

AD-A078 966

D'APPOLONIA CONSULTING ENGINEERS INC PITTSBURGH PA  
NATIONAL DAM INSPECTION PROGRAM. RACCOON CREEK STATE PARK DAM (--ETC(U)  
JUN 79 L D ANDERSEN

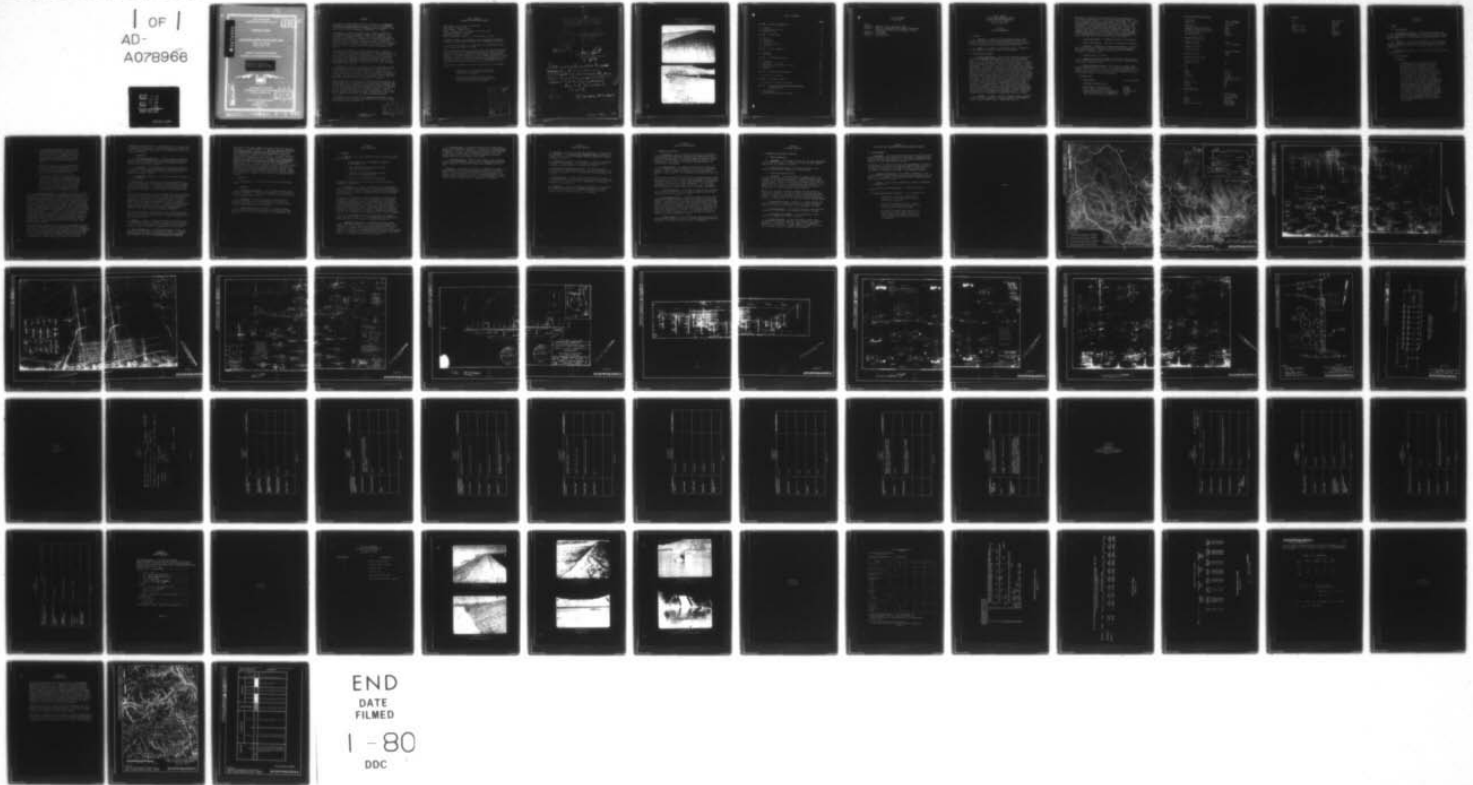
F/G 13/13

DACW31-79-C-0014

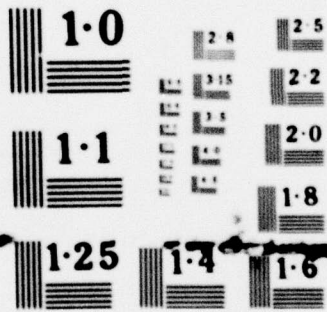
NL

UNCLASSIFIED

1 OF 1  
AD-  
A078966

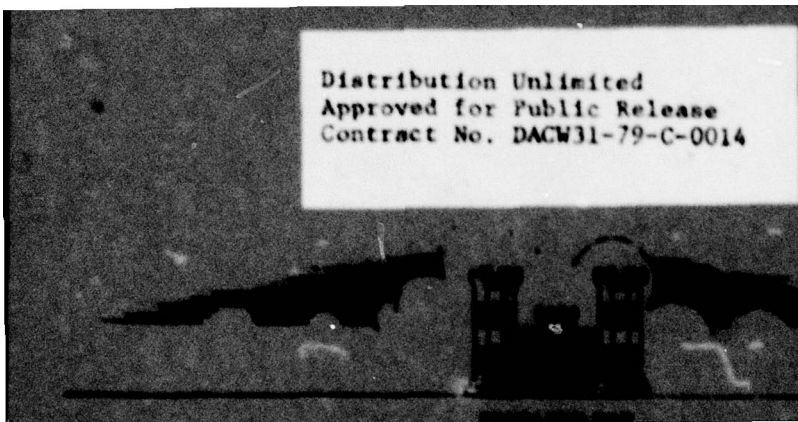


END  
DATE  
FILMED  
1-80  
DDC



NATIONAL BUREAU OF STANDARDS  
MICROCOPY RESOLUTION TEST CHART

Distribution Unlimited  
Approved for Public Release  
Contract No. DACW31-79-C-0014



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.

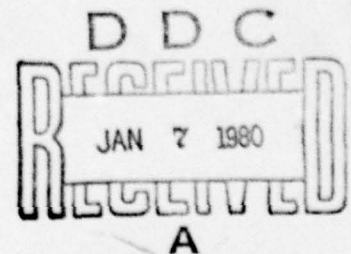
The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon visual observations and review of available data. Detailed investigation and analyses involving topographic 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.



[cont'd from p. 1]

PHASE I REPORT  
NATIONAL DAM INSPECTION PROGRAM

NAME OF DAM: Raccoon Creek State Park Dam  
STATE LOCATED: Pennsylvania  
COUNTY LOCATED: Beaver County  
STREAM: Traverse Creek, a tributary of Raccoon Creek  
SIZE CLASSIFICATION: Intermediate  
HAZARD CLASSIFICATION: High  
DATE OF INSPECTION: December 13, 1978 and April 16, 1979

ASSESSMENT: Based on the evaluation of the existing conditions, the condition of Raccoon Creek State Park Dam is considered to be good.

No conditions were noted at this time that would significantly affect the structural performance of the dam.

The flood discharge capacity of Raccoon Creek State Park Dam was evaluated according to the recommended procedure and was found to pass 90 percent of the probable maximum flood (PMF) without overtopping the embankment. Therefore, according to the recommended criteria, the flood discharge capacity of the dam was classified to be inadequate. It was found that during the passage of full PMF, the embankment would be overtopped for a duration of two hours by a maximum depth of 0.4 foot.

The following recommendations should be implemented on a continuing basis:

1. Seepage points and the wet areas along the downstream toe of the dam should be periodically visually monitored.
2. The dam and appurtenant structures should continue to be inspected regularly and necessary maintenance should be performed.

Accession For	
NTIS GRA&I	<input checked="" type="checkbox"/>
DDC TAB	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification	
By _____	
Distribution/	
Availability Codes	
Dist.	Avail and/or special
A	

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



*Lawrence D. Andersen*

10 Lawrence D. Andersen, P.E.  
Vice President

9 AUG 1979

Date

Approved by:

*James W. Peck*

JAMES W. PECK  
Colonel, Corps of Engineers  
District Engineer

11 Sep 79

Date

11 Jun 79

6 National Dam Inspection Program  
Raccoon Creek State Park Dam  
(NDI-ID# PA-262, DER-ID# 4-34), Ohio  
River Basin, Traverses Creeks,  
Beaver County, Pennsylvania  
Phase I Inspection  
Report,

Number

12, 72

Number

15) DAOW 32-79-C-0024

RACCOON CREEK STATE PARK DAM  
NDI I.D. NO. PA-262  
DECEMBER 13, 1978



Upstream Face



Downstream Face

## TABLE OF CONTENTS

	<u>PAGE</u>
SECTION 1 - PROJECT INFORMATION	1
1.1 General	1
1.2 Description of Project	1
1.3 Pertinent Data	1
SECTION 2 - DESIGN DATA	5
2.1 Design	5
2.2 Construction	7
2.3 Operation	7
2.4 Other Investigations	7
2.5 Evaluation	8
SECTION 3 - VISUAL INSPECTION	9
3.1 Findings	9
3.2 Evaluation	10
SECTION 4 - OPERATIONAL FEATURES	11
4.1 Procedure	11
4.2 Maintenance of the Dam	11
4.3 Maintenance of Operating Facilities	11
4.4 Warning System	11
4.5 Evaluation	11
SECTION 5 - HYDRAULICS AND HYDROLOGY	12
5.1 Evaluation of Features	12
SECTION 6 - STRUCTURAL STABILITY	13
6.1 Evaluation of Structural Stability	13
SECTION 7 - ASSESSMENT AND RECOMMENDATIONS/PROPOSED REMEDIAL MEASURES	14
7.1 Dam Assessment	14
7.2 Recommendations/Remedial Measures	14

TABLE OF CONTENTS  
(Continued)

PLATES

- APPENDIX A - CHECKLIST, VISUAL INSPECTION, PHASE I
- APPENDIX B - CHECKLIST, ENGINEERING DATA, DESIGN, CONSTRUCTION,  
OPERATION AND HYDROLOGIC AND HYDRAULIC, PHASE I
- APPENDIX C - PHOTOGRAPHS
- APPENDIX D - CALCULATIONS
- APPENDIX E - REGIONAL GEOLOGY

PHASE I REPORT  
NATIONAL DAM INSPECTION PROGRAM  
RACCOON CREEK STATE PARK DAM  
NDI I.D. NO. PA-262  
DER I.D. NO. 4-34

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. Raccoon Creek State Park Dam consists of an earth embankment approximately 960 feet long with a maximum height of 45 feet from the downstream toe and a crest width of 14 feet. The flood discharge facilities for the dam consist of a combined primary and emergency spillway located on the right abutment (looking downstream). The spillway structures of the dam consist of a concrete ogee overflow section and a trapezoidal concrete-lined spillway discharge channel which terminates in a concrete-lined stilling basin at the toe level of the dam near the right abutment. The ogee weir is 300 feet wide and is located at a level 8 feet below the dam crest. The spillway discharge channel is trapezoidal in cross section and is 300 feet wide at the weir and uniformly converges to a 213-foot width at the stilling basin level. The outlet works consist of a concrete box culvert with a concrete intake tower located on the upstream end. The 8-foot by 7.5-foot concrete box culvert is equipped with a concrete outlet structure at the downstream end. Flow through the outlet conduit is controlled by a manually operated sluice gate from the intake tower. The conduit entrance is equipped with trash racks and provisions were made to install stop logs in the intake tower. An 8-inch bypass line constitutes the stream augmentation discharge facility. This outlet system constitutes the emergency drawdown facilities for the dam.

*Continued on page 117*

b. Location. The dam is located on Traverse Creek, a tributary of Raccoon Creek, approximately 25 miles northwest of Pittsburgh in Hanover Township, Beaver County, Pennsylvania (Plate 1).

