

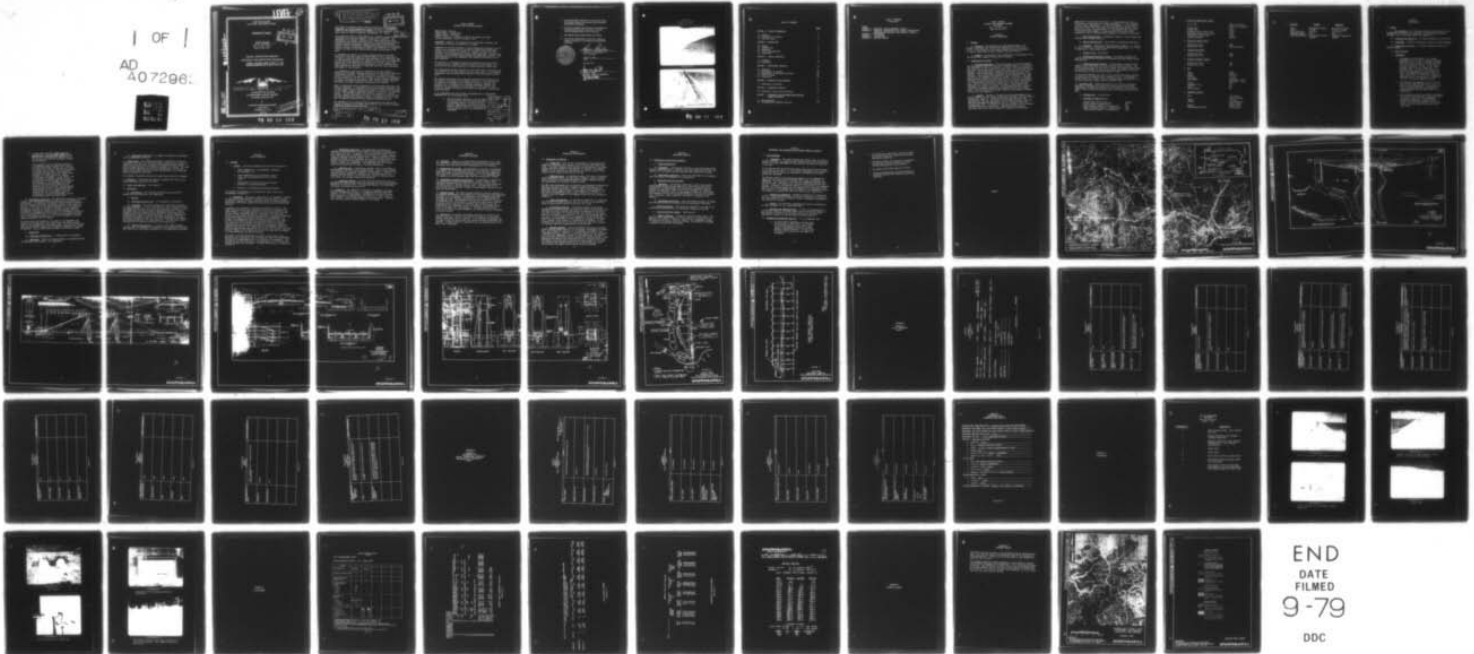
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D'APPOLONIA CONSULTING ENGINEERS INC PITTSBURGH PA
NATIONAL DAM INSPECTION PROGRAM. KYLE DAM (NDI ID NUMBER PA-417--ETC(U)
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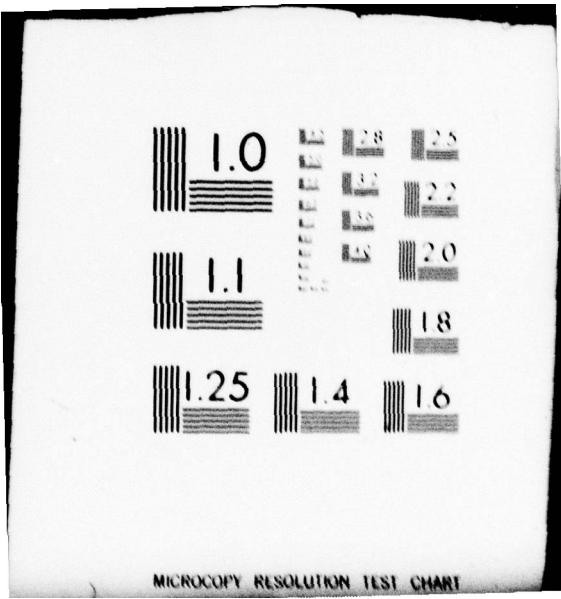
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MICROCOPY RESOLUTION TEST CHART

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KYLE RUN, JEFFERSON COUNTY

PENNSYLVANIA

KYLE DAM

NDI I.D. NO: PA-417

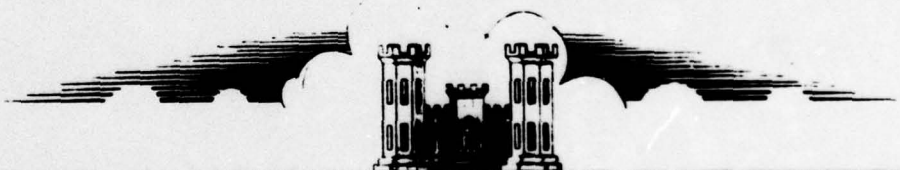
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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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Contract # DAC W31-79-C-0014

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

JUNE 1979

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6 National Dam Inspection Program.
Kyle Dam (NDI ID Number PA-417 DER ID
Number 33-1), Ohio River Basin, Kyle
Run, Jefferson County, Pennsylvania.
Phase I Inspection Report.

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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.

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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.

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PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

NAME OF DAM: Kyle Dam
 STATE LOCATED: Pennsylvania
 COUNTY LOCATED: Jefferson
 STREAM: Kyle Run, a secondary tributary of Sandy Lick Creek
 DATE OF INSPECTION: April 5 and May 4, 1979

ASSESSMENT: Based on the evaluation of the existing conditions, the condition of Kyle Dam is considered to be good.

Comparison of as-built drawings to field observations indicates that the riprap on the upstream face of the dam has significantly dislocated relative to its original configuration. However, in spite of this movement, the riprap appears to be performing adequately. Nevertheless, the owner should consider rehabilitating the riprap when practical. The remaining portions of the embankment were examined and found to be in good condition.

The concrete in the emergency spillway overflow structure was found to be deteriorating. However, this deterioration does not appear to be affecting the structural stability of these structures at this time.

Fish Commission personnel reported that the outlet works sluice gate for the reservoir has not been operated in the recent past. It is therefore recommended that the operational condition of the sluice gate be evaluated.

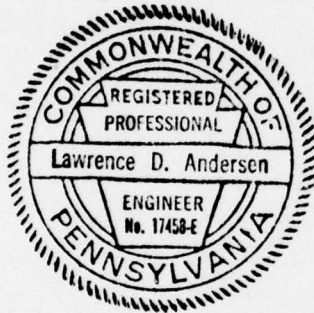
The spillway cannot pass the recommended spillway design flood of full PMF without overtopping the embankment; therefore, it is classified to be inadequate according to the recommended criteria. However, the spillway is not considered to be seriously inadequate because it is estimated that overtopping of the embankment by less than 0.1 foot during the passage of 50 percent PMF would not constitute a significant breach potential.

It is recommended that the following recommendations be implemented immediately or on a continuing basis:

1. The owner should immediately initiate additional studies to more accurately ascertain the spillway capacity and the nature and extent of improvements required to provide adequate spillway capacity. Filling of the low area on the crest of the dam should be considered.

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2. The operational condition of the outlet works sluice gate should be evaluated and necessary maintenance performed.
3. Necessary remedial work should be performed on the spillway concrete structures to avoid further deterioration of the concrete.
4. The animal burrow holes should be filled.
5. The dam and appurtenant structures should be inspected regularly and necessary maintenance performed.



Lawrence D. Andersen

Lawrence D. Andersen, P.E.
Vice President

June 25, 1979
Date

Approved by:

James W. Peck

JAMES W. PECK
Colonel, Corps of Engineers
District Engineer

27 July 1979
Date

KYLE DAM
NDI I.D. NO. PA-417
APRIL 5, 1979



Upstream Face



Downstream Face

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PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM
KYLE DAM
NDI I.D. NO. PA-417
DER I.D. NO. 33-1

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

a. Dam and Appurtenances. Kyle Dam consists of an earth embankment approximately 1000 feet long with a maximum height of 33 feet from the downstream toe and a crest width of 12 feet. The flood discharge facilities for the dam consist of two open channels, one located on each abutment. The 50-foot-wide rectangular concrete channel on the left abutment (looking downstream) constitutes the primary spillway of the reservoir. The 71-foot-wide rectangular concrete channel on the right abutment is the emergency spillway of the dam. The crest of the emergency spillway is about 0.9 foot above the crest level of the primary spillway, as measured during this inspection. The outlet works consist of a reinforced concrete intake tower, two 12-inch cast-iron supply pipes, and two 30-inch cast-iron outlet pipes. Pipes through the embankment are encased in concrete. Flow through the outlet pipes is controlled by manually operated sluice gates located in the intake tower. The two 30-inch outlet pipes constitute the emergency drawdown facility for the reservoir. ← ABSTRACT

b. Location. The dam is located on Kyle Run approximately two miles northwest of Falls Creek in Washington Township, Jefferson County, Pennsylvania (Plate 1). Downstream from the dam, Kyle Run flows approximately 1000 feet east where it flows under Interstate Route 80, and joins Beaverdam Run immediately south of Interstate Route 80, forming Falls Creek. The valley of Kyle Run upstream of its confluence with Beaverdam Run is uninhabited. Downstream from Interstate Route 80, Falls Creek flows southeasterly towards the residential

areas west of the town of Falls Creek. It flows around the town of Falls Creek, joining Sandy Lick Creek approximately 1/2 mile southeast of Falls Creek, Pennsylvania. At least five homes at the west end of the town of Falls Creek are within the potential flood plain of Falls Creek in the event of a dam failure. It is estimated that failure of the dam would cause damage at Interstate Route 80 and would cause significant loss of life and property damage in the town of Falls Creek.

c. Size Classification. Intermediate (based on 33-foot height and 2300 acre-feet storage capacity).

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

e. Ownership. Pennsylvania Fish Commission (address: Mr. Edward R. Miller, Director of Bureau of Fisheries and Engineering, R. D. 3, Box 70, Bellefonte, Pennsylvania 16823).

f. Purpose of Dam. Recreation.

g. Design and Construction History. The dam was designed and constructed by Buffalo, Rochester & Pittsburgh Railroad Company during 1909 and 1910.

h. Normal Operating Procedure. The reservoir is normally maintained at the crest level of the uncontrolled primary spillway. The inflow occurring when the lake is at or above the primary spillway level is discharged through the uncontrolled primary and emergency spillways. The outlet works sluice gates are normally closed.

In the design drawings, the crest of the uncontrolled primary spillway is shown to be at Elevation 1533. However, in the U.S. Geological Survey (USGS) Falls Creek 7.5-minute quadrangle map, photorevised 1973, the pool elevation is shown to be at Elevation 1550.

