major dam failure, BREACH AT TOP OF DAM, the computed maximum water surface elevation for each downstream station is tabulated in Table 5.2 (Sta 3+00 not used for breach routing) and is plotted on each cross section beginning on Appendix D-28. The top widths of flow determined from each cross section are tabulated in Table 5.2 and are plotted on Appendix D-1 to define the limit of the hazard area, i.e., the limit of flooding due to the dam failure. Also, the computed water surface is shown on the channel profile, Appendix D-31.

The average velocity of peak flow (flow divided by total flow area) is also listed in Table 5.2 for each downstream station for both flow cases. For the dam breach case, the flow area calculation is shown on each cross section plot starting on Appendix D-28, and consists of storage for the channel reach defined by the cross section divided by reach length. The channel storage was computed by the HEC-1 DB program for both flow cases.

Just prior to the dam breach, outflow from the dam was 4180 cfs, and flow 2600 feet downstream was about 5.3 feet deep at about 28 fps. After the breach, peak outflow from the dam

dam was routed downstream using the HEC-1 DB program. Stream conditions just prior to and after the assumed failure were compared. Corps of Engineers' criteria call for breaching the dam with no inflow flood and with the water surface static at the top of the dam, or static at the test flood pool if a test flood of full PMF does not overtop the dam. Since the overtopping analysis shows that the test flood of one-half PMF does overtop the dam, the dam breach was begun at time zero with the water surface at the top of the dam. The contents of the reservoir were routed through the breach as the breach progressed.

To model a sudden major dam breach, maximum breach geometry was selected as follows: constant trapezoidal shape with moderate 0.5H:1V side slopes, breach width across the bottom of the trapezoid equal to the bottom width of the original valley (approximately 100 feet), and a breach depth below the low point on top of the dam equal to 27.2 feet (down to EL 1284), which approximates a full depth failure that would almost completely drain the reservoir. Breach geometry is illustrated on Appendix D-36.

Breach time, or time for the breach width to progress from the top to the bottom of the dam, was selected so that the peak outflow using the HEC-1 DB program would approximate that computed by the Corps of Engineers' "Rule of Thumb" method using the same breach width and depth, plus additional flow equal to total spillway capacity at top of dam, since the breach could be located separate from the spillway. The selection of breach time is shown on Appendix D-36. Rule of Thumb peak breach outflow is about 23,900 cfs. Additional flow due to spillway capacity is 4180 cfs. Therefore, total peak outflow from the dam is about 28,000 cfs. A breach time of 0.023 hours, or 1.38 minutes, was selected for the HEC-1 DB program, which results in a peak outflow of about 28,000 cfs.

The inputted cross sections defining average downstream channel reaches were developed from and are located on the USGS map included as Appendix D-1. Hand plottings of the cross sections start on Appendix D-27, while Appendix D-31 is a profile of the downstream channel. Normal depth channel routing was performed by the HEC-1 DB program using the Manning's n values for left overbank, channel, and right overbank as listed on each cross section plot. The overbank points and the actual channel section in between are only an approximation of the true natural channel. This is because of the constraints of the small scale USGS map that the cross sections were developed from and of the limited 8-point cross section accepted by the program. The third and sixth point on each cross section are defined as the overbank points. Therefore, distinguishing between in-channel and overbank flow cannot be done reliably by simple comparison of computed water surface depth with the defined overbank

TABLE 5.1

SUCKER BROOK DAM

OVERTOPPING ANALYSIS

CONDITIONS — Total Drainage Area = 10.51 Square Miles including Sugar Hill [e] Reservoir and its Total Drainage Area of 2.97 Square Miles.
Start Routing at Spillway Crest Elev. 1302.
Top of Dam Elev. 1311.2 (lowest point of non-level top)
Total Project Discharge Capacity at Top of Dam = 4280 cfs ± due to two Spillways and Outlet Penstock Fully Open.
Some Values Rounded from Computed Results.

		TEST FLOOD ONE-HALF PMF [a]
INFLOW		
24-hour Rainfall (inches)		10.6 [b]
24-hour Rainfall Excess (inches) [c]		8.0 [d]
Peak Inflow	(cfs)	7290
	(csm)	694
OUTFLOW		
Peak Outflow	(cfs)	7290
	(csm)	694
Time to Peak Outflow (hours)		19.00
Maximum Storage (acre-feet)		63
Max. W.S. Elevation (feet-NGVD)		1313.1
Minimum Freeboard (feet)		overtopped
Maximum Depth over Dam (feet)		1.9
Duration of Overtopping (hours)		5.00

(a) One-half of full PMF total runoff, including base flow. For one-half PMF base flow = 2 cfs per square mile = 21 cfs ±
(b) Approximation assuming total losses are the same as for the full PMF. Full PMF 24-hour rainfall equals 18.5 inches.
(c) Rainfall Excess = Rainfall for the Reservoir Surface. For the rest of the drainage area, losses are assumed to be 1.0 inch initially and 0.1 inch per hour thereafter.
(d) Equal to one-half of full PMF value. Full PMF 24-hour rainfall excess for the land surface equals 15.9 inches.
(e) Sugar Hill Dam: Minimum Freeboard = 0.8 foot, peak inflow = 2160 cfs, and peak outflow = 2020 cfs. Routing started with W.S. at spillway crest Elev. 1768.

critical flow over a broad-crested weir) and resulting discharge capacity are included as Appendix D-12. The outlet works were assumed closed. Any flow over the dam was computed by the program assuming critical flow over a non-level dam crest.

Flow from Sugar Hill Reservoir through Subarea 3 to Sucker Brook Reservoir was modeled by the HEC-1 DB program using normal depth channel routing. The inputted cross sections defining average channel reaches were developed from and are located on the USGS map included as Appendix D-1. Hand plottings of the cross sections are included on Appendices D-13 and D-14. The construction and limitations of the cross sections are the same as for the downstream cross sections used in the dam failure analysis as explained later in Section 5.5.a.

f. Overtopping Potential

The results of the overtopping analysis using the HEC-1 DB program are summarized in Table 5.1. The overtopping analysis computer input and complete output for the test flood of one-half PMF are included starting on Appendix D-15.

As noted from Table 5.1, the test flood of one-half PMF overtops the dam by a maximum of about 1.9 feet with duration of overtopping of about 5 hours. Peak inflow for the test flood is 7290 cfs, or 694 csm (cfs per square mile). Peak outflow is unaffected by reservoir routing and is the same as peak inflow, or 7290 cfs, or 694 csm, and occurs about 19 hours after the start of the storm. The peak portion of the inflow and outflow hydrograph for the test flood of one-half PMF is shown by the computer plot on Appendix D-23. Total project discharge capacity at the top of the dam is due to the two-level chute spillway plus the outlet penstock fully open, and is equal to 4280 cfs, or 59% of the test flood peak outflow.

As indicated by footnote (e) on Table 5.1, the test flood of one-half PMF does not overtop Sugar Hill Dam, but results in a minimum freeboard of 0.8 of a foot. Peak inflow is about 2160 cfs. Peak outflow is reduced very little by reservoir routing to about 2020 cfs. Therefore, it appears that Sugar Hill Dam and Reservoir, when starting with a water surface at the spillway crest, does not provide significant flood reduction for Sucker Brook Dam under test flood conditions of one-half PMF.

5.5 Dam Failure Analysis

a. Failure Conditions

In order to evaluate the downstream hazard, the flow just prior to and then due to an assumed major failure or breach of the square miles or less and was used for this actual 10.51-square-mile drainage area) were inputted to the program as percentages of the index PMP in accordance with HMR 33. A storm reduction coefficient was then applied internally by the program in order to transpose or center the storm over the actual total drainage area. Thus, the corrected 24-hour PMP for the actual total drainage area became 18.5 inches.

In accordance with accepted practice, floods as ratios of the PMF (e.g., one-half PMF) were taken as ratios of runoff, not of precipitation. The HEC-1 DB program applies the ratio to total runoff, including base flow. This method of applying the ratio introduces an increasing error in base flow as the ratio of the PMF gets smaller. However, this error was eliminated by inputting twice the desired base flow to the full PMF, so that one-half PMF, the test flood, would have the correct base flow.

All precipitation was distributed by the program using the Standard Project Storm arrangement of EM 1110-2-1411 (Reference 13), including the percentage distribution for the maximum 6-hour precipitation, and by both the arrangement and percentage distribution from HYDRO-35 (Reference 6) for the maximum 1-hour precipitation.

Appendices D-8 through D-10 summarize the subarea, loss rate, and unit hydrograph data inputted to the program. Five subareas were used (see Appendix D-1). Subareas 1, 3, and 4 consist of all of the land area excluding reservoirs, and Subareas 2 and 5 consist of just Sugar Hill Reservoir and Sucker Brook Reservoir, respectively. For the land in Subareas 1, 3, and 4, loss rates were assumed to be 1.0 inch initially and a constant 0.1 inch per hour thereafter. Snyder unit hydrograph parameters were assumed for average conditions per Appendices D-8 and D-9 and inputted to the program. Conservative standard lag times were used. The program uses the inputted Snyder coefficients to solve by iteration for approximate Clark coefficients, which are then used to calculate the runoff hydrograph.

For the reservoir surfaces making up Subareas 2 and 5, loss rates were set to zero so that rainfall would equal rainfall excess, or runoff. Assuming no delay in the rainfall/runoff response, a constant unit hydrograph for a rainfall duration equal to the HEC-1 DB calculation interval was developed per Appendices D-8 and D-10 and inputted to the program.

Routing through Subarea 2, Sugar Hill Reservoir, was done by the HEC-1 DB program in the same way as in the separate Phase I Inspection Report for Sugar Hill Dam, VT 00176. Inputted stage-area and resulting storage capacity are included as Appendix D-11. Inputted spillway characteristics (for let conduit and the two spillways was inputted directly to the HEC-1 DB program. Flow over the dam was computed by the HEC-1 DB program, assuming critical flow over a non-level dam crest, using inputted crest length and elevation data (see Appendix B2). The computed results for flow over the dam are hand tabulated on Appendix D-6.

With the reservoir at the low point on the dam crest, EL 1311.2, 9.2 feet over the lower spillway crest, the total discharge from the dam is about 4280 cfs. This is due to the outlet conduit and penstock fully open (about 100 cfs) plus the two-level chute spillway (about 4180 cfs). Also, with an average discharge of about 2140 cfs over the 9.2-foot depth from the top of the dam down to the lower spillway crest, it would take about 11 minutes for the spillway to drain the 33 acre-feet of storage between the top of the dam and the lower spillway crest, or about 1.2 minutes per foot, all assuming no inflow.

d. Selection of Test Flood

Based on the dam failure analysis presented later in Section 5.5, Sucker Brook Dam is classified as having a significant hazard potential (increase in flow due to a dam failure would result in appreciable economic loss and possible loss of less than a few lives caused by damage to portions of Branbury State Park, an increase in damage to a highway bridge on Town Route 53 and the road on either side of the bridge, and flooding of the first floors of about 8 houses along Lake Dunmore to a depth of less than 1 foot, with the moderate flow velocity of 7 fps probably damaging the homes). Since the dam is also classified as small in size (see Section 1.2.c), recommended guidelines of the Corps of Engineers (Reference 1) indicate a test flood in the range of the 100-year flood to one-half PMF (probable maximum flood). Since as many as 8 homes and other facilities are involved in the hazard potential with regard to economic loss, and since the dam is at the upper limit of its small size range with regard to height (36 feet close to the 40-foot limit), the test flood selected for this evaluation was one-half PMF (per Table 5.1, peak inflow = 7290 cfs, peak outflow = 7290 cfs).

The PMF event is that hypothetical flood flow produced by the most critical combination of precipitaiton, minimum infiltration loss, and concentration of runoff that is considered reasonably possible for a particular drainage area.

e. Development of Test Flood

The index PMP (probable maximum precipitation) inputted to the HEC-1 DB program was 17.5 inches for a 24-hour duration, all-season storm over a 200 square mile basin, according to HMR 33 (Reference 4). Maximum 6-hour, 12-hour, and 24-hour precipitation for the actual size of the drainage area (same for 10

c. Discharge Capacity

The outlet works consists of a gated concrete outlet conduit about 3 feet-2 inches wide by 4 feet high by about 100 feet long from the gate well through the dam. About at the downstream toe, the conduit transitions to a 4-foot diameter penstock about 1.5 miles long to an open channel just short of Silver Lake. (See Appendix D-1.) Originally the penstock was wood stave pipe, but it is thought to have been replaced in recent years with fully paved and coated, smooth-flow corrugated metal pipe.

Assuming the outlet works are fully open, their discharge capacity was found to be strictly a function of the hydraulic capacity of the penstock created by the difference in head between the water surface behind Sucker Brook Dam and the fixed-elevation outlet of the penstock. The formula used and the results of hand computations are shown on Appendix D-5. At the lower spillway crest, EL 1302, the capacity of the outlet conduit and penstock is about 90 cfs. At the dam crest, EL 1311.2, the capacity increases to about 100 cfs.

The only spillway for the dam is a chute spillway at the right abutment. Referring to the engineering data in Appendix B and Photos C-9B, C-10-A, C-10B, and C-11B, the spillway consists of an approach section, two adjacent concrete overflow weir control sections at different elevations, and an excavated earth and rock chute discharge channel, which runs down along the right abutment of the dam and empties into the natural stream channel. The overflow control weirs are 40 feet long and 20 feet long, with crests at EL 1302 and EL 1306, respectively. The lower weir crest is about 5 feet wide and has had its pin-type flashboards removed. The control section has vertical sides on both ends of the weir. The upper weir crest is about 1 foot wide and has no provision for flashboards.

The discharge capacity for each of the two spillways was computed assuming critical flow over a rectangular broad-crested weir. Total spillway capacity was taken as the sum of the capacities of the two spillways. The formulas used and the results of hand computations are shown on Appendix D-6. With water 9.2 feet over the lower spillway crest (i.e., level at the dam crest and 5.2 feet above the upper spillway crest), the two spillways together have a discharge capacity of about 3450 +730 = about 4180 cfs.

Taking the minimum draft elevation for the outlet works at EL 1293, the spillway crests at EL 1302 and EL 1306, and the dam crest at EL 1311.2, total discharge computations are summarized on Appendix D-6 and graphed on Appendix D-7. Total discharge from the dam is the sum of the discharges from the outlet conduit, the two chute spillways, plus flow over the dam for the overtopping condition. The sum of the hand-computed discharges for the out-

5.4 Test Flood Analysis

a. Initial Conditions

The U.S. Army Corps of Engineers Hydrologic Engineering Center's Program HEC-1 DB (Reference 3) was used to develop the test flood hydrology and perform the reservoir routing.

The purpose of this analysis was to evaluate the dam and spillway with respect to their surcharge storage and spillway capacity. Accordingly, it was assumed that the water surface was at the lower spillway crest at the start of the flood routing. Also, it was assumed that the outlet conduit and penstock were fully open as they are normally. The outlet conduit drain pipe was assumed in its normal closed position. Discharge of the low level drain is included in the outlet conduit and penstock.

The effect of Sugar Hill Dam and Reservoir on inflow into Sucker Brook Dam was included in the analysis. The drainage area, storage, and discharge parameters for Sugar Hill Dam are discussed later in Section 5.4.e (calculations on Appendices D-8, D-11, and D-12). It was assumed that the water surface was at the spillway crest at the start of the flood routing.

A constant base flow of 2 cfs per square mile was chosen to represent average conditions in the drainage area and was inputted into the program for all subareas.

b. Storage Capacity

Using a bathymetric map of the reservoir from the original design/construction plans (Appendix B3-7), areas inside contour elevations were measured and the capacity of the reservoir was computed by the method of conic sections. The computations were done by the HEC-1 DB program with the results on Appendices D-22 and D-26. A hand tabulation of the input and the computed results is on Appendix D-2.

The total computed storage capacity at the upper spillway crest (EL 1306) agrees within about 4% of reported values (34 acre-feet or 1.481 million cubic feet (mcf) vs. 1.425 mcf per Appendix B3-3 and 1.5 mcf per Appendices B3-13 and B3-24).

Using the measured and computed values, stage-area and stage-storage curves are presented on Appendices D-3 and D-4, respectively. At the lower spillway crest, EL 1302, the reservoir has a surface area of 3.0 acres and a total capacity of 21 acre-feet. At the dam crest, EL 1311.2, the surface area increases to 4.5 acres and the capacity to 54 acre-feet, or about 17.6 million gallons. Surcharge storage between the spillway crest and the dam crest amounts to 33 acre-feet, or about 0.06 inches of runoff from the 10.51 square mile drainage area. Therefore, the reservoir has almost no capacity to attenuate peak inflow.

SECTION 5

EVALUATION OF HYDRAULICS AND HYDROLOGY

5.1 General

Sucker Brook Dam is shown on the Location and Vicinity Maps at the beginning of this report and on the the Drainage Area Map, Appendix D-1. The dam and the reservoir are located on Sucker Brook in central Vermont at the confluence of Dutton Brook with Sucker Brook. About 10,300 feet downstream of the dam Sucker Brook drains into Lake Dunmore. Lake Dunmore is at the head of the Leicester River which runs westward to the Otter Creek. The Otter Creek runs northward and flows into Lake Champlain, which in turn is drained to the north by the Richelieu River.

The total drainage area at the dam was measured to be about 10.51 square miles, of which about 0.005 square miles (3.0 acres), or less than 0.1%, is the surface area of Sucker Brook Reservoir at the lower spillway crest. (See Appendices D-1 and D-2). The measured total drainage area is as much as about 21% larger than that reported in existing engineering data (10.51 square miles measured vs. 8.7 to 9.0 square miles reported in Appendices B3-3, B3-11, and B3-24). Being in the northwestern foothills of the Green Mountain National Forest, the topography is characterized by wooded slopes averaging 5% to 20%. The elevation of the drainage area varies approximately from EL 1293 to EL 3230.

Upstream of this dam is the Sugar Hill Reservoir, which has a drainage area measured to be about 2.97 square miles. This drainage area is included as part of the total drainage area for Sucker Brook Dam. Therefore, about 28% of the total drainage area of Sucker Brook Dam is regulated by Sugar Hill Reservoir. The measured drainage area tributary to Sugar Hill Dam is as much as about 29% larger than that reported in existing engineering data (2.97 square miles measured vs. 2.3 to 2.5 square miles reported in Appendices B3-3, B3-11, and B3-24).

5.2 Design Data

There are no known records of the hydraulic and hydrologic criteria used in the original design of the dam and reservoir. The engineering data which was available, mainly old design and reconstruction plans and reports of construction, are discussed in Section 2 of this report.

5.3 Experience Data

There are no known records of routine water levels and discharges or of past floods at the dam. However, according to the available data in Appendix B3, it is known that a flood occurred in September of 1938 which caused extensive damage to the spillway channel necessitating its relocation.

4.2 Maintenance Procedures

a. General

According to the Owner, maintenance crews visit and inspect the dam once a week and perform routine maintenance, such as brush clearing, annually. There are no written maintenance procedures for the dam and reservoir and their operating facilities.

b. Operating Facilities

(Covered under preceding Section 4.2.a - General.)

4.3 Evaluation

Written operation and maintenance procedures for this dam do not exist. Although routine maintenance of the dam is said to occur annually, our visual inspection suggests that slope maintenance, for instance, has been rather irregular and less often than yearly. Brush growth and tree stumps were evident on the slopes. Effective operation and maintenance procedures need to be developed and implemented by the Owner in order to avoid deterioration of the dam.

As part of the operation procedure, the Owner should formalize the reservoir regulation plan that is now used to maintain normal water level below the spillway crest. This is necessary due to the dam's inadequate spillway capacity when starting with a normal pool at the spillway crest (see Sections 5 and 7), and due to questions about the physical condition of the dam and spillway (see Sections 3, 6 and 7).

SECTION 4

OPERATION AND MAINTENANCE PROCEDURES

4.1 Operation Procedures

a. General

Sucker Brook Reservoir was originally used as a diversion and storage reservoir as part of the Silver Lake Hydroelectric Development. Presently, the reservoir is used only to divert water with the normal water level reportedly being maintained well below the spillway crest. At the time of inspection, the reservoir was almost empty, about down to the level of the intake port at the base of the control tower, which is about 9 feet below the lower spillway crest. The slide gate in the gate well under the control tower was open, and it allowed continuous outflow from the dam through the penstock to Silver Lake. Apparently the slide gate is left fully open so that as much water as possible is diverted to Silver Lake. Except for heavy flows in the spring, it appears that all the normal flow of Sucker and Dutton Brooks is diverted to Silver Lake.

The chute spillway is ungated and wide open, and its flashboards have been cut off by the Owner. (See Photo C-10A.) Reportedly the spillway operates only in the spring when a large amount of inflow into the reservoir occurs.

There are no written operation procedures for the dam and reservoir.

The Owner indicates that the dam is inspected annually by the firm of Kleinschmidt and Dutting, Engineering Consultants, 70 Main Street, Pittsfield, Maine 04967, telephone (207) 487-3328. However, the Owner did not make the results of those inspections available for review.

b. Emergency Action Plan and Warning System

An emergency action plan with a warning system is in effect for Sucker Brook Dam, according to the Owner. It involves stationing a company employee with a radio at the dam during severe storm events. If an emergency situation develops, he alerts a dispatcher who then informs State Police and local Town officials of the situation.

According to the Owner, the emergency action plan is in writing. However, the Owner would not produce a copy for review or inclusion in this report.

Logs lodged in the spillway discharge channel should be cleared. Also, all brush and small trees in the spillway discharge channel, particularly next to the training wall, should be removed.

The cause of the scarps near the upstream toeline approximately opposite the leftmost angle point of the dam should be investigated. The scarps should be monitored until such time as they are investigated.

The brush and small trees should be cut from all slopes annually to a distance of about 20 feet from the toeline. Existing rotting stumps and their roots on the downstream slope should be removed and replaced with proper backfill.

The clear seepage that was observed exiting from the rock cover at the downstream toeline should be monitored at least annually.

The deteriorated concrete seat for the service bridge on the control tower should be repaired. Also, the vertical crack in the left side of the control tower should be investigated and repaired.

The inside of the intake structure, the gate well under the control tower, and the outlet conduit should be dewatered and thoroughly inspected. The service slide gate should be inspected and its operation checked.

The low level drain should be exposed if buried by sediment and its condition checked.

The depth of sediment in the reservoir - suspected to be well over several feet and covering the low level drain - should be verified. Sediment should be cleaned out at least down to the level of the low level drain. This will help to eliminate the trash and leaves that collect against the intake rack, and which should be kept cleaned off.

The left end of the lower horizontal pipe railing on top of the control tower toward the intake should be secured by replacing the missing piece.

One or two wooden deck planks on the service bridge near the control tower appear weak and should be replaced. All planks should be kept bolted tightly. Also, a preservative should be considered for the apparently bare wooden decking.

The downstream end of the left training wall of the spillway discharge channel should be repaired or rebuilt where it is cracked and undermined. Also, spalling at two construction joints in the training wall should be repaired. The significant hairline cracking and efflorescence near the second break in slope of the wall top downstream of the spillway weir should be repaired.

increases about 6.7 times to 28,000 cfs. This causes water at Sta 26+00 to rise from 5.3 to 10.1 feet deep, an increase of 4.8 feet, which floods an area about 70 feet wide. Velocity increases about 1.4 times to 40 fps.

At Sta 85+00 at the highway bridge on Town Route 53 (formerly a State highway), peak flow increases about 2.4 times to 10,000 cfs after the breach. This causes the water to rise from 2.6 to 3.2 feet deep, an increase of 0.6 foot, which floods an area about 570 feet wide. Velocity increases about 1.2 times to 14 fps. The highway bridge, which is visible in Photo C-12B, has an estimated capacity (Reference 17) of only 1000 to 1500 cfs with headwater 8 feet deep (i.e., water level with the road), which is less than even the prior flow of 4180 cfs. Therefore, the increase in flow due to the dam failure would only worsen the already out-of-channel and over-the-roadway flow condition that would exist just prior to the failure.

At Sta 93+00 near houses along Lake Dunmore, peak flow increases about 1.8 times to 7600 cfs after the breach. This causes the water to rise from 2.5 to 3.1 feet deep, an increase of 0.6 of a foot, which floods an area about 910 feet wide. Velocity remains the same at about 7 fps. Ground around the houses is estimated at EL 580 with the first floors estimated at EL 581. Prior flow at EL 580.5 appears to not quite flood the first floors. The 0.6-foot increase due to the dam failure appears to flood the first floors to a depth of less than 1 foot. The 7 fps velocity would probably damage the structures. It is estimated that about 8 houses would be involved in this flooding, plus miscellaneous outbuildings. An adjacent State Pa·k would also be flooded and damaged.

The flood routing was not carried any further downstream than Sta 93+00 because Sucker Brook drains into Lake Dunmore just after this station. Lake Dunmore has a surcharge storage capacity of over 1035 acre-feet per foot as compared to the total volume of Sucker Brook Reservoir at the top of dam of only about 54 acre-feet. Therefore, it appears that a failure of Sucker Brook Dam would have a negligible effect on Lake Dunmore and any other area further downstream.

In summary, it appears that the increase in flow due to a failure of the dam would damage portions of Branbury State Park and flood the first floors of about 8 houses along Lake Dunmore to a depth of less than 1 foot, with the moderate flow velocity of 7 fps probably damaging the structures. Damage to a highway bridge on Town Route 53 and to the road on either side of the bridge would only be increased by a dam failure. Total economic loss is judged appreciable. Loss of less than a few lives is judged possible. Therefore, according to recommended guidelines (Reference 1), the dam is classified as having a significant hazard potential.

SECTION 6

EVALUATION OF STRUCURAL STABILITY

6.1 Visual Observations

The presence of a hole on the upstream side of the dam adjacent to the concrete wall that apparently passes transversely through the dam is a feature that may lead to future internal erosion. This feature, described in Section 3.1.b, is located on the upstream end of the concrete wall near the rightmost angle point in the dam.

In a Nov. 27, 1939 letter (Appendix B3-19), H.K. Barrows indicated that the above-mentioned wall, which formed the left training wall of a former spillway, was to be removed prior to extending the embankment. The embankment was extended to construct a new spillway subsequent to the 1938 flood. It is not known whether the wall was actually removed or what precautions were taken to ensure that a waterstop was present along this wall. Also, it is not known whether the original spillway crest was buried in the new embankment.

During periods when the water level in the reservoir rises above this hole, an inspection should be made to determine whether there is any sign of flow into the hole. A careful examination should be made at the same time of the downstream side of the dam to detect any outflow that is observable. Dye-tracing techniques may be valuable for this purpose.

The small scarps that exist near the upstream toeline approximately opposite the leftmost angle point in the dam (see Section 3.1.b) may be due to placement of embankment fill over a highly organic soil. Excavation into these small scarps to examine the subsoils would be desirable to determine whether any conditions exist that require repair. Measurements should be made on a periodic basis to determine whether the scarps are presently deforming.

The presence of tree stumps that were cut many years ago and left in the downstream slope indicates that rotting roots are in the embankment. These roots may create channels where flow will concentrate and erode the dam internally. Such an effect is not serious in dams which are zoned with a pervious downstream shell.

6.2 Design and Construction Data

The dam is on a clay foundation, according to the April 17, 1951 inspection report by Stephen H. Haybrook (Appendix B3-24). The presence of clay in the foundation has not caused any obvious differential settlement of the crest.

In the original (1937) report by H. K. Barrows (Appendix B3-11), he indicated that the foundation material is a "clay hardpan". If this is the case, settlements would not be expected to occur.

The plans submitted in connection with the 1937 construction permit application to the State of Vermont (see Appendix B3-6) indicate that this dam was to be zoned. The upstream and downstream shells were to be free-draining material, whereas the center was to be composed of clay hardpan from a nearby borrow pit. However, the report submitted by Barrows to the Vermont Public Service Commission on Nov. 20, 1937 (Appendix B3-11), indicates the use of a rockfill toe on the downstream side of a homogeneous embankment of "hardpan." There is no indication that a filter was placed between the rockfill toe and the hardpan. It was mentioned, however, that the hardpan was well graded.

6.3 Post-Construction Changes

One year after construction of this dam, the 1938 hurricane struck Vermont. The flood "caused the spillway channel below the dam to be so badly washed as to necessitate the reconstruction of the channel." (See Nov. 27, 1939 letter by H.K. Barrows, Appendix B3-19.) Therefore, the spillway was moved to the right onto a bedrock foundation. The spillway length was reduced from 150 feet. to 40 feet, but its permanent crest elevation was lowered 4 feet. Flashboards that would break when the head over the spillway crest was 5.3 feet (leaving 4.7 feet of freeboard to the design dam crest) were installed. These flashboards are no longer in place.

6.4 Seismic Stability

This dam is in Seismic Zone 2. Therefore, according to recommended guidelines (Reference 1), a seismic stability analysis is not warranted.

SECTION 7

ASSESSMENT, RECOMMENDATIONS, AND REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition

Sucker Brook Dam is in FAIR condition. Significant problems include several scarps near the upstream toeline about opposite the leftmost angle point of the dam; brush and small trees on the embankment slopes with some larger stumps on the downstream slope; cracking and undermining of the downstream end of the left concrete training wall of the spillway discharge channel; and what appears to be a significant amount of reservoir sedimentation that reduces total storage capacity and could hinder operation of the low level drain. Also, a hole was observed beneath the upstream extension of the left training wall of the original spillway (now covered with embankment) that could be a potential seepage path through the embankment.

The spillway is INADEQUATE to pass the test flood without overtopping the dam. In accordance with recommended guidelines of the Corps of Engineers, the dam is classified as SMALL in size and as having a SIGNIFICANT hazard potential. Accordingly, a TEST FLOOD equal to ONE-HALF PMF (probable maximum flood) was judged as appropriate within the recommended range of the 100-year flood to one-half PMF. The test flood overtops the dam by a maximum of about 1.9 feet with duration of overtopping of about 5 hours. Peak inflow for the test flood is 7290 cfs. Peak outflow is unaffected by reservoir routing and is the same as peak inflow, or 7290 cfs. Total project discharge capacity at the top of the dam is due to the two-level chute spillway plus the outlet penstock fully open, and is equal to 4280 cfs, or 59% of the test flood peak outflow.

b. Adequacy of Information

This Phase I Inspection was based primarily on the visual inspection and the hydraulic and hydrologic computations performed, coupled with sound engineering judgement. The visual inspection was done when the pool was very low, about 18 feet below the top of an approximately 36-foot high dam. Available data consisted of a letter and two reports on construction of the dam and relocation and construction of the new spillway 2 years later, including poor copies of four various design/construction drawings, together with one report of an inspection some years later. Such data as the design calculations, construction specifications, detailed data on the foundation and embankment soils, and detailed operation and performance data were not available. The lack of such in-depth engineering data does not permit a comprehensive review. Therefore, the adequacy of this dam could not be assessed with respect to reviewing design, construction, and operation data.

c. Urgency

WITHIN ONE YEAR after their receipt of this Phase I Inspection Report, the Owner should implement the recommendations given in Section 7.2 and the remedial measures given in Section 7.3

7.2 Recommendations

WITHIN ONE YEAR after their receipt of this Phase I Inspection Report, the Owner should engage a registered engineer qualified in the design of dams to do the following work and provide the consequent recommendations. The Owner should implement those recommendations.

a. Determine whether the hole that was observed beneath the upstream extension of the left training wall of the original spillway passes through the dam. It so, provide recommendations on any necessary repairs.

b. Investigate the cause of the scarps near the upstream toeline approximately opposite the leftmost angle point in the dam.

c. Advise how to repair or rebuild the downstream end of the left training wall of the spillway discharge channel where it is cracked and undermined.

d. Select appropriate backfill for root holes left after removal of roots and stumps (see Section 7.3.a.2).

e. Investigate and advise on the vertical crack in the left side of the concrete control tower.

f. Perform a detailed hydraulic and hydrologic study to better evaluate spillway capacity. Any detailed hydrologic work should take into account all upland storage that may exist in the drainage area that would tend to reduce inflow. If necessary, spillway capacity should be increased by new design and construction.

g. Check the hydraulics of the spillway discharge channel to see if the left training wall would be overtopped during heavy flows, and if so, make recommendations.

7.3 Remedial Measures

a. Operation and Maintenance Procedures

WITHIN ONE YEAR after their receipt of this Phase I Inspection Report, the Owner should implement the following operation and maintenance procedures:

1) Cut the brush and small trees from all slopes annually to a distance of about 20 feet downstream from the toeline.

2) Remove and replace the roots of rotting stumps on the downstream slope with a properly selected, compacted backfill.

3) Monitor the clear seepage that was observed exiting from the rock cover at the downstream toeline.

4) Monitor the scarps (Section 7.2.b) until such time as they have been investigated.

5) Repair the spalling at two construction joints in the left training wall of the spillway discharge channel. The significant hairline cracking and efflorescence near the second break in slope of the wall top downstream of the spillway weir should be repaired.

6) Clear the logs lodged in the spillway discharge channel. Also, all brush and small trees in the channel, particularly next to the training wall, should be removed.

7) Repair the deteriorated concrete seat for the service bridge on the control tower.

8) Dewater and thoroughly inspect the inside of the intake structure, the gate well under the control tower, and the outlet conduit. The service slide gate should be inspected and its operation checked.

9) Expose and check the condition of the low level drain, which is suspected of being buried by sediment.

10) Verify the depth of sediment in the reservoir. Sediment should be cleaned out at least down to the level of the low level drain. Keep the trash and leaves cleaned off the intake rack.

11) Secure the left end of the lower horizontal pipe railing on top of the control tower by replacing the missing piece.

12) Replace one or two weak wooden deck planks on the service bridge near the control tower. All planks should be kept bolted tightly. A preservative should be considered for the apparently bare wooden decking.

13) Develop and implement effective operation and maintenance procedures to avoid deterioration of the dam.

14) Continue to carry out an annual technical inspection of the dam and make repairs as needed.

15) Make any improvements necessary in the existing emergency action plan and warning system to ensure proper and timely action during critical periods.

7.4 Alternatives

No practical alternatives exist to the recommendations and remedial measures contained in this report.

APPENDIX A

INSPECTION CHECKLIST

VISUAL INSPECTION CHECKLIST
DAM INSPECTION

DAM	SUCKER BROOK DAM	DATE	November 7, 1979
ID NO.	VT 00212	TIME	1300 - 1530
TOWN	Salisbury	WEATHER	Drizzly, Overcast, 45° F
COUNTY	Addison	W.S. ELEV.	1293± UPSTREAM
STATE	Vermont		1275± DOWNSTREAM

INSPECTION PARTY — RECORDER (X)

1. Thomas Bennedum, Gordon E. Ainsworth & Assoc., Inc. — X
2. Edwin Vopelak, Jr., Gordon E. Ainsworth & Assoc., Inc.
3. John Kenworthy, Gordon E. Ainsworth & Assoc., Inc.
4. Steve J. Poulos, Geotechnical Engineers, Inc. — X
5. Peter Barranco, Jr., Vermont Dept. of Water Resources
6. J. Douglas Graham, Manager of Hydraulic Generation, Central Vermont Public Service Corporation (CVPS)
7.
8. Edward Lurvey, General Hydraulic Foreman, CVPS
9.
10.

PROJECT FEATURE/DISCIPLINE	INSPECTOR	REMARKS
1. H & H	T. Bennedum	-
2. Geotechnical	S. Poulos	-
3. Structural	T. Bennedum	-
4. Mechanical	T. Bennedum	-
5. Electrical	None	N/A
6.		

2

VISUAL INSPECTION CHECKLIST

PROJECT: SUCKER BROOK DAM — DATE: Nov. 7, 1979

PROJECT FEATURE: —— — NAME: ——

DISCIPLINE: Geotechnical — NAME: S. J. Poulos

		AREA EVALUATED	CONDITION
		DAM EMBANKMENT	
		Crest Elevation	EL 1311.2
		Current Pool Elevation	EL 1293 ±
		Maximum Impoundment to Date	Unknown
GEI	4	Surface Cracks	None observed.
GEI	5	Pavement Condition	No pavement. Partially bare dirt road.
GEI	6	Movement or Settlement of Crest	Small (6 in.) dip in crest about 180 ft left of spillway wall. Otherwise not observable.
GEI	7	Lateral Movements	None observed.
GEI		Vertical Alignment	See item 6.
GEI		Horizontal Alignment	Not observable.
GEI		Condition at Abutment and at Concrete Structures	Good at left and right walls of spillway, at intake structure, and at old wall that passes transversely across embankment. Undermining of upstream end of concrete wall at upstream toe of dam, about 100 ft left of left spillway wall. Left abutment good. Stones have been placed in erosion gully 1-2' deep of left downstream contact line. Other contacts ok. Two rodent holes (fresh) seen on downstream face 10' below crest 50' right of left abutment. These contain silty coarse sand. Three chuckholes in earth below downstream toe. One hole 4" in. dia. at upstream toe near angle point in dam.
GEI		Indications of Movement of Structural Items on Slopes	None observed.
GEI		Trespassing on Slopes	Free access.
GEI		Sloughing or Erosion of Slopes or Abutments	Two scarps, 6 to 12 in. high, at left angle point in dam on u.s. slope about 3 ft and 6 ft downstream from pool shoreline. A few bare spots on upstream and downstream slopes.