Downstream from the dam, Traverse Creek flows east approximately one mile where it passes under U.S. Route 30 and joins Raccoon Creek. There are no inhabitable structures in this reach of the stream. The first potential damage location downstream from the dam is along U.S. Route 30 approximately 1.5 miles downstream of the dam in the vicinity of the confluence of Little Traverse Creek and Raccoon Creek. In this area, there are about four mobile homes and two commercial buildings. It is estimated that failure of the dam would cause loss of life and large property damage along the course of Raccoon Creek. A major shopping center and residential areas of Aliquippa are located approximately 10 miles downstream from the dam along the Raccoon Creek valley.

c. Size Classification. Intermediate (based on 45-foot height).

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 dam was designed by The Chester Engineers of Pittsburgh, Pennsylvania in 1946. The construction of the dam was completed in 1948.

h. Normal Operating Procedure. The reservoir is normally maintained at Elevation 894, the level of the uncontrolled spillway crest, leaving 8 feet of freeboard to the top of the dam at Elevation 902. The inflow occurring when the lake is at or above the spillway crest level is discharged through the uncontrolled spillway.

### 1.3 Pertinent Data

a. Drainage Area 19.1 square miles

b. Discharge at Dam Site (cfs)

Maximum known flood at dam site	Unknown
Outlet conduit at maximum pool	Unknown
Gated spillway capacity at maximum pool	Not applicable
Ungated spillway capacity at maximum pool	26,340
Total spillway capacity at maximum pool	26,340

c. Elevation (USGS Datum) (feet)

Top of dam	902 (as designed)
Maximum pool	902.1 (low spot on crest)
Normal pool	894
Upstream invert outlet works	859.0
Downstream invert outlet works	859.0
Streambed at center line of dam	857+
Maximum tailwater	Unknown
Downstream toe of dam	857+

d. Reservoir Length (feet)

Normal pool level	6,000
Maximum pool level	6,500 (estimated)

e. Storage (acre-feet)

Normal pool level	Unknown (estimated 1,000)
Maximum pool level	1,800

f. Reservoir Surface (acres)

Normal pool level	80
Maximum pool level	103

g. Dam

Type	Earth
Length	960 feet
Height	45 feet
Top width	14 feet
Side slopes	Downstream: 2.5H:1V; upstream: 3H:1V
Zoning	Yes
Impervious core	None
Cutoff	Yes
Grouting	Yes

h. Regulating Outlet

Type	8-foot by 7.5-foot reinforced concrete culvert
Length	255 feet
Closure	Sluice gate
Access	Control tower
Regulating facilities	Sluice gate

1. Spillway

Type	Ogee concrete overflow
Length	300 feet
Crest elevation	894 feet
Gate	None
Upstream channel	Lake
Downstream channel	Concrete trapezoidal channel

SECTION 2  
DESIGN DATA

2.1 Design

a. Data Available

(1) Hydrology and Hydraulics. The available hydrologic and hydraulic information is summarized in a state report entitled, Report Upon the Application of the Department of Forests and Waters, dated March 8, 1948.

(2) Embankment. The available information consists of design drawings, construction specifications, boring logs, post-construction engineering reports, and past state inspection reports and various correspondence.

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

b. Design Features

(1) Embankment

a. As designed, the dam is essentially a homogeneous embankment consisting of two zones. An impervious fill, identified as Class A embankment material, forms the core and upstream slope of the dam (Plates 2 and 3). Pervious fill, which is identified as Class B embankment material, forms the downstream slope of the embankment. In the specifications, these materials were described as follows: Class A - sandy clay containing approximately 50 percent pure clay, Class B - shale materials and rock not over four inches or sandy material mixed with shale which is not suitable for Class A embankment fill. The design shows the impervious fill material extending to the top of rock through a cutoff trench along the axis of the dam. A concrete cutoff wall is located at the center of the cutoff trench for seepage control. The cutoff trench and cutoff wall extend from the embankment side of the spillway to a point approximately 250 feet from the left abutment.

- b. The embankment was designed to have a 2.5H:1V slope on the downstream face and a 3H:1V slope on the upstream face. The upstream face of the dam is protected by concrete blocks placed on a 6-inch layer of gravel (Plate 4). This paving extends from crest level to Elevation 1886, which is 8 feet below the normal pool level.
- c. As shown in Plate 3, at least 12 borings were drilled for subsurface investigation. As illustrated in Plate 2, the typical subsurface profile consists of approximately 10 to 30 feet of overburden underlain by shale.
- d. The available information indicates that a 150-foot long section of the foundation on the left side of the original streambed was grouted through holes drilled at 5-foot centers extending to a depth of 25 feet below the base of the cutoff trench. Plates 5 and 6 illustrate the locations of grout holes through the spillway and the right side of the embankment, which was performed after the completion of the dam.

(2) Appurtenant Structures. The appurtenant structures of the dam consist of a combined primary and emergency spillway and an outlet works (Plate 3). The spillway structures include a 40-foot-long concrete-lined approach channel, a 300-foot-long ogee concrete overflow section, a trapezoidal discharge channel, and a stilling basin at the toe level of the dam. The bottom of the approach channel as designed is at Elevation 1885, leaving a 9-foot approach depth at normal pool level. The ogee overflow crest is at Elevation 1894. The trapezoidal concrete discharge channel is approximately 250 feet long and converges uniformly from a width of 300 feet at the overflow section to 213 feet at the downstream end. A 213-foot-wide, 130-foot-long stilling basin is also trapezoidal in cross section. The minimum depth of water in the stilling basin is maintained at 4 feet by the sill at the downstream end. The slab sections of the spillway discharge channel and the stilling basin are 9 inches thick and underlain by a one-foot gravel filter. The gravel filter drains into the spillway channel through 4-inch weepholes.

The outlet works are located at the center of the embankment and consist of a concrete intake tower at the upstream toe of the embankment, an 8-foot by 7.5-foot reinforced concrete conduit through the embankment, and a concrete outlet structure at the downstream toe of the embankment. The outlet conduit is equipped with reinforced concrete cutoff collars. Plate 4 illustrates the details of the outlet works. The flow through the outlet conduit is controlled by a sluice gate

operated from the intake tower. The upstream end of the outlet conduit is equipped with trash racks. The design incorporates provisions to place stop logs on the upstream side of the intake tower to allow the tower to be drained.

c. Design Data

(1) Hydrology and Hydraulics. The 1948 state report indicates that the 26,340 cfs spillway capacity provided was greater than the spillway capacity required by the Pennsylvania design criteria in effect at the time (C curve criteria).

(2) Embankment. The embankment design was apparently based on the results of the subsurface investigation. However, no reference was found to indicate whether any soils testing or stability or seepage analyses were performed.

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

2.2 Construction. The construction of the dam was apparently conducted in accordance with the drawings and specifications as prepared by The Chester Engineers. The construction was supervised by Chester Engineers field personnel. No reference was found to indicate that any unusual problems were encountered during the construction of the dam.

During the initial filling of the lake, seepage was observed along the toe of the dam near the right abutment when the pool level was within 10 feet of the spillway crest level. The quantity of seepage was estimated to be on the order of 70 gallons per minute. In 1949, a remedial grouting program was undertaken to control the seepage. Plates 5 and 6 illustrate the extent of the remedial grouting program. In the subsequent inspection reports, no reference was found to the seepage problem, indicating that the grouting program apparently effectively controlled the seepage through the embankment.

The available information indicates that due to continued deterioration of the concrete in the spillway structures, these structures were renovated and partially rebuilt in 1965. The extent of repairs is shown on Plates 7 and 8.

2.3 Operation. The lake is normally maintained at the crest level of the uncontrolled spillway. Only under low flow conditions, when the pool is below the crest elevation of the spillway, is the eight-inch bypass line opened to maintain flow downstream in Traverse Creek.

2.4 Other Investigations. The available information includes the following three post-construction engineering reports: (1) Raccoon Creek State Park Dam, Report on Drilling and Grouting Operations, dated November 27, 1949, by The Chester Engineers of Pittsburgh,

Pennsylvania. The report summarizes the post-construction grouting work done on the right abutment. (2) Report on Subsurface Exploration for Proposed Repairs to Raccoon Creek State Park Dam, dated April 1964, prepared by the Commonwealth of Pennsylvania, Department of Forests and Waters, Division of Flood Control. The report summarizes the subsurface investigation work conducted in conjunction with the repairs to the spillway structures. (3) Report on the Investigation of Slides at Earth Dam on Traverse Creek, Raccoon Creek State Park Dam, dated June 22, 1967, by Division of Flood Control, Department of Forests and Waters. This report describes four landslides that occurred during May 1967 along the left abutment of the dam. The report indicates that one of the slides was located upstream of the dam, one at the left abutment, and two downstream from the left abutment. Subsequent correspondence indicates that the landslide on the left abutment of the dam was not considered to be a threat to the integrity of the embankment.

## 2.5 Evaluation

a. Availability. The available information was obtained from PennDER.

### b. Adequacy

(1) Hydrology and Hydraulics. Only the design capacity of the spillway was reported. Therefore, this information is not adequate to assess the conformance of the spillway capacity in accordance with the current spillway design criteria.

(2) Embankment. The dam was apparently designed based on subsurface investigation and engineering analyses. However, no references were found to indicate any field or laboratory testing or detailed engineering analyses were performed.

(3) Appurtenant Structures. Review of the design drawings indicates that as designed no significant design deficiencies exist that should affect the overall performance of the appurtenant structures.

SECTION 3  
VISUAL INSPECTION

3.1 Findings

a. General. The on-site inspection of Raccoon Creek State Park Dam consisted of:

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

The specific observations are illustrated in Plate 9 and in the photographs in Appendix C.

b. Embankment. In general, the 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 wet area was found along the toe of the dam near the left abutment. No measurable seepage was found to be associated with this wet area. Two seepage points were identified in the vicinity of the outlet conduit discharge structure. The quantity of seepage was estimated to be one to two gallons per minute. The seepages were clear and no indication of internal erosion was found. A portion of the upstream erosion protection adjacent to the spillway sidewall was found to be settled. The settlement does not appear to be due to recent movements.

The crest of the embankment was surveyed relative to the spillway crest level and was found to be at or slightly above the design crest level. The profile of the crest is illustrated on Plate 10.

c. Appurtenant Structures. The spillway structures, outlet conduit, and visible portions of the intake tower 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. Concrete in the spillway structures was found to be spalling. However, this spalling is not considered to be to an extent that would affect the structural performance of these structures.

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 the shorelines are likely to be susceptible to landslides. However, massive landslides which would affect the storage volume of the reservoir or cause overtopping of the dam by displaced water are not considered to be likely.

e. Downstream Channel. Below the dam, Traverse Creek flows east and joins Raccoon Creek approximately one mile downstream from the dam. Further description of downstream conditions is included in Section 1.2b.

3.2 Evaluation. The condition of the dam is considered to be good. No conditions were observed that would require attention at this time. However, the wet area observed along the toe of the dam near the left abutment should be periodically observed to determine whether or not a seepage condition is developing. Due to continued spalling of concrete in the spillway structures, periodic repairs will be required.

SECTION 4  
OPERATIONAL FEATURES

4.1 Procedure. The dam is operated and maintained in accordance with the requirements of the Operation and Maintenance Manual, prepared by PennDER, Office of Resource Management, Bureau of Operations, Division of Completed Projects.

4.2 Maintenance of the Dam. The maintenance of the dam is considered to be good. The downstream face of the dam is covered with well established grass and appears to be periodically mowed.

4.3 Maintenance of Operating Facilities. The field observations indicate that the operating facilities are adequately maintained. The sluice gate was operated by state park personnel and was observed to be functional.

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 via the park office.

4.5 Evaluation. The dam is satisfactorily maintained. No conditions were observed that would require immediate attention at this time. Due to the concrete spalling problem in the spillway structures, periodic repairs to these structures will be required.

