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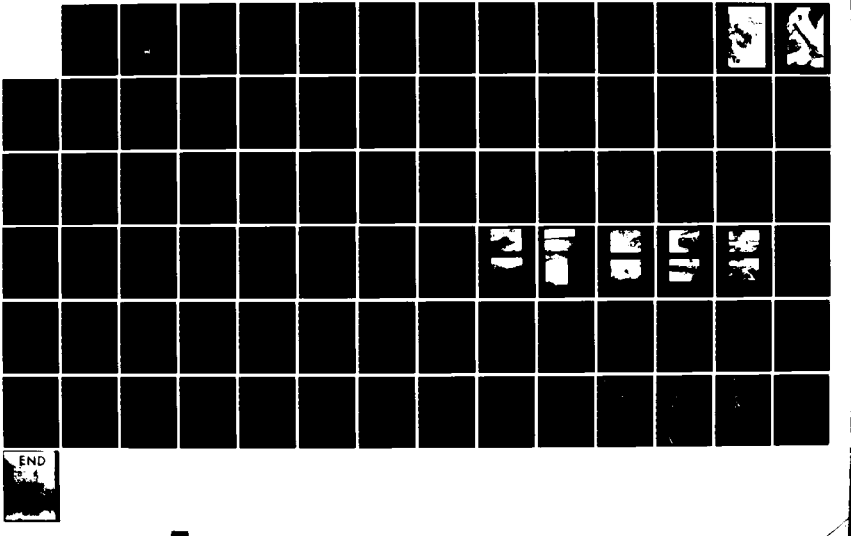

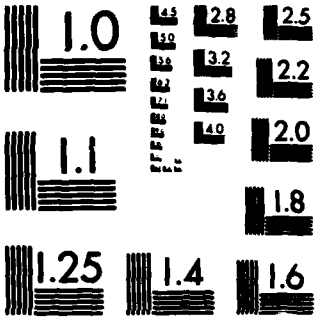

NAUGATUCK RIVER BASIN

WATERTOWN, CONNECTICUT

BLACK ROCK POND DAM
CT 00633

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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

SEPTEMBER 1980

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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

DAMS, INSPECTION, DAM SAFETY,

Naugatuck River Basin
Watertown, Connecticut

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

The Black Rock Pond Dam consists of an earth embankment with the outlet works located near the left end of the dam. The dam has a top width of 10 feet, a maximum height of 20 feet, a total length of 160 feet. Based on the visual inspection, the dam is judged to be in poor condition.The dam is classified as "Small" in size with a "High" hazard potential. A test flood equal to ½ the PMF was selected.

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BLACK ROCK DAM
CT 00633

NAUGATUCK RIVER BASIN
WATERTOWN, CONNECTICUT

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT

IDENTIFICATION NO: CT 00633

NAME OF DAM: Black Rock Pond Dam

TOWN: Watertown

COUNTY AND STATE: Litchfield County, Connecticut

STREAM: Purgatory Brook

DATE OF INSPECTION: July 28, 1980

BRIEF ASSESSMENT

The Black Rock Pond Dam consists of an earth embankment with the outlet works located near the left end of the dam. An overflow spillway is located at a small dike approximately 800 feet to the left of the dam on a separate arm of the pond. The dam has a top width of 10 feet, a maximum height of 20 feet, a total length of 160 feet, an upstream slope of 3 horizontal to 1 vertical, and a downstream slope of 1.6 horizontal to 1 vertical. The outlet works consist of a 12-inch cast iron low level outlet or blowoff pipe controlled by an upstream gate. The overflow spillway consists of a concrete channel 5 feet wide by 5 feet high with slots for flashboards at the upstream end.

The dam impounds Black Rock Pond, which is used for swimming and fishing.

Based on the visual inspection, the dam is judged to be in poor condition. Features that could affect the future integrity of the dam are downstream seepage, erosion of the crest and slopes, the presence of tree stumps on the slopes, and inadequate spillway capacity.

The dam is classified as "Small" in size with a "High" hazard potential. A test flood equal to one-half the Probable Maximum Flood (1/2 PMF) was selected in accordance with the Corps of Engineers' Recommended Guidelines for Safety Inspection of Dams. The test flood inflow of 1,200 cfs results in a test flood routed outflow of 1,000 cfs that would overtop the dam and dike by 1.6 feet.

The spillway capacity without flashboards and with the water level at the top of the spillway dike is 180 cfs, or 18 percent of the test flood routed outflow.

It is recommended that a qualified, registered engineer be retained to investigate the downstream seepage, the erosion on the crest and slopes, the condition of the low level outlet or blowoff channel, and the condition of the stone masonry walls at the spillway; to oversee the removal of tree stumps from the slopes of the dam; to perform a detailed hydrologic and hydraulic analysis; and to inspect the dam annually. In addition, brush should be cleared from the dam, erosion channels on the slopes should be filled and a vegetative cover should be establablished. A formal operations and maintenance manual should also be prepared, and a formal warning system put into effect.

The owner should implement these recommendations as described herein and in greater detail in Section 7 of the Report within one year of receipt of this Phase I Inspection Report.

Ronald G. Litke, P.E.
Project Engineer

Roald Haestad
President

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 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 <u>not</u> 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 of the public. An evaluation of the project for compliance with OSHA rules and regulations is also excluded.

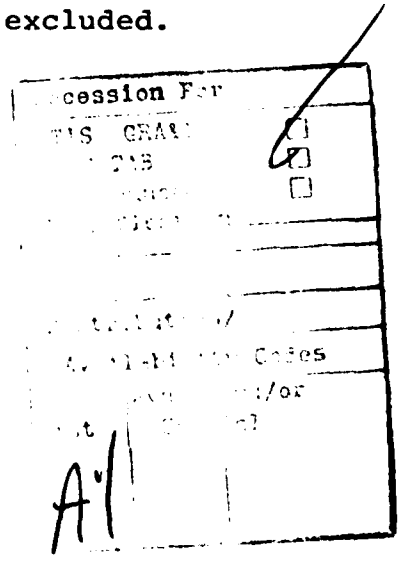


TABLE OF CONTENTS

INDEX TO REPORT

INDEX TO APPENDIXES

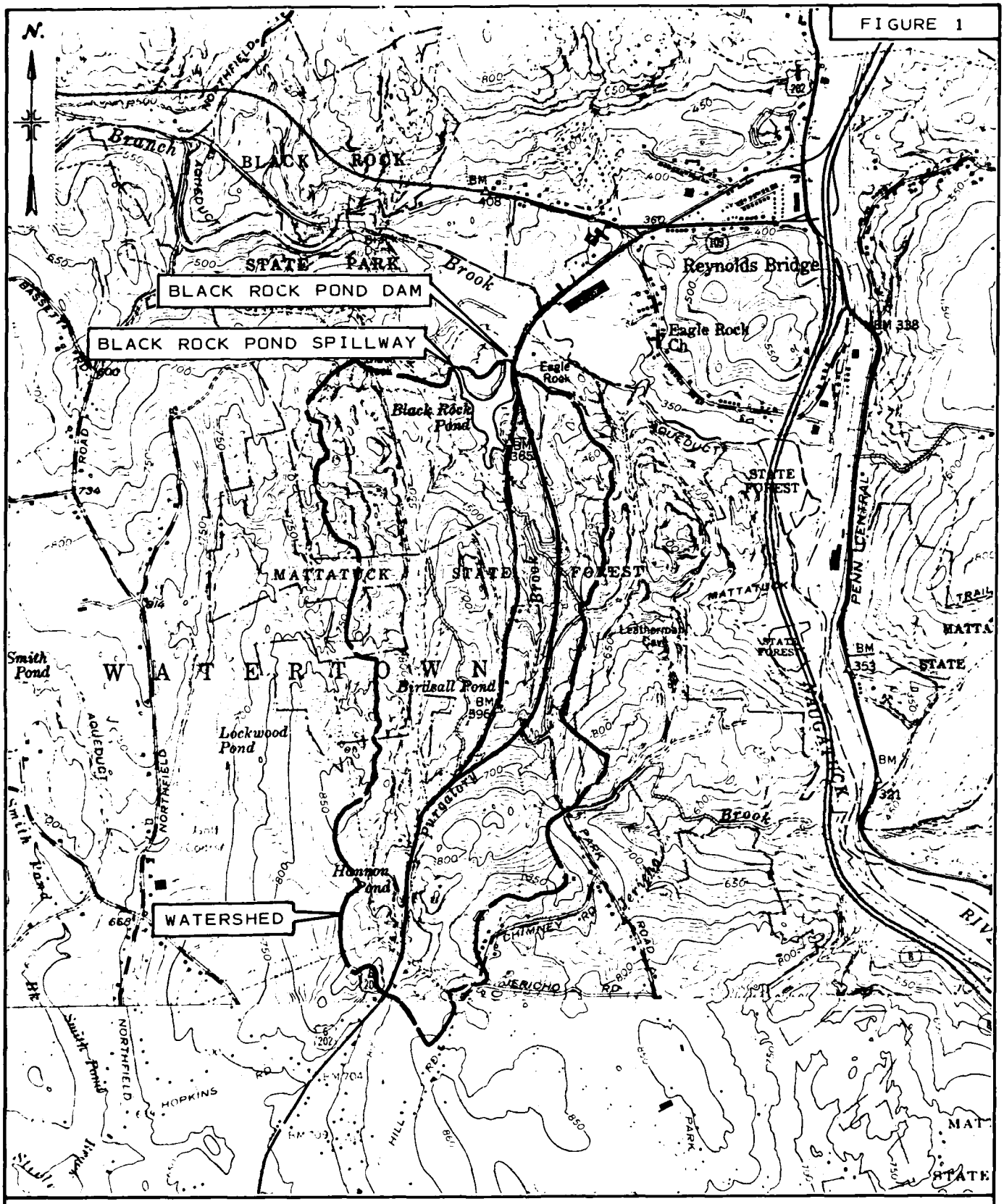
OVERVIEW PHOTO OF DAM AND SPILLWAY

U S ARMY ENGINEER DIV NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASSACHUSETTS	NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS	PLACE ROCK POND DAM - CT 00633
ROALD HAESTAD, INC. CONSULTING ENGINEERS WATERBURY, CONNECTICUT		TRIBUTARY BROOK
		WATERFORD, CONNECTICUT — 19 APRIL '80

OVERVIEW OF DAM

U S ARMY ENGINEER DIV NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASSACHUSETTS	NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS	BLACK ROCK POND DAM CT 00633 BRIDGEBURY BRIDGE WATERTOWN, CONNECTICUT 15 APRIL '80
ROALD HAESTAD, INC. CONSULTING ENGINEERS WATERBURY, CONNECTICUT		

FIGURE 1



LOCATION PLAN

BLACK ROCK POND DAM
WATERTOWN, CONNECTICUT

SCALE: 1" = 2000'

ROALD HAESTAD, INC. THOMASTON QUADRANGLE 1969

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT

PROJECT INFORMATION
SECTION 1

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. Roald Haestad, Inc., has been retained by the New England Division to inspect and report on selected dams in the State of Connecticut. Authorization and notice to proceed were issued to Roald Haestad, Inc., under a letter of April 14, 1980, from William E. Hodgson, Jr., Colonel, Corps of Engineers. Contract No. DACW33-80-C-0048 has been assigned by the Corps of Engineers for this work.

b. Purpose of Inspection

The purposes of the program are to:

1. Perform technical inspection and evaluation of non-federal dams to identify conditions requiring correction in a timely manner by non-federal interest.
2. Encourage and prepare the States to quickly initiate effective dam inspection programs for non-federal dams.
3. To update, verify and complete the National Inventory of Dams.

1.2 Description of Project

a. Location

The dam is located on Purgatory Brook, a tributary to the Naugatuck River, approximately 150 feet west of U.S. Route 6 in the north-eastern section of Watertown, Connecticut. The dam is shown on the Thomaston U.S.G.S. Quadrangle Map having coordinates of latitude N41° 39.1', and longitude W73° 05.8'.

b. Description of Dam and Appurtenances

The Black Rock Pond Dam consists of an earth embankment with the outlet works located near the left end of the dam. An overflow spillway is located at a small dike, approximately 800 feet to the left of the dam on a separate arm of the pond.

The dam consists of a 160 foot long earth embankment with a maximum height of 20 feet. There is no slope protection on the upstream slope of the dam. The upstream slope and crest are eroded to the point where the upstream slope and crest merge to form a 5 horizontal to 1 vertical slope from the downstream edge of the crest to the waterline. Near the right abutment, where erosion has not taken place, the dam has a top width of approximately 10 feet and an upstream slope of about 3 horizontal to 1 vertical. The dam has a downstream slope of about 1.6 horizontal to 1 vertical which is intermittently covered with brush, weeds and tree stumps.

The outlet works located near the left end of the dam consist of a 12-inch cast iron low level outlet or blowoff pipe through the embankment controlled by a manually operated gate located in a reinforced concrete pipe gate chamber on the upstream slope of the dam.

The overflow spillway located at a small dike approximately 800 feet to the left of the dam consists of a concrete channel 5 feet wide and 5 feet high, with slots for flashboards at the upstream end of the channel. There is a short earth embankment with upstream and downstream stone masonry walls on either side of the spillway and a wooden footbridge over the spillway.

c. Size Classification - "Small"

According to the Corps of Engineers' Recommended Guidelines for Safety Inspection of Dams, a dam is classified as "Small" in size if the height is between 25 feet and 40 feet, or the dam impounds between 50 Acre-Feet and 1,000 Acre-Feet. The dam has a maximum height of 20 feet and a maximum storage capacity of 164 Acre-Feet. Therefore, the dam is classified as "Small" in size based upon the maximum storage capacity of 164 Acre-Feet.

d. Hazard Classification - "High"

Based on the Corps of Engineers' Recommended Guidelines for Safety Inspection of Dams, the hazard classification of the dam is "High". A dam failure analysis indicates that a campground with approximately 80 campsites would be flooded, possibly resulting in the loss of more than a few lives. Based on the maximum spillway capacity of 180 cfs, the flow in the area of the campground prior to dam breach would be about 1.5 feet deep and would be contained within the stream channel. The depth of flow in this area as a result of the dam breach would be approximately 6 feet above streambed or 2 feet deep at the camp sites.

e. Ownership

The State of Connecticut
Department of Environmental Protection
William Miller, Chief, Parks and Recreation
165 Capitol Avenue
Hartford, Connecticut 06115
(203) 566-2304

f. Operator

Dan Dickinson, Unit Manager
Bidwell Hill Road
Watertown, Connecticut 06795
(203) 677-1819 - office
(203) 283-4882 - home

g. Purpose of Dam

The dam impounds Black Rock Pond, a portion of Black Rock State Park, which is used for swimming and fishing.

h. Design and Construction History

There was no information available on the design and construction of the dam and spillway. It was reported that a new spillway was built in 1978 and reconstructed during the summer of 1979 to its present condition.

i. Normal Operating Procedures

In the summer months flashboards are added to the spillway during storms to try to increase the water level in the pond. The low level outlet or blowoff is opened occasionally to lower the water level in order to make repairs to the beach.

1.3 Pertinent Data

a. Drainage Area

The drainage area consists of 1.13 square miles of wooded, "rolling" terrain. A large portion of the watershed is within the Mattatuck State Forest Boundaries.

b. Discharge at Damsite

Discharge at the damsite is over a 5 foot long spillway located at a dike 800 feet to the left of the dam. The outlet works consist of a 12-inch low level outlet or blowoff.

1.	Outlet Works (conduits) Size:	12"
	Invert Elevation:	363.1
	Discharge Capacity:	13 cfs
2.	Maximum Known Flood at Damsite:	Unknown
3.	Ungated Spillway Capacity at Top of Dike:	180 cfs*
	Elevation:	381.7
4.	Ungated Spillway Capacity at Test Flood Elevation:	260 cfs*
	Elevation:	383.3
5.	Gated Spillway Capacity at Normal Pool Elevation:	N/A
	Elevation:	
6.	Gated Spillway Capacity at Test Flood Elevation:	N/A
	Elevation:	
7.	Total Spillway Capacity at Test Flood Elevation:	260 cfs*
	Elevation:	383.3
8.	Total Project Discharge at Top of Dam:	180 cfs*
	Elevation:	381.7
9.	Total Project Discharge at Test Flood Elevation:	1,000 cfs*
	Elevation:	383.3

*without flashboards

c. Elevation - Feet Above Mean Sea Level (NGVD)

1. Streambed at Toe of Dam:	362
2. Bottom of Cutoff:	Unknown
3. Maximum Tailwater:	N/A
4. Recreation Pool:	378.5 (on 7/3/80)
5. Full Flood Control Pool:	N/A
6. Spillway Crest:	376.0
7. Design Surcharge - Original Design:	Unknown
8. Top of Dam:	382
9. Test Flood Surcharge:	383.3

d. Reservoir - Length in Feet

1. Normal Pool:	1,700 feet
2. Flood Control Pool:	N/A
3. Spillway Crest Pool:	1,700 feet
4. Top of Dam:	1,800 feet
5. Test Flood Pool:	1,800 feet

e. Storage - Acre-feet

1. Normal Pool:	92 Acre-Feet
2. Flood Control Pool:	N/A
3. Spillway Crest Pool:	92 Acre-Feet
4. Top of Dam:	164 Acre-Feet
5. Test Flood Pool:	183 Acre-Feet

f. Reservoir Surface - Acres

1. Normal Pool:	9 acres
2. Flood-Control Pool:	N/A
3. Spillway Crest:	9 acres
4. Test Flood Pool:	15 acres
5. Top of Dam:	14 acres

g. Dam

1.	Type:	Earth embankment
2.	Length:	160'
3.	Height:	20'
4.	Top Width:	10' at right abutment
5.	Side Slopes:	Upstream below water and at right abutment: 3 hor. to 1 vert. Upstream above water: 5 hor. to 1 vert. Downstream 1.6 hor. to 1 vert.
6.	Zoning:	Unknown
7.	Impervious Core:	Unknown
8.	Cutoff:	Unknown
9.	Grout Curtain:	N/A
10.	Other:	Upstream slope and crest eroded over most of the dam so that there is no horizontal crest width.

h. Diversion and Regulating Tunnel N/A

i. Spillway

1. Type:	Concrete channel with flashboards at upstream end.
2. Length of Weir:	5'
3. Crest Elevation with Flash Boards:	378.5' (on 7/3/80) 379 (on 7/28/80)
without Flash Boards:	376.0
4. Gates:	N/A
5. Upstream Channel:	N/A
6. Downstream Channel:	Natural Streambed
7. General:	

j. Regulating Outlets

1. Invert:	363.1
2. Size:	12"
3. Description:	Cast-iron pipe through earth embankment
4. Control Mechanism:	Manually operated upstream gate valve
5. Other:	Capacity with water level at top of dam 13 cfs

ENGINEERING DATA
SECTION 2

2.1 Design Data

There was no design data available for review on either the dam or the spillway.