:A

VISUAL INSPECTION CHECKLIST

PROJECT SUCKER BROOK DAM | DATE Nov. 7, 1979

PROJECT FEATURE —— | NAME ——

DISCIPLINE Geotechnical | NAME S. J. Poulos

	AREA EVALUATED	CONDITION
;EI	Rock Slope Protection - Riprap Failures	Riprap covers upstream slope non-uniformly. Appears unfiltered.
;EI	Unusual Movement or Cracking at or Near	None observed near downstream toe. See above "Sloughing or Erosion..." for upstream slope.
;EI	Unusual Embankment or Downstream Seepage	Stream flowing clear at about 4 gpm in original stream channel below dam. No other seeps observed.
;EI	Piping or Boils	None observed.
;EI	Foundation Drainage Features	None.
;EI	Toe Drains	None.
;EI	Instrumentation System	None.
;EI	Vegetation	Upstream: Bushes to 5' high and grass down to riprap. Riprap overgrown. Downstream: Small balsam, spruce, and white birch beginning to grow. Raspberry and other bushes to 5' high. Old stumps to 8" dia., now rotted.

VISUAL INSPECTION CHECKLIST

DAM SUCKER BROOK DAM DATE Nov. 7, 1979

DISCIPLINE Structural/H & H INSPECTOR T. Bennedum

DISCIPLINE Geotechnical INSPECTOR S.J. Poulos

4

AREA EVALUATED	CONDITION
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	
a. Approach Channel	
Slope Conditions	Heavily forested.
Bottom Conditions	Natural old bog. Bottom is visible. Organic soils and grass cover the bottom.
Rock Slides or Falls	None.
Log Boom	None.
Debris	Trash & leaves around intake. Some trees higher on banks.
Condition of Concrete Lining	N/A
Drains or Weep Holes	N/A
b. Intake Structure	Partially underwater.
Condition of Concrete	Fair to good.
Stop Logs and Slots	None observed.
	Large wooden trash rack structure over inclined intake port. Rack structure in fair to good condition.

VISUAL INSPECTION CHECKLIST

DAM SUCKER BROOK DAM DATE Nov. 7, 1979 5

DISCIPLINE Structural/Mechanical INSPECTOR T. Bennedum

DISCIPLINE No Geotechnical Features INSPECTOR -

AREA EVALUATED	CONDITION
OUTLET WORKS - CONTROL TOWER	
a. Concrete and Structural	
General Condition	Good, except for crack.
Condition of Joints	N/A
Spalling	None. (See Service Bridge, A-9)
Visible Reinforcing	None.
Rusting or Staining of Concrete	At vertical crack on left side.
Any Seepage or Efflorescence	None.
Joint Alignment	N/A
Unusual Seepage or Leaks in Gate Chamber	Inside not observable.
Cracks	Vertical crack on left side at pipe socket.
Rusting or Corrosion of Steel	None observed.
b. Mechanical and Electrical	
Air Vents	Top of structure open.
Float Wells	None.
Crane Hoist	None.
Elevator	None.
Hydraulic System	None.
Service Gates	Not observable. In gate well. Control mechanism O.K.
Emergency Gates	None.
Lightning Protection System	None.
Emergency Power System	None.
Wiring and Lighting System	None.
	Railing on U/S side toward rack structure loose - broken weld.

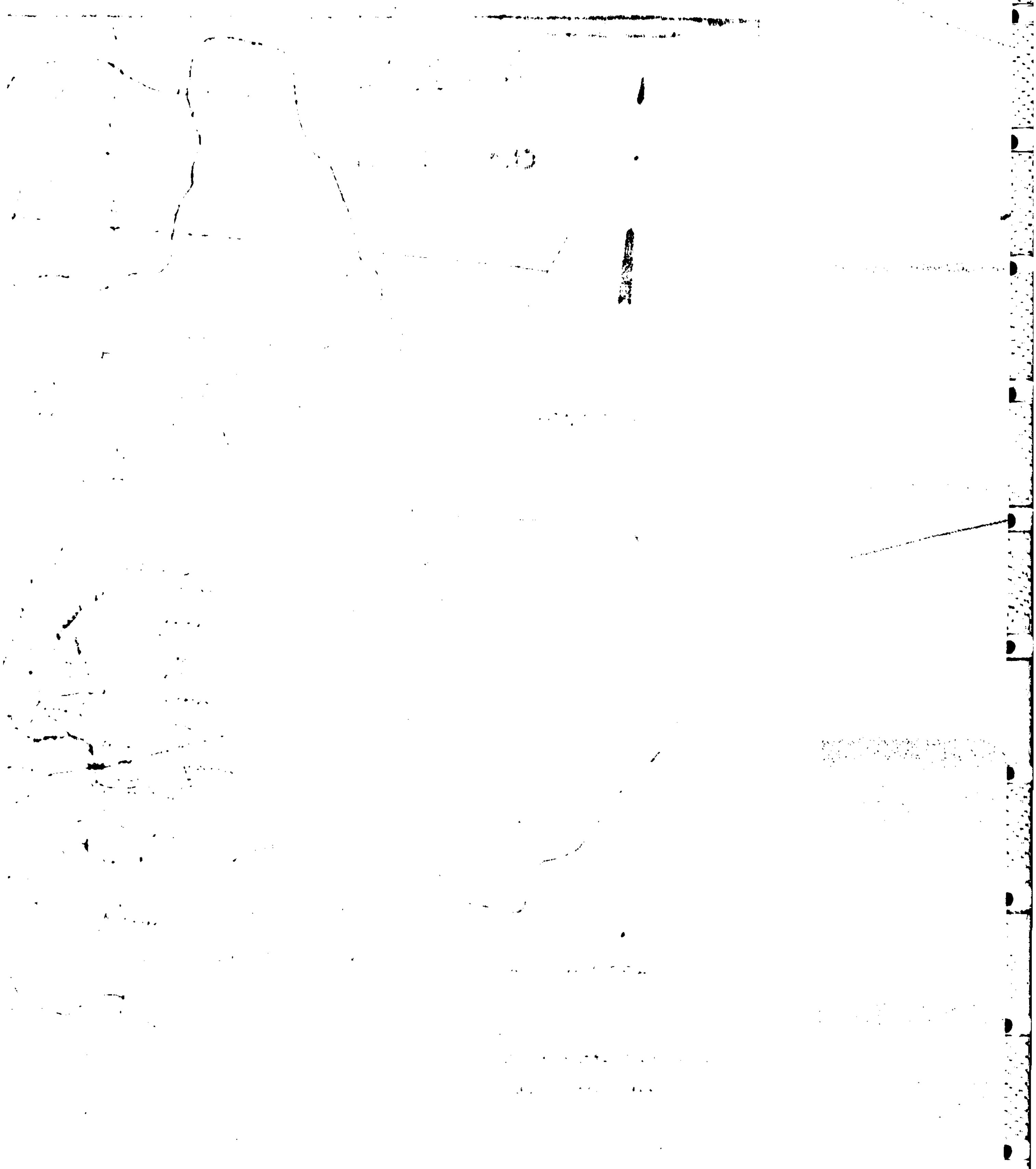
VISUAL INSPECTION CHECKLIST

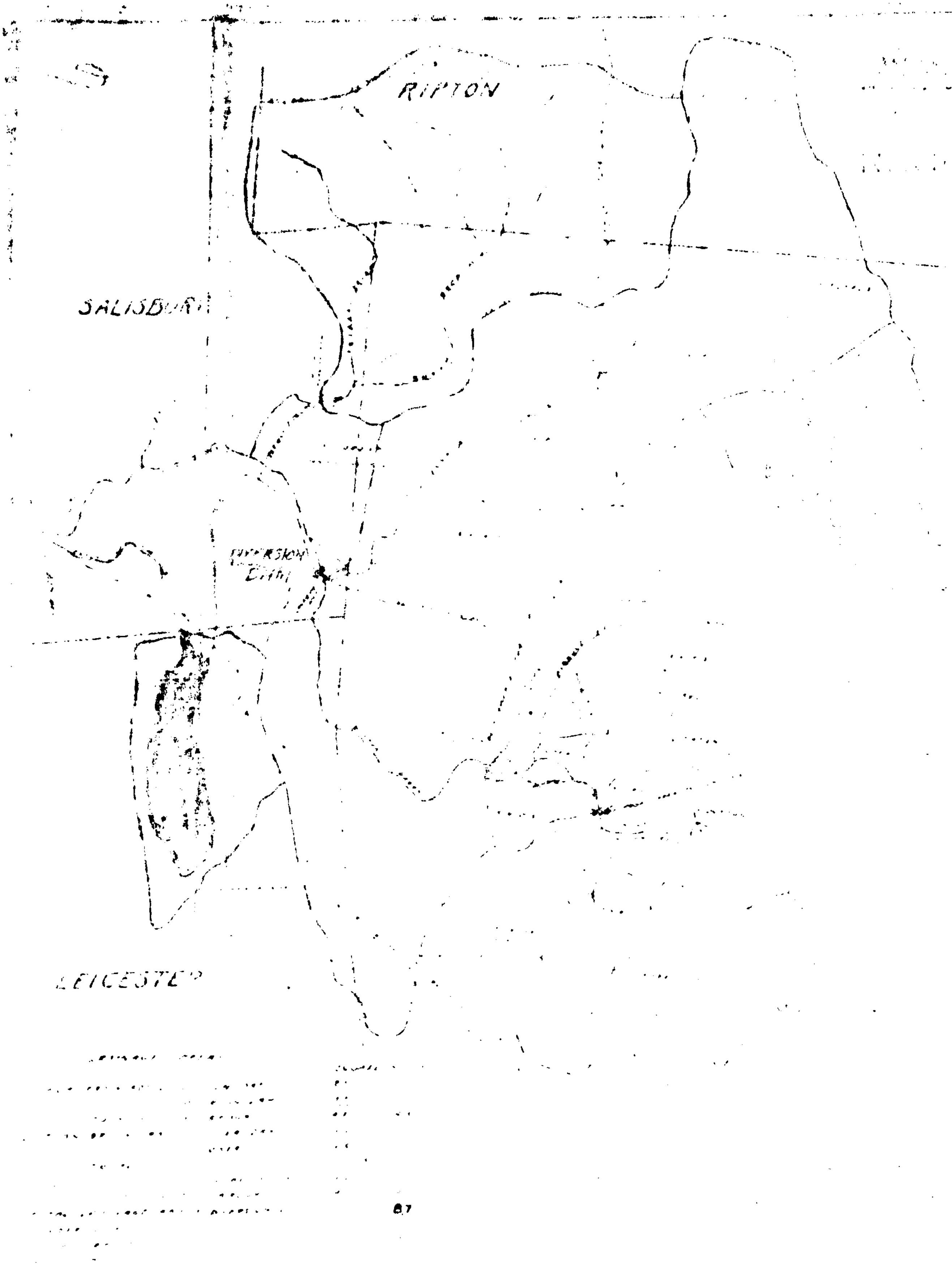
DAM SUCKER BROOK DAM DATE Nov. 7, 1979 6

DISCIPLINE Structural/H & H INSPECTOR T. Bennedum

DISCIPLINE No Geotechnical Features INSPECTOR -

AREA EVALUATED	CONDITION
OUTLET WORKS - TRANSITION AND CONDUIT	Not observable. Access difficult and partially underwater. Consists of 3'-2" wide x 4' high concrete box section outlet conduit from gate well through dam to 4'-dia. penstock beginning just after D/S toe. Penstock runs about 1.5 miles to Silver Lake. Connection to penstock consists of a concrete transition to a round section, followed by a 47 3/4"-dia. steel pipe section, w/20"-dia. drain pipe to side, and then a partially exposed corrugated metal pipe connection to the penstock.
General Condition of Concrete	
Rust or Staining on Concrete	
Spalling	
Erosion or Cavitation	
Cracking	
Alignment of Monoliths	
Alignment of Joints	
Numbering of Monoliths	




RIPTON
SALISBURY
LEICESTER

Salisbury in the county of Addison aforesaid, in which said proposed diversion dam is located, and has delivered to said selectmen a copy thereof.

WHEREFORE, your petitioner prays:

That your Honorable Commission may review the plans and specifications hereinabove set forth and referred to and annexed hereto, and make such additional investigation through such engineers or in such other manner as said Public Service Commission shall deem necessary respecting said dam, and shall thereupon make and issue its order approving such construction, all in accordance with the provisions of Sections 6122 to 6130 of the Public Laws in such case made and provided, and for such other and further order in the premises as shall be proper.

Dated at City of Rutland, in the County of Rutland and State of Vermont this 27th day of May, A. D. 1937.

CENTRAL VERMONT PUBLIC SERVICE CORPORATION

By [signature]

Its Attorneys

The total drainage area above the proposed dam is 8.7 square miles, 2.3 square miles of which is now controlled by the so-called "Sugar Hill Reservoir" of said petitioner located in Goshen, in the County of Addison, constructed under the permission, authority and order of your Honorable Commission in proceeding No. 1697 dated January 21st, 1952. The capacity of the pond which will be created by said proposed dam at spillway elevation 1306 is 1,425,000 cubic feet.

The intake structure for the pipe line will be bottomed on ledge and constructed as set forth in detail on the map hereto attached marked 412-33; the details of construction of the pipe line and intake pipe attached thereto leading from said dam being set forth on map hereto attached marked 412-36. Attached hereto is a graph or chart numbered 412-35 showing pondage and spillway capacity of said diversion dam by curves.

On Map 412-32 there is delineated the location of a concrete and rubble masonry dam located upstream on Dutton Brook and extending across Sucker Brook, which has been formerly used for a diversion dam for like purposes, but which dam is now to be abandoned but is to be left in place to collect any silt or gravel deposit and protect the intake of the proposed dam from damage which might result therefrom.

The work of construction of said proposed dam is to be performed by Sanders Engineering Company under the engineering direction of Frank H. Mason, Civil Engineer for Nepsco Services, Inc.

Your petitioner further represents that it has given notice of this petition to the selectmen of said town of upon a copy of the United States Geological Survey Map for the Brandon Quadrangle attached hereto. As will appear from the notation on the right hand margin of said map the junction of Sucker and Ditton Brooks above referred to is inaccurately shown thereon as being in the town of Leicester, when in fact said junction of said streams is in the town of Salisbury. Said locations are further shown on a map or drawing No. S.L. 59 attached hereto.

Your petitioner proposes to construct a dam hereinafter described at the junction of said two streams for the purpose of collecting, storing and diverting the waters of said streams by means of a pipe line or penstock into Silver Lake, so-called, and thence by means of another pipe line of said petitioner now in use to its Silver Lake generating station, so-called, as outlined on said map above referred to.

The plans for the proposed construction of said dam and intake to said pipe line contemplate that the dam will be founded upon a good clay foundation to be constructed of an earth embankment with a clay core. The maximum height of the proposed dam to be forty (40) feet with an average height of approximately thirty (30) feet. The top of said dam to be at elevation 1312 M.S.L. The width at the top of said dam to be ten (10) feet with two to one slopes on both upstream and downstream sides, the width of the base necessarily varying according to the height of the dam, said slopes to be rip-rapped with extra heavy rip-rapping at the toe of said dam on both slopes, and the full length of the upstream slope. The length of the spillway to be one hundred fifty (150) feet. All in accordance with a general plan and cross-sections thereof set forth on the plan annexed hereto marked 412-32.

S T A T E   O F   V E R M O N T

ADDISON   COUNTY

VERMONT PUBLIC SERVICE COMMISSION
MAY 29 1937
RECEIVED

IN RE: PETITION OF CENTRAL VERMONT PUBLIC SERVICE CORPORATION FOR AUTHORITY TO CONSTRUCT A DAM ON SUCKER BROOK, SO-CALLED, IN SALISBURY, VERMONT	) ( ) ( ) ( ) ( )	Before Public Service Commission

P E T I T I O N

To the Honorable Public Service Commission, within and for the State of Vermont:

The Central Vermont Public Service Corporation, a corporation organized under the laws of the State of Vermont, and having its principal place of business in the City of Rutland, in the County of Rutland and State of Vermont, respectfully represents:

THAT it is a corporation engaged in the generation, manufacture and sale of electricity to the public for heating, lighting and power purposes, and is subject to the jurisdiction of the Public Service Commission of Vermont.

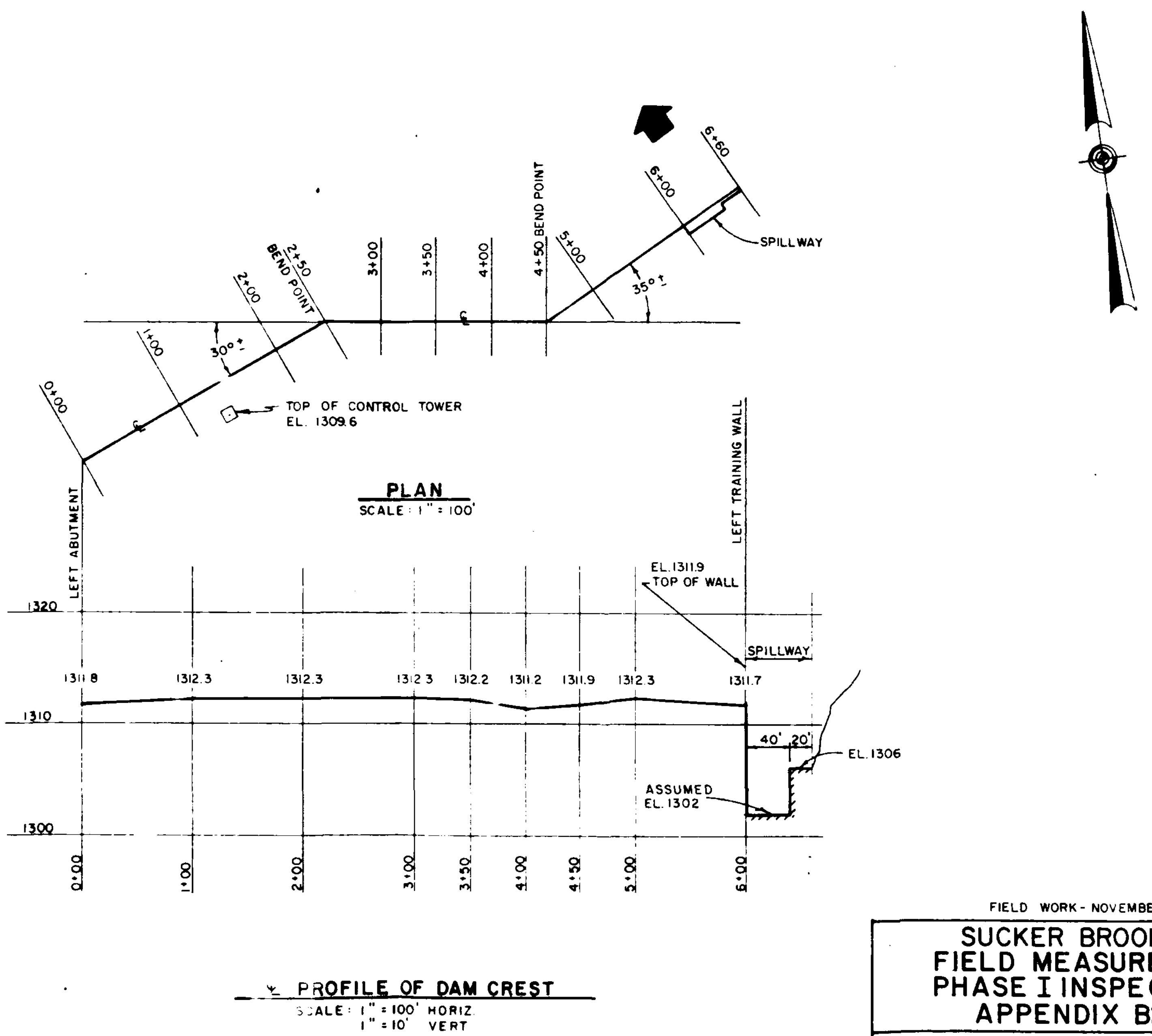
THAT it is the owner of certain lands, rights, easements, and water rights in the towns of Leicester, Salisbury and Goshen, all in the County of Addison, and particularly of certain lands, water rights and easements in Sucker Brook, so-called, and on Dutton Brook, so-called, the general location of the streams and drainage area being set forth

APPENDIX B

SECTION B3

COPIES OF PAST INSPECTION REPORTS AND DATA

TABLE OF CONTENTS



FIELD WORK - NOVEMBER 7, 1979

SUCKER BROOK DAM
FIELD MEASUREMENTS
PHASE I INSPECTION
APPENDIX B2

GORDON E. AINSWORTH & ASSOCIATES INC

20 SUGARLOAF ST SOUTH DEERFIELD MASS

f. Vermont Public Records
133 State Street
Montpelier, Vermont 05602
(802) 828-3280

1) PSC petition and approval
2) drawings
3) letter and reports

APPENDIX B

SECTION B1

LISTING OF LOCATIONS FOR AVAILABLE RECORDS AND DATA

a. Owner: Central Vermont Public Service Corporation
77 Grove Street
Rutland, Vermont 05701
Attention: J. Douglas Graham,
Manager of Hydraulic Generation
(802) 773-2711

1) drawings
2) inspection reports
3) warning system

(Details and extent of data not known due to unwillingness of Owner to make such information available.)

b. Designer of Present Dam:

New England Public Service Corporation
(NEPSCO)
(Location and business status unknown.)

c. Contractor for Present Dam:

Sanders Engineering Company

(Location and business status unknown.)

d. Agency of Environmental Conservation
Department of Water Resources
Water Quality Division
Montpelier, Vermont 05602
Attention: A. Peter Barranco, Jr., P.E.
Dam Safety Engineer
(802) 828-2761

1) inspection reports

e. Vermont Public Service Board
State Office Building
120 State Street
Montpelier, Vermont 05602
Attention: Wayne Foster, Utility Engineer
(802) 828-2326

1) case numbers

APPENDIX B

ENGINEERING DATA

Section	Description
B1	Listing of Locations for Available Records and Data
B2	Drawings (See B3-6 thru 8 & B3-23)
B3	Copies of Past Inspection Reports and Data

VISUAL INSPECTION CHECKLIST

DAM SUCKER BROOK DAM DATE Nov. 7, 1979

DISCIPLINE Structural INSPECTOR T. Bennedum

DISCIPLINE No Geotechnical Features INSPECTOR -

AREA EVALUATED	CONDITION
OUTLET WORKS - SERVICE BRIDGE	
a. Super Structure	
Bearings	OK.
Anchor Bolts	OK.
Bridge Seat	OK.
Longitudinal Members	Open web beams. Good shape.
Underside of Deck	OK.
Secondary Bracing	Steel channel. OK.
Deck	2"x6" wood planks. Some loose. One or two near tower are poor.
Drainage system	Runs off and through.
Railings	Steel pipe. Good.
Expansion Joints	End on dam appears free to move.
Paint	Good on steel. Wood bare.
b. Abutment & Piers	
General Condition of Concrete	Poor on control tower seat.
Alignment of Abutment	OK.
Approach to Bridge	OK. Walk down from crest.
Condition of Seat & Backwall	Poor. Cracked & broken concrete on tower seat.

VISUAL INSPECTION CHECKLIST

DAM: SUCKER BROOK DAM. DATE: Nov. 7, 1979

DISCIPLINE: Structural/H & H INSPECTOR: T. Bennedum 8

DISCIPLINE: Geotechnical INSPECTOR: S.J. Poulos

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS</u>	One spillway with two adjacent weirs, 4' between crest elevations.
a. Approach Channel	
General Condition	Fair.
Loose Rock Overhanging Channel	None.
Trees Overhanging Channel	Forested, trees overhanging on right side.
Floor of Approach Channel	Natural stream channel in bedrock.
b. Weir and Training Walls	
General Condition of Concrete	Good.
Rust or Staining	Rust at cut-off flashboard pins.
Spalling	At 2 const. joints in left training wall, one near 1st break in slope & other 30' from D/S end.
Any Visible Reinforcing	None.
Any Seepage or Efflorescence	Effl. at H/L cracking for 10' D/S of 2nd break in slope on left TW.
Drain Holes	2-3 inch dia. 4 feet o.c., 4 ft. and 8 ft. down from top of left D/S training wall. N/A on right.
c. Discharge Channel	
General Condition	Good.
Loose Rock Overhanging Channel	None.
Trees Overhanging Channel	Forested. Trees overhanging on right.
Floor of Channel	Natural bedrock.
Other Obstructions	Logs trapped in channel from previous flows.

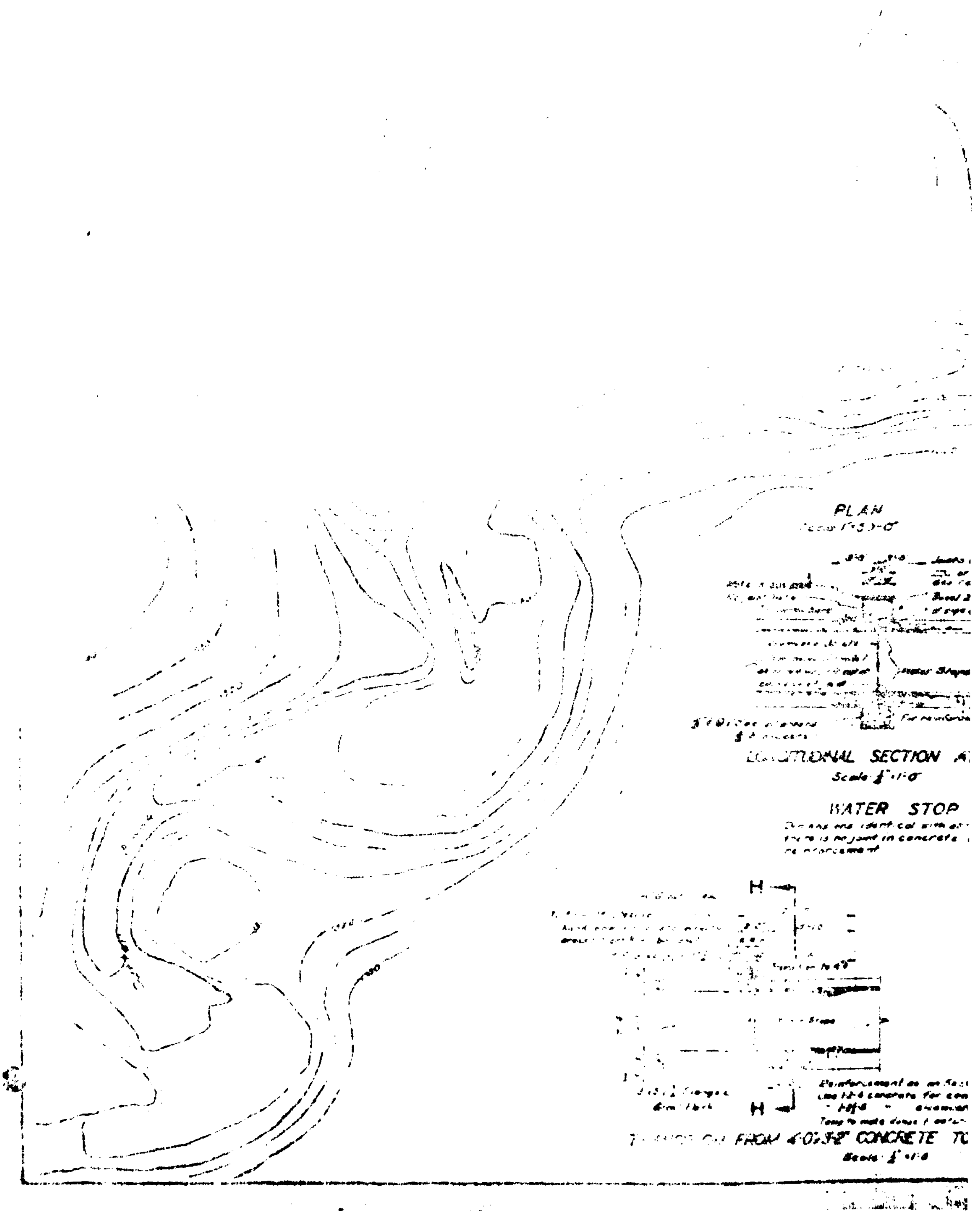
VISUAL INSPECTION CHECKLIST

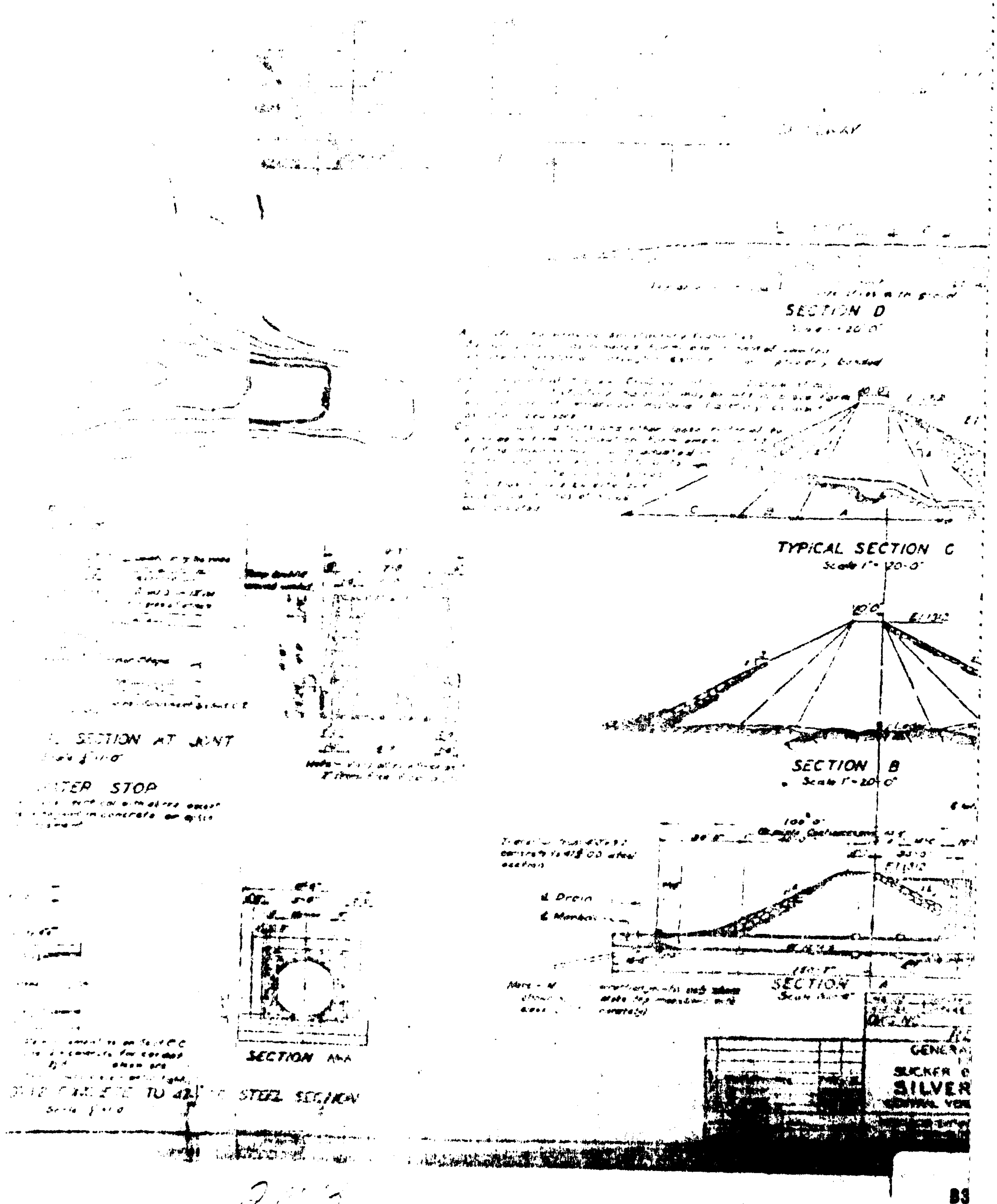
DAM: SUCKER BROOK DAM DATE: Nov. 7, 1979

DISCIPLINE: Structural/H & H INSPECTOR: T. Bennedum

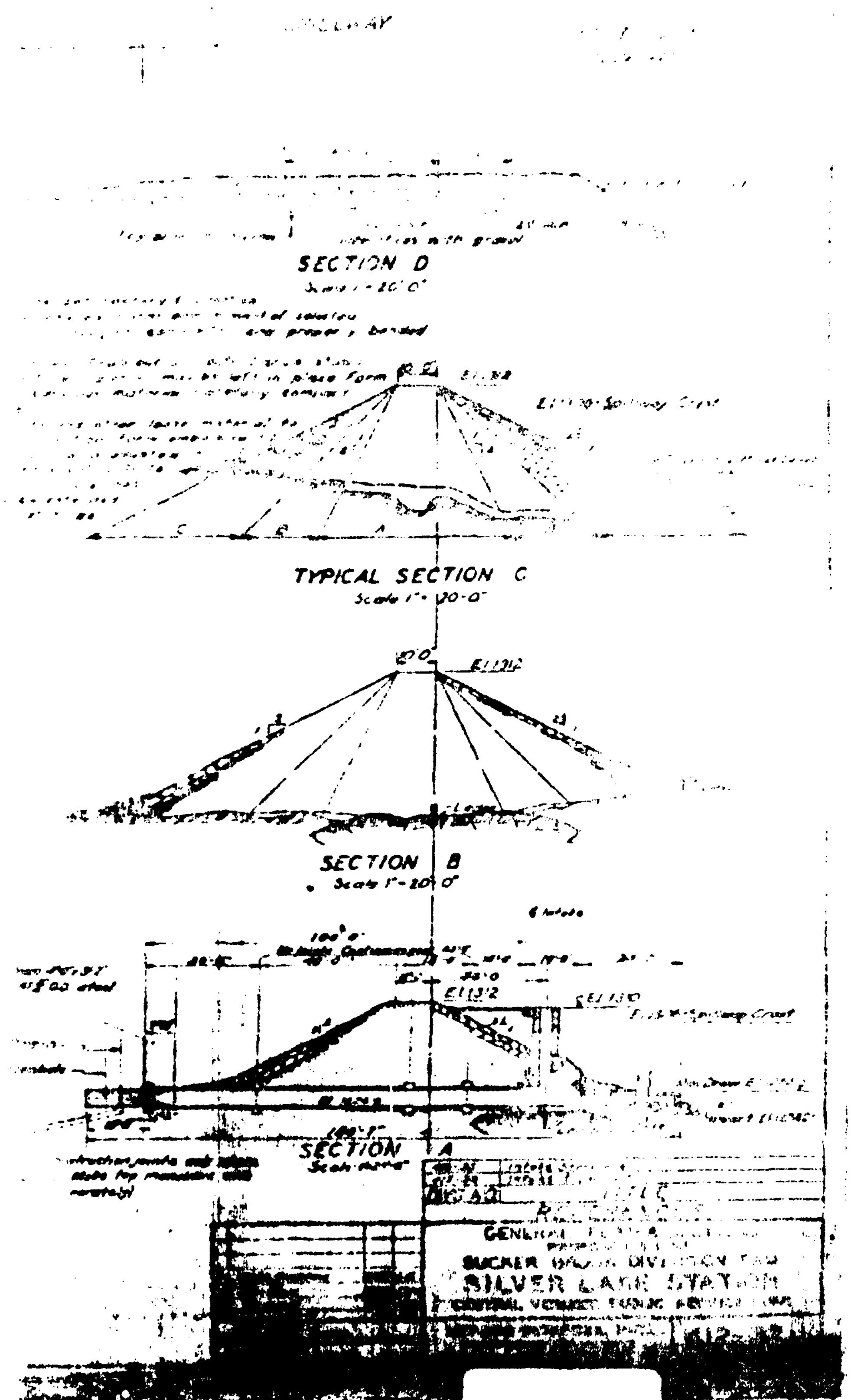
DISCIPLINE: Geotechnical INSPECTOR: S.J. Poulos 7

	AREA EVALUATED	CONDITION
	OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	Outlet is a penstock leading to Silver Lake in Town of Leicester, Vermont. Structure at end of 1.5-mile penstock not inspected.
	General Condition of Concrete	
	Rust or Staining	
	Spalling	
	Erosion or Cavitation	
	Visible Reinforcing	
	Any Seepage or Efflorescence	
	Condition at Joints	
EI	Drain holes	
GEI	Channel	N/A
EI	Loose Rock or Trees Overhanging Channel	N/A
EI	Condition of Discharge Channel	N/A

