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NATIONAL DAM INSPECTION PROGRAM. CORNWALL TAILINGS DAM (NDI NUM--ETC(U)
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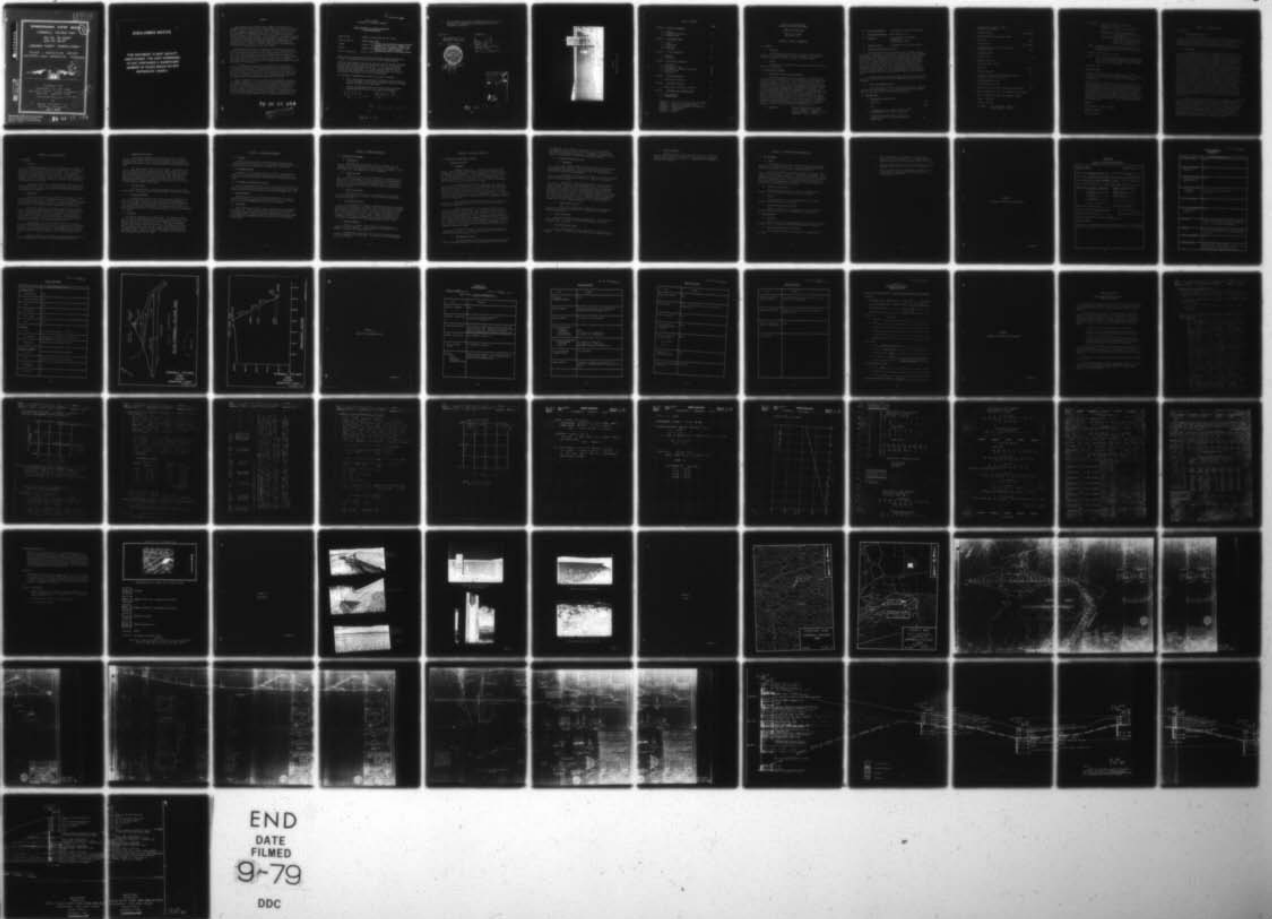
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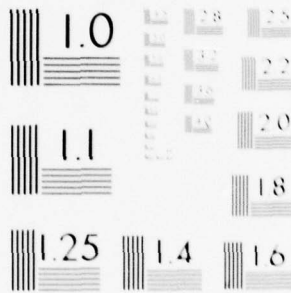
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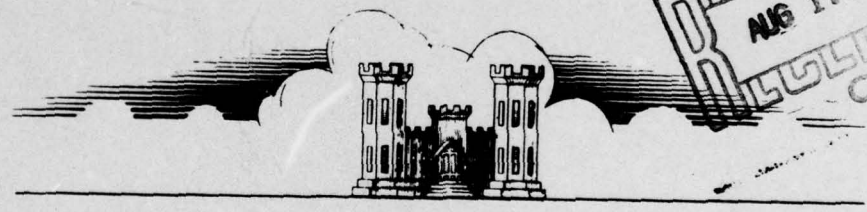
CORNWALL TAILINGS DAM

NDI NO. PA-00597
DER NO. 38-87

LEBANON COUNTY, PENNSYLVANIA ✓

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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PREPARED FOR
DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

Contract # DACW31-79-C-0012

BY

Berger Associates, Inc.
Harrisburg, Pennsylvania

JULY 1979

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PREFACE

This report has been 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 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 available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

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

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

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PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

BRIEF ASSESSMENT OF GENERAL CONDITIONS
AND RECOMMENDATIONS

Name of Dam:	CORNWALL TAILINGS DAM, NDI NO. PA-597
State & State No:	PENNSYLVANIA, 38-87
County:	LEBANON
Stream:	BERNHARD CREEK
Date of Inspection:	May 11, 1979

6 National Dam Inspection Program, Cornwall Tailings Dam (NDI Number PA-00597, DER Number 38-87), Susquehanna River Basin, Bernhard Creek, Lebanon County, Pennsylvania, Phase I Inspection Report.

Based upon the visual inspection and the available engineering data, the dam and its appurtenant structures appear to be in good condition.

Hydrologic and hydraulic calculations indicate that the present reservoir has sufficient storage capacity to handle the inflow of the Probable Maximum Flood without overtopping the dam. It is considered that the storage capacity is adequate. It has been estimated that the yearly evaporation and leakage equals the annual inflow and that, as a result, an increase in the normal pool level is very unlikely.

The following recommendations are made for action by the owner:

1. That a staff gauge be installed on the decant tower located in the pool and that at least monthly readings be taken to establish records of changes in the pool level.
2. That the 6-inch blowoff valve on the decant pipe be located and made operable for use in the event of an emergency.

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3. That a formal surveillance and downstream warning system be developed for implementation during periods of heavy or prolonged precipitation.

SUBMITTED BY:

BERGER ASSOCIATES, INC.
HARRISBURG, PENNSYLVANIA

DATE: July 13, 1979



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APPROVED BY:

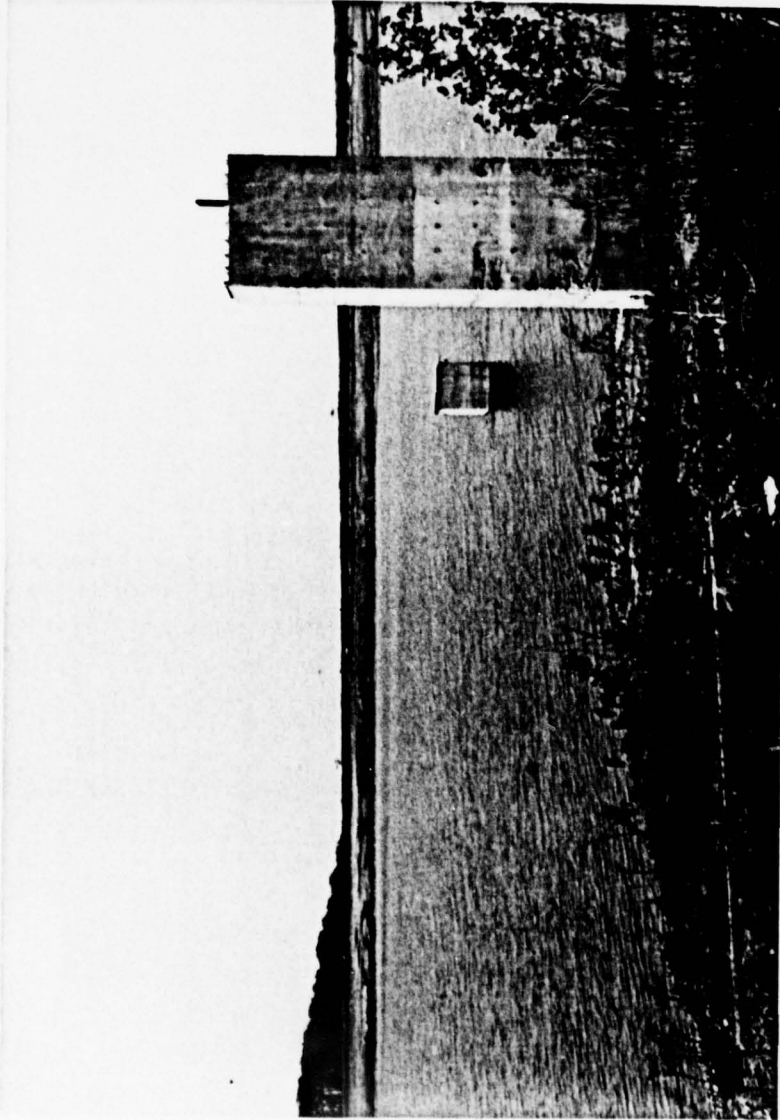
James W. Peck

JAMES W. PECK
Colonel, Corps of Engineers
District Engineer

DATE 28 July 1979

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OVERVIEW
CORNWALL TAILINGS DAM

TABLE OF CONTENTS

	<u>Page</u>
<u>SECTION 1 - PROJECT INFORMATION</u>	
1.1 GENERAL	1
1.2 DESCRIPTION OF PROJECT	1
1.3 PERTINENT DATA	2
<u>SECTION 2 - ENGINEERING DATA</u>	
2.1 DESIGN	5
2.2 CONSTRUCTION	6
2.3 OPERATION	6
2.4 EVALUATION	6
<u>SECTION 3 - VISUAL INSPECTION</u>	
3.1 FINDINGS	8
3.2 EVALUATION	9
<u>SECTION 4 - OPERATIONAL PROCEDURES</u>	
4.1 PROCEDURES	10
4.2 MAINTENANCE OF DAM	10
4.3 MAINTENANCE OF OPERATING FACILITIES	10
4.4 WARNING SYSTEM	10
4.5 EVALUATION	10
<u>SECTION 5 - HYDROLOGY/HYDRAULICS</u>	
5.1 EVALUATION OF FEATURES	11
<u>SECTION 6 - STRUCTURAL STABILITY</u>	
6.1 EVALUATION OF STRUCTURAL STABILITY	12
<u>SECTION 7 - ASSESSMENT AND RECOMMENDATIONS</u>	
7.1 DAM ASSESSMENT	15
7.2 RECOMMENDATIONS	15
APPENDIX A - CHECK LIST OF VISUAL INSPECTION REPORT	
APPENDIX B - CHECK LIST OF ENGINEERING DATA	
APPENDIX C - HYDROLOGY AND HYDRAULIC CALCULATIONS	
APPENDIX D - GEOLOGIC REPORT	
APPENDIX E - PHOTOGRAPHS	
APPENDIX F - PLATES	

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

CORNWALL TAILINGS DAM

NDI-ID NO. PA-00597
DER-ID NO. 38-87

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

A. Authority

The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspections of dams throughout the United States.

B. Purpose

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

1.2 DESCRIPTION OF PROJECT

A. Description of Dam and Appurtenances

Refer to → Cornwall Tailings Dam was constructed by the Bethlehem Mine Corporation as a settlement basin for their tailings from a nearby iron ore mine operation. The mine was closed in 1977 and the facilities of the dam are presently not in use. At the time of inspection, it was estimated that the top of the dam is approximately at elevation 908 and the pool level was at elevation 890. The U-shaped embankment is 3800 feet in length. (Refer to ~~Plate III~~, Appendix F). The northern part of the embankment, which spans the original valley, is about 1900 feet long and has a maximum height of 200 feet above the downstream toe. The remainder of the embankment closes off lower areas on the east side of the reservoir with heights varying up to 60 feet. Most of the embankment was constructed from trap rock, with the exception of an impervious upstream toe and upstream blanket. There is no spillway. The only outlet is a 20-inch decant line which returned water to the mine. At present, this line is closed off near the downstream toe. *ABSTRACT*

B. Location:

Cornwall Borough, Lebanon County
U.S.G.S. Quadrangle, Lebanon, PA
Latitude 40°-16.5', Longitude 76°-22.8'
(Appendix F, Plates I and II)

- C. Size Classification: Large (200 feet high, 667 acre-feet)
- D. Hazard Classification: High (Section 3.1.E)
- E. Ownership: Bethlehem Mines Corporation
Martin Tower
Bethlehem, PA 18016
- F. Purpose of Dam: Settlement basin for mine tailings
- G. Design and Construction History

Cornwall Tailings Dam was designed by the Bethlehem Cornwall Corporation, a subsidiary of Bethlehem Steel Corporation. The foundation investigation, soils and geologic report, stability and seepage analysis were prepared by E. D'Appolinia Associates, Pittsburgh, Pennsylvania. The permit for construction was issued on March 6, 1961, and actual construction started in April of that year. The contractor, Reisinger Bros., Inc., Carlisle, Pennsylvania, completed the initial phase of construction in October, 1961. This construction was limited to an embankment length of about 700 feet, and to a finished crest elevation of 805 (Plate VI, Appendix F). This initial phase was constructed of impervious material and is now incorporated in the dam as the upstream toe.

The subsequent raising of the dam to the design crest elevation of 910 was constructed by the owner when additional tailing storage was required.

H. Normal Operating Procedures

The tailing pond is not in use at the present time. Representatives of the owner stated that the reservoir water level has dropped since becoming inactive due to evaporation and seepage.

1.3 PERTINENT DATA

A. Drainage Area (square miles)

From files: 0.16

Use: 0.16

B. Discharge at Dam Site (cubic feet per second)

See Appendix C for hydraulic calculations

Maximum known inflow, June 22, 1972 from records for the U.S.G.S. gaging station on a nearby creek 230

	Outlet works at pool Elev. 889.7 (presently inoperative)	28
	Spillway capacity	No Spillway
C.	<u>Elevation</u> (feet above mean sea level)	
	Top of dam	908
	Spillway crest	No Spillway
	Streambed at toe of dam - estimate from inspection survey	708
D.	<u>Reservoir</u> (miles)	
	Length of pool	0.3
E.	<u>Storage</u> (acre-feet)	
	Top of dam (Elev. 908.0)	
	Tailings	3,213
	Water (estimated)	667
	Present pool level (Elev. 889.7) Water surface estimated from inspection survey	40
F.	<u>Reservoir Surface</u> (acres)	
	Top of dam (Elev. 908.0)	62
	Present level (Elev. 889.7) (estimated water area)	12
G.	<u>Dam</u> (See Appendix F, Plates III through VIII for details.)	
	Type: Rockfill with impervious upstream blanket.	
	Length: 3,800 feet.	
	Height: 200 feet.	
	Top Width: Main embankment - 100 feet. Other sections - 30 feet.	

Side Slopes: * Design (See Plate IV, Appendix F)
Upstream: 2H to 1V
Downstream: 1.75H to 1V with one berm.

Survey (See Plate A-II, Appendix A)
Upstream: All covered with tailings (silt)
to elevation 903±.
Downstream: Varies between 1.1H to 1V and
1.7H to 1V. Several wide berms.
Average slope from top to toe
1.95H to 1V (Waste Rock 4"±).

Zoning: Impervious upstream toe to elevation 805 and a 10
foot impervious blanket above that elevation as per
design drawings.

Impervious Core: None, see Zoning.

Cutoff: None. An intercepting lateral 8-inch seepage drain
was installed under the embankment, backfilled with
reject rock. This drain outlets through a 12-inch
drain near the toe of the dam.

Grouting: None.

H. Outlet Facilities

At the present time, the only operating outlet from this
reservoir is the underdrain of the dam embankment. This drain
discharges about 0.3 cfs to Bernhard Creek. The drain is
uncontrolled.

