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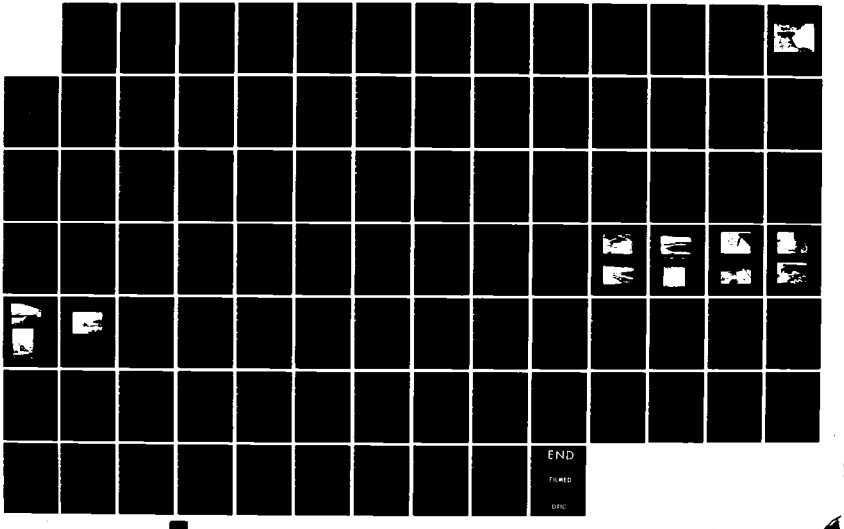

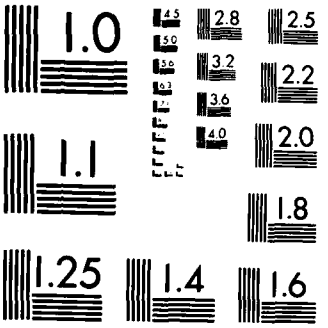

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KNAPP BROOK SITE NO. 1
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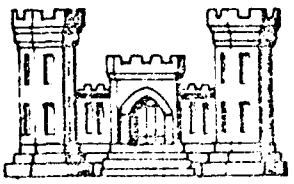
NATIONAL DAM INSPECTION PROGRAM



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1. REPORT NUMBER VT 00076	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Knapp Brook Site No. 1 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 March 1980 13. NUMBER OF PAGES 34
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

APPROVAL FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED

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

18. SUPPLEMENTARY NOTES

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

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

DAMS, INSPECTION, DAM SAFETY,

Connecticut River Basin
Cavendish, VT.
Knapp Brook

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

TCe dam is an earth embankment dam with a clay core, It is about 400 ft. long and 21 ft. high. TLe dam is small in size with a significant hazard potential. Tbe dam is judged to be in good condition. THere were a few significant findings which should be corrected. Among remedial measures are: Remove brush and beaver dams from the emergency spillway: Round the clock monitoring should be provided suring periods of unusually heacy rain.

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KNAPP BROOK SITE NO. 1

VT00076

CAVENDISH, VERMONT

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT

Identification No:	VT00076
Name of Dam:	Knapp Brook Site No. 1
Town:	Cavendish
County and State:	Windsor County, Vermont
Stream:	Knapp Brook
Date of Inspection:	April 23, 1979 and May 22, 1979

BRIEF ASSESSMENT

The Knapp Brook Site No. 1 dam is an earth embankment dam with clay core. The dam is approximately 400 feet long and 21 feet high. The dam and pond are currently utilized as a State of Vermont Fish and Game Pond. A concrete drop structure containing a 4-foot concrete discharge pipe is the primary control of flow at the dam. This structure is supplemented by an emergency spillway cut out of the left abutment. The drainage area for the dam is 3.2 square miles, of which 2.9 square miles is controlled by another dam, Knapp Brook Site No. 2, 1400 feet upstream. Under normal flow conditions, the impoundment behind Knapp Brook Site No. 1 is 166 acre-feet with a surface area of 26 acres.

The dam is classified as small and has a significant hazard potential. Based on size and hazard classifications, a 1/2 Probable Maximum Flood (1/2 PMF) of 4,600 CFS was used as the test flood inflow. The routed test flood outflow was 4,570 CFS. The total spillway and drop structure capacity is 2,550 CFS which is 56 percent of the routed test flood outflow. The test flood would overtop the dam by 1.1 feet.

The dam is judged to be in good condition. The following significant findings were determined during the investigation:

1. The emergency spillway is overgrown with brush and does not have adequate capacity to carry the test flood.

2. A wet area was found near the left abutment of the dam. No water was seen flowing, but the area was soggy and had developed some minor sloughing.

3. The dam, as constructed, appears to be inconsistent with the plans for elevation and emergency spillway detail.

4. The earth embankment dam has a nonuniform crest elevation. The center of the earth embankment is 1.5 feet lower than the abutments.

The present dam is in good condition and it is recommended that the following actions be instituted under the guidance of a registered professional engineer qualified in dam design within two years of the receipt of this report:

1. Institute a biennial program of technical inspections to include monitoring of the wet areas near the left abutment for flow volume and evidences of soil transport.

2. Remove brush and beaver dams from the emergency spillway.

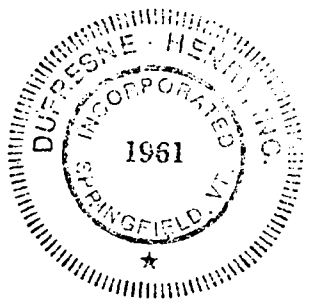
3. Assess the need for greater spillway capacity.

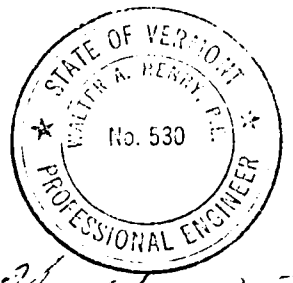
4. Level the top of the dam from abutment to abutment.

5. Inspect the inlet structure for evidence of cracking and spalling.

6. Prepare as-built plans to reflect elevations and distances as they exist.

7. Round-the-clock monitoring should be provided during periods of unusually heavy rain.





PREFACE

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

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

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

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

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OVERVIEW OF
KNAPP BROOK SITE NO. 1
CAVENDISH, VERMONT

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. Design Data

There is no known hydraulic or hydrologic design data for the Knapp Brook Site No. 1 Dam.

b. Experience Data

During interviews with Fish and Game personnel it was reported that in the history of the dam it has never been overtopped. The maximum water surface was during the 1973 Flood when the water got 2.0± feet deep at the concrete cut-off wall in the emergency spillway (elevation 94.6) or 1.2 feet below the top of the dam.

c. Visual Observations

The primary discharge structure is the 12-foot by 6.5 foot drop structure (see Photo 5). This structure functions as a weir for the first 2 feet of head. For higher heads it is controlled by orifice flow by the 4-foot concrete discharge pipe. At the present time the north side of the structure is equipped with stop logs which run to full height of the concrete structure. The relative location of this structure, 15 feet from the dam, and its primary use as a spillway could cause debris to collect around the iron pipe railing. This could lead to possible reduction in discharge.

d. Test Flood Analysis

The dam is classified as small size with a significant hazard potential due to four homes downstream. Therefore, the test flood selected was one-half of the Probable Maximum Flood. The computations of the test flood and discharges were carried out using the HEC-1 computer program. The input data computations and results are contained in Appendix D of this report. The project study dam, Knapp Brook Site No. 1, with a small pond area offers insignificant flood regulation for the 3.17 square mile drainage area. The peak discharge was only reduced from 4,600 CFS to 4,570 CFS. Since the total spillway and drop structure discharge of 2,550 CFS is 56 percent of the routed test flood outflow, the low sections of the dam would be overtopped by 1.1 foot producing a test flood elevation of 96.9.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 Procedures*

There are no operational procedures as the stop logs are left in place all year.

4.2 Maintenance of Dam*

The existing maintenance of the dam consists of periodic mowing of grass slopes on dam, removal of obstructions from the drop structures and yearly cutting of brush from dam embankment.

4.3 Maintenance of Operating Facilities

The stop logs are the only operating facilities and they appear to be in a well maintained condition. They are normally maintained at an elevation at the top of the inlet structure.

4.4 Description of Warning System in Effect

None exists for this dam.

4.5 Evaluation

The maintenance of the dam and drop structure is being carried out on a periodic basis. Overall, the dam is being maintained in a good condition. The only recommendation is that the brush and saplings in the emergency spillway be cut and removed. Also, the old beaver dams should be removed.

*Interviews with Fish and Game personnel.

outlet. The emergency spillway is a wide channel cut into the left abutment. There are saplings and brush growing on the spillway channel, severely restricting its ability to pass water (see Photos 9, 10 and 11).

d. Reservoir Area

There are no evidences of instability along the edges of the reservoir in the vicinity of the dam.

e. Downstream Channel

The downstream channel for the outlet of the drop inlet spillway is the natural streambed. No significant obstruction to flow can be seen (see Photo 7).

3.2 Evaluation

The dam is in good condition. The ability of the emergency spillway to pass water is restricted by heavy growth of saplings and brush.

SECTION 3 - VISUAL INSPECTION

3.1 Findings

a. General

At the time of inspection on April 23, 1979, the water level was two inches over the concrete weir of the drop inlet spillway. During the April inspection there was snow on some portions of the downstream slope. The downstream slope was reinspected on May 22, 1979 in the absence of snow for any evidence of seepage. On May 22, the water level in the reservoir was about 2 inches lower than the concrete weir of the drop inlet.

b. Dam

The upstream slope of the dam is riprap protected below elevation 94 feet. Above this elevation the slope is grass covered with some minor erosion due mainly to trespassing (see Photo 3). Some of the riprap could be observed through the water, (see Photo 4), and it appears in good condition with some siltation cover.

The crest of the dam is mostly grass covered with no signs of erosion. The crest is not at a uniform elevation as it varies by 1.5 feet from the abutments to the center of the dam.

The downstream slope was grass covered with only minor sloughing and erosion (see Photo 8). The slope and the toe of the slope show no evidence of seeps with the exception of an area next to the left abutment. There is a wet area on the slope about 2 feet above the toe and at 65 feet from the abutment, measured along the crest. No water could be seen flowing, but the area is soggy. Minor sloughing has occurred above this area. Between this wet area and the abutment, the ground was soft and wet along the toe of the slope. Emanating from the wet area was a small streambed connecting with the outlet channel; however, no water could be seen moving, but it is apparently maintained wet by the seeps. No discharge could be seen at the outlet channel.

c. Appurtenant Structures

The drop inlet spillway appears to be in good condition; however, it could not be inspected closely because of lack of access (see Photos 2, 4 and 5). There is a small depression behind the ends of the headwall of the outlet where some soil may have washed out through the stone protection next to the

SECTION 2 - ENGINEERING DATA

2.1 Design

The plans describing the design of this earth embankment dam with drop structure and emergency spillway are contained in Appendix B of this report.

2.2 Construction

The present dam is a 400-foot earth embankment dam with shallow clay core built across the original streambed of Knapp Brook. This dam was constructed in 1958 on the existing old ground. A concrete drop structure with 4-foot concrete pipe is used as the principal discharge of seasonal rainfall and an emergency spillway structure was excavated out of the left abutment. The flows return to Knapp Brook 1400 feet downstream.

2.3 Operation

The flow of water is not controlled at all, according to Fish and Game personnel. The stop logs are left in place all year. The stop logs can be removed by the means of a portable hoist assembly.

2.4 Evaluation

a. Availability

The design plans for this dam are on file with the Agency of Environmental Conservation, Department of Water Resources, Montpelier, Vermont 05602.

b. Adequacy

The lack of in-depth engineering design computations does not allow for a definitive review. Therefore, the adequacy of the dam, structurally and hydraulically, cannot be assessed from the standpoint of review of design calculations, but must be based primarily on the visual inspection, past performance history and sound hydrologic and hydraulic engineering judgment.

c. Validity

The 142-foot spillway length shown on the available plans is inconsistent with field observations. In addition the mean sea level elevations on the plans do not agree with the topographic map prepared in 1972 or to the relative elevations used in the construction of the Knapp No. 2 dam. There also is a discrepancy in the elevation difference from the top of the drop structure to the top of the dam.

i. Spillway

(1) Type

Trapezoidal channel with concrete cut-off wall.

(2) Length

125-foot crest at concrete cut-off wall.

(3) Elevation of Crest

92.6 at concrete cut-off wall.

(4) Gates

None.

(5) Upstream Channel

125-foot wide excavated earth trapezoidal channel overgrown with brush. Length 200+ feet.

(6) Downstream Channel

125-foot wide excavated earth trapezoidal channel overgrown with brush and restricted by beaver dams. The length is 400 feet. Downstream 50 feet from the weir is a 105-foot wide restricted section.

j. Regulating Outlets

The 12-foot by 6.5-foot concrete drop structure is equipped with stop logs from the invert of the 48-inch concrete pipe to the top of the drop structure spillway. The stop logs appear to be in good condition. The inspection team was unable to gain access to the structure during the two inspection trips. Presently the stop logs are installed all the way to the top of the drop structure and according to Fish and Game personnel, this is the standard operating procedure for the entire year.

(3) Spillway Crest

27 acres.

(4) Test Flood Pool

31 acres.

(5) Top of Dam

31 acres.

g. Dam

(1) Type

Earth embankment with a shallow clay core under the upstream slope.

(2) Length

400 feet ±.

(3) Height

21 feet.

(4) Top Width

16 feet.

(5) Side Slopes

Downstream slope - 2:1. Upstream slope - 3:1.

(6) Zoning

None known.

(7) Impervious Core

Shallow clay pad under the upstream slope.

(8) Cut-Off

Clay pad extends 2 feet into the foundation soils.

(9) Grout Curtain

None known.

h. Diversion and Regulating Tunnel

Not applicable.

(8) Top of Dam

Varies. 95.8 at centerline of outlet pipe. 97.3 at abutments.

(9) Test Flood Surcharge

96.9.

d. Reservoir

(1) Length of Maximum Pool

1700 feet.

(2) Length of Recreation Pool

1600 feet.

(3) Length of Flood Control Pool

Not applicable.

e. Storage

(1) Recreation Pool

166 acre-feet.

(2) Flood Control Pool

Not applicable.

(3) Spillway Crest Pool

192 acre-feet.

(4) Top of Dam

292 acre-feet.

f. Reservoir Surface

(1) Recreation Pool

25.6 acres.

(2) Flood Control Pool

Not applicable.

(6) Gated Spillway Capacity at Normal Pool Elevation

Not applicable.

(7) Gated Spillway Capacity at Test Flood Elevation

Not applicable.

(8) Total Spillway Capacity at Test Flood Elevation

3,450 CFS at elevation 96.8 - no brush.
1,770 CFS at elevation 96.9 - heavy brush.

(9) Total Project Discharge at Test Flood Elevation

4,570 CFS at elevation 96.9.

c. Elevation

The following elevations are based on a local datum which is tied into Knapp Brook Site No. 2 dam. The elevation of 91.6 at the top of the concrete weir of the drop structure is the datum at Knapp Brook Site No. 1.

(1) Streambed at Outlet of Drop Structure

73.0.

(2) Maximum Tailwater

Could not be determined.

(3) Upstream Portal Invert Diversion Tunnel

Not applicable.

(4) Recreation Pool

91.6 - stop logs in position.

(5) Full Flood Control Pool

Not applicable.

(6) Spillway Crest

77.2 - drop structure, stop logs removed.
91.6 - drop structure, stop logs in place.
92.6 - emergency spillway.

(7) Design Surcharge

Not applicable.

ture is a 125-foot wide emergency spillway, trapezoidal channel, which is one foot higher than the drop structure and was excavated out of the left abutment. The spillway channel has been overgrown with saplings and brush which have restricted the capacity of the spillway.

(2) Maximum Known Flood at Dam Site

There are no gauging stations or operating records for the Knapp Brook dams, but according to Bob Horton, Fish and Game Maintenance Supervisor, the maximum known flood at the Knapp Brook Site No. 1 Dam was the June-July 1973 Flood during which the water was approximately 2 feet deep at the emergency spillway. Based on 2 feet of water in the brush-overgrown spillway channel, elevation 94.6, the maximum discharge in the spillway was 423± CFS and from the drop structure 317 ± CFS, for a total of 740 CFS. During this event, the maximum storage was 250 acre-feet and the dam and structures weathered the flood with no damage.

(3) Spillway Capacity

Knapp Brook Site No. 1 Dam contains two discharge structures: the primary spillway (see Figure 5) which is a 12-foot long by 6.5-foot wide concrete drop structure, 14 feet high with a 48-inch concrete discharge pipe. According to Fish and Game personnel, the stop logs which extend from the invert of the pipe to the top of the weir are left alone, but can be removed should this be required. Based on the stop logs in place, the primary spillway functions as a weir until the maximum height of 1.9 feet (elevation 93.3), after which the spillway is controlled by the 48-inch concrete pipe orifice flow. With the stop logs in place, and water surface at the top of the dam (elevation 95.8), the maximum discharge is 330 CFS. The second primary structure is an emergency spillway channel, one foot higher than the crest of the drop structure, excavated from the left abutment slope. This channel is a 500± foot long trapezoidal channel with a designed concrete key cut-off wall 125 feet long. The controlling element at present is the restricted channel 50 feet downstream which is only 105 feet wide and overgrown with brush which reduces the discharge capacity greatly.

(4) Ungated Spillway Capacity at Top of Dam

2,220 CFS at elevation 95.8 - no brush.
1,060 CFS at elevation 95.8 - heavy brush.

(5) Ungated Spillway Capacity at Test Flood Elevation

3,450 CFS at elevation 96.8 - no brush.
1,770 CFS at elevation 96.9 - heavy brush.

g. Purpose

The Knapp Brook Ponds 1 and 2 were constructed as part of a fish management project for southern Vermont and are still being used for this purpose.

h. Design and Construction History

This dam was designed by E. W. Culver in 1956 and built by the Fish and Game Department in 1958. The plans for the dam are on file with the State of Vermont Agency of Environmental Conservation, Department of Water Resources, Environmental Engineering Division, Montpelier, Vermont. There is no additional information on Knapp Brook Site No. 1 design and construction history.

i. Normal Operating Procedures

The pond is used for fishing and as a fish habitat and as such the water surface is controlled by the Fish and Game Department. According to Bob Horton, Maintenance Supervisor, the stop logs in the drop structure are left in place all year. This keeps the water elevation at the top of the drop structure. The emergency spillway which is one foot higher than the top of the drop structure carries the spring run-off. Usually the flow is less than 0.3 feet over the spillway in the spring.