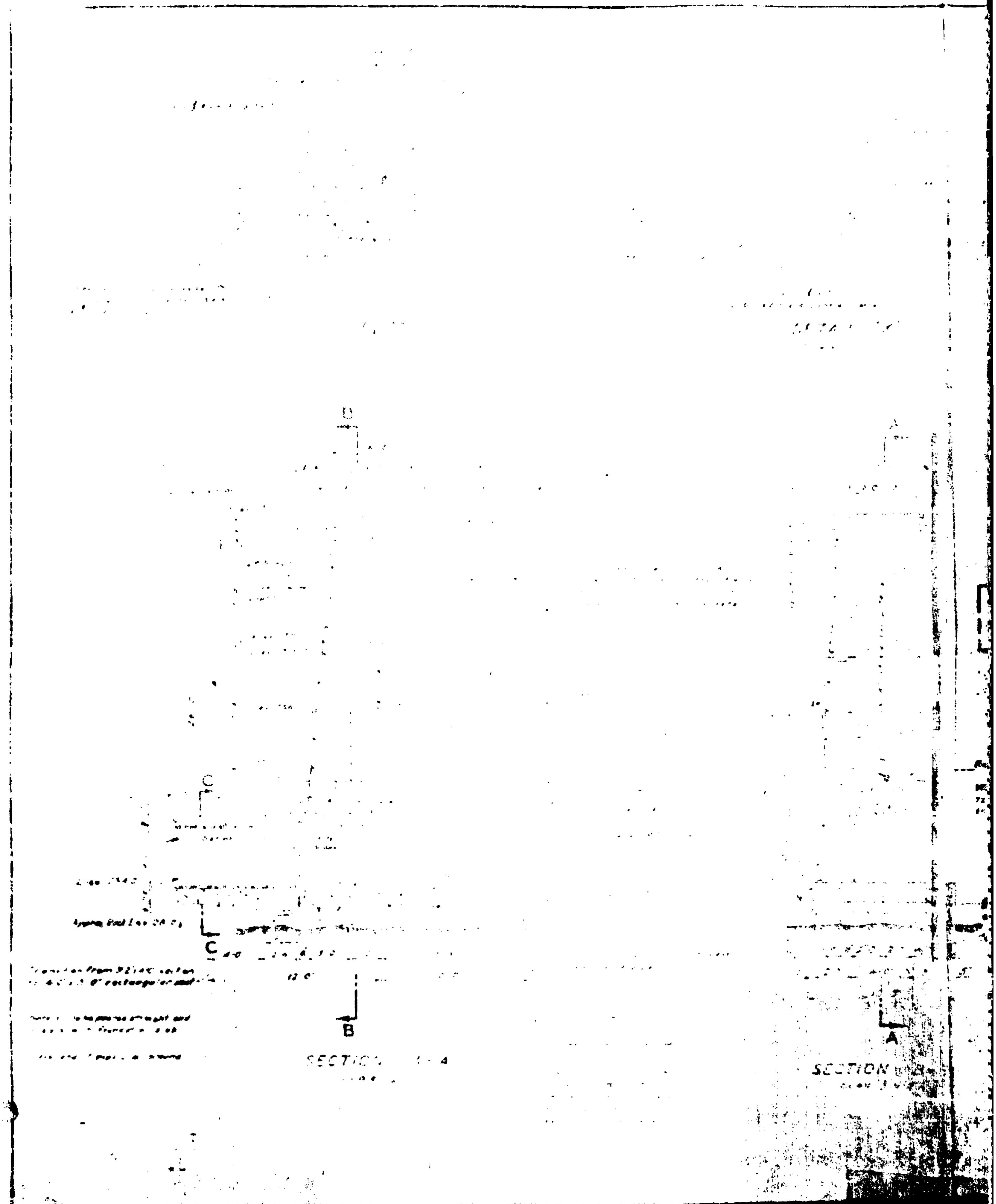

PLAN
SECTION
WATER STOP
H
H
CONCRETE


SECTION D
TYPICAL SECTION C
SECTION B
SECTION A
SECTION AT JOINT
SECTION AA
STEEL SECTION
SILVER

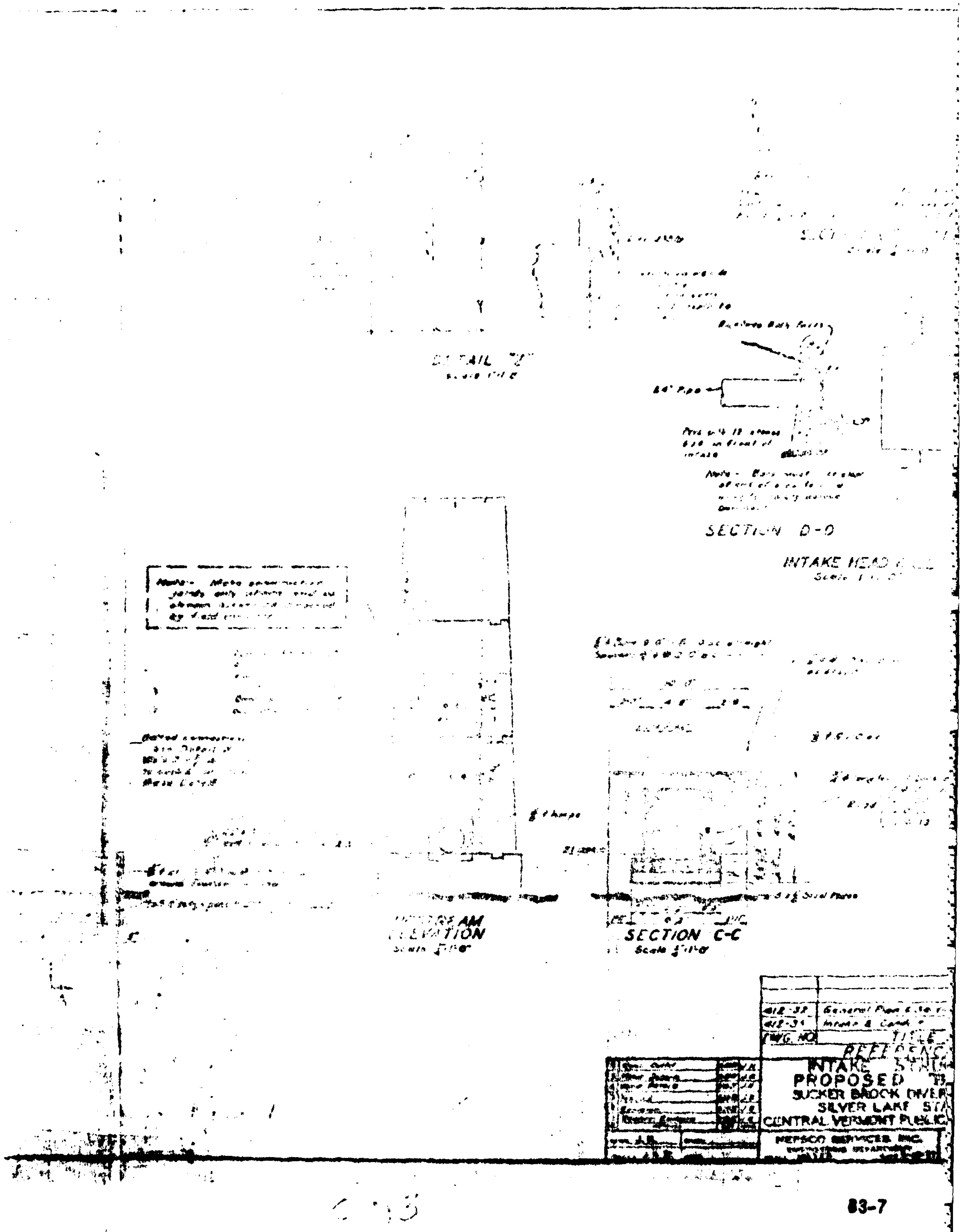
B3


SECTION D
TYPICAL SECTION C
Scale 1" = 20'-0"
SECTION B
Scale 1" = 20'-0"
SECTION A
GENERAL
SUCKER BROOK

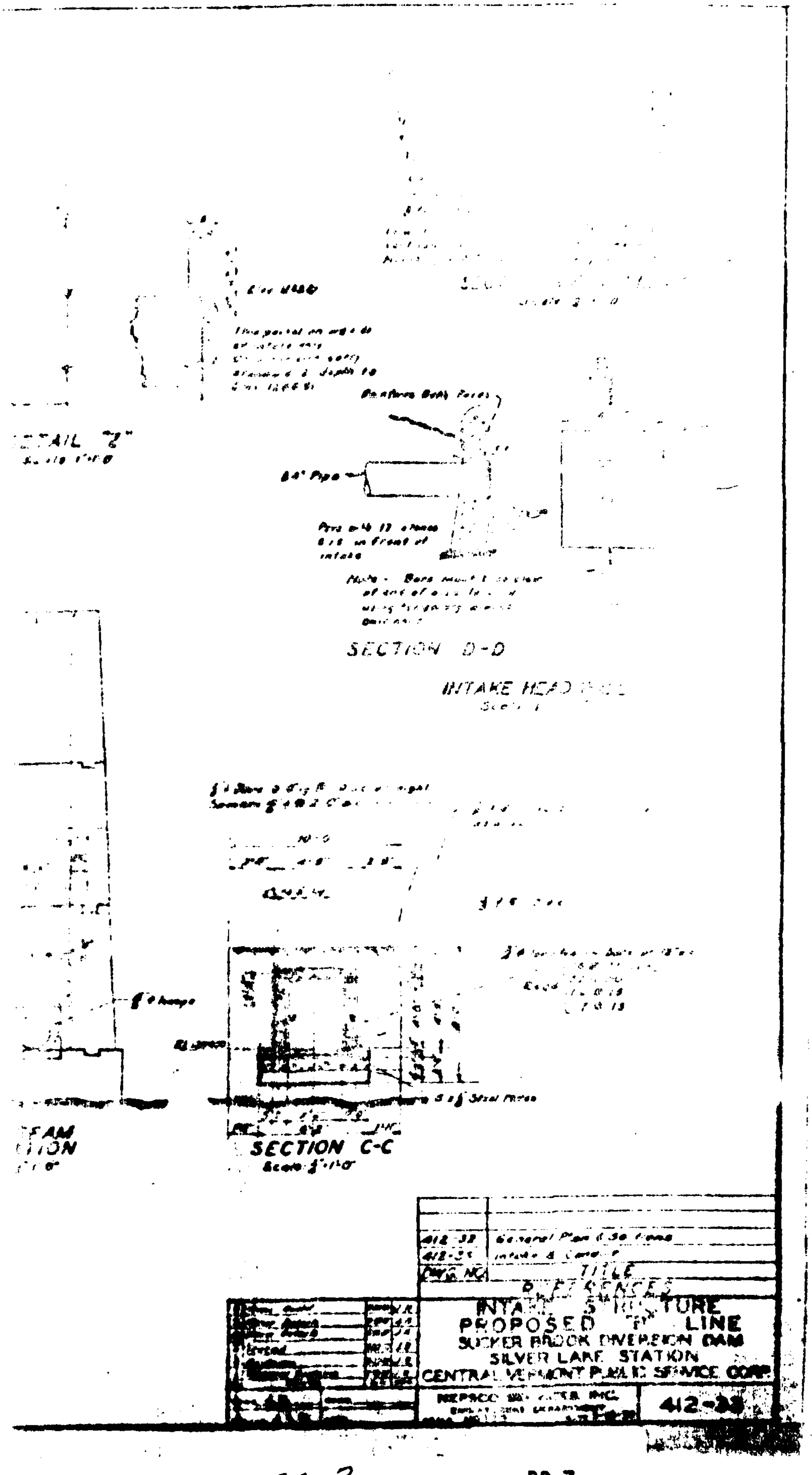
3083



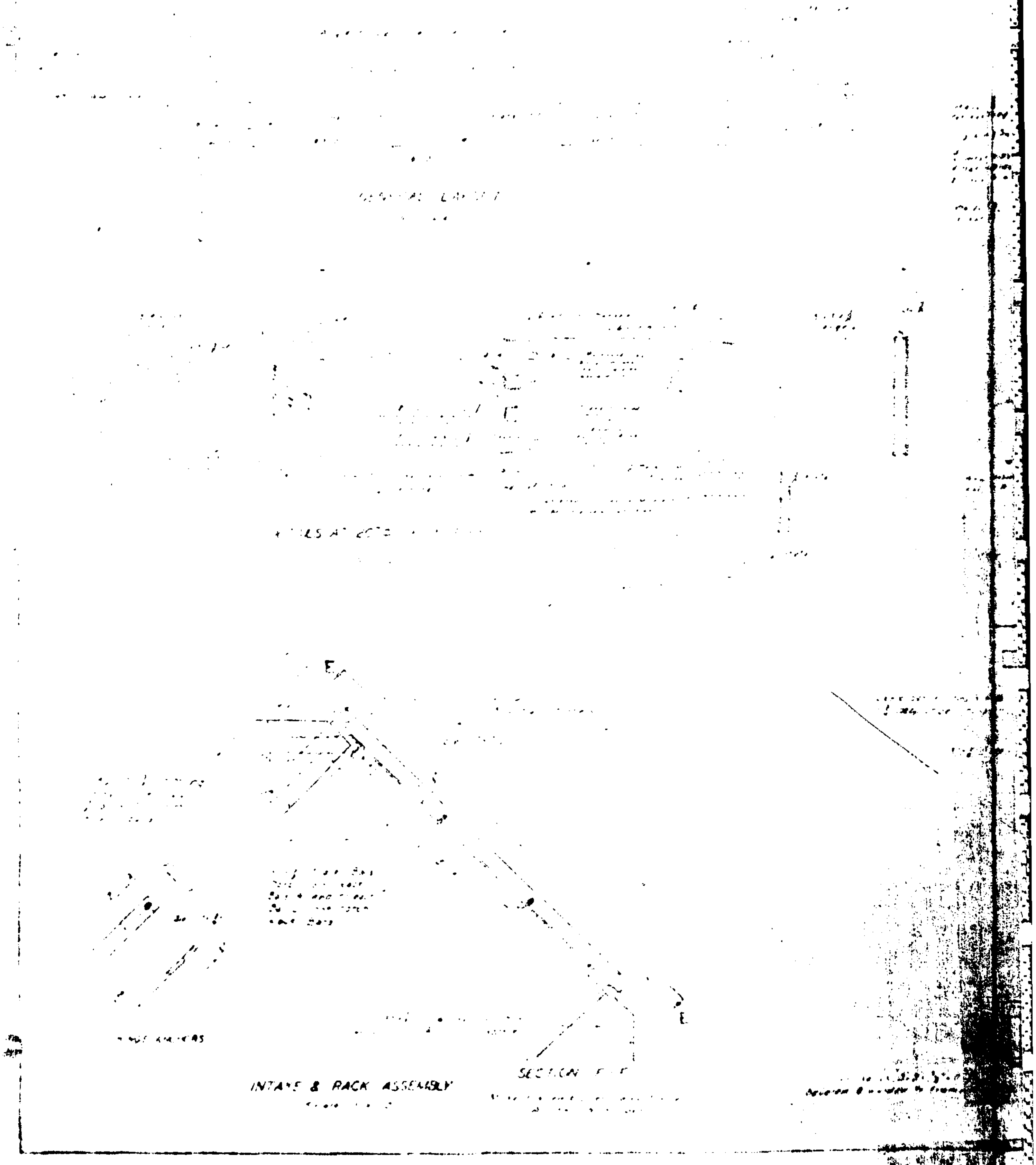
1883

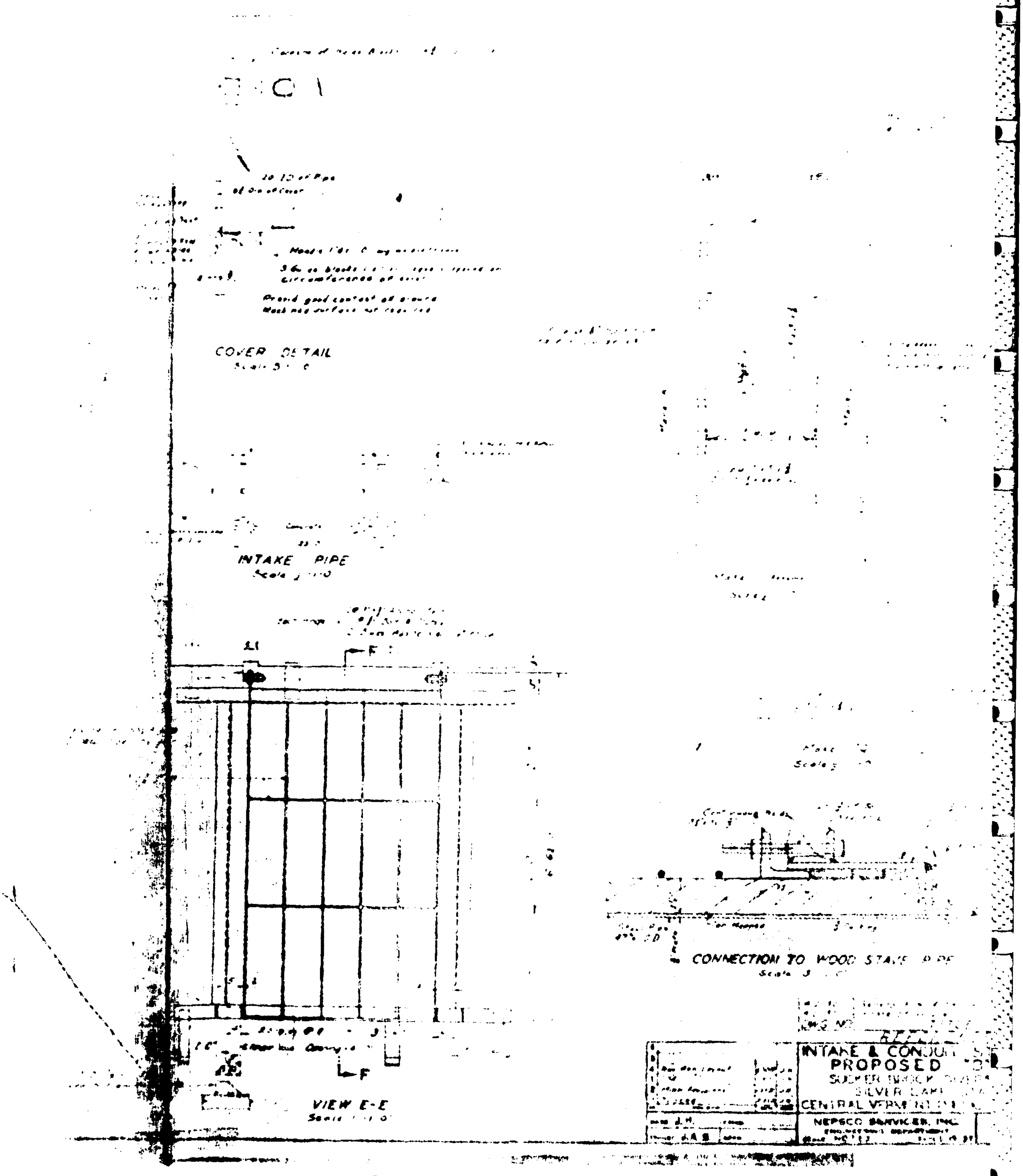


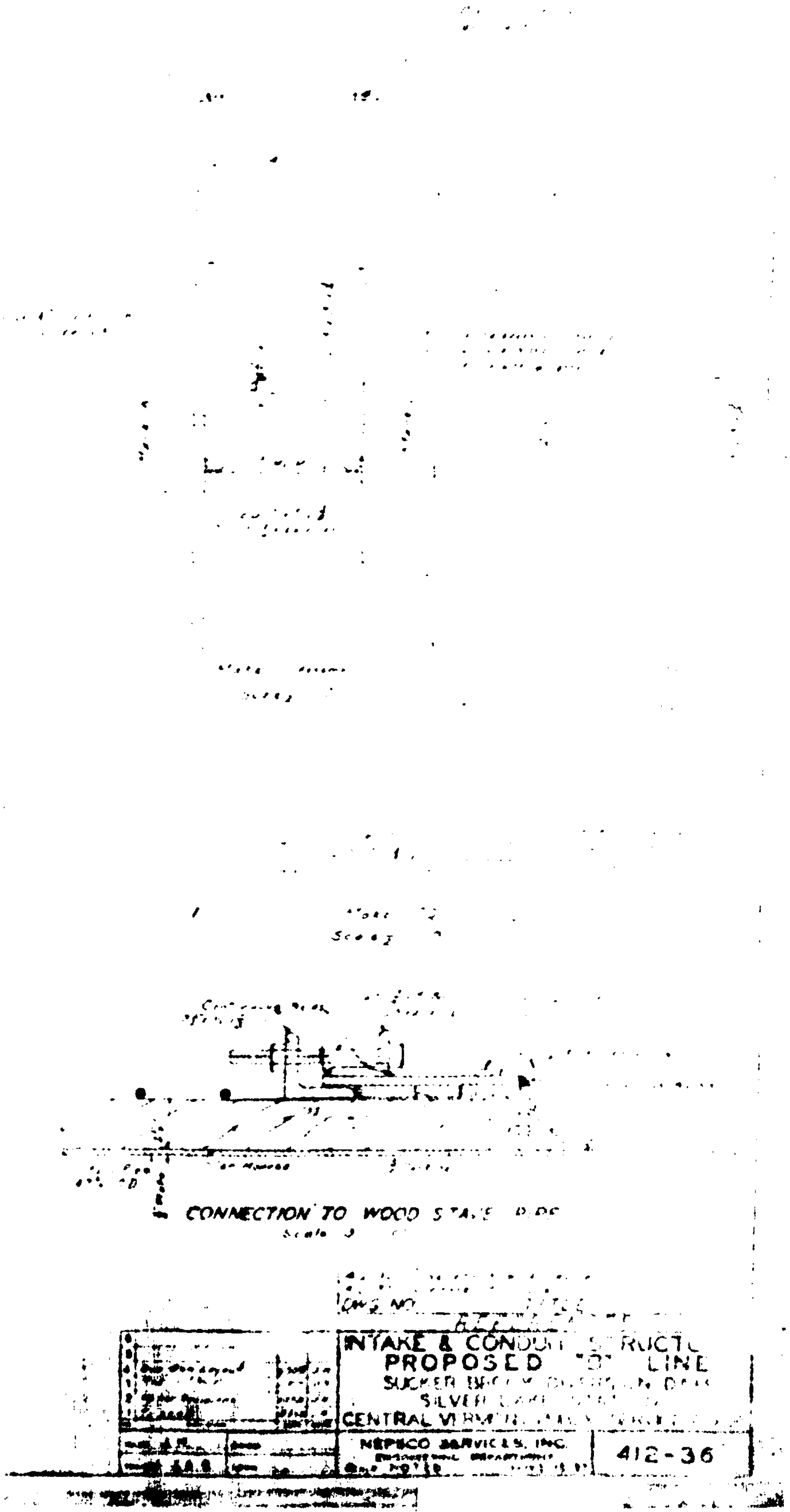
SECTION D-D
SECTION C-C
PROPOSED
SUCKER BROOK DIVER
SILVER LAKE STA
CENTRAL VERMONT PUBLIC
NEPSCO SERVICES INC.



SECTION D-D
INTAKE HEAD
54" Pipe
Reinforce Both Faces
SECTION C-C
412-32 General Plan
412-33 Intake & Canal
DWG. NO.
TITLE
REFERENCES
INTAKE STRUCTURE
PROPOSED "F" LINE
SUCKER BROOK DIVERSION DAM
SILVER LAKE STATION
CENTRAL VERMONT PUBLIC SERVICE CORP.
412-33


E
E
INTAKE & RACK ASSEMBLY
SECTION


COVER DETAIL
INTAKE PIPE
VIEW E-E
CONNECTION TO WOOD STAVE PIPE
INTAKE & CONDU
PROPOSED
CENTRAL VERM
NEPSCO SERVICES, INC.


CONNECTION TO WOOD
DWG. NO.
INTAKE & CONDU
PROPOSED
LINE
CENTRAL VERMONT
NEPSCO SERVICES, INC.
412-36

COPY

H. K. BARROWS
M. AM. SOC. C. E.
CONSULTING ENGINEER
6 BEACON STREET
BOSTON

Hon. Stephen S. Cushing
Chairman, Vermont
Public Service Comm'n.

June 18, 1937

Mr. H. L. Durgin, Chief Engineer
Central Vermont Public Service Corp'n
Rutland, Vermont

#1[illegible]
Sucker Brook Diversion Dam

Dear Mr. Durgin:

Since my visit with you June 11th to the site of your proposed Sucker Brook Diversion Dam, I have studied the plans and given some thought to the proposed construction.

48" Outlet Pipe

I think it would be better to make this a reinforced concrete conduit rather than a 3'8" steel pipe. The pipe will deteriorate rather rapidly in the earth fill and its outside will not be accessible for inspection or painting. Moreover, it will be carrying a heavy load of earth and is likely to distort somewhat between times of filling and emptying the pipe, which will occur from time to time - thus tending to start leaks.

If the steel pipe has been ordered I think it would be well to embed it in concrete, which could be of a cross-section about 5'-6" square in outside dimensions, with some cross and longitudinal reinforcement. Two cut-offs projecting about 1[illegible]" outside the 5'-6" square section should be located in about the upstream third of the dam cross-section.

If the steel pipe order can be countermanded, it can be omitted and a concrete section with suitable reinforcement used in its place.

The 20" diameter pipe should leave the [illegible] pipe at a point outside the downstream slope of the dam - otherwise this may be a source of future trouble.

Earth Section

As shown on the plans this is adequate. Wherever the foundation is of [illegible] rock there should be a suitable concrete cut-off [illegible] longitudinally located about as shown on Section B of Sheet [illegible] of the plans and projecting upward about 3 feet.

Spillway

I assume that the crest wall or cutoff, as well as the side walls, is to be of concrete. The length of the latter does not show on the plans, but I assume this will be for a distance of about 70 ft. (20 ft. upstream and 50 ft. downstream from the crest wall).

I will make from time to time such further suggestions as seem advisable. Meanwhile please send me a brief progress statement about every week or 10 days, so that I can keep in touch with the work.

Yours very truly,

(Sgd.) H. K. Barrows.

c.c.

Hon.Stephen S.Cushing,
Ch. Pub.Service Comm'n.

Mr.F.H.Mason, Ch.Engr.
N.E.Public Service Corp'n.

H. K. BARROWS
M. AM. SOC. C. E.
CONSULTING ENGINEER
6 BEACON STREET
BOSTON

November 20, 1937

Hon. Stephen S. Cushing, Chairman
Public Service Commission
Montpelier, Vermont

No.1998 - Sucker Brook Diversion Dam

Dear Sir:

In accordance with the order of your Commission dated June 4, 1937, I submit the following report upon the Sucker Brook Diversion Dam in the town of Salisbury, Vermont.

DESCRIPTION

The Sucker Brook Diversion Dam, at the junction of Sucker and Dutton Brooks, is located about 1/2 mile easterly from the northerly end of Silver Lake. See Fig. 1. It replaces, with a higher water level, an old concrete and rubble masonry dam which has been in use at this point for over 20 years. The drainage area at this point is about 9 square miles, of which 2.5 square miles is controlled by Sugar Hill Reservoir, completed in 1931. Water from the Sucker Brook Diversion Dam (Spillway Level El. 1306) will be fed into Silver Lake Reservoir at El. 1251 by means of a 4 ft. diameter wood stave pipe line about 1-1/2 miles long, which has been reconstructed during the present season.

From Silver Lake a pipe line takes the water to the Silver Lake Power Station of the Central Vermont Public Service Corporation located near the easterly shore of Lake Dunmore (El. 571), developing a head of about 670 ft., in use 20 years or more.

The water stored above the Sucker Brook Diversion Dam is about 1.5 mill.cu.ft. at spillway level - El. 1306.

The dam is constructed of rolled earth fill about 400 ft. long and 40 ft. in maximum height, with a 150 ft. concrete spillway, all upon a clay foundation except near the westerly end of the earth fill, where ledge rock occurs and where a 4 ft. reinforced concrete outlet conduit and gate well is located. The lower end of this conduit connects with the 4 ft. wood stave pipe line to Silver Lake.

The old masonry diversion dam lies 50 to 100 ft. upstream from the earth fill section and was left in place.

The earth embankment is 10 ft. wide at the top (El. 1312), upstream it has slopes of 1 on 2½, covered with boulder riprap the full height. Downstream slope is 1 on 2, covered for some distance up with boulder riprap and the remainder loamed and seeded with grass. The fill is of borrow material obtained on the hillside west of the dam, a "hard-pan" well graded and with sufficient fines to make a relatively impervious structure. The downstream toe is well reinforced with rock fill.

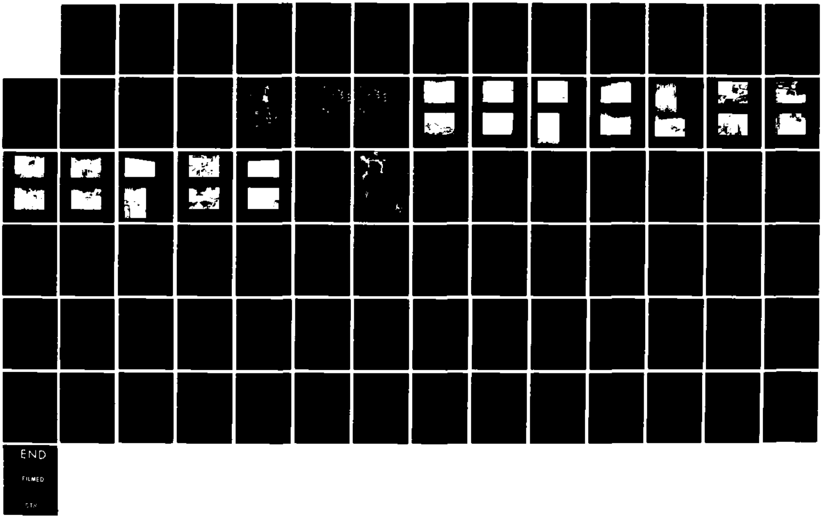
The spillway, 150 ft. long at El. 1306, between concrete abutment walls with their tops at El. 1312, is formed by a vertical cutoff wall 2 ft. thick extending downward about 8 ft. into an impervious clay bottom. The easterly wall is backed up with undisturbed earth; the westerly wall, which runs downstream about 50 ft., is backed up with earth fill covered with boulder riprap. The spillway channel curves somewhat westerly and is covered with heavy boulder riprap with gravel filling, terminating in a row of heavy boulders and joining a natural gully or channel entering the bank some distance downstream from the dam.

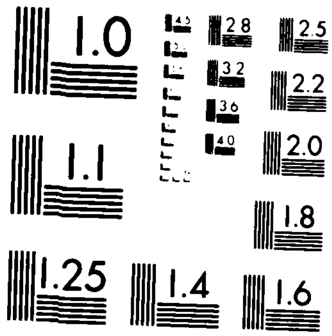
The outlet works include a 3' x 4' gate well, a 4 ft. x 5 ft. gate, manually operated, over the upper end of the outlet conduit whose invert is at El. 1284, a rack structure opening just upstream from the gate well, with scarsocks which permit draft to about El. 1293. A 14" steel pipe between the gate well and upstream toe of the dam, invert at El. 1284, permits draft to El. 1288.

The outlet conduit is of reinforced concrete, 4 ft. high x w wide, about 100 ft. long, running to a point a little downstream from the downstream toe of the earth fill where it joins the 4 ft. wood stave pipe line, the transition being through a short length of 4 ft. diameter pipe. The upstream end of the outlet

AD-A156 009 NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS SUCKER BROOK DAM (VT. (U) CORPS OF ENGINEERS WALTHAM MA NEW ENGLAND DIV FEB 80 2/2

UNCLASSIFIED F/G 13/13 NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963-A

conduit and the gate well are on ledge rock, the remainder in hard clay excavation, with a cutoff about 30 ft. from the gate well.

Details of the various portions of the dam and its accessories are shown on plans 412-32, 412-33 and 412-36 appended.

INVESTIGATIONS

In the Field.

June 15,1937 Visited the work with Messrs Durgin, Belden and Burditt of the Company's staff. Work beginning - building road and developing borrow pits. Suggested that outlet pipe should be changed from a steel pipe to a reinforced concrete conduit, for better permanence and safety. This change made.

July 6,1937 Visited the work with Messrs. Belden and Burditt. Some excavation of bottom for earth fill section. Borrow pits being developed. Excavation made for outlet conduit. Sand and stone for concrete just beginning to arrive. Cement on way. Arranged for samples of cement and sand to be sent to Boston for testing.

Aug. 9,1937 Visited work with R.A.Burditt - Resident Engineer Flanders also on hand. Starting impervious fill cutoff. Little progress on spillway. Bottom of outlet conduit all poured and sides and top under way. Borrow pit for fill developed on side hill west of dam.

Sept. 14, 1937 Visited work with Messrs. Durgin and Burditt. Resident Engineer Flanders on hand. Earth fill approximately half in place - well compacted. Spillway - about half concrete wall in place - good impervious foundation - reinforced with steel. Conduit completed, including steel pipe for waste below dam.

Oct. 13, 1937 Visited work with Messrs. Burditt and Belden. Resident Engineer Flanders on hand. Earth fill completed. Spillway channel under way. Made suggestions as to riprap and backing up of westerly abutment wall, confirmed in detail by letter to R. A. Burditt on Oct. 16th.

Oct. 22, 1937 Visited work with Messrs. Burditt and Belden. Resident Engineer Flanders on hand. Spillway channel nearly completed, and in accordance with suggestions made by letter of Oct. 16th. Downstream slopes of earth fill about half loamed. Little further work required for completion.

Photographs of Project. Appended are a number of photographs taken at different times during construction by the Company's engineers, with descriptive notes.

Office Work. This has included a study to determine the adequacy of the spillway and its channel and a review of design. With such changes as suggested and carried out these are satisfactory.

CONCLUSIONS AND RECOMMENDATIONS

This project was designed by competent engineers and has been well carried out under the immediate direction of Resident Engineer Flanders and supervision of Mr. R. A. Burditt. The superintendent upon the work, Mr. Wm. Leighton, is a man of much experience in such work.

While the spillway and its channel are constructed upon an earth foundation, this is of clay hard-pan and the construction is adequate for those conditions.

Some wash in the natural earth channel at the end of the boulder riprap may occur as time goes on, although this is hard material with numerous boulders. Flow over the spillway will occur frequently as the storage above the dam is relatively small. The condition of the spillway channel should therefore be noted from time to time and repairs made if necessary.

This dam as constructed, in my judgment provides adequately for the public safety and its manner of construction is satisfactory.

Acknowledgments are made to the engineers of the Central Vermont Public Service Corporation for assistance and courtesies rendered.

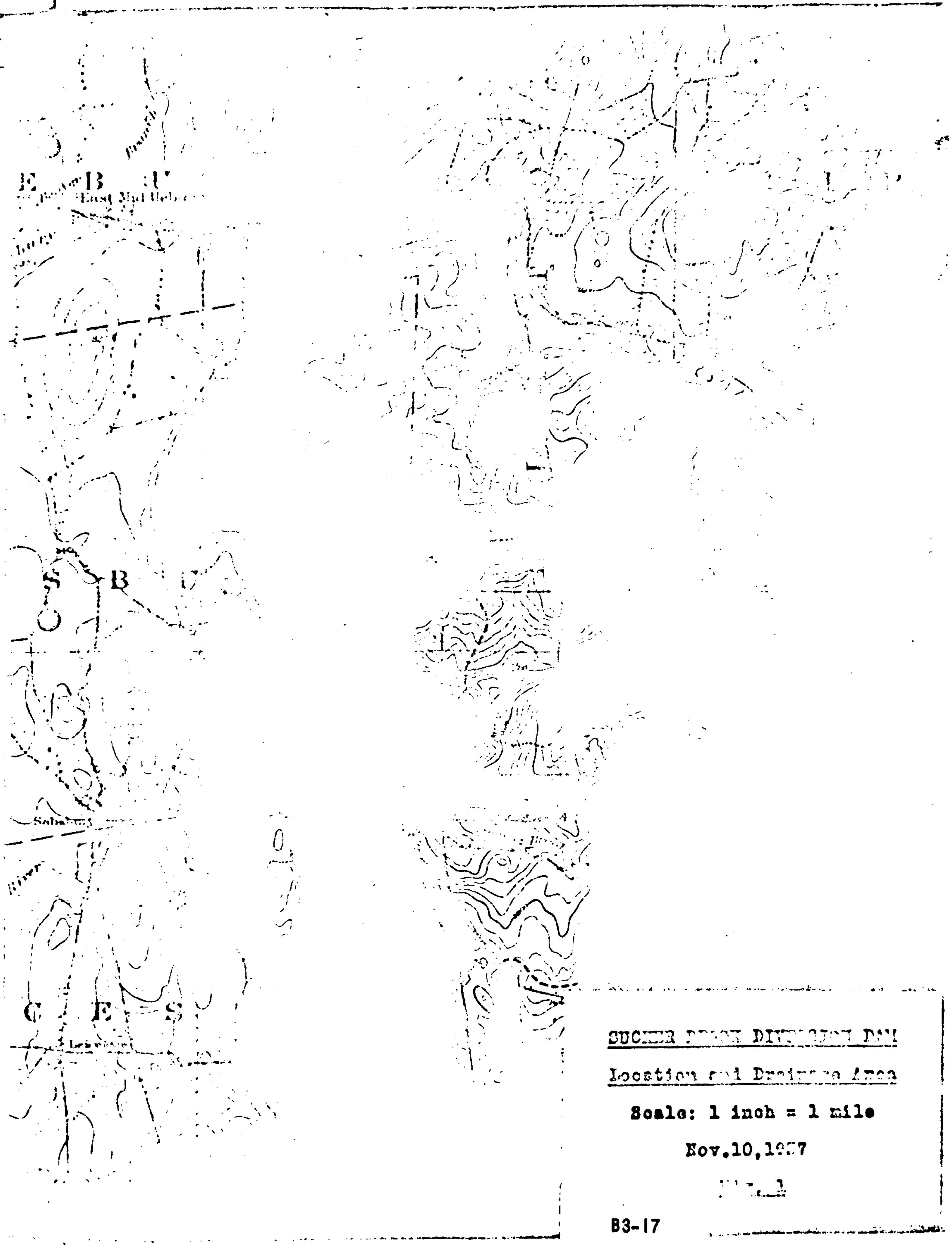
Respectfully submitted,

[signature]

Accompanied by:-

(1) Plans: Fig. 1
412-32
412-33
412-36

(2) 6 Photographs during construction.



SUCKER BROOK DIVERSION DAM

Location and Drainage Area

Scale: 1 inch = 1 mile

Nov. 10, 19[illegible]7

Plate 1

B3-17

STATE OF VERMONT
PUBLIC SERVICE COMMISSION

No. 1998

Petition of Central Vermont Public Service Corporation for authority to construct a dam on Sucker Brook, so-called, in Salisbury, Vermont.

