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NATIONAL DAM INSPECTION PROGRAM, CRABAPPLE DAM (NDI NUMBER PA 0--ETC(U)
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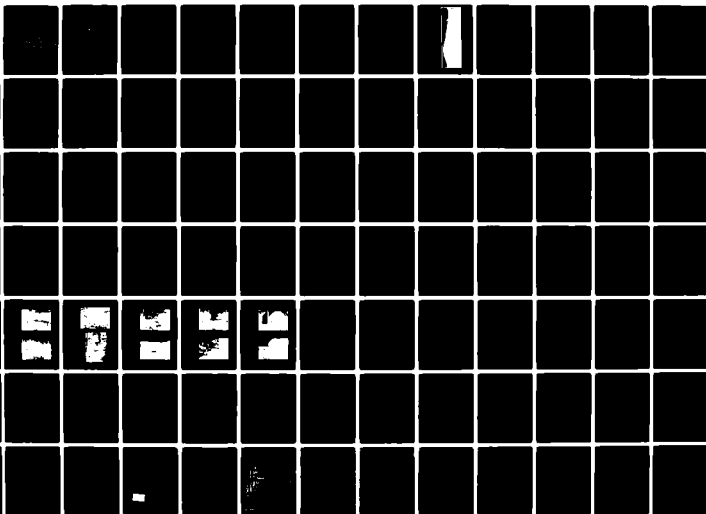
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OHIO RIVER BASIN
CRABAPPLE RUN
FAYETTE COUNTY

B.S. ①

PENNSYLVANIA

NDI No. PA 00907

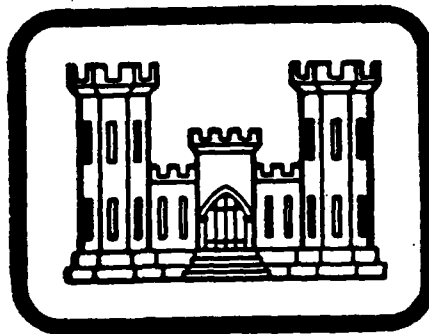
PENN DER No. 26-32

LEVEL II

CRABAPPLE DAM

STEPHEN VINCINSKI and GEORGE THOMAS

PHASE I INSPECTION REPORT NATIONAL DAM INSPECTION PROGRAM



PREPARED FOR

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

BY

✓ DAC W31-80-C-0026
ACKENHEIL & ASSOCIATES GEO SYSTEMS, INC.
CONSULTING ENGINEERS
1000 BANKSVILLE ROAD
PITTSBURGH, PENNSYLVANIA 15216

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OHIO RIVER BASIN
National Dam Inspection Program.
CRABAPPLE DAM
FAYETTE COUNTY, COMMONWEALTH OF PENNSYLVANIA
NDI # PA 00907, Number
PennDER # 26-32)
Ohio River Basin, Crabapple Run,
Fayette County, Pennsylvania
~~STEPHEN VINCENT AND GEORGE THOMAS~~

PHASE I INSPECTION REPORT,
NATIONAL DAM INSPECTION PROGRAM

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10 James F. Harwood
James F. Harwood

Prepared for: DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

Prepared by: ACKENHEIL & ASSOCIATES GEO SYSTEMS, INC.
Consulting Engineers
1000 Banksville Road
Pittsburgh, Pennsylvania 15216

Date: July 1980

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BY
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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.

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 investigations and analyses involving topographic mapping, subsurface investigations, materials testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify the 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 and safety 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 time 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 investigations 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" (PMF) 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.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

SYNOPSIS OF ASSESSMENT AND RECOMMENDATIONS

NAME OF DAM: Crabapple Dam
STATE LOCATION: Pennsylvania
COUNTY LOCATION: Fayette
STREAM: Crabapple Run, a tributary of
Redstone Creek.
DATE OF INSPECTION: 6 November 1979
COORDINATES: Lat. 40°01'34",
Long. 79°46'14"

ASSESSMENT

Based on a review of available design information and visual observations, ~~of conditions~~ as they existed on the date of the field inspection, the general condition of the Crabapple Dam is considered to be poor.

This assessment is based on visual observations and hydrology calculations that indicate:

- (1) A possible inadequate margin of safety against slope failure as indicated by slope irregularities and groundwater conditions;
- (2) "Inadequate" discharge capacity of the Principal Spillway as determined by using HEC-1 Dam Safety Version computer program; and
- (3) The lack of accessible control facilities on the outlet works pipelines.

The structure is classified as a "small" size, "high" hazard dam. Corps of Engineers guidelines recommend 0.5 to 1 times the Probable Maximum Flood (PMF) as the Spillway Design Flood for a "small" size, "high" hazard dam. Crabapple Dam's Spillway Design Flood is 1/2 the Probable Maximum Flood. Spillway capacity is "inadequate" because the non-overflowing flood discharge using the HEC-1 computer program was found to be 24 percent of the PMF. A computer breach analysis indicated that the spillway is not "seriously inadequate".

The visual inspection indicates several deficiencies which are considered correctable. The deficiencies can be corrected or improved through implementation of the following recommended remedial, monitoring and/or maintenance efforts.

SYNOPSIS OF ASSESSMENT AND RECOMMENDATIONS (CONT'D)
Crabapple Dam

RECOMMENDATIONS

1. Additional Investigations: It is recommended that the owner immediately retain the services of a registered professional engineer knowledgeable and experienced in the design and construction of earth dams and masonry spillways to provide a detailed engineering investigation of Crabapple Dam. This investigation should include but not be limited to the following:

(a) Detailed evaluation of spillway capacity and development of recommendations for remedial action.

(b) Detailed investigation of the seepage and wet conditions and structural stability of the embankment.

(c) Investigation of the outlet works with specific recommendations on making it operable and including provisions for upstream flow control.

2. Emergency Operation and Warning Plan: Concurrent with the additional investigations recommended above, the owner should develop an Emergency Operation and Warning Plan including:

(a) Guidelines for evaluating inflow during periods of heavy precipitation or runoff.

(b) Procedures for around the clock surveillance during periods of heavy precipitation or runoff.

(c) Procedures for emergency drawdown of the reservoir under emergency conditions.

(d) Procedures for notifying downstream residents and public officials, in case evacuation of downstream areas is necessary.

3. Remedial Work. The Phase I Inspection of Crabapple Dam also disclosed several deficiencies of lower priority which should be corrected immediately.

(a) Remove the trees from the upstream and downstream slopes including all root systems of 1/2 inch diameter or larger. This work should be performed under the direction of a professional engineer, knowledgeable in dam design and construction.

SYNOPSIS OF ASSESSMENT AND RECOMMENDATIONS (CONT'D)
Crabapple Dam

(b) Closely mow the embankment slopes, crest, groins, abutments and immediate downstream areas. Remove the cuttings from the site.

(c) Locate and backfill completely, all animal burrows on the embankment, groins and adjacent abutment areas.

(d) Regrade the upstream slope and provide wave erosion protection.

(e) Fill wheel ruts and minor erosion gullies on the embankment and adjacent areas.

(f) Raise the embankment crest to design elevation.

(g) Develop and implement formal maintenance and inspection procedures.

4. Orderly Breaching: In lieu of performing the above recommendations, the owner should engage the services of a professional engineer, knowledgeable in dam design and performance, to prepare specifications for breaching the structure, to make it incapable of impounding water. The structure should then be breached under the direction of the professional engineer and in accordance with applicable state and local regulations.



James P. Hannan July 1980
Project Engineer Date

James E. Barrick, P.E. 26 July 1980
PA Registration No. 022639-E Date

Approved by: James W. Peck

JAMES W. PECK
Colonel, Corps of Engineers
District Engineer

21 Aug. 11 1980
Date

CRABAPPLE DAM



OVERVIEW

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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
CRABAPPLE DAM
NATIONAL I. D. NO. PA 00907
PennDER No. 26-32

SECTION 1
PROJECT INFORMATION

1.1 GENERAL

a. Authority: The Phase I investigation was performed pursuant to authority granted by Public Law 92-367 (National Dam Inspection Act) 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 the investigation is to make a determination on whether or not the dam constitutes a hazard to human life or property.

1.2 DESCRIPTION OF PROJECT

a. Dam and Appurtenances:

(1) Embankment: Crabapple Dam was designed and constructed as a homogeneous earthfill structure with a clay cutoff 400 feet long beneath the central portion of the embankment. The embankment is 720 feet long, with a maximum toe to crest height of 30 feet and a crest width of 20 feet. At the embankment's deepest section, the upstream slope was observed to be 1H:1V above the water line; the downstream slope was observed to be 1.9H:1V near the crest, flattening to 2.3H:1V near the toe.

(2) Outlet Works: An 18 inch cast iron pipe was placed beneath the embankment to provide water supply and "blow off" capacity. The only visual evidence of the facility was the outlet end of the "blow off" (pond drain) pipe and a partially concrete encased section of 12 inch diameter cast iron water supply pipeline. No flow control devices were located.

(3) Principal (and Emergency) Spillway: The principal (and emergency) spillway for Crabapple Dam consists of a reinforced concrete, rectangular cross-section open channel chute structure at the left end of the embankment. The reservoir pool level is maintained by a concrete block and asphalt sill (overflow weir) located across the chute at the embankment crest centerline. The discharge channel is a continuation of the chute that directs reservoir outflows to a "plunge pool" stilling area beyond the toe of dam.

(4) Freeboard Conditions: The principal spillway training walls rise five feet above the crest of the principal spillway sill (overflow weir). The low point on the embankment crest is 3.6 feet above the sill.

(5) Downstream Conditions: Crabapple Run flows under State Route 51, a major north-south highway, approximately 50 feet below the end of the principal spillway chute. Beyond the highway embankment, Crabapple Run flows through a moderately steep-sided valley for two miles before joining Redstone Creek near the village of Rowe's Run.

There are at least two inhabited dwellings on the Crabapple Run floodplain below the dam that appeared to be low enough to be imperiled by a dam failure.

(6) Reservoir: Crabapple Dam reservoir, also known as Spillway Lake, is 1300 feet long at normal pool elevation and has a normal surface area of 14.7 acres. When the pool is at the crest of the dam, the reservoir length increases to 1400 feet and the surface area is 21.0 acres.

(7) Watershed: The watershed contributing to Crabapple Dam contains both woodland and pasture. There are a few inhabited dwellings and local roads.

b. Location: Crabapple Dam is located in Franklin Township, Fayette County, Pennsylvania. The dam is approximately 1.5 miles south of the intersection of State Routes 51 and 201 and 2.5 miles south of the village of Star Junction.

c. Size Classification: The dam has a maximum storage capacity of 188 acre-feet and a maximum toe to crest height of 30 feet. Based on Corps of Engineers guidelines, this dam is classified as a "small" size structure.

d. Hazard Classification: Crabapple Dam is classified as a "high" hazard dam. In the event of a dam failure, at least two inhabited dwellings and State Route 51, a major north-south highway, would be subjected to substantial damage and loss of life could result.

e. Ownership: Crabapple Dam is owned by Mr. Stephen Vincinski and Mr. George Thomas and correspondence can be addressed to:

Spillway Lake
c/o Provost Auto Wreckers
Provost and Weyman Roads
Pittsburgh, Pennsylvania 15236
(412) 882-7065 - Mr. Vincinski
(412) 884-4488 - Mr. Thomas

f. Purpose of Dam: The dam was originally designed to supply water for the Washington Coal and Coke Company's mines and coke ovens. The dam is currently used for recreational purposes.

g. Design and Construction History: The dam was designed and built under the supervision of Thomas J. Zimmerman, Chief Engineer, of the Washington Coal and Coke Company in 1905-1906.

h. Normal Operating Procedure: Crabapple Dam was designed to operate as an uncontrolled structure. Under normal operating conditions, the pool level is maintained at Elev. 1028.4 by the overflow weir of the principal spillway. An 18 inch diameter cast iron pipeline passes beneath the embankment and splits into an 18 inch pond drain and 12 inch water supply pipeline.

The pond drain is normally not operative and no control valves were located during the visual inspection.

1.3 PERTINENT DATA

a. Drainage Area 1.33 sq. mi.

b. Discharge at Dam Facility:

Maximum Flood at Dam Facility	860 cfs*
Storm of 4 June 1941	
Principal (and Emergency) Spillway	
Capacity at Design Top of Dam	1150 cfs
Principal (and Emergency) Spillway	
Capacity at Current Top of Dam	708 cfs

c. Elevation (feet above MSL):

Design Top of Dam	1033.4
Current Top of Dam (Low Point)	1032.0
Design High Water	1033.4
Normal Pool	1028.4*
Principal Spillway Overflow Weir Crest	1028.4*
Base of Embankment	1002+
Maximum Tailwater	Unknown

d. Reservoir Length:

Length of Maximum Pool	1400 feet
Length of Normal Pool	1300 feet

e. Total Storage:

Design Top of Dam	209 acre-feet
Design Highwater	209 acre-feet
Current Top of Dam	188 acre-feet
Principal (and Emergency)	
Spillway Crest	128 acre-feet*
Normal Pool Level	128 acre-feet*

f. Reservoir Surface:

Design Top of Dam	23.5 acres
Design Highwater	23.5 acres
Current Top of Dam	21.0 acres
Principal (and Emergency)	
Spillway Crest	14.7 acres*
Normal Pool	14.7 acres*

g. Embankment:

Type	Earth With Clay Cut-off*
Length	720 feet
Height	30 feet
Top Width	20 feet
Side Slopes: Upstream	0.9H:1V
Downstream	Varies from
	1.9H:1V to 2.3H:1V
Zoning	Unknown*
Cut-off Provisions	Clay*

h. Principal (and Emergency) Spillway:

Type	Asphalt and Concrete Block Open Channel with Trapazoidal Cross-Section Weir
Length of Weir	28.5 feet
Weir Crest Elevation	1028.4 feet

i. Outlet Works (Pond Drain and Water Supply):

Type	18 inch diameter Cast Iron Pipe
Riser Height	Unknown
Riser Dimensions	Unknown
Length of Outlet Pipe	Unknown
Gates	Unknown

*Taken or derived from available engineering data in
PennDER files.

SECTION 2 ENGINEERING DATA

2.1 DESIGN

The files of the Commonwealth of Pennsylvania, Department of Environmental Resources (PennDER) were reviewed but no engineering data related to the original design of the embankment or spillway was found.

2.2 CONSTRUCTION

The dam was designed and constructed in 1905-1906 by the Washington Coal and Coke Company. Thomas A. Zimmerman, Chief Engineer, was the design engineer and supervised the construction.

2.3 MODIFICATION/REPAIR

PennDER files indicate that modifications were made to the dam in 1915 and 1923. The repairs made in 1915 included increasing the capacity of the spillway to 1200 cfs, raising the crest of the embankment to Elev. 1031, adding riprap protection to the upstream slope, and installing a monitoring weir at a spring at the toe of the embankment. The modifications performed in 1923 included repairing and strengthening the spillway chute and increasing the storage capacity by adding a 1.4 foot high trapezoidal weir across the spillway crest.

2.4 OPERATION

The dam was designed to operate without a dam tender. The principal (and emergency) spillway is uncontrolled and performance and operation records are not maintained. There is no information available on the operation of the outlet works pipeline.

2.5 EVALUATION

a. Availability: Engineering data was provided by PennDER Bureau of Dams and Waterway Management.

b. Adequacy: The available engineering information, though greatly limited, was supplemented by field inspections and supporting engineering analyses and is considered adequate for the purpose of this Phase I inspection report.

c. Validity: Based on the review of the available information, there appears to be no reason to question the validity of the limited engineering data.

SECTION 3
VISUAL INSPECTION

3.1 FINDINGS

a. General: Crabapple Dam, which impounds Spillway Lake, consists of an earthen embankment and a reinforced concrete spillway on the left abutment. The spillway is an uncontrolled, open channel chute structure with an 18 inch high sill that maintains the reservoir pool level and provides for discharge of normal and flood flows.

The visual observations of Crabapple Dam and Spillway Lake were performed on 5 May 1980 and consisted of:

- (1) Visual observations of the embankment crest and slopes, groins and abutments;
- (2) Visual observations of the principal (and emergency) spillway including sill, concrete walls and approach and discharge channels.
- (3) Visual observations of the embankment's downstream toe area including springs and the pond drain pipe and discharge channel.
- (4) Visual observations of the reservoir shoreline, inlet stream channel and watershed.
- (5) Transit stadia survey of relative elevations along the embankment crest centerline, spillway, and across the embankment slopes.
- (6) Visual observations of downstream conditions and evaluation of the downstream hazard potential.

The visual observations were made during a period when the reservoir and tailwater were at normal operating levels.

The visual observations checklist, field plan, profile and section containing the observations and comments of the field inspection team are contained in Appendix A. Specific observations are illustrated on photographs in Appendix C. Detailed findings of the visual inspection are presented in the following sections.

b. Embankment:

(1) Crest: The crest of the embankment was observed to be straight and generally level on the date of inspection. The stadia survey indicated a low point near the center of the embankment that was 1.4 feet lower than the training wall of the spillway.

The crest was generally grass or gravel covered its entire length. Several low spots were noted that have, at recent times, impounded water.

(2) Upstream Slope: The upstream slope was observed to be very steep and generally tree and brush covered. It contained several local erosional gulleys. A bench was observed immediately below the water line indicating a general erosion of the slope. However, considerable crest width remains. No cracks were observed anywhere on the crest of the embankment.

(3) Downstream Slope: Two significant bulges were observed in the downstream slope. The larger of the two, near the center of the dam, was located immediately above an area of significant seepage and spring activity at the embankment's toe. The smaller bulge was located to the right of the larger bulge and was also associated with significantly wet conditions at and below the toe. They were generally sparsely covered with vegetation and small trees. A significant line of seepage on the embankment slope was observed passing through the right bulge and onto the area between the two bulges. Soil conditions above the line of seepage were generally firm but were quite wet and soft below. No scarps or indications of recent movement of either bulge was observed.

The remainder of the embankment was more or less uniform with some small local bulges and small erosional gulleys. In general, the embankment appeared to flatten toward the toe. The effect appeared to be more due to colluvial deposition than creep or movement of the embankment.