1.3 Pertinent Data

a. Drainage Area

The present drainage area to Knapp Brook Site No. 1 pond is 3.17 square miles. Located at the northwest corner of Knapp Brook Site No. 1 is the second pond called Knapp Brook Site No. 2. This pond controls a total of 2.89 square miles and has a normal water surface area of 26 acres. The main channel is approximately 2.6 miles long to Knapp Site No. 2 and the average slope is 137 feet per mile. The watershed is approximately 90 percent wooded on steeply sloping terrain with the surrounding hills rising 600 feet above the ponds.

b. Discharge at Dam Site

(1) Outlet Works

The outlet works at Knapp Brook Site No. 1 consist of one drop structure with stop logs and one emergency spillway at the left abutment. The drop structure (see Photo 5) is a concrete structure 15 feet high with a total opening of 12 feet by 6.5 feet and a 48-inch reinforced concrete pipe outlet. Stop logs extend from the top of the north wall to the invert of the 4-foot pipe. The second struc-

b. Description of Dam and Appurtenances

The Knapp Brook Site No. 1 Dam is approximately 400 feet long and 21 feet high. Plans of the dam are available and the earth embankment dam built in 1958 reportedly has a clay core. The water level is controlled by a 12-foot by 6.5 foot concrete drop structure which regulates the reservoir level by 4.0-foot wide stop logs which are 14'-5" high and a 125-foot long trapezoidal emergency spillway. Knapp Brook Site No. 1 is known locally as Lower Knapp Pond.

c. Size Classification

The Knapp Brook Site No. 1 Dam is approximately 21 feet high with a maximum storage of 292 acre-feet. The United States Corps of Engineers (USCE) guidelines place dams with a height between 25 and 40 feet or storage between 50 and 1000 acre-feet in the small category. Therefore the size classification of Knapp Brook Site No. 1 is small.

d. Hazard Classification

If the Knapp Brook Site No. 1 Dam were to fail with the water level at the top of the dam, a flood wave 12 feet high and flowing at a rate of 13,000 CFS would be released. The project discharge with water at the top of the dam would be 2,200 CFS. The flood stages in Knapp Brook would increase from 1 foot overbank to 7 feet overbank at 13,000 CFS. Knapp Brook has a slope varying from 3.5 to 4.5 percent; consequently little storage of the flood wave would result until it enters the flood plain of the North Branch of the Black River. Along Knapp Brook the flood wave would damage 4 homes and 1 commercial property. The hazard classification then is significant.

e. Ownership

The present owner of Knapp Brook Site No. 1 is:

State of Vermont
Fish and Game Department
Montpelier, Vermont 05602

Telephone: 802-828-3371

f. Operator

Mr. Bob Horton, Maintenance Supervisor
Fish and Game Department
Chittenden, Vermont 05737

Telephone: 802-773-9507

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT
NAME OF DAM: KNAPP BROOK NO. 1

SECTION 1 - PROJECT INFORMATION

1.1 General

a. Authority

Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Dufresne-Henry Engineering Corporation 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 were issued to Dufresne-Henry Engineering Corporation under a letter of November 20, 1978 from Max B. Scheider, Colonel, Corps of Engineers. Contract No. DACW33-79-C-0010 has been assigned by the Corps of Engineers for this work.

b. Purpose

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

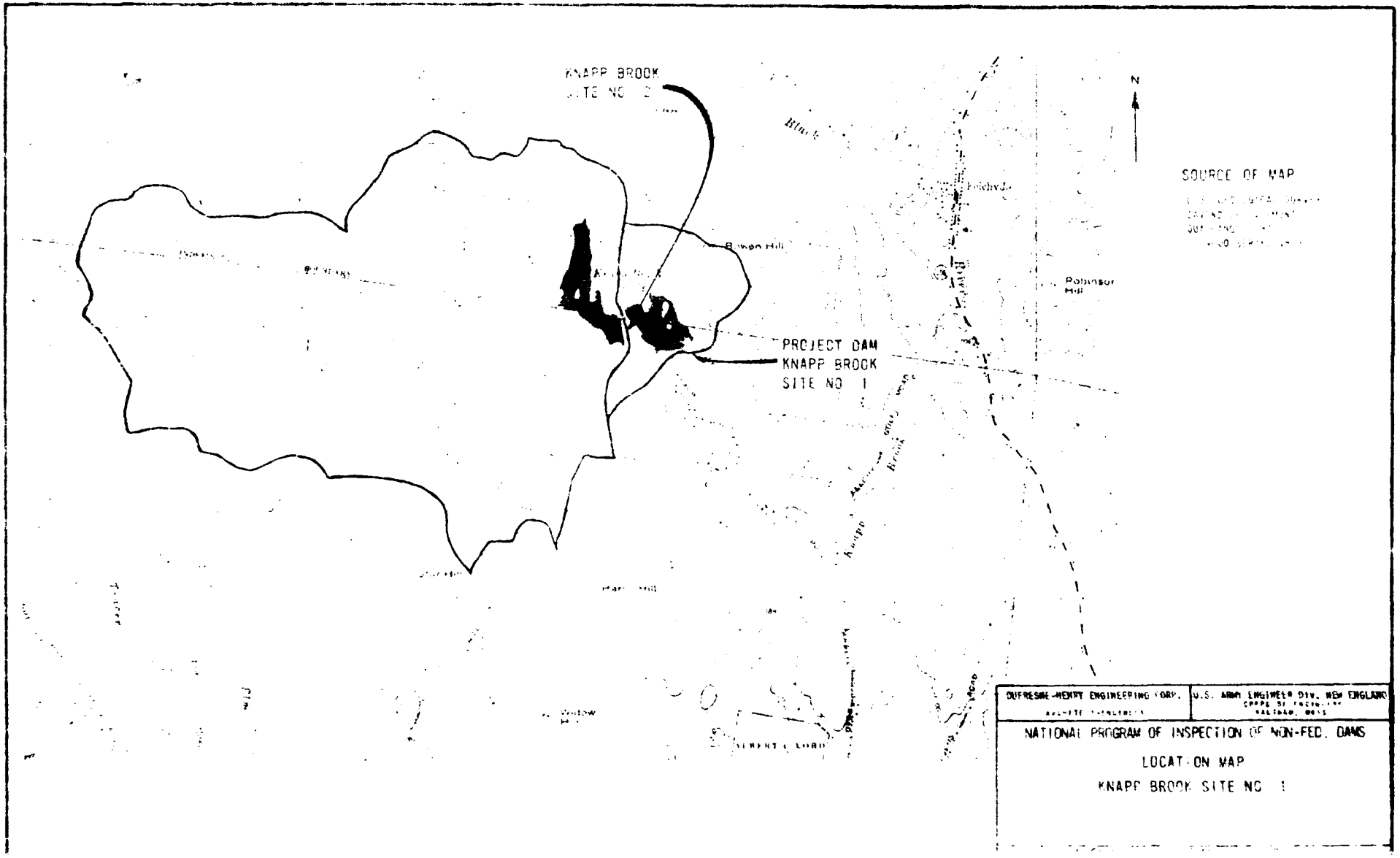
(2) Encourage and prepare the states to initiate quickly effective dam safety programs for nonfederal dams.

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

1.2 Description of Project

a. Location

The Knapp Brook Site No. 1 Dam is located in southeastern Vermont, in the Town of Cavendish, Windsor County, and is in the Connecticut River Basin. The dam is located 5.0 miles north-northeast of the Village of Canvendish. Knapp Brook Site No. 1 is 1400 feet downstream of Knapp Brook Site No. 2. Knapp Brook Site No. 1 is on Knapp Brook which is a tributary to the North Branch of the Black River and is located at N 43° 26.7' latitude and W 72° 33.7' longitude.



e. Dam Failure Analysis

If the Knapp Brook Site No. 1 Dam were to fail, a wave of water would be released into the lower channel of Knapp Brook. By the time this flood wave reached Vermont State Highway 106, 2.4 miles downstream, the flood wave would have reached the ground floor elevation of 4 homes. The depth of the flood wave will range from 12 feet at the dam (7 feet above banks) to 2 feet over the banks at Vermont 106. The dam failure discharge of 13,000 CFS would be a significant increase over the spillway capacity of 2,550 CFS with flood stages increasing by about 6 feet. This flood wave would pass at stages in excess of 11 feet through a narrow section on the North Branch of the Black River and then would spread over about 400 acres of flood plain before it reached the next possible impact area.

SECTION 6 - STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

No evidence of instability was observed.

b. Design and Construction Data

Three drawings of the dam and appurtenant structures were available for review. The dam is an earth dam with slopes of 3H to 1V and a shallow clay core under the upstream slope. The drawings indicate that the core penetrated 2 feet into the foundation soils and the top of the core was 5 feet below the crest of the dam. There are no indications of other provisions to prevent flow through the foundation soils. Some minor seepage was observed at the toe of the dam near the left abutment. It is possible that at water levels above the level of the top of the clay core, some seepage may take place through the upper part of the dam. There were no visual indications of significant safety problems due to the seep near the left abutment or to possible past seepage through the top part of the dam.

c. Operating Records

No operating records are available.

d. Post-Construction Changes

There are no known post-construction changes.

e. Seismic Stability

The dam is located in Seismic Zone 2 and in accordance with the recommended Phase I guidelines does not warrant seismic analysis.

SECTION 7 - ASSESSMENT, RECOMMENDATIONS/ REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition

Overall, the dam is judged to be in good condition on the basis of the visual inspection. However, the spillway does not have adequate capacity to pass the test flood.

b. Adequacy of Information

The only available information is the plans which appear to be inconsistent with the visual observations and thus the assessment of the condition of the dam is based largely on the visual inspection.

c. Urgency

The remedial measures recommended in Section 7.3 should be carried out within two years of receipt of this report by the Owner.

d. Need for Additional Investigation

There is no need for additional investigations.

7.2 Recommendations

It is recommended that a registered professional engineer experienced in the design of dams be engaged to assess the need for additional spillway capacity. The crest of the dam embankment should be graded to a uniform elevation from right abutment to left abutment. The drop inlet should be inspected for evidence of cracking or spalling and as-built plans should be prepared to reflect elevations and distances as they exist.

7.3 Remedial Measures

a. Operating and Maintenance Procedures

1. A biennial program of technical inspection should be instituted including monitoring of the wet areas near the left abutment for flow volume and evidences of soil transport.

2. Bushes and saplings should be removed from the emergency spillway.

3. A formal warning system should be developed.

4. Around-the-clock monitoring should be provided during periods of unusually heavy rain.

APPENDIX A

VISUAL INSPECTION CHECK LIST

VISUAL INSPECTION CHECK LIST
PARTY ORGANIZATION

PROJECT KNAPP BROOK SITE NO. 1

DATE April 23, 1979 & May 22, 1979

TIME 9:30-11:00 AM 10:15-11:00 AM

WEATHER Clear, Cool Clear, windy

W.S. ELEV._____ U.S.____ DN.S.

PARTY:	APRIL 23, 1979		MAY 22, 1979	
1.	Walter A. Henry	D-H	Sherward G. Farnsworth	D-H
2.	Morris J. Root	D-H	Gonzalo Castro	GEI
3.	Sherward G. Farnsworth	D-H		
4.	Gonzalo Castro	GEI		
5.				

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

PERIODIC INSPECTION CHECK LIST

PROJECT KNAPP BROOK SITE NO. 1 DATE April 23, 1979

PROJECT FEATURE _____ NAME _____

DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
DAM EMBANKMENT (EARTH)	
Crest Elevation	92.6 (emergency spillway).
Current Pool Elevation	92.1
Maximum Impoundment to Date	
Surface Cracks	None observed.
Pavement Condition	Not applicable.
Movement or Settlement of Crest	None observed.
Lateral Movement	None observed.
Vertical Alignment	Too irregular to judge.
Horizontal Alignment	Too irregular to judge.
Condition at Abutment	Good.
Indications of Movement of Structural Items on Slopes	Not applicable.
Trespassing on Slopes	Minor, on upper part of upstream slope.
Sloughing or Erosion of Slopes or Abutments	None observed.
Rock Slope Protection - Riprap Failures	Riprap in good condition.
Unusual Movement or Cracking at or Near Toes	None observed.
Embankment or Downstream Seepage	A wet area near left abutment. No flow could be observed.
Piping or Boils	None observed.
Foundation Drainage Features	None observed.
Vegetation	Grass cover on crest and downstream slop in good condition
Toe Drains	None observed.
Instrumentation System	None observed.

PERIODIC INSPECTION CHECK LIST

PROJECT KNAPP BROOK SITE NO. 1 **DATE** April 23, 1979

PROJECT FEATURE _____ **NAME** _____

DISCIPLINE _____ **NAME** _____

AREA EVALUATED	CONDITION
DIKE EMBANKMENT	NONE.
Crest Elevation	
Current Pool Elevation	
Maximum Impoundment to Date	
Surface Cracks	
Pavement Condition	
Movement or Settlement of Crest	
Lateral Movement	
Vertical Alignment	
Horizontal Alignment	
Condition at Abutment and at Concrete Structures	
Indications of Movement of Structural Items on Slopes	
Trespassing on Slopes	
Sloughing or Erosion of Slopes or Abutments	
Rock Slope Protection - Riprap Failures	
Unusual Movement or Cracking at or Near Toes	
Unusual Embankment or Downstream Seepage	
Piping or Boils	
Foundation Drainage Features	
Toe Drains	
Instrumentation System	
Vegetation	

PERIODIC INSPECTION CHECK LIST

PROJECT KNAPP BROOK SITE NO. 1 DATE April 23, 1979

PROJECT FEATURE _____ NAME _____

DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
OUTLET WORKS - INTAKE STRUCTURE	
a. Approach Channel	None observed, under water, unable to get out to drop structure and check water depth and inlet elevation of stop logs.
Slope Conditions	
Bottom Conditions	
Rock Slides or Falls	
Log Boom	
Debris	
Condition of Concrete Lining	
Drains or Weep Holes	
b. Intake Structure	Concrete drop structure
Condition of Concrete	Good.
Stop Logs and Slots	Stop logs on upstream side to top of drop structure (see note above, a.). It appears that stop logs go down from top of structure at least 10± feet.
Railing Around Structure	One inch galvanized pipe, fair condition.

PERIODIC INSPECTION CHECK LIST

PROJECT KNAPP BROOK SITE NO. 1 **DATE** April 23, 1979

PROJECT FEATURE _____ **NAME** _____

DISCIPLINE _____ **NAME** _____

AREA EVALUATED	CONDITION
OUTLET WORKS - CONTROL TOWER	NONE.
a. Concrete and Structural	
General Condition	
Condition of Joints	
Spalling	
Visible Reinforcing	
Rusting or Staining of Concrete	
Any Seepage or Efflorescence	
Joint Alignment	
Unusual Seepage or Leaks in Gate Chamber	
Cracks	
Rusting or Corrosion of Steel	
b. Mechanical and Electrical	
Air Vents	
Float Wells	
Crane Hoist	
Elevator	
Hydraulic System	
Service Gates	
Emergency Gates	
Lightning Protection System	
Emergency Power System	
Wiring and Lighting System	

PERIODIC INSPECTION CHECK LIST

PROJECT KNAPP BROOK SITE NO. 1 DATE April 23, 1979

PROJECT FEATURE _____ NAME _____

DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
OUTLET WORKS - TRANSITION AND CONDUIT	NONE.
General Condition of Concrete	
Rust or Staining on Concrete	
Spalling	
Erosion or Cavitation	
Cracking	
Alignment of Monoliths	
Alignment of Joints	
Numbering of Monoliths	

PERIODIC INSPECTION CHECK LIST

PROJECT KNAPP BROOK SITE NO. 1 **DATE** April 23, 1979

PROJECT FEATURE _____ **NAME** _____

DISCIPLINE _____ **NAME** _____

AREA EVALUATED	CONDITION
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	
General Condition of Concrete	Good.
Rust or Staining	None observed.
Spalling	None observed.
Erosion or Cavitation	Minor erosion of stream banks.
Visible Reinforcing	None observed in pipe headwall.
Any Seepage or Efflorescence	None observed.
Condition at Joints	Good.
Drain Holes	None observed.
Channel	Natural stream bed, boulder bottom.
Loose Rock or Trees Overhanging Channel	Some, but of little significance.
Condition of Discharge Channel	Good.

PERIODIC INSPECTION CHECK LIST

PROJECT KNAPP BROOK SITE NO. 1 DATE April 23, 1979

PROJECT FEATURE _____ NAME _____

DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
OUTLET WORKS - EMERGENCY SPILLWAY WEIR APPROACH AND DISCHARGE CHANNELS	
a. Approach Channel	
General Condition	Overgrown with brush and 1-inch stock.
Loose Rock Overhanging Channel	None observed.
Trees Overhanging Channel	No.
Floor of Approach Channel	Overgrown with brush.
b. Weir	Extends above channel only 1 foot.
General Condition of Concrete	Good.
Rust or Staining	None observed.
Spalling	None observed.
Any Visible Reinforcing	None observed.
Any Seepage or Efflorescence	None observed.
Drain Holes	Not applicable.
c. Discharge Channel	
General Condition	Overgrown with brush and 1-inch stock.
Loose Rock Overhanging Channel	None observed.
Trees Overhanging Channel	None observed.
Floor of Channel	Overgrown with brush.
Other Obstructions	Restricted channel 50 feet downstream of weir, 105 wide, i.e., 20 feet narrower than channel entrance and 1.5 feet lower than weir crest.

PERIODIC INSPECTION CHECK LIST

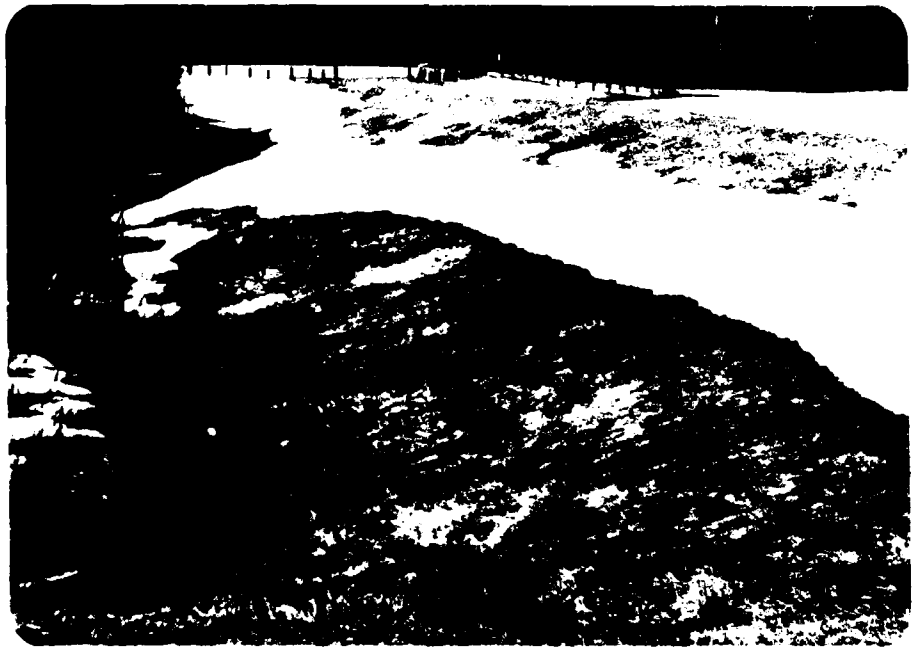
PROJECT KNAPP BROOK SITE NO. 1 DATE April 23, 1979

PROJECT FEATURE _____ NAME _____

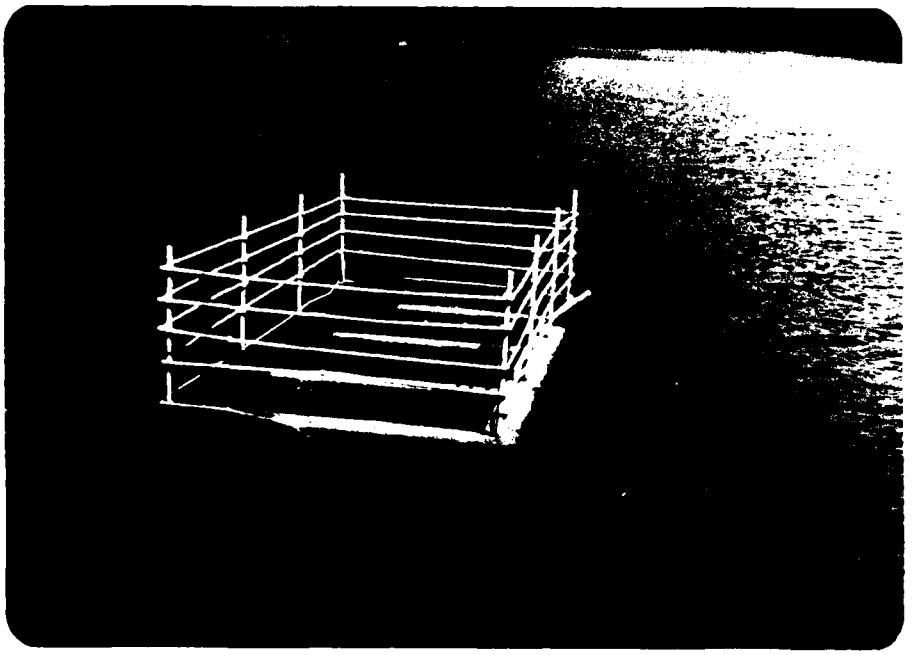
DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
OUTLET WORKS - SERVICE BRIDGE	NONE.
a. Super Structure	
Bearings	
Anchor Bolts	
Bridge Seat	
Longitudinal Members	
Underside of Deck	
Secondary Bracing	
Deck	
Drainage System	
Railings	
Expansion Joints	
Paint	
b. Abutment and Piers	
General Condition of Concrete	
Alignment of Abutment	
Approach to Bridge	
Condition of Seat and Backwall	

#7. OUTLET CHANNEL FROM DROP STRUCTURE.