ORDER

WHEREAS, the Central Vermont Public Service Corporation, a corporation under the laws of Vermont engaged in the generation, manufacture and sale of electricity to the public, on the 19th day of May, 1937 filed with this Commission its petition seeking the approval of this Commission to the construction of a dam impounding more than 500,000 cubic feet of water at the junction of Dutton and Sucker Brooks in Salisbury, Vermont, and

WHEREAS, this Commission on the 4th day of June, 1937, with the approval of George D. Aiken, Governor of Vermont, designated H. K. Barrows of Boston as engineer to investigate the property, review the plans and specifications and to make such additional investigation as the Commission should deem necessary and

WHEREAS, such investigations and review have been made by said H. K. Barrows, and

WHEREAS, said H. K. Barrows on the 22nd day of November, 1937, filed with this Commission his report on the Sucker Brook Diversion Dam at the junction of Dutton Brook and Sucker Brook in Salisbury, Vermont, in which it is set forth that said dam as constructed provides adequately for the public safety and its manner of construction is satisfactory,

THEREFORE, this Commission issues its Order approving the construction of such dam in accordance with the report filed by said H. K. Barrows.

Dated at Montpelier, County of Washington, State of Vermont, this 8th day of December, A. D. 1937.

Stephen S. Cushing) Public Service
[illegible]) Commission
[illegible]) of Vermont

OFFICE OF CLERK
Filed: December 8, 1937
[illegible]

H. K. BARROWS
CONSULTING ENGINEER
6 BEACON STREET
BOSTON

November 27, 1939

Hon. E. B. Cornwall, Chairman
Public Service Commission
Montpelier, Vermont

No. 2102 - Sucker Brook Spillway Improvement

Dear Sir:

In accordance with the order of your Commission dated April 24, 1939, I submit the following report upon Spillway Improvement at Sucker Brook Diversion Dam in the town of Salisbury, Vermont.

Description

The Sucker Brook Diversion Dam was completed in 1937 and is fully described in my report to the Commission dated November 20, 1937.

The flood of September 1938 caused the spillway channel below the dam to be so badly washed as to necessitate the reconstruction of the channel. Bed-rock in the channel was uncovered by the wash, so that it was considered desirable to relocate the spillway on a rock foundation, and reconstruct the channel in such bed-rock. The new spillway location is at the North-East of the original spillway.

The work involved the removal of the retaining wall at the East end of the embankment and the extension of the embankment in a North-East direction about 160 ft. to the new spillway location; construction of new retaining wall and wing wall at the North-East end of embankment; placing heavy riprap on downstream side of embankment adjacent to the channel; construction of a new concrete spillway crest, with wooden flashboards; and excavation for the new channel.

The new concrete spillway is 40 ft. long at El. 1302, with 4 ft. flashboards, and there is an additional length of 20 ft. of permanent crest at El. 1306. Flashboards are designed to go out when the water level reaches El. 1307.3.

The new spillway and retaining wall are founded on solid rock and the new channel bottom is rock for some distance downstream from the spillway.

The ordinary elevation of the water surface upstream from the dam remains unchanged.

Details of the work are shown on plan 412-46, appended.

[illegible] [illegible] [illegible] [illegible], [illegible] [illegible] additional [illegible] had been [illegible], [illegible] [illegible] previously by letter. [illegible] rock [illegible] [illegible] fill [illegible] spillway wall [illegible] [illegible].

[illegible]. Visited the work. Present,- Messrs. Harris, Belding, [illegible], Whitcomb (Resident Engineer) and Merry (Contractor). Ledge in part uncovered at spillway and spillway wall.

Aug. 24, 1939. Visited the work. Present,- Messrs. Durgin and Whitcomb (Resident Engineer). Spillway foundation rock uncovered and excavated to El. 130± and O.K. Spillway wall foundation rock in part uncovered. Earth fill being placed between new spillway and earth dam.

Oct. 5, 1939. Visited the work. Present,- Messrs. Durgin, Belding, Whitcomb (Resident Engineer) and Merry (Contractor).

Spillway - Concrete nearly all poured - rock foundation all the way - O.K.

Spillway Wall - Complete except for 28 ft. section near middle. Rock foundation all the way - some seamy, but O.K.

[illegible]

pl[illegible] [illegible] [illegible].

[illegible]

[illegible] of the [illegible] of [illegible] to [illegible], [illegible] of the [illegible]-[illegible] and a general review of the plans. These were found to be [illegible].

Conclusions and Recommendations

The project was designed and constructed by competent engineers and was satisfactorily carried out. The new spillway and channel are entirely in solid rock except for the North bank. Though some wash might occur here in a large flood, it would not affect the safety of the dam.

This spillway and dam as constructed, in my judgment provide adequately for the public safety.

Acknowledgments are made to the engineers of the Central Vermont Public Service Corporation for assistance and courtesies rendered.

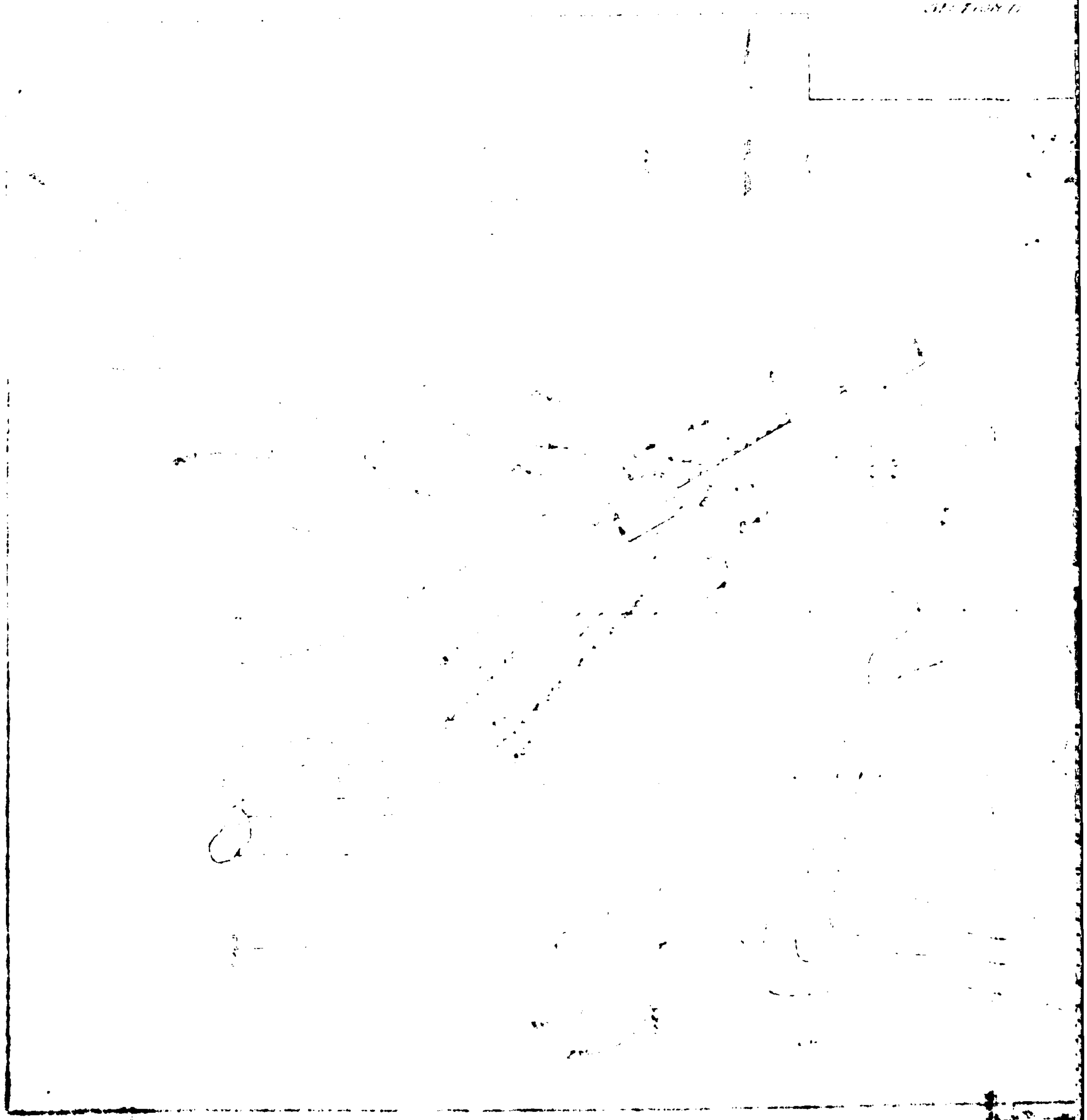
Respectfully submitted,

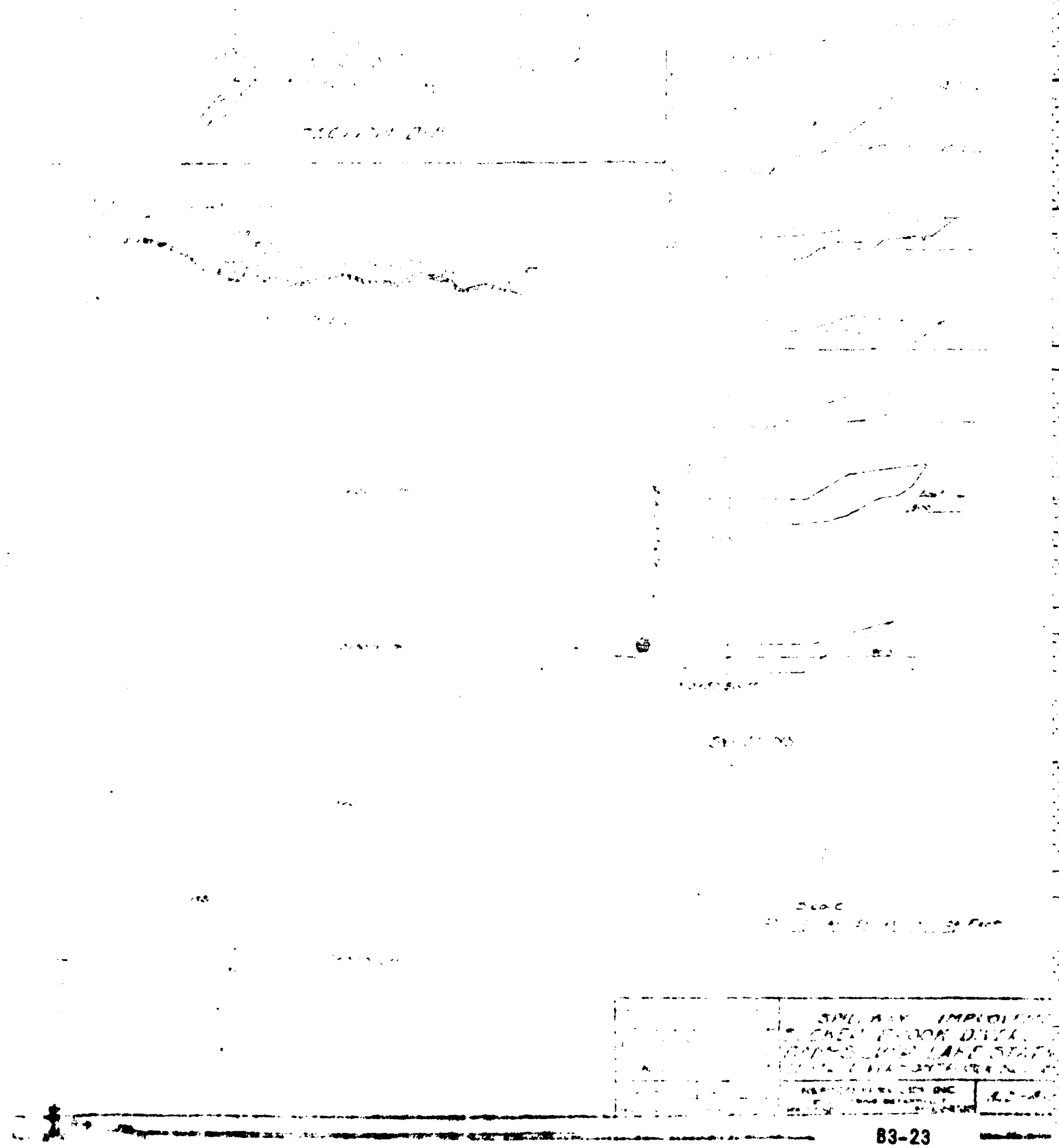
[illegible]

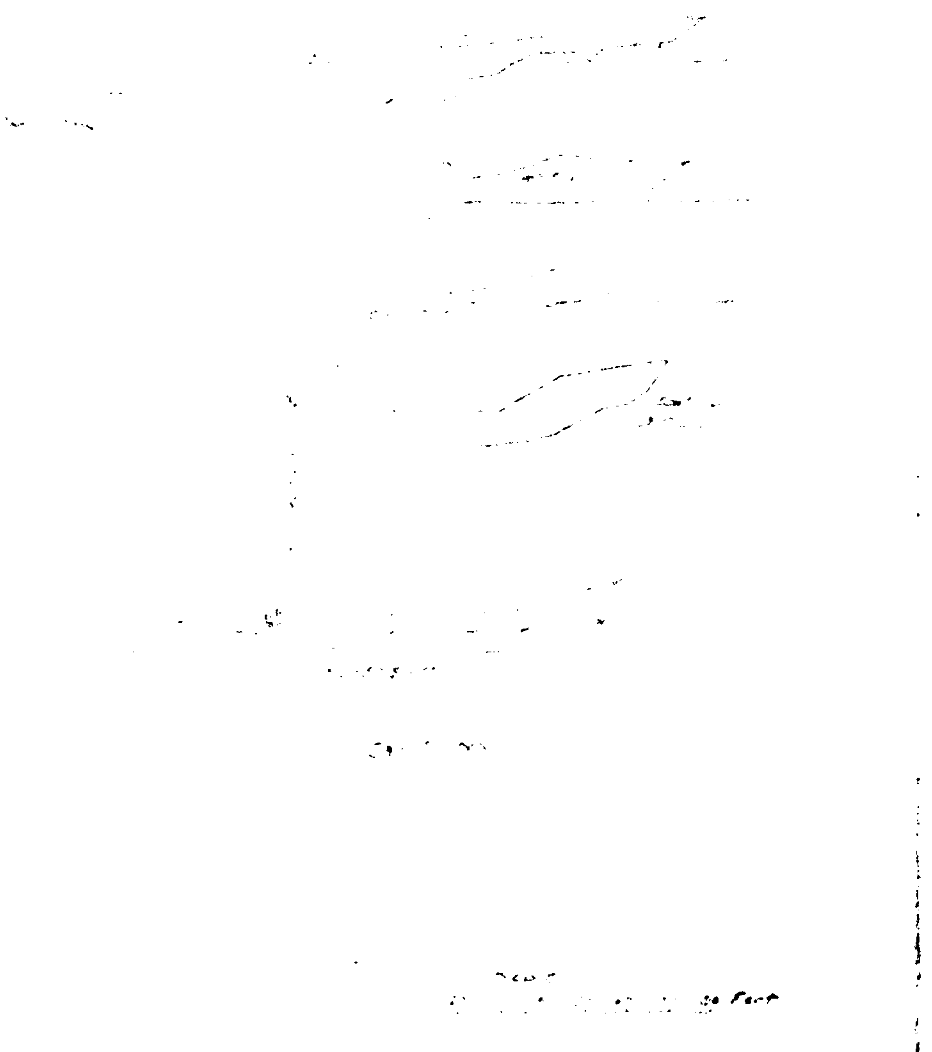
Accompanied by:-

(1) [illegible]

(2) 5 Photo[illegible]



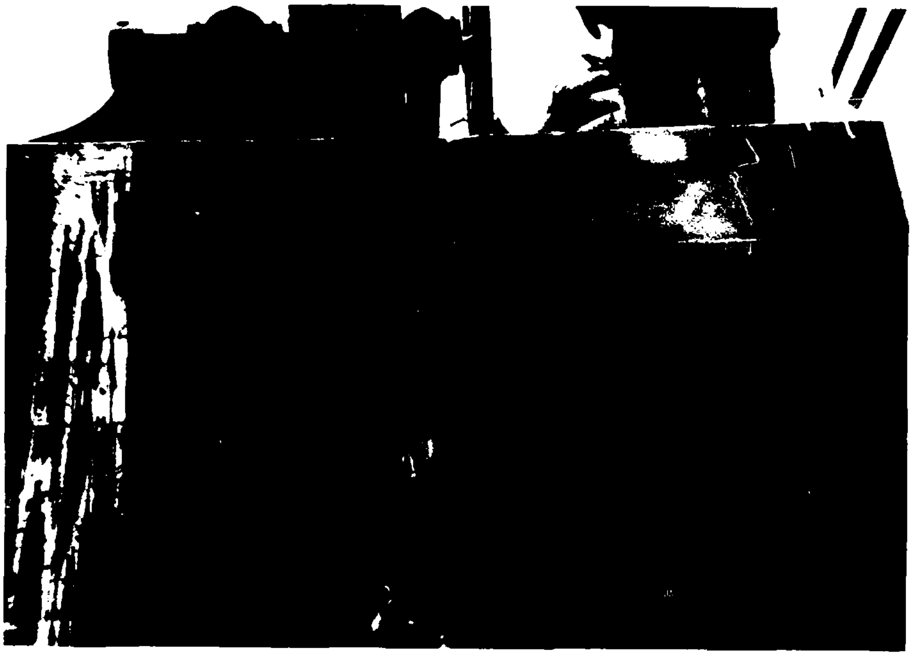




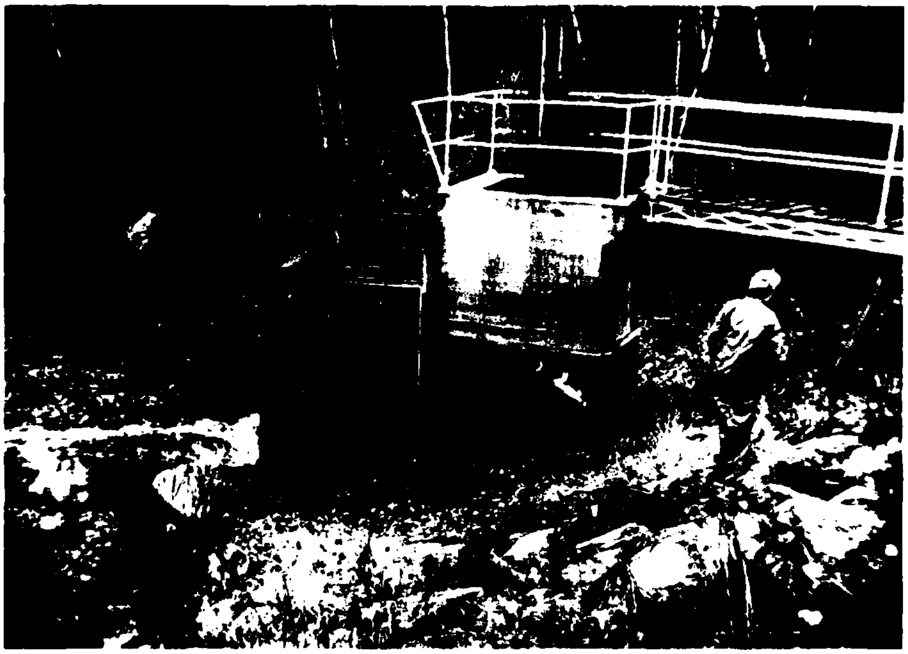
SPILLWAY IMPROVEMENT
S. CREEK BROOK DIVERSION
DAM - SLIP LAKE STATION
CENTRAL VERMONT PUBLIC SERVICE

REPRO SERVICES INC.

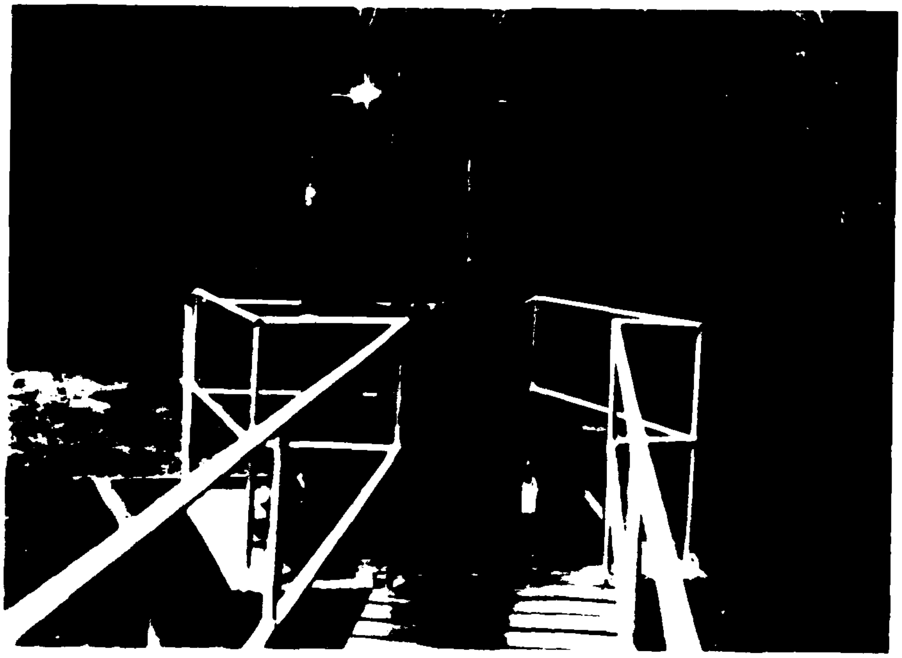
C-8A Deteriorated concrete support for service bridge on control tower - 11/07/79



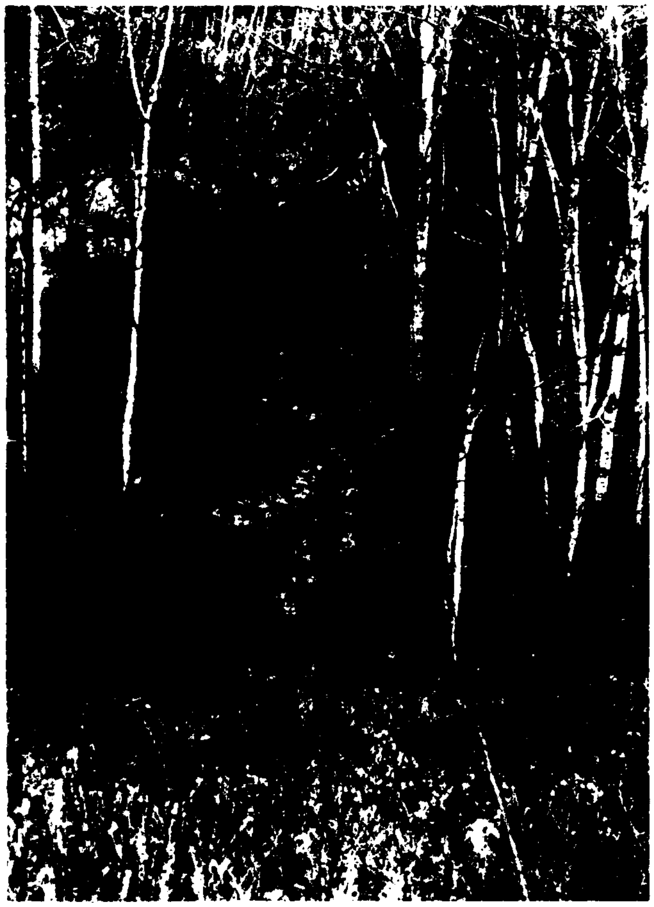
C-8B Crack in concrete on left side of control tower - 11/07/79



C-7A Intake structure and control tower - 11/07/79



C-7B Slide gate control mechanism on top of control tower
11/07/79



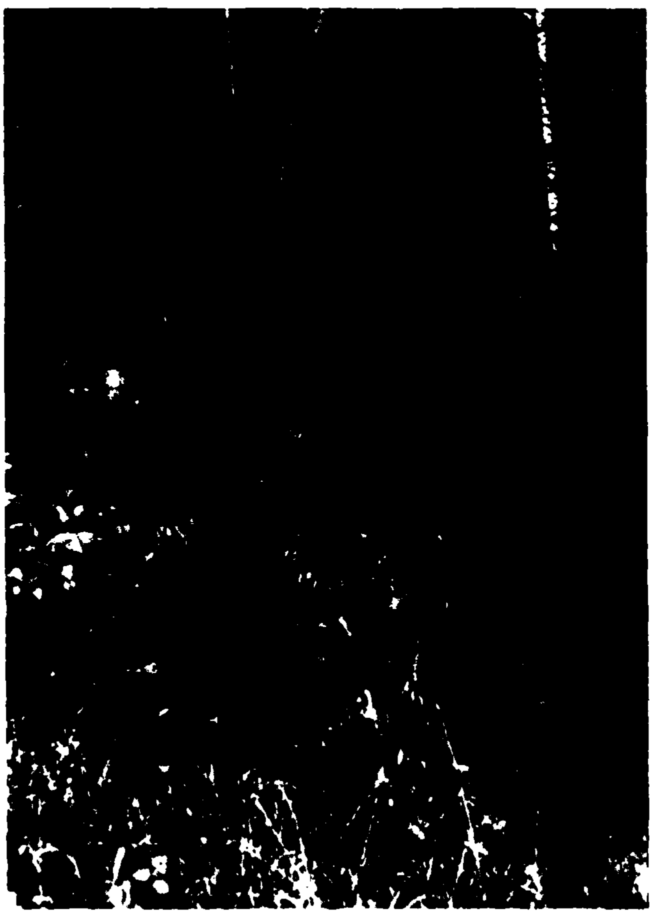
C-6A Ponded water at downstream toe of dam looking from dam crest 11/07/79

C-6B Upstream slope of dam looking left from spillway approach channel. Note riprap - 11/07/79

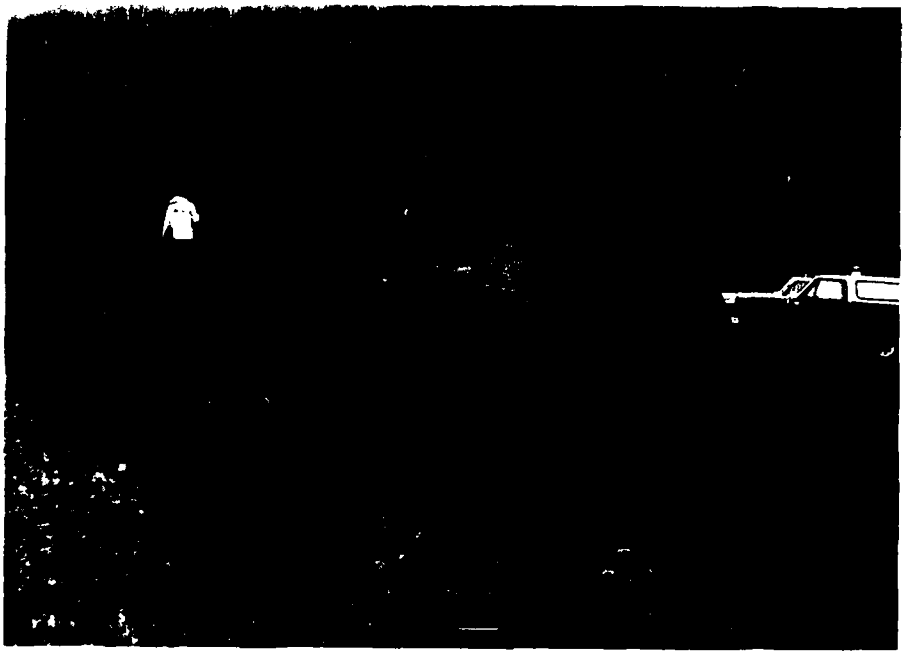
C-5A Left side of downstream slope of dam looking from left abutment. Note rock cover at bottom left - 11/07/79

C-5B Right side of downstream slope of dam looking from left abutment - 11/07/79

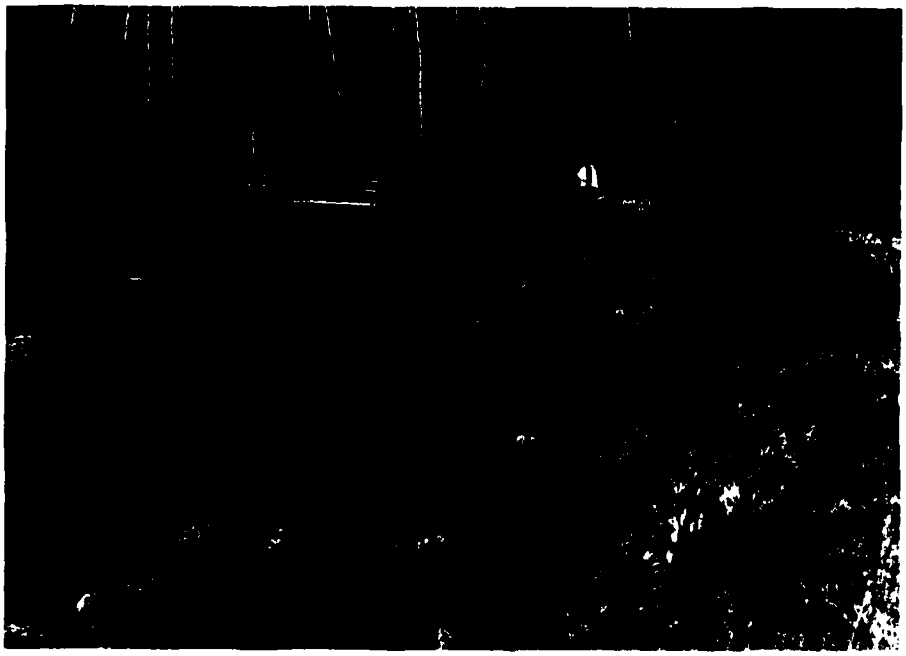
C-4A Dam crest looking from left abutment toward right abutment
11/07/79



C-4B Downstream slope of dam near left abutment. Note rock cover on slope and outlet penstock just visible in background above center
11/07/79

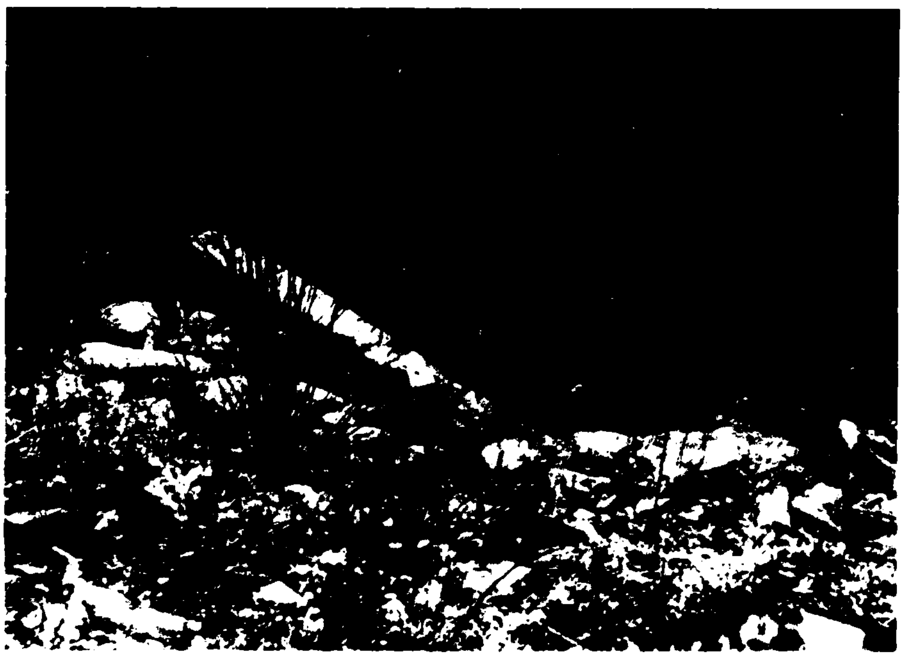


C-3A Dam crest looking from left spillway training wall toward left abutment. Note left training wall of old spillway right of center - 11/07/79

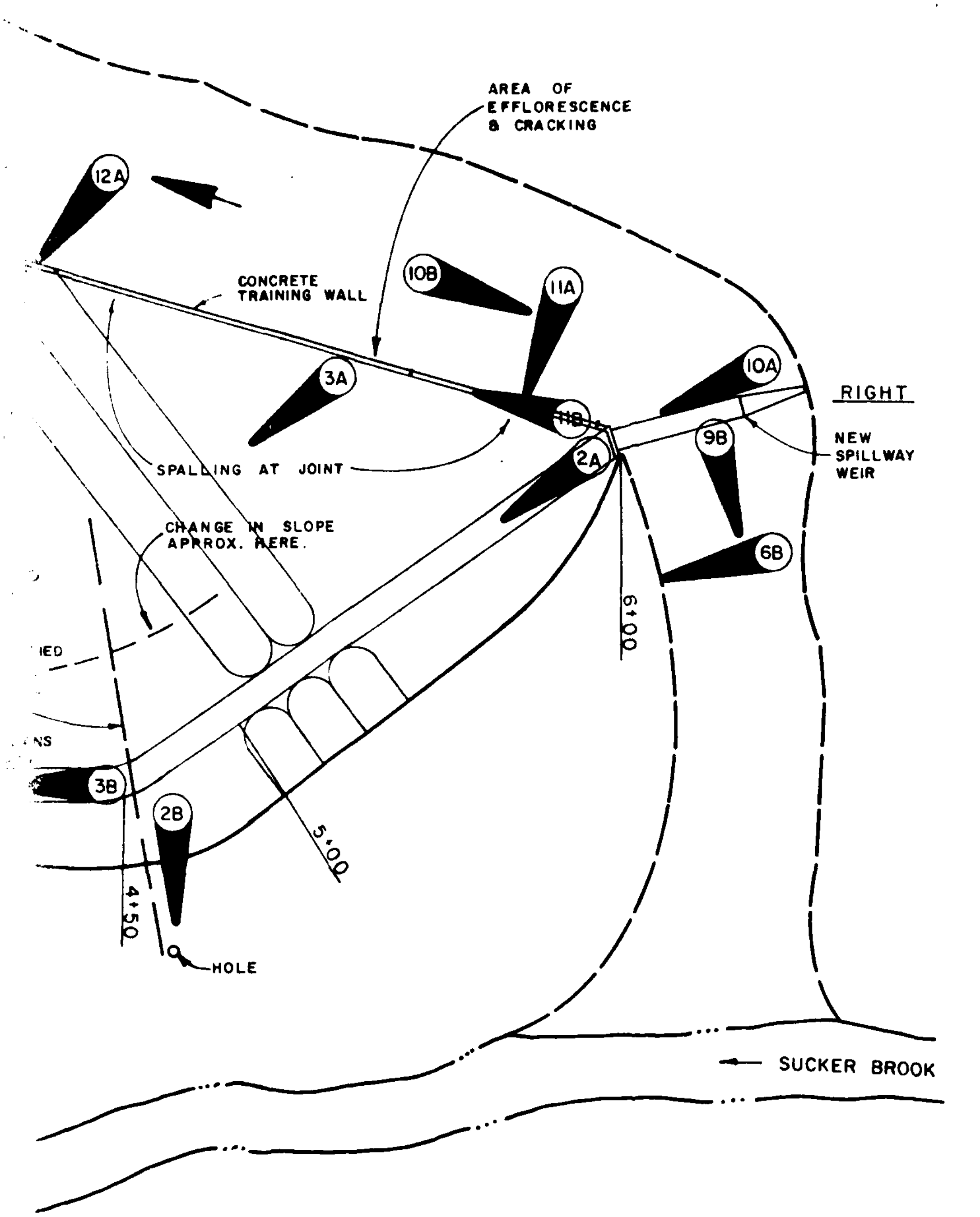


C-3B Upstream face of dam looking from right angle point toward left abutment - 11/07/79

C-2A Dam crest looking from left spillway training wall toward right angle point. Note top of left training wall of old spillway just visible at extreme left of center - 11/07/79



C-2B Close-up of upstream end of left training wall of old spillway where it starts through dam - 11/07/79



FOLLOWING PHOTOS ARE INDEXED ON APPENDIX D-1:

12 B
13 A
13 B

SUCKER BROOK DAM
PHOTO INDEX MAP
APPENDIX C-1

GORDON E. AINSWORTH & ASSOCIATES INC.