When the mine was operating (prior to 1977), the water level
in the reservoir was controlled by the tailings deposit system.
A pipe running along the top of the dam discharged a mixture
of water and mine tailings into the reservoir. Decant towers
at the upstream end of the reservoir collected the clear water
and returned it to the mine workings via a 20-inch welded
steel pipe. This pipe is now shut off and buried. If feasible,
overflow for the reservoir could be provided by uncovering the
20-inch pipe. The water would return to Bernhard Creek via an
an existing ditch.

I. Spillway

This dam does not have a spillway.

J. Regulating Outlets

See Section 1.3.H.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

A. Hydrology and Hydraulics

The files of Pennsylvania Department of Environmental Resources (PennDER) or the files of the owner did not contain information concerning the hydrologic and hydraulic design of this dam. Due to the small drainage area, the function of the reservoir, and the presence of a 20-inch return line to the mine, a hydraulic analysis was not performed.

B. Embankment

The preliminary design of the embankment and the subsurface soils investigation was prepared by E. D'Appolinia Associates, Pittsburgh, Pennsylvania. A report written by this company includes a geologic report, seepage calculations and stability analysis for the main embankment. Based on this report, Bethlehem Cornwall Corporation prepared the design drawings. The embankment was constructed in several phases. The first phase consisted of an impervious embankment with a crest elevation of 805 (Plate VI, Appendix F) and the placing of an 8-inch seepage drain under the future extension of the embankment. This lateral 8-inch drain discharges into a 12-inch drain running to the downstream toe. A 24-inch pipe was installed under the embankment as a temporary diversion. This pipe was filled with lean concrete after the first phase was completed. Mine waste was brought to the reservoir through a 12-inch pipe. The clear water was taken from the reservoir at decant towers through a 20-inch pipe. This pipe would be extended upstream in the reservoir with additional decant towers if tailings would cover the first two constructed decant towers. When the decant tower was abandoned, the 20-inch pipe inlet was sealed with a steel plate and part of the tower was plugged with concrete. The 20-inch decant line led to a valve house near the downstream toe. A 6-inch pipe with a valve is tapped into the line and could be used for minimum flow requirements in Bernhard Creek. The 20-inch pipe was reduced to a 16-inch pipe in the valve house and could be closed off with a valve on this pipe. This 16-inch pipe was the return line to the mine.

The report on "Design Consideration" for this dam by E. D'Appolinia considered flow net patterns under the dam for the condition with a pool level of 739 and no sedimentation. The estimated seepage was 25,600 gallons per day. Another flow net using a pool level of 820 with tailings up to elevation 815 indicated a seepage flow of 2,000 gallons a day, due to the sealing effect of the tailings. The downstream design slope was 1.75H to 1V and one berm giving a factor of safety against sliding of the downstream slope of 4.13. The report stated that the material probably would stand to a slope of 1.5H to 1V. All pipes under the dam were placed on concrete pads and have antiseepage collars.

C. Appurtenant Structures

This facility has no spillway and the only appurtenant structures are the decant towers and a 20-inch decant pipeline with valve house. See previous section for discussion.

2.2 CONSTRUCTION

Progress reports in the PennDER files indicate that the first phase was constructed as shown on Plate VI, Appendix F. The dam was raised to its final elevation in stages as required for tailing storage or as waste rock was available. Construction records are not available. A photograph taken in 1970 shows two 6-inch pipes projecting out of the slope about 20 feet above the toe having a small discharge. Origin of water is unknown and these pipes were dry at the time of the inspection. Additional decant towers were constructed and the 20-inch pipe was extended as needed.

2.3 OPERATION

Records of operation were not located and the facilities are not in use at the present.

2.4 EVALUATION

A. Availability

The available information was obtained from the files of PennDER and include a design report, construction drawings, and construction specifications for the first phase. Some of this information is also available in the offices of the owner.

B. Adequacy

1. Hydrology and Hydraulics

No information was located concerning the hydrologic and hydraulic design for this dam. Other available information and the visual inspection are, however, considered sufficient to review the adequacy of the structure.

2. Embankment

The available information is considered to be sufficient to review the design criteria and analysis of the embankment.

3. Appurtenant Structures

The information located in the PennDER files are considered to be adequate to review the design of these structures.

C. Operating Records

There are no operating records on file with D.E.R. or the owner.

D. Post Construction Changes

The construction permit was issued for a dam with a maximum height of 158 feet and a crest elevation of 910. Refer to Section 1.2.G for design and construction history. The embankment was constructed in stages over some 15 years and although variations occurred from the original drawings, the main elements were not changed.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

A. General

The general appearance of Cornwall Tailings Dam is good. The reservoir, constructed by Bethlehem Steel Corporation as a settlement basin, is not in active use at the present time. Only a small pool of water exists in the south end of this reservoir. The depth of the reservoir is unknown and can only be estimated. It appears that a large amount of storage is available. There is no spillway or functionable discharge line. At the time of inspection, the pool level was about 18 feet below the top of the dam.

The inspection team was accompanied by two representatives of the owner during part of the time. The visual inspection check list is in Appendix A of this report. Photographs taken during the inspection are reproduced in Appendix E.

B. Embankment

The crest of the dam is about 3,800 feet long and is U-shaped (see Appendix F, Plate III). The highest section of the abutment is located at the north end of the reservoir. A typical section was surveyed and a schematic plan and survey section is shown in Appendix A, Plates A-I and A-II. A crest profile was not made during the inspection.

The main section has a crest width of about 98 feet, appears to be level and well compacted and is covered with grass and small weed growth. The upstream slope is mostly covered with silt deposits and slopes gently to the water surface about 600 feet upstream from the crest. The 98 foot wide crest has a rock dike at the downstream side, over most of its length. This rock pile is about 3 feet high and presumably was constructed as a safety barrier for trucks.

The downstream slope is steep (Plate A-II) and has several benches of variable width. The slope is all exposed waste rock (Appendix E, Plate E-1). The height of the fill at its maximum section is about 200 feet. Some water was seeping out of the embankment near the drain pipe which has been installed under the fill. The estimated flow is .3 cfs.

The major length of the dam has an estimated height from 30 to 60 feet maximum and has a similar rock dike and downstream slope.

C. Appurtenant Structures

As previously mentioned, this dam does not have a spillway. The fine (silt) crusher waste of the mine was pumped to the reservoir through a 12-inch pipe. After the silt settled out, the clear water was returned to the mine for reuse by gravity through a 20-inch welded steel pipe.

Two intake decant towers are still visible. Both towers have an open flange 20-inch pipe through which the water could enter if the pool level would reach the invert elevation. A valve house was located near the downstream toe from which a 6-inch tap line could discharge water into an open ditch to the natural stream. This valve house was destroyed by vandalism and the owners have filled the valve pit with sand and gravel to prevent unauthorized use of the valves. The location of the valve pit is known to the owners.

D. Reservoir Area

The reservoir area is mostly banks formed from silt with some brush growth. The drainage area is wooded outside of the actual reservoir.

E. Downstream Channel

The downstream channel is the natural stream (Bernhard Creek) with several houses close to the stream and close to the embankment fill. About 2,000 feet downstream from the dam, the stream runs through the town of Rexmont with several homes located close to the stream. If the dam would fail due to overtopping, it is expected that the hazard to loss of life would increase. The hazard category for this dam is considered to be "High".

3.2 EVALUATION

The general appearance of the dam is good. The available storage in the reservoir is considerable for the size of the drainage area (less than .2 square miles). Based on the visual inspection it appears very unlikely that the reservoir would ever fill. Evaporation and normal leakage will probably control the pool level. The length of the embankment, the width of the crest and type of rock on the downstream slope all indicate that a relatively large outflow could be handled over the embankment without a chance of failure. Calculations to confirm any of these assumptions have not been made.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURE

Bethlehem Steel Corporation closed the mining facilities near Cornwall in 1977 and no active use is being made of this reservoir. At present, there are no operational procedures for this facility.

4.2 MAINTENANCE OF DAM

Maintenance is not being performed at the dam. The downstream slope has a rock surface without any growth at the present time. The crest of the dam is either bare stone and gravel or overgrown with low weeds.

4.3 MAINTENANCE OF OPERATING FACILITIES

The only operating facilities are the two decant towers and the 20-inch decant line with valve control near the downstream toe. The control valve has been buried and maintenance has not been performed since 1977.

4.4 WARNING SYSTEM

Although the property is guarded and surrounded by a fence, no formal surveillance or downstream warning system exists. It appears that visits to the embankment only occur very occasionally.

4.5 EVALUATION

Formal maintenance procedures do not exist and are not required at the present time. Brush and tree growth should be prevented on the downstream slope, the crest and the upstream slope near the crest. It is recommended that a formal surveillance and downstream warning system be developed for implementation during periods of high or prolonged precipitation.

SECTION 5 - HYDROLOGY/HYDRAULICS

5.1 EVALUATION OF FEATURES

A. Design Data

The hydrologic and hydraulic analyses available from the PennDER file for Cornwall Tailings Dam was not very extensive. No frequency curve, unit hydrograph or flood routing was available. There was a stage vs. total volume curve for the reservoir.

B. Experience Data

Because of the large storage volume of the reservoir and the small size of the drainage area there has never been a flood problem at this project. Since the mine ceased operation in 1977, the combined effects of the 0.3 cfs of embankment drainage and of the evaporation from the pool have kept the pool contents at a small percentage of the available storage.

C. Visual Observations

On the date of the inspection, no conditions were observed that would indicate that the project could not operate satisfactorily during a flood event.

D. Overtopping Potential

The calculations in Appendix C indicate that there is a minimum possibility of overtopping. The inflow of one full PMF (Probable Maximum Flood) would raise the existing pool elevation of 890 to about elevation 899, leaving a freeboard of 9 feet. The storage requirements for one PMF is 251 acre-feet, the present storage capacity is estimated at 667 acre-feet or sufficient to store the PMF. Calculations indicate that evaporation and leakage on an annual basis equals the yearly inflow. It is, therefore, considered that overtopping potential does not exist.

E. Spillway Adequacy

There is no spillway. The reservoir is considered to be adequate in storage capacity. Annual evaporation and leakage is estimated to be equal to the annual inflow.

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

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

A. Visual Observation

1. Embankment

A report prepared by E. D'Appolonia Associates, dated October, 1960 describes the preliminary design considerations for the construction of the embankment. The recommended ratio for the design of the downstream slope was 1.75H to 1V and for the upstream slope 2H to 1V. It was noted that the slope ratios on the downstream slope will stand on slopes of 1.5H to 1V and that the actual slopes will depend on the stability of the rock materials in the slope.

The slope measurements made during this inspection are shown on Plate A-II in Appendix A. This section shows the slope above the uppermost bench to the top of the dam to be 1.7H to 1V, (H = 82'±); the slope to the next lower bench is 1.1H to 1V, (H = 35'±); the next lower slope is 1.4H to 1V, (H = 72'±); and the remainder of the slopes between two narrow benches is 1.5H to 1V (combined H = 15'±). An overall slope line from the top to the downstream toe of the embankment indicates a ratio of 1.95H to 1V.

The elevation of the uppermost bench varies, because this wide bench was used as an access road to the top of the dam from an elevation of about 795.

The visual inspection of the downstream slope did not reveal any evidence of instability. The rock slope surfaces appear to have stabilized with varying slope angles between the 1:1H to 1V and 1:7H to 1V range dependent upon the size of the rock and the amounts of fine stone in a particular area. When considering the dimensions of the entire downstream portion of the embankment, 395±H to 203±V, the benches do not appear to be significant in the evaluation of the slope stability. The overall top to toe slope is flatter than the recommended 1.75H to 1V. This fact, together with the observed conditions indicates that the embankment slopes are stable.

The upstream slope is flatter than 2H to 1V and is also considered to be stable. The crest of the dam has a width of 98 feet rather than the design width of 30 feet.

2. Appurtenant Structures

The only visible part of these structures were two decant towers in the upstream area of the reservoir and the 12-inch outlet of

the drain pipe. All structures appeared to be in good condition. A boat would be required to inspect the tower located in the reservoir. The owner's representative stated that a standpipe was located in this tower on the decant line. The inflow elevation is unknown.

B. Design and Construction Data

1. Embankment

The available engineering data includes a report prepared by E. D'Appolonia Associates. This report describes the details of investigations and engineering calculations that were made regarding seepage and stability of the embankment.

The project was constructed in stages as the waste materials from the mining (iron ore) became available. There are no records of construction of this dam.

The available engineering data indicates that the design was prepared according to accepted engineering data. The stability against sliding, according to the calculations, are well above minimum requirements for safety. The only exception made is that sliding was considered on a horizontal plane, with a maximum dam height of 158 feet (elevation 752 to 910). However, the actual toe of the dam is at elevation 708± and the valley dips nearly 44 feet in 800 feet and no consideration of sliding of the decomposed diabase in a saturated condition was made. The sloping plain will reduce the factor of safety against sliding slightly but is still considered adequate.

2. Appurtenant Structures

There is no spillway and it appears that the decant pipe and towers were designed and detailed in accordance with acceptable engineering standards.

C. Operating Records

Record of operation have not been maintained. Representatives of the owner did not recollect any problems affecting the safety or stability of the structures.

D. Post Construction Changes

The present embankment has been constructed in stages over a period of 15 years. No changes have been made since the dam was completed in 1977.

E. Seismic Stability

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

SECTION 7 - ASSESSMENT AND RECOMMENDATIONS

7.1 DAM ASSESSMENT

A. Safety

The visual inspection and the review of available design data indicates that Cornwall Tailings Dam is in good condition and has been designed in accordance with acceptable engineering practice.

Although this dam does not have a spillway, the present storage capacity of the reservoir can handle the PMF without overtopping. The yearly inflow of the small drainage area nearly balances with the expected evaporation and seepage losses and no increase in pool level is expected. The type of embankment with its rock slopes could also withstand some overtopping without endangering the stability. For these reasons, the facilities are considered to be satisfactory.

B. Adequacy of Information

The information available for review is considered to be adequate to make a reasonable assessment of these facilities.

C. Urgency

It is considered that the recommendations in this section should be implemented as soon as practical.

D. Necessity for Additional Studies

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

7.2 RECOMMENDATIONS

A. Facilities

There are no special recommendations for the overall facilities. Recommendations are related to operation and maintenance procedures.

B. Operation and Maintenance Procedures

The following operations are presented for implementation by the owner:

1. That a staff gauge be installed on the decant tower located in the pool and that at least monthly readings be taken to establish records of changes in the pool level.
2. That the 6-inch blowoff valve on the decant pipe be located and made operable for use in the event of an emergency.
3. That a formal surveillance and downstream warning system be developed for implementation during periods of heavy or prolonged precipitation.

APPENDIX A

CHECKLIST OF VISUAL INSPECTION REPORT

APPENDIX A

CHECK LIST

PHASE I - VISUAL INSPECTION REPORT

PA DER # <u>38-87</u>	NDI NO. <u>PA-00597</u>
NAME OF DAM <u>Cornwall Tailings Dam</u>	HAZARD CATEGORY <u>High</u>
TYPE OF DAM <u>Rockfill with impervious toe section & upstream blanket.</u>	
LOCATION <u>Borough of Cornwall</u> TOWNSHIP <u>Lebanon</u> COUNTY, PENNSYLVANIA	
INSPECTION DATE <u>5/11/78</u>	WEATHER <u>Sunny - Warm</u> TEMPERATURE <u>70's</u>
INSPECTORS: <u>R. Houseal (Recorder)</u>	OWNER'S REPRESENTATIVE(s):
<u>R. Steacy</u>	<u>Charles Neil</u>
<u>A. Bartlett</u>	<u>Ned Kiscadden</u>
<u>H. Jongsma</u>	
NORMAL POOL ELEVATION: <u>N/A</u>	AT TIME OF INSPECTION:
BREAST ELEVATION: <u>908.0 (Estimated)</u>	POOL ELEVATION: <u>889.7</u>
SPILLWAY ELEVATION: <u>N/A</u>	TAILWATER ELEVATION: <u>703</u>
MAXIMUM RECORDED POOL ELEVATION: <u>Unknown</u>	
GENERAL COMMENTS:	
This is not a conventional dam with spillway, outlet, etc. The reservoir was used for storage of silt which was a waste product of iron ore mining.	