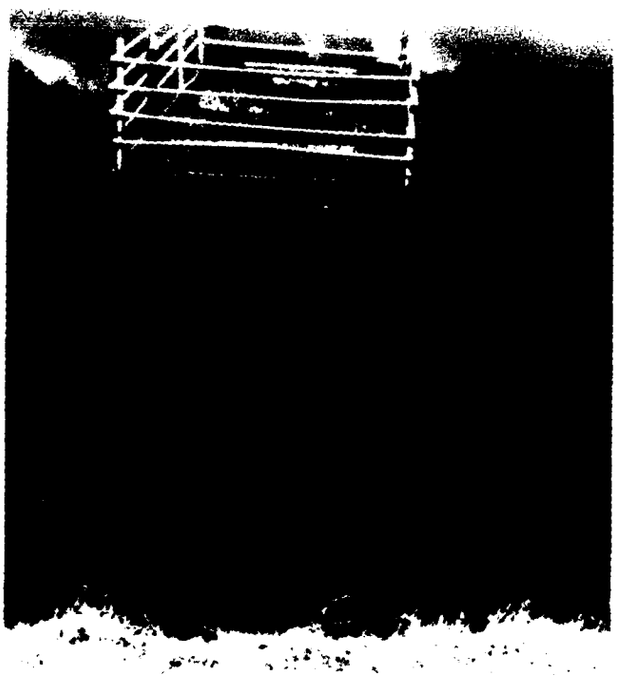
#8. DOWNSTREAM FACE OF DAM; WET AREA IN FOREGROUND.



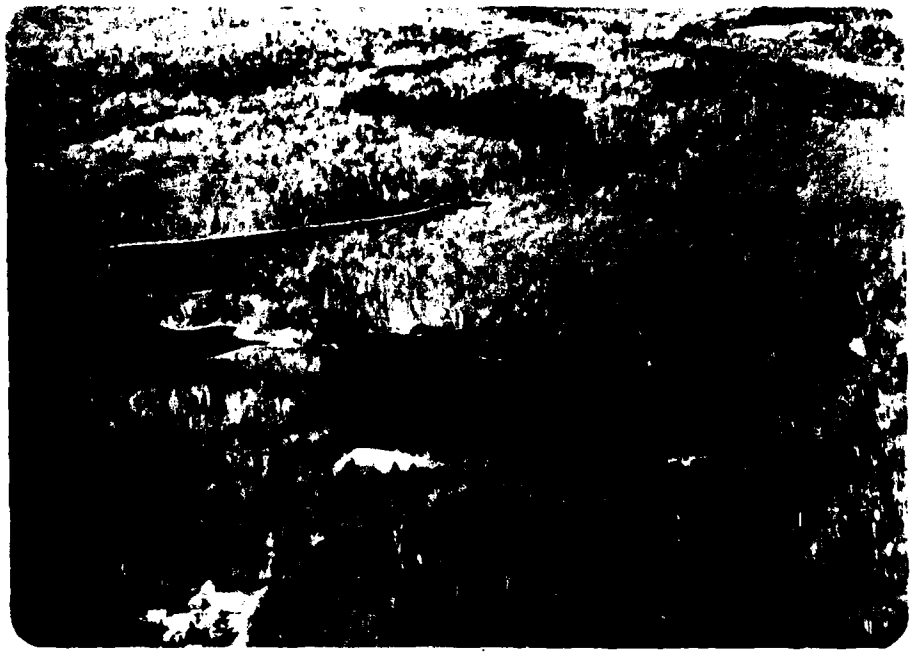
#5. DROP STRUCTURE WITH STOP LOGS IN AND RAILING.

#6. 4-FOOT OUTLET PIPE FROM DROP STRUCTURE.

#3. UPSTREAM FACE OF DAM SHOWING RIPRAP AT WATER'S EDGE.



#4. DROP STRUCTURE WITH HALF A FOOT OF WATER ABOVE CREST. NOTE RIP-RAP IN FOREGROUND AT TOE OF EMBANK-MENT.



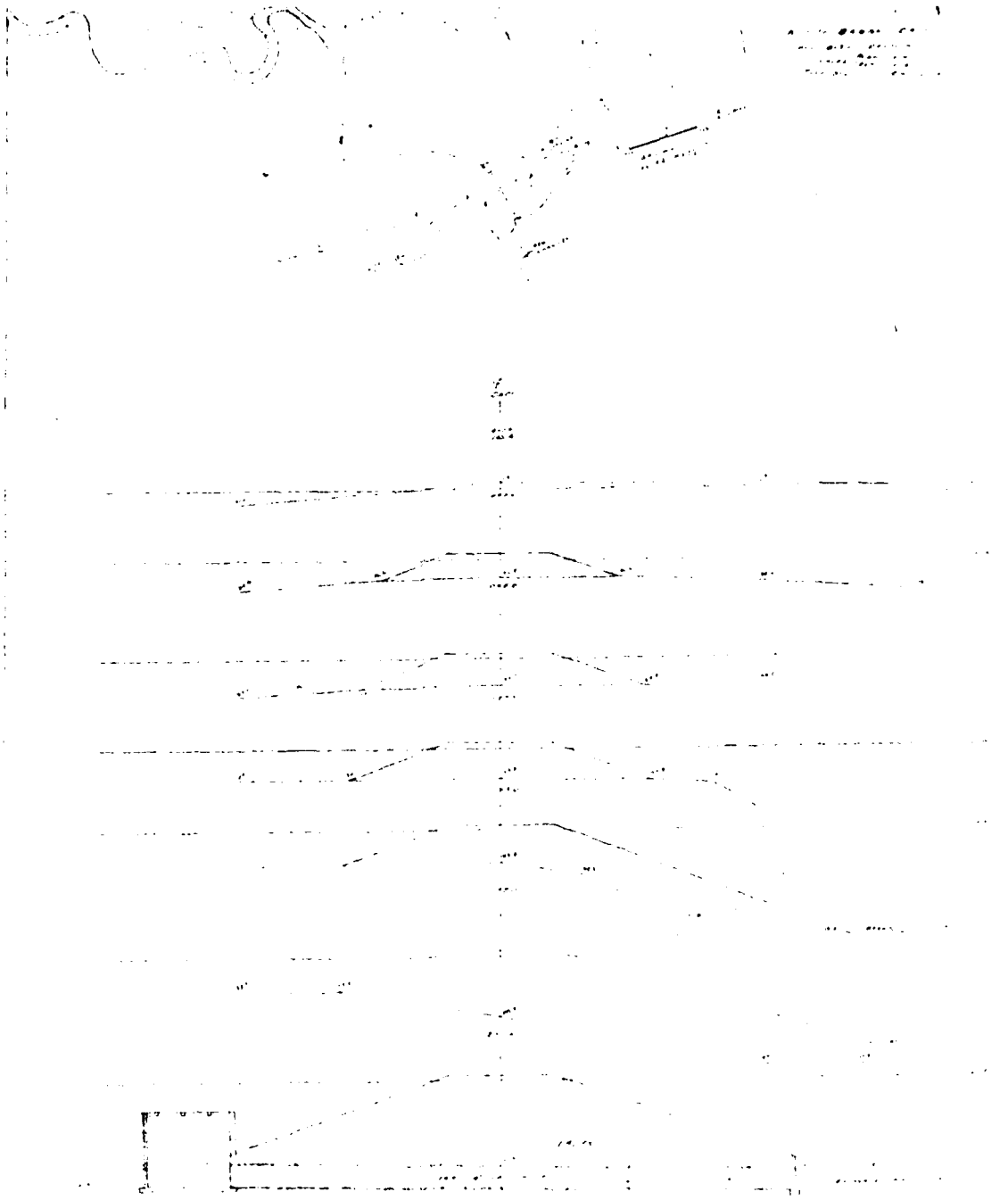
#1. OVERVIEW OF BOTH KNAPP BROOK SITE NO. 1 AND SITE NO. 2 (SITE NO. 1 ON RIGHT).

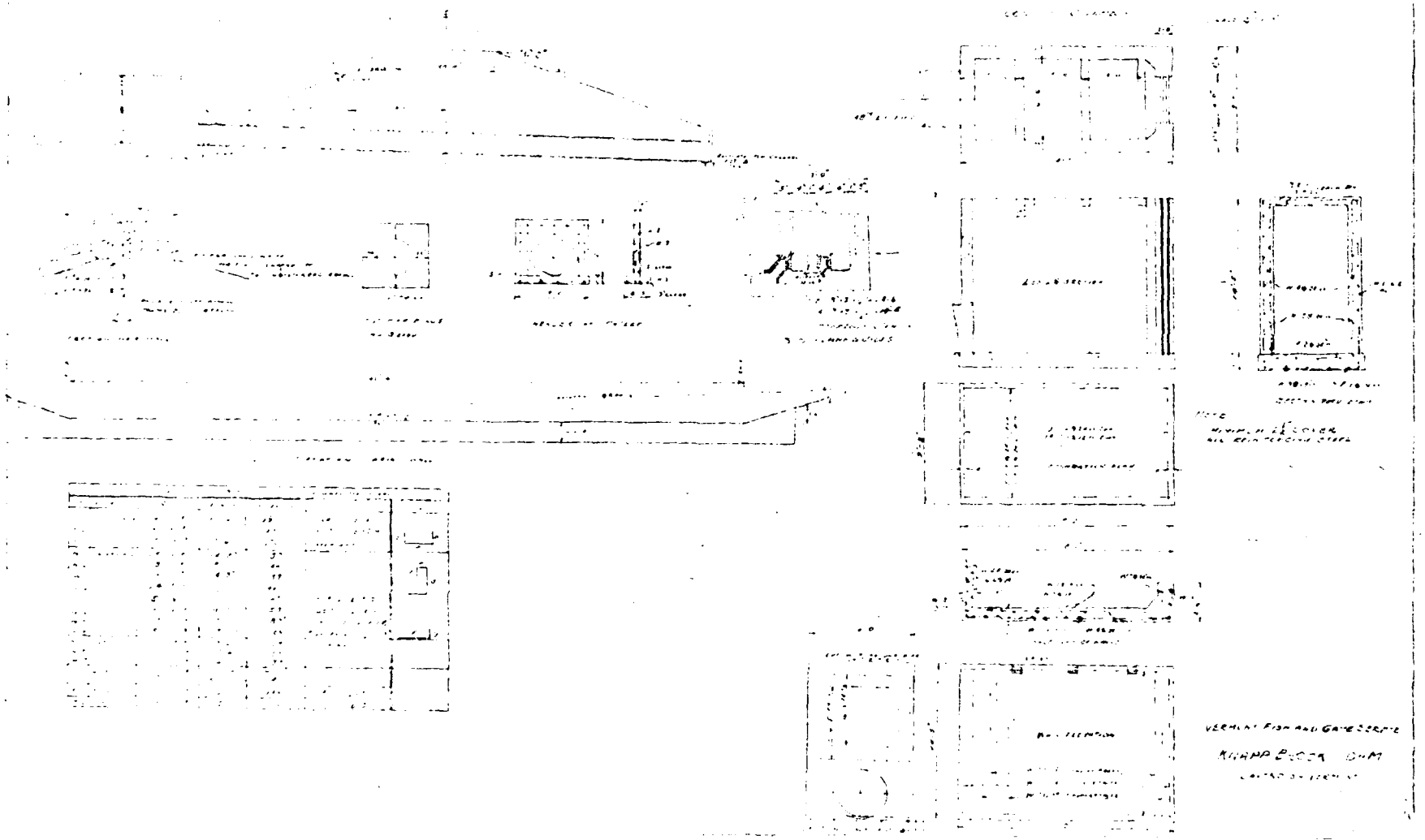
#2. UPSTREAM FACE OF DAM WITH DROP STRUCTURE AND FISHING ACCESS.

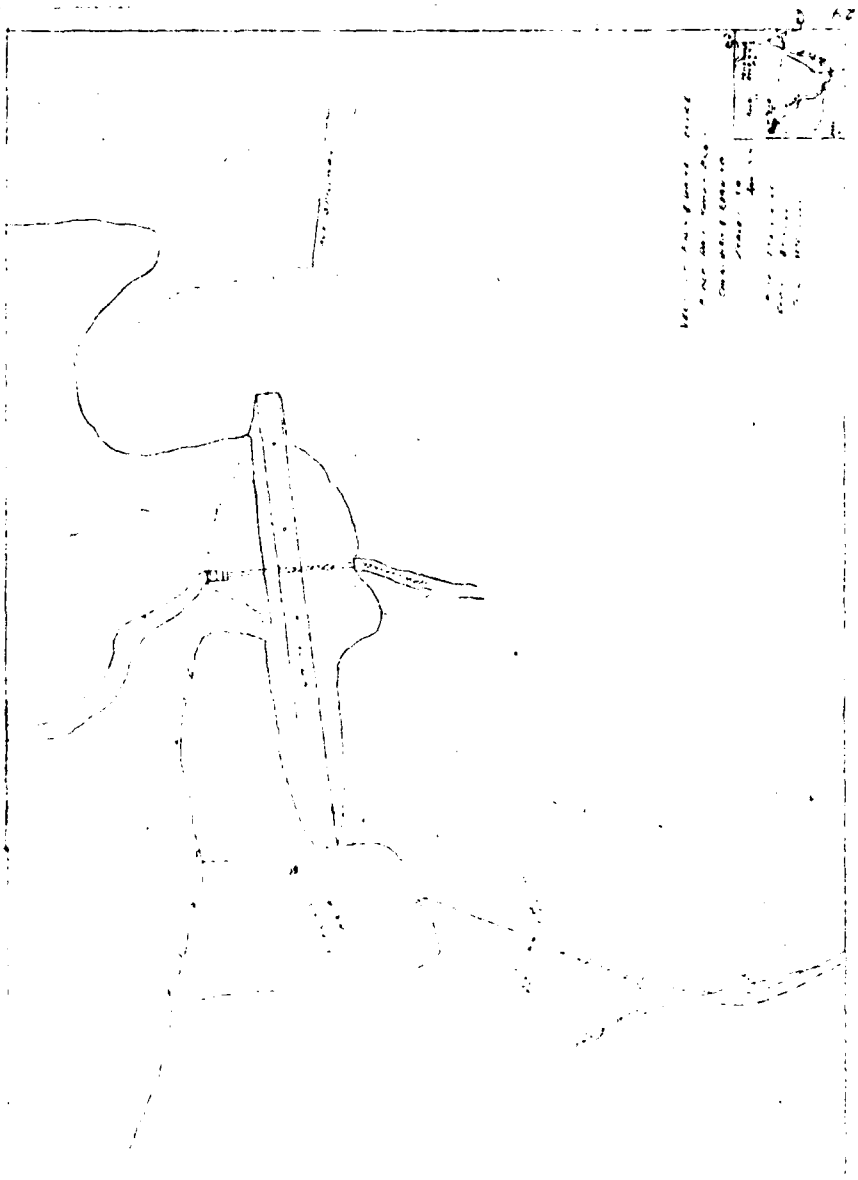
APPENDIX C

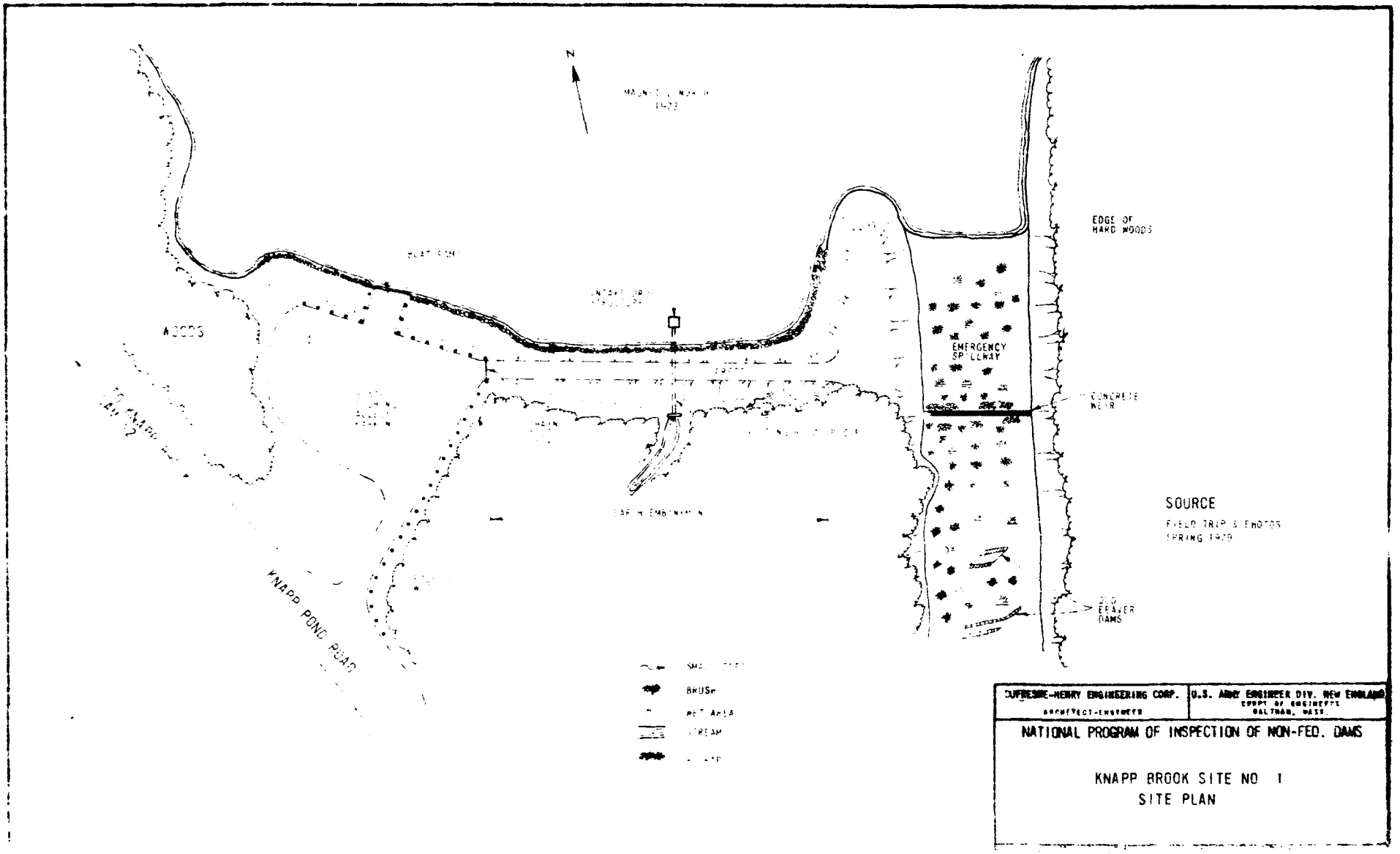
PHOTOGRAPHS

1. Overview of Both Knapp Brook Site No. 1 and Site No. 2 (Site No. 1 on Right).
2. Upstream Face of Dam With Drop Structure and Fishing Access.
3. Upstream Face of Dam Showing Riprap at Water's Edge.
4. Drop Structure With Half a Foot of Water Above Crest. Note Riprap in Foreground at Toe of Embankment.
5. Drop Structure With Stop Logs in and Railing.
6. 4-Foot Outlet Pipe From Drop Structure.
7. Outlet Channel From Drop Structure.
8. Downstream Face of Dam; Wet Area in Foreground.
9. Inlet Channel to Emergency Spillway.
10. Concrete Cut-Off Wall in Emergency Spillway With Riprap on Upstream and Downstream Sides.
11. Outlet Channel of Emergency Spillway With Brush, Trees and Beaver Dam.