SECTION 5  
HYDRAULICS AND HYDROLOGY

5.1 Evaluation of Features

a. Design Data. Raccoon Creek State Park Dam has a watershed of 19.1 square miles and impounds a reservoir with a surface area of 80 acres at normal pool level. The flood discharge facilities for the dam consist of a combined primary and emergency spillway located on the right abutment. The capacity of the spillway was determined to be 26,300 cfs with no freeboard.

b. Experience Data. As previously stated, Raccoon Creek State Park Dam is classified as an intermediate size 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. Data used for the computer analysis are presented in Appendix D. The PMF inflow hydrograph was found to have a peak flow of 28,156 cfs. The computer input and summary of computer output are also included in Appendix D.

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

d. Overtopping Potential. Various percentages of the PMF inflow hydrograph were routed through the reservoir starting from normal pool elevation using approximate stage versus storage data derived from map studies. It was found that the spillway can pass 90 percent of the PMF without overtopping the embankment. For 100 percent of the PMF, a low spot on the crest of the dam which was found to be 0.1 foot above the design crest elevation of 920 would be overtopped for a duration of two hours with a maximum depth of 0.4 foot. It is estimated that overtopping of the dam by a maximum of 0.4 foot would not constitute significant potential for embankment erosion.

e. Spillway Adequacy. Since the spillway cannot pass the recommended spillway design of 100 percent of the PMF without overtopping the embankment, the spillway capacity is rated to be inadequate.

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 at this time that would significantly affect the stability of the dam.

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

b. Design and Construction Data

(1) Embankment. The dam was apparently designed based on the evaluation of the subsurface conditions. Although boring logs were available for review, no information or reference was found of any soil testing program. Similarly, no documents or references were found to indicate that any stability or seepage analyses were conducted. It is reported that the construction of the dam was conducted under the supervision of The Chester Engineers field personnel.

Review of the available information indicates that the dam was constructed with reasonable care and the design incorporated such basic elements as zoning of the embankment, a cutoff trench extending to top of rock, a concrete foundation cutoff wall, and foundation grouting. However, the design did not include a positive internal drainage system.

(2) Appurtenant Structures. Review of the design drawings indicates that there are 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. For the description of post-construction changes, see Sections 2.2 and 2.4.

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 the 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 Raccoon Creek State Park Dam is in good condition. At this time, no conditions were observed that would significantly affect the overall performance of the structure, and none were reported in the past.

The capacity of the spillway was found to be approximately 90 percent of the PMF, which is less than the recommended capacity based on the size and hazard classification for the dam. Therefore, the spillway is classified to be inadequate according to the recommended criteria.

b. Adequacy of Information. The available information, in conjunction with the visual observations and the previous experience of the inspectors, is considered to be sufficient to make a reasonable assessment of the condition of the dam.

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

d. Necessity for Additional Data. No additional data are required.

7.2 Recommendations/Remedial Measures. It is recommended that:

1. Seepage points and the wet areas along the downstream toe of the dam should be periodically visually monitored.
2. The dam and appurtenant structures should continue to be inspected regularly and necessary maintenance should be performed.
3. Around-the-clock surveillance should be provided during unusually heavy runoff and a formal warning system should be developed to alert the downstream residents in the event of emergencies.

PLATES

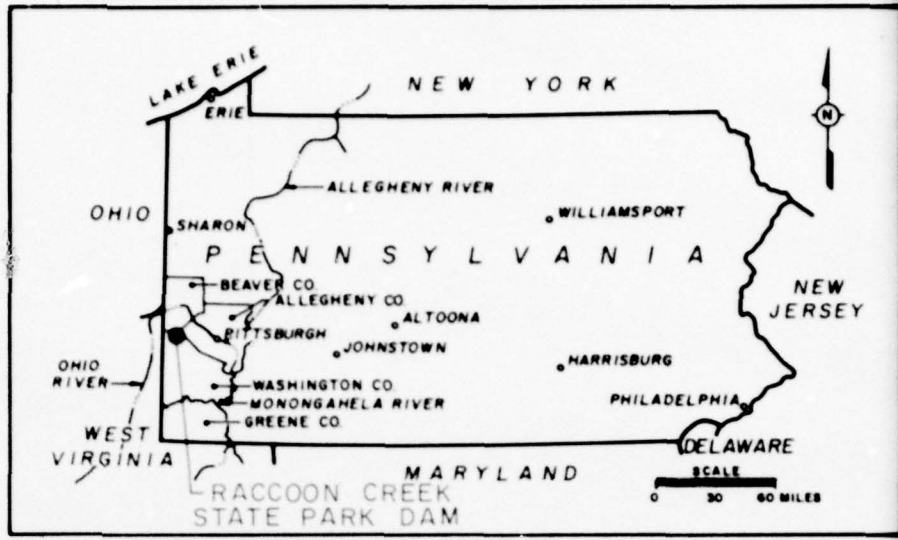
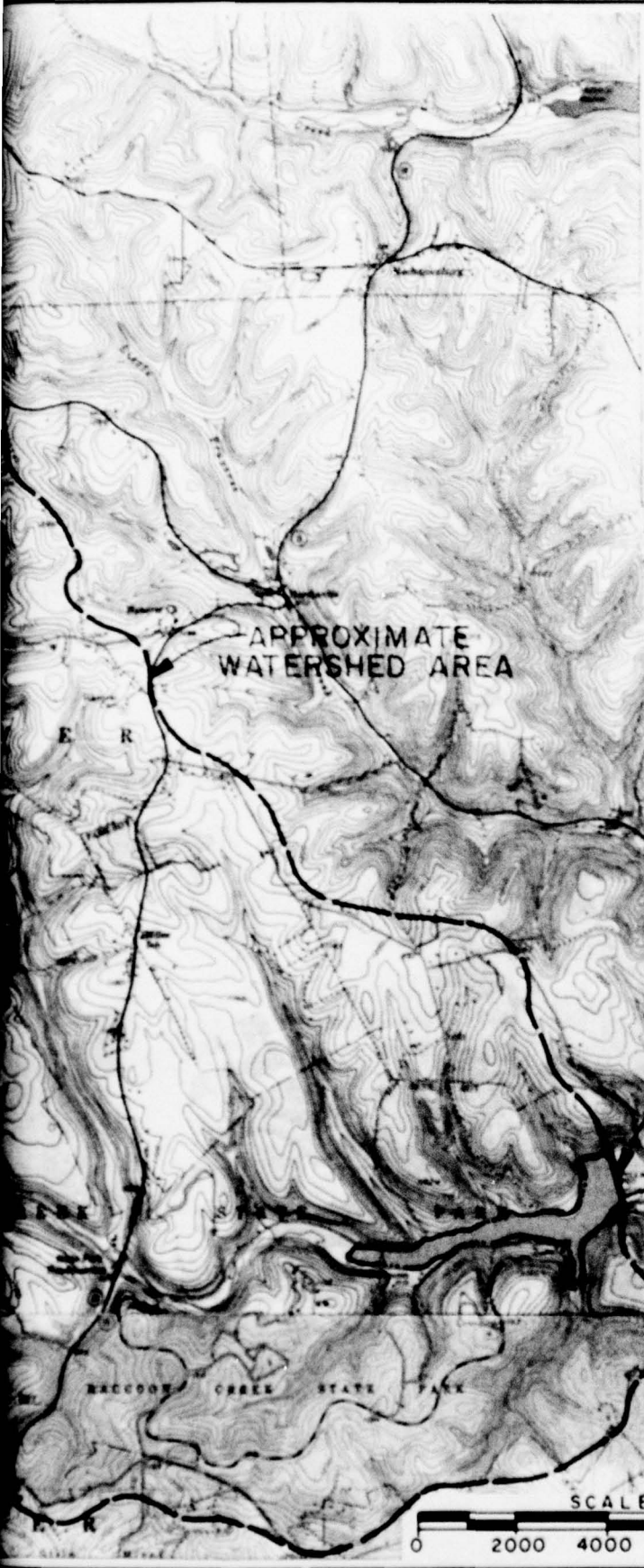
DRAWN BY ACS CHECKED BY *PA* DRAWING NUMBER 78-367-B189  
 APPROVED BY *HP* 7/29/79



**REFERENCES:**

1. USGS 7.5' HOOKSTOWN, PA QUADRANGLE  
PHOTOREVISED 1969, SCALE 1:24,000
2. USGS 7.5' ALIQUIPPA, PA QUADRANGLE  
PHOTOREVISED 1969, SCALE 1:24,000
3. USGS 7.5' BURGETTSTOWN, PA QUADRANGLE  
PHOTOREVISED 1969, SCALE 1:24,000
4. USGS 7.5' CLINTON, PA QUADRANGLE  
PHOTOREVISED 1969, SCALE 1:24,000