2.2 Construction Data

There was no construction data available for review on either the dam or spillway. It was reported that the spillway was constructed in 1978 and again in 1979 by the maintenance crew at Black Rock State Park.

2.3 Operation Data

There was no operation data on the dam available for review.

2.4 Evaluation of Data

a. Availability

The State of Connecticut Department of Environmental Protection, owner of the dam, did not have any engineering data for the dam.

b. Adequacy

As there was no information available, the assessment of the condition of the dam was based upon the visual inspection, past performance history, and hydrologic and hydraulic calculations made for this Report.

VISUAL INSPECTION

SECTION 3

3.1 Findings

a. General

The visual inspection of the dam was conducted on July 28, 1980. At the time of inspection 3 feet of flashboards were in place and the water level was approximately 10 inches below the top of the flashboards.

The dam consists of an earth embankment with a low level outlet or blowoff located near the left end. An overflow spillway is located at a small dike, approximately 800 feet to the left of the dam on a separate arm of the pond. See Overview Photo of Dam and Spillway, page x.

b. Dam

The upstream slope and crest of the dam above the waterline are severely eroded, to the point where the upstream slope and crest merge to form about a 5 horizontal to 1 vertical slope from the downstream edge of the crest to the waterline over most of the length of the dam, Photo 1. The majority of the crest and upstream slope is bare, exposing a gravelly sand material. The right end of the crest and upstream slope is covered by brush and has not been severely eroded. In this area, the horizontal crest width is about 10 feet with a 3 horizontal to 1 vertical upstream slope. Constant foot traffic is evident on the crest, and there are several footpaths from the crest to the waterline near the right end of the dam which show signs of erosion. Several low spots in the crest of the dam have been caused by erosion of footpaths on the downstream slope, Photo 2. At the left end of the dam there were two

tree stumps 18 inches and 24 inches in diameter, Photo 3.

The downstream face of the dam has an average slope of about 1.6 horizontal to 1 vertical, based on field surveys performed for this investigation. The slope is intermittently covered with brush and weeds, Photo 4. Numerous large tree stumps to 24 inches in diameter were located on the downstream face, Photo 4. These trees were reportedly cut down in July 1979. Several footpaths on the downstream face show signs of erosion.

Seepage was observed at several points on the downstream toe across the entire width of the dam. Just to the left of the low level outlet or blowoff pipe, seepage estimated at 2 to 3 gpm was exiting on the slope about 2'4" above the invert of the pipe, Photo 5. The seepage has eroded back into the toe of the dam, causing a depression about 6 feet wide and about 2 feet deep. Seeps with well-defined flow channels were also noted at about 10 feet, 20 feet and 30 feet right of the outlet pipe. Seepage volumes were also about 2 to 3 gpm, but no erosion of the dam had occurred. Seepage was also observed near the right abutment and from beneath a tree stump about 15 feet downstream from the toe of the dam. At the time of inspection the seepage appeared to be clear. However, the ground surface below each seep was covered with silt and rust-colored floccules.

The entire downstream toe area was covered with shallow ponded water and was stained a rusty orange color, Photo 6. The natural channel downstream of the outlet was partially blocked by branches and weeds, Photo 6.

c. Appurtenant Structures

The appurtenant structures consist of the low level outlet or blowoff and the spillway.

Outlet Works

The low level outlet or blowoff consists of a 12 inch diameter cast iron pipe through the dam controlled by an upstream gate contained in a reinforced concrete pipe chamber, Photos 4 and 7. There was a slight amount of leakage coming from the pipe. The upstream gate was reported to be operable.

Spillway

The spillway consists of a concrete channel about 5 feet wide and 5 feet high. There is a short earth embankment with upstream and downstream masonry walls on either side of the spillway, Photos 8 and 9. The pond level is regulated by flashboards at the upstream end of the channel. Three feet of flashboards were in place at the upstream end of the channel, with the water level approximately 10 inches below the top of the flashboards.

The spillway itself appears to be in good condition. There was some small leakage between and around the ends of the flashboards. Several stones were missing in both the upstream and downstream stone masonry walls, Photos 8 and 9. A small amount of seepage was noted at the base of the left downstream wall. Some erosion was also noted around the ends of the walls.

d. Reservoir Area

There were no indications of instability along the edges of the reservoir in the vicinity of the dam.

e. Downstream Channel

The channel downstream of the spillway is a natural streambed lined with gravel, cobbles and occasional boulders, Photo 10. The channel is generally clear, but there are some overhanging trees.

3.2 Evaluation

Based on the visual observation, the dam appears to be in poor condition. The following features could affect the future integrity of the dam:

1. Seepage at the downstream toe may lead to continued erosion of the dam in the left toe area and could induce erosion in other areas of the toe, leading to piping failure of the embankment.
2. Severe erosion on the crest and upstream face and the lack of riprap and vegetative protection could lead to rapid erosion of the upstream embankment, causing a breach and failure of the dam.
3. Tree stumps on the downstream slope and in the immediate downstream toe area will eventually decay, leaving open root holes which may act as seepage paths, leading to internal erosion and piping failure of the foundation or embankment soils.
4. Constant foot traffic on crest and slopes of the dam may lead to accelerated erosion and formation of severe erosion gullies, resulting in overtopping of the dam during periods of high water level.
5. Voids in the masonry stonework may permit erosion of the spillway dikes due to wave action on the usptream face and seepage on the downstream face.

4.1 Operational Procedures

a. General

In the summer months flashboards are added to the spillway as required during storms to increase the water level in the pond for swimming. The low level outlet or blowoff is opened occasionally to lower the water level in order to make repairs to the beach.

b. Description of Any Warning System In Effect

There is no formal warning system in effect. The pond is monitored 24 hours a day during the summer months and during heavy rains the remaining months of the year.

4.2 Maintenance Procedures

a. General

There are no formal maintenance procedures for the dam and operating facilities. Trees on the upstream and downstream slopes were cut down in July 1979.

b. Operating Facilities

In the past repairs have been made to the spillway as required.

4.3 Evaluation

Present operations and maintenance procedures are inadequate, as is evident by the overall condition of the dam.

An operations and maintenance manual should be prepared for the dam and operating facilities, and a formal warning system put into effect. In addition, the dam should be inspected annually by a qualified, registered engineer.

EVALUATION OF HYDRAULIC/HYDROLOGIC FEATURES
SECTION 5

5.1 General

The spillway for Black Rock Dam is a 5 foot long slot in the middle of a small dike. The dike is located 800 feet west of the main dam. The water level in the pond is controlled by flashboards at the upstream end of the spillway channel. At the time of the inspection, 3 feet of flashboards were in place.

The dam has a tributary watershed of 1.13 square miles. A large portion of the watershed is within the Mattatuck State Forest boundaries. The terrain is "rolling" wooded hills with a few residential homes. Incorporated within the watershed are two small ponds upstream of Black Rock Dam. Elevations range from about 850 feet in the upper portion of the watershed to 376 feet at the dam.

The outlet works consist of a 12-inch low level outlet or blowoff located near the left end of the dam and controlled by an upstream gate valve. The outlet or blowoff has a capacity of 13 cfs with the water level at the top of the dam.

5.2 Design Data

No design data on the dam or spillway was available for review.

5.3 Experience Data

No records of past flood experience were available.

5.4 Test Flood Analysis

Based on the dam failure analysis, the dam is classified as "High" hazard potential. The size of the dam is "Small" based on a height of 20 feet and storage capacity of 164 Acre-Feet. According to the Recommended Guidelines for Safety Inspeciton of Dams,

by the Corps of Engineers, the test flood should be in the range of one-half the Probable Maximum Flood (1/2 PMF) to the Probable Maximum Flood (PMF) depending on the involved risk. A test flood equal to the 1/2 PMF was selected because of the low hydraulic height and small storage capacity of the dam. The test flood was calculated using 2,125 cubic feet per second per square mile (csm) inflow for the PMF, from the minimum 2 square mile drainage area shown on the Guide Curves supplied by the Corps of Engineers, and the 1.13 square mile watershed of Black Rock Dam. The peak 1/2 PMF inflow was calculated to be 1,200 cfs and the routed outflow about 1,000 cfs. The flood routing through the reservoir was done in accordance with "Estimating Effect of Surcharge Storage on Maximum Probable Discharges" provided by the Corps of Engineers.

The spillway capacity was calculated to be 180 cfs without flashboards in place or 18 percent of the test flood routed outflow. The test flood would overtop the dam and dike by 1.6 feet. The spillway capacity of the dam appears to be inadequate and overtopping could occur in the future.

5.5 Dam Failure Analysis

A dam failure analysis was made using the "Rule of Thumb" guidance provided by the Corps of Engineers. Failure was assumed when the water level reached the top of the dam.

The dam breach would release up to 9,025 cfs into the stream below the dam. The flood wave would travel 600 feet downstream and overtop the access road to Black Rock State Park by approximately 3.5 feet. However, the flood waters would not overtop U.S. Route 6. A private campground with approximately 80 sites is located

just downstream of U.S. Route 6. The campsites are approximately 4 feet above the riverbed. The flood waters would be approximately 2 feet deep in the area of the camps. Beyond the campsites the flood waters would flow through an undeveloped area, cross under Connecticut Route 8 without overtopping it, and continue to the Naugatuck River within the channel limits.

Based on the maximum spillway capacity of 180 cfs, the flow in the area of the campground prior to dam breach would be about 1.5 feet deep and would be contained within the stream channel. The depth of flow as a result of the dam breach would be approximately 6 feet above streambed.

The failure of Black Rock Dam could result in the loss of more than a few lives. Therefore, the dam is classified as "High" hazard potential.

EVALUATION OF STRUCTURAL STABILITY
SECTION 6

6.1 Visual Observations

The visual observations did not disclose any evidence of present or past structural instablilty except for some sloughing at the left downstream toe near the low level outlet or blowoff pipe in a zone of seepage and at the right toe at the base of an erosion channel on the downstream slope. The future stability of the dam could be affected by seepage at the toe, erosion of the crest and upstream slope and tree stumps on the downstream slope.

6.2 Design and Construction Data

No design or construction drawings or records are available for either the dam or the spillway.

6.3 Post-Construction Changes

The spillway was rebuilt in 1978 and again in 1979, but no drawings or records of the work are available.

6.4 Seismic Stability

The dam is located in Seismic Zone 1 and in accordance with the recommended Phase I guidelines does not warrant seismic stability analysis.

ASSESSMENT, RECOMMENDATIONS, & REMEDIAL MEASURES
SECTION 7

7.1 Assessment

a. Condition

On the basis of the visual inspection, the dam is judged to be in poor condition. The future integrity of the dam could be affected by the following:

1. Seepage from the downstream face and at the toe of the dam.
2. Severe erosion of the crest and upstream slope, and lack of riprap and vegetative protection for prevention of further erosion.
3. Erosion channels on the downstream face and lack of protective vegetation cover.
4. Tree stumps on the upstream and downstream slopes and the downstream toe area.
5. Discharge of low level outlet or blowoff into an unlined chann l directly at the toe of the embankment.
6. Missing stones in the walls on either side of the spillway.

An evaluation of the hydraulic and hydrologic features of the dam determined that the spillway, without flashboards in place, is capable of passing 18 percent of the test flood routed outflow (1/2 PMF).

b. Adequacy of Information

As no design or construction data was available for review, the assessment of the condition of the dam was based on the visual inspection, past performance history, and hydraulic and hydrologic calculations made for this Report.

c. Urgency

The recommendations described in Sections 7.2 and 7.3 should be carried out by the owner within one year after receipt of this Report.

7.2 Recommendations

The following items should be carried out under the direction of a qualified, registered engineer:

1. Investigate the seepage at the downstream toe and design and install seepage collection and control measures.
2. Restore crest and upstream embankment to original configuration and elevation, and provide protection against future erosion.
3. Remove stumps on upstream and downstream slopes and to within 20 feet of the downstream toe and carefully backfill the root zones with selected soils.
4. Investigate the requirements for channel and slope protection at the low level outlet or blowoff pipe and recommend measures for preventing scour and undermining of the pipe and embankment.
5. Investigate the cause of missing stones in the stone masonry walls on either side of the spillway and recommend remedial measures.
6. Perform a detailed hydrologic and hydraulic analysis in order to determine the need for and means to provide additional project discharge capacity.

The owner shall implement all of the engineers' recommendations based upon the above investigations.

7.3 Remedial Measures

a. Operations and Maintenance Procedures

1. Clear brush on downstream and upstream slopes and to within 20 feet of the toe.
2. Fill erosion channels on downstream slope.
3. Establish vegetative cover on the crest and upstream and downstream slopes, and institute a regular maintenance program.
4. Institute a program of annual technical inspections by qualified, registered engineers.
5. Prepare a formal operations and maintenance manual for the dam and operating facilities.
6. Put into effect a formal warning system, to include monitoring of the dam during extremely heavy rains and procedures for notifying downstream authorities in the event of an emergency.

7.4 Alternatives

There are no practical alternatives to the recommendations described herein.

APPENDIX A

VISUAL CHECK LIST WITH COMMENTS

VISUAL INSPECTION CHECK LIST
PARTY ORGANIZATION

PROJECT: Black Rock Pond Dam

DATE: 7/28/80 TIME: 9:15 a.m. to 11:00 a.m. WEATHER: partly cloudy - 80°

W.S. ELEVATION: 378.1 U.S. N/A DN.S
10" below top of 3 ft high flashboards

	PARTY	DISCIPLINE
1.	Ronald G. Litke, P.E., Roald Haestad, Inc.	Civil/Structural
2.	Donald L. Smith, P.E., Roald Haestad, Inc.	Civil/Hydrology
3.	Gonzalo Castro, PhD, P.E., Geotechnical Engineers, Inc.	Geotechnical
4.	Frank Leathers, P.E., Geotechnical Engineers, Inc.	Geotechnical
5.		
6.		

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.	Dam Embankment	RGL, DLS, GC, FL	Upstream slope & crest eroded Seepage at downstream toe
2.	Outlet Works - Intake Channel and Structure	RGL, DLS GC, FL	Not visible - underwater
3.	Outlet Works - Control Tower	RGL, DLS	Concrete riser pipe at upstream slope
4.	Outlet Works - Transition & Conduit	RGL, DLS	12-inch cast iron pipe
5.	Outlet Works - Outlet Structure & Channel	RGL, DLS, GC, FL	No structure channel - natural streambed
6.	Outlet Works - Spillway, Weir, Appr., and Disch. Channels	RGL, DLS, GC, FL	Good condition
7.	Outlet Works - Service Bridge	RGL, DLS	Recently built
8.			
9.			
10.			
11.			
12.			

PROJECT: Black Rock Pond Dam DATE: 7/28/80

PROJECT FEATURE: Dam Embankment NAME: GC, FL

DISCIPLINE: Geotechnical and Civil Engineers NAME: RGL, DLS

AREA ELEVATION	CONDITIONS
DAM EMBANKMENT	
CREST ELEVATION	382'±
CURRENT POOL ELEVATION	378.1' (10" below top of 3' high flash-boards).
MAXIMUM IMPOUNDMENT TO DATE	Unknown
SURFACE CRACKS	None observed
PAVEMENT CONDITION	N/A
MOVEMENT OR SETTLEMENT OF CREST	Crest severely eroded
LATERAL MOVEMENT	None observed
VERTICAL ALIGNMENT	Crest elevation uneven due to severe erosion
HORIZONTAL ALIGNMENT	Too irregular to judge
CONDITION AT ABUTMENT	Good
INDICATIONS OF MOVEMENT OF STRUCTURAL ITEMS ON SLOPES	None observed
TRESPASSING ON SLOPES	Evidence of constant pedestrian traffic on upstream slope and crest
VEGETATION ON SLOPES	Vegetation intermittent on slopes and crest. Several large tree stumps on slopes. Some brush on upstream slope.
SLOUGHING OR EROSION OF SLOPES OR ABUTMENTS	Some sloughing at toe of downstream slope due to seepage and erosion.
ROCK SLOPE PROTECTION - RIPRAP FAILURES	No riprap or other type of slope protection observed.
UNUSUAL MOVEMENT OR CRACKING AT OR NEAR TOES	Some sloughing due to seepage and erosion.
EMBANKMENT OR DOWNSTREAM SEEPAGE	Seepage at downstream toe in several places.
PIPING OR BOILS	None observed.
FOUNDATION DRAINAGE FEATURES	None observed.
TOE DRAINS	None observed
INSTRUMENTATION SYSTEM	None observed.