DUFRESNE-HENRY ENGINEERING CORP.
ARCHITECT-ENGINEERS

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

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

KNAPP BROOK SITE NO 1
SITE PLAN

Knapp Brook Pond Dam, Site #1 - Cavendish

Edward F. Kehoe, Commissioner, Dept. of Fish & Game

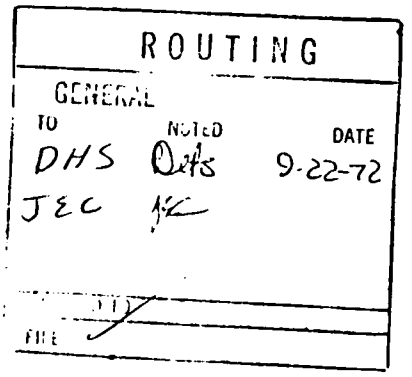
Donald H. Spies, Dam Construction Engineer, Dept. of Water Resources

September 22, 1972

The writer inspected the subject structure on September 21, 1972. The dam is an earth fill structure with a concrete drop inlet and a 4-foot reinforced concrete pipe for the principal spillway. The drop inlet has stop logs to control the water level. The emergency spillway consists of an earth channel with a concrete weir for the control section.

The dam is in very good shape and has been well maintained. However, the same is not so with the emergency spillway. The channel is quite overgrown with brush and saplings, all of which should be cut down and removed.

cc: Robert Collins, Maintenance Supervisor
Richard Sears, Land Negotiator



1 of

VERMONT DEPARTMENT OF WATER RESOURCES

INFORMATION SHEET

Name of Dam Knapp Brook Site #61 Town Cavendish

Owner VT Dept. of Fish & Game Name of Stream Knapp Brook

Address Montpelier Classification II

Vermont

U.S.G.S. Coordinates: Lat. 43°-26'-42" Long. 72°-33'-40"

U.S.G.S. Map Ludlow Aerial Photos VT-62-H 36 232, 233

U.S.G.S. Elev. @ Spillway 1313.68

Total Length of Dam 400' Crest Width of Emergency Spillway 142'

Width of Top 20' Maximum Height 22.5 ft

Spillway Capacity: Principal 360 cfs @ DHWL Emergency 3100 cfs @ DHWL

Pond Area 35 acres Drainage Area 3.41 sq. mi

Pond Volume: Normal Water Level ~~4~~ ' Design High Water Level ~~44~~ '

Maximum Water Depth: Normal Water Level _____ Design High Water Level _____

Storage Before Emergency Spillway is Used _____

Use of Reservoir Trout Pond

Description of Dam: ~~Concrete and~~ earth fill w/3 on 1 slopes on each face

Description of Spillway(s): ~~Dry pipe 48" pipe~~ Concrete Box D.I 15'x6.5' w/ planks. 48 ℄ concrete barrel with slop planks E.S. earth cut w/concrete weir across control section.

Designed by Dept. of Fish & Game Year Built 1957

Hearing Date April 26, 1957 Order Date May 20, 1957

Additional Remarks: * Details w/ closure ; plan file PF 6 (dams)

KNAPP BROOK DAMS

Site No. 1

a. Drainage area - 3.41 square miles
b. Spillway design capacity - 3,410 c.f.s.
c. Normal water surface elevation - 95.00'
d. Crest of emergency spillway - 96.00'
e. Maximum design water surface elevation - 99.5'
f. Top of dam- elevation - 101.00'
g. The 48" drop inlet spillway will handle a maximum of approximately 325 c.f.s. for a design head about 18'
h. The emergency spillway must be capable of passing 3,410 c.f.s.
- 325 c.f.s.
3,085 c.f.s.

i. Length of emergency spillway (required)

$Q = 3.33 L H 3/2$
$3085 = 3.33 \times L \times (3\frac{1}{2}) 3/2$ (feet)
$21.8L = 3085$
$L = 142'$

$Q = 3.33 L H 3/2$
$3085 = 3.33 \times L \times (3) 3/2$
$17.32L = 3085$
$L = 178'$

APPENDIX B

PROJECT RECORDS AND PLANS

PERIODIC INSPECTION CHECK LIST

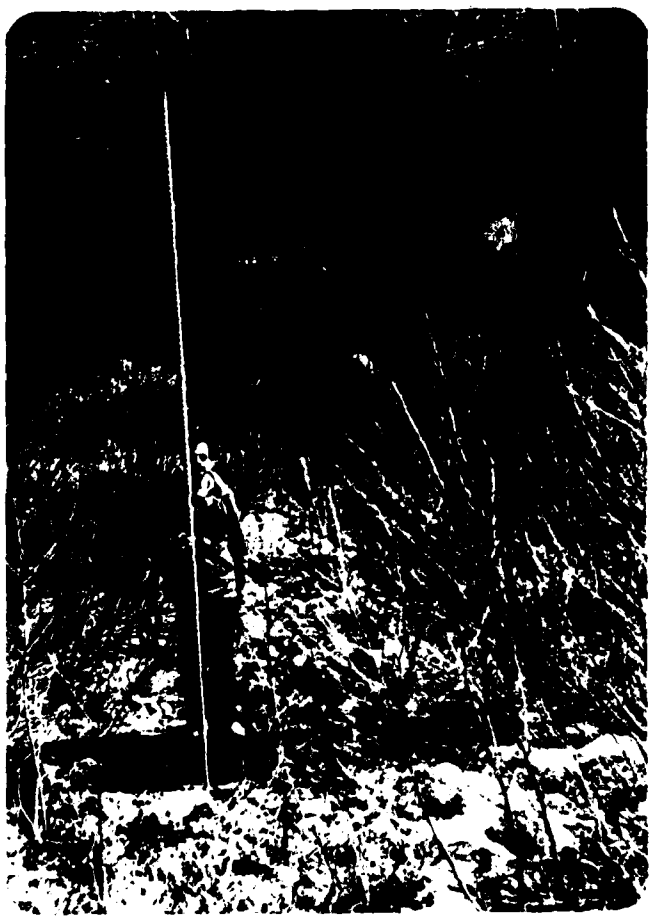
PROJECT KNAPP BROOK SITE NO. 1 DATE April 23, 1979

PROJECT FEATURE _____ NAME _____

DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
RESERVOIR	
Stability of Shoreline	Good stand of trees and brush.
Sedimentation	None observed.
Changes in Watershed Runoff Potential	Very unlikely.
Upstream Hazards	None.
Downstream Hazards	Lower Dam and 4 homes.
Alert Facilities	None.
Hydrometeorological Gauges	None.
Operational and Maintenance Regulations	Fish management pond.

#9. INLET CHANNEL TO EMERGENCY SPILLWAY



#10. CONCRETE CUT-OFF WALL IN EMERGENCY SPILLWAY WITH RIP-RAP ON UPSTREAM AND DOWNSTREAM SIDES.

NOTE: Wall is flush with ground located at base of level rod.

#11. OUTLET CHANNEL OF EMERGENCY SPILLWAY WITH BRUSH, TREES AND BEAVER DAM.

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

CONTENTS

DUFRESNE-HENRY ENGINEERING CORPORATION

BY S.G. FARNSWORTH SUBJECT KNAPP BROOK #2 SHEET NO. 1 OF
DATE 3-22-79 HYDROLOGY COMPUTATIONS FOR HEC-1 JOB NO. 09-0091

DRAINAGE AREA:*

$20.15\ IN^2 * (2000\ FT/IN)^2 * (1\ ACRE/43,560\ SF) = 1850\ ACRE = 2.89\ SQ.MI.$

POND AREA:*

$0.44\ IN^2 * (2000\ FT/IN)^2 * (1\ ACRE/43,560\ SF) = 40.4\ ACRE = .063\ SQ.MI.$

LENGTH OF MAIN STREAM FROM POND TO HEADWATERS:

$6.95\ IN * 2000\ FT/IN = 13,900\ FEET = 2.63\ MILES$

ELEV. @ 85%:

$15\% * 13,900\ FEET \div 2000\ FT/IN = 1.04\ IN \Rightarrow 1600\ ELEV.$

ELEV @ 10%:

$10\% * 13,900\ FEET \div 2000\ FT/IN = 0.70\ IN \Rightarrow 1330\ ELEV.$

AVERAGE STREAM SLOPE:

$$S = \frac{1600\ FEET - 1330\ FEET}{75\%\ \ 2.63\ MILES} = 137\ FT/MILE$$

PRECIPITATION INDEXES:

10 SQ MI	PMS	17.5.
	R 6	111 %
	R 12	123 %
	R 24	133 %

IMPERVIOUS AREA:

$\frac{.44}{20.15} = .022$

$$T_p = 2.2\left[\frac{(L)(L_c)}{(\sqrt{S})}\right]^{.37}$$

L = STREAM LENGTH (MILES)
L_c = 0.6 L
S = AVE SLOPE FT/MI.

$$T_p = 2.2\left[\frac{(2.63)(66)(2.63)}{\sqrt{137}}\right]^{.37} = 1.50$$

* REFERENCE - U.S.G.S SHEET, CAVENDISH, VT., 7½ MINUTE, 1972, 1" = 2000 FEET.

DUFRESNE-HENRY ENGINEERING CORPORATION

BY S.L. FARNSWORTH SUBJECT KNAPP BROOK #2 SHEET NO. 2 OF ___
DATE 3-22-79 HYDROLOGY DATA. JOB NO. 09-0091

SOIL CLASSIFICATION:

FROM THE WINDSOR COUNTY, VERMONT, GENERAL SOIL MAP, U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE.

APPROXIMATELY 50% OF THE AREA IS COVERED WITH WOODSTOCK-PEACHAM (C-B) & 50% OF THE AREA IS COVERED WITH COLRAIN OF THE COLRAIN-SUNCOOK ASSOCIATION (B-C).

USING GROUP C, LAND USE WOODED (FAIR)
CN # 73

INITIAL RAINFALL LOSS FROM SCS TABLE 10.1 I_a (IN/HR.)

$I_a = 0.30$ = STRTL

CNSTL ⇒ .12 IN/HR.

DUFRESNE-HENRY ENGINEERING CORPORATION

BY S. G. FARNSWORTH SUBJECT KNAPP BROOK SITE NO. 1 SHEET NO. 3 OF
DATE 5-10-79 HAZARD CLASSIFICATION & JOB NO. 04-0092
DRAINAGE AREA DATA FOR HEC-1

DAM DATA (GENERAL):

LENGTH OF DAM 390'
HEIGHT OF DAM 21'
LENGTH OF DAM @ MID HEIGHT 200'

STORAGE AT TOP OF DAM 292 AC-ft.

DOWN STREAM HAZARD INFORMATION:
4 HOMES AT TOP OF STREAM BANKS; 0.9 MILES, 1.1 MILES & 2 @ 2.3 MILES

DAM BREAK DISCHARGE:

$$Q_{p1} = \frac{8}{27} W_b \sqrt{g}\, Y_0^{3/2} = \frac{8}{27}[200'(640)]\sqrt{32.2}\,(21)^{1.5} \simeq 12{,}900 \text{ CFS}$$

USING 13,000 CFS

DRAINAGE AREA TO KNAPP #1 BELOW KNAPP #2: *

$$1.96\ IN^2 * (2000\ FT/IN)^2 * 1\ SQ.M/640\ AC * 1\ AC/43560\ SF = 0.28\ SQ.MI.$$
$$(.1435\ SQMI/IN^2)$$

TOTAL DRAINAGE AREA TO KNAPP #1
$(1.96 + 20.15\ IN^2) * .1435\ SQ.MI./IN.^2 = 3.17\ SQ.MI.$

KNAPP #1 SUB-AREA: * (AREA ONLY BETWEEN KNAPP #1 & KNAPP #2)

LENGTH OF STREAM, $0.80" * 2000\ FT/IN = 1600\ FT = 0.30$ MILES
ELEVATION @ .1L = 1285
ELEVATION @ .85L = 1400
SLOPE (S) = $(1400-1285)/(675)(.30\ MILES) = 511\ FT/MILE$

$$T_p = 2.2\left[\frac{L_c L}{\sqrt{S}}\right]^{.37} = 2.2\left[\frac{.6(3)(.3)}{\sqrt{511}}\right]^{.37} = 0.24\ hrs$$

SOIL TYPE: WOOD STOCK - COLRAIN & COLRAIN - BUCKLAND
SOIL IS B-C ⇒ .18
I_a = 0.30

PRECIPITATION:

PMS	18.0
R6	111
R12	123
R24	133

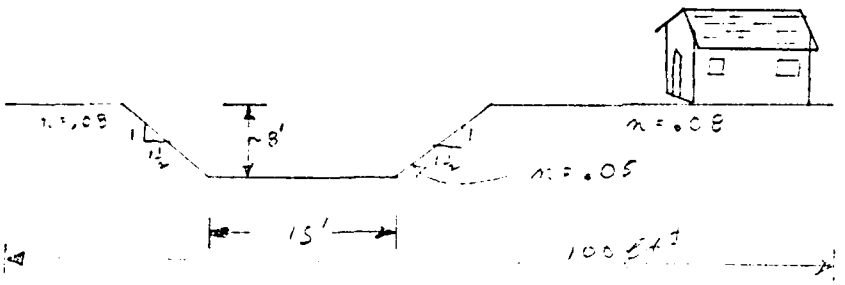
IMPERVIOUS AREA (T10): $\frac{.30}{1.96} = .15$

* REFERENCE, FIG. , U.S.G.S. SHEET, CALVINISH, VT, 1:24000

DUFRESNE-HENRY ENGINEERING CORPORATION

BY S. G. FARNSWORTH SUBJECT KNAPP BROOK SITE NO. 1 SHEET NO. 4 OF ___
DATE 5-10-79 HAZARD CLASSIFICATION JOB NO. 04-0692

FLOOD [illegible] TO VT. 106



$S = \frac{20}{150} = 0.044$ ft/ft

CROSS SECTION 400 FT UPSTREAM OF VT 106

DEPTH ABOVE STREAM BED	n	AREA	WP	Q* (CFS)
8'	.05	216	44	3890 CFS
10'	.05	294	44	6502
	.08	122	61	755
		416		7257 CFS
11'	.05	333	44	8002
	.08	183	61	1483
		516		9485 CFS
12'	.05	372	44	9625
	.08	244	61	2396
				12021 CFS

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

TRIAL #1 ASSUMING 9,500 CFS @ VT 106.

$$Q_{P_2\ (TRIAL)} = Q_{P_1}\left(1 - \frac{V_1}{S}\right)$$

$$Q_{P_2} = 13{,}000\ CFS\left(1 - \frac{516\ Ft \times 2.035\ MILE \times 5280\ FT/MILE \times 43{,}560\ SF/AC}{247\ AC\text{-}Ft}\right)$$

(100 AC-Ft)

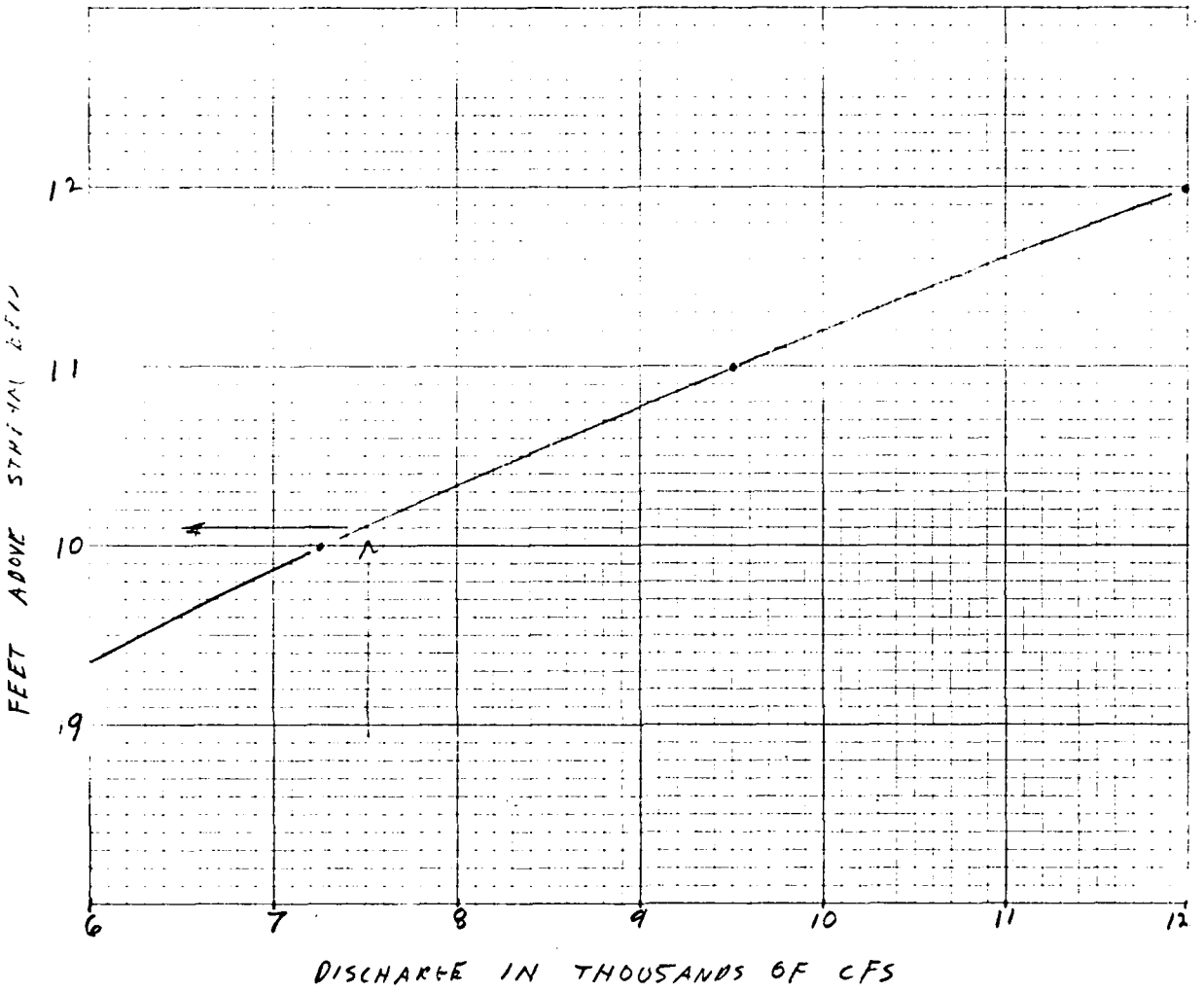
$Q_{P_2} = 6456$ CFS COMPARED TO 9500 CFS

