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NATIONAL DAM SAFETY PROGRAM. PUTNAM LAKE DAM (90), LOWER HUDSON--ETC(U)
SEP 78 G KOCH DACW51-78-C-0035

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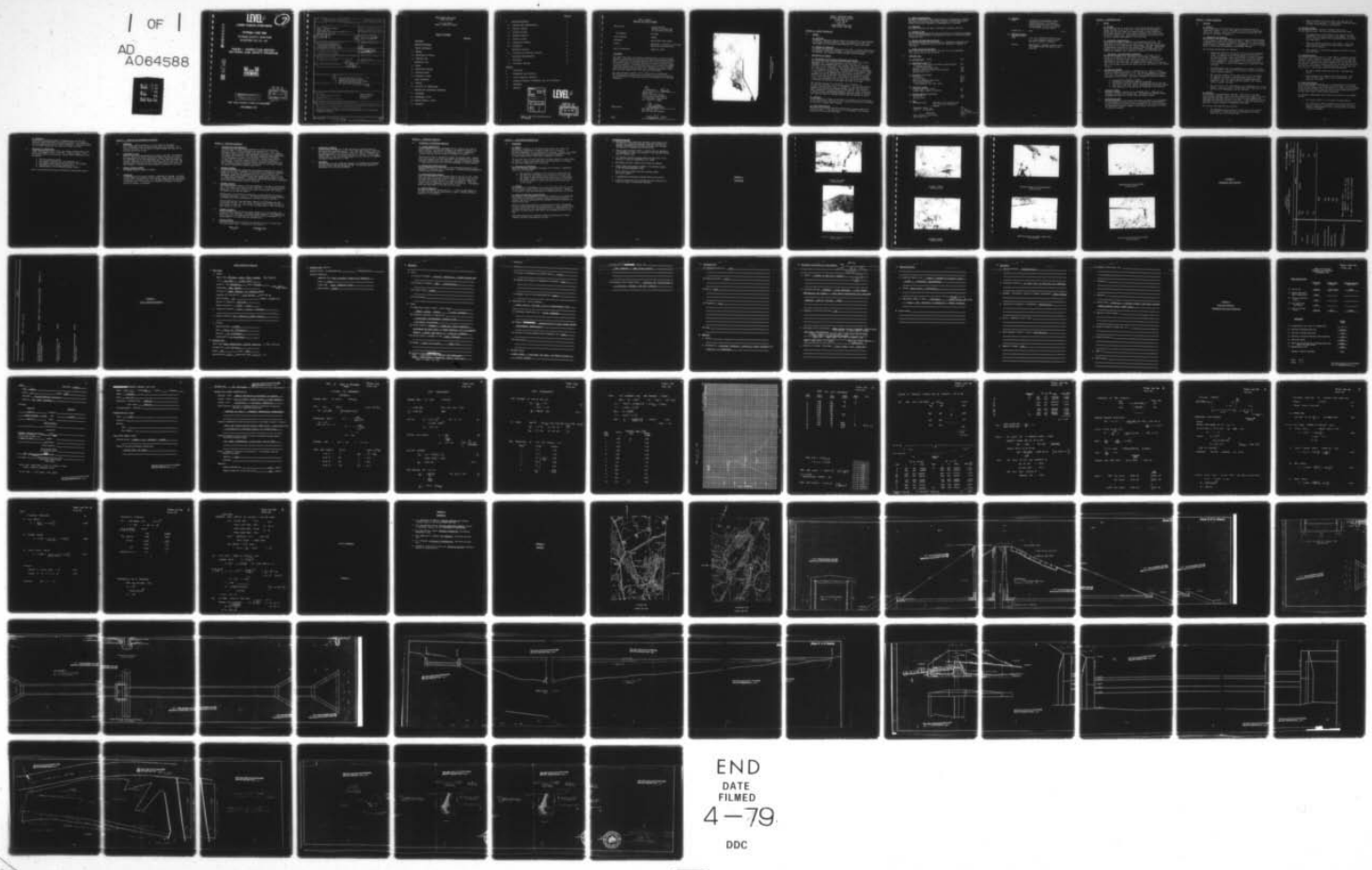

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LOWER HUDSON RIVER BASIN

PUTNAM LAKE DAM

PUTNAM COUNTY, NEW YORK

INVENTORY NO. N.Y. 90

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

NEW YORK DISTRICT CORPS OF ENGINEERS

SEPTEMBER, 1978

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

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3. RECIPIENT'S CATALOG NUMBER

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Putnam Lake Dam
Lower Hudson River Basin, Putnam Co. N.Y.
Inventory No. N.Y. 90

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National Dam Safety Program

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7. AUTHOR(s)
(10) George Koch P.E.

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Visual Inspection
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Putnam County
Bog Brook

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)
This report provides information and analysis on the physical condition of the dam as of the report date. Information and analysis are based on visual inspection of the dam by the performing organization.

Putnam Lake Dam was judged to be unsafe-non-emergency due to a seriously inadequate spillway.

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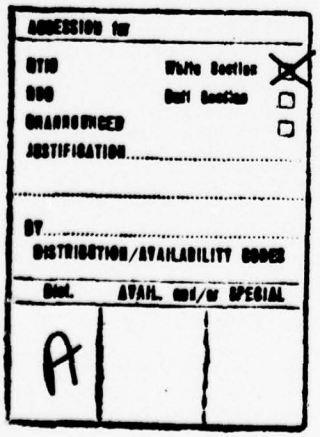
UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

LOWER HUDSON RIVER BASIN
PUTNAM LAKE DAM

I.D. No. NY-90
PHASE I INSPECTION REPORT

TABLE OF CONTENTS



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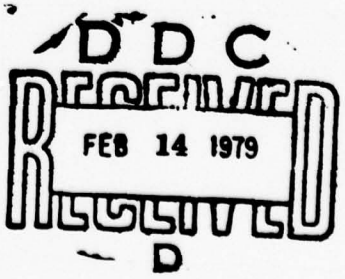


Sheets 1 and 2 of 4 are not part of the document

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Putnam Lake Dam (formerly Bog Brook Dam) I.D. No. NY-90 (#231-901)
State Located:	New York
County Located:	Putnam
Watershed:	Lower Hudson River Basin
Stream:	Bog Brook, a tributary of the East Branch of the Croton River
Date of Inspection:	August 17, 1978

ASSESSMENT

The Putnam Lake Dam is an earthfill structure with a concrete service spillway , constructed for the purpose of creating recreational Putnam Lake. Examination of available documents and a visual inspection of the dam did reveal deficiencies which are in need of corrective action as soon as possible. Of primary importance is the evidence of seepage conditions existing near and along the embankment toe and the overall lack of maintenance for the entire dam. Immediate maintenance could satisfactorily remedy many of the observed deficiencies.

The total discharge capacity of the spillway is not sufficient for satisfactorily passing either the Probable Maximum Flood (PMF) or 1/2 PMF. Therefore, the spillway capacity is considered to be seriously inadequate.

George Koch
Chief, Dam Safety Section
New York State Department of
Environmental Conservation
N.Y. License No. 45937

Approved by:

Clark H. Benn
New York District Engineer

Date: 27 September 1978

OVERVIEW of PUTNAM LAKE DAM
(Looking East)

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
PUTNAM LAKE DAM
I.D. No. NY-90
(#231-901)
LOWER HUDSON RIVER BASIN
PUTNAM COUNTY, NEW YORK

SECTION 1: PROJECT INFORMATION

1.1 GENERAL

a. Authority

The Phase I Inspection reported herein was authorized by the Department of the Army, New York District, Corps of Engineers, to fulfill the requirements of the National Dam Inspection Act, Public Law 92-367.

b. Purpose of Inspection

To evaluate the existing conditions of the dam, to identify deficiencies and hazardous conditions, determine if they constitute hazards to life and property, and recommend remedial measures where necessary.

1.2 DESCRIPTION OF PROJECT

a. Description of the Dam and Appurtenant Structures

The Putnam Lake Dam, (formerly Bog Brook Dam) consists of an earth embankment with a concrete spillway on the west end. The embankment has a maximum height of 24 feet. The crest is 295 feet long and is 6 to 8 feet wide. The upstream slope of the embankment is 1 vertical on 2 horizontal at the top and flattens to 1 vertical on 2.5 horizontal at the bottom. The downstream slope varies between 1 vertical on 1.5 horizontal and 1 vertical on 1.75 horizontal. There is stone fill on the upstream slope for erosion protection. A plain concrete core and cut-off wall is located in the center of the dam. It is 1 foot wide at the top, 3 feet wide at the bottom and extends 2 feet into the bedrock under the dam. The core wall was constructed to elevation 472 which is 2 feet below the crest of the dam.

The concrete spillway is 30 feet wide. It is located in a cut section on the west end of the embankment. The spillway crest is located 4 feet below the crest of the dam. The spillway channel has masonry side walls and an irregular bedrock bottom. The reservoir drain consists of a reinforced concrete, 3 feet by 3 feet, sluice box. A vertical sluice gate mechanism mounted along the inside of the gate well near the center of the dam controls the flow through the drain.

b. Location

Putnam Lake Dam is located on Bog Brook, a tributary of the East Branch of the Croton River, just east of the village of Putnam Lake on Fairfield Drive which is Putnam County Road 66.

c. Size Classification

This dam is 24 feet high and the reservoir has a storage capacity of 1,535 acre feet. It is classified as an "intermediate" dam (storage between 1,000 and 50,000 acre feet).

d. Hazard Classification

The dam is classified "high" hazard because of the presence of several dwellings and structures downstream including a private grade school having a year round attendance of approximately 100 children.

e. Ownership

This dam is owned by the Town of Patterson, Patterson, New York.

f. Purpose of Dam

The dam impounding Putnam Lake was constructed for recreational purposes. Hence, the area immediately surrounding the lake is a heavily developed residential area.

g. Design and Construction History

The dam was designed and constructed by W. Wickstrom of New York City. Construction occurred during 1931 and was completed in November of that year.

h. Normal Operating Procedures

Water flows over the spillway on the west end of the embankment. Flow from the lake is not regulated.

1.3 PERTINENT DATA

a. Drainage Area (acres)	1728
b. Discharge at Dam (cfs)	
Total (of all facilities excluding reservoir drain) @ Maximum High Water	1000
Spillway @ Maximum High Water	1000
Reservoir Drain @ Spillway Crest Elevation	220
Maximum Known Flood	489
c. Elevation (plan datum)	
Top of Dam	474.0
Spillway Crest	470.0
Invert of Reservoir Drain Inlet	450.2
Lake Surface Elevation (USGS Brewster, N.Y.-Conn. Quad)	493
d. Reservoir (acres)	
Surface area @ Top of Dam	257
Surface area @ Crest of Spillway	232
e. Storage Capacity (acre-feet)	
Top of Dam	2510
Spillway Crest	1535
f. Dam	
Embankment type:	Earthfill with a concrete core and cut-off wall keyed into bedrock.
Embankment length (ft)	295
Slopes (V : H) Upstream	1:2 Top 1:2.5 Bottom
Downstream	From 1:1.5 to 1:1.75
Crest elevation (plan datum)	474.0
Crest width (ft)	6 - 8

g. Spillway

Type:	Uncontrolled, rectangular concrete structure having a 24 inch wide sharp-crested weir and a reinforced concrete apron (10 x 30 ft.) leading to the bedrock spillway channel.	
Length (ft.) :	Weir	30.16

h. Regulating Outlet

Reservoir Drain:	
Type:	(3 x 3 ft) reinforced concrete sluice box with reinforced concrete inlet and outlet headwall structures.
Control:	Mechanically - operated vertical sluice gate mounted along the inside of the gate well.

SECTION 2: ENGINEERING DATA

2.1 DESIGN

a. Geology

The Putnam Lake Dam is located in the "New England Uplands" physiographic province of New York State. Rocks are either metamorphic or igneous and the land forms are closely related to their durability. The present surficial soils have resulted primarily from glaciations during the Cenozoic Era. The Wisconsin glaciation was the most recent one which occurred approximately 11,000 years ago.

b. Subsurface Investigations

There were no records of subsurface investigations available. The application for construction of a dam in 1931 stated that the dam would rest on silt, sand and clay over bedrock. The plans show bedrock located within a few feet of the original ground surface. Bedrock was exposed in the bottom of the spillway channel. The application also stated that abutment areas consisted of a mixture of sand and clay.

c. Embankment and Appurtenant Structures

The dam was designed by W. Wickstrom 221 West 57th Street, N.Y.C. Copies of two drawings for the project are included in Appendix F. The design of the dam includes a plain concrete core and cut-off wall extending two feet into rock. The seepage found at the toe of the dam indicates that there must be leakage near the bottom of the cut-off wall. The concrete spillway and apron were also constructed on the bedrock surface.

2.2 CONSTRUCTION RECORDS

The only information available on construction is a copy of a field inspection report dated May 24, 1932. The dam was completed in November 1931 and it was inspected on May 23, 1932 by representatives from the Department of Public Works. The report includes the following comments:

1. Dam was built according to plans
2. Workmanship and materials appeared to be good.
3. The blow-off valve was located on downstream side of core wall.
4. There was a very small leak at downstream end of blow-off culvert.
5. The foundation for the dam was not inspected by DPW personnel.

2.3 OPERATION RECORDS

The dam is visually inspected on an irregular basis. There are no operating or water level records kept. Residents have reported though, a maximum lake level of 2.5 feet above the spillway crest.

2.4 EVALUATION OF DATA

The data presented in this report was either available in the Department of Environmental Conservation files or provided by Mr. James Macaulay of Bibbo Associates, the consulting engineers for the Town of Patterson. The information available appears to be adequate and reliable for Phase I Inspection purposes.

SECTION 3: VISUAL INSPECTION

3.1 FINDINGS

a. General

Visual inspection of the Putnam Lake Dam and surrounding area was conducted on August 17, 1978. The weather was clear and temperatures were in the eighties. Water was flowing one-half inch deep over the spillway at the time of inspection.

b. Embankment and Abutments

The surface of the earth embankment could not be easily observed because of the presence of the heavy vegetative growth. However, the horizontal alignment of the crest was satisfactory and there were no surface cracks, animal burrows, or seepage evident on the embankment. Erosion or seepage were not found along the embankment and abutment contacts.

The following deficiencies were observed:

1. Seepage was found just beyond the toe of the entire embankment slope. It appeared to be greatest between the sluice box outlet and the east end of the embankment toe where the ground was soft and spongy. There were no signs of particle removal but the seepage had a rusty appearance in nearly all areas. A plan (Appendix F) was prepared in 1973 for installation of a curtain drain to collect the seepage but the drain was never installed.

2. The downstream slope of the embankment was covered with trees, brush and weeds. The surface was slightly irregular indicating signs of minor sloughing.

3. The vertical alignment of the crest was not level and smooth but appeared to be wavy in several places along its' length. In addition, the crest sloped slightly downward toward the reservoir. Also, the crest width was narrower than normally found on similar size dams.

4. The stone fill on the upstreamslope of the embankment was not well graded. There was a lack of larger-sized stone especially on the west end of the embankment near the spillway.

c. Spillway

The spillway is in satisfactory condition. Two cracks in the east wall have been repaired. There were four sockets in the crest of the concrete spillway and anchor bolts on the side walls where supports for flashboards may have been located at one time. A pipe extending about two feet above the spillway crest was located in one socket on the west end. There was no other evidence of flashboards being used.

The following deficiencies were observed:

1. The embankment material behind the east wall of the spillway has settled or eroded away and is approximately 18 inches below the top of the concrete wall.

2. Brush is growing on the west side of the lake near the entrance to the spillway. A large piece of wood was laying in front of the entrance to the spillway.

d. Spillway Channel

The rectangular channel consists of masonry walls with a natural bedrock bottom. The following deficiencies were found:

1. The masonry walls on both sides of the channel have been undermined by the water flowing in the channel. The east wall is tilting slightly and the downstream end of the wall has broken apart.

2. Brush and trees were growing in the channel. Roots from trees outside the channel have grown under the masonry walls into the channel.

3. Rock outcrops in the channel substantially reduce its cross sectional area.

e. Regulating Outlet

The reservoir drain consists of a 3 feet square, reinforced concrete sluice box with a vertical slide gate. The slide gate is operated through a vertical gate well located in the center of the dam. The gate well was locked at the time of inspection so the gate could not be operated. The visible concrete around the gate well and the sluice box was in good condition. Tailwater depth was 1.6 feet above the sluice invert. The following deficiencies were observed:

1. The outlet channel below the sluice box contained some debris.

2. Water appeared to be dripping down the gate well. The source of that water could not be located because the gate well was locked.

f. Downstream Channel

The spillway channel discharges into a corrugated metal pipe culvert under Fairfield Drive. The channel below the culvert is in good condition and has adequate stone slope protection. There is an unoccupied building near the culvert outlet as well as several dwellings and a private grade school located further downstream.

The following deficiencies were found in the vicinity of the highway culvert:

1. The entrance channel to the culvert contained debris.

2. The culvert was 5 feet in diameter but the last section of pipe has started to collapse so that the opening has been reduced to approximately 4 feet. The bottom of the culvert is heavily corroded.

g. Reservoir

There was a considerable amount of sedimentation into the lake caused by runoff from nearby construction activity. Air photos of the area indicated there are no major landslides. Some minor sloughing is evident around the lake where the slopes are steep.

3.2 EVALUATION OF OBSERVATIONS

Visual observations did not reveal any serious problems which would affect the immediate safety of the dam. However, several of the deficiencies such as the following, should receive attention as soon as possible.

1) The tree and brush growth
2) The seepage conditions near the embankment toe
3) The slight erosion behind the east wall of the spillway
4) Undermining of the spillway channel walls
5) Deterioration of the downstream channel culvert

Many of these deficiencies may be corrected by maintenance efforts.

SECTION 4: OPERATION AND MAINTENANCE PROCEDURES

4.1 PROCEDURE

Normal water surface elevation is at the crest of the spillway. Downstream flows are uncontrolled over this spillway. The reservoir provides 975 acre-feet of storage between the crest of the spillway and the top of dam.

