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NATIONAL DAM INSPECTION PROGRAM. ZINC DAM. (NDI NUMBER PA-00496--ETC(U)
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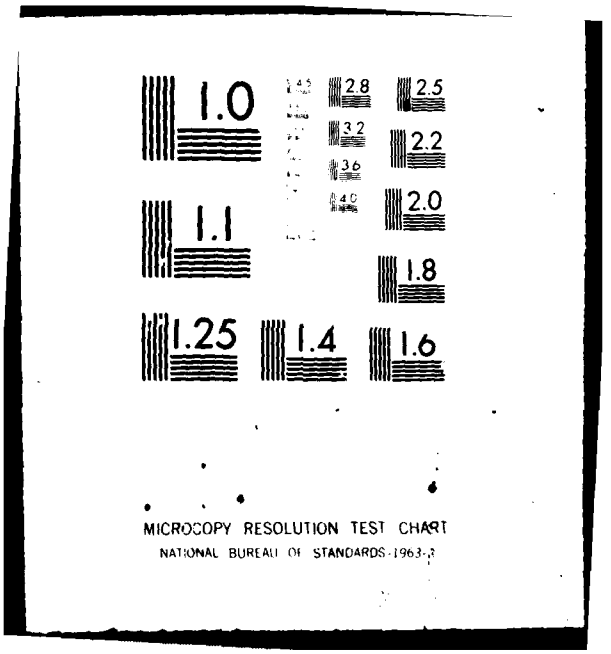
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(6) National Dam Inspection Program. Zinc Dam. (NDI Number PA-00496, PennDER Number 63-7), OHIO RIVER BASIN. Branch of Burgetts Fork,

~~ZINC DAM~~

WASHINGTON COUNTY, ~~COMMONWEALTH OF~~ PENNSYLVANIA.

~~NDI No. PA-00496~~

PennDER ~~No. 63-7~~

PHASE I INSPECTION REPORT

~~NATIONAL DAM INSPECTION PROGRAM~~

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

Prepared by: MICHAEL BAKER, JR., INC.
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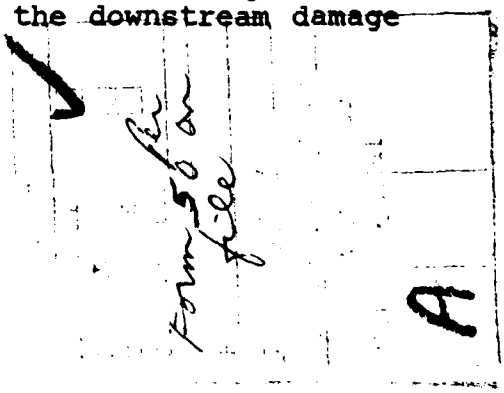
PREFACE

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 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.



PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

Zinc Dam, Washington County, Pennsylvania
NDI No. PA 00496, PennDER No. 63-7
Branch of Burgetts Fork on Raccoon Creek
Inspected 20 November 1979

ASSESSMENT OF GENERAL CONDITIONS

Zinc Dam is classified as a "Small" size - "High" hazard dam. The dam and reservoir are owned by Bologna Coal Company of Burgettstown, Pennsylvania.

Hydraulic/hydrologic evaluations, performed in accordance with procedures established by the Baltimore District, Corps of Engineers, for Phase I Inspection Reports, revealed the spillway will not pass the spillway design flood (SDF) without overtopping the dam. An SDF in the range of the 1/2 Probable Maximum Flood (1/2 PMF) to the Probable Maximum Flood (PMF) is required for Zinc Dam. The 1/2 PMF was chosen because the dam is on the low side of the "Small" size category. The analysis indicated that the spillway will pass only 5 percent of the PMF before overtopping will occur. Analysis performed to assess the impact of failure of the dam on the damage center downstream indicated that no significant increase in damages would occur compared to conditions if the dam did not fail. Therefore, the spillway is assessed as being "inadequate," but not "seriously inadequate."

Because of seepage through the embankment and evidence of overtopping of the embankment during a hazard review on 19 September 1979, the dam was considered to be in need of emergency attention. The Baltimore District, Corps of Engineers, was notified that same day by telephone of the condition of the dam. Subsequent inspections by representatives of PennDER and the Pittsburgh District, Corps of Engineers, recommended to the owner that he immediately drawdown the reservoir. The pool was drawn down and the Phase I visual inspection was performed on 20 November 1979. The overall condition of the dam was very poor. The results of the downstream routings indicate that damage would be minimal in the event of an overtopping failure of the dam. This analysis assumed that the buttressed core wall would not fail. Therefore Zinc Dam is classified as being in an "Unsafe" - "Non-Emergency" condition.

It is recommended that the owner give consideration to breaching the dam as an alternate to performing the necessary

repairs to the structure. If the owner feels the dam and reservoir constitutes an important part of their water supply system, then the following items should be performed without delay. Items 1 through 4 below should be designed by a qualified professional engineer experienced in the design of earth dams.

1) Reconstruct the spillway, including reduction of the overtopping potential of the dam.

2) Repair the embankment to the immediate left of the spillway where seepage through the embankment was previously observed. This should include any necessary excavation/investigation to determine the limits of sound material.

3) Repair the downstream slope where the embankment has been overtopped or eroded.

4) Repair the hole to the right of the spillway; a subsequent inspection for seepage should be performed if the reservoir reaches Elevation 1050 feet or higher.

5) The trees and brush on the dam should be cleared.

6) The marshy area at the left downstream toe of the dam should be examined periodically for seepage. The quantity and turbidity of any seepage identified should be recorded to identify any changing conditions.

7) Upstream closure (i.e. gate valve) for the outlet pipe should be installed. Closure of this valve in the event of a pipe rupture or leak will protect the embankment.

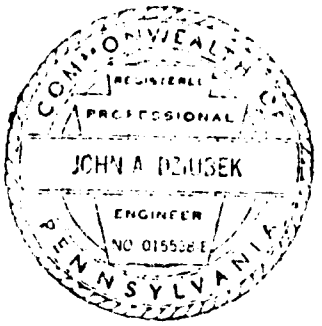
In addition, the following operational measures are recommended to be undertaken by the owner:

1) Develop a detailed emergency operation and warning system.

2) During periods of unusually heavy rain, provide around-the-clock surveillance of the dam.

3) When warning of a storm of major proportions is given by the National Weather Service, the owner should activate the emergency operation and warning system.

It is further recommended that formal inspection, maintenance, and operation procedures and records be developed and implemented.



Submitted by:

MICHAEL BAKER, JR., INC.

John A. Dziubek, P.E.
Engineering Manager-Geotechnical

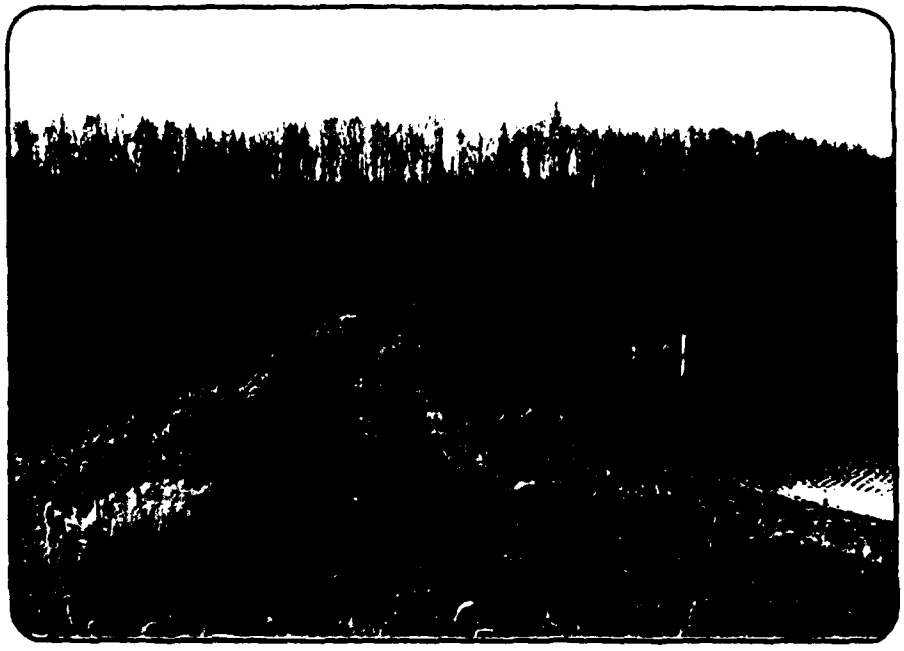
Date: 19 February 1980

Approved by:

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS

JAMES W. PECK
Colonel, Corps of Engineers
District Engineer

Date: 19 March 1980



Overall View of Dam from Left Abutment

Overall View of Dam from Right Abutment

TABLE OF CONTENTS

APPENDICES

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
ZINC DAM
NDI No. PA 00496, PennDER No. 63-7

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 inspection of dams throughout the United States.