TRIAL #2 ASSUMING 7257 CFS

$$Q_{P_2} = 13{,}000\ CFS\left(1 - \frac{416 \times 2.035 \times 5280 \times 43{,}560}{247\ AC\text{-}Ft}\right)$$

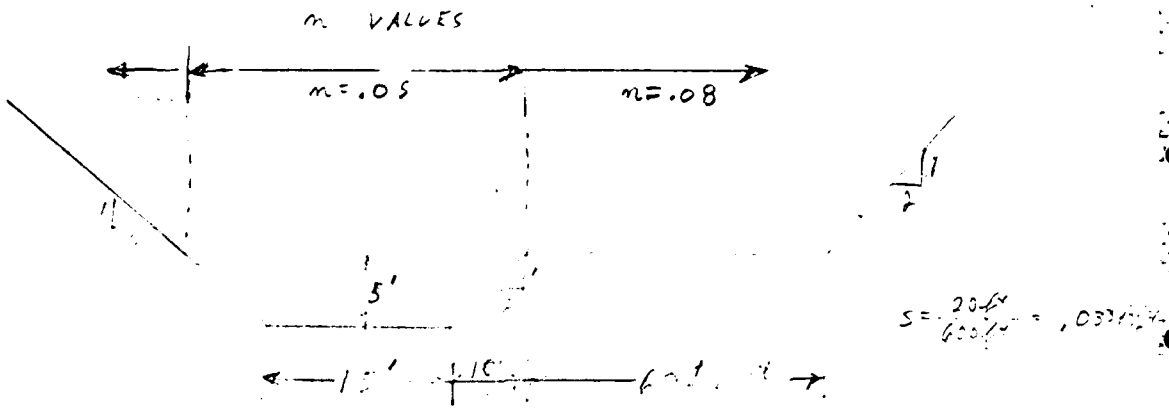
(116 AC-Ft)

$Q_{P_2} = 7724$ CFS VS 7257, USING 7500 CFS



SUMMARY

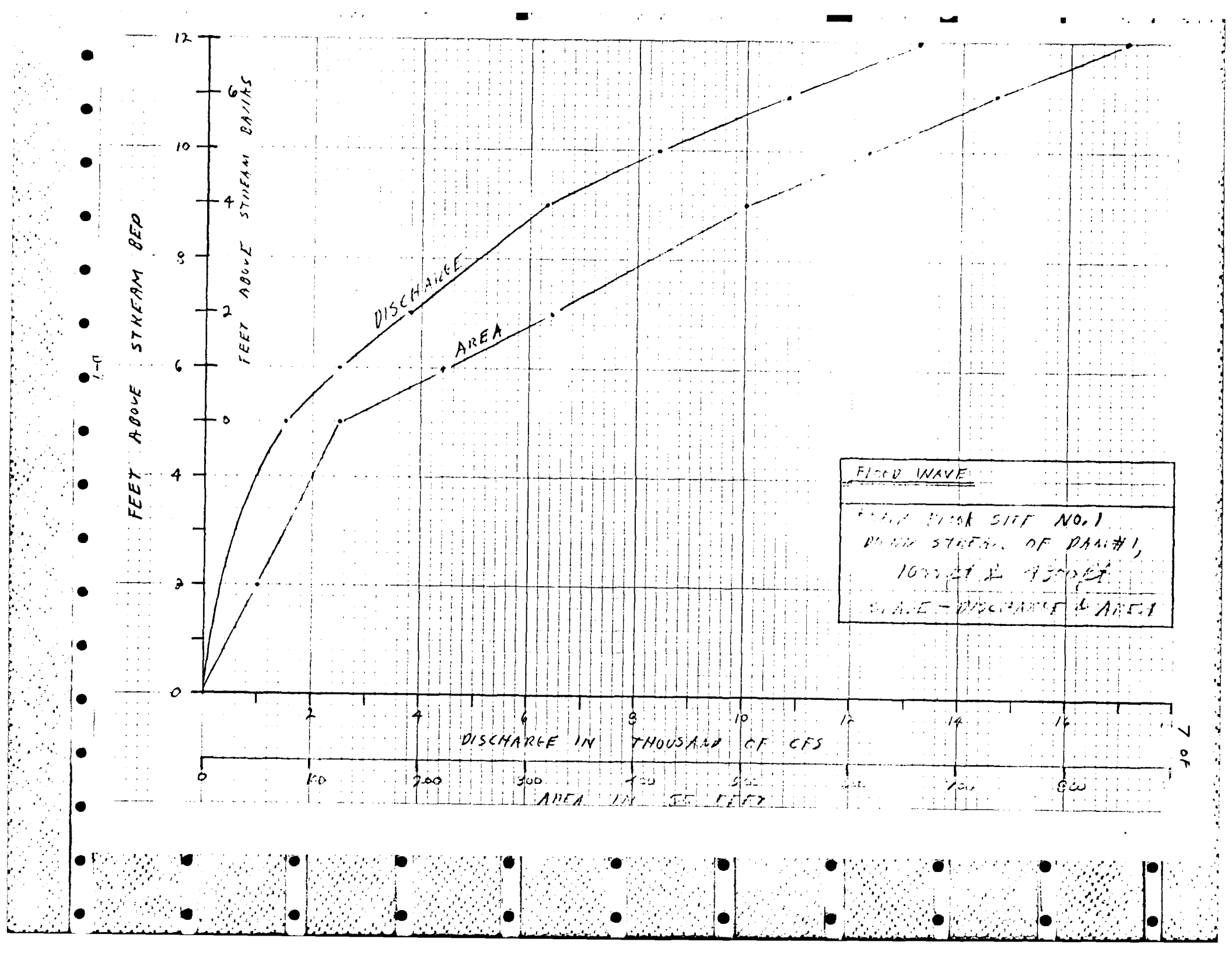
BASED ON FLOOD ROUTING OF DAM BREAK DISCHARGE, THE DEPTH OF FLOW ABOVE STARTING EL. WOULD BE 10.1 FT OR APPROXIMATELY 2 FEET OF FLOW OVER THE DAMS. THIS DISCHARGE WOULD CAUSE THE FLOODING OUT OF 4 OR MORE HOMES AND POSSIBLE LOSS OF A FEW LIVES. ∴ THIS DAM IS RATING CLASSIFIED AS A SIGNIFICANT HAZARD POT. BUT SMALL SCS DAM. ∴ A ½ PMF WILL BE USED TO STUDY DAM.



DEPTH ABOVE STREAM BED (ft)	n	AREA (S.F.)	WP (ft)	Q (CFS)
5	.05	125	37	1519 CFS
6	.05	160	37	2293
	.08	62	64	204
		222		2497 CFS
7	.05	195	37	3188 CFS
	.08	128	68	654
		323		3842 CFS
9	.05	230	37	4198
	.08	272	78	2110
		502		6308
10	.05	265	37	5316
	.08	350	82	3108
		615		8424 CFS
11	.05	300	37	6597
	.08	432	87	4243
		732		10,789 CFS
12	.05	335	37	7857
	.08	518	91	5572
		853		13,229 CFS

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

(ESTIMATED FLOOD HEIGHT AT FOOT OF DAM 7 feet ABOVE STREAM BED, OR 12 feet ABOVE STREAM BED)


FEET ABOVE STREAM BED
FEET ABOVE STREAM BANKS
DISCHARGE
AREA
DISCHARGE IN THOUSAND OF CFS
AREA IN SQ FEET
FLOOD WAVE
SCALE - DISCHARGE & AREA

DUFRESNE-HENRY ENGINEERING CORPORATION

BY M. Root SUBJECT Routing to SHEET NO. 7.1 OF ___
DATE 3-19-80 Potential Damage Cls - Amsden JOB NO. 04-0091

La Bri - Black River Flood Plain
Flood plain = 1400' wide

9,600 + 2,800 = 13,400' = 2.54 miles long

13,400' x 1400' = 430 acres of flood plain V.

292 Ac-ft from dam failure.

Therefore flood wave readily dissipates in flood plain before it reaches Amsden.

other useful hydraulic data

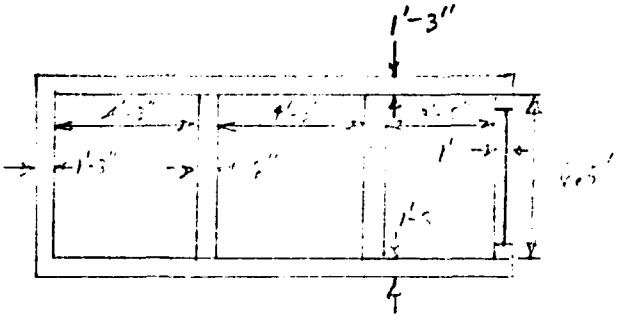
No. Branch - Black River

1973 Flood 5,760 cFS

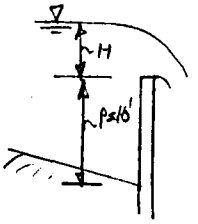
100-Year Flood 7,350 cFS @ 11' above streambed

500-Year Flood 11,550 cFS at 15' above streambed

through "Narrows" in the Town of Cavendish as computed in Cavendish Flood Insurance study.



ELEVATION	H (ft)	H/P	C_e	Q CFS
91.6	0	0	—	0 cfs
92.0	0.4	.04	3.1	28
92.5	0.9	.09	3.21	99
92.6	1.	1.0	3.21	118
93.0	1.4	.14	3.23	193
93.5	1.9	.19	330	311
94.0	2.4	.24	3.31	443
94.5	2.9	.29	3.35	596
95.0	3.4	.34	3.35	756
95.5	3.9	.39	3.39	940
96.0	4.4	.44	3.41	1133
96.5	4.9	.49	3.42	1335
97.0	5.4	.54	3.44	1554
97.5	5.9	.59	3.46	1785
98.0	6.4	.64	3.48	2028



CHECK FOR PIPE MAX DISCHARGE

CONTROLLED BY 4" ORIFICE SEE SHEET #2

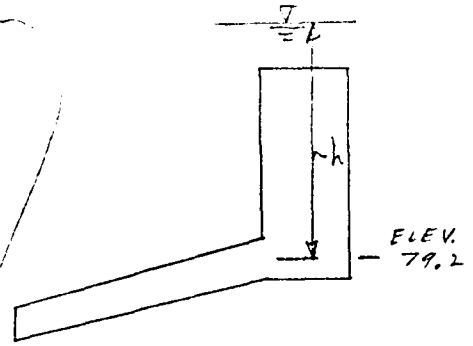
CONTINUE ON NEXT SHEET

DROP STRUCTURE

CHECKING FOR MAXIMUM DISCHARGE OF 48" R.C.P

$$Q = CA\sqrt{2gh} = (.9)(12.6\,SF)\sqrt{2g\,h} = 80.8\sqrt{h}$$

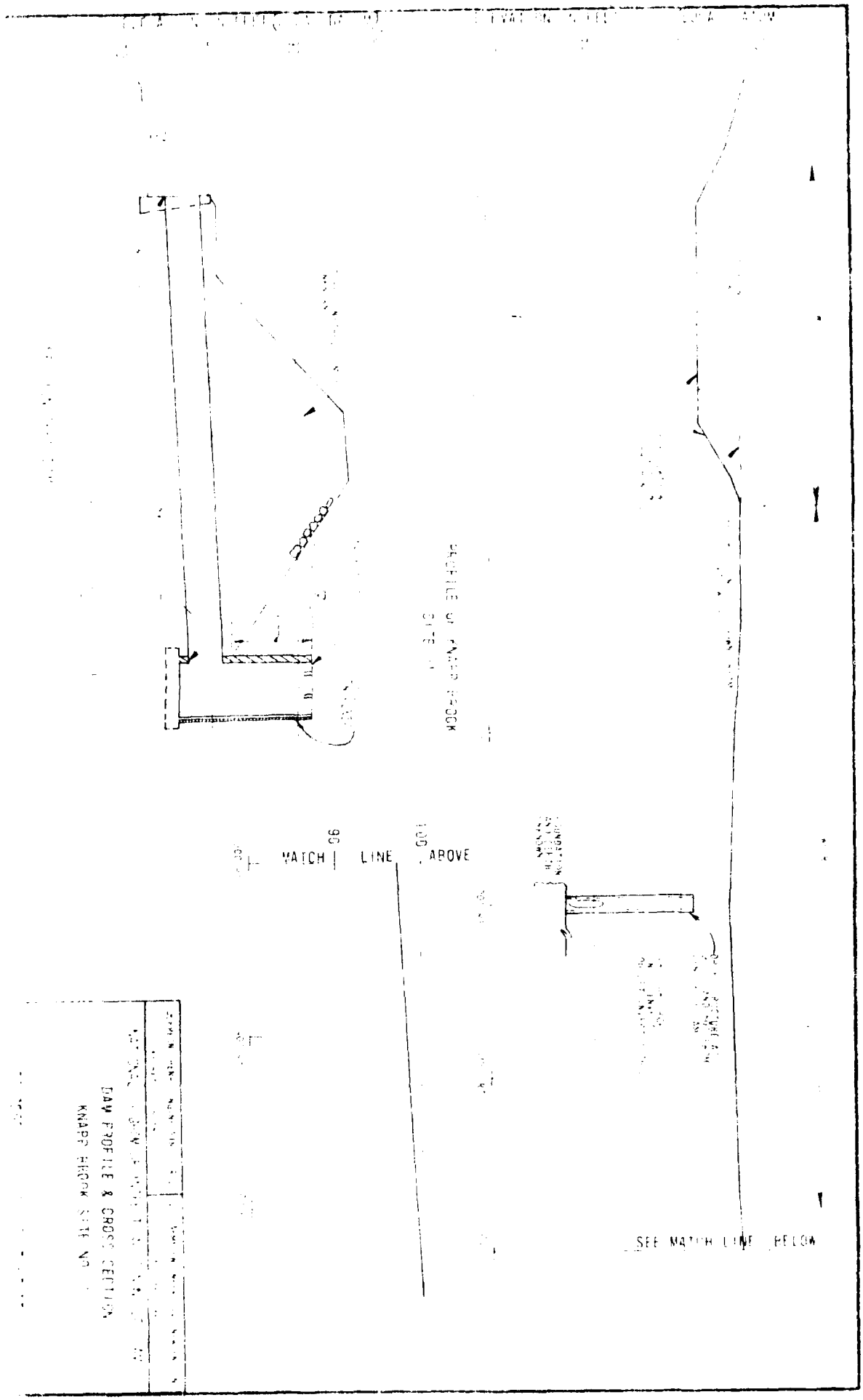
E.F.	h	Q (CFS)
92	12.6	287 CFS
92.5	13.3	295
93.0	13.8	300
93.5	14.3	306
94.0	14.8	311
94.5	15.3	316
95.0	15.8	321
95.5	16.3	326
96.0	16.8	331
96.5	17.3	336
97.0	17.8	341
97.5	18.3	346
98.0	18.8	350
98.5	19.3	355
99.0	19.8	360
100.0	20.8	369



VOID UNDER DROP INLET CONTROL.

UNDER 48" ORIFICE CONTROL, SEE SHEET # 1

TOP OF SPILLWAY AT 92.6
TOP OF DROP AT 95.8


MATCH LINE ABOVE
SEE MATCH LINE BELOW

1	6	40	0.06	0.03	32.
1	6	50	0.06	0.03	49.
1	6	60	0.06	0.03	71.
1	7	10	0.06	0.03	96.
1	7	20	0.06	0.03	123.
1	7	30	0.06	0.03	152.
1	7	40	0.06	0.03	180.
1	7	50	0.06	0.03	206.
1	7	60	0.06	0.03	229.
1	8	10	0.06	0.03	248.
1	8	20	0.06	0.03	263.
1	8	30	0.06	0.03	277.
1	8	40	0.06	0.03	288.
1	8	50	0.06	0.03	297.
1	8	60	0.06	0.03	304.
1	9	10	0.06	0.03	311.
1	9	20	0.06	0.03	316.
1	9	30	0.06	0.03	321.
1	9	40	0.06	0.03	324.
1	9	50	0.06	0.03	328.
1	9	60	0.06	0.03	330.
1	10	10	0.06	0.03	332.
1	10	20	0.06	0.03	334.
1	10	30	0.06	0.03	336.
1	10	40	0.06	0.03	337.
1	10	50	0.06	0.03	338.
1	10	60	0.06	0.03	339.
1	11	10	0.06	0.03	339.
1	11	20	0.06	0.03	340.
1	11	30	0.06	0.03	341.
1	11	40	0.06	0.03	341.
1	11	50	0.06	0.03	341.
1	11	60	0.06	0.03	342.
1	12	10	0.33	0.30	352.
1	12	20	0.33	0.30	389.
1	12	30	0.33	0.30	462.
1	12	40	0.33	0.30	575.
1	12	50	0.33	0.30	730.
1	12	60	0.33	0.30	925.
1	13	10	0.40	0.37	1156.
1	13	20	0.40	0.37	1415.
1	13	30	0.40	0.37	1691.
1	13	40	0.40	0.37	1973.
1	13	50	0.40	0.37	2248.
1	13	60	0.40	0.37	2499.
1	14	10	0.50	0.47	2729.
1	14	20	0.50	0.47	2946.
1	14	30	0.50	0.47	3155.
1	14	40	0.50	0.47	3358.
1	14	50	0.50	0.47	3556.
1	14	60	0.50	0.47	3747.
1	15	10	1.27	1.24	3958.
1	15	20	1.27	1.24	4236.
1	15	30	1.27	1.24	4606.
1	15	40	1.27	1.24	5075.
1	15	50	1.27	1.24	5644.
1	15	60	1.27	1.24	6308.
1	16	10	0.47	0.44	7016.
1	16	20	0.47	0.44	7688.
1	16	30	0.47	0.44	8266.
1	16	40	0.47	0.44	8707.
1	16	50	0.47	0.44	8964.
1	16	60	0.47	0.44	9004.
1	17	10	0.37	0.34	8842.
1	17	20	0.37	0.34	8526.
1	17	30	0.37	0.34	8100.
1	17	40	0.37	0.34	7610.
1	17	50	0.37	0.34	7111.
1	17	60	0.37	0.34	6650.
1	19	10	0.03	0.00	6226.
1	18	20	0.03	0.00	5816.
1	18	30	0.03	0.00	5402.
1	18	40	0.03	0.00	4979.
1	18	50	0.03	0.00	4542.
1	18	60	0.03	0.00	4093.
1	19	10	0.03	0.00	3636.
1	19	20	0.03	0.00	3183.
1	19	30	0.03	0.00	2743.
1	19	40	0.03	0.00	2327.
1	19	50	0.03	0.00	1951.
1	19	60	0.03	0.00	1623.
1	20	10	0.03	0.00	1358.
1	20	20	0.03	0.00	1132.
1	20	30	0.03	0.00	943.
1	20	40	0.03	0.00	874.
1	20	50	0.03	0.00	840.
1	20	60	0.03	0.00	806.
1	21	10	0.03	0.00	774.
1	21	20	0.03	0.00	743.
1	21	30	0.03	0.00	714.
1	21	40	0.03	0.00	685.
1	21	50	0.03	0.00	658.
1	21	60	0.03	0.00	632.