4.2 MAINTENANCE OF DAM

There is very little maintenance being done on the dam. The spillway, spillway channel and outlet channel have debris collecting in them. The embankment has not been maintained so trees, brush and weeds are growing, especially on the downstream slope. The gate valve was last operated seven years ago and was in good condition at that time. The Town intends to initiate an annual inspection program for the valve.

4.3 WARNING SYSTEM IN EFFECT

No apparent warning system is present.

4.4 EVALUATION

A comprehensive maintenance program is required for the dam. It should include items such as mowing, brush removal, debris removal, monitoring the quantity of seepage at the toe, and annual operation and lubrication of the gate valve. In addition, all concrete and masonry structures should be repaired as necessary.

SECTION 5: HYDROLOGIC/HYDRAULIC

5.1 DRAINAGE AREA CHARACTERISTICS

Delineation of the contributing watershed to Putnam Lake was made using the USGS 7.5 minute quadrangle for Brewster N.Y. - Conn. The watershed consists of steep sloped grasslands and woods in the northern and eastern upper reaches; highly developed residential areas immediately surrounding the entire lake; and additional residential development in the southeastern portion of the watershed. Relief ranges from low to steep with the steeper slopes occurring in the upper reaches of the watershed. With the watershed having a generally oblong shape, and with a similarly oblong Putnam Lake located near the watershed's center, the time of concentration becomes quite short.

5.2 ANALYSIS CRITERIA

No hydrologic/hydraulic information was available regarding the original design for this dam. Therefore, the analysis of the floodwater retarding capability of the dam was performed using the "Snyder Synthetic Unit Hydrograph" method and recommended spillway design flood criteria of the U.S. Army Corps of Engineers. A short-cut, approximation method of flood routing developed by the Soil Conservation Service was then used to determine the reservoir storage/peak outflow conditions.

5.3 SPILLWAY CAPACITY

The single spillway located at the west abutment of the dam is uncontrolled, with a flat crest 2 feet wide and 30.16 feet long. A flat sloping concrete apron (10 x 30.16 feet) located 2 feet below the spillway crest conveys discharges to the spillway channel.

Hydraulically, the spillway was analyzed as a sharp-crested weir having a discharge coefficient, C, of 4.1. The computed spillway discharge capacity at maximum high water corresponding to the top of dam was 1000 cfs.

The spillway does not have sufficient capacity for discharging the peak outflow from the PMF. For this storm, the peak inflow is 5400 cfs and the peak outflow is 4380 cfs. For 1/2 PMF, the peak inflow is 2700 cfs and the peak outflow is 2190 cfs.

5.4 RESERVOIR CAPACITY

Normal reservoir capacity when the water surface is at the spillway crest elevation is 1535 acre-feet. Surcharge storage capacity to the maximum high water elevation is an additional 975 acre-feet, which is equivalent to a runoff depth of 6.8 inches over the drainage area.

5.5 FLOODS OF RECORD

The maximum known flood was reported and verified as being 30 inches deep over the spillway crest. The data for this flood is:

Elev. (ft.)	Discharge (cfs)
472.5	489

5.6 OVERTOPPING POTENTIAL

Analysis using the PMF and 1/2 PMF indicates the spillway does not have sufficient discharge capacity. For a PMF peak outflow of 4380 cfs, the spillway capacity of 1000 cfs is only 23%. Hence, overtopping to a computed depth of 2.2 feet would occur for this outflow. For the peak outflow from 1/2 PMF, the spillway capacity is only 46% and the computed overtopping depth would be 1.1 feet.

5.7 EVALUATION

This dam does not have sufficient capacity to satisfactorily discharge the peak outflow from the PMF and 1/2 PMF. The spillway capacity is considered to be seriously inadequate.

SECTION 6: STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations

Visual observation of the embankment did not indicate any signs of major distress. The vertical alignment was slightly irregular and there was minor sloughing on the downstream slope. Seepage was located along the toe of the dam as discussed in Section 3.

There were no signs of instability around the spillway area. However, the water flowing in the spillway channel was undermining the masonry side walls causing them to be unstable. Movement and eventual collapse of these masonry walls could cause the embankment to become unstable.

b. Design and Construction Data

Design computations or other data on the structural stability of the embankment or spillway were not available. Construction photographs and records could not be located.

c. Post-Construction Changes

Stone fill was added to the upstream slope of the dam in 1976. There were also plans to install a curtain drain at the toe of the dam but the drain has not been installed. A copy of a drawing showing the stone fill and curtain drain is included in Appendix F. Trees were removed from the embankment section about two years ago. Considerable brush has grown again on the dam since that time.

d. Seismic Stability

The dam is located in Seismic Zone No. 1. Since the dam appears to be stable and the seismic coefficient is small, a seismic stability analysis is not warranted.

SECTION 7: ASSESSMENT/RECOMMENDATIONS

7.1 ASSESSMENT

a. Safety

The Phase I inspection of the Putnam Lake Dam did not reveal conditions which constitute a hazard to human life or property. The earth embankment is not considered to unstable. However, the seepage found near and along the embankment toe and the undermining of the spillway channel walls should receive immediate attention.

The spillway does not have sufficient discharge capacity to pass either the PMF or 1/2 PMF. Alternatives need to be evaluated for increasing the discharge capability of the structure.

b. Adequacy of Information

There was adequate information available for the Phase I inspection except for the following:

1. The quantity of seepage at the toe has not been monitored.
2. The gate well was locked so the condition of the well and the source of the dripping water could not be investigated.
3. The present condition of the sluice gate valve is not known. The owner intends to inspect the valve on an annual basis in the future.

c. Urgency

The seepage at the embankment toe and the structural condition of the spillway channel walls should receive immediate attention. Removal of the debris, trees and brush should be completed before next spring.

d. Need for Additional Investigations

The seepage at the embankment toe and the sloughing on the downstream slope should be monitored. Seepage studies and a slope stability analysis can aid in determining the necessary corrective measures required forthis dam.

Additional hydrologic/hydraulic investigations are also recommended to more reliably determine the PMF peak outflow. These studies should consider the specific site characteristics of the watershed such as surcharge storage capacity both within the drainage area and at the dam.

Continuous monitoring of reservoir levels during periods of heavy rainfall should be instituted by the Town.

7.2 RECOMMENDED MEASURES

a. The results of the previously discussed investigations will determine the corrective measures required to correct the seepage, downstream slope sloughing and gate well problems. The quantity of seepage should be monitored.

b. Trees, brush and weeds should be removed from the embankment, the embankment toe area, the entrance to the spillway and the spillway channel area.

c. Fill material should be placed behind the east wall of the spillway to bring the embankment up to grade.

d. The masonry spillway channel walls should be repaired.

e. Larger sized stone should be added to the existing riprap on the upstream embankment slope.

f. Debris should be removed from the spillway channel and outlet channel.

g. A comprehensive maintenance program should be initiated.

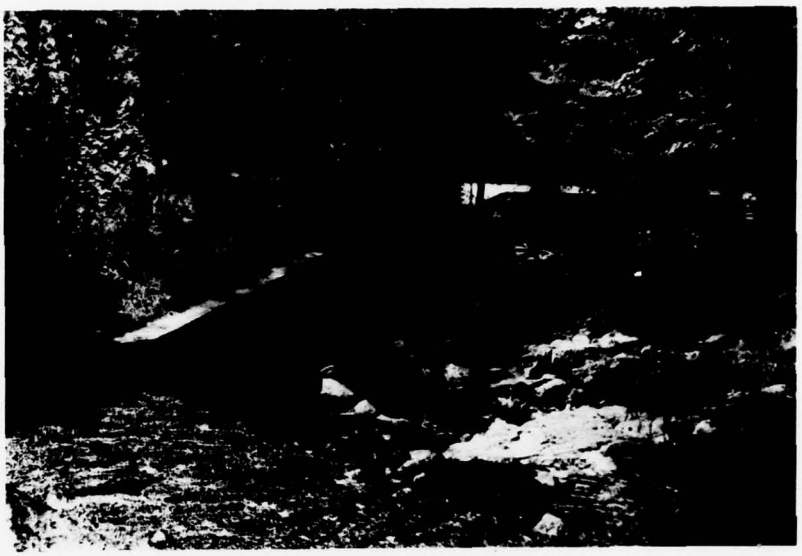
h. A warning system should be developed and made operational to insure the safety of downstream residents.

APPENDIX A

PHOTOGRAPHS

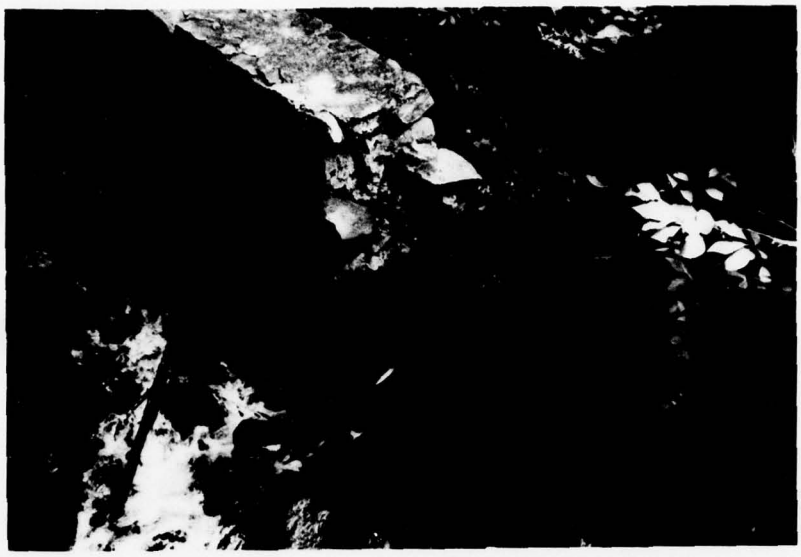
SPILLWAY AND APRON
(Looking West)

SPILLWAY CHANNEL WALL-SPILLWAY WALL
(Looking West)



SPILLWAY CHANNEL
(Looking South)

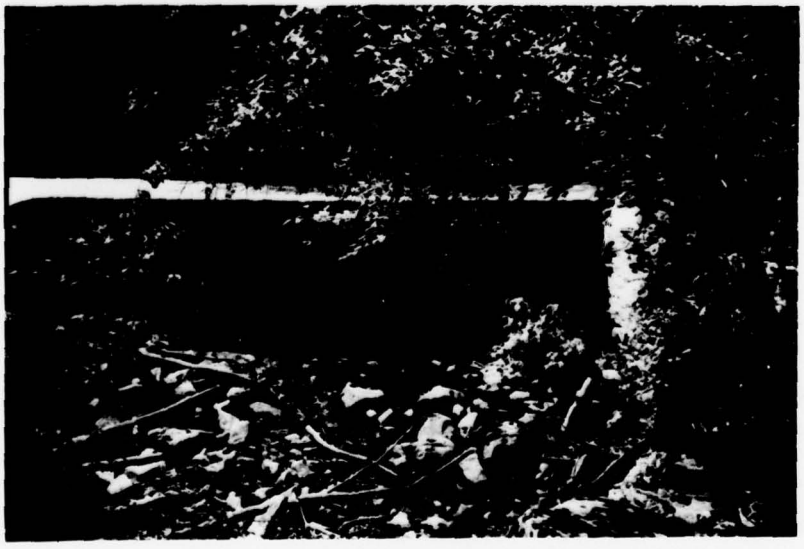
SPILLWAY CHANNEL
(Looking North)



SPILLWAY CHANNEL WALL DETERIORATION
(Looking East)

DOWNSTREAM END OF SPILLWAY CHANNEL WALL
(Looking East)

RESERVOIR DRAIN-SLUICE OUTLET
(Looking North)



CULVERT INLET-TAILWATER RESTRICTION
(Looking South)

APPENDIX B

ENGINEERING DATA CHECKLIST

Check List
Engineering Data
Design Construction Operation

Name of Dam PUTNAM LAKE

I.D. # NY-90

231-901

Item	Remarks		
	Plans	Details	Typical Sections
Dam	YES		YES
Spillway(s)	YES		YES
Outlet(s)	YES		YES
Design Reports	N/A		
Design Computations	N/A		
Discharge Rating Curves	N/A		
Dam Stability	N/A		
Seepage Studies	N/A		
Subsurface and Materials Investigations	PERMIT APPLICATION STATES: STREAMBED - SILT, SAND AND CLAY BANKS - SAND AND CLAY MIXTURE NO OTHER SOILS INFORMATION AVAILABLE		

Item	Remarks
Construction History	DPW LETTER (ONLY)
Surveys, Modifications, Post-Construction Engineering Studies and Reports	PROPOSED CURTAIN DRAIN INSTALLATION (1976) - APPENDIX F
Accidents or Failure of Dam Description, Reports	NONE
Operation and Maintenance Records Operation Manual	NONE

APPENDIX C

VISUAL INSPECTION CHECKLIST

VISUAL INSPECTION CHECKLIST

1) Basic Data

a. General

Name of Dam PUTNAM LAKE DAM (FORMERLY BOG BROOK)

I.D. # NY-90 (231-901)

Location: Town PATTERSON County PUTNAM

LOWER HUDSON RIVER BASIN

Stream Name BOG BROOK

Tributary of EAST BRANCH OF CROTON RIVER

Longitude (W), Latitude (N) N 41-27-30 W 73-32-48

Hazard Category C PURPOSE - RECREATIONAL

Date(s) of Inspection 8/17/78

Weather Conditions 85°F SUNNY

b. Inspection Personnel KOCH LYNICK STODDARD

c. Persons Contacted MR. J. MACAULEY (BIBBO ASSOC.)

d. History:

Date Constructed 11/1931

Owner TOWN OF PATTERSON

Designer W. WICKSTROM

Constructed by W. WICKSTROM

2) Technical Data

Type of Dam EARTH EMBANKMENT w/CONC. CORE WALL & CONC. SPILLWAY

Drainage Area 2.7 SQ. MILES

Height 24' Length 295'

Upstream Slope 1:2.5 , Downstream Slope 1:1.5 TO 1:2

2) Technical Data (Cont'd.)

External Drains: on Downstream Face _____ @ Downstream Toe _____

Internal Components:

Impervious Core PLAIN CONCRETE KEYED INTO BEDROCK

Drains NONE

Cutoff Type (SEE IMPERVIOUS CORE)

Grout Curtain NONE

3) Embankment

a. Crest

(1) Vertical Alignment SLIGHTLY IRREGULAR ; PITCHED TOWARD LAKE

(2) Horizontal Alignment ~~OK~~ SATISFACTORY

(3) Surface Cracks NONE

(4) Miscellaneous

b. Slopes

(1) Undesirable Growth or Debris, Animal Burrows

TREES BRUSH WEEDS ← NONE OBSERVED

(2) Sloughing, Subsidence or Depressions

UNDULATING DOWNSTREAM SURFACE SLOPE

NO MAJOR SLOUGHING

(3) Slope Protection UPSTREAM - IRREGULAR RIPRAP GRADATION

DOWNSTREAM @ RESV. DRAIN - RIPRAP EXTENDING 10' ± DOWNSTREAM

REQUIRE LARGER SIZE STONE ON WEST END UPSTREAM

(4) Surface Cracks or Movement at Toe NONE APPARENT

(5) Seepage NONE ON SLOPE (SEE d.)

(6) Condition Around [redacted] SPILLWAY

WEST - SATISFACTORY ; WALL EXTENDS INTO EMBANKMENT

EAST - SOME EROSION IMMEDIATELY BEHIND CONC. WALL

DEPTH - 1.5' BELOW TOP WALL

c. Abutments

(1) Erosion at Embankment and Abutment Contact NONE

(2) Seepage along Contact of Embankment and Abutment NONE

(3) Seepage at toe or along downstream face NONE

d. Downstream Area - below embankment

HEAVY BRUSH BETWEEN ROAD & EMBANKMENT TOE

(1) Subsidence, Depressions, etc. NONE OBSERVED

(2) Seepage, [redacted] SEEPAGE (RUSTY COLOR) ALONG ENTIRE DOWNSTREAM EMBANKMENT

(3) Evidence of surface movement beyond embankment toe NONE

(4) Miscellaneous

e. Drainage System

LAKE OUTLET - TAILWATER @ LEVEL 1.4' BELOW CROWN OF 3' x 3' SLUICE

(1) Condition of [redacted], drains, etc. NOT OPERATED - GATE HOUSE LOCKED

(2) Discharge from Drainage System LEAKAGE @ SLUICE GATE & IN SLUICE AUDIBLE BUT NOT VISIBLE

4) Instrumentation

(1) Monumentation/Surveys N/A

(2) Observation Wells N/A

(3) Weirs N/A

(4) Piezometers N/A

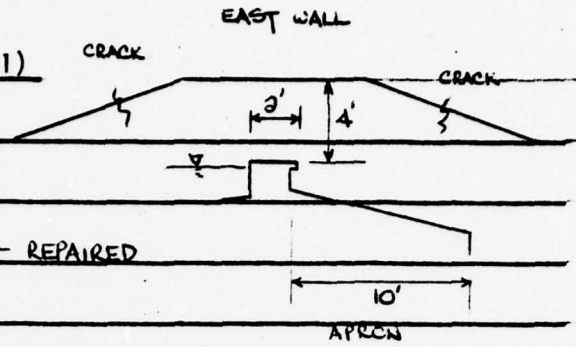
(5) Other

5) Reservoir

a. Slopes

b. Sedimentation DEFINITE PROBLEM; ESPECIALLY FROM CONSTRUCTION ACTIVITY IN WATERSHED

6) Spillway(s): (including tail race channel)



a. General 2 CRACKS IN EAST WALL - REPAIRED

b. Principle Spillway CONCRETE - GOOD CONDITION (INCL. APRON)

WEST APPROACH TO CHANNEL - SOME BRUSH ENCROACHING INTO FLOW AREA

DISTANCE: ROAD TO SPILLWAY <500'

c. Emergency or Auxiliary Spillway N/A

d. Condition of Tail race channel STONE BLOCK WALLS IN MORTAR - RECTANGULAR OPEN CHANNEL W/ IRREG. BEDROCK INVERT

WALL TOPS - SATISFACTORY

BOTTOMS - UNDERMINED & BROKEN APART WHERE FLOW HAS OCCURRED
EAST SIDE - ALONG ENTIRE CHANNEL
WEST SIDE - NEAR APRON AND LAST 1/3 NEAREST ROAD

TREES & TREE ROOTS IN CHANNEL EAST WALL TIPPING BECAUSE OF UNDERMINING

e. Stability of Channel side/slopes ROCK LINED - OK (SEE d.)