Vegetal cover on the downstream slope ranged from none through medium sized trees. In general, the trees were located on the left most portion of the embankment. Very little ground cover existed in the wooded area. Considerable barren earth was visible with some minor erosional gulleying noted. Vegetal cover appeared to thicken toward the right end of the embankment and a dense stand of brush and small trees existed at the right end.

2

Near the left end of the embankment, in the wooded section, a 2 1/2 inch diameter steel pipe protruded from the embankment slope, approximately 10 feet below the crest. The pipe was bent in an upstream direction and could not be checked for water depth.

c. Groins (Junction of Embankment and Abutments):

(1) Spillway Area: The left groin between the spillway and the embankment was dry and uneroded in the upper reach. At a point near the lower end of the spillway, the groin has been eroded, apparently by water flowing over the spillway wall and into the groin beyond. The depth of this erosion was approximately four feet but because of the great thickness of the spillway slab base, the slab has not yet been undercut.

Similar conditions existed at the right groin between the spillway and abutment. Erosion has occurred along the spillway training wall near the downstream end but is not as extensive as on the left. The remainder of the groin was dry and uneroded.

(2) Lower Left: The groin between the left end of the embankment and the abutment was observed to be generally dry and uneroded. Soil conditions in the vicinity were moist, but a uniform ground covering indicated no erosional activity along the groin. No seeping water was observed.

(3) Right: The groin between the right end of the embankment and the original abutment was observed to be dry and uneroded. Toward the central portion of the embankment, groin conditions become wet with seepage. This condition extended along the entire downstream toe to a point where the left abutment rises above the valley floodplain.

d. Abutments:

(1) Left: The left abutment beyond the spillway was generally dry and wooded, and showed no indication of seepage or slope instability.

The lower left abutment between the spillway and the floodplain was generally dry and uneroded. A spring was noted at the toe of the lower left abutment near the end of the spillway chute. A swampy area was observed along the toe of the lower left abutment that extended up to the toe of the dam.

(2) Right: The upper right abutment consists of wooded hillside which was dry and showed no signs of instability. The lower right abutment consists of a wide sloping bench that appears to have been excavated into natural ground below the toe of the dam. Considerable wetness and seeping water were observed on the lower portion of this sloping bench, as well as in the floodplain below the bench.

e. Outlet Works:

(1) Intake Structure: The outlet works intake structure was not observed because of the reservoir pool level.

(2) Discharge Conduit: The outlet works discharge conduit is an 18 inch diameter cast iron pipe.

(3) Outlet: The outlet works discharges to an outlet channel excavated into the floodplain below the toe of the dam. The cast iron pipe has no headwall and discharges with the bell at the downstream end. Some debris and sedimentation were observed in the bottom of the pipe at the outlet.

The discharge channel below, flows into the creek that runs along the toe of the State Route 51 highway embankment. The channel had some minor debris and contained a pool of standing water about four feet below the pipe outlet. The channel side slopes were steep and bare and were observed to be moist to damp, but no flowing water was noted.

(4) Emergency Controls: None observed.

f. Principal (and Emergency) Spillway:

(1) Approach Channel: The approach channel to the spillway sill was clear and unobstructed and capable of permitting full spillway discharge.

(2) Overflow Weir (Sill): The overflow weir that maintains the reservoir pool level consists of concrete blocks, backfilled with asphalt, forming a trapezoidal cross-section. The width of the crest is approximately one foot and the height of the weir, above the base of the approach and discharge channels, is approximately 18 inches. Erosion of both the block and asphalt has occurred, particularly near the left training wall, where the majority of the discharge from the reservoir was flowing. The length of the weir was measured to be 28.5 feet.

(3) Discharge Channel: The discharge channel consists of a reinforced concrete chute, lying on the left abutment, that transports reservoir flows to the toe area of the dam. The discharge channel cross-section is rectangular and the training walls in the vicinity of the overflow weir are five feet high for a distance of approximately 40 feet downstream. Below this, the height of the training walls decreases to 3 feet. The training walls showed considerable spalling and deterioration particularly at construction joints. However, because the walls are exceptionally thick, they remain functional, even in a deteriorated state.

The base slab is straight for the first 40 feet below the overflow weir and slopes at approximately 0.04 feet per foot. Below this, the slab turns to the right and slopes more steeply as it approaches the toe of the dam.

Some spalling and joint deterioration was observed in the base slab. The most significant deterioration was observed in the area immediately below the sill where joints have been deeply eroded and considerable spalling has occurred. On the steeper portions of the chute, the slab was in reasonably good condition.

At the toe of the spillway, the slope of the slab flattens and discharge from the channel is via free overfall to the stilling pool below. The drop of the overfall is approximately five feet. The end of the spillway slab, observed at the overfall, indicated at least a three foot thickness of concrete that was in reasonably good condition for its age. Below, the slab is based on bedrock and some undermining has occurred.

g. Instrumentation: No instrumentation was observed during the inspection. Remnants of a seepage monitoring weir were noted below the spring at the toe of the embankment.

h. Downstream Conditions:

(1) Downstream Channel: The downstream channel consisted of a stilling pool area below the end of the concrete spillway chute. The pool discharges to an 18 foot wide, 13.5 feet high culvert beneath State Route 51. The pool area contained minor amounts of debris but nothing that would affect performance of the spillway. The highway culvert was free of debris and unobstructed. Below the highway culvert, the creek channel passes through a lightly wooded pasture area.

(2) Floodplain Development: In the first 2000 feet below the dam, two inhabited dwellings lie on the floodplain at an elevation low enough to be imperiled by a dam failure. Also, State Route 51, a major north-south highway, crosses Crabapple Run approximately 100 feet downstream of the dam. The elevation of the highway embankment is generally higher than the elevation of the dam. In the event of a failure of Crabapple Dam, a failure of the highway embankment would be unlikely, but damage could occur to the large, reinforced concrete culvert beneath the roadway.

i. Reservoir:

(1) Slopes: The reservoir's left shoreline is generally flat to moderately sloping. The shoreline, which is residential in nature, was grass covered and contained numerous large trees. No erosion or sloughing on the left shoreline was observed.

The right shoreline is somewhat steeper than the left and generally tree covered to the water line. Minor amounts of duntimber and a small amount of surficial erosion, apparently due to surface runoff, were noted along the right shoreline.

(2) Sedimentation: The entire upper end of the lake is significantly sedimented and contains a dense growth of cattails and other water related vegetation. The development is deltaic in nature, as a result of deposition of sediments carried by the inflowing stream.

(3) Inlet Stream: The inlet stream approaches the lake through a narrow, winding, brush clogged channel that passes beneath two bridges before entering the lake. The upstream bridge carries a township road across the creek. The lower bridge, the smaller of the two, carries a lake access road across the inlet stream. The significant sedimentation described above begins immediately below the lower bridge.

(4) Watershed: The watershed tributary to the reservoir was observed to be more or less as indicated on the U.S.G.S. topographic map; i.e., mostly farm and woodland. The watershed is generally hilly, consisting of steep slopes and narrow, steep valleys. No major new construction or mining operations were observed.

3.2 EVALUATION

a. Embankment: The general, overall condition of the Crabapple Dam embankment is considered to be poor. This assessment is based on the following observations:

- (1) Irregularities in the crest profile resulting in a loss of a maximum 1.4 feet of freeboard;
- (2) Local and general erosion of the upstream slope;
- (3) Bulges and irregularities on the downstream slope;
- (4) Evidence of a high groundwater level in the embankment;
- (5) Significant spring and seepage activity, and general swampy conditions downstream;
- (6) Minor erosion and lack of vegetation on portions of the downstream slope;
- (7) Large trees on both the upstream and downstream slopes;
- (8) Dense vegetal growth including brush, weeds and trees on portions of the downstream slope;

b. Outlet Works: The outlet works facility is considered to be in poor condition. This assessment is based on the inability to locate and evaluate the operability of flow control devices.

c. Principal (and Emergency) Spillway: The principal (and emergency) spillway is considered to be in fair condition. This assessment is based on field observations that the facility was unobstructed and functional on the date of inspection. Minor deficiencies including concrete spalling and deterioration, and backfill erosion were observed. However, because the structure is quite massive, these deficiencies do not pose an immediate threat to adequate performance of the facility.

d. Hazard Category: Based on observations of downstream conditions, the hazard category for Crabapple Dam is "high".

SECTION 4 OPERATIONAL FEATURES

4.1 PROCEDURE

The reservoir pool level is maintained by the uncontrolled overflow weir of the principal (and emergency) spillway.

Operational facilities such as valves or other flow controls for the outlet works pipeline could not be located. There was no indication of the existence of an upstream flow control mechanism for the outlet works pipeline.

Normal operating procedure does not require a dam tender.

4.2 MAINTENANCE OF DAM

No planned maintenance schedule is on record. Observations indicate maintenance procedures are poor.

4.3 INSPECTION OF DAM

The owners are required by the State of Pennsylvania to inspect the dam annually and make needed repairs.

4.4 WARNING SYSTEM

There is no warning system and no formal emergency procedure to alert or evacuate downstream residents upon threat of a dam failure.

4.5 EVALUATION

The current dam maintenance program is considered to be inadequate.

The failure to locate and inability to observe the operability of outlet works pipeline controls is considered to be a serious deficiency.

The lack of a downstream flood warning plan is considered to be a deficiency.

SECTION 5
HYDROLOGY/HYDRAULICS

5.1 EVALUATION OF FEATURES

a. Design Data: The Crabapple Dam has a watershed of 851 acres which is vegetated primarily by pasture and woodland. The watershed is about two miles long and one mile wide and has a maximum elevation of 1425 feet (MSL). At normal pool the dam impounds a reservoir with a surface area of 14.7 acres and a storage volume of 128 acre-feet. Normal pool level is maintained at Elev. 1028.4 by a concrete block and asphalt sill (overflow weir) in the principal spillway.

Spillway capacity and embankment freeboard were sufficient to accomodate 1200 cubic feet per second which was considered sufficient for this structure and watershed at the time of design. No additional hydrologic calculations were found relating reservoir/spillway performance to the Probable Maximum Flood or fractions thereof.

b. Experience Data: Records are not kept of reservoir level or rainfall amounts. There is no record or report of the embankment ever being overtopped.

c. Visual Observations: On the date of the field reconnaissance, no serious deficiencies were observed that would prevent the principal spillway from functioning.

d. Overtopping Potential: Overtopping potential was investigated through the development of the Probable Maximum Flood (PMF) for the watershed and the subsequent routing of the PMF and fractions of the PMF through the reservoir and spillway. The Corps of Engineers guidelines recommend 0.5 to 1 times the Probable Maximum Flood (PMF) for "small" size, "high" hazard dams. Based on observed downstream conditions, Crabapple Dam has a Spillway Design Flood (SDF) of 0.5 PMF.

Hydrometeorological Report No. 33 indicates the adjusted 24 hour Probable Maximum Precipitation (PMP) for the subject site is 19.4 inches. No calculations are available to indicate whether the reservoir and spillway are sized to pass a flood corresponding to one half of the runoff from 19.4 inches of rainfall in 24 hours. Consequently, an evaluation of the reservoir/spillway system was performed to determine whether the dam's spillway capacity is adequate under current Corps of Engineers guidelines.

The Corps of Engineers, Baltimore District, has directed that the HEC-1 Dam Safety Version computer program be utilized. The program was prepared by the Hydrologic Engineering Center (HEC), U.S. Army Corps of Engineers, Davis, California, July, 1978. The major methodologies and key input data for this program are discussed briefly in Appendix D.

The peak inflow to Crabapple Dam was determined by HEC-1 to be 2972 cfs for a full PMF. The peak inflow for the SDF was determined to be 1486 cfs.

An initial pool elevation of 1028.4 was assumed prior to commencement of the storm.

e. Spillway Adequacy: The capacity of the combined reservoir and spillway system was determined to be 0.24 PMF by HEC-1. According to Corps of Engineers' guidelines, Crabapple Dam spillway is "inadequate."

At 0.5 PMF, the dam overtops by a maximum 1.03 feet for a duration of five hours.

Because the reservoir/spillway system capacity is less than 0.5 PMF and overtopping depth and duration conditions were judged by the evaluating engineer to cause failure of the embankment, a dam breach analysis was performed to determine if the spillway is "seriously inadequate."

For the dam breach analysis, it was assumed that dam failure would begin when the water level in the reservoir reached Elev. 1033.0 which corresponds to a depth of one foot above the crest's observed minimum elevation.

To achieve the assumed overtopping failure condition, a 0.49 PMF was routed through the reservoir/spillway system. Initially, the flood wave was routed downstream without embankment failure conditions considered. Results of the dam breach analysis indicated that downstream flooding and the risk of loss of life would not be significantly increased by the assumed failure of the dam. The stream level would rise to less than two feet at the nearest house, 2000 feet downstream in the vicinity of the dam. This analysis did not consider the existence of the State Route 51 highway embankment and culvert downstream of the dam. Calculations in Appendix D show this to be a conservative assumption.

Therefore the Crabapple Dam's spillway is rated "inadequate" but not "seriously inadequate."

SECTION 6
STRUCTURAL STABILITY

6.1 AVAILABLE INFORMATION

a. Design and Construction Data: All available design documentation, calculations and other data received from the Pennsylvania Department of Environmental Resources were reviewed. This data is discussed in Section 2 and a detailed listing is included in Appendix B. Selected items are presented in Appendix E.

b. Operating Records: There are no written operating records or procedures for this dam.

c. Visual Observations:

(1) Embankment: The large bulge, near the center of the embankment, lies above and to either side of the three springs that discharge at the embankment's toe. The smaller bulge, located to the right of the larger bulge, is also associated with wet toe conditions. A pronounced seepage line was observed on the slope between the two bulges.

The embankment downstream slope was measured to be 1.9H:1V at the embankment's deepest section.

(2) Downstream (Toe Area): The floodplain below the Crabapple Dam embankment is generally soft and swampy. The lower right abutment consists of a wide, sloping bench which contains wet, swampy zones.

(3) Principal Spillway: The principal spillway was observed to be suffering minor structural deficiencies including spalling and deterioration of concrete surfaces and joints, and erosion of wall backfill in the lower reach.

The walls and base slab were observed to be quite massive.

d. Performance: Crabapple Dam has been periodically inspected over the seventy-four year life of structure by Water and Power Resources Board personnel and later PennDER personnel. Twelve inspections from 17 June 1919 to 28 August 1962 are on file. Several of the reports note the existence of seepage and wet zones. A weir was installed at the spring discharge area near the center of the embankment, and readings were taken periodically from 1915 to at least 1935. No indication was found in PennDER files of distress to the embankment due to this seepage condition and there were no reports of definite slope instability conditions.

6.2 EVALUATION

a. Embankment: The margin of safety against slope failure of Crabapple Dam may be less than required by current Corps of Engineers guidelines for static stability conditions. This is based on observed embankment slope geometry, irregularities, materials and groundwater conditions.

b. Principal Spillway: Based on visual observations, the principal spillway appeared to be structurally stable and capable of design performance. Minor deficiencies were noted (which should be corrected), but at present, these do not appear to threaten the stability of the structure.

c. Seismic Stability: According to the Seismic Risk Map of the United States, Crabapple Dam is located in Zone 1 where damage due to earthquake would most likely be minor.

A dam located in Seismic Zone 1 may be assumed to present no hazard from an earthquake provided static stability conditions are satisfactory and conventional safety margins exist. Since there is concern regarding the static stability of the embankment, the seismic stability is questionable and should be assessed as part of the investigations recommended in Section 7.

SECTION 7
ASSESSMENT AND RECOMMENDATIONS

7.1 ASSESSMENT

a. Evaluation:

(1) Embankment: Crabapple Dam's embankment is considered to be in poor condition. This is based on visual observations of slope non-uniformities, wetness and seepage conditions and detrimental vegetal and erosional conditions.

(2) Outlet Works: The condition of the 18 inch diameter cast iron outlet pipe could not be determined. No intake structures or flow controls were observed. In particular, there was no indication of the existance of an upstream flow control.

(3) Principal Spillway: The principal spillway is assessed to be in fair condition. This is based on visual observations of the overflow weir, training walls and base slab.

(4) Flood Discharge Capacity: The principal spillway discharge capacity is assessed to be "inadequate." This is based on hydrologic/hydraulic computations using the HEC-1 Dam Safety Version computer program, that indicated the existing reservoir/spillway system is capable of passing 0.24 PMF. At 0.5 PMF, the embankment is overtopped by a maximum 1.03 feet for a duration of 5 hours. In the opinion of the evaluating engineer, this amount of overtopping is sufficient to cause failure of the embankment. However, the risk of loss of life downstream would not be significantly increased by failure of the dam.

(5) Downstream Conditions: Based on the results of the visual observations and the hydrologic/hydraulic computations, the lack of an emergency warning and operation plan is considered to be a deficiency.

b. Adequacy of Information: The available information and the observations made during the field inspection of the dam are considered sufficient for purposes of the Phase I inspection report.

c. Urgency: The recommendations presented in Sections 7.2a and 7.2b should be implemented immediately.

d. Necessity for Additional Data/Evaluation: Additional engineering information is required to adequately evaluate and improve the structural stability and hydraulic capacity of the facilities.

7.2 RECOMMENDATIONS

a. Additional Investigations: It is recommended that the owner immediately retain the services of a registered professional engineer knowledgeable and experienced in the design and construction of earth dams and masonry spillways to provide a detailed engineering investigation of Crabapple Dam. This investigation should include but not be limited to the following:

(1) Detailed evaluation of spillway capacity and development of recommendations for remedial action.

(2) Detailed investigation of the seepage and wet conditions and structural stability of the embankment.

(3) Investigation of the outlet works with specific recommendations on making it operable and including provisions for upstream flow control.

b. Emergency Operation and Warning Plan: Concurrent with the additional investigations recommended above, the owner should develop an Emergency Operation and Warning Plan including:

(1) Guidelines for evaluating inflow during periods of heavy precipitation or runoff.

(2) Procedures for around the clock surveillance during periods of heavy precipitation or runoff.

