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NATIONAL DAM INSPECTION PROGRAM. LAUREL CREEK DAM, SUSQUEHANNA --ETC(U)
JUL 78 DACW31-78-C-0044
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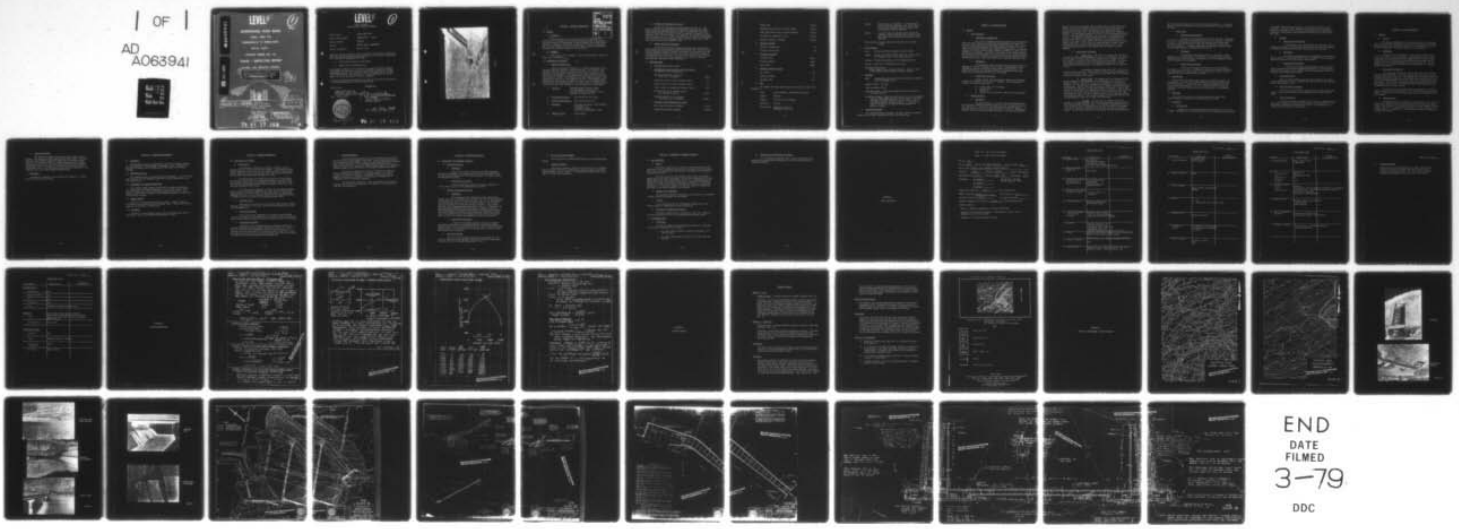

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LEVEL II

(1)

SUSQUEHANNA RIVER BASIN

LAUREL CREEK DAM

COMMONWEALTH OF PENNSYLVANIA

MIFFLIN COUNTY

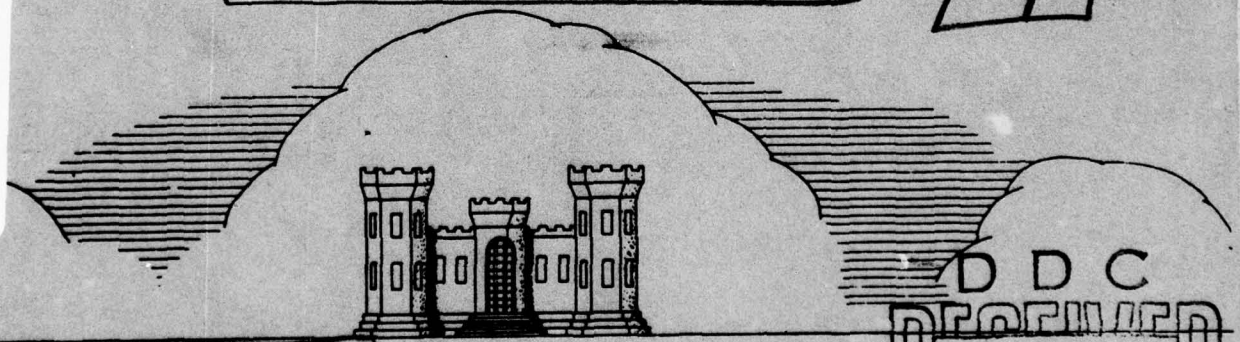
INVENTORY NUMBER NDS 578

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

(6) National Dam Inspection Program. Laurel Creek Dam, Susquehanna River Basin, Commonwealth of Pennsylvania, Mifflin County, ~~Inventory Number~~ (NDS 578). Phase I Inspection Report.

(12) 52p.



(15) DACW31-78-C-0044

Prepared For
DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland

by

BERGER ASSOCIATES, INC
CONSULTING ENGINEERS
HARRISBURG, PA.

(11) JULY 1978

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LEVEL II

PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

Name of Dam:	LAUREL CREEK DAM
State & State Number:	PENNSYLVANIA - 44-62
County Located:	MIFFLIN
Stream:	LAUREL CREEK, SUSQUEHANNA
Date of Inspection:	May 12, 1978

Based on a visual inspection, past performance and available engineering data, the dam and its appurtenances appear to be in excellent condition. The following recommendations are made:

1. Owner should install a staff gauge.

2. Repair crack in spillway wall.

The spillway capacity is not sufficient to pass the Probable Maximum Flood (PMF), as defined in the Corps of Engineers guidelines, without overtopping the dam. The spillway, however, has the capacity to pass 81% of the PMF peak flow and while it is rated inadequate on the PMF basis, it is not considered seriously inadequate.

A formal surveillance and downstream warning system should be developed to be used during periods of high precipitation.

Submitted By:

BERGER ASSOCIATES, INC.
HARRISBURG, PENNSYLVANIA
Contract No. DACW31-78-C-0044

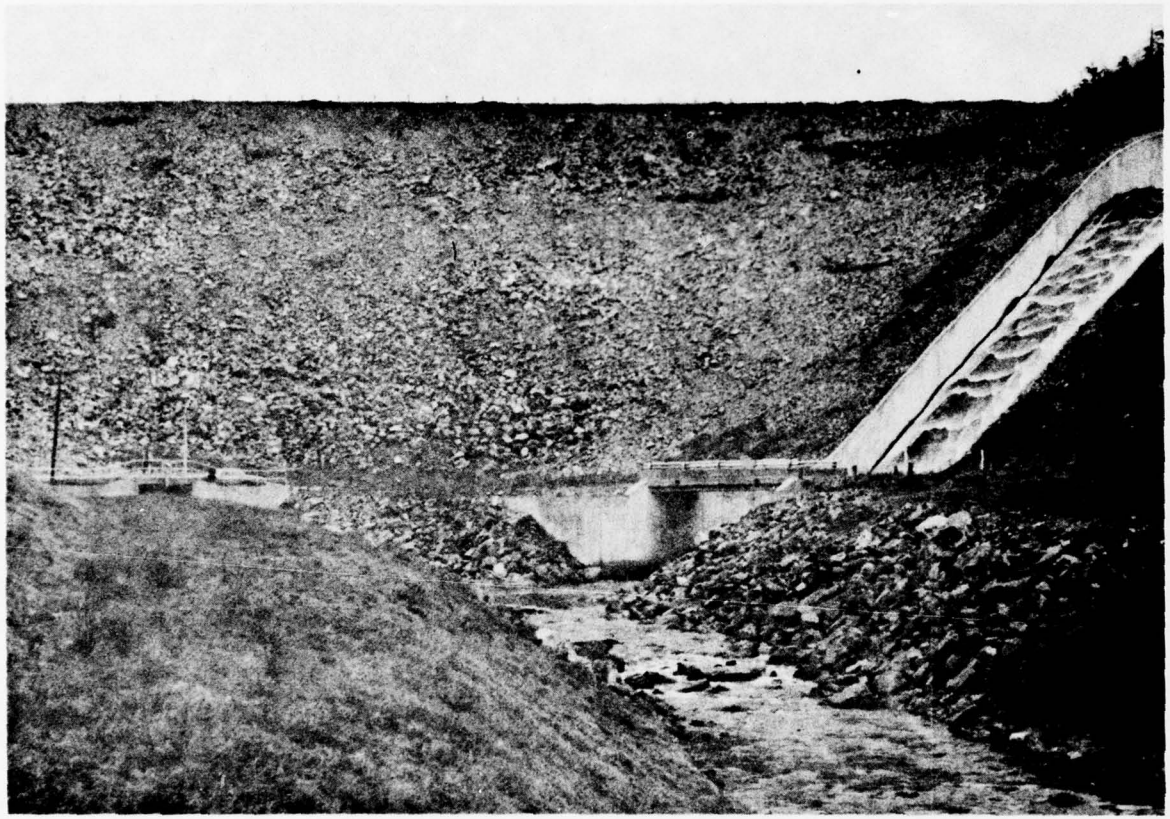
Date: July 5, 1978

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
HENDRIX JONGSMA
ENGINEER
No. 5557E

APPROVED BY:

G. K. WITHERS
Colonel. Corps of Engineers
District Engineer

DATE: 28 July 1978



OVERVIEW

ABSTRACT

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority

The Dam Inspection Act, Public Law 92-237 (Appendix III), authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspections of dams throughout the United States. The Phase I Inspection and Report is limited to a review of available data, a visual inspection of the dam site and the basic calculations to determine the hydraulic adequacy of the spillway.

b. Purpose

The purpose is to determine if the dam constitutes a hazard to human life and property.

ABSTRACT

1.2 DESCRIPTION OF PROJECT

a. Dam and Appurtenances

Laurel Creek Dam is composed of a rockfill embankment with an upstream impervious asphaltic concrete membrane. For a general plan view and a typical section, see Appendix D, Plates VI and VII. The embankment is approximately 600 feet long and has a maximum height of 135 feet above streambed. The minimum crest elevation is 1175 and the crest width is 20 feet. The spillway is an ogee section having a crest elevation of 1161 and a crest length of 135 feet. The spillway chute and deflector bucket were excavated into rock. They are composed of a concrete slab and retaining walls. An intake tower is located upstream of the dam in the right abutment and is accessible by a footbridge.

b.	Location:	Armaugh Township, Mifflin County U.S. Quadrangle, Barrville, Pa. Latitude 40°43.8', Longitude 77°37.8' (Appendix D, Plates I & II)
c.	Size Classification:	Large (over 100 feet high)
d.	Hazard Classification:	High (See Section 3.1.e)
e.	Ownership:	Municipal Authority of the Borough of Lewistown, Pa. 70 Chestnut Street Lewistown, Pennsylvania 17044
f.	Purpose of Dam:	Water Supply

g. Design and Construction History

The dam was designed by Gwin Engineers, Altoona, Pa. The Permit Application was approved by Pennsylvania Department of Environmental Resources (PennDER) in March, 1968. The contractor was Green Construction Company, Des Moines, Iowa, who started the project in the spring of 1969. Due to strike by the operators, the actual construction did not start until April, 1970. Construction was completed in September, 1972 and filling of the impoundment lake started in July, 1972. Full pool level was reached in December, 1972.

h. Normal Operating Procedures

The reservoir has been constructed and is used for domestic water supply for the Borough of Lewistown, Pennsylvania. Water is taken from the impounded lake at different elevations at the intake tower and carried through a pressure conduit to an outlet control pit located at the downstream toe of the dam. From this point the water flows through a 24 inch cast iron pipe to the treatment plant, which is situated approximately 1200 feet further downstream.

1.3 PERTINENT DATA

a. Drainage Area (square miles)	12.8
b. Discharge at Dam Site (cubic feet per second) See Appendix B for calculations	
Maximum known flood at dam site June, 1972 - Estimated	1,000
Warm water outlet at pool elevation 1161.0	93
Outlet tunnel at low pool elevation 1060.0	93
Outlet tunnel at normal pool elevation 1161.0	200
Spillway capacity at maximum design pool elevation 1170.0	13,700
Spillway capacity at maximum pool elevation 1175.0 - Estimate	25,000
c. Elevation (feet above mean sea level)	
Top of dam (low point of camber)	1,175.0
Maximum pool design surcharge	1,170.0

Normal pool	1,161.0
Upstream portal invert of outlet conduit	1,047.0
Downstream portal invert of outlet conduit	1,031.5
Streambed at centerline of dam	1,040.0
Maximum tailwater - Estimate	1,036.0

d. Reservoir (miles)

Length of maximum pool	1.0
Length of normal pool	0.9

e. Storage (acre-feet)

Spillway crest	3,050
Design surcharge	3,690
Top of dam	4,080

f. Reservoir Surface (acres)

Top of dam	80
Design surcharge	75
Spillway crest	67

g. Dam

For general plan and typical section see Plates VI and VII of Appendix D.

Type:	Rolled Rockfill, hydraulically sluiced.
Length:	600 feet
Height:	135 feet above streambed
Top Width:	20 feet
Side Slopes:	Upstream 1.75H to 1V Downstream 1.4H to 1V

Zoning: Main section is a rockfill. A 15 foot thick zone of material, between 3" and 18" in size is placed on the upstream side as a support for the asphaltic concrete membrane.

Cutoff: A cutoff trench is located at the toe of the membrane. This trench was filled with concrete and a special key connects this concrete to the membrane.

Grout Curtain: A grout curtain is indicated at the cutoff trench.

h. Outlet Conduit

Type: 42-inch and 60-inch diameter concrete pipes.

Length: 71 feet of 42-inch diameter pipe and 719 feet of 60-inch diameter pipe. Total length 790 feet.

Closure: 24-inch Howell-Bunger valve at downstream end.

Access: Valve pit at downstream toe of dam.

Regulating Facilities:
Howell-Bunger valve, manually operated. There is also a 5-inch bypass and gate valve for small releases.

i. Spillway

Type: Uncontrolled ogee weir with side channel and concrete lined rectangular chute.

Length of weir: 135 feet.

Crest elevation: 1161.0

Upstream channel: Paved area between reservoir and weir at elevation 1141.0.