VERSION DATED JAN 1973
D AUG 74
NO. 01

KNAPP POND NO. 1 AND 2
CAVENDISH, VERMONT
TEST FLOOD ROUTING - 0.5 PMF

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
144	0	10	1	0	0	0	2	0	0

JOPER	NWT
3	0

SUB-AREA RUNOFF COMPUTATION

WATERSHED RUN OFF INTO KNAPP POND

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

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	2.89	0.0	0.0	1.00	0.500	0	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.0	18.00	111.00	123.00	133.00	0.0	0.0	0.0

LOSS DATA

STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0.0	0.0	1.00	0.0	0.0	1.00	0.30	0.18	0.0	0.02

UNIT HYDROGRAPH DATA
TP# 1.50 CP#0.75 NTA# 0

RECESSION DATA
STRTQ# 6.00 QRCSN# -0.10 RTIOR# 1.50

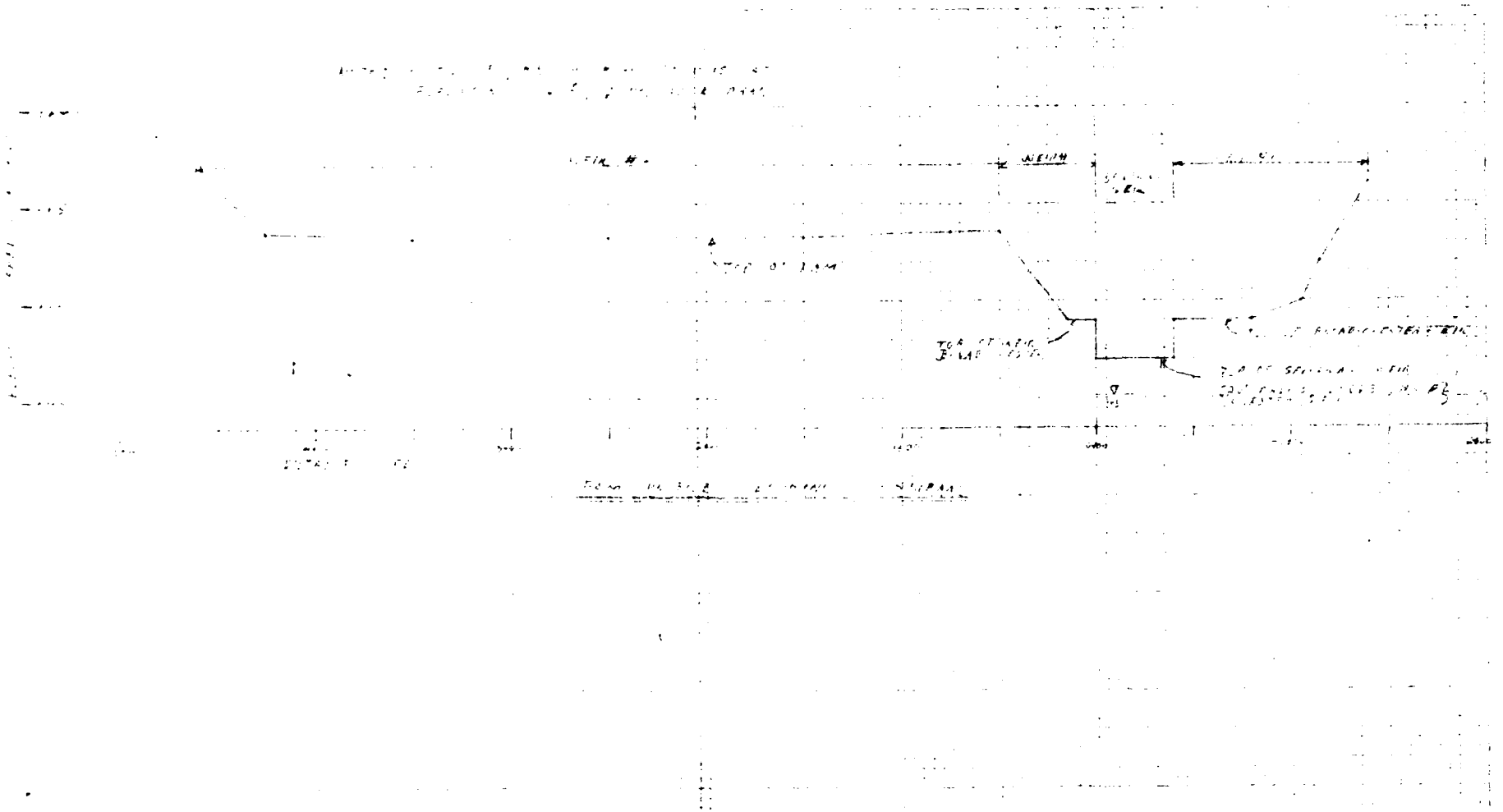
CLIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC#10.75 AND R# 5.58 INTERVALS

UNIT HYDROGRAPH 36 END-OF-PERIOD ORDINATES, LAG# 1.50 HOURS, CP# 0.75 VOL# 1.00

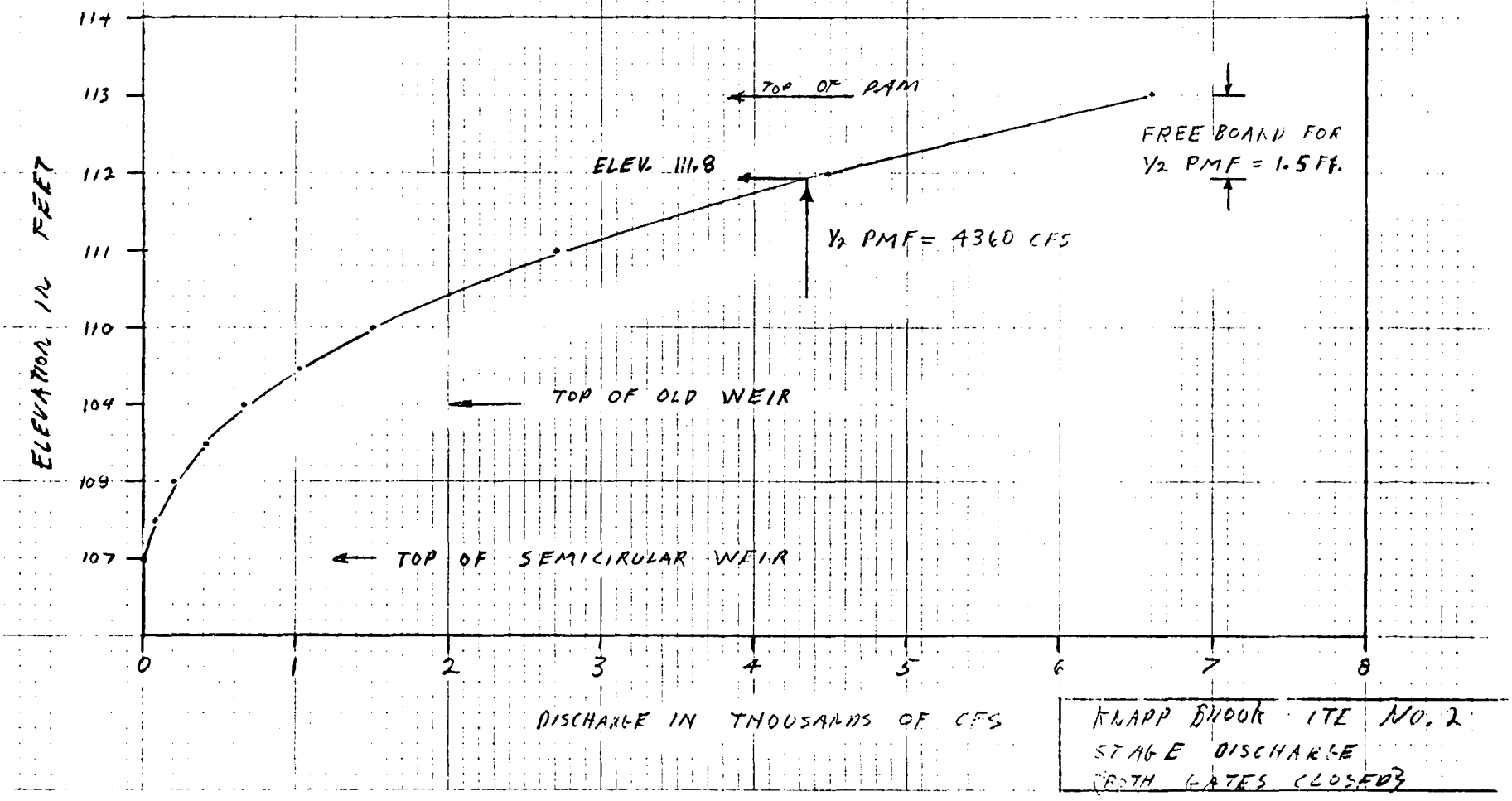
37.	135.	268.	414.	567.	716.	838.	913.	946.	935.
865.	748.	625.	522.	436.	365.	305.	255.	213.	178.
149.	124.	104.	87.	72.	61.	51.	42.	35.	30.
25.	21.	17.	14.	12.	10.				

END-OF-PERIOD FLOW

	TIME	RAIN	EXCS	COMP Q
I	0 10	0.02	0.00	6.
1	0 20	0.02	0.00	6.
1	0 30	0.02	0.00	6.
1	0 40	0.02	0.00	5.
1	0 50	0.02	0.00	6.
1	0 60	0.02	0.00	6.
1	1 10	0.02	0.00	6.
1	1 20	0.02	0.00	6.
1	1 30	0.02	0.00	6.
1	1 40	0.02	0.00	7.
1	1 50	0.02	0.00	7.
1	1 60	0.02	0.00	7.
1	2 10	0.02	0.00	7.
1	2 20	0.02	0.00	7.
1	2 30	0.02	0.00	7.
1	2 40	0.02	0.00	7.
1	2 50	0.02	0.00	7.
1	2 60	0.02	0.00	7.
1	3 10	0.02	0.00	7.
1	3 20	0.02	0.00	7.
1	3 30	0.02	0.00	7.
1	3 40	0.02	0.00	7.
1	3 50	0.02	0.00	7.
1	3 60	0.02	0.00	7.
1	4 10	0.02	0.00	7.
1	4 20	0.02	0.00	7.
1	4 30	0.02	0.00	7.
1	4 40	0.02	0.00	7.
1	4 50	0.02	0.00	7.
1	4 60	0.02	0.00	7.
1	5 10	0.02	0.00	7.
1	5 20	0.02	0.00	7.
1	5 30	0.02	0.00	6.
1	5 40	0.02	0.00	6.
1	5 50	0.02	0.00	6.
1	5 60	0.02	0.00	6.
1	6 10	0.06	0.03	7.
1	6 20	0.06	0.03	11.
1	6 30	0.06	0.03	19.



FIELD	1	2	3	4	5	6	7	8	9	10
ELEVATION (FT)	107	107.5	108	108.5	109	109.5	110	111	112	113
STORAGE (AC-FT)	368	387	405	420	444	460	483	524	566	610
DISCHARGE (CFS)	0	74	217	420	666	1004	1509	2727	4474	6600



KNAPP BROOK ITE NO. 2
STAGE DISCHARGE
(BOTH GATES CLOSED)

DUFRESNE-HENRY ENGINEERING CORPORATION

S.G. FARNSWORTH 5-16-79

SUBJECT KNAPP BROOK SITE NO2 OPEN FLOW HYDRAULICS

SHEET NO. 20 OF

JOB NO. 04-0091

$Q = C L_{AVE} H^{3/2}$

ELEVATION (msl)	WEIR #1 (BROAD-CRESTED) H	L	L_{AVE}	C	Q (CFS)	WEIR #2 (BROAD-CRESTED) $H_{(FT)}$	$L_{(FT)}$	L_{AVE}	C	Q (CFS)	SPILLWAY FROM SHEET #1	TOTAL Q
104.0	0	55	55	2.78	0						666	666
104.5	.5	70	62.5	2.78	61 CFS						963	1024
110.0	1.0	88	71	2.78	197						1312	1509
110.5	1.5	93	76.5	2.78	391						—	—
111.0	2.0	100	81	2.78	637						2090	2727
111.5	2.5	106	85	2.78	934						—	—
112.0	3.0	113	89	2.78	1286						3188	4474
112.5	3.5	120	93	2.78	1693						—	—
113.0	4.0	126	97	2.78	2157						4449	6606
113.3	4.3	130~	98	2.78	2430	0	200	200	2.78	0	4725	7155
113.5	4.5	133	100	2.78	2654	.2	350	275	2.78	68	5152	7874
114.0	5.0	137	104	2.78	3232	.7	380	310	2.78	504	5908	9644
114.5	5.5	140	107	2.79	3851	1.2	385	329	2.78	1203	—	—
115.0	6.0	143	109	2.80	4486	1.7	390	341	2.78	2100	7602	14,188
115.5	6.5	147	112	2.80	5196	2.2	395	350	2.78	3175	8539	16,910

$Q = C L_{AVE} H^{3/2}$

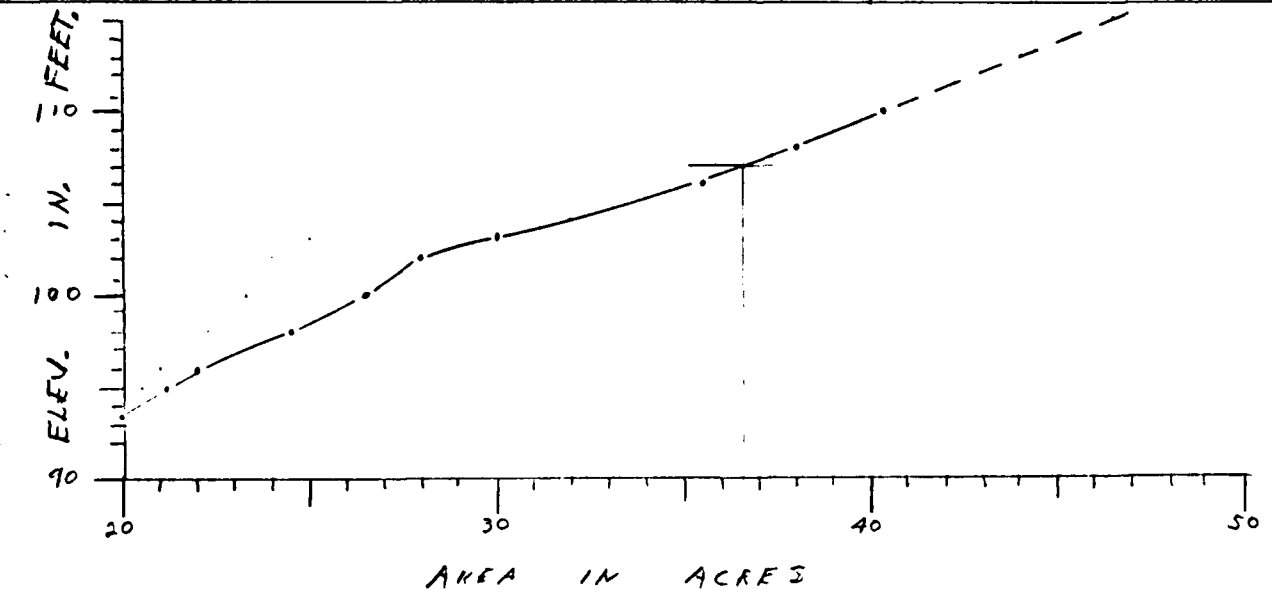
C VALUES FROM KING & BRATER, HANDBOOK OF HYDRAULICS, TABLE 5-5(a), (LEVEL CREST)

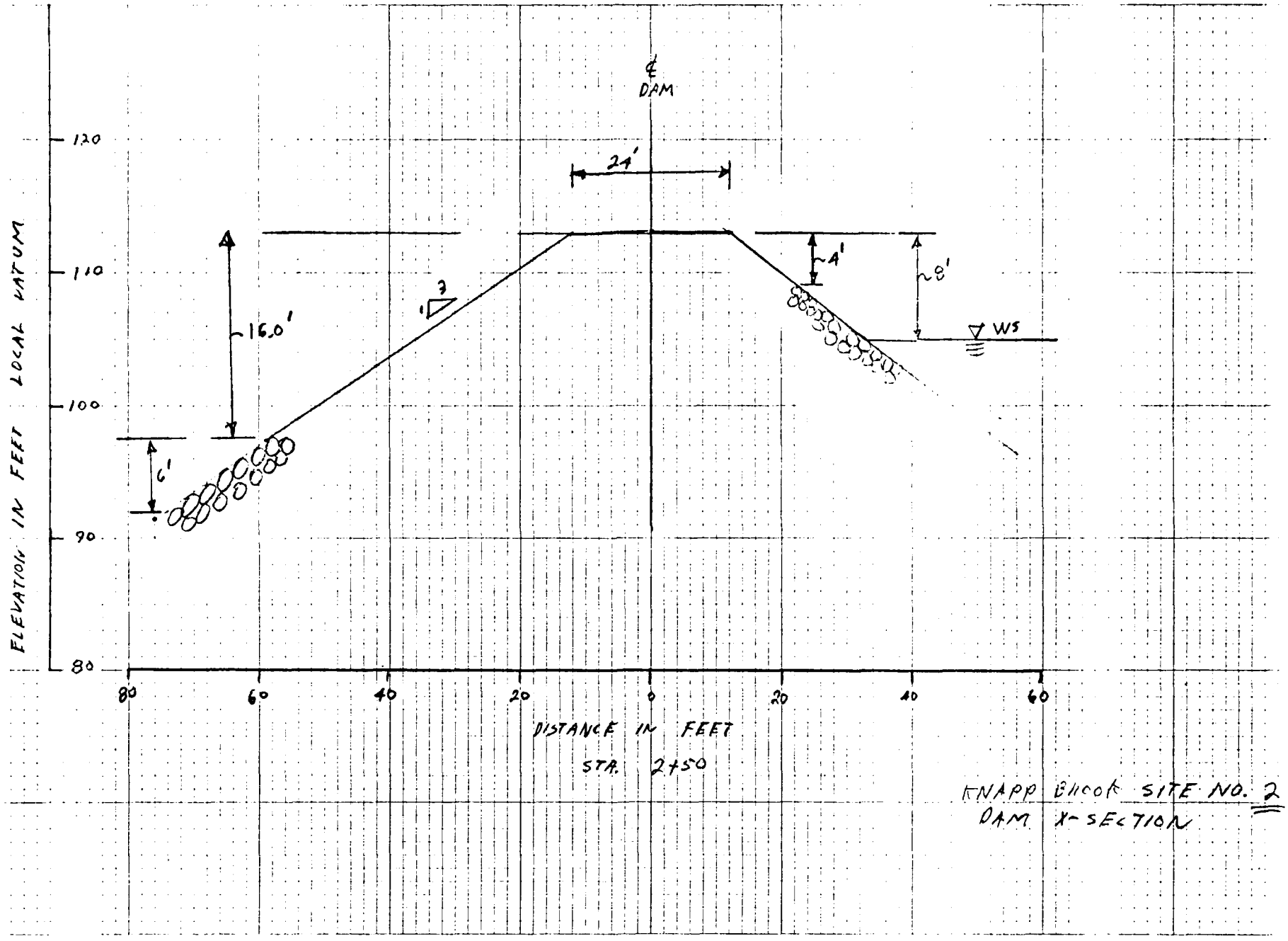
DUFRESNE-HENRY ENGINEERING CORPORATION

BY S.G. FARNSWORTH SUBJECT KNAPP BROOK SITE #2 SHEET NO. 19 OF ___

DATE 5-29-79 STORAGE JOB NO. C9-0691

ELEVATION (FEET)	SURFACE AREA (ACRES)	STORAGE TO EXISTING STREAM BED AT MAIN (AC-FT)	REMARKS
115	46.5	700	NOTE 1. FROM PAST DH STUDY
114	45.4	654	
113	44.0 — NOTE 3	610 → TOP OF DAM	NOTE 2. FROM PAST DH STUDY CONTOURS OF 1" APPROX.
112	43.0	566	
111	41.7	524	
110	40.3	483	NOTE 3. TAKEN FROM GRAPH AT BOTTOM OF PAGE.
108	38.0 — NOTE 2	405 → TOP OF SPILLWAY (107)	
106	35.5	331	
104	32.0 — NOTE 3	264	
103	30.0	232.8	
102	28.0	203.8	
100	26.6 — NOTE 1	149.2	
98	24.5	98.1	
96	22	51.6	
95	21.1	30.1	
93.5	19	0	