PERIODIC INSPECTION CHECK LIST

PROJECT: Black Rock Pond Dam DATE: 7/28/80

PROJECT FEATURE: Outlet Works - Intake Channel and Structure NAME: RGL, DLS

DISCIPLINE: Civil & Geotechnical Engineers NAME: GC, FL

AREA EVALUATED	CONDITIONS
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	
A. APPROACH CHANNEL:	No channel visible
SLOPE CONDITIONS	
BOTTOM CONDITIONS	
ROCK SLIDES OR FALLS	
LOG BOOM	
DEBRIS	
CONDITION OF CONCRETE LINING	
DRAINS OR WEEP HOLES	
B. INTAKE STRUCTURE:	No structure visible
CONDITION OF CONCRETE	
STOP LOGS AND SLOTS	

PERIODIC INSPECTION CHECK LIST

PROJECT: Black Rock Pond Dam DATE: 7/28/80

PROJECT FEATURE: Outlet Works-Control Tower NAME: RGL

DISCIPLINE: Civil Engineers NAME: DLS

AREA EVALUATED	CONDITIONS
OUTLET WORKS - CONTROL TOWER	
A. CONCRETE AND STRUCTURAL:	
GENERAL CONDITION	Reinforced concrete riser pipe at upstream slope
CONDITION OF JOINTS	No joints observed
SPALLING	Some chipped concrete at top
VISIBLE REINFORCING	None observed
RUSTING OR STAINING OF CONCRETE	None observed
ANY SEEPAGE OR EFFLORESCENCE	Chamber was locked
JOINT ALIGNMENT	Could not be observed
UNUSUAL SEEPAGE OR LEAKS IN GATE CHAMBER	Could not be observed
CRACKS	None observed
RUSTING OR CORROSION OF STEEL	N/A
B. MECHANICAL AND ELECTRICAL:	
AIR VENTS	N/A
FLOAT WELLS	N/A
CRANE HOIST	N/A
ELEVATOR	N/A
HYDRAULIC SYSTEM	N/A
SERVICE GATES	Could not be observed - reported to be operable
EMERGENCY GATES	N/A
LIGHTNING PROTECTION SYSTEM	N/A
EMERGENCY POWER SYSTEM	N/A
WIRING AND LIGHTING SYSTEM IN GATE CHAMBER	N/A

PERIODIC INSPECTION CHECK LIST

PROJECT: Black Rock Pond Dam DATE: 7/28/80

PROJECT FEATURE: Outlet Works - Transition & Conduit NAME: RGL

DISCIPLINE: Civil Engineers NAME: DLS

AREA EVALUATED	CONDITIONS
OUTLET WORKS - TRANSITION AND CONDUIT GENERAL CONDITION OF CONCRETE	Conduit consists of 12-inch cast iron pipe
RUST OR STAINING ON CONCRETE	N/A
SPALLING	N/A
EROSION OR CAVITATION	N/A
CRACKING	N/A
ALIGNMENT OF MONOLITHS	N/A
ALIGNMENT OF JOINTS	N/A
NUMBERING OF MONOLITHS	N/A

PERIODIC INSPECTION CHECK LIST

PROJECT: Black Rock Pond Dam DATE: 7/28/80

PROJECT FEATURE: Outlet Works - Outlet Structure and Channel NAME: RGL, DLS

DISCIPLINE: Geotechnical and Civil Engineers NAME: GC, FL

AREA EVALUATED	CONDITIONS
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL GENERAL CONDITION OF CONCRETE	There is no outlet structure - 12-inch cast iron pipe projects from toe of embankment
RUST OR STAINING	N/A
SPALLING	N/A
EROSION OR CAVITATION	N/A
VISIBLE REINFORCING	N/A
ANY SEEPAGE OR EFFLORESCENCE	Seepage present at downstream toe in vicinity of pipe
CONDITION AT JOINTS	N/A
DRAIN HOLES	N/A
CHANNEL	Natural streambed
LOOSE ROCK OR TREES OVERHANGING CHANNEL	Trees and brush overhanging the channel downstream of the toe
CONDITION OF DISCHARGE CHANNEL	Channel is partially filled with branches and weeds

PERIODIC INSPECTION CHECK LIST

PROJECT: Black Rock Pond Dam DATE: 7/28/80

PROJECT FEATURE: Outlet Works - Spillway Weir, Approach & Disch. Channel NAME: RGL, DLS

DISCIPLINE: Geotechnical and Civil Engineers NAME: GC, FL

AREA EVALUATED	CONDITIONS
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
A. APPROACH CHANNEL:	
GENERAL CONDITION	Good natural streambed
LOOSE ROCK OVERHANGING CHANNEL	None observed
TREES OVERHANGING CHANNEL	None of significance
FLOOR OF APPROACH CHANNEL	Not visible
B. WEIR AND TRAINING WALLS:	3' of flashboards in place
GENERAL CONDITION OF CONCRETE	Concrete walls of channel in good conditions - recently constructed
RUST OR STAINING	None observed
SPALLING	Some stones missing from walls upstream & downstream of adjoining embankment
ANY VISIBLE REINFORCING	None observed
ANY SEEPAGE OR EFFLORESCENCE	Some seepage through cracks in mortar between stones on downstream wall.
DRAIN HOLES	None observed
C. DISCHARGE CHANNEL:	
GENERAL CONDITION	Good
LOOSE ROCK OVERHANGING CHANNEL	None observed
TREES OVERHANGING CHANNEL	None of significance
FLOOR OF CHANNEL	Natural streambed - gravelly with some cobbles and boulders
OTHER OBSTRUCTIONS	Some brush encroaching on edges of channel

PERIODIC INSPECTION CHECK LIST

PROJECT: Black Rock Pond Dam DATE: 7/28/80

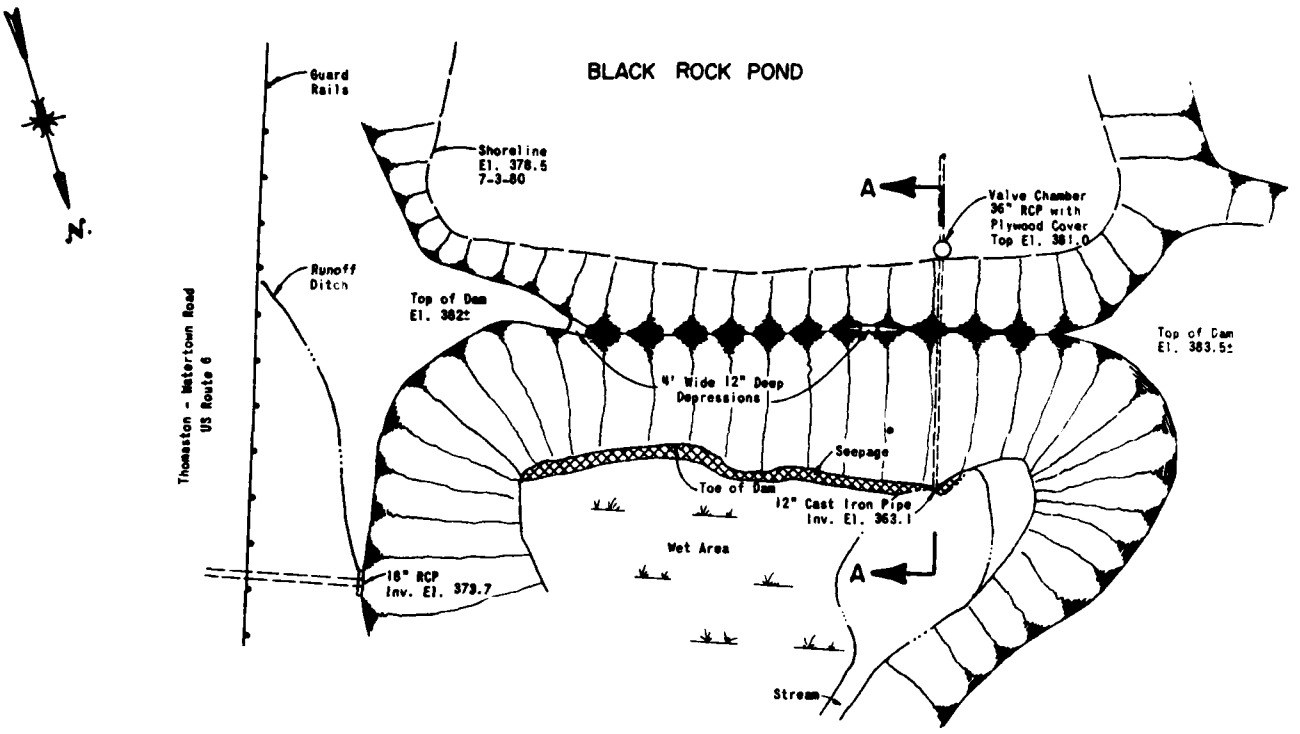
PROJECT FEATURE: Outlet Works - Service Bridge NAME: RGL

DISCIPLINE: Civil Engineers NAME: DLS

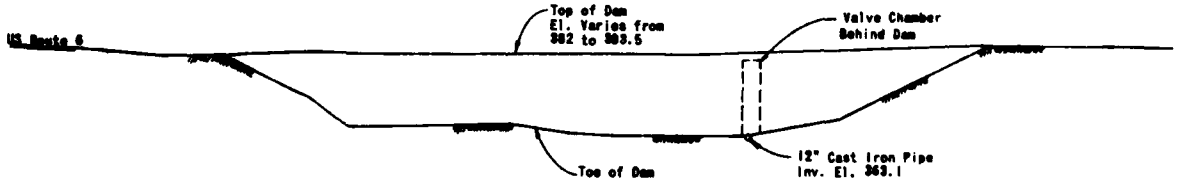
AREA EVALUATED	CONDITIONS
OUTLET WORKS - SERVICE BRIDGE	
A. SUPER STRUCTURE:	
BEARINGS	Wooden beams bear on spillway walls
ANCHOR BOLTS	N/A
BRIDGE SEAT	N/A
LONGITUDINAL MEMBERS	New wooden beams
UNDER SIDE OF DECK	Good condition
SECONDARY BRACING	N/A
DECK	New wood deck
DRAINAGE SYSTEM	N/A
RAILINGS	Good
EXPANSION JOINTS	N/A
PAINT	Good
B. ABUTMENT AND PIERS:	
GENERAL CONDITION OF CONCRETE	Good - new concrete
ALIGNMENT OF ABUTMENT	Good
APPROACH TO BRIDGE	Normal
CONDITION OF SEAT AND BACKWALL	N/A

APPENDIX B

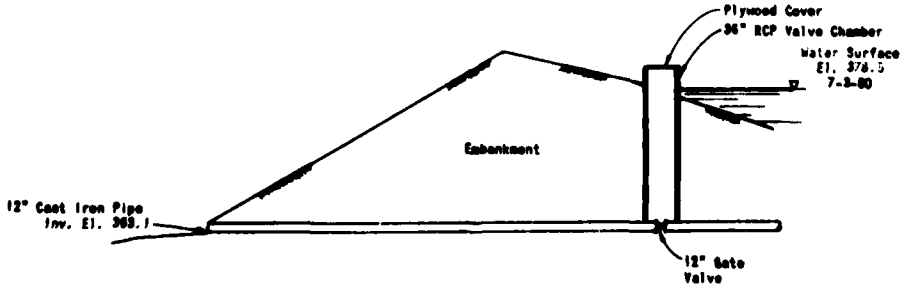
ENGINEERING DATA



PLAN
Scale 1"=40'



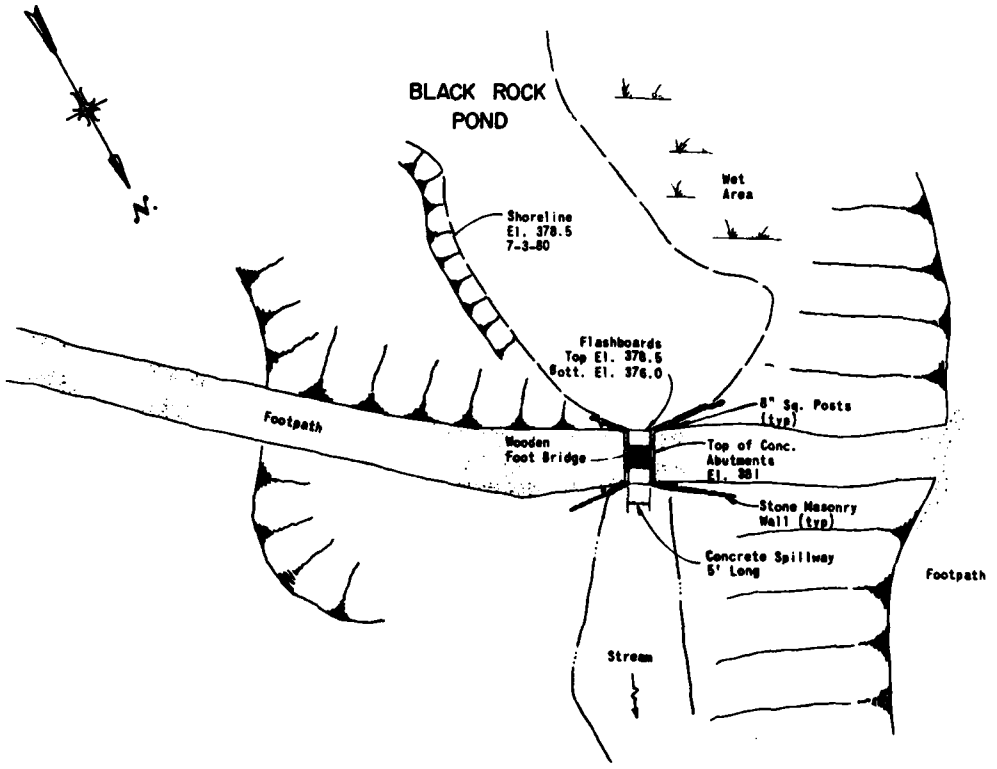
ELEVATION
Scale 1"=40'



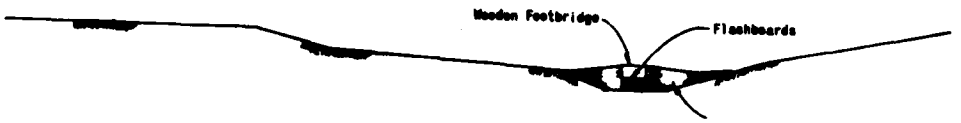
SECTION A-A
Scale 1"=20'

MAIN DAM

FIGURE 2



PLAN
Scale 1"=40'



ELEVATION
Scale 1"=40'

DIKE AND SPILLWAY

ROALD HAESTAD, INC. *CONSULTING ENGINEERS* WATERBURY, CONNECTICUT	U.S. ARMY ENGINEER DIV. NEW ENGLAND *CORPS OF ENGINEERS* WALTHAM, MASS