VISUAL INSPECTION
EMBANKMENT

	OBSERVATIONS AND REMARKS
A. SURFACE CRACKS	None.
B. UNUSUAL MOVEMENT BEYOND TOE	None.
C. SLOUGHING OR EROSION OF EMBANKMENT OR ABUTMENT SLOPES	None.
D. ALIGNMENT OF CREST: HORIZONTAL: VERTICAL:	Curved and several sharp angles. Not surveyed.
E. RIPRAP FAILURES	None.
F. JUNCTION EMBANKMENT & ABUTMENT OR SPILLWAY	Good.
G. SEEPAGE	Designed for seepage by underdrain to supply minimum flow. About 2 gallon per second from pipe. No seepage from embankment.
H. DRAINS	Lateral and a traverse drain. Two 6-inch pipes about 12 feet above toe. Refer to Appendix F for plans.
J. GAGES & RECORDER	None.
K. COVER (GROWTH)	Waste rock on downstream slope. Upstream slope - silt covered - very flat slope. Several bushes on 100-foot wide crest. Top - grassed area with some fine stones.

VISUAL INSPECTION
OUTLET WORKS

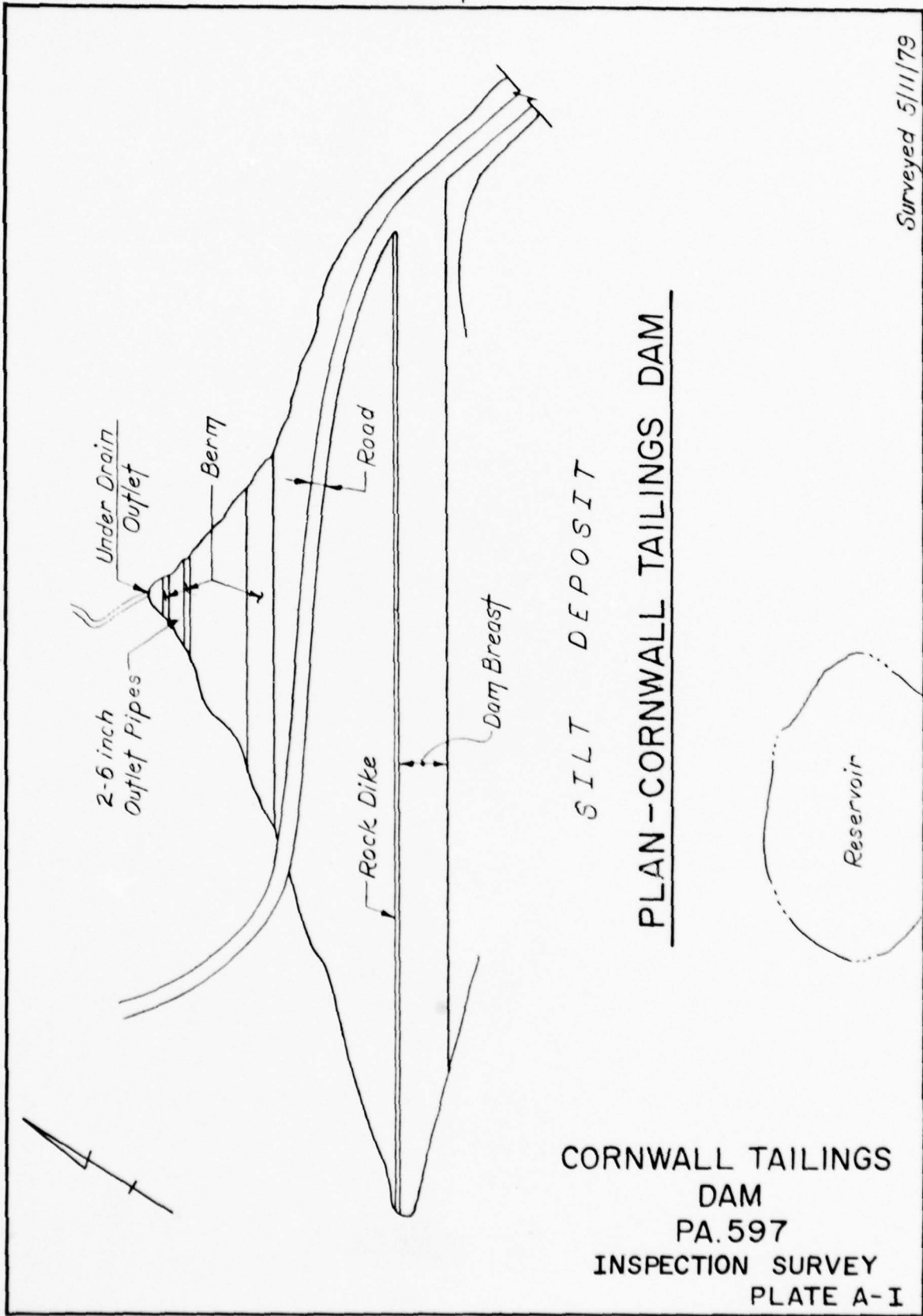
	OBSERVATIONS AND REMARKS
A. INTAKE STRUCTURE	Two decanter towers tied to 20-inch pipe. Probably only one open.
B. OUTLET STRUCTURE	As near as could be determined in conversation with owner's employees, this structure was vandalized and burned some time ago and was subsequently buried under sand and rock.
C. OUTLET CHANNEL	Natural stream.
D. GATES	None.
E. EMERGENCY GATE	None.
F. OPERATION & CONTROL	None.
G. BRIDGE (ACCESS)	None.

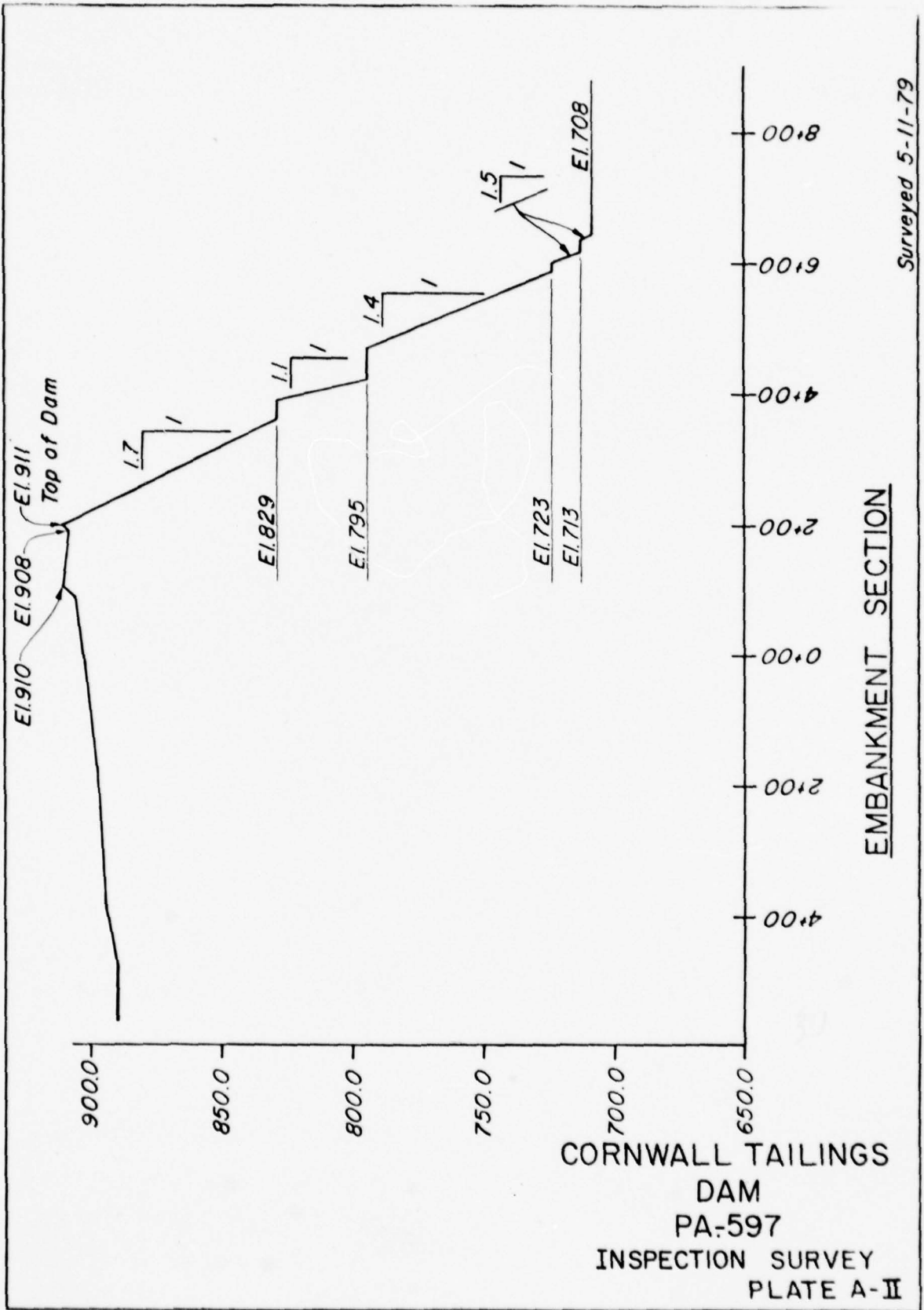
VISUAL INSPECTION
SPILLWAY

	OBSERVATIONS AND REMARKS
A. APPROACH CHANNEL	None - discharge comes directly from reservoir. Design considered seepage and evaporation as control.
B. WEIR: Crest Condition Cracks Deterioration Foundation Abutments	None.
C. DISCHARGE CHANNEL: Lining Cracks Stilling Basin	None.
D. BRIDGE & PIERS	None.
E. GATES & OPERATION EQUIPMENT	None.
F. CONTROL & HISTORY	None.

VISUAL INSPECTION

	OBSERVATIONS AND REMARKS
<u>INSTRUMENTATION</u>	
Monumentation	None.
Observation Wells	None.
Weirs	None.
Piezometers	None.
Staff Gauge	None.
Other	None.
<u>RESERVOIR</u>	
Slopes	Silt and exposed ground - some trees.
Sedimentation	Silt accumulation (this is the purpose of reservoir)
Watershed Description	Woodland and the reservoir itself.
<u>DOWNSTREAM CHANNEL</u>	
Condition	Small village (Rexmont) downstream.
Slopes	Wooded over 500 feet, then houses.
Approximate Population	100
No. Homes	25





APPENDIX B
CHECKLIST OF ENGINEERING DATA

APPENDIX B

CHECK LIST
ENGINEERING DATA

PA DER # 38-87

NDI NO. PA-00 597

NAME OF DAM Cornwall Tailings Dam

ITEM	REMARKS
AS-BUILT DRAWINGS	None.
REGIONAL VICINITY MAP	U.S.G.S. Quadrangle, Lebanon, PA See Plate II, Appendix F
CONSTRUCTION HISTORY	Construction of first phase started in 1961 and completed that year. Contractor - Reisinger Bros., Inc., Carlisle, PA. Embankment raised from original elevation 805 to present elevation 908±.
GENERAL PLAN OF DAM	See Appendix F, Plate III.
TYPICAL SECTIONS OF DAM	See Appendix F, Plate IV.
OUTLETS: PLAN DETAILS CONSTRAINTS DISCHARGE RATINGS	None active at present. This tailings dam had a 20-inch decanter line, which is closed off by a valve near the downstream toe.

ENGINEERING DATA

ITEM	REMARKS
RAINFALL & RESERVOIR RECORDS	None.
DESIGN REPORTS	"Design Consideration" by E. D'Appolinia, Pittsburgh, PA., in PennDER file.
GEOLOGY REPORTS	See report by E. D'Appolinia.
DESIGN COMPUTATIONS: HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	None. See report by E. D'Appolinia. See report by E. D'Appolinia.
MATERIALS INVESTIGATIONS: BORING RECORDS LABORATORY FIELD	See Appendix F, Plate VII. See report by E. D'Appolinia. Additional borings in PennDER files.
POST CONSTRUCTION SURVEYS OF DAM	None available.
BORROW SOURCES	Upstream toe formed from material out of reservoir. Main dam formed by trap rock from mine.

ENGINEERING DATA

ITEM	REMARKS
MONITORING SYSTEMS	None.
MODIFICATIONS	None, except downstream slope was placed on natural slope.
HIGH POOL RECORDS	None.
POST CONSTRUCTION ENGINEERING STUDIES & REPORTS	None.
PRIOR ACCIDENTS OR FAILURE OF DAM Description: Reports:	None.
MAINTENANCE & OPERATION RECORDS	None.
SPILLWAY PLAN, SECTIONS AND DETAILS	No spillway.

ENGINEERING DATA

ITEM	REMARKS
OPERATING EQUIPMENT, PLANS & DETAILS	See Appendix F, Plates III, V and VI. Valve house is presently buried.
CONSTRUCTION RECORDS	Monthly progress records for first phase to elevation 805.
PREVIOUS INSPECTION REPORTS & DEFICIENCIES	None.
MISCELLANEOUS	

CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: Small area above reservoir. All wooded.

ELEVATION:

TOP NORMAL POOL & STORAGE CAPACITY: Elev. 890 62 Acre-Feet

TOP FLOOD CONTROL POOL & STORAGE CAPACITY: Elev. 908 667 Acre-Feet

MAXIMUM DESIGN POOL: _____ Elev. None

TOP DAM: _____ Elev. 908±

SPILLWAY:

No Spillway

a. Elevation _____

b. Type _____

c. Width _____

d. Length _____

e. Location Spillover _____

f. Number and Type of Gates _____

OUTLET WORKS:

a. Type 20-inch decanter line.

b. Location Left abutment.

c. Entrance inverts 890±.

d. Exit inverts None.

e. Emergency drawdown facilities 6-inch valve on 20-inch line.
Buried at present.

HYDROMETEOROLOGICAL GAGES:

a. Type None.

b. Location _____

c. Records _____

MAXIMUM NON-DAMAGING DISCHARGE: Unknown.

APPENDIX C

HYDROLOGY AND HYDRAULIC CALCULATIONS

APPENDIX C

SUMMARY DESCRIPTION
OF
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION

The hydrologic and hydraulic evaluation for this inspection report has employed computer techniques using the Corps of Engineers computer program identified as the Flood Hydrograph Package (HEC-1) Dam Safety Version.

The program has been designed to enable the user to perform two basic types of hydrologic analyses: (1) the evaluation of the overtopping potential of the dam, and (2) the capability to estimate the downstream hydrologic-hydraulic consequences resulting from assumed structural failures of the dam. A brief summary of the computation procedures typically used in the dam overtopping analysis is shown below.

- Development of an inflow hydrograph to the reservoir.
- Routing of the inflow hydrograph(s) through the reservoir to determine if the event(s) analyzed would overtop the dam.
- Routing of the outflow hydrograph(s) of the reservoir to desired downstream locations. The results provide the peak discharge, time of the peak discharge and maximum stage of each routed hydrograph at the outlet of the reach.

The output data provided by this program permits the comparison of downstream conditions just prior to a breach failure with that after a breach failure and the determination as to whether or not there is a significant increase in the hazard to loss of life as a result of such a failure.

The results of the studies conducted for this report are presented in Section 5.

For detailed information regarding this program refer to the Users Manual for the Flood Hydrograph Package (HEC-1) Dam Safety Version prepared by the Hydrologic Engineering Center, U. S. Army Corps of Engineers, Davis, California.

Maximum Known Flood

At USGS Gaging Station Back creek near
 Cloona, Max Flood 1963-1976 was 5,150 cfs,
 June '22, 1972, Drainage Area = 7.87 sq. mi.