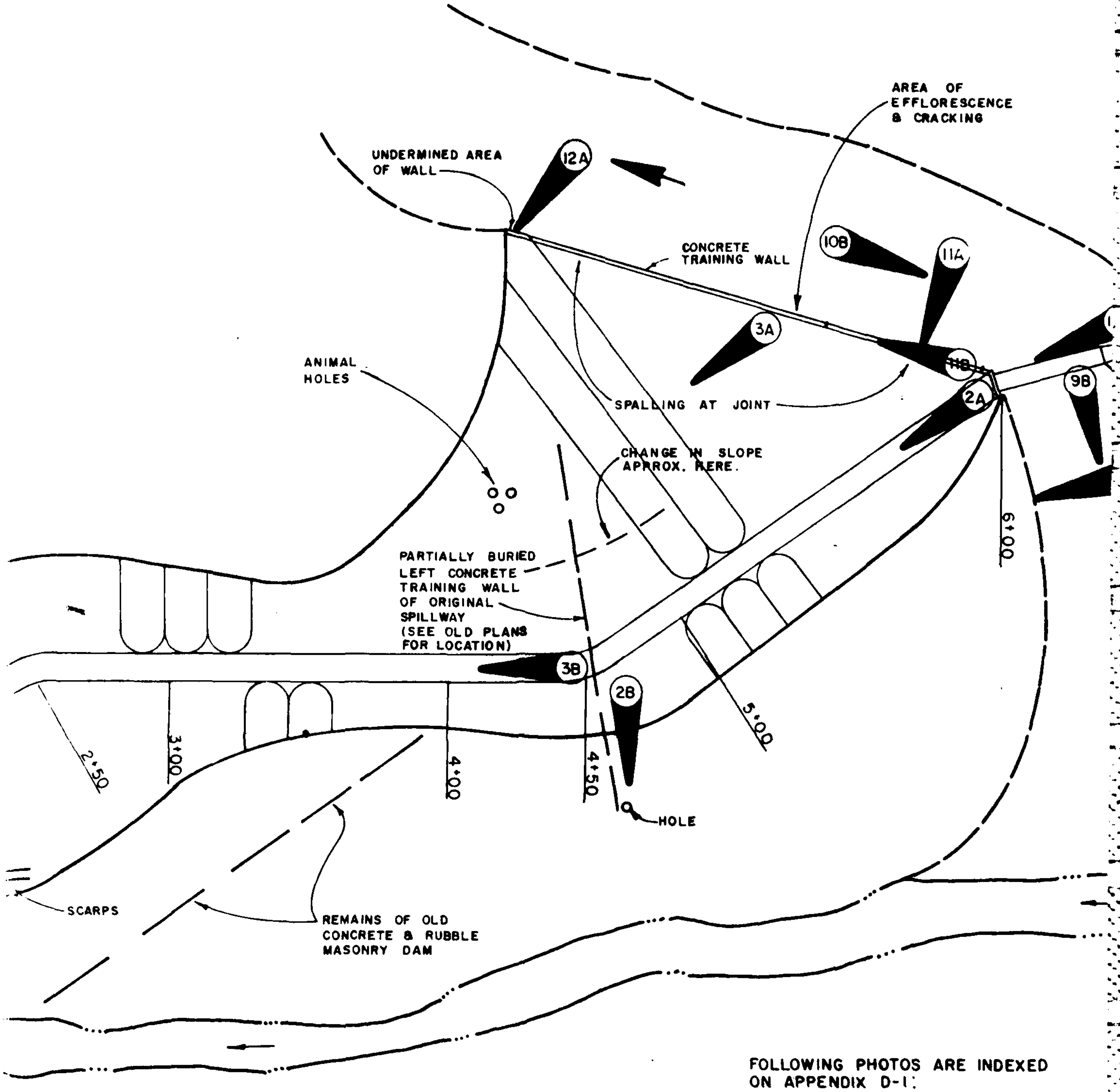
Engineers, Surveyors and Planners

20 SUGARLOAF ST. SOUTH DEERFIELD MASS. 01373

SCALE: NONE

FEBRU 980

DWG. NO. 80-119



FOLLOWING PHOTOS ARE INDEXED ON APPENDIX D-1:

12 B
13 A
13 B

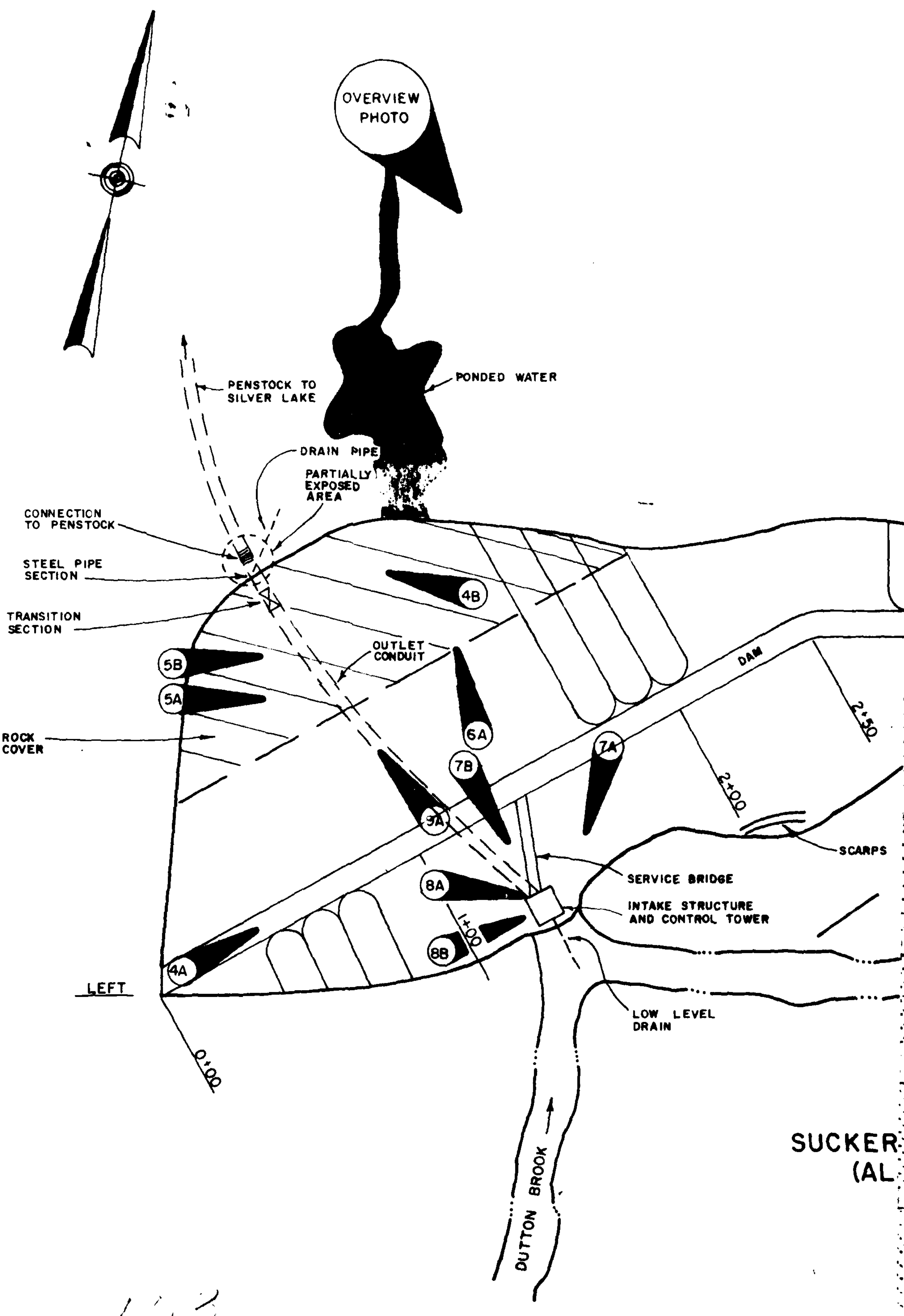
SUCKER BROOK RESERVOIR
(ALMOST EMPTY)

SCALE: NONE

SUCKER BROOK
PHOTO INDEX
APPENDIX C-

GORDON E. AINSWORTH & ASSC
Engineers, Surveyors and Plan
20 SUGARLOAF ST. SOUTH DEERFIELD

FEBRUARY 1980



SUCKER
(AL

123

APPENDIX C

PHOTOGRAPHS

Conclusions

There is no appreciable change in the stability of this dam since its construction.

STEPHEN H. HAYBROOK
HYDRAULIC ENGINEER

Public Service Commission

April 17, 1951

Report No. 199

has a stone riprap cover, while the remainder of the dam is seeded with grass.

At the north-east end of the embankment is a spillway located on a ledge rock foundation. It consists of a concrete cap anchored to the bed rock. Of this, a 40 ft. length has its crest 10 ft. below the top of the dam, and a 20 ft. extension has its crest 6 ft. below the top of the dam. The 40 ft. length is fitted with 4 ft. of pin-type flashboards designed to fall with 1.3 ft. of water over them. A concrete retaining wall and wing wall protects the embankment fill.

Near the westerly end of the embankment is a 4'x3.2' reinforced concrete outlet on a rock foundation. At the upstream end is a 3'x4' gate well, and a rack structure. At the downstream end is a transition to a 4 ft. dia. wood stave pipe. The wood-stave pipe continues to Silver Lake, a distance of 1.5 miles.

Comments on Inspection

From inspection, this dam appears in a good condition. It is a relatively recent structure, properly maintained.

Acknowledging H. K. Barrows' two reports on this dam, it was designed and built in a satisfactory manner. After damage by the 1938 Flood, the spillway was relocated in a more ideal position.

The embankment fill is a well graded material. There is ample spillway capacity.

The discharge channel may be subjected to erosion in flood time but the safety of the dam from such a condition would not be affected.

REPORT ON SUCKER BROOK DAM

General Data

1. Owner & Operator - Central Vermont Public Service Corp.
2. Purpose of dam - Diversion for Silver Lake hydro-electric development
3. Stream location - Sucker Brook (junction of Dutton Br.)
4. Town location - Salisbury, Vt. (south east corner)
5. Size of Pond - At maximum level the surface area is 4 acres and the volume 1,500,000 cu. ft.
6. Drainage area - Approximately 9 sq. mi. of which, 2.5 sq. mi. is regulated by Sugar Hill Dam.

Historical brief

Constructed in 1937, the dam replaces, with a larger capacity, an old concrete and rubble masonry structure. The project was approved by PSC in Case #1998, with H. K. Barrows. Consulting Engineer, designated as the Commission's engineer in the matter.

The flood of September, 1938 damaged the spillway channel. Improvements in 1939 were approved under PSC Case #2102. H. K. Barrows again acted for the Commission.

Description of the dam

Layout, dimensions and details are contained in the PSC case files on the dam. Briefly, it consists of the following:

The dam is a rolled earth embankment on a clay foundation. It is about 550 ft. in length and 40 ft. in maximum height. Its top width is 10 ft. and its upstream and downstream faces slopes, respectively, 1 on 2½ and 1 on 2. In general, the upstream face

C-9A Path of penstock at downstream end of outlet pipe. Note exposed penstock near center - 11/07/79

C-9B Approach channel to spillway looking from spillway weir - 11/07/79

C-10A Spillway weir looking toward left training wall - 11/07/79

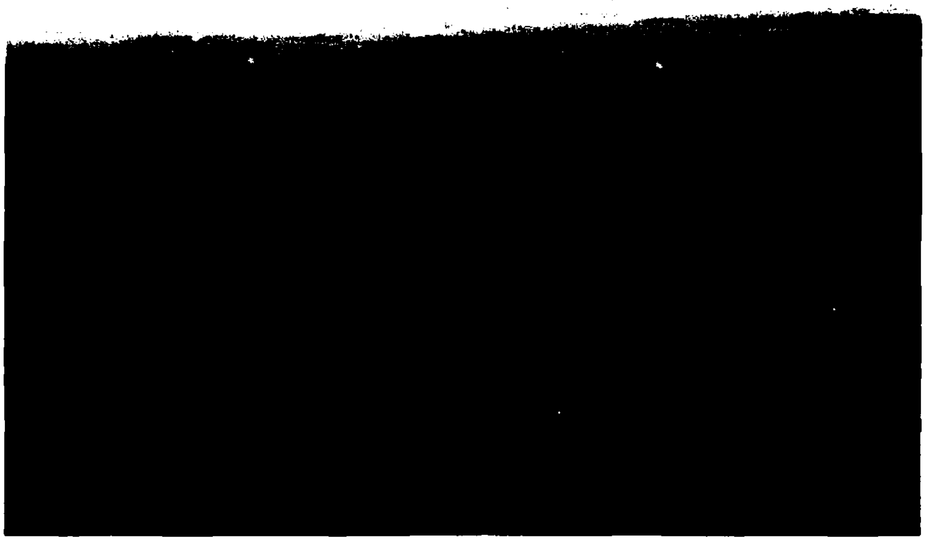
C-10B Spillway weir looking upstream from discharge channel
11/07/79

C-11A Spalling of concrete at construction joint in left training wall of spillway discharge channel - 11/07/79

C-11B Spillway discharge channel looking downstream from left training wall of spillway. Note training wall along left side of channel - 11/07/79

C-12A Undermining and deterioration of downstream end of left training wall of spillway discharge channel - 11/07/79

C-12B Vermont State Route No. 53 bridge over Sucker Brook near Lake Dunmore. Note top of powerhouse for Silver Lake Hydro-electric Development visible over left end of bridge - 11/08/79



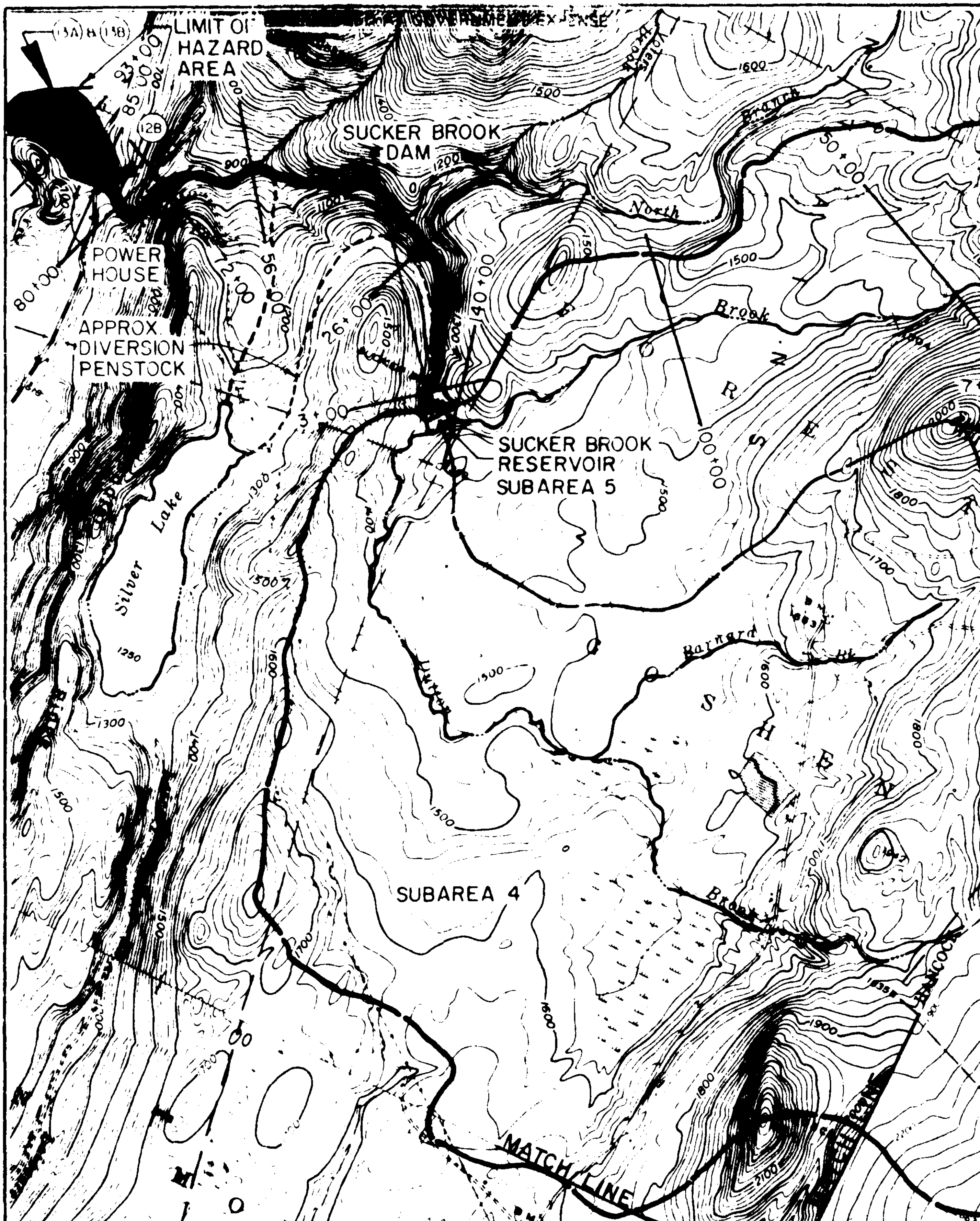
C-13A Aerial overview of downstream hazard area along Lake Dunmore. Sucker Brook Dam is in the mountains in the background - 11/30/79

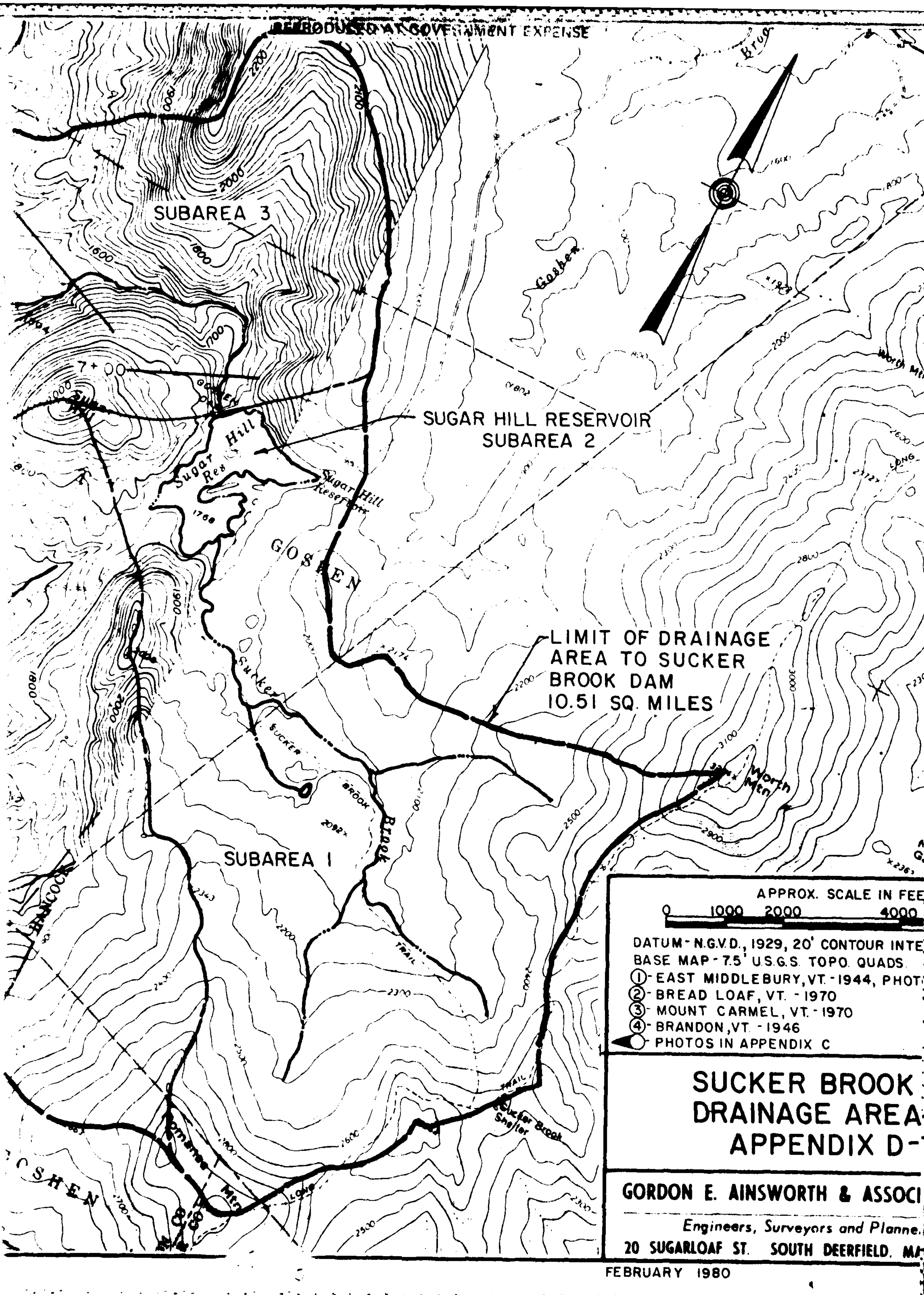
C-13B Aerial overview of downstream hazard area along Lake Dunmore. Note Vermont State Route No. 53 across center, Branbury State Park in left center and outlet to Sucker Brook in right foreground - 11/30/79

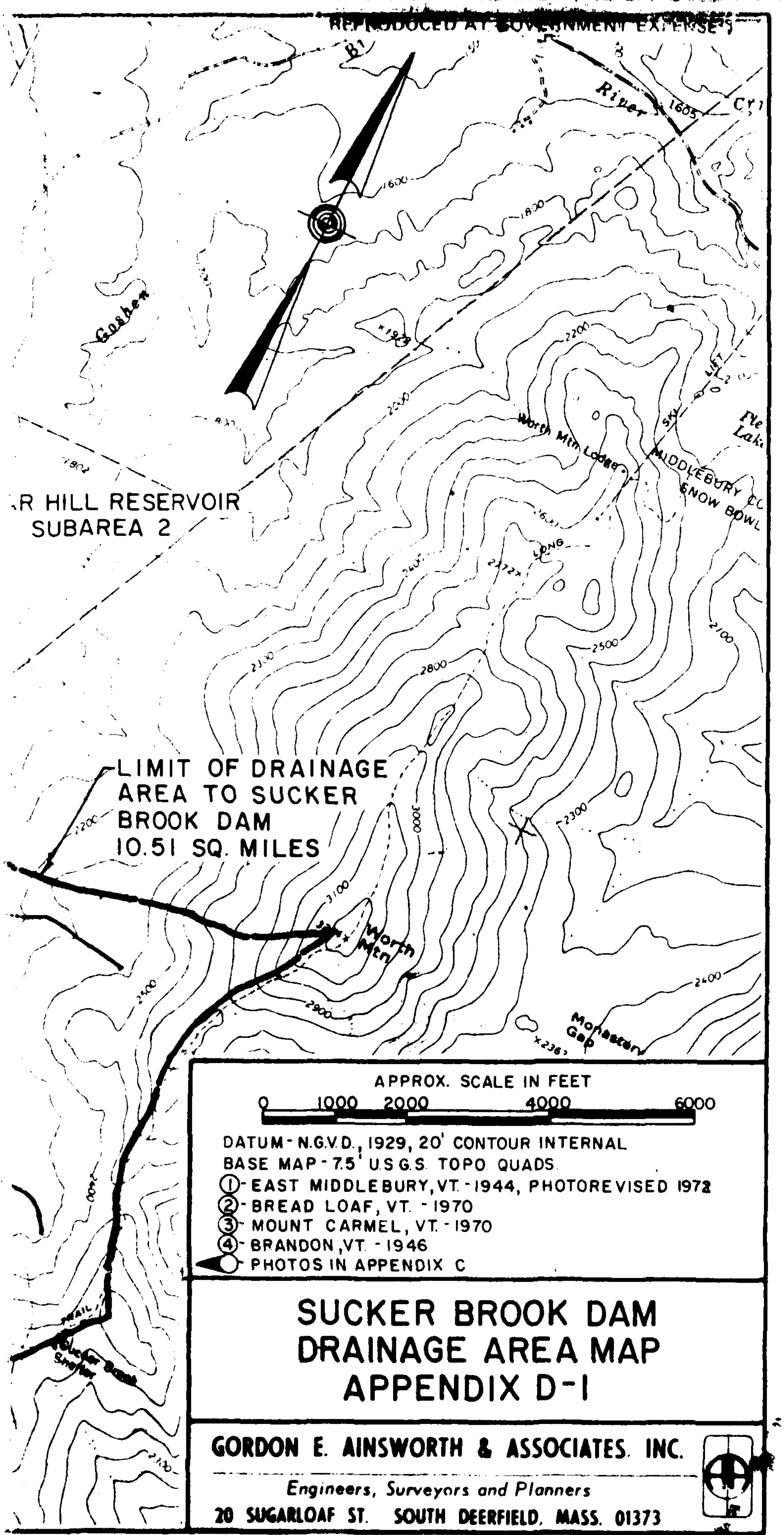
APPENDIX D

HYDRAULIC AND HYDROLOGIC COMPUTATIONS

TABLE OF CONTENTS


[redacted]
LIMIT OF HAZARD AREA
SUCKER BROOK DAM
POWER HOUSE
APPROX. DIVERSION PENSTOCK
SUCKER BROOK RESERVOIR SUBAREA 5
SUBAREA 4
MATCH LINE
Silver Lake
North Branch
Brook
Barnard Bk
GOSHEN
HANCOCK


SUBAREA 3
SUGAR HILL RESERVOIR
SUBAREA 2
Sugar Hill Res
Sugar Hill Reservoir
GOSHEN
LIMIT OF DRAINAGE AREA TO SUCKER BROOK DAM 10.51 SQ. MILES
Sucker Brook
SUBAREA 1
Worth Mtn
HANCOCK
Romance Mtn
Sucker Brook Shelter
TRAIL
APPROX. SCALE IN FEET
0 1000 2000 4000
DATUM - N.G.V.D., 1929, 20' CONTOUR INTERVAL
BASE MAP - 7.5' U.S.G.S. TOPO. QUADS.
① - EAST MIDDLEBURY, VT. - 1944, PHOTO
② - BREAD LOAF, VT. - 1970
③ - MOUNT CARMEL, VT. - 1970
④ - BRANDON, VT. - 1946
PHOTOS IN APPENDIX C
SUCKER BROOK
DRAINAGE AREA
APPENDIX D-
GORDON E. AINSWORTH & ASSOCI
Engineers, Surveyors and Planne
20 SUGARLOAF ST. SOUTH DEERFIELD, MA
FEBRUARY 1980



APPROX. SCALE IN FEET

0 1000 2000 4000 6000

DATUM - N.G.V.D., 1929, 20' CONTOUR INTERNAL
BASE MAP - 7.5' U.S.G.S. TOPO. QUADS.
1 - EAST MIDDLEBURY, VT. - 1944, PHOTOREVISED 1972
2 - BREAD LOAF, VT. - 1970
3 - MOUNT CARMEL, VT. - 1970
4 - BRANDON, VT. - 1946
PHOTOS IN APPENDIX C

SUCKER BROOK DAM
DRAINAGE AREA MAP
APPENDIX D-1

GORDON E. AINSWORTH & ASSOCIATES, INC.

Engineers, Surveyors and Planners

20 SUGARLOAF ST. SOUTH DEERFIELD, MASS. 01373

FEBRUARY

DWG NO 80-120

G. E. Ainsworth Associates
20 Sugarloaf Street
S. DEERFIELD, MA 01373
Phone 665-2161

JOB: SUCKER BROOK DAM
SHEET NO. ____ OF ____
CALCULATED BY: CLV DATE: 1/29/80
CHECKED BY: JMB DATE: 5/80
SCALE: 21-06-79108

ELEVATION - AREA - STORAGE COMPUTATIONS

SUCKER BROOK RESERVOIR VOLUME: COMPUTED BY PROGRAM USING METHOD OF CONIC SECTIONS $V_{12} = \frac{h}{3}(A_1 + A_2 + \sqrt{A_1 A_2})$

	ELEVATION (NGVD - ft)	AREA (acres)		V_T (acre-feet)	
	1280	0.02	BATHYMETRIC MAP	0	
	1290	0.33	BATHYMETRIC MAP	1	
	1300	2.76	BATHYMETRIC MAP	15	
LOWER SPILLWAY CREST →	1302*	3.0 (EST.)		21	
UPPER SPILLWAY CREST →	1306**	3.51	BATHYMETEC MAP	34	= 1.481 MCF ?
	1310	4.19	BATHYMETEC MAP	49	(1.425 MCF + 1.5 MCF REPORTED)
DAM CREST (LOW POINT) →	1311.2**	4.5 (EST.)		54	
	1320	6.67	BATHYMETRIC MAP	103	

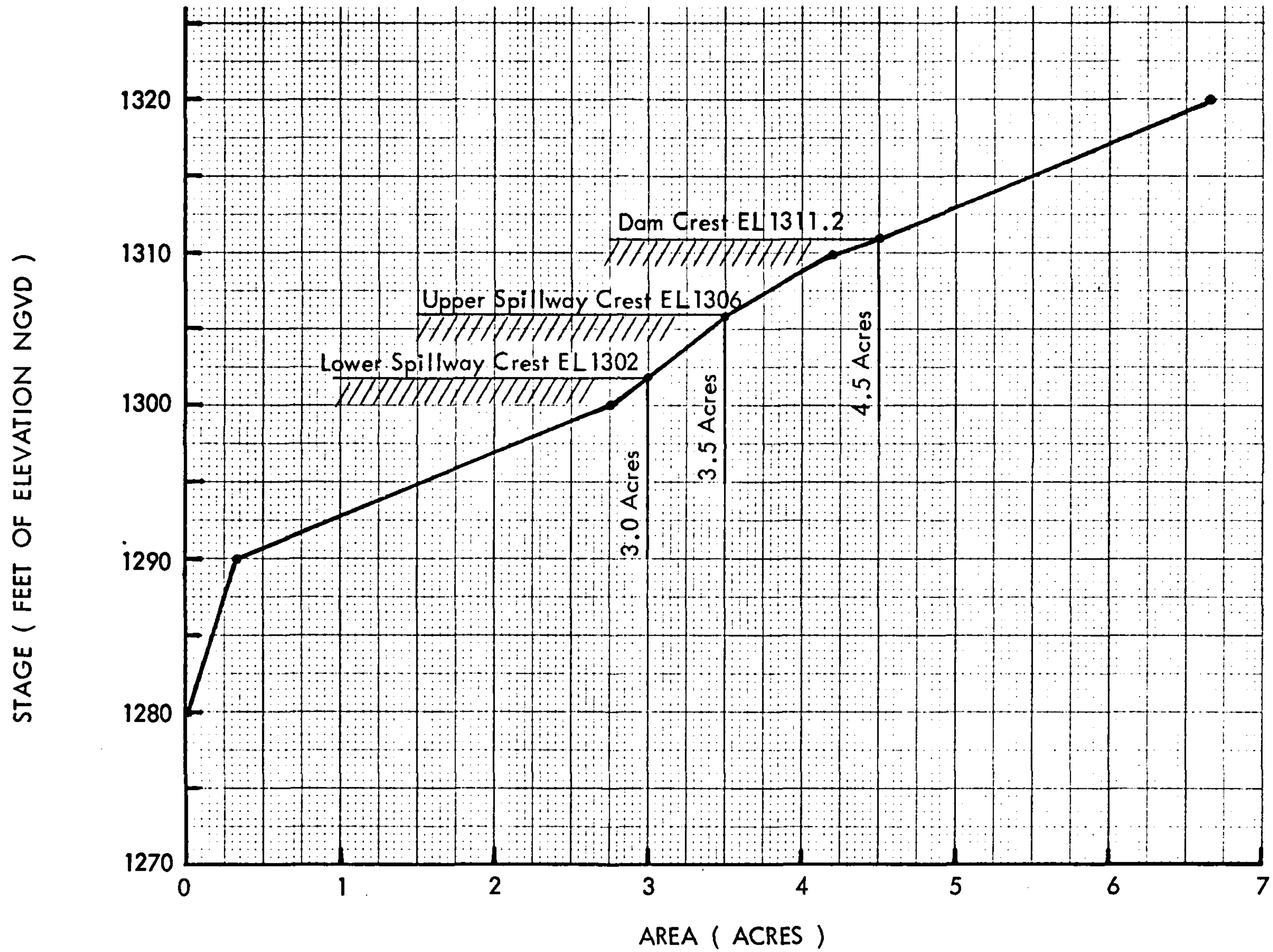
DRAINAGE AREA

		AREA (acres)	AREA (square miles)
	SUGAR HILL RESERVOIR SURFACE (SUBAREA 2) @ NORMAL POOL EL = 1768 (PHASE I REPORT FOR VT00176)	74.1	0.116
USGS MAP	WATERSHED DIRECT TO SUGAR HILL DAM (SUBAREA 1)	1827.2	2.855
			2.971
USGS MAP	SUCKER BROOK ABOVE SUCKER BROOK DAM (SUBAREA 3)	1742.1	2.722
USGS MAP	DUTTON BROOK ABOVE SUCKER BROOK DAM (SUBAREA 4)	3079.7	4.812
USGS MAP	SUCKER BROOK RESERVOIR SURFACE (SUBAREA 5) @ SPILLWAY CREST EL = 1302	3.0	0.005
			7.539
	TOTAL DRAINAGE AREA TO SUCKER BROOK DAM	6726.1	10.51

* FROM ENGINEERING DATA IN APPENDIX B3.
** FROM FIELD MEASUREMENTS

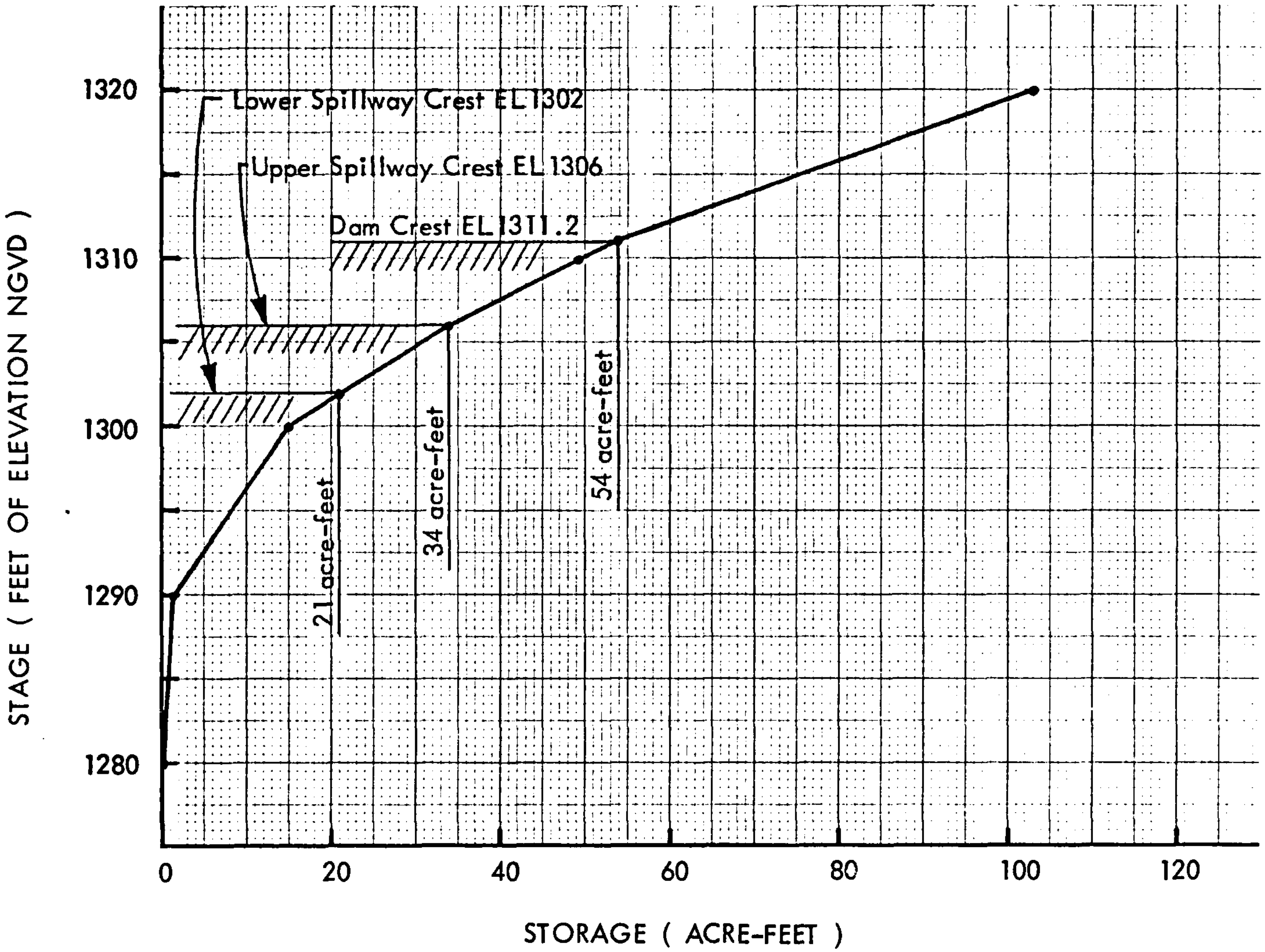
SUCKER BROOK DAM, SALISBURY, VERMONT

STAGE - AREA



SUCKER BROOK DAM, SALISBURY, VERMONT

STAGE - STORAGE



G. E. Ainsworth Associates
20 Sugarloaf Street
S. DEERFIELD, MA 01373
Phone 665-2161

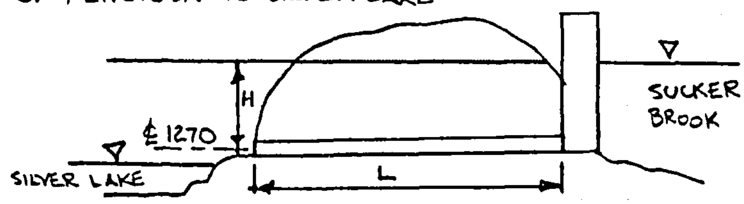
JOB SUCKER BROOK DAM
SHEET NO. ______ OF ______
CALCULATED BY ELV DATE 1/29/80
CHECKED BY JPB DATE 5/80
SCALE 21-06-79108

DISCHARGE COMPUTATIONS - SUCKER BROOK DAM

OUTLET CONDUIT

(OUTLET CONTROLED DUE TO LENGTH + LOW HEAD)
SEE INLET CONTROL CHECK BELOW.