Downstream channel: Ogee weir delivers water to the rectangular concrete side channel having a 50-foot width. The chute descends a vertical distance of about 120 feet over a horizontal distance of about 660 feet. It narrows to a width of 30 feet at the bottom and terminates in a deflector bucket.

j. Regulating Outlets

The regulating outlet includes a low flow inlet to the outlet conduit with an invert elevation of 1047.0 in intake tower.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

a. Data Available

1. Hydrology and Hydraulics

The files of PennDER contained a report by the Consulting Design Engineer covering the hydrology and spillway calculations for this dam. The permit application report dated January 19, 1968, states that the required discharge at this site should be 9,600 cfs. This report also reviews the hydrologic analysis and states that the maximum probable storm would produce a peak inflow of 33,800 cfs., which can be handled by the spillway. Included in the report by the design engineer were design flood hydrographs, flood routing data, side channel spillway design calculations, a spillway rating curve, spillway chute and bucket calculations, outlet tunnel rating data and a reservoir capacity curve.

2. Embankment

The embankment design was based on a geological report by Lawrence H. Lattman, Geologist, State College, Pennsylvania, and the embankment stability calculations were made by Gwin Engineers, Inc. Design calculations for embankment stability, embankment zoning and cutoff wall are available in the files of PennDER.

3. Appurtenant Structures

Design criteria and calculations prepared by the design engineer are available in the files of PennDER. These computations include the following structures:

a. Intake tower and footbridge.
b. Outlet works.
c. Spillway.
d. Bridges over the Spillway (upper and lower bridge).

b. Design Features

1. Embankment

The dam embankment is a rolled rockfill embankment with two zones and a asphaltic concrete membrane on the upstream side (Plate VII, Appendix D). Zone one is the main portion of the dam and the material used in this zone is graded between the limits of 100% passing 36-inch and less than 10% passing 4-inch size. The zone two material

had to be free of rock smaller than 3-inches with a maximum size of 18 inches. The stone was placed in layers of 36 inches in zone one and of 18 inches in zone two and sluiced with water immediately after dumping of each truck load. The rockfill was compacted by vibratory rollers. The embankment slopes are 1.75H to 1V at the upstream side and 1.4H to 1V on the downstream side. The top width of the embankment is 20 feet. The asphaltic concrete membrane varies in thickness from 8 inches at the crest to 10 inches at the base. The asphalt was to be placed in at least 10 foot strips along the slope and sealed with a hot asphalt seal coat. At the toe of the upstream slope, a cutoff trench was excavated and a grout curtain was placed in this trench. This concrete filled trench was tied together with the asphalt concrete membrane.

2. Appurtenant Structures

a. Intake Tower. The tower is located about 200 feet upstream from the dam and accessible by way of a footbridge. The height of the tower is 135 feet above stream bottom and is founded on rock. The footing is fastened to the rock with rock anchor bolts. The tower is circular in shape with an inside diameter of 9 feet and a 2 foot thick reinforced concrete wall. The operating platform is at elevation 1175.75.

An emergency drawdown sluice gate (36" x 48") is at elevation 1055.0 (invert). There are four intakes, each controlled by a 30 inch round sluice gate at the outside of the tower and a 30 inch gate valve on the inside of the tower.

b. Outlet Works. The intake tower is connected to the outlet control building located at the downstream toe of the dam by a pressure conduit. The first 70 feet of this conduit is 42 inches in diameter. At this point, an increaser was installed to transition to a 60 inch pipe. This 60 inch pipe was used as a bypass during construction. The conduit is placed in a trench and encased in concrete. Flow in the conduit is controlled at the downstream end in the outlet control building. The end of the conduit has a 60 inch by 24 inch reducer and a 24 inch Howell-Bunger valve. The water supply takeoff is a 24 inch pipe located just above the reducer. The control building is reinforced concrete and is approximately 20 feet by 23 feet by 17 feet deep.

c. Spillway. The spillway is located in the left abutment of the dam and has a 135 foot long ogee shaped overflow section, with a side channel spillway chute. The available discharge head is 14 feet (Elevation 1061 to Elevation 1175.0) and the width of the channel is 50 feet. The chute narrows down to 30 feet just above a deflector bucket. All walls and slabs are of reinforced concrete construction and

the chute slab is anchored to the rock strata with rockbolts. A drainage system is installed beneath the slab and clean backfill is placed behind the walls.

c. Design Data

1. Hydrology and Hydraulics

PennDER's Permit Application Report states that a discharge of 13,700 cfs would have a discharge depth of 9 feet, leaving a freeboard of 5 feet. The maximum probable storm is indicated as having a peak inflow of 33,800 cfs and it is stated that the spillway is sufficient for this discharge. A complete hydrologic and hydraulic analysis report by the design engineer is available in the files.

2. Embankment

The embankment design was based on a geological report. Results of test borings were not available. The design report includes computations for mass sliding, arc sliding and for the thickness of zone two for bridging of settlements.

3. Appurtenant Structures

A full set of design calculations for all appurtenant structures is in the file. No summary of design criteria was found, but all computations for overturning, foundation pressure, uplift, sudden drawdown and high groundwater were included.

2.2 CONSTRUCTION

The available construction data consists of progress reports and photographs. In April, 1971, Harza Engineering Company inspected the site and submitted an inspection report with recommendations for the cutoff trench and grouting. Mr. A. N. Vanderlip was the consulting engineer at the site assisting with the installation of the asphaltic concrete.

2.3 OPERATION

The purpose of the dam is to supply domestic drinking water. Formal records of operation are not available for review.

2.4 EVALUATION

a. Availability

A complete set of design drawings is available in the file of PennDER. Although the files indicate that as-built drawings were submitted

to PennDER, these were not obtained. The files do, however, include copies of a geologic report, embankment calculations, hydrology and hydraulic calculations and structural computations for the appurtenant structures. The contract specifications for this project are also in the files.

b. Adequacy

1. Hydrology and Hydraulics

A considerable amount of hydrologic and hydraulic information is available. This data was submitted by the consulting engineer to PennDER and describes the design criteria used for this dam.

2. Embankment

The design calculations for the embankment were reviewed and the design is considered adequate and in accordance with acceptable engineering practice for this type of construction.

3. Appurtenant Structures

A review of the design drawings indicate that all appurtenant structures are properly designed and detailed. The footings of retaining walls appear to be adequate and the drainage system under the spillway slab should prevent uplift.

c. Operating Records

While no formal operating records were available for review, it was reported that no major problems have occurred since this facility became operational in 1972.

d. Post Construction Changes

There have been no reported modifications to the original dam design, except that grouting was not staged due to the small take of grout.

e. Seismic Stability

The dam is located in Seismic Zone 1 and it is considered that the static stability with normal safety factors is sufficient to withstand minor earthquake induced dynamic forces. No calculations or studies have been made to confirm this.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General

The general appearance of the dam is excellent. The appearance of the facilities indicate that the dam was constructed by a good contractor under good supervision and that all appurtenant structures are well maintained. The visual checklist is in Appendix A.

b. Embankment

The dam is in good condition. The vertical camber on the crest of the dam is still noticeable. Records indicate that maximum settlement after construction has been approximately .03 feet. Maintenance has not been required on the downstream rock slopes and the visible part of the upstream membrane is in good condition. It was reported that the membrane becomes soft in hot weather. No apparent seepage was detected.

c. Appurtenant Structures

All appurtenant structures were in good condition. Besides some shrinkage cracking, a crack was noticed near the entrance of the spillway (Appendix D, Plate V). The manager stated that this crack will be pressure grouted during the summer (1978), when the pool level falls 3 or 4 feet below spillway crest. The cause of the crack could not be determined. Water over the spillway has not been high enough to cause any stresses in this wall. It could have been a cold joint with poor workmanship after the pour started.

All the gates on the intake tower are operated on a regular basis, except the 42 x 30 inch gate at the bottom, which has never been opened, Opening of the 42 x 30 inch gate would cause turbidity in the water supply.

d. Reservoir Area

Sedimentation was not reported in the reservoir. The reservoir slopes are a mixture of well protected banks and some open cut areas. During heavy precipitation the upstream end of the lake becomes slightly turbid. The rock for this dam was excavated in an area adjacent to the spillway (Plate IV, Appendix D). No exceptional erosion, sloughing or sliding were noticed.

e. Downstream Channel

The downstream channel below the deflector bucket is well defined. The slopes are stable and protected with riprap. The creek flows past the treatment plant and under Route 322 through a large culvert. The Borough of Milroy is located approximately 2.3 miles downstream from the dam. Many houses and trailers in this community are located close to the stream. A failure of the dam would cause considerable loss of life and property and therefore, this dam is considered to be in the "High" Hazard Classification.

3.2 EVALUATION

The observed condition of the facility was excellent. No major points of concern were noticed.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

The impoundment dam was constructed to serve as a storage reservoir for drinking water for the Borough of Lewistown. Water is taken from the lake as demands require through the 24 inch pipe in the control building.

4.2 MAINTENANCE OF DAM

The treatment plant has around-the-clock attendance. Mr. Bob Sellers, plant operator for the Borough, stated that a casual inspection of the dam is made daily.

4.3 MAINTENANCE OF OPERATING FACILITIES

The treatment plant operator stated that the gates and valves on the intake tower are operated regularly (2 to 3 times a year), except the low drawdown gate, which has not been operated since 1972. Ice damage to the stem of the highest intake prevents operation of this gate until repairs are made.

4.4 WARNING SYSTEM

There is no formal warning system in effect. However, there is around-the-clock attendance in the treatment plant. There were no staff gages on the spillway or intake tower.

4.5 EVALUATION

The dam is well maintained, except that the drawdown gate has not been used. There is no formal warning system in effect.

SECTION 5 - HYDROLOGY/HYDRAULICS

5.1 EVALUATION OF FEATURES

a. Design Data

The hydrologic and hydraulic analysis available from the PennDER files for Laurel Creek Dam was complete. Included were design flood hydrographs, flood routing, side channel spillway design calculations, spillway rating curve, spillway chute and bucket calculations, outlet tunnel rating and reservoir capacity curves.

The design inflow of 17,900 cfs is based on a Jarvis-Meyer coefficient of 5,000 and a unit hydrograph developed from the records for the USGS gaging station on Standing Stone Creek. Routing of this flood through the proposed reservoir gave a maximum outflow of 13,700 cfs with a freeboard of 5.0 feet.

In a review dated September 13, 1967, the Pennsylvania Department of Forests and Waters expressed the belief that the above design assumptions were on the low side. On the other hand, the thought was expressed that the 5.0 foot freeboard might raise the spillway capacity to 33,800 cfs which was given as the maximum probable flood.

b. Experience Data

Examination of records for the two nearby USGS gaging stations indicates that inflow for the June, 1972 flood was probably about 1,000 cfs (See Appendix B).

c. Visual Observations

On the date of the inspection, no conditions were observed that would indicate that the appurtenant structures of the dam could not operate satisfactorily during a flood event, until the dam is overtoppped.

d. Overtopping Potential

Comparison of the estimated PMF peak inflow of 31,000 cfs, with the estimated ultimate spillway capacity of 25,000 cfs, indicates that the potential for overtopping of Laurel Creek Dam exists. An estimate of the storage effect of the reservoir shows that Laurel Creek Dam Reservoir does not have the storage available that would be necessary to pass the PMF without overtopping (See Appendix B).

e. Spillway Adequacy

Laurel Creek Dam Reservoir can store 4,080 acre-feet of water and the dam has a total height of 135 feet. These dimensions indicate a size classification of "Large". Failure of this dam could cause extensive loss of life and property. The indicated hazard classification is "High" (Section 3.1.e). These two classifications indicate a recommended spillway design flood (SDF) equal to the Probable Maximum Flood (PMF).

The spillway capacity of the dam is sufficient to pass the design discharge as calculated by the design engineer, but only 81 percent of the PMF peak inflow as determined by using the Corps of Engineers guidelines. Therefore, the spillway is considered to be inadequate, but not seriously inadequate.

The hydrologic analysis for this investigation was based upon existing conditions of the watershed. The effects of future development were not considered.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observation

1. Embankment

There were no visual indications of undue embankment stresses or sloughage. The embankment was in excellent shape and the upstream membrane appeared to be in good condition. No unusual amount of seepage was detected.

2. Appurtenant Structures

Visual observations indicate no present stability or stress problems in any of the appurtenant structures.

b. Design and Construction Data

1. Embankment

The inspection report prepared by Harza Engineering Company describes the foundation of the dam after most of the stripping and excavation to "solid" rock had occurred. Most of the foundation is a severely folded quartzite, with the folds normal to the creek bed, which is favorable for stability and water tightness. This report describes the recommended grouting procedure. Mr. A. N. Vanderlip, who had considerable experience with this type of membrane, acted as a consulting engineer during the installation of the asphaltic concrete. The design computations indicate that acceptable safety factors were used. The minimal amount of settlement that has occurred, indicates that the method of sluicing and embankment rolling was excellent.

2. Appurtenant Structures

A review of the design drawings indicates a properly engineered intake tower and control building. Reinforcing appears adequate and a review of the foundation of the tower indicates a design against uplift. The detailing of the spillway weir and chute applied good engineering techniques.

c. Operating Records

While no formal operating records were available, Mr. Bob Sellers, operator for the Borough, stated that no major problems have occurred since the dam became operational in 1972.

d. Post Construction Changes

There have been no reported modifications to the original dam design.

e. Seismic Stability

This dam is located in Seismic Zone No.1 and it is considered that the static stability is sufficient to withstand minor earthquake induced dynamic forces. However, no calculations, studies, etc., were made to confirm this conclusion.

SECTION 7 - ASSESSMENT & REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety

The visual inspection, the review of design drawings and the operational history indicates that the dam is in excellent condition and that it has been designed and constructed in accordance with acceptable engineering practice.