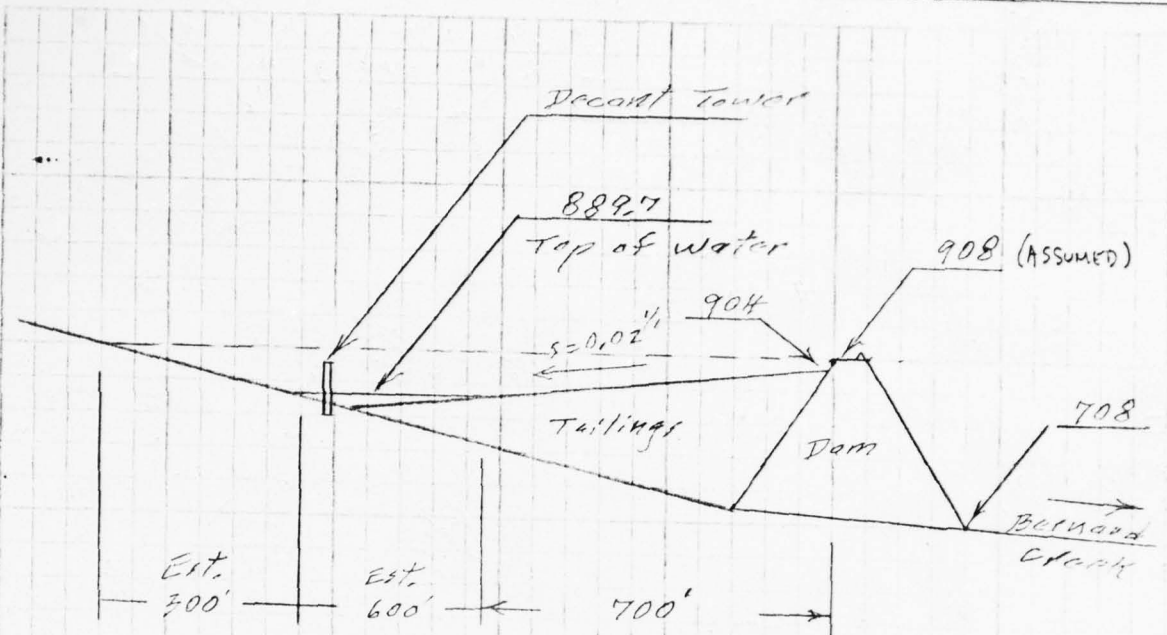
Estimate maximum inflow to Tailings Dam
 Reservoir

$$\left(\frac{0.16}{7.87}\right)^{0.8} \times 5150 = 230 \text{ cfs } 6-22-72.$$

Estimated surface area of water in
 reservoir.

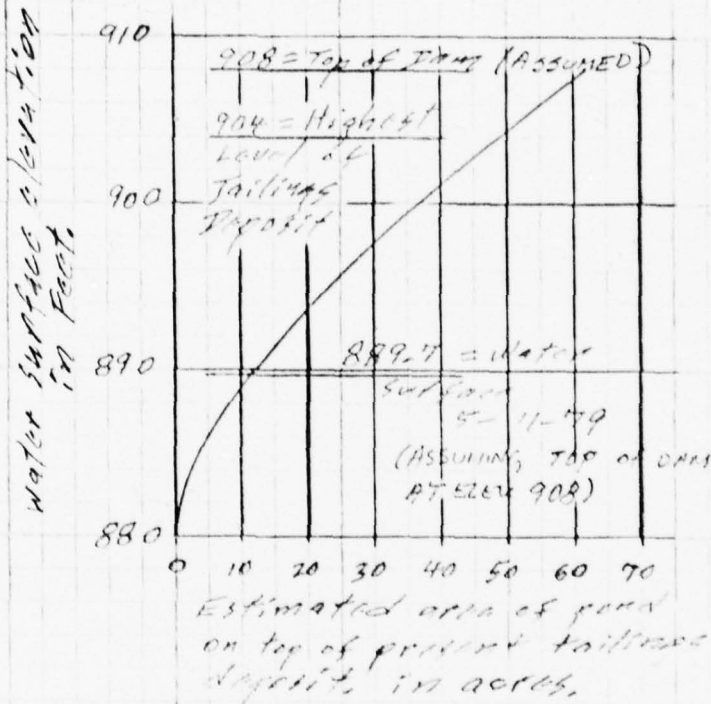
Over the years, a mixture of tailings
 and water has been introduced to
 the reservoir from various openings
 in a pipe stretched along the
 top of the dam. The tailings
 dropped out of the mixture
 and formed an incline with
 the highest elevation near the
 dam and the lowest at the
 upstream side of the reservoir.
 Water was removed through decant
 towers at the upstream side of
 the reservoir and returned to the
 plant to pick up more tailings.
 The system had been out of
 operation since 1977. At the
 present time there is a pond at
 the upstream side of the
 reservoir which is estimated
 to cover 20 percent of the
 total reservoir area or $0.2 \times 62 =$
 12 acres. The remaining 50 acres
 is occupied by the inclined fill
 of tailings whose top surface is
 above the level of water surface.
 In levels at 5-11-79, it was
 determined that the present
 pond is at elev. 882.7 (if the top
 of dam is at elev. 908). The top
 of the tailings deposit next to
 the dam is at elev. 904.
 It is estimated that the average year
 has a maximum depth of 10 feet.

PROJECT Dam Rehabilitation SHEET NO. 1 OF 1
 SUBJECT Cornwall Tailings Dam ID No. PA-577
 COMPUTED BY RES DATE JUNE 4, 1979 CHECKED BY JJPR



No scale

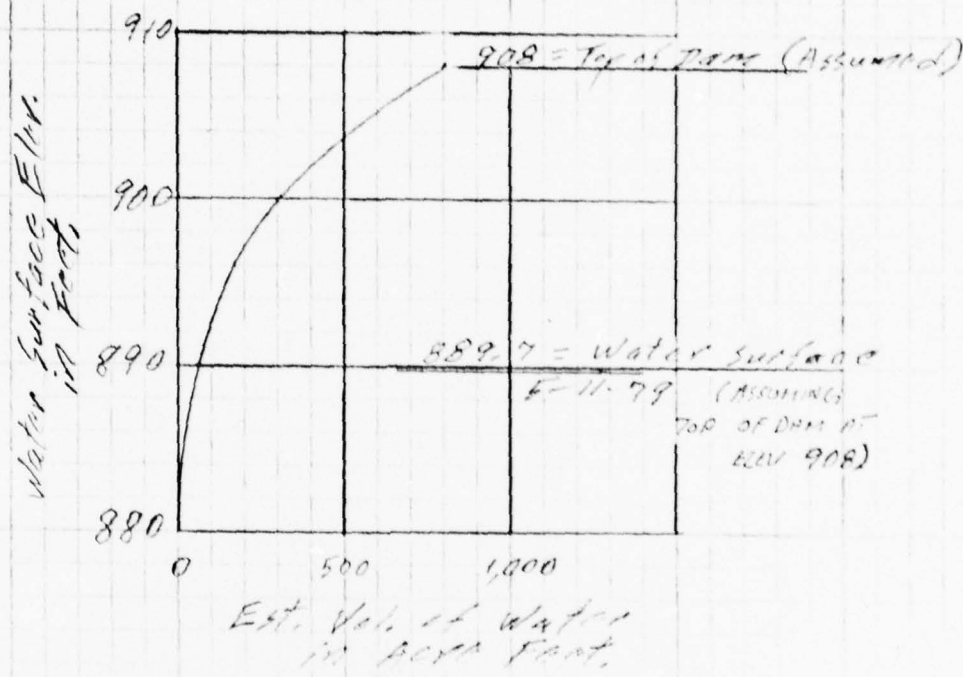
Estimated surface area of water in Reservoir (cont.)



Estimated volume of water in pond at top of tailings deposit

Elev	Area Acres	Av. Area A-VAR ₂	Height ft	Vol Ac Ft	Tot Vol Ac Ft
880	0	0	10	40	0
890	17	21	10	234	40
900	37	48	8	393	274
908	62				667

Estimated Volume of Water in Pond on Top of Tailings Deposit (Cont.)



Evaporation from Lake Surface
 U.S. Weather Bureau Technical Paper No. 37
 "Evaporation Maps for the United States"
 Plate 7 "Average Annual Lake Evaporation in Inches" gives 34 inches for this location.

Use 34 inches annually
 $34 \div 12 = 2.83 \text{ ft annually}$

Seepage from Reservoir
 This dam was built about 1961. Information on the files of the owner indicates that measured seepage was 320 gallons per width of 0.71 cfs in 1964.
 On May 11, 1979, the seepage flowing from the toe of the dam was measured and found to be 0.3 cfs = 217' over the 100' dam, the 100' length.

Estimate of Future changes in water surface Elevation

The mining operation has been shut down since 1977, and, at the present time, the owners do not expect to add any water to the pond, nor does he expect to drain any water from the pond. The owners' representative reports that the pond has been gradually losing water.

This statement is checked in the calculations below by assuming that the change in pond water elevation is equal to the precipitation in that minus the evaporation and minus the seepage. Instead of calculated from runoff figures for the USGS gauging station Bear Creek near Clifton.

Clifton Gauge

Year	Runoff in inches	Year	Runoff in inches
1964	9.64	1971	13.59
65	4.84	72	27.72
66	4.33	73	19.21
67	9.14	74	15.08
68	12.79	75	17.81
69	9.31	76	19.31
70	14.93	77	16.24
		14)	193.94
			13.9

Reservoir 62 acres.
 Entire basin = 16 sq mi = 102 acres
 Wooded area = 102 - 62 = 40 acres (100% Av.)
 Use 40 inches runoff for reservoir (exists)
 $(\text{Rainfall} \times \text{Res. Area}) + (\text{Av Runoff} \times \text{Wooded Area}) \div \text{Tot. Area} = \text{weighted runoff}$
 $(4.0 \times 62) + (13.9 \times 40) = 30 \text{ inches weighted runoff}$
 102
 Inches \times 53.33 \times Sq. Mi. = Tot. Ft. of runoff
 $30 \times 53.33 \times 0.16 = 256 \text{ Ac Ft weighted runoff}$

* Runoff from wooded area based on timber at Silva base

Water Year	Inflow Cu. Ft.	Area Acres	Evap. Fe. Ft.	Seepage Alc. Ft.	Yr. End Ac. Ft.	Yr. End Elev.
1978	256	12	34	217	60	889.7
1979	256	12	34	217	65	890.0
1980	256	13	37	217	70	890.8
1981	256	14	40	217	72	891.2
1982	256	14	40	217	71	891.1
1983	256	14	40	217	70	890.8

Evaporation = 2.83 x area in acres.

The above calculations use precipitation and runoff figures for an average year. They show that the pond elevation may be expected to rise a foot or two in a wet year and to fall a foot or two in a dry year. The rise or fall of the pool tends to be self-limiting since a large pool would increase the loss due to evaporation.

At the present time the reservoir has sufficient capacity to hold the runoff from about three average years without any allowance for seepage and evaporation.

This storage capacity can also be expressed as 26 inches of runoff or over three times the 26 inches of runoff some times used as the size of a probable maximum flood.

Outlet Works (Inoperative)

A 20-inch welded steel decant pipe runs about 1400 feet from a concrete decant structure in the reservoir to a buried valve 300 feet downstream from the centerline of the dam. At present, there is no flow in this pipe. If a 20-inch tap and valve could be installed* at this location water from the reservoir could be discharged into a ditch leading to Bernard Creek. *(FEASIBILITY OF INSTALLATION WOULD REQUIRE DETAILED STUDIES)

calculate maximum discharges

$$H = \sqrt{\frac{2.5204(1+K_c) + \frac{466.187^2 L}{D^{4.33}}}{D^5}} \left(\frac{Q}{10}\right)^2$$

From levels of 5-11-79 pool level was 889.7
 From design drawing, end of 20-inch pipe is at elev. 790.

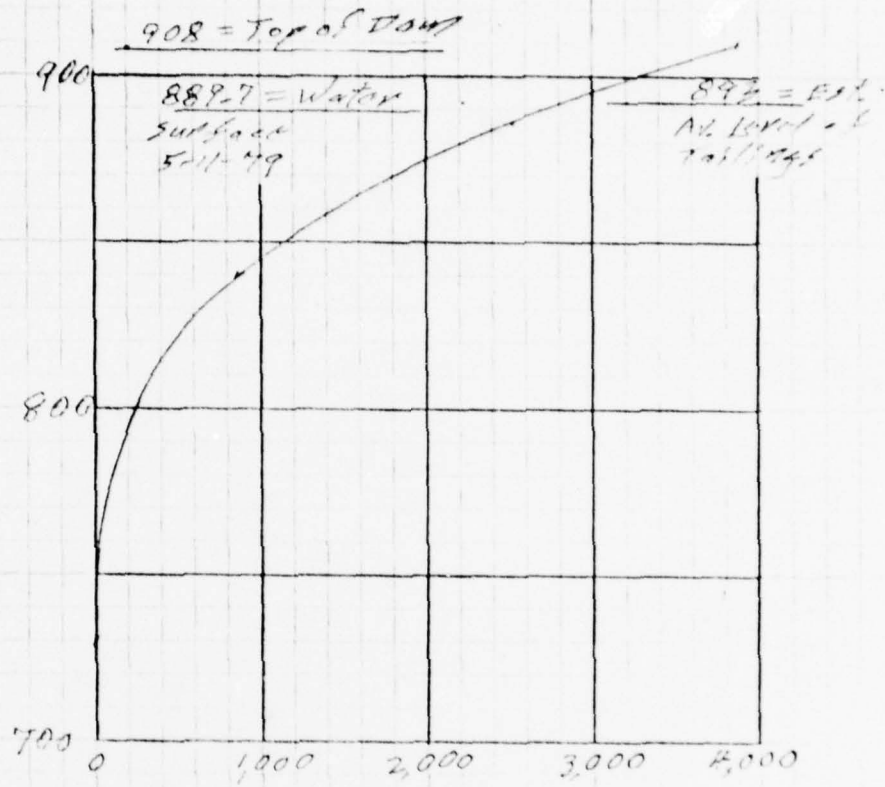
$H = 889.7 - 790 = 99.7 \text{ ft.}$
 $K_c = 0.5$
 $D = \frac{20}{12} = 1.67 \text{ ft.}$
 $n = 0.017$
 $L = 1400 \text{ ft.}$

$$\begin{aligned}
 99.7 &= \sqrt{\frac{2.5204 \times (1.5) + \frac{466.18 \times (0.017)^2 \times 1400}{(1.67)^{4.33}}}{(1.67)^5}} \left(\frac{Q}{10}\right)^2 \\
 &= \sqrt{0.486 + 12.26} \left(\frac{Q}{10}\right)^2
 \end{aligned}$$

$$\left(\frac{Q}{10}\right)^2 = \frac{99.7}{17.75} = 5.62$$

$$\frac{Q}{10} = 2.37 \quad Q = 23.7 \text{ cfs}$$

PROJECT DAM INVESTIGATION SHEET NO. 0 OF 1
 SUBJECT Cornwall Tailings Dam, I.D. No. 511
 COMPUTED BY KES DATE May 30, 1979 CHECKED BY JPS



Total Volume in Basin Feet
Including Tailings

BASIN STORAGE CURVE
FROM STATE FILES

BY RLS DATE 6/8/79
CHKD. BY _____ DATE _____
SUBJECT _____

BERGER ASSOCIATES

SHEET NO. 9 OF
PROJECT D 8490

CORNWALL TAILINGS DAM

SIZE CLASSIFICATION

MAXIMUM STORAGE = 667 ACRE-FEET

MAXIMUM HEIGHT = 200 FEET

SIZE CLASSIFICATION IS "LARGE"

HAZARD CLASSIFICATION

VILLAGE OF REXMONT LIES DOWNSTREAM
OF THIS DAM.

USE "HIGH"

RECOMMENDED SPILLWAY DESIGN FLOOD

THE ABOVE CLASSIFICATIONS INDICATE USE
OF AN SDF EQUAL TO THE PROBABLE
MAXIMUM FLOOD.

BY RLS DATE 6/8/79
 CHKD. BY DATE
 SUBJECT

BERGER ASSOCIATES

SHEET NO. 10 OF
 PROJECT 2899

CORNWALL TAILINGS DAM

HEC -1 DATA

DRAINAGE AREA = 0.16 SQ. MI.

