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NATIONAL DAM SAFETY PROGRAM. RYERSON STATION STATE PARK DAM (ND--ETC(U)
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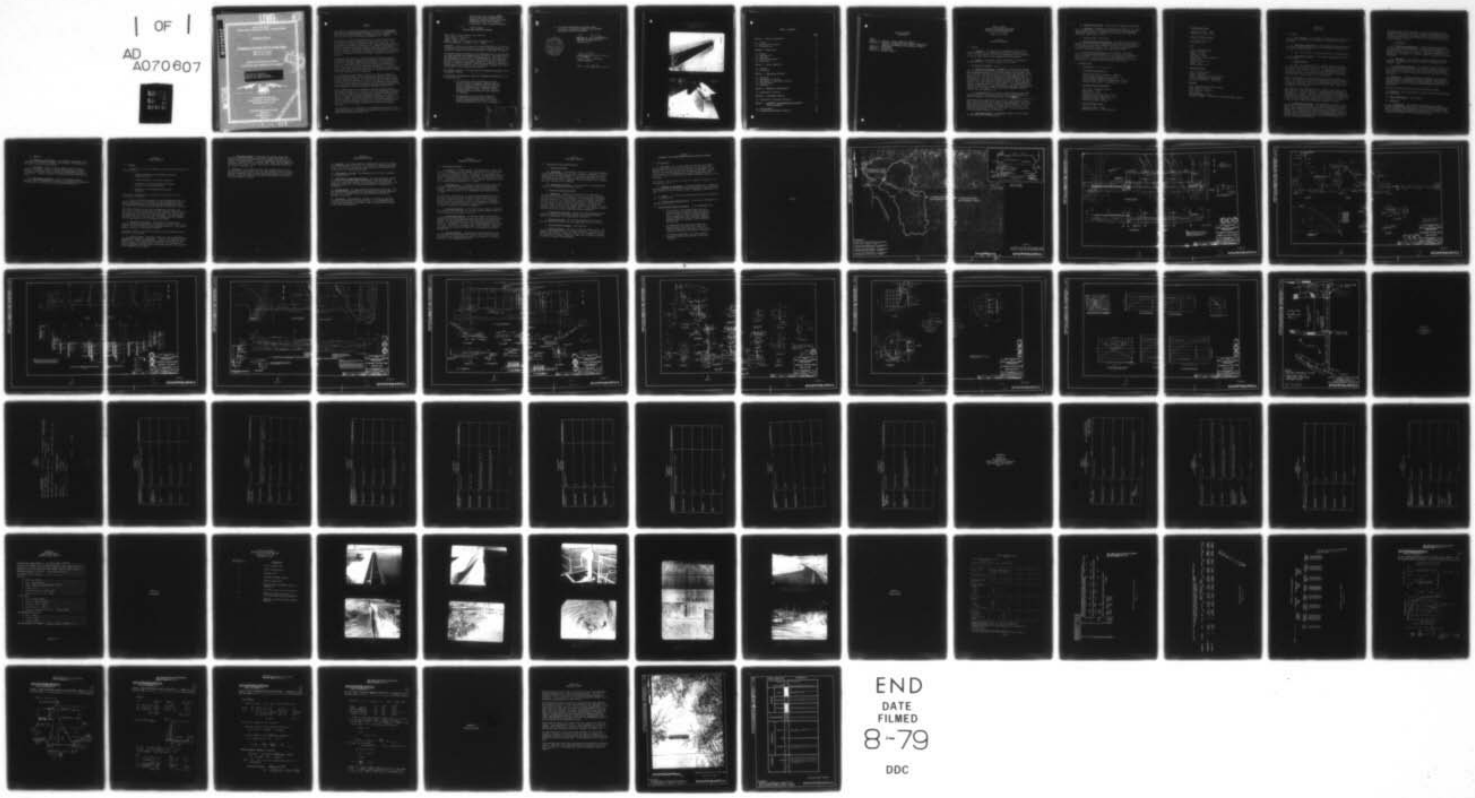

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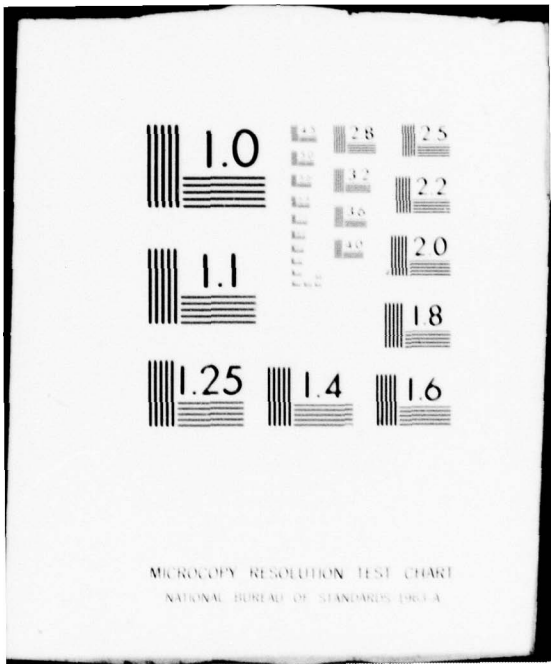
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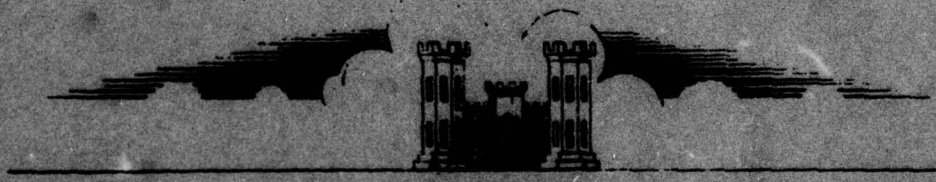
OHIO RIVER BASIN
NORTH FORK OF WHEELING CREEK , GREENE COUNTY

PENNSYLVANIA

RYERSON STATION STATE PARK DAM

NDI I.D. NO: PA-193
DER I.D. NO: 30-20

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM



PREPARED FOR

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS
BALTIMORE, MARYLAND 21203

BY

D'APPOLONIA CONSULTING ENGINEERS
10 DUFF ROAD
PITTSBURGH, PA. 15235

MARCH 1979

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Department of the Army, Office of Chief of Engineers, Washington, D.C. 20314.

The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon visual observations and review of available data. Detailed investigation and analyses involving topographic mapping, subsurface investigations, material testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the inspection is intended to identify any need for such studies which should be performed by the owner.

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

It is important to note that the condition of the dam depends on numerous and constantly changing internal and external factors which are evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

The assessment of the conditions and recommendations was made by the consulting engineer in accordance with generally and currently accepted engineering principles and practices.

PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

(11) Mar 79

(12) 74p.

NAME OF DAM: Ryerson Station State Park Dam
STATE LOCATED: Pennsylvania
COUNTY LOCATED: Greene
STREAM: North Fork of Dunkard Fork of Wheeling Creek
DATE OF INSPECTION: December 6 and 21, 1978

(10) Lawrence D. Anderson

ASSESSMENT: Based on the evaluation of the conditions as they existed on the dates of inspection and as revealed by visual observations, the condition of Ryerson Station State Park Dam is considered to be good.

A structural crack was observed on the downstream face of the dam near the right abutment and extending across the crest. Only minor seepage was associated with this crack, indicating that the crack does not extend through the whole section. This condition is not considered to be serious relative to the overall stability of the dam at this time. However, it should be regularly inspected and monitored to document if further structural distress occurs, and necessary remedial work should be performed if such conditions are observed.

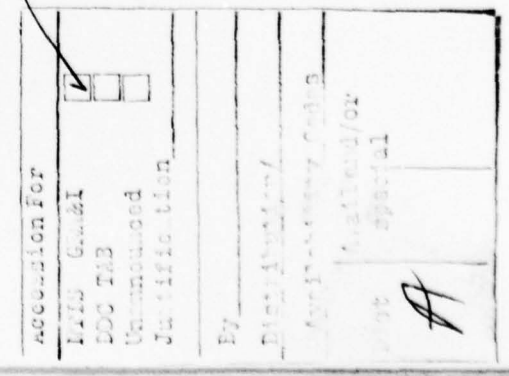
The spillway capacity is classifified to be adequate according to the recommended criteria.

(15) DACW31-79-C-0014

The following recommendations should be implemented immediately or on a continuing basis:

1. The structural crack observed near the right abutment should be regularly inspected and monitored for signs of further structural distress, such as displacements and increased quantity of seepage through the crack. Necessary remedial measures should be performed if such conditions are observed.

2. An around-the-clock surveillance should be provided during unusually heavy runoff and a formal warning system developed to alert the downstream residents in the event of emergencies.



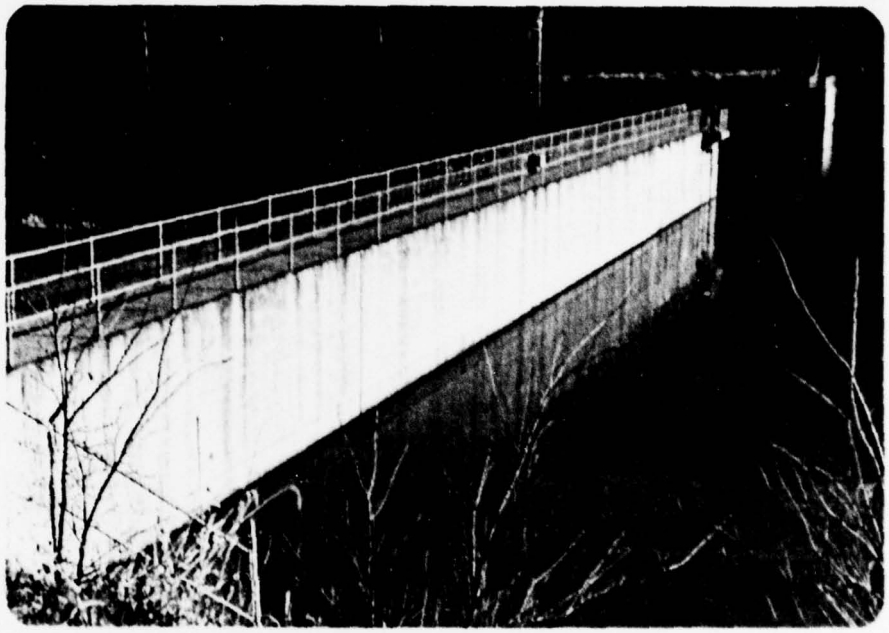
3. The dam and appurtenant structures should continue to be inspected regularly and necessary maintenance should be performed.

Lawrence D. Andersen

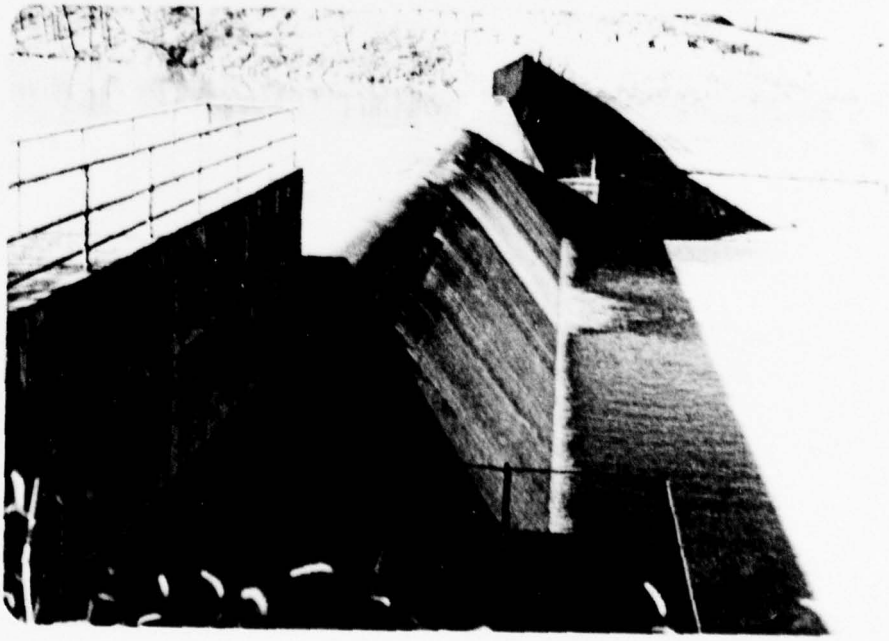
Lawrence D. Andersen, P.E.
Vice President

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

DATE: 22 Apr 79



Upstream Face



Downstream Face

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(CONTINUED)

PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM
RYERSON STATION STATE PARK DAM
NDI I.D. NO. PA-193
DER I.D. NO. 30-20

SECTION 1
PROJECT INFORMATION

1.1 General

a. Authority. The inspection was performed pursuant to the authority granted by The National Dam Inspection Act, Public Law 92-367, to the Secretary of the Army, through the Corps of Engineers, to conduct inspections of dams throughout the United States.

b. Purpose. The purpose of this inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project

ABSTRACT
Ryerson Station State Park Dam

a. Dam and Appurtenances. ~~The dam,~~ is a 515-foot-long concrete gravity structure. A 200-foot-long ogee section near the right abutment (looking downstream) is the combined primary and emergency spillway of the dam. The maximum height of the dam is about 30 feet for the spillway and 42 feet for the nonoverflow section measured from the downstream toe. The width of the dam varies from a minimum of 6 feet at the crest of the nonoverflow section to about 30 feet at the base of the dam. The outlet works for the dam consist of a 36-inch-diameter conduit through the dam left of the spillway. Flow through the outlet conduit is controlled by a manually operated sluice gate located at the upstream end. The outlet works constitute the emergency drawdown facility for the reservoir.

b. Location. The dam is located in Ryerson Station State Park approximately one mile upstream from the town of Ryerson Station in Richville Township, Greene County, Pennsylvania, ~~(Plate 1)~~.

ABSTRACT

Downstream from the dam, North Fork initially flows north and turns west, joining the South Fork of Dunkard Fork approximately 1-1/2 miles downstream from the dam near the town of Ryerson Station. There are eight houses and one commercial building within this reach. It is estimated that failure of the dam would cause the loss of many lives and large property damage in this reach.

c. Size Classification. Intermediate (based on 42-foot height and 3520 acre-feet storage capacity).

d. Hazard Classification. High (based on downstream conditions).

e. Ownership. Commonwealth of Pennsylvania (address: Mr. Samuel Reed, Director, Bureau of Operations, Office of Resource Management, Pennsylvania Department of Environmental Resources, P.O. Box 2063, Harrisburg, Pennsylvania 17120).

f. Purpose of Dam. Recreation.

g. Design and Construction History. The subsurface investigation for the dam was conducted by Berger Associates, Inc., of Harrisburg, Pennsylvania, and the dam was designed by Swindell-Dressler Corporation of Pittsburgh, Pennsylvania in 1957. The dam was constructed by Seabright Construction Company, with completion in 1960.

h. Normal Operating Procedure. The reservoir is normally maintained at the spillway crest level of Elevation 965, leaving 11.8 feet of freeboard to the crest level of the nonoverflow section at Elevation 976.8. Inflow occurring when the reservoir is at or above the spillway is discharged over the uncontrolled spillway.

1.3 Pertinent Data

a. Drainage Area - 25.9 square miles

b. Discharge at Dam Site (cfs)

Maximum known flood at dam site - Unknown
Outlet conduit at maximum pool - 160±
Gated spillway capacity at maximum pool - N/A
Ungated spillway capacity at maximum pool - 30,780
Total spillway capacity at maximum pool - 30,780

c. Elevation (USGS Datum) (feet)

Top of dam - 976.8 (See Plate 2)
Maximum pool - 976.8
Normal pool - 965.0
Upstream invert outlet works - 941.0
Downstream invert outlet works - 941.0
Streambed at center line - 941.0
Maximum tailwater - Unknown

d. Reservoir Length (feet)

Normal pool level - 4000±
Maximum pool level - 4500 (estimated)

e. Storage (acre-feet)

Normal pool level - 2680
Maximum pool level - 3500

f. Reservoir Surface (acres)

Normal pool level - 62
Top of dam - 80

g. Dam

Type - Concrete gravity
Length - 515 feet
Height - 42 feet
Top width - 6 feet
Side slopes - Vary, see Plate 3
Zoning - N/A
Impervious core - N/A
Cutoff - N/A
Grout curtain - Yes

h. Regulating Outlet

Type - 36-inch conduit
Length - 30± feet
Closure - Sluice gate at upstream end
Access - Submerged, not accessible
Regulating facilities - Sluice gate

i. Spillway

Type - Concrete ogee overflow section
Crest length - 200 feet
Crest elevation - 965 feet
Gate - None
Upstream channel - Lake
Downstream channel - Trapezoidal concrete discharge channel

SECTION 2
DESIGN DATA

2.1 Design

a. Data Available. The available information was provided by the Commonwealth of Pennsylvania, Department of Environmental Resources (PennDER).

(1) Hydrology and Hydraulics. The available information consists of spillway design hydrograph, spillway and tailwater rating curves, and reservoir drawdown curve.

(2) Dam. The available information consists of design drawings.

(3) Appurtenant Strutures. The available information consists of design drawings.

b. Design Features

(1) Dam. The dam (Plate 2) is a concrete gravity structure consisting of overflow and nonoverflow sections. Plate 3 illustrates the typical cross sections of the dam. The drawings indicate that the dam is founded on rock. Both the ogee overflow section and the nonoverflow section of the dam were constructed with a 3-foot-wide, 5-foot-deep key trench at the heel of the sections.

Plate 4 illustrates the typical subsurface profile at the dam site. At least nine borings were drilled to investigate the subsurface conditions. The rock beneath the site was predominantly classified as soft to hard gray sandstone. Calcareous claystone and shale layers were encountered on the abutments.

The foundation rock was grouted through a single line of grout holes along the heel of the dam (Plate 5). Grouting was also performed on the abutments. Available information indicates that the grouting was performed in two stages. The first stage grouting was performed during foundation excavation prior to placement of concrete. The second stage of grouting was accomplished through holes drilled after at least 5 feet of concrete had been poured above the base of the dam.

(2) Appurtenant Structures. The appurtenant structures of the dam consist of a combined primary and emergency spillway and an outlet works. The spillway structures consist of a concrete ogee overflow section and a concrete paved stilling basin at the downstream toe of the dam. The stilling basin is 200 feet wide and 60 feet long and is equipped with a 2-1/2-foot-high sill at the downstream end. The slab sections of the stilling basin are 12 inches thick and anchored to rock by reinforcing bars (Plate 6).