L = 1.5 miles = 7920′ LENGTH OF PENSTOCK TO SILVER LAKE
D = 4′ DIAMETER OUTLET
n = 0.013 (ASSUMED)
$k_{entrance}$ = 1.0 (ASSUMED)
k_{exit} = 0.5 (ASSUMED)



H = 23′ MINIMUM HEIGHT DIFFERENCE BETWEEN WATER SURFACE IN SUCKER BROOK RESERVOIR (EL 1293 @ INTAKE INVERT) AND OUTLET ℄ AT SILVER LAKE (EL 1270)

FOR OUTLET CONTROL:

(DERIVED FROM APPLICATION OF BERNOULLI'S EQUATION USING MANNING'S EQUATION FOR FRICTION LOSS)

$$Q = \left[\frac{S_{ws}}{\frac{K_{en}+K_{ex}}{2gA^2L} + \frac{n^2}{2.21A^2R^{4/3}}} \right]^{1/2}$$

$S_{ws} = H/L$
$A = \frac{\pi D^2}{4} = 12.566$ SQ. FT.
$R = A/p = 1.0'$

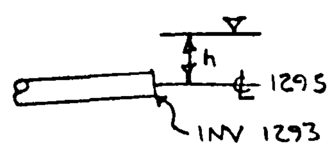
	WATER SURFACE ELEVATION (NGVD - ft.)	H (ft.)	Q (cfs)	CHECK Q INLET CONTROL (cfs)
INTAKE INVERT →	1293	23	0	
	1293.1	23.1	76.2	
	1295	25	79.2	
	1300	30	86.8	
LOWER SPILLWAY CREST →	1302	32	89.6 → SAY 90	(160)
	1303	33	91.0	
	1304	34	92.4	
	1305	35	93.7	
UPPER SPILLWAY CREST →	1306	36	95.1 → SAY 95	(201)
	1307	37	96.4	

	WATER SURFACE ELEVATION (NGVD - ft.)	H (ft.)	Q (cfs)	CHECK Q INLET CONTROL (cfs)
	1308	38	97.7	
	1309	39	99.0	
	1310	40	100.2	
	1311	41	101.5	
DAM CREST →	1311.2	41.2	101.7 → SAY 100	(258)
	1312	42	102.7	
	1313	43	103.9	
	1314	44	105.1	(277)
	1315	45	106.3	
	1316	46	107.5	
	1320	50	112.0	

A = 12.566 SF (4′ ϕ) OR 12.6 SF (3′-2″ x 4′)
C = 0.6

CHECK INLET CONTROL

$Q = CA\sqrt{2gh}$
$= 60.5 (h)^{1/2}$



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20 Sugarloaf Street
S. DEERFIELD, MA 01373
Phone 665-2161

JOB: SUCKER BROOK DAM
SHEET NO. ____ OF ____
CALCULATED BY: ELV DATE: 1/29/80
CHECKED BY: GPB DATE: 5/80
SCALE: 21-06-79108

DISCHARGE COMPUTATIONS - SUCKER BROOK DAM

DAM APPURTENANCE	ELEVATION (NGVD)	SIZE
LOWER CHUTE SPILLWAY (LS)*	CREST EL = 1302	40' CREST LENGTH
UPPER CHUTE SPILLWAY (US)* (MODELED AS BROAD-CRESTED WEIR BECAUSE OF APPROACH AND DISCHARGE CHANNEL BOTTOMS)	CREST EL = 1306	20' CREST LENGTH
DAM**	CREST EL = 1311.2 (LOW POINT, NON-LEVEL)	600' CREST LENGTH W/O SPILLWAY
OUTLET CONDUIT	INTAKE EL = 1293	4' DIAMETER

	ELEVATION (NGVD)	Q_{spill} (cfs)	H_{LS} (feet)	H_{US} (feet)	H_{DAM} (feet)	Q_{OUTLET} (cfs)	Q_{LS}* (cfs)	Q_{US}* (cfs)	Q_{DAM}** (cfs)	Q_T (cfs)
TAKE VERT →	1293	0	0	0	0	0	0	0	0	0
	1293.1	0	0	0	0	76.2	0	0	0	76
	1295	0	0	0	0	79.2	0	0	0	79
	1300	0	0	0	0	86.8	0	0	0	87
OWER ILLWAY REST →	1302	0	0	0	0	89.6	0	0	0	90
	1303	124	1	0	0	91.0	123.5	0	0	214
	1304	349	2	0	0	92.4	349.3	0	0	(442) 437
	1305	642	3	0	0	93.7	641.6	0	0	736
PER ILLWAY EST →	1306	988	4	0	0	95.1	987.8	0	0	1083
	1307	1442	5	1	0	96.4	1380.5	61.7	0	1538
	1308	1989	6	2	0	97.7	1814.8	174.6	0	2087
	1309	2618	7	3	0	99.0	2286.9	330.8	0	2717
	1310	3288	8	4	0	100.2	2794.0	493.9	0	3388
	1311	4024	9	5	0	101.5	3334.0	690.3	0	4126
M EST →	1311.2	4182	9.2	5.2	0	101.7	3450.2	732.1 (730)	0	4284 (4280)
	1312	4812	10	6	0.8	102.7	3904.8	907.4	130	5045
	1313	5648					4504.9	1143.4		
	1314	6530	12	8	2.8	105.1	5133.0	1397.0	4399	11,034
	1315	7455					5787.8	1667.0		
	1316	8421	14	10	4.8	107.5	6468.3	1952.4	13664	22192
	1320	12,664					9430.0	3234.1		

* FOR FLOW OVER SPILLWAY: $Q = 3.087\,LH^{1.5}$ (FORMULA FOR CRITICAL FLOW OVER BROAD-CRESTED WEIR, REFERENCE 9)

** FOR FLOW OVER DAM: CALCULATED W/ HEC-1 DB PROGRAM FOR FLOW OVER NON-LEVEL DAM CREST.

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
0.00 1340.00 70.00 1320.00 100.00 1300.00 110.00 1297.00 115.00 1297.00
125.00 1300.00 370.00 1300.00 500.00 1340.00

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

SUB-AREA RUNOFF COMPUTATION

SUBAREA 3 RUNOFF COMPUTATION

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
SA-3	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	2.72	0.00	10.51	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	17.50	111.00	123.00	132.00	0.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS 0.802

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	0.10	0.00	0.00

UNIT HYDROGRAPH DATA

TP= 2.90 CP=0.63 NTA= 0

RECESSION DATA

STRTQ= -4.00 QRCSN= 0.00 RTIOR= 1.00

UNIT HYDROGRAPH100 END-OF-PERIOD ORDINATES, LAG= 2.88 HOURS, CP= 0.62 VOL= 0.91

2.	7.	16.	25.	36.	48.	61.	75.	90.	105.
120.	136.	152.	165.	186.	203.	221.	238.	256.	274.
290.	305.	319.	332.	344.	354.	363.	371.	378.	384.
389.	392.	394.	394.	393.	390.	385.	377.	366.	355.
344.	334.	324.	314.	305.	295.	286.	278.	269.	261.
253.	246.	238.	231.	224.	217.	211.	204.	198.	192.
186.	181.	175.	170.	165.	160.	155.	150.	146.	141.
137.	133.	129.	125.	121.	117.	114.	110.	107.	104.
101.	98.	95.	92.	89.	86.	84.	81.	79.	76.
74.	72.	70.	67.	65.	63.	62.	60.	58.	56.

0

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q

SUM 18.52 15.90 2.62 303637.
(470.)(404.)(67.)(8597.18)

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

SUB-AREA RUNOFF COMPUTATION

SUBAREA 4 RUNOFF COMPUTATION

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
SA-4	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	4.91	0.00	10.51	0.00	0.000	0	1	0

```
     CAPACITY=        0.        4.       26.       80.      170.      297.      467.      674.      930.     1240.
                   1591.     1666.     1743.     1821.     1901.     1983.     2629.

     ELEVATION=     1717.     1723.     1728.     1733.     1738.     1743.     1748.     1753.     1758.     1763.
                   1768.     1769.     1770.     1771.     1772.     1773.     1780.

                              CREL     SPWID     COQW      EXPW     ELEVL      COQL     CAREA      EXPL
                            1766.0     150.0       3.1       1.5       0.0       0.0       0.0       0.0

                                                                DAM DATA
                                                 TOPEL      COQD      EXPD     DAMWID
                                                1771.5       0.0       0.0        0.

     CREST LENGTH          0.       60.      200.      370.      455.      575.      615.      700.
     AT OR BELOW
     ELEVATION         1771.5    1771.6    1771.8    1771.9    1772.1    1772.3    1773.0    1776.8

 PEAK OUTFLOW IS      2017. AT TIME  19.33 HOURS


 NORMAL DEPTH CHANNEL ROUTING
 ----------------------------

           QN(1)     QN(2)     QN(3)    ELNVT     ELMAX     RLNTH      SEL
          0.0400    0.0300    0.0400   1710.0    1740.0      700.  0.01000

           CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
              0.00 1760.00    50.00 1740.00   150.00 1720.00   240.00 1710.00   250.00 1710.00
            310.00 1720.00   560.00 1720.00   650.00 1740.00


 NORMAL DEPTH CHANNEL ROUTING
 ----------------------------

           QN(1)     QN(2)     QN(3)    ELNVT     ELMAX     RLNTH      SEL
          0.0400    0.0300    0.0400   1540.0    1580.0     4300.  0.04000

           CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
              0.00 1580.00    60.00 1560.00   140.00 1544.00   150.00 1540.00   170.00 1540.00
            200.00 1544.00  1850.00 1544.00  1860.00 1580.00


 NORMAL DEPTH CHANNEL ROUTING
 ----------------------------

           QN(1)     QN(2)     QN(3)    ELNVT     ELMAX     RLNTH      SEL
          0.0400    0.0300    0.0400   1430.0    1480.0     5000.  0.02200

           CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
              0.00 1480.00  1000.00 1460.00  1450.00 1440.00  1540.00 1430.00  1550.00 1430.00
           1850.00 1460.00  2600.00 1465.00  2600.00 1480.00


 NORMAL DEPTH CHANNEL ROUTING
 ----------------------------

           QN(1)     QN(2)     QN(3)    ELNVT     ELMAX     RLNTH      SEL
          0.0400    0.0300    0.0400   1297.0    1340.0     4600.  0.03300
```

```
                                    END-OF-PERIOD FLOW
  MO.DA  HR.MN  PERIOD   RAIN   EXCS   LOSS   COMP Q        MO.DA  HR.MN  PERIOD   RAIN   EXCS   LOSS    COMP Q

                                                                           SUM  18.52  15.90   2.62   208581.
                                                                              ( 470.)( 404.)(  67.)( 5738.03)

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

                                   SUB-AREA RUNOFF COMPUTATION

               SUBAREA 2 RUNOFF COMPUTATION (SUGAR HILL RESERVOIR)
                          ISTAQ   ICOMP   IECON   ITAPE   JPLT    JPRT   INAME  ISTAGE   IAUTO
                          SA-2      0       0       0       0       0      1       0       0

                                      HYDROGRAPH DATA
                  IHYDG   IUHG   TAREA   SNAP   TRSDA   TRSPC   RATIO   ISNOW  ISAME   LOCAL
                    1      -1     0.12   0.00   10.51    0.00   0.000     0       1       0

                                        PRECIP DATA
                        SPFE     PMS      R6      R12     R24      R48     R72     R96
                        0.00   17.50  111.00  123.00  132.00     0.00    0.00    0.00
 TRSPC COMPUTED BY THE PROGRAM IS 0.802

                                         LOSS DATA
            LROPT   STRKR   DLTKR   RTIOL   ERAIN   STRKS   RTIOK   STRTL   CNSTL   ALSMX   RTIMP
              0      0.00    0.00    1.00    0.00    0.00    1.00    0.00    0.00    0.00    0.00

                                      RECESSION DATA
                          STRTQ=    -4.00    QRCSN=    0.00    RTIOR= 1.00
                                    END-OF-PERIOD FLOW
  MO.DA  HR.MN  PERIOD   RAIN   EXCS   LOSS   COMP Q        MO.DA  HR.MN  PERIOD   RAIN   EXCS   LOSS    COMP Q

                                                                           SUM  18.52  18.52   0.00   16754.
                                                                              ( 470.)( 470.)(   0.)( 474.42)

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

                                     COMBINE HYDROGRAPHS

               COMBINING HYDROGRAPHS 1,2
                          ISTAQ   ICOMP   IECON   ITAPE   JPLT    JPRT   INAME  ISTAGE   IAUTO
                          SA-2C     2       0       0       0       0      1       0       0

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

                                     HYDROGRAPH ROUTING

               ROUTING FLOWS THROUGH RESERVOIR 1 (SUGAR HILL RESERVOIR)
                          ISTAQ   ICOMP   IECON   ITAPE   JPLT    JPRT   INAME  ISTAGE   IAUTO
                          RES1      1       0       0       0       0      1       0       0
                                        ROUTING DATA
                      QLOSS   CLOSS    AVG    IRES   ISAME   IOPT    IPMP            LSTR
                        0.0   0.000   0.00     1       1       0       0               0

                          NSTPS   NSTDL    LAG   AMSKK      X      TSK    STORA   ISPRAT
                            1       0       0    0.000   0.000   0.000   -1768.      0

  SURFACE AREA=      0.       2.       7.      15.      21.      30.      38.      45.      58.      67.
                    74.      76.      77.      79.      81.      82.     103.
```

```
**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  26 FEB 79
**********************************

RUN  DATE: [illegible]
     TIME: 8:54 AM

                  NED DAM INSPECTION CONTRACT: DACW33-80-C-0012  SPOT1
                  VT. 00212 SUCKER BROOK DAM, 21-06-75108
                  OVERTOPPING - TEST FLOOD = HALF PMF

                                    JOB SPECIFICATION
                  NO     NHR    NMIN    IDAY     IHR    IMIN   METRC    IPLT    IPRT   NSTAN
                 288       0       5       0       0       0       0       0       4       0
                                       JOPER     NWT   LROPT   TRACE
                                           5       0       0       0

                               MULTI-PLAN ANALYSES TO BE PERFORMED
                                  NPLAN= 1 NRTIO= 1 LRTIO= 1
                    RTIOS=   0.50

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

                                 SUB-AREA RUNOFF COMPUTATION

                 SUBAREA 1 RUNOFF COMPUTATION
                                 ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                                  SA-1       0       0       0       0       0       1       0       0

                                               HYDROGRAPH DATA
                  IHYDG    IUHG   TAREA    SNAP   TRSDA   TRSPC   RATIO   ISNOW   ISAME   LOCAL
                      1       1    2.85    0.00   10.51    0.00   0.000       0       1       0

                                               PRECIP DATA
                               SPFE     PMS      R6     R12     R24     R48     R72     R96
                               0.00   17.50  111.00  123.00  132.00    0.00    0.00    0.00
TRSPC COMPUTED BY THE PROGRAM IS 0.802

                                                 LOSS DATA
              LROPT   STRKR   DLTKR   RTIOL   ERAIN   STRKS   RTIOK   STRTL   CNSTL   ALSMX   RTIMP
                  0    0.00    0.00    1.00    0.00    0.00    1.00    1.00    0.10    0.00    0.00

                                           UNIT HYDROGRAPH DATA
                                      TP=  3.20    CP=0.63    NTA=  0

                                               RECESSION DATA
                                 STRTQ=   -4.00    QRCSN=    0.00    RTIOR= 1.00

                 UNIT HYDROGRAPH100 END-OF-PERIOD ORDINATES, LAG=   3.20 HOURS, CP= 0.63  VOL= 0.89
                     2.        6.       13.       21.       30.       40.       51.       63.       75.       87.
                   100.      114.      127.      142.      156.      171.      185.      200.      216.      231.
                   246.      261.      276.      289.      301.      313.      323.      333.      342.      349.
                   356.      362.      367.      371.      374.      376.      377.      377.      375.      372.
                   369.      360.      351.      341.      331.      322.      313.      304.      296.      288.
                   280.      272.      264.      257.      250.      243.      236.      230.      223.      217.
                   211.      205.      199.      194.      188.      183.      178.      173.      169.      164.
                   159.      155.      150.      146.      142.      138.      134.      131.      127.      123.
                   120.      117.      113.      110.      107.      104.      101.       98.       96.       93.
                    90.       88.       87.       83.       81.       79.       76.       74.       72.       70.
```

```
Y2      1
Y6    .04     .03     .04    1297    1340    4000    .333
Y7      0    1340      70    1320     100    1300     110    1297     115    1297
Y7    125    1300     370    1300     500    1340
K       0    SA-3                                       1
K1 SUBAREA 3 RUNOFF COMPUTATION
M       1       1   2.722            10.51                             1
P            17.5     111     123     132
T                                                     1.0     .10
J     2.9    .025
X     -4.       0       1
K       0    SA-4                                       1
K1 SUBAREA 4 RUNOFF COMPUTATION
M       1       1   4.812            10.51                             1
P            17.5     111     123     132
T                                                     1.0     .10
J     3.4    .025
X     -4.       0       1
K       0    SA-5                                       1
K1 SUBAREA 5 RUNOFF COMPUTATION (SUCKER BROOK RESERVOIR)
M       1      -1   0.005            10.51                             1
P            17.5     111     123     132
T                                                       0       0
O       1
S1     30
X     -4.       0       1
KK    4SA-2345C                                         1
K1 COMBINING HYDROGRAPHS RES1,3,4,5
K       1    RES2                     2                 1
K1 ROUTING FLOWS THROUGH RESERVOIR 2 (SUCKER BROOK RESERVOIR)
Y                               1       1
Y1      1                                           -1302      -1
Y4   1293  1293.1    1295    1300    1302    1303    1304    1305    1306    1307
Y4   1309    1309    1310    1311    1312    1313    1314    1315    1320
Y5      0      76      79      87      90     214     437     736    1083    1538
Y5   2987    2717    3380    4126    4915    5752    6635    7561   12776
$A    .02     .33    2.76    3.51    4.19    6.67
$E   1280    1290    1300    1306    1310    1320
$$   1302
$D 1311.2
$L      0      60      90     120     300     600     600
$V 1311.2  1311.7  1311.8  1311.5  1312.2  1317.0  1320.0
K      99
A
A
A
A
A
```

```
A NED DAM INSPECTION CONTRACT: DACW33-80-C-0012   SBOT1                                                   PAGE 0001

A NED DAM INSPECTION CONTRACT: DACW33-80-C-0012   SBOT1
A VT. 00212 SUCKER BROOK DAM. 21-06-79108
A OVERTOPPING - TEST FLOOD = HALF PMF
B      288       0       5                                                                            4
B1       5
J        1       1       1
J1     0.5     0.50
K        0    SA-1                                               1
K1 SUBAREA 1 RUNOFF COMPUTATION
M        1       1   2.555             10.51                                                          1
P             17.5     111     123       132
T                                                              1.0     .10
W      3.2     .625
X      -4.       0       1
K        0    SA-2                                               1
K1 SUBAREA 2 RUNOFF COMPUTATION (SUGAR HILL RESERVOIR)
M        1      -1    .116             10.51                                                          1
P             17.5     111     123       132
T                                                                0       0
W        1
W1     198
X      -4.       0       1
K        2    SA-2C                                              1
K1 COMBINING HYDROGRAPHS 1,2
K        1    RES1                                               1
K1 ROUTING FLOWS THROUGH RESERVOIR 1 (SUGAR HILL RESERVOIR)
Y                                    1       1
Y1       1                                                   -1768
Y4       0     2.0     7.3    14.8    21.2    30.2    37.6    45.4    57.5    66.5
Y4    74.1    75.6    77.4    79.1    80.7    82.4   102.7
Y5    1717    1723    1728    1733    1738    1743    1748    1753    1758    1763
Y5    1768    1769    1770    1771    1772    1773    1780
$$    1768     150   3.087     1.5
$$1771.5
$L       0      60     200     370     455     575     615     700
$V1771.5  1771.6  1771.8  1771.9  1772.1  1772.3  1773.0  1776.8
K        1    7+00                                       5       1
K1 CHANNEL ROUTING STA 7+00
Y                                    1       1
Y1       1
Y6     .04     .03     .04    1710    1740     700     .01
Y7       0    1760      50    1740     150    1720     240    1710     250    1710
Y7     310    1720     560    1720     650    1740
K        1   52+00                                       5       1
K1 CHANNEL ROUTING STA 50+00
Y        1                           1       1
Y1       1
Y6     .04     .03     .04    1540    1580    4300    .040
Y7       0    1590      60    1560     140    1544     160    1540     170    1540
Y7     200    1544    1850    1544    1950    1540
K        1  100+00                                       5       1
K1 CHANNEL ROUTING STA 100+00
Y                                    1       1
Y1       1
Y6     .04     .03     .04    1430    1480    5000    .022
Y7       0    1480    1000    1460    1450    1440    1540    1430    1550    1430
Y7    1440    1460    1600    1460    2020    1420
K        1  140+00                                       5       1
K1 CHANNEL ROUTING STA 140+00
Y                                    1       1
```

GORDON E. AINSWORTH
& ASSOCIATES, INC.
20 Sugarloaf Street
SOUTH DEERFIELD, MASSACHUSETTS 01373
(413) 665-2161

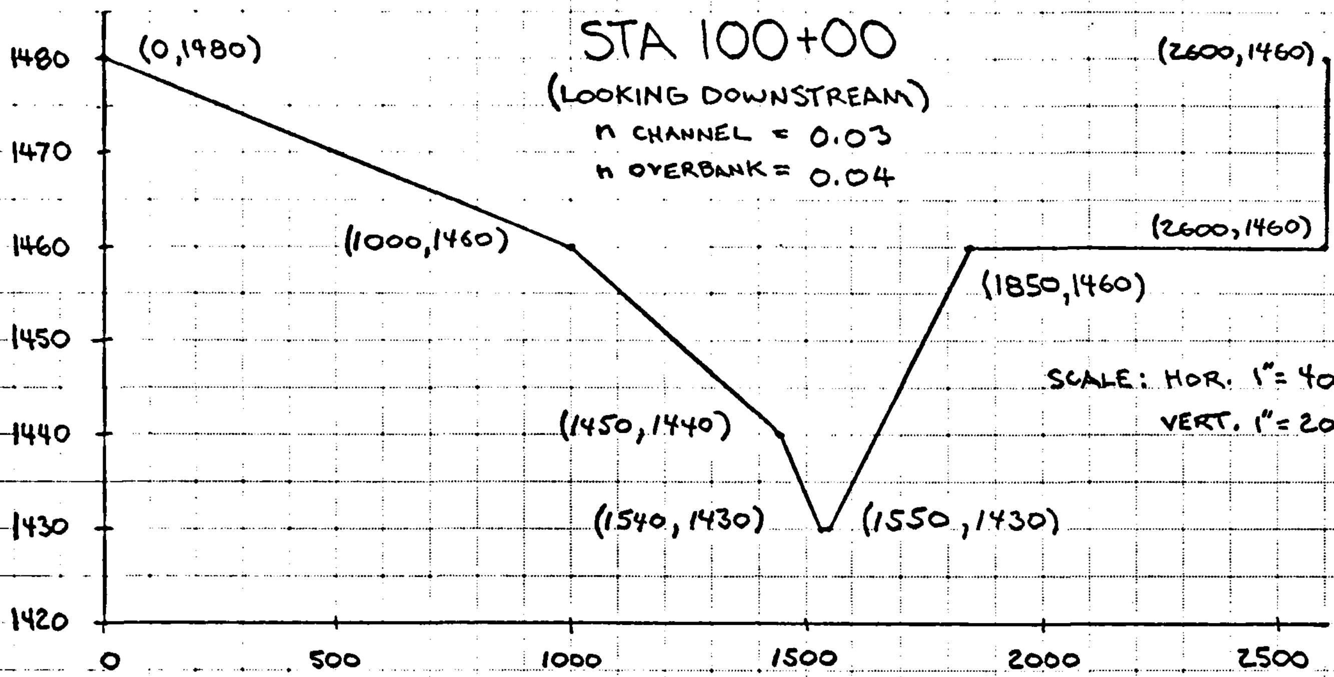
JOB SUCKER BROOK DAM

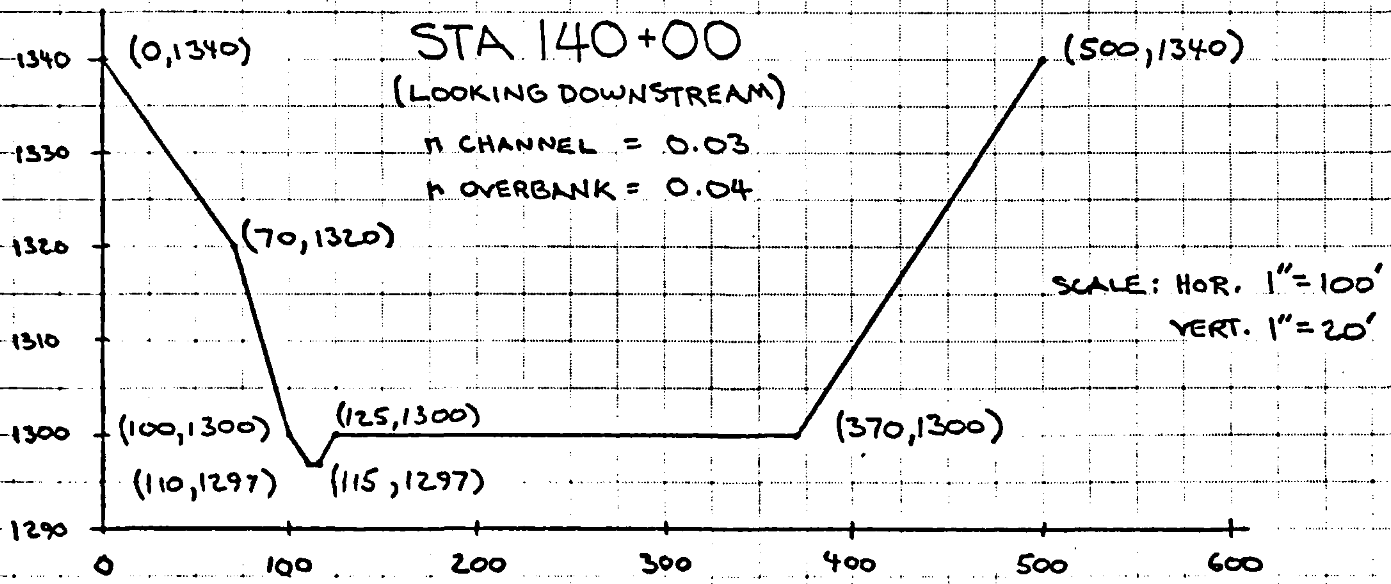
SHEET NO. ____ OF ____

CALCULATED BY ELV DATE 2/1/80

CHECKED BY [illegible] DATE 5/80

SCALE 21-06-79108





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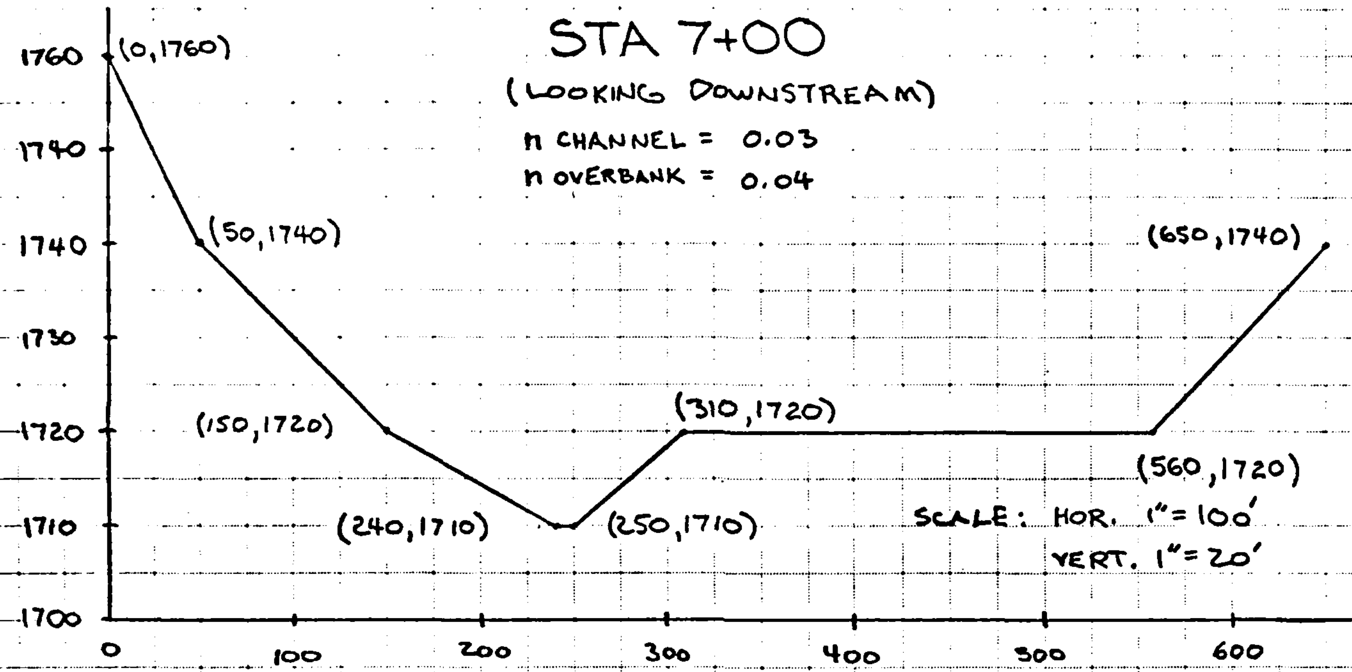
JOB SUCKER BROOK DAM

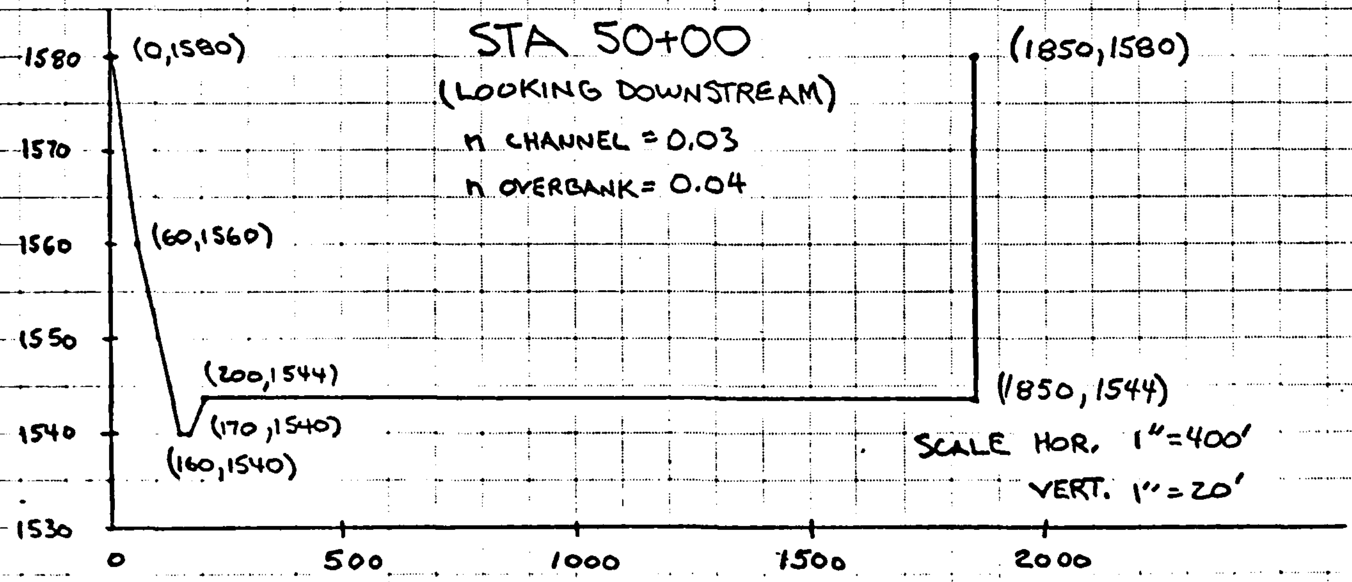
SHEET NO. ______ OF ______

CALCULATED BY ELV DATE 2/1/80

CHECKED BY [illegible] DATE 5/80

SCALE 21-06-79108





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Phone 665-2161

JOB SUCKER BROOK DAM
SHEET NO. ______ OF ______
CALCULATED BY ELV DATE 1/25/80
CHECKED BY [illegible] DATE 2/80
SCALE 21-06-79106

DISCHARGE COMPUTATIONS - SUGAR HILL DAM

DAM APPURTENANCE	ELEVATION (NGVD)	SIZE
SPILLWAY	CREST EL. = 1768	150' TOTAL LENGTH W/ A 100' + A 50' WEIR CREST
DAM	CREST EL. = 1771.5 (LOW POINT, NON-LEVEL)	700' CREST LENGTH W/O SPILLWAY
OUTLET CONDUIT	INVERT IN EL. = 1707	4'x4' BOX CULVERT W/ VARIOUS CONTROLS

FOR FLOW OVER SPILLWAY ONLY: $Q = 3.087 L H^{1.5}$

(FORMULA FOR CRITICAL FLOW OVER A BROAD-CRESTED WEIR. INPUTED INTO HEC-1DB COMPUTER PROGRAM FOR DISCHARGE COMPUTATIONS. REFERENCE 9)

	ELEVATION (NGVD)	$H_{SPILLWAY}$ (feet)	H_{DAM} (feet)	$Q_{SPILLWAY}$ (cfs)	Q_{DAM}* (cfs)	$Q_{OUTLET\ WORKS}$ (cfs)	Q_T (cfs)
SPILLWAY CREST →	1768	0	0	0	0	0	0
	1769	1	0	463	0	ALL OUTLETS ASSUMED CLOSED	463
	1770	2	0	1310	0		1310
	1771	3	0	2406	0		2406
DAM CREST →	1771.5	3.5	0.5	3032	0		3032
	1772	4	1.5	3704	159		3863
	1773	5	2.5	5177	2262		7439
	1774	6	3.5	6805	5761	↓	12566
	1775	7	4.5	8576	10446	0	19022

* CALCULATED W/ HEC-1DB PROGRAM FOR FLOW OVER NON-LEVEL DAM CREST.

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JOB SUCKER BROOK DAM
SHEET NO. ______ OF ______
CALCULATED BY ELV DATE 1/25/80
CHECKED BY JPB DATE 2/80
SCALE 21-06-79106

ELEVATION - AREA - STORAGE COMPUTATIONS

SUGAR HILL
RESERVOIR VOLUME: COMPUTED BY PROGRAM USING METHOD OF CONIC SECTIONS: $\Delta V_{12} = \frac{h}{3}(A_1 + A_2 + \sqrt{A_1 A_2})$

	ELEVATION (NGVD - ft.)*	AREA*** (acres)		V_T ** (acre-feet)
	1717	0		0
	1723	2.0		4
	1728	7.3		26
	1733	14.8		80
	1738	21.2		170
	1743	30.2		297
	1748	37.6		467
	1753	45.4		674
	1758	57.5		930
	1763	66.5		1240
SPILLWAY CREST →	1768	74.1		1591
	1769	75.8		1666
	1770	77.4		1743
	1771	79.1		1821
DAM CREST →	1771.5	79.9	EST.	1861
	1772	80.7		1901
	1773	82.4		1983
	1780	102.7		2629

* APPLICATION REPORTS AND PLANS SUBMITTED IN 1930'S BY CENTRAL VERMONT PUBLIC SERVICE CORPORATION TO THE VERMONT PUBLIC SERVICE COMMISSION UTILIZE AN ARBITRARY DATUM. NGVD ELEVATIONS ARE 1,613' HIGHER THAN THIS ARBITRARY DATUM.

** COMPUTED BY HEC-1 DB COMPUTER PROGRAM.

*** STAGE-AREA DATA FROM FILES OF VERMONT DAM SAFTY ENGINEER (SEE PHASE I REPORT FOR SUGAR HILL DAM, VT00176)

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JOB: SUCKER BROOK DAM
SHEET NO. ______ OF ______
CALCULATED BY: ELV DATE: 1/29/80
CHECKED BY: GPB DATE: 5/80
SCALE: 21-06-79108

DRAINAGE AREA DATA FOR HEC-1 DB MODEL

SUBAREA 5: SUCKER BROOK RESERVOIR SURFACE, AREA: 0.005 SQUARE MILES (3.0 ACRES)

LOSS RATES: NONE BECAUSE RAINFALL = RUNOFF FOR WATER SURFACE

UNIT HYDROGRAPH PARAMETERS:

FOR U.H. W/5 MINUTE DURATION + 1" RAIN

$$\bar{Q} = \frac{A(1")}{t} = \frac{0.005\,mi^2(1")}{5\,minutes}\left(\frac{43560\ SQ.FT.}{1\ acre}\right)\left(\frac{1'}{12"}\right)\left(\frac{1\,minute}{60\ seconds}\right)\left(\frac{640\ acres}{1\ mi^2}\right)$$

$\bar{Q}$ = 39 cfs (SINCE NO LOSS RATE)

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JOB SUCKER BROOK DAM
SHEET NO. ______ OF ______
CALCULATED BY ELV DATE 1/29/80
CHECKED BY JPB DATE 5/80
SCALE 21-06-79108

DRAINAGE AREA DATA FOR HEC-1DB MODEL

SUBAREA 3: SUCKER BROOK ABOVE SUCKER BROOK DAM, AREA = 2.722 SQ. MI.

LOSS RATES: 1.0"-INITIALLY, 0.1"/HOUR - CONSTANT LOSS RATE

UNIT HYDROGRAPH PARAMETERS: USE SNYDER METHOD

A = DRAINAGE AREA = 2.722 SQUARE MILES
L = LENGTH OF MAIN WATERCOURSE TO UPSTREAM LIMIT OF DRAINAGE AREA = 2.70 MILES
L_{CA} = LENGTH OF MAIN WATERCOURSE TO POINT OPPOSITE THE CENTROID OF THE DRAINAGE AREA = 1.25 MILES
C_t = SNYDER'S BASIN COEFFICIENT = 2.0 ASSUMED AVERAGE
C_p = SNYDER'S PEAKING COEFFICIENT = 0.625 ASSUMED AVERAGE
t_p = STANDARD LAG IN HOURS = $C_t(LL_{CA})^{0.3}$ = 2.9 HOURS

∴ USE t_p = 2.9 HOURS

SUBAREA 4: DUTTON BROOK ABOVE SUCKER BROOK DAM, AREA = 4.812 SQ. MI.