SUSQUEHANNA BASIN REGION 15B

$$C_p = 0.85$$

$$C_T = 2.20$$

$$L' \text{ END OF RESERVOIR TO BASIN DIVIDE} = 0.23 \text{ MI.}$$

$$T_p = C_T (L')^{.6}$$

$$T_p = 0.9$$

RAINFALL (HMR-33)

$$\text{INDEX (200 SQ. MI. - 24 HR.)} = 23.2''$$

ZONE 6

INCREMENTAL RAINFALL

$$6 \text{ HR} = 113\%$$

$$12 \text{ HR} = 123\%$$

$$24 \text{ HR} = 132\%$$

$$48 \text{ HR} = 143\%$$

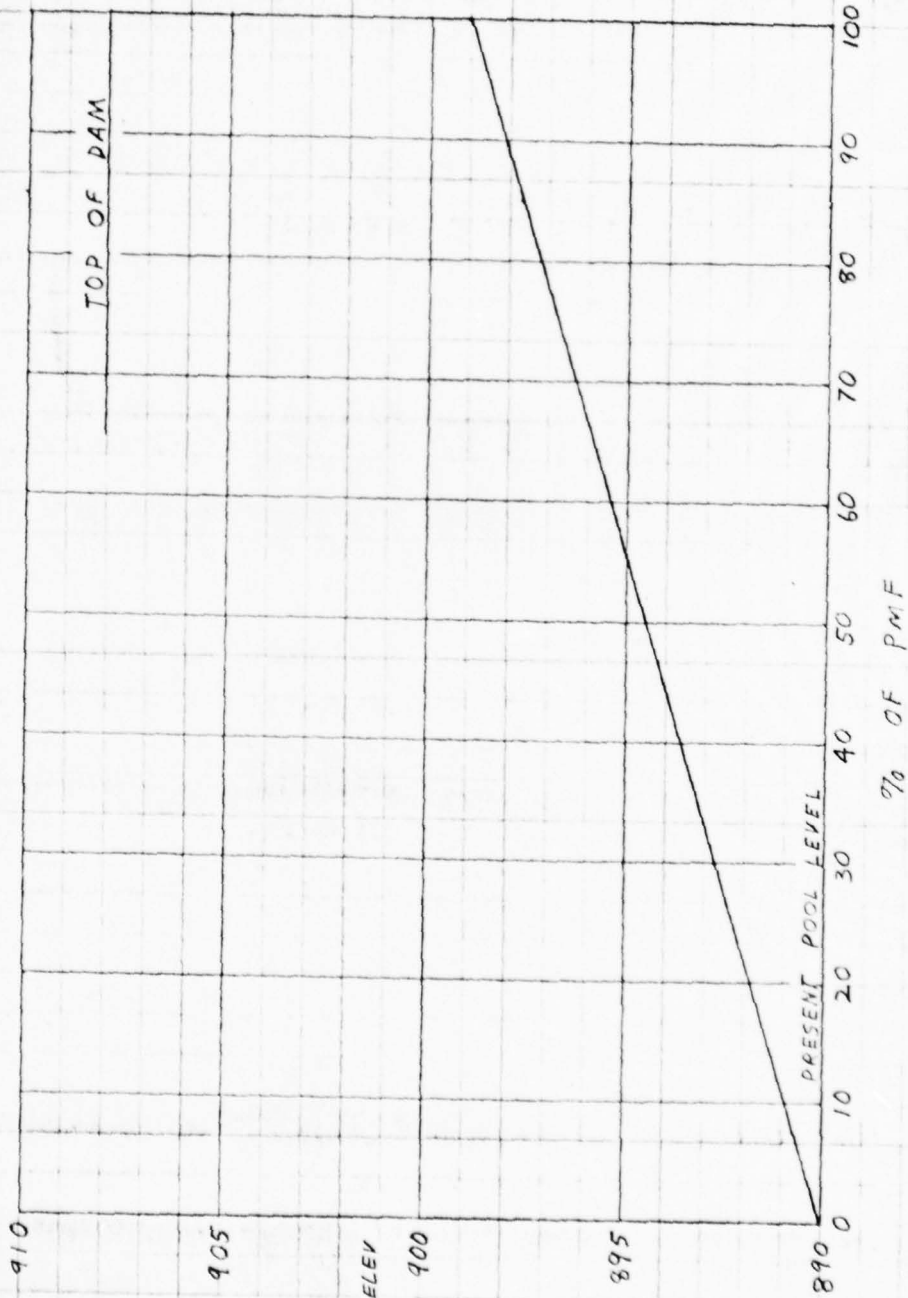
BY RLS DATE 4/8/79
CHKD. BY _____ DATE _____
SUBJECT _____

BERGER ASSOCIATES

SHEET NO. 11 OF
PROJECT 28490

CORNWALL TAILINGS DAM

CAPACITY CURVE



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

1	A1	CORNWALL TAILINGS DAM **** BERNHARD CREEK									
2	A2	BOROUGH OF CORNWALL, LEBANON COUNTY, PA.									
3	A3	NDI # PA-00597 PA DER # 38-87									
4	B	300	0	15	0	0	0	0	0	-4	0
5	B1	5									
6	J	1	9	1							
7	J1	1	.85	.7	.6	.5	.4	.3	.2	.1	
8	K		1					1			
9	K1	INFLOW HYDROGRAPH									
10	M	1	1	.16							1
11	P		23.2	113	123	132	143				
12	T							.1	.05		
13	W	.9	.85								
14	X	-1.5	-.05	2							
15	X	1	2							1	
16	K1	RESERVOIR ROUTING									
17	Y			1	0						
18	Y1	1						40	-1		
19	Y4	908	908.1	908.2	908.3	908.4	908.5	908.6	908.8	909	
20	Y5	0	324	918	1686	2596	3627	4768	7341	10260	
21	Y5	0	40	274	667	730					
22	ZE	800	890	900	908	909					
23	ZE	908									
24	ZE	908									
25	K	99									

1

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: 79/06/07.
 TIME: 07.18.28.

CORNWALL TAILINGS DAM **** BERNHARD CREEK
 BOROUGH OF CORNWALL, LEBANON COUNTY, PA.
 NDI # PA-00597 PA DER # 38-87

JOB SPECIFICATION

NO	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IFRT	NSTAN
300	0	15	0	0	0	0	0	-4	0
			JOPER	NWT	LROPT	TRACE			
			5	0	0	0			

MULTI-PLAN ANALYSES TO BE PERFORMED

NPLAN= 1 NRTIO= 9 LRTIO= 1
 RTIOS= 1.00 .85 .70 .60 .50 .40 .30 .20 .10

CORNWALL TAILINGS DAM **** BERNHARD CREEK
 BOROUGH OF CORNWALL, LEBANON COUNTY, PA.
 NDI # PA-00597 PA DEF # 38-87

JOB SPECIFICATION

NO	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAV
300	0	15	0	0	0	0	0	-4	0
			JOFER	NWT	LROPT	TRACE			
			5	0	0	0			

MULTI-PLAN ANALYSES TO BE PERFORMED

NPLAN= 1 NRTIO= 9 LRTIO= 1
 RTIOS= 1.00 .85 .70 .60 .50 .40 .30 .20 .10

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH

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

HYDROGRAPH DATA

IHYDG	IUNG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	.16	0.00	.16	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	23.20	113.00	123.00	132.00	143.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRNS	RTIOK	STRIL	DNSTL	ALSHX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA

TP= .90 CP= .85 NTA= 0

RECESSION DATA

STRD= -1.50 DRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 9 END-OF-PERIOD ORDINATES, LAG= .90 HOURS, CP= .84 VOL= 1.00
 15. 48. 80. 95. 85. 54. 23. 9. 3.

END-OF-PERIOD FLOW

MO,DA	HR,MIN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO,DA	HR,MIN	PERIOD	RAIN	EXCS	LOSS	COMP Q
-------	--------	--------	------	------	------	--------	-------	--------	--------	------	------	------	--------

SUM 26.54 24.13 2.41 10216.
 (674.)(613.)(61.)(289.28)

HYDROGRAPH ROUTING

HYDROGRAPH ROUTING

RESERVOIR ROUTING

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

ROUTING DATA

GLOSS 0.0 CLOSS 0.000 AVG 0.00 IRES 1 ISAME 0 IOPT 0 IPMP 0 LSTR 0

NSTPS 1 NSTDL 0 LAG 0 AMSKK 0.000 X 0.000 TSK 0.000 STORA 40. ISPRAT -1

STAGE	908.00	908.10	908.20	908.30	908.40	908.50	908.60	908.80	909.00
FLOW	0.00	324.00	918.00	1686.00	2596.00	3627.00	4768.00	7341.00	10260.00
CAPACITY=	0.	740.	274.	667.	730.				
ELEVATION=	880.	890.	900.	908.	909.				

CREL 908.0 SFWID 0.0 COOW 0.0 EXPW 0.0 ELEVEL 0.0 COOL 0.0 CAREA 0.0 EXPL 0.0

DAM DATA

TOPEL 908.0 COOD 0.0 EXPD 0.0 DAMWID 0.

PEAK OUTFLOW IS 0. AT TIME 0.00 HOURS

PEAK OUTFLOW IS 0. AT TIME 0.00 HOURS

PEAK OUTFLOW IS 0. AT TIME 0.00 HOURS

PEAK OUTFLOW IS 0. AT TIME 0.00 HOURS

PEAK OUTFLOW IS 0. AT TIME 0.00 HOURS

PEAK OUTFLOW IS 0. AT TIME 0.00 HOURS

PEAK OUTFLOW IS 0. AT TIME 0.00 HOURS

PEAK OUTFLOW IS 0. AT TIME 0.00 HOURS

PEAK OUTFLOW IS 0. AT TIME 0.00 HOURS

APPENDIX D
GEOLOGIC REPORT

APPENDIX D

GEOLOGIC REPORT

Bedrock - Dam and Reservoir

Formation Names: Hammer Creek Formation and Diabase.

Lithology: Predominantly red to brown quartz sandstone with interbeds of quartz pebble conglomerate and some red shale. The sandstone beds are typically a few inches to a foot, or more, thick. Grain size ranges from very fine to coarse. Sand grains are angular to sub-rounded quartz, imbedded in a matrix of clay and hematite. The conglomerates consist of pebbles and cobbles of quartzite, vein quartz and sandstone in a matrix of coarse sandstone, clay and hematite. The shale beds are red, thin bedded, non-fissile, composed of clay, hematite and some calcite.

Diabase is an intrusive igneous rock composed essentially of pyroxene and feldspar. Quartz, ilmenite and magnetite are common accessory minerals. The fresh rock is gray to dark gray with massive crystalline texture. Weathered surfaces are dark gray with local brown iron staining. The interlocking crystals of pyroxene and feldspar make the rock very tough and strong.

Structure

At the dam site, beds of the Hammer Creek Formation which strike N55°E and dip 20° to 25°NW, have been intruded by a diabase dike. The geologic map of the Lebanon Quadrangle (see map) shows a major diabase sheet just north of the dam. This sheet dips to the south at about 30°, but the upper surface has many irregularities. Exploration drilling for the dam found diabase to be present under the lower slopes of the valley. This is probably a continuation of the small mass shown in the tailings pond area on the geologic map. The mass is apparently a dike offshoot of the main diabase sheet. The dike approximately parallels the valley, and is probably responsible for the mapped fracture trace. There are no faults mapped in the area, but faults are known nearby, thus offsetting both the Hammer Creek and diabase formation.

Overburden

The sides of the valley were covered with colluvium derived from the Hammer Creek Formation, mostly sand and conglomerate boulders with some weathered shale. This was from 0 to 10 feet thick. In the center of the valley this colluvium covered the decomposed and weathered diabase.

Aquifer Characteristics

Diabase is a very impermeable rock. Ground water movement is entirely along joints and other fractures. The Hammer Creek beds are also relatively impermeable, ground water moves almost entirely along bedding planes and fractures. Tests made in the drill holes indicated that the weathered diabase was more permeable than the decomposed diabase. This means that there is a relatively permeable zone sandwiched between the decomposed diabase (near surface) and the fresh diabase; (depths of 17 to 30 feet).

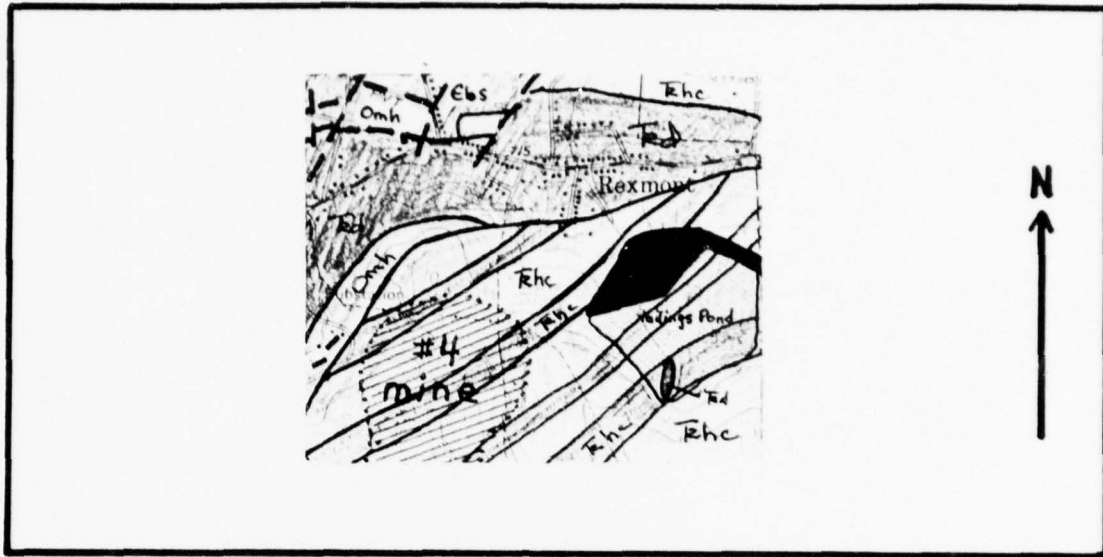
Discussion

This dam was not constructed to impound water, but to hold tailings. It therefore, has a drain rather than a cutoff trench. It can only be commented that the decomposed diabase has a high clay content, and that the underlying permeable zone could keep that clay wet and therefore, susceptible to slippage.

Sources of Information

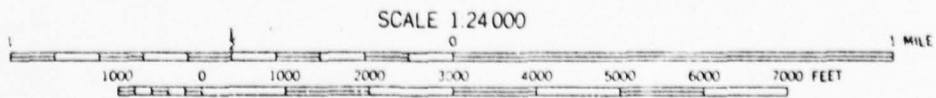
1. Lapham, D.M. and Gray, C. (1972). "Geology and Origin of the Triassic Magnetite Deposit at Cornwall, Pa.". Pa. Geological Survey, Bulletin M56.
2. Air Photographs, dated 1969. Scale 1:20,000.
3. Core boring data in file.