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

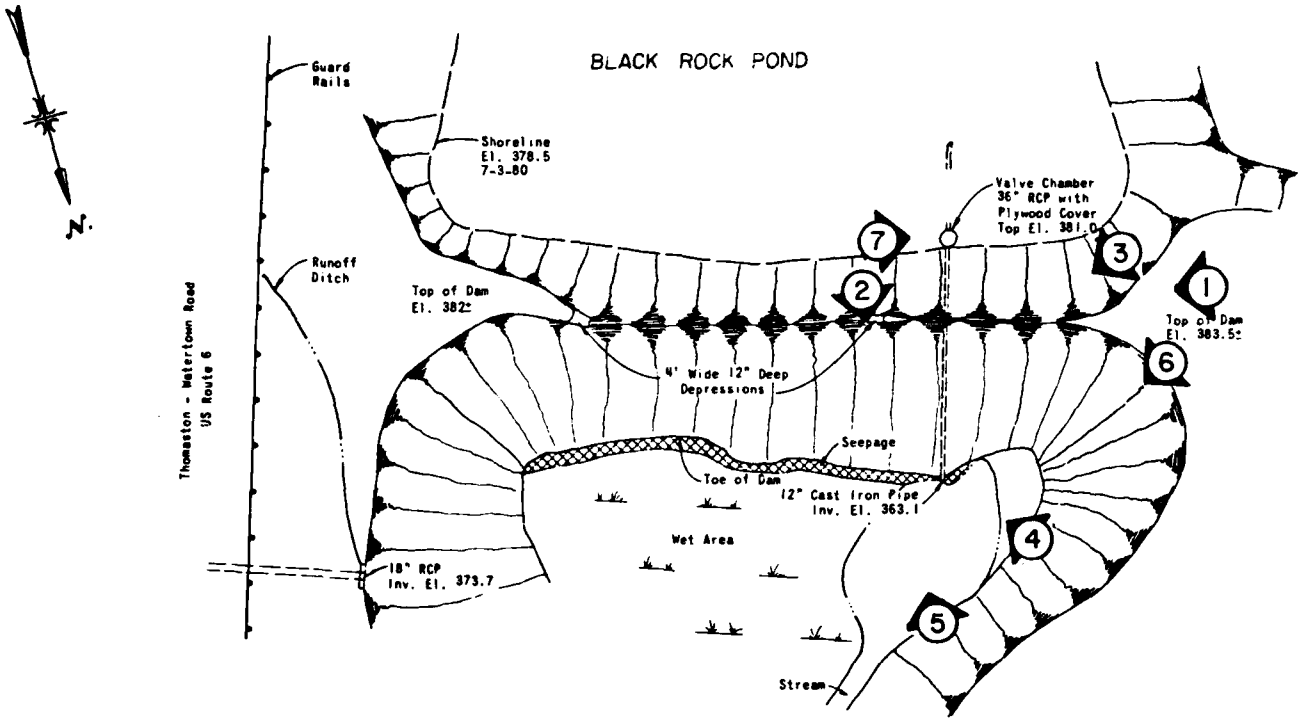
BLACK ROCK POND DAM

DRAWN	CHECKED	APPROVED	SCALES AS NOTED	
JRS	RBL	RH	DATE SEPT 1980	PAGE B-1

APPENDIX C

PHOTOGRAPHS

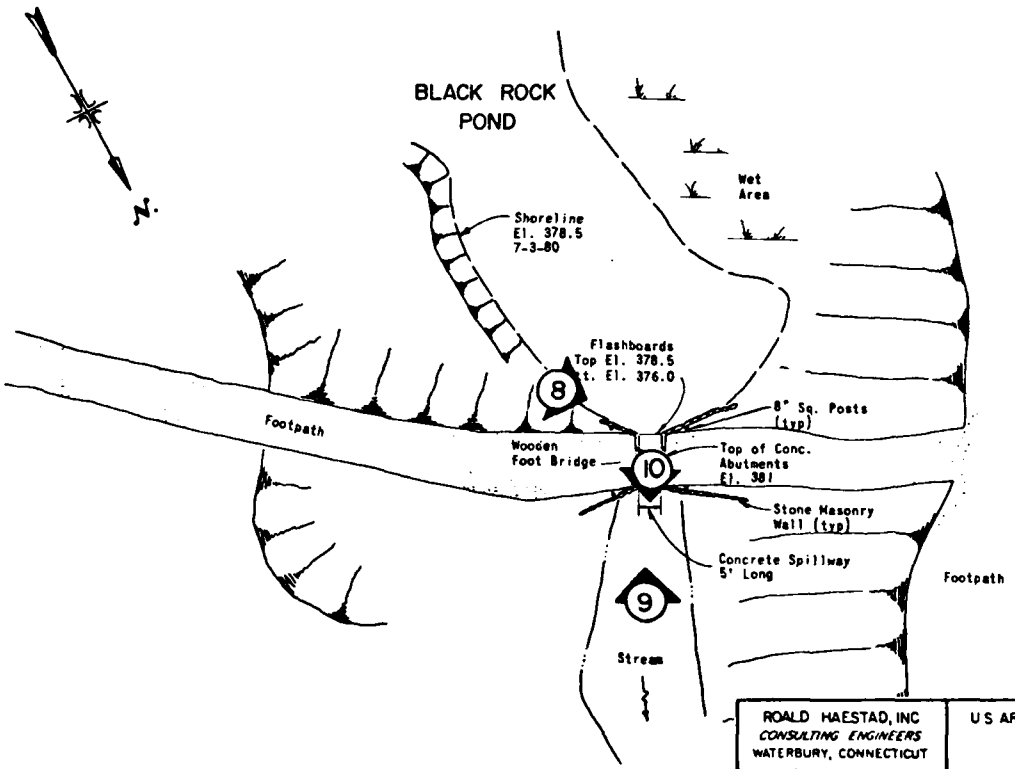
FIGURE 3



MAIN DAM

PLAN

Scale 1"=40'



DIKE AND SPILLWAY

PLAN

Scale 1"=40'

Denotes photo number and direction in which photo was taken.

ROALD HAESTAD, INC CONSULTING ENGINEERS WATERBURY, CONNECTICUT	US ARMY ENGINEER DIV NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS

NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

PHOTO LOCATION PLAN

BLACK ROCK POND DAM

WATERTOWN, CONNECTICUT

DRAWN	CHECKED	APPROVED	SCALES AS NOTED
JRS	RGL	RH	DATE SEPT. 1980 PAGE C-1

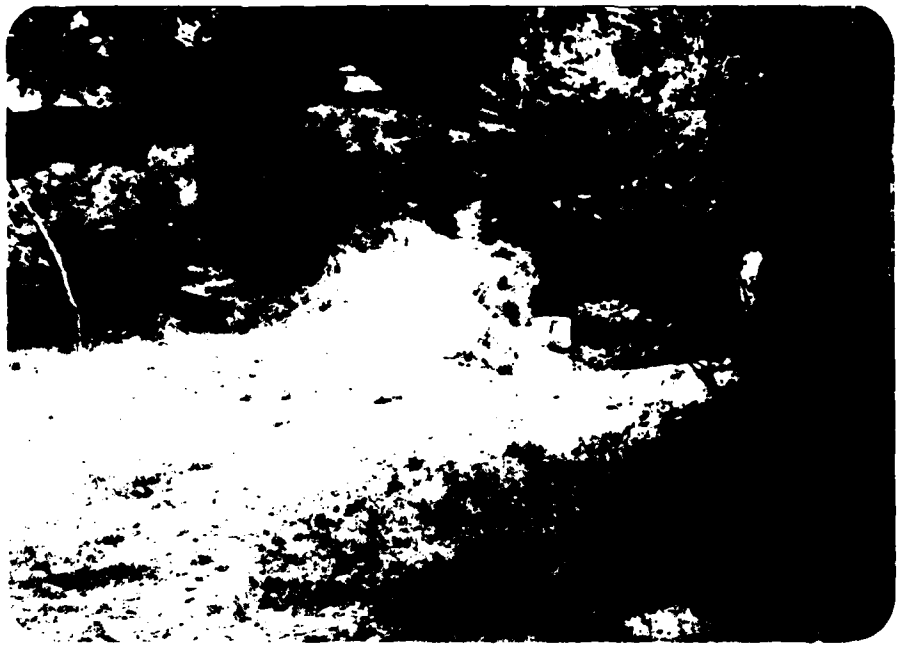


PHOTO NO. 1

DAM FROM LEFT ABUTMENT
NOTE SLOPING CREST

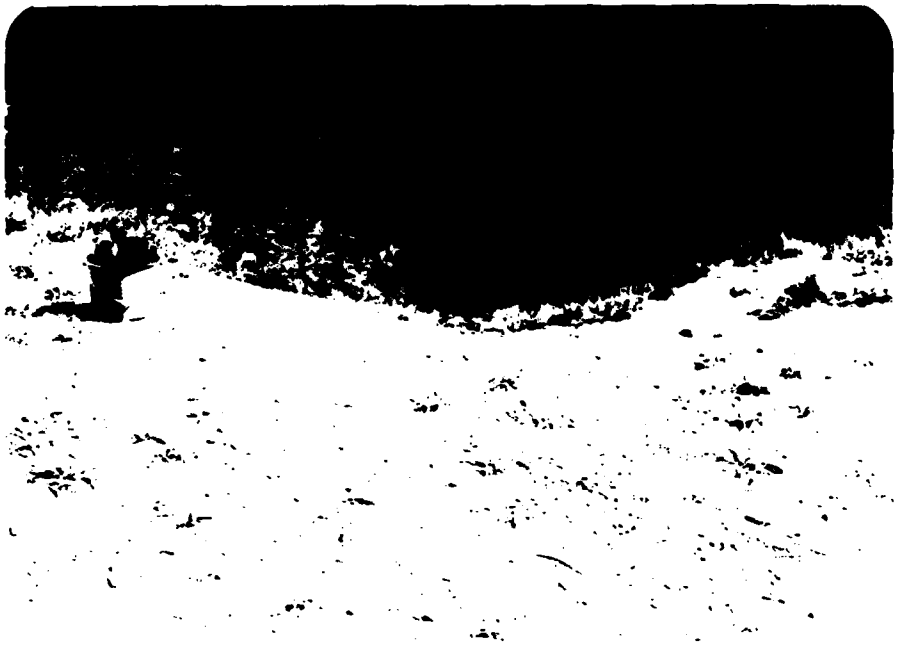


PHOTO NO. 2

LOW SPOT IN DAM CREST DUE TO
EROSION OF FOOT PATH
ON DOWNSTREAM SLOPE

U S ARMY ENGINEER DIV NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASSACHUSETTS	NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS	BLACK ROCK POND DAM PURGATORY BROOK WATERTOWN, CONNECTICUT CT 00633 28 JULY '80
ROALD HAESTAD, INC. CONSULTING ENGINEERS WATERBURY, CONNECTICUT		

PHOTO NO. 3

TREE STUMP ON UPSTREAM SLOPE NEAR LEFT ABUTMENT. NOTE LACK OF SLOPE PROTECTION

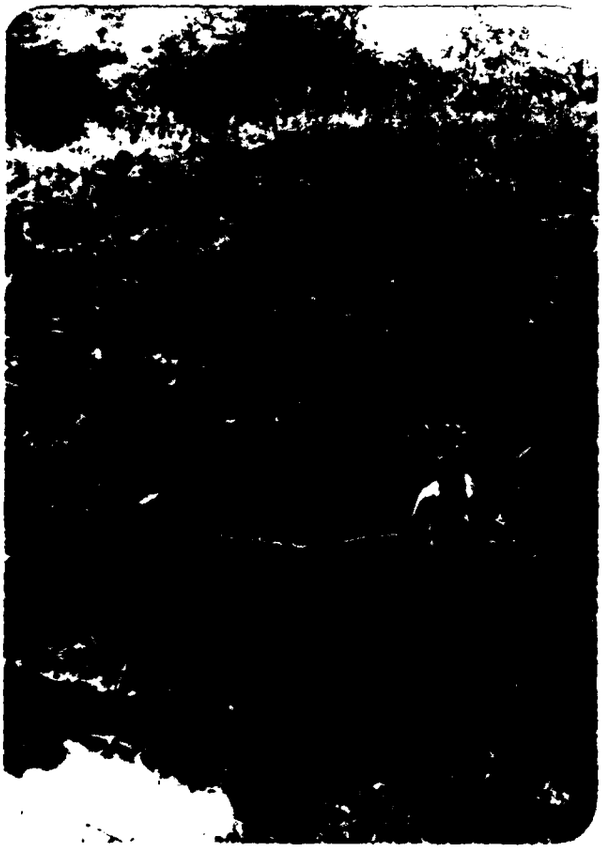


PHOTO NO. 4

DOWNSTREAM SLOPE FROM LEFT ABUTMENT. NOTE TREE STUMPS AND OUTLET PIPE

U S ARMY ENGINEER DIV NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASSACHUSETTS	NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS	BLACK ROCK POND DAM PURGATORY BROOK WATERTOWN, CONNECTICUT CT 00633 28 JULY '80
ROALD HAESTAD, INC. CONSULTING ENGINEERS WATERBURY, CONNECTICUT		

PHOTO NO. 5

SEEPAGE TO LEFT OF LOW LEVEL OUTLET OR BLOWOFF
NOTE EROSION BACK INTO DOWNSTREAM SLOPE

PHOTO NO. 6

AREA DOWNSTREAM OF TOE

U.S ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASSACHUSETTS	NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS	BLACK ROCK POND DAM PURGATORY BROOK WATERTOWN, CONNECTICUT CT 00633 28 JULY '80
ROALD HAESTAD, INC. CONSULTING ENGINEERS WATERBURY, CONNECTICUT		

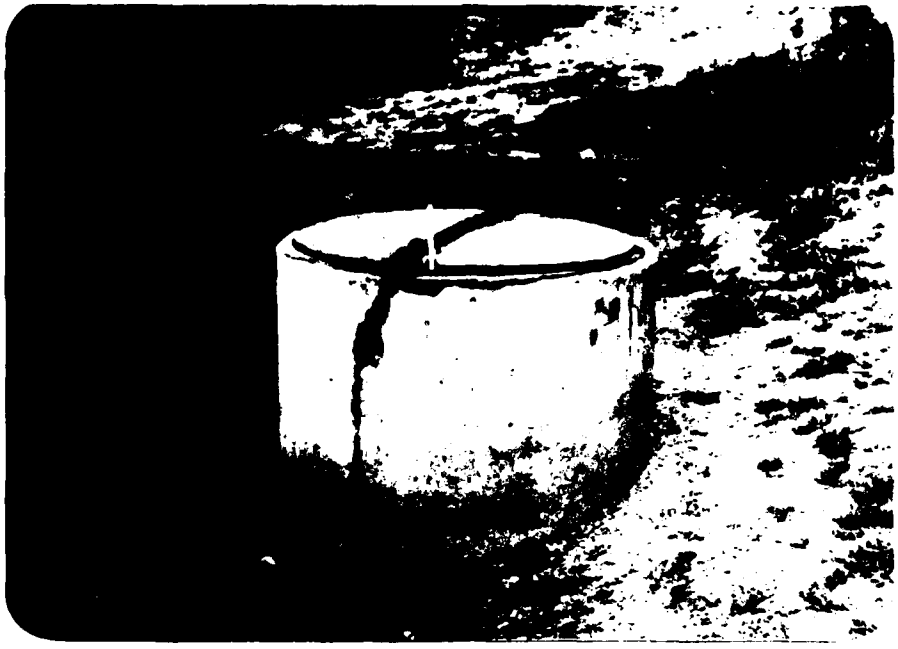


PHOTO NO. 7

CONCRETE RISER FOR LOW LEVEL
OUTLET OR BLOWOFF GATE

PHOTO NO. 8

SPILLWAY FROM UPSTREAM
RIGHT ABUTMENT

U.S.ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASSACHUSETTS	NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS	BLACK ROCK POND DAM PURGATORY BROOK WATERTOWN, CONNECTICUT CT 00633 28 JULY '80
ROALD HAESTAD, INC. CONSULTING ENGINEERS WATERBURY, CONNECTICUT		