1.3 Pertinent Data. Elevations referred to in this and subsequent sections of the report were calculated based on approximate field measurements assuming the spillway crest elevation to be 1550 (USGS Datum), which is the pool elevation shown in the above-referenced USGS map.

a. Drainage Area - 6 square miles

b. Discharge at Dam Site (cfs)

Maximum known flood at dam site	Unknown
Outlet conduit at maximum pool	150
Gated spillway capacity at maximum pool	N/A
Ungated spillway capacity at maximum pool	3930
Total spillway capacity at maximum pool	3930

c. Elevation (USGS Datum) (feet)

Top of dam	1555.4 (low spot)
	1556.5 (as designed)
Maximum pool	1555.4
Normal pool	1550
Upstream invert outlet works	1525+
Downstream invert outlet works	1520+
Streambed at center line	1519+
Maximum tailwater	Unknown

d. Reservoir Length (feet)

Normal pool level	5000
Maximum pool level	6000 (estimated)

e. Storage (acre-feet)

Normal pool level	1440
Maximum pool level	2300

f. Reservoir Surface (acres)

Normal pool level	138
Maximum pool level	180

g. Dam

Type	Earth
Length	1000 feet
Height	33 feet
Top width	12 feet
Side slopes	Downstream: 2H:1V Upstream: 2.5H:1V
Zoning	Yes
Impervious core	Yes
Cutoff	Yes
Grout curtain	No

h. Regulating Outlet

Type	Two 30-inch cast-iron pipes
Length	166 feet
Closure	Sluice gates at control tower
Access	Control tower
Regulating facilities	Sluice gates

1. Spillway

Primary

Emergency

Type -	Rectangular channel	Rectangular channel
Length -	50 feet	71 feet 4 inches
Crest elevation -	1550 feet	1550.9 feet
Upstream channel -	Lake	Lake
Downstream channel -	Rectangular concrete channel	Riprapped trapezoidal 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), and by the Pennsylvania Fish Commission.

- (1) Hydrology and Hydraulics. No design information is available.
- (2) Embankment. Available information consists of design drawings.
- (3) Appurtenant Structures. Available information consists of design drawings.

b. Design Features

(1) Embankment

- a. As designed, the dam (Plate 2) is a zoned embankment (Plate 3) with a reinforced concrete cutoff wall at the center of the dam extending from the foundation level to the dam crest for the entire length of the dam. In the design drawings, three zones are identified: (1) "selected clay" - a zone 12 feet wide at the base of the dam tapering to zero thickness at crest level immediately upstream of the concrete cutoff wall; (2) "clay fill" forming the upstream shell of the dam; and (3) "shale and clay fill" forming the downstream slope.
- b. The embankment was designed to have a 2H to 1V slope on the downstream face and a 2.5H to 1V slope on the upstream face. The upstream face of the dam was protected with hand-placed riprap extending from the crest level to the upstream toe.
- c. The reinforced concrete cutoff wall was designed to be 8 feet thick from the foundation of the core walls to the base of the embankment. Through the embankment, the width of the concrete core wall was uniformly reduced from 8 feet at the base level to one foot at the crest level.

- d. A state report entitled, Report Upon the Application of the Kyle Water Company, dated June 20, 1913, describes the construction of the concrete core wall and foundation preparation as follows:

"The foundation for the core-wall was dug to a considerable depth, varying from 8 feet at the south end to about 28 feet near the center of the dam, and to only a few feet at the north end, where rock was found. The foundation consisted for almost the entire length of the core-wall of a hard yellow clay, having a consistency of hardpan. In the central part of the valley the surface material on the upstream side of the core-wall was removed for the foundation of the embankment to a depth equal to that excavated in preparing the foundation for the core-wall, this excavation being carried 20 feet on the upstream side of the core-wall and for a length of 175 feet parallel with it, the excessive depth of foundation at this point being made to bring the foundation below a pervious wash."

(2) Appurtenant Structures. The appurtenant structures of the dam consist of two open-channel spillways located on each abutment and outlet works. A 50-foot-wide rectangular concrete channel located on the left abutment constitutes the primary spillway of the reservoir (Plate 4). The crest of the primary spillway is 5.3 feet below the low point on the crest of the dam, as surveyed in this inspection. The emergency spillway is located on the right abutment and also consists of a rectangular concrete channel. The emergency spillway is 71.3 feet wide and its crest is 0.9 foot above the primary spillway crest. The approach channels for both of the spillways are unlined channels excavated into the abutment.

The outlet works are located at the center of the embankment and consist of two 30-inch cast-iron outlet pipes and concrete intake tower at the upstream end of the outlet pipes. The two 30-inch outlet pipes and two 12-inch supply lines through the embankment are encased in concrete. Plate 5 illustrates the details of the outlet works.

c. Design Data

- (1) Hydrology and Hydraulics. No design data are available.
- (2) Embankment. Other than design drawings, no engineering data are available on the design of the embankment.

(3) Appurtenant Structures. No design calculations are available for the appurtenant structures.

2.2 Construction. Very limited information is available on the construction of the dam. The 1913 state report indicates that the dam was constructed by the Buffalo, Rochester & Pittsburgh Railroad Company under the supervision of their division engineer, Mr. Cleaver. The same report further indicates that while the upstream shell section was placed in horizontal layers and rolled, the material in the downstream shell was wetted but not rolled.

The available information indicates no major post-construction changes.

2.3 Operation. Fish Commission personnel reported that there are no formal operating records for this dam.

2.4 Other Investigations. None reported.

2.5 Evaluation

a. Availability. The available information was provided by PennDER and the Pennsylvania Fish Commission.

b. Adequacy

(1) Hydrology and Hydraulics. No information is available.

(2) Embankment. The dam was apparently constructed according to the design drawings. In view of the age of the dam, completed in 1910, the design approach and construction techniques are not likely to be in conformance with currently accepted engineering practices. Design documents lack such considerations as embankment slope stability and seepage analyses and other quantitative data to aid the assessment of the adequacy of design. However, the design incorporated such components as embankment zoning, the cutoff wall extending to the impervious foundation material, and slope protection. The 1913 state report indicates that the dam was constructed with adequate care.

(3) Appurtenant Structures. A review of the design drawings indicates that, as designed, no significant design deficiencies existed that would affect the overall performance of the appurtenant structures.

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. General. The on-site inspection of Kyle Dam consisted of:

1. Visual inspection of the embankment, abutments, and embankment toe.
2. Visual examination of the spillways, intake tower, and the downstream end of the outlet conduit.
3. Observations of factors affecting the runoff potential of the drainage basin.
4. Evaluation of downstream area hazard potential.

The specific observations are illustrated on Plate 6 and in the photographs in Appendix C.

b. Embankment. The general inspection of the embankment consisted of searching for indications of structural distress, such as cracks, subsidence, bulging, wet areas, seeps and boils, and observing general maintenance conditions, vegetative cover, erosion, and other surficial features.

In general, the condition of the dam is considered to be good. One swampy and one wet area were found below the toe of the dam near the right abutment. No seepage appeared to be associated with the areas and the observed conditions are not considered to be significant, relative to the overall performance of the dam. A wet area was observed on the downstream slope at about midheight of the embankment. No seepage or sloughing was found to be associated with this wet area. At least three animal burrow holes were noted adjacent to this wet area along the toe of the dam. The upstream face of the dam was inspected with the shoreline being found to be irregular, apparently caused by wave action. The riprap near the left abutment, which is protected against large wave action, was found to be in better condition than the riprap over the middle one-third of the dam, which is exposed to waves generated by the prevailing winds.

The crest of the dam was surveyed, relative to the primary crest elevation, and it was found that the middle one-third of the embankment has settled by approximately one foot relative to the abutments. The low spot on the crest was found to be approximately 5.4 feet above the primary spillway crest elevation. The dam crest profile is illustrated on Plate 7.

c. Appurtenant Structures. The appurtenant structures were examined for deterioration or other signs of distress and obstructions that would limit flow. In general, the structures were found to be in good condition except for spalling of the concrete in various locations along the emergency spillway channel walls. Concrete spalling in the emergency spillway is not considered to be to such an extent that would affect the structural performance of the emergency spillway walls. However, repairs are recommended. The downstream ends of the outlet pipes were observed with no signs of distress being noted.

d. Reservoir Area. A map review indicates that the watershed is predominantly covered by wood and pasturelands. Several rural residential buildings are scattered throughout the watershed. A review of the regional geology (Appendix E) indicates that the shorelines of the reservoir are not likely to be susceptible to massive landslides which would affect the storage volume of the reservoir.

e. Downstream Channel. Kyle Run flows under Interstate Route 80 approximately 1000 feet downstream from the dam, and then joins Beaverdam Run Dam to form Falls Creek. A further description of the downstream conditions is included in Section 1.2b.

3.2 Evaluation. The condition of the dam is considered to be good. However, the spalling concrete in the emergency spillway should be repaired to avoid further damage. Although over the years the hand-placed riprap on the upstream slope has moved due to wave action, it still appears to be providing adequate erosion protection. Nevertheless, the owner should consider repairs to the riprap.

SECTION 4
OPERATIONAL FEATURES

4.1 Procedure. There are no formal operating procedures for the dam. The reservoir is normally maintained at the uncontrolled primary spillway crest level with excess inflow discharging over the spillways.

4.2 Maintenance of the Dam. The maintenance of the dam is considered to be good. The crest and downstream face of the dam are covered with grass and appear to be periodically mowed. Some brush and vegetation were found to be growing on the upstream face. It is recommended that the vegetation on the upstream slope should be periodically cleared.

4.3 Maintenance of Operating Facilities. The maintenance condition of the operating facilities is considered to be good. However, Fish Commission personnel reported that the outlet conduit sluice gates have not been operated in the last several years. The operation of the sluice gates was not observed, because the operational condition of the gates was questionable.

4.4 Warning System. The formal warning system for Kyle Dam consists of an emergency preparedness plan prepared by the Pennsylvania Fish Commission. According to the procedure, the Pennsylvania Fish Commission Waterways Patrolmen have been assigned responsibility for the implementation of the emergency plan. The emergency operation plan consists of initiation of around-the-clock surveillance by the patrolmen when certain signs of distress listed in the plan are identified and notification of the Pennsylvania Fish Commission, local civil defense, and PennDER offices as to the existence of a dam emergency. The plan requires further action to be taken as jointly decided by the various officials following an on-site meeting.

4.5 Evaluation. The overall maintenance condition of the dam is considered to be good. However, the operational condition of the outlet conduit sluice gates was not observed. It is therefore recommended that the owner operate the sluice gates and perform necessary maintenance, as required. Periodic removal of vegetation from the upstream face of the dam is also recommended.