**KEY PLAN**

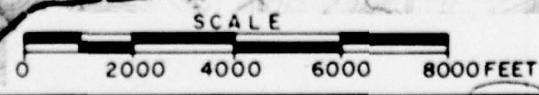
APPROXIMATE  
WATERSHED AREA

RACCOON CREEK STATE PARK DAM

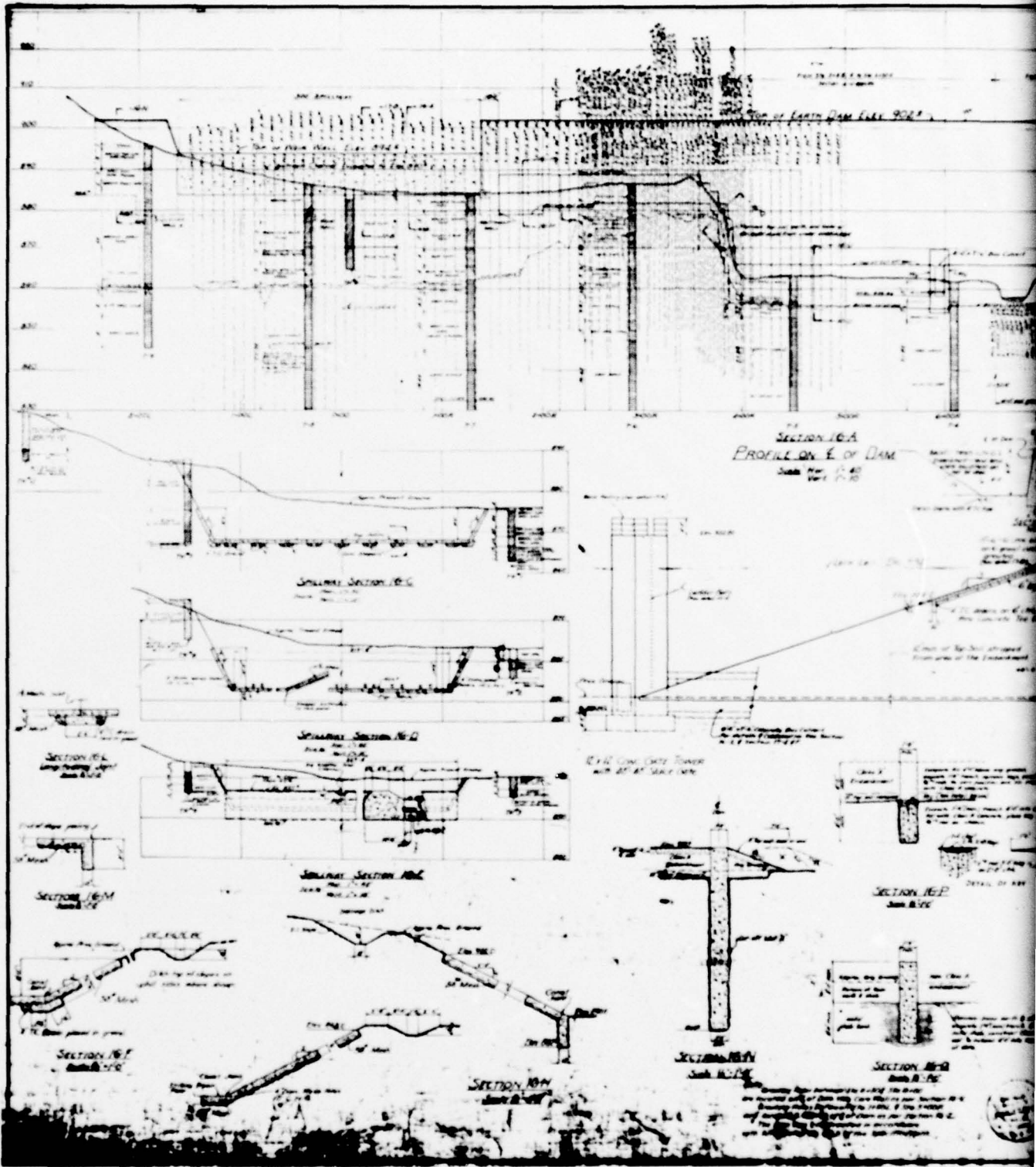
PLATE I

RACCOON CREEK STATE PARK DAM  
VICINITY, FLOOD PLAIN & WATERSHED MAP

**D'APPOLONIA**

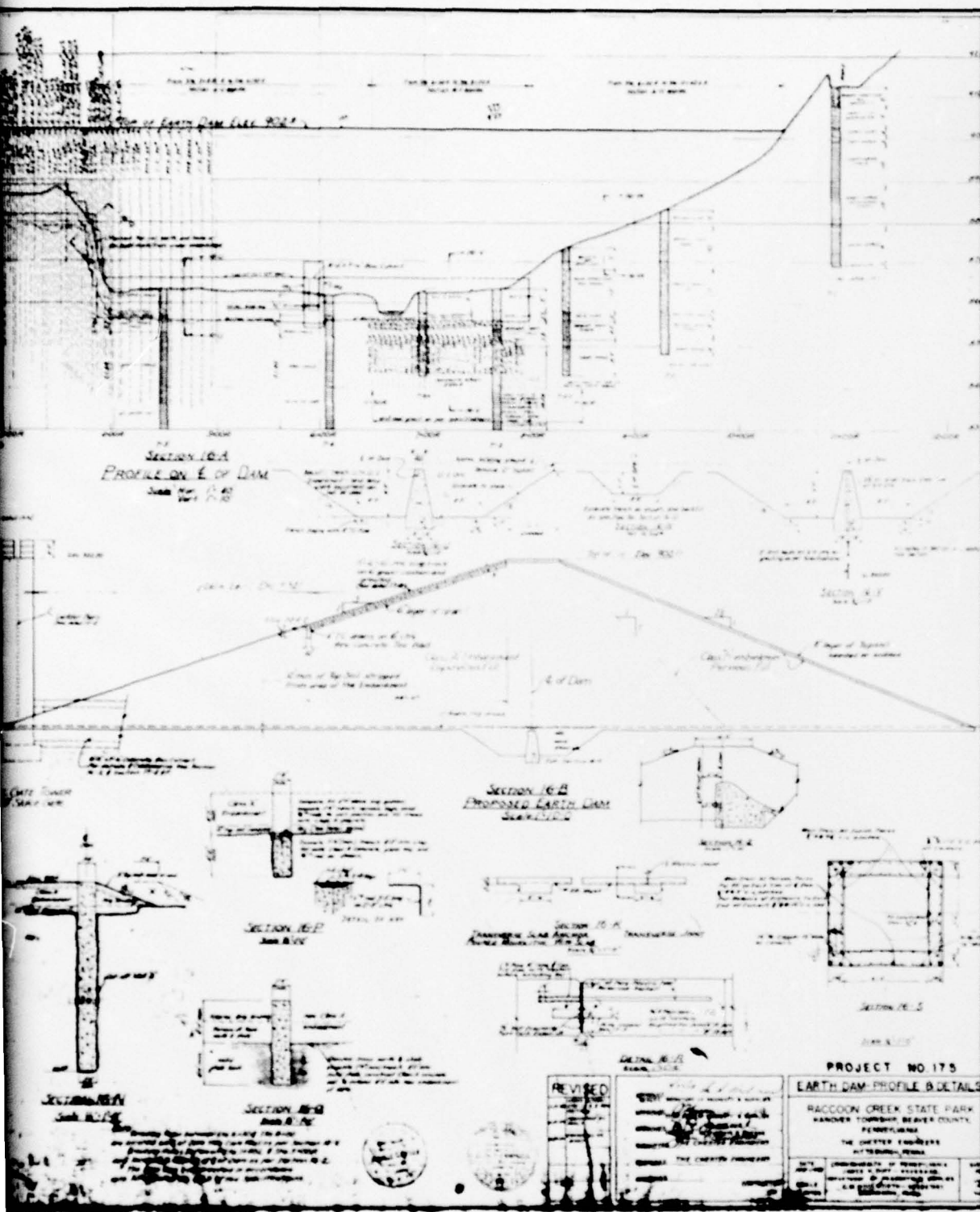


DRAWN BY: *Art* 7-23-79 CHECKED BY: *SE* 7-28-79 DRAWING NUMBER: 78-367-B190  
 APPROVED BY: *JHP* 7-28-79



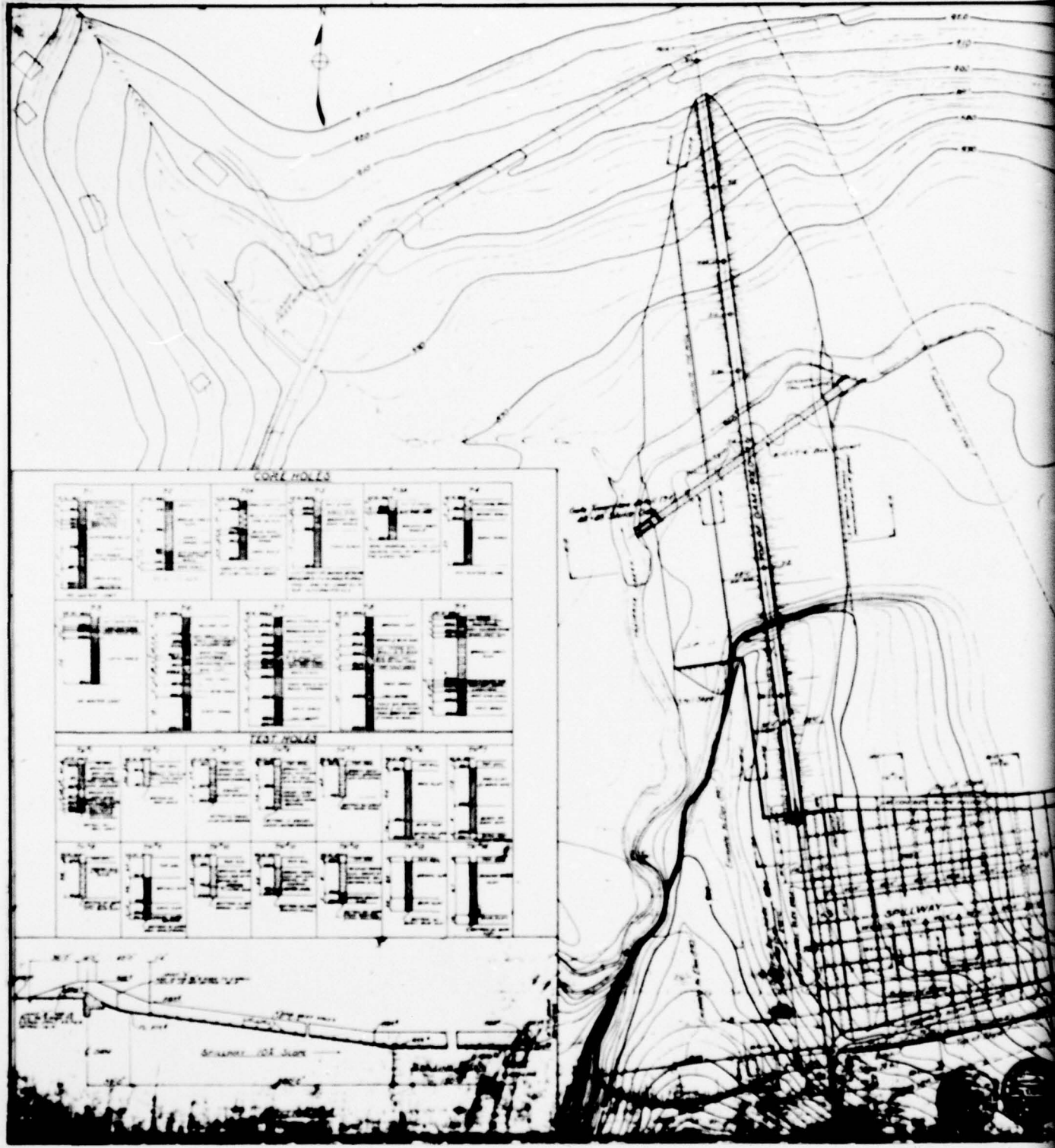
THIS PAGE IS A QUALITY FRAGMENT  
 FROM ONE OF OUR 80 DGS