(3) Procedures for drawdown of the reservoir under emergency conditions.

(4) Procedures for notifying downstream residents and public officials, in case evacuation of downstream areas is necessary.

c. Remedial Work. The Phase I Inspection of Crabapple Dam also disclosed several deficiencies of lower priority which should be corrected during routine maintenance.

(1) Remove the trees from the upstream and downstream slopes including all root systems of 1/2 inch diameter or larger. This work should be performed under the direction of a professional engineer, knowledgeable in dam design and construction.

(2) Closely mow the embankment slopes, crest, groins, abutments and immediate downstream areas. Remove the cuttings from the site.

(3) Locate and backfill completely, all animal burrows on the embankment, groins and adjacent abutment areas.

(4) Regrade the upstream slope and provide wave erosion protection.

(5) Fill wheel ruts and minor erosion gullies on the embankment and adjacent areas.

(6) Raise the embankment crest to design elevation.

(7) Develop and implement formal maintenance and inspection procedures.

d. Orderly Breaching: In lieu of performing the above recommendations, the owner should engage the services of a professional engineer, knowledgeable in dam design and performance, to prepare specifications for breaching the structure, to make it incapable of impounding water. The structure should then be breached under the direction of the professional engineer and in accordance with applicable state and local regulations.

APPENDIX A
VISUAL INSPECTION CHECKLIST

VISUAL OBSERVATIONS CHECKLIST I
(NON-MASONRY IMPOUNDING STRUCTURE)

Name Dam Crabapple County Fayette State Pennsylvania National ID # PA 00907
Type of Dam Earth Hazard Category High

Date (s) Inspection 5 May 1980 Weather Clear, mild Temperature 50°F

Pool Elevation at Time of Inspection 1028.4 (MSL)

Tailwater at Time of Inspection 992 + (MSL)

Inspection Personnel: J. E. Barrick, P.E. Ackenheil & Associates, Hydrologist and
Project Manager.
J. P. Hannan Ackenheil & Associates, Geotechnical Engineer
S. G. Mazzella Ackenheil & Associates, Civil Engineer

Recorder J. E. Barrick

GEO Project G79153-U
PENNDER I.D. No. 26-32

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None observed.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None observed.	

SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES

The downstream embankment slope was observed to have two pronounced bulges at and above the toe of the embankment. The larger bulge existed at the approximate center of the embankment and approached to within 10 feet of the crest of the embankment. The bulge was approximately 100 feet in length and was centered approximately above the spring fed swamp area at the toe of the embankment. The second bulge, was observed on the right central portion of the embankment. This bulge was somewhat smaller than the first although it approached to within approximately the same distance of the crest. However, in this area, the toe was somewhat higher than at the central portion of the embankment. No cracking or scarps were observed in the vicinity of either bulge. They contained vegetal growth, including trees, and did not appear to be of recent development. The remainder of the embankment was observed to be moderately steep in slope and generally uniform except for a minor flattening near the toe of the embankment along its entire length.

EMBANKMENT (cont'd)

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES (continued)	<p>Minor erosion has occurred on the downstream slope in areas where there is no vegetal cover. However, this erosion is not extensive and does not appear to constitute a threat to the structure.</p> <p>The upstream slope was observed to be quite steep having slopes ranging from vertical to 1H:1V. The slope is grass and tree covered but is eroded in several spots. Also, a bench was observed just below the water line suggesting an overall general erosion of the upstream slope. Near the left end of the embankment, several large trees are growing on the upstream slope indicating that erosional activity on the slope is not recent. A considerable amount of crest width remains.</p> <p>The crest of the embankment was observed to be generally straight and appeared to be level. A roadway traverses the crest and is surfaced with a "reddog" material. Near the central portion of the embankment, several wheel ruts existed that had impounded water at one time. Otherwise, the crest was generally grass and brush covered.</p> <p>No cracks were observed on the crest or the upstream or downstream slopes of the embankment.</p>	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	<p>The crest was observed to be generally straight and appeared to be level throughout its entire length. The stadia survey indicated a low point on the embankment crest of Elev. 1032.0. This point is located 200 feet from the right spillway training wall.</p>	

EMBANKMENT (cont'd)

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
RIPRAP FAILURES	No riprap observed.	
SETTLEMENT	No settlement observed.	
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	<p>The groin between the spillway left training wall and the left abutment was observed to be dry. The groin contained considerable tree and brush growth and appeared to be in good condition through the upper reach of the spillway. Near the lower end of the discharge channel chute, some erosion has occurred behind the left training wall, possibly as the result of flow over the wall, eroding the natural ground behind. In this area, the discharge channel slab has been slightly undercut.</p> <p>The groin between the right spillway training wall and the left abutment was observed to be in similar condition, including an area of erosion behind the training wall, that has occurred apparently as the result of spillway flows overtopping the wall. The groin between the embankment and the left abutment was found to be dry and uneroded. Considerable duntimber and brush littered the area but no seeps were observed. At the valley bottom, the junction between the embankment and the floodplain below was observed to be wet and seeping in numerous locations. The swamp occupied the floodplain below the embankment toe and extended from one side of the valley to the other.</p>	

EMBANKMENT (cont'd)

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM (continued)	A bench containing an access roads exists on the right abutment. The lower toe area was swampy. The upper groin between the access road to the embankment and the upper right abutment contains a drainage swale that was observed to be passing flows which appeared to be natural runoff from the right abutment.	
ANY NOTICEABLE SEEPAGE	Considerable seepage was observed in and around the downstream area of Crabapple Dam. The most significant seepage was occurring at three springs that were located at the toe near the central portion of the embankment. The left most spring was the largest and appeared to be emitting 15 or more gallons per minute. The remaining two springs were relatively small, contributing approximately 5 gallons per minute. These springs were located at the base of the bulge described earlier. A line of seepage was observed on the embankment in the left central portion in the vicinity of the smaller bulge on the slope. The seepage line was quite pronounced as the demarkation between firm and soft earth. No flowing water was observed although small drops and puddles were noted.	

EMBANKMENT (cont'd)

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE (continued)	<p>On the left portion of the embankment at the toe, another seepage zone was observed that was causing a swampy area below the toe of the dam. Also, near the end of the spillway chute, a small spring was observed.</p> <p>The entire downstream area between the toe of the embankment and the creek that runs along the State Route 51 embankment, was very swampy and soft and contained considerable water related vegetation including cattails, etc.</p>	
STAFF GAGE AND RECORDER	None observed.	
DRAINS	None observed.	

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Outlet conduit is 18 inch I.D. (nominal) cast iron. No headwall exists.	
INTAKE STRUCTURE	None observed due to pool level.	
OUTLET STRUCTURE	See "Cracking and Spalling . . ." above.	
OUTLET CHANNEL	Outlet channel consists of an excavated ditch approximately 4 feet deep that extends downstream from the outlet pipe to the creek channel along the toe of the State Route 51 embankment. The channel was observed to be clogged with small debris, brush, leaves, ground litter, etc., and contained a small pool, approximately 4 feet below the end of the cast iron drain pipe outlet. The side slopes of the outlet channel were steep and unvegetated. Some dampness was noted in the dirt but no seeping water was observed. General condition of the outlet channel-fair to poor.	
EMERGENCY GATE	None observed.	

PRINCIPAL (AND EMERGENCY) SPILLWAY

<u>VISUAL EXAMINATION OF</u>	<u>OBSERVATIONS</u>	<u>REMARKS OR RECOMMENDATIONS</u>
CONCRETE SILL	<p>The principal spillway flow control structure is a sill constructed of concrete blocks backfilled on both sides with asphaltic concrete material. The cross-section of the sill is trapezoidal having a crest width of approximately 12 inches and a height of 18 inches above the approach channel floor. The length of the weir crest was 28.5 feet. The sill has begun to deteriorate, particularly at the left end near the left training wall, where considerable deterioration and erosion of both concrete and asphalt has occurred. At this point, the primary discharge of the lake is occurring through the lowered cross-section. Otherwise, the crest of the weir is approximately level.</p>	
APPROACH CHANNEL	<p>The approach channel is short and lies between two concrete training walls for a distance of approximately 15 feet into the reservoir. The approach channel was clear and unobstructed on the date of inspection.</p>	
DISCHARGE CHANNEL	<p>The discharge channel consists of a concrete lined chute on the left abutment, that carries flow from the sill to the valley below the embankment.</p> <p>The discharge channel cross-section is approximately rectangular and consists of a concrete lined base slab between concrete training walls. The training walls are approximately 5 feet high for a distance of 40 feet below the sill. At this point, the height of the wall decreases to approximately 3 feet for the remainder of the channel chute below. The initial</p>	

PRINCIPAL (AND EMERGENCY) SPILLWAY (cont'd)

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
APPROACH CHANNEL (continued)	<p>stretch of channel has a slope of four percent to a point where the channel curves. At this point, the channel steepens and turns to the right on its approach to the valley bottom. At the lower end, the channel bottom levels and approaches an overfall of approximately 5 feet. At the overfall, the concrete slab is approximately 3 feet thick and has been constructed on bedrock below. Some erosion of bedrock has caused undermining of the end of the slab, but due to the slab thickness, the undermining appears to have no significant effect on the discharge channel structure.</p>	
	<p>The discharge channel walls have suffered considerable spalling, particularly at the downstream end. A wire mesh screen, 6 inches square, was visible in the deteriorated concrete. Some disintegration was observed in the vicinity of construction joints.</p>	
	<p>The slab of the discharge channel also shows some spalling and some deterioration at construction joints. However, its overall condition is generally better than the training walls. No open holes were observed, although local areas show some spalling of the surface. The most deteriorated section of discharge channel slab occurs in the reach immediately below the sill. In this area, considerable erosion at construction joints has occurred and considerable deterioration of the surface was noted.</p>	

INSTRUMENTATION

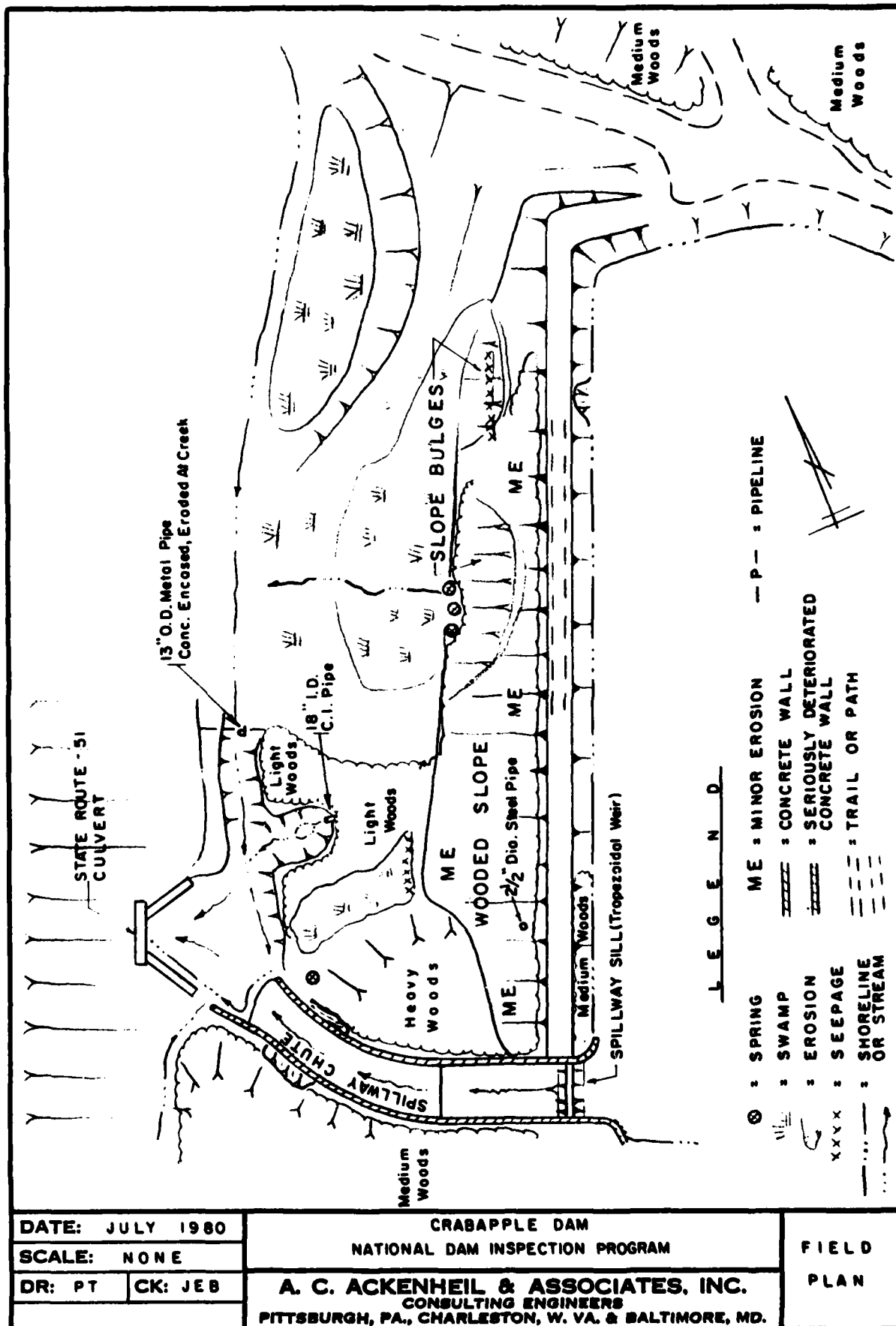
<u>VISUAL EXAMINATION OF</u>	<u>OBSERVATIONS</u>	<u>REMARKS OR RECOMMENDATIONS</u>
MONUMENTATION/SURVEYS	None observed.	
OBSERVATION WELLS	None observed.	
WEIRS	None observed.	
PEIZOMETERS	None observed.	
OTHER		

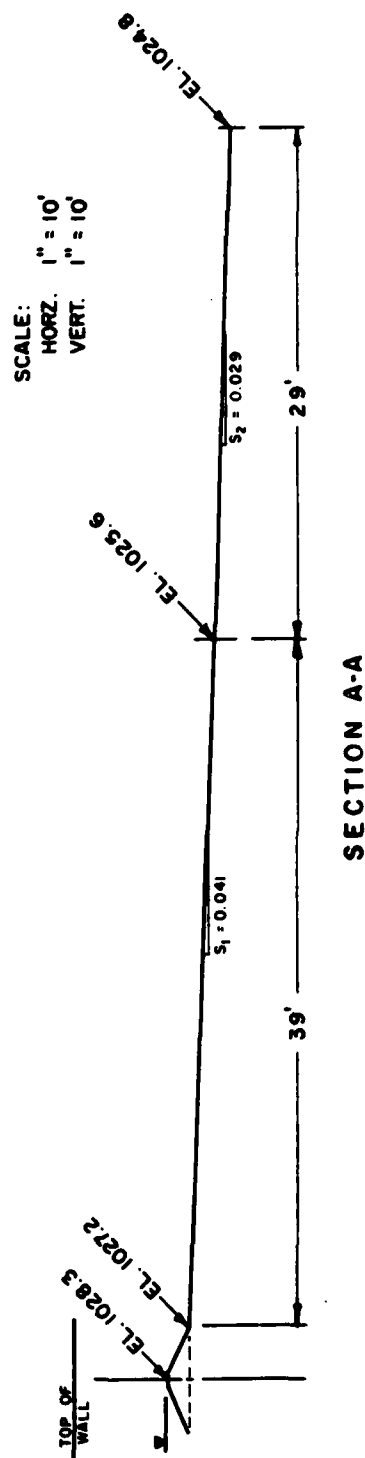
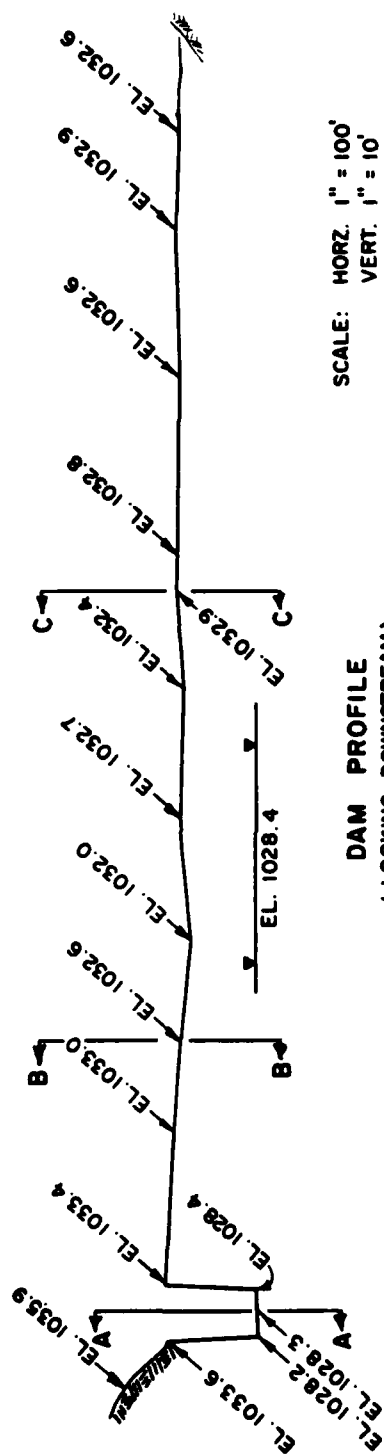
RESERVOIR

<u>VISUAL EXAMINATION OF</u>	<u>OBSERVATIONS</u>	<u>REMARKS OR RECOMMENDATIONS</u>
<u>SLOPES</u>	The reservoir slopes are gentle to moderately steep with the steeper slopes existing on the right side of the reservoir. The slopes were generally grass covered, had some trees, particularly in the upper end of the reservoir. The right shoreline toward the upper end of the lake had some minor erosion. The left shoreline was quite gentle and reasonably well maintained.	
<u>SEDIMENTATION</u>	The upper end of the lake contains considerable deltaic development with a dense growth of water related vegetation including cattails. The development appears to be the result of long-term deposition of sediments carried by the inlet stream.	
<u>INLET STREAMS</u>	The inlet stream follows a relatively winding course through a narrow, flat bottomed valley. In the area immediately above the lake, the valley is used as a pasture for cattle. Prior to entering the lake, the inlet stream passes beneath two bridges. The uppermost bridge carries a township road over the creek. The lower bridge carries a lake related access road over the inlet area to the lake. The lower bridge is the smaller of the two, being approximately 4 feet high, 8 feet wide and constructed of wood timbers resting on reinforced concrete sidewalls.	
<u>WATERSHED</u>	The watershed tributary to Crabapple Dam was observed to be essentially as indicated on the U.S.G.S. 7 1/2 minute Fayette City, Pennsylvania, quadrangle. The watershed consists primarily of steep sided hills and narrow valleys containing primarily woodland, cropland and pasture. No major construction or mining activities were observed in the watershed.	