GEOLOGIC MAP - Tailings Dam



(geology from Pa. Geol. Surv. Report M-56)

- Rd diabase
- Rhc Hammer Creek Fm.- sandstone and shale
- Rhc Hammer Creek Fm.- conglomerate lenses
- Omh Mill Hill Slate
- Ebs Buffalo Springs Fm.
- fault
- · - · - air photo fracture trace



APPENDIX E
PHOTOGRAPHS

APPENDIX E



Top of Dam
Looking to
Left Abutment

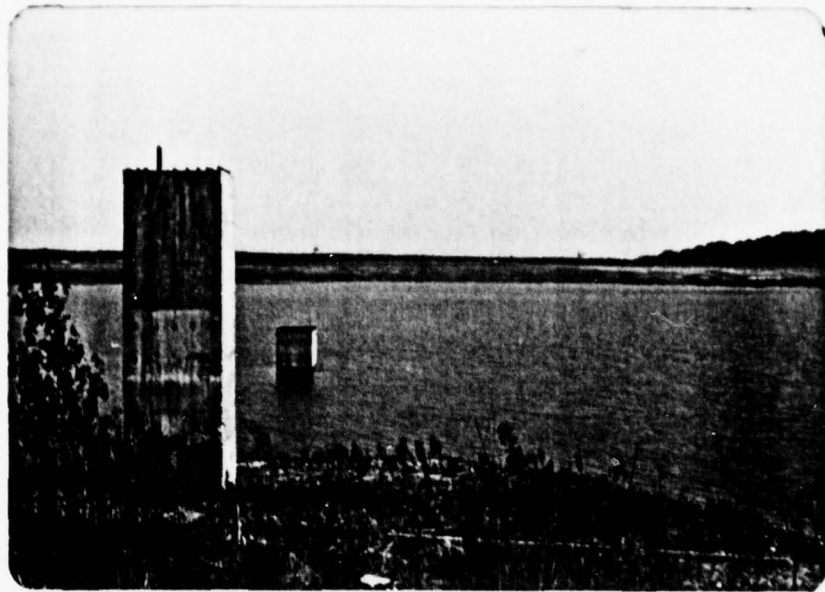


Downstream Slope

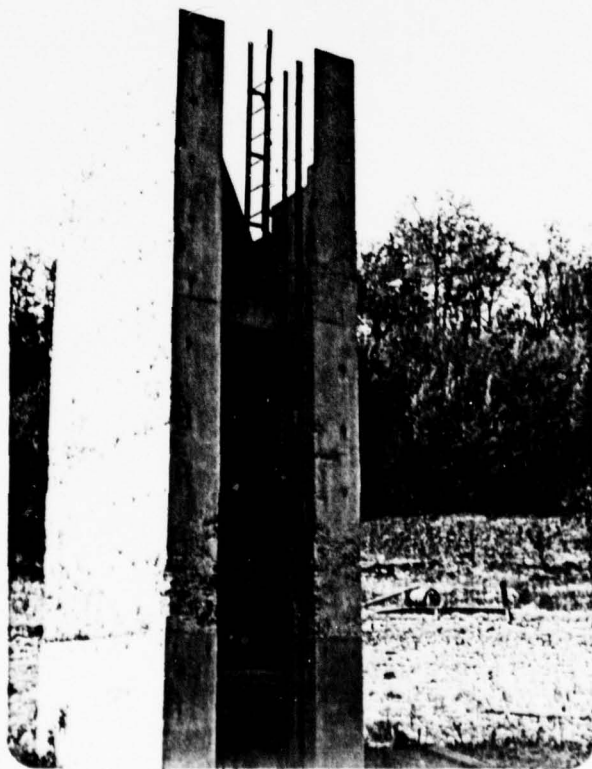


View from top of
dam towards
decant towers

PA-597
Plate E-1



Reservoir with decant towers.
Dam in background



Detail of Decant Tower

PA-597
Plate E-II



Reservoir - Dam in background

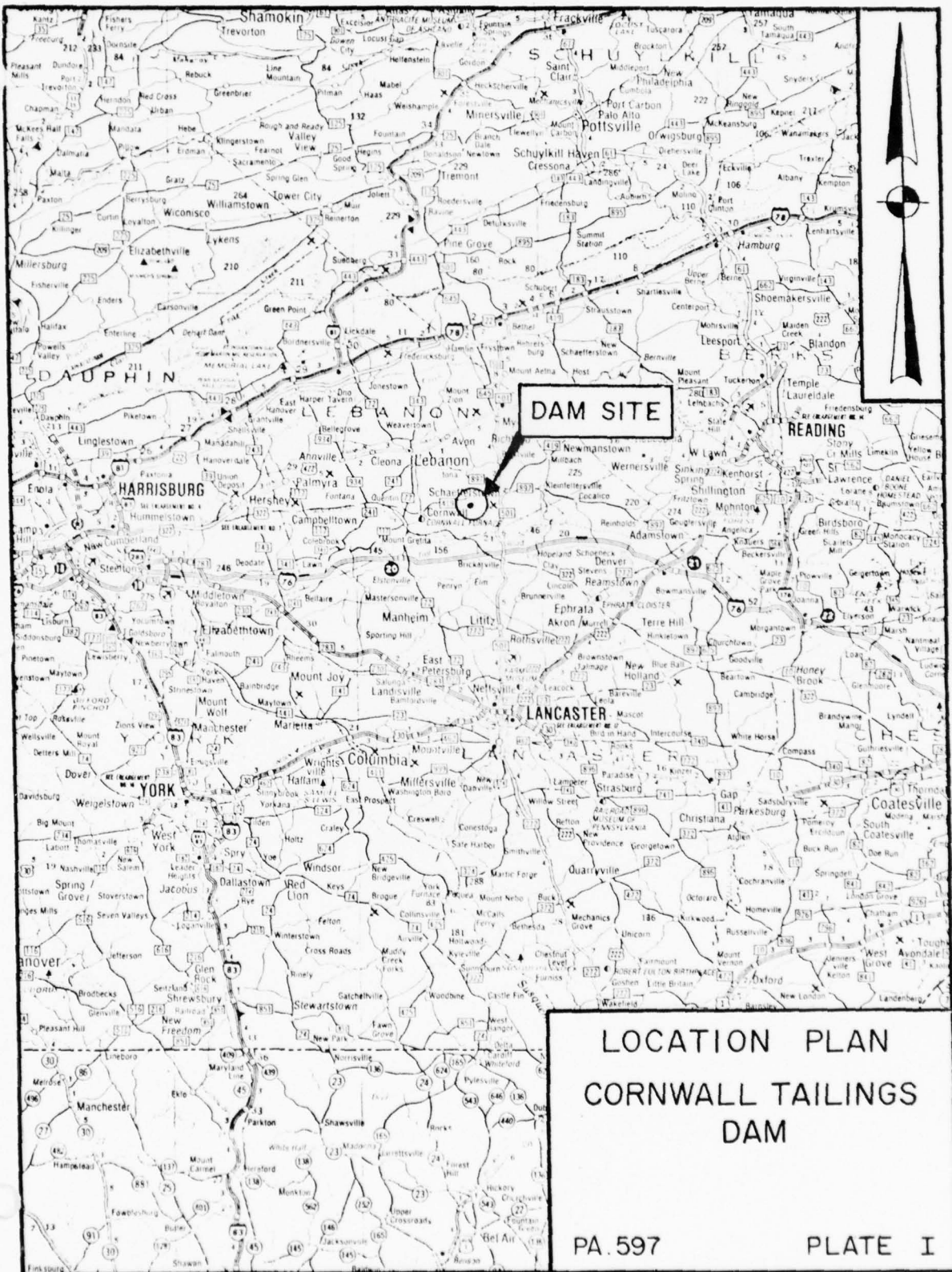


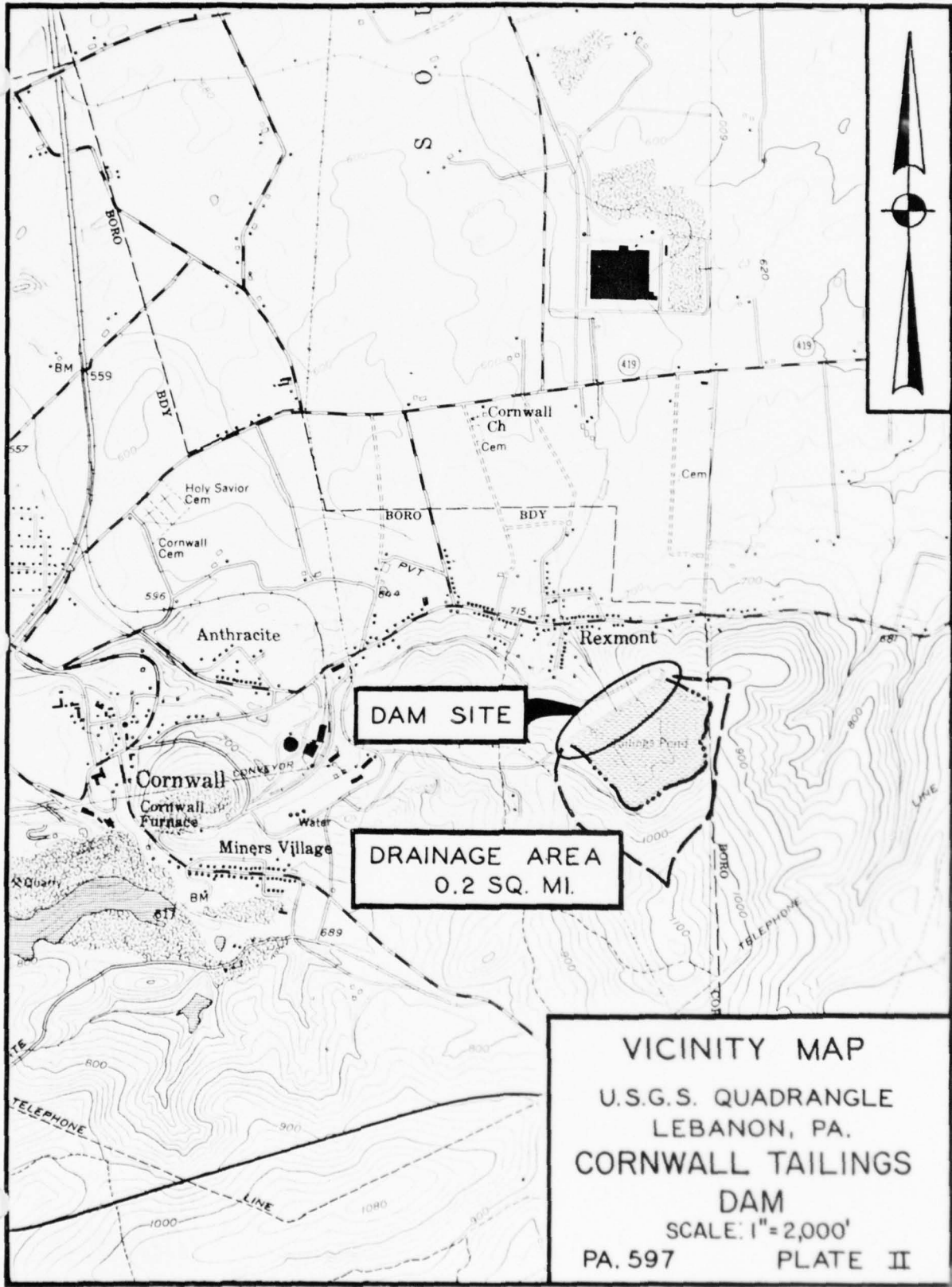
Looking downstream from top of dam

PA-597
Plate E-111

APPENDIX F
PLATES

APPENDIX F





DAM SITE

DRAINAGE AREA
0.2 SQ. MI.

VICINITY MAP
U.S.G.S. QUADRANGLE
LEBANON, PA.
CORNWALL TAILINGS
DAM
SCALE: 1" = 2,000'
PA. 597 PLATE II



Wave House
See enlarged detail

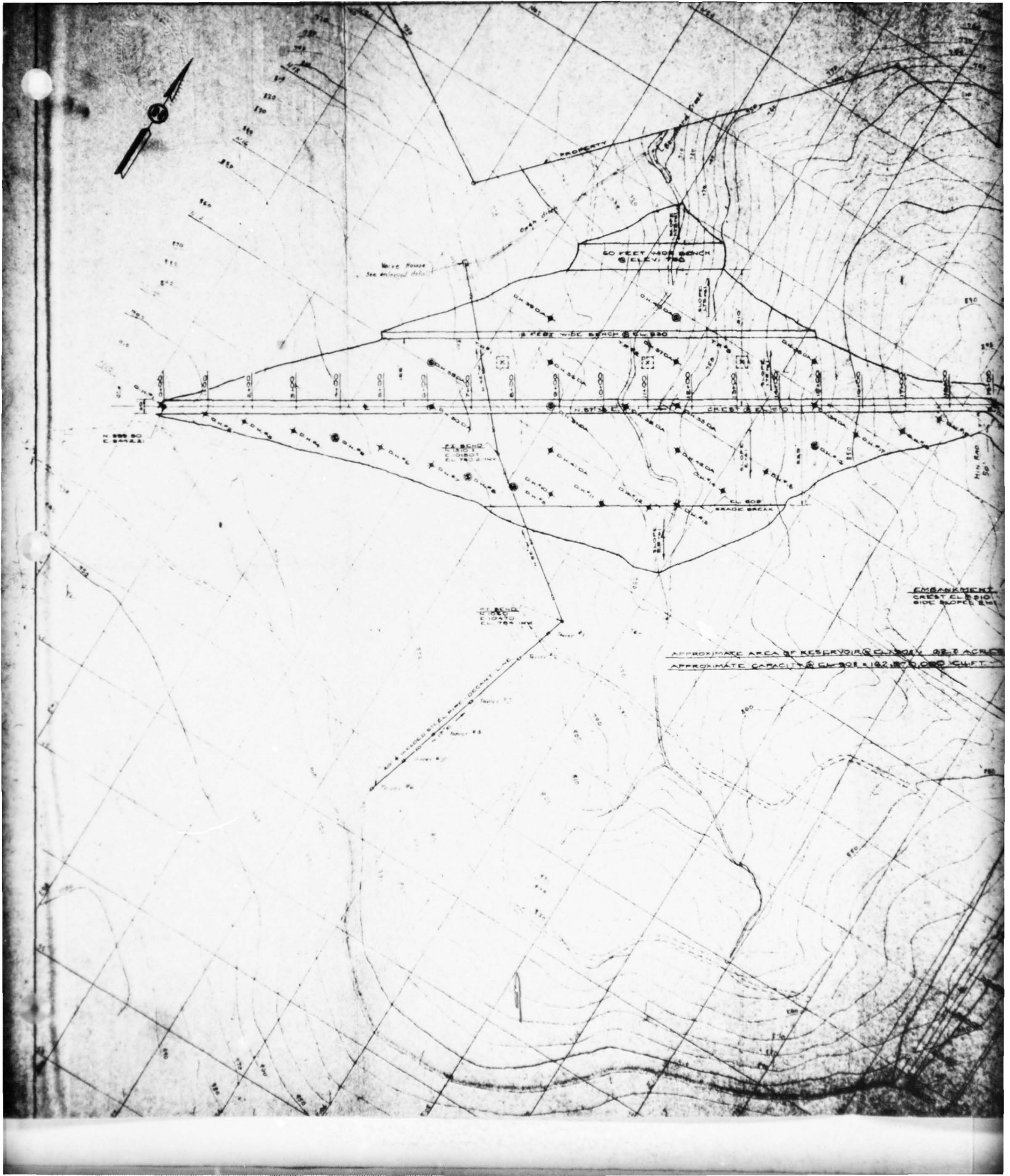
50 FEET HIGH BENCH
ELEV. 780

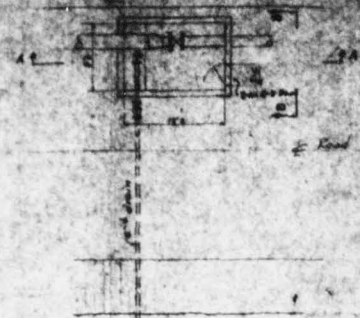
5 FEET HIGH BENCH ELEV. 850

OF BENCH
ELEV. 850
ELEV. 780

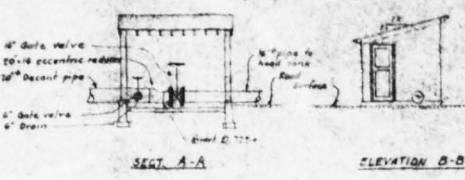
EMBANKMENT
HEIGHT 5 FT
SIDE SLOPE 2:1

APPROXIMATE AREA OF RESERVOIR 600,000 SQ. FT.
APPROXIMATE CAPACITY 6,000,000 GALLONS





Open ditch to Bernhard Creek
ENLARGED PLAN OF VALVE HOUSE
 Scale 1" = 10'



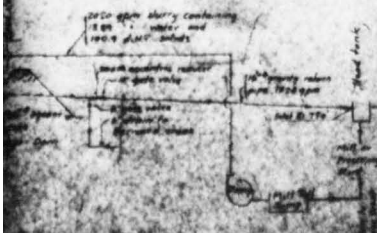
Note:
 The capacity of the Reservoir at 21.901' w.c. full is sufficient to contain 7,315,000 gal. of water, assuming densities reported by D'Appolonia Associates (a/c) and shown on SK 157-00. Adjustments for Crest elevation must be made on basis of actual conditions.