The outlet works for the dam consist of a 36-inch-diameter conduit through the dam located left of the spillway. Flow through the outlet conduit is controlled by a manually operated sluice gate located at the upstream face of the dam. Details of the outlet works are illustrated in Plates 7 and 8.

c. Design Data

(1) Hydrology and Hydraulics. A report prepared by Swindell-Dressler Corporation indicates that the spillway was designed to pass a hydrograph with a peak of 16,140 cfs with 4 feet of freeboard. The design storm was taken as 10.2 inches of rainfall in six hours with a maximum hourly increment of 1.7 inches. Plate 9 illustrates the design hydrograph.

(2) Embankment. The available information consists of design drawings. No reference was found to stability calculations in the engineer's report.

(3) Appurtenant Structures. The engineer's report indicates that the stilling basin was sized to insure that the hydraulic jump would occur within the stilling basin for the design flow of the spillway. Impact blocks at the base of the ogee section were provided for energy dissipation.

2.2 Construction. Limited information is available on the construction of the dam. Correspondence indicates that the construction was performed under the supervision of a state engineer. No reference was found to indicate that any unusual construction difficulties were encountered.

Available information indicates no postconstruction changes.

2.3 Operation. State park personnel reported that no formal operating records are kept.

2.4 Other Investigations. None reported.

2.5 Evaluation

a. Availability. The available information was provided by PennDER. Although the design calculations and subsurface investigation report prepared by Berger Associates, Inc., were not available in the files, the available information is considered to be sufficient to make a reasonable assessment of the condition of the dam.

b. Adequacy

(1) Hydrology and Hydraulics. The available information is not considered to be adequate to assess the conformity of the analysis to the current spillway design criteria.

(2) Embankment. Review of the geotechnical and structural aspects of the design indicates that the design generally followed currently accepted practices for subsurface investigation and structural design. However, stability calculations were not available for review.

(3) Appurtenant Structures. Review of the design drawings indicates that the appurtenant structures were designed and constructed in conformance with currently accepted engineering practices.

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. General. The on-site inspection of Ryerson Station State Park Dam consisted of:

1. Visual inspection of the retaining structure, abutments and toe.

2. Visual examination of spillway structures.

3. Observation of factors affecting the runoff potential of the drainage basin.

4. Evaluation of the downstream area hazard potential.

The specific observations are illustrated in Plate 10 and in the photographs in Appendix C.

b. Dam. The general inspection of the retaining structure consisted of searching for indications of structural distress, such as cracks and deterioration of concrete surfaces, seepage areas, and observing general maintenance conditions and other surficial features.

The overall condition of the dam is considered to be good. One structural crack was observed near the left abutment, extending across the crest and on the downstream face of the dam. Only minor seepage was associated with this crack, indicating that it is not extending throughout the entire cross section. The seepage flow was estimated to be on the order of one to two gallons per minute.

c. Appurtenant Structures. The spillway crest and visible portions of the stilling basin were examined for deterioration or other signs of distress and obstructions that would limit flow. No signs of apparent distress or erosion were observed.

The outlet conduit sluice gate was operated by park personnel and was observed to be functional.

d. Reservoir Area. A map review indicates that the watershed is predominantly covered with woodlands. A review of the regional geology (Appendix E) indicates that although the slopes surrounding the reservoir are likely to be susceptible to landslides, the occurrence of massive landslides which may affect the storage volume of the reservoir is not considered to be likely.

e. Downstream Channel. Downstream from the dam, North Fork initially flows north and then turns west, joining the South Fork of Dunkard Creek approximately 1-1/2 miles downstream from the dam near the town of Ryerson Station. There are eight houses and one commercial building in this reach. Further description of downstream conditions is included in Section 1.2b.

3.2 Evaluation. The condition of the dam is considered to be good. The structural crack observed near the right abutment should be closely observed to document that no further structural distress is occurring. Necessary repair work should be performed if movement of the crack or increased seepage is observed.

SECTION 4
OPERATIONAL FEATURES

4.1 Procedure. State park personnel reported that there are no formal operating procedures for the dam. The reservoir is normally maintained at the crest level of the spillway, with inflow into the reservoir discharging over the uncontrolled spillway.

4.2 Maintenance of the Dam. The maintenance of the dam is considered to be satisfactory.

4.3 Maintenance of Operating Facilities. The only operational feature of the dam is the outlet conduit sluice gate. The sluice gate was operated by state park personnel and was observed to be functional. The maintenance condition of the operating equipment is considered to be satisfactory.

4.4 Warning System. No formal warning system exists for the dam. The park superintendent responsible for the operation of the dam resides in the park area. Telephone and radio communication facilities are available at the site.

4.5 Evaluation. The maintenance condition of the dam and operating facilities is considered to be satisfactory. It is recommended that a formal warning system be developed to alert the downstream residents in the event of emergencies.

SECTION 5
HYDRAULICS AND HYDROLOGY

5.1 Evaluation of Features

a. Design Data. Ryerson Station State Park Dam has a watershed area of 25.9 square miles and impounds a reservoir with a surface area of 62 acres at normal pool level. The capacity of the spillway was determined to be 30,780 cfs with no freeboard. The spillway was designed to pass a hydrograph with a peak of 16,140 cfs with four feet of freeboard. The design storm was taken as 10.2 inches of rainfall in 6 hours with a maximum hourly increment of 1.7 inches.

b. Experience Data. As previously stated, Ryerson Station State Park Dam is classified as an intermediate dam in the high hazard category. Under the recommended criteria for evaluating emergency spillway discharge capacity, such impoundments are required to pass full PMF.

The PMF inflow hydrograph for the reservoir was determined using the Dam Safety Version of the HEC-1 computer program developed by the Hydrologic Engineering Center of the U.S. Army, Corps of Engineers. The data used for the computer analysis are presented in Appendix D. The PMF inflow hydrograph was found to have a peak flow of 34,286 cfs. The computer outputs are included in Appendix D.

c. Visual Observations. On the date of inspection, no conditions were observed that would indicate that the spillway capacity would be seriously reduced in the event of a flood.

d. Overtopping Potential. Various percentages of PMF inflow hydrograph were routed through the reservoir, and it was found that the spillway can pass 90 percent PMF without overtopping the nonoverflow section. For 100 percent PMF, the nonoverflow section would be overtopped for a duration of 2.75 hours with a maximum depth of overflow of 0.71 foot. The effect of tailwater depth on the discharge capacity of the spillway was reviewed and found not to be reducing the capacity (Appendix D).

e. Spillway Adequacy. As discussed in the subsequent section, the stability of the dam under PMF flow was found to be satisfactory and therefore the flood discharge capacity is classified as adequate according to the recommended criteria.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

(1) Embankment. As discussed in Section 3, the overall condition of the dam was considered to be good. Although a structural crack was observed near the right abutment, at this time, the condition is not considered to be serious relative to the overall stability of the dam. This condition was noted in previous inspection reports, and it appears that the condition is not changing.

(2) Appurtenant Structures. The performance of the appurtenant structures is considered to be satisfactory.

b. Design and Construction Data

(1) Embankment. Stability calculations for the dam were not included in the available information. As a part of this inspection, the stability of the dam was reevaluated by an independent preliminary analysis (Appendix D). The preliminary stability analysis indicated that the factor of safety against overturning is 1.4 when the pool is 0.7 foot above the crest of the dam, which would occur during the passage of PMF. Under the same loading condition, the factor of safety against sliding was found to be greater than 4. This analysis indicates that the dam would be stable under PMF loading conditions.

(2) Appurtenant Structures. Review of the design drawings indicates no apparent structural deficiencies that would significantly affect the performance of the appurtenant structures.

c. Operating Records. The structural stability of the dam is not considered to be affected by the operational features of the dam.

d. Post-Construction Changes. None reported.

e. Seismic Stability. The dam is located in Seismic Zone 1, and based on preliminary analysis, the static stability of the dam is considered to be adequate. Therefore, based on the recommended criteria for evaluation of seismic stability of dams, the structure is presumed to present no hazard from earthquakes.

SECTION 7
ASSESSMENT AND RECOMMENDATIONS/PROPOSED REMEDIAL MEASURES

7.1 Dam Assessment

a. Assessment. The visual inspection indicates that Ryerson Station State Park Dam is in good condition. No conditions were observed that would seriously affect the overall performance of the structure at this time and none were reported in the past. However, the structural crack observed near the right abutment should be regularly inspected to document that further structural distress is not occurring.

The capacity of the spillway is found to be adequate according to the recommended criteria.

b. Adequacy of Information. Available information in conjunction with visual observations and the previous experience of the inspectors are considered to be sufficient to make a reasonable assessment of the dam.

c. Urgency. The following recommendations should be implemented on a continuing basis.

d. Necessity for Additional Data. No data are considered to be required at this time.

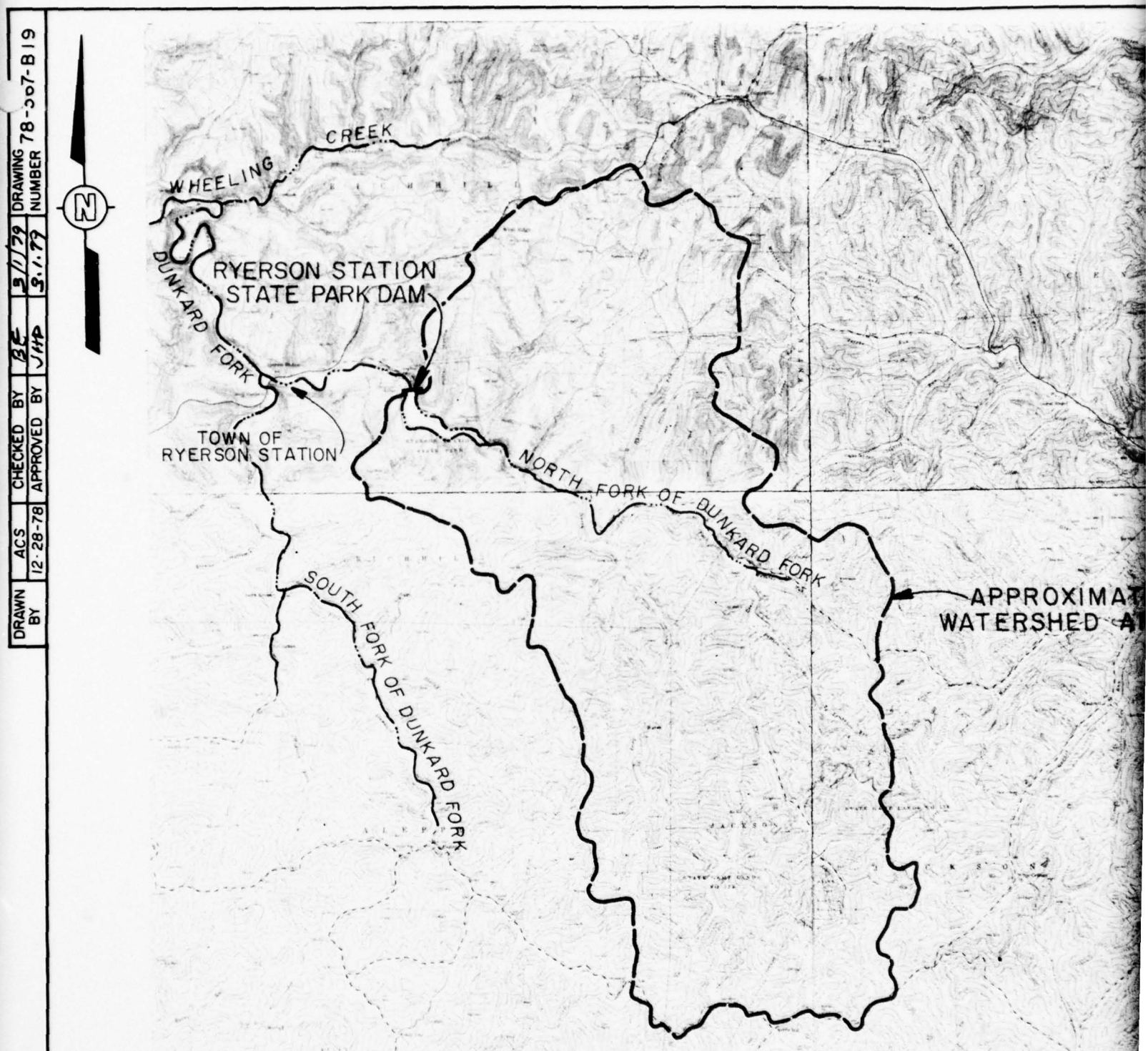
7.2 Recommendations/Remedial Measures. It is recommended that:

1. The structural crack observed near the right abutment should be regularly inspected and monitored for signs of further structural distress, such as displacements and increased quantity of seepage through the crack. Necessary remedial measures should be performed if such conditions are observed.

2. An around-the-clock surveillance should be provided during unusually heavy runoff and a formal warning system developed to alert the downstream residents in the event of emergencies.

3. The dam and appurtenant structures should be inspected regularly and necessary maintenance performed.

PLATES



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	12-28-78	APPROVED BY	JHP	3/1/79

REFERENCES:

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DATED 1964, SCALE 1:24000

U.S.G.S. 7.5' ROGERSVILLE, PA. QUADRANGLE
PHOTOREVISED 1973, SCALE 1:24000

U.S.G.S. 7.5' NEW FREEPORT, PA. QUADRANGLE
PHOTOREVISED 1973, SCALE 1:24000

U.S.G.S. 7.5' HOLBROOK, PA. QUADRANGLE
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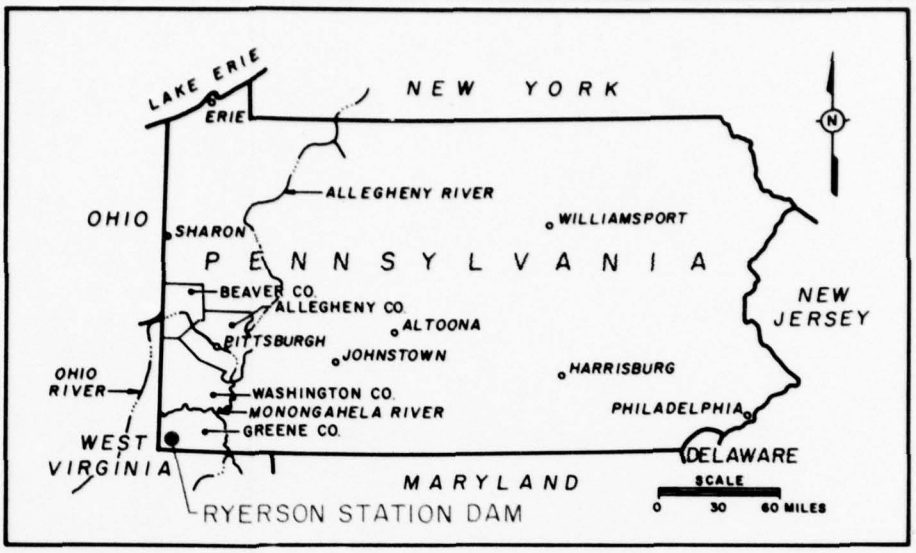

KEY PLAN

APPROXIMATE WATERSHED AREA

SCALE
0 4000 8000 12000 FEET

PLATE I

RYERSON STATION STATE PARK DAM
VICINITY, FLOOD PLAIN & WATERSHED MAP

D'APPOLONIA

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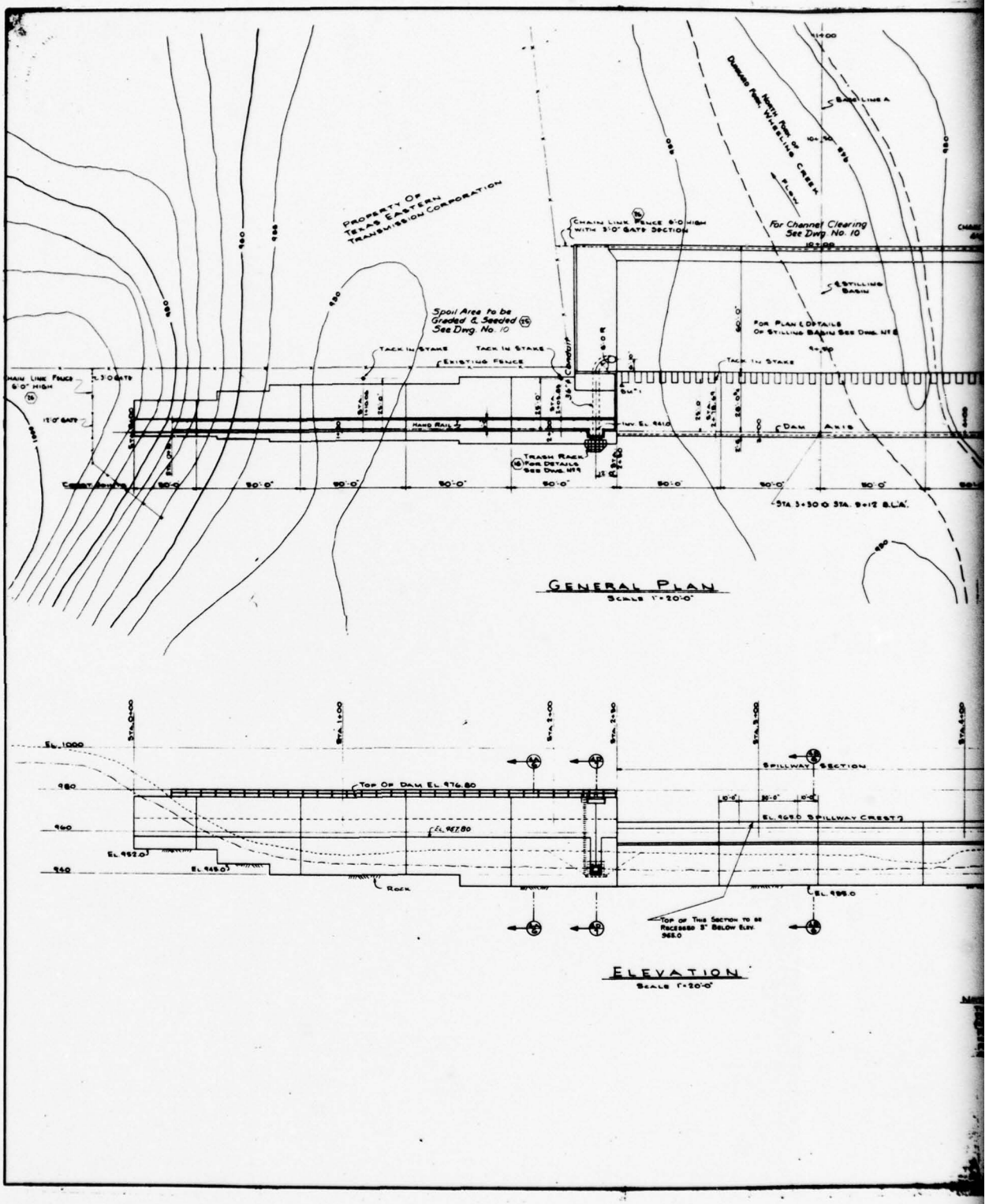