The only concern is the spillway capacity and the possible damage which could occur downstream. The dam is considered to be a high hazard dam with a large size classification. The recommended Spillway Design Flood (SDF) is the PMF but the spillway capacity is actually 81 percent of the PMF peak inflow as obtained from the Corps of Engineers guidelines. The spillway capacity is, however, capable of passing the PMF based on the design engineer's calculations.

b. Adequacy of Information

The available hydraulic information is considered to be adequate to make a detailed assessment of the project.

c. Urgency

It is considered that the recommended suggestions in this section should be implemented as soon as practical

d. Necessity for Additional Studies

Additional studies are not required at this time. However, attention should be given to the recommendations presented below.

7.2 RECOMMENDATIONS

a. Facilities

In order to assure continued adequate operation of this dam, the following recommendations are made:

1. The owner should install an outside staff gage on the control tower.

2. The owner should repair the crack in the wall near the spillway.

b. Operation and Maintenance Procedure

It is considered important that a formal surveillance and downstream warning system be developed to be used during periods of high precipitation.

APPENDIX A

VISUAL INSPECTION

CHECK LIST - DAM INSPECTION PROGRAM

PHASE I - VISUAL INSPECTION REPORT

NAD NO. 578

PA. ID # 44-62 NAME OF DAM Laurel Creek Dam HAZARD CATEGORY High

TYPE OF DAM: Rockfill with Asphaltic Concrete Membrane

LOCATION: Armagh TOWNSHIP Mifflin COUNTY, PENNSYLVANIA

INSPECTION DATE 5/12/78 WEATHER Cloudy - Cool TEMPERATURE 60's

INSPECTORS: H. Jongsma
Bob Sellers - Borough
Stewart Giansell - DER
R. Houseal
R. Steacy

NORMAL POOL ELEVATION: 1161.0 AT TIME OF INSPECTION:

BREAST ELEVATION: 1175.0 (Vert.Curve to 1179.50) POOL ELEVATION: 1161.3±

SPILLWAY ELEVATION: 1161.0 TAILWATER ELEVATION:

MAXIMUM RECORDED POOL ELEVATION: Spillway + 1'± (Visual Observation)

GENERAL COMMENTS:

Project - excellent appearance - very well maintained.

Access to all facilities excellent. Paved roads at outlet, top of embankment and to control tower.

Operation - 24 hours attendance at plant.

DAM NO. NAD 378

VISUAL INSPECTION

EMBANKMENT	OBSERVATIONS	REMARKS & RECOMMENDATIONS
A. SURFACE CRACKS	None evident Upstream slope paved bituminous concrete Top paved road bituminous concrete	
B. UNUSUAL MOVEMENT BEYOND TOE	None evident	
C. SLOUGHING OR EROSION OF EMBANKMENT OR ABUTMENT SLOPES	No sloughing evident downstream Upstream paved - no distress evident	
D. VERTICAL & HORIZONTAL ALIGNMENT OF CREST	Vertical camber - as designed.	
E. RIPRAP FAILURES	Downstream dumped rock No failures evident	
F. JUNCTION EMBANKMENT & ABUTMENT OR SPILLWAY	Embankment abuts exposed rock face vertical bedding - fractured very blocky sandstone	
G. SEEPAGE	From rock face left side looking upstream - but downstream from contact with embankment slope line. Further inspection on roadway (U.S.322)	
H. DRAINS	Above this area shows seepage from rock slope above roadway on the other side of U.S.322. Appears thus to be a natural drainage phenonoma	
J. GAGES & RECORDER	None	
K. COVER(GROWTH)	Downstream rock, cobbles, boulders, some small patches of grass. Grass on flat at toe.	

DAM NO. NAD 578

VISUAL INSPECTION

OUTLET WORKS	OBSERVATIONS	REMARKS & RECOMMENDATIONS
A. INTAKE STRUCTURE	Concrete tower Good condition	
B. OUTLET STRUCTURE	Good	
C. OUTLET CHANNEL	Bridge across stilling basin Riprap	
D. GATES	4 - 30" 1 - large (does not or is not used)	
E. EMERGENCY GATE	Bottom large gate	
F. OPERATION & CONTROL	Ice damage to air lines with the movement of ice toward spillway	
G. BRIDGE (ACCESS)	Concrete - fenced Good	

DAM NO. NAD 578

VISUAL INSPECTION

SPILLWAY	OBSERVATIONS	REMARKS & RECOMMENDATIONS
A. APPROACH CHANNEL	Clear - direct from impoundment	
B. WEIR: Crest Condition Cracks Deterioration Foundation Abutments	Ogee Section Good In embankment side Nil Good	
C. DISCHARGE CHANNEL Lining Cracks Spilling Basin	Concrete Longitudinal crack on spillway wall about 2 feet± below spillway crest. Left side of spillway looking D/S. No weep holes anywhere Long Chute - good appearance	
D. BRIDGE & PIERS	Roadway bridge across spillway channel walls Good condition	
E. GATES & OPERATION EQUIPMENT	No gates in spillway area (see control tower - inlet control)	
F. CONTROL & HISTORY	No staff gage - to identify depths of flow over spillway	

C. DISCHARGE CHANNEL

Indications are from representative of owner that when the reservoir gets below spillway level and the crack level repairs are going to be made. (7' to 8' normal drop below spillway during summer) has been as much as 14' below.

DAM NO. NAD 578

VISUAL INSPECTION

MISCELLANEOUS	OBSERVATIONS	REMARKS & RECOMMENDATIONS
INSTRUMENTATION		
Monumentation	None	
Observation Wells	None	
Weirs	None	
Piezometers	None	
Other	Recorder on minimum discharge pipe	
RESERVOIR		
Slopes	Light timber along edges of reservoir. Heavier above slopes exposed from excavation Seeded with light cover - some soil exposed Runoff erosion.	
Sedimentation	None to date	
DOWNSTREAM CHANNEL		
Condition	Good	
Slopes	Sandstone cobbles - boulders	
Approximate Population	6,000±	
No. Homes	Town of Milroy	

APPENDIX B

HYDROLOGY/HYDRAULICS

PROJECT Dam Investigation SHEET NO. 1

SUBJECT Laurel Creek Dam ID #578

COMPUTED BY RES DATE 6-1-78 CHECKED BY JJRJ 6-7-78

Maximum known flood at damsite

No records are kept of pool stage or discharge. Dam operator recalls that dam was under construction at the time of the June 22, 1972 flood. The diversion works backed up a pool that came within 12 feet of the spillway crest. Discharge is estimated below on the basis of nearby gaging stations.

Gage	Drainage Area (Sq. Mi.)	Discharge 6-22-72 (cfs)
Oakland Mills	6.52	468
Snow Shoe	12.2	1170

$\left(\frac{12.8}{6.52}\right)^{0.8} \times 468 = 803$ $\left(\frac{12.8}{12.2}\right)^{0.8} \times 1170 = 1216$

$\frac{803+1216}{2} = 1{,}010$ Use 1,000 cfs

Warm-water outlet

Normal pool elev. & Highest Intake (30" Dia. Valve)

1161.0
− 1145.0
$h = 16.0$

$Q = Ca\sqrt{2gh}$

$= 0.59 \times 4.91 \times (64.3 \times 16)^{1/2}$

$= 93$ cfs

$C = 0.59$ Kings Handbook, 6th Ed. Table 4-8

$a = \pi (1.25)^2 = 4.91$

Outlet tunnel at low pool elev. 1060.0

From designer's graph 93 cfs

Check computation

3-ft by 4-ft gate, & at 1057.0

$Q = Ca\sqrt{2gh}$

$= 0.6 \times 12 \times \sqrt{64.3 \times 3}$

$= 100$ cfs Use 93 cfs

$C = 0.60$

$h = 3.0$

$a = 3 \times 4 = 12$

Outlet tunnel at normal pool elev. 1161

From designer's graph 200 cfs.

Rough check - Assume control is 24-inch Howell-Bunger valve at point of discharge

$h = 1161 - 1032.5 = 128.5$ $C = 0.6$

$Q = CA\sqrt{2gh} = 0.6 \times 3.14 \sqrt{64.3 \times 128.5} = 171$ cfs. Use 200 cfs

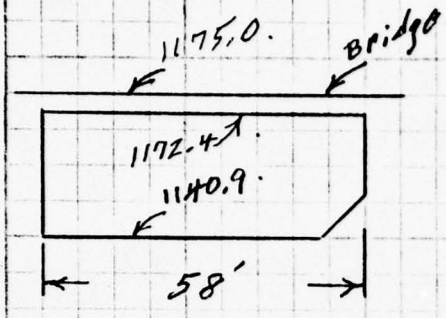
PROJECT Dam Investigation SHEET NO. ___ OF ___

SUBJECT Laurel Creek Dam ID # 578

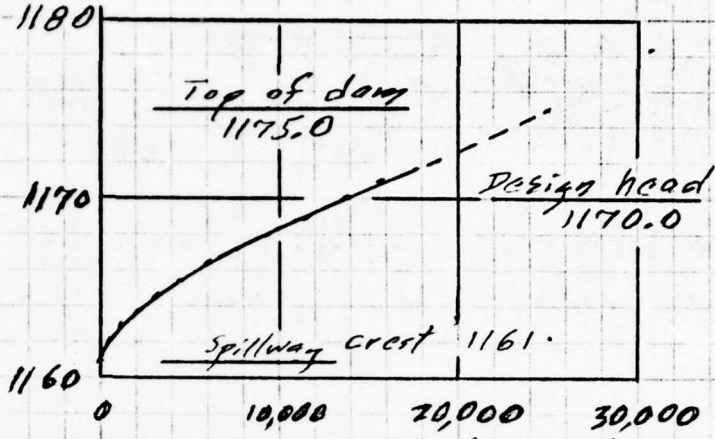
COMPUTED BY RES DATE 6-1-78 CHECKED BY JJPJr

6-7-78

Spillway capacity at top of dam - elev. 1175.0



Section of chute at bridge about 60 feet downstream from end of overflow section



Spillway capacity for pool elevation at top of dam (1175.0) has been estimated at 25,000 cfs by extending the curve calculated by the designer. The extended curve has been given a reversal of curvature because of the expected submergence of the weir due to the limited capacity of the side channel and the possible effect of the bridge over the side channel. Using the straight weir formula with a coef. of 4.1 the Q would be 29,000 cfs

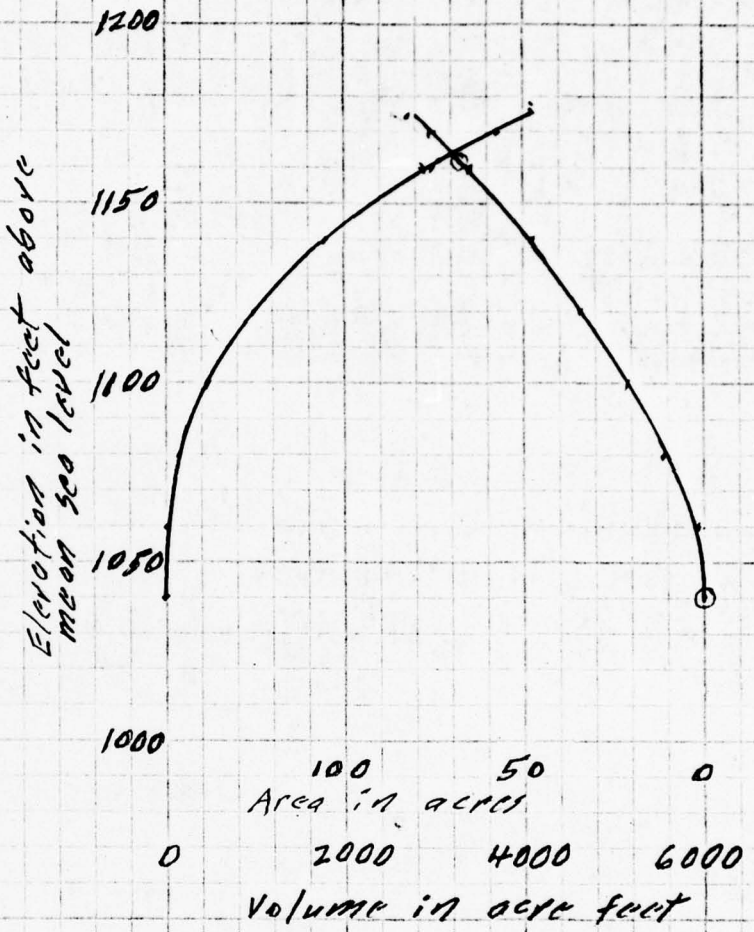
Use 25,000 cfs

PROJECT [illegible] SHEET NO. [illegible]

SUBJECT Laurel Creek Dam ID # 578

COMPUTED BY RES DATE 6-2-78 CHECKED BY JJPJr 6-7-78

Reservoir Area and Capacity.



Elev. (ft)	Area (acres)	Av. Area (acres)	Vol. (acre-ft)	Total Vol. (acre-ft)
1040	0	1.5	30	0
1060	3	6.5	130	30
1080	10	15.5	310	160
1100	21	27.0	540	470
1120	33	41.0	820	1010
1140	49	57.5	1150	1830
1160	66	66.6	67	2980
1161	67.2	71.1	640	3047
1170	75	77.5	388	3687
1175	80			4075

SUBJECT Laurel Creek Dam ID # 378

COMPUTED BY RES DATE 6-6-78 CHECKED BY JJP Jr 6-7-78

Overtopping Potential

Drainage Area = 12.8 sq. mi.

PMF = 2,200 cfs per sq. mi.

= 28,200 cfs.

Time = 30 hours.

From relation curves furnished by Balt. Dist., Corps of Engineers,

PMF = 33,800 cfs.

Time = 16 hours

From PMF hydrograph prepared by Pa. Dept. of Forests and Waters in 1967.

Use PMF = 31,000 cfs.