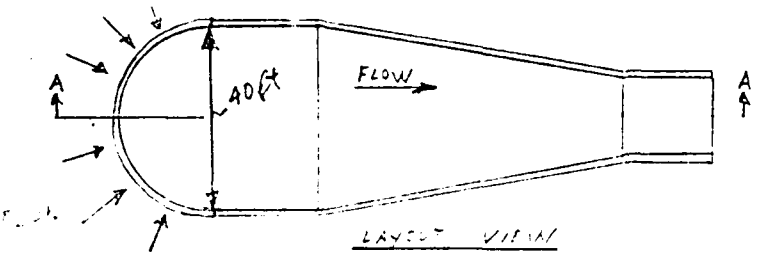
KNAPP BROOK SITE NO. 2
DAM X-SECTION

DUFRESNE-HENRY ENGINEERING CORPORATION

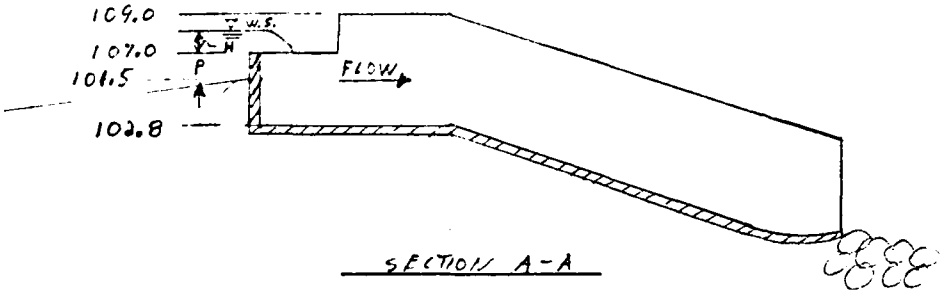
BY S.C. FARNSWORTH SUBJECT KNAPP DAM SITE NO. 2 SHEET NO. 17 OF ___
DATE 5-16-79 SPILLWAY HYDRAULICS JOB NO. 09-0091

SPILLWAY HYDRAULICS:

ELEVATIONS, LOCAL DATUM.



$L = \pi \, DIA/2 = \pi \, 40\frac{ft}{2} = 62.8'$



$Q = Ce \, L \, H^{3/2}$

ELEVATION (ft.)	H (ft)	H/P *	Ce *	Q
107	0	0	0	0 CFS
107.5	.5	.33	3.35	74 CFS
108.0	1.0	.67	3.45	217
108.5	1.5	1.0	3.64	420
109.0	2.0	1.33	3.75	666
109.5	2.5	1.67	3.85	963
110	3.0	2.0	4.02	1312
111	4.0	2.4	4.16	2090
112	5.0	3.3	4.54	3188
113	6.0	4.0	4.82	4449
113.5	6.5	4.33	4.95	5152
114	7.0	4.66	5.08	5908
115	8.0	5.33	5.35	7602
116	[illegible]	MAX Q...	5.49	[illegible]

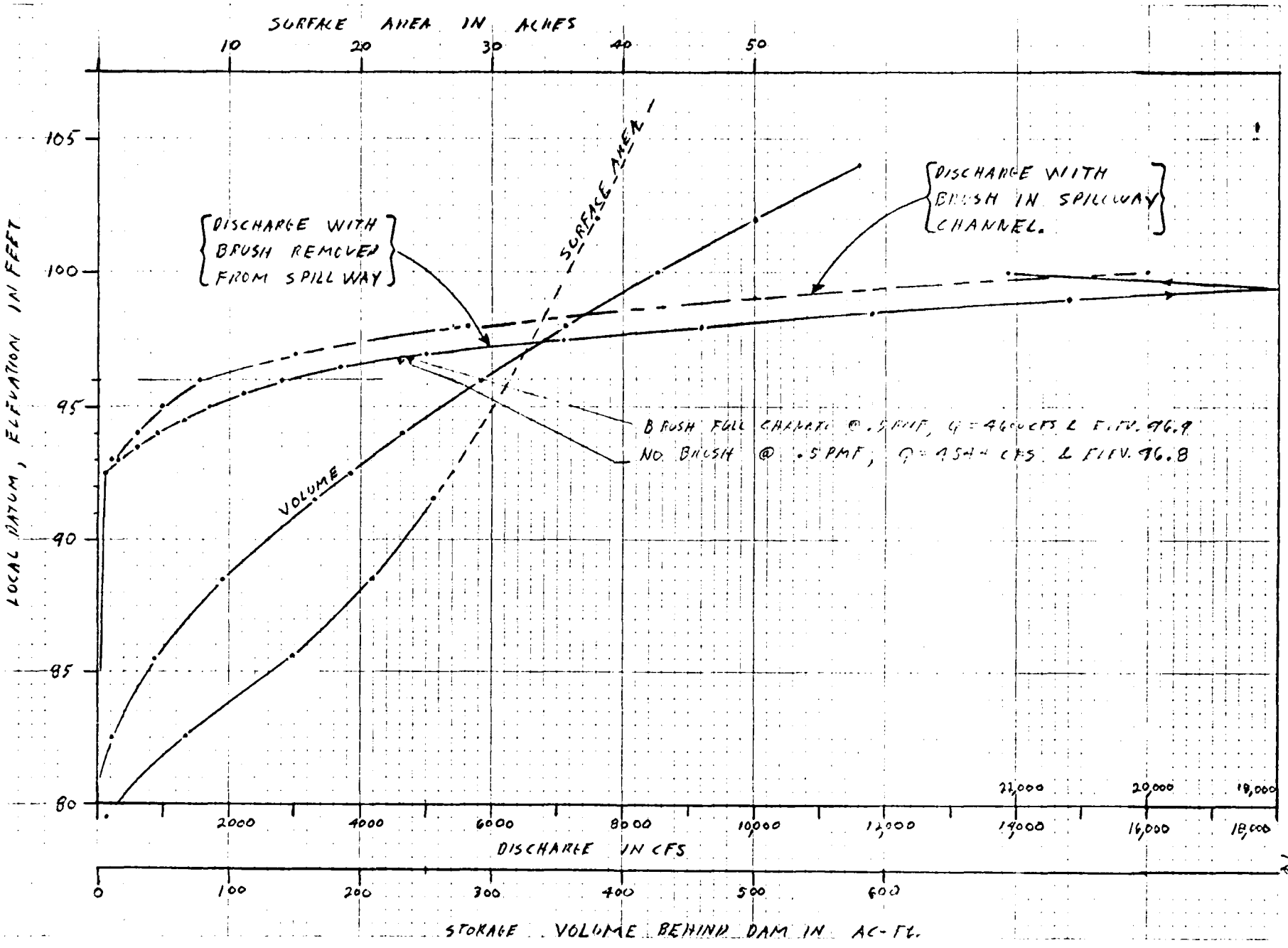
* REFERENCE - KING & BRATER, HANDBOOK OF HYDRAULICS, SIX EDITION, PAGE 5-14.

Ce, (.33 → 2.4) H/P
F.G. 5.3(b)

FOR Ce WHEN H/P IS BETWEEN 2.4 & 5.67

$Ce = 3.22 + .4\frac{H}{P}$

[MAX. PRO. FLOOD. = 2.89 sq mi * 2400 cfs/sq mi = 6736 CFS]
1/2 3500 ?



S.G. FARNSWORTH
5-22-79
MAIN BRUSH SITE #1.
04-0092

DUFRESNE-HENRY ENGINEERING CORPORATION

BY S.G. FARNSWORTH SUBJECT KNAPP BROOK SITE NO. 1 SHEET NO. 15 OF ___

DATE 5-23-79 STAGE STORAGE - DISCHARGE TABLE JOB NO. 09-0092

ELEVATION (Ft)	STORAGE AC-Ft	DISCHARGE (CFS) BRUSH REMOVED FROM SPILLWAY	DISCHARGE (CFS) BRUSH COVERED SPILLWAY	REMARKS
91.6	166	0	0	INVERT OF DROP STRUCTURE.
92.0	179	28	28	
92.6	192	118	118	INVERT OF SPILLWAY WEIR. (START HEC-1 HERE)
93.0	205	277	236	
94.0	231	898	589	
95.0	260	1,707	989	
96.0	292	2,802 *	1549 *	TOP OF EARTH DAM
97.0	325	4,991	3011	
98.0	357	9,182	5669	
99.0	391	14,813	10,081	
100.0	427	22,153	15,933	

EC-1 INPUT

* $\frac{1509}{2802} * 100\% = 54\%$, BECAUSE OF THE BRUSH IN THE SPILLWAY, THE CAPACITY OF THE SPILLWAY DISCHARGE AT TOP OF DAM IS REDUCED BY 46% ±. STRONGLY RECOMMEND THE REMOVAL OF BRUSH FROM THE SPILLWAY AND BEAVER DAMS FROM THE SPILLWAYS DISCHARGE CHANNEL.

KNAPP BROOK SITE NO. 1 SPILLWAY IS COMPLETLY COVERED WITH 1" - 2" BRUSH STANDING 8' HIGH. ESTIMATED N = 0.12. THE FOLLOW HYDRAULICS IS BASED ON EXISTING CONDITIONS, ASSUMING NORMIAL FLOW AT THE RESTRICTED SECTION AND BRUSH IN CHANNEL.

ELEV. (ft)	AREA (S.F.)	W.P. (ft.)	DISCHARGE (CFS)
93.0	54	112	43 CFS
93.5	113	118	143
94.0	172	124	278
94.5	237	130	367
95.0	302	136	668
95.5	373	142	922
96.0	444	148	1200
96.5	523	158	1509
97.0	602	168	1830
97.5	706	232	1926
98.0	809	240	2362
98.5	935	249	2934
99.0	1061	257	3546
99.5	1194	266	4220
100.0	1328	274	4940 CFS

$S = 4\text{ft}/370\text{ft} = .011$

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

$$Q = \frac{1.486}{0.12}(.011)^{1/2} A R^{2/3}$$

$$Q = 1.30\ A R^{2/3}$$

$$Q = 1.30\ A \left(\frac{A}{WP}\right)^{2/3}$$

$Q = C L_{AVE} H^{3/2}$

RESTRICTED SECTION DOWN STREAM OF ONLY 105' WIDE

[IF BRUSH IS REMOVED!] {ASSUMING CRITICAL DEPTHS}

BY S.G. FARNSWORTH DATE 5-16-79 SUBJECT DAM - SHAPP ROAD SITE NO. 1 SHEET NO. 13 OF JOB NO. 64-5092

ELEVATION (Feet)	SPILLWAY – BROAD CRESTED WEIR #1 H (Ft)	L (Ft)	L_{A-E} (Ft)	C	Q (CFS)	DAM – BROAD CRESTED WEIR #2 H	L	L_{A-E}	C	Q (CFS)	TOTAL Q (CFS)	TOTAL Q BRUSH REMOVED FROM SPILLWAY (CFS)
92.6	0	105	105	3.08	0 CFS						118	118 CFS
93.0	.4	112	108		84						193	277
93.5	.9	118	112		294						306	600
94.0	1.4	124	115		587						311	898
94.5	1.9	130	118		952						316	1,268
95.0	2.4	135	121		1386						321	1,707
95.5	2.9	141	124		1888						326	2,214
96.0	3.4	147	127		2453	.2	75	75	2.78	18 CFS	331	2,802
96.5	3.9	158	130		3084	.7	260	167		272	336	3,692
97.0	4.4	170	134		3810	1.2	355	230		940	341	4,991
97.5	4.9	235	143		4777	1.7	450	285		1756	346	6,879
98.0	5.4	245	152		5875	2.2	490	326		2957	350	9,182
98.5	5.9	250	159		7018	2.7	520	358		4415	355	11,788
99.0	6.4	260	166		8278	3.2	565	388	2.78	6175	360	14,813
100.0	7.4	280	180		11,160	4.2	670	444		14624	369	22,153

DUFRESNE-HENRY ENGINEERING CORPORATION

USING FISH & GAME CONTOUR MAP OF KNAPP NO. 1 *

ASSUMING ZERO DEPTH AS TOP OF DROP STRUCTURE: {ELEVATION 96.6}

DEPTH	ELEVATION	AREA IN²	AREA ACRES	ΔH	VOL (AC-FT)	Σ VOL (AC-FT)
-12	79.6	0.18	0.7		0	0
				3		
-9	82.6	1.75	6.4		10.7	10.7
				3		
-6	85.6	4.03	14.8		31.8	42.5
				3		
-3	88.6	5.70	20.9		53.6	96.0
				3		
0	91.6	6.98	25.6**		69.8	166
				1.0		
	92.6	-	27		26.3	192
				1.4		
	94	-	29		39.2	231
				2		
	96	-	31.2		60.2	292
				2		
	98	-	34.2		65.4	357
				2		
	100	-	35.8		70.0	427
				2		
	102	-	38***		73.8	501
				2		
	104	-	40		78.0	579

* INCORRECT SCALE ON MAP, 1" = 400 FT & NOT 200 FT
∴ 1 IN² = (400 FT/IN)² / 43,560 SF/AC = 3.67 AC/IN²

** AS COMPARED TO 25.7 AC FROM U.S.G.S SHEET . .
{0.28 IN² × (2000 FT/IN)² × 1 AC/43,560 SF = 25.7 AC}

*** ESTIMATED USING U.S.G.S SHEET @ ELEV 1280

(1) CHEMICAL STATION

AQUATIC VEGETATION

GILLNET SETS

SOURCE OF MAP:

VERMONT FISH & GAME
MONTPELIER VERMONT
SCALE: 1" 400' APPROX

DUFRESNE-HENRY ENGINEERING CORP. ARCHITECT-ENGINEER	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

DEPTH CONTOUR MAP
KNAPP BROOK SITE NO. 1

CLIENT NO	04-0092		SCALE 1"=400'
ENGINEER	SGF		DATE MARCH 1980

1 22 10	0.03	0.00	607.
1 22 20	0.03	0.00	583.
1 22 30	0.03	0.00	560.
1 22 40	0.03	0.00	537.
1 22 50	0.03	0.00	516.
1 22 60	0.03	0.00	496.
1 23 10	0.03	0.00	476.
1 23 20	0.03	0.00	457.
1 23 30	0.03	0.00	439.
1 23 40	0.03	0.00	421.
1 23 50	0.03	0.00	405.
1 23 60	0.03	0.00	389.
SUM	24.00	20.04	231868.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	9004.	5375.	1610.	1610.	231865.
INCHES		17.30	20.73	20.73	20.73
AC-FT		2667.	3195.	3195.	3195.

NAC

RUNOFF MULTIPLIED BY 0.50

3.	3.	3.	3.	3.	3.	3.	3.	3.	3.
3.	3.	4.	4.	4.	4.	4.	4.	4.	4.
4.	4.	4.	3.	3.	3.	3.	3.	3.	3.
3.	3.	3.	3.	3.	3.	4.	6.	10.	16.
24.	35.	48.	62.	76.	90.	103.	114.	124.	132.
138.	144.	148.	152.	155.	158.	160.	162.	164.	165.
166.	167.	168.	168.	169.	169.	170.	170.	170.	171.
171.	171.	176.	194.	231.	287.	365.	463.	578.	707.
845.	987.	1124.	1250.	1365.	1473.	1578.	1679.	1778.	1873.
1979.	2118.	2303.	2537.	2822.	3154.	3508.	3844.	4133.	4353.
4482.	4502.	4421.	4263.	4050.	3805.	3555.	3325.	3113.	2908.
2701.	2489.	2271.	2046.	1818.	1592.	1372.	1164.	975.	814.
679.	566.	472.	437.	420.	403.	387.	372.	357.	343.
329.	316.	303.	291.	280.	269.	258.	248.	238.	228.
219.	211.	202.	194.						

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	4502.	2687.	805.	805.	115932.
INCHES		8.65	10.37	10.37	10.37
AC-FT		1333.	1598.	1598.	1598.

OVN

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HYDROGRAPH ROUTING

RESERVOIR ROUTING --- KNAPP POND DAM NO. 2 --GATES

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

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME
0.0	0.0	0.0	1	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA
1	0	0	0.0	0.0	0.0	-1.

STORAGE#	363.	337.	405.	420.	444.	460.	483.	524.	566.	610.
OUTFLOW#	0.	74.	217.	420.	666.	1024.	1509.	2727.	4474.	6600.

	TIME	EOP STOR	AVG IN	EOP OUT
1	0 10	369.	3.	3.
1	0 20	369.	3.	3.
1	0 30	369.	3.	3.
1	0 40	369.	3.	3.
1	0 50	369.	3.	3.
1	0 60	369.	3.	3.
1	1 10	369.	3.	3.
1	1 20	369.	3.	3.
1	1 30	369.	3.	3.
1	1 40	369.	3.	3.
1	1 50	369.	3.	3.
1	1 60	369.	3.	3.
1	2 10	369.	4.	3.
1	2 20	369.	4.	3.
1	2 30	369.	4.	3.
1	2 40	369.	4.	3.
1	2 50	369.	4.	3.
1	2 60	369.	4.	3.
1	3 10	369.	4.	3.
1	3 20	369.	4.	3.
1	3 30	369.	4.	3.
1	3 40	369.	4.	3.
1	3 50	369.	4.	3.
1	3 60	369.	4.	3.
1	4 10	369.	3.	3.
1	4 20	369.	3.	3.
1	4 30	369.	3.	3.
1	4 40	369.	3.	3.
1	4 50	369.	3.	3.
1	4 60	369.	3.	3.
1	5 10	369.	3.	3.
1	5 20	369.	3.	3.
1	5 30	369.	3.	3.
1	5 40	369.	3.	3.
1	5 50	369.	3.	3.
1	5 60	369.	3.	3.
1	6 10	369.	3.	3.
1	6 20	369.	5.	3.
1	6 30	369.	8.	4.
1	6 40	369.	13.	4.
1	6 50	369.	20.	5.
1	6 60	370.	30.	6.
1	7 10	370.	42.	8.
1	7 20	371.	55.	11.
1	7 30	371.	69.	14.
1	7 40	372.	83.	17.
1	7 50	373.	97.	21.
1	7 60	375.	109.	26.
1	8 10	376.	119.	31.
1	8 20	377.	128.	36.
1	8 30	379.	135.	41.
1	8 40	380.	141.	46.
1	8 50	381.	146.	51.
1	8 60	383.	150.	57.
1	9 10	384.	154.	62.
1	9 20	385.	157.	67.
1	9 30	386.	159.	72.
1	9 40	388.	161.	78.
1	9 50	389.	163.	87.
1	9 60	390.	164.	95.
1	10 10	391.	166.	102.
1	10 20	391.	167.	109.
1	10 30	392.	167.	115.
1	10 40	393.	168.	121.