1



THIS FILE IS BEST QUALITY REPRODUCTION  
 FROM COPY PUBLISHED TO DDB

DRAWN BY *JHP* 2.25.74 CHECKED BY *DE* 7.20.73 DRAWING NUMBER 78-367-B 191 APPROVED BY *JHP* 7.28.73



THIS PAGE IS BEST QUALITY FRAGRANCE  
FROM THE PUBLISHING TO DOC

1



THIS PLOT IS BEST QUALITY PAPER  
 FROM THE PUBLISHED TO THE

PLATE 3

D'APPOLONIA

1

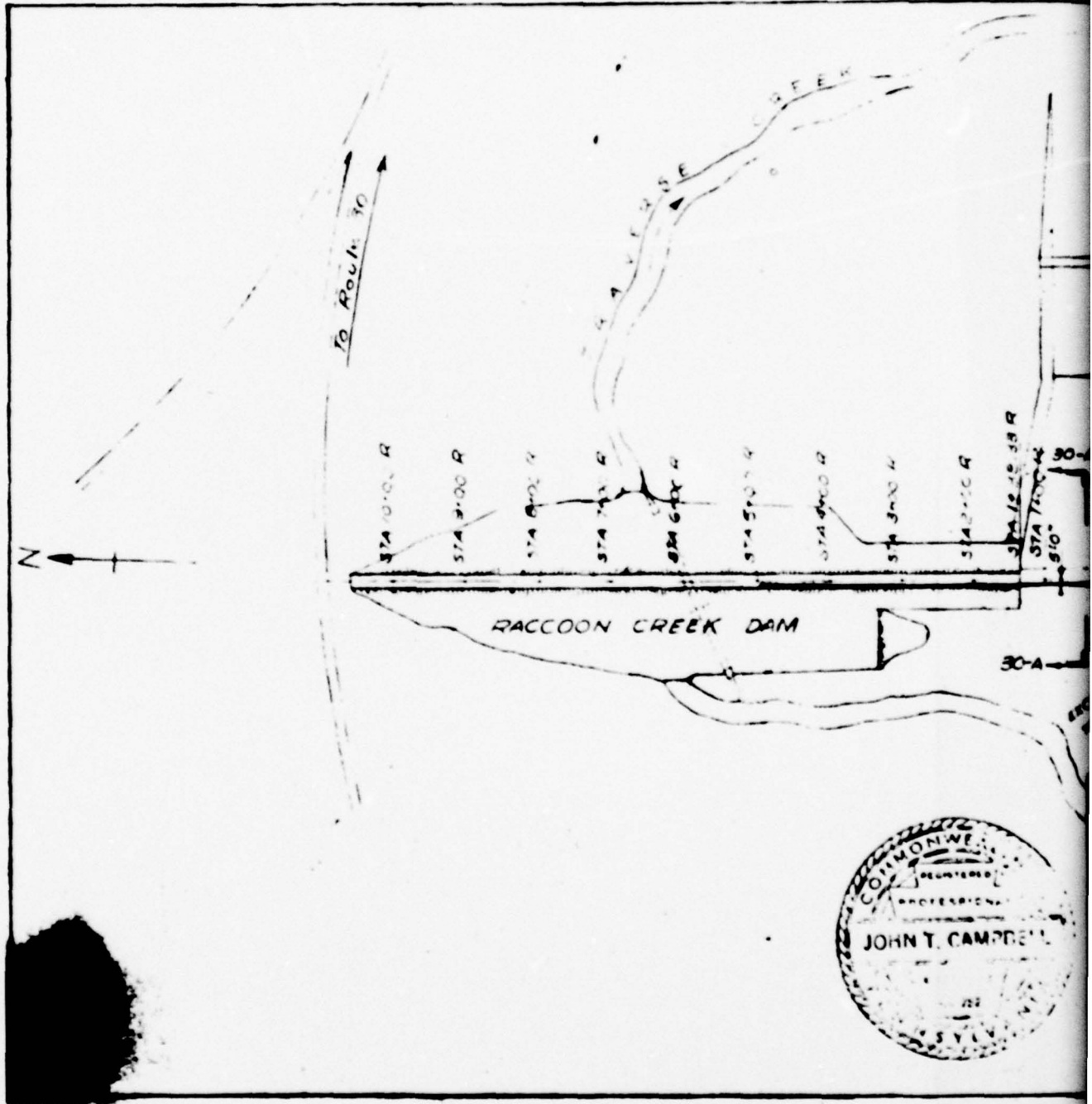
1

1 2



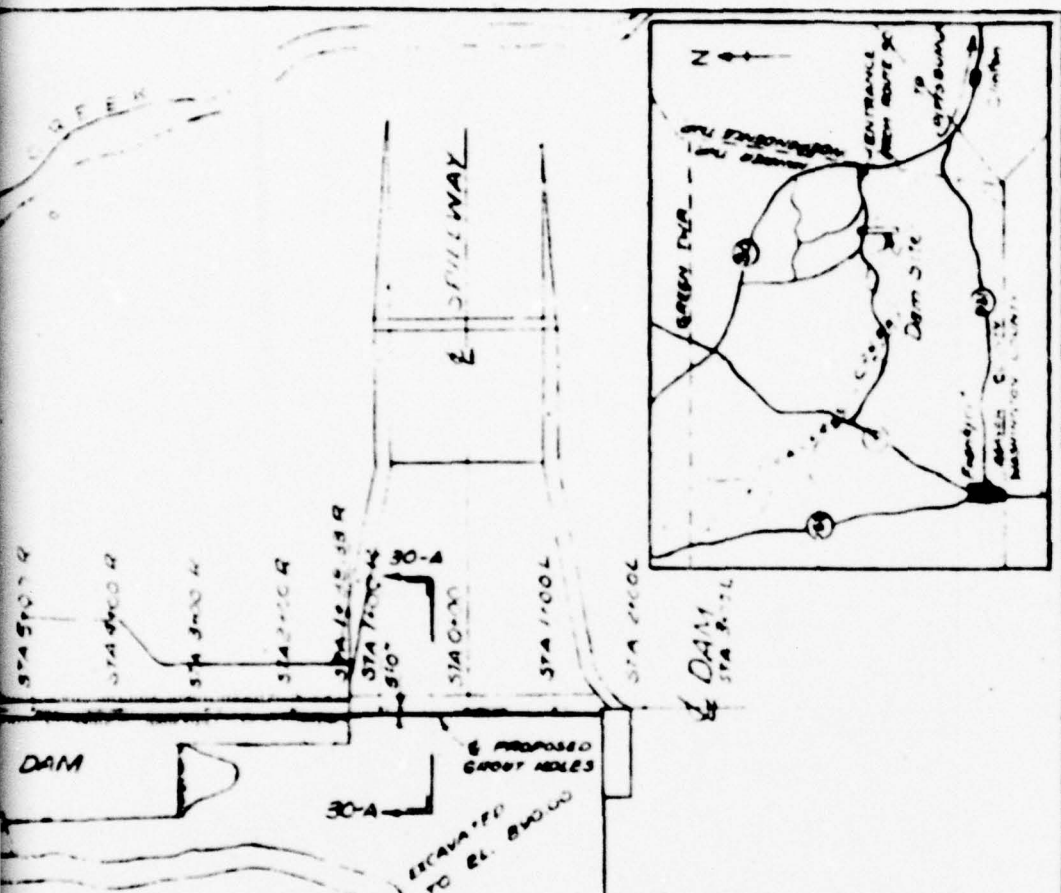


DRAWN BY	Apr 7 23 74	CHECKED BY	BE	DRAWING NUMBER	78-567-B193
		APPROVED BY	JHP		



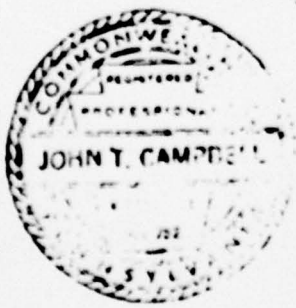
THIS PAGE IS BEST QUALITY FRAGILE  
 FROM COPY FURNISHED TO L&M

1



PROJECT NO. 175  
 LOCATION OF PRESSURE  
 GROUTING PLAN  
 RACCOON CREEK STATE PARK  
 HANOVER TOWNSHIP, BEAVER COUNTY,  
 PENNSYLVANIA  
 THE CHESTER ENGINEERS  
 PITTSBURGH, PENNA.

DATE	COMMONWEALTH OF PENNSYLVANIA	SHEET
AUG. 1933	JAMES H. DUFF - GOVERNOR	NO
SCALE	DEPARTMENT OF PROMOTIVE & SUPPLY	1
1" = 80'	C. M. WOOLWORTH - SECRETARY	
	HARRISBURG, PENNA.	



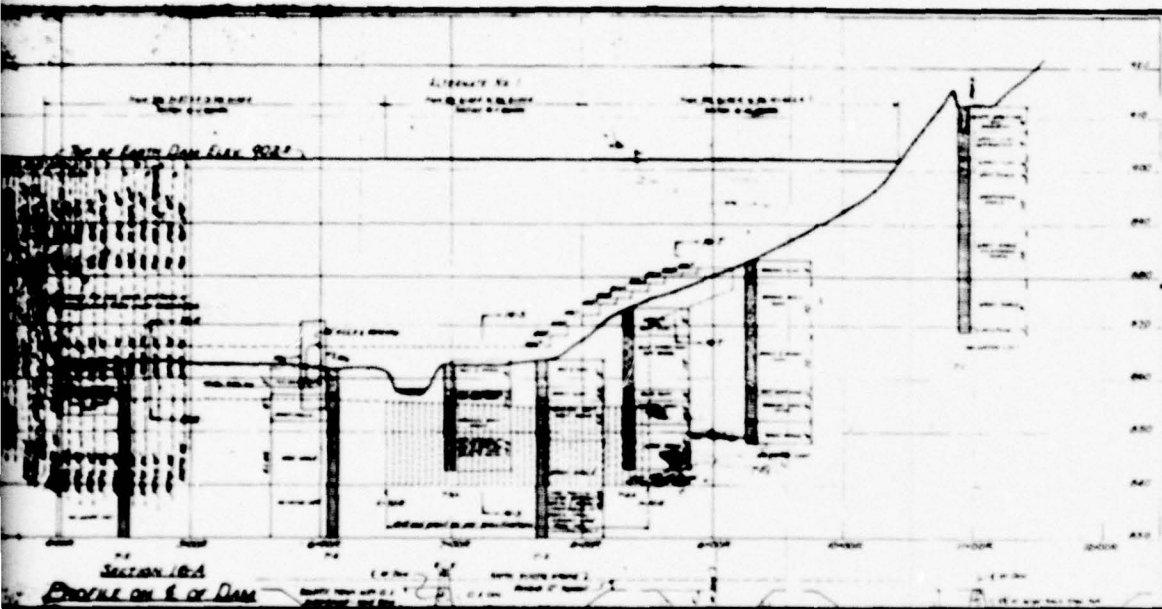
THIS PAGE IS THE BEST QUALITY PAPER AVAILABLE  
 FROM THE PAPER MANUFACTURING INDUSTRY