7) Downstream Channel

a. Condition (debris, etc.) DEBRIS UPSTREAM OF CULVERT INLET INVERT - RIPRAPPED; SATISFACTORY

b. Slopes ROCK-LINED; SATISFACTORY

c. Approximate number of homes <15 HOMES PRIVATE GRADE SCHOOL (YR-ROUND) HAVING 100 STUDENTS IN ATTENDANCE; APPROX. 15 BLDGS.

8) Miscellaneous

9) Structural

a. Concrete Surfaces SATISFACTORY

b. Structural Cracking ON EAST WALL OF SPILLWAY BUT REPAIRED

c. Movement - Horizontal & Vertical Alignment (Settlement) NONE APPARENT

d. Junctions with Abutments or Embankments SATISFACTORY

e. Drains - Foundation, Joint, Face

f. Water passages, conduits, sluices SATISFACTORY

g. Seepage or Leakage N/A

h. Joints - Construction, etc. _____

i. Foundation _____

j. Abutments _____

k. Control Gates LEAKING - SOUND AUDIBLE BUT NOT VISIBLE WATER DRIPPING DOWN GATE WELL

l. Approach & Outlet Channels _____

m. Energy Dissipators (plunge pool, etc.) _____

n. Intake Structures _____

o. Stability _____

p. Miscellaneous _____

APPENDIX D

HYDROLOGIC/HYDRAULIC

ENGINEERING DATA AND COMPUTATIONS

PUTNAM LAKE DAM
#231-901 1

CHECK LIST FOR DAMS
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

AREA-CAPACITY DATA:

	Elevation (ft.)	Surface Area (acres)	Storage Capacity (acre-ft.)
1) Top of Dam	474.0	257 (EST.)	2510
2) Design High Water (Max. Design Pool)	NA		
3) Auxiliary Spillway Crest	NA		
4) Pool Level with Flashboards	NA		
5) Service Spillway Crest	470.0	232	1535

DISCHARGES

	Volume (cfs)
1) Average Daily (AT TIME OF INSPECTION)	1
2) Spillway @ Maximum High Water	1000
3) Spillway @ Design High Water	N/A
4) Spillway @ Auxiliary Spillway Crest Elevation	N/A
5) Low Level Outlet	220
6) Total (of all facilities) @ Maximum High Water (EXCLUDING RESV. DRAIN)	1000
7) Maximum Known Flood	489

MAXIMUM DESIGN DISCHARGE 1000

WIDTH 30'-0"
HEIGHT 4'-1"

CREST: ELEVATION: 474.0

Type: EARTH

Width: 6' Length: 295'

Spillover PRINCIPAL/SERVICE SPILLWAY

Location @ WEST ABUTMENT

SPILLWAY:

PRINCIPAL		EMERGENCY
470.0	Elevation	
SHARP-CRESTED 2' WIDE	Type	NONE
30'-2"	Width	
	Type of Control	
✓	Uncontrolled	
	Controlled:	
POSSIBLY USED @ ONE TIME SOCKETS IN CONCRETE	Type (Flashboards; [redacted])	
1.9' HIGH PIPE ON WEST ABT. BOLTS IN WALLS	Number	
	Size/Length	
	Invert Material	
	Anticipated Length of operating service	
30' LEADING TO TAILRACE CHANNEL	APRON [redacted] Length	
≤1'	Height Between Spillway Crest & Approach Channel Invert (Weir Flow)	

5' DIA. CMP UNDER ROAD (4' DIA. @ CENTER OF ROAD)
HEAVILY CORRODED; PERFORATED INVERT

TOP OF ROAD - 5.5' ABOVE PIPE INVERT

[redacted]/EMERGENCY DRAWDOWN FACILITIES:

Type: Gate ✓ Sluice PIPE ✓ Conduit _____ Penstock _____

Shape : SQUARE

Size: 3' x 3'

Elevations: Entrance Invert 450.20

Exit Invert 450.00

Tailrace Channel: Elevation _____

HYDROMETEROLOGICAL GAGES:

Type : N/A

Location: _____

Records:

Date - _____

Max. Reading - _____

FLOOD WATER CONTROL SYSTEM:

Warning System: NORMAL CIVIL DEFENSE SYSTEM

Method of Controlled Releases (mechanisms):

SLUICE PIPE W/ GATE

DRAINAGE AREA: 2.7 SQ. MILES

DRAINAGE BASIN RUNOFF CHARACTERISTICS:

Land Use - Type: HEAVILY RESIDENTIAL (5 LOTS/ACRE) @ LAKESIDE

Terrain - Relief: LOW TO STEEP ; STEEPER SLOPES IN UPPER REACHES

Surface - Soil: SILT/CLAY RELATIVELY IMPERVIOUS

Runoff Potential (existing or planned extensive alterations to existing (surface or subsurface conditions)

MODERATE TO HIGH : WATERSHED RESIDENTIAL DEVELOPMENT

Potential Sedimentation problem areas (natural or man-made; present or future)

LAKE HAS SILTED HEAVILY DURING PAST 10 YRS ; LAND DEVELOPMENT IN CONNECTICUT (TRIBUTARY STREAM TO PUTNAM LAKE)

Potential Backwater problem areas for levels at maximum storage capacity including surcharge storage:

NO HOME BASEMENTS LOWER THAN TOP OF DAM

Dikes - Floodwalls (overflow & non-overflow) - Low reaches along the Reservoir perimeter:

Location: N/A

Elevation: _____

Reservoir:

Length @ Maximum Pool 1.47 (Miles)

Length of Shoreline (@ Spillway Crest) N/A (Miles)

PMF BY CORPS OF ENGINEERS METHOD

PUTNAM LAKE
#231-901

(SNYDER UNIT HYDROGRAPH)

RAINFALL

DRAINAGE AREA : 2.7 SQ MI. 1728 acres

PMP : Zone 1 (FIG. 1) (NWS - HR #33)

PMP = 21.5 inches [24 HR/200 SQ MI.]

TRANSPOSITION FACTOR : $TF = 1 - \frac{.3008}{(D.A.)^{.17718}}$

D.A. = 2.7
LOWER LIMIT D.A. = 10

$$T.F. = 1 - \frac{.3008}{(10)^{.17718}}$$

$$= 1 - .2$$

$$TF = 0.8$$

ADJUSTED PMP = 21.5 x 0.8 = 17.2 ins.

DEPTH - AREA - DURATION (FIG. 2) (NWS - HR #33)

6 HR %	=	111	RAIN = 19.1 inches
12 HR %	=	123	= 21.2 "
24 HR %	=	133	= 22.9 "
48 HR %	=	142	RAIN = 24.4 "

PUTNAM LAKE
231 - 901

UNIT HYDROGRAPH

DRAINAGE AREA = 2.7 SQ MI 1728 acres

L = 2.405 miles - 7800 + 1800 + 3100 = 12700'

L_{CA} = 0.909 miles 4800'

LAG TIME : $t_p = C_t (L \cdot L_{CA})^{0.3}$ USE $C_t = 2.0$ (1)

$= 2 (2.405 \cdot 0.909)^{0.3}$

$t_p = 2.529$ HRS

DURATION - UNIT RAINFALL : $t_r = \frac{t_p}{5.5}$ (2)

$= \frac{2.529}{5.5}$

$t_r = 0.46$ HRS

[USE t_R 1-HR UNIT HYDROGRAPH

LAG TIME - ADJUSTED :

$t_{PR} = t_p + 0.25 (t_R - t_r)$ (4)

$= 2.529 + 0.25 (1 - 0.46)$

$t_{PR} = 2.664$ HRS ←

PEAK DISCHARGE FOR 1-HR UH :

$q_{PR} = \frac{640\ C_p}{t_{PR}}$ USE $640\ C_p = 400$ (5)

$= \frac{400}{2.664}$

$q_{PR} = 150.2$ cfs/sq Mi

PUTNAM LAKE
231-901

UNIT HYDROGRAPH

PEAK DISCHARGE OF 1-HR UH OVER D.A. =

$Q_p = q_{pR} \times DA$ (6)

$= 150.2 \times 27$

$Q_p = 405.54$ cfs ←

UH WIDTHS : PLATE #7 FOR $q_{pR} = 150.2$ cfs) (EM 1110-2-1405 pg 43)

				40/60
W_{75}	= 2.0 HRS	@	304 cfs	.8/1.2
W_{50}	= 3.5 HRS	@	202 cfs	1.4/2.1

TIME DISTRIBUTION OF 6-HR MAX. RAINFALL = 19.1"

PERIOD #	% DIST.		RAINFALL
1	10		1.91
2	12		2.29
3	15	x 19.1" RAIN	2.87
4	38		7.26
5	14		2.67
6	11		2.10
	100		19.10

PUTNAM LAKE
#231-901

CHECK: UNIT HYDROGRAPH CURVE DOES REPRESENT 1" RAINFALL

AREA: 1ST - 8.89 in^2 2ND - 8.98 in^2 USE 8.94 in^2

VOL = 8.94 ins^2 × 100 ft^3/sec @ 2hr × 120 $min/2hr$ × 60 sec/min

$V = 6.4368 \times 10^6\ ft^3$

AREA = $2.7 \times (5280)^2$

$A = 7.5272 \times 10^7\ ft^2$

$DEPTH = \frac{V}{A} = \frac{6.4368 \times 10^6}{7.5272 \times 10^7} = .0855\ ft$ 1.026"

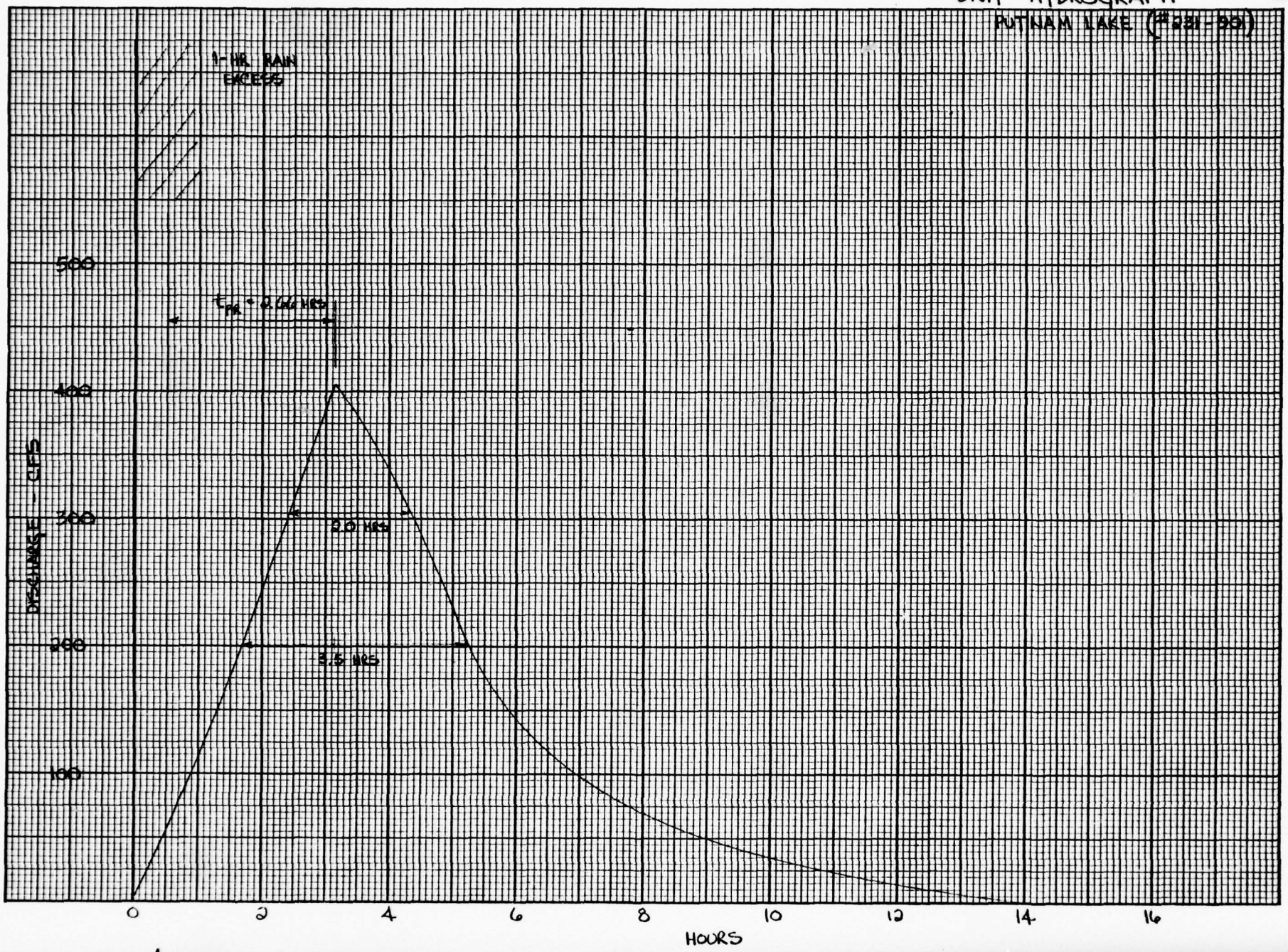
∴ CURVE - OK

RAINFALL FOR PMF

TIME PERIOD (HRS)	RAINFALL	LOSS	RAINFALL EXCESS
1	0.35	0.1	0.25
2	0.35		0.25
3	0.35		0.25
4	0.35		0.25
5	0.35		0.25
6	0.35		0.25
7	1.91		1.81
8	2.29		2.19
9	2.87		2.77
10	7.26		7.16
11	2.67		2.57
12	2.10	0.1	2.00

UNIT HYDROGRAPH ⑤

PUTNAM LAKE (#231-501)



PMF FROM UNIT HYDROGRAPH

TIME (HRS)	RAIN EXCESS	UNIT HYDRO.	FLOOD HYDRO.	BASE FLOW	TOTAL
1	0.25	115	29	5	
2	0.25	245			
3	0.25	385	186		
4	0.25	340			
5	0.25	232			
6	0.25	143			
7	1.81	98	569		
8	2.19	70			
9	2.77	50			
10	7.16	35			
11	2.57	24	4386		
12	2.00	14	5398	5	5403 ←
13		6	5097		
14					

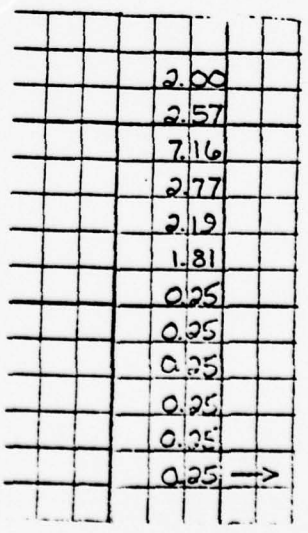
BASE FLOW = 2 cfs/sq Mi

2.7 x 2 = 5.4 cfs

PMF PEAK INFLOW = 5403 cfs (USE 5400 cfs)

FIG 17-11 (SCS)
STORAGE/ROUTING REDUCTION = 0.81

PMF PEAK OUTFLOW = 4376 cfs (USE 4380 cfs)

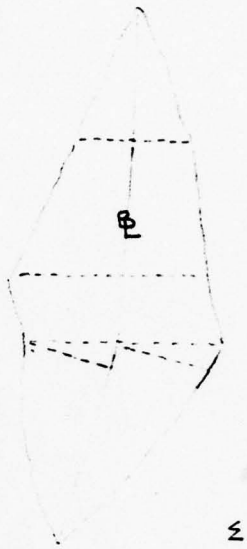


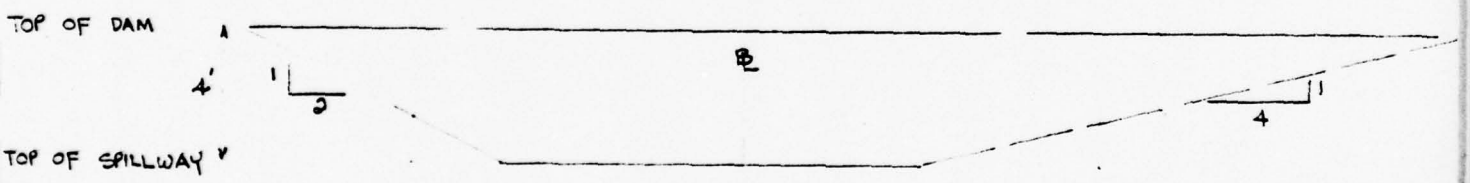
PUTNAM LAKE DAM
#2318-901

ESTIMATE OF RESERVOIR SURFACE AREA @ ELEVATION = TOP OF DAM :

REF: USGS 7.5 MIN. TOPO SHEET

WIDTH LEFT	WIDTH RIGHT	LENGTH
900'	650'	3150'
1550'	500'	2200'
500'	550'	600'
400'	800'	1850'
		Σ = 7800' (1.47 MILES)





	TOP OF SPILLWAY				TOP OF DAM			
SHAPE	L	W	AREA$_1$	SLOPE	L	W	AREA$_2$	RATIO $\left(\frac{A_2}{A_1}\right)$
△	3150	900	1417500	1:2	3158	908	1433732	1.0115
△	3150	650	1023750		3158	658	1038982	1.0149
▱	2200	1225	2695000		2200	1233	2712600	1.0065
▱	2200	575	1265000		2200	583	1282600	1.0139
▱	600	1025	615000		600	1033	619800	1.0078
▱	600	525	315000		600	533	319800	1.0152
△	1850	400	370000		1858	408	379032	1.0244
△	1850	800	740000	1:2	1858	808	750632	1.0144
[SURFACE AREA = 220 acres]			Σ = 8441250 ft² (194 acres)					Σ = 1.1086