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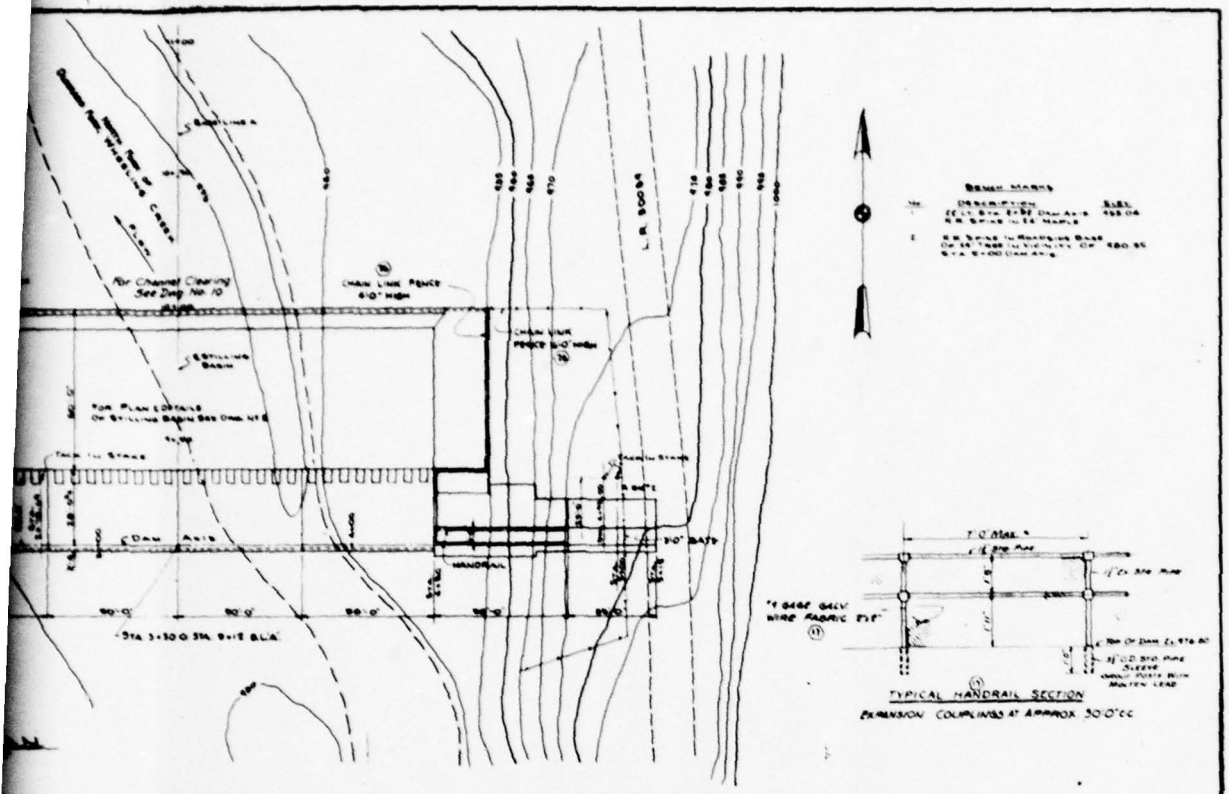

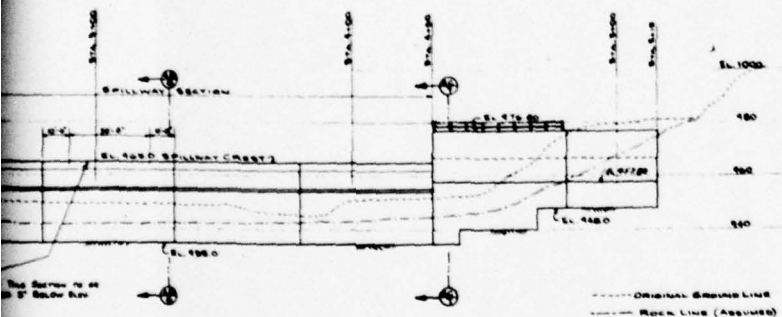

SWINDELL-DRESSLER CORPORATION
ENGINEERS
PITTSBURGH PENNSYLVANIA

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF FORESTS AND WATERS
RECREATIONAL PROJECT

RYERSON STATION DAM
GENERAL PLAN AND ELEVATION

NORTH FORK, DUNKARD FORK, WHEELING CREEK – RICHHILL TWP.
GREENE COUNTY, PA.

PLATE 2

1 2

D'APPOLONIA

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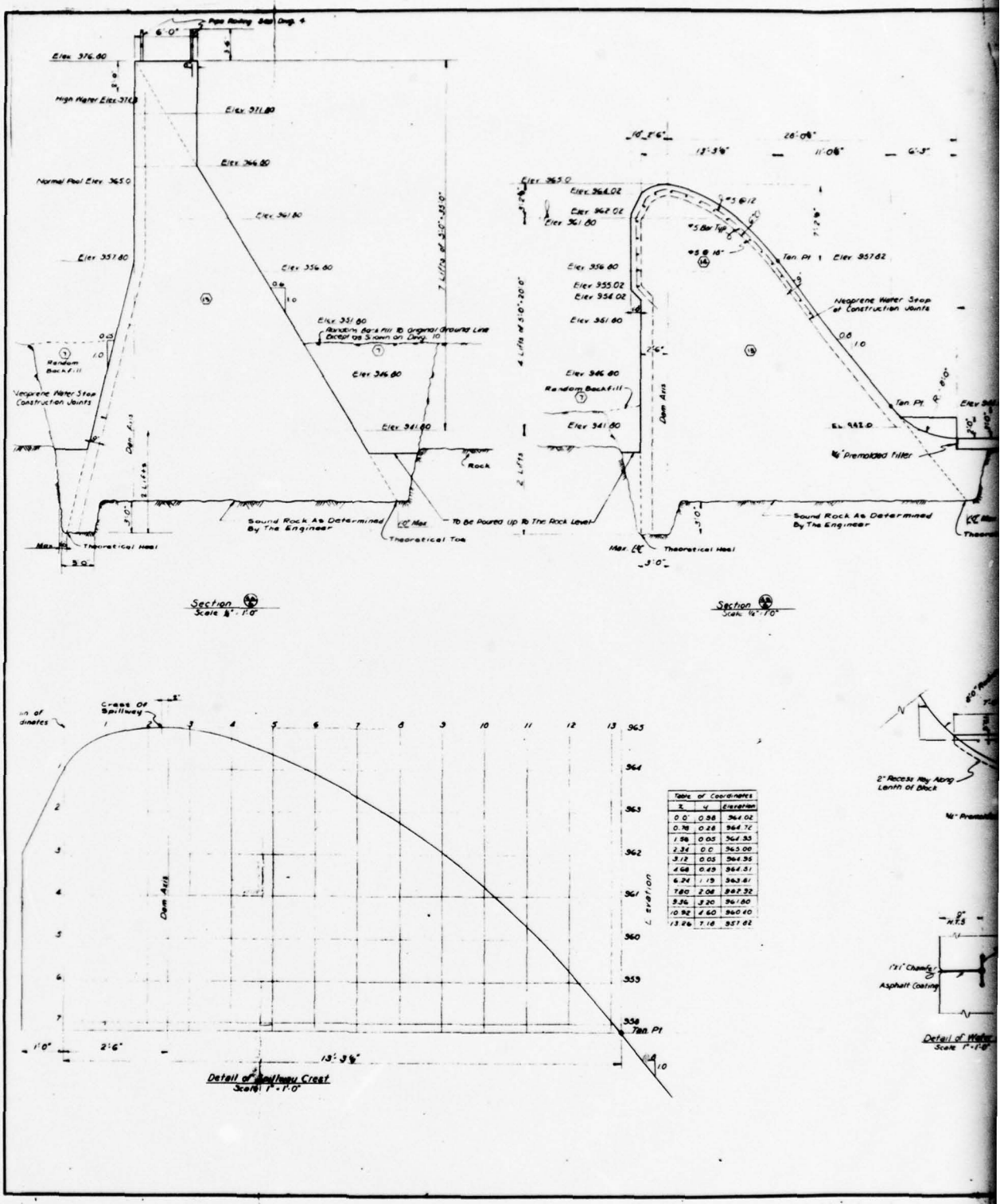

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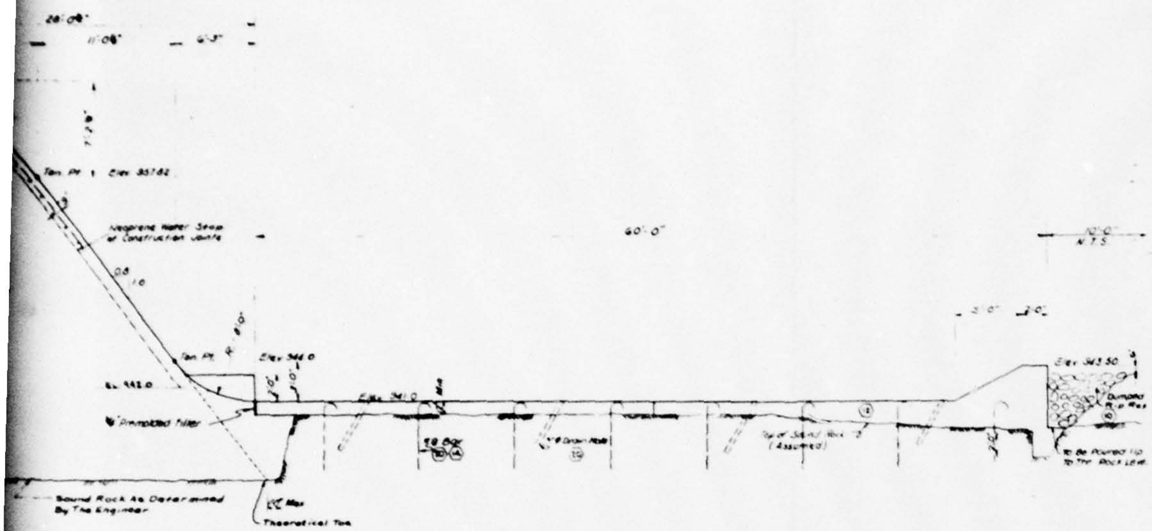
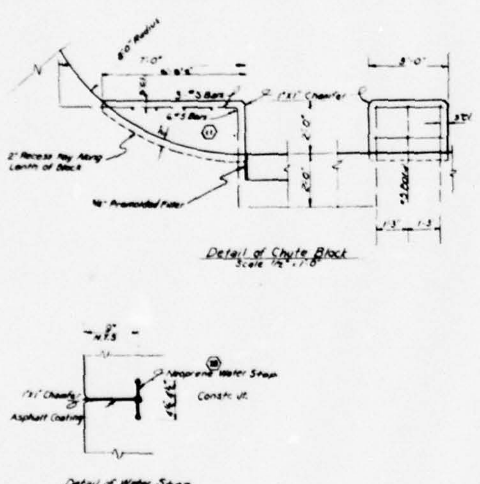




Detail of Chute Block

Detail of Water Stop

Notes:
The Foundation Elevations Shown Are Tentative
The Final Elevations To Be Determined By The Engineer.

SWINDELL-DRESSLER CORPORATION
ENGINEERS
PITTSBURGH PENNSYLVANIA

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF FORESTS AND WATERS
RECREATIONAL PROJECT

RYERSON STATION DAM

CROSS SECTIONS

NORTH FORK, DUNKARD FORK, WHEELING CREEK – RICHHILL TWP.
GREENE COUNTY, PA.

NO.	DATE	REVISION	REV.	CHK.	APPR.	

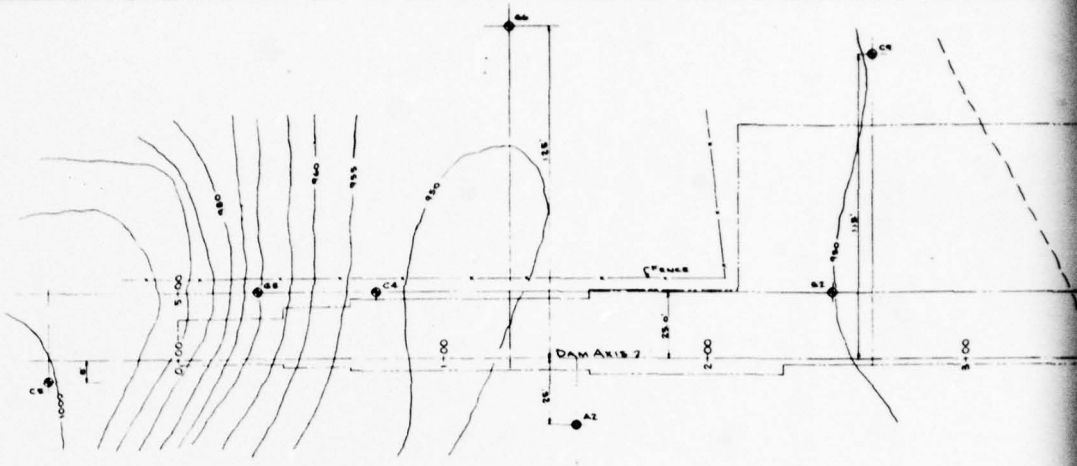
DESIGNED / DRAWN G.C.C. / TRACED / CHECKED
SUBM. — CHIEF, FLOOD CONTROL DIV. — DATE
RECOM. — CHIEF ENGINEER
APPD. — SECRETARY

PLATE 3

D'APPOLONIA

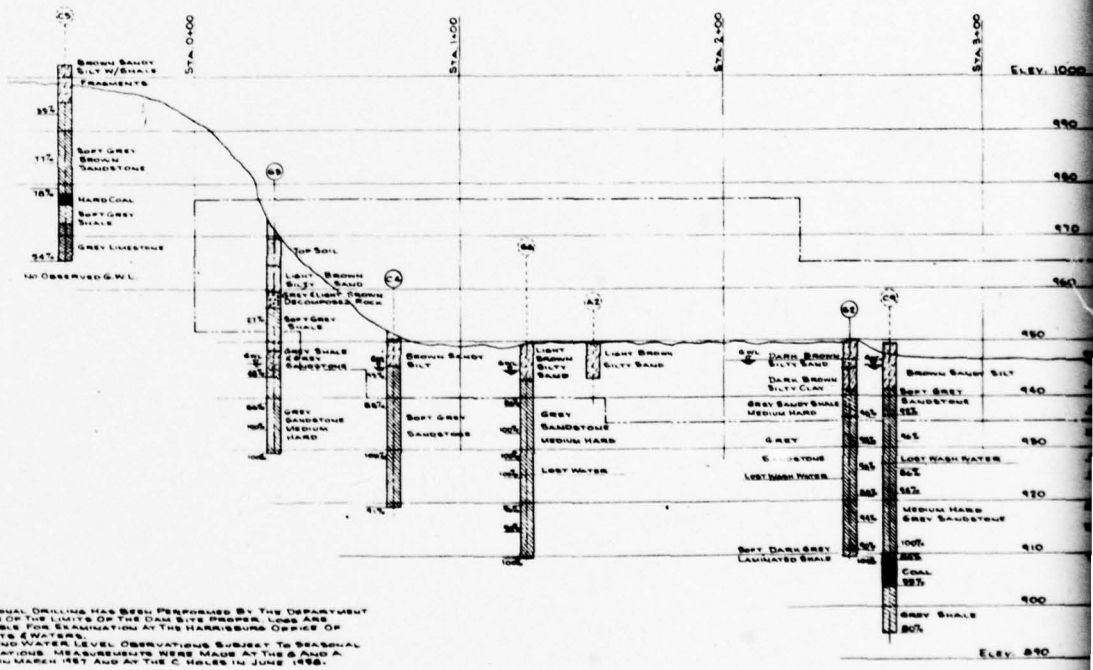
2

DRAWN BY	ACS	CHECKED BY	BE	3/1/79	DRAWING NUMBER 78-367-B22
	12-27-78	APPROVED BY	JHP	3.1.79	



PLAN

SCALE 1"=20'-0"



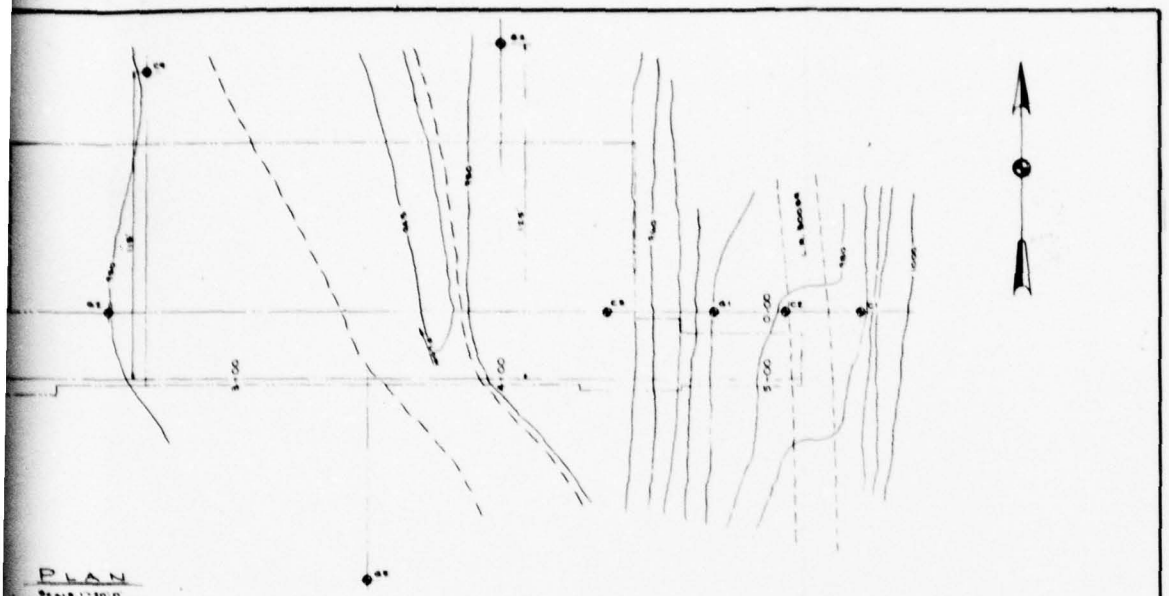
NOTES:

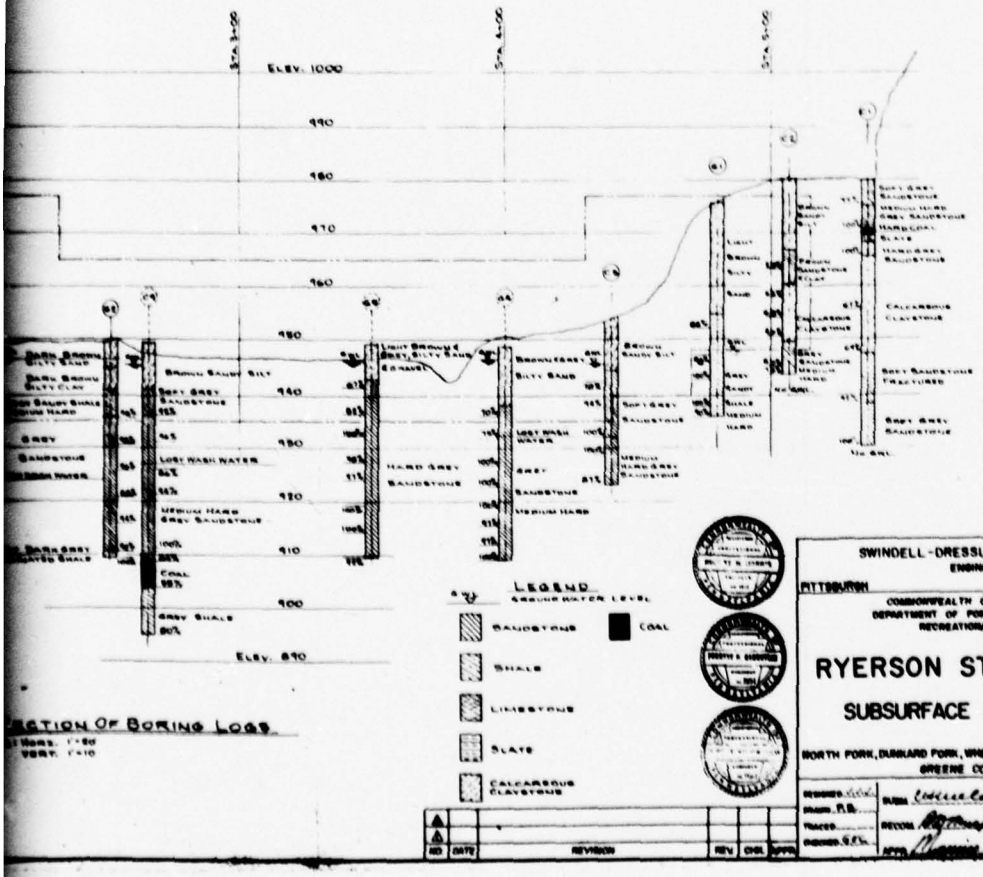
1. Additional Drilling Has Been Performed By The Department Outside Of The Limits Of The Dam Site Proper. Logs Are Available For Examination At The Harrisburg Office Of Forests & Waters.
2. Ground Water Level Observations Subject To Seasonal Fluctuations. Measurements Were Made At The A And A Holes In March 1977 And At The C Holes In June 1978.

PROJECTED CROSS SECTION OF BORING LOGS

SCALE: HORZ. 1"=50'
VERT. 1"=10'

1





SECTION OF BORING LOGS

SWINDELL-DRESSLER CORPORATION
ENGINEERS
PITTSBURGH PENNSYLVANIA

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF FORESTS AND WATERS
RECREATIONAL PROJECT

RYERSON STATION DAM
SUBSURFACE EXPLORATION

NORTH FORK, DUNKARD FORK, WHEELING CREEK - RICHHILL TWP.
GREENE COUNTY, PA.

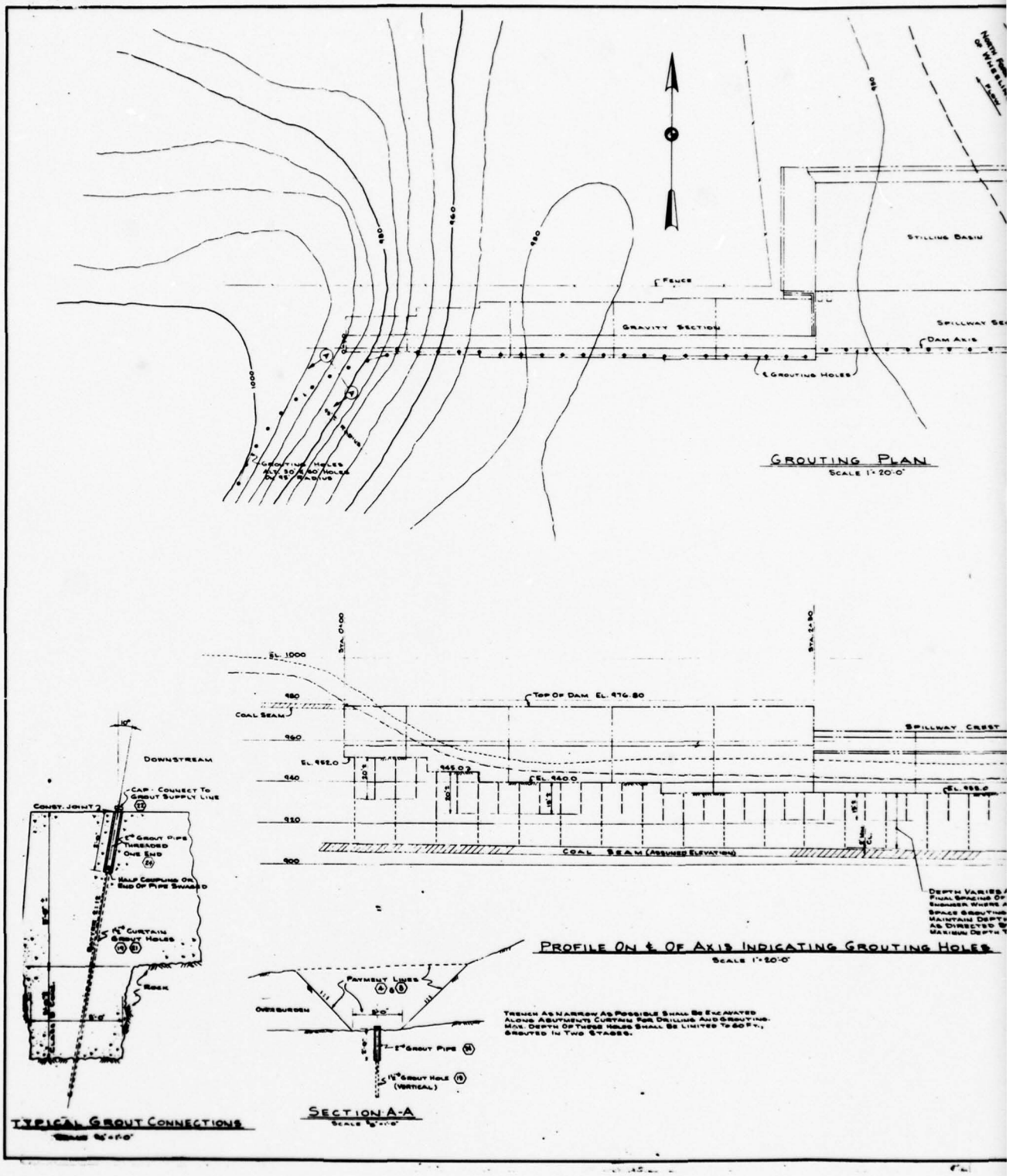
PLATE 4

2

1

D'APPOLONIA

DRAWN BY	ACS	CHECKED BY	BE	3/1/77	DRAWING NUMBER 78-367-B23
	12·27·78	APPROVED BY	JHP	3.1.77	



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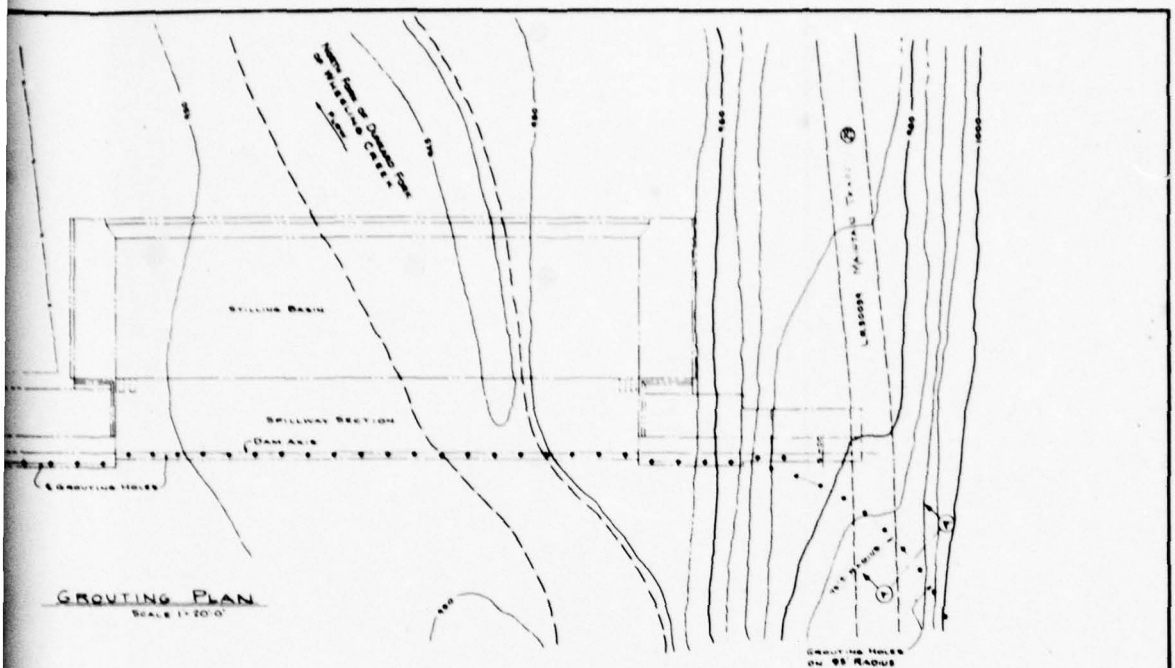
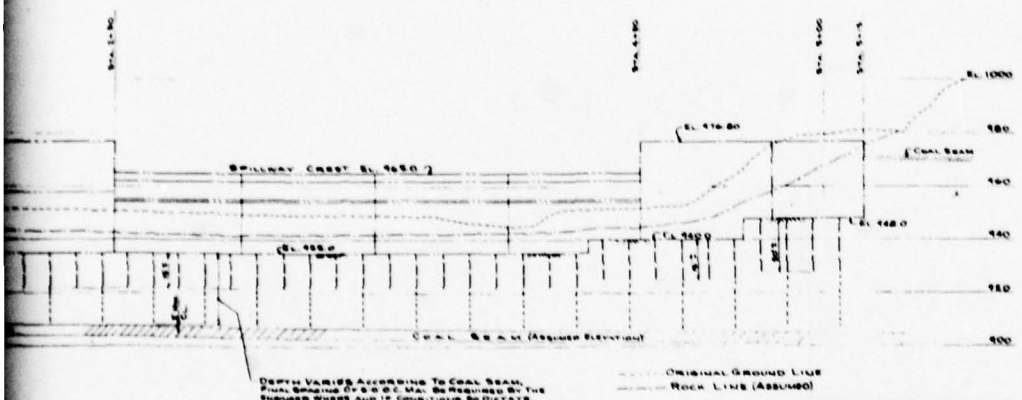


GROUTING PLAN

SCALE 1"=20'-0"



INDICATING GROUTING HOLES

SCALE 1"=50'-0"

NOTES:

THE ORDER OF DRILLING, DEPTH OF HOLES AND FINAL SPACING SHALL BE DETERMINED IN THE FIELD BY THE ENGINEER, HOWEVER, GROUTING SHALL ALWAYS PROCEED UPHILL.

(No.) INDICATES PLAN ITEM

GROUT HOLES TO BE 1½" DIAMETER (EX). DRILLING AND GROUTING SHALL BE DONE BY STAGE METHODS IN ACCORDANCE WITH THE SPECIFICATION AND DIRECTIONS OF THE ENGINEER IN FIELD. THERE SHALL BE A MINIMUM CONCRETE COVER OF 5'-0" ON HOLES AS DIRECTED BY THE ENGINEER, BEFORE DRILLING FOR GROUTING UNDER THE DAM.

DRILLING AND GROUTING IN ABUTMENTS SHALL BE DONE THROUGH 6" PIPE SET IN ROCK. ALTERNATE METHOD BY SETTING AN EXPANDER 1 FT. MAX BELOW TOP OF ROCK. OR TOP OF CONCRETE WILL BE ACCEPTABLE.

DEPTH VARIES ACCORDING TO COAL SEAM. FINAL SPACING OF 8'-0" O.C. MAY BE REQUIRED BY THE ENGINEER WHERE AUGER CONDITIONS SO DICTATE

SPARE GROUTING HOLES AT APPROX. 10 CALCEDTERS MAINTAIN DEPTH PATTERN AS INDICATED OR AS DIRECTED BY THE ENGINEER. MAXIMUM DEPTH TO BE 40'

NO.	DATE	REVISION	DES	DR	CH
1					
2					

SWINDELL-DRESSLER CORPORATION
ENGINEERS
PITTSBURGH PENNSYLVANIA

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF FORESTS AND WATERS
RECREATIONAL PROJECT

RYERSON STATION DAM

GROUTING PLAN

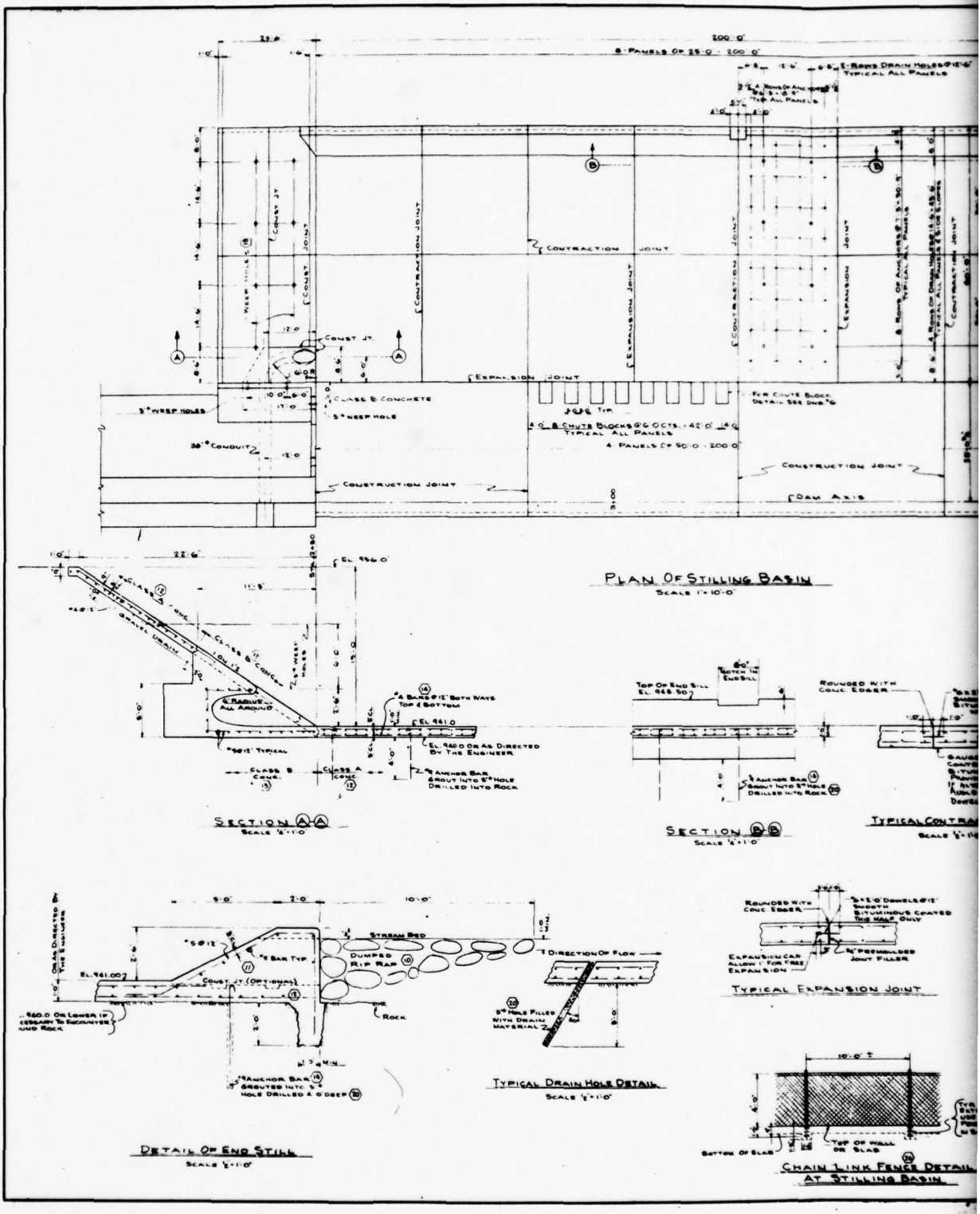
NORTH FORK, DUNGARD FORK, WHEELERS CREEK - RICHHILL TWP.
GREENE COUNTY, PA.

DESIGNED J.L.V. DATE
DRAWN D.D.
TRACED
CHECKED A.S.C.
CHIEF, FLOOD CONTROL DIV. CHIEF, DIV. OF
CHIEF, GEOL. SECT. CHIEF ENGR.