2

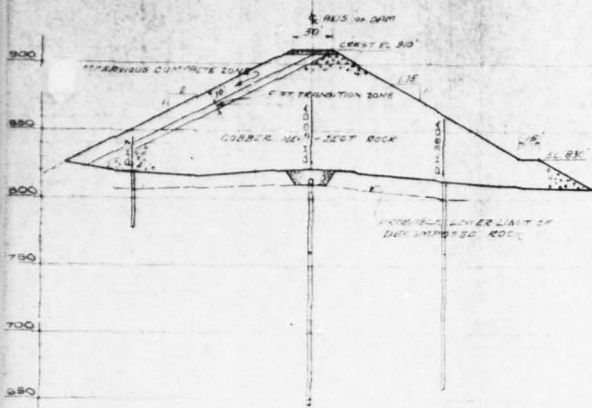
- TEST PIT
- ◆ DIAMOND DRILL HOLES
- WATER TESTED O.B. HOLES

3

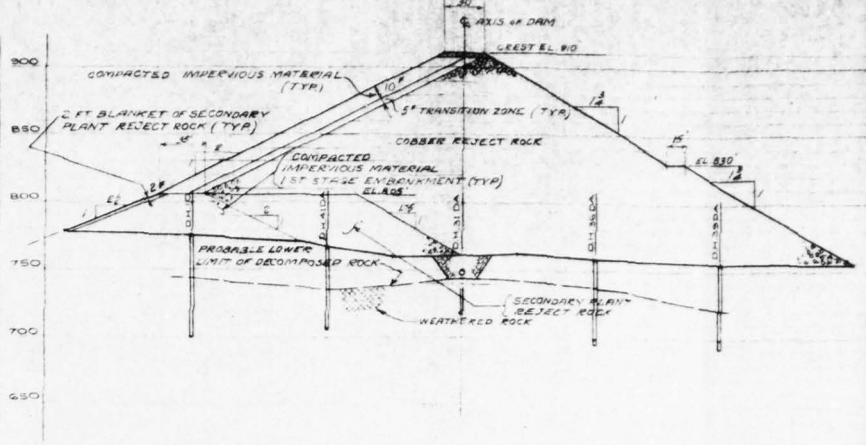


REFERENCES		NO.	DATE
S-1558 TOPOGRAPHY AT DAM SITE			
S-1558 SMALL MILL & RESERVOIR PLAN			
GENERAL PLAN & TOPOGRAPHY			
PAVING PLAN & ELEVATION			
GENERAL PLAN & TOPOGRAPHY			
PAVING PLAN & ELEVATION			
GENERAL PLAN & TOPOGRAPHY			
PAVING PLAN & ELEVATION			

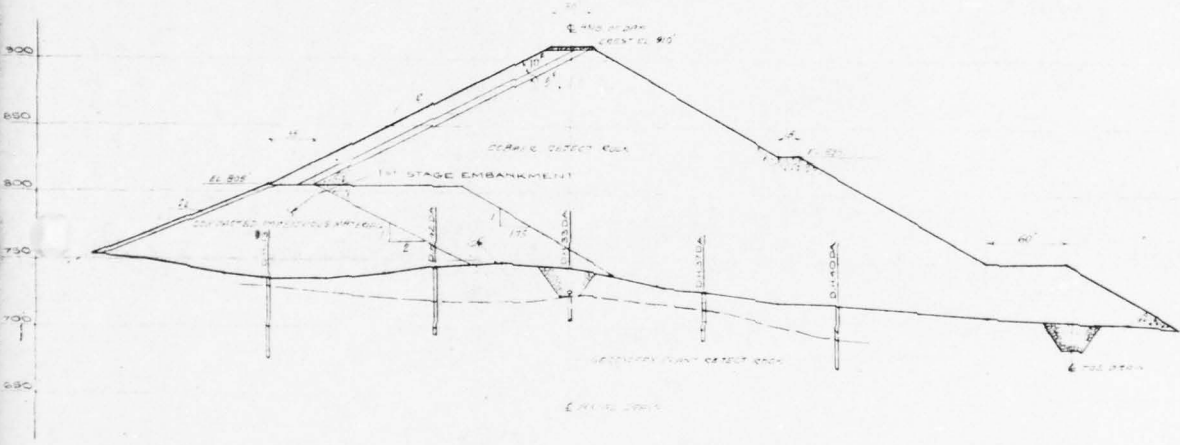
PA. 597
 PLATE III



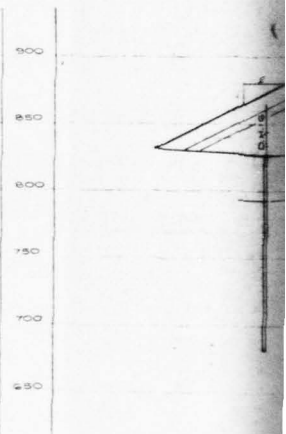
SECTION 1-1
E STA 8+0

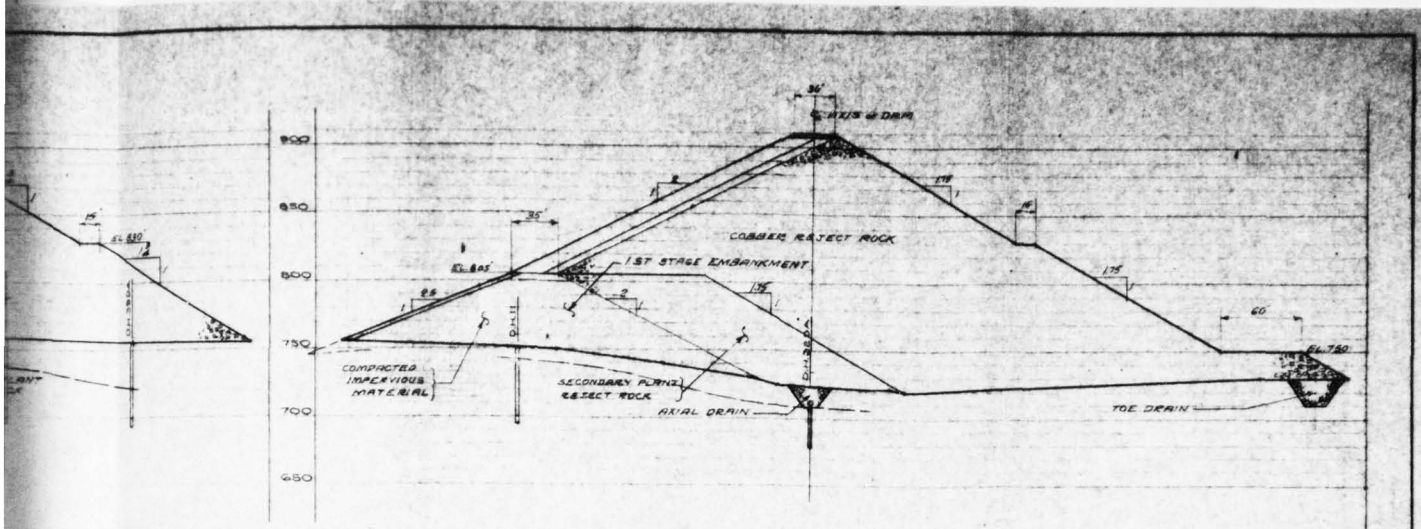


SECTION 2-2
E STA 8+80

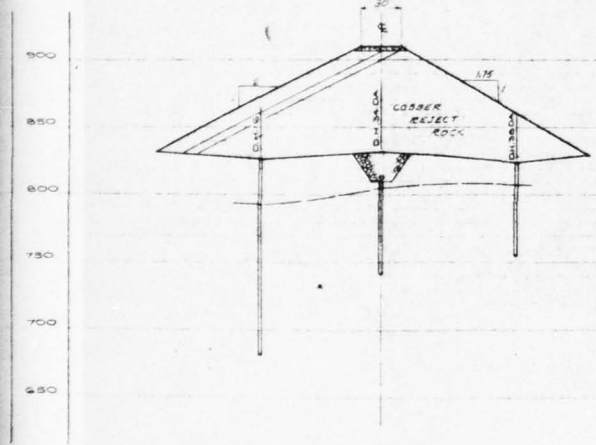


SECTION 3-3
E STA 1+20

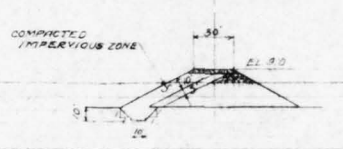




SECTION 3-3
 STA. 10+80



SECTION 4-4
 STA. 14+80



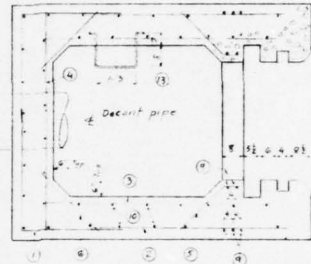
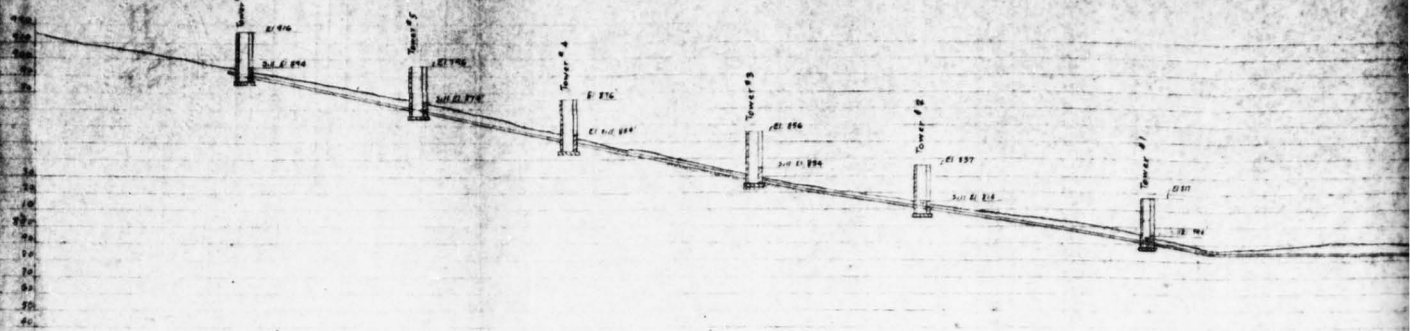
TYPICAL CROSS-SECTION OF WING

2



1087-91	GENERAL PLAN TAILINGS DAM	NO.	BY	DATE
REFERENCE DRWG. NO.	REFERENCE TITLE	REVISIONS		
CORNWALL MILL & PELLET PLANT				
TYPICAL CROSS-SECTIONS OF TAILINGS DAM				
CORNWALL DIVISION BETHLEHEM MINERALS COMPANY OPERATED BY BETHLEHEM CORNWALL CORPORATION BETHLEHEM, PA.				
DRAWN: E.D.P.	CHECKED: J.H. Miller	SCALE: 1"=20'		
TRACED: [Signature]	DATE: 12-1-66	ORDER: 1087-91-10		
APPROVED: [Signature]			NO. 1087-91-10	

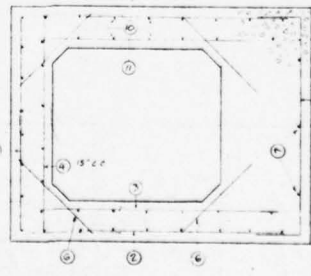
PA.
 PL.



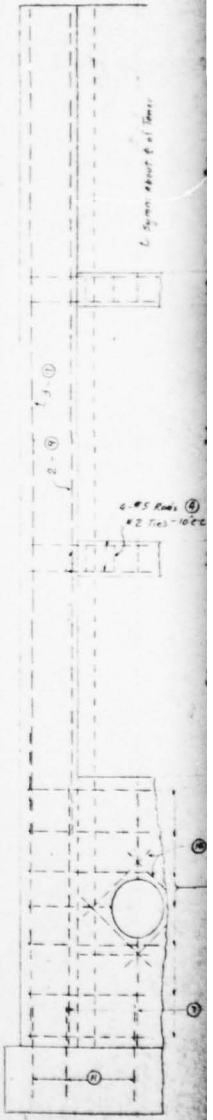
SECTIONS 2-2, 3-3 & 4-4

LIST OF REINFORCING BARS ONE TOWER

No.	Mark	Size	Type	Length	Dimensions			
				A B C				
70	①	#5	1	6-9	3-9	3-0	Spaced 10" Sect 2 & 5	
64	②	#5	Straight	6-0			12" c/c = 3	
50	③	#5	Straight	7-0			15" c/c = 4	
28	④	#5	Straight	2-0			8" c/c = 2	
20	⑤	#5	2	2-0	2-0	0-6	10" c/c = 3	
56	⑥	#5	Straight	2-6			12" c/c = 4	
7	⑦	#5	Straight	8-6			15" c/c = 5	
8	⑧	#5	3	9-6	16	4-6	16	Sect 5-5
10	⑨	#6	Straight	25-0				Sect 2-3 & 4
64	⑩	#6	Straight	16-3				Sect 5
42	⑪	#5	1	3-2	3-0	4-6		Dowels Sect 1 & 5
84	⑫	#5	Straight	2-3				Stap Loops
22	⑬	#6	5	4-3	3	1-3	1-3	Ladder
0	⑭	#5	4	3-4	10	6	4	Tie
274	⑮	#5	4	1-0	42	28	4	Tie
16	⑯	#5	Straight	3-0				Sect 6-6



SECT 5-5



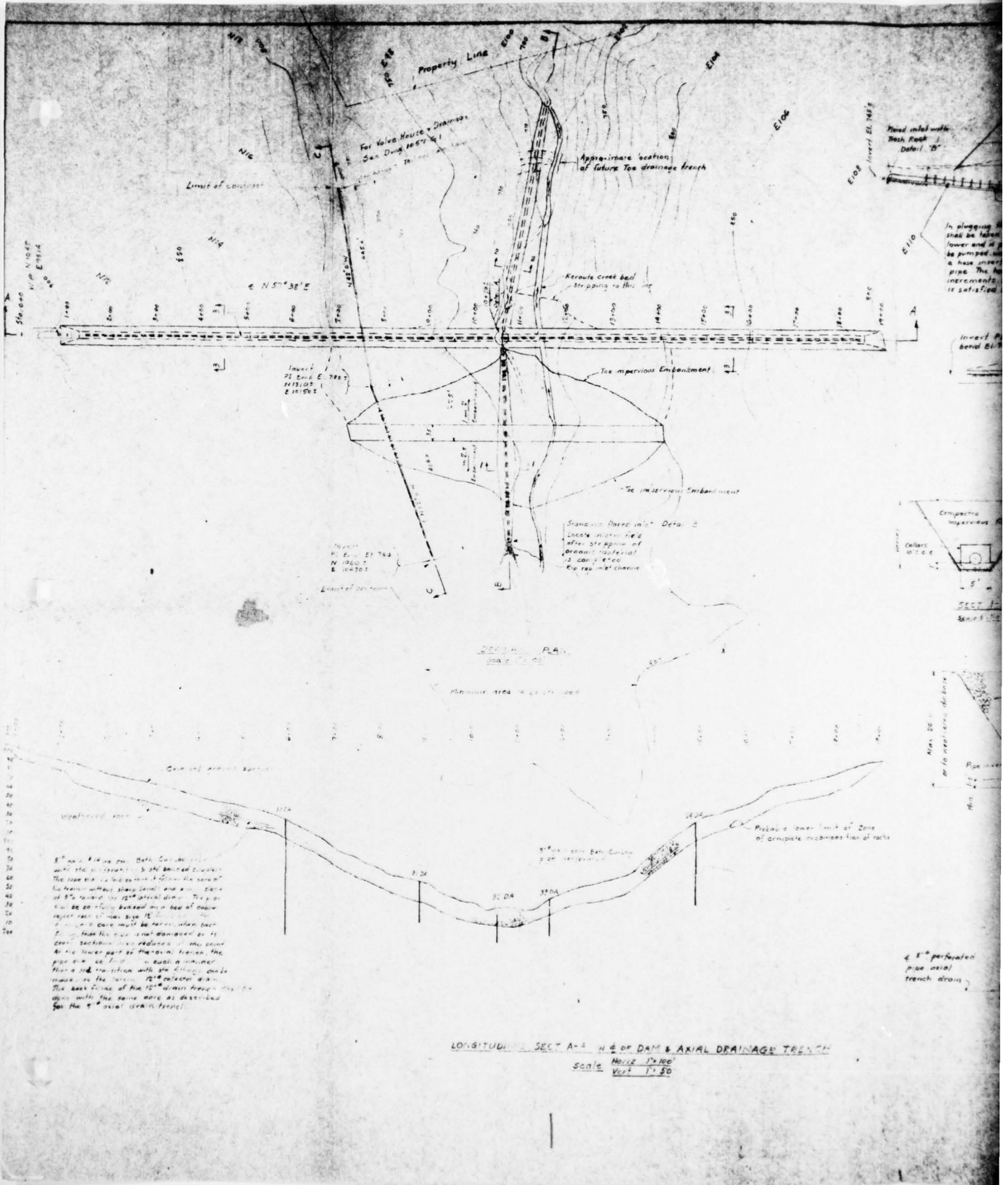
SECT 6-6

Foundation shall be made to firm soil with supporting pressure of 10 lb per sq ft

SECT 1-1
Scale 3/4" = 1'-0"