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

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances - Zinc Dam is a diaphragm earthfill embankment approximately 23 feet high and 410 feet long. The upstream slope is 1.5H:1V (Horizontal to Vertical) and is riprap-lined. The downstream slope is 2H:1V and vegetated. The majority of the embankment material consist of low to medium plasticity clay (CL). The buttressed concrete core wall, according to the design plan, is 4 feet below the design top of dam. The foundation for the core wall is shown to extend 6 to 12 feet below the original ground line into sandstone rock. An additional 2 feet by 2 feet key on the centerline of the foundation is indicated on the plans.

The spillway, located 60 feet from the right abutment of the dam, is 50 feet long and 4 feet deep as originally designed. A mortared block wall was installed in the spillway which was subsequently covered with earth, reducing the freeboard to as low as 0.4 foot. The discharge channel is a concrete slab overlying rock rubble on the downstream embankment. The training walls for the spillway are approximately 2 feet high above the chute slab and extend one foot below grade. The spillway crest (original) is at Elevation 1050.0 feet and consists of the underlying concrete corewall.

The outlet works for the dam consist of a 16 inch cast-iron pipe extending from the intake tower in

the reservoir to the abandoned pumphouse downstream. The original inlet in the tower has become silted in and nine 2 inch diameter holes have been installed through the wall of the riser at approximate Elevation 1048.0 feet. A gate valve is located on the downstream end of the pipe before it discharges into the pumphouse.

b. Location - Zinc Dam is located in Smith Township, Washington County, Pennsylvania. The coordinates of the dam are N 40° 21.4' and W 80° 23.9'. The dam is located on USGS 7.5 minute topographic quadrangle, Avella, Pennsylvania.

c. Size Classification - The maximum height of the dam is 23 feet. The reservoir volume to the top of dam at Elevation 1053.7 feet is 54.5 acre-feet. Therefore, the dam is in the "Small" size category.

d. Hazard Classification - Because of homes located along Burgetts Fork immediately below the confluence of Burgetts Fork and the stream from the dam, loss of life would likely result from a failure of the dam. In addition, economic losses would occur to the homes along Burgetts Fork. Based on the above, the dam is considered in the "High" hazard category.

e. Ownership - The dam and reservoir are owned by the Bologna Coal Company, Box 127, Burgettstown, Pennsylvania 15021. Mr. Dick Williams represented the coal company at the inspection.

f. Purpose of Dam - The dam and reservoir were used, formerly, to supply water to the American Zinc and Chemical Company. Later the facilities were abandoned and the reservoir was used for recreation (fishing). The Bologna Coal Company, at the time of preparation of this report, had not made a decision whether they intend to breach the dam or repair it and use the reservoir for water supply to a coal preparation plant.

g. Design and Construction History - The dam was designed and constructed by the American Zinc and Chemical Company of Langeloth, Pennsylvania. Work on the dam started in April 1913 and was essentially complete in November 1914.

h. Normal Operational Procedures - The spillway is uncontrolled and until recently the pool level was usually at the spillway (modified) crest level.

Since the recent drawdown of the reservoir, the pool remains at the level of the holes punched into the old intake tower (Elevation 1048.0 feet±).

1.3 PERTINENT DATA

a. Drainage Area (square miles) - 0.95

b. Discharge at Dam Site (c.f.s.) -

Maximum Flood -	Unknown
Spillway Capacity (Crest El. 1053.0 ft.; at Pool El. 1053.7 ft.) -	82

c. Elevation (feet above Mean Sea Level [M.S.L.]) -

Design Top of Dam -	1054.0
Minimum Top of Dam -	1053.7
Spillway Crest (At Time of Inspection) -	1053.0
Spillway Crest (Design) -	1050.0
Streambed at Centerline of Dam -	1031
Maximum Tailwater of Record -	Unknown

d. Reservoir (feet) -

Length of Maximum Pool -	1600
Length of Normal Pool -	1500

e. Storage (acre-feet) -

Top of Dam (El. 1053.7 ft.) -	54.5
Normal Pool (El. 1053.0 ft.) -	47.3

f. Reservoir Surface (acres) -

Top of Dam (El. 1053.7 ft.) -	10.5
Normal Pool (El. 1053.0 ft.) -	10.2

g. Dam -

Type -	Diaphragm earthfill
Length (feet) -	410
Height (feet) -	23
Top Width (feet) -	12

Side Slopes - Upstream - 1.5H:1V
Downstream - 2H:1V
Zoning - None
Impervious Core - Concrete core wall with buttresses on 16 foot centers. Top elevation is approximately 4 feet below top of dam.
Cut-off - The foundation for the concrete core wall extends 6 to 12 feet below the original ground level and a 2 foot key was socketed into bedrock below the center of the foundation.
Grout Curtain - None
Drains - None

h. Diversion and Regulating Tunnel - None

i. Spillway -

Type - Broad-crested weir
Length of Crest Perpendicular to Flow (feet) - 50
Crest Elevation (At Time of Inspection; feet M.S.L.) - 1053.0
Crest Elevation (Design; feet M.S.L.) - 1050.0
Gates - None
Upstream Channel - The upstream channel had an obstruction placed on it consisting of mortar and block covered with earth.
Downstream Channel - Fifty feet by 2 feet chute channel discharging into natural rock-lined streambed.

j. Regulatory Outlets - A 16 inch cast-iron pipe, from a circular intake tower in the reservoir, exiting into the abandoned pumphouse downstream. The intake on the tower is not functioning because of silt; however, nine 2 inch diameter holes at El. 1048.0 ft. now serve to drain the reservoir. A control valve (gate type) is on the downstream end of the pipe.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

The review of information for this dam included Pennsylvania Department of Environmental Resources' (PennDER) File No. 63-7. Included in this file were a print of the original design drawing (Plate 3) and the correspondence file. The following information is contained in the correspondence file:

1) Application Report prepared by the Water Supply Commission (PennDER predecessor), dated 11 May 1914.

2) Progress Reports and Final Report prepared by the Water Supply Commission (final report dated 30 November 1914).

3) Miscellaneous post-construction inspection reports, photographs, and correspondence by PennDER personnel, including the last recorded inspection on 22 June 1972.

4) Photographs taken by the Pittsburgh District Corps of Engineers' personnel on 12 May 1972 and 24 September 1979.

2.2 CONSTRUCTION

The American Zinc and Chemical Company of Langeloth, Pennsylvania originally designed and constructed Zinc Dam for water supply purposes. The following individuals were responsible for this work: Mr. N. L. Heinz, General Manager; Mr. J. W. Geib, Assistant to General Manager; Mr. H. M. Roy, Engineer; and Mr. MacBeth, General Superintendent of Construction. Work on the dam started in April 1913 and was essentially complete in November 1914. Although the dam was started without a permit, the Water Supply Commission of Pennsylvania did scrutinize the design and construction at an early stage in the construction. Design changes were recommended and incorporated into the dam.

2.3 OPERATION

Operation records are not available for this dam. In recent years the reservoir has been maintained at a level approximately one foot below the top of dam.