T = 23 hours

$$\frac{\text{Max. Spillway Q}}{\text{Peak inflow}} = \frac{25,000}{31,000} = 0.81$$

$$\frac{\text{Req. Resv. Storage}}{\text{Vol. of Inflow Hyd.}} = 0.19$$

$$\text{Vol of Inflow} = \frac{31,000 \times \frac{23}{24}}{2} = 14,900 \text{ cfs-days} = 29,600 \text{ acre-ft.}$$

$26''$ Runoff $= \frac{26}{12} \times 12.8 \times 640 = 17,700$ acre ft (use)

Req. Resv. storage $= 0.19 \times 17,700 = 3,400$ acre-feet.

From relations furnished by Baltimore Dist., Corps of Engineers.

Available storage $= 4,080 - 3,050 = 1,030$ ac. ft.

Since sufficient storage is not available, there is an indication that this dam would be overtopped by a PMF.

Since the spillway can pass $\frac{25,000}{31,000} = 81\%$ of the PMF it is not considered to be seriously inadequate.

APPENDIX C

GEOLOGIC REPORT

GEOLOGIC REPORT

Bedrock - Dam

Formation Names: Tuscarora Formation, Juniata Formation, Ref.(1).

Lithology: The Tuscarora Formation consists of mostly light gray, quartz sandstone, cemented with quartz, with some interbeds of darker gray less pure sandstone having a higher clay content. The upper most beds of the Juniata Formation, which underlie the downstream toe of the dam only, are grayish red sandstone with silty shale interbeds. The contact between the two formations is gradational at the dam site, that is, there is interbedding of the lithologies characteristic of each unit over a distance of more than 100 feet, beginning 50 feet south of the crest of the dam, Ref. (2).

Bedrock - Reservoir

Formation Names: Juniata Formation, Tuscarora Formation, Rose Hill Formation, Ref. (1).

Lithology: *Juniata and Tuscarora Formations, see above.* The Coxes Valley portion of the reservoir is underlain by the Rose Hill Formation, which is dary gray silty shale, weathering to light gray and light olive gray, with some interbedded fine grained gray siltstone, Ref.(2).

Overburden

The valley side were covered with talus derived from the Tuscarora Formation. The original geologic report, Ref. (4), estimated that fresh bedrock would be below 25 feet.

Structure

The Laurel Creek Dam is located on the north limb of the Kishacoquillas anticlinorium. Here the beds have been thrown into an unusually tight series of folds, complicated by some faulting. At this dam the beds strike N60°E. The dip is vertical to steep SE, overturned. The overall steep dip is interrupted locally by small folds (a few tens of feet across), and minor faulting. The faults are parallel to, or make slight angles to, the strike of the bedding. No cross faulting has been reported here. Ref. (1) and (2). The

dam is located in a gap through Spruce Mountain. This is one of several similar gaps seen on the topographic map and air photos which all have N30° to 35°W orientation. This is probably a minor fracture system along which stream erosion was possible in otherwise very resistant rocks.

Aquifer Characteristics

The Tuscarora and Juniata Formations are composed of essentially impermeable rocks. Ground water movement is almost entirely on bedding planes and fractures. The rocks are insoluble and ground water movement causes little or no change in the rocks.

Discussion

Young, Ref. (3) notes that "the fact that the bedrock bedding planes are nearly vertical and the strike of the rock is nearly parallel to the axis of the dam makes each layer of bedrock (with the exception of some fractures, of course) a potential 'watertight curtain'". He also states that the engineers were surprised how little grout was required. This suggests that the fractures paralleling the original stream course are tight, and that any leakage on them would be minor. As noted above, there is little possibility that ground water leakage would alter or weaken the bedrock.

Sources of Information

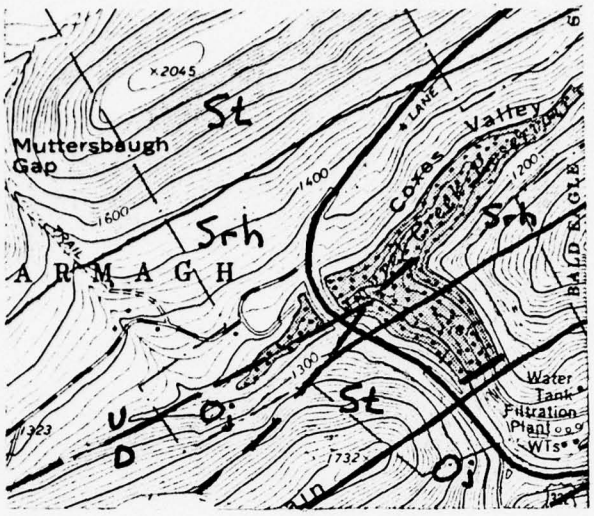
1). Manuscript Geologic Map, Open File, Pa. Geological Survey, Harrisburg, Pa.

2). R. T. Faill, R. B. Wells and others, "Structure and Silurian Stratigraphy of the Valley and Ridge Province in Central Pennsylvania". Guidebook, 38th Annual Field Conference of Pennsylvania Geologists, 1973.

3). K. A. Young, "Lewistown Laurel Creek Dam - Geologic Features related to construction".

4). Lattman, Laurence, File copy of Geologic Report on proposed dam site, Laurel Creek.

GEOLOGIC MAP - Laurel Creek Dam



(geology from: Manuscript Geologic Map, open file;
Barrville Quadrangle;
Pa. Geologic Survey, Harrisburg)

KEY

Srh	Rose Hill Fm.
St	Tuscarora Fm.
Oj	Juniata Fm.
Obe	Bald Eagle Fm.
— — U/D	fault
———	formation contact

SCALE 1:24 000

1 0 1 MILE

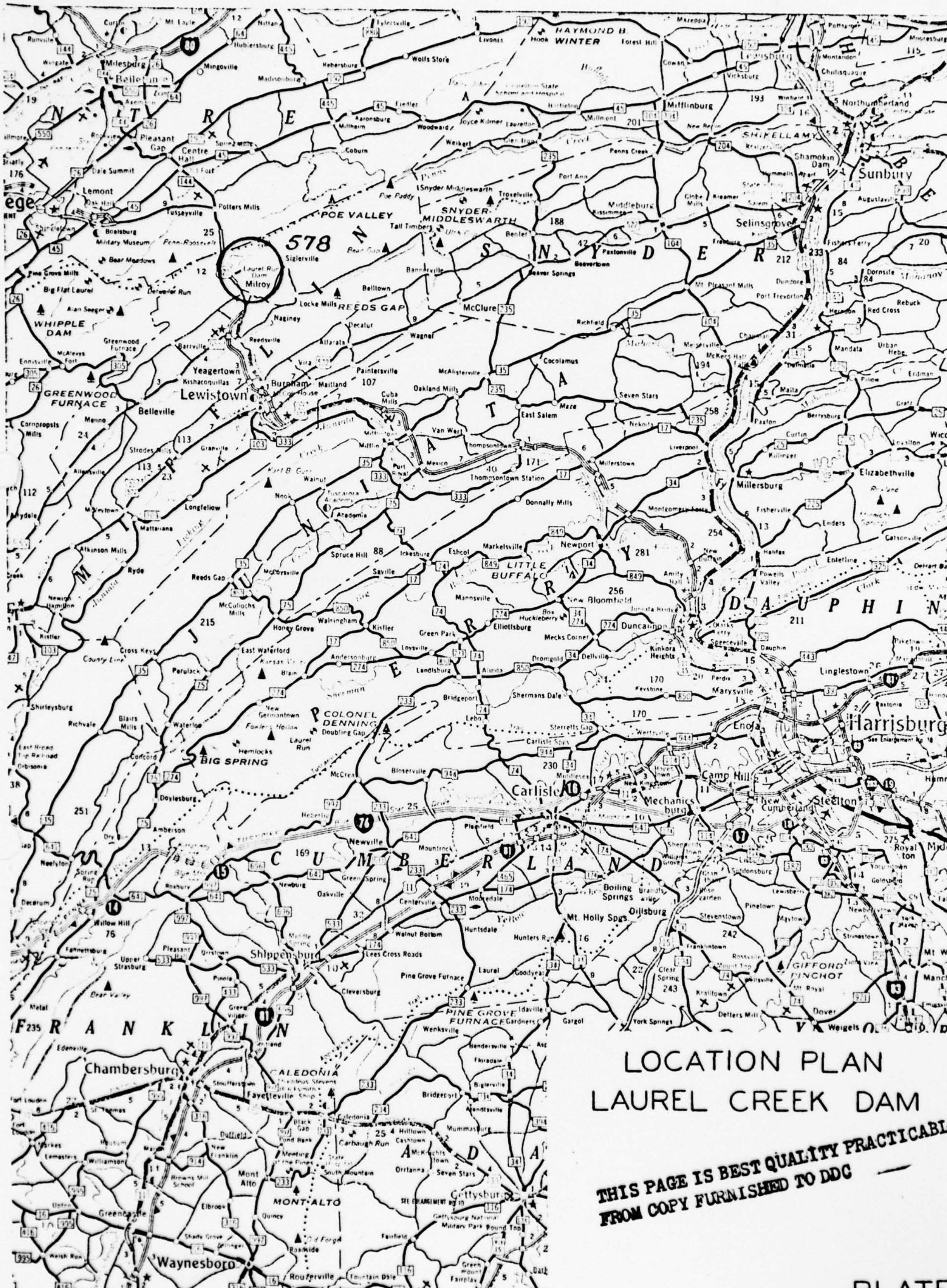
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