PUTNAM LAKE DAM
#231 B-901

	SHORELINE SLOPE	L	W	AREA$_2$	RATIO $\left(\frac{A_2}{A_1}\right)$
△	1:4	3166	916	1450028	1.0229
△		3166	666	1054278	1.0298
▱		2200	1241	2730200	1.0131
▱		2200	591	1300200	1.0278
▱		600	1041	624600	1.0156
▱		600	541	324600	1.0305
△		1866	416	388128	1.0490
△	1:4	1866	816	761328	1.0288

$\Sigma = 1.2175$

RATIO : $\frac{\text{KNOWN SURFACE AREA}}{\text{SCALED SURFACE AREA}} = \frac{232}{194} = 1.2$

RESULT : USE FACTOR FOR 1:2 SHORELINE SLOPES (1.1086)

RESERVOIR SURFACE AREA @ TOP OF DAM

232 x 1.1086 = 257 acres (ESTIMATED)

STORAGE CAPACITY @ TOP OF DAM

$1535 + \left(\frac{257+232}{2}\right)4 = 2513$ acre-ft [USE 2510 acre-ft]

(978)

NOTE : 1931 PLANS FOR DAM GIVE ELEVATIONS @

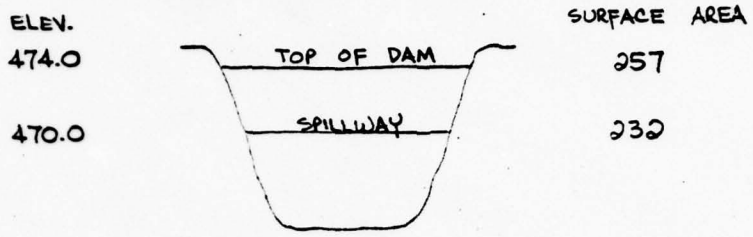
TOP OF DAM = 474.0

SPILLWAY CREST = 470.0

1958 USGS DATUM ELEVATION @

RESERVOIR POOL = 493.0

ANALYSIS FOR PEAK OUTFLOW:



RESERVOIR DETENTION VOLUME (RDV):

$$RDV = A \times h = \left(\frac{257+232}{2}\right)(474-470) = 978 \text{ acre-ft}$$

$$\frac{978}{1728} \times 12 = 6.8 \text{ ins}$$

INFLOW RUNOFF VOLUME (IRV):

$$IRV = \frac{Q^{6\text{-HR}}}{12} \times A = \left(\frac{19.1}{12}\right)(2.7)(640) = 2750 \text{ acre-ft}$$

RATIO: $\frac{RDV}{IRV} = \frac{978}{2750} = 0.3556$

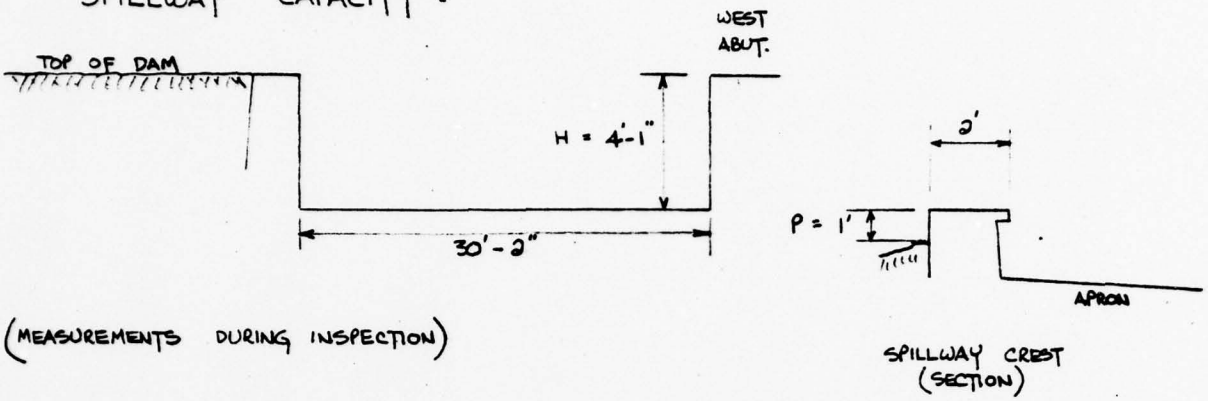
FIG 17-11 (SCS) STORAGE/ROUTING ADJUSTMENT

RATIO: $\frac{OPR}{IPR} = 0.81$

OUTFLOW PEAK RATE (OPR) = (0.81) 5403 (HYDROGRAPH PEAK INFLOW) = 4376 cfs

			USE
RESULT: PMF	PEAK INFLOW:	5403 cfs	5400 cfs
	PEAK OUTFLOW:	4376 cfs	4380 cfs
½ PMF	PEAK OUTFLOW:	2188 cfs	2190 cfs

SPILLWAY CAPACITY :



(MEASUREMENTS DURING INSPECTION)

SPILLWAY CREST (SECTION)

CONDITION:

HORIZONTAL SHARP-CRESTED WEIR w/ $L/b = 1.0$

FOR FLOW DEPTH TO TOP OF DAM: $H/P = \frac{4.08}{1} = 4.08$

USE: $C = 4.1$

CAPACITY: $Q = CLH^{3/2}$

$= (4.1)(30.16)(4.08)^{3/2}$

$Q = 1019$ cfs $\quad [Q_{DESIGN} = 1000 \text{ cfs}]$

(USE $Q = 1000$ cfs)

CONCLUSION: SPILLWAY INADEQUATE FOR ½ PMF

MAXIMUM KNOWN FLOOD: @ ELEV. 472.5 (30" ABOVE SPILLWAY CREST)

$C = 4.1 \quad L = 30.16 \quad H = 2.5$

$Q = (4.1)(30.16)(2.5)^{3/2}$

$Q = 489$ cfs

DISCHARGE COEFFICIENT FOR HORIZONTAL SHARP-CRESTED WEIR:

	REFERENCE:	LIMITATIONS:	C
1)	USBUREC "DESIGN OF SMALL DAMS"		3.3
2)	USARMY - WES		
	HDC CHART III-3 FOR $\frac{H_e}{H_d} = 1.0$	HIGH OVERFLOW DAMS	4.02

→ KING & BRATER "HANDBOOK OF HYDRAULICS" 5TH ED.

3) FRANCIS FORMULA — APPROACH VELOCITY < 5 fps

$$C = 3.33\left(1 + 0.259\frac{H^2}{d^2}\right) \qquad 3.886$$

$H = 4.08 \qquad P = 1.0$

$d = P + H$

4) FTELEY & STEARNS FORMULA — APPROACH VEL. < 2 fps

$$C = 3.31\left(1 + 0.383\frac{H^2}{d^2} + \frac{0.007}{H^{3/2}}\right) \qquad 4.130$$

5) BAZIN FORMULA

$$C = \left(3.248 + \frac{0.079}{H}\right)\left(1 + 0.55\frac{H^2}{d^2}\right) \qquad 4.427$$

6) FRESE FORMULA

$$C = \left(3.288 + \frac{0.0368}{H}\right)\left(1 + 0.55\frac{H^2}{d^2}\right) \qquad 4.467$$

(cont.)

DISCHARGE COEFFICIENT

C

7) KING FORMULA

$$C = \frac{3.34}{H^{0.03}}\left(1 + 0.56\frac{H^2}{d^2}\right)$$ 4.359

8) REHBOCK FORMULA

$$C = 3.235 + \frac{1}{60H - 0.56} + 0.428\frac{H}{P}$$ 4.985

9) SWISS SOCIETY FORMULA

$$C = \left(3.288 + \frac{1}{92.8H + 0.49}\right)\left(1 + 0.5\frac{H^2}{d^2}\right)$$ 4.352

ANALYSIS:

AVERAGE OF VALUES (EQN'S 1 – 9) 4.214

AVERAGE OF 3) 5) 6) 7) 9) 4.298

CONCLUSION: USE "C" = 4.1

OVERTOPPING POTENTIAL :

DAM – BROAD-CRESTED WEIR $Q = CLH^{3/2}$

$C = 3.087$ $L = 295 + 30 = 325'$

SPILLWAY CAPACITY (W.S. @ TOP OF DAM) – 1019 cfs

	PMF	½ PMF
PEAK OUTFLOW :	4376	2188
SPILLWAY :	1019	1019
	3357	1169
$H^{3/2}$:	3.346	1.165
OVERTOPPING HT. = H	2.2'	1.1'

DISCHARGE (@ TIME OF INSPECTION)

DEPTH OVER SPILLWAY = 0.04'

$Q = CLH^{3/2}$

$= (4.1)(30.16)(.04)^{3/2}$

$Q = 1$ cfs

(SLUICE GATE)

RESERVOIR DRAIN CAPACITY @ W.S. ELEV. = SPILLWAY CREST

		DIST.
ELEV. - SPILLWAY CREST	470.0	
CONDUIT INLET - INVERT	450.2	> 52'-10"
CONDUIT @ GATE - INVERT	450.08	> 34'
CONDUIT OUTLET - INVERT	450.0	

CONDUIT - RECTANGULAR 3' x 3' AREA = 9 ft²

THROAT SECTION - SQUARE EDGED

INLET HEADWALL - FLARE ANGLE :

$\tan \chi = \frac{67}{116} = .57759 \qquad \chi = 30^\circ$

REF: KING & BRATER "HANDBOOK OF HYDRAULICS" 5TH ED.

SUBMERGED ORIFICE: $Q = CA\sqrt{2g\,\Delta h}$

$A = 9.0\,ft^2 \quad g = 32.2\,ft/sec^2 \quad \Delta h = (470 - 450) - 3 = 17'$

[LENGTH LIMITED ≤ 50']

$C = \left(1 + 0.4r^{0.3} + \frac{0.0045L}{r^{1.25}}\right)^{-1/2} \qquad r = \frac{A}{WP} = \frac{9}{12} = 0.75$

$L = 86'-10" \quad (86.34')$

$= (1 + 0.367 + 0.56)^{-1/2}$

$C = 0.720$

$Q = (0.72)(9)\sqrt{2(32.2)(17)}$

$= (33.088)$

$\longrightarrow Q = 214$ cfs

[USE Q = 220 cfs]

REF: US BUREC "DESIGN OF SMALL DAMS"

PRESSURE FLOW IN CONDUITS: $Q = A\sqrt{\frac{2gH_T}{K_L}}$; $K_L = K_e + K_g + K_v$

$H_T = 17'$

0.5 0.19 1.0

$Q = (9)\sqrt{\frac{2(32.2)(17)}{1.69}}$

$\longrightarrow Q = 229$ cfs

LIST OF REFERENCES

APPENDIX E

APPENDIX E

REFERENCES

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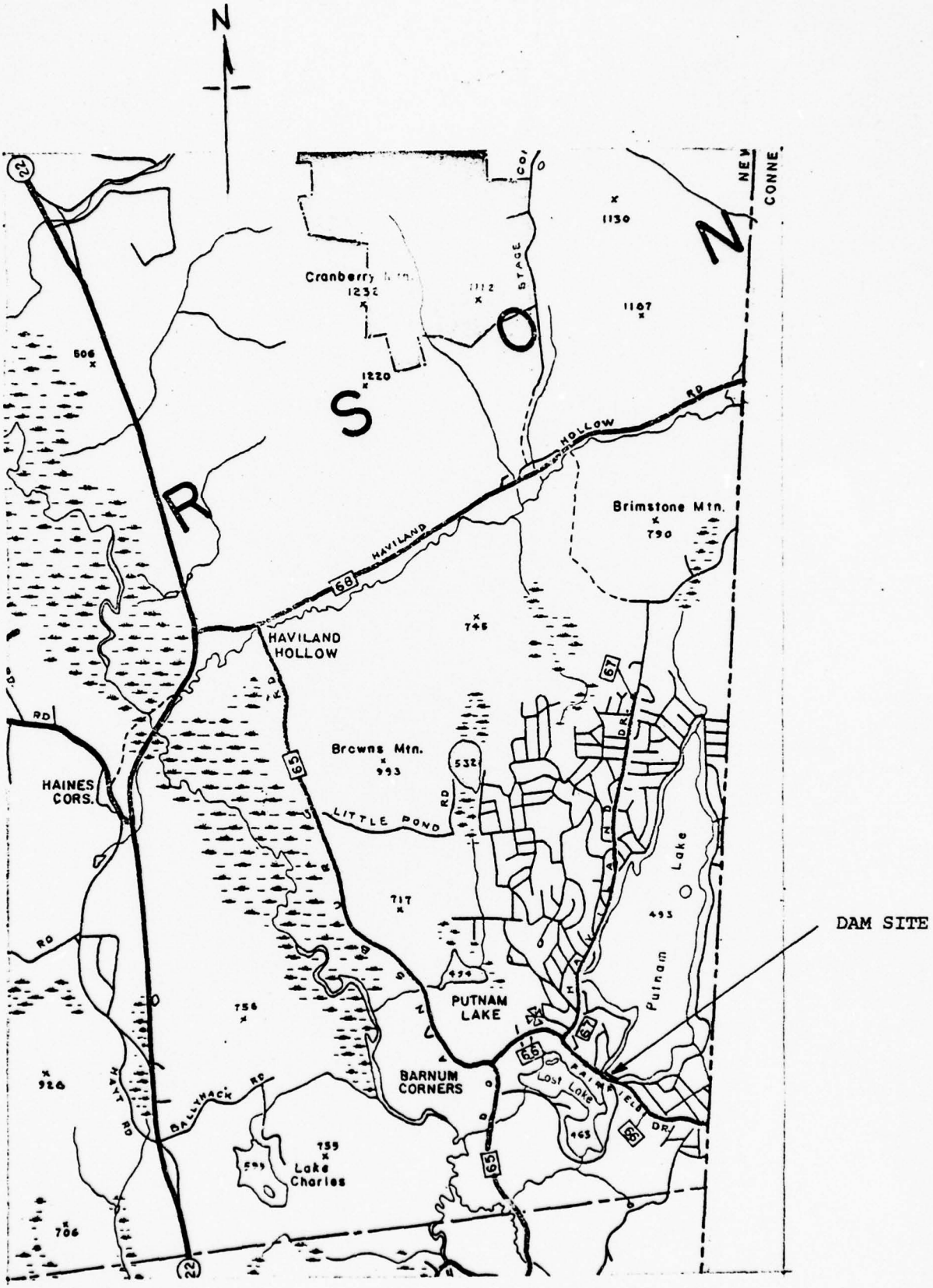
APPENDIX F

DRAWINGS

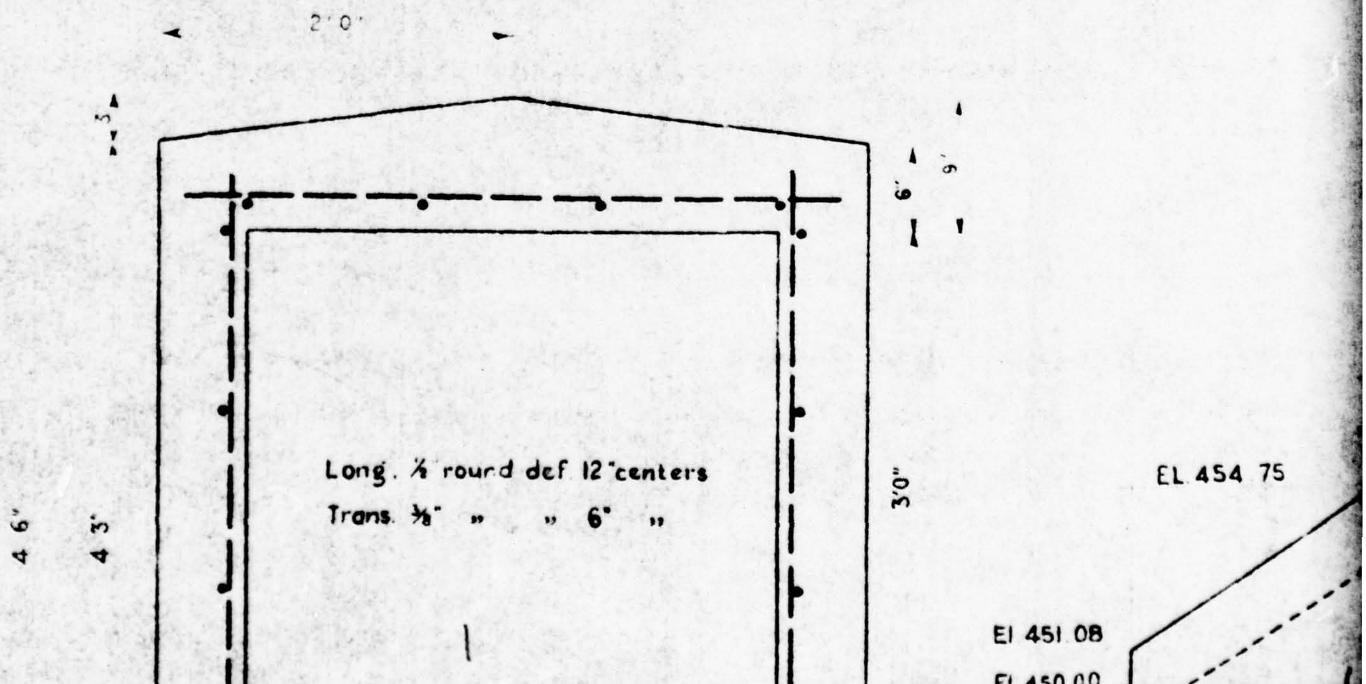


VICINITY MAP

PUTNAM LAKE DAM

TOPOGRAPHIC MAP

PUTNAM LAKE DAM



40' 0"

34' 6"