2.4 EVALUATION

a. Availability - The information used is readily available from PennDER's File No. 63-7.

b. Adequacy - The information available is adequate for a Phase I Inspection of this dam.

c. Validity - There is no reason to doubt the validity of the information reviewed.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General - The inspection was performed on 20 November 1979 and no unusual weather conditions were present. The pool was drawn down at the time of inspection and the owner was in the process of making some modifications to the dam. The dam and appurtenant structures were in very poor overall condition. Noteworthy deficiencies are described briefly below. The complete visual inspection check list, field sketch, top of dam profile, and typical cross-section are presented in Appendix A.

b. Dam - The embankment had been overtopped sometime in the period between 1972 and 1979. The majority of the flow passed over the embankment immediately to the left of the spillway (see Photo 6), while a minor amount of overtopping (see Photo 10) had occurred from approximate Station 2+50 to Station 3+00 (approximate stationing is shown on the field sketch). At both locations a portion of the downstream embankment had been eroded. On a brief visit to the dam on 19 September 1979 while the reservoir was at full pool, seepage was observed passing through the embankment to the left of the spillway, then passing under the spillway training wall at the edge of the downstream crest. The seepage then exited from beneath the spillway chute slab approximately one-half of the way down the embankment (see Photo 2). This seepage has caused the undermining and deterioration of the spillway chute slab. Previous photos taken in 1972 show this same seepage passing through the embankment and entering and exiting from under the spillway. This seepage contributed to the formation of the erosion ditch on the downstream slope immediately to the left of the spillway. In 1972 repairs were ordered and performed to the embankment on the left side of the spillway. During an inspection conducted after the repairs were completed, no seepage was observed. It is estimated that the recently observed seepage may be related to the overtopping and erosion of the embankment and subsequent repairs using improper backfill construction and materials.

A hole in the downstream face was observed on 20 November 1979 with an erosion gully below it. This hole, located approximately 20 feet to the

right of the spillway and 5 feet below the crest, was not flowing at the time of inspection. However, it should be noted that the pool was drawn down at the time of inspection.

Small trees are present on the downstream slope of the embankment and the vegetation on the downstream slope was thick and, therefore, slightly hindered the inspection. The area below the left side of the embankment was marshy and covered with cattails. A pipe located to the left and slightly downstream from the abandoned pumphouse was standing vertical and was full of water. After a portion of the water was removed from the pipe the water level rose again very slowly to the top of the pipe, thus indicating that an artesian condition exists in the downstream area. (Details such as the depth of the pipe or the material into which it was installed is not known.)

c. Appurtenant Structures - The spillway structure is in very poor overall condition. The downstream half is undermined and deteriorated (see Photo 2). The crest elevation of the spillway was modified (raised) with a concrete block and mortar wall with earth piled on top. The freeboard was reduced to as low as 0.4 foot, while approximately one foot was the average (see Photos 3 and 5).

The outlet structure (water works) has been abandoned for a number of years. The intake is silted up and nonfunctional. At the time of the inspection, nine 2 inch diameter holes were punched through the wall of the riser tower at approximate Elevation 1048 feet. These holes were placed to maintain a conservation pool below the spillway crest. The 16 inch cast-iron pipe exiting inside the abandoned pumphouse was cleaned out prior to the holes being placed in the tower and a new valve installed just upstream from the exit in the pumphouse (see Photo 8). The water which flowed into the pumphouse was allowed to seek its own exit from the pumphouse.

d. Reservoir Area - The reservoir has become very silted in. The deepest point by the intake riser is only 2.4 feet (Elevation 1045.6 feet) below the water level at the time of inspection (Elevation 1048 feet). This is approximately 8.4 feet below the design top of dam.

The area on the right side of the reservoir is moderately sloping and forested. The left side is

parallel to an old railroad line running approximately 100 feet to the left of the shoreline. A sewer line pipe runs parallel to the left shoreline of the reservoir and open manholes along the pipe can be observed. One open manhole for this sewer line is present in the crest of the dam at the left abutment. Upstream from the reservoir is the community of Langeloth, Pennsylvania.

e. Downstream Channel - The downstream channel flows on a mild (less than 1 percent) slope through a forested area for approximately 1500 feet before passing under a railroad line. The confluence with Burgetts Fork is an additional 100 feet beyond the railroad line. Across Burgetts Fork is an auto repair shop. An additional 25 homes are located in the floodplain of Burgetts Fork within 2000 feet downstream of the confluence of Burgetts Fork and the stream from the dam.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

There are no formal written procedures in the event of impending failure of the dam. The dam is now reportedly visited everyday by someone from the Bologna Coal Company. Modifications recently performed to the dam should keep the pool drawn down to Elevation 1048 feet providing heavy rainfall does not occur.

It is recommended that formal emergency procedures be prepared, prominently displayed, and furnished to all operating personnel.

4.2 MAINTENANCE OF DAM

Maintenance of the dam has become the responsibility of Bologna Coal Company. It is recommended that formal maintenance procedures be developed and implemented.

4.3 MAINTENANCE OF OPERATING FACILITIES

Bologna Coal Company is responsible for maintenance of the operating facilities. Although maintenance of these facilities were not performed by the previous owners, Bologna Coal Company has taken steps to keep the pool drawn down and has installed a new valve at the downstream exit of the 16 inch outlet pipe. However, it is recommended that formal procedures be developed.

It is recommended that an upstream valve (or other type of closure) be installed in the outlet pipe. Closure of this valve in the event of a pipe rupture or leak will help protect the embankment.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

There are no warning procedures in the event of a dam failure. An emergency warning procedure should be developed.

4.5 EVALUATION OF OPERATIONAL ADEQUACY

The maintenance performed by previous owners of the dam has been very poor. Modifications performed by a previous owner has jeopardized the safety of the entire structure. Bologna Coal Company should be commended on having taken steps to reduce the unsafe condition of the dam; however, such steps are only intermediate and the necessary repairs (or breaching) of the dam should be carried out and the required maintenance performed as necessary.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data - No hydrologic or hydraulic design calculations are available for Zinc Dam.

b. Experience Data - Although no specific records of major floods are available, washed out areas along the crest of the dam indicate that the dam has been overtopped in the recent past. From the extent of these eroded areas, it is believed that the depth of overtopping was from 0.1 to 0.3 foot.

c. Visual Observations - There is one major low spot on the dam crest which is only 0.7 foot above the present spillway crest elevation. Erosion of the dam crest has taken place in this area despite what appears to be past efforts to fill this spot.

A concrete block or masonry wall has been placed in the spillway to raise the crest from the original design Elevation of 1050.0 feet to an average Elevation of 1053.0 feet. This wall is shown in pictures taken in May 1972 and September 1979. Prior to the most recent inspection (November 1979), this wall had apparently been covered up by loose earth and rock, making it impossible to inspect its condition.

d. Overtopping Potential - Zinc Dam is a "Small" size, "High" hazard dam requiring evaluation for a spillway design flood (SDF) in the range of the 1/2 Probable Maximum Flood (1/2 PMF) to the Probable Maximum Flood (PMF). Because of the relatively low number of structures in the downstream damage center and the relatively small size of the drainage area and impoundment, the 1/2 PMF has been selected as the SDF.

The hydraulic capacity of the dam, reservoir, and spillway was assessed by utilizing the U.S. Army Corps of Engineers Flood Hydrograph Package, HEC-1. The hydrologic characteristics of the drainage basin, specifically, the Snyder's unit hydrograph parameters, were obtained from a regionalized study conducted by the Baltimore District of the U.S. Army Corps of Engineers.

Analysis of the dam and spillway was performed assuming that the concrete block or masonry wall previously mentioned is in place in the spillway. For this spillway configuration, the dam will be overtopped by a maximum depth of 1.1 feet for a duration of 14.9 hours during the 1/2 PMF event.

The dam is capable of passing approximately 5 percent of the PMF without overtopping.

e. Spillway Adequacy - The dam, as outlined in the above analysis, would be overtopped by the 1/2 PMF. The long duration of overtopping combined with the overall poor condition of the dam would more than likely lead to the dam's failure.

To assess the impact of the dam's failure on the damage center downstream in Slovan, the 1/2 PMF was routed downstream and compared with conditions that would exist if the dam would not fail. This analysis indicated that there is no significant increase in damage from the non-failure and failure cases. This is primarily due to the large depth of overtopping in the non-failure case and the limited breach depth allowed in the failure case. A breach depth of only four feet is used because of the presence of a concrete core wall in the dam which extends to within four feet of the dam crest.

The relatively small change in downstream damages which results from dam failure during overtopping places the dam's spillway in the "inadequate" as opposed to "seriously inadequate" category.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations - As discussed in Section 3, seepage had been flowing through a section of the embankment to the left of the spillway and subsequently undermining the spillway chute slab. Although the pool has been drawn down, a piping hole through the embankment still exists and should be corrected. Furthermore, the spillway structure should be reconstructed to provide adequate spillway capacity to prevent overtopping and protect the embankment from erosion.

The hole observed to the right of the spillway on the downstream face should be repaired. This area should be examined for seepage when the pool is at or above Elevation 1050 feet.