PLATE 5

D'APPOLONIA

DRAWN BY	ACS	CHECKED BY		3/1/79	DRAWING
	12·27·78	APPROVED BY	JHD	3.1.79	NUMBER 78-367-B24



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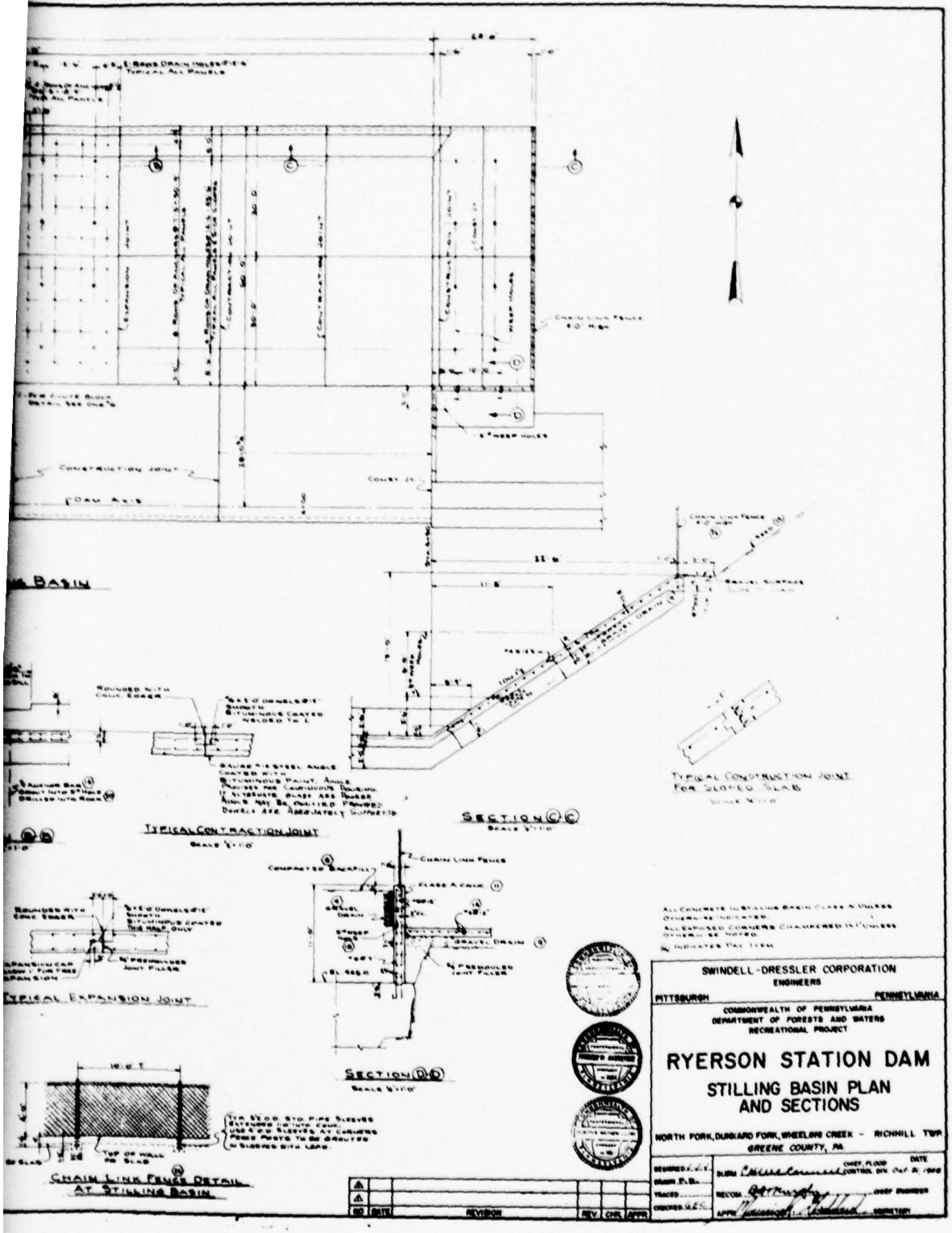


SWINDELL-DRESSLER CORPORATION
ENGINEERS
PITTSBURGH PENNSYLVANIA

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF FORESTS AND WATERS
RECREATIONAL PROJECT

RYERSON STATION DAM

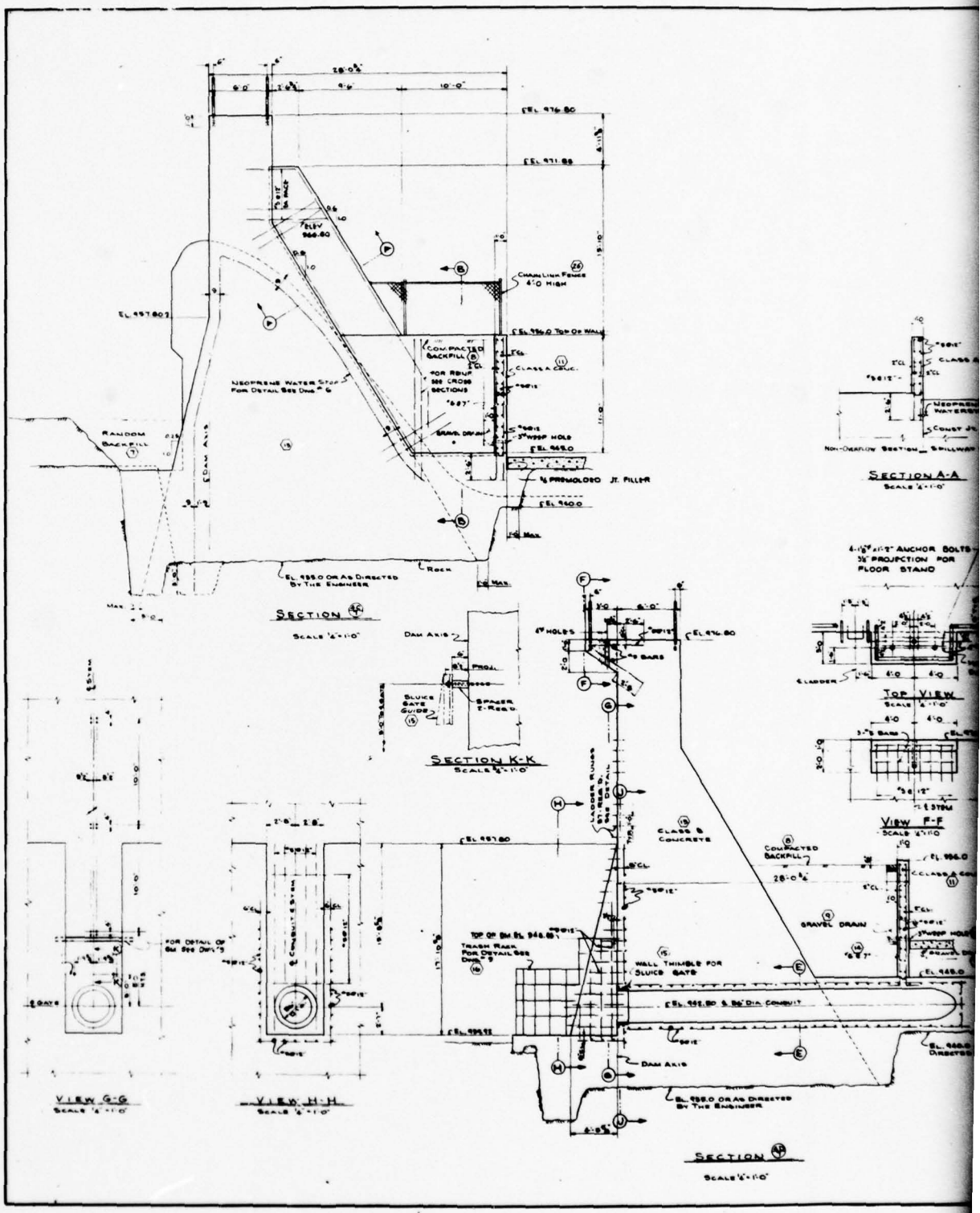
STILLING BASIN PLAN AND SECTIONS

NORTH FORK, DUNKARD FORK, WHEELING CREEK - RICHHILL TWP.
GREENE COUNTY, PA.

PLATE 6

D'APPOLONIA

DRAWN BY	ACS	CHECKED BY	BE	3/1/79	DRAWING NUMBER 78-367-B 25
	12·27·78	APPROVED BY	JHP	3.1.79	



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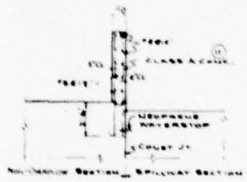
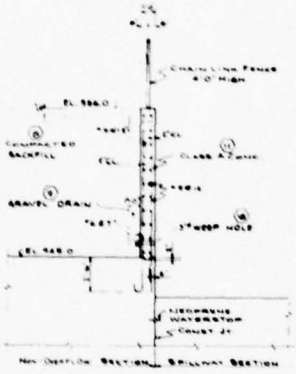
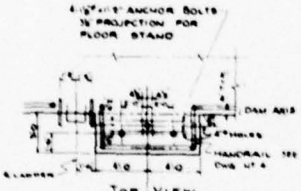


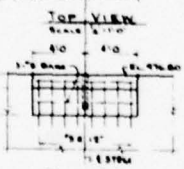
SECTION A-A



SECTION B-B

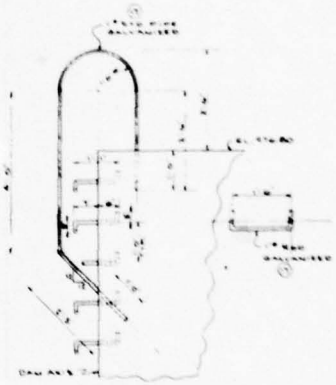


TOP VIEW



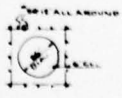
VIEW F-F

SECTION J-J



LADDER DETAILS

NOTE:



SECTION E-E

SWINDELL-DRESSLER CORPORATION
ENGINEERS
PITTSBURGH PENNSYLVANIA

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF FORESTS AND WATERS
RECREATIONAL PROJECT

RYERSON STATION DAM

CROSS SECTIONS

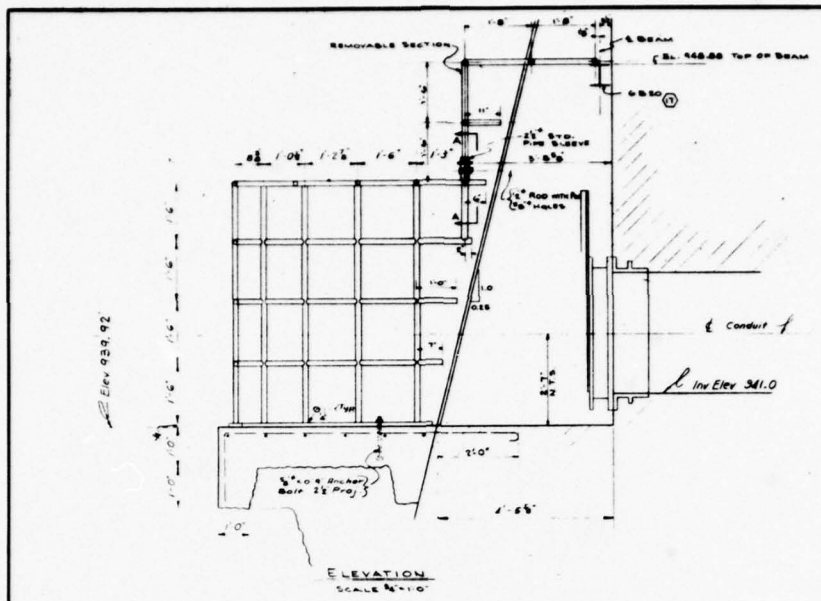
NORTH FORK, DUNLAP FORK, WHEELING CREEK - RICHHILL TWP.
GREENE COUNTY, PA.

NO	DATE	REVISION	REV	CHK	APPR

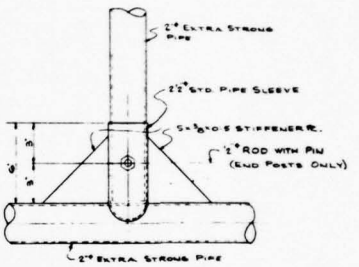
PLATE 7

2

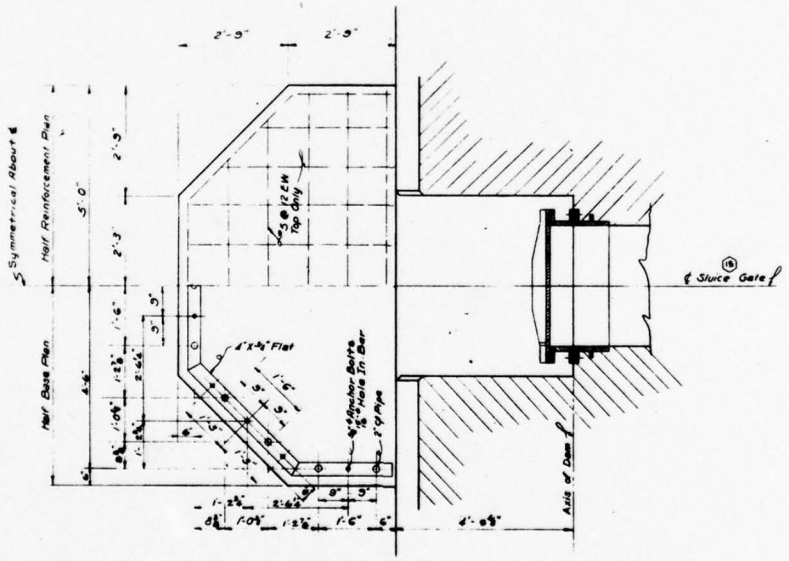
DRAWN BY	ACS	CHECKED BY		3/1/79	DRAWING NUMBER 78-[illegible]7-B 26
	12-27-78	APPROVED BY		3.1.79	



ELEVATION
SCALE 3/8"=1'-0"

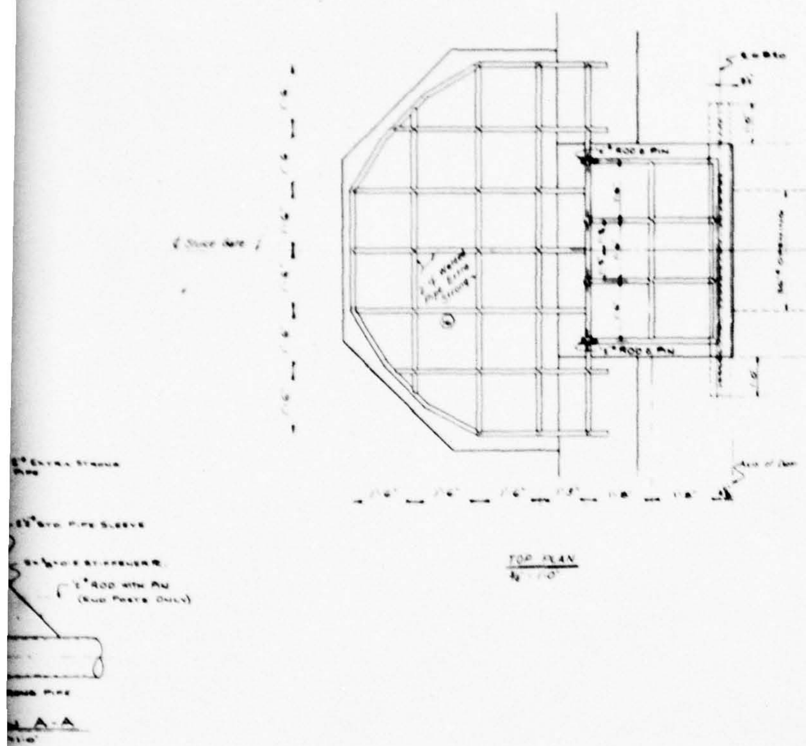


SECTION A-A
SCALE 3"=1'-0"



BASE PLAN
SCALE 3/8"=1'-0"

1



NOTE:
TRASH RACK TO BE ALL WELDED CONSTRUCTION.
TRASH RACK TO BE GALVANIZED AFTER ASSEMBLY.
ALL ANCHOR BOLTS & NUTS TO BE STAINLESS STEEL.
INDICATES PAY ITEM.

SWINDELL-DRESSLER CORPORATION
ENGINEERS
PITTSBURGH PENNSYLVANIA

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF FORESTS AND WATERS
RECREATIONAL PROJECT

RYERSON STATION DAM

TRASH RACK DETAILS

NORTH FORK, DUNKARD FORK, WHEELING CREEK - RICHHILL
GREENE COUNTY, PA.

NO.	DATE	REVISION	REV.	CHK.	APPR.