One Rodney Hunt Floor Stand # S 3204

Slope 1:5

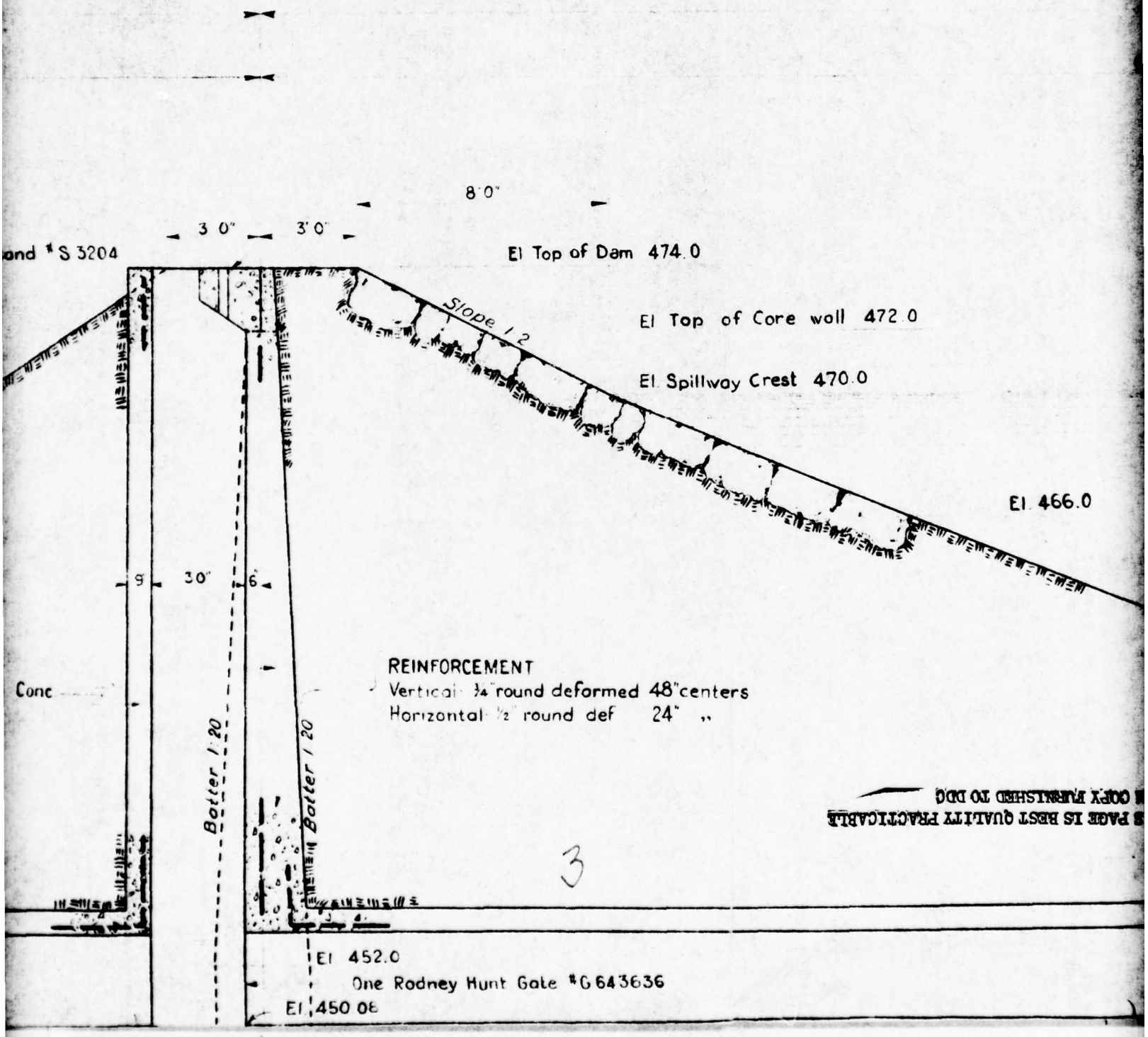
1:2:5 Conc

1'2"

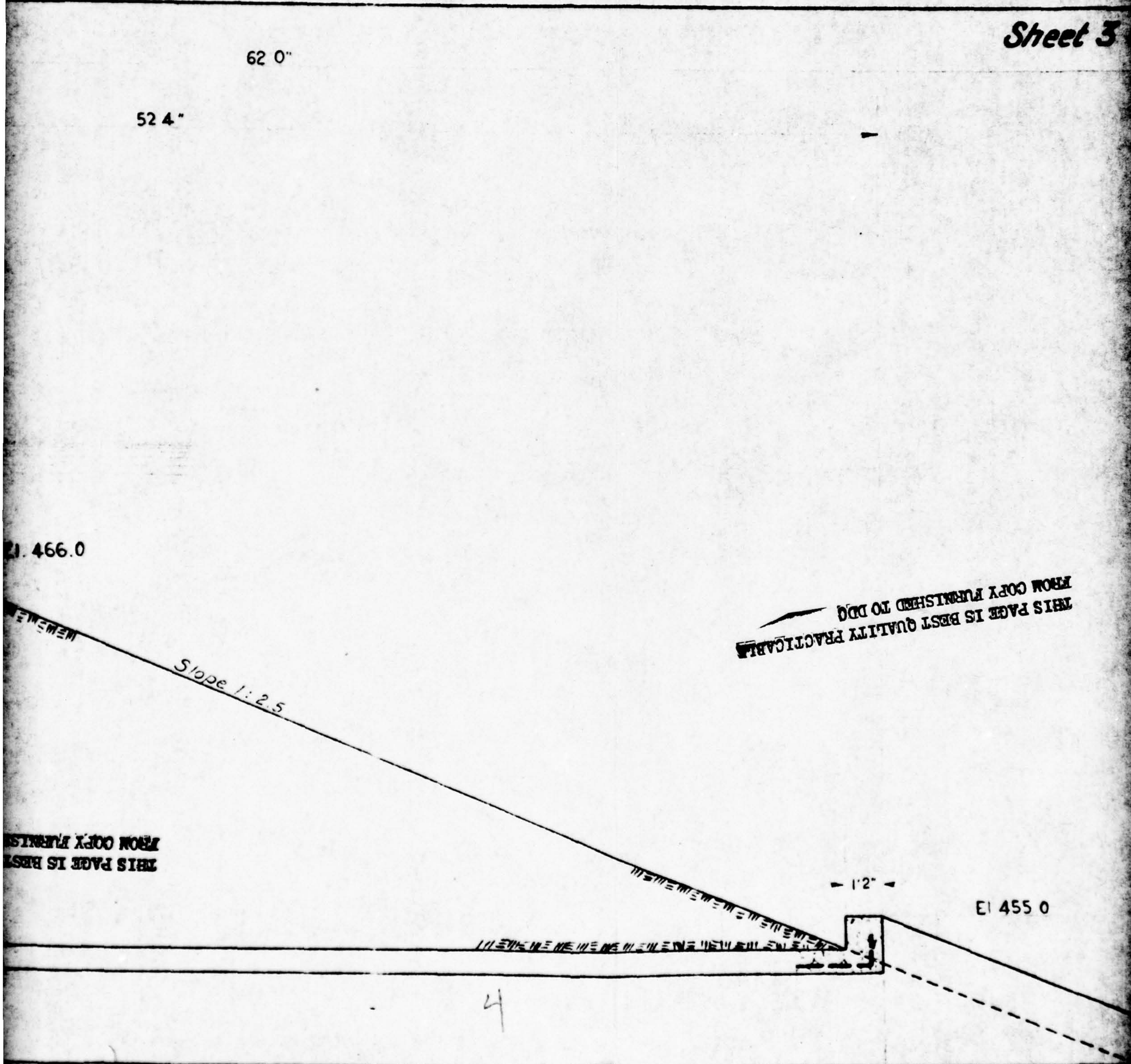
454 75

2

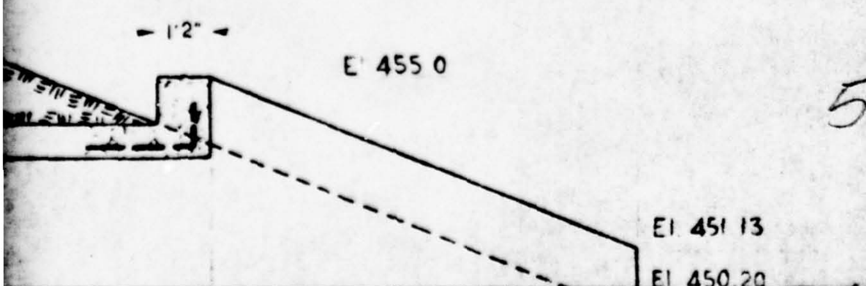
Slope .002 ft per foot

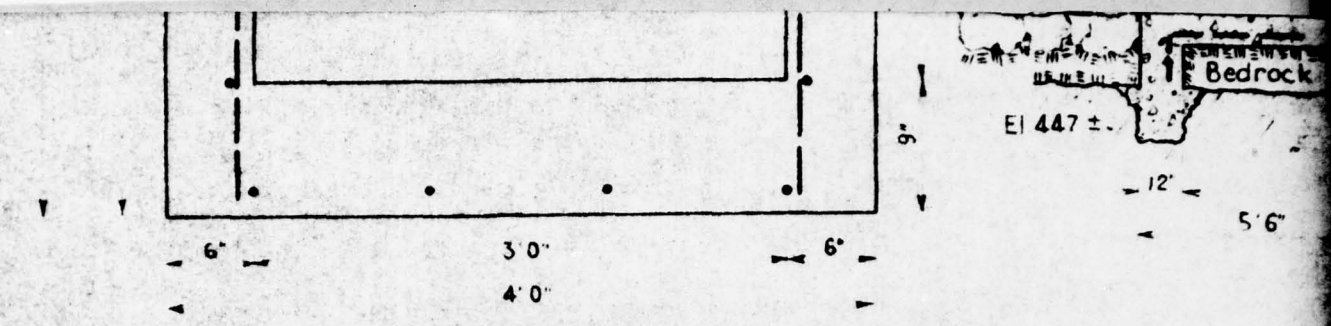


3

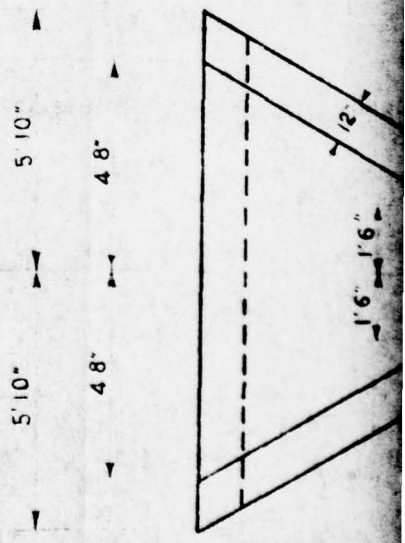


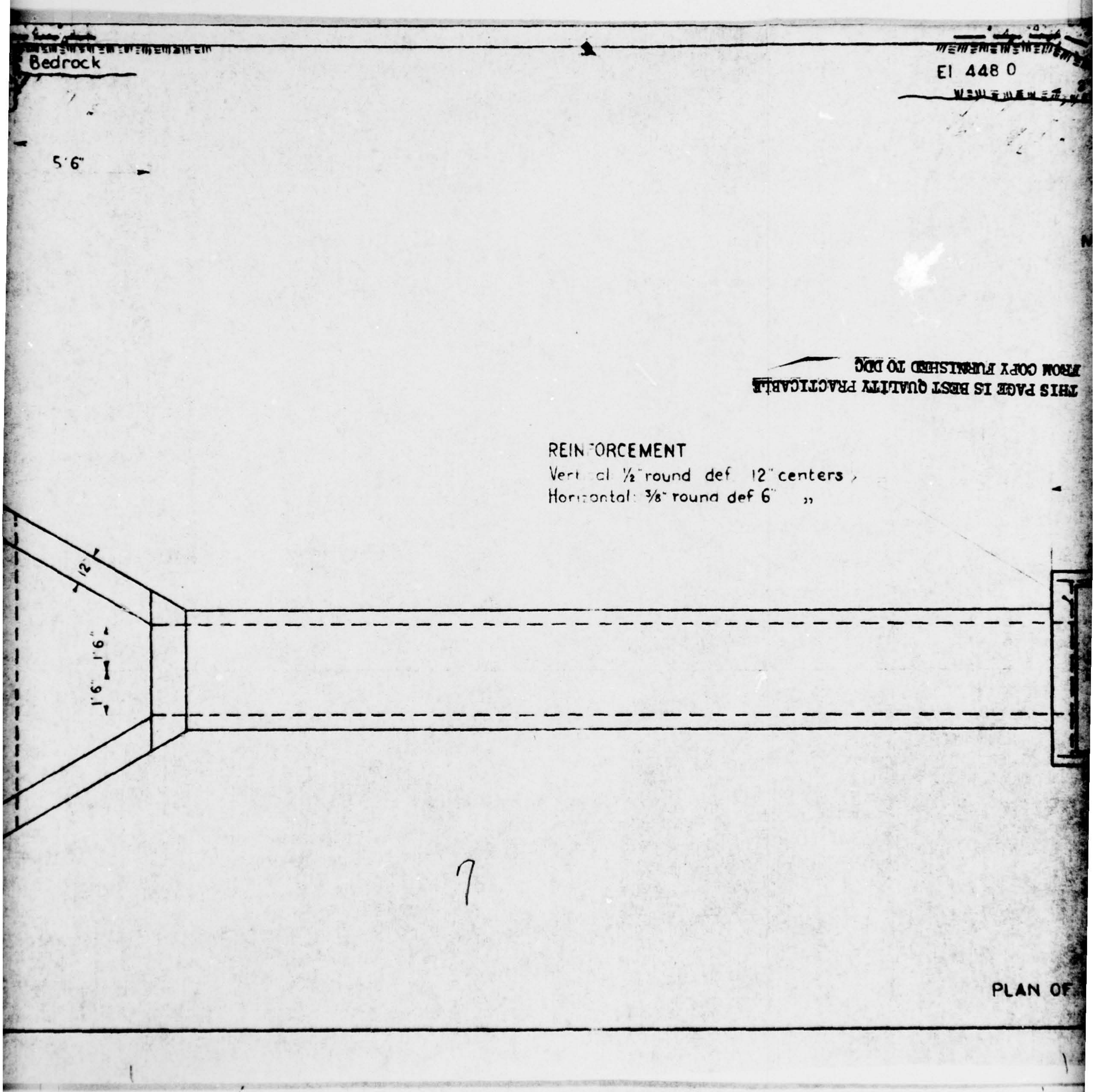
THIS PAGE IS BEST
FROM COPY FURNISH

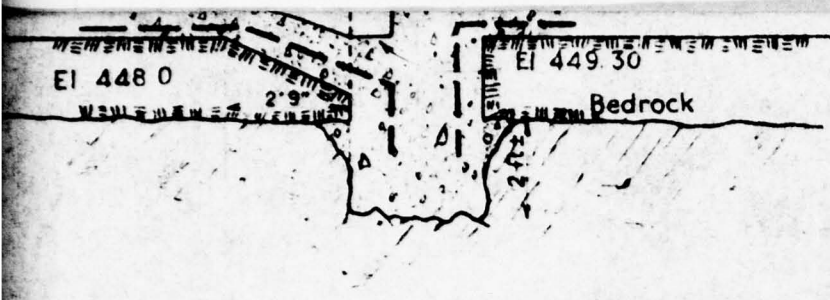




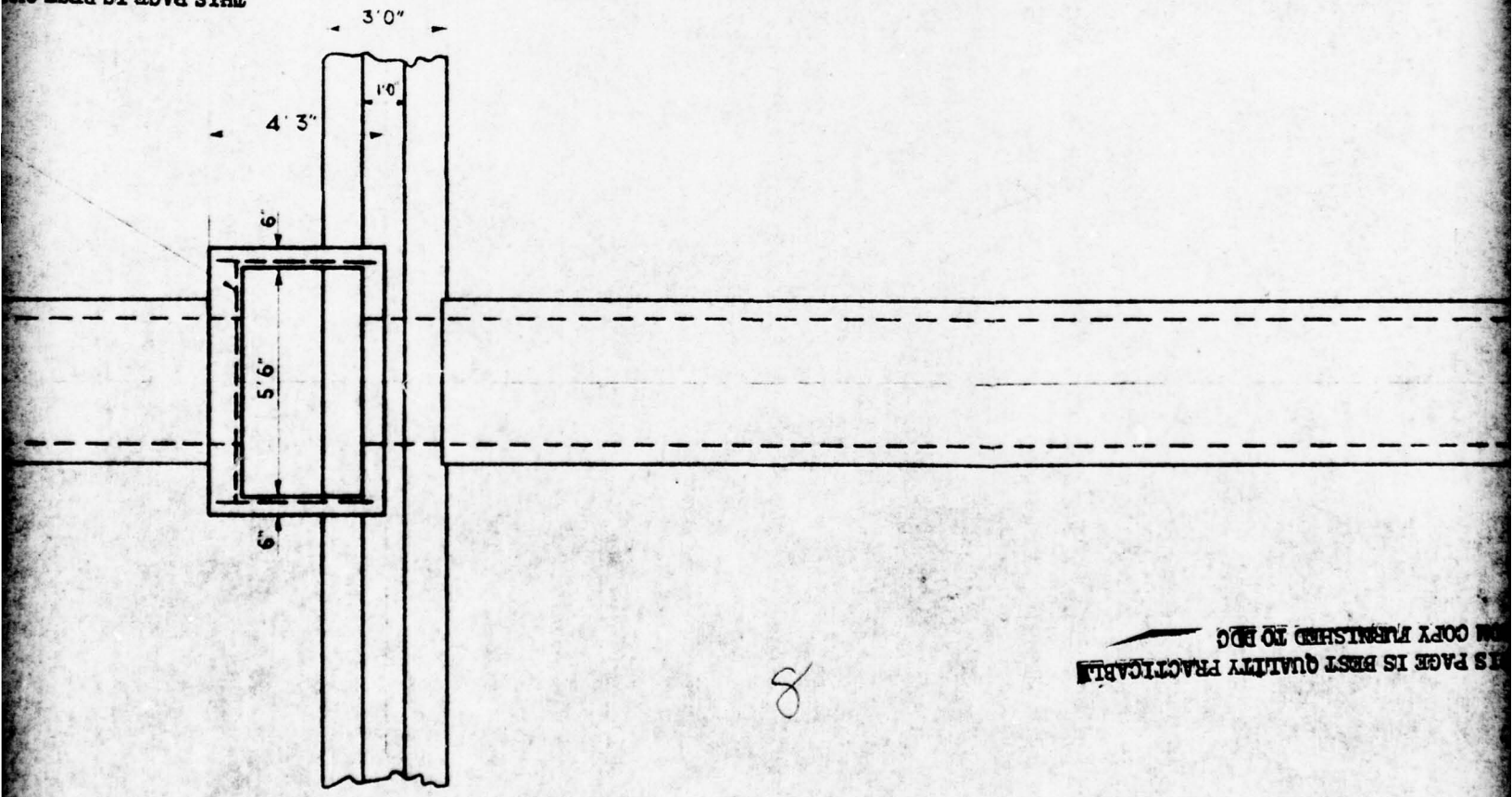
CROSS SECTION OF SLUICE PIPE
Scale 1 inch = 1 ft.