The marshy area at the toe of the embankment on the left side is not considered to adversely affect the embankment at this time. However, it is recommended that this area be examined during the annual inspections and the condition recorded.

b. Design and Construction Data - Calculations of embankment slope and foundation stability were not available for review. According to information in the PennDER file for this dam, the foundation of the concrete core wall extended through shale and limestone into a tight sandstone. Because of the low height of the earthfill section of the dam and the inclusion of a buttressed concrete core wall, it is inferred that further assessments of the structural stability are not necessary for this Phase I Inspection Report.

c. Operating Records - No operating records are available for Zinc Dam and reservoir. The previous procedure of maintaining the reservoir level very near the elevation of the top of dam was an unsafe practice relative to overtopping of the dam. This procedure has been revised and other procedures do not indicate cause for concern relative to the structural stability of the dam.

d. Post-Construction Changes - The modification of the spillway crest reducing the spillway capacity could possibly have had serious consequences for the dam. The dam had been partially overtopped as

a result of this modification. Changes recently performed have helped to reduce the unsafe condition of the dam; however, permanent solutions are recommended.

e. Seismic Stability - The dam is located in Seismic Zone 1 of the "Seismic Zone Map of the Contiguous United States," Figure 1, page D-30, "Recommended Guidelines for Safety Inspection of Dams." This is an area of minor seismic activity and further assessment of the seismic stability is not necessary.

SECTION 7 - ASSESSMENT, RECOMMENDATIONS/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety - Zinc Dam is evaluated as a "High" hazard - "Small" size dam requiring a spillway capacity in the range of 1/2 PMF to PMF. The 1/2 PMF was chosen as the SDF because the dam is on the low side of the "Small" size category. As presented in Section 5, the spillway and reservoir were determined to have a capacity of only 5 percent of the PMF. However, analyses performed to assess the impact of the failure of the dam on the damage center downstream compared with conditions if the dam would not fail indicate that no significant increase in damages would probably occur. Because of this the spillway is assessed as being "inadequate," but not "seriously inadequate."

The overall condition of the dam at the time of inspection was very poor. The seepage through the embankment observed on 19 September 1979 combined with the evidence of overtopping and material blocking the spillway crest led the engineers performing the hazard review of the dam to assess the dam as being in an unsafe condition. This situation was reported that day by telephone to the Baltimore District, Corps of Engineers. PennDER was subsequently notified by the Baltimore District, Corps of Engineers, and their regional representative examined the dam and concurred to the immediate drawdown of the reservoir. The pool has been drawn down to Elevation 1048 feet (approximately 6 feet below the design top of dam) and actions have been taken to correct the deficiencies of the dam.

b. Adequacy of Information - The information available and the observations made during the field inspection are considered sufficient for this Phase I Inspection Report.

c. Urgency - The presence of the seepage through the dam and the evidence of previous overtopping of the dam indicated that the dam was in need of emergency attention. The subsequent action taken by the owner has reduced the potential for catastrophic failure of the dam. However, the action taken is considered temporary and permanent repairs or breaching of the dam (whichever the owner finds more advantageous) should be performed immediately by the owner.

d. Necessity for Additional Data/Evaluation - The hydraulic/ hydrologic analyses performed for this dam has indicated the need for additional spillway capacity. In addition, the condition of the spillway has deteriorated to such extent that reconstruction is recommended. Therefore, the owner should retain the services of a qualified professional engineer experienced in the design and construction of earth dams to develop recommendations for the reconstruction of the spillway. Additionally, the engineer should provide recommendations for the repair of the embankment immediately to the left of the spillway and the left portion of the embankment which has been overtopped.

7.2 RECOMMENDATIONS/REMEDIAL MEASURES

It is recommended that the owner give consideration to permanently breaching the dam as an alternate to performing the necessary repairs to the structure. If, however, the owner feels the dam and reservoir constitutes an important part of their water supply system, then the following items should be performed without delay. Items 1 through 4 below should be designed by a qualified professional engineer experienced in the design of earth dams.

1) Reconstruct the spillway structure (using current design standards).

2) Repair the embankment to the immediate left of the spillway where seepage through the embankment was previously observed. This should include any necessary excavation/ investigation to determine the limits of sound material.

3) Repair the downstream slope where the embankment has been overtopped or eroded.

4) Repair the hole to the right of the spillway; the subsequent inspection for seepage should be performed if the reservoir reaches Elevation 1050 feet or higher.

5) The trees and brush on the dam should be cleared. In addition, it is advisable that the dense vegetation be removed and replaced with well maintained grass to facilitate future inspections.

6) The marshy area at the left downstream toe of the dam should be examined periodically for seepage. The quantity and turbidity of any seepage identified should be recorded to identify any changing conditions.

7) Upstream closure (i.e. gate valve) should be installed in the outlet pipe. Closure of this valve in the event of a pipe rupture or leak will help protect the embankment.

In addition, the following operational measures are recommended to be undertaken by the owner:

1) Develop a detailed emergency operation and warning system.

2) During periods of unusually heavy rain, provide around-the-clock surveillance of the dam.

3) When warning of a storm of major proportions is given by the National Weather Service, the owner should activate the emergency operation and warning system.

It is further recommended that formal inspection, maintenance, and operation procedures and records be developed and implemented.

APPENDIX A

VISUAL INSPECTION CHECK LIST, FIELD SKETCH, TOP OF DAM PROFILE, AND TYPICAL CROSS-SECTION

Check List
Visual Inspection
Phase 1

Name of Dam Zinc Dam County Washington State PA Coordinates Lat. N 40°21.4'
NDI # PA 00496
PennDER # 63-7 Long. W 80°23.9'

Date of Inspection 20 November 1979 Weather Sunny, clear Temperature 45°-50° F.

Pool Elevation at Time of Inspection 1048.0 ft.* M.S.L. Tailwater at Time of Inspection 1035.8 ft.* M.S.L.

*All elevations referenced to the original spillway crest (El. 1050 ft.)

Inspection Personnel:

Michael Baker, Jr., Inc.:

James G. Ulinski
David J. Greenwood
Wayne D. Lasch

Field Review 6 February 1980

John A. Dziubek
James G. Ulinski

Owner's Representatives -

Bologna Coal Company:

Mr. Dick Williams (part-time)

PennDER:

Mr. Larry Busack

Pittsburgh District Corps of Engineers:

Mr. Stuart Long (part-time)
Mr. Jim Brown (part-time)

James G. Ulinski Recorder

CONCRETE/MASONRY DAMS - Not Applicable

Name of Dam: ZINC DAM
NDI # PA 00496

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
LEAKAGE		
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS		
DRAINS		
WATER PASSAGES		
FOUNDATION		

CONCRETE/MASONRY DAMS - Not Applicable

Name of Dam: ZINC DAM
NDI # PA 00496

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES		
STRUCTURAL CRACKING		
VERTICAL AND HORIZONTAL ALIGNMENT		
MONOLITH JOINTS		
CONSTRUCTION JOINTS		

EMBANKMENT

Name of Dam: ZINC DAM

NDI # PA 00496

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 embankment had been partially overtopped previously and portions of the embankment eroded away. A major amount of erosion has occurred immediately to the left of the spillway into the downstream slope of the embankment. This may have been the result of overtopping, long term seepage through the embankment, or a combination of the two. Additional erosion due to overtopping has occurred in the left half of the dam from approximate Station 2 + 50 to Station 3 + 00 (approximate stationing is shown on the field sketch). A minor erosion ditch is present on the downstream slope approximately 20 ft. to the right of the spillway.	The owner should retain the services of qualified professional engineer experienced in earth dams and appurtenances to develop recommendations for repair of the embankment 1) immediately to the left of the spillway including the piping hole in the embankment and the area of former erosion and backfill 2) the downstream slope along the left half of the dam which was previously overtopped and eroded 3) the small erosion ditch on the downstream face approximately 20 ft. to the right of the spillway.
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	The horizontal alignment is acceptable except for areas where the erosion has progressed into the crest of the dam. The area adjacent to the left side of the spillway is low (see top of dam profile at the end of this appendix). Some minor rutting of the crest was present at the time of inspection.	The rutting should be repaired with the rest of the embankment.