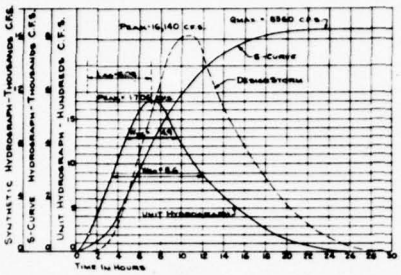
DESIGNED
DRAWN
TRACED
CHECKED

SUBM. CHIEF, FLOOD CONTROL DIV.
RECOM. CHIEF ENGINEER
APPR. SECRETARY

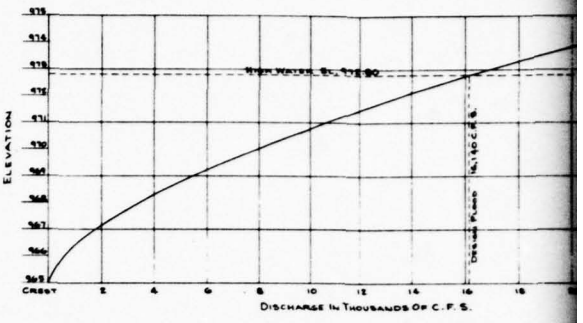
PLATE 8

D'APPOLONIA

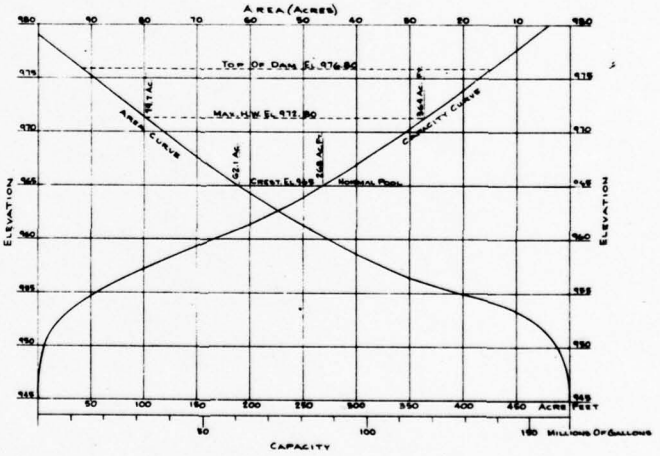
DRAWN BY	ACS	CHECKED BY	BE	3/1/79	DRAWING NUMBER 78-307-827
	12·27·78	APPROVED BY	JHP	3.1.79	



TWO HOUR UNIT HYDROGRAPH, S-CURVE HYDROGRAPH & DESIGN STORM SYNTHETIC HYDROGRAPH

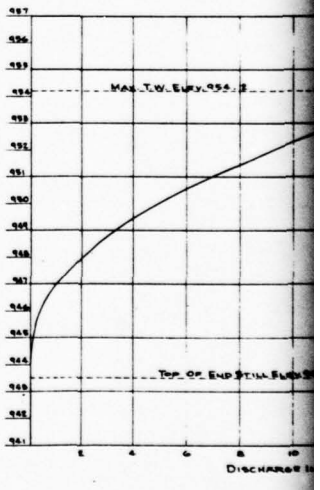


SPILLWAY RATING CURVE



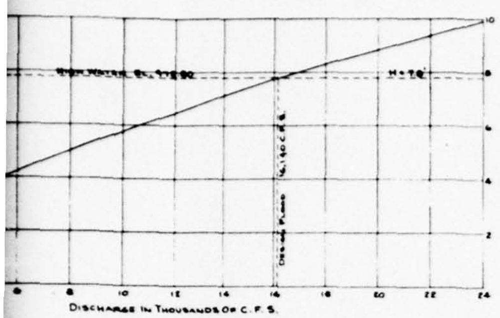
RESERVOIR AREA & CAPACITY CURVES

DRAINAGE AREA: 25.93 SQ. MI.

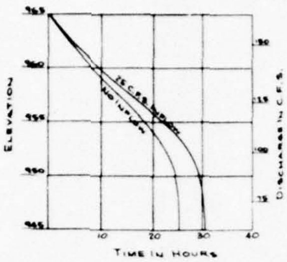


TAIL WATE

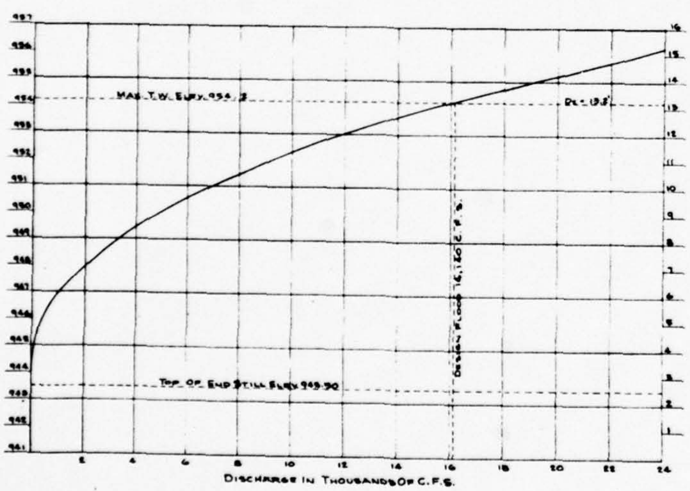
1



Spillway Rating Curve



Reservoir Draw-Down Curves
(Gate Fully Opened)



Tail Water Rating Curve

SWINDELL-DRESSLER CORPORATION
ENGINEERS
PITTSBURGH PENNSYLVANIA

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF FORESTS AND WATERS
RECREATIONAL PROJECT

RYERSON STATION DAM

DESIGN CURVES

NORTH FORK, DUNKARD FORK, WHEELING CREEK – RICHHILL TWP.
GREENE COUNTY, PA.

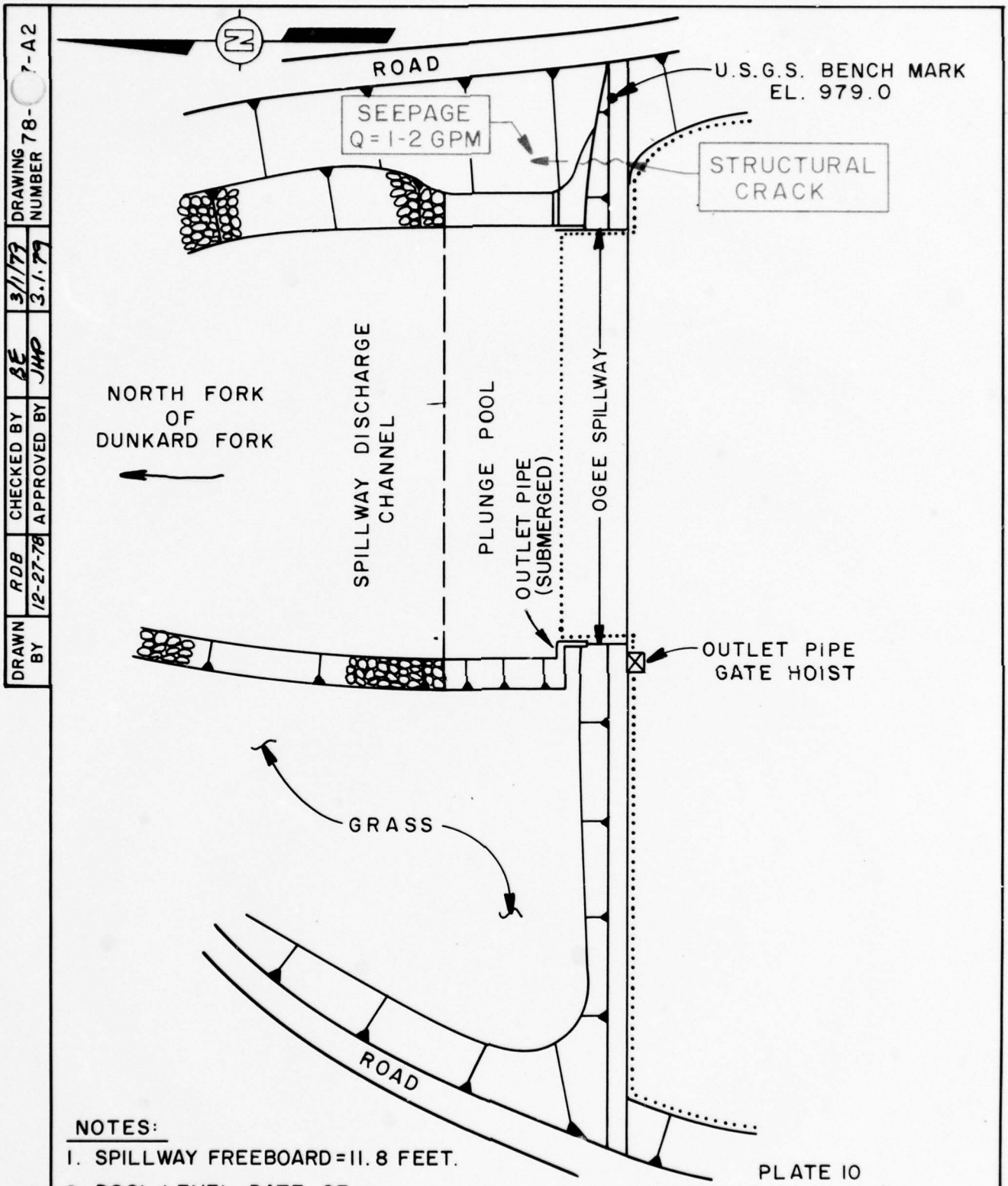
SUBM. [signature] CHIEF, FLOOD CONTROL DIV. Oct. 31, 1960
RECOM. [signature] CHIEF ENGINEER
APPR. Maurice K. Goddard SECRETARY

NO.	DATE	REVISION	REV.	CHK.	APPR.

PLATE 9

D'APPOLONIA

2



DRAWN BY	RDB	CHECKED BY	BE	3/1/79	DRAWING NUMBER 78-7-A2
	12-27-78	APPROVED BY	JHP	3.1.79	

NOTES:

1. SPILLWAY FREEBOARD = 11.8 FEET.
2. POOL LEVEL DATE OF INSPECTION: 1 INCH OVER SPILLWAY CREST.

NOT TO SCALE

PLATE 10

RYERSON STATION STATE PARK DAM
GENERAL PLAN
FIELD INSPECTION NOTES
FIELD INSPECTION DATE: DEC. 6, 1978

D'APPOLONIA

APPENDIX A

CHECKLIST
VISUAL INSPECTION
PHASE I

APPENDIX A

CHECKLIST
VISUAL INSPECTION
PHASE I

NAME OF DAM Ryerson Station State Park Dam COUNTY Greene STATE Pennsylvania ID# NDI I.D. NO. PA-193
DER I.D. NO. 30-20

TYPE OF DAM Concrete gravity HAZARD CATEGORY High

DATE(S) INSPECTION December 6, 1978 WEATHER Sunny TEMPERATURE

POOL ELEVATION AT TIME OF INSPECTION 965.1 M.S.L. TAILWATER AT TIME OF INSPECTION 943.9 M.S.L.

INSPECTION PERSONNEL:	REVIEW INSPECTION PERSONNEL: (December 21, 1978)
Bilgin Erel	L. D. Andersen
Wah-Tak Chan	J. H. Poellot
	B. Erel

Bilgin Erel RECORDER

VISUAL INSPECTION
PHASE I
CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	Through a crack near the right abutment (approximately one gallon per minute).	
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	No visual signs of distress. No seepage.	
DRAINS	None found.	
WATER PASSAGE	200-foot-wide ogee section.	
FOUNDATION	No perceivable signs of distress.	

VISUAL INSPECTION
PHASE I
CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	None significant.	
STRUCTURAL CRACKING	Near right abutment. Extends across the crest and through downstream face. Minor associated seepage (approximately one gallon per minute).	This crack should be periodically inspected and monitored.
VERTICAL AND HORIZONTAL ALIGNMENT	No measurable misalignment.	
MONOLITH JOINTS	No significant signs of distress.	
CONSTRUCTION JOINTS	No significant signs of distress.	

VISUAL INSPECTION
PHASE I
OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Submerged, not visible.	
INTAKE STRUCTURE	Submerged, not visible.	
OUTLET STRUCTURE	Submerged, not visible.	
OUTLET CHANNEL	Spillway stilling basin.	
EMERGENCY GATE	Operated by park personnel. Observed to be functional. Operating equipment in good condition.	

VISUAL INSPECTION
PHASE I
UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	In good condition.	
APPROACH CHANNEL	Lake. Free of debris.	
DISCHARGE CHANNEL	200-foot-wide trapezoidal earth channel. Sides are protected by riprap. In good condition.	
BRIDGE AND PIERS	A 3-span single lane highway bridge across the discharge channel about 500 feet downstream from the dam.	

VISUAL INSPECTION
PHASE I
GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	No gated spillway. N/A.	
APPROACH CHANNEL	N/A.	
DISCHARGE CHANNEL	N/A.	
BRIDGE PIERS	N/A.	
GATES AND OPERATION EQUIPMENT	N/A.	

VISUAL INSPECTION
PHASE I
INSTRUMENTATION

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	A USGS bench mark is located on the crest of the dam near the right abutment.	
OBSERVATION WELLS	None.	
WEIRS	None.	
PIEZOMETERS	None.	
OTHER	None.	

VISUAL INSPECTION
PHASE I
RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Moderate to steep slopes.	
SEDIMENTATION	Unknown.	
UPSTREAM RESERVOIRS	None.	

VISUAL INSPECTION
PHASE I
DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	In good condition.	
SLOPES	Protected by riprap.	
APPROXIMATE NUMBER OF HOMES AND POPULATION	Eight houses and one commercial building in the town of Ryerson Station 1-1/2 miles downstream. Population: Approximately 35.	

APPENDIX B

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
AND HYDROLOGIC AND HYDRAULIC
PHASE I

APPENDIX B

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM: Ryerson Station State Park Dam

ID#: NDI I.D. NO. PA-193
DER I.D. NO. 30-20

ITEM	REMARKS
AS-BUILT DRAWINGS	Available in state files.
REGIONAL VICINITY MAP	See Plate 1.
CONSTRUCTION HISTORY	Designed by Swindell-Dressler Corporation.
TYPICAL SECTIONS OF DAM	See Plate 3.
OUTLETS - PLAN - DETAILS - CONSTRAINTS - DISCHARGE RATINGS	See Plate 7 for details and Plate 9 for reservoir drawdown curve.

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

ITEM	REMARKS
RAINFALL/RESERVOIR RECORDS	Not recorded.
DESIGN REPORTS	A report prepared by Swindell-Dressler Corporation of Pittsburgh, Pennsylvania dated November 7, 1953.
GEOLOGY REPORTS	A report prepared by Berger Associates, Inc., of Harrisburg, Pennsylvania dated 1957 (not available for review).
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	Results of hydrology and hydraulic calculations referenced in engineer's report. Stability calculations not available.
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	See Plate 4.

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

ITEM	REMARKS
POST CONSTRUCTION SURVEYS OF DAM	Not reported.
BORROW SOURCES	N/A.
MONITORING SYSTEMS	None.
MODIFICATIONS	None reported.
HIGH POOL RECORDS	Not recorded.

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

ITEM	REMARKS
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None reported.
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	None reported.
MAINTENANCE OPERATION RECORDS	Available in state files.
SPILLWAY PLAN SECTIONS DETAILS	See Plates 2 and 3.
OPERATING EQUIPMENT PLANS AND DETAILS	See Plate 7.

CHECKLIST
ENGINEERING DATA
HYDROLOGIC AND HYDRAULIC

DRAINAGE AREA CHARACTERISTICS: 25.6 square miles (wooded)

ELEVATION; TOP NORMAL POOL AND STORAGE CAPACITY: 965.0 (2680 acre-feet)

ELEVATION; TOP FLOOD CONTROL POOL AND STORAGE CAPACITY: Same as above

ELEVATION; MAXIMUM DESIGN POOL: 976.8 (3500 acre-feet)

ELEVATION; TOP DAM: 976.8

SPILLWAY:

a. Elevation 965.0

b. Type Ogee overflow

c. Width 200 feet (perpendicular to flow)

d. Length N/A

e. Location Spillover Entire crest

f. Number and Type of Gates None

OUTLET WORKS:

a. Type 36-inch conduit

b. Location Left of spillway

c. Entrance Inverts 941.0

d. Exit Inverts 941.0

e. Emergency Draindown Facilities 36-inch conduit

HYDROMETEOROLOGICAL GAGES:

a. Type None

b. Location None

c. Records None

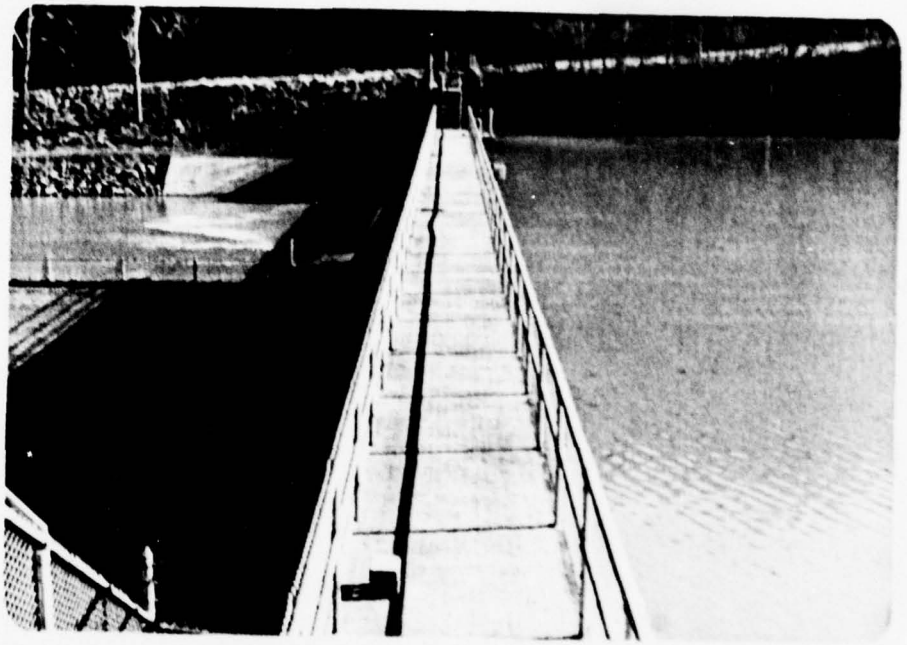
MAXIMUM NONDAMAGING DISCHARGE: Spillway capacity (30,000+ cfs)

APPENDIX C

PHOTOGRAPHS

LIST OF PHOTOGRAPHS
RYERSON STATION STATE PARK DAM
NDI I.D. NO. PA-193
DECEMBER 6, 1978

PHOTOGRAPH NO.	DESCRIPTION
1	Crest (looking east).
2	Crest (looking west).
3	Spillway crest.
4	Spillway discharge channel.
5	Blow-off valve hoist.
6	Blow-off valve discharging (pipe is submerged).
7	Structural crack near right abutment.
8	Community of Ryerson Station 1-1/2 miles downstream (looking downstream).
9	Community of Ryerson Station (looking upstream).

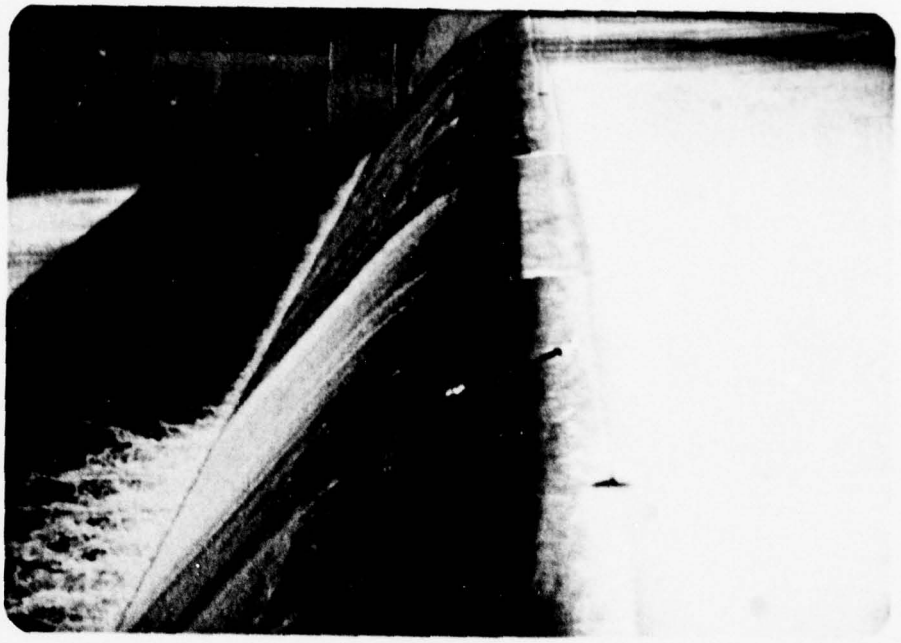


Photograph No. 1

Crest (looking east).