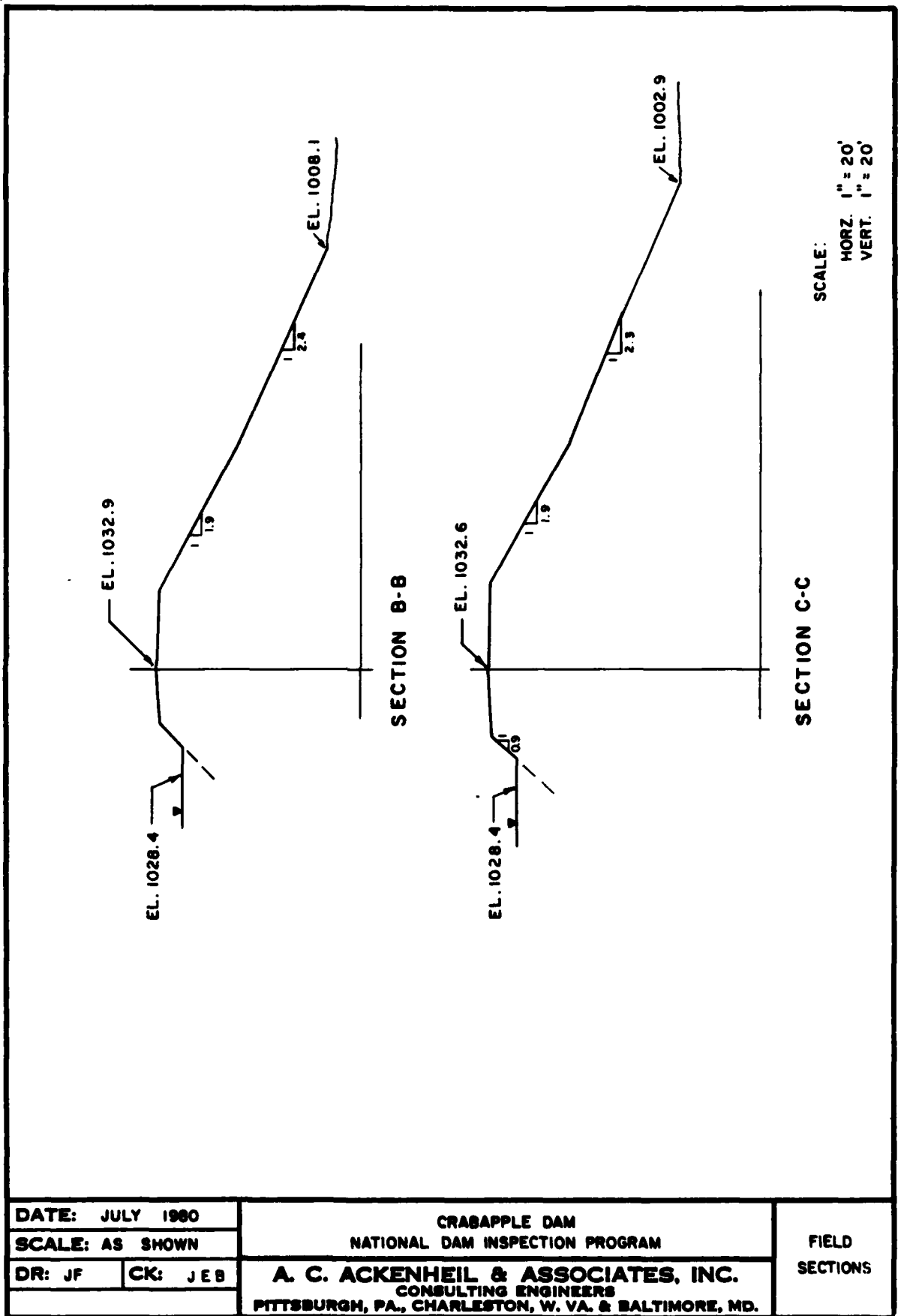
DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	The downstream channel immediately below the discharge channel overfall is a gravel and sand lined pool that lies at the inlet to the reinforced concrete culvert beneath State Route 51. The pool area has some vegetal growth at the perimeter and has some down timber obstructing flow, though not to a detrimental extent. The channel through the culvert beneath State Route 51 is generally clear and unobstructed. The inlet to the culvert consists of reinforced concrete wingwalls placed at 45° to the opening.	
APPROXIMATE NO. OF HOMES AND POPULATION	Below Crabapple Dam, two inhabited dwellings were observed to lie on the floodplain of Crabapple Run at elevations low enough to possibly be imperiled in the event of a dam failure.	





DATE: JULY 1980		CRABAPPLE DAM NATIONAL DAM INSPECTION PROGRAM	FIELD PROFILE AND SECTION
SCALE: AS SHOWN			
DR: JF	CK: JEB	A. C. ACKENHEIL & ASSOCIATES, INC. CONSULTING ENGINEERS PITTSBURGH, PA., CHARLESTON, W. VA. & BALTIMORE, MD.	



DATE: JULY 1980

SCALE: AS SHOWN

DR: JF

CK: JEB

CRABAPPLE DAM
 NATIONAL DAM INSPECTION PROGRAM

A. C. ACKENHEIL & ASSOCIATES, INC.
 CONSULTING ENGINEERS
 PITTSBURGH, PA., CHARLESTON, W. VA. & BALTIMORE, MD.

FIELD
 SECTIONS

APPENDIX B
ENGINEERING DATA CHECKLIST

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM Crabapple Dam
I.D. No. PA 00907

ITEM	REMARKS
Design Drawings	None available.
*As-Built Drawings	"Plan of Crabapple Reservoir, Crabapple Valley W.C. & C. Co." undated. Received by Water Supply Commission of Pennsylvania,, 20 November 1914.##
	"Plan and Sections of W.C. & C. Co.'s Crabapple Reservoir Dam showing proposed change in height", dated July 1915. Prepared by Thomas M. Zimmerman, Eng.##.
	"W.C. & C.Co. Crabapple Reservoir on Crabapple Run",##, June 1923 showing proposed spillway repair work.
Regional Vicinity Map	U.S.G.S. 7-1/2 Minute Fayette City, Pennsylvania Quadrangle Map.
*Construction History	Designed and built in 1905 - 1906 for Washington Coal and Coke Company by Thomas A. Zimmerman, Chief Engineer.
*Typical Sections of Dam	Longitudinal and transverse sections, see As-Built Drawings.

ITEM	REMARKS
*Outlets-Plan Details Constraints Discharge Ratings	One 18 inch diameter C.I. water supply and "blowoff" pipeline.
*Rainfall/Reservoir Records	Correspondence dated 19 January 1951 stating that the storm of 4 June 1941 had a flow of 860 cfs at Crabapple Dam.
*Design Reports	See "Report Upon the Crabapple Dam of the Washington Coal and Coke Company", dated 12 January 1915 by Water Supply Commission of PA. See "Supplemental Report Upon the Crabapple Dam of Washington Coal and Coke Company", dated 17 November 1915. See "Report Upon the Application of the Washington Coal and Coke Company" to make changes and additions to Crabapple Dam, dated 23 June 1923.
Geology Reports	None available.
Design Computations	None available.
*Hydrology and Hydraulics	Storage calculation between spillway crest and top of embankment dated 11 January 1915; Curve for spillway depth vs. area dated 15 January 1915; Curve for spillway depth vs. capacity dated 11 January 1915; Storage-runoff outflow-calcula- tion, dated 13 January 1915. Reservoir routing calculation, undated.
Dam Stability	None Available.
Seepage Studies	None Available.

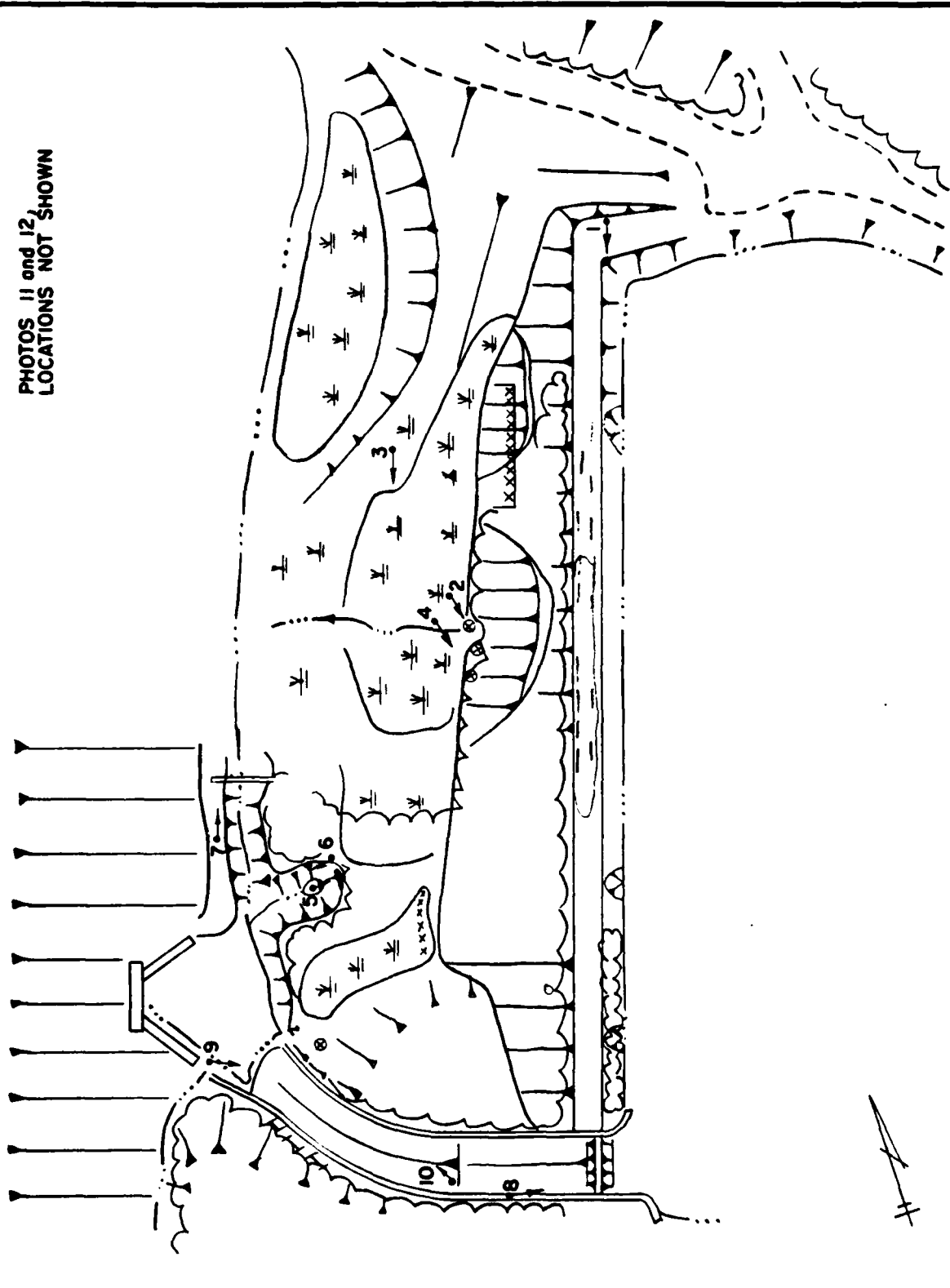
ITEM	REMARKS
Materials Investigations, Boring Records, Laboratory, Field	None Available.
*Post-Construction Surveys of Dam	See As-Built Drawing above.
Borrow Sources	Data not available.
*Monitoring Systems	Various weir measurements from June 1915 to December 1916 and February 1917 to December 1918. Weir replaced in 1930 and according to correspondence readings were taken at least to 1935.
*Modifications	<p>The following modifications were performed in 1915:</p> <ol style="list-style-type: none"> 1. Increased spillway capacity to 1200 cfs. 2. Riprap added to upstream slope. 3. Seepage monitoring weir installed at spring on downstream slope. 4. Raised crest of dam to Elevation 1032. <p>The following modifications were performed in 1923:</p> <ol style="list-style-type: none"> 1. Strengthened the spillway. 2. Increased storage capacity.

ITEM	REMARKS
*High Pool Records	See Rainfall/Reservoir Records above.
*Post-Construction Engineering Studies and Reports	Twelve inspection reports from 17 June 1919 to 28 August 1962 by State of Pennsylvania personnel. One inspection report dated 6 May 1924 from owner to state.
Maintenance, Operation, Records	None available.
*Spillway Plan Sections Details	See As-Built Drawings above.
*Miscellaneous	<p>Miscellaneous correspondence involving application requirements and approval conditions including:</p> <p>"Application of the Washington Coal and Coke Company, Fayette County, Pennsylvania" for consent to make modifications to a dam on Crabapple Run, Franklin Township, Fayette County, Pennsylvania dated 13 June 1923.</p> <p>"Permit" to make modifications to a dam across Crabapple Run in Franklin Township, Fayette County, issued by the Water and Power Resources Board, Department of Forests and Waters, Commonwealth of Pennsylvania, 14 June 1923.</p>

ITEM	REMARKS
*Miscellaneous (continued)	Miscellaneous correspondence related to twelve dam inspections of Crabapple Dam by the Water and Power Resources Board personnel and the one inspection by Owner to state dated 6 May 1924.
Prior Accidents or Failure of Dam Description Reports	None reported.
*Information and data may be obtained from the PennDER, Harrisburg, Pennsylvania. **Reduced size reproductions contained in Appendix E.	

APPENDIX C
PHOTOGRAPHS

PHOTOS 11 and 12,
LOCATIONS NOT SHOWN



DATE: JULY 1980		CRABAPPLE DAM NATIONAL DAM INSPECTION PROGRAM	PHOTO KEY MAP
SCALE: NONE			
DR: JF	CK:	A. C. ACKENHEIL & ASSOCIATES, INC. CONSULTING ENGINEERS PITTSBURGH, PA., CHARLESTON, W. VA. & BALTIMORE, MD.	

CRABAPPLE DAM



PHOTO 1. CREST

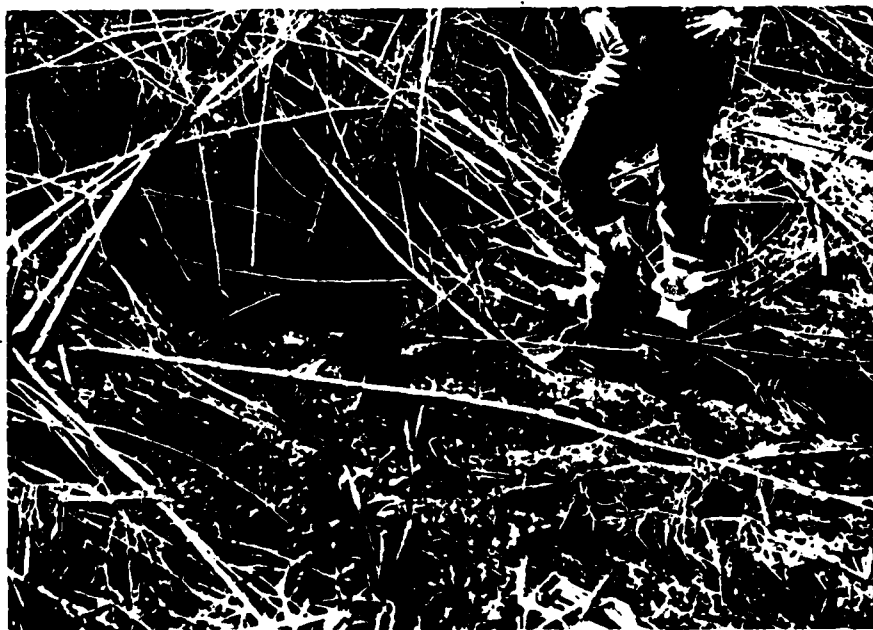


PHOTO 2 SPRING

CRABAPPLE DAM



PHOTO 3. SWAMP



PHOTO 4. DOWNSTREAM SLOPE

CRABAPPLE DAM



PHOTO 5. POND DRAIN OUTLET



PHOTO 6. POND DRAIN DISCHARGE CHANNEL

CRABAPPLE DAM



PHOTO 7. WATER SUPPLY PIPELINE



PHOTO 8. PRINCIPAL SPILLWAY

CRABAPPLE DAM



PHOTO 9. PRINCIPAL SPILLWAY DISCHARGE CHANNEL



PHOTO 10. PRINCIPAL SPILLWAY DISCHARGE CHANNEL

CRABAPPLE DAM



PHOTO 11. ROUTE 51 CULVERT



PHOTO 12. DOWNSTREAM HAZARD

DETAILED PHOTO DESCRIPTIONS

- Photo 1 Crest of dam as seen from right abutment.
- Photo 2 Spring at toe of dam.
- Photo 3 Swamp beyond toe of dam.
- Photo 4 Downstream Slope showing tree cover and swampy conditions at toe.
- Photo 5 Pond Drain Outlet.
- Photo 6 Pond Drain Discharge Channel. Note Route 51 culvert in background.
- Photo 7 Water Supply Pipeline at creek crossing at toe of Rt. 51 embankment.
- Photo 8 Principal Spillway showing flow control weir.
- Photo 9 Principal Spillway Discharge Channel outfall looking upstream.
- Photo 10 Principal Spillway Discharge Channel looking downstream, showing Rt. 51 culvert below.
- Photo 11 Route 51 Culvert, downstream end.
- Photo 12 Downstream Hazard. Note creek at center of photo.