PLATE 5

**D'APPOLONIA**

1 2





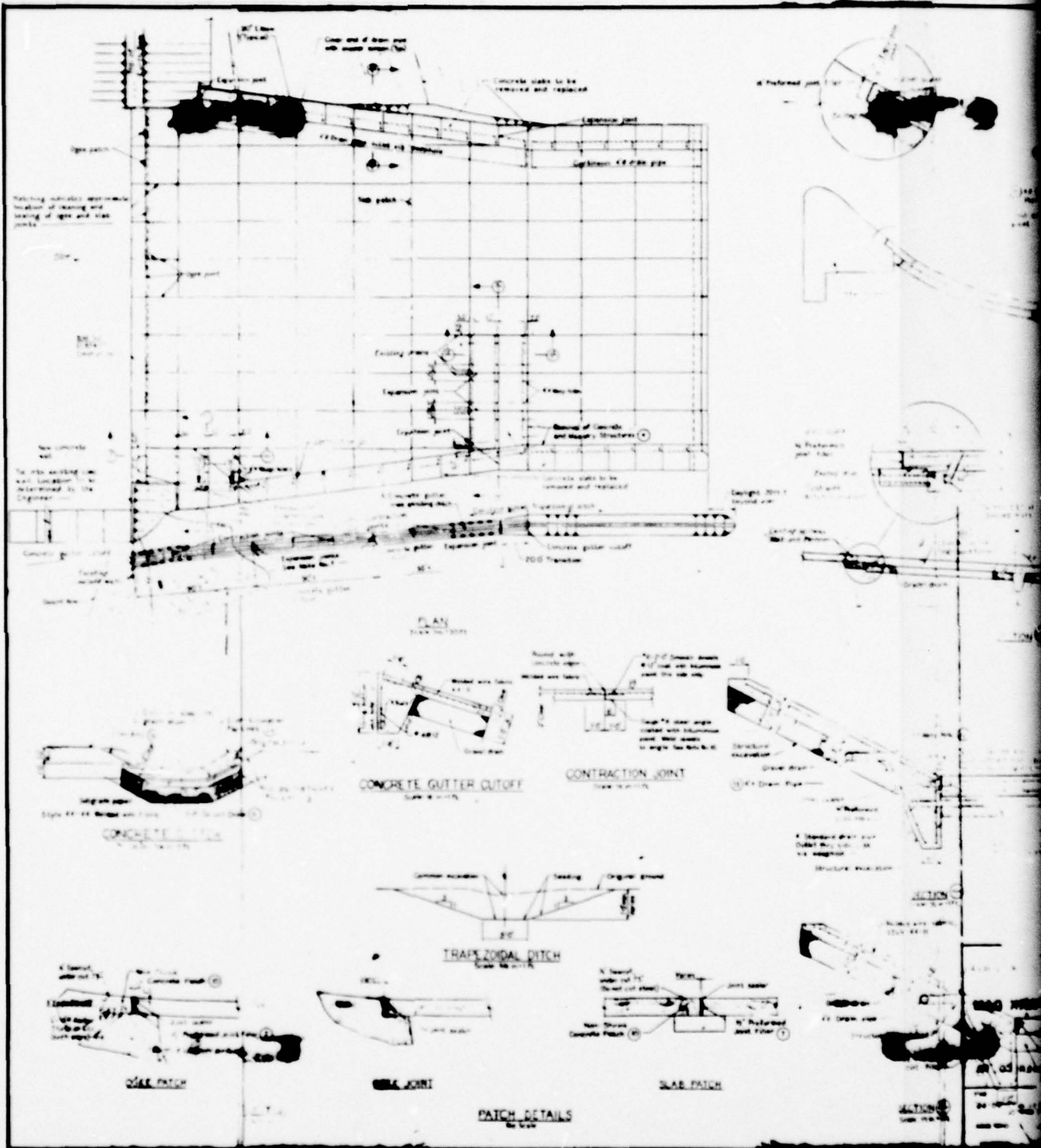
THIS PAGE IS BEST QUALITY PRACTICES  
FROM THE PUBLISHED IN 1900

2

PLATE 6

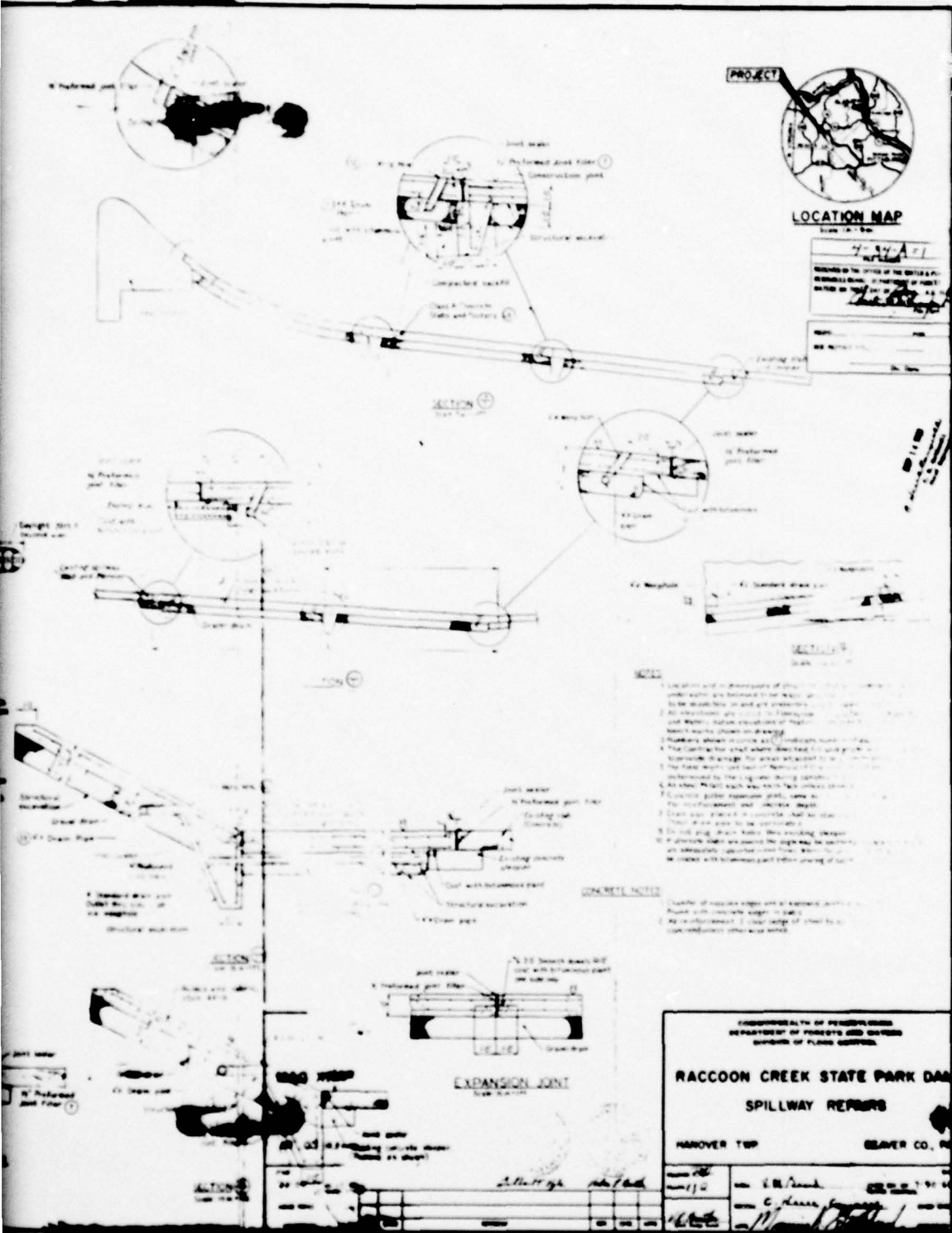
**D'APPOLONIA**

DRAWN BY: [Signature]    CHECKED BY: [Signature]    DRAWING NUMBER: 78-367-B195  
 APPROVED BY: [Signature]