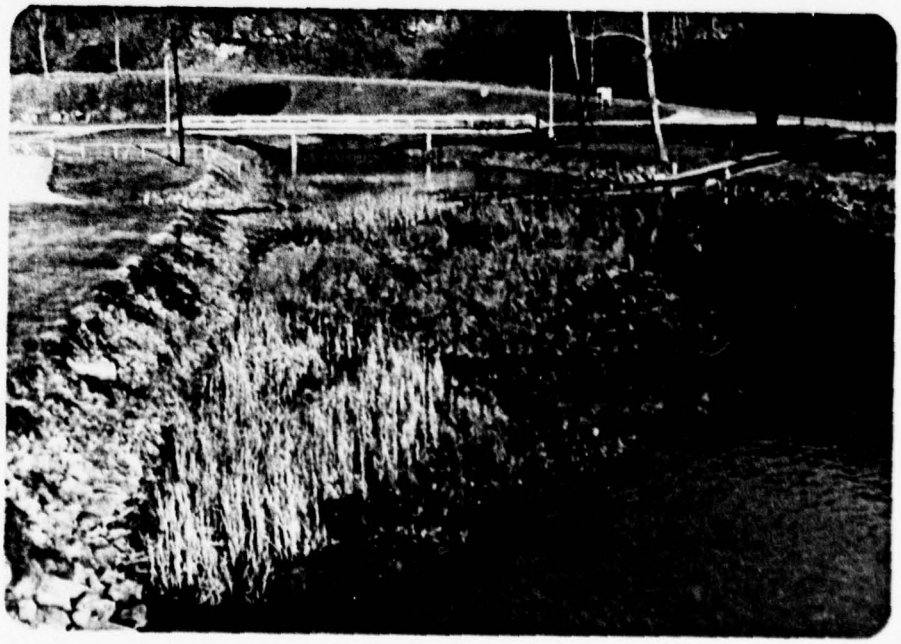
Photograph No. 2

Crest (looking west).



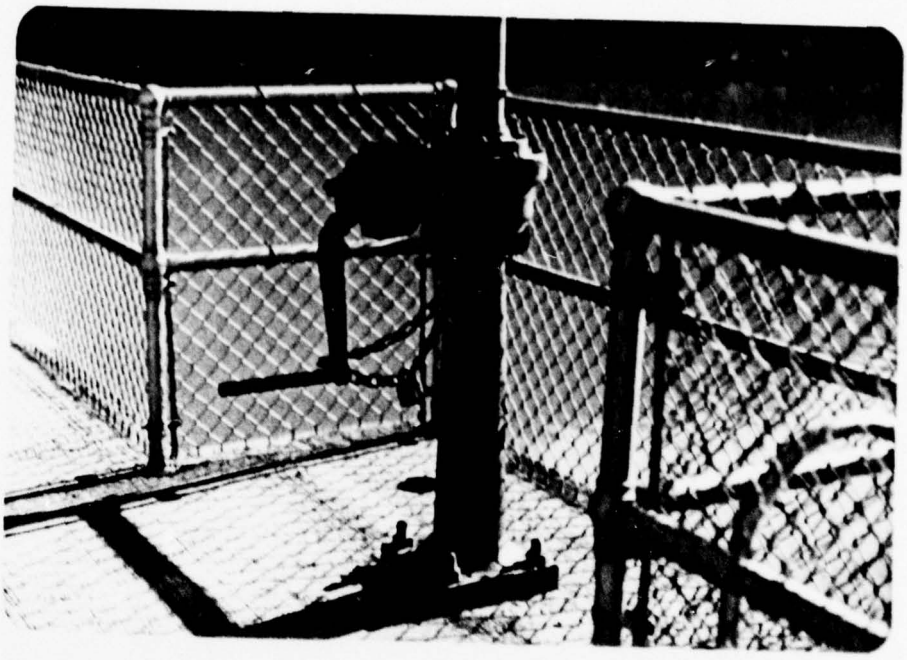
Photograph No. 3

Spillway crest.



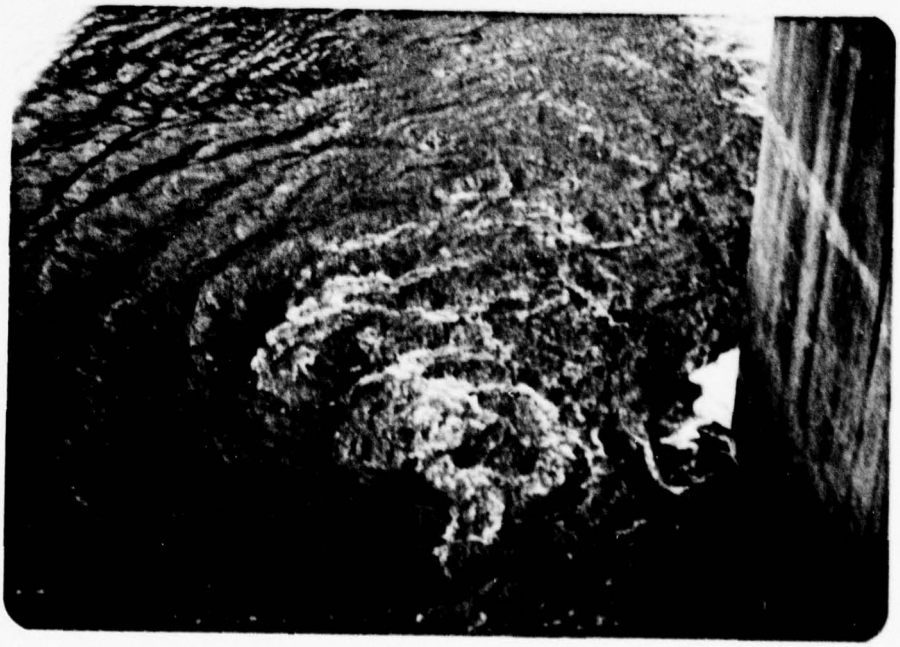
Photograph No. 4

Spillway discharge channel.



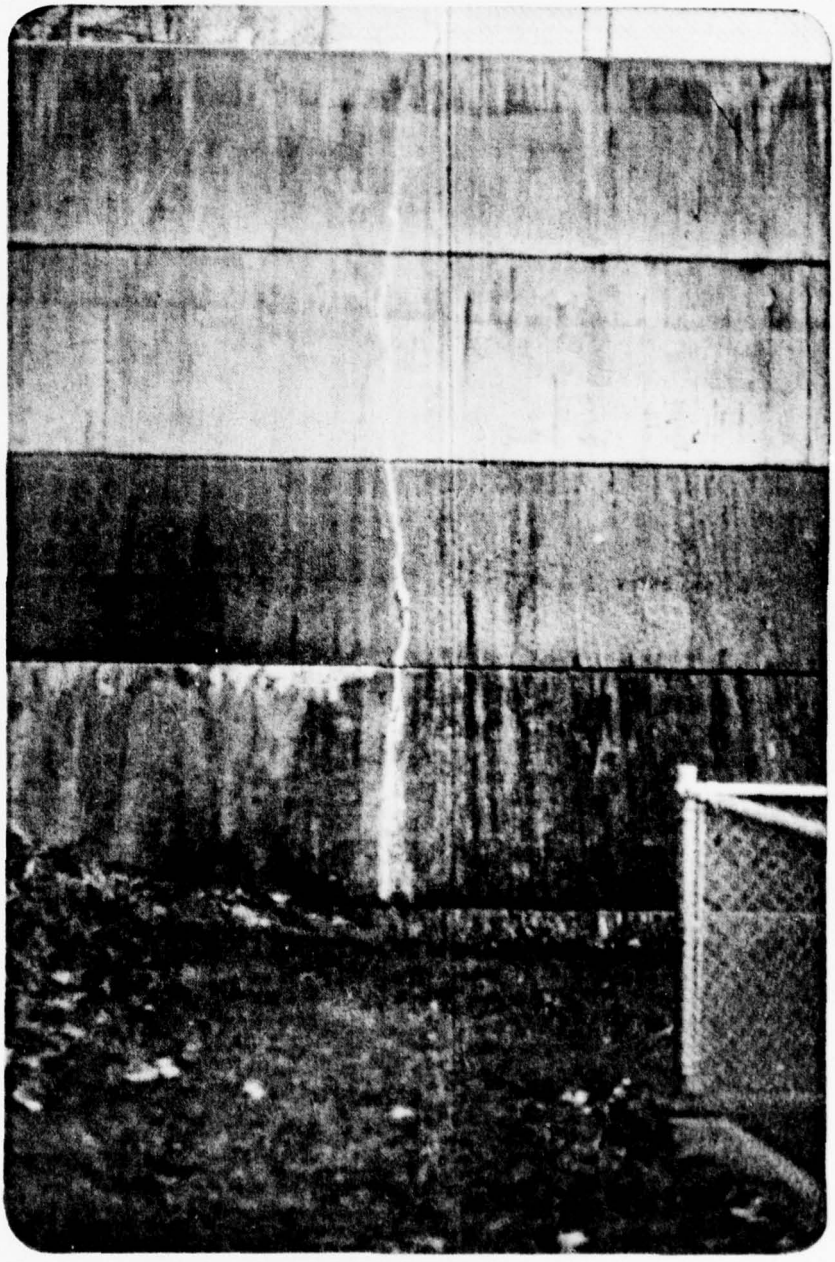
Photograph No. 5

Outlet valve hoist.



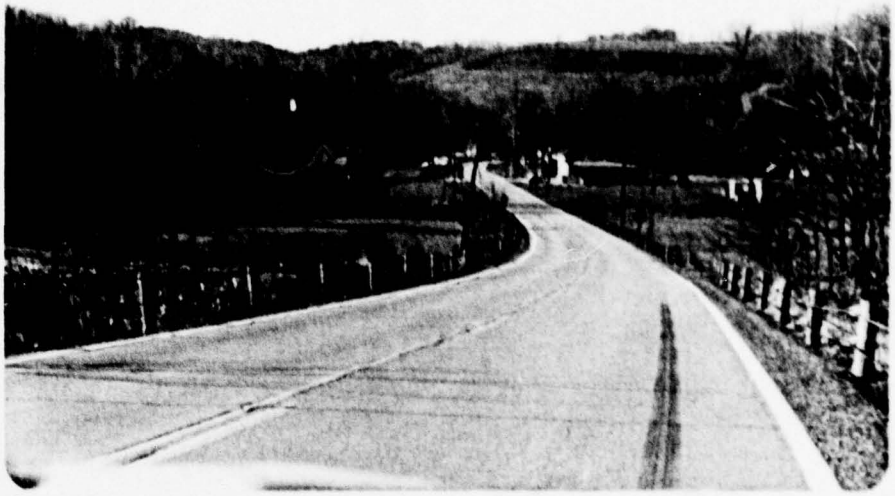
Photograph No. 6

Outlet valve discharging (pipe is submerged).



Photograph No. 7

Structural crack near right abutment.



Photograph No. 8

Community of Ryerson Station 1-1/2 miles downstream (looking downstream).

Photograph No. 9

Community of Ryerson Station (looking upstream).

APPENDIX D
CALCULATIONS

HYDROLOGY AND HYDRAULIC ANALYSIS
DATA BASE

NAME OF DAM: Ryerson Station State Park Dam
(NDI I.D. PA-193)

PROBABLE MAXIMUM PRECIPITATION (PMP) = 24.3 INCHES/24 HOURS[1]

STATION	1	2	3	4	5
Station Description	Ryerson Station Lake	Ryerson Station Dam			
Drainage Area (square miles)	25.9	-			
Cumulative Drainage Area (square miles)	25.9	25.9			
Adjustment of PMF for Drainage Area (%)[2]					
6 Hours	93	-			
12 Hours	111	-			
24 Hours	121	-			
48 Hours	131	-			
72 Hours	-	-			
Snyder Hydrograph Parameters					
Zone[3]	288	-			
C_p/C_t[4]	0.57/1.7	-			
L (miles)[5]	9.5	-			
L_{ca} (miles)[5]	3.8	-			
$t_p = C_t(L \cdot L_{ca})^{0.3}$ (hours)	5.0	-			
Spillway Data					
Crest Length (ft)	-	200			
Freeboard (ft)	-	11.8			
Discharge Coefficient	-	3.8			
Exponent	-	1.5			

(1) Hydrometeorological Report 33 (Figure 1), U.S. Army, Corps of Engineers, 1956.

(2) Hydrometeorological Report 33 (Figure 2), U.S. Army, Corps of Engineers, 1956.

(3) Hydrological zone defined by Corps of Engineers, Baltimore District, for determining Snyder's Coefficients (C_p and C_t).

(4) Snyder's Coefficients.

(5) L = Length of longest water course from outlet to basin divide.
L_{ca} = Length of water course from outlet to point opposite the centroid of drainage area.