APPENDIX D
HYDROLOGY AND HYDRAULICS
ANALYSES

APPENDIX D HYDROLOGY AND HYDRAULICS

Methodology: The dam overtopping analysis was accomplished using the systemized computer program HEC-1 (Dam Safety Version), July, 1978, prepared by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California. A brief description of the methodology used in the analysis is presented below.

1. Precipitation: The Probable Maximum Precipitation (PMP) is derived and determined from regional charts prepared from past rainfall records including "Hydrometeorological Report No. 33" prepared by the U.S. Weather Bureau.

The index rainfall is reduced from 10% to 20% depending on watershed size by utilization of what is termed the HOP Brook adjustment factor. Distribution of the total rainfall is made by the computer program using distribution methods developed by the Corps.

2. Inflow Hydrograph: The hydrologic analysis used in development of the overtopping potential is based on applying a hypothetical storm to a unit hydrograph to obtain the inflow hydrograph for reservoir routing.

The unit hydrograph is developed using the Snyder method. This method requires calculation of several key parameters. The following list gives these parameters, their definition and how they were obtained for these analyses.

<u>Parameter</u>	<u>Definition</u>	<u>Where Obtained</u>
Ct	Coefficient representing variations of watershed	From Corps of Engineers*
L	Length of main stream channel	From U.S.G.S. 7.5 minute topographic map
Lca	Length on main stream to centroid of watershed	From U.S.G.S. 7.5 minute topographic map

Cp	Peaking coefficient	From Corps of Engineers*
A	Watershed size	From U.S.G.S. 7.5 minute topographic map

3. Routing: Reservoir routing is accomplished by using Modified Puls routing techniques where the flood hydrograph is routed through reservoir storage. Hydraulic capacities of the outlet works, spillways and the crest of the dam are used as outlet controls in the routing.

The hydraulic capacity of the outlet works can either be calculated and input or sufficient dimensions input and the program will calculate an elevation-discharge relationship.

Storage in the pool area is defined by an area-elevation relationship from which the computer calculates storage. Surface areas are either planimetered from available mapping or U.S.G.S. 7.5 minute series topographic maps or taken from reasonably accurate design data.

4. Dam Overtopping: Using given percentages of the PMF the computer program will calculate the percentage of the PMF which can be controlled by the reservoir and spillway without the dam overtopping.

5. Dam Breach Downstream Routing: The computer program is equipped to determine the increase in downstream flooding due to failure of the dam caused by overtopping. This is accomplished by routing both the pre-failure peak flow and the peak flow through the breach (calculated by the computer with given input assumptions) at a given point in time and determining the water depth in the downstream channel. Channel cross-sections taken from U.S.G.S. 7.5 minute topographic maps were used in the downstream flood wave routing. Pre and post failure water depths are calculated at locations where cross-sections are input.

*Developed by the Corps of Engineers on a regional basis for Pennsylvania.

HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: Predominately pasture, with
some woodland, a few dwellings and local roads

ELEVATION TOP NORMAL POOL (STORAGE
CAPACITY): 1028.4 (128 acre-feet.)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE
CAPACITY): 1032.0 (188 acre-feet.)

ELEVATION MAXIMUM DESIGN POOL: 1033.4

ELEVATION TOP DAM: 1032.0 (minimum)

OVERFLOW SECTION

- a. Elevation 1028.4
- b. Type Asphalt and concrete block weir (trapezoidal cross-section)
- c. Width 1 foot
- d. Length 28.5 feet
- e. Location Spillover Left abutment
- f. Number and Type of Gates None

OUTLET WORKS

- a. Type 18 inch cast iron pipe (water supply pipe and pond drain)
- b. Location Unknown
- c. Entrance Inverts Unknown
- d. Exit Inverts 995 + for pond drain outlet
- e. Emergency Drawdown Facilities Unknown

HYDROMETEOROLOGICAL GAGES

- a. Type None
- b. Location N/A
- c. Records None

MAXIMUM REPORTED NON-DAMAGING
DISCHARGE 860 cfs during storm of 4 June 1941

HEC-1 DAM SAFETY VERSION
HYDROLOGY AND HYDRAULIC ANALYSIS
DATA BASE

NAME OF DAM:	Crabapple Dam	NDI ID NO.	PA 00907
Probable Maximum Precipitation (PMP)		24.2*	
Drainage Area		1.33 sq. mi.	
Reduction of PMP Rainfall for Data Fit		0.8 (24.2)	
Reduce by 20%, therefore PMP rainfall =		=19.4 in.	
Adjustments of PMF for Drainage Area (Zone 7)			
6 hrs.		102%	
12 hrs.		120%	
24 hrs.		130%	
Snyder Unit Hydrograph Parameters			
Zone		29**	
C _p		0.5	
C _t		1.6	
L		1.8 miles	
L _{ca}		0.9 mile	
$t_p = C_t (L \cdot L_{ca})^{0.3} =$		1.85 hours	
Loss Rates			
Initial Loss		1.0 inch	
Constant Loss Rate		0.05 inch/hour	
Base Flow Generation Parameters			
Flow at Start of Storm	1.5 cfs/sq.mi=	2.00 cfs	
Base Flow Cutoff		0.05 x Q peak	
Recession Ratio		2.0	
Overflow Section Data			
Crest Length		28.5 feet	
Freeboard		3.6 feet	
Discharge Coefficient		2.82-3.61	
Exponent		1.5	
Discharge Capacity		708 cfs	
Breach Parameters			
Section Slope		0.5:1	
Section Height		30 feet	
Duration of Failure		1 hour	
Depth of Overtopping Prior to Failure		1.00 foot	
PMF Storm		0.49	

* Hydrometeorological Report 33

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

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Sheet _____ of _____
Job CRABAPPLE DAM Job No. 79153 U
Subject DATA INPUT
Made By TPH Date _____ Checked SGM Date 6/25/80

Loss Rate And Base Flow Parameters

As Recommended By Corps of Engineers, Baltimore District

STRTL = 1 inch
CNSTL = 0.05 in/hour
STRTQ = 1.5 cfs/mi²
QRCSN = 0.05 (5% of Peak Flow)
RTIOR = 2.0

Elevation - Area - Capacity Relationships

From U.S.G.S 7.5 min Quad, Penn Der Files and
Field Inspection Data

At Elevation = 1027

Storage = 109.2 Acre-feet

Pond Area = 12.3 Acres

At Elevation 1040 Area = 35 Acres

From Conic Method of Reservoir Volume

Flood Hydrograph Package (HEC-1)

Dam Safety Version (Users Manual)

$$H = 3V/A$$

$$= \frac{3(109.2)}{12.3} = 26.6$$

Elevation at which Area equals zero

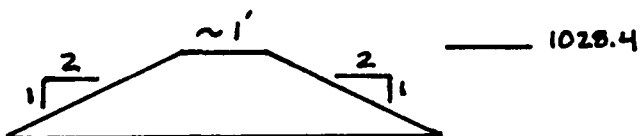
$$1027 - 26.6 = 1000.4$$

Area	\$ A	0.0	12.3	35.0
Elevation	\$ E	1000.4	1027	1040

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Sheet _____ of _____

Job Crabapple Dam Job No. _____Subject Spillway Rating CurveMade By JPH Date _____ Checked SGM Date 6/25/80SPILLWAY WEIRSPILLWAY RATING CURVE

Elevation	Head	"C"*	Q
1028.4	0	-	0.0
1028.6	0.2	2.82	7.2
1028.7	0.3	2.94	13.8
1028.8	0.4	3.04	21.9
1028.9	0.5	3.13	31.5
1029.0	0.6	3.20	42.4
1029.1	0.7	3.26	54.4
1029.2	0.8	3.32	67.7
1029.3	0.9	3.38	82.3
1029.4	1.0	3.43	97.8
1029.6	1.2	3.51	131.5
1029.9	1.5	3.61	189.0
1030.4	2.0	3.61	291.0
1031.4	3.0	3.61	534.6
1032.4	4.0	3.61	823.1
1033.4	5.0	3.61	1150.3
1034.4	6.0	3.61	1512.1
1035.4	7.0	3.61	1905.5
1036.4	8.0	3.61	2328.0

* Values of "C" taken from "King and Brater" Tables 5-9

Pg 5 of 49

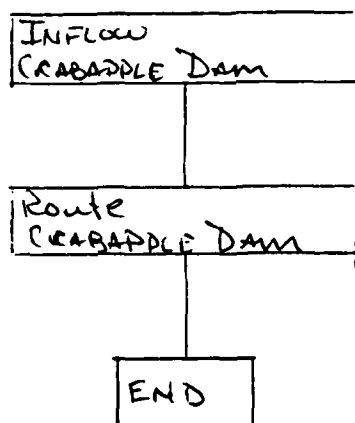
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Sheet _____ of _____
Job Crabapple Dam Job No. 79153J
Subject Data Input
Made By JPH Date _____ Checked _____ Date _____

Over-top Parameters

Top of Dam Elevation (minimum) 1092.0
Length of Dam (Excluding Spillway) 720 feet
Coefficient of Discharge (c) 3.08
SL max 73' SU max. 1033.5

Program Schedule



 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION JULY 1978
 LAST MODIFICATION 26 FEB 79

1	A1	NATIONAL PROGRAM FOR THE INSPECTION OF NON FEDERAL DAMS									
2	A2	HYDROLOGIC AND HYDRAULIC ANALYSIS OF CRABAPPLE DAM									
3	A3	PROBABLE MAXIMUM FLOOD PMF/UNIT HYDROGRAPH BY SNYDER'S METHOD									
4	B	300	0	20	0	0	0	0	0	-4	0
5	B1	5									
6	J	1	3	1							
7	J1	1.	.5	.2							
8	K	0	1					1			
9	K1	INFLOW HYDROGRAPH FOR CRABAPPLE DAM									
10	M	1	1	1.33	1.33	1				1	
11	P		19.4	102	120	130					
12	T							1.0	.05		
13	W	1.85	0.5								
14	X	-1.5	-0.05	2.0							
15	K	1	2					1			
16	K1	ROUTING AT CRABAPPLE DAM									
17	Y			1	1						
18	Y1	1						-1028.4	-1		
19	Y4	1028.4	1028.6	1028.7	1028.8	1029.	1029.1	1029.2	1029.3	1029.4	1029.6
20	Y4	1029.9	1030.4	1031.4	1032.4	1033.4	1034.4	1035.4	1036.4		
21	Y5	0.	7.2	13.8	21.9	41.5	53.4	66.5	80.8	96.3	128.5
22	Y5	183.8	291.	534.6	823.1	1150.3	1512.1	1905.5	2328.		
23	\$A	0.0	12.3	35.							
24	\$E	1000.4	1027.	1040.							
25	\$S	1028.4									
26	\$D	1032.	3.08	1.5	720.						
27	\$L	40.	50.	720.	730.						
28	\$V	1032.	1032.5	1033.	1033.5						
29	K	99									
30	A										
31	A										
32	A										
33	A										
34	A										

PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

RUNOFF HYDROGRAPH AT 1
 ROUTE HYDROGRAPH TO 2
 END OF NETWORK

 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION JULY 1978
 LAST MODIFICATION 26 FEB 79

RUN DATE: 17 JUL 80
 RUN TIME: 9.45.50

NATIONAL PROGRAM FOR THE INSPECTION OF NON FEDERAL DAMS
 HYDROLOGIC AND HYDRAULIC ANALYSIS OF CRABAPPLE DAM
 PROBABLE MAXIMUM FLOOD PMF/UNIT HYDROGRAPH BY SNYDER'S METHOD

JOB SPECIFICATION									
NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
300	0	20	0	0	0	0	0	-4	0
			JOPER	NWT	LROPT	TRACE			
			5	0	0	0			

MULTI-PLAN ANALYSES TO BE PERFORMED

NPLAN= 1 NRTIO= 3 LRTIO= 1
 RTIOS= 1.00 0.50 0.20

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH FOR CRABAPPLE DAM

ISTAQ ICOMP IECON ITAPE JPLT JPRT INAME ISTAGE IAUTO
1 0 0 0 0 0 1 0 0

HYDROGRAPH DATA
IHYDG IUHG TAREA SNAP TRSDA TRSPC RATIO ISNOW ISAME LOCAL
1 1 1.33 0.0 1.33 1.00 0.0 0 1 0

PRECIP DATA
SPFE PMS R6 R12 R24 R48 R72 R96
0.0 19.40 102.00 120.00 130.00 0.0 0.0 0.0

LOSS DATA
LROPT STRKR DTKR RTIOL ERAIN STRKS RTIOK STRTL CNSTL ALSMX RTIMP
0 0.0 0.0 1.00 0.0 0.0 1.00 1.00 0.05 0.0 0.0

UNIT HYDROGRAPH DATA
TP= 1.85 CP=0.50 NTA= 0

RECESSION DATA
STRTQ= -1.50 QRCSN= -0.05 RTIOR= 2.00

UNIT HYDROGRAPH 44 END-OF-PERIOD ORDINATES, LAG= 1.84 HOURS, CP= 0.50 VOL

= 1.00

15.	57.	115.	174.	216.	231.	217.	190.	167.	146.
128.	113.	99.	87.	76.	67.	58.	51.	45.	39.
35.	30.	27.	23.	20.	18.	16.	14.	12.	11.
9.	8.	7.	6.	6.	5.	4.	4.	3.	3.
3.	2.	2.	2.						

0
MO.DA HR.MN PERIOD RAIN EXCS LOSS END-OF-PERIOD FLOW
COMP Q MO.DA HR.MN PERIOD RAIN EXCS LOSS COMP Q

SUM 25.22 23.34 1.88 61059.
(641.)(593.)(48.)(1729.00

HYDROGRAPH ROUTING

ROUTING AT CRABAPPLE DAM

ISTAQ ICOMP IECON ITAPE JPLT JPRT INAME ISTAGE IAUTO
2 1 0 0 0 0 1 0 0

ROUTING DATA
QLOSS CLOSS AVG IRES ISAME IOPT IPMP LSTR
0.0 0.0 0.0 1 1 0 0 0

NSTPS NSTDL LAG AMSKK X TSK STORA ISPRAT
1 0 0 0.0 0.0 0.0 -1028. -1

STAGE	1028.40	1028.60	1028.70	1028.80	1029.00	1029.10	1029.20	1029.30	1029.40
	1029.60	1029.90	1030.40	1031.40	1032.40	1033.40	1034.40	1035.40	1036.40
FLOW	0.0	7.20	13.80	21.90	41.50	53.40	66.50	80.80	96.30
	128.50	183.80	291.00	534.60	823.10	1150.30	1512.10	1905.50	2328.00

SURFACE AREA= 0. 12. 35.

CAPACITY= 0. 109. 404.

ELEVATION= 1000. 1027. 1040.

CREL SPWID COQW EXPW ELEV COQL CAREA EXPL
1028.4 0.0 0.0 0.0 0.0 0.0 0.0 0.0

DAM DATA
TOPEL COQD EXPD DAMWID
1032.0 3.1 1.5 720.

CREST LENGTH	40.	50.	720.	730.
AT OR BELOW				
ELEVATION	1032.0	1032.5	1033.0	1033.5

PEAK OUTFLOW IS 2972. AT TIME 17.33 HOURS

PEAK OUTFLOW IS 1486. AT TIME 17.67 HOURS

PEAK OUTFLOW IS 542. AT TIME 18.33 HOURS

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
				1.00	0.50	0.20
HYDROGRAPH AT	1	1.33	1	2987.	1494.	597.
	(3.44)	(84.60)(42.30)(16.92)(
ROUTED TO	2	1.33	1	2972.	1486.	542.
	(3.44)	(84.15)(42.07)(15.36)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM				
	ELEVATION	1028.40	1028.40	1032.00				
	STORAGE	128.	128.	188.				
	OUTFLOW	0.	0.	708.				
	RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
	1.00	1033.55	1.55	221.	2972.	8.67	17.33	0.0
	0.50	1033.03	1.03	209.	1486.	5.00	17.67	0.0
	0.20	1031.43	0.0	177.	542.	0.0	18.33	0.0