LOSS RATES: 1.0"-INITIALLY, 0.1"/HOUR - CONSTANT LOSS RATE

UNIT HYDROGRAPH PARAMETERS: USE SNYDER METHOD

A = DRAINAGE AREA = 4.812 SQUARE MILES
L = LENGTH OF MAIN WATERCOURSE TO UPSTREAM LIMIT OF DRAINAGE AREA = 3.40 MILES
L_{CA} = LENGTH OF MAIN WATERCOURSE TO POINT OPPOSITE THE CENTROID OF THE DRAINAGE AREA = 2.10 MILES
C_t = SNYDER'S BASIN COEFFICIENT = 2.0 ASSUMED AVERAGE
C_p = SNYDER'S PEAKING COEFFICIENT = 0.625 ASSUMED AVERAGE
t_p = STANDARD LAG IN HOURS = $C_t(LL_{CA})^{0.3}$ = 3.6 HOURS

∴ USE t_p = 3.6 HOURS

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JOB SUGAR HILL DAM
SHEET NO. ______ OF ______
CALCULATED BY ELV DATE 1/25/80
CHECKED BY [initials] DATE 2/80
SCALE 21-06-79106

DRAINAGE AREA DATA FOR HEC-1DB MODEL

SUBAREA 1: AREA TRIBUTARY DIRECTLY TO SUGAR HILL RESERVOIR
AREA = 2.855 SQUARE MILES

LOSS RATES: 1.0" - INITIALLY
0.1"/HOUR - CONSTANT LOSS RATE

UNIT HYDROGRAPH PARAMETERS : USE SNYDER METHOD

A = DRAINAGE AREA = 2.855 SQUARE MILES

L = LENGTH OF MAIN WATERCOURSE TO UPSTREAM LIMIT OF DRAINAGE AREA = 2.75 MILES

L_{CA} = LENGTH OF MAIN WATERCOURSE TO POINT OPPOSITE THE CENTROID OF THE DRAINAGE AREA = 1.75 MILES

C_t = SNYDER'S BASIN COEFFICIENT = 2.0 ASSUMED AVERAGE

C_p = SNYDER'S PEAKING COEFFICIENT = 0.625 ASSUMED AVERAGE

t_p = STANDARD LAG IN HOURS = $C_t(LL_{CA})^{0.3}$ = 3.2 HOURS

$\therefore$ USE t_p = 3.2 HOURS

SUBAREA 2: SUGAR HILL RESERVOIR SURFACE, AREA = 0.116 SQUARE MILES (74.1 ACRES)

LOSS RATES: NONE BECAUSE RAINFALL = RUNOFF FOR WATER SURFACE

UNIT HYDROGRAPH PARAMETERS:

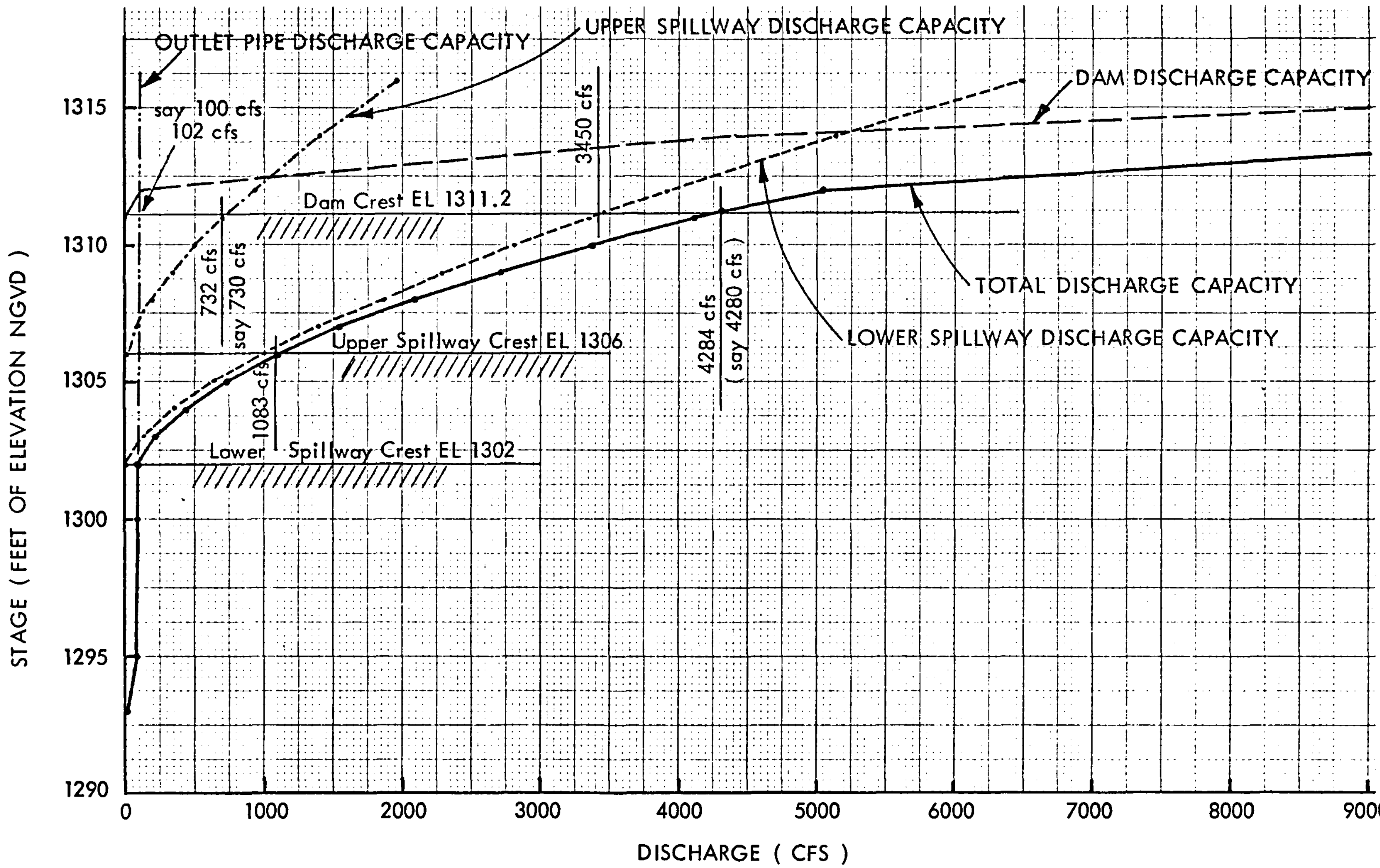
FOR U.H. W/ 5 MINUTE DURATION + 1" RAIN

$$\bar{Q} = \frac{A(1")}{t} = \frac{.116\ mi^2\ (1")}{5\ minutes}\left(\frac{43560\ sq.\ ft.}{1\ acre}\right)\left(\frac{1'}{12"}\right)\left(\frac{1\ minute}{60\ seconds}\right)\left(\frac{640\ acres}{1\ mi^2}\right)$$

$\bar{Q}$ = 898 cfs (SINCE NO LOSS RATE)

SUCKER BROOK DAM, SALISBURY, VERMONT

STAGE - DISCHARGE



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                                        PRECIP DATA
                      SPFE      PMS       R6       R12      P24       R48       R72       R96
                      0.00     17.50   111.00   123.00   132.00      0.00      0.00      0.00
TRSPC COMPUTED BY THE PROGRAM IS 0.802

                                         LOSS DATA
       LROPT   STRKR   DLTKR   RTIOL   ERAIN   STRKS   RTIOK   STRTL   CNSTL   ALSMX   RTIMP
           0    0.00    0.00    1.00    0.00    0.00    1.00    1.00    0.10    0.00    0.00

                                   UNIT HYDROGRAPH DATA
                              TP=  3.60     CP=0.63    NTA=  0

                                      RECESSION DATA
                          STRTQ=    -4.00    QRCSN=     0.00     RTIOR= 1.00

          UNIT HYDROGRAPH100 END-OF-PERIOD ORDINATES, LAG=   3.58 HOURS, CP= 0.62  VOL= 0.85
          2.        5.       16.       26.       36.       51.       64.       79.       94.      110.
        127.      144.      162.      180.      199.      218.      237.      256.      276.      296.
        316.      336.      357.      377.      397.      416.      433.      449.      465.      479.
        492.      504.      515.      525.      533.      541.      548.      553.      557.      560.
        562.      562.      561.      559.      555.      548.      538.      526.      513.      500.
        486.      476.      464.      453.      442.      431.      420.      410.      400.      390
        381.      371.      362.      353.      345.      336.      328.      320.      312.      304.
        297.      290.      283.      276.      269.      262.      256.      249.      243.      237.
        232.      226.      220.      215.      210.      204.      199.      195.      190.      185.
        181.      176.      172.      168.      164.      160.      156.      152.      148.      144.

    0                                   END-OF-PERIOD FLOW
 MO.DA  HR.MN  PERIOD   RAIN   EXCS   LOSS    COMP Q       MO.DA  HR.MN  PERIOD   RAIN   EXCS   LOSS     COMP Q

                                                                               SUM  18.52  15.90   2.62   493037.
                                                                                  ( 470.)( 404.)(  67.)(13961.24)


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

                                  SUB-AREA RUNOFF COMPUTATION

              SUBAREA 5 RUNOFF COMPUTATION (SUCKER BROOK RESERVOIR)
                            ISTAQ    ICOMP    IECON    ITAPE     JPLT     JPRT    INAME   ISTAGE    IAUTO
                            SA-5         0        0        0        0        0        1        0        0

                                        HYDROGRAPH DATA
              IHYDG    IUHG    TAREA    SNAP    TRSDA    TRSPC    RATIO    ISNOW    ISAME    LOCAL
                  1      -1     0.00    0.00    10.51     0.00    0.000        0        1        0

                                        PRECIP DATA
                      SPFE      PMS       R6       R12      R24       R48       R72       R96
                      0.00     17.50   111.00   123.00   132.00      0.00      0.00      0.00
TRSPC COMPUTED BY THE PROGRAM IS 0.802

                                         LOSS DATA
       LROPT   STRKR   DLTKR   RTIOL   ERAIN   STRKS   RTIOK   STRTL   CNSTL   ALSMX   RTIMP
           0    0.00    0.00    1.00    0.00    0.00    1.00    0.00    0.00    0.00    0.00

                                      RECESSION DATA
                          STRTQ=    -4.00    QRCSN=     0.00     RTIOR= 1.00

    0                                   END-OF-PERIOD FLOW
 MO.DA  HR.MN  PERIOD   RAIN   EXCS   LOSS    COMP Q       MO.DA  HR.MN  PERIOD   RAIN   EXCS   LOSS     COMP Q

                                                                               SUM  18.52  18.52   0.00     616.
                                                                                  ( 470.)( 470.)(   0.)(   17.43)
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**********          **********          **********          **********          **********

                                    COMBINE HYDROGRAPHS

              COMBINING HYDROGRAPHS RES1,3,4,5
                              ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                             -23450       4       0       0       0       0       1       0       0

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

                                    HYDROGRAPH ROUTING

              ROUTING FLOWS THROUGH RESERVOIR 2 (SUCKER CROOK RESERVOIR)
                              ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                               RES2       1       0       0       2       0       1       0       0
                                              ROUTING DATA
                      QLOSS   CLOSS     AVG    IRES   ISAME    IOPT    IPMP                   LSTR
                        0.0   0.000    0.00       1       1       0       0                      0

                              NSTPS   NSTDL     LAG   AMSKK       X     TSK   STORA  ISPRAT
                                  1       0       0   0.000   0.000   0.000  -1302.      -1

  STAGE      1293.00    1293.10    1295.00    1300.00    1302.00    1303.00    1304.00    1305.00    1306.00
             1308.00    1309.00    1310.00    1311.00    1312.00    1313.00    1314.00    1315.00    1320.00

  FLOW          0.00      76.00      79.00      87.00      95.00     214.00     437.00     736.00    1093.00
             2067.00    2717.00    3388.00    4126.00    4915.00    5752.00    6635.00    7561.00   12776.00

SURFACE AREA=      0.        0.        3.        4.        4.        7.

   CAPACITY=       0.        1.       15.       34.       49.      103.

  ELEVATION=    1293.     1295.     1300.     1306.     1310.     1320.

                           CREL   SPWID    COQW    EXPW   ELEVL    COOL   CAREA    EXPL
                         1302.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0

                                                 DAM DATA
                                         TOPEL    COQD    EXPD  DAMWID
                                        1311.2     0.0     0.0      0.

   CREST LENGTH        2.      62.      92.     120.     500.     600.     600.
   AT OR BELOW
   ELEVATION       1311.2   1311.7   1311.8   1311.9   1312.2   1313.0   1320.0

 PEAK OUTFLOW IS     7289. AT TIME  19.00 HOURS
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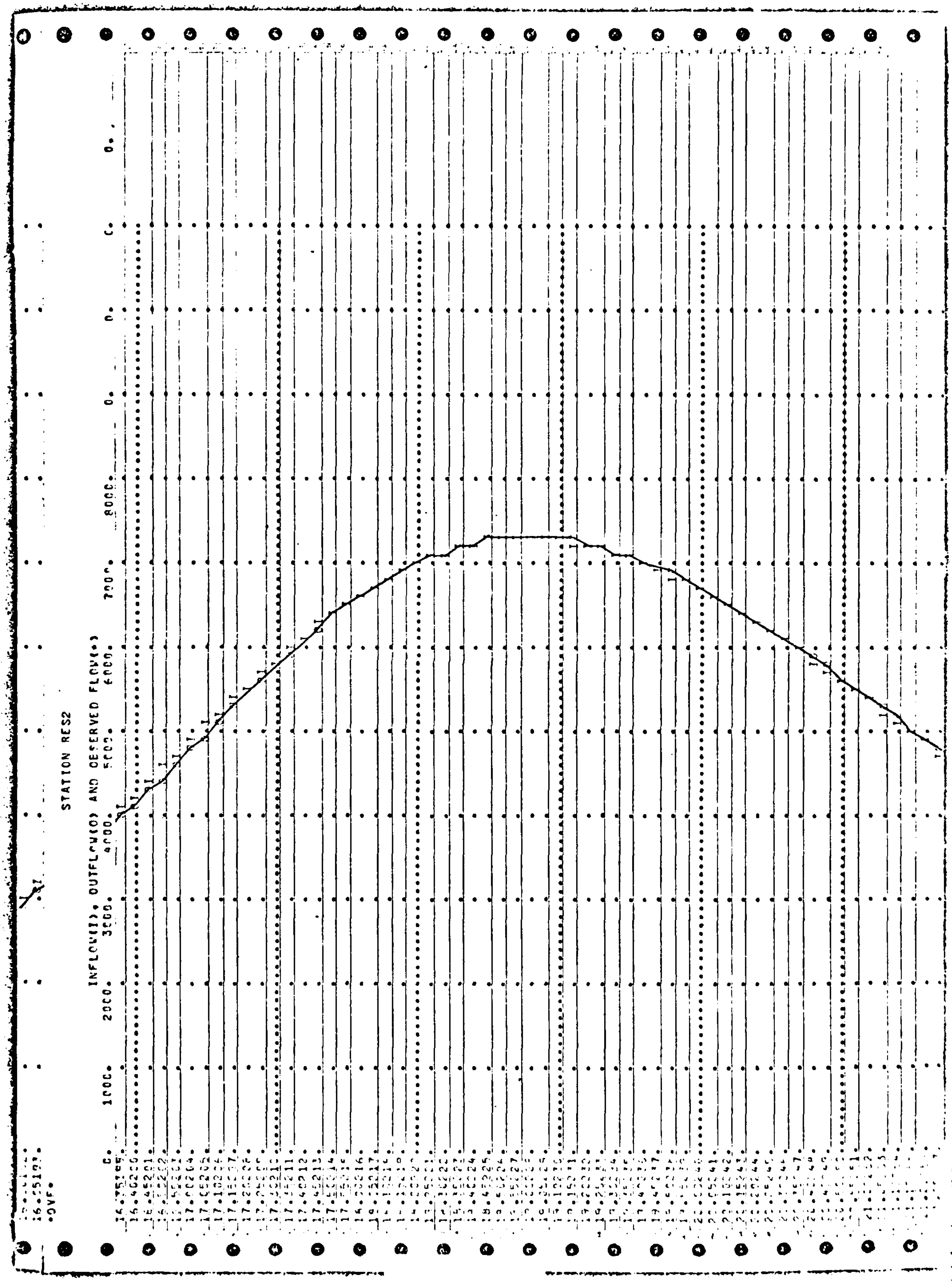
STATION RES2
INFLOW(I), OUTFLOW(O) AND OBSERVED FLOW(*)
0.
1000.
2000.
3000.
4000.
5000.
6000.
7000.
8000.

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 0.50
HYDROGRAPH AT	SA-1	2.85	1	2153.
		(7.39)		(60.96)(
HYDROGRAPH AT	SA-2	0.12	1	744.
		(0.30)		(21.07)(
2 COMBINED	SA-2C	2.97	1	2158.
		(7.69)		(61.12)(
ROUTED TO	RES1	2.97	1	2017.
		(7.69)		(57.12)(
ROUTED TO	7+00	2.97	1	2017.
		(7.69)		(57.12)(
ROUTED TO	50+00	2.97	1	2010.
		(7.69)		(56.92)(
ROUTED TO	100+00	2.97	1	2009.
		(7.69)		(56.89)(
ROUTED TO	140+00	2.97	1	2007.
		(7.69)		(56.83)(
HYDROGRAPH AT	SA-3	2.72	1	2172.
		(7.05)		(61.50)(
HYDROGRAPH AT	SA-4	4.81	1	3345.
		(12.46)		(94.73)(
HYDROGRAPH AT	SA-5	0.00	1	32.
		(0.01)		(0.92)(
4 COMBINED	-2345C	10.51	1	7290.
		(27.22)		(206.42)(
ROUTED TO	RES2	10.51	1	7289.
		(27.22)		(206.41)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1768.00	1768.00	1771.50
STORAGE	1591.	1591.	1861.
OUTFLOW	0.	0.	3032.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
0.50	1770.67	0.00	1795.	2017.	0.00	19.33	0.00

PLAN 1 STATION 7+00

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.50	2017.	1714.7	19.42

PLAN 1 STATION 50+00

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.50	2010.	1543.1	19.58

PLAN 1 STATION 100+00

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.50	2009.	1433.4	19.67

PLAN 1 STATION 140+00

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.50	2007.	1306.1	19.75

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1302.00	1302.00	1311.20
STORAGE	21.	21.	54.
OUTFLOW	90.	90.	4284.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
0.50	1313.05	1.85	63.	7289.	5.00	19.00	0.00

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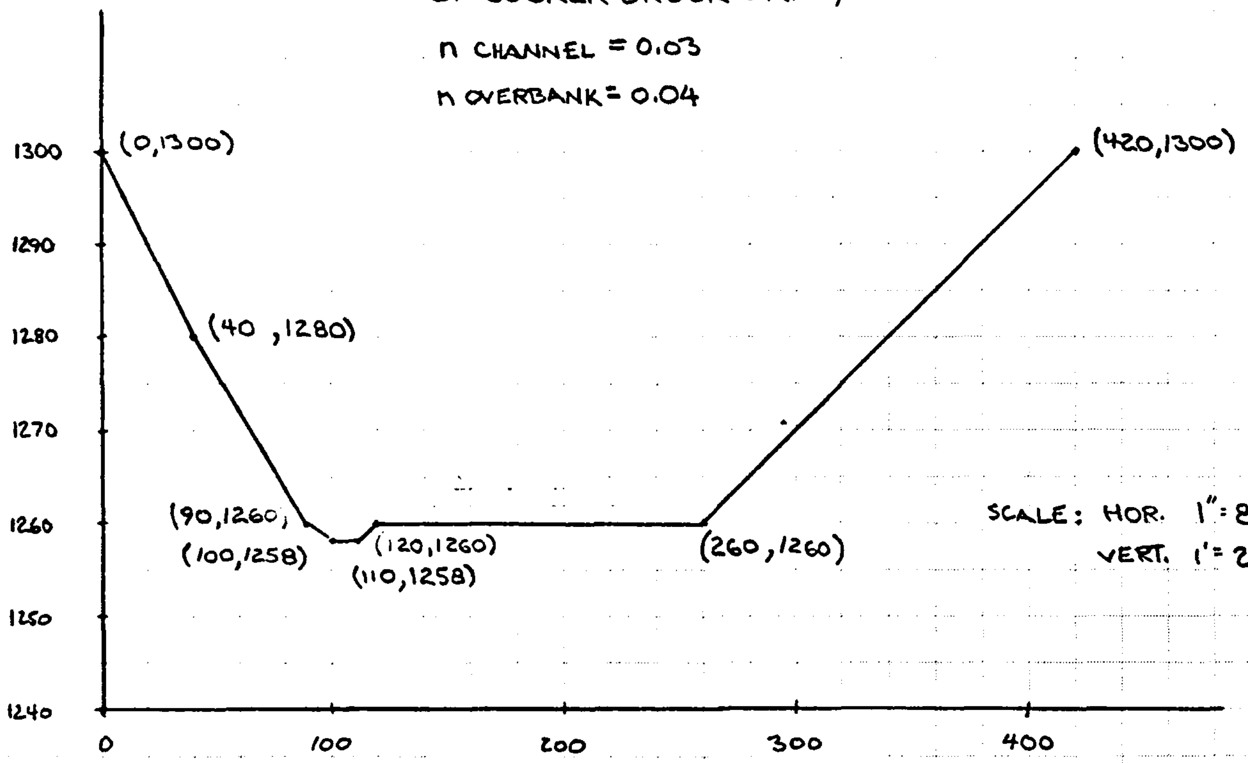
JOB: SUCKER BROOK DAM
SHEET NO. ____ OF ____
CALCULATED BY: CLV DATE: 2/1/80
CHECKED BY: TPB DATE: 5/80
SCALE: 21-06-79108

STA 3+00 SUCKER BROOK
STA 147+00 SUGAR HILL
(700 FEET DOWNSTREAM OF SUCKER BROOK DAM)



THIS SECTION ONLY USED FOR PRIOR FLOW. NOT USED FOR BREACH.

GORDON E. AINSWORTH
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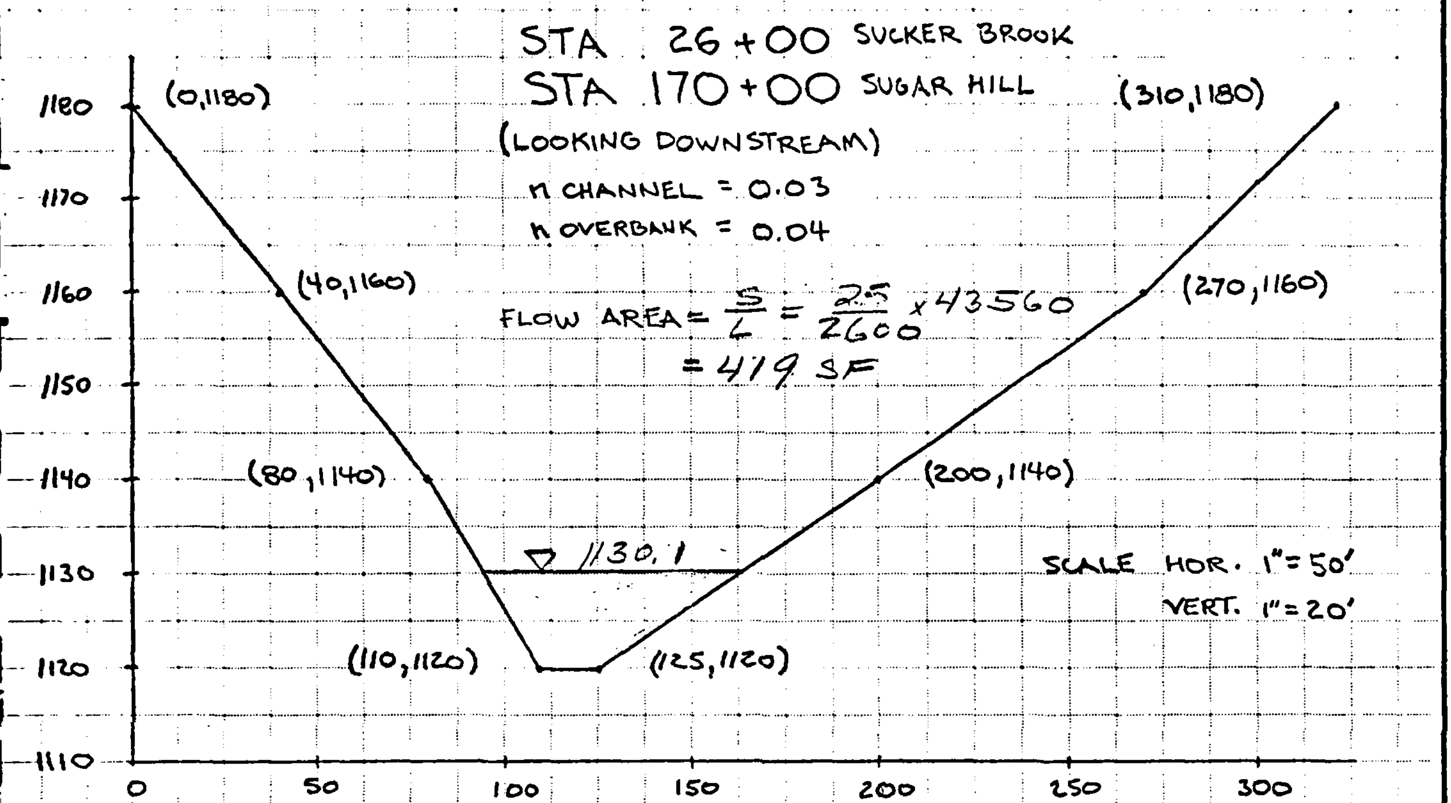
JOB: SUCKER BROOK DAM

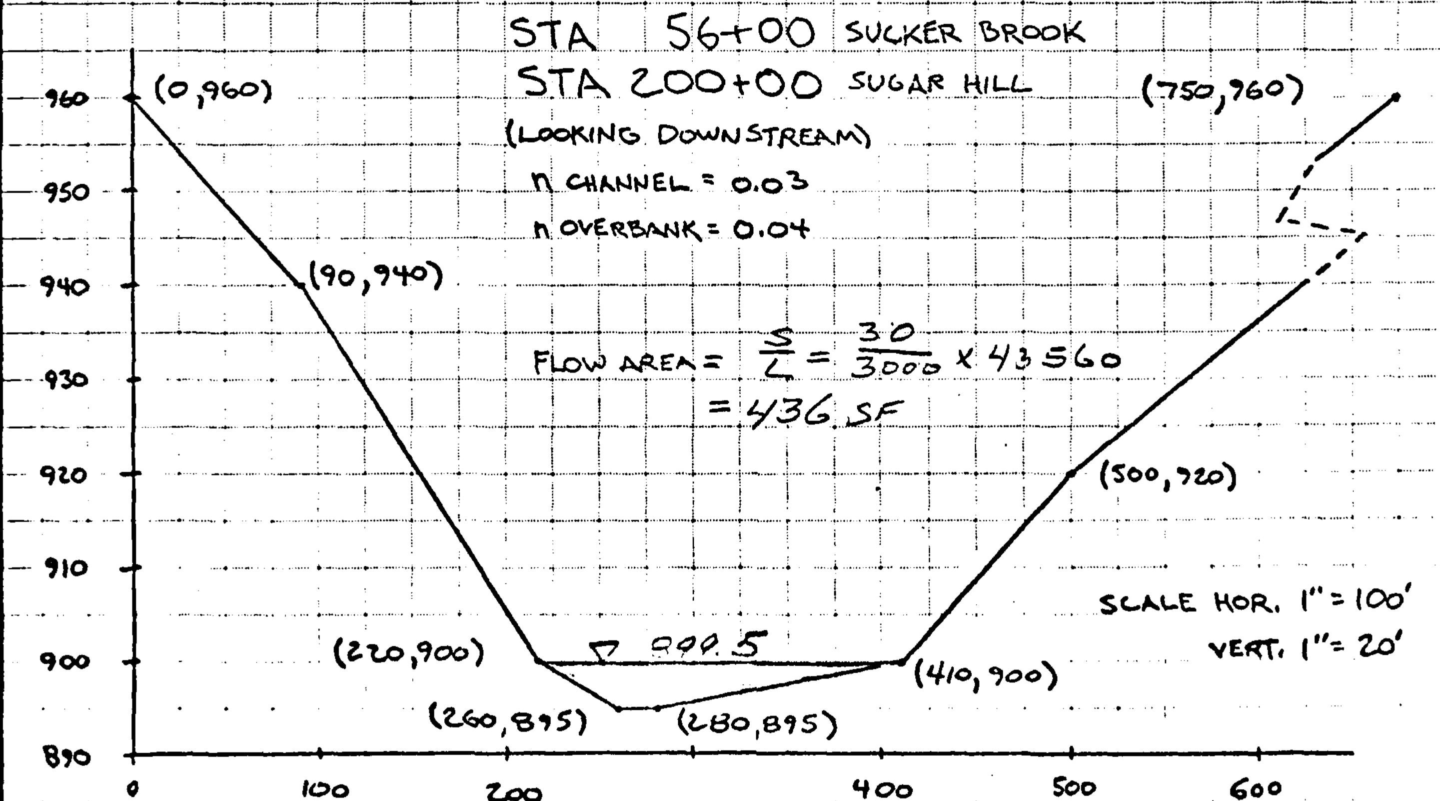
SHEET NO. ______ OF ______

CALCULATED BY: ELV DATE: 2/1/80

CHECKED BY: JPB DATE: 5/30

SCALE: 21-06-79108





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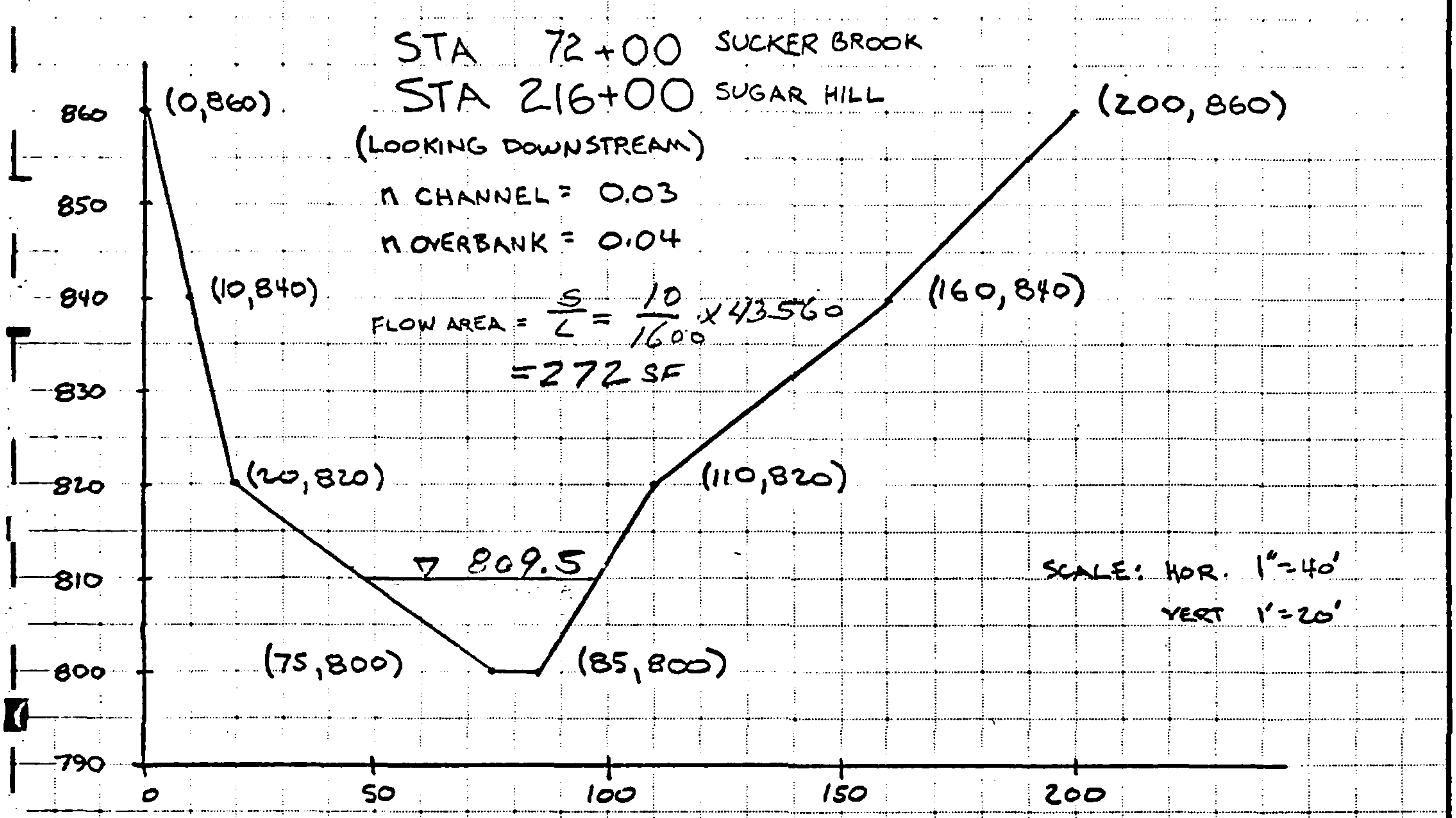
JOB SUCKER BROOK DAM