EMBANKMENT

Name of Dam: ZINC DAM

NDI # PA 00496

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
RIPRAP FAILURES	The riprap is rock rubble, hand lain, and grouted. No problems were observed.	
MISCELLANEOUS	A hole was observed in the embankment approximately 20 ft. to the right of the spillway and 5 ft. below the crest of the dam. An erosion gully was noticed below this hole; however, it is not known whether it is the result of seepage or a rodent.	The hole should be properly repaired.
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	The right abutment of the embankment was acceptable. The junction of the spillway and the embankment on the right side was also acceptable. The junction of the left side of the spillway and the embankment is in very poor condition. A piping hole has developed through the embankment at this location and the seepage has travelled under the spillway leading to undermining of the spillway chute slab. Prior to 1972, this seepage had exited from beneath the spillway and had eroded a major ditch into the downstream slope of the embankment immediately to the left of the spillway structure. The left abutment of the embankment was acceptable, although an open catch basin for a sanitary sewer and the pipe passing through the embankment is an undesirable situation. It is (continued next page)	The area to the left of the junction of the spillway and the embankment should be repaired. The loosely backfilled material should be removed and the embankment examined for piping holes prior to making the final embankment repairs.

EMBANKMENT

Name of Dam: ZINC DAM

NDI # PA 00496

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM (Con't)	felt that this catch basin and pipe have contributed to the swampy condition below the toe in this area.	
ANY NOTICEABLE SEEPAGE	No seepage was observed at the time of inspection. The downstream area beneath the left side of the dam was wet and marshy. Cattails were also present at this location. Seepage through the embankment was observed immediately to the left of the spillway on 19 September 1979. This seepage travelled through the embankment, went under the left training wall, and exited one-half of the way down the chute slab.	This area of the embankment should be repaired. The area where the cattails are present should be examined for seepage in the future.
STAFF GAGE AND RECORDER	None	
DRAINS	No drains observed.	

OUTLET WORKS

Name of Dam: ZINC DAM
NDI # PA 00496

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	The outlet conduit is a 16 in. C.I.P. The inlet was submerged and could not be examined. The outlet is located in the abandoned pumphouse downstream. A new valve was recently installed at the outlet and the pipe was pressure cleaned before the recent modification to keep the reservoir drawn down.	An upstream closure of the outlet conduit should be installed.
INTAKE STRUCTURE	The intake tower is a 5 ft. diameter tower located near the center of the dam in profile (Station 1 + 30). At the time of inspection nine 2 in. diameter holes were jackhammered into the tower at approximate El. 1048.0 ft. The inlet is buried under silt around the tower and is no longer functional.	
OUTLET STRUCTURE	The outlet is in the abandoned pumphouse downstream. The water is allowed to find its own path out of the pumphouse.	
OUTLET CHANNEL	There is no outlet channel associated with the outlet works. The water is allowed to find its own path out of the pumphouse.	

OUTLET WORKS

Name of Dam: ZINC DAM

NDI # PA 00496

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
EMERGENCY GATE	A new gate valve was recently installed at the downstream end of the outlet pipe at the entrance into the pumphouse. It is not known whether a gate was installed on the inlet in the intake structure or whether a permanent closure was installed when abandoned.	An upstream closure in the outlet conduit should be installed.

UNGATED SPILLWAY

Name of Dam: ZINC DAM
NDI # PA 00496

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	Obstructions have been constructed on the original spillway crest reducing the free-board to as little as 0.4 ft. At the time of inspection, the owner had started to remove these mortared blocks as well as the spillway structure.	It is recommended that the spillway be totally recon-structed. It is recommended that the owner engage the services of a qualified pro-fessional engineer experienced in the design of appurtenant structures for earth dam.
APPROACH CHANNEL	Filled in with mortared block and earth covered.	
DISCHARGE CHANNEL	The chute slab is undermined and badly deteriorated.	The spillway structure should be reconstructed.
BRIDGE AND PIERS	Not Applicable	

Name of Dam: ZINC DAM

NDI # PA 00496

GATED SPILLWAY - Not Applicable

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL		
APPROACH CHANNEL		
DISCHARGE CHANNEL		
BRIDGE AND PIERS		
GATES AND OPERATION EQUIPMENT		

INSTRUMENTATION - None

Name of Dam: ZINC DAM
NDI # PA 00496

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS		
OBSERVATION WELLS		
WEIRS		
PIEZOMETERS		
OTHER		

RESERVOIR

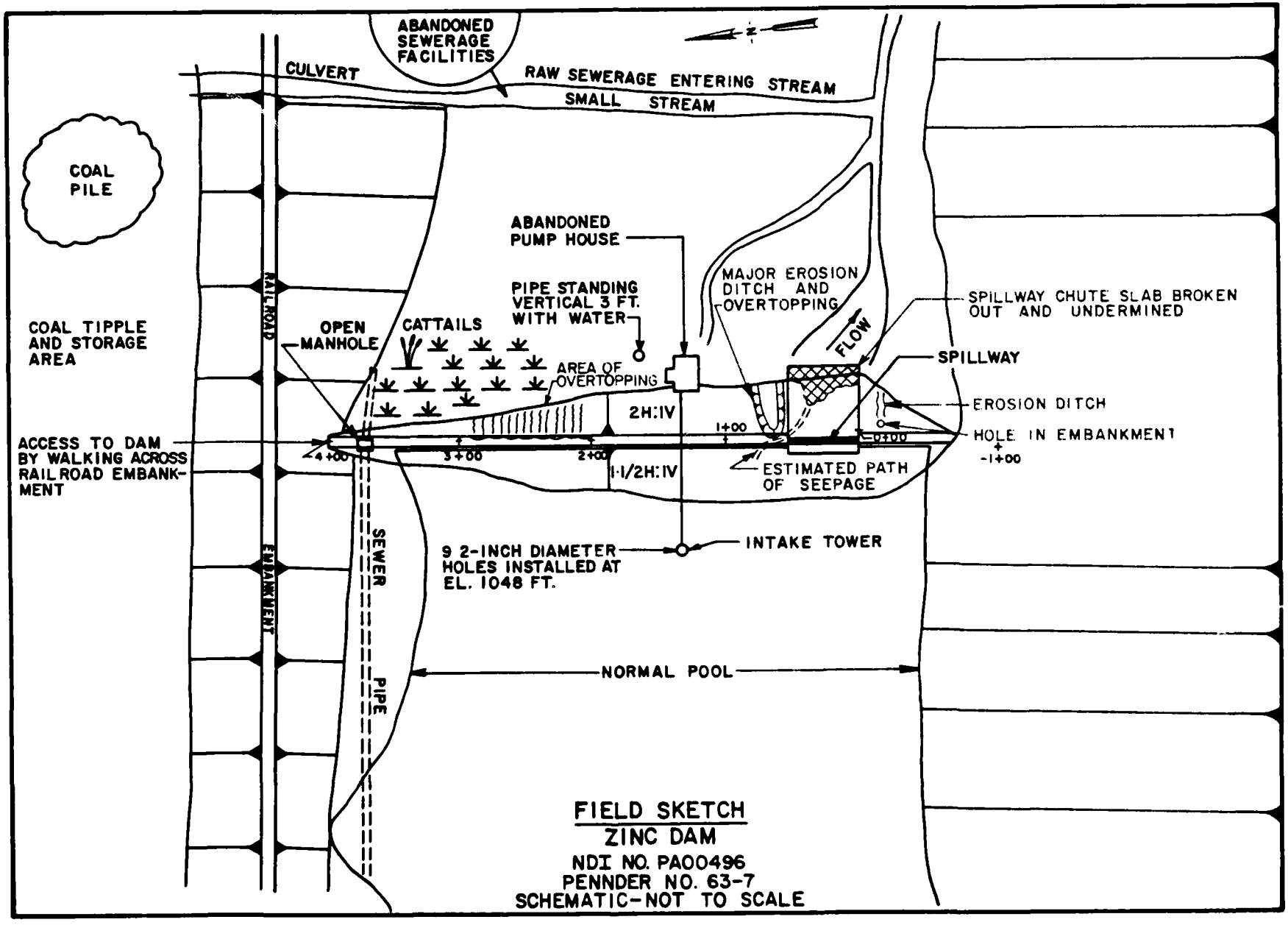
Name of Dam: ZINC DAM
NDI # PA 00496

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	The reservoir slopes are mild on the left side and moderate on the right side. No problems from a soil mechanics point of view were observed. A sewer pipe runs along the reservoir shoreline (and in the former reservoir) on the left side.	
SEDIMENTATION	The reservoir has become very silted since original construction. At the present time the deepest point is 8.4 ft. below the top of dam.	