SECTION 5
HYDRAULICS AND HYDROLOGY

5.1 Evaluation of Features

a. Design Data. Kyle Dam has a watershed of 6 square miles and impounds a reservoir with a surface area of 130 acres at normal pool level. The flood discharge facilities for the dam consist of two open-channel spillways located on each abutment of the dam. The combined capacity of the spillways was determined to be 3930 cfs with no free-board at the low spot on the crest of the dam.

b. Experience Data. As previously stated, Kyle 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 utilizing the Dam Safety Version of the HEC-1 computer program developed by the Hydrologic Engineering Center of the U.S. Army, Corps of Engineers. Data used for the computer analysis are presented in Appendix D. The PMF inflow hydrograph was found to have a peak flow of 11,517 cfs. Computer input and summary of the computer output are also included in Appendix D.

c. Visual Observations. On the date of inspection, no conditions were observed that would indicate that the capacity of the spillways would be significantly 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 spillways can pass 40 percent PMF without overtopping the low spot on the crest of the dam. For 50 percent PMF, the low spot on the crest would be overtopped for a duration of 2.7 hours with a maximum depth of 0.35 foot. It is estimated that overtopping of the dam during the passage of 50 percent PMF may cause significant erosion on the embankment. However, total failure is considered to be unlikely. It is estimated that filling of the low area on the dam crest will increase the spillway capacity to approximately 60 percent PMF.

e. Spillway Adequacy. Since the spillway cannot pass the recommended spillway design flood of full PMF without overtopping the embankment, the spillway is classified to be inadequate according to the recommended criteria. However, the spillway capacity is not considered to be seriously inadequate, because it is estimated that the dam can pass 50 percent PMF without posing a significant breach potential. This conclusion was based on the observation that the concrete cutoff wall extending to the crest level would prevent rapid erosion of the crest; and, further, well established grass on the downstream slope would provide protection against rapid erosion during overtopping.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

(1) Embankment. As discussed in Section 3, the field observations did not reveal any signs of distress that would significantly affect the stability of the dam at this time and none were reported in the past.

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

b. Design and Construction Data

(1) Embankment. The dam was constructed in 1910, when limited understanding of geotechnical behavior of earth structures existed. Consequently, available design and construction information does not provide any quantitative data to aid in the assessment of stability. However, as previously noted, the dam appears to have been constructed with adequate care and has performed satisfactorily since its construction. Therefore, static stability of the dam is considered to be adequate.

(2) Appurtenant Structures. Other than design drawings, no design and construction data are available for 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 visual observations, 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 observations indicate that Kyle Dam is in good condition. No conditions were observed that would significantly affect the overall performance of the structure and none were reported in the past.

It is reported that the outlet pipe sluice gates have not been operated in the last several years. It is therefore recommended that the operational condition of the outlet pipe gate be evaluated and necessary maintenance performed.

The spillway capacity was evaluated according to the recommended procedure and was found to pass 40 percent PMF without overtopping the embankment. This capacity is less than the recommended spillway capacity of full PMF. according to the size and hazard classification for the dam. Therefore, the spillway capacity is classified to be inadequate. However, the spillway capacity is not considered to be seriously inadequate because it is estimated that overtopping of the embankment during the passage of 50 percent PMF would not likely cause a dam failure.

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

c. Urgency. The following recommendations should be implemented as soon as possible or on a continuing basis.

d. Necessity for Additional Data. In view of the inadequacy of the spillway capacity, the owner should initiate additional studies to more accurately ascertain the spillway capacity and the extent of improvements required to provide adequate spillway capacity.

7.2 Recommendations/Remedial Measures. It is recommended that:

1. The owner should immediately initiate additional studies to more accurately ascertain the spillway capacity and the nature and extent of improvements required to provide adequate spillway capacity. Filling of the low area on the crest of the dam should be considered.

2. The operational condition of the outlet works sluice gate should be evaluated and necessary maintenance performed.
3. Necessary remedial work should be performed on the spillway concrete structures to avoid further deterioration of the concrete.
4. The animal burrow holes should be filled.
5. The dam and appurtenant structures should be inspected regularly and necessary maintenance performed.

PLATES

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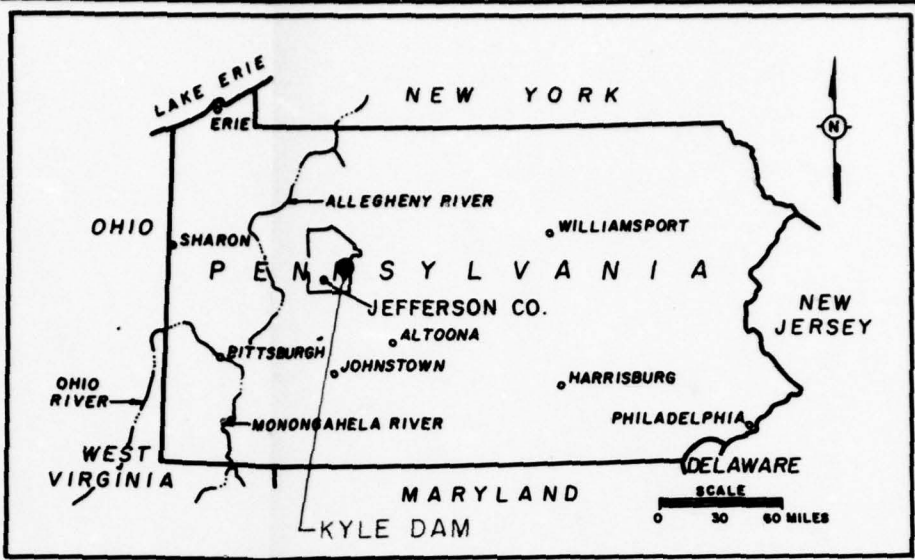
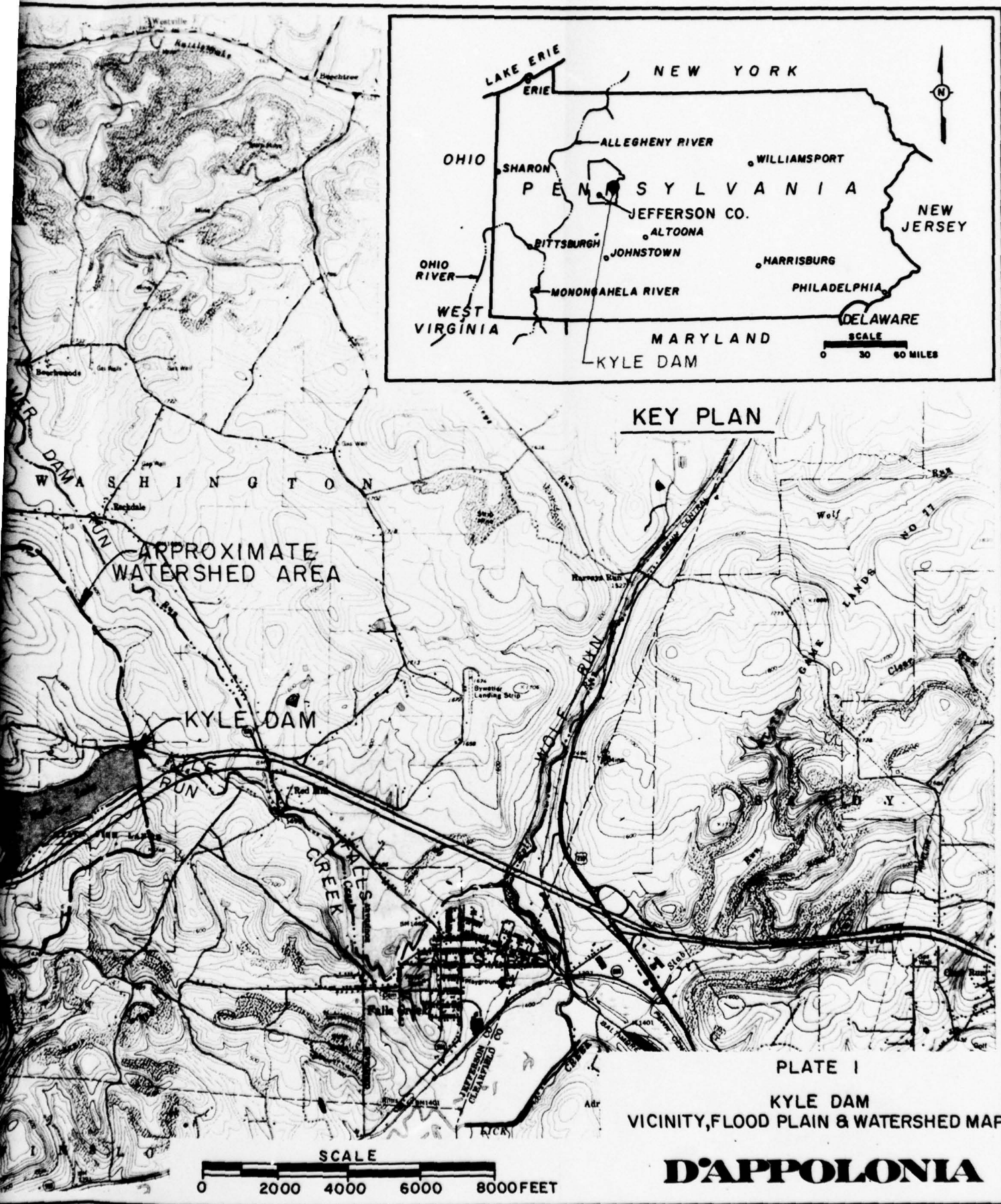
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REFERENCES:

1. U.S.G.S. 7.5' FALLS CREEK, PA. QUADRANGLE
PHOTOREVISED 1973, SCALE 1:24,000
2. U.S.G.S. 7.5' HAZEN, PA. QUADRANGLE
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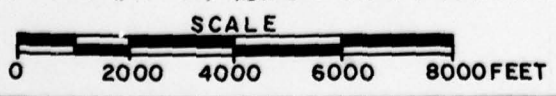


APPROXIMATE
WATERSHED AREA

KYLE DAM

KEY PLAN

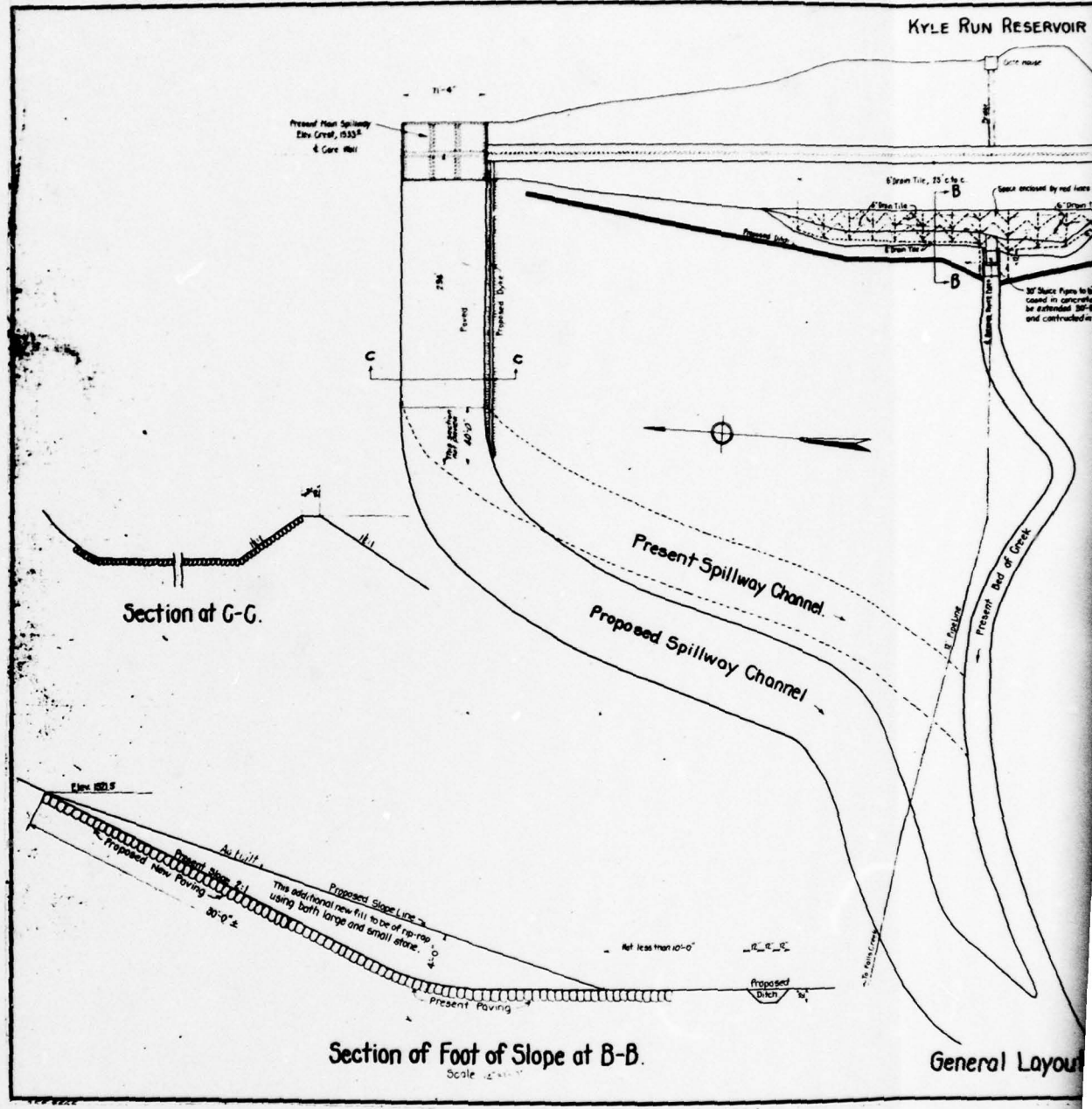
PLATE I
KYLE DAM
VICINITY, FLOOD PLAIN & WATERSHED MAP