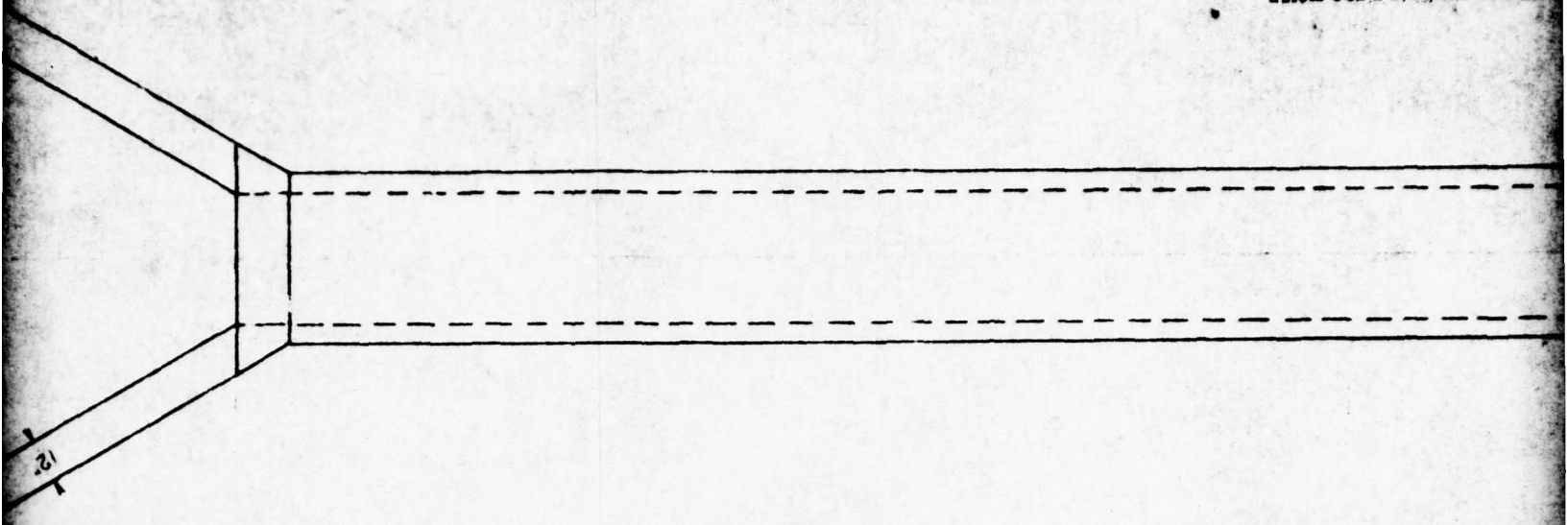


MAXIMUN SECTION
Scale: 1 inch = 4 feet



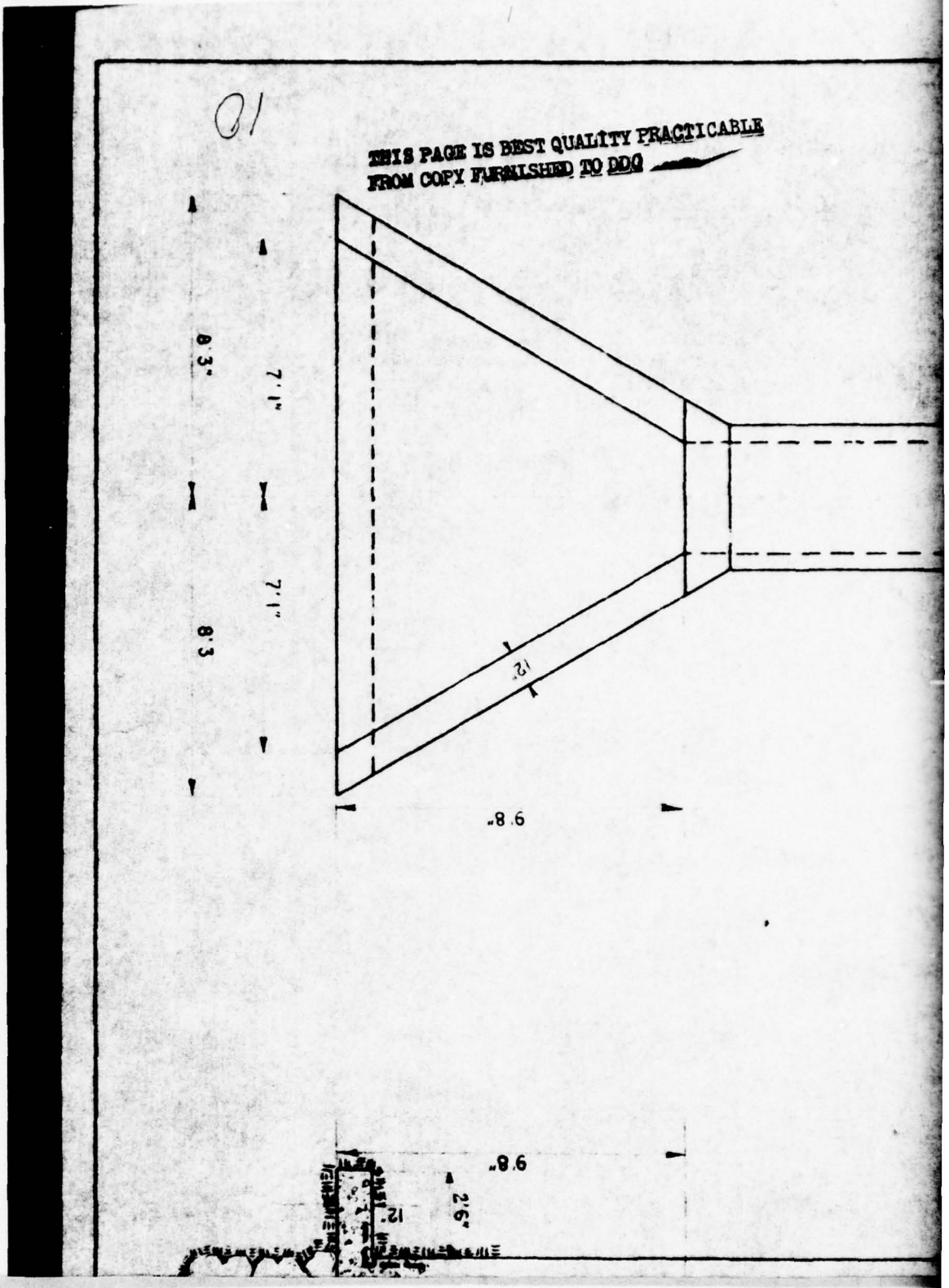
PLAN OF SLUICE PIPE AND GATE WELL
Scale: 1 inch = 4 feet