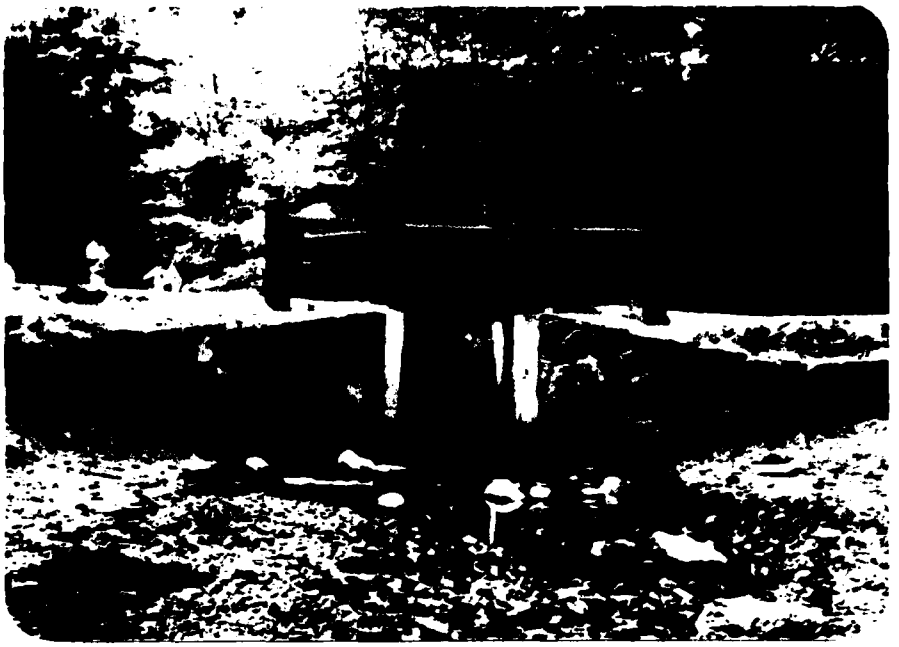


PHOTO NO. 9

SPILLWAY FROM DOWNSTREAM

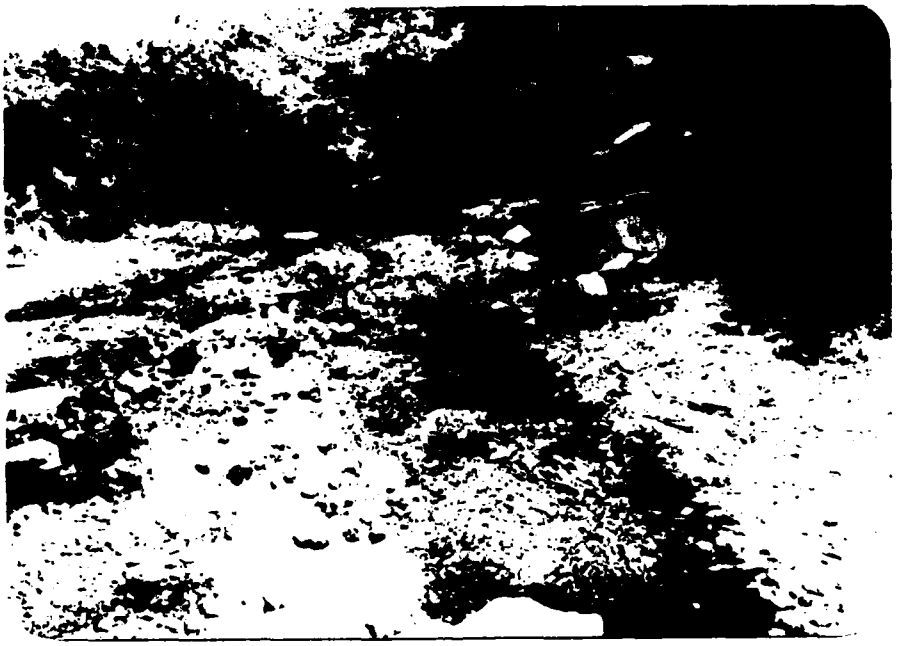


PHOTO NO. 10

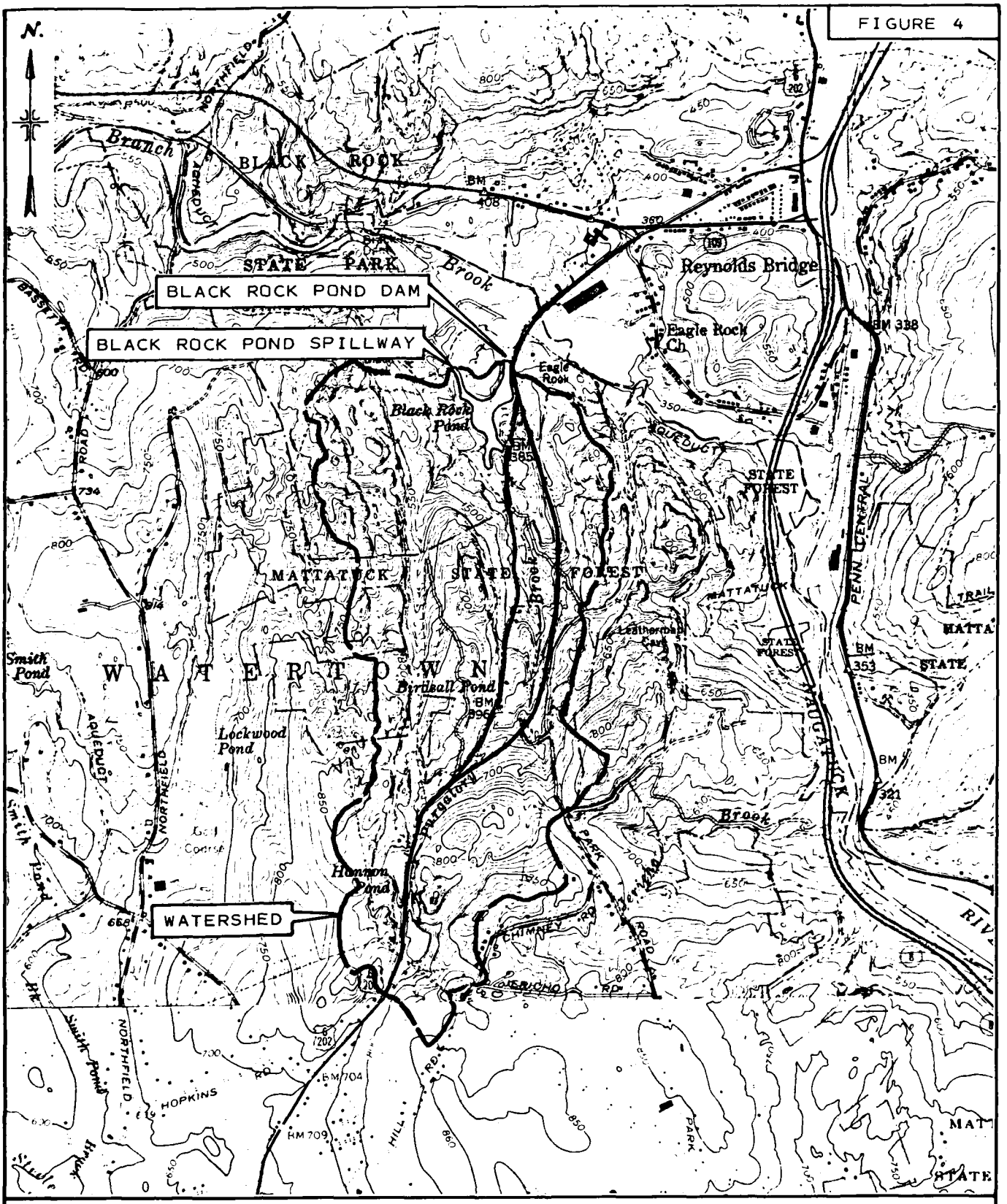
DOWNSTREAM CHANNEL FROM SPILLWAY

U.S.ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASSACHUSETTS	NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS	BLACK ROCK POND DAM PURGATORY BROOK WATERTOWN, CONNECTICUT CT 00633 28 JULY '80
ROALD HAESTAD, INC. CONSULTING ENGINEERS WATERBURY, CONNECTICUT		

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

FIGURE 4



WATERSHED MAP

BLACK ROCK POND DAM
WATERTOWN, CONNECTICUT

SCALE: 1" = 2000'

ROALD HAESTAD, INC.

THOMASTON QUADRANGLE 1969

BY SAL DATE 8/25/80 **ROALD HAESTAD, INC.** SHEET NO 1 OF 23

CONSULTING ENGINEERS

CKD BY DWS DATE 9/22/80 37 Brookside Road - Waterbury, Conn. 06708 JOB NO 49-028

SUBJECT BLACK ROCK DAM - Project Discharge Capacity

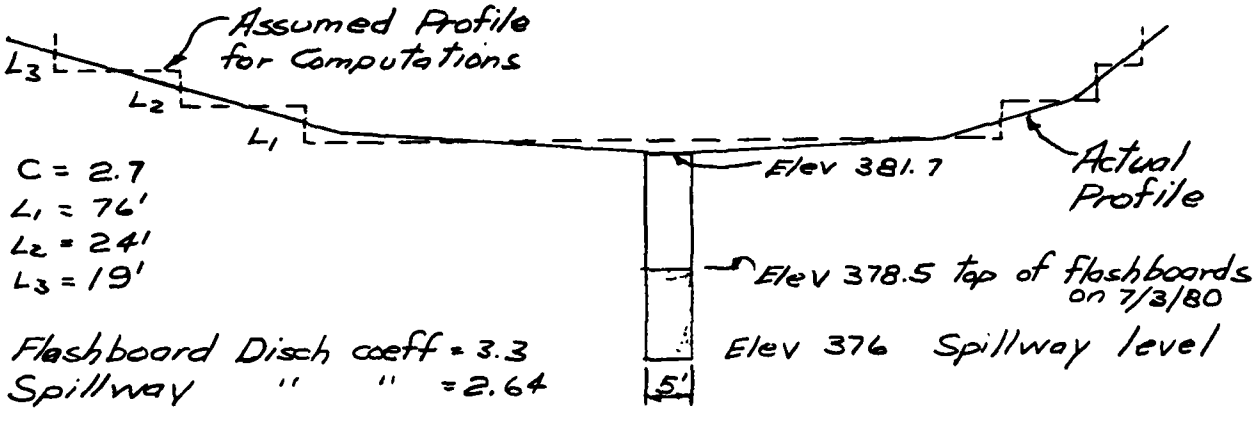
Main Dam & Spillway Dike Profiles:

Scale: 1" = 40' Horiz
1" = 5' Vert

C = 3.0 L_1 = 97' L_2 = 51'

MAIN DAM

Scale 1" = 20' Horiz
1" = 5' Vert



C = 2.7
L_1 = 76'
L_2 = 24'
L_3 = 19'

Flashboard Disch coeff = 3.3
Spillway " " = 2.64

SPILLWAY DIKE

Spillway Capacity @ top of dike W/Flashboards

$$Q = C L H^{3/2} = 3.3(5)(3.2)^{1.5}$$
$$Q = 94 \text{ cfs}$$

Spillway Capacity @ top of dike W/O Flashboards

$$Q = C L H^{3/2} = 2.64(5)(5.7)^{3/2}$$
$$Q = 180 \text{ cfs}$$

BY SAL DATE 8/25/80 **ROALD HAESTAD, INC.** SHEET NO 2 OF 23

CONSULTING ENGINEERS

CKD BY D.S. DATE 8/25/80 37 Brookside Road - Waterbury, Conn. 06708 JOB NO 49-028

SUBJECT BLACK ROCK DAM - Project Discharge Capacity

Note: 1) For length of spillway and discharge coefficients see computation sheet 1 of 23.

2) The foot bridge above the spillway was assumed to fail during a flood.

Capacity w/o flashboards:

Elev. (Ft)	SPILLWAY (cfs)	MAIN DAM (cfs)	SPILLWAY DIKE (cfs)	TOTAL DISCH. CAPACITY (cfs)
376	0	0	0	0
377	13	0	0	13
378	37	0	0	37
379	69	0	0	69
380	106	0	0	106
381	148	0	0	148
382	194	0	0	194
382.5	219	103	73	395
383	244	291	205	740
383.5	271	589	400	1,260
384	299	976	645	1,920

Capacity w/flashboards

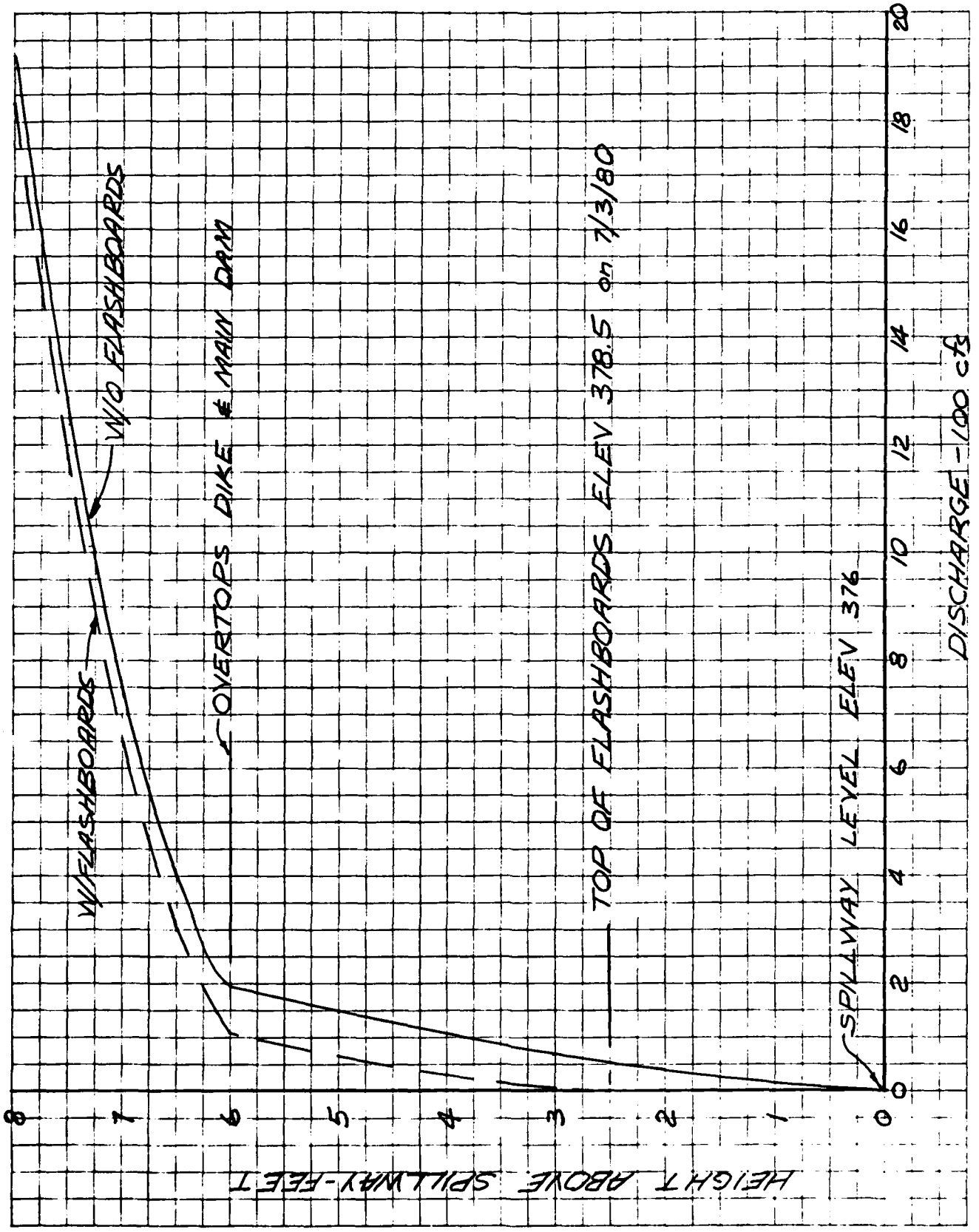
Elev (ft)	SPILLWAY (cfs)	MAIN DAM (cfs)	SPILLWAY DIKE (cfs)	TOTAL DISCH. CAPACITY (cfs)
378.5	0	0	0	0
379	6	0	0	6
380	30	0	0	30
381	65	0	0	65
382	108	0	0	108
382.5	132	103	73	308
383	158	291	205	654
383.5	184	589	400	1,173
384	213	976	645	1,834

BY SAL DATE 8/25/80 **ROALD HAESTAD, INC.** SHEET NO 3 OF 23

CONSULTING ENGINEERS

CKD BY DLS DATE 8/28/80 37 Brookside Road - Waterbury, Conn. 06708 JOB NO 49-028

SUBJECT BLACK ROCK DAM - Project Discharge Capacity Curve



BY SAL DATE 8/14/80 **ROALD HAESTAD, INC.** SHEET NO 4 OF 23

CKD BY DLS DATE 8/20/80 CONSULTING ENGINEERS 37 Brookside Road - Waterbury, Conn. 06708 JOB NO 49-028

SUBJECT BLACK ROCK DAM - Surcharge Storage Capacity

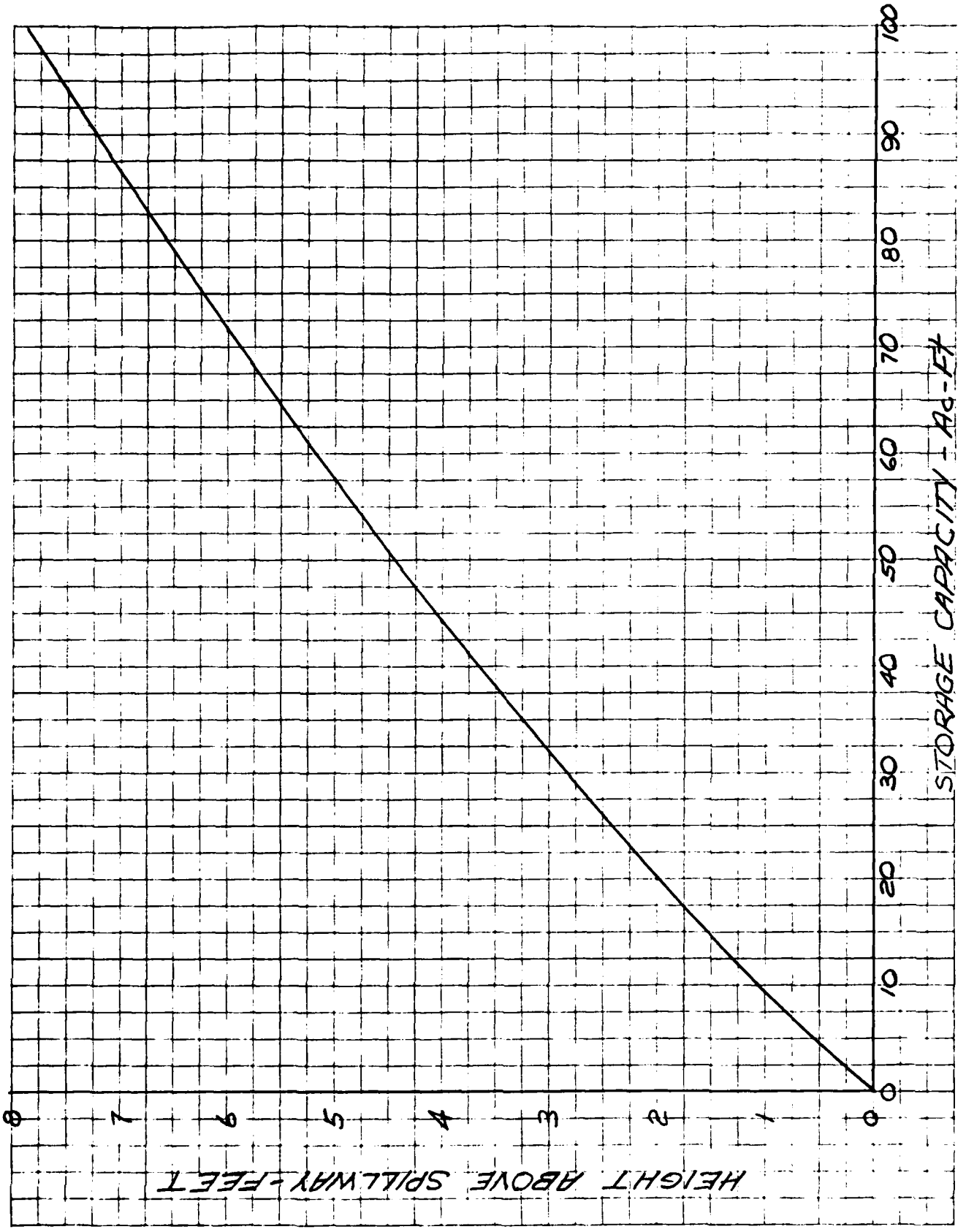
Height Above Spillway (feet)	Surface Area (Acres)	Average Surface Area (Acres)	Storage Capacity (Acre-Ft)
0	9.2		0
		10.15	
2	11.1		20.3
		12.00	
4	12.9		44.3
		13.65	
6	14.4		71.6
		15.10	
8	15.8		101.8
		16.55	
10	17.3		134.9
		18.00	
12	18.7		170.9
		19.45	
14	20.2		209.8

BY SAL DATE 8/26/80 **ROALD HAESTAD, INC.** SHEET NO 5 OF 23

CONSULTING ENGINEERS

CKD BY DLS DATE 8/28/80 37 Brookside Road - Waterbury, Conn. 06708 JOB NO 49-028

SUBJECT BLACK ROCK DAM - Surcharge Storage Capacity Curve



Test Flood = 1/2 PMF

Drainage Area = 723 Acres = 1.13 sq. mi.