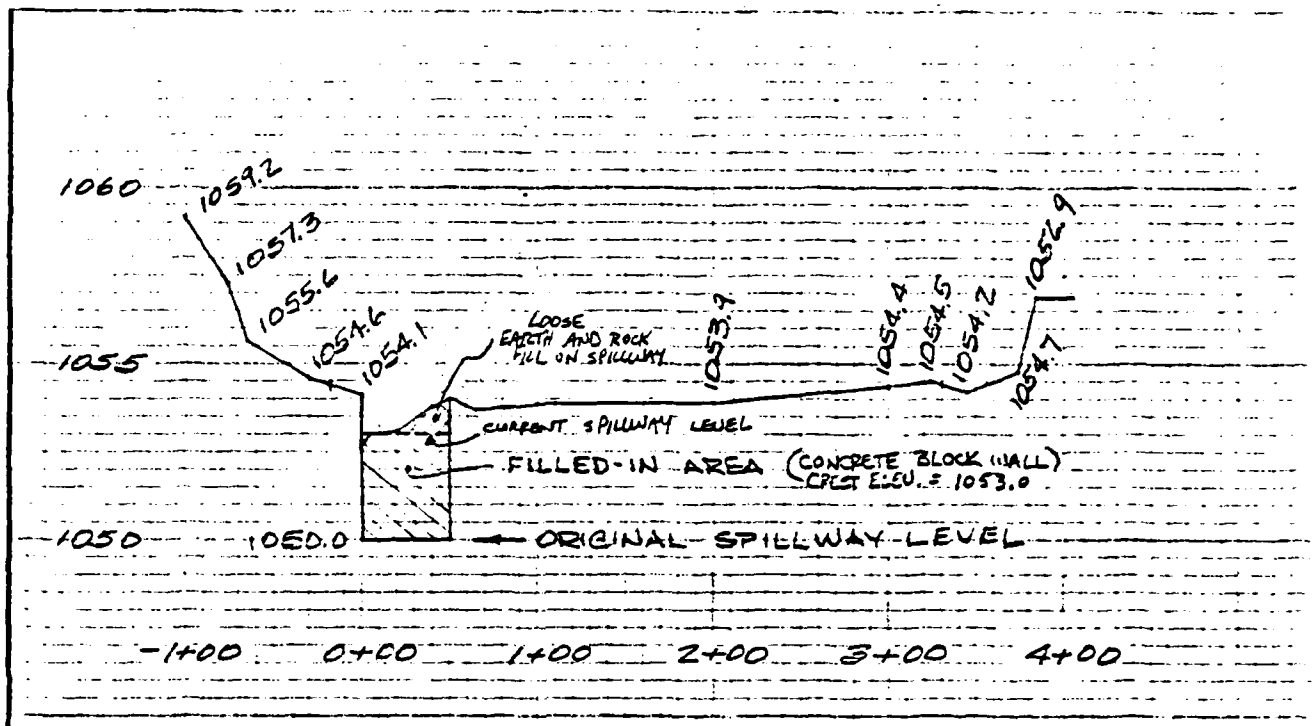
DOWNSTREAM CHANNEL

Name of Dam: ZINC DAM
NDI # PA 00496

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	The downstream channel flows for approximately 1500 ft. before passing under a railroad line. One hundred ft. from the railroad line is the confluence with Burgetts Fork.	
SLOPES	The channel slope to Burgetts Fork is mild (less than 1%). The left side of the valley is formed by a railroad embankment. The right side is a natural and forested slope with a moderately steep slope.	
APPROXIMATE NO. OF HOMES AND POPULATION	Approximately 1700 ft. downstream from the dam is an auto repair shop on the east (far) side of Burgetts Fork. An additional 25 homes are located within the floodplain of Burgetts Fork within 2000 ft. downstream of the confluence of Burgetts Fork and the stream from the dam.	


ABANDONED SEWERAGE FACILITIES
CULVERT
RAW SEWERAGE ENTERING STREAM
SMALL STREAM
COAL PILE
ABANDONED PUMP HOUSE
PIPE STANDING VERTICAL 3 FT. WITH WATER
MAJOR EROSION DITCH AND OVERTOPPING
SPILLWAY CHUTE SLAB BROKEN OUT AND UNDERMINED
COAL TIPPLE AND STORAGE AREA
OPEN MANHOLE
CATTAILS
AREA OF OVERTOPPING
FLOW
SPILLWAY
EROSION DITCH
2H:IV
1+00
0+00
HOLE IN EMBANKMENT
+
-1+00
ACCESS TO DAM BY WALKING ACROSS RAILROAD EMBANKMENT
4+00
3+00
2+00
1-1/2H:IV
ESTIMATED PATH OF SEEPAGE
RAILROAD EMBANKMENT
SEWER PIPE
9 2-INCH DIAMETER HOLES INSTALLED AT EL. 1048 FT.
INTAKE TOWER
NORMAL POOL
FIELD SKETCH
ZINC DAM
NDI NO. PA00496
PENNDER NO. 63-7
SCHEMATIC-NOT TO SCALE

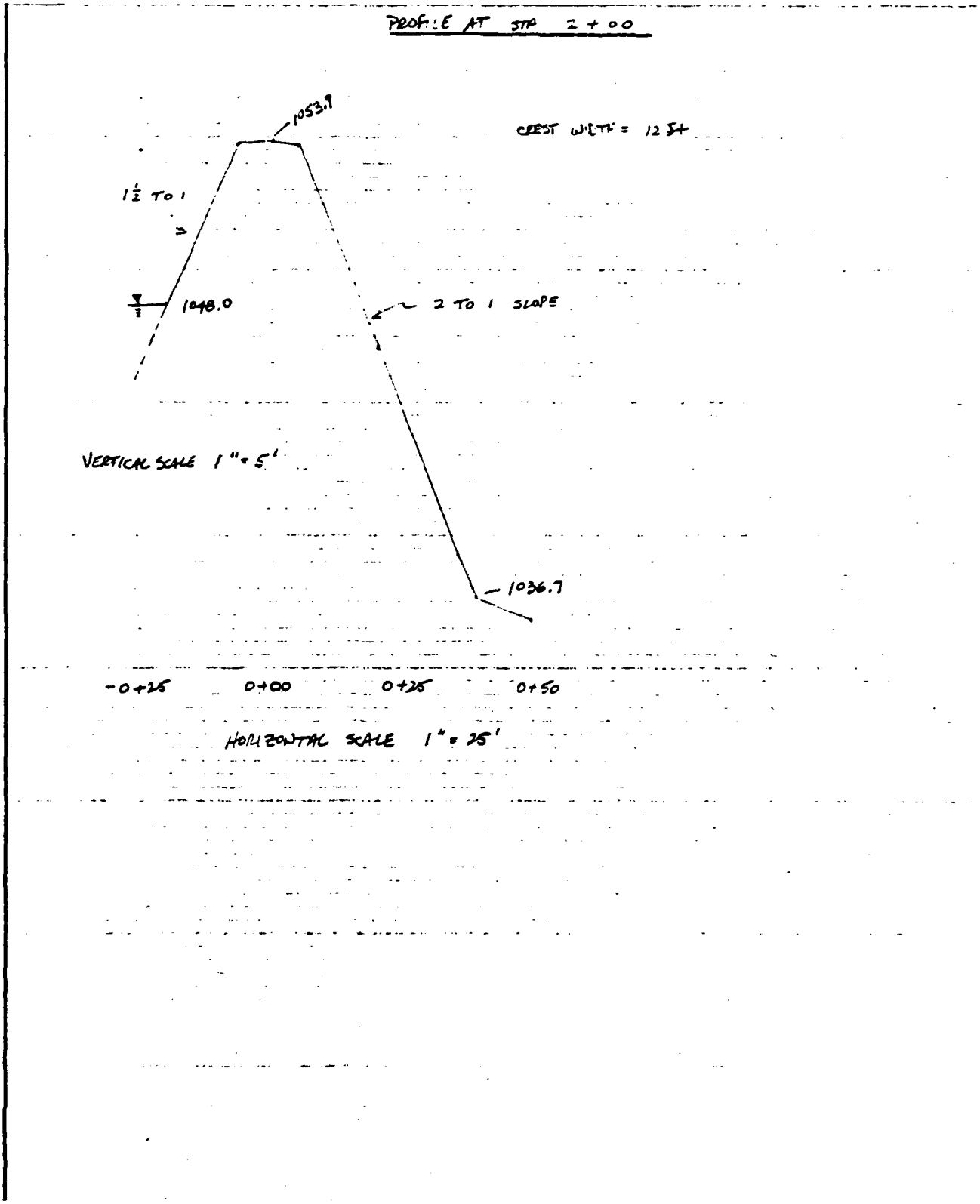
TOP OF DAM PROFILE



NOTE:

FOR HEC-1 ANALYSIS, THE DAM CREST LENGTH WHICH IS SUBJECT TO ACTIVE OVERTOPPING IS USED (343 FT, FROM STATION 0+50 TO STA. 3+73)

TYPICAL CROSS-SECTION



APPENDIX B

ENGINEERING DATA CHECK LIST

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

Name of Dam: ZINC DAM
NDI # PA 00496

ITEM	REMARKS
PLAN OF DAM	See Plate 4 of this report.
REGIONAL VICINITY MAP	A portion of a USGS 7.5 minute topographic quadrangle Avella, Pennsylvania was used to prepare the vicinity map which is included in this report as the Location Plan, Plate 1.
CONSTRUCTION HISTORY	The dam was designed and constructed by the American Zinc and Chemical Company of Langeloth, Pennsylvania. The following individuals were responsible for the dam: N.L. Heinz, General Manager; J.W. Geib, Assistant to General Manager; H.M. Roy, Engineer; MacBeth, General Superintendent of Construction. Work on the dam started in April 1913 and was essentially completed in November 1914.
TYPICAL SECTIONS OF DAM	See Plate 3 of this report.
HYDROLOGIC/HYDRAULIC DATA	No design data were available.
OUTLETS - PLAN	See Plates 3 and 4 of this report.
DETAILS	See Plate 3 of this report.
CONSTRAINTS	None
DISCHARGE RATINGS	No information available.
RAINFALL/RESERVOIR RECORDS	No rainfall or reservoir records are recorded or measured.

Name of Dam: ZINC DAM

NDI # PA 00496

ITEM	REMARKS
DESIGN REPORTS	None available
GEOLOGY REPORTS	None available, see Appendix F for regional geology.
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	None available
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	Test pits were excavated in 1914 (after the core wall was completed) to the foundation level of the cut-off wall, adjacent to the upstream side of the cut-off at distances of 8, 55, 100, 132, 203, 207, 309, and 350 ft. from the left end of the core wall. These pits showed that the foundation of the wall was founded on shale and limestone, except for the 2 ft. key in the middle. However, other information shows that the foundation was extended into underlying sandstone.
POST-CONSTRUCTION SURVEYS OF DAM	None available
BORROW SOURCES	The borrow for the dam was obtained from the reservoir area.

Name of Dam: ZINC DAM

NDI # PA 00496

ITEM	REMARKS
MONITORING SYSTEMS	None
MODIFICATIONS	From reviewing the photographs taken after construction of the dam, it appears that the foot bridge to the intake tower was never constructed. In 1930, repairs to the crest of embankment (to raise it near the spillway) and to the spillway apron were ordered to be performed and were repaired according to the information in the PennDER file. At sometime the intake has either become silted up or was blocked shut. The date this took place is not known. It is estimated that the pumphouse was abandoned at approximately that same time. In 1961 the owner was ordered to rebuild the spillway and clear the vegetation on the downstream slope. The vegetation was cleared but no record is available stating that the spillway had been repaired at that time. At some previous time, treatment facilities were installed and operated downstream from the dam; no information is available concerning these facilities.
HIGH POOL RECORDS	No records available, but it is estimated that within the past 2 years a portion of the embankment has been overtopped by as much as 0.1 to 0.3 ft. of water.
POST-CONSTRUCTION ENGINEERING STUDIES AND REPORTS	No detailed engineering report other than the 1915 Water Supply Commission Report (approximately the time of construction) was available. A number of inspection reports are available in the PennDER file, including the last recorded inspection on 22 June 1972.
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	In 1972 a report was noted that 300-500 g.p.m. of seepage was flowing through the embankment along the left side of spillway. A subsequent inspection report (date of inspection, 16 May 1972) noted that "the spillway of this dam is overgrown, undermined and in complete disrepair. The left abutment of the spillway is broken and the water is flowing under it and down the earthen slope. There are several spots where the water has gone over the earth embankment and eroded ditches on the downstream slope." A subsequent inspection report (date of inspection, 22 June 1972) noted that the embankment sections where the erosion or leakage (continued next page)

ITEM	REMARKS
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS (Con't)	had occurred were repaired. However, the spillway itself was not repaired. Subsequent letters to the owner (at that time Mr. Gus Barbush of Langeloth, PA owned the dam) ordered spillway repairs and removal of spillway obstructions. The required repairs were not performed.
MAINTENANCE OPERATION RECORDS	None available
SPILLWAY PLAN, SECTIONS, and DETAILS	See Plates 3 and 4 of this report.
OPERATING EQUIPMENT PLANS & DETAILS	No information available

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 0.95 sq.mi. (primarily low-density residential with one recently completed housing development near the upper end of the impoundment)

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 1053.0 ft. (47.3 ac.-ft.)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): 1053.7 ft. (54.5 ac.-ft.)

ELEVATION MAXIMUM DESIGN POOL: Unknown

ELEVATION TOP DAM: 1054.0 ft.

CREST: Spillway

a. Elevation 1053.0 ft.
b. Type Broad crested weir
c. Width of Crest Parallel to Flow 1.0 ft.
d. Length of Crest Perpendicular to Flow 50 ft.
e. Location Spillover 60 ft. from right abutment
f. Number and Type of Gates None

OUTLET WORKS:

a. Type One 16 in. dia. pipe
b. Location At center of embankment
c. Entrance inverts 9-2 in. dia. holes, El. 1048.0 to 1048.7 ft.
d. Exit inverts Approximate El. 1035.0 ft.
e. Emergency draindown facilities None

HYDROMETEOROLOGICAL GAGES: None

a. Type
b. Location
c. Records

MAXIMUM NON-DAMAGING DISCHARGE No records available

APPENDIX C

PHOTOGRAPH LOCATION PLAN AND PHOTOGRAPHS

DETAILED PHOTOGRAPH DESCRIPTIONS

Overall View of Dam

Top Photo (OV-T) - Overall View of Dam from Left Abutment (Note areas of overtopping in the embankment at left center of photo)

Bottom Photo (OV-B) - Overall View of Dam from Right Abutment (Spillway is at the center of photo)

Photograph Location Plan

Photo 1 - View of Entrance to Spillway (Syphon used for drawdown in center of photo)

Photo 2 - View of Spillway Slab (Area at center of photo where the slab is broken out is the exit point for seepage from the left side of the spillway)

Photo 3 - View Across Crest of Spillway (Note, owner had already started removal of the spillway for abandonment or repairs)

Photo 4 - Close-up View of Spillway Slab Condition; Area at Upper Center of Photo Exit Point of Seepage from Left Side of the Spillway

Photo 5 - Close-up View of Additional Material Placed on Spillway Crest; Bottom End of Rule Shows the Original Crest of the Spillway

Photo 6 - View of Eroded Area on the Downstream Embankment to the Left of the Spillway