D'APPOLONIA

2

DRAWN BY ACS CHECKED BY *BE* DRAWING NUMBER 78-367-B120
 BY 5-22-79 APPROVED BY *SPD* 6.5.79



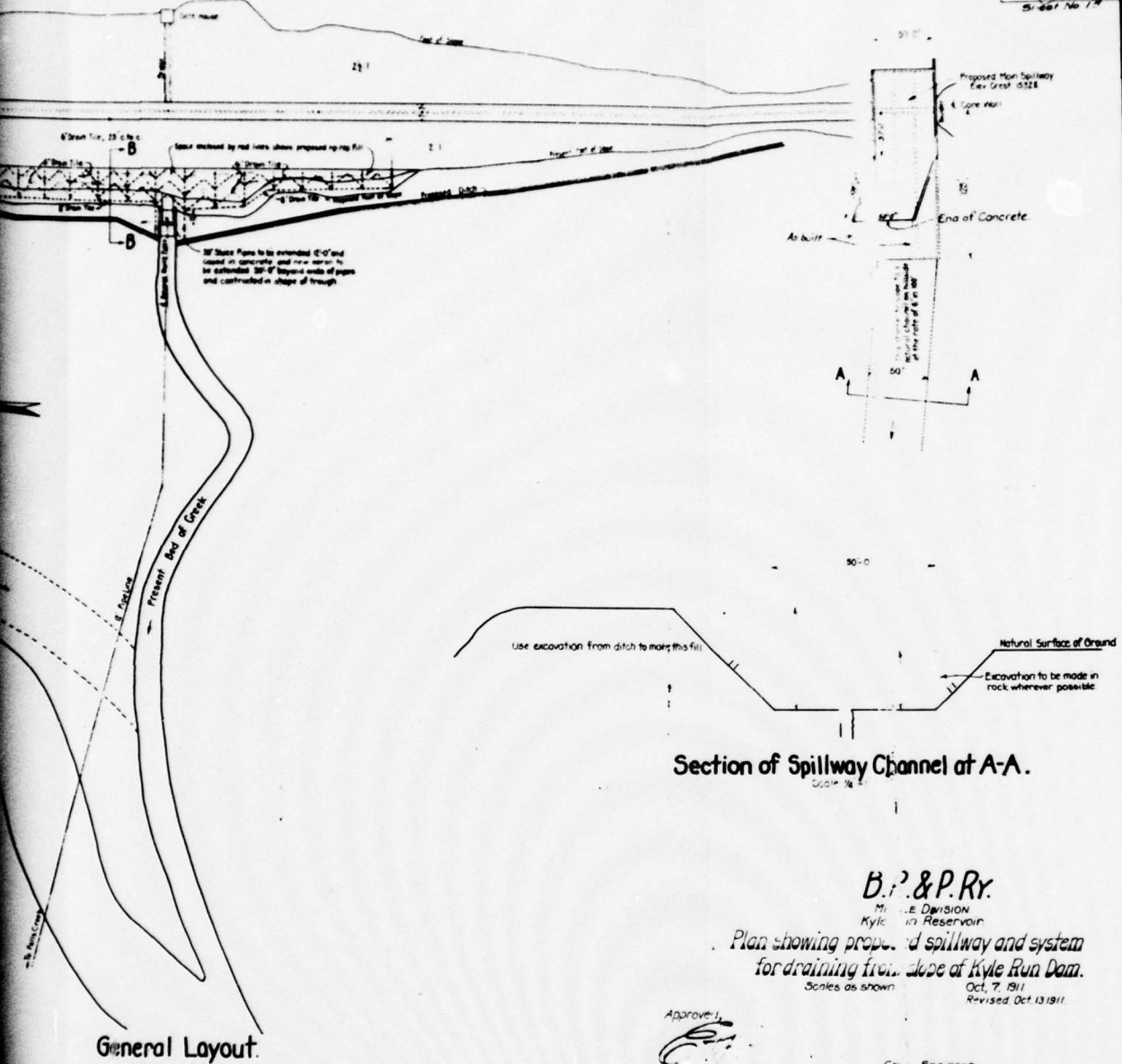
Section at G-G.

Section of Foot of Slope at B-B.
 Scale 1/4" = 10'-0"

General Layout

KYLE RUN RESERVOIR

51-261 No. 174



General Layout.

Section of Spillway Channel at A-A.

B. & P. Ry.

MILE DIVISION
Kyle Run Reservoir

Plan showing proposed spillway and system
for draining from slope of Kyle Run Dam.

Scales as shown

Oct. 7, 1911
Revised Oct. 13, 1911.

Approved
[Signature]