From Corps of Engineers chart for "Rolling" Terrain

MPF = 2,125 cfs/sq. mi. (2.0 sq. mi. Minimum)

PMF = 2,125 cfs/sq mi x 1.13 sq mi = 2,401 cfs

1/2 PMF = 1/2 (2,401 cfs) = 1,200.5 use 1,200 cfs

Q_{P1} = 1,200 cfs

H_1 = 7.4 ft. above Spillway, from Discharge Curve

$STOR_1$ = 92.5 ac-ft, From Surcharge Storage Capacity Curve.
= 1.5" runoff from 1.13 sq. mi.

Maximum Probable Flood Runoff in New England equals Approx. 19 in. Therefore 1/2 PMF equals approx. 1/2(19) = 9.5".

$Q_{P2} = Q_{P1} \times (1 - STOR_1/9.5) = 1{,}200 \text{ cfs } (1 - 1.5/9.5) = 1{,}011 \text{ cfs}$

H_2 = 7.3 ft $STOR_2$ = 91 ac-ft

$STOR_{AVE} = (STOR_1 + STOR_2)/2 = (91 + 92.5)/2 = 91.75$ use 92 ac-ft
= 1.5" runoff

$Q_{P3} = Q_{P1} (1 - STOR_{AVE}/9.5) = 1{,}200 \text{ cfs } (1 - 1.5/9.5) = 1{,}011 \text{ cfs}$
Use 1,000 cfs

H_3 = 7.3 ft.

Spillway Capacity @ top of dike W/O flashboards

$$Q = CLH^{3/2}$$
$$Q = 2.64(5)(5.7)^{3/2} = 180 \text{ cfs}$$

% of 1/2 PMF = $(180/1{,}000) \times 100$ = 18% of 1/2 PMF

S = Storage at time of failure with water level at top of dam.

S = Storage at spillway level + Freeboard Storage

S = (Surface Area × Average depth) + (From surcharge storage capacity curve)

S = (9.2 acres × 10 feet) + (72 acre-feet) = 164 acre-ft

Q_{p1} = Peak Failure Outflow = $8/27\ W_b(\sqrt{g})\ Y_o^{3/2}$

W_b = Breach Width = 40% of dam length across river at mid-height = 0.4(150') = 60'

Y_o = Total height from river bed to pool level at time of failure = 20'

$Q_{p1} = 8/27\ (60)(\sqrt{32.2})(20)^{3/2} = 9,022.9$ use 9,025 cfs

SECTION NUMBER 1

STORAGE CAPACITY WITHIN REACH

HEIGHT (FEET)	SURFACE AREA (ACRES)	STORAGE VOLUME (ACRE-FEET)
1.0	.20	.1
2.0	.40	.4
3.0	.60	.9
4.0	.80	1.6
5.0	1.00	2.5
6.0	3.30	4.7
7.0	5.60	9.1
8.0	7.90	15.9
9.0	10.20	24.9
10.0	12.50	36.3
11.0	14.80	49.9
12.0	17.10	65.9
13.0	19.40	84.1
14.0	21.70	104.7
15.0	24.00	127.5
16.0	28.60	153.8
17.0	33.20	184.7
18.0	37.80	220.2
19.0	42.40	260.3
20.0	47.00	305.0
21.0	51.60	354.3
22.0	56.20	408.2
23.0	60.80	466.7
24.0	65.40	529.8
25.0	70.00	597.5

STORAGE CAPACITY CALCULATED FROM SURFACE AREAS AT KNOWN ELEVATIONS.

BY SAL DATE 9/19/80 ROALD HAESTAD, INC. SHEET NO 9 OF 23

CKD BY DLS DATE 9/22/80 CONSULTING ENGINEERS JOB NO 49-028

SUBJECT BLACK ROCK DAM-FLOOD ROUTING AT TOP OF DAM

SECTION NUMBER 1

RT-6 AND RT-202

HEIGHT ABOVE INVERT (FEET)	D I S C H A R G E CONDUIT #1 (CFS)	CONDUIT #2 (CFS)	C A P A C I T Y SPILLWAY (CFS)	TOTAL (CFS)
1.0	270	0	0	270
2.0	540	0	0	540
3.0	810	0	0	810
4.0	1080	0	0	1080
5.0	1512	0	0	1512
6.0	1944	0	0	1944
7.0	2376	14	0	2390
8.0	2970	28	0	2998
9.0	3645	59	0	3704
10.0	4320	90	0	4410
11.0	4914	123	0	5037
12.0	5508	155	0	5663
13.0	6264	183	0	6447
14.0	7020	210	0	7230
15.0	7830	230	425	8485
16.0	8586	250	1602	10438
17.0	9180	265	3577	13022
18.0	9990	285	6338	16613

STORAGE AT TIME OF FAILURE=S= 164 AC. FT.
LENGTH OF REACH=L= 800 FT.

BY SAL DATE 9/19/80 ROALD HAESTAD, INC. SHEET NO 10 OF 23

CKD BY DLS DATE 9/22/80 CONSULTING ENGINEERS JOB NO 49-028

SUBJECT BLACK ROCK DAM-FLOOD ROUTING AT TOP OF DAM

SECTION NUMBER 1

RT-6 AND RT-202

TIME (MIN.)	AVERAGE INFLOW (AC-FT)	TRIAL DEPTH OF FLOW (FEET)	AVERAGE OUTFLOW FOR, ΔT (AC-FT)	INCREMENTAL STORAGE, ΔS (AC-FT)	TOTAL STORAGE (AC-FT)	DEPTH OF FLOW END OF, ΔT (FEET)
1.0	12.4	6.9	3.2	9.2	9.2	7.0
2.0	12.4	8.2	4.3	8.1	17.3	8.2
3.0	12.4	9.0	5.1	7.4	24.7	9.0
4.0	12.4	9.5	5.6	6.8	31.5	9.6
5.0	12.4	10.1	6.1	6.3	37.8	10.1
6.0	12.4	10.5	6.5	5.9	43.7	10.5
7.0	12.4	10.9	6.9	5.6	49.3	11.0
8.0	12.4	11.3	7.2	5.3	54.5	11.3
9.0	12.4	11.6	7.4	5.0	59.5	11.6
10.0	12.4	11.9	7.7	4.8	64.3	11.9
11.0	12.4	12.1	7.9	4.5	68.8	12.2
12.0	12.4	12.3	8.2	4.3	73.1	12.4
13.0	12.4	12.6	8.4	4.0	77.1	12.6
14.0	0.0	12.1	7.9	- 7.9	69.2	12.2
15.0	0.0	11.6	7.5	- 7.5	61.7	11.7
16.0	0.0	11.2	7.1	- 7.1	54.6	11.3

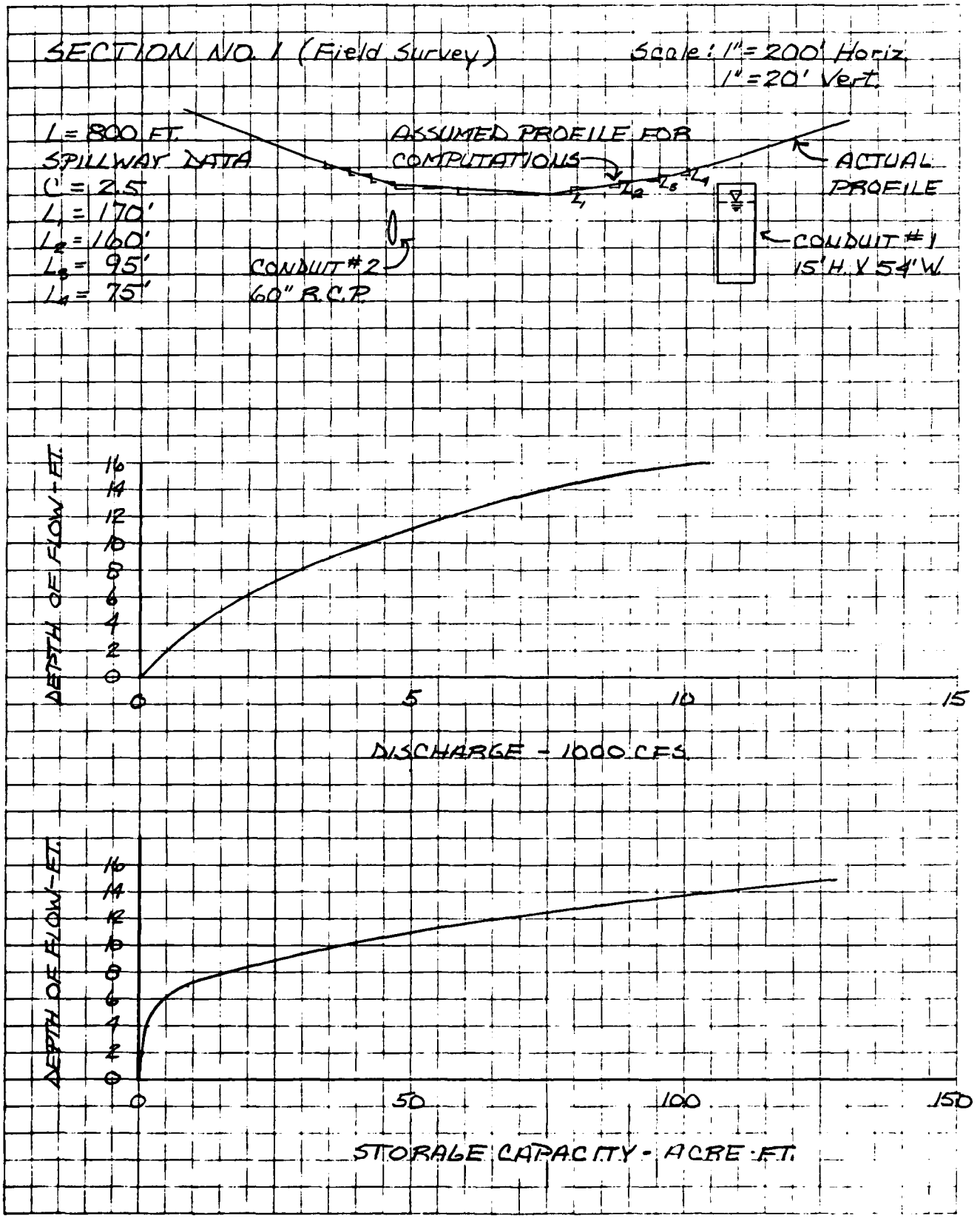
REACH OUTFLOW=QP2= 6098 CFS

HEIGHT ABOVE CONDUIT INVERT=H2= 12.6 FT.

BY LBG DATE 8-8-80 **ROALD HAESTAD, INC.** SHEET NO 11 OF 23

CKD BY DLS DATE 8/12/80 CONSULTING ENGINEERS 37 Brookside Road - Waterbury, Conn. 06708 JOB NO 49-028

SUBJECT BLACK ROCK DAM - FLOOD ROUTING



BY SAL DATE 9/19/80 ROALD HAESTAD, INC. SHEET NO 12 OF 23

CKD BY DLS DATE 9/22/80 CONSULTING ENGINEERS JOB NO 49-028

SUBJECT BLACK ROCK DAM-FLOOD ROUTING AT TOP OF DAM

SECTION NUMBER 2A

MAIN CHANNEL

H	W	A	R	S	V	Q
1.0	67	60	.90	.0056	1.48	89
2.0	73	129	1.76	.0056	2.32	300
3.0	80	205	2.56	.0056	2.97	609
4.0	87	287	3.31	.0056	3.53	1011
5.0	93	374	4.03	.0056	4.02	1506
6.0	99	467	4.72	.0056	4.47	2086
7.0	105	564	5.37	.0056	4.87	2750
8.0	111	667	6.00	.0056	5.25	3497
9.0	117	774	6.60	.0056	5.59	4330
10.0	123	887	7.19	.0056	5.92	5248

MANNING COEFFICIENT=N=.0700

BY SAL DATE 9/19/80 ROALD HAESTAD, INC. SHEET NO 13 OF 23

CKD BY DLS DATE 9/22/80 CONSULTING ENGINEERS JOB NO 49-028

SUBJECT BLACK ROCK DAM-FLOOD ROUTING AT TOP OF DAM

SECTION NUMBER 2B

RIGHT OVERBANK

H	W	A	R	S	V	Q
5.0	398	336	.84	.0056	1.99	668
6.0	491	779	1.59	.0056	3.03	2359
7.0	583	1314	2.25	.0056	3.82	5022
8.0	676	1940	2.87	.0056	4.49	8716
9.0	769	2658	3.46	.0056	5.09	13520
10.0	861	3467	4.03	.0056	5.63	19518

MANNING COEFFICIENT=N=.0500

SECTION NUMBER 2

TOTAL SECTION

	AREA			DISCHARGE		
H	A	B	TOTAL	A	B	TOTAL
1.0	60	0	60	89	0	89
2.0	129	0	129	300	0	300
3.0	205	0	205	609	0	609
4.0	287	0	287	1011	0	1011
5.0	374	336	711	1506	668	2174
6.0	467	779	1246	2086	2359	4445
7.0	564	1314	1878	2750	5022	7771
8.0	667	1940	2607	3497	8716	12213
9.0	774	2658	3432	4330	13520	17850
10.0	887	3467	4354	5248	19518	24766

STORAGE AT TIME OF FAILURE=S= 164 AC. FT.
LENGTH OF REACH=L= 1600 FT.

INFLOW INTO REACH=QP1= 6098 CFS
DEPTH OF FLOW=H1= 6.5 FT.
CROSS SECTIONAL AREA=A1= 1574 SQ. FT.
STORAGE IN REACH=V1= 57.8 AC. FT.

TRIAL REACH OUTFLOW=QP(TRIAL)= 3949 CFS
TRIAL DEPTH OF FLOW=H(TRIAL)= 5.8 FT.
TRIAL CROSS SECTIONAL AREA=A(TRIAL)= 1140 SQ. FT.
TRIAL STORAGE IN REACH=V(TRIAL)= 41.9 AC. FT.