THIS PAGE IS OF POOR QUALITY REPRODUCED FROM COPY FURNISHED TO L&G

1

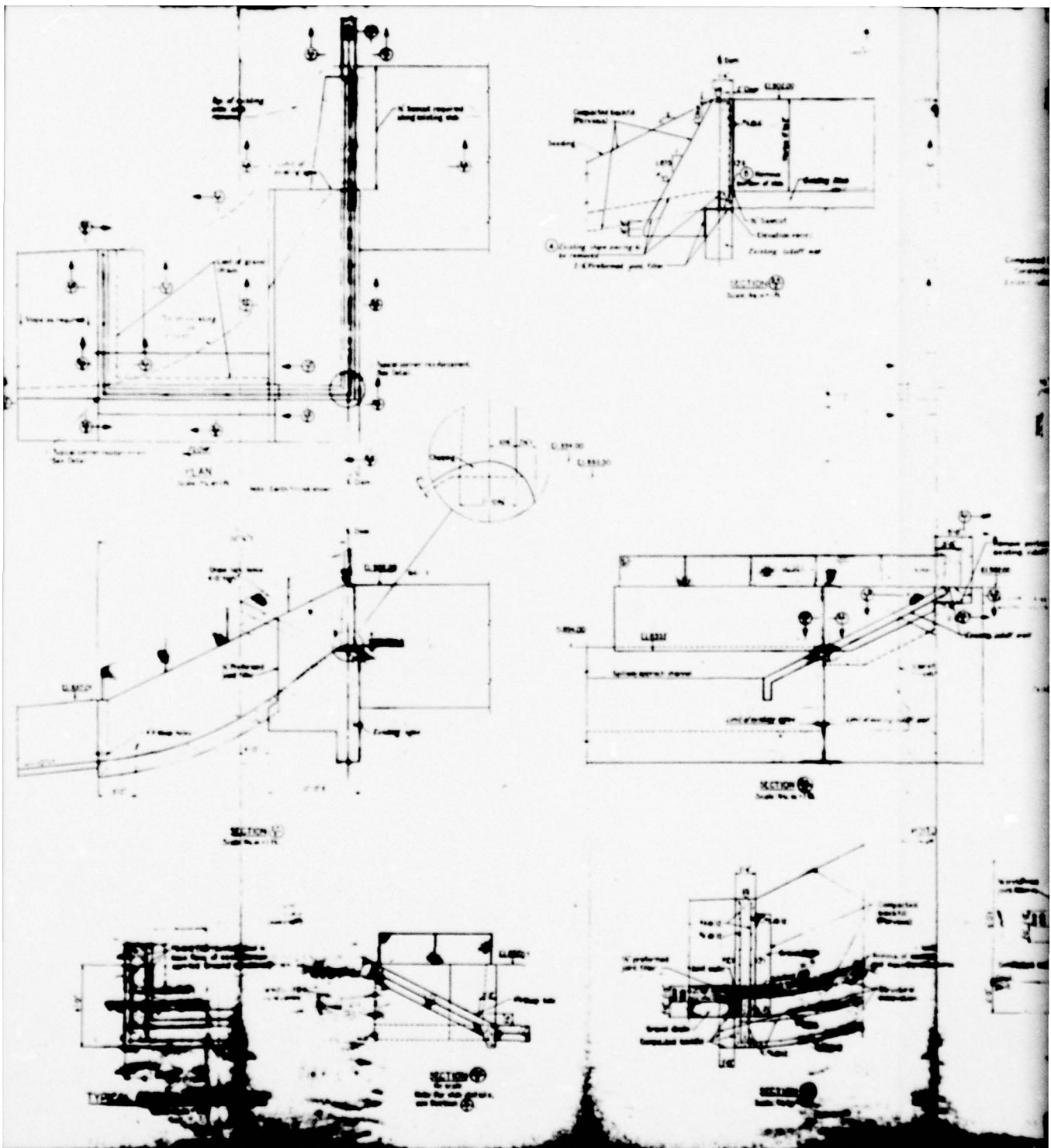


THIS PAGE IS BEST QUALITY PAPER (100% R.F.)  
 FROM PAPER PUBLISHED TO L&O

PLATE 7

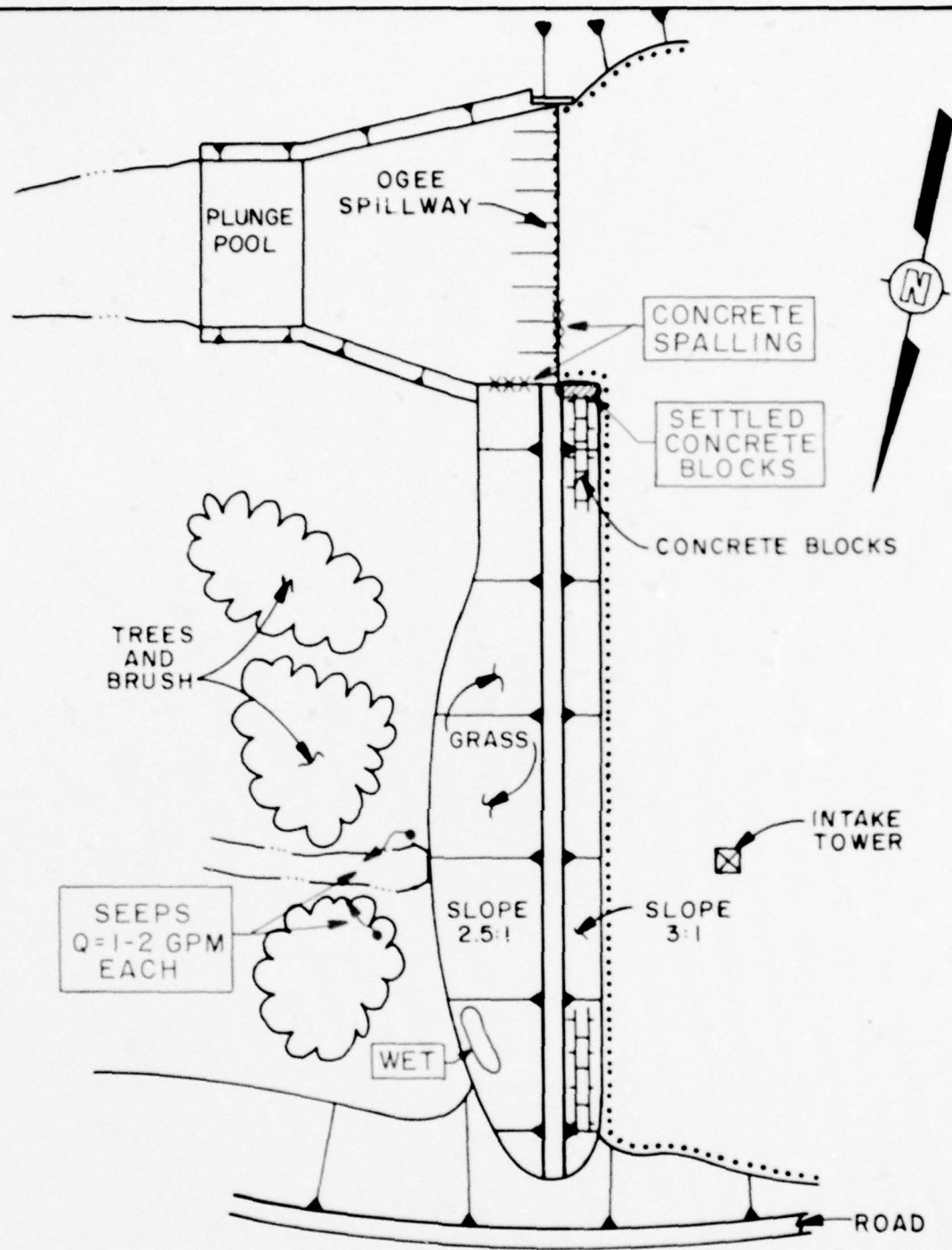
**D'APPOLONIA**

1 2





DRAWN BY	R.D.B.	CHECKED BY	DRAWING NUMBER
	1-4-79	JAC	367-A15
		JAP	7-24-79
			7-29-79

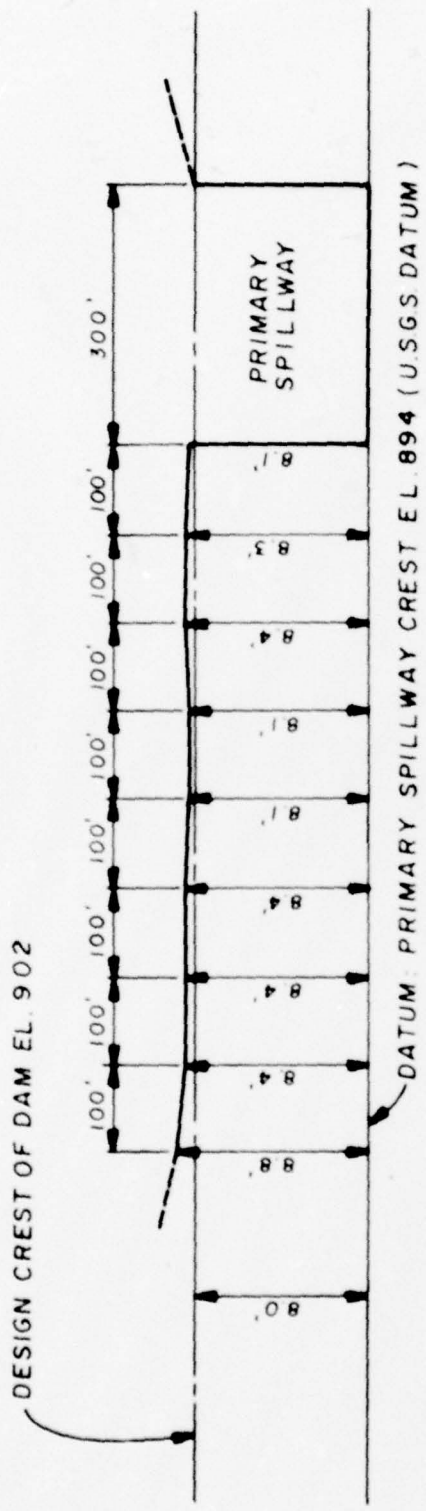


- NOTES:**
1. SPILLWAY FREEBOARD = 8.0 FEET.
  2. POOL LEVEL DATE OF INSPECTION: 0.1 FT. ABOVE SPILLWAY CREST.

PLATE 9  
 RACON CREEK STATE PARK DAM  
 GENERAL PLAN  
 FIELD INSPECTION NOTES  
 FIELD INSPECTION DATE: DEC. 13, 1978

**D'APOLONIA**

DRAWN BY	ACS	CHECKED BY	DRAWING NUMBER
	6-28-79	BE	76
		APPROVED BY	67-A46



DAM CREST PROFILE  
( LOOKING UPSTREAM )

NOTE  
DAM CREST IS SURVEYED RELATIVE  
TO PRIMARY SPILLWAY CREST LEVEL

PLATE 10

RACCOON CREEK STATE PARK DAM  
DAM CREST SURVEY  
FIELD INSPECTION DATE: DEC. 13, 1978

**D'APOLONIA**

APPENDIX A  
CHECKLIST  
VISUAL INSPECTION  
PHASE I

APPENDIX A  
CHECKLIST  
VISUAL INSPECTION  
PHASE I

NDI I.D. PA-262  
DER I.D. 4-34

NAME OF DAM Raccoon Creek State Park COUNTY Beaver STATE Pennsylvania ID# 100

TYPE OF DAM Earth HAZARD CATEGORY High

DATE(S) INSPECTION December 13, 1979 WEATHER Sunny TEMPERATURE 40°

POOL ELEVATION AT TIME OF INSPECTION 894.1 M.S.L. TAILWATER AT TIME OF INSPECTION 858.4 M.S.L.

INSPECTION PERSONNEL: REVIEW INSPECTION PERSONNEL:  
(April 16, 1979)

Biggin Erel L. D. Andersen  
Mah-Tek Chan J. H. Poillot  
B. Erel

Biggin Erel RECORDER

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.	
SLOUCHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	None.	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	See Plate 10.	
RIPRAP FAILURES	None.	

VISUAL INSPECTION  
 PHASE I  
 EMBANKMENT  
 OBSERVATIONS

VISUAL EXAMINATION OF JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
	No signs of distress.	
ANY NOTICEABLE SEEPAGE	Two small seeps (one to two gallons per minute) were located on each side of the outlet works discharge channel. Seeps are clear. No indication of internal erosion was observed.	
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	REPAIRS OR RECOMMENDATIONS
INTAKE STRUCTURE	The outlet conduit was inspected and was found to be in good condition.	
OUTLET STRUCTURE	In good condition.	
OUTLET CHANNEL	No significant obstructions.	
EMERGENCY GATE	The emergency gate was operated by park personnel and was observed to be functional.	

VISUAL INSPECTION  
 PHASE I  
 UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REPAIRS OR RECOMMENDATIONS
CONCRETE WEIR	Structurally in good condition. There is some concrete spalling at various locations.	
APPROACH CHANNEL	Submerged. Appears to be free of debris.	
DISCHARGE CHANNEL	Trapezoidal concrete-lined channel in good condition.	
BRIDGE AND PIERS	None.	

VISUAL INSPECTION  
 PHASE I  
 GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	Not applicable.	
APPROACH CHANNEL	Not applicable.	
DISCHARGE CHANNEL	Not applicable.	
BRIDGE PIERS	Not applicable.	
GATES AND OPERATION EQUIPMENT	Not applicable.	

VISUAL INSPECTION  
 PHASE I  
 INSTRUMENTATION

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

VISUAL INSPECTION  
 PHASE I  
 RESERVOIR  
 OBSERVATIONS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Moderately steep to steep. No significant shoreline erosion was noted. Although some landslides were reported in the past located along the left abutment, none were observed at this time.	
SEDIMENTATION	Unknown.	
UPSTREAM RESERVOIRS	One small reservoir approximately 3 miles upstream from the dam. The upstream reservoir is considered to be hydrologically insignificant.	

VISUAL INSPECTION  
 PHASE I  
 DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	No apparent obstructions immediately downstream from the dam that would affect the discharge capacity of spillway or the outlet works.	
SLOPES	No apparent instability (immediately downstream from the dam).	
APPROXIMATE NUMBER OF HOMES AND POPULATION	Four mobile homes and two commercial buildings are located approximately 1-1/2 miles downstream from the dam along Raccoon Creek. A major shopping center and residential sections of Aliquippa are located approximately 10 miles downstream. Population: approximately 20 (in the initial impact area).	

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 Raccoon Creek State Park

ID# NDI I.D. PA-262

DER I.D. 4-34

ITEM	REMARKS
AS-BUILT DRAWINGS	The design drawings are available in the state files.
REGIONAL VICINITY MAP	See Plate 1.
CONSTRUCTION HISTORY	The dam was designed by The Chester Engineers of Pittsburgh, Pennsylvania in 1946. Construction of the dam was completed in 1948.
TYPICAL SECTIONS OF DAM	See Plate 2.
OUTLETS - PLAN - DETAILS - CONSTRAINTS - DISCHARGE RATINGS	See Plate 4.

CHECKLIST  
ENGINEERING DATA  
DESIGN, CONSTRUCTION, OPERATION  
PHASE 1

ITEM	REMARKS
RAINFALL/RESERVOIR RECORDS	Not available.
DESIGN REPORTS	Not available.
GEOLOGY REPORTS	Not available.
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	Not available.
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	See Plates 2 and 3 for boring logs.

CHECKLIST  
 ENGINEERING DATA  
 DESIGN, CONSTRUCTION, OPERATION  
 PHASE I

ITEM	REMARKS
POST CONSTRUCTION SURVEYS OF DAM	None reported.
BORROW SOURCES	Unknown.
MONITORING SYSTEMS	None.
MODIFICATIONS	Remedial grouting along the right abutment in 1949. Renovation and partial rebuilding of the spillway in 1965.
HIGH POOL RECORDS	Not recorded.

CHECKLIST  
ENGINEERING DATA  
DESIGN, CONSTRUCTION, OPERATION  
PHASE I

ITEM	REMARKS
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	See Section 2.4 of the report.
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	None reported.
MAINTENANCE OPERATION RECORDS	Available in the state files.
SPILLWAY PLAN SECTIONS DETAILS	See Plates 3, 4, 7, and 8.
OPERATING EQUIPMENT PLANS AND DETAILS	

CHECKLIST  
ENGINEERING DATA  
HYDROLOGIC AND HYDRAULIC

DRAINAGE AREA CHARACTERISTICS: 19.1 square miles (woodlands)  
ELEVATION; TOP NORMAL POOL AND STORAGE CAPACITY: 894 (1000 acre-feet estimated)  
ELEVATION; TOP FLOOD CONTROL POOL AND STORAGE CAPACITY: 902 (1800 acre-feet estimated)  
ELEVATION; MAXIMUM DESIGN POOL: 902  
ELEVATION; TOP DAM: 902 (as designed)

SPILLWAY:

- a. Elevation 894
- b. Type Concrete ogee overflow section
- c. Width 300 feet (perpendicular to flow)
- d. Length Not applicable
- e. Location Spillover Middle of embankment
- f. Number and Type of Gates None

OUTLET WORKS:

- a. Type 8-foot by 7.5-foot concrete box culvert
- b. Location Center of embankment
- c. Entrance Inverts 859.0
- d. Exit Inverts 857.7
- e. Emergency Draindown Facilities 48-inch sluice gate

HYDROMETEOROLOGICAL GAGES:

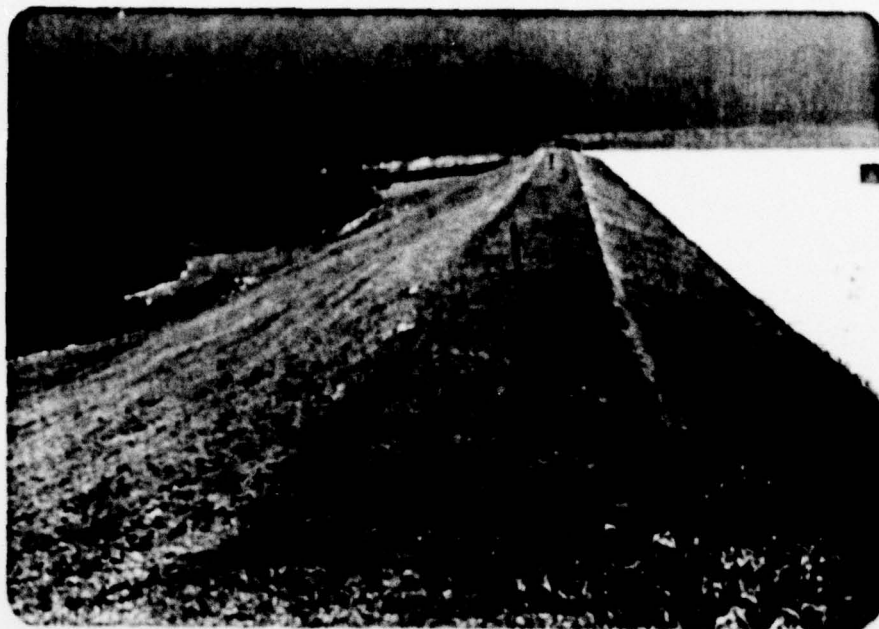
- a. Type None
- b. Location None
- c. Records None

MAXIMUM NONDAMAGING DISCHARGE: 26,000 cfs (spillway capacity)

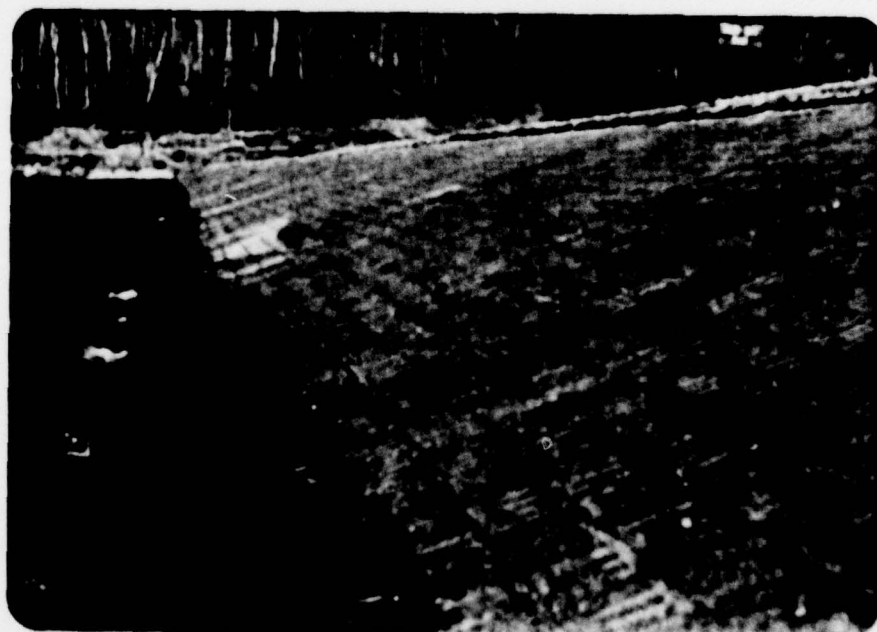
APPENDIX C  
PHOTOGRAPHS

LIST OF PHOTOGRAPHS  
RACCOON CREEK STATE PARK DAM  
NDI I.D. NO. PA-262  
DECEMBER 13, 1978

<u>PHOTOGRAPH NO.</u>	<u>DESCRIPTION</u>
1	Crest (looking south).
2	Upstream slope protection.
3	Spillway crest.
4	Spillway chute.
5	Outlet works intake tower.
6	Downstream end of outlet conduit.