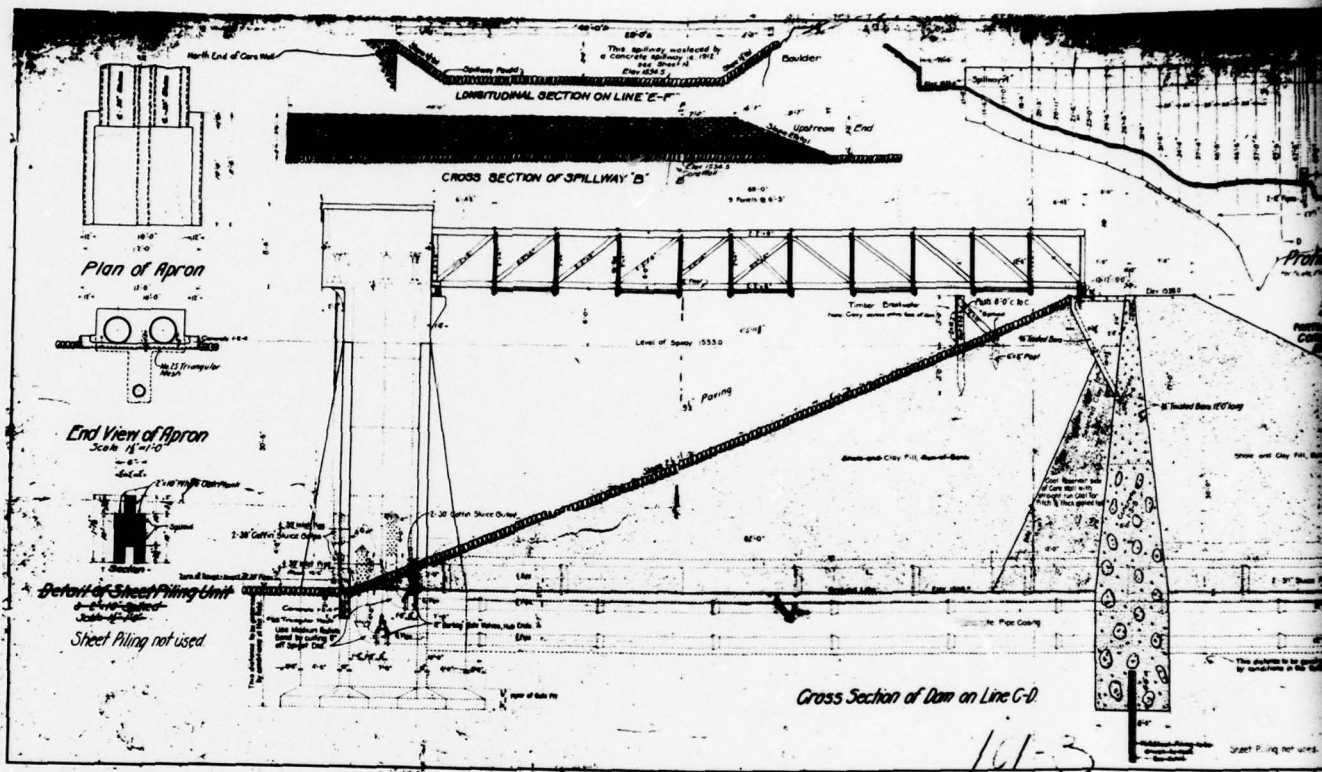
Chief Engineer

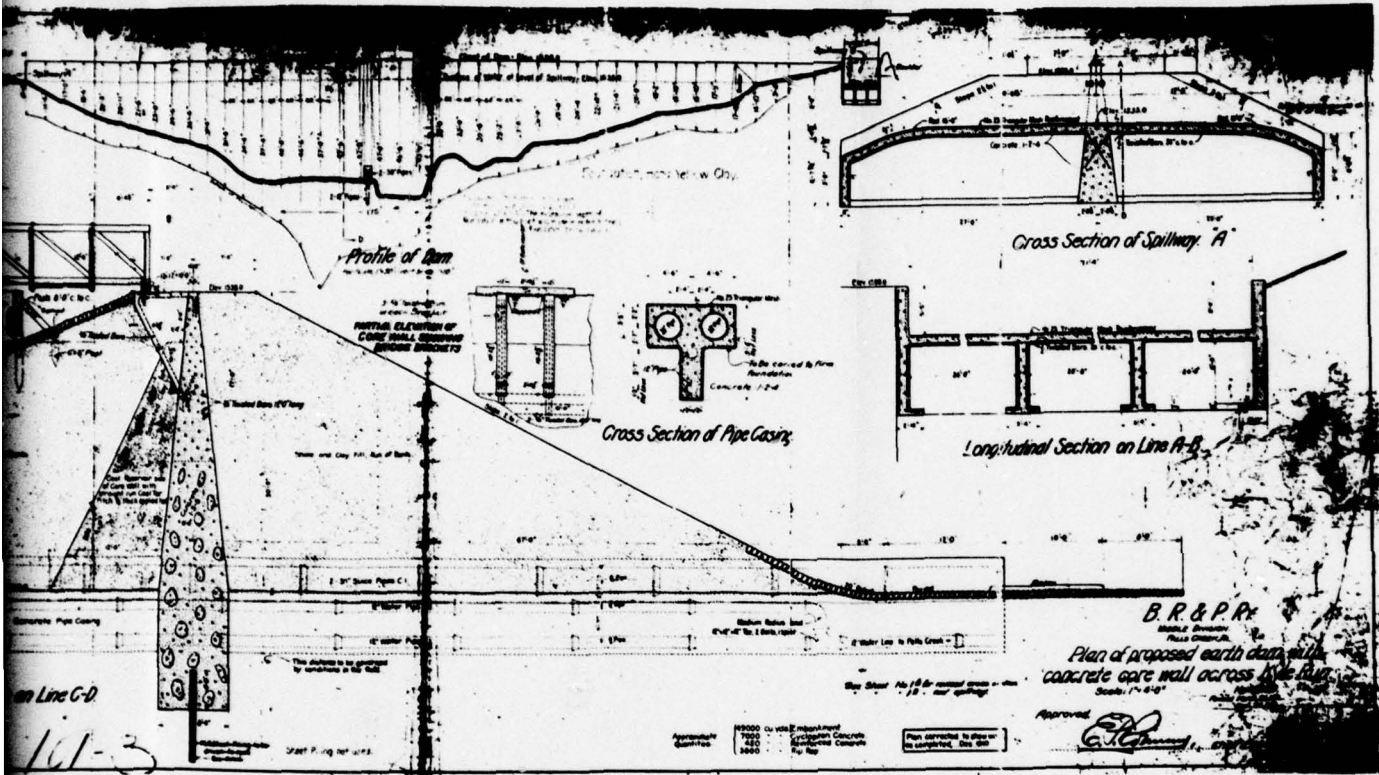
2

PLATE 2

D'APPOLONIA

DRAWN BY ACS CHECKED BY BE 6-4-79 DRAWING NUMBER 78-367-B121
 APPROVED BY STP 6.5.79



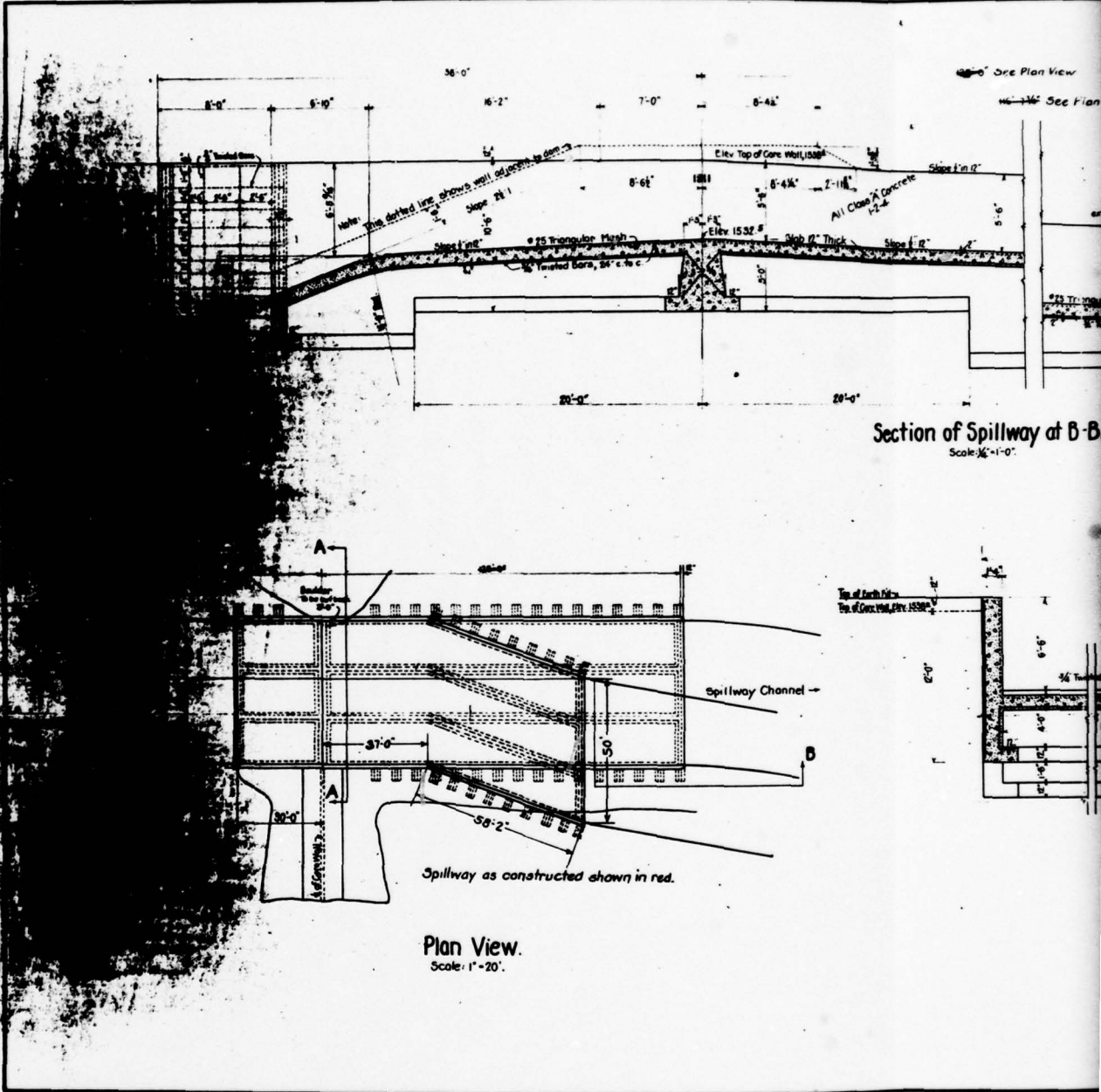


2

PLATE 3

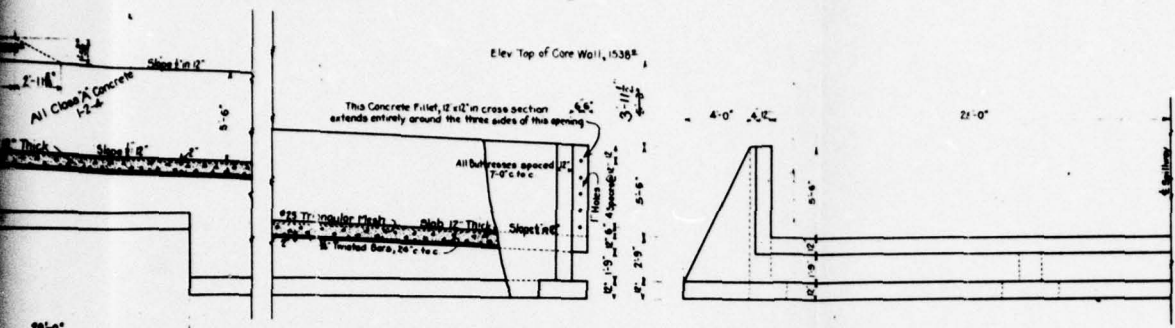
D'APPOLONIA

DRAWN BY	ACS	CHECKED BY	6-1-79	DRAWING NUMBER	78-367-B122
BY	5-22-79	APPROVED BY	6/5/79		



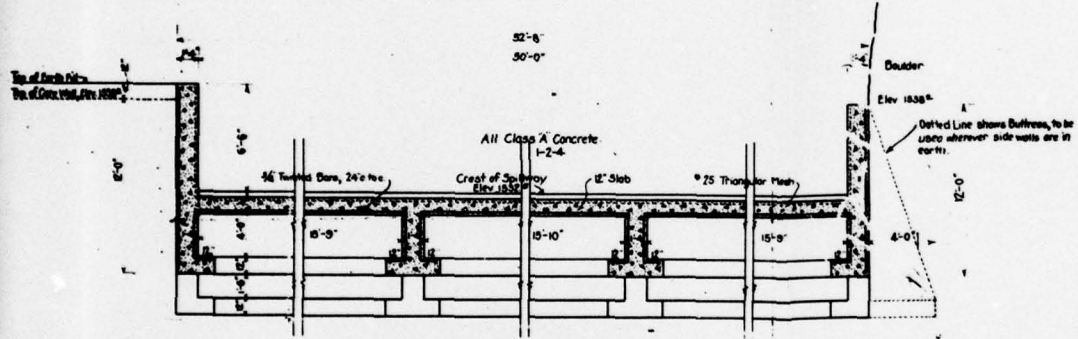
Drawn by: E. O. F.
 Checked by: H. P. G.
 Corrected: J. W. C.
 Office Eng.
 Sheet No. 14

See Plan View
 See Plan View



Section of Spillway at B-B.
 Scale: 1/4" = 1'-0"


Half End Elevation.
 Scale: 1/4" = 1'-0"



Section of Spillway at A-A.
 Scale: 1/4" = 1'-0"

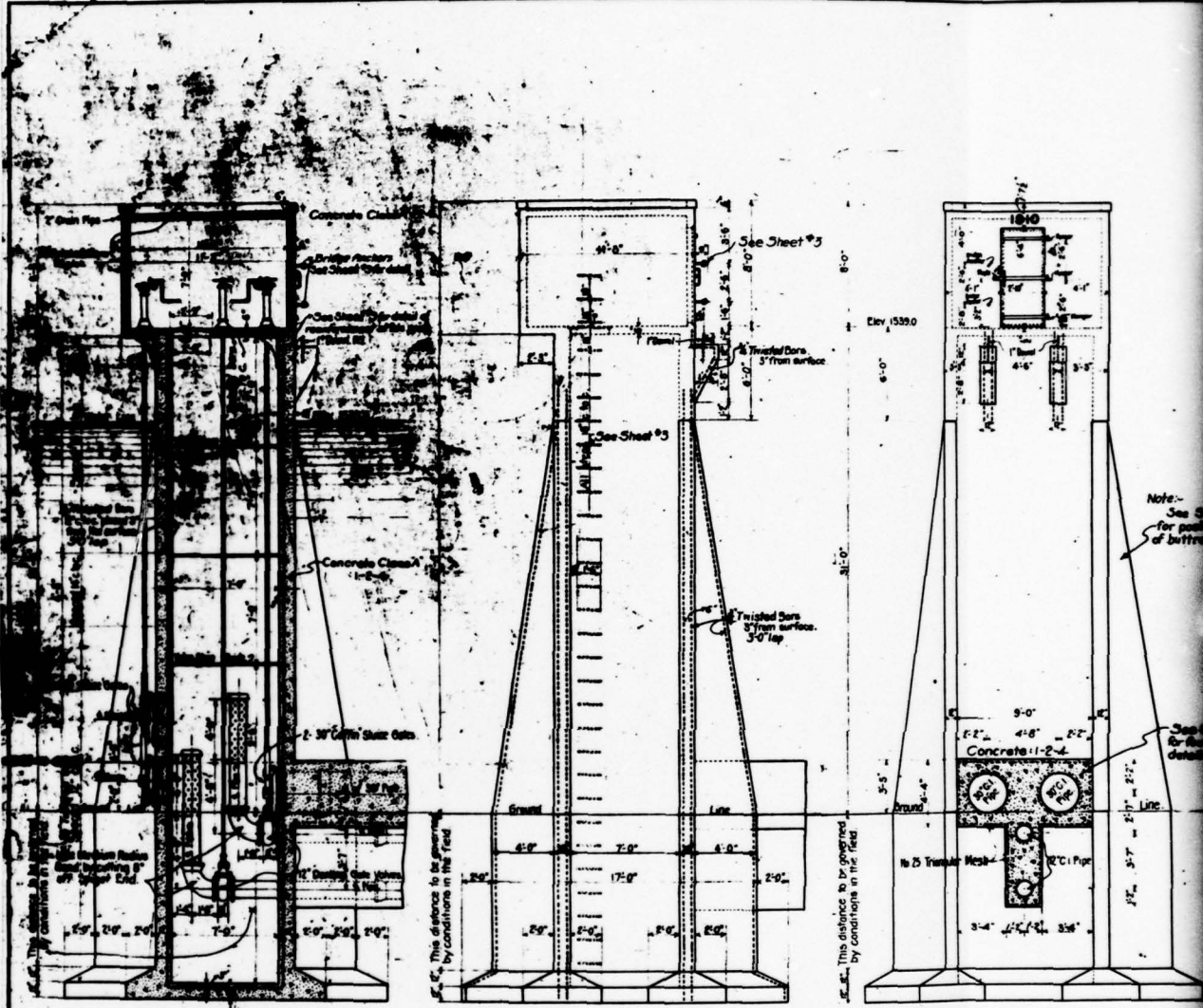
Constructed according to plan except as noted.