1 10 50	393.	169.	126.	
1 10 60	394.	169.	130.	
1 11 10	395.	170.	134.	
1 11 20	395.	170.	138.	
1 11 30	395.	170.	141.	
1 11 40	396.	170.	144.	
1 11 50	396.	171.	147.	
1 11 60	397.	171.	149.	
1 12 10	397.	173.	152.	
1 12 20	397.	185.	155.	
1 12 30	398.	213.	161.	
1 12 40	399.	259.	171.	
1 12 50	401.	326.	188.	
1 12 60	404.	414.	211.	
1 13 10	408.	520.	260.	
1 13 20	413.	643.	325.	
1 13 30	419.	776.	402.	
1 13 40	425.	916.	474.	
1 13 50	433.	1055.	551.	
1 13 60	441.	1187.	634.	
1 14 10	449.	1307.	782.	
1 14 20	457.	1419.	952.	
1 14 30	464.	1525.	1101.	
1 14 40	470.	1628.	1235.	
1 14 50	476.	1729.	1360.	
1 14 60	482.	1826.	1478.	
1 15 10	487.	1926.	1620.	
1 15 20	492.	2049.	1766.	
1 15 30	497.	2210.	1917.	
1 15 40	502.	2420.	2088.	
1 15 50	509.	2680.	2289.	
1 15 60	517.	2988.	2526.	
1 16 10	526.	3331.	2822.	
1 16 20	535.	3676.	3203.	
1 16 30	544.	3989.	3553.	
1 16 40	551.	4243.	3860.	
1 16 50	557.	4418.	4108.	
1 16 60	561.	4492.	4279.	
1 17 10	563.	4461.	4360.	
1 17 20	563.	4342.	4352.	
1 17 30	561.	4156.	4265.	
1 17 40	557.	3928.	4115.	
1 17 50	553.	3680.	3921.	
1 17 60	548.	3440.	3707.	
1 18 10	542.	3219.	3490.	
1 18 20	537.	3010.	3276.	
1 18 30	532.	2805.	3066.	
1 18 40	527.	2595.	2856.	
1 18 50	522.	2380.	2664.	
1 18 60	516.	2159.	2492.	
1 19 10	510.	1932.	2302.	
1 19 20	503.	1705.	2099.	
1 19 30	496.	1482.	1889.	
1 19 40	489.	1268.	1678.	
1 19 50	482.	1070.	1481.	
1 19 60	475.	895.	1332.	
1 20 10	468.	747.	1184.	
1 20 20	461.	622.	1041.	
1 20 30	455.	519.	903.	
1 20 40	449.	454.	783.	
1 20 50	445.	428.	688.	
1 20 60	442.	411.	641.	
1 21 10	438.	395.	608.	
1 21 20	435.	379.	578.	
1 21 30	433.	364.	550.	
1 21 40	430.	350.	523.	
1 21 50	428.	336.	499.	
1 21 60	425.	323.	475.	
1 22 10	423.	310.	454.	
1 22 20	421.	297.	433.	
1 22 30	419.	286.	412.	
1 22 40	418.	274.	388.	
1 22 50	416.	263.	367.	
1 22 60	415.	253.	348.	
1 23 10	413.	243.	330.	
1 23 20	412.	233.	313.	
1 23 30	411.	224.	298.	
1 23 40	410.	215.	284.	
1 23 50	409.	207.	271.	
1 23 60	408.	198.	258.	
SUM			113110.	

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	4360.	2633.	785.	785.	113110.
INCHES		8.47	10.11	10.11	10.11
AC-FT		1306.	1559.	1559.	1559.

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SUB-AREA RUNOFF COMPUTATION

SUB-AREA NO. 2 TO KNAPP 1

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
2	0	0	0	0	0	1

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	0.30	0.0	0.0	1.00	0.500	0	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.0	18.00	111.00	123.00	133.00	0.0	0.0	0.0

LOSS DATA

STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0.0	0.0	1.00	0.0	0.0	1.00	0.30	0.18	0.0	0.15

UNIT HYDROGRAPH DATA

TP# 0.24 CP#0.75 NTA# 0

RECESSION DATA

STRTQ# 1.00 QRCSN# -0.10 RTIOR# 1.50

APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC# 1.98 AND R# 0.65 INTERVALS

UNIT HYDROGRAPH 5 END-OF-PERIOD ORDINATES, LAG# 0.24 HOURS, CP# 0.75 VOL# 1.00

255. 537. 320. 43. 6.

END-OF-PERIOD FLOW

	TIME	RAIN	EXCS	COMP Q
1	0 10	0.02	0.00	2.
1	0 20	0.02	0.00	3.
1	0 30	0.02	0.00	4.
1	0 40	0.02	0.00	4.
1	0 50	0.02	0.00	4.
1	0 60	0.02	0.00	4.
1	1 10	0.02	0.00	4.
1	1 20	0.02	0.00	4.
1	1 30	0.02	0.00	4.
1	1 40	0.02	0.00	4.
1	1 50	0.02	0.00	4.
1	1 60	0.02	0.00	4.
1	2 10	0.02	0.00	4.
1	2 20	0.02	0.00	4.
1	2 30	0.02	0.00	4.
1	2 40	0.02	0.00	4.
1	2 50	0.02	0.00	4.
1	2 60	0.02	0.00	4.
1	3 10	0.02	0.00	4.
1	3 20	0.02	0.00	4.
1	3 30	0.02	0.00	4.
1	3 40	0.02	0.00	4.
1	3 50	0.02	0.00	4.
1	3 60	0.02	0.00	4.
1	4 10	0.02	0.00	4.
1	4 20	0.02	0.00	4.
1	4 30	0.02	0.00	4.
1	4 40	0.02	0.00	4.
1	4 50	0.02	0.00	4.
1	4 60	0.02	0.00	4.
1	5 10	0.02	0.00	4.
1	5 20	0.02	0.00	4.
1	5 30	0.02	0.00	4.
1	5 40	0.02	0.00	4.
1	5 50	0.02	0.00	4.
1	5 60	0.02	0.00	4.
1	6 10	0.06	0.03	12.
1	6 20	0.06	0.03	29.
1	6 30	0.06	0.03	39.
1	6 40	0.06	0.03	40.
1	6 50	0.06	0.03	40.
1	6 60	0.06	0.03	40.
1	7 10	0.06	0.03	40.
1	7 20	0.06	0.03	40.
1	7 30	0.06	0.03	40.
1	7 40	0.06	0.03	40.
1	7 50	0.06	0.03	40.
1	7 60	0.06	0.03	40.
1	8 10	0.06	0.03	40.
1	8 20	0.06	0.03	40.
1	8 30	0.06	0.03	40.
1	8 40	0.06	0.03	40.
1	8 50	0.06	0.03	40.
1	8 60	0.06	0.03	40.
1	9 10	0.06	0.03	40.
1	9 20	0.06	0.03	40.
1	9 30	0.06	0.03	40.
1	9 40	0.06	0.03	40.
1	9 50	0.06	0.03	40.

1	9	60	0.06	0.03	40.
1	10	10	0.06	0.03	40.
1	10	20	0.06	0.03	40.
1	10	30	0.06	0.03	40.
1	10	40	0.06	0.03	40.
1	10	50	0.06	0.03	40.
1	10	60	0.06	0.03	40.
1	11	10	0.06	0.03	40.
1	11	20	0.06	0.03	40.
1	11	30	0.06	0.03	40.
1	11	40	0.06	0.03	40.
1	11	50	0.06	0.03	40.
1	11	60	0.06	0.03	40.
1	12	10	0.33	0.31	110.
1	12	20	0.33	0.31	256.
1	12	30	0.33	0.31	343.
1	12	40	0.33	0.31	355.
1	12	50	0.33	0.31	357.
1	12	60	0.33	0.31	357.
1	13	10	0.40	0.37	374.
1	13	20	0.40	0.37	409.
1	13	30	0.40	0.37	431.
1	13	40	0.40	0.37	434.
1	13	50	0.40	0.37	434.
1	13	60	0.40	0.37	434.
1	14	10	0.50	0.47	459.
1	14	20	0.50	0.47	513.
1	14	30	0.50	0.47	545.
1	14	40	0.50	0.47	549.
1	14	50	0.50	0.47	550.
1	14	60	0.50	0.47	550.
1	15	10	1.27	1.24	745.
1	15	20	1.27	1.24	1156.
1	15	30	1.27	1.24	1401.
1	15	40	1.27	1.24	1434.
1	15	50	1.27	1.24	1438.
1	15	60	1.27	1.24	1438.
1	16	10	0.47	0.44	1235.
1	16	20	0.47	0.44	806.
1	16	30	0.47	0.44	550.
1	16	40	0.47	0.44	516.
1	16	50	0.47	0.44	511.
1	16	60	0.47	0.44	511.
1	17	10	0.37	0.34	486.
1	17	20	0.37	0.34	432.
1	17	30	0.37	0.34	400.
1	17	40	0.37	0.34	396.
1	17	50	0.37	0.34	395.
1	17	60	0.37	0.34	395.
1	18	10	0.03	0.00	310.
1	18	20	0.03	0.00	143.
1	18	30	0.03	0.00	138.
1	18	40	0.03	0.00	132.
1	18	50	0.03	0.00	127.
1	18	60	0.03	0.00	122.
1	19	10	0.03	0.00	117.
1	19	20	0.03	0.00	112.
1	19	30	0.03	0.00	108.
1	19	40	0.03	0.00	104.
1	19	50	0.03	0.00	100.
1	19	60	0.03	0.00	96.
1	20	10	0.03	0.00	92.
1	20	20	0.03	0.00	88.
1	20	30	0.03	0.00	85.
1	20	40	0.03	0.00	81.
1	20	50	0.03	0.00	78.
1	20	60	0.03	0.00	75.
1	21	10	0.03	0.00	72.
1	21	20	0.03	0.00	69.
1	21	30	0.03	0.00	66.
1	21	40	0.03	0.00	64.
1	21	50	0.03	0.00	61.
1	21	60	0.03	0.00	59.
1	22	10	0.03	0.00	56.
1	22	20	0.03	0.00	54.
1	22	30	0.03	0.00	52.
1	22	40	0.03	0.00	50.
1	22	50	0.03	0.00	48.
1	22	60	0.03	0.00	46.
1	23	10	0.03	0.00	44.
1	23	20	0.03	0.00	42.
1	23	30	0.03	0.00	41.
1	23	40	0.03	0.00	39.
1	23	50	0.03	0.00	38.
1	23	60	0.03	0.00	36.
		SUM	24.00	20.10	26291.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1438.	609.	183.	183.	26296.
INCHES		18.87	22.65	22.65	22.65
AC-FT		302.	362.	362.	362.

OVN

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

COMBINE HYDROGRAPHS

COMBINING FLOW KNAPP 1 AND 2

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
20	2	0	0	0	0	1

SUM OF 2 HYDROGRAPHS AT 20

4.	5.	5.	5.	5.	5.	5.	5.	5.	5.
5.	5.	5.	5.	5.	5.	5.	5.	5.	5.
5.	5.	5.	5.	5.	5.	5.	5.	5.	5.
5.	5.	5.	5.	5.	5.	9.	18.	23.	24.
25.	26.	28.	31.	34.	37.	41.	46.	51.	56.
61.	66.	72.	77.	82.	87.	92.	98.	107.	115.
123.	129.	135.	141.	146.	150.	154.	158.	161.	164.
167.	170.	207.	283.	333.	349.	366.	389.	447.	530.
617.	691.	768.	851.	1012.	1209.	1374.	1509.	1635.	1753.
1992.	2344.	2617.	2805.	3008.	3245.	3440.	3606.	3828.	4118.
4364.	4535.	4603.	4548.	4465.	4313.	4119.	3905.	3644.	3348.
3135.	2923.	2727.	2553.	2361.	2155.	1943.	1730.	1531.	1380.
1230.	1085.	945.	824.	727.	678.	644.	613.	583.	555.
529.	505.	482.	460.	438.	413.	391.	371.	352.	334.
318.	303.	289.	276.						

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	4603.	2889.	877.	877.	126258.
INCHES		8.43	10.23	10.23	10.23
AC-FT		1433.	1740.	1740.	1740.

HYDROGRAPH ROUTING

RESERVOIR ROUTING --- KNAPP POND DAM NO 1 W/BRUSH

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
3	1	0	0	0	0	1

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME
0.0	0.0	0.0	1	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA
1	0	0	0.0	0.0	0.0	-1.

STORAGE#	192.	205.	231.	260.	292.	325.	357.	391.	427.	0.
OUTFLO##	118.	236.	589.	989.	1549.	3011.	5669.	10081.	15933.	0.

	TIME	EOP STOR	AVG IN	EOP OUT
1	0 10	193.	4.	4.
1	0 20	192.	4.	118.
1	0 30	191.	5.	105.
1	0 40	189.	5.	93.
1	0 50	188.	5.	83.
1	0 60	187.	5.	73.
1	1 10	186.	5.	65.
1	1 20	185.	5.	58.
1	1 30	185.	5.	52.
1	1 40	184.	5.	47.
1	1 50	184.	5.	42.
1	1 60	183.	5.	37.
1	2 10	183.	5.	34.
1	2 20	182.	5.	30.
1	2 30	182.	5.	27.
1	2 40	182.	5.	25.
1	2 50	181.	5.	22.
1	2 60	181.	5.	20.
1	3 10	181.	5.	18.
1	3 20	181.	5.	17.
1	3 30	181.	5.	16.
1	3 40	181.	5.	14.
1	3 50	180.	5.	13.
1	3 60	180.	5.	12.
1	4 10	180.	5.	11.
1	4 20	180.	5.	11.
1	4 30	180.	5.	10.
1	4 40	180.	5.	9.
1	4 50	180.	5.	9.
1	4 60	180.	5.	9.
1	5 10	180.	5.	8.
1	5 20	180.	5.	8.
1	5 30	180.	5.	7.
1	5 40	180.	5.	7.
1	5 50	180.	5.	7.
1	5 60	180.	5.	7.
1	6 10	180.	7.	7.
1	6 20	180.	13.	8.
1	6 30	180.	20.	9.
1	6 40	180.	24.	11.
1	6 50	180.	25.	12.
1	6 60	181.	26.	14.
1	7 10	181.	27.	16.
1	7 20	181.	29.	17.
1	7 30	181.	32.	19.
1	7 40	181.	35.	21.
1	7 50	182.	39.	23.
1	7 60	182.	44.	25.
1	8 10	182.	48.	28.
1	8 20	182.	53.	31.
1	8 30	183.	59.	34.
1	8 40	183.	64.	38.
1	8 50	184.	69.	41.
1	8 60	184.	74.	45.
1	9 10	184.	79.	49.
1	9 20	185.	84.	53.
1	9 30	185.	89.	58.
1	9 40	186.	95.	62.
1	9 50	186.	103.	67.
1	9 60	187.	111.	72.
1	10 10	188.	119.	78.
1	10 20	188.	126.	83.
1	10 30	189.	132.	89.
1	10 40	189.	138.	95.
1	10 50	190.	143.	100.
1	10 60	191.	148.	106.
1	11 10	191.	152.	111.
1	11 20	192.	156.	117.
1	11 30	192.	160.	122.
1	11 40	193.	163.	127.
1	11 50	193.	166.	131.
1	11 60	194.	168.	136.
1	12 10	195.	189.	142.
1	12 20	196.	245.	154.
1	12 30	198.	308.	172.
1	12 40	200.	341.	192.

1	12	50	202.	357.	211.
1	12	60	204.	374.	231.
1	13	10	207.	418.	261.
1	13	20	210.	488.	300.
1	13	30	213.	574.	347.
1	13	40	217.	654.	399.
1	13	50	221.	729.	456.
1	13	60	226.	810.	516.
1	14	10	231.	932.	587.
1	14	20	237.	1110.	678.
1	14	30	245.	1291.	784.
1	14	40	253.	1441.	898.
1	14	50	262.	1572.	1021.
1	14	60	270.	1694.	1166.
1	15	10	279.	1873.	1318.
1	15	20	289.	2168.	1501.
1	15	30	300.	2480.	1903.
1	15	40	309.	2711.	2281.
1	15	50	315.	2906.	2573.
1	15	60	321.	3127.	2832.
1	16	10	326.	3343.	3104.
1	16	20	330.	3523.	3409.
1	16	30	332.	3717.	3633.
1	16	40	335.	3973.	3880.
1	16	50	339.	4241.	4143.
1	16	60	341.	4449.	4366.
1	17	10	343.	4569.	4514.
1	17	20	344.	4586.	4566.
1	17	30	343.	4517.	4530.
1	17	40	342.	4389.	4427.
1	17	50	340.	4216.	4273.
1	17	60	338.	4012.	4083.
1	18	10	335.	3775.	3859.
1	18	20	332.	3496.	3595.
1	18	30	329.	3241.	3338.
1	18	40	326.	3029.	3113.
1	18	50	323.	2825.	2942.
1	18	60	320.	2640.	2801.
1	19	10	317.	2457.	2640.
1	19	20	313.	2258.	2461.
1	19	30	308.	2049.	2269.
1	19	40	304.	1837.	2067.
1	19	50	299.	1630.	1863.
1	19	60	295.	1455.	1672.
1	20	10	291.	1305.	1527.
1	20	20	286.	1158.	1447.
1	20	30	281.	1015.	1354.
1	20	40	275.	884.	1253.
1	20	50	269.	776.	1150.
1	20	60	264.	703.	1054.
1	21	10	259.	661.	973.
1	21	20	255.	628.	913.
1	21	30	251.	598.	859.
1	21	40	247.	569.	808.
1	21	50	244.	542.	762.
1	21	60	240.	517.	720.
1	22	10	238.	493.	680.
1	22	20	235.	471.	644.
1	22	30	233.	449.	610.
1	22	40	230.	425.	578.
1	22	50	228.	402.	548.
1	22	60	226.	381.	520.
1	23	10	224.	361.	492.
1	23	20	222.	343.	467.
1	23	30	220.	326.	443.
1	23	40	219.	311.	420.
1	23	50	217.	296.	399.
1	23	60	216.	283.	379.
		SUM			124656.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	4566.	2829.	866.	866.	124656.
INCHES		8.25	10.10	10.10	10.10
AC-FT		1404.	1718.	1718.	1718.

RUNOFF SUMMARY, AVERAGE FLOW

		PEAK	6-HOUR	24-HOUR	72-HOUR	AREA
HYDROGRAPH AT	1	4502.	2687.	805.	805.	2.89
ROUTED TO	1	4360.	2633.	785.	785.	2.89
HYDROGRAPH AT	2	719.	304.	91.	91.	0.30
2 COMBINED	20	4603.	2889.	877.	877.	3.19
ROUTED TO	3	4566.	2829.	866.	866.	3.19

APPENDIX E

Information as Contained in the National Inventory of Dams

END

FILMED

8-85

DTIC