SECT 5-5

SECT 6-6





D.H. 30 DA

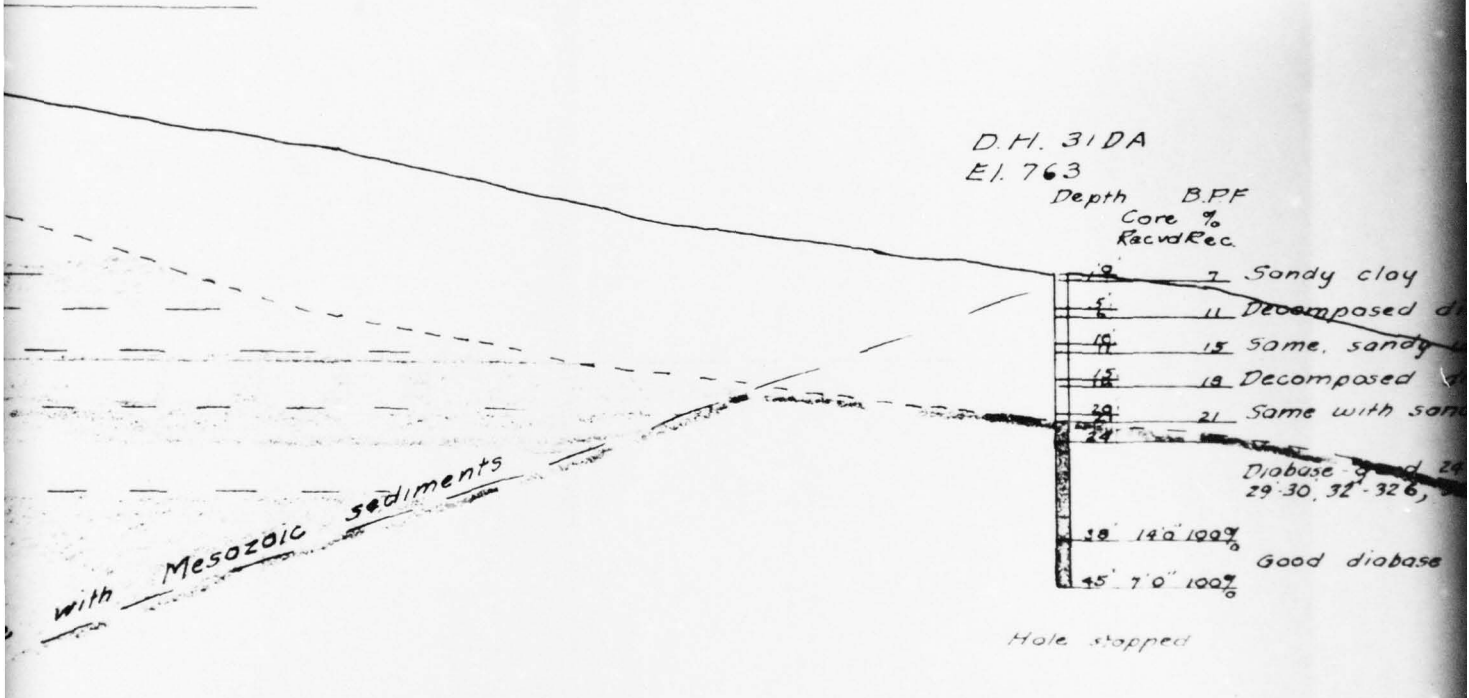
EL. 828





Depth BPF
Core %
Recid Rec

	0'	2	Brown sandy clay & gravel
	4'	14	Brown clay & cg frags
	7'	200	Silty sandstone fragments Good cong Bottom of run is shale
	10'	57%	Badly broken mottled red shale
EL. 800			No core 25-28 Balance badly broken sandstone
	32' 6" 9"	66%	
	38' 8" 9"	26%	Badly broken conglomerate
			Some
	44' 7" 0"	100%	
	50' 3" 0"	60%	Cong 1st 11" and last 8" badly broken. Bal solid
	52' 7" 11"		Dark gray broken sandstone
	58' 3" 6"	100%	Top 29" dark very fg. Ss Bal is broken gray Ss
	60' 4" 6"	100%	Hard red gray Ss. Last 1' broken
	66' 6" 0"	100%	Ss to 62'6", then cong. all broken
	71' 5" 0"	100%	Fint & mottled red shale - then sandstone
EL. 750			Sandstone - broken 76'-77'
	77' 6" 0"	100%	
	85' 5" 0"	100%	Hard mottled red shale
	85' 1' 7"	53%	Mottled red shale
	88' 2" 0"	100%	Cong - little shale upper 3' badly broken
	89' 2" 0"	100%	Ss & shak last 3' badly broken
			No core
	97' 5" 11"	99%	Gray sandstone Broken 91-93 & 95'6" - 96'
	100' 3" 0"	100%	Conglomerate
	104' 3" 0"	100%	Cong little indication diabase mineralization
	108' 4" 0"		Cong - less diabase staining Ss 104' 104'9"
	114' 3" 6"	100%	Conglomerate - Good core
			Conglomerate weathered zones 117-114, 117-118 and 124-124'6"
EL. 700			
	126' 30" 6"	100%	
			Approx contact of diabase with
			Gray sandstone - weathered & broken
	136' 27" 6"	100%	No Core
	172' 2" 6"	83%	No core
	177'		No core
179	180' 9" 3"	100%	Weathered & decomposed diabase Good core - weathered diabase



DAM
 SCALE: 1" = 2,000'
 PA. 597 PLATE II



-  Sandstone
-  Conglomerate
-  Shale
-  Diabase

2

B.P.F.
%
Rec.

- 7 Sandy clay
- 11 Decomposed diabase
- 15 Same, sandy with cong. pebbles
- 18 Decomposed diabase
- 21 Same with sand & cg pebbles

Diabase good 24'-25' Some weathering
29-30, 32'-32.6, 35'-36' & 37'-38.

100%
100%
Good diabase

D.H. 32 D'A
E1 731'

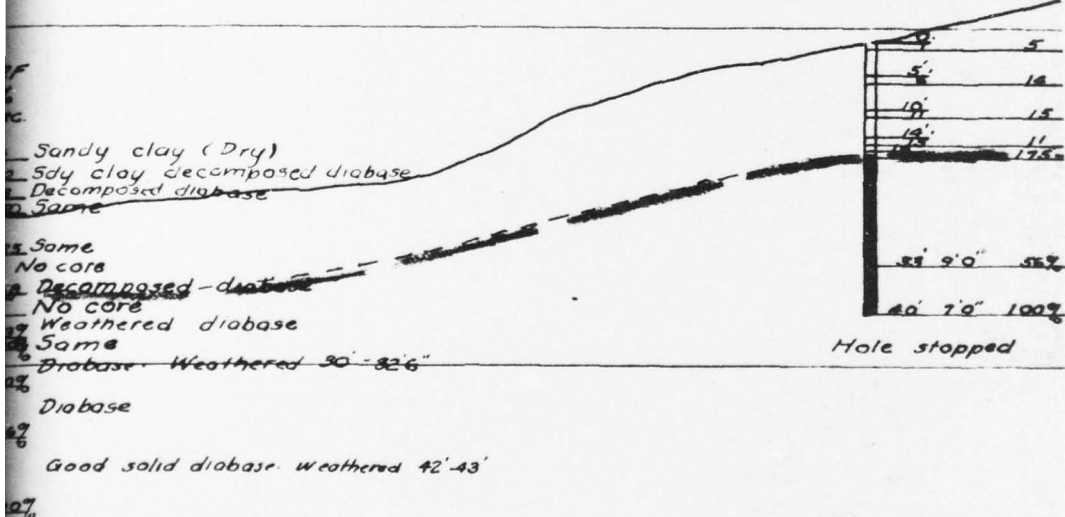
Depth B.P.F.
Core %
Recrs Rec.

0'	4	Sandy clay (Dry)
4'	12	Sdy clay decomposed diab
6'	18	Decomposed diabase
9'	180	Same
14.5'	225	Same
		No core
20'	358	Decomposed - diabase
24'		No core
27'	1.0'	83% Weathered diabase
29'	2.0'	100% Same
34.6'	5.6'	100% Diabase - Weathered 30'
		Diabase
42'	6.5'	86%
		Good solid diabase. Weather
55'	10.7'	100%



D.H. 33 DA
E1.747

Depth	B.P.I
Core %	Recrd Rec



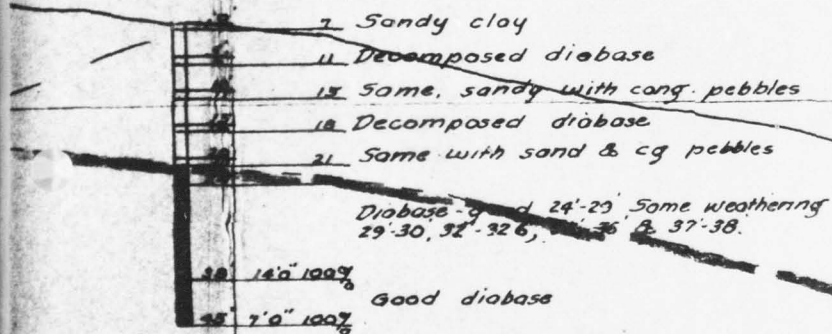
77 4

PA. 597
PLATE VII

Note:
Blows per foot - spoon samples and % core recovered are shown in the same column. Drill hole elevations are from Map 224 pl. 4 and may vary a few feet from levels run to holes.

D.H. 31 DA
Ei. 763

Depth B.P.F.
Core %
Recvd Rec.



Hole stopped

D.H. 32 DA
Ei 731'

Depth B.P.F.
Core %
Recvd Rec.

Depth	B.P.F.	Core %	Recvd Rec.
0	+	50	
2		12	50
5		18	De
5		180	50
14		225	50
19			No
20		360	De
24			N
27	1'0"	339	n
29	2'0"	100%	S
34	5'	100%	S
42	6'5"	86%	D
55	10'7"	100%	

DH 33 DA
E1.747

Depth BPF
Core %
Recrd Rec

32 DA
731'

Depth BPF
Core %
Recrd Rec

0'	4	Sandy clay (Dry)
4'	12	Sdy clay decomposed diabase
5'	18	Decomposed diabase
5'	180	Same
19'	225	Some No core
20'	350	Decomposed - diabase
24'		No core
27'	110	Weathered diabase
29'	210	Same
34'	515	Diabase - Weathered 30'-32.6'
		Diabase
42'	615	Good solid diabase - weathered 42'-43'
55'	1071	100%

0'	5	50
5'	14	50
19'	15	50
19'	11	Rec
19'	175	500
		Diab. Mo:
33'	90	56%
40'	70	100%
		Good

Hole stopped

2

Note:

Blows per foot - spoon samples and % core recovered are shown in the same column. Drill hole elevations are from Map 224 pl 4 and may vary a few feet from levels run to holes.

B.P.F.
%
Rec

- 5 Sandy clay
- 14 Same with cong pebbles
- 15 Same
- 11 Decomposed diabase
- 175 Same

~~Diabase somewhat weathered & broken~~
Most weathered at 27'

Presumed contact of diabase with M

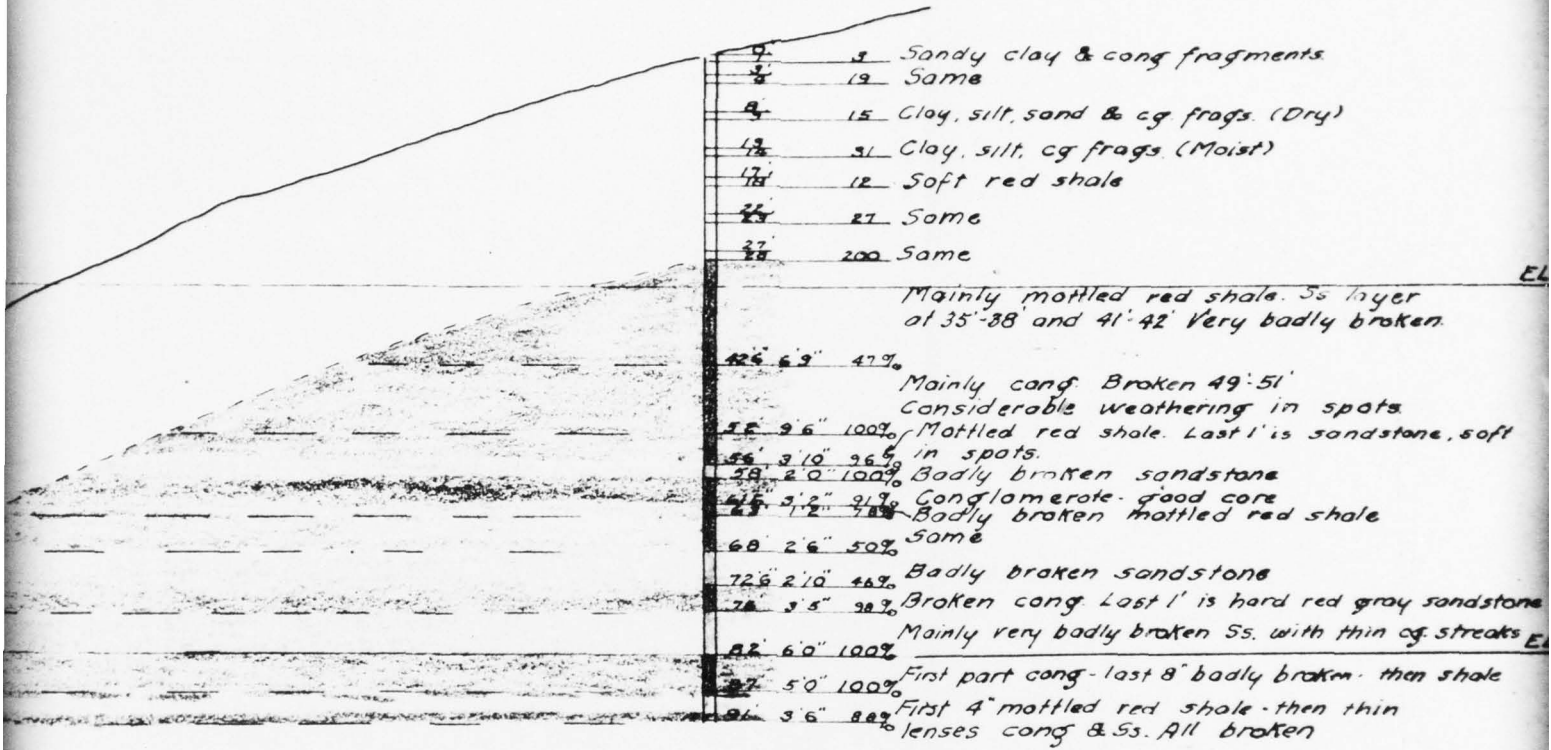
- 55% Good diabase
- 100%

3

ore
d may

D.H. 34DA
 El. 832

Depth BPF
 Core %
 Recvd Rec



Hole stopped

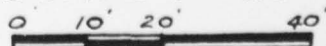
with Mesozoic sediments

4

SECTION
 THROUGH
 DRILL HOLES 30DA, 31DA, 32DA, 33DA & 3
 PROPOSED TAILINGS DAM

CORNWALL

SCALE 1" = 20'



DA

BPF

ve %
d Rec

3 Sandy clay & cong fragments
 19 Same
 15 Clay, silt, sand & cg frags. (Dry)
 31 Clay, silt, cg frags. (Moist)
 12 Soft red shale
 27 Same
 200 Same

EL. 800'

Mainly mottled red shale. Ss layer
 at 35'-38' and 41'-42' Very badly broken.

3" 42% Mainly cong Broken 49'-51'
 Considerable weathering in spots

6" 100% Mottled red shale. Last 1' is sandstone, soft
 in spots.

10" 26% Badly broken sandstone

10" 100% Conglomerate. good core

12" 78% Badly broken mottled red shale

16" 50% Same

10" 46% Badly broken sandstone

15" 38% Broken cong. Last 1' is hard red gray sandstone

10" 100% Mainly very badly broken Ss. with thin cg streaks EL 750'

10" 100% First part cong - last 8" badly broken - then shale

16" 88% First 4' mottled red shale - then thin
 lenses cong & Ss. All broken

topped

EL. 700'

SECTION
 THROUGH
 HOLES 30DA, 31DA, 32DA, 33DA & 34DA
 PROPOSED TAILINGS DAM

CORNWALL
 SCALE 1" = 20'
 0' 10' 20' 40'

PA. 597
 PLATE VIII

5