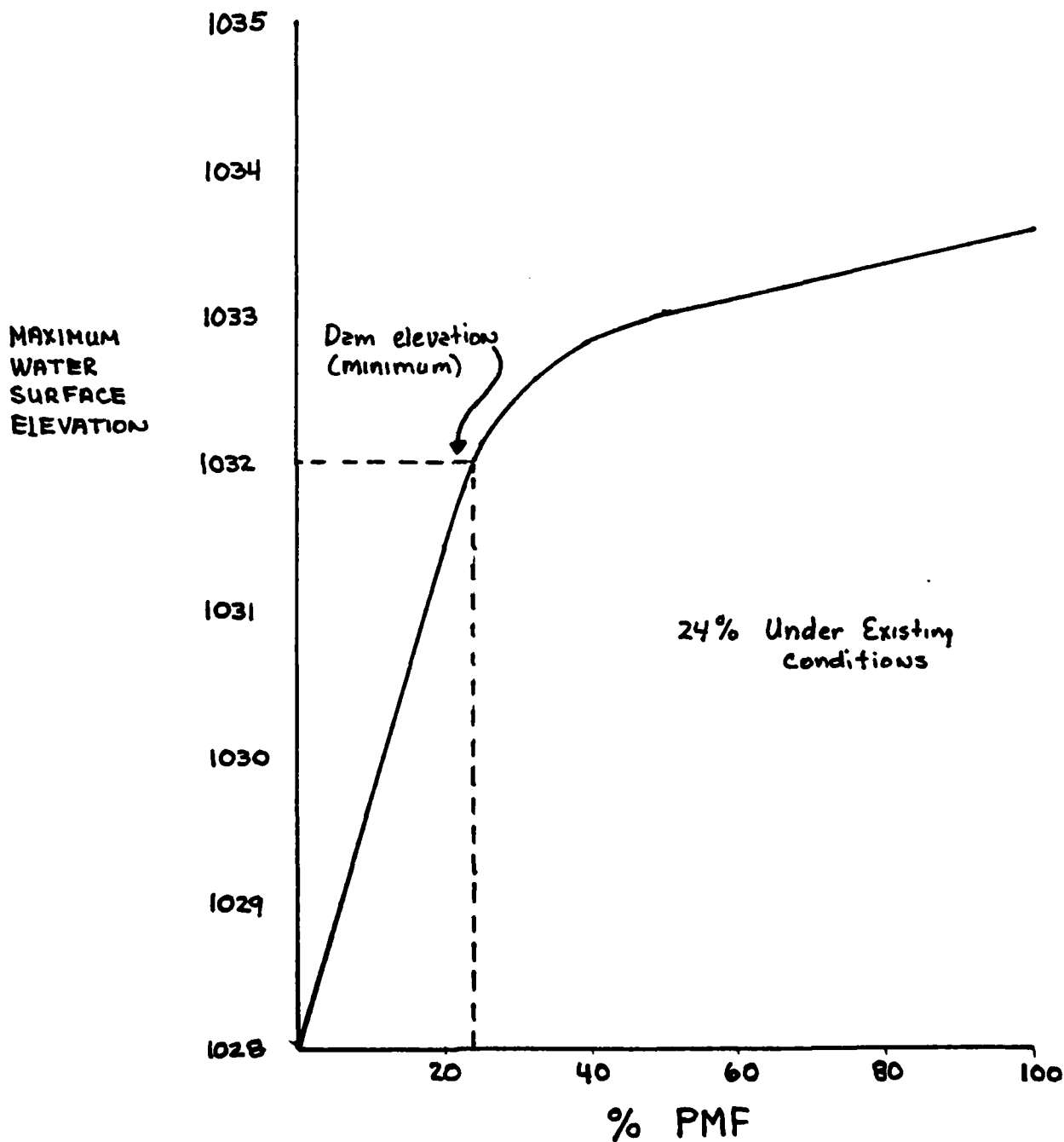
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Sheet _____ of _____

Job Crabapple Dam Job No. _____

Subject Hydrologic Performance Plot

Made By JPH Date _____ Checked JEB Date 6/18/80

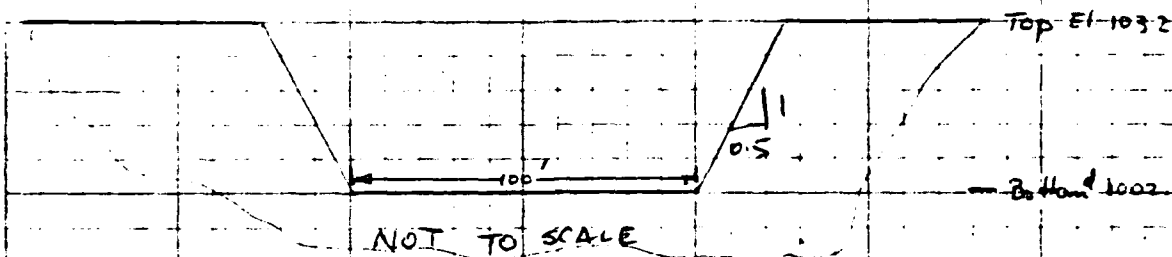


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 (412) 531-7111

Sheet _____ of _____
 Job CARADDE Dam Job No. 79153-3
 Subject Breach and Downstream Routing Parameters
 Made By JP/H Date 6/15/80 Checked _____ Date _____

BREACH PARAMETERS

Failure Equation 1033



RATIO of PMF (RTIO) = 0.49
 SIDE SLOPE OF BREACH (Z) = 0.5
 FAILURE TIME (TFAIL) = 1 hour

CHANNEL ROUTING

CHANNEL CROSS SECTION OBTAINED FROM USGS 7 1/2' QUAD

CHANNEL MANNINGS 'N' $Q(N) (2) = 0.03$

OVERBANK MANNINGS 'N' $Q(N) (1) = 0.07$

FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 26 FEB 79

1	A1	NATIONAL PROGRAM FOR THE INSPECTION OF NON FEDERAL DAMS									
2	A2	HYDROLOGIC AND HYDRAULIC ANALYSIS OF CRABAPPLE DAM									
3	A3	PROBABLE MAXIMUM FLOOD PMF/UNIT HYDROGRAPH BY SNYDER'S METHOD									
4	B	300	0	20	0	0	0	0	0	0	0
5	B1	5									
6	J	2	1	1							
7	J1	0.49									
8	K	0	1				1				
9	K1	INFLOW HYDROGRAPH FOR CRABAPPLE DAM									
10	M	1	1	1.33	1.33	1				1	
11	P		19.4	102	120	130					
12	T						1.0	.05			
13	W	1.85	0.5								
14	X	-1.5	-0.05	2.0							
15	K	1	2				1				
16	K1	ROUTING AT CRABAPPLE DAM									
17	Y			1	1						
18	Y1	1					-1028.4	-1			
19	Y4	1028.4	1028.6	1028.7	1028.8	1029.	1029.1	1029.2	1029.3	1029.4	1029.6
20	Y4	1029.9	1030.4	1031.4	1032.4	1033.4	1034.4	1035.4	1036.4		
21	Y5	0.	7.2	13.8	21.9	41.5	53.4	66.5	80.8	96.3	126.5
22	Y5	183.8	291.	534.6	823.1	1150.3	1512.1	1905.5	2328.		
23	\$A	0.0	12.3	35.							
24	\$E	1000.4	1027.	1040.							
25	\$S	1028.4									
26	\$D	1032.	3.08	1.5	720.						
27	\$L	40.	50.	720.	730.						
28	\$V	1032.	1032.5	1033.	1033.5						
29	\$B	100.	0.5	1002.	1.0	1028.4	1033.				
30	\$B	100.	0.5	1002.	1.0	1028.4	1035.				
31	K	1	3								
32	K1	MOD PULS ROUTING FROM DAM TO STATION THREE									
33	Y			1	1						
34	Y1	1									
35	Y6	.07	.03	.07	970.	1100.	2000.	.015			
36	Y7	0.0	1100.	350.	1000.	700.	972.	700.	970.	705.	970.
37	Y7	705.	972.	850.	1000.	1800.	1100.				
38	K	1	4								
39	K1	MOD PULS ROUTING FROM STATION THREE TO STATION FOUR									
40	Y			1	1						
41	Y1	1									
42	Y6	.07	.03	.07	940.	1040.	3000.	.01			
43	Y7	0.0	1040.	600.	960.	750.	942.	750.	940.	755.	940.
44	Y7	755.	942.	850.	960.	1400.	1040.				
45	K	99									
46	A										
47	A										
48	A										
49	A										
50	A										

PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

RUNOFF HYDROGRAPH AT	1
ROUTE HYDROGRAPH TO	2
ROUTE HYDROGRAPH TO	3
ROUTE HYDROGRAPH TO	4
END OF NETWORK	

 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION JULY 1978
 LAST MODIFICATION 26 FEB 79

RUN DATE: 17 JUL 80
 RUN TIME: 9.44. 1

NATIONAL PROGRAM FOR THE INSPECTION OF NON FEDERAL DAMS
 HYDROLOGIC AND HYDRAULIC ANALYSIS OF CRABAPPLE DAM
 PROBABLE MAXIMUM FLOOD PMF/UNIT HYDROGRAPH BY SNYDER'S METHOD

JOB SPECIFICATION
 NQ 300 NHR 0 NMIN 20 IDAY 0 IHR 0 IMIN 0 METRC 0 IPLT 0 IPRT -4 NSTAN 0
 JOPER 5 NWT 0 LROPT 0 TRACE 0

MULTI-PLAN ANALYSES TO BE PERFORMED
 NPLAN= 2 NRTIO= 1 LRTIO= 1

RTIOS= 0.49

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH FOR CRABAPPLE DAM

LISTAQ ICOMP IECON ITAPE JPLT JPRT INAME LSTAGE LAUTO
 1 0 0 0 0 0 1 0 0

HYDROGRAPH DATA
 IHYDG IUNG TAREA SNAP TRSDA TRSPC RATIO ISNOW ISAME LOCAL
 1 1 1.33 0.0 1.33 1.00 0.0 0 1 0

PRECIP DATA
 SPFE PMS R6 R12 R24 R48 R72 R96
 0.0 19.40 102.00 120.00 130.00 0.0 0.0 0.0

LOSS DATA
 LROPT STRKR DLTKR RTIOL ERAIN STRKS RTIOK STRTL CNSTL ALSMX RTIMP
 0 0.0 0.0 1.00 0.0 0.0 1.00 1.00 0.05 0.0 0.0

UNIT HYDROGRAPH DATA
 TP= 1.85 CP=0.50 NTA= 0

RECESSION DATA
 STRTQ= -1.50 QRCSN= -0.05 RTIOR= 2.00

UNIT HYDROGRAPH 44 END-OF-PERIOD ORDINATES, LAG= 1.84 HOURS, CP= 0.50 VOL

= 1.00

15.	57.	115.	174.	216.	231.	217.	190.	167.	146.
128.	113.	99.	87.	76.	67.	58.	51.	45.	39.
35.	30.	27.	23.	20.	18.	16.	14.	12.	11.
9.	8.	7.	6.	6.	5.	4.	4.	3.	3.
3.	2.	2.	2.						

0
 MO.DA HR.MN PERIOD RAIN EXCS LOSS END-OF-PERIOD FLOW
 MO.DA HR.MN PERIOD RAIN EXCS LOSS COMP Q

SUM 25.22 23.34 1.88 61059.
 (641.)(593.)(48.)(1729.00)

HYDROGRAPH ROUTING

ROUTING AT CRABAPPLE DAM

	ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
	2	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME ROUTING DATA

	QLOSS	CLOSS	AVG	IRE	ISAME	IOPT	IPMP	LSTR
	0.0	0.0	0.0	1	1	0	0	0

	NSTPS	NSTD	LAG	AMSKK	X	TSK	STORA	ISPRAT
	1	0	0	0.0	0.0	0.0	-1028.	-1

	STAGE	1028.40	1028.60	1028.70	1028.80	1029.00	1029.10	1029.20	1029.30	1029.40
		1029.60	1029.90	1030.40	1031.40	1032.40	1033.40	1034.40	1035.40	1036.40

	FLOW	0.0	7.20	13.80	21.90	41.50	53.40	66.50	80.80	96.30
		128.50	183.80	291.00	534.60	823.10	1150.30	1512.10	1905.50	2328.00

	SURFACE AREA=	0.	12.	35.
	CAPACITY=	0.	109.	404.
	ELEVATION=	1000.	1027.	1040.

	CREL	SPWID	COQW	EXPW	ELEV	COQL	CAREA	EXPL
	1028.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

	TOPEL	COQD	EXPD	DAMWID
	1032.0	3.1	1.5	720.

	CREST LENGTH	40.	50.	720.	730.
	AT OR BELOW ELEVATION	1032.0	1032.5	1033.0	1033.5

DAM BREACH DATA

	BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
	100.	0.50	1002.00	1.00	1028.40	1033.00

BEGIN DAM FAILURE AT 17.33 HOURS

PEAK OUTFLOW IS 6106. AT TIME 17.73 HOURS

DAM BREACH DATA

	BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
	100.	0.50	1002.00	1.00	1028.40	1035.00

PEAK OUTFLOW IS 1455. AT TIME 17.67 HOURS

HYDROGRAPH ROUTING

MOD PULS ROUTING FROM DAM TO STATION THREE

	ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
	3	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME ROUTING DATA

	QLOSS	CLOSS	AVG	IRE	ISAME	IOPT	IPMP	LSTR
	0.0	0.0	0.0	1	1	0	0	0

	NSTPS	NSTD	LAG	AMSKK	X	TSK	STORA	ISPRAT
	1	0	0	0.0	0.0	0.0	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
0.0700	0.0300	0.0700	970.0	1100.0	2000.	0.01500

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

0.0	1100.00	350.00	1000.00	700.00	972.00	700.00	970.00	705.00	970.00
705.00	972.00	850.00	1000.00	1800.00	1100.00				

STORAGE	0.0	11.09	58.55	144.00	267.46	427.01	615.25	831.43	1075.55
	1347.61	1647.61	1975.56	2331.45	2715.28	3127.05	3566.76	4034.42	
4530.02	5053.55	5605.04							
OUTFLOW	0.0	1476.03	11761.83	37870.20	85356.50	162095.81	270718.69	411123.19	585330.31
	795523.00	1043923.06	1332751.00	1664204.00	2040448.00	2463616.00	2935803.00	3459077.00	4035463.00
	4666963.00	5355537.00							
STAGE	970.00	976.84	983.68	990.53	997.37	1004.21	1011.05	1017.89	1024.74
	1031.58	1038.42	1045.26	1052.10	1058.95	1065.79	1072.63	1079.47	1086.31
	1093.16	1100.00							
FLOW	0.0	1476.03	11761.83	37870.20	85356.50	162095.81	270718.69	411123.19	585330.31
	795523.00	1043923.06	1332751.00	1664204.00	2040448.00	2463616.00	2935803.00	3459077.00	4035463.00
	4666963.00	5355537.00							

MAXIMUM STAGE IS 979.1

MAXIMUM STAGE IS 976.8

HYDROGRAPH ROUTING

MOD PULS ROUTING FROM STATION THREE TO STATION FOUR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	LAUTO
4	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.0	0.0	1	1	0	0	0
NSTPS	NSTD L	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.0	0.0	0.0	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
0.0700	0.0300	0.0700	940.0	1040.0	3000.	0.01000

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

0.0	1040.00	600.00	960.00	750.00	942.00	750.00	940.00	755.00	940.00
755.00	942.00	850.00	960.00	1400.00	1040.00				

STORAGE	0.0	6.80	37.69	94.55	177.40	287.21	424.44	589.09	781.16
	1000.65	1247.57	1521.91	1823.67	2152.85	2509.45	2893.48	3304.93	3743.79
	4210.09	4703.79							

OUTFLOW	0.0	479.39	3596.27	11570.45	26108.03	48753.97	81193.06	124806.19	180899.12
	250713.75	335439.06	436217.75	554153.19	690313.75	845738.25	1021438.12	1218398.00	1437582.00
	1679934.00	1946378.00							
STAGE	940.00	945.26	950.53	955.79	961.05	966.31	971.58	976.84	982.10
	987.37	992.63	997.89	1003.16	1008.42	1013.68	1018.94	1024.21	1029.47
	1034.73	1040.00							
FLOW	0.0	479.39	3596.27	11570.45	26108.03	48753.97	81193.06	124806.19	180899.12
	250713.75	335439.06	436217.75	554153.19	690313.75	845738.25	1021438.12	1218398.00	1437582.00
	1679934.00	1946378.00							

MAXIMUM STAGE IS 951.7

MAXIMUM STAGE IS 946.9

 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	RATIO 1	RATIOS APPLIED TO FLOWS
				0.49	
HYDROGRAPH AT	1	1.33	1	1464.	
	(3.44)	(41.45)(
			2	1464.	
			(41.45)(
ROUTED TO	2	1.33	1	5941.	
	(3.44)	(168.23)(
			2	1455.	
			(41.21)(
ROUTED TO	3	1.33	1	4924.	
	(3.44)	(139.42)(
			2	1459.	
			(41.33)(
ROUTED TO	4	1.33	1	5310.	
	(3.44)	(150.36)(
			2	1455.	
			(41.20)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1	ELEVATION	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM				
	STORAGE	1028.40	1028.40	1032.00				
	OUTFLOW	128.	128.	188.				
		0.	0.	708.				
	RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
	0.49	1033.01	1.01	209.	6106.	1.49	17.73	17.33

PLAN 2	ELEVATION	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM				
	STORAGE	1028.40	1028.40	1032.00				
	OUTFLOW	128.	128.	188.				
		0.	0.	708.				
	RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
	0.49	1033.01	1.01	209.	1455.	5.00	17.67	0.0

PLAN	1	STATION	3
RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.49	4924.	979.1	18.00

PLAN	2	STATION	3
RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.49	1459.	976.8	17.67

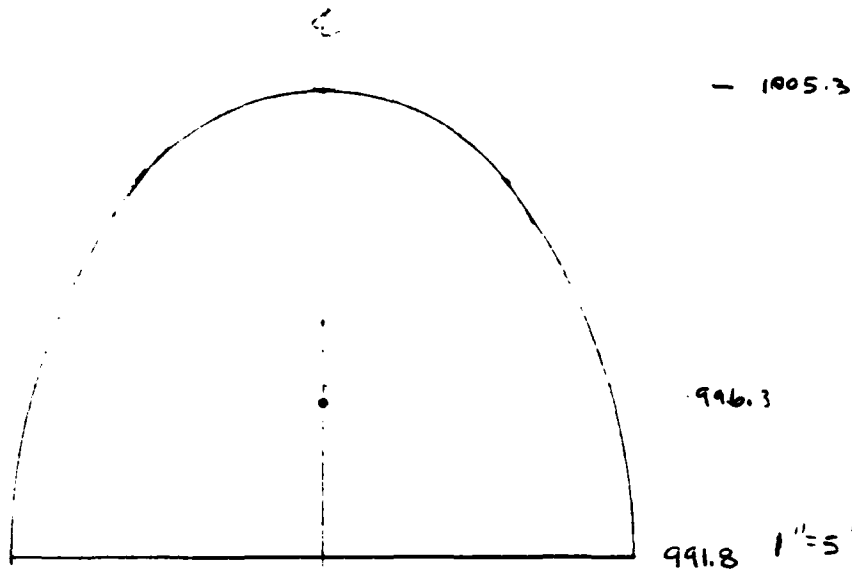
PLAN	1	STATION	4
RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.49	5310.	951.7	18.00

PLAN	2	STATION	4
RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.49	1455.	946.9	17.67

ACKENHEIL & ASSOCIATES
 GEO Systems, Inc.
 1000 Banksville Road
 PITTSBURGH, PA. 15216
 (412) 531-7111

Sheet _____ of _____
 Job _____ Job No. _____
 Subject _____
 Made By _____ Date _____ Checked _____ Date _____