B.R.&P.Ry.
 Middle Division
 Kyle Run Reservoir
 Plan of proposed main spillway
 for Kyle Run Reservoir.
 Scales as shown. Revised, Oct. 14, 1911.

Approved: 
 Chief Engineer.

2

DRAWN BY 5-22-79 ACS CHECKED BY BE 6-1-79 DRAWING NUMBER 78-367-B123
 APPROVED BY SP/NO 6.5.71



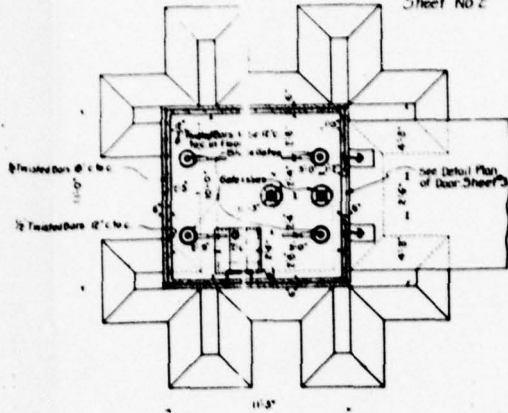
Section

Side Elevation

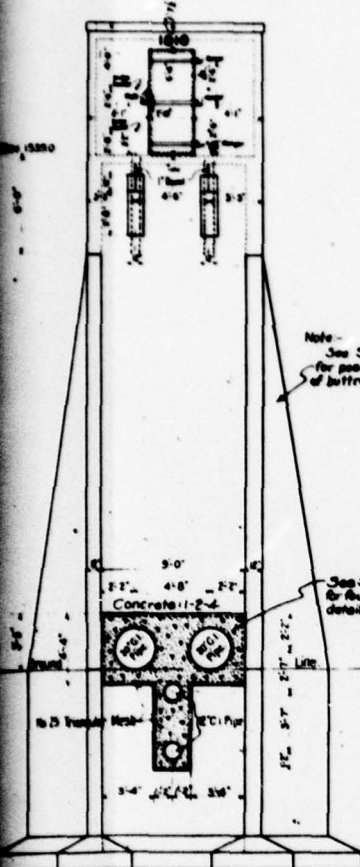
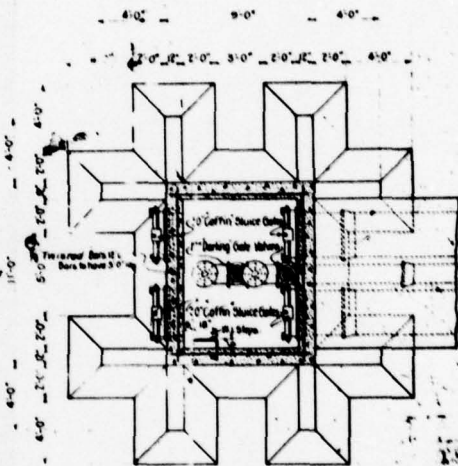
Front Elevation

Floor Plan

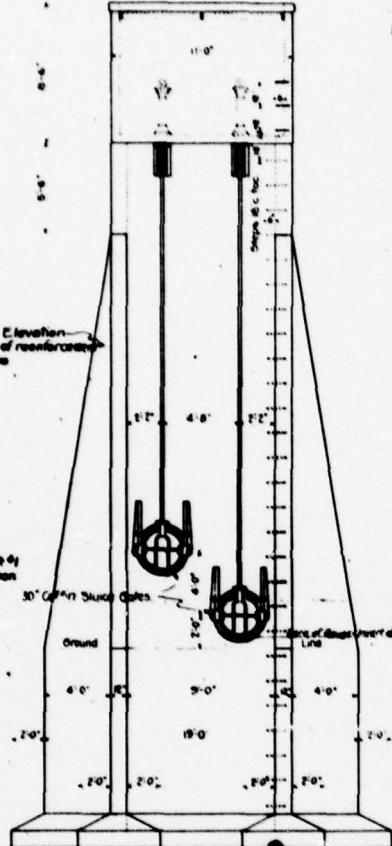
Designed by: H. G. W.
 Drawn by: E. H. F.
 Checked by: W. J. P.
 Corrected by: J. H. C.
 Office Exp.
 Sheet No 2



Section of Pit



Front Elevation.



Rear Elevation.

Note -
 See Side Elevation
 for position of reinforcement
 of buttresses

See Sheet #1
 for foundation
 details

B. R. & P. R. Y.

MIDDLE DIVISION
 FALLS CREEK, PA.

Plan of Gate House for
 Nye's Run Reservoir.

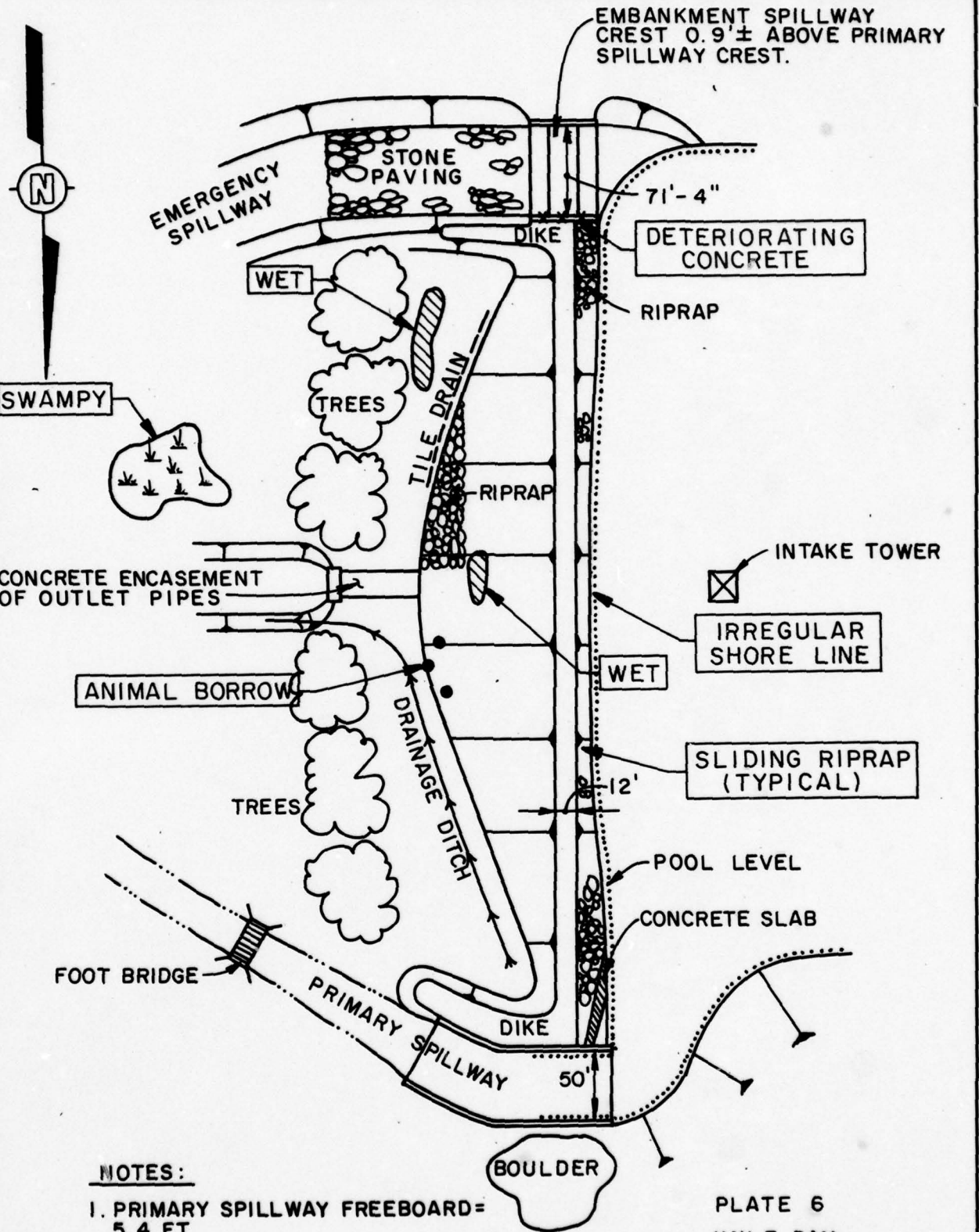
Approved: *[Signature]* Chief Engineer
 Dec. 1928
 6227

2

PLATE 5

D'APPOLONIA

DRAWING 78-17-A27
 NUMBER 6-1-79
 CHECKED BY BE
 APPROVED BY SJP
 6-5-79
 ACS 5-7-79
 DRAWN BY



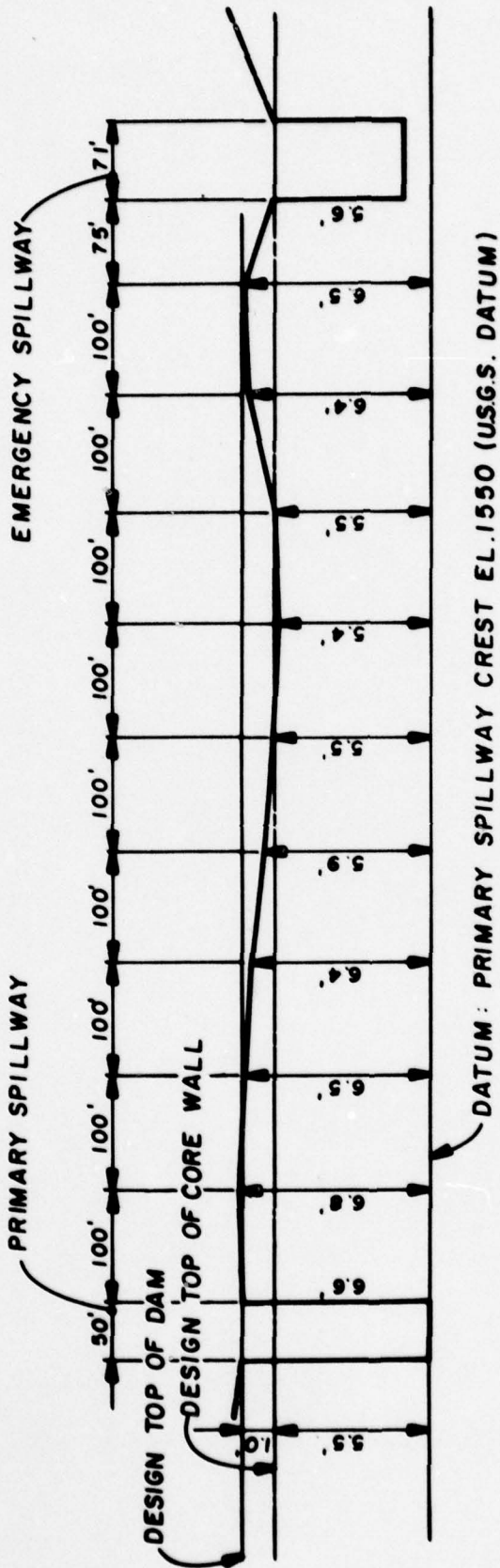
NOTES:

1. PRIMARY SPILLWAY FREEBOARD = 5.4 FT.
2. POOL LEVEL DATE OF INSPECTION: 0.4 FT. ABOVE SPILLWAY CREST

PLATE 6
 KYLE DAM
 GENERAL PLAN
 FIELD INSPECTION NOTES
 FIELD INSPECTION DATE: APR. 5, 79

D'APPOLONIA

DRAWN BY	ACS	CHECKED BY	BE	DRAWING NUMBER	78
	6-28-79	APPROVED BY	JAC		67-A42



DAM CREST PROFILE
(LOOKING DOWNSTREAM)

NOTE:
DAM CREST IS SURVEYED RELATIVE TO PRIMARY SPILLWAY CREST LEVEL.

PLATE 7

KYLE DAM
DAM CREST SURVEY
FIELD INSPECTION DATE: APR. 5, 79

D'APOLONA

APPENDIX A
CHECKLIST
VISUAL INSPECTION
PHASE I

VISUAL INSPECTION
 PHASE I
 EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	None.	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Middle one-third of the embankment was found to be approximately one foot lower than the abutments.	
RIPRAP FAILURES	Hand-placed riprap has buckled and slid at various locations. However, it appears that it is still providing adequate erosion protection.	

VISUAL INSPECTION
 PHASE I
 EMBANKMENT
 OBSERVATIONS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	No signs of distress.	
ANY NOTICEABLE SEEPAGE	One wet and one swampy area were located below the toe of the dam near the right abutment. No seepage was found.	
STAFF GAGE AND RECORDER	None.	
DRAINS	None.	

VISUAL INSPECTION
 PHASE I
 OUTLET WORKS

VISUAL EXAMINATION OF CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
INTAKE STRUCTURE	The outlet conduit is not accessible for inspection. Only the downstream end was visible. No distress was observed.	
OUTLET STRUCTURE	Submerged.	
OUTLET CHANNEL	Outlet conduit would directly discharge into the outlet channel.	
EMERGENCY GATE	No obstructions in the outlet channel that would significantly affect discharge capacity of the outlet works.	Operational condition of the outlet conduit sluice gates should be evaluated and necessary maintenance performed.

VISUAL INSPECTION
 PHASE I
 UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	Primary spillway 50-foot wide concrete overflow section in good condition. Emergency spillway 71.3-foot wide concrete overflow section in fair condition. There is some concrete spalling on the side walls of the emergency spillway.	The spalling in the emergency spillway walls should be repaired.
APPROACH CHANNEL	Submerged. Appears to be free of debris.	
DISCHARGE CHANNEL	Primary spillway: rectangular concrete channel in good condition. Emergency spillway: trapped earth channel in good condition.	
BRIDGE AND PIERS	None.	

VISUAL INSPECTION
 PHASE I
 GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	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
MORPHOMETRIE/SURVEYS	None.	
OBSERVATION WELLS	None.	
WEIRS	None.	
PIEZOMETERS	None.	
OTHER	None.	

VISUAL INSPECTION
 PHASE I
 RESERVOIR
 OBSERVATIONS

VISUAL EXAMINATION OF	OBSERVATIONS	REPAIRS OR RECOMMENDATIONS
SLOPES	Gentle to moderately steep. No significant shoreline erosion was noted.	
SEDIMENTATION	Unknown.	
UPSTREAM RESERVOIRS	None.	

VISUAL INSPECTION
 PHASE I
 DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REPAIRS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	No apparent obstructions immediately downstream from the dam that would affect the discharge capacity of the spillway.	
SLOPES	No apparent instability (immediately downstream from the dam).	
APPROXIMATE NUMBER OF HOMES AND POPULATION	Interstate Route 80 is located immediately downstream from the dam. There are approximately 5 homes within the potential flood plain in the town of Falls Creek. Population: approximately 20.	

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 Kyle Dam
 ID# NDI I.D. PA-617
DER I.D. 33-1

ITEM	REMARKS
AS-BUILT DRAWINGS	The design drawings are available in state files.
REGIONAL VICINITY MAP	See Plate 1.
CONSTRUCTION HISTORY	The dam was designed and constructed by Buffalo, Rochester & Pittsburgh Railroad Company with completion in 1910.
TYPICAL SECTIONS OF DAM	See Plate 2.
OUTLETS - PLAN - DETAILS - CONSTRAINTS - DISCHARGE RATINGS	See Plates 3 and 5.

**CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I**

ITEM	REMARKS
RAINFALL/RESERVOIR RECORDS	Not available.
DESIGN REPORTS	None available.
GEOLOGY REPORTS	None available.
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	Not available.
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	Not available.

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

ITEM	REMARKS
POST CONSTRUCTION SURVEYS OF DAM	None reported.
BORROW SOURCES	Unknown.
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	Not available.
SPILLWAY PLAN SECTIONS DETAILS	See Plates 2 and 4.
OPERATING EQUIPMENT PLANS AND DETAILS	See Plate 5.

**CHECKLIST
ENGINEERING DATA
HYDROLOGIC AND HYDRAULIC**

DRAINAGE AREA CHARACTERISTICS: 6 square miles (wood and pasturelands)
ELEVATION; TOP NORMAL POOL AND STORAGE CAPACITY: 1550 (1440 acre-feet)
ELEVATION; TOP FLOOD CONTROL POOL AND STORAGE CAPACITY: 1555.4 (2300 acre-feet)
ELEVATION; MAXIMUM DESIGN POOL: 1555.4
ELEVATION; TOP DAM: 1555.4 (measured low spot)
SPILLWAY: (Emergency spillway)

- a. Elevation 1555.9
- b. Type Concrete overflow section
- c. Width 71 feet 4 inches (perpendicular to flow)
- d. Length N/A
- e. Location Spillover Middle of embankment
- f. Number and Type of Gates None

OUTLET WORKS:

- a. Type Two 30-inch cast-iron pipes
- b. Location Center of embankment
- c. Entrance Inverts 1525+
- d. Exit Inverts 1520+
- e. Emergency Draindown Facilities Outlet conduits

HYDROMETEOROLOGICAL GAGES:

- a. Type None
- b. Location None
- c. Records None

MAXIMUM NONDAMAGING DISCHARGE: 3900 cfs full capacity of spillways

APPENDIC C
PHOTOGRAPHS

LIST OF PHOTOGRAPHS
KYLE DAM
NDI I.D. NO. PA-417
APRIL 5, 1979

PHOTOGRAPH NO.

DESCRIPTION

- | | |
|---|----------------------------------------------------------------------------------------------------------------|
| 1 | Crest (looking south). Note concrete core wall. |
| 2 | Primary spillway on left abutment (looking downstream). |
| 3 | Emergency spillway on right abutment (looking north). Note concrete deterioration. |
| 4 | Intake tower. |
| 5 | Outlet pipes. |
| 6 | Outlet pipe controls at intake tower. |
| 7 | Interstate Route 80 underpass (1000 feet downstream). |
| 8 | Falls Creek at town of Falls Creek (approximately two miles downstream). Note highway bridge over Falls Creek. |



Photograph No. 1

Crest (looking south). Note concrete core wall.



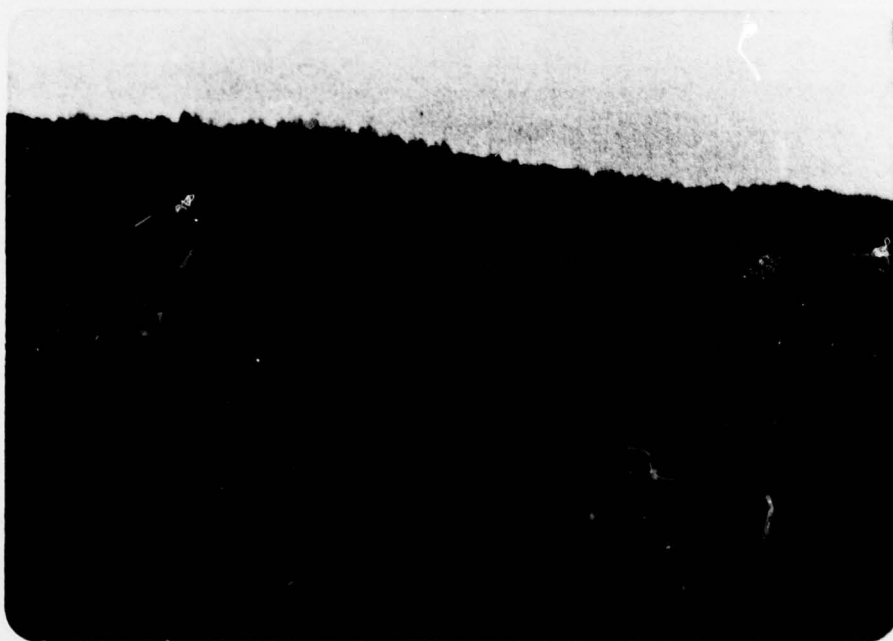
Photograph No. 2

Primary spillway on left abutment (looking downstream).



Photograph No. 3

Emergency spillway on right abutment (looking north). Note concrete deterioration.



Photograph No. 4

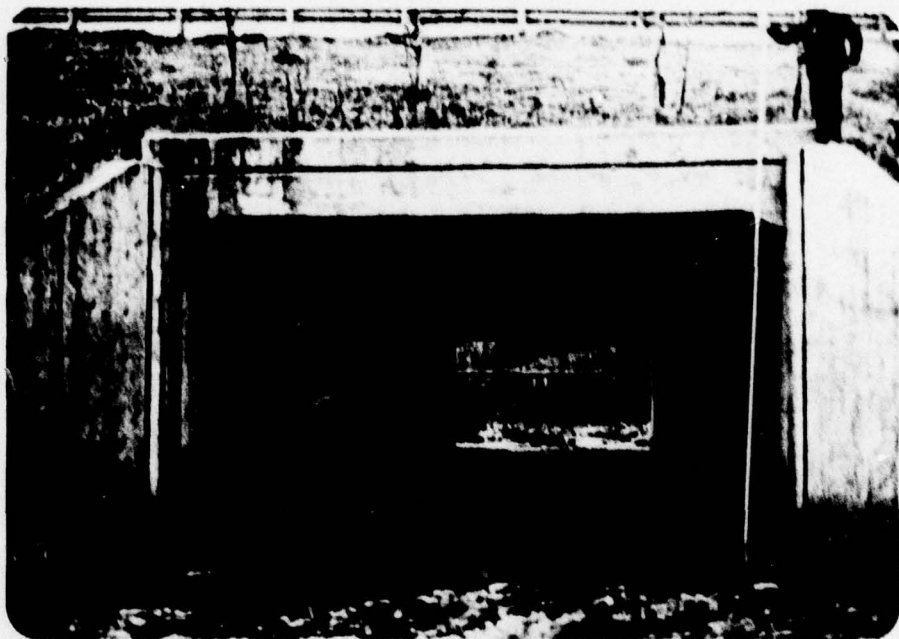
Intake tower.