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  11 JAN 79
**********
    1                A1       SNYDER UNIT HYDROGRAPH,FLOOD ROUTING   DAM OVERTOPPING ANALYSES
    2                A2       RYERSON STATION DAM,GREENE COUNTY,NDI-ID.PA193      PROJECT NO.78-367-02
    3                A3       FOR 20%,30%,40%,50%,60%,70%,80%,90%,AND 100% PMF
    4                B     300        0       15        0        0        0        0        0       -4        0
    5                B1      5
    6                J       1        9        1
    7                J1   0.20     0.30     0.40     0.50     0.60     0.70     0.80     0.90     1.00
    8                K       0        1                                          1
    9                K1       CALCULATION OF INFLOW HYDROGRAPH TO RYERSON STATION DAM,NDI-ID.PA193
   10                M       1        1     25.9             25.9                                    1
   11                P                24.3       93      111      121      131
   12                I                                                          1.0      .05             0.003
   13                W   4.986     0.57
   14                X    -1.0    -0.05      2.0
   15                K       1        2                                          1
   16                K1       ROUTING FLOW THROUGH RYERSON STATION DAM,NDI-ID.PA193
   17                Y                                          1        1
   18                Y1      1                                                2686.0
   19                $S    0.0   2686.0   3522.0   3782.0
   20                $E  900.0    965.0    976.8    980.0
   21                $$  965.0    200.0      3.8      1.5
   22                $D  976.8     3.08      1.5    315.0
   23                K      99
```

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

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 .20	RATIO 2 .30	RATIO 3 .40	RATIO 4 .50	RATIO 5 .60	RATIO 6 .70	RATIO 7 .80	RATIO 8 .90	RATIO 9 1.00
HYDROGRAPH AT	1	25.90	1	6857.	10286.	13714.	17143.	20572.	24000.	27429.	30858.	34286.
	(	67.08)	(	194.18)(	291.26)(	388.35)(	485.44)(	582.53)(	679.61)(	776.70)(	873.79)(	970.88)
ROUTED TO	2	25.90	1	6810.	10227.	13653.	17079.	20506.	23933.	27360.	30784.	34231.
	(	67.08)	(	192.83)(	289.60)(	386.61)(	483.63)(	580.67)(	677.70)(	774.74)(	871.71)(	969.30)

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

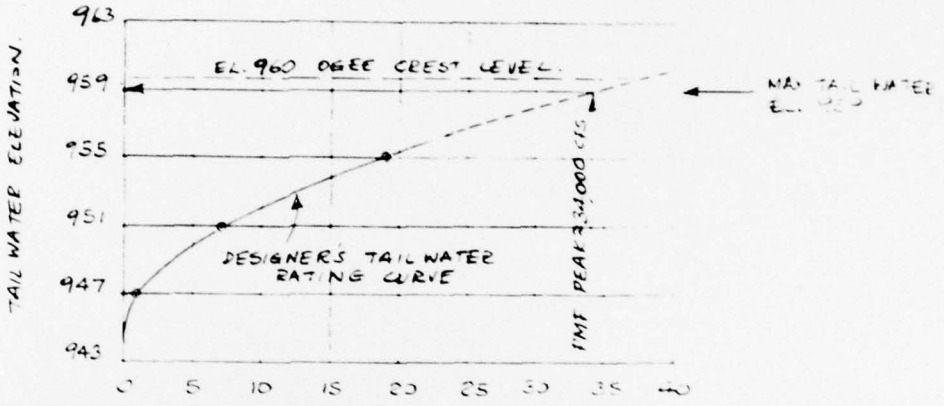
	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	965.00	965.00	976.80
STORAGE	2686.	2686.	3522.
OUTFLOW	0.	0.	30806.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.20	969.31	0.00	2992.	6810.	0.00	44.75	0.00
.30	970.66	0.00	3087.	10227.	0.00	44.50	0.00
.40	971.86	0.00	3172.	13653.	0.00	44.50	0.00
.50	972.96	0.00	3250.	17079.	0.00	44.50	0.00
.60	974.00	0.00	3323.	20506.	0.00	44.50	0.00
.70	974.97	0.00	3392.	23933.	0.00	44.50	0.00
.80	975.90	0.00	3458.	27360.	0.00	44.50	0.00
.90	976.79	0.00	3522.	30784.	0.00	44.50	0.00
1.00	977.51	.71	3580.	34231.	2.75	44.50	0.00

D'APPOLONIA
CONSULTING ENGINEERS, INC

By EE Date 3/16/79 Subject RYERSON STATE PARK DAM Sheet No ___ of ___
Chkd By WTC Date 3/17/79 HYDRAULICS - TAILWATER EFFECT Proj No 28-[illegible]7

TAILWATER RATING CURVE
(REDRAWN FROM PLATE 8)



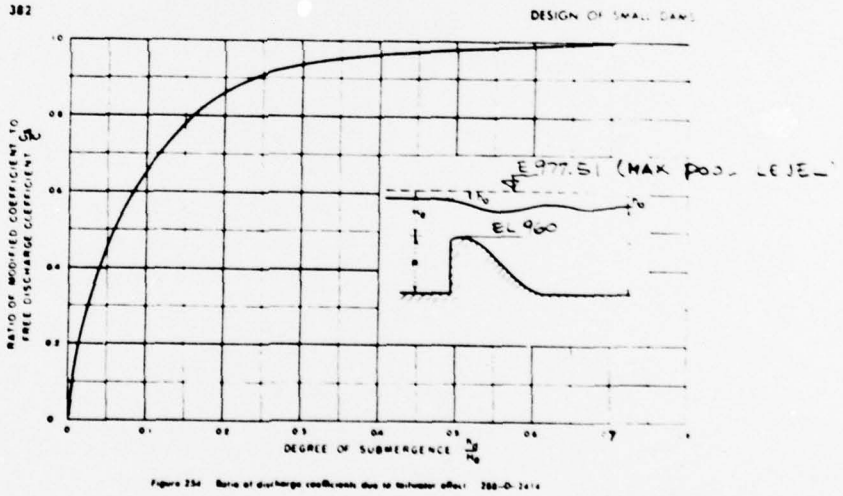


Figure 254 Ratio of discharge coefficients due to tailwater effect. 28-D-2414

② 34,000 cfs H_e = 977.51 − 960.00 = 17.5'

h_d = 977.51 − 959.00 = 18.5'

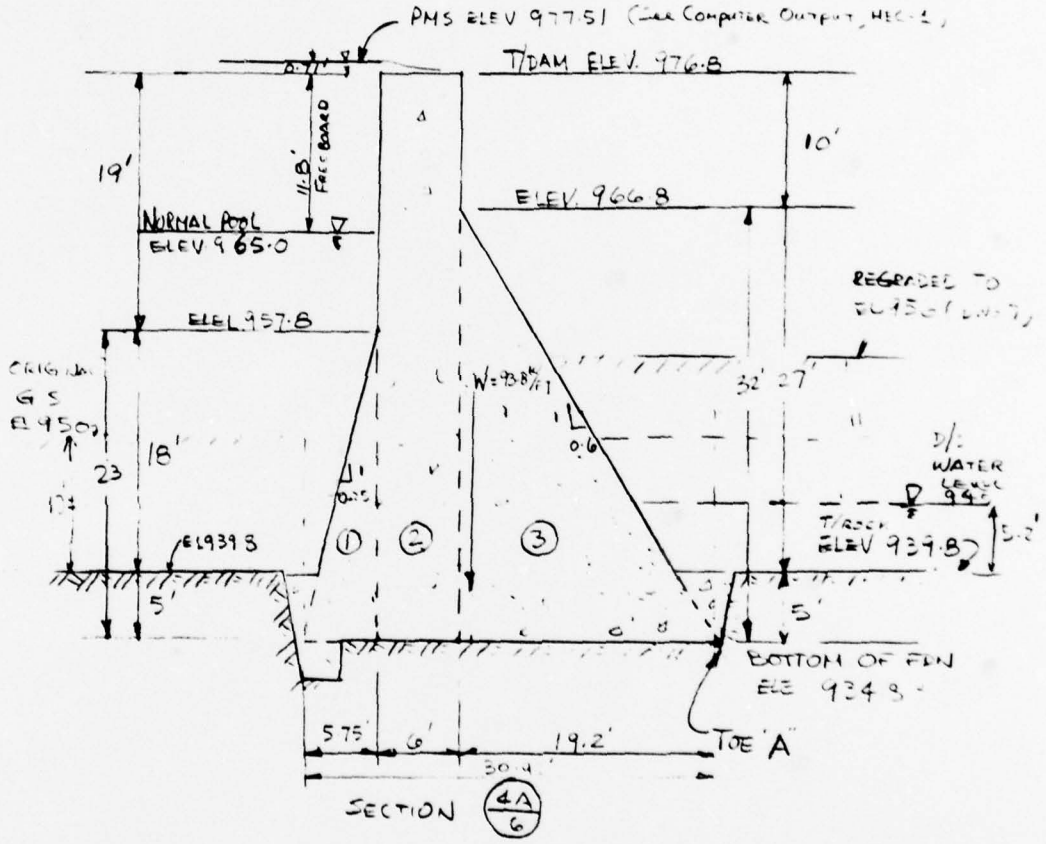
$\therefore \frac{h_d}{H_e} = \frac{18.5'}{17.5'} = 1.06 > 0.8$ ∴ NO REDUCTION IN DISCHARGE CAPACITY DUE TO TAILWATER EFFECT.

DAPPOLONIA
CONSULTING ENGINEERS INC

By JCH Date 2-12 79 Subject RYERSON STATION DAM Sheet No 1 of 4
Chkd By LSH Date 2-26-79 STABILITY Proj No 78-367-02

STABILITY CALCULATIONS

@ DAM SECTION (4A/6)



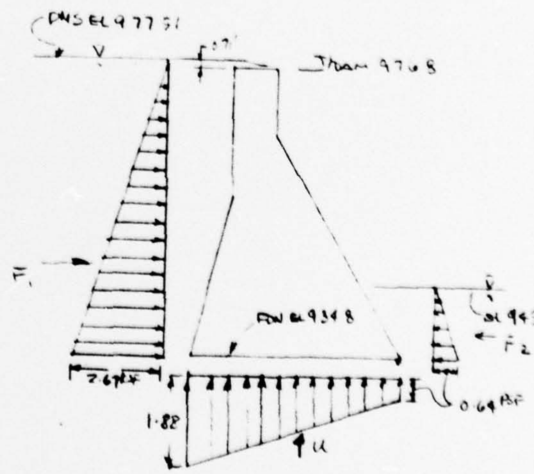
D'APPOLONIA
CONSULTING ENGINEERS INC

By ________ Date 2-13-79 Subject Ryerson Station Dam
Chkd By ESM Date ________ Proj No 78-36702

WEIGHTS

ITEMS	WEIGHT, kip	ARM to pt 'A' FT	MOMENT @ pt 'A' k-'
①	$\frac{1}{2}(5.75)(23)(0.15) = 9.92^k$	$19.2+6+\frac{5.75}{3} = 27.12'$	268.96
②	$(6)(42)(0.15) = 37.80^k$	$19.2+\frac{6}{2} = 22.20'$	839.16
③	$\frac{1}{2}(19.2)(32)(.15) = 46.08^k$	$19.2 \times \frac{2}{3} = 12.80$	589.82
	$\Sigma V = 93.8^k$		$\Sigma M_a = 1698$

uplift & water pressures



AT HEEL $p = (977.51 - 934.8)(0.0624) = 2.67$ KSF (42.71')

AT TOE $p = (945 - 934.8)(0.0624) = 0.64$ KSF (10.2')

AT HEEL uplift $p' = (965 - 934.8)(0.0624) = 1.88$ (30.2')

ITEM		ARM	M_a k-'
F_1	$= (\frac{1}{2})(2.67)(42.71) = 56.9$	$\times \frac{42.71}{3} = 14.24$	810.3
F_2	$= (\frac{1}{2})(0.64)(10.2) = -3.3$	$\times \frac{10.2}{3} = 3.4$	-11.0
	$\Sigma F_x = 53.67^k$		
U_1	$= (\frac{1}{2})(30.95)(1.88-0.64) = 19.3^k$	$\times \frac{2}{3}(30.95) = 20.6$	398.5
U_2	$= (0.64)(30.95) = 19.7$	$\times \frac{30.95}{2} = 15.5$	304.8 (703.3)
	$\Sigma F_y = 39^K$		$M_a = 1513.6 - 11 = 1502.6$

SOIL PRESSURE

ASSUME $\phi = 30°$ $K_a = 0.3$, $K_p = 3.3$ $\gamma_T = 0.11^{KCF}$, $\gamma_{sub} = 0.065^{KCF}$

ACTIVE	$P_a = \frac{1}{2}(0.3)(.065)(10)^2 = -0.98^K$		$5 + \frac{10}{3} = 8.3$	8.1
PASSIVE	$P_p = \frac{1}{2}(3.3)(0.11)(11)^2 = 21.96^K$	45.6^K	$5.2 + 5 + \frac{11}{3} = 13.87$	304.5
	$+(3.3)(.11)(11)(5.2) = 20.76^K$		$5 + \frac{5.2}{2} = 7.6$	157.80 · 481.6
	$\frac{1}{2}(3.3)(.065)(5.2)^2 = 2.90$		$5 + \frac{5}{3} = 6.67$	19.33

$\Sigma F_x = 44.6^K$ $\Sigma M_a = 473.5^K$

FACTOR SAFETY AGAINST OVER TURNING

RESISTING MOMENT (DUE TO WEIGHT, WATER AND SOIL)

$M_R = 1698 + 11 + 481.6 = 2190.6^{K\text{-}'}$

DRIVING MOMENT (DUE TO WATER PRESSURE, uplift, & SOIL)

$M_D = 810.3 + 703.3 + 8.1 = 1521.7$

$$(F.S)_{OT} = \frac{M_R}{M_D} = \frac{2190.6}{1521.7} = 1.44$$

> 1.25 ok

FACTOR SAFETY AGAINST SLIDING

EFFECTIVE F_y (VERTICAL) = (Dead Load − uplift)

$\Sigma V = 93.8 - 39^K = 54.8^K$/FT

REF COE, ETL 1110-2-184, GRAVITY DAM DESIGN STABILITY / 25 FEB 1974

SLIDING RESISTANCE = $(\Sigma V)(\tan\phi) + (S)(A)$

$$R = 54.8^K/_{FT} (\tan\phi) + (S)(3095 \text{ }) \frac{144}{1000}$$

D'APPOLONIA
CONSULTING ENGINEERS INC

By NJTC Date 2-13-79 Subject Ryerson Station Dam Sheet No. 4 of 4
Chkd. By [illegible] Date [illegible]-79 Proj No 78-[illegible]-02

According to the typical ϕ, S values given in Ref

	$\phi°$	S(psi)	R kip
Potsville Sandstone	64	1300	5906
Berea Sandstone	70°	500	2379
Massillon Sandstone	69°	420	2015 ← [illegible]
Tensleep Sandstone	47	2450	10978

Value S is considered too high, therefore use typical value of bond stress between concrete & rock = 120 psi & $\phi' = 50°$
which $\tan\phi = \tan\frac{2}{3}\phi' = 0.65$, $R = (54.8)(.65) + (120)(3.95)(\frac{144}{1000}) = 570^k/ft$
Driving force Fx (Water Pressure, Soil Pressure)

= 56.9 + 1.0

= 57.9

say $60^k/ft$

Factor of Safety = $\frac{570^k}{60} = 9.5$ >> 4 ok

if consider soil resistance

Sliding Resistance = Passive Soil Pressure + friction

= $446^k + 570^k$

= $44.6^k + 570^k$

= 614.6^k

$F.S. = \frac{614.6}{60} = 10.2$

DAM IS STABLE UNDER PMS CONDITION WITH FACTOR SAFETY OF 1.4 & 9 AGAINST OVERTURNING & SLIDING, RESPECTIVELY

APPENDIX E

REGIONAL GEOLOGY

APPENDIX E
REGIONAL GEOLOGY

Ryerson Station State Park Dam is located on strata of the Washington Formation (Dunkard Group, Pennsylvanian-Permian Age). The site is located just east of the axis of the northeast trending Washington Anticline. In the vicinity of the dam, the bedding dips gently to the southeast at approximately 50 feet per mile.

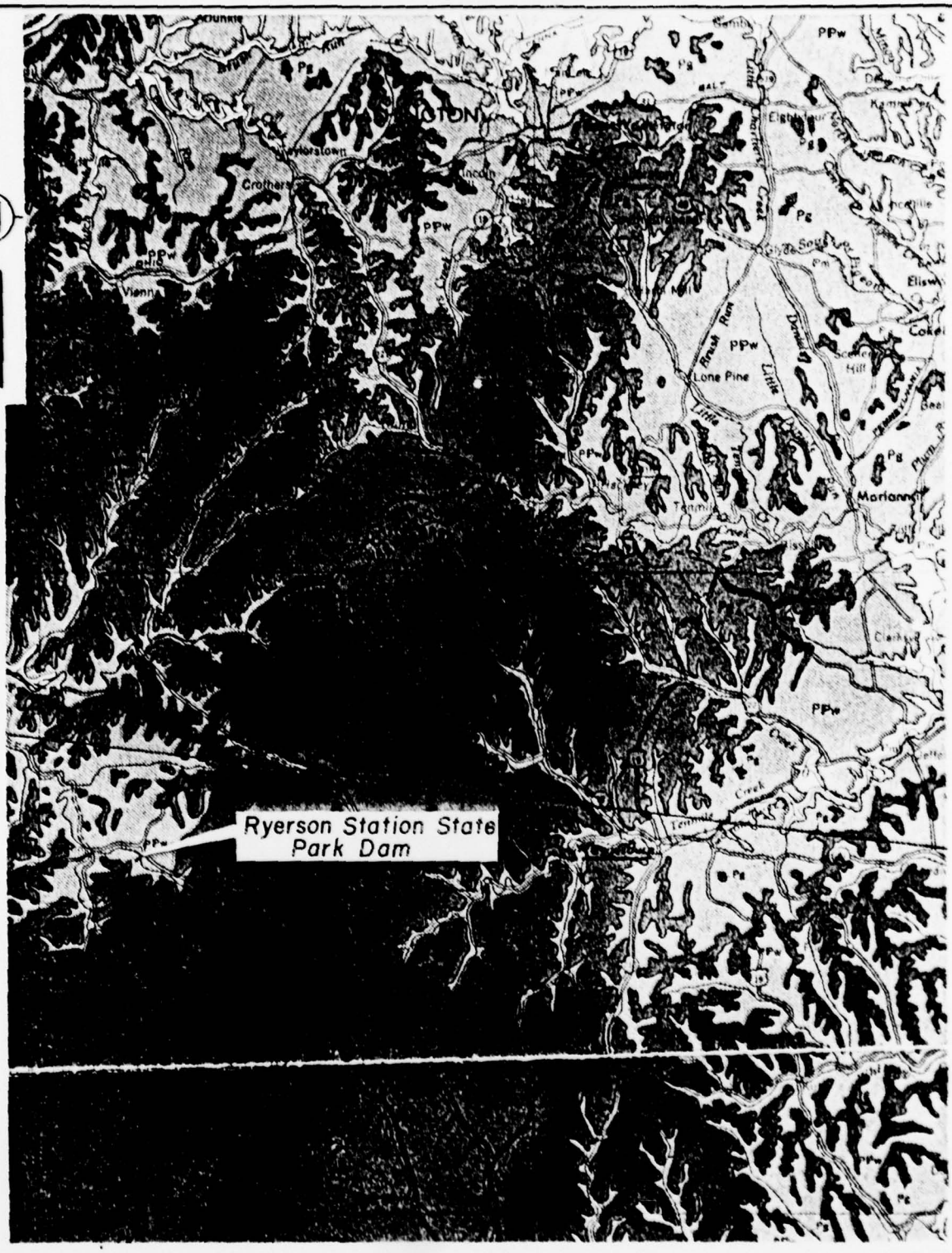
The Washington Formation consists of interbedded shale and sandstone with several coal seams. In the upper portion of the formation, in the slopes above the dam, there is a relatively thick limestone bed. This seam may be 30 or more feet thick and is interbedded with thin shale beds. Below the limestone is a thick sequence of dark gray shale and claystone, which overlies a relatively thin sequence of limestone and shales. The Washington coal seam separates the limestone from the underlying Waynesburg Sandstone, a gray massive coarse-grained sandstone. The Waynesburg coal marks the top of the Monongahela Group with the Pittsburgh coal seam marking the base.

While there are several coal seams in the rock strata, only three are minable. The Washington coal has been mined northwest of the dam in several country bank mines. However, thick shale partings in the coal prevent the seam from being economically minable on a large scale.

The Waynesburg coal seam has been mined northwest of the dam where it outcrops. Although it is five to seven feet thick in places, its variability and high sulfur content and the presence of shale partings prevent its mining on a large scale. It probably occurs just below the dam.

The Pittsburgh coal seam occurs approximately 400 feet below the ground surface. The depth of the seam has previously prevented its exploitation. However, it is a valuable seam and is economically minable at present.

DRAWN BY	ACS	CHECKED BY	JE	3/19/79	DRAWING NUMBER 78- -7-A24
	3-1-79	APPROVED BY	JMP	3.19.79	



SCALE

0 2 4 6 8 10 miles

RYERSON STATION STATE PARK DAM

GEOLOGY MAP

REFERENCE:

GEOLOGIC MAP OF PENNSYLVANIA PREPARED BY COMMONWEALTH OF PENNA, DEPT. OF INTERNAL AFFAIRS, DATED 1960, SCALE 1" = 4 MILES

DRAPER DIAGNOSTICS

DRAWN BY	ACS	CHECKED BY	BE	2-6-79	DRAWING NUMBER 78- 7-A22
	2-5-79	APPROVED BY	JHP	2-6-79	

GROUP	FORMATION		DESCRIPTION
	Alluvium	Qt	Sand, gravel, clay.
	Terrace deposits		Sand, clay, gravel on terraces above present rivers; includes Carmichaels Formation.
DUNKARD	Greene		Cyclic sequences of sandstone, shale, red beds, thin limestones and coals.
	Washington	Pw	Cyclic sequences of sandstone, shale, limestone, and coal; contains Washington coal bed at base.
	Waynesburg		Cyclic sequences of sandstone, shale, limestone and coal; contains Waynesburg coal bed at base.
MONONGAHELA		Pm	Cyclic sequences of shale, limestone, sandstone and coal; contains Pittsburgh coal bed at base.
CONEMAUGH	Casselman	Pcc	Cyclic sequence of sandstone, shale, red beds and thin limestone and coal.
	Ames		
	Glenshaw	Pcg	Cyclic sequences of sandstone, shale, red beds and thin limestone and coal; several fossiliferous limestone; Ames limestone bed at top.
ALLEGHENY	Vanport	Pa	Cyclic sequences of shale, sandstone, limestone, and coal; contains Brookville coal at base and Upper Freeport coal at top; within group are the commercial Vanport limestone and Kittanning and Clarion coals.

GEOLOGY MAP LEGEND

REFERENCE:
GREATER PITTSBURGH REGION GEOLOGIC MAP
COMPILED BY W.R. WAGNER, J.L. CRAFT, L. HEYMAN
AND J.A. HARPER, DATED 1975, SCALE 1:125000