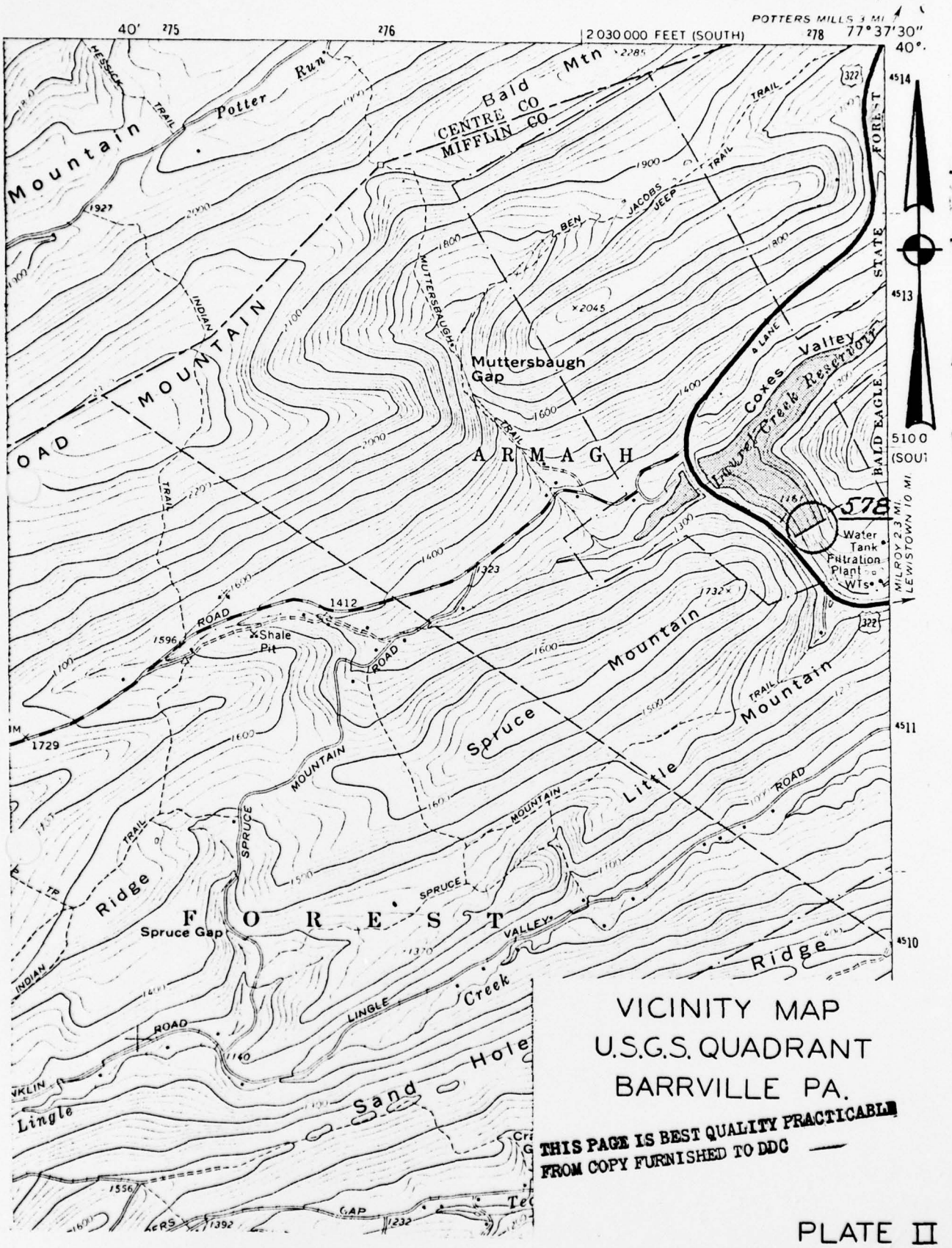
APPENDIX D

LOCATION, PHOTOGRAPHS & DESIGN DRAWINGS



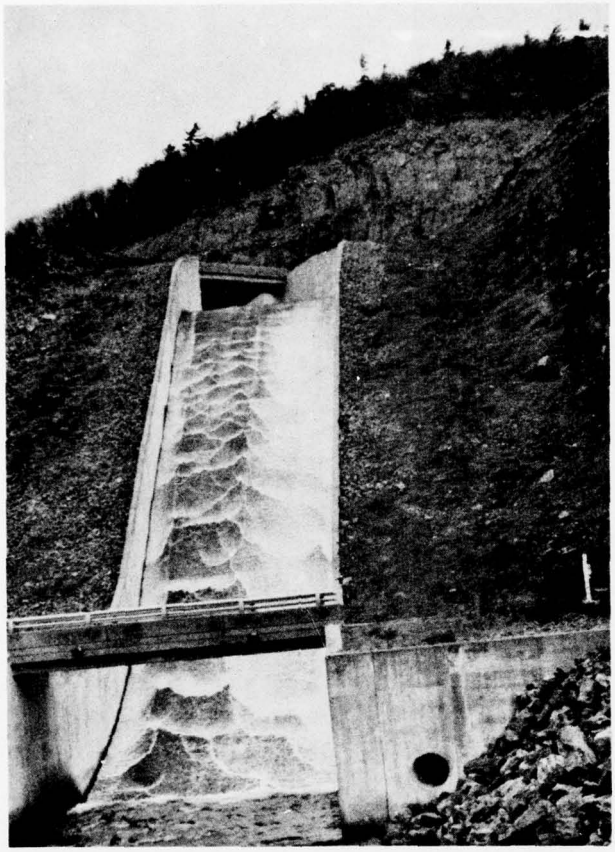
LOCATION PLAN
LAUREL CREEK DAM

PLATE I

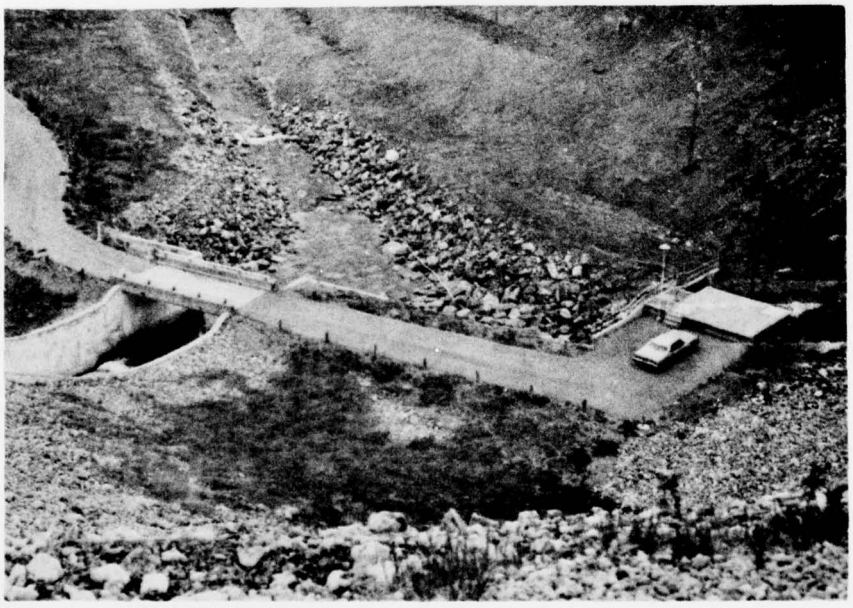


VICINITY MAP
U.S.G.S. QUADRANT
BARRVILLE PA.