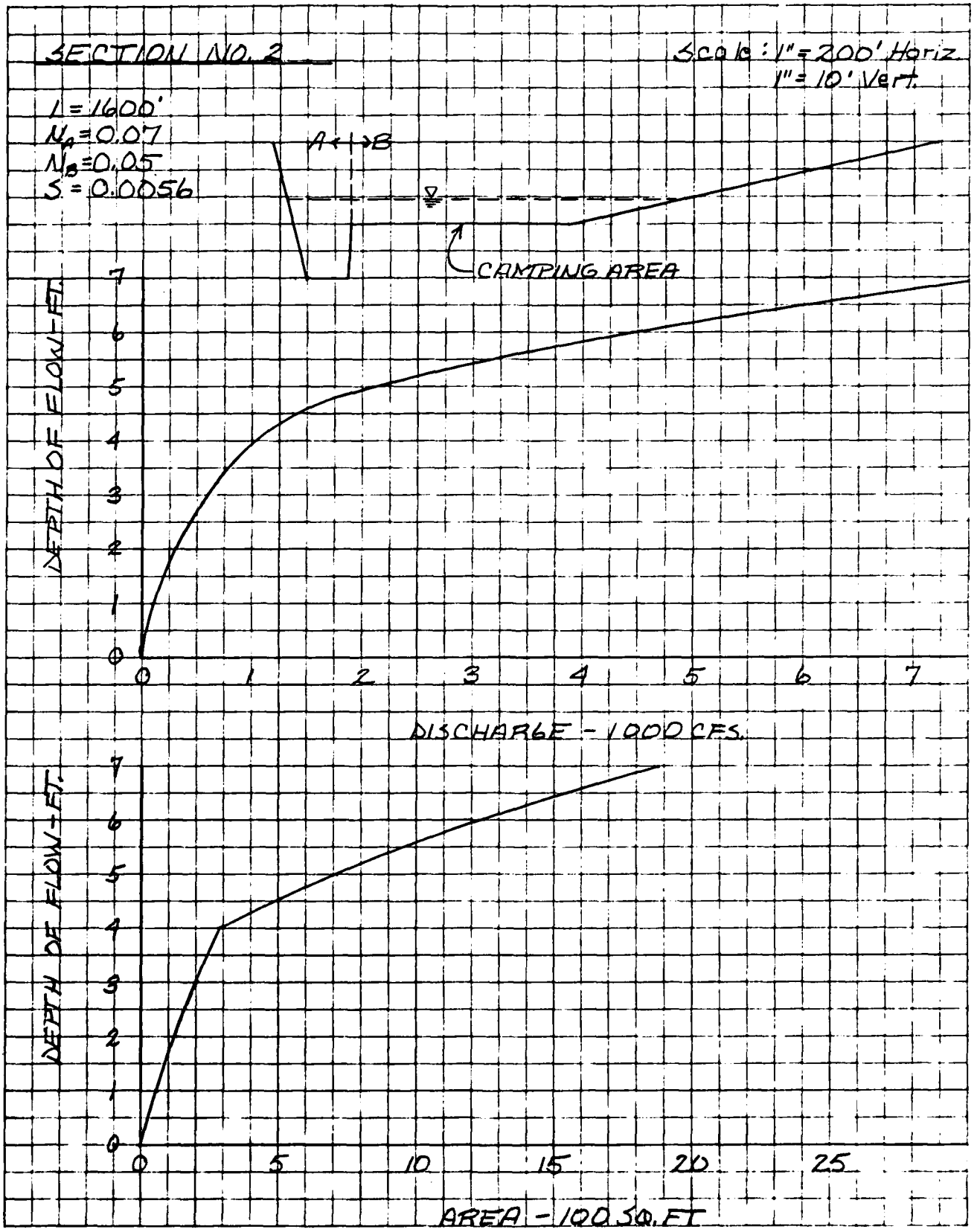
REACH OUTFLOW=QP2= 4245 CFS
DEPTH OF FLOW=H2= 5.9 FT.

BY LBG DATE 8/27/80 **ROALD HAESTAD, INC.** SHEET NO 15 OF 23

CONSULTING ENGINEERS

CKD BY DLS DATE 9/16/80 37 Brookside Road - Waterbury, Conn. 06708 JOB NO 49-028

SUBJECT BLACK ROCK DAM - FLOOD ROUTING



SECTION NUMBER 3

TOTAL SECTION

H	W	A	R	S	V	Q
1.0	28	14	.50	.0052	.67	9
2.0	56	56	1.00	.0052	1.07	60
3.0	84	126	1.49	.0052	1.40	176
4.0	112	224	1.99	.0052	1.70	380
5.0	141	350	2.49	.0052	1.97	689
6.0	169	504	2.99	.0052	2.22	1121
7.0	197	686	3.49	.0052	2.46	1690
8.0	225	896	3.98	.0052	2.69	2413
9.0	253	1134	4.48	.0052	2.91	3304
10.0	281	1400	4.98	.0052	3.13	4376
11.0	294	1687	5.73	.0052	3.43	5788
12.0	307	1986	6.46	.0052	3.72	7383
13.0	321	2299	7.17	.0052	3.98	9159
14.0	334	2624	7.86	.0052	4.24	11119
15.0	347	2963	8.54	.0052	4.48	13264
16.0	360	3314	9.20	.0052	4.71	15597
17.0	373	3679	9.86	.0052	4.93	18121
18.0	386	4056	10.50	.0052	5.14	20839
19.0	400	4447	11.13	.0052	5.34	23752
20.0	413	4850	11.75	.0052	5.54	26865

MANNING COEFFICIENT=N= .1000
STORAGE AT TIME OF FAILURE=S= 164 AC. FT.
LENGTH OF REACH=L= 1200 FT.

INFLOW INTO REACH=QP1= 4245 CFS
DEPTH OF FLOW=H1= 9.9 FT.
CROSS SECTIONAL AREA=A1= 1368 SQ. FT.
STORAGE IN REACH=V1= 37.7 AC. FT.

TRIAL REACH OUTFLOW=QP(TRIAL)= 3270 CFS
TRIAL DEPTH OF FLOW=H(TRIAL)= 9.0 FT.
TRIAL CROSS SECTIONAL AREA=A(TRIAL)= 1125 SQ. FT.
TRIAL STORAGE IN REACH=V(TRIAL)= 31.0 AC. FT.

REACH OUTFLOW=QP2= 3356 CFS
DEPTH OF FLOW=H2= 9.0 FT.

BY LBG DATE 8/15/80 **ROALD HAESTAD, INC.** SHEET NO 17 OF 23

CONSULTING ENGINEERS

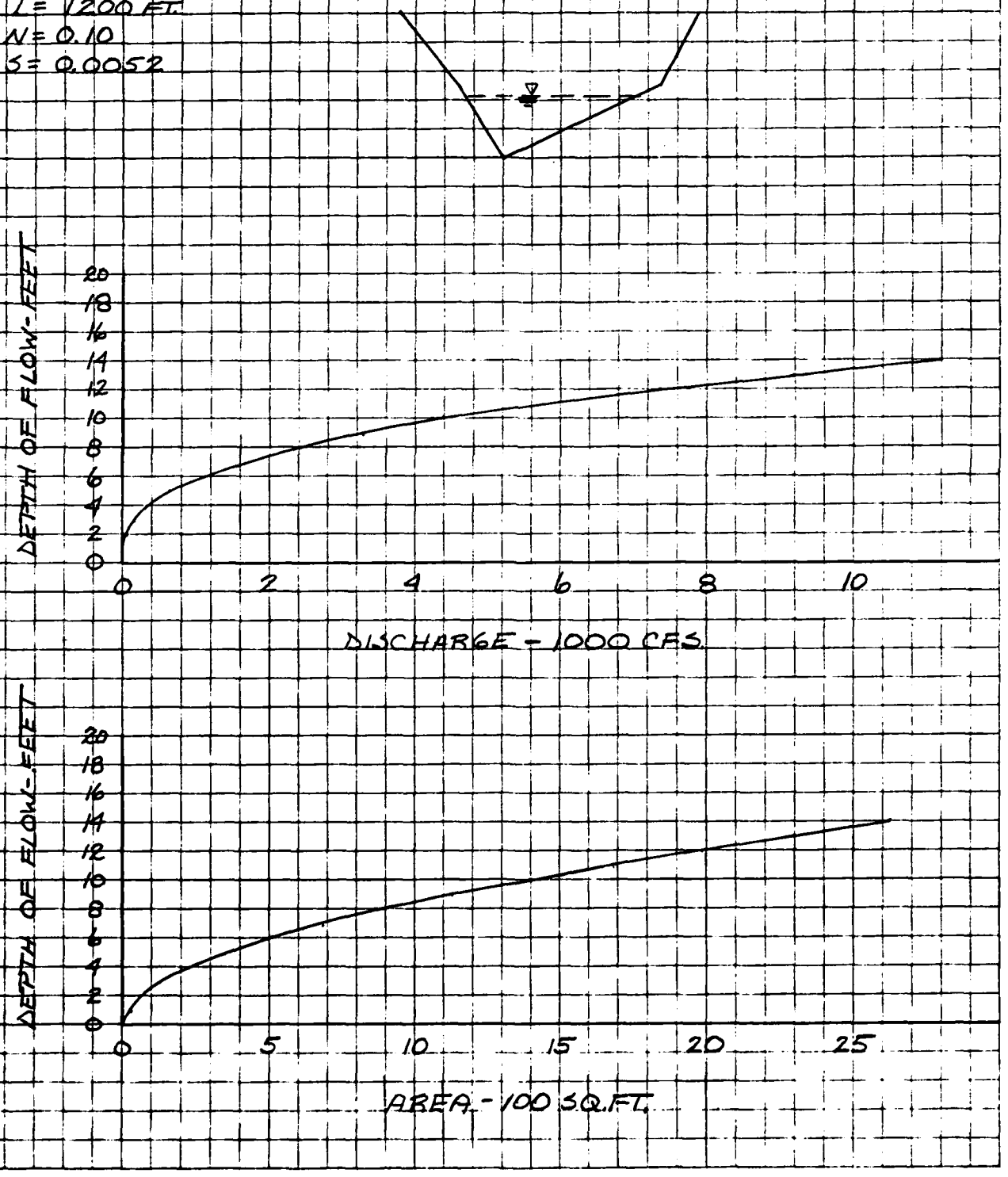
CKD BY DLS DATE 8/15/80 37 Brookside Road - Waterbury, Conn. 06708 JOB NO 49-028

SUBJECT BLACK ROCK DAM - FLOOD ROUTING

SECTION NO. 3

Scale: 1"=200' Horiz.
1"=20' Vert.

L = 1200 FT.
N = 0.10
S = 0.0052



BY SAL DATE 9/19/80 ROALD HAESTAD, INC. SHEET NO 18 OF 23

CKD BY DLS DATE 9/22/80 CONSULTING ENGINEERS JOB NO 49-028

SUBJECT BLACK ROCK DAM-FLOOD ROUTING AT TOP OF DAM

SECTION NUMBER 4A

MAIN CHANNEL

H	W	A	R	S	V	Q
1.0	10	5	.49	.0048	.64	3
2.0	20	20	.98	.0048	1.02	20
3.0	31	45	1.47	.0048	1.33	60
4.0	41	80	1.96	.0048	1.61	129
5.0	51	125	2.45	.0048	1.87	234
6.0	56	177	3.18	.0048	2.23	393
7.0	60	232	3.85	.0048	2.53	587
8.0	65	291	4.48	.0048	2.80	813
9.0	70	353	5.08	.0048	3.04	1073
10.0	74	419	5.64	.0048	3.26	1367
11.0	79	488	6.19	.0048	3.47	1694
12.0	83	561	6.72	.0048	3.67	2056
13.0	88	637	7.23	.0048	3.85	2452
14.0	93	717	7.73	.0048	4.02	2884
15.0	97	800	8.21	.0048	4.19	3353
16.0	103	888	8.58	.0048	4.31	3828
17.0	110	980	8.94	.0048	4.44	4347
18.0	116	1078	9.31	.0048	4.56	4911
19.0	122	1180	9.69	.0048	4.68	5522
20.0	128	1288	10.07	.0048	4.80	6181

MANNING COEFFICIENT=N=.1000

BY SAL DATE 9/19/80 ROALD HAESTAD, INC. SHEET NO 19 OF 23

CKD BY DLS DATE 9/22/80 CONSULTING ENGINEERS JOB NO 49-028

SUBJECT BLACK ROCK DAM-FLOOD ROUTING AT TOP OF DAM

SECTION NUMBER 4B

RIGHT OVERBANK

H	W	A	R	S	V	Q
6.0	40	19	.49	.0048	.64	12
7.0	79	77	.97	.0048	1.01	78
8.0	119	173	1.46	.0048	1.33	230
9.0	158	308	1.95	.0048	1.61	495
10.0	198	481	2.44	.0048	1.86	897
11.0	237	693	2.92	.0048	2.10	1459
12.0	277	943	3.41	.0048	2.33	2200
13.0	316	1232	3.90	.0048	2.55	3141
14.0	356	1559	4.38	.0048	2.76	4301
15.0	395	1925	4.87	.0048	2.96	5696
16.0	399	2312	5.79	.0048	3.32	7673
17.0	403	2701	6.69	.0048	3.66	9878
18.0	408	3094	7.59	.0048	3.98	12300
19.0	412	3489	8.47	.0048	4.28	14929
20.0	416	3888	9.35	.0048	4.57	17759

MANNING COEFFICIENT=N=.1000

SUBJECT BLACK ROCK DAM-FLOOD ROUTING AT TOP OF DAM

SECTION NUMBER 4

TOTAL SECTION

	AREA			DISCHARGE		
H	A	B	TOTAL	A	B	TOTAL
1.0	5	0	5	3	0	3
2.0	20	0	20	20	0	20
3.0	45	0	45	60	0	60
4.0	80	0	80	129	0	129
5.0	125	0	125	234	0	234
6.0	177	19	196	393	12	406
7.0	232	77	309	587	78	665
8.0	291	173	464	813	230	1043
9.0	353	308	661	1073	495	1568
10.0	419	481	900	1367	897	2264
11.0	488	693	1181	1694	1459	3153
12.0	561	943	1504	2056	2200	4256
13.0	637	1232	1869	2452	3141	5593
14.0	717	1559	2276	2884	4301	7185
15.0	800	1925	2725	3353	5696	9049
16.0	888	2312	3199	3828	7673	11501
17.0	980	2701	3681	4347	9878	14225
18.0	1078	3094	4171	4911	12300	17211
19.0	1180	3489	4669	5522	14929	20451
20.0	1288	3888	5175	6181	17759	23940

STORAGE AT TIME OF FAILURE=S= 164 AC. FT.
LENGTH OF REACH=L= 1300 FT.

INFLOW INTO REACH=QP1= 3356 CFS
DEPTH OF FLOW=H1= 11.2 FT.
CROSS SECTIONAL AREA=A1= 1241 SQ. FT.
STORAGE IN REACH=V1= 37.0 AC. FT.

TRIAL REACH OUTFLOW=QP(TRIAL)= 2598 CFS
TRIAL DEPTH OF FLOW=H(TRIAL)= 10.4 FT.
TRIAL CROSS SECTIONAL AREA=A(TRIAL)= 1006 SQ. FT.
TRIAL STORAGE IN REACH=V(TRIAL)= 30.0 AC. FT.

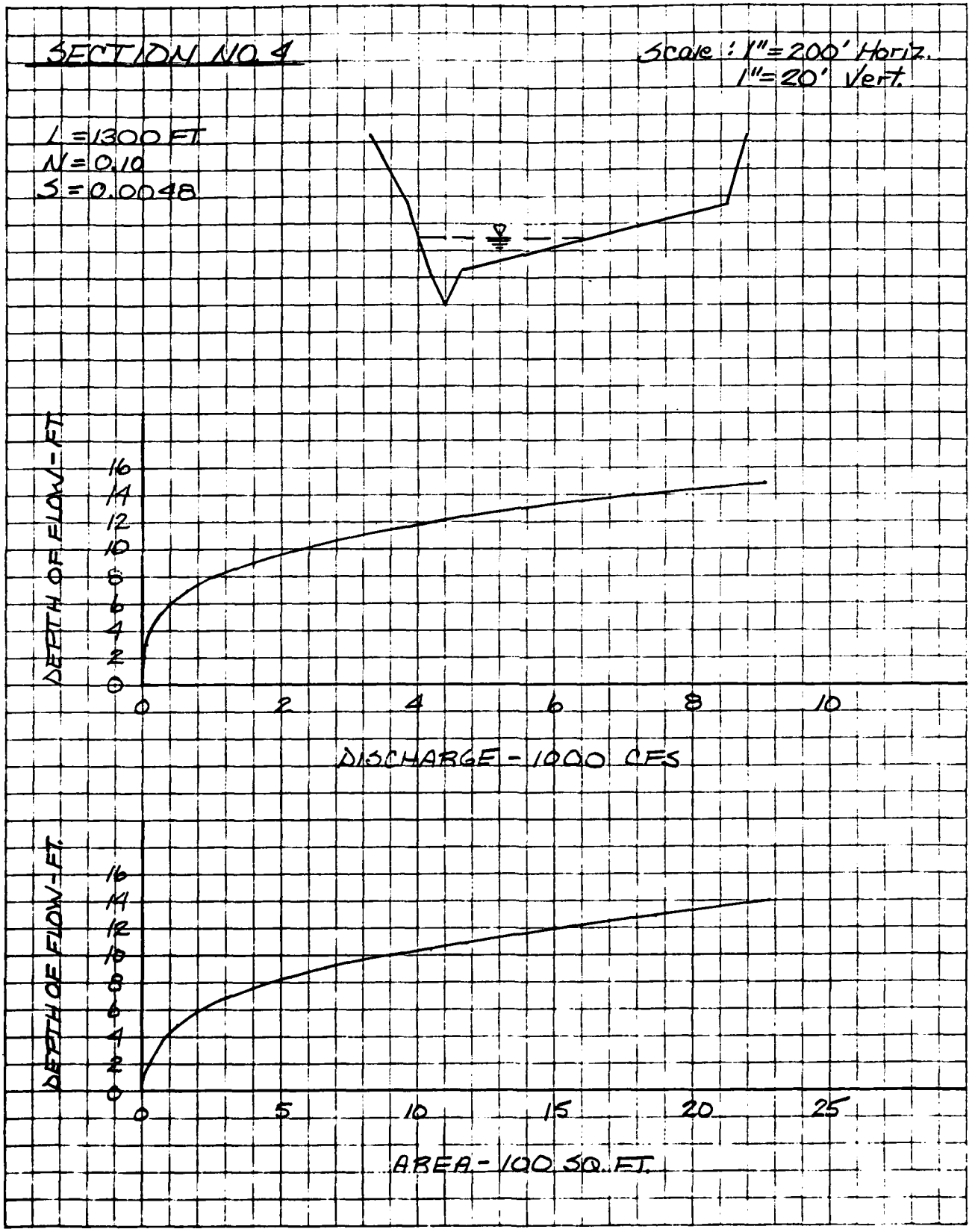
REACH OUTFLOW=QP2= 2670 CFS
DEPTH OF FLOW=H2= 10.5 FT.