Elevation of road 1044.1



Approximate Centroid $\frac{1}{3}$ height from bottom = elevation 996.3

$$A = 184.32 \text{ ft}^2$$

For a total Flow of 4924 cfs FIND height on Road Embankment

$$Q = C A \sqrt{2gh} \quad \text{assume } C = 0.5$$

$$4924 = (0.5)(184.32) \sqrt{2(32.2)} \sqrt{h}$$

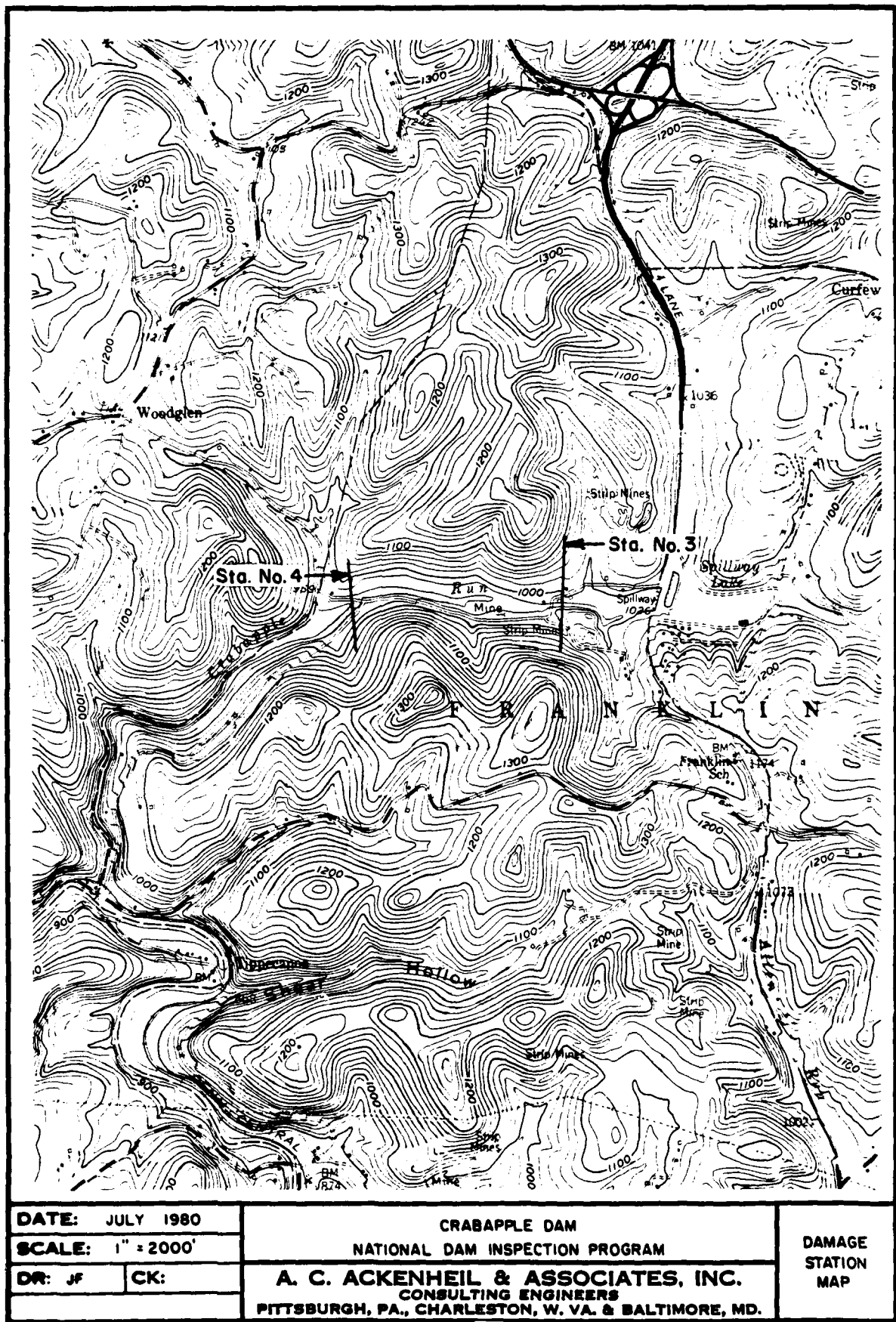
$$\sqrt{h} = 6.66$$

$$h = 44.3 \quad \text{above elevation } 996.3$$

water elevation ~ 1040.6 on highway embankment

Cassapple Dam's water pool at Failure During failure storm would be
 Approximately 21033

Therefore the actual Flow through the culvert would be
 less than 4924 cfs AND the actual water surface would be
 less than that given in the computer output. The calculation
 can be assumed to be a conservative estimate of flow downstream

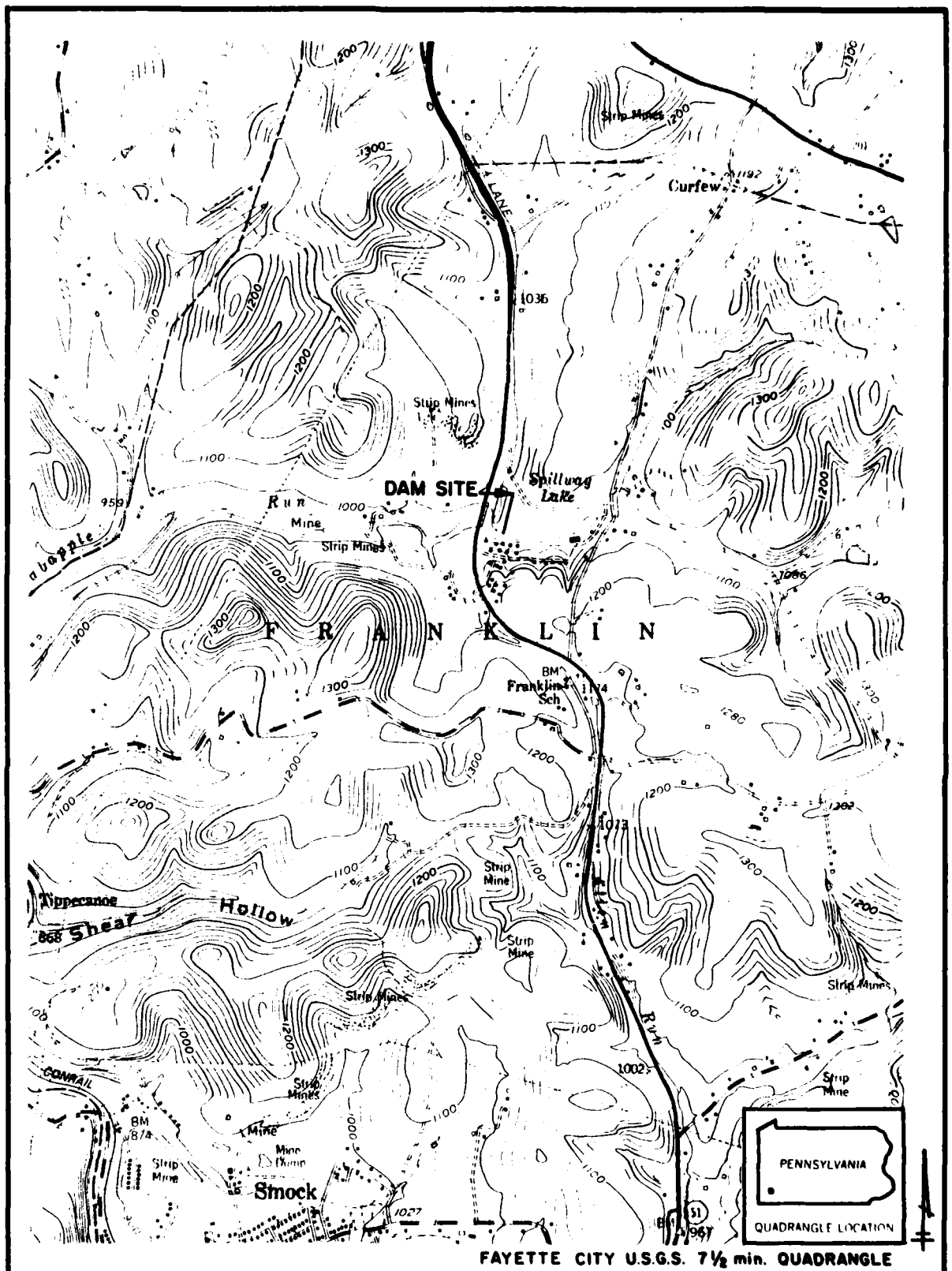


APPENDIX E

PLATES

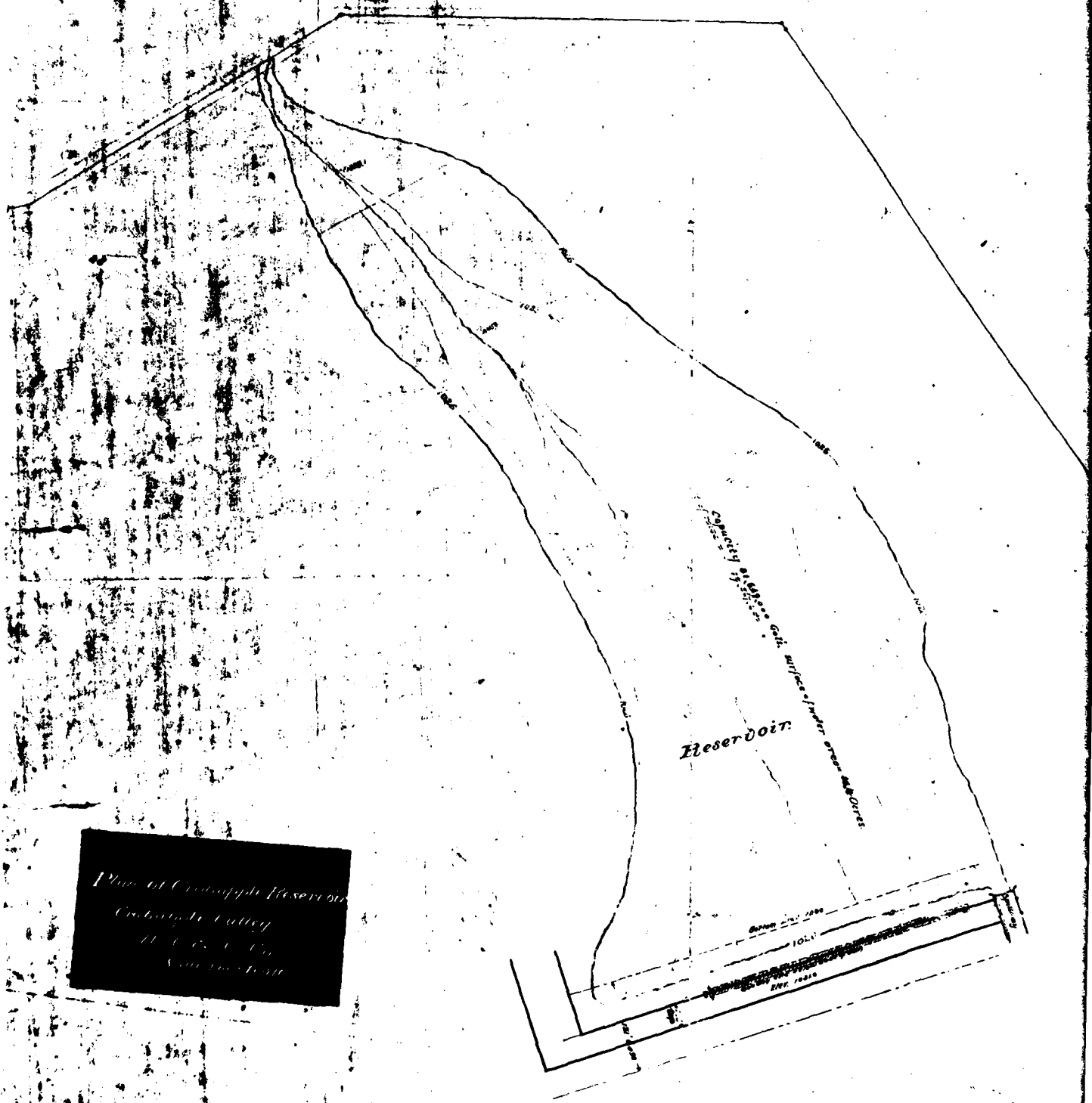
LIST OF PLATES

- Plate I Regional Vicinity Map.
- Plate II "Plan of Crabapple Reservoir, Crabapple
Valley, W.C. & C. Company".
- Plate III "Plan and Sections of W.C. & C. Co's,
Crabapple Reservoir Dam showing proposed
change in Height," Thomas M. Zimmerman,
Eng., dated July 1915.
- Plate IV "W.C. & C. Co., Crabapple Reservoir on
Crabapple Run" showing proposed spillway
repair work.

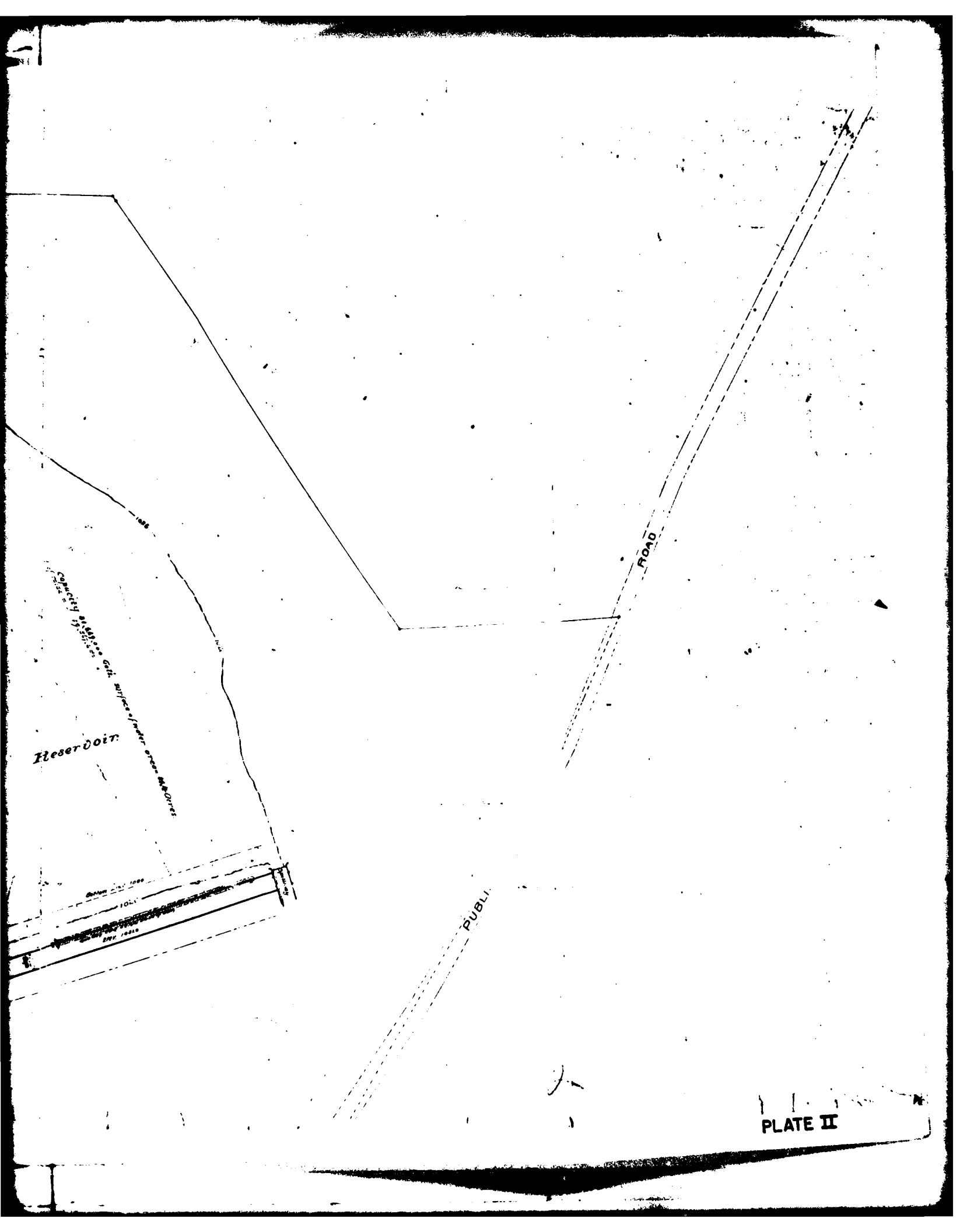


DATE: JULY 1980		CRABAPPLE DAM NATIONAL DAM INSPECTION PROGRAM	REGIONAL VICINITY MAP
SCALE: 1" = 2000'			
DR: JF	CK:	A. C. ACKENHEIL & ASSOCIATES, INC. CONSULTING ENGINEERS PITTSBURGH, PA., CHARLESTON, W. VA. & BALTIMORE, MD.	
DWG. NO. PLATE I			

10 7100 ALBANY A. & S. SMITH CO., PHO., PA.