PLATE II

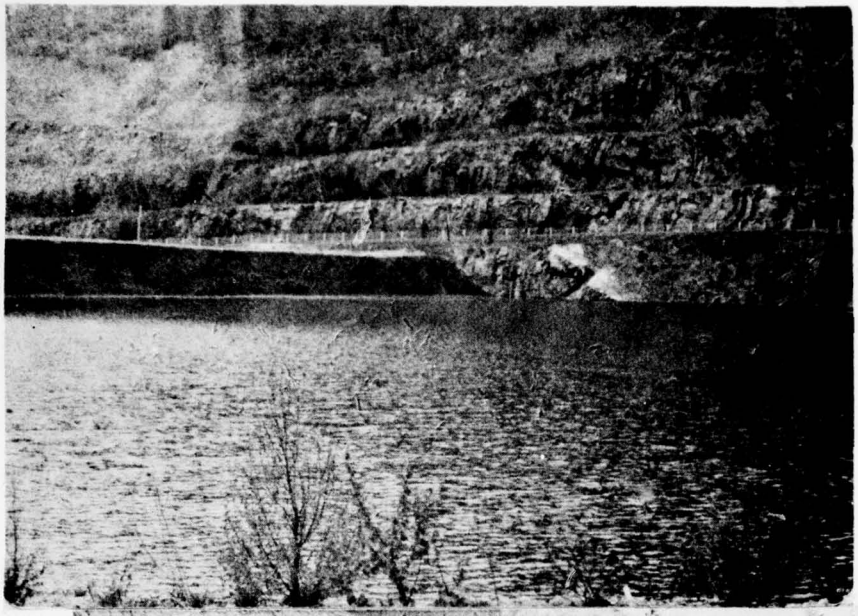


Spillway

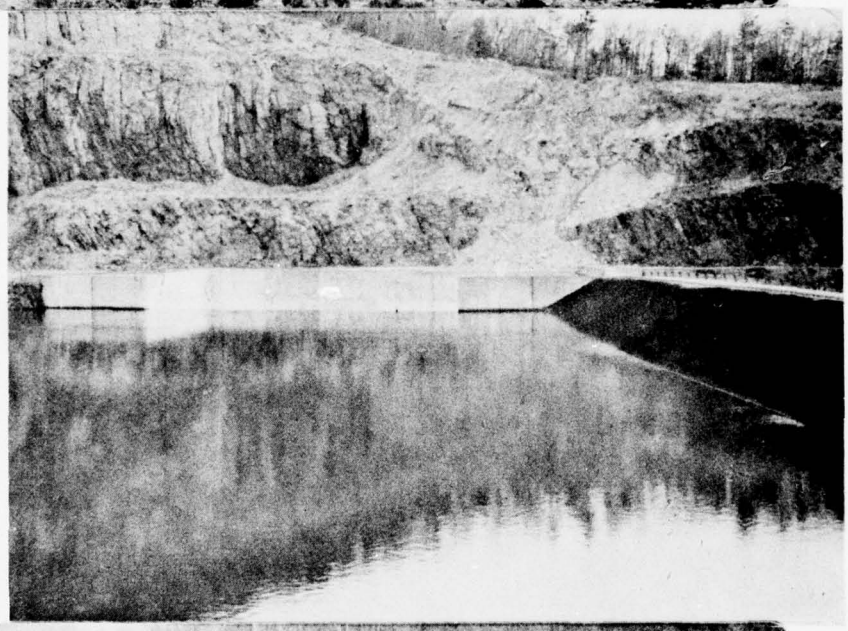


Downstream
Channel

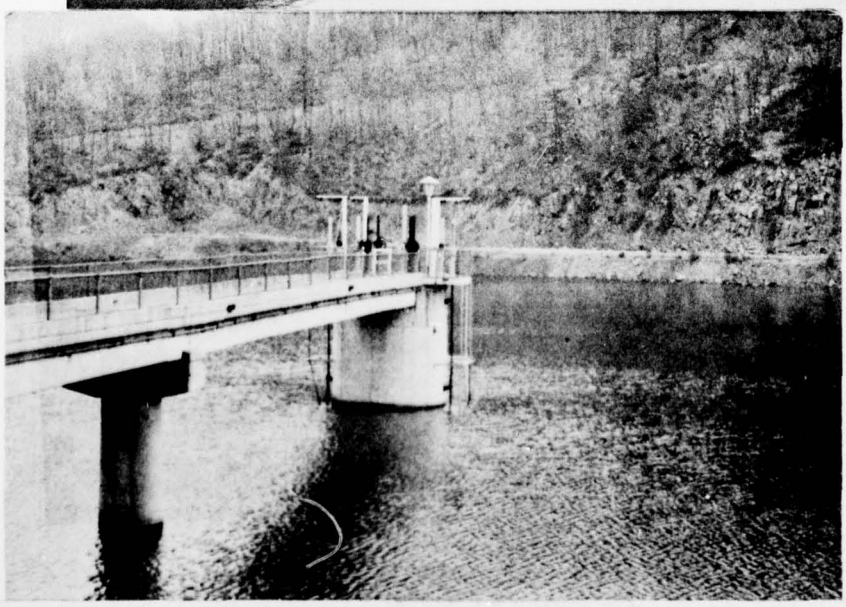
PLATE III



Upstream Slope
Right Abutment

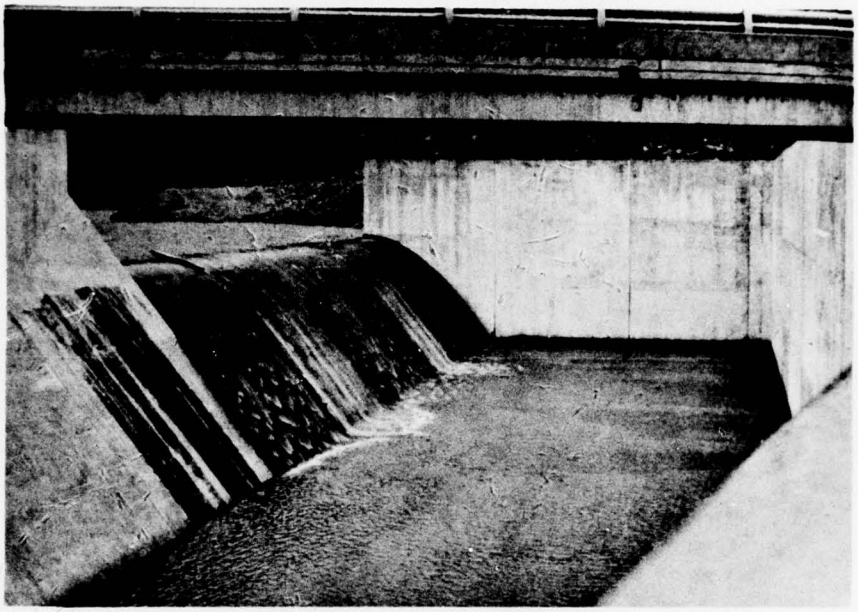


Upstream
Left Abutment

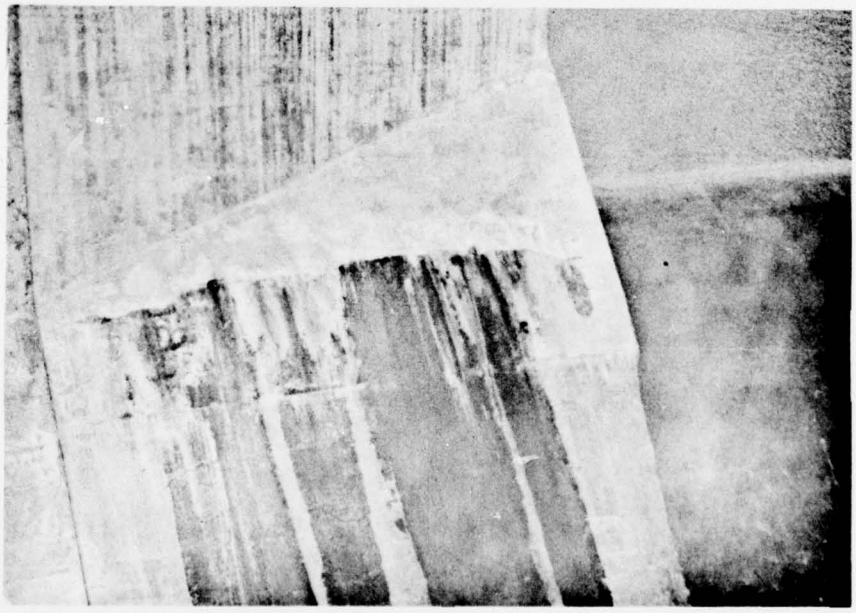


Control Tower

PLATE IV

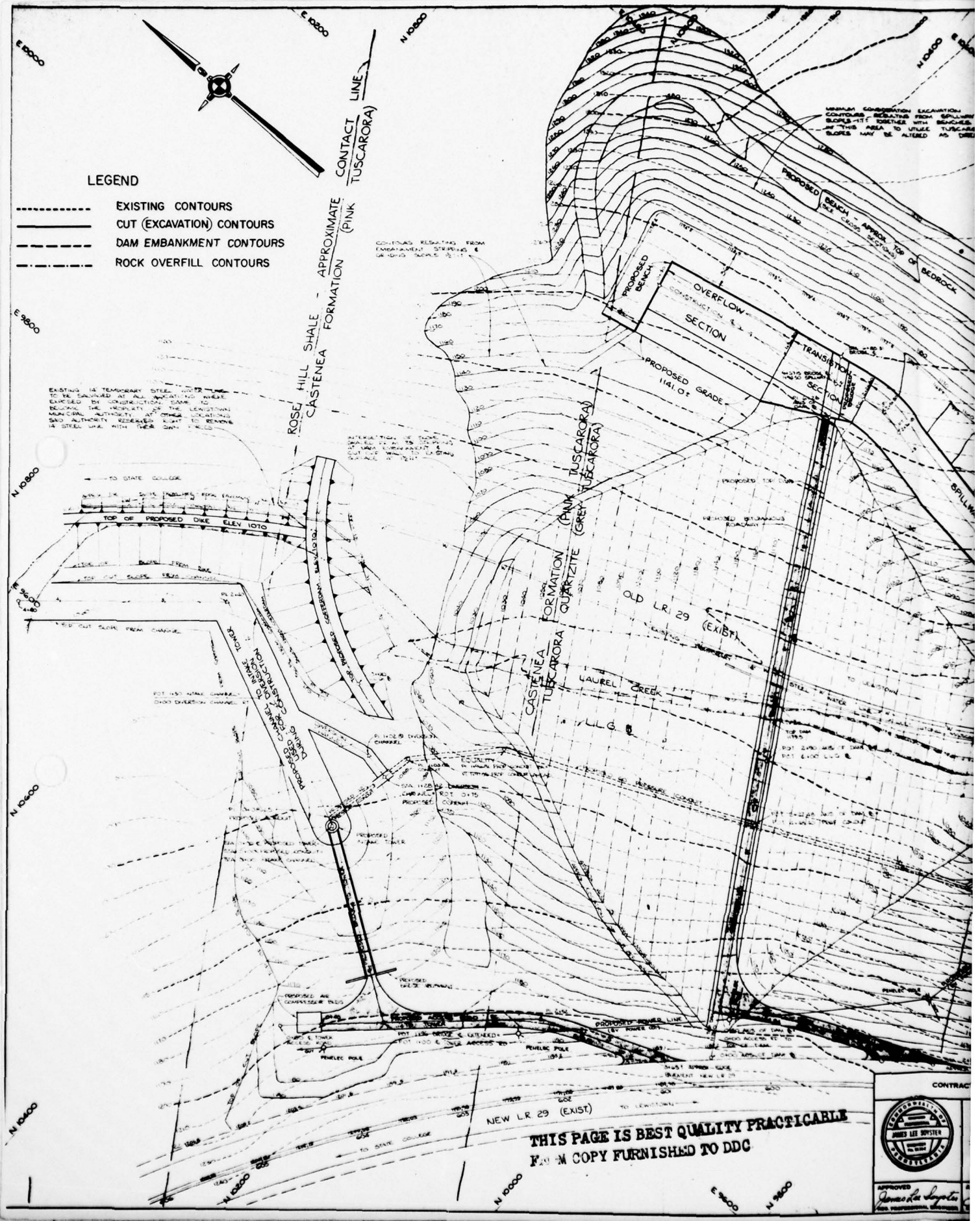


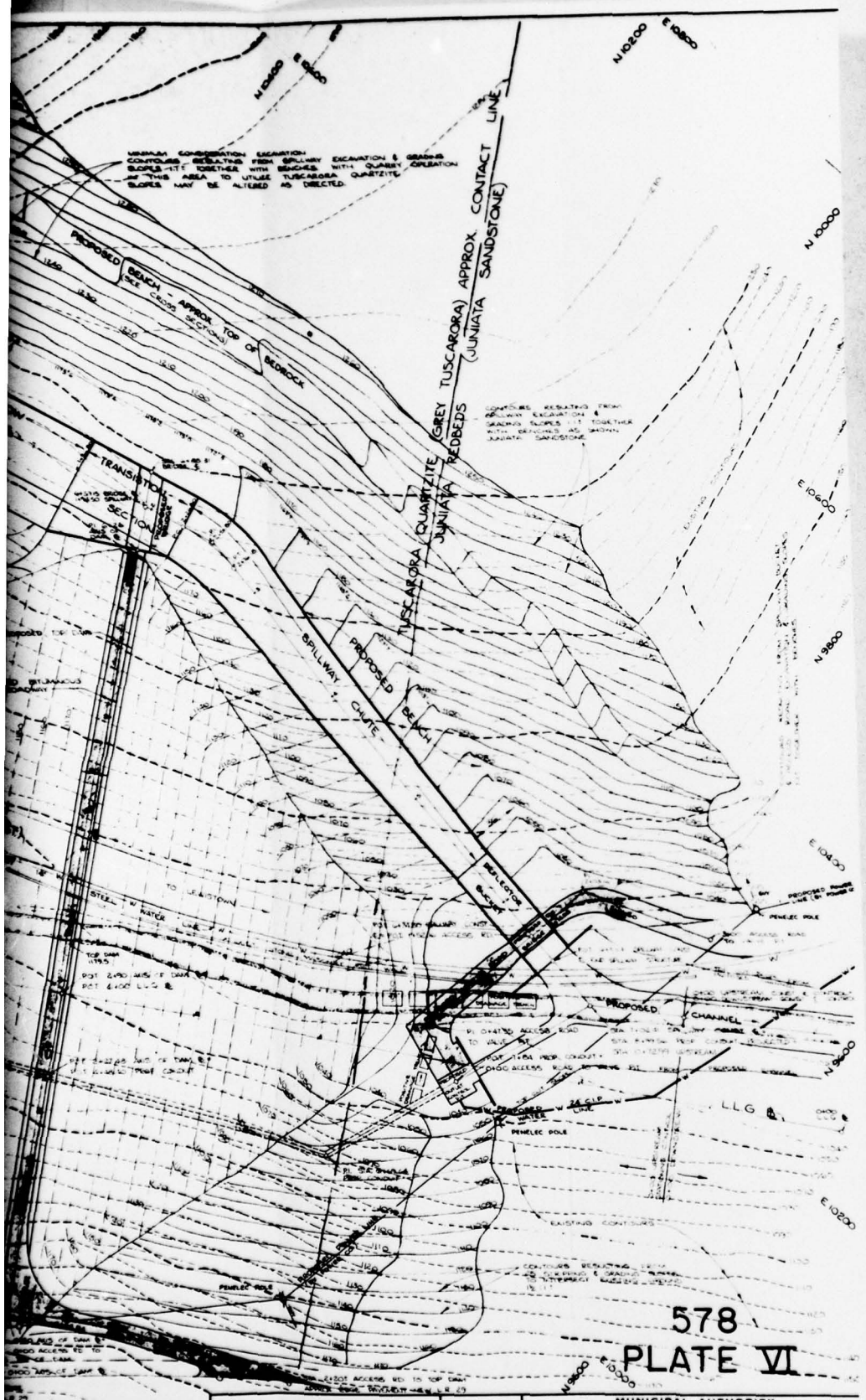
Spillway
Weir



Cracked Wall
At Spillway

PLATE V





578

PLATE VI

CONTRACT NO.	REVISIONS

MUNICIPAL AUTHORITY OF THE BOROUGH OF LEWISTOWN

WATER SYSTEM IMPROVEMENTS

LAUREL CREEK DAM & RESERVOIR

SITE PLAN AT PROPOSED DAM EMBANKMENT & GENERAL VICINITY 2

DRAWN BY		LEWIS L. GWIN CONSULTING ENGINEERS ALTOONA, PENNSYLVANIA	DATE OF ISSUE 5-
TRACED BY			SCALE 1"=40'
CHECKED BY			SHEET NO. 5

APPROVED James Lee Snyder REG. PROFESSIONAL ENGINEER

APPROVED Lewis L. Gwin REG. PROFESSIONAL ENGINEER

TY PRACTICABLE
DDC

NOTE: IF GROUTING REQUIREMENTS REFLECT THE NEED FOR GROUT PIPES LARGER THAN 3½ DIA., THE CONTRACTOR MAY ELECT TO PLACE THE LARGER DIAMETER PIPE THROUGH CUT-OFF WALL.

SEE SECTION XIX - ASPHALTIC CONCRETE DECK OF THE DETAILED TECHNICAL PROVISIONS OF THE SPECIFICATIONS FOR PREPARATION OF BASE FOR A.C. DECK - COMPACTION, FILLING SURFACE VOIDS, HOT ASPHALT PENETRATION WITH AGGREGATE APPLICATION AND CONSOLIDATION FOR OPEN TEXTURED BASE COURSE FOR A.C. DECK.

NOTE: CONTRACTOR SHALL EXER... CARE AT ALL TIMES TO ... SUPPORT FOR ASPHALT ... PLANKING SHALL BE USE... NECESSARY PRECAUTIONS ... PLACEMENT OF ASPHALT ... AS DIRECTED BY THE ...

ASPHALT CONC DECK

1.0

1.75

THICKNESS VARIES - SEE APPROPRIATE PLANS.

PROVIDE AND PROPERLY PLACE HOT POURED ASPHALT JOINT MATERIAL AS DIRECTED BY THE ENGINEER

THIS SURFACE OF CONCRETE SHALL BE THOROUGHLY CLEANED AND SPECIALLY TREATED PRIOR TO PLACEMENT OF ASPHALT CONCRETE DECK

RESERVOIR

POUR CONCRETE AGAINST ROCKFILL EMBANKMENT

ROCKFILL EMBANKMENT

BEDROCK

NEAT LINES TO BE MAINTAINED

TYPICAL SECTION

CUT-OFF WALL AND SPILLWAY ASPHALT CONC. DECK

SCALE: 1/2" = 1'-0"

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ZONE 1

MAIN EMBANKMENT

TYPICAL SECTION

ROCKFILL DAM EMBANKMENT

NO. 5816

CONTRACT NO.

NOTE: CONTRACTOR SHALL EXERCISE EXTREME CARE AT ALL TIMES TO PROTECT CONC SUPPORT FOR ASPHALT CONC. DECK - WOODEN PLANKING SHALL BE USED AND ALL OTHER NECESSARY PRECAUTIONS TAKEN DURING PLACEMENT OF ASPHALT CONCRETE DECK AS DIRECTED BY THE ENGINEER

2½ BITUMINOUS SURFACE COURSE (COMPACTED) PEN. ID-2 PLACED AND COMPACTED IN ACCORDANCE WITH PENNA DEPT OF HIGHWAYS FORM 408 AS AMENDED

PROVIDE CONTINUOUS GUARD FENCE FROM ACCESS ROAD TO BRIDGE ACROSS TRANSITION SECTION OF SPILLWAY. SEE DETAILS OF GUARD FENCE.

PROVIDE AND PROPERLY PLACE HOT POURED ASPHALT JOINT MATERIAL AS DIRECTED BY THE ENGINEER

THIS SURFACE OF CONCRETE SHALL BE THOROUGHLY CLEANED AND SPECIALLY TREATED PRIOR TO PLACEMENT OF ASPHALT CONCRETE DECK

RESERVOIR

POUR CONCRETE AGAINST ROCKFILL EMBANKMENT

10.0

10.0

2.0 1.0 1.0 6.0

6.0 1.0 1.0 2.0

3-⅝" WIRE CABLES

3-⅝" WIRE CABLES

2½

2

PROVIDE REINFORCED CONCRETE SUPPORT FOR ASPHALT CONCRETE DECK. PROVIDE CONST. JOINTS 3' O/C AT EACH CONST. JOINT PROPERLY PLACE HOT POURED ASPHALT JOINT MATERIAL AS DIRECTED BY THE ENGINEER

PROVIDE FIVE (5) #5 REINFORCING BARS EFFECTIVELY CONTINUOUS FROM DAM APUTMENT TO DAM ABUTMENT (MIN. LAP 30 DIA.

PROVIDE FOR #4 STONE TO DEPTH AS DIRECTED AND SPREAD PLACE IN TWO LIFTS WITH EACH LIFT COMPACTED WITH 10 TON ROLLER MIN. 4 PASSES

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NOTE: USE SAME SECTIONAL REQUIRE DAM EMBANKMENT FOR PONDAGE STRIPPING SURFACE PREPARED ROCK OVERFILL ETC.

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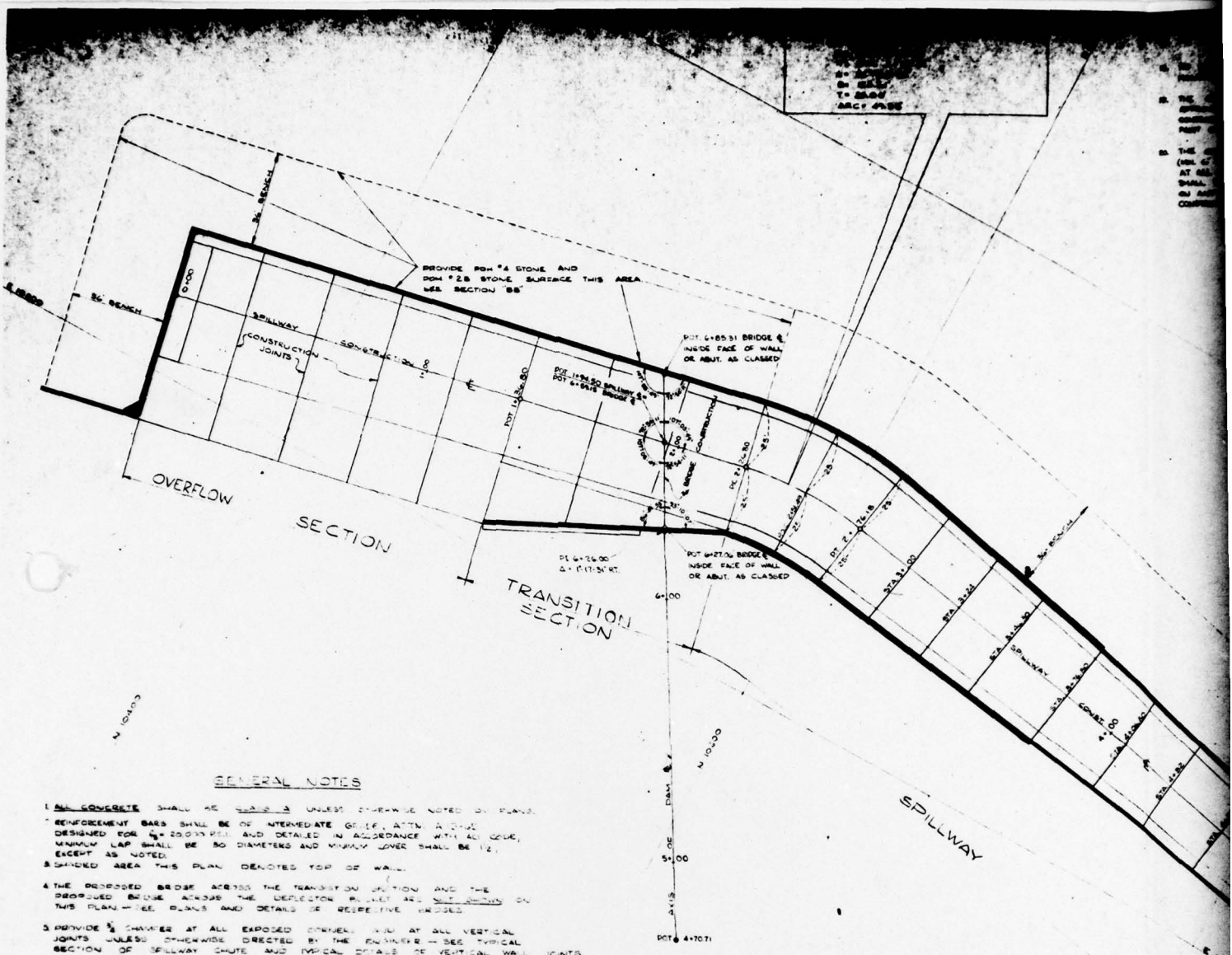
PLATE VII