BY LRG DATE 8/15/80 **ROALD HAESTAD, INC.** SHEET NO 21 OF 23

CONSULTING ENGINEERS

CKD BY DAS DATE 8/15/80 37 Brookside Road - Waterbury, Conn. 06708 JOB NO 49-028

SUBJECT BLACK ROCK DAM - FLOOD ROUTING

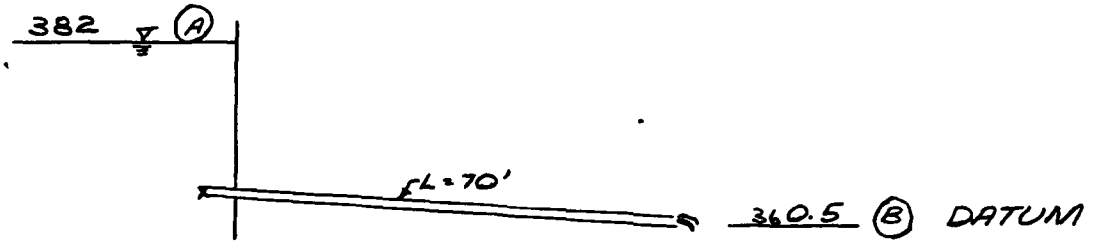


SUBJECT BLACK ROCK DAM - Blowoff Capacity

Blowoff consists of a 12" CIP approximately 70' long

Top of dam Elev = 382
Inv of blowoff Elev = 360.5

Head losses: 1) In the pipe = $f\, L/D\, V_2^2/2g$
2) Gate Valve = $K\, V_2^2/2g$ ($K = 0.25$)
3) Entrance - projecting conn. = $K\, V_2^2/2g$ ($K = 1$)



$$P_a + V_a^2/2g + Z_a = P_B + V_B^2/2g + Z_b + H_{L\,A-B}$$

$$0 + 0 + Z_a = 0 + V_B^2/2g + 0 + H_{L\,A-B}$$

$$21.5 = V_B^2/2g + (f(70/1) + 0.25 + 1)\, V_B^2/2g$$

$$21.5 = (70f + 2.25)\, V_B^2/2g$$

Solve by trial and error:

Assume $V_B = 10$ ft/sec $\rightarrow$ $f = 0.0375$ $\therefore V_B = 16.8$ ft/sec
" $V_B = 17$ ft/sec $f = 0.0363$ $\therefore V_B = 17$ ft/sec

Discharge capacity at top of dam:

$$Q = V_B A$$
$$= 17 \text{ ft/sec} \times (\pi (1)^2/4)$$
$$= 13 \text{ cfs}$$

SUBJECT BLACK ROCK DAM - SURFACE AREAS

PLANIMETER READINGS:
(Scale : 1" = 2000')

1) WATERSHED (AREA 1) : THIRD 53.34 SQ. IN. 7.80
FIRST 37.74 SQ. IN. 7.81
START 29.93 SQ. IN.

$$7.80\ IN.^2 \times \frac{(2000\ FT.)^2}{IN.^2} \times \frac{1\ ACRE}{43{,}560\ FT.^2} = 716\ ACRES$$

2) WATERSHED (AREA 2) : THIRD 18.73 SQ. IN. 0.08
FIRST 18.57 SQ. IN. 0.08
START 18.49 SQ. IN.

$$0.08\ IN.^2 \times \frac{(2000\ FT.)^2}{IN.^2} \times \frac{1\ ACRE}{43{,}560\ FT.^2} = 7.3\ ACRES$$

TOTAL WATERSHED = AREA 1 + AREA 2 = 716 + 7.3 = 723.3 - USE 723 ACRES

3) ELEV. 376 (WATER SURFACE): THIRD 20.65 SQ. IN. 0.10
FIRST 20.46 SQ. IN. 0.11
START 20.35 SQ. IN.

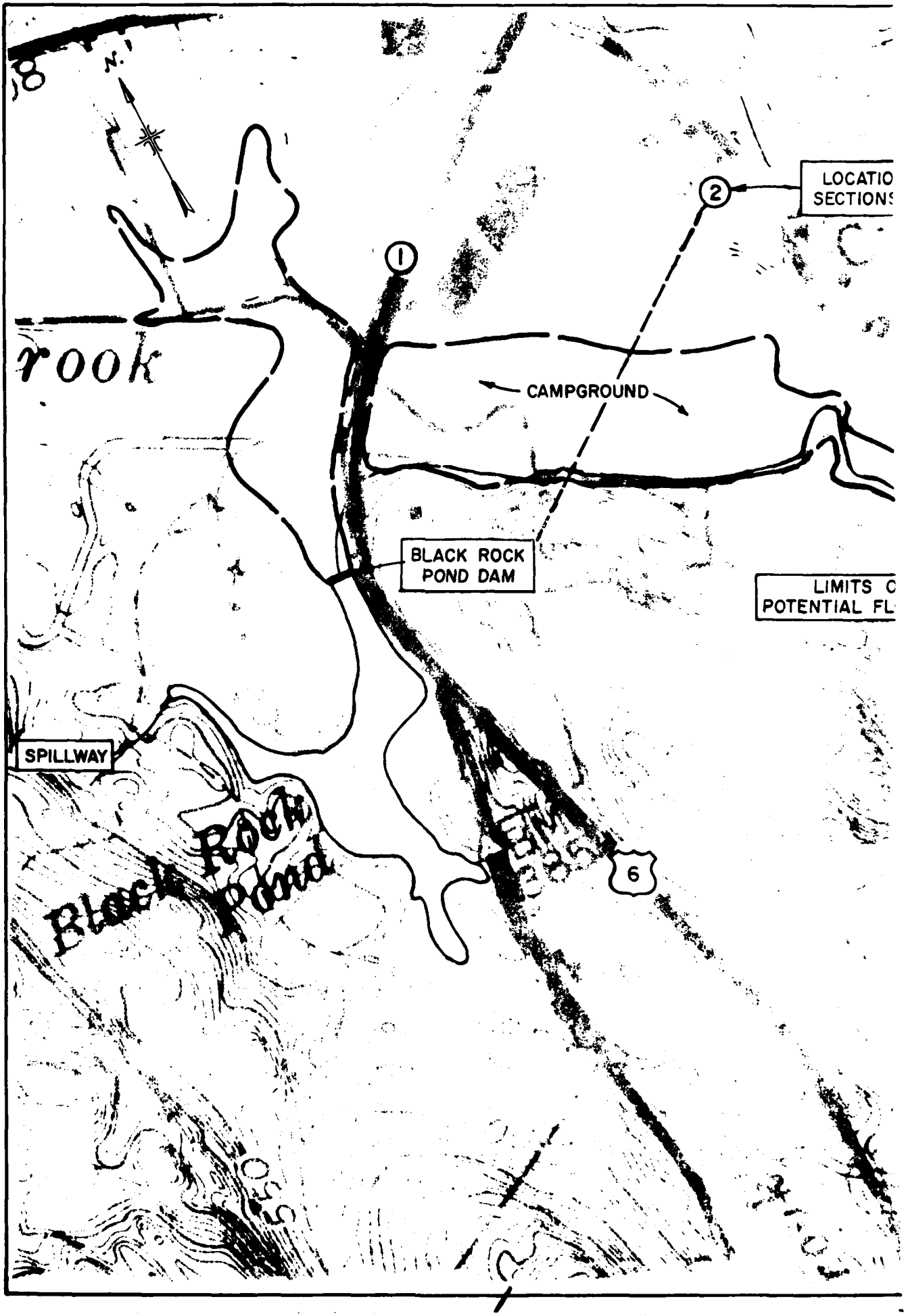
$$0.10\ IN.^2 \times \frac{(2000\ FT.)^2}{IN.^2} \times \frac{1\ ACRE}{43{,}560\ FT.^2} = 9.2\ ACRES$$

4) CONTOUR 380 : THIRD 4.05 SQ. IN. 0.14
FIRST 3.76 SQ. IN. 0.12
START 3.64 SQ. IN.

$$0.14\ IN.^2 \times \frac{(2000\ FT.)^2}{IN.^2} \times \frac{1\ ACRE}{43{,}560\ FT.^2} = 12.9\ ACRES$$

5) CONTOUR 390 : THIRD 4.71 SQ. IN. 0.22
FIRST 4.27 SQ. IN. 0.22
START 4.05 SQ. IN.

$$0.22\ IN.^2 \times \frac{(2000\ FT.)^2}{IN.^2} \times \frac{1\ ACRE}{43{,}560\ FT.^2} = 20.2\ ACRES$$


N
1
2
LOCATIO
SECTIONS
CAMPGROUND
BLACK ROCK
POND DAM
LIMITS O
POTENTIAL FL
SPILLWAY
Black Rock Pond
6

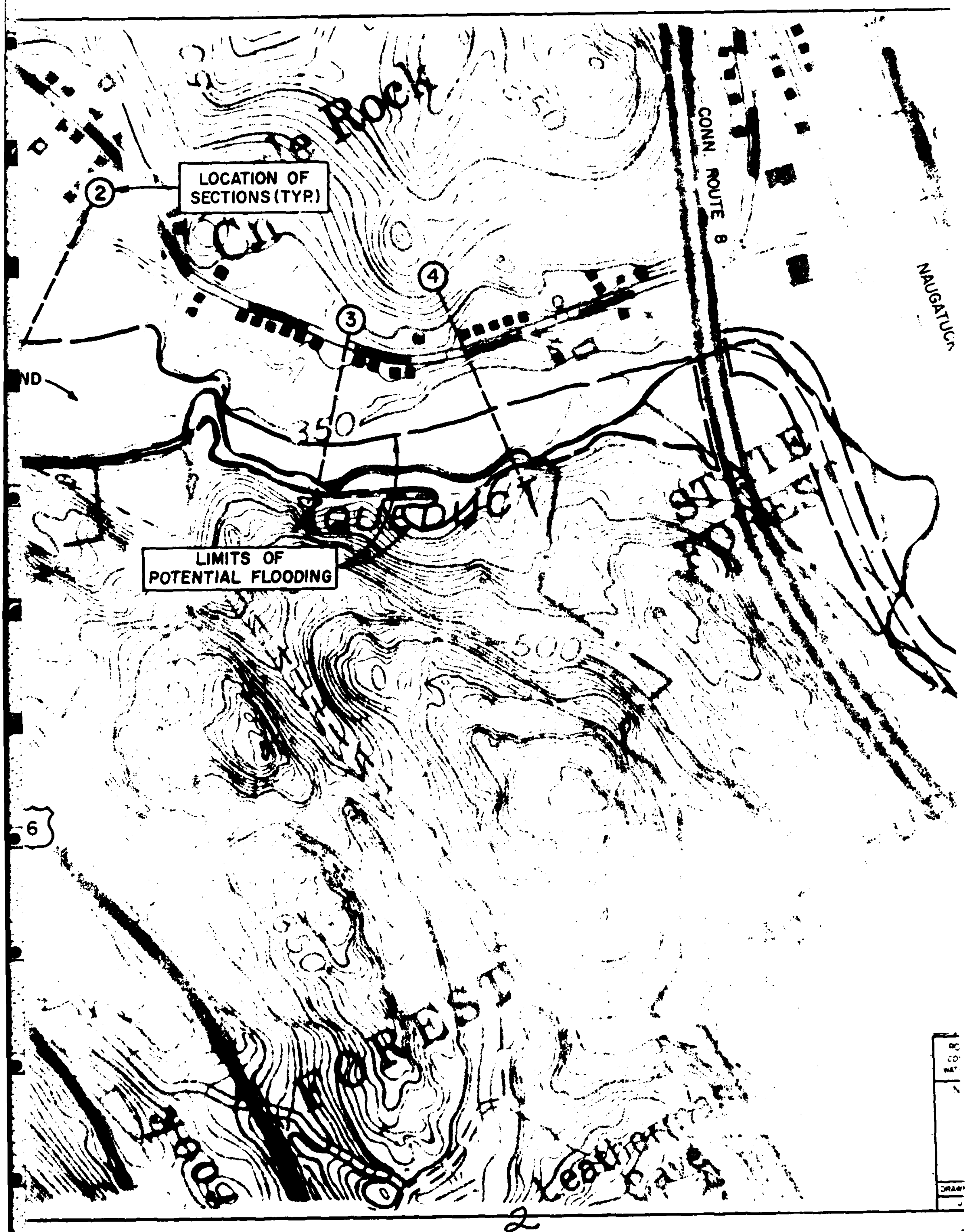
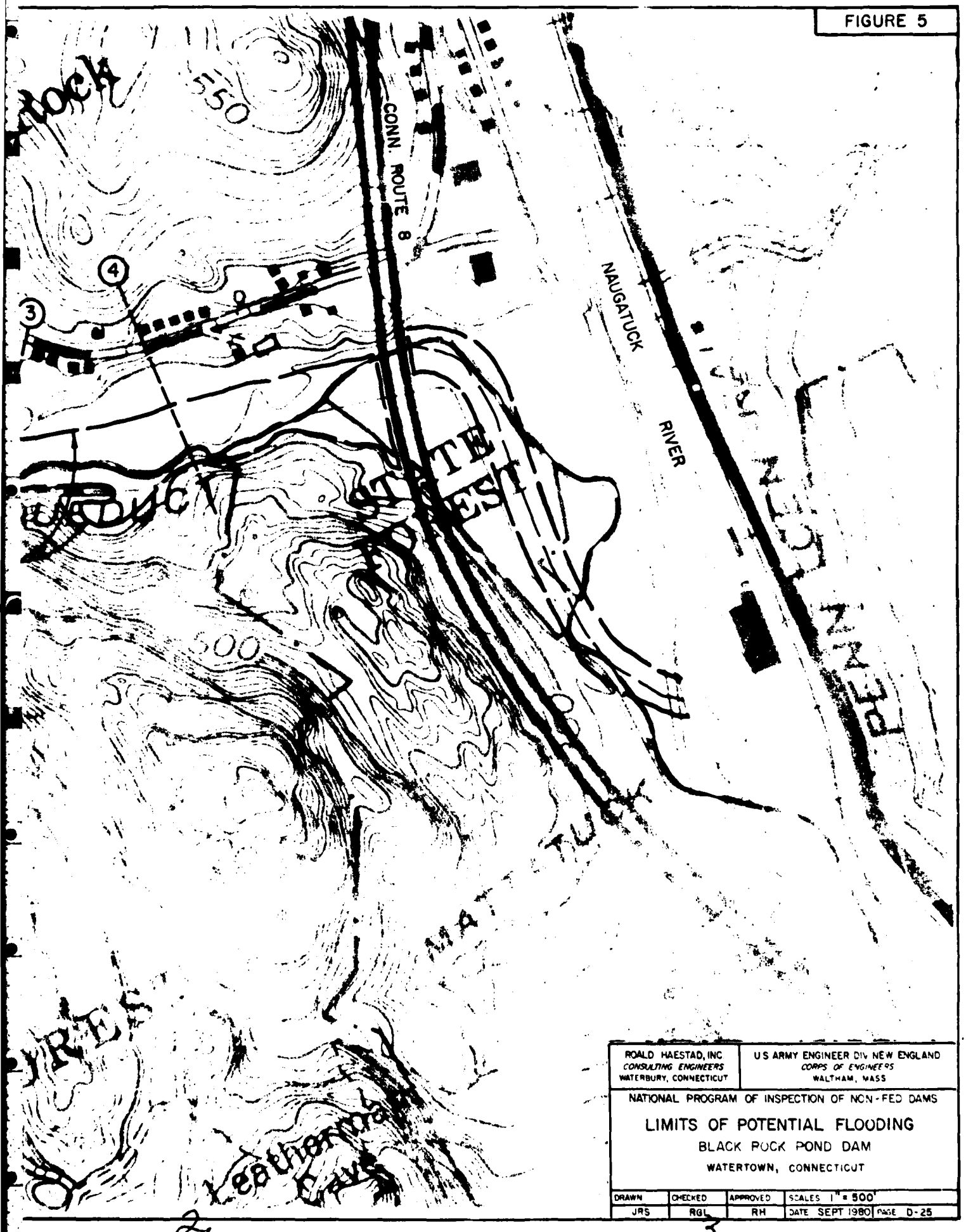

LOCATION OF
SECTIONS (TYP.)
LIMITS OF
POTENTIAL FLOODING
CONN. ROUTE 8
NAUGATUCK
350
500
6

FIGURE 5



ROALD HAESTAD, INC *CONSULTING ENGINEERS* WATERBURY, CONNECTICUT	U S ARMY ENGINEER DIV NEW ENGLAND *CORPS OF ENGINEERS* WALTHAM, MASS

NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

LIMITS OF POTENTIAL FLOODING

BLACK ROCK POND DAM

WATERTOWN, CONNECTICUT

DRAWN	CHECKED	APPROVED	SCALES 1" = 500'
JRS	RGL	RH	DATE SEPT 1980 PAGE D-25

APPENDIX E

INFORMATION AS CONTAINED IN

THE NATIONAL INVENTORY OF DAMS

END

FILMED

DTIC