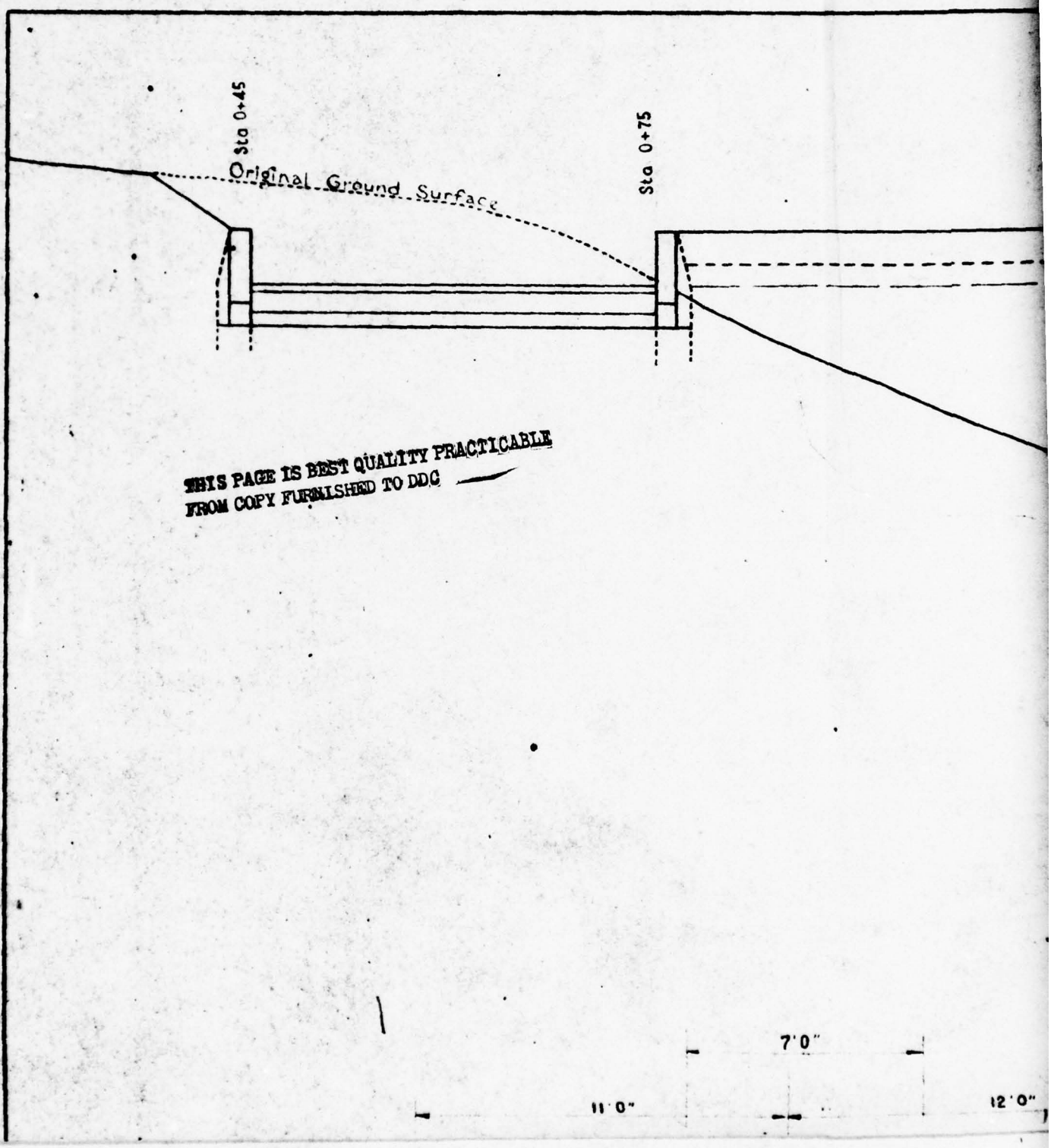
b

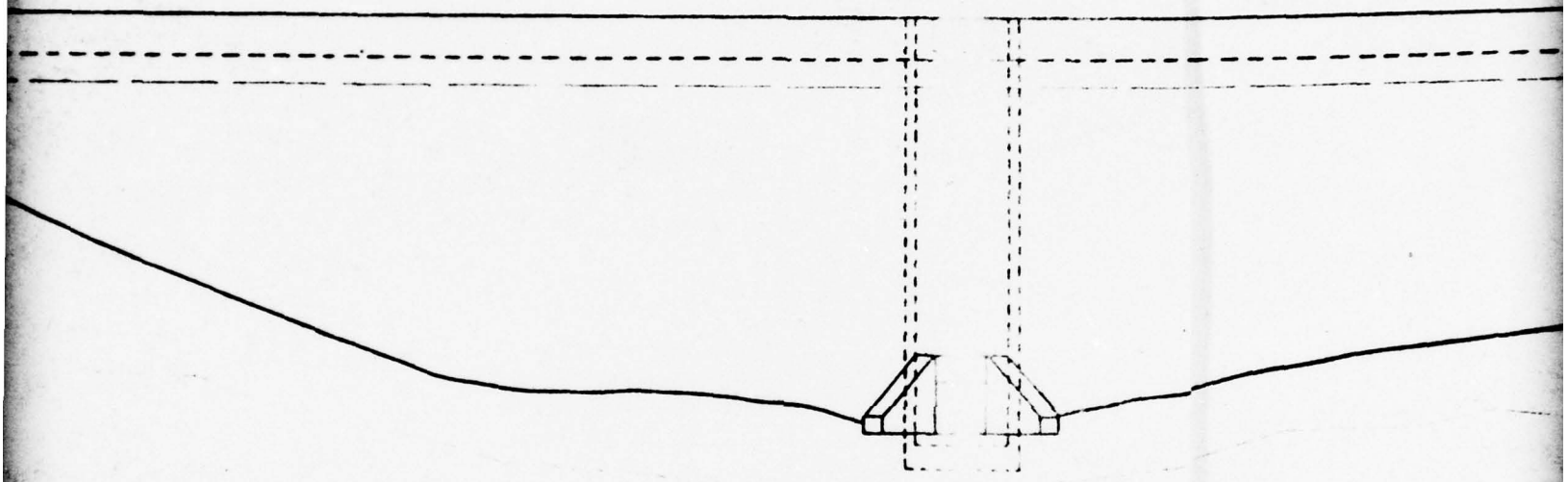


8.6

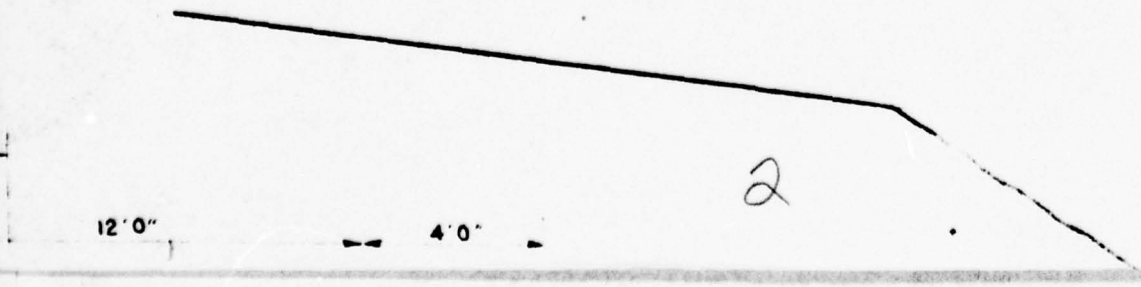
8.6







DOWN STREAM ELEVATION
Scale 1

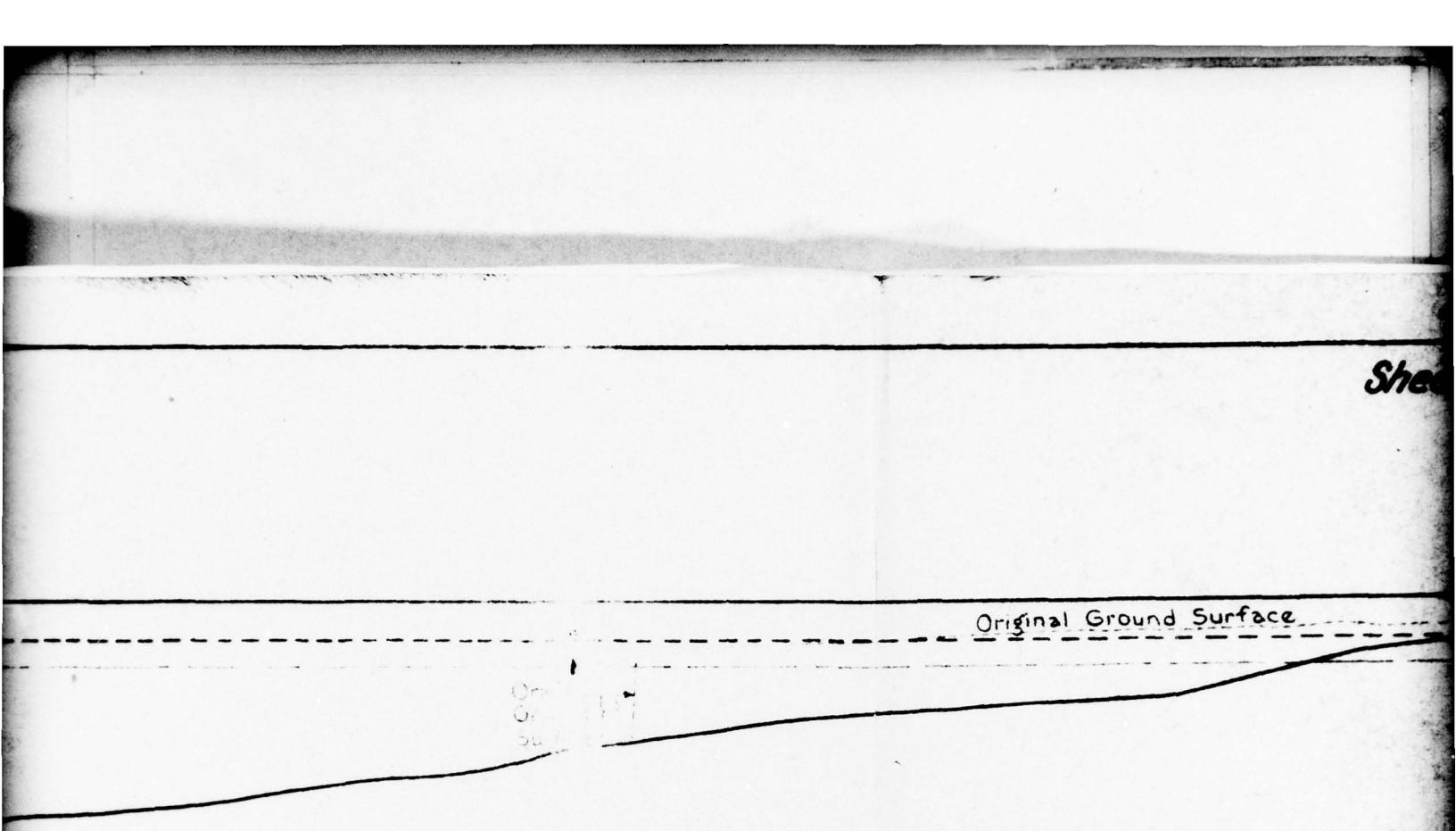


Top of Dam

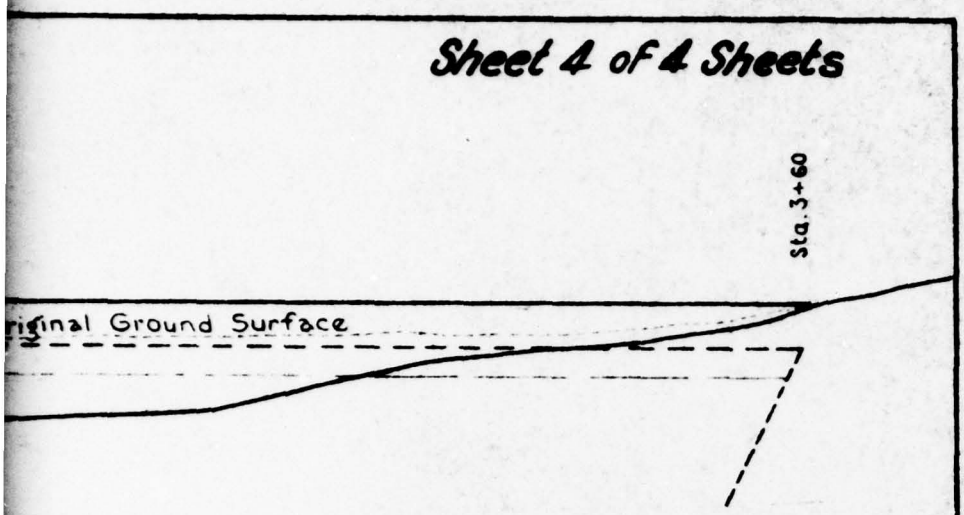
Top of Core Wall

Water Line

Bottom of Core Wall
Bedrock

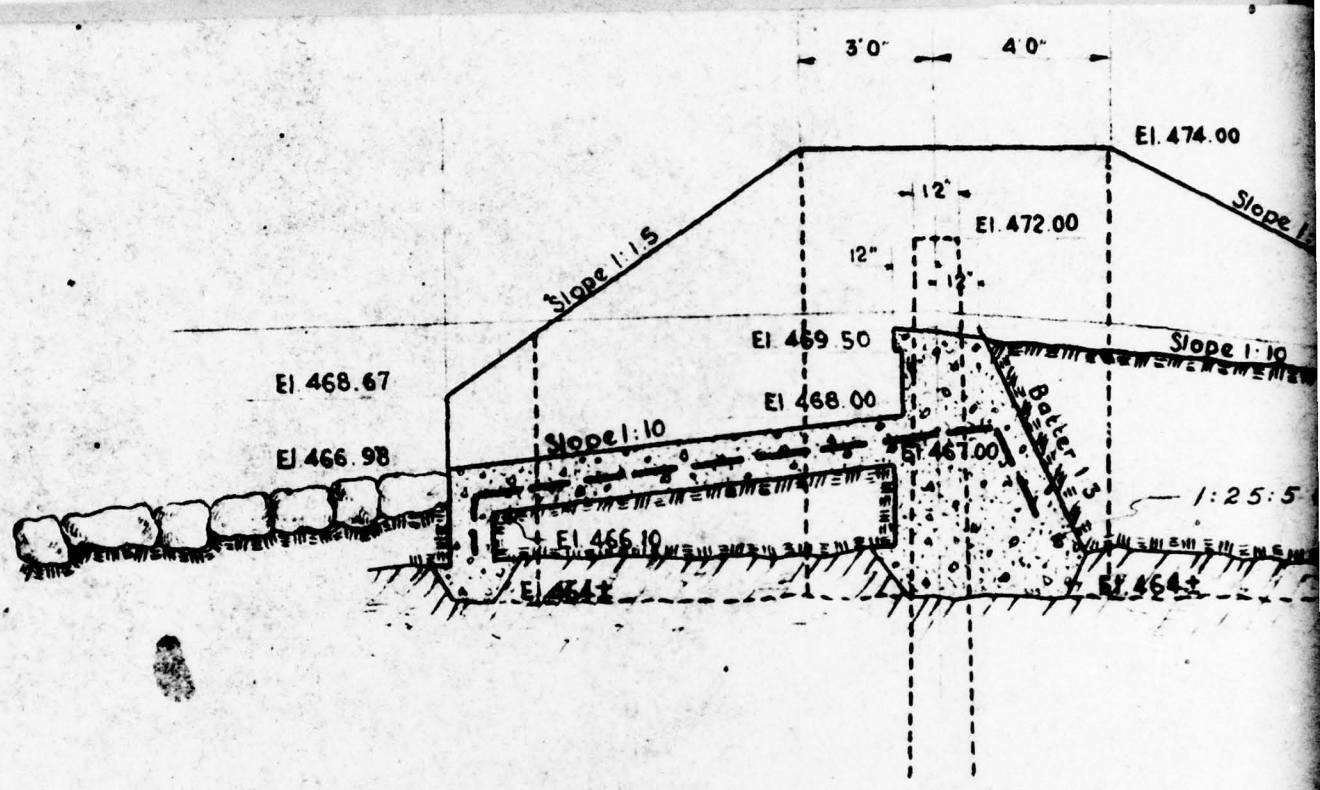


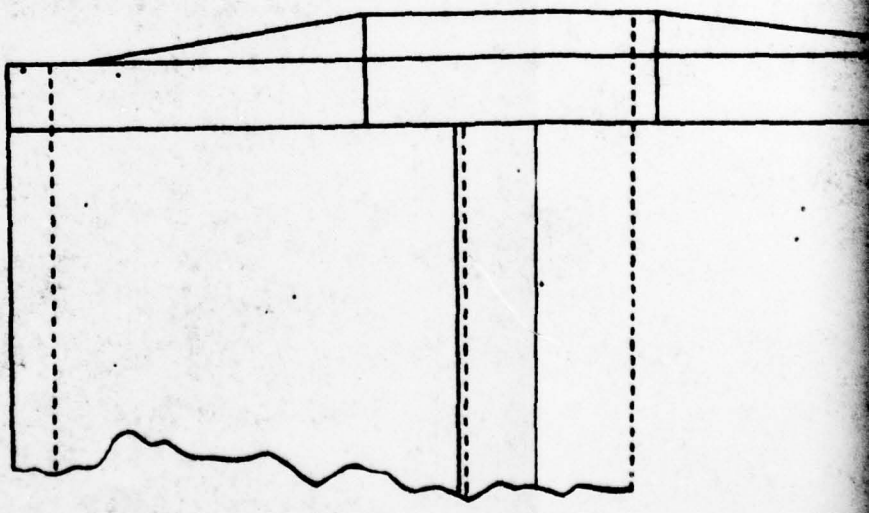
Sheet 4 of 4 Sheets

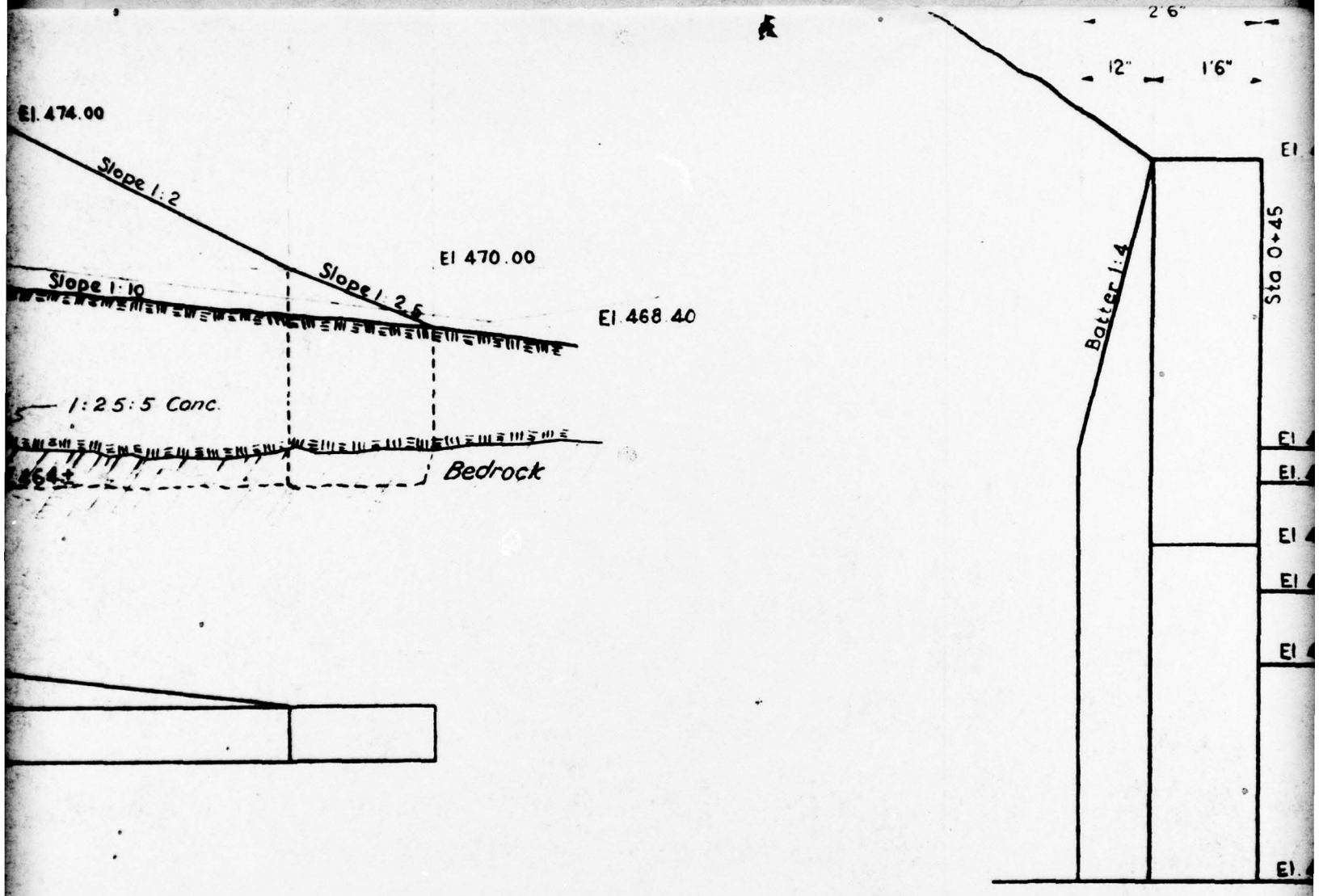


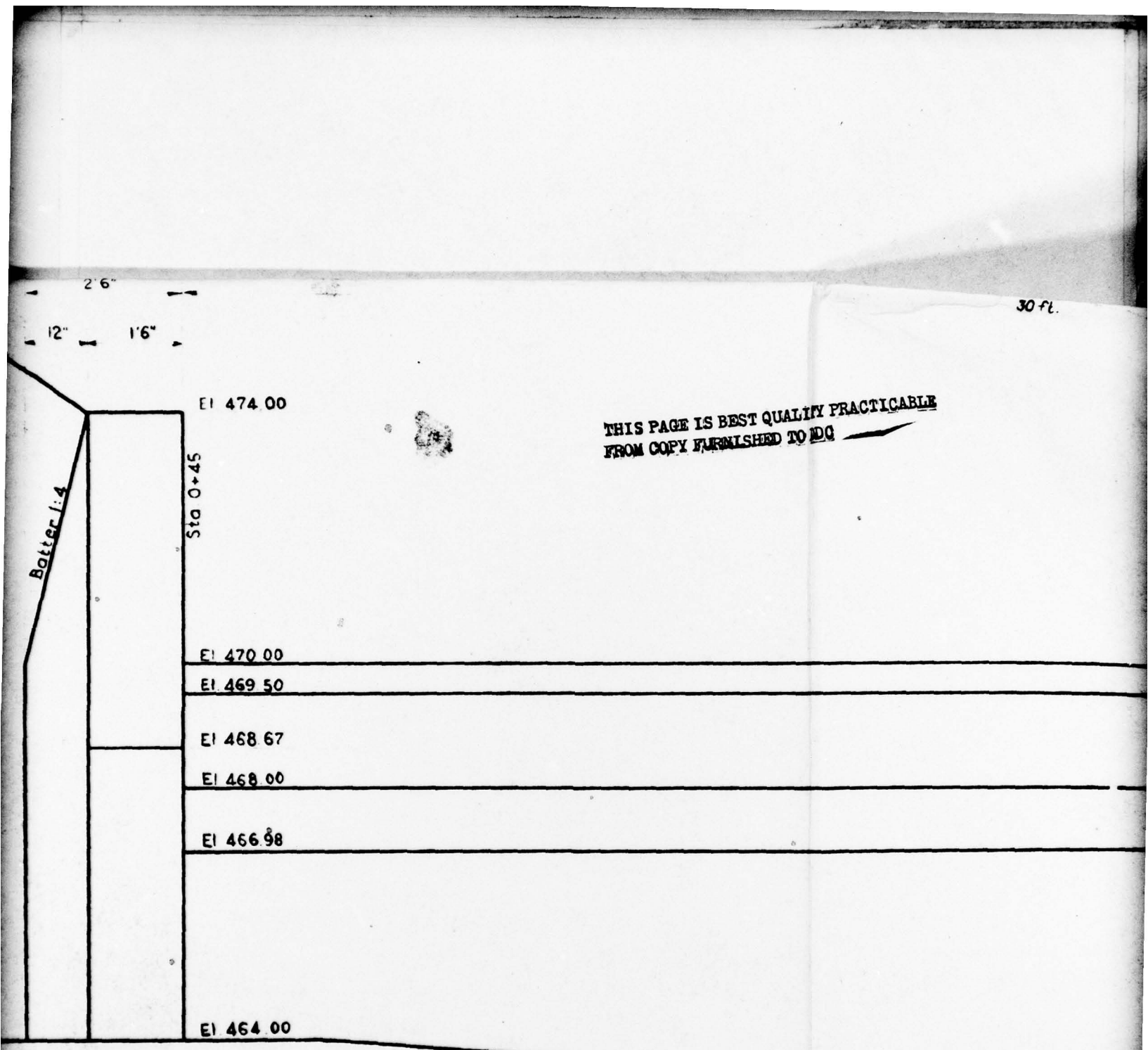
RACTICABLE

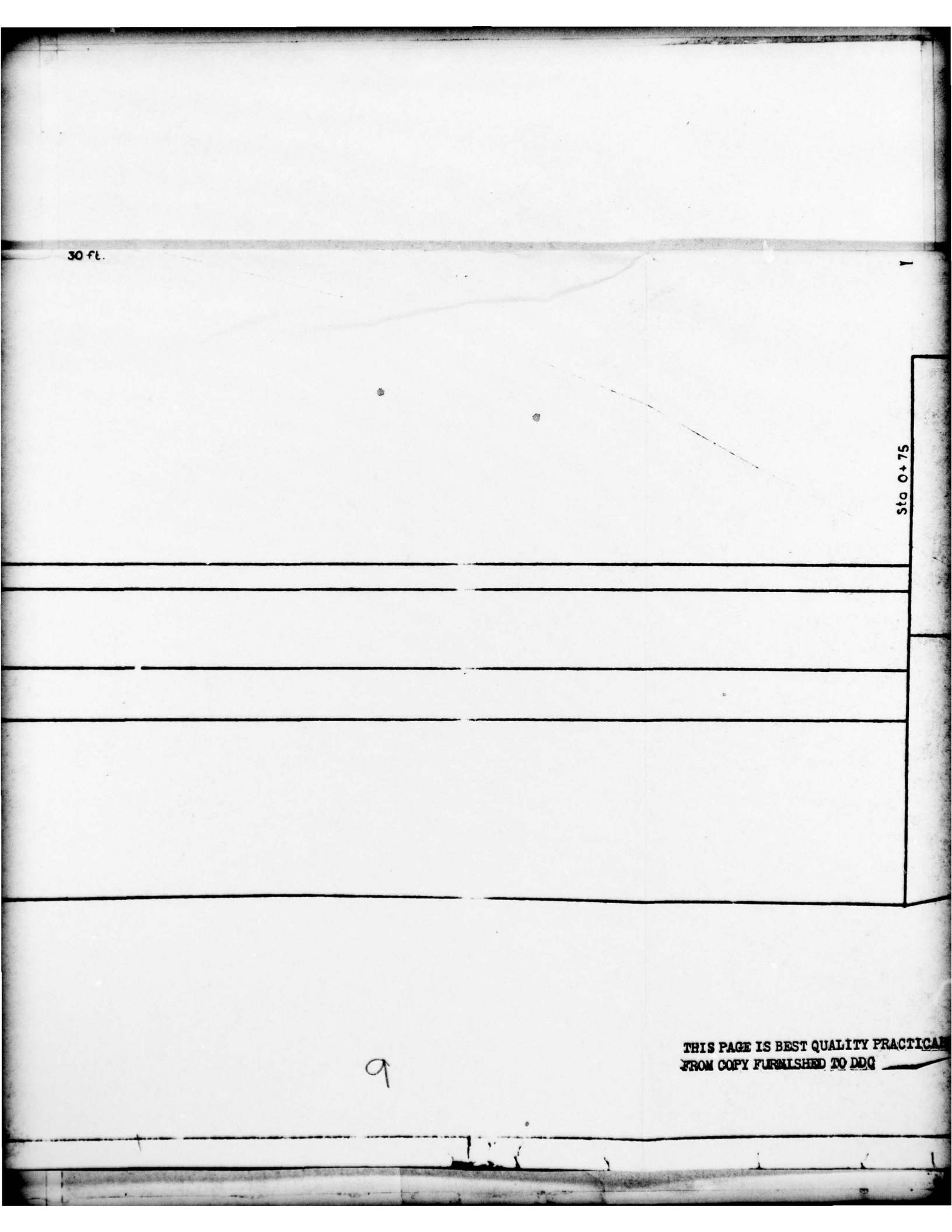
5

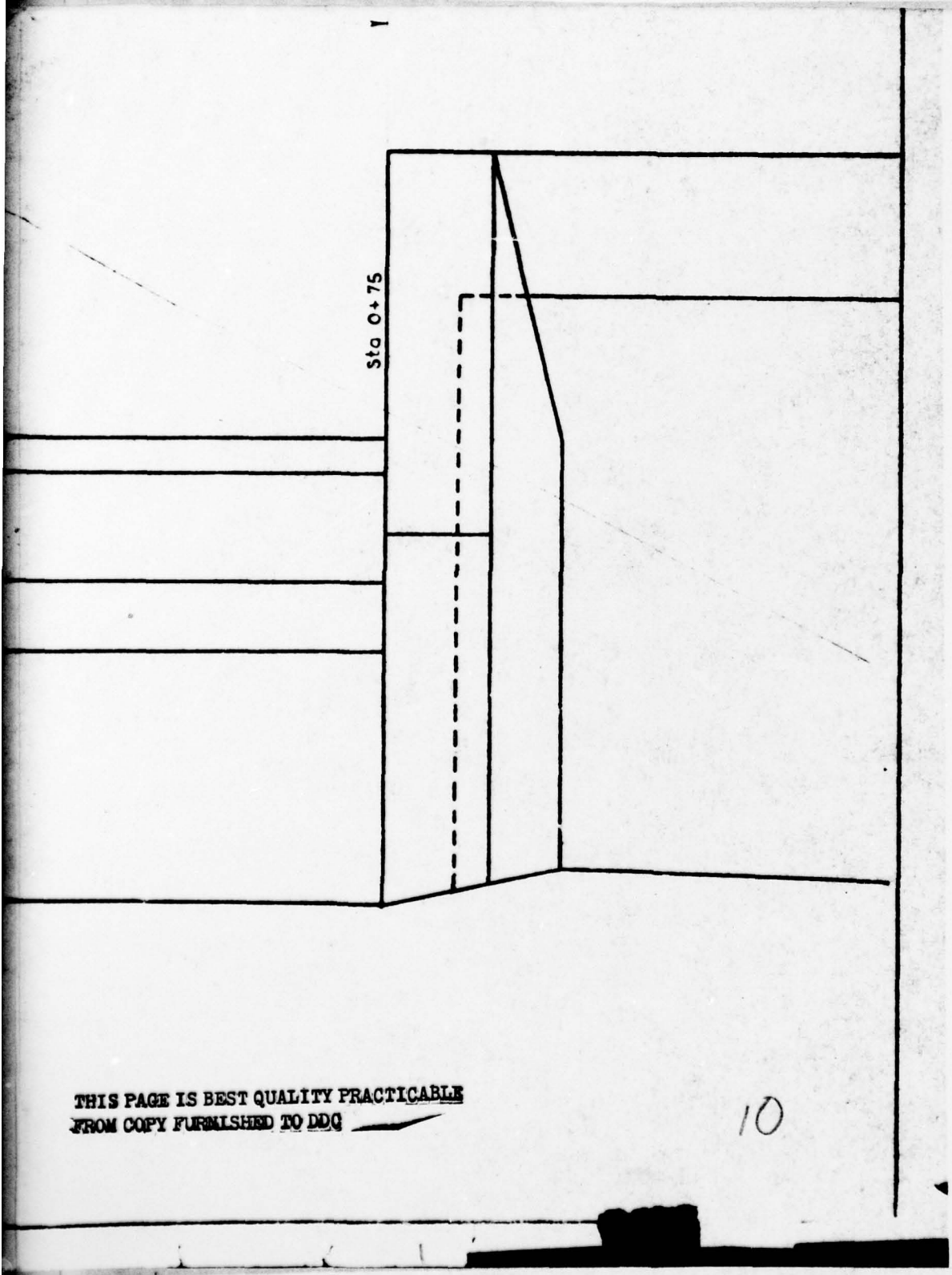


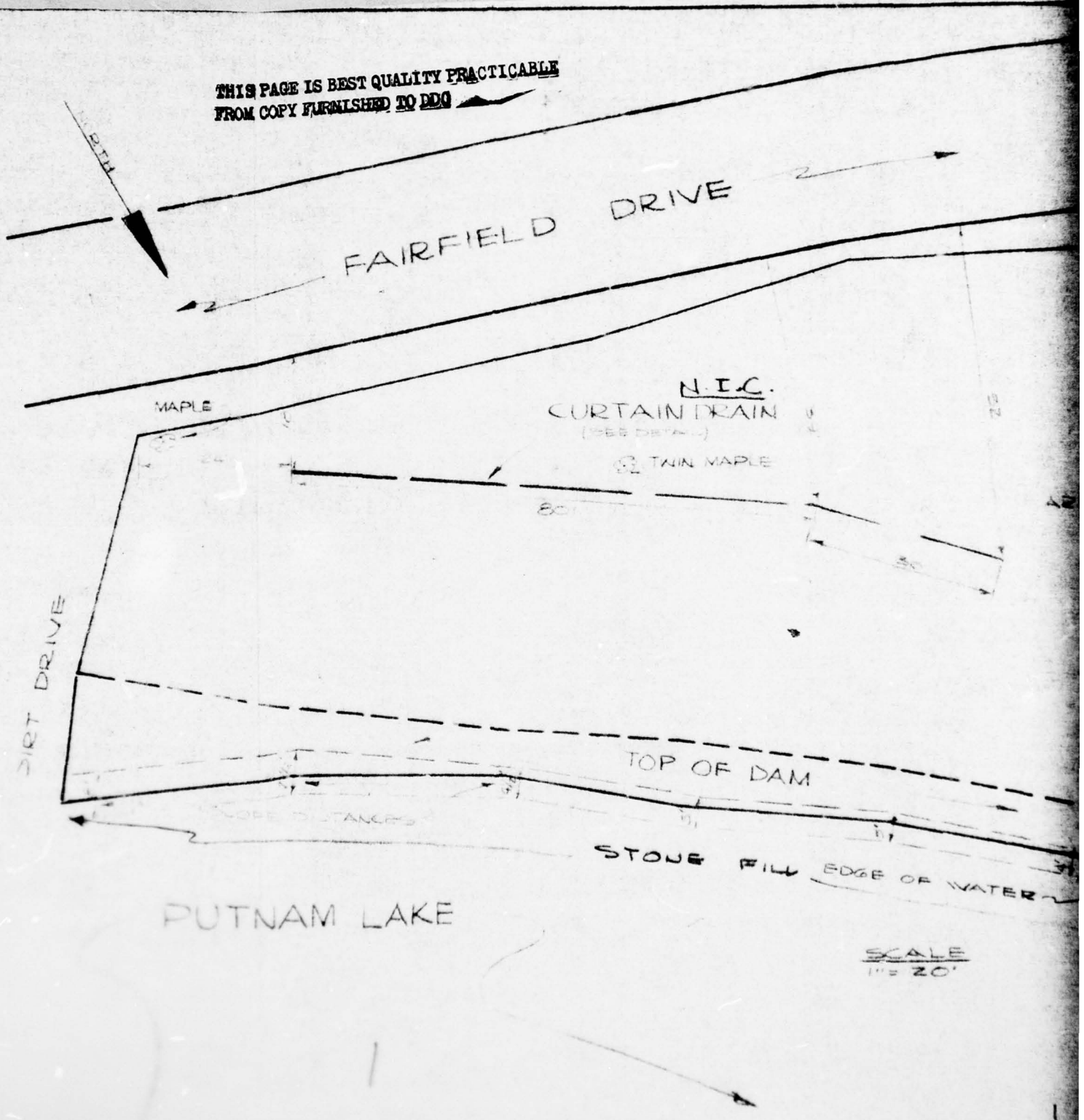


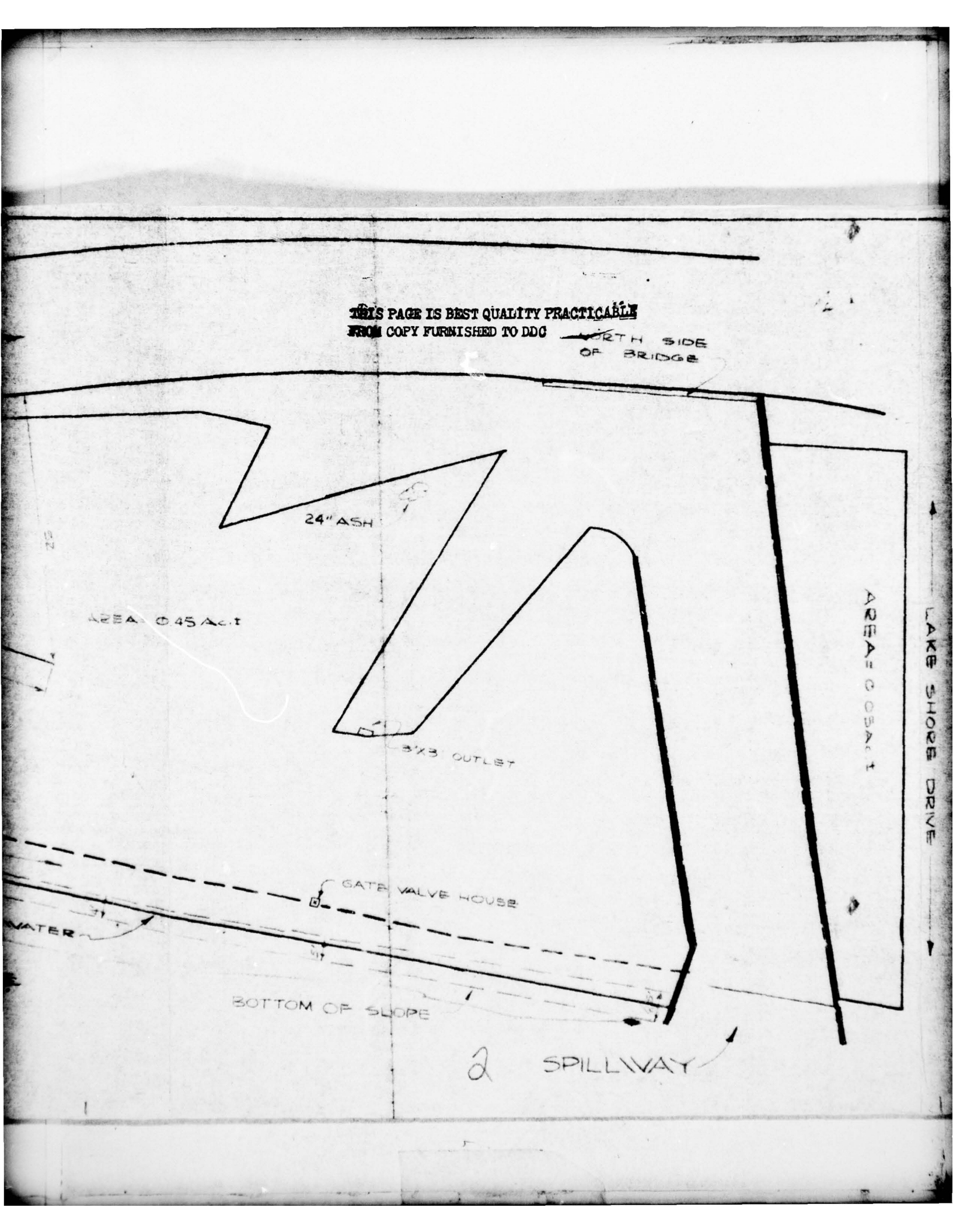