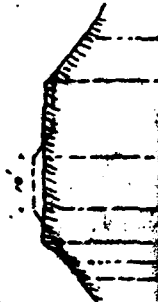
Plan of Crocker-Hale Reservoir
 Crocker-Hale Valley
 H. C. & C. Co.
 San Francisco



Heser Doin

ROAD

PUBLI



1027.0 EVES Flow Line

102.00
102.00

Scale Hor 30' Ver 20' = 1"

103121 P
103122 G

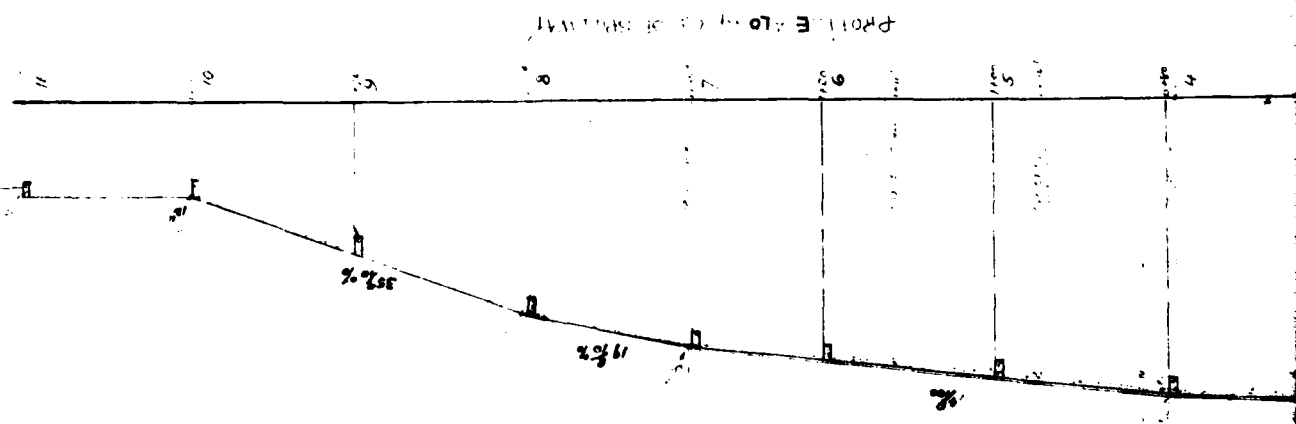
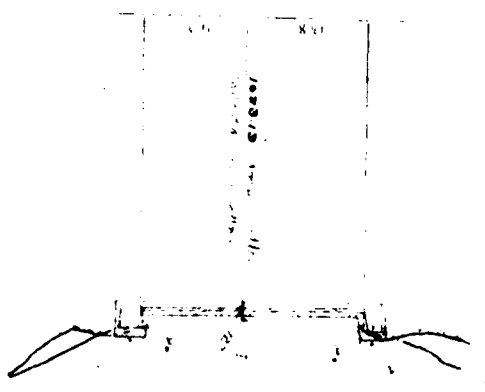
EDGE OF WATER 1025.

SCALE 30' = 1"

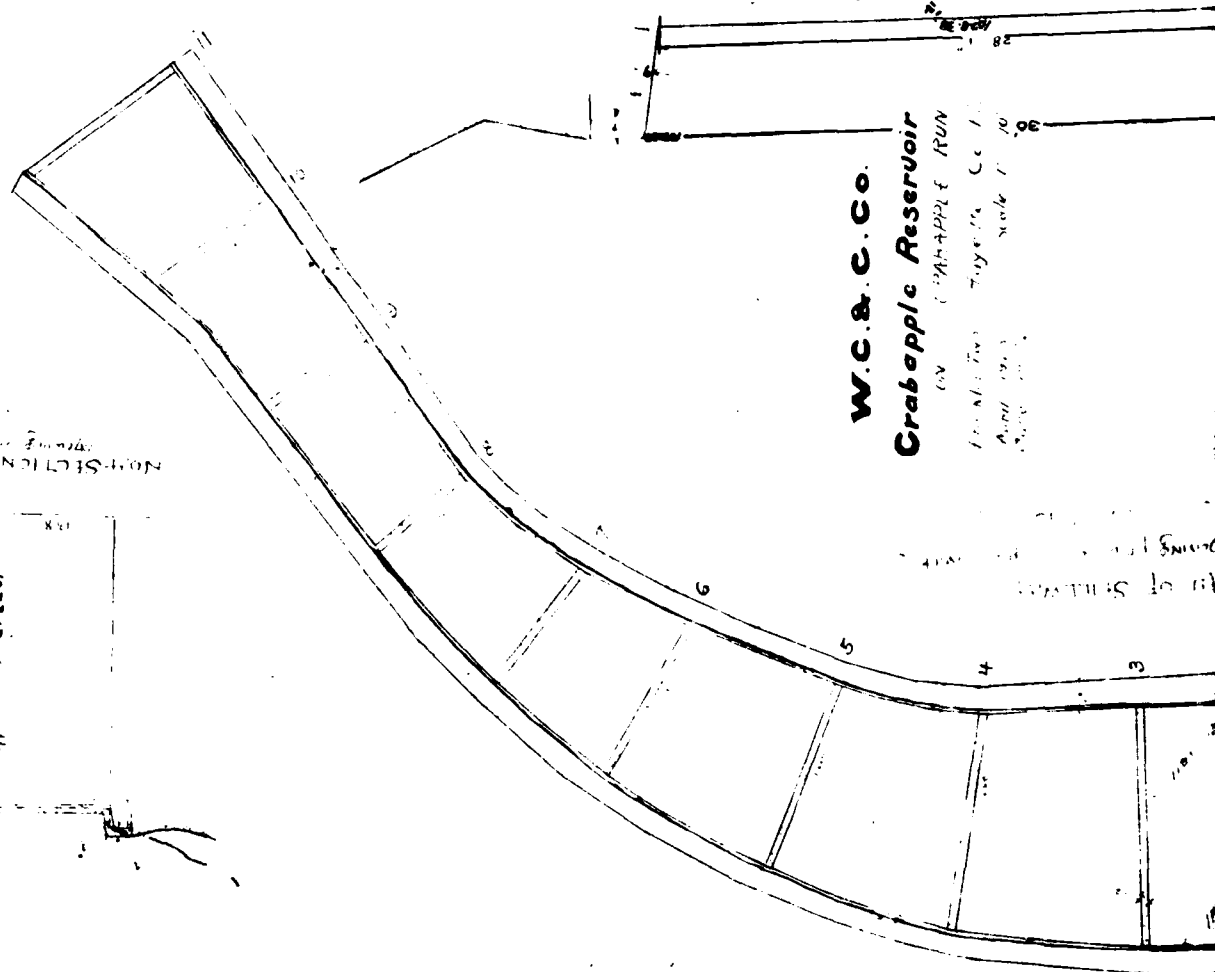
Crabapple

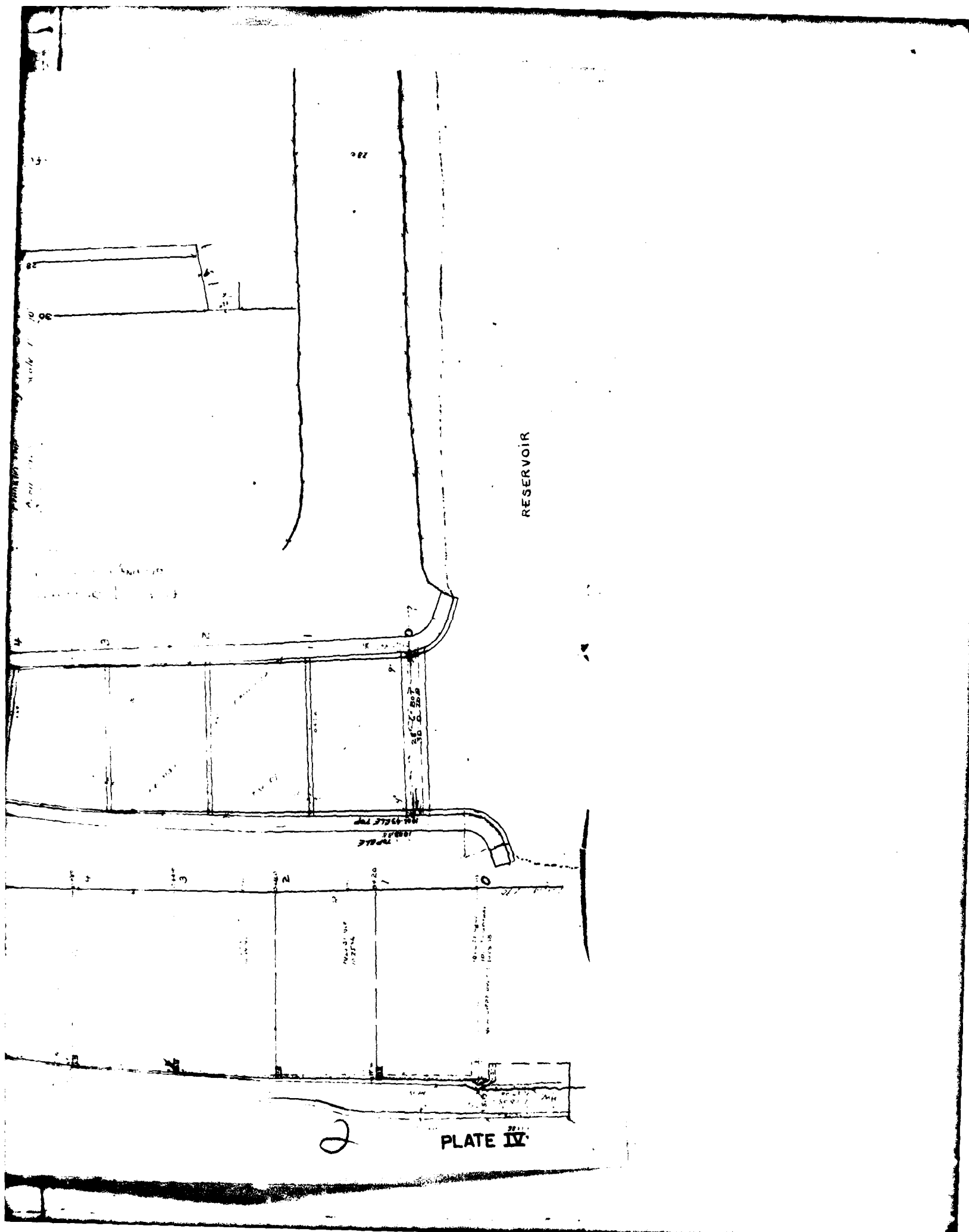
Reservoir.

North Section at 1880



W.C. & C. Co.
Crabapple Reservoir
 ON CRABAPPLE RUN
 Located Two Miles S. of
 Appleton, Wis.
 Made in 1900





APPENDIX F

GEOLOGY

GEOLOGY

Geomorphology

Crabapple Dam is located within the Pittsburgh Plateau section of the Appalachian Plateau Physiographic Province. This area is characterized as a mature plateau of nearly flat lying sedimentary rocks which in many places form steep sided valleys when dissected by streams. The dam is located along Crabapple Run which is a tributary to Redstone Creek.

Structure

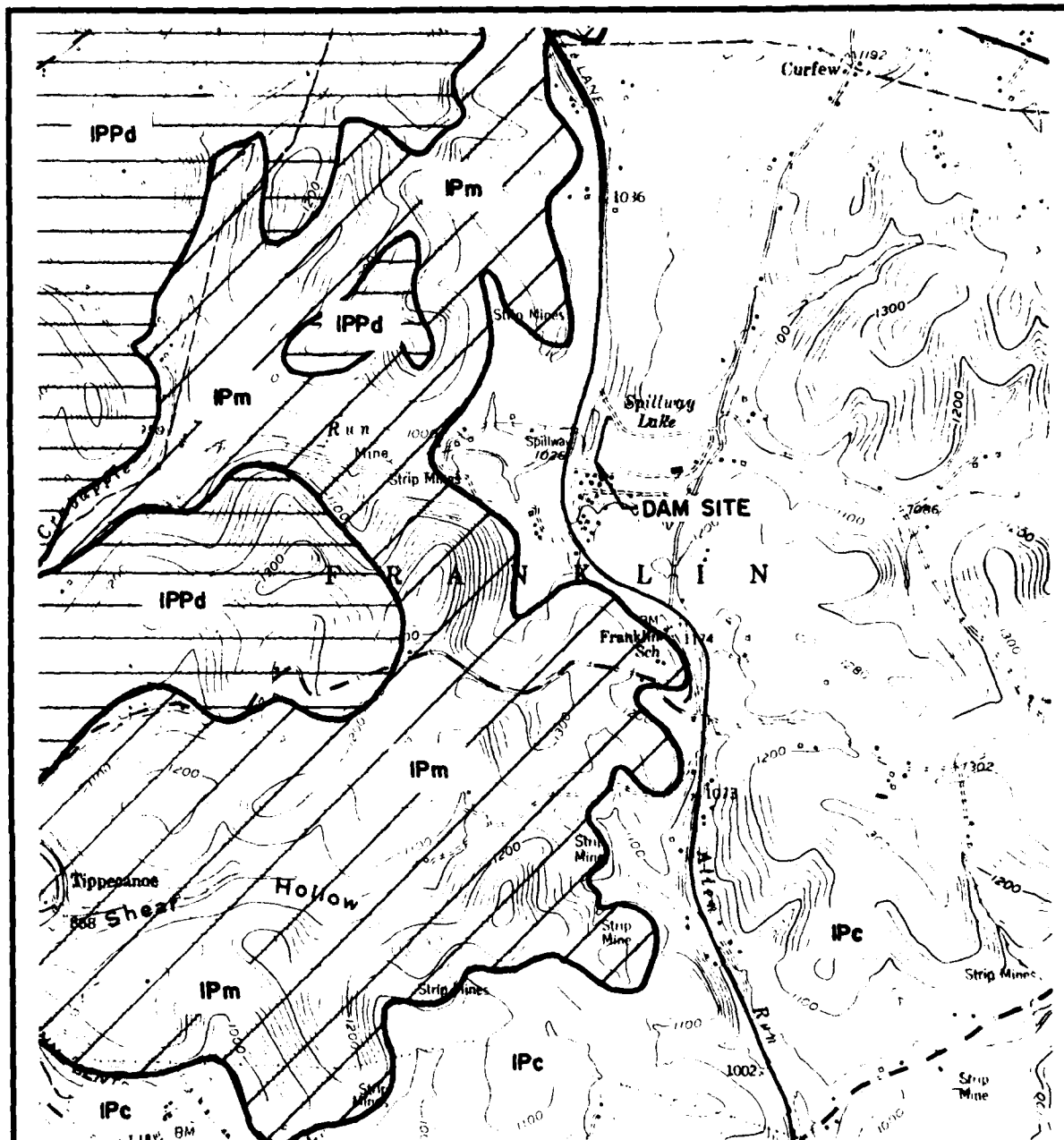
General: Crabapple Dam is located midway between the axis of the Fayette anticline and the Lambert syncline. Both these structures trend NE-SW. The regional dip of the bedrock at the dam site is 350 ft./mile (3.8°) to the west.

Faults: No observations were made that would indicate faulting in the rocks outcropping around the dam site. In general, only a few evidences of faulting have been observed in all of Fayette County.

Stratigraphy

General: The rocks exposed in the immediate area of Crabapple Dam are part of the Conemaugh Group of Pennsylvanian Age, and include primarily the middle to upper members of the Casselman Formation.

Rock Types: The rocks outcropping in the area of the dam are composed of cyclic sequences of sandstone, siltstone and shale with some thin beds of limestone and coal. The Pittsburgh Coal Seam, which stratigraphically marks the top of the Conemaugh Group, and the base of the Monongahela Group outcrops along the valleys north and south of the dam.



FAYETTE CITY QUADRANGLE, FAYETTE COUNTY, PENNSYLVANIA

SCALE: 0 1/2 MILE 1:24000

CONTOUR INTERVAL 20 FT. DATUM IS MEAN SEA LEVEL

—— FORMATION CONTACT

DATA OBTAINED FROM PENNSYLVANIA TOPOGRAPHIC AND GEOLOGIC SURVEY, GEOLOGIC MAP OF FAYETTE COUNTY, PENNSYLVANIA, 1940 and COAL AND SURFACE STRUCTURE MAP OF FAYETTE COUNTY, PENNSYLVANIA, 1940

DATE: JULY 1980	CRABAPPLE DAM NATIONAL DAM INSPECTION PROGRAM	GEOLOGIC MAP
SCALE: 1" = 2000'		
DR: JF	A. C. ACKENHEIL & ASSOCIATES, INC. CONSULTING ENGINEERS PITTSBURGH, PA., CHARLESTON, W. VA. & BALTIMORE, MD.	
CK:		

AD-A091 529

ACKENHEIL AND ASSOCIATES INC PITTSBURGH PA
NATIONAL DAM INSPECTION PROGRAM, CRABAPPLE DAM (NDI NUMBER PA 0--ETC(U)
JUL 80 J P HANNAN, J E BARRICK

F/G 13/13

DACW31-80-C-0026

NL

UNCLASSIFIED

2 - 2

AD
00140



END
DATE
FILMED
12 80
DTIC

AGE	SCORE	P-1234	COLUMNAR SECTION	PROMINENT BEDS
QUATERNARY				PLEISTOCENE GLACIAL OUTWASH, RIVER TERRACE DEPOSITS AND ALLUVIUM
PERMIAN	DUNBAR (P-10)	WASHINGTON (P-11)		UPPER WASHINGTON LIMESTONE
				WASHINGTON COAL
				WYTHEBURG SANDSTONE
				WYTHEBURG COAL
				UNIONTOWN SANDSTONE
				UNIONTOWN COAL
				BENWOOD LIMESTONE
				SEWICKLEY COAL
				PITTSBURGH SANDSTONE
				PITTSBURGH COAL
PENNSYLVANIAN	MORGANTHAU (P-1)	PITTSBURGH (P-2)		CONNELLSVILLE SANDSTONE
				MORGANTHAU SANDSTONE
				AMES LIMESTONE
				PITTSBURGH RED BEDS
				SALTSBURG SANDSTONE
				MAHONING SANDSTONE
				UPPER FREEPORT COAL
				UPPER HITTANNING COAL
				WORTHINGTON SANDSTONE
				LOWER HITTANNING COAL
MISSISSIPPIAN	POTTSVILLE (P-3)	GLACIUS (P-4)		HOMEROCK SANDSTONE
				MERCER SANDSTONE, SHALE & COAL
				CONROQUESSING SANDSTONE
				BURROCK SANDSTONE
				CUYAHOGA SHALE
				BEREA SANDSTONE

DATE: JULY 1980

SCALE: 1" = 360'

DR: JF

CK:

CRABAPPLE DAM

NATIONAL DAM INSPECTION PROGRAM

A. C. ACKENHEIL & ASSOCIATES, INC.

CONSULTING ENGINEERS

PITTSBURGH, PA., CHARLESTON, W. VA. & BALTIMORE, MD.

GEOLOGICAL

COLUMNAR

DA FILM 2-