CONTRACT NO.	REVISIONS	MUNICIPAL AUTHORITY OF THE BOROUGH OF LEWISTOWN
		WATER SYSTEM IMPROVEMENTS
		LAUREL CREEK DAM & RESERVOIR
		TYPICAL SECTION ROCKFILL DAM EMBANKMENT AND RELATED DETAILS



GENERAL NOTES

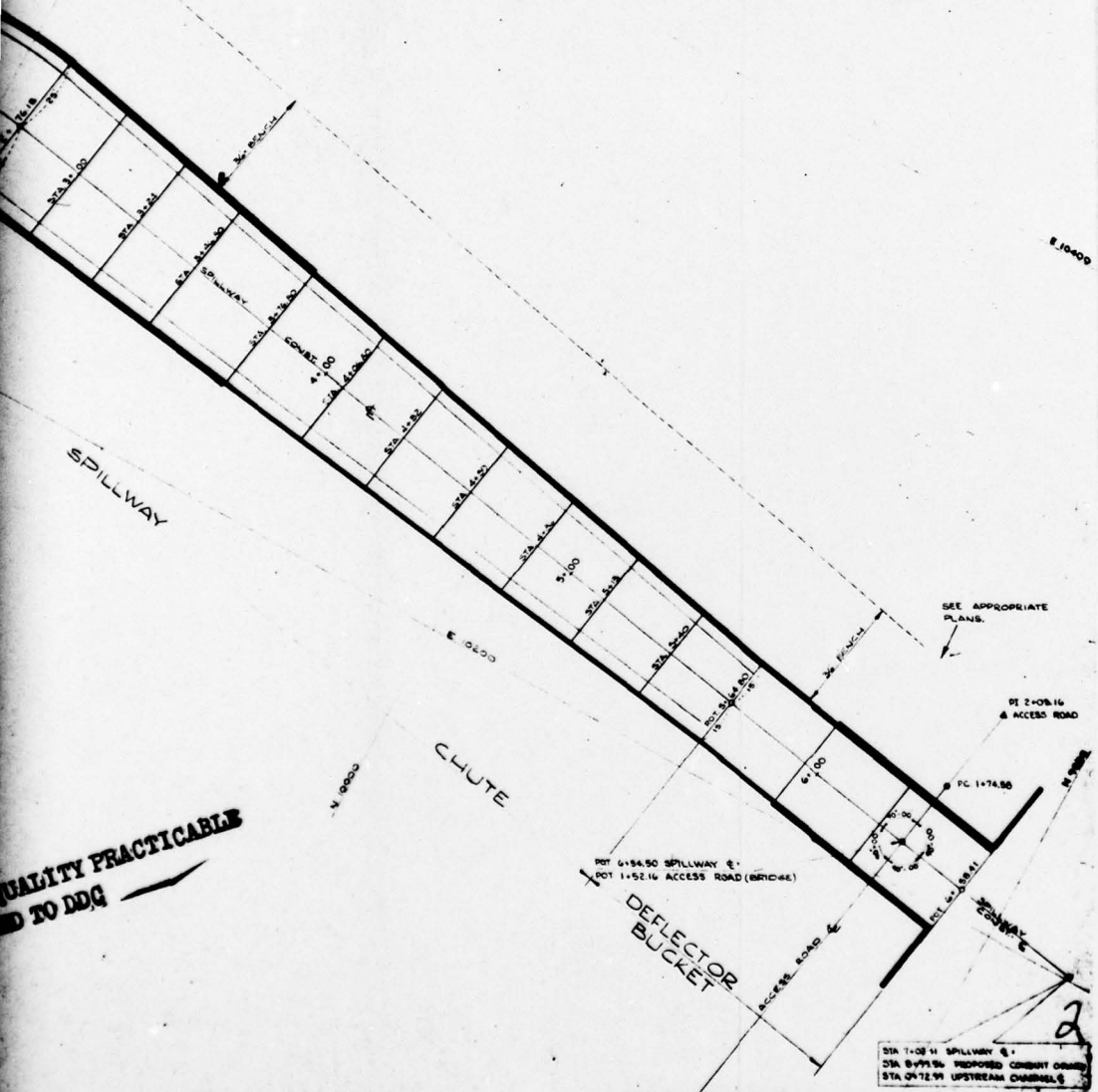
1. ALL CONCRETE SHALL BE CLASS A UNLESS OTHERWISE NOTED ON PLANS.
2. REINFORCEMENT BARS SHALL BE OF INTERMEDIATE GRADE, ASTM A 305 DESIGNED FOR f_s = 20,000 PSI AND DETAILED IN ACCORDANCE WITH ACI CODE, MINIMUM LAP SHALL BE 30 DIAMETERS AND MINIMUM COVER SHALL BE 12" EXCEPT AS NOTED.
3. SHADED AREA THIS PLAN DENOTES TOP OF WALL
4. THE PROPOSED BRIDGE ACROSS THE TRANSITION SECTION AND THE PROPOSED BRIDGE ACROSS THE DEFLECTOR BUCKET ARE NOT SHOWN ON THIS PLAN — SEE PLANS AND DETAILS OF RESPECTIVE BRIDGES
5. PROVIDE ¾" CHAMFER AT ALL EXPOSED CORNERS AND AT ALL VERTICAL JOINTS UNLESS OTHERWISE DIRECTED BY THE ENGINEER — SEE TYPICAL SECTION OF SPILLWAY CHUTE AND TYPICAL DETAILS OF VERTICAL WALL JOINTS.
6. PROVIDE PCM #4 STONE AND PCM #28 STONE SURFACE ON 36' BENCH AROUND OVERFLOW SECTION AND TRANSITION SECTION — SEE SECTION 'BB'
7. PROVIDE EFFECTIVELY CONTINUOUS RUBBER WATERSTOPS IN (WALLS, FOOTERS, OGEE SECTION, AND CHANNEL) OF OVERFLOW SECTION AND TRANSITION SECTION — SEE APPROPRIATE PLANS AND DETAILS.
8. PROVIDE RUBBER WATERSTOPS IN DEFLECTOR BUCKET AT TRANSVERSE CONST. JOINT STA 6+24.50 AND WING WALLS — SEE APPROPRIATE PLANS AND DETAILS.
9. PROVIDE AN EFFECTIVELY CONTINUOUS UNDERDRAIN SYSTEM UNDER OVERFLOW SECTION AND TRANSITION SECTION AND SPILLWAY CHUTE — SEE APPROPRIATE PLANS AND DETAILS.
10. ALL SPILLWAY UNDERDRAINS SHALL BE 6" EXTRA STRENGTH FIBERMITE CLAY TILE ACCEPTED TO ASTM SPECIFICATION C-211-61T (CLASS II PIPE) AS AMMENDED.
11. PROVIDE 4" WROUGHT IRON PIPE (STANDARD WALL) DRAINS AND WEEP HOLES IN DEFLECTOR BUCKET — SEE APPROPRIATE PLANS AND DETAILS.
12. AT ALL VERTICAL CONSTRUCTION JOINTS (WALLS, FOOTERS, OGEE AND CHANNEL) PROVIDE A PREMOULDED MASTIC JOINT MATERIAL OVER ENTIRE JOINT, UNLESS OTHERWISE NOTED ON THE PLANS — SEE APPROPRIATE DETAILS.
13. PROVIDE BUSTICATION AT ALL TRANSVERSE JOINTS IN CONCRETE CHANNEL — SEE BUSTICATION DETAIL.
14. ALL FORMS AND FORMWORK SHALL BE INSPECTED AND APPROVED BY THE ENGINEER PRIOR TO PLACEMENT OF CONCRETE; THIS SHALL NOT RELIEVE THE CONTRACTOR OF HIS RESPONSIBILITY TO PROVIDE ADEQUATE AND SAFE FORMWORK.
15. THE CONTRACTOR SHALL CONSTRUCT THE TYPE AND QUALITY OF FORMS THAT WILL PRODUCE A CONCRETE STRUCTURE:
    a. WITH FINISHED EXPOSED SURFACES OF TRUE ALIGNMENT AND GRADE, STRAIGHT OR CURVED AS DESIGNATED ON THE PLANS, PROFILES, SECTIONS AND DETAILS.
    b. WITH EXPOSED SURFACES FREE OF ROUGH PROTRUSIONS OR DEPRESSIONS OR ANY OTHER DEFECT.
16. THE CONTRACTOR SHALL PROVIDE TREMIES, ELEPHANT TRUNKS AND ALL ELSE NECESSARY TO PROPERLY PLACE THE CONCRETE. THE CONCRETE SHALL BE PROPERLY PLACED AND SHALL NOT BE DROPPED VERTICALLY MORE THAN 5 FT. THE CONCRETE SHALL NOT BE MOVED FROM PLACE TO PLACE BY MEANS OF MECHANICAL VIBRATORS.
17. THE CONTRACTOR SHALL PROVIDE A MINIMUM OF 2 MECHANICAL VIBRATORS PER EACH HOUR. THE CONCRETE SHALL BE VIBRATED PROPERLY TO CONSOLIDATE THE CONCRETE AND ELIMINATE [illegible] OPERATION OF THE MECHANICAL VIBRATORS SHALL BE DIRECTLY UNDER [illegible]

GENERAL NOTES CONTINUED

18. NO PLACING OF CONCRETE ON WALLS WILL BE PERMITTED, THEREFORE MONITORED MUST BE ELIMINATED.

19. THE CONTRACTOR SHALL PROVIDE AND PROPERLY PLACE ONE COAT OF APPROVED BITUMASTIC PAINT ON ALL BACKFILLED WALL SURFACES. THE CONTRACTOR SHALL EXERCISE EXTREME CARE NOT TO PLACE BITUMASTIC PAINT ON ANY EXPOSED CONCRETE SURFACE.

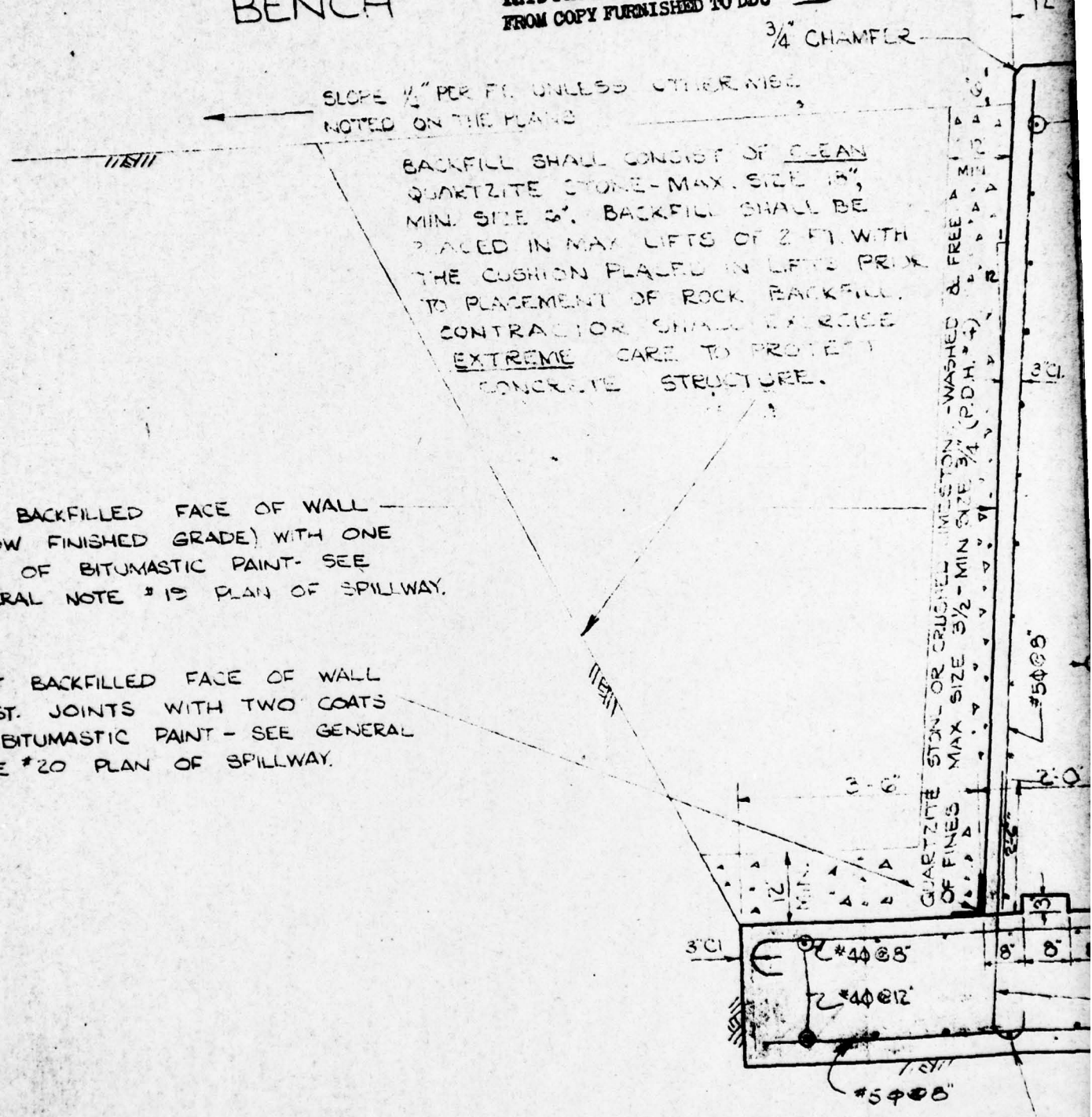
20. THE CONTRACTOR SHALL PROVIDE AND PROPERLY PLACE TWO COATS (MIN. 6" WIDE) OF APPROVED BITUMASTIC PAINT ON BACKFILLED FACE OF WALL AT ALL CONSTRUCTION JOINTS (HORIZONTAL & VERTICAL). THE CONTRACTOR SHALL EXERCISE EXTREME CARE NOT TO PLACE BITUMASTIC PAINT ON ANY EXPOSED CONCRETE SURFACE. - SEE TYPICAL DETAIL OF VERTICAL CONSTRUCTION JOINTS IN SPILLWAY WALLS.