Photograph No. 1  
Crest (looking south).



Photograph No. 2  
Upstream slope protection.



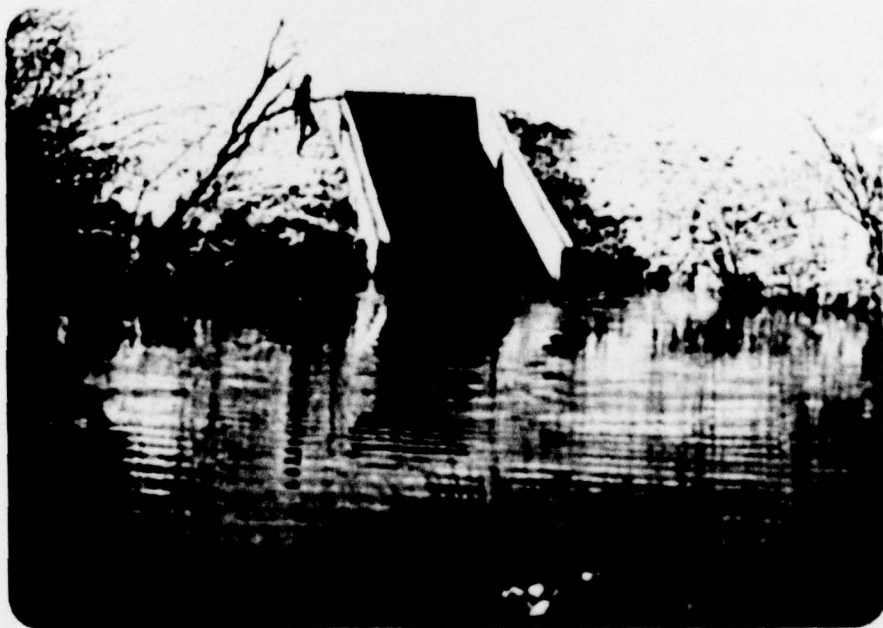
Photograph No. 3  
Spillway crest.



Photograph No. 4  
Spillway chute.



Photograph No. 5  
Outlet works intake tower.



Photograph No. 6  
Downstream end of outlet conduit.

APPENDIX D  
CALCULATIONS

HYDROLOGY AND HYDRAULIC ANALYSIS  
DATA BASE

NAME OF DAM: Raccoon Creek State Park Dam  
(NDI I.D. PA-262)

PROBABLE MAXIMUM PRECIPITATION (PMP) = 24.1 INCHES/24 HOURS<sup>(1)</sup>

STATION	1	2	3	4	5
Station Description	Lake	Dam			
Drainage Area (square miles)	19.1	0			
Cumulative Drainage Area (square miles)	19.1	19.1			
Adjustment of PMP for Drainage Area (2) <sup>(2)</sup>					
6 Hours	96	-			
12 Hours	113	-			
24 Hours	124	-			
48 Hours	134	-			
72 Hours	-	-			
Snyder Hydrograph Parameters					
Zone (3)	28	-			
C <sub>p</sub> /C <sub>t</sub> (4)	0.57/1.7	-			
L (miles) (5)	6.8	-			
L <sub>ca</sub> (miles) (5)	3.2	-			
t <sub>p</sub> = C <sub>t</sub> (L·L <sub>ca</sub> ) <sup>0.3</sup> (hours)	4.3	-			
Spillway Data					
Crest Length (ft)	-	300			
Freeboard (ft)	-	8.1			
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<sub>p</sub> and C<sub>t</sub>).

(4) Snyder's Coefficients.

(5) L = Length of longest water course from outlet to basin divide.

L<sub>ca</sub> = 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 24 FEB 79  
 .....

1	A1	SNYDER UNIT HYDROGRAPH, FLOOD ROUTING     DAM OVERTOPPING ANALYSES										
2	A2	RACOOM CREEK STATE PARK DAM, BEAVER COUNTY, MDI-ID. PA.262, PROJ. NO. 78-367-15										
3	A3	FOR 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, AND 100% PMF										
4	B	100	0	10	0	0	0	0	0	C	-4	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	1									
9	K1	CALCULATION OF INFLOW HYDROGRAPH TO RACOOM CREEK STATE PARK DAM, (PA.262)										
10	M	1	1	19.1								
11	P	1	24.1	96	113	124	134					
12	T							1.0	.05			0.0066
13	U	4.28	0.57									
14	X	-1.0	-0.05	2.0								
15	Z	1										
16	Z1	ROUTING FLOW THROUGH RACOOM CREEK STATE PARK DAM, MDI-ID. PA.262										
17	V	1	1									
18	V1	1										1000.0
19	SS	0.0	1000.0	3277.0								
20	SE	864.0	894.0	920.0								
21	SS	894.0	300.0	3.80								
22	SD902.05	3.08	1.5	960.0	1.5							
23	SL 200.0	300.0	400.0	500.0	600.0	800.0	800.0	900.0	900.0			
24	SV902.05	902.08	902.25	902.35	902.36	902.40	902.80	902.80				
25	E											

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	19.10	1	5431.	8447.	11262.	14078.	16893.	19709.	22525.	25340.	28156.
	(	49.47)	(	159.66)	239.19)	318.91)	398.64)	478.37)	558.10)	637.83)	717.56)	797.28)
ROUTED TO	2	19.10	1	5580.	8389.	11198.	14008.	16817.	19626.	22435.	25246.	28058.
	(	49.47)	(	159.00)	237.55)	317.11)	396.66)	476.20)	555.75)	635.28)	714.88)	795.65)

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....  
 INITIAL VALUE      SPILLWAY CREST      TOP OF DAM  
 894.00              894.00              902.05  
 1000.              1000.              1765.  
 0.                  0.                  26037.

ELEVATION  
 STORAGE  
 OUTFLOW

RATED OF PMF	MAXIMUM RESERVOIR M.S.FLEV	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	896.88	0.00	1252.	5580.	0.00	44.00	0.00
.30	897.78	0.00	1331.	8389.	0.00	44.00	0.00
.40	898.59	0.00	1402.	11198.	0.00	44.00	0.00
.50	899.32	0.00	1466.	14108.	0.00	44.00	0.00
.60	900.01	0.00	1527.	16917.	0.00	44.00	0.00
.70	900.67	0.00	1584.	19426.	0.00	44.00	0.00
.80	901.29	0.00	1638.	22435.	0.00	44.00	0.00
.90	901.89	0.00	1691.	25246.	0.00	43.83	0.00
1.00	902.47	.37	1737.	28198.	2.00	43.83	0.00

OVERTOPPING ANALYSIS SUMMARY

THIS PAGE IS BEST QUALITY PRINTING  
 FROM A COPY SUBMITTED TO DOD

# D'APPOLONIA

CONSULTING ENGINEERS, INC.

By WTC Date 2-12-79 Subject RACCON CO. STATE PARK DAM Sheet No 1 of 1  
 Chkd. By BE Date 7-3-79 STORAGE VS ELEV. Proj No 78-367-13

## STORAGE VS ELEVATION

<u>ELEV</u>	<u>Δ ELEV</u>	<sup>(2)</sup> <u>AREA ACRES</u>	<sup>(3)</sup> <u>ΔV AC-FT</u>	<u>ΣV AC-FT</u>
884		0	(1)	0
900	36	78	1000	1000
920	20	154	2277	3277

(1) VOL. BELOW SPILLWAY CREST UNKNOWN

ESTIMATE VOL. = LAKE AREA x AVG DEPTH

$$= \frac{78 \text{ ACRES} \times 36'}{3} = 936 \text{ AC-FT}$$

DAY 1000 AC-FT

(2) BASED ON APPROXIMATE MEASUREMENT FROM USGS MAP.

$$(3) \Delta V = \frac{h}{3} (A_1 + A_2 + \sqrt{A_1 \times A_2})$$

APPENDIX E  
REGIONAL GEOLOGY

APPENDIX E  
REGIONAL GEOLOGY

Raccoon Creek State Park Dam is located on strata of the Conemaugh Group (Pennsylvanian Age). The Conemaugh Group is subdivided into the Glenshaw Formation, which is composed of strata below the Ames Limestone to the Upper Freeport coal, and the Casselman Formation, which is composed of strata above the Ames Limestone to the Pittsburgh coal. The dam is located on the Glenshaw Formation, which is characterized by interbedded sandstones, siltstones, and claystones. Thin limestone and coal beds may also occur locally. The claystones below the Ames Limestone, which outcrop along the valley walls above the dam and reservoir, are known as the Pittsburgh Red Beds and are prone to landslides. Above the Ames Limestone lies the Casselman Group which consists of numerous red beds, shales, and sandstones.

The Pittsburgh coal, which marks the top of the Casselman, has been removed by erosion and is consequently absent in the area. The Upper Freeport coal lies at about Elevation 700 or about 140 feet below the valley bottom and appears to be of minable thickness.

Well developed jointing at the site resulted in moderate seepage after completion of the dam, which necessitated an extensive grouting program. The overall geologic structure consists of a series of shallow domes and basins with strata dipping 60 to 80 feet per mile to the southeast.

DRAWING 7A-367-A21  
 NUMBER  
 CHECKED BY  
 2-5-79 APPROVED BY  
 ACS  
 DRAWN BY



BRADY, J.C. BACON, RACCOON CREEK  
 AND LITTLE BLUE RUN DAMS  
 GEOLOGY MAP

REFERENCE  
 GREATER PITTSBURGH REGION GEOLOGIC MAP  
 COMPILED BY W R WAGNER, J L CRAFT, L HEYMAN  
 AND J A HARPER, DATED 1975, SCALE 1:125 000

DNMPLADNLA

DRAWING 78-367-A22  
 NUMBER  
 2-4-79  
 CHECKED BY BE  
 APPROVED BY  
 2-5-79  
 ACS  
 DRAWN BY

**GROUP FORMATION**

**DESCRIPTION**

Alluvium		Qt	Sand, gravel, clay.
Terrace deposits			Sand, clay, gravel on terraces above present rivers, includes Carmichaels Formation.
<b>DUNKARD</b>	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.
<b>MONONGAHELA</b>		Pm	Cyclic sequences of shale, limestone, sandstone and coal; contains Pittsburgh coal bed at base.
<b>P: CONEMAUGH</b>	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.
<b>ALLEGHENY</b>	Vanport		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.
		Pg	

**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 1:125,000

**INDIANA**