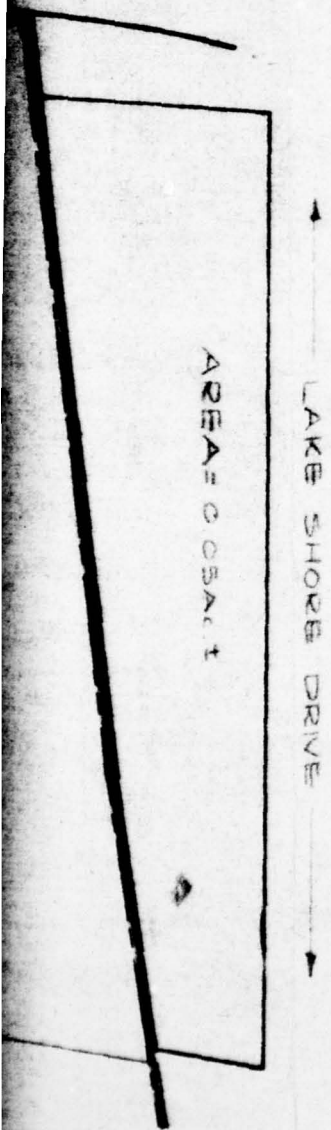










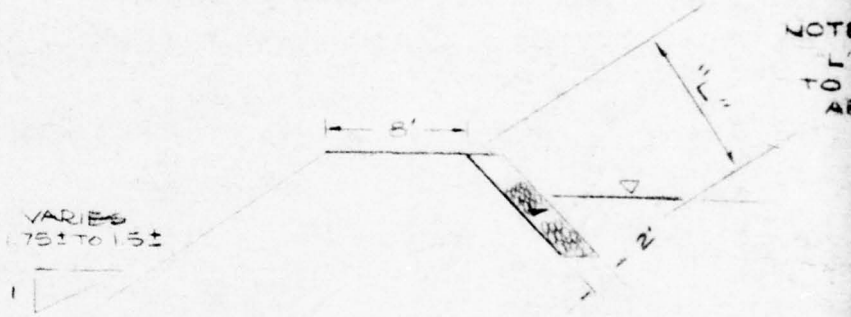


LAKE SHORE DRIVE

TOTAL AREA TO BE
CLEARED = 0.5 Ac. N.E.C.

TREES SHOWN ARE TO REMAIN
ALL OTHERS TO BE CLEARED UNLESS
DIRECTED OTHERWISE BY ENGINEER

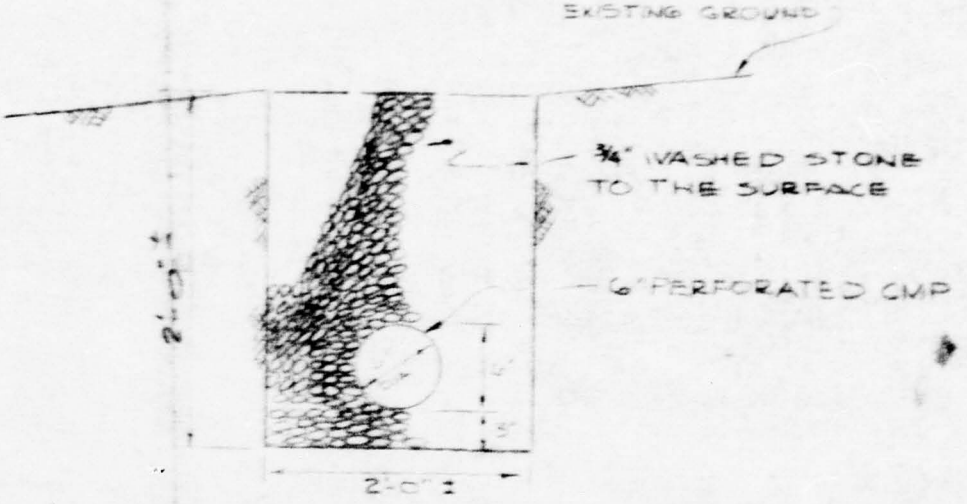
DAM
SECTION



SCALE: 1"= 10'

CURTAIN DRAIN DETAIL

N.I.C.



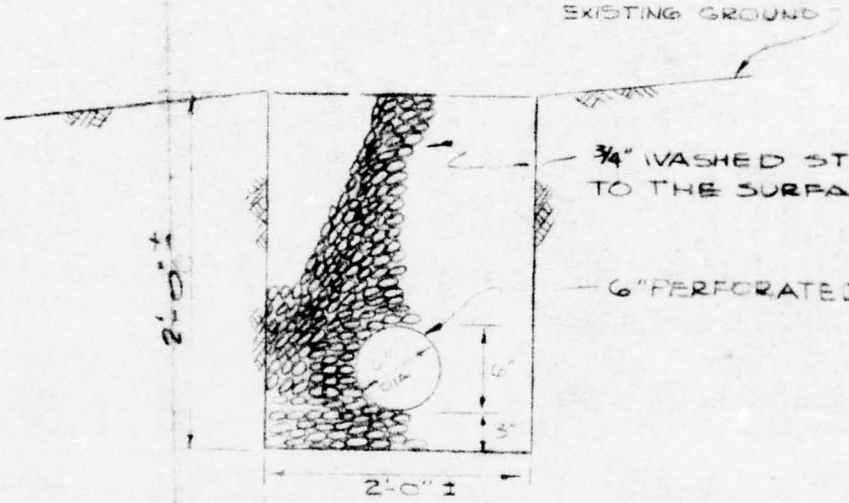
NOTE:
L VARIES ACCORDING TO THE SLOPE DISTANCES ABOVE

CHINKED FACE

SCALE: 1" = 1'

CURTAIN DRAIN DETAIL

N.I.C.



NOTE:
L" VARIES ACCORDING TO THE SLOPE DISTANCES ABOVE

CHINKED FACE

SCALE: 1" = 1'

.I.C.

UND

D STONE
REFACE

ATED CMP

6

TOWN OF
PATTERSON

DAM AT
PUTNAM LAKE

OCT. 1, 1973
NOV. 2, 73
MAY 1, 76

AS NOTED
48