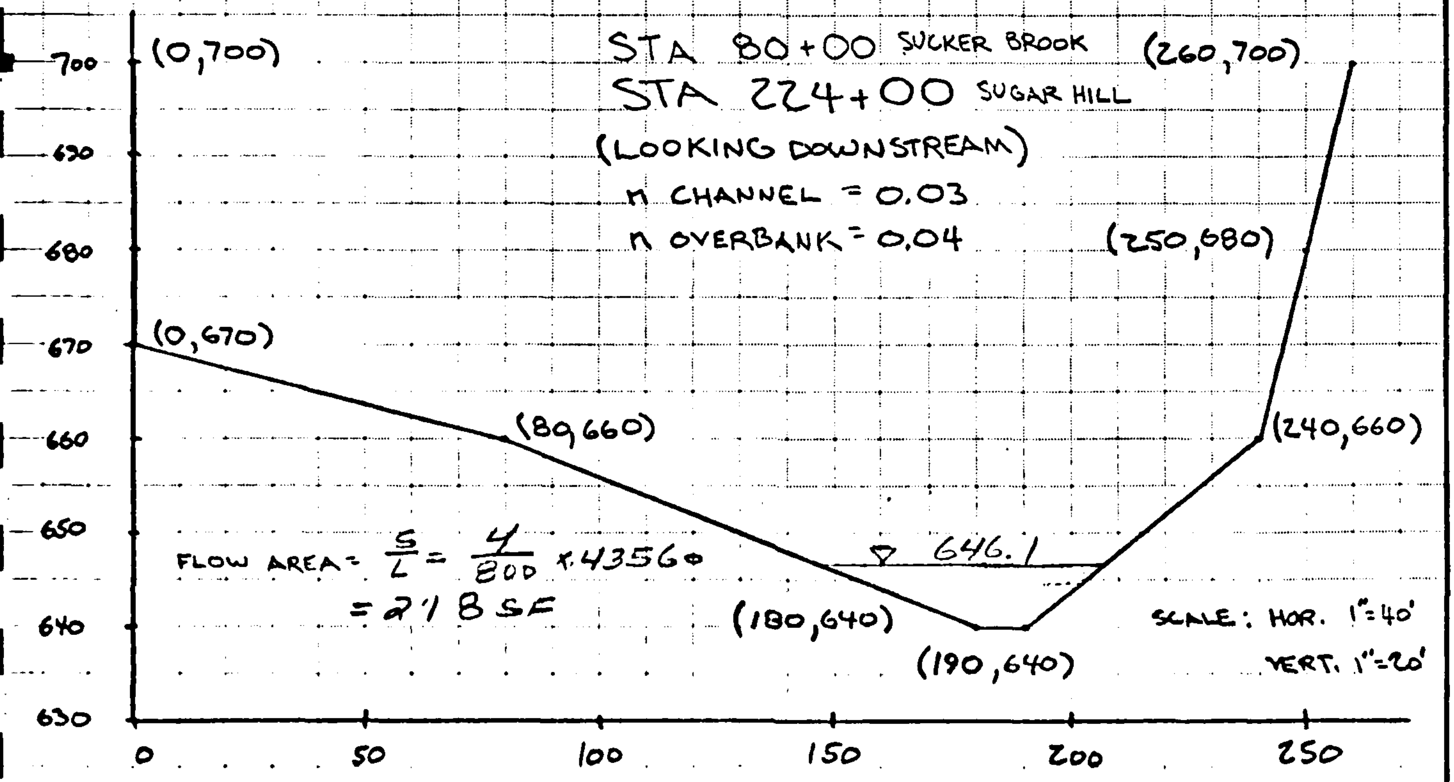
SHEET NO. ______ OF ______

CALCULATED BY ELV DATE 2/1/80

CHECKED BY [illegible] DATE 5/80

SCALE 21-06-79108





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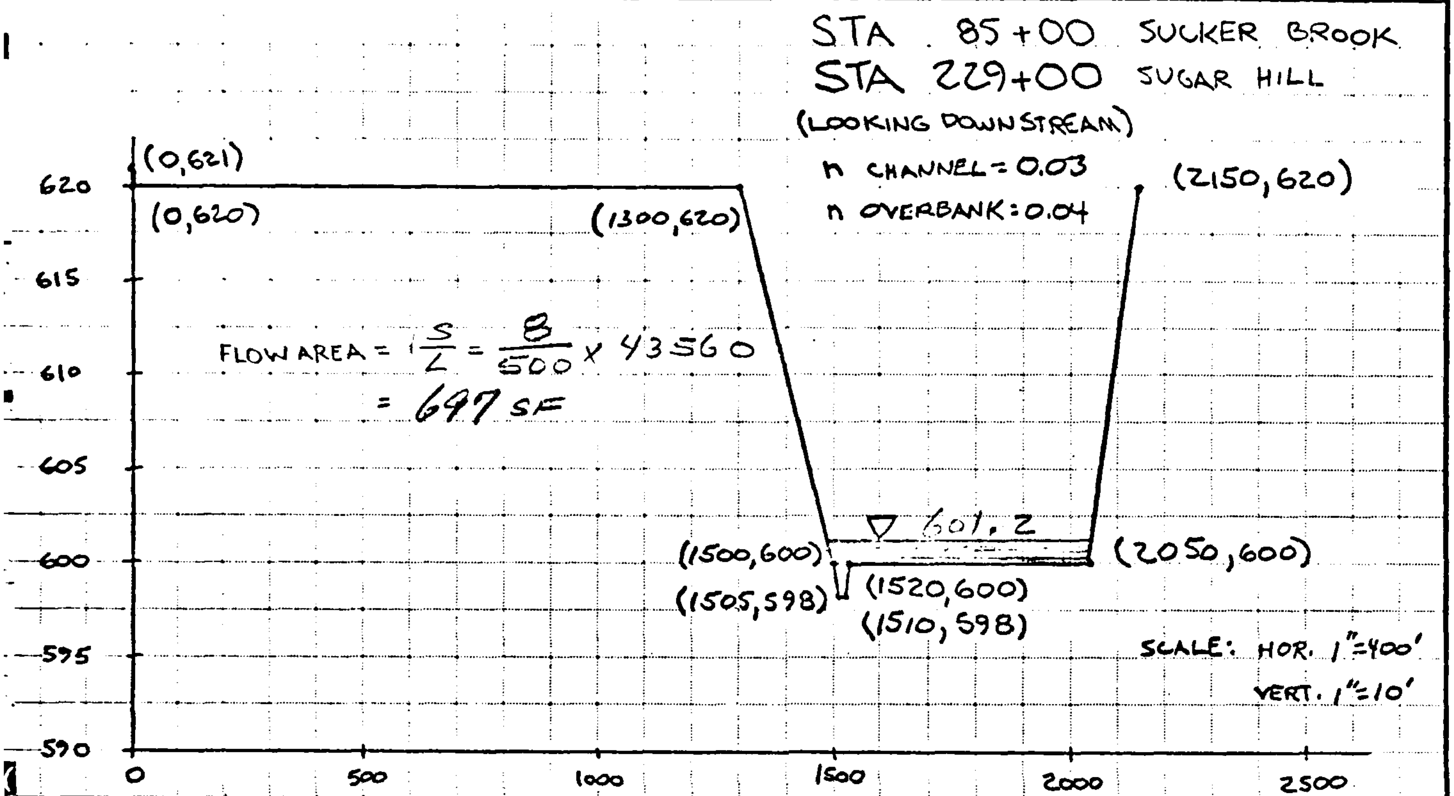
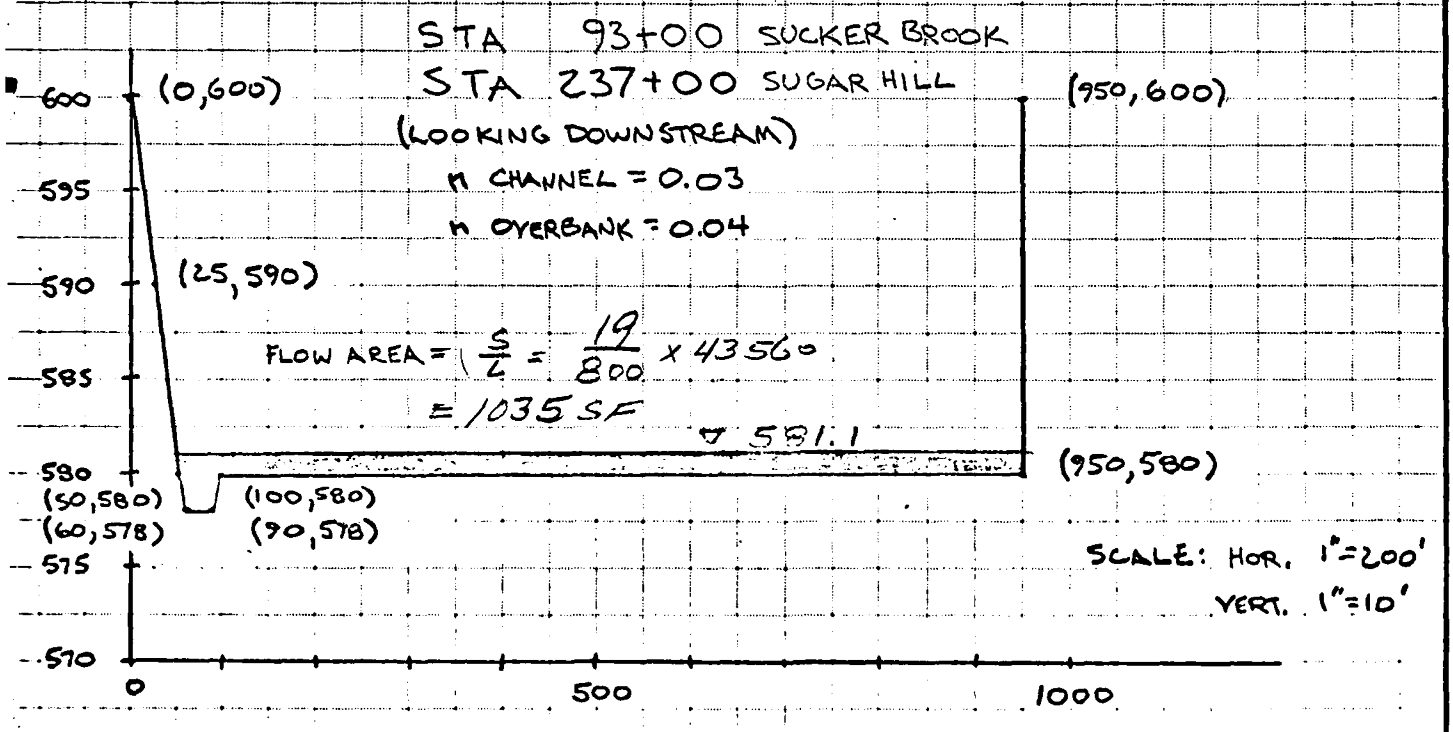
SOUTH DEERFIELD, MASSACHUSETTS 01373
(413) 665-2161

JOB: SUCKER BROOK DAM
SHEET NO. ____ OF ____
CALCULATED BY: ELV DATE: 2/1/80
CHECKED BY: GMB DATE: 5/80
SCALE: 21-06-79108





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Phone 665-2161

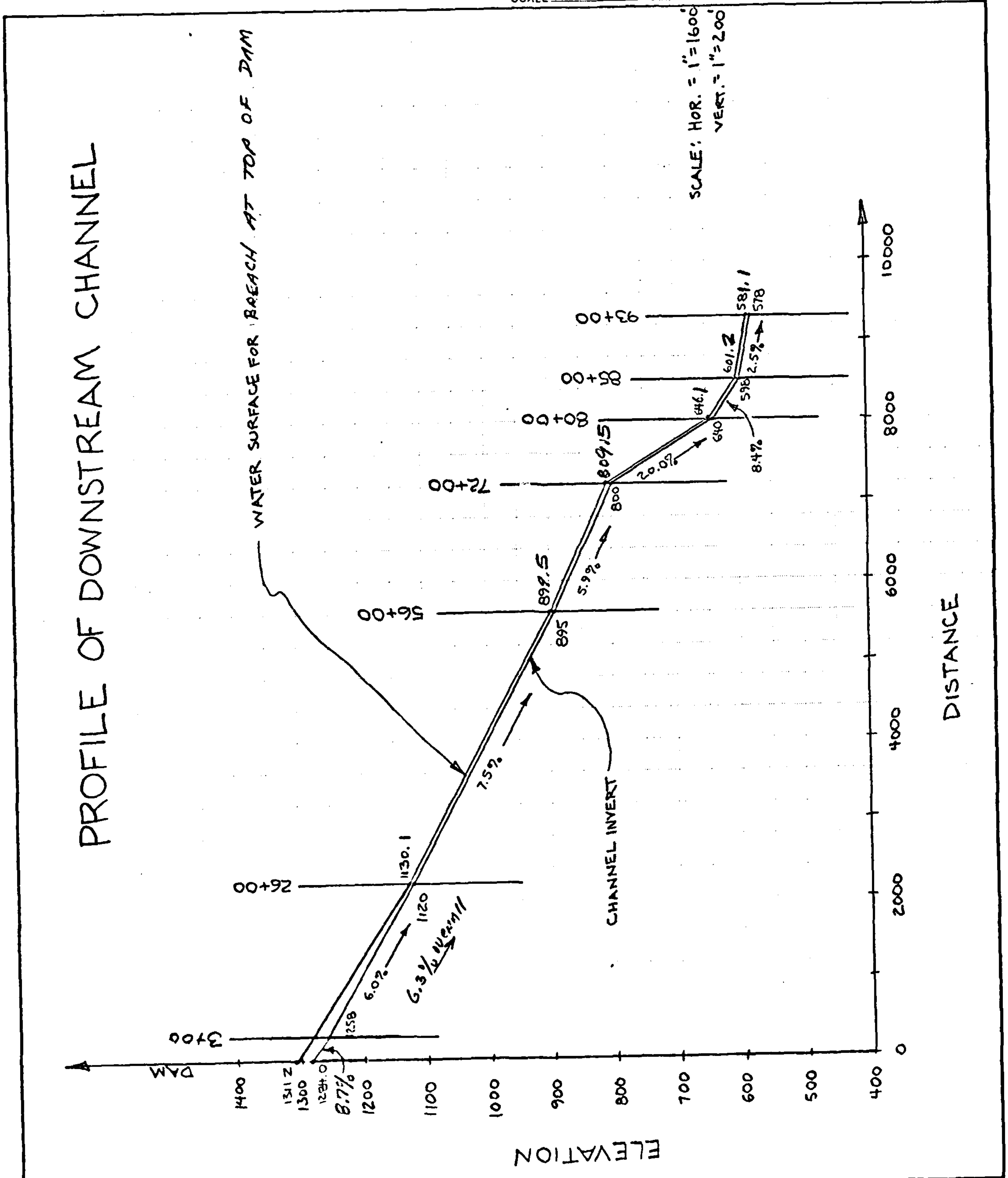
JOB SUCKER BROOK DAM

SHEET NO. ______ OF ______

CALCULATED BY ELV DATE 2/1/80

CHECKED BY [signature] DATE 5/80

SCALE 21-06-79108



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A NED DAM INSPECTION CONTRACT: DACW33-R0-C-0012  SBPF1
A VT. 00212 SUCKER BROOK DAM, 21-06-79108
A PRIOR FLOW AT TOP OF DAM
B      10       0       1                                                4
B1      5
J       1       1       1
J1    1.0
K       0     SA-5                                      1
K1 SUBAREA 5 RUNOFF COMPUTATION (SUCKER BROOK RESERVOIR)
M       1      -1   0.005          10.51                                 1
P
T
U       1
U1
V    4182       0       1
K       1    FES2                               1       1
K1 ROUTING FLOWS THROUGH RESERVOIR 2 (SUCKER BROOK RESERVOIR)
Y                               1       1
Y1      1                                          -1311.2      -1
Y4   1293  1293.1    1295    1300    1302    1303    1304    1305    1306    1307
Y4   1308    1309    1310    1311    1312    1313    1314    1315    1320
Y5      0       0       0       0       0     124     349     642     988    1442
Y5   1189    2618    3268    4024    4812    5648    6530    7455   12664
$A    .02     .33    2.76    3.51    4.19    6.67
$E   1290    1293    1303    1306    1310    1320
$$   1302
$D1311.2
K       1    3+00                               1       1
K1 CHANNEL ROUTING STA  3+00
Y                               1       1
Y1      1                                           -1
Y6    .04     .03     .04    1258    1277     300    .073
Y7      0    1300      40    1280      90    1260     100    1258     110    1258
Y7    120    1260     260    1260     420    1300
K       1   26+00                               1       1
K1 CHANNEL ROUTING STA  26+00
Y                               1       1
Y1      1                                           -1
Y6    .04     .03     .04    1120    1139    2300     .06
Y7      0    1180      40    1160      80    1140     110    1120     125    1120
Y7    200    1140     270    1160     310    1180
K       1   56+00                               1       1
K1 CHANNEL ROUTING STA 56+00
Y                               1       1
Y1      1                                           -1
Y6    .04     .03     .04     895     914    3000    .075
Y7      0     960      90     940     220     900     260     895     280     895
Y7    410     900     500     920     750     960
K       1   72+00                               1       1
K1 CHANNEL ROUTING STA 72+00
Y                               1       1
Y1      1                                           -1
Y6    .04     .03     .04     800     819    1500    .059
Y7      0     840      10     840      20     820      75     800      85     800
Y7    110     820     160     840     200     860
K       1   80+00                               1       1
K1 CHANNEL ROUTING STA 80+00
Y                               1       1
Y1      1                                           -1
Y6    .04     .03     .04     640     659     800     .20
```

```
Y7      0     700       0     670      80     660     180     640     190     640
Y7    240     660     250     680     260     700
K       1   85+00                                   1       1
K1 CHANNEL ROUTING STA 85+00
Y                             1       1
Y1      1                                          -1
Y6    .04     .03     .04     598     617     600   .084
Y7      0     621    1300     620    1500     600    1505     598    1510     598
Y7   1920     600    2150     600    2150     621
K       1   93+00                                   1       1
K1 CHANNEL ROUTING STA 93+00
Y                             1       1
Y1      1                                          -1
Y6    .04     .03     .04     578     597     600   .025
Y7      0     600      25     590      50     580      60     578      40     578
Y7    100     580     950     580     950     600
K      99
A
A
A
A
A
```

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 1.00
HYDROGRAPH AT	SA-5	0.00	1	4182.
	(	0.01)	(	118.42)(
ROUTED TO	RES2	0.00	1	4182.
	(	0.01)	(	118.41)(
ROUTED TO	3+00	0.00	1	4182.
	(	0.01)	(	118.41)(
ROUTED TO	26+00	0.00	1	4182.
	(	0.01)	(	118.41)(
ROUTED TO	56+00	0.00	1	4182.
	(	0.01)	(	118.41)(
ROUTED TO	72+00	0.00	1	4182.
	(	0.01)	(	118.41)(
ROUTED TO	80+00	0.00	1	4182.
	(	0.01)	(	118.41)(
ROUTED TO	85+00	0.00	1	4182.
	(	0.01)	(	118.41)(
ROUTED TO	93+00	0.00	1	4182.
	(	0.01)	(	118.41)(

12. "Hydraulic Design of Spillways", EM 1110-2-1603, U.S. Army Corps of Engineers, 31 March 1965.

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17. "Hydraulic Charts For the Selection of Highway Culverts", Hydraulic Engineering Circular No. 5, U.S. Department of Commerce, Bureau of Public Roads, December 1965.

18. 33 CFR Part 22, Final Rule, "Engineering and Design; National Program For Inspection of Non-Federal Dams", ER 1110-2-106, U.S. Army Corps of Engineers, March 24, 1980.

19. "Water Resources Data For New Hampshire and Vermont - Water Year 1977", USGS Water-Data Report NH-VT-77-1, U.S. Geological Survey, Boston, Ma., 1978.

20. "Climatological Data - May 1979 - New England", Volume 91, No. 5, National Oceanic and Atmospheric Administration, National Climatic Center, Asheville, North Carolina.

21. "Climatological Data - Annual Summary - New England", Volume 90, No. 13, National Oceanic and Atmospheric Administration, National Climatic Center, Asheville, North Carolina.

REFERENCES

This is a general list of references pertinent to dam safety investigations. Not all references listed have necessarily been used in this specific report.

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2. "HEC-1 Flood Hydrograph Package, Users Manual", The Hydrologic Engineering Center, U.S. Army Corps of Engineers, January 1973.

3. "Flood Hydrograph Package (HEC-1), Users Manual for Dam Safety Investigations", The Hydrologic Engineering Center, U.S. Army Corps of Engineers, September 1978.

4. HMR 33, "Seasonal Variations of Probable Maximum Precipitation, East of the 105th Meridian for Areas 10 to 1000 Square Miles and Durations from 6 to 48 Hours," U.S. Department of Commerce, NOAA, National Weather Service, 1956.

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6. HYDRO-35, "Five-to-60 Minute Precipitation Frequency for the Eastern and Central United States", U.S. Department of Commerce, NOAA, National Weather Service, June 1977.

7. "Technical Paper No. 40, Rainfall Frequency Atlas of the United States", U.S. Department of Commerce, Weather Bureau, 1961.

8. Design of Small Dams, United States Department of the Interior, Bureau of Reclamation, Second Edition, 1973.

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10. "Flood Hydrograph Analyses and Computations", EM 1110-2-1405, U.S. Army Corps of Engineers, 31 August 1959.

11. "Technical Release No. 55, Urban Hydrology for Small Watersheds", U.S. Department of Agriculture, Soil Conservation Service (Engineering Division), January 1975.

APPENDIX F

REFERENCES

INFORMATION AS CONTAINED IN

THE NATIONAL INVENTORY OF DAMS

THIS SHEET TO BE FURNISHED BY

THE CORPS OF ENGINEERS

APPENDIX E

INFORMATION AS CONTAINED IN

THE NATIONAL INVENTORY OF DAMS

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1311.20	1302.00	1311.20
STORAGE	54.	21.	54.
OUTFLOW	4182.	0.	4182.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	1311.16	0.00	54.	27579.	0.00	0.02	0.00

PLAN 1 STATION 26+00

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	16609.	1130.1	0.03

PLAN 1 STATION 56+00

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	11125.	899.5	0.05

PLAN 1 STATION 72+00

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	9953.	809.5	0.07

PLAN 1 STATION 80+00

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	10175.	646.1	0.07

PLAN 1 STATION 85+00

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	10100.	691.2	0.07

PLAN 1 STATION 93+00

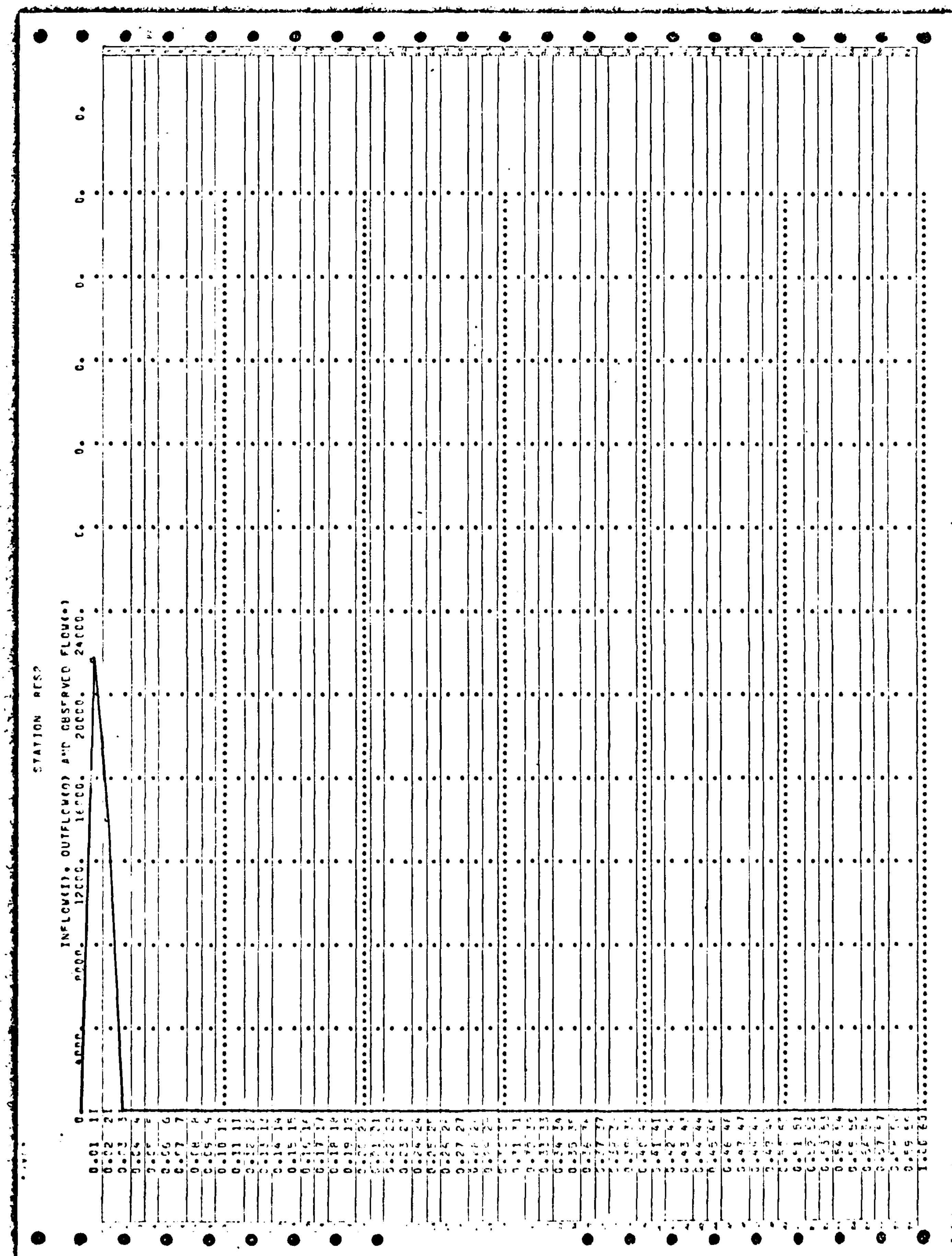
RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	7579.	581.1	0.10

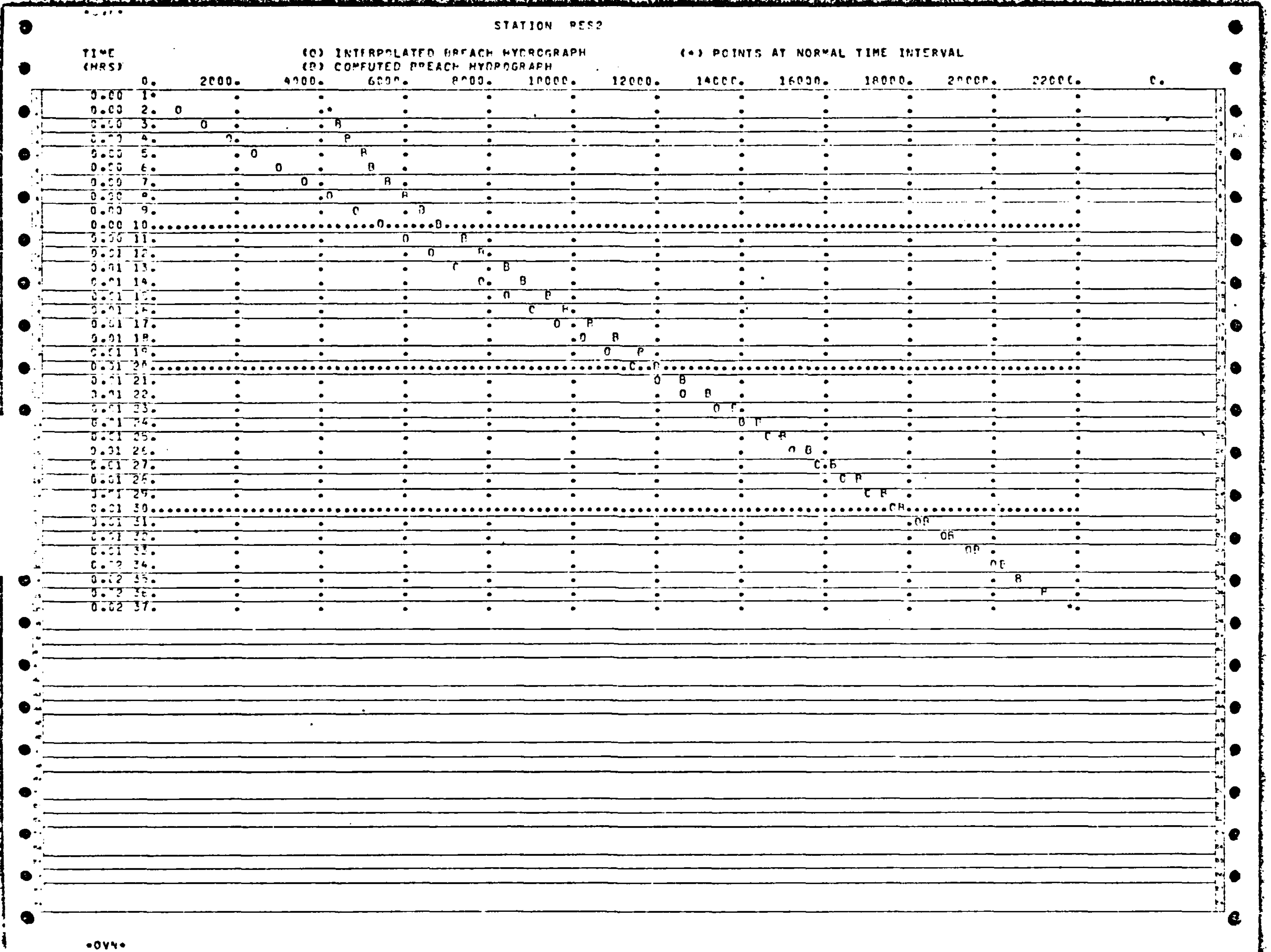
****
FLOOD HYDROGRAPH PACKAGE (HEC-1)

MAXIMUM STAGE IS 591.1

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 1.00
HYDROGRAPH AT	SA-5	0.00 (0.01)	1	0. (0.00)(
ROUTED TO	RES2	0.00 (0.01)	1	21770. (616.45)(
ROUTED TO	26+00	0.00 (0.01)	1	16609. (470.32)(
ROUTED TO	56+00	0.00 (0.01)	1	11125. (315.04)(
ROUTED TO	72+00	0.00 (0.01)	1	9953. (281.83)(
ROUTED TO	80+00	0.00 (0.01)	1	10175. (288.13)(
ROUTED TO	85+50	0.00 (0.01)	1	10100. (285.99)(
ROUTED TO	93+00	0.00 (0.01)	1	7579. (214.62)(


STATION RES2
INFLOW(I), OUTFLOW(O) AND OBSERVED FLOW(*)
0.
4000.
8000.
12000.
16000.
20000.
24000.


STATION RES2
TIME (HRS)
(O) INTERPOLATED BREACH HYDROGRAPH
(B) COMPUTED BREACH HYDROGRAPH
(*) POINTS AT NORMAL TIME INTERVAL
0. 2000. 4000. 6000. 8000. 10000. 12000. 14000. 16000. 18000. 20000. 22000. 0.

THE DAM BREACH HYDROGRAPH WAS DEVELOPED USING A TIME INTERVAL OF 0.000 HOURS DURING BREACH FORMATION.
DOWNSTREAM CALCULATIONS WILL USE A TIME INTERVAL OF 0.017 HOURS.
THIS TABLE COMPARES THE HYDROGRAPH FOR DOWNSTREAM CALCULATIONS WITH THE COMPUTED BREACH HYDROGRAPH.
INTERMEDIATE FLOWS ARE INTERPOLATED FROM END-OF-PERIOD VALUES.

TIME (HOURS)	TIME FROM BEGINNING OF BREACH (HOURS)	INTERPOLATED BREACH HYDROGRAPH (CFS)	-	COMPUTED BREACH HYDROGRAPH (CFS)	=	ERROR (CFS)	ACCUMULATED ERROR (CFS)	ACCUMULATED ERROR (AC-FT)
0.000	0.000	0.		0.		0.	0.	0.
0.000	0.000	605.		4266.		-3661.	-3661.	-0.
0.001	0.001	1209.		4442.		-3233.	-6894.	-0.
0.001	0.001	1814.		4678.		-2864.	-9758.	-0.
0.002	0.002	2419.		4961.		-2542.	-12300.	-0.
0.002	0.002	3024.		5282.		-2259.	-14559.	-1.
0.003	0.003	3628.		5640.		-2012.	-16571.	-1.
0.003	0.003	4233.		6029.		-1795.	-18365.	-1.
0.004	0.004	4838.		6441.		-1604.	-19969.	-1.
0.004	0.004	5442.		6879.		-1436.	-21405.	-1.
0.005	0.005	6047.		7337.		-1290.	-22695.	-1.
0.005	0.005	6652.		7814.		-1162.	-23857.	-1.
0.006	0.006	7257.		8307.		-1050.	-24907.	-1.
0.006	0.006	7861.		8816.		-954.	-25862.	-1.
0.006	0.006	8466.		9337.		-871.	-26732.	-1.
0.007	0.007	9071.		9870.		-799.	-27531.	-1.
0.007	0.007	9675.		10412.		-737.	-28268.	-1.
0.008	0.008	10280.		10963.		-682.	-28950.	-1.
0.008	0.008	10885.		11521.		-636.	-29586.	-1.
0.009	0.009	11490.		12087.		-598.	-30184.	-1.
0.009	0.009	12094.		12663.		-569.	-30753.	-1.
0.010	0.010	12699.		13242.		-543.	-31296.	-1.
0.010	0.010	13304.		13823.		-520.	-31815.	-1.
0.011	0.011	13908.		14406.		-498.	-32313.	-1.
0.011	0.011	14513.		14987.		-476.	-32790.	-1.
0.012	0.012	15118.		15572.		-454.	-33244.	-1.
0.012	0.012	15722.		16152.		-429.	-33673.	-1.
0.012	0.012	16327.		16734.		-407.	-34080.	-1.
0.013	0.013	16932.		17314.		-382.	-34462.	-1.
0.013	0.013	17537.		17889.		-352.	-34814.	-1.
0.014	0.014	18141.		18458.		-317.	-35131.	-1.
0.014	0.014	18746.		19021.		-275.	-35406.	-1.
0.015	0.015	19351.		19579.		-228.	-35634.	-1.
0.015	0.015	19955.		20141.		-185.	-35819.	-1.
0.016	0.016	20560.		20694.		-134.	-35953.	-1.
0.016	0.016	21165.		21237.		-72.	-36026.	-1.
0.017	0.017	21770.		21770.		0.	-36026.	-1.

```
Y6    .04      .03      .04      598      617      500      .084
Y7      0      621     1300      620     1500      600      1505      598     1510      598
Y7   1520      600     2050      600     2150      621
K       1    93+00                                   1         1
K1 CHANNEL ROUTING STA 93+00
Y                                  1        1
Y1      1
Y6    .04      .03      .04      578      597      800      .025
Y7      0      600       25      590       50      580        60      578       90      578
Y7    1?0      580      850      580      850      600
K      99
A
A
A
A
A
```

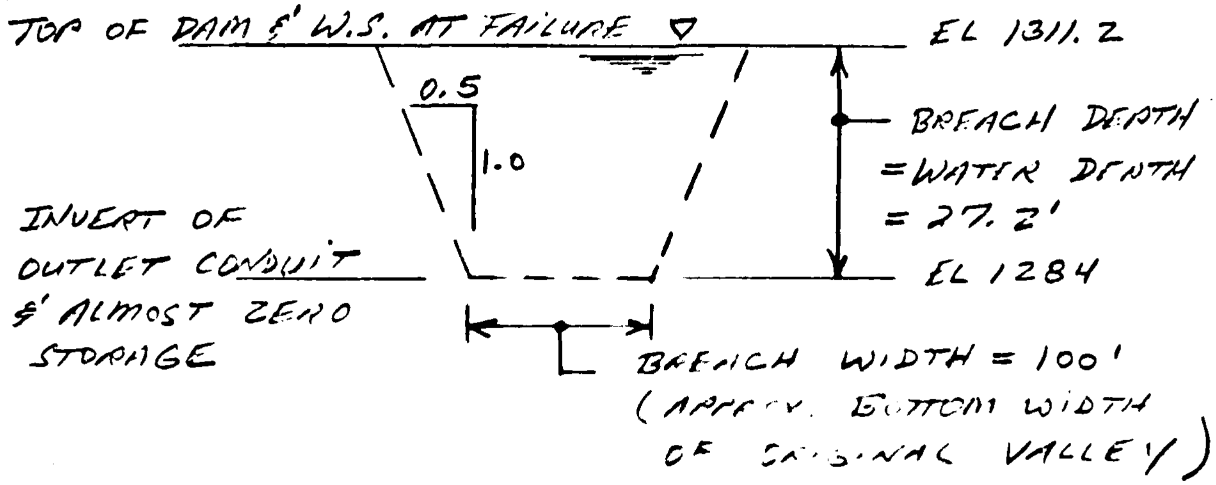
```
A NED DAM INSPECTION CONTRACT: DACW33-80-C-0012  SBDB)
A VT. CC212 SUCKER BROOK DAM, 21-06-79108
A BREACH AT TOP OF DAM
B     60        0         1
B1     5
J      1        1         1
J1   1.0
K      0     SA-5                                        1
K1 SUBAREA 5 RUNOFF COMPUTATION (SUCKER BROOK RESERVOIR)
M      1       -1     0.605           10.51                                 1
P
T
U      1
U1
X      0        0         1
K      1     RES2                               2         1         1
K1 ROUTING FLOWS THROUGH RESERVOIR 2 (SUCKER BROOK RESERVOIR)
Y                                     1         1
Y1     1                                                  -1311.2      -1
Y4  1293   1293.1      1295      1300      1302      1303      1304      1305      1306      1307
Y4  1308     1309      1310      1311      1312      1313      1314      1315      1320
Y5     0        0         0         0         0       124       349       642       988      1442
Y5  1985     2618      3288      4024      4812      5648      6530      7455     12664
SA   .02      .33      2.76      3.51      4.19      6.67
SE  1282     1290      1300      1306      1310      1320
S#  1302
SD1311.2
$3   100      0.5      1284     0.023    1311.2    1311.2
K      1    26+00                                     1         1
K1 CHANNEL ROUTING STA  26+00
Y                                     1         1
Y1     1
Y6   .04      .03       .04      1120      1139      2600       .06
Y7     0     1150        40      1160        80      1140       110      1120       125      1120
Y7   200     1140       270      1160       310      1180
K      1    56+00                                     1         1
K1 CHANNEL ROUTING STA 56+00
Y                                     1         1
Y1     1
Y6   .04      .03       .04       895       914      3000      .075
Y7     0      960        90       940       220       900       260       895       280       895
Y7   410      900       500       920       750       960
K      1    72+00                                     1         1
K1 CHANNEL ROUTING STA 72+00
Y                                     1         1
Y1     1
Y6   .04      .03       .04       800       819      1600      .059
Y7     0      860        10       840        20       820        75       800        85       800
Y7   110      820       160       840       200       860
K      1    83+00                                     1         1
K1 CHANNEL ROUTING STA 83+00
Y                                     1         1
Y1     1
Y6   .04      .03       .04       640       659       800       .20
Y7     0      700         0       670        80       660       180       640       190       640
Y7   240      660       250       680       260       700
K      1    85+00                                     1         1
K1 CHANNEL ROUTING STA 85+00
Y                                     1         1
Y1     1
```

GORDON E. AINSWORTH
& ASSOCIATES, INC.
20 Sugarloaf Street
SOUTH DEERFIELD, MA 01373
Phone 665-2161

JOB SUCKER BROOK DAM
SHEET NO. ______ OF ______
CALCULATED BY JPB DATE 9/16/80
CHECKED BY JPB DATE 9/16/80
SCALE n/a

BREACH CRITERIA

EARTH DAM, NO CORE WALL



RULE OF THUMB PEAK [illegible]
SUDDEN BREACH

$$Q = \frac{8}{27} W_b \sqrt{g}\, Y_0^{\frac{5}{2}}$$

[illegible] WIDTH = 100'
[illegible] DEPTH = 27.2'

Q = 23,900 cfs ±

ADDITIONAL FLOW [illegible] FROM SPILLWAY
TOTAL PROJECT AT T.D. = 4280 cfs ±
LESS DIVERSION FLOW TO [illegible] 100 cfs ±
4180 cfs

TOTAL PEAK OUTFLOW FROM DAM
Q_p = 23,900 cfs + 4180 cfs = 28,080 SAY 28,000 cfs

HEC-1 DB BREACH PROGRAM
CALCULATION INTERVAL = 1 MINUTE

BREACH TIME	PEAK OUTFLOW (cfs)
0.03 hr.	24,100
0.02	30,200
0.025	26,800
USE 0.023 hr. = 1.38 min	28,000 cfs

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1311.20	1302.00	1311.20
STORAGE	54.	21.	54.
OUTFLOW	4182.	0.	4182.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	1311.20	0.00	54.	4182.	0.17	0.00	0.00

PLAN 1 STATION 3+00

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	4182.	1261.3	0.02

PLAN 1 STATION 26+00

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	4182.	1125.3	0.02

PLAN 1 STATION 56+00

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	4182.	898.0	0.02

PLAN 1 STATION 72+00

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	4182.	806.3	0.02

PLAN 1 STATION 80+00

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	4182.	644.1	0.02

PLAN 1 STATION 85+00

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	4182.	600.6	0.02

PLAN 1 STATION 93+00

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	4182.	580.5	0.02

....
FLOOD HYDROGRAPH PACKAGE (HEC-1)

END

FILMED

8-85

DTIC