CONTRACT NO.	REVISIONS	MUNICIPAL AUTHORITY OF THE BOROUGH OF LEWISTOWN
	12-1-67 GENERAL	WATER SYSTEM IMPROVEMENTS
		LAUREL CREEK DAM AND RESERVOIR
		PLAN OF SPILLWAY

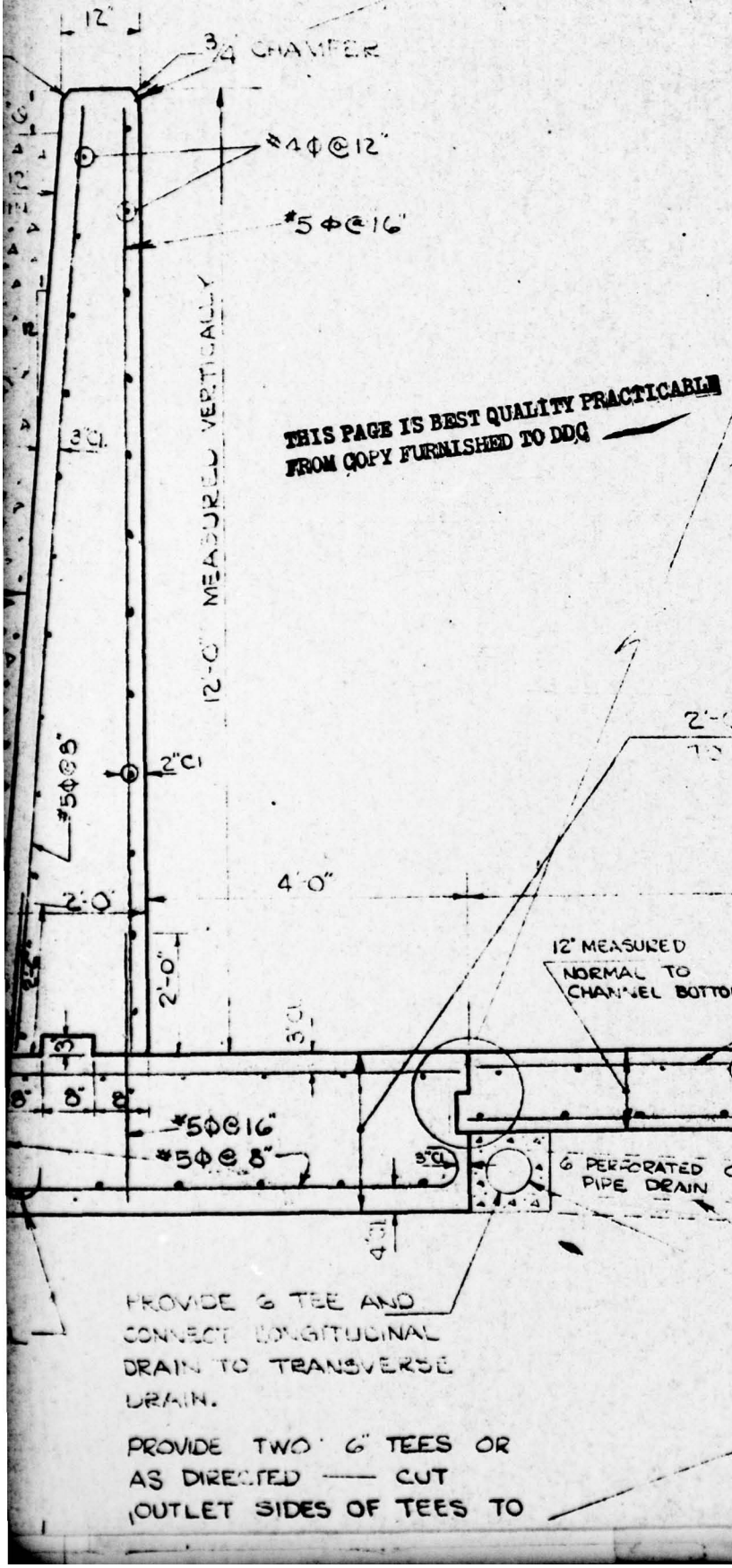
578 PLATE VIII

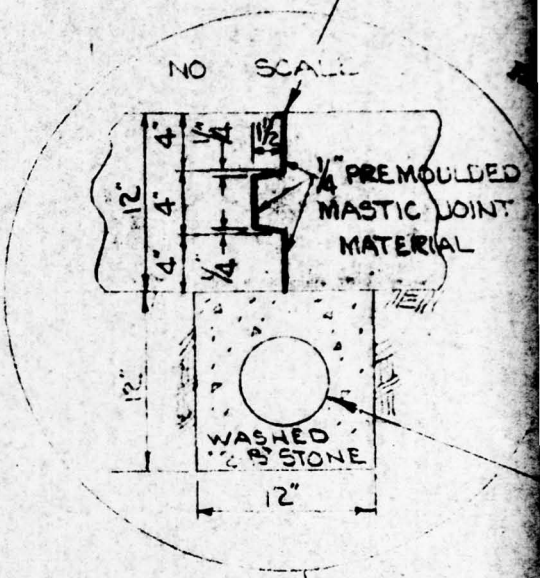
BENCH



(DIMENSIONS, REINFORCING STE
ARE BETWEEN STA. 4+06.
STA. 5+64.80 ONLY.

PROVIDE AND PROPE
APPROVED HOT PO
JOINT MATERIAL (

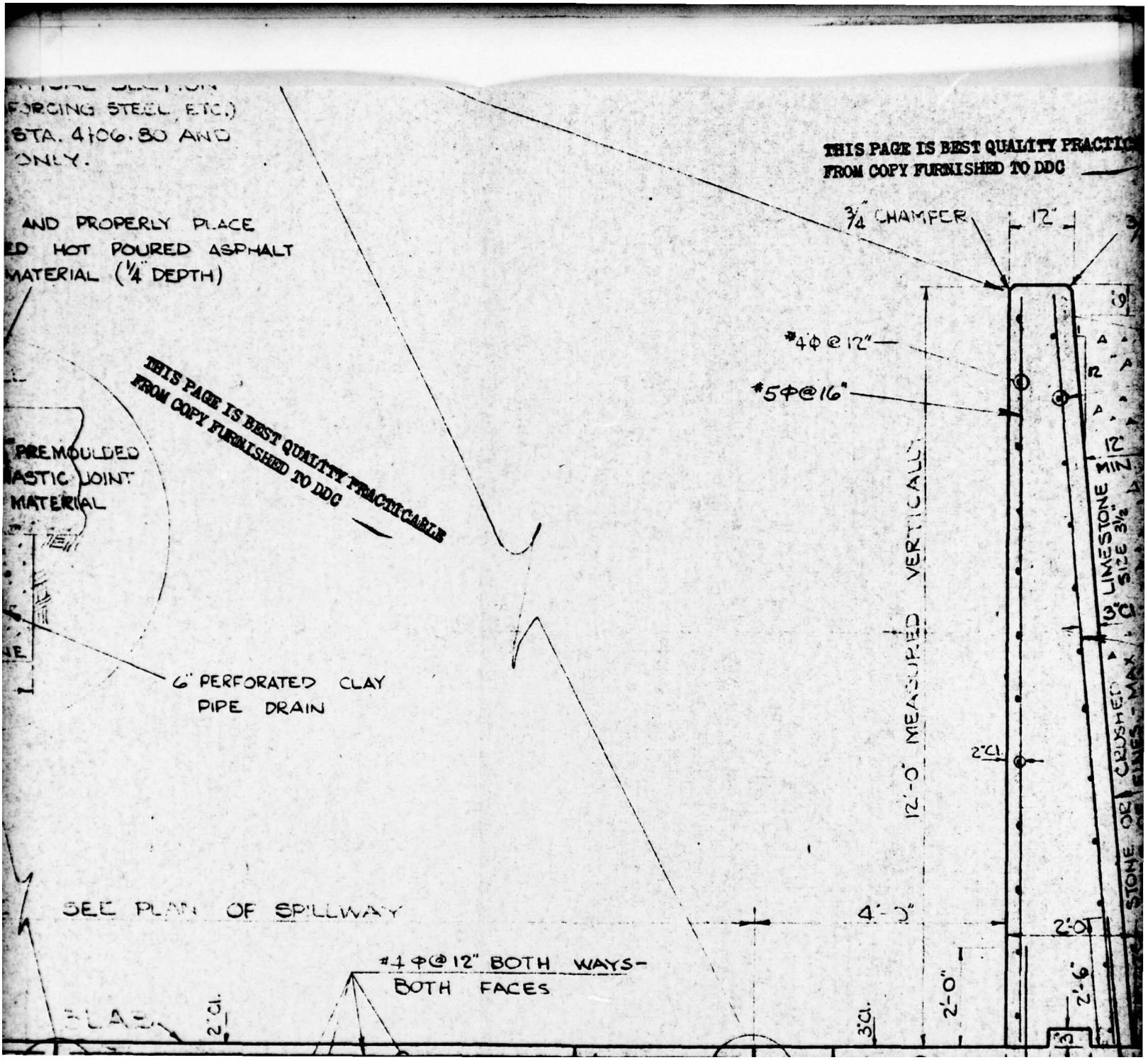




PROVIDE 6" TEE AND CONNECT LONGITUDINAL DRAIN TO TRANSVERSE DRAIN.

PROVIDE TWO 6" TEES OR AS DIRECTED — CUT OUTLET SIDES OF TEES TO

6" PERFORATED CLAY PIPE DRAIN LAID IN "WASHED" 2B (NO FINES).



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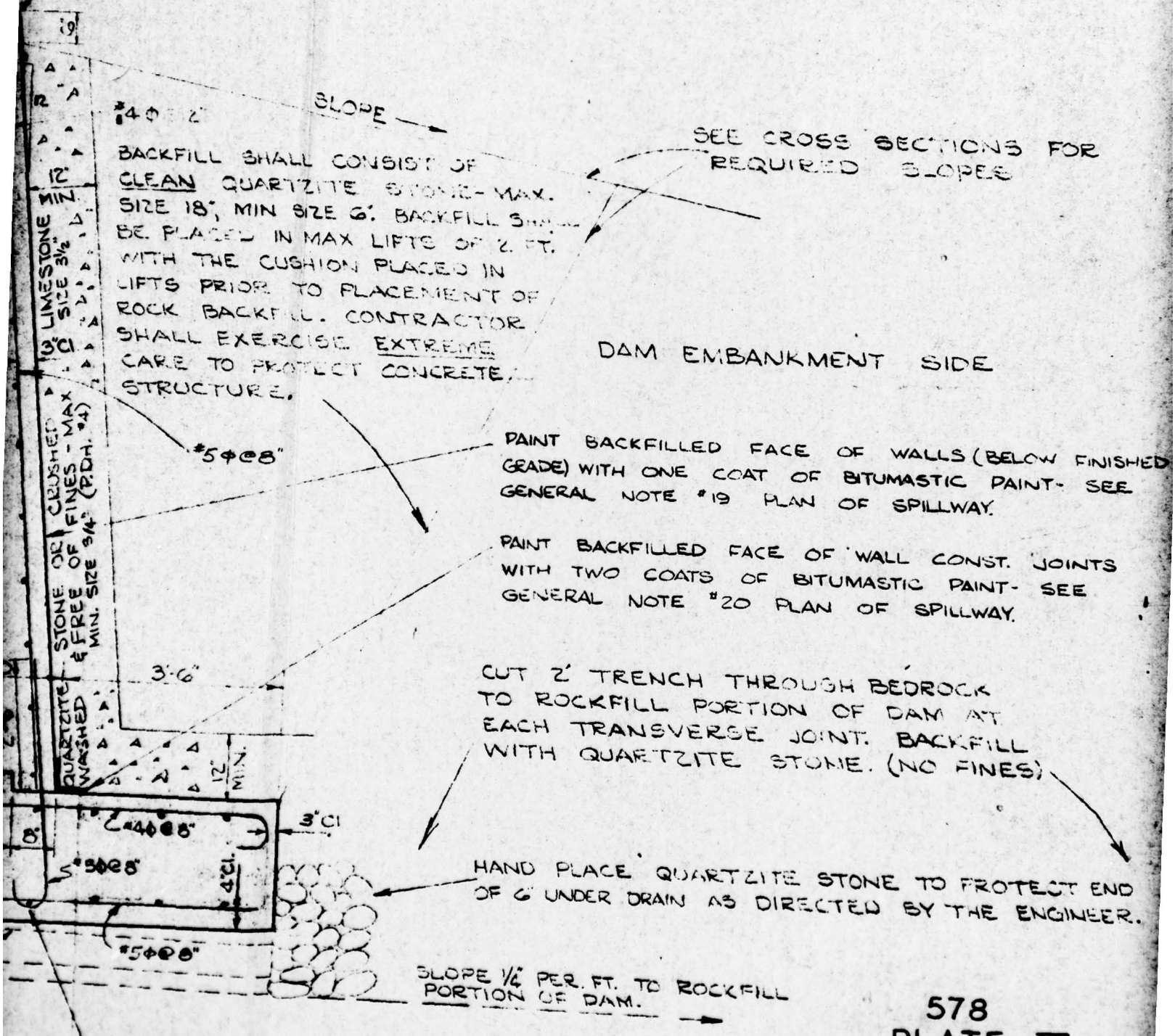

12" MIN LIMESTONE SIZE 3½" (P.D.H. #4) CRUSHED STONE OR QUARTZITE WASHED & FREE OF FINES - MAX MIN. SIZE 3/4"

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PLATE IX

NOTE: PROVIDE MECHANICAL ANCHOR FOR VERTICAL #5Φ@8", VERTICAL #5Φ@8" SHALL BE FASTENED TO CONTINUOUS LONGITUDINAL #4Φ, CONTINUOUS LONGITUDINAL #4Φ SHALL BE FASTENED