Photograph No. 5
Outlet pipes.



Photograph No. 6
Outlet pipe controls at intake tower.



Photograph No. 7

Interstate Route 80 underpass (1000 feet downstream).



Photograph No. 8

Falls Creek at town of Falls Creek (approximately two miles downstream). Note highway bridge over Falls Creek.

APPENDIX D
CALCULATIONS

HYDROLOGY AND HYDRAULIC ANALYSIS
DATA BASE

NAME OF DAM: Kyle Dam (NDI I.D. PA-417)

PROBABLE MAXIMUM PRECIPITATION (PMP) = 23.3 INCHES/24 HOURS⁽¹⁾

STATION	1	2	3	4	5
Station Description	Kyle Lake	Kyle Dam			
Drainage Area (square miles)	5.5	0			
Cumulative Drainage Area (square miles)	5.5	5.5			
Adjustment of PMP for Drainage Area (%) ⁽²⁾					
6 Hours	118	-			
12 Hours	127	-			
24 Hours	141	-			
48 Hours	151	-			
72 Hours	-	-			
Snyder Hydrograph Parameters					
Zone ⁽³⁾	24 | 24A	-			
C _p /C _t ⁽⁴⁾	0.45/1.6 | 0.45/4.4	-			
L (miles) ⁽⁵⁾	3.0	-			
L _{ca} (miles) ⁽⁵⁾	1.0	-			
t _p = C _t (L·L _{ca}) ^{0.3} (hours)	2.2 | 5.8	-			
Spillway Data		<u>Pri-</u> <u>mary</u>	<u>Emer-</u> <u>gency</u>		
Crest Length (ft)	-	50	71.3		
Freeboard (ft)	-	5.4	4.5		
Discharge Coefficient	-	3.1	3.1		
Exponent	-	1.5	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). Zone 24A was recommended by the COE. However, conservative Zone 24 was used.

(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 (MEC-1)
DAM SAFETY VERSION      JULY 1978
LAST MODIFICATION      26 FEB 79
.....
1  A1  SMYDER UNIT HYDROGRAPH, FLOOD ROUTING, AND DAM OVERTOPPING ANALYSES
2  A2  KYLE DAM, JEFFERSON COUNTY, MDI-ID.PA.417
3  A3  FOR 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90% AND 100% PMF
4  B  300  0  10  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
5  B1  5
6  J  1  9
7  J1  0.20  0.30  0.40  0.50  0.60  0.70  0.80  0.90  1.00
8  K  0
9  K1  CALCULATION OF SMYDER INFLOW HYDROGRAPH TO KYLE DAM, MDI-ID.PA.417
10  M  1  5.5
11  P  23.3  118  127  141  151
12  T  1  1.0  0.05  0.390
13  W  2.23  0.45
14  X  -1.0  -0.05  2.0
15  K  1  2
16  K1  ROUTING FLOW THROUGH KYLE DAM, MDI-ID.PA.417
17  Y  1
18  Y1  1
19  Y41550.0  1550.5  1550.85  1551.0  1551.5  1552.0  1552.5  1553.0  1553.5  1554.0
20  Y41554.5  1555.0  1555.5  1556.0  1556.5  1557.0  1557.5  1558.0  1559.0  1560.0
21  Y5  0.0  54.8  121.5  167.8  400.6  711.0  1081.2  1502.2  1968.4  2475.7
22  Y53020.9  3601.6  4215.6  4861.2  5537.0  6241.7  6974.0  7733.1  9327.7  11019.2
23  S5  0.0  1820.0
24  S1550.0  1560.0
25  S1550.0
26  S1555.4  3.1  1.5  975.0
27  SL 100.0  300.0  325.0  425.0  625.0  825.0  875.0  975.0
28  S1555.4  1555.45  1555.55  1555.85  1556.35  1556.45  1556.55  1556.80
29  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	RATIO 2	RATIO 3	RATIO 4	RATIO 5	RATIO 6	RATIO 7	RATIO 8	RATIO 9
				.20	.30	.40	.50	.60	.70	.80	.90	1.00
HYDROGRAPH AT	1	5.50	1	2303.	3455.	4607.	5759.	6910.	8062.	9214.	10365.	11517.
	(	14.24)	(	65.23)	(97.84)	(130.45)	(163.06)	(195.68)	(228.29)	(260.90)	(293.52)	(326.13)
ROUTED TO	2	5.50	1	1598.	2579.	3579.	4728.	6097.	7454.	8759.	10014.	11236.
	(	14.24)	(	45.25)	(73.02)	(101.36)	(133.88)	(172.63)	(211.07)	(248.02)	(283.56)	(318.16)

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1	RATIO OF PMF	ELEVATION STORAGE	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM	MAXIMUM RESERVOIR W.S. ELEV	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
	.20	1553.10	1550.00	1550.00	1555.40	0.00	565.	1598.	0.00	44.33	0.00
	.30	1554.09	0.	0.	983.	0.00	745.	2579.	0.00	44.17	0.00
	.40	1554.98	0.	0.	4093.	0.00	907.	3579.	0.00	46.00	0.00
	.50	1555.75				-.35	1046.	4728.	2.67	43.67	0.00
	.60	1556.24				.84	1136.	6097.	4.33	43.33	0.00
	.70	1556.59				1.19	1199.	7454.	5.33	43.00	0.00
	.80	1556.85				1.45	1246.	8759.	6.17	42.83	0.00
	.90	1557.07				1.67	1286.	10014.	7.00	42.67	0.00
	1.00	1557.26				1.86	1322.	11236.	7.67	42.50	0.00

OVERTOPPING ANALYSIS SUMMARY

PAGE D4 of 4

D'APPOLONIA

CONSULTING ENGINEERS, INC

By NTC Date 5/21/79 Subject KYLE DAM Sheet No. 1 of 1
 Chkd. By BE Date 5/22/79 SPILLWAY RATING & STORAGE - VOL Proj. No. 78-357-20

SPILLWAY RATING

PRIMARY SPILLWAY $Q_p = (3.1)(50)(WL - 1550)^{1.5}$
 EMERGENCY " $Q_e = (3.1)(71.3)(WL - 1550.85)^{1.5}$
 $\Sigma Q = 3.1 [(50)(WL - 1550)^{1.5} + (71.3)(WL - 1550.85)^{1.5}]$

ELEV	Q_p (cfs)	Q_e (cfs)	ΣQ cfs
1550.0	0	-	0.0
1550.5	54.8	-	54.8
1550.85	121.5	0.0	121.5
1551.0	155.0	12.8	167.8
1551.5	204.0	115.8	400.6
1552.0	438.4	272.6	711.0
1552.5	612.7	468.5	1081.2
1553.0	805.4	696.8	1502.2
1553.5	1014.9	953.5	1968.4
1554.0	1240.0	1235.7	2475.7
1554.5	1479.6	1541.3	3020.9
1555.0	1733.0	1868.6	3601.6
1555.5	1999.3	2216.3	4215.6
1556.0	2278.0	2583.2	4861.2
1556.5	2568.6	2968.4	5537.0
1557.0	2870.6	3371.0	6241.7
1557.5	3183.6	3790.4	6974.0
1558.0	3507.2	4225.8	7733.1
1559.0	4125.0	5142.7	9327.7
1560.0	4901.5	6117.6	11,019.2

STORAGE - VOLUME

LAKE AREA @ 1550 = 1.5 in² = 138 ACRES
 " " @ 1560 = 2.5 in² = 230 ACRES

ELEV	ΔH	AREA	ΔV (ACRE-FT)
1550		138	
1560	10'	230	1820

APPENDIX E
REGIONAL GEOLOGY

APPENDIX E
REGIONAL GEOLOGY

Kyle Dam is located on strata of the Allegheny Formation (Pennsylvanian Age). The site lies along the northwestern flank of the Punxsutawney-Caledonia Syncline. Strata in the area dip gently to the southeast at about 100 feet per mile.

The Allegheny Formation consists primarily of thick-bedded to massive, coarse-grained sandstones and conglomerates. Thin coal seams and shales also exist. The Brookville coal seam, which is the lowest minable seam in the stratigraphic section, outcrops at approximately Elevation 1560. Kyle Reservoir is located at Elevation 1550; therefore, it is not likely that any coal exists beneath the dam.

DRAWN BY
 ACS
 5-29-79
 CHECKED BY
 36
 APPROVED BY
 6474
 DRAWING NUMBER
 76
 67-A34



STORAGE, WOLF CREEK, KYLE,
 LAKE RENE, LAKE SABULA,
 GALION BAY AND CLOE DAM

GEOLOGY MAP

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

D'APOLONIA

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PENNSYLVANIAN

APPALACHIAN PLATEAU

Pm **Monongahela Formation**
Cyclic sequences of sandstone, shale, limestone and coal, limestone prominent in northern outcrop areas; shale and sandstone increase southward; commercial coals present, base at the bottom of the Pittsburgh Coal.

Pc **Conemaugh Formation**
Cyclic sequences of red and gray shales and siltstones with thin limestones and coals; massive Mahoning Sandstone commonly present at base; Ames Limestone present in middle of section; Brush Creek Limestone in lower part of section.

Pa **Allegheny Group**
Cyclic sequences of sandstone, shale, limestone and coal, numerous commercial coals; limestones thicker westward; Vanport Limestone in lower part of section; includes Freeport, Kittanning, and Clarion Formations.

Pp **Pottsville Group**
Predominantly sandstones and conglomerates with thin shales and coals; some coals mineable locally.

ANTHRACITE REGION

Ppo **Post-Pottsville Formations**
Brown or gray sandstones and shales with some conglomerate and numerous mineable coals.

Pp **Pottsville Group**
Light gray to white, coarse grained sandstones and conglomerates with some mineable coal; includes Sharp Mountain, Schuylkill, and Tumbling Run Formations.

MISSISSIPPIAN

Mmc **Mauch Chunk Formation**
Red shales with brown to greenish gray flaggy sandstones; includes Greenbrier Limestone in Fayette, Westmoreland, and Somerset counties; Loyalhanna Limestone at the base in southwestern Pennsylvania.

Po **Pocono Group**
Predominantly gray, hard, massive, cross-bedded conglomerate and sandstone with some shale; includes in the Appalachian Plateau: Ruzgon, Shenango, Crumhorn, Cassinago, Cory, and Knapp Formations; includes part of "Onango" of M. L. Fuller in Potter and Tioga counties.

GEOLOGY MAP LEGEND

REFERENCE:

GEOLOGIC MAP OF PENNSYLVANIA PREPARED BY COMMONWEALTH OF PENNA. DEPT. OF INTERNAL AFFAIRS, DATED 1960, SCALE 1 $\frac{1}{2}$ 4 MILES

DIAPOLONA