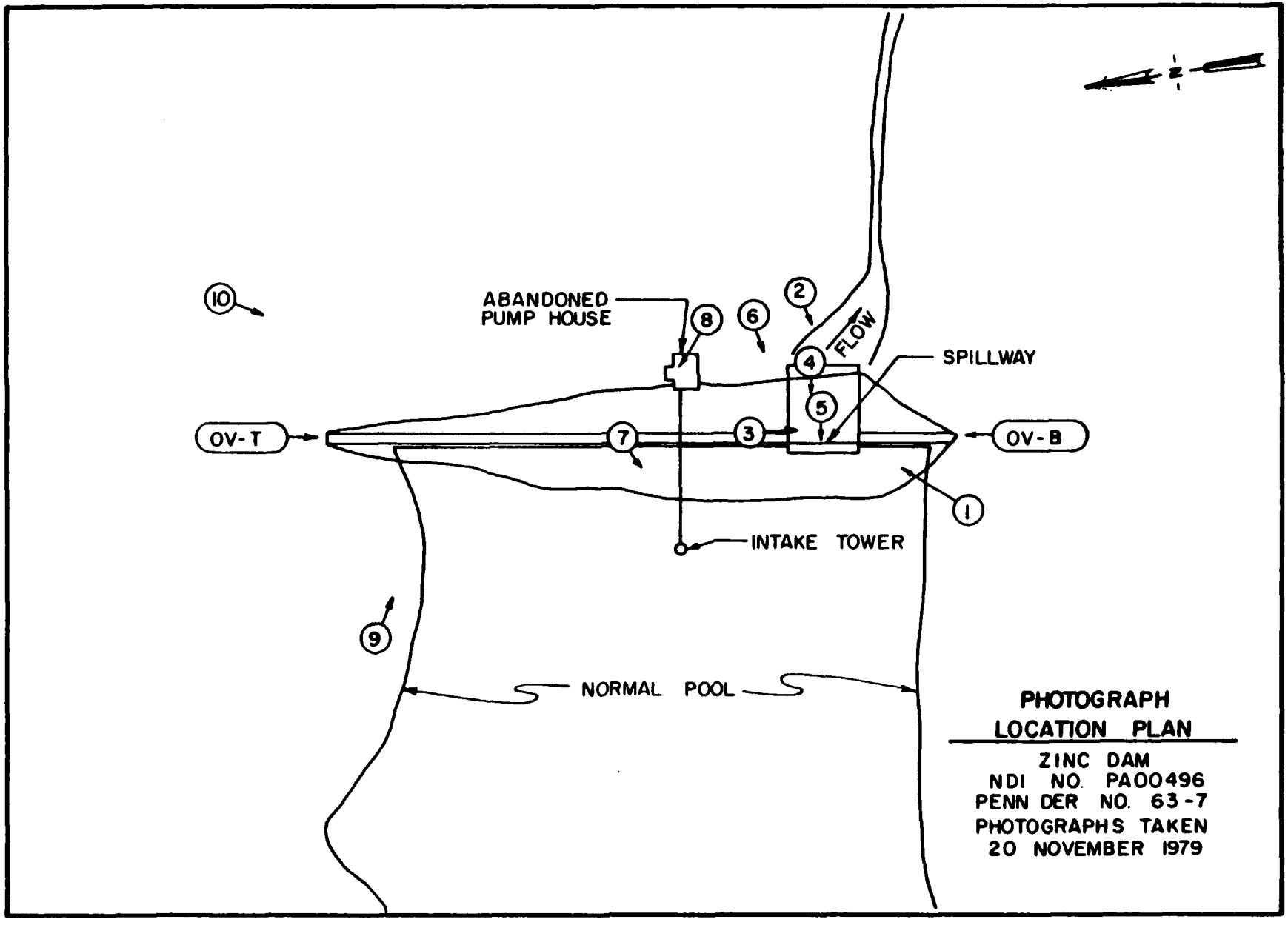
Photo 7 - View of Intake Tower

Photo 8 - View of Outlet in Abandoned Pump House Downstream

Photo 9 - View of the Upstream Embankment Slope

Photo 10 - View of the Downstream Embankment Slope (Note erosion along downstream crest of the embankment)

Note: Photographs were taken on 20 November 1979.



PHOTOGRAPH LOCATION PLAN

ZINC DAM
NDI NO. PA00496
PENN DER NO. 63-7
PHOTOGRAPHS TAKEN
20 NOVEMBER 1979

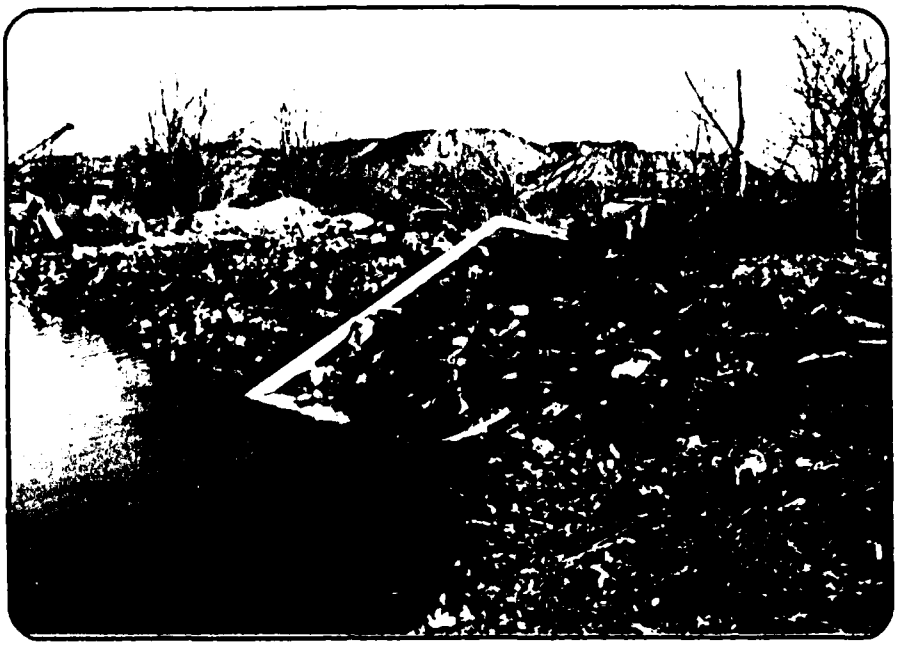


PHOTO 1. View of Entrance to Spillway

PHOTO 2. View of Spillway Slab

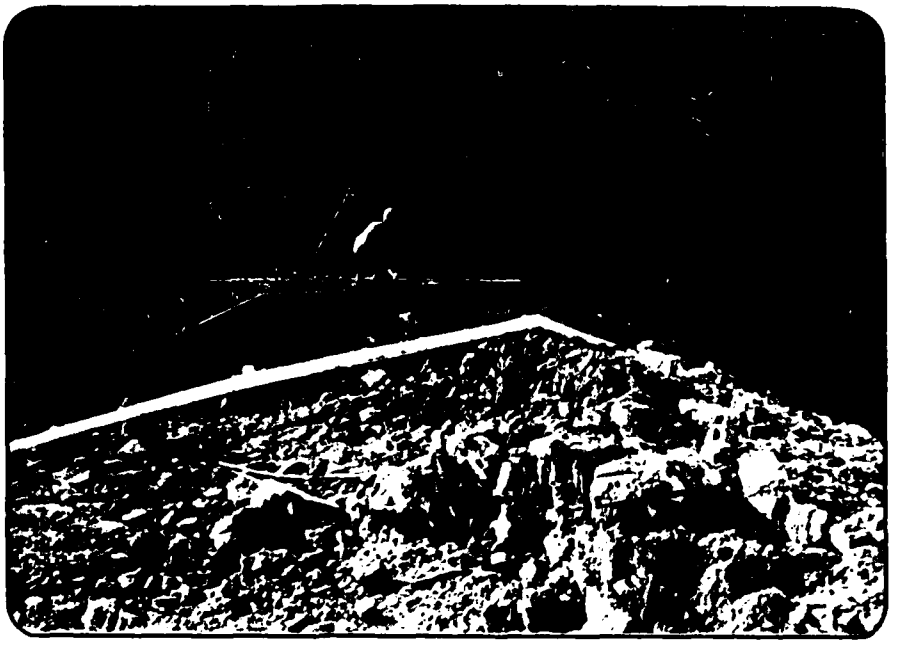


PHOTO 3. View Across Crest of Spillway

PHOTO 4. Close-up View of Spillway Slab Condition

PHOTO 5. Close-up View of Additional Material Placed on Spillway Crest

PHOTO 6. View of Eroded Area on the Downstream Embankment to the Left of the Spillway

PHOTO 7. View of Intake Tower

PHOTO 8. View of Outlet in Abandoned Pump House Downstream

PHOTO 9. View of the Upstream Embankment Slope

PHOTO 10. View of the Downstream Embankment Slope

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject ZINC DAM S.O. No.
APPENDIX D - HYDROLOGIC Sheet No. of
AND HYDRAULIC CALCULATIONS Drawing No.
Computed by Checked by Date

TABLE OF CONTENTS

PREFACE

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

The hydrologic determinations presented in this Phase I Inspection Report are based on the use of a Snyder's unit hydrograph developed by the U.S. Army Corps of Engineers. Due to the limited number of gaging stations available in this hydrologic region and the wide variations of watershed slopes, the Snyder's coefficients may yield results of limited accuracy for this watershed. As directed however, a further refinement of these coefficients is beyond the scope of this Phase I Investigation.

In addition, the conclusions presented pertain to present conditions, and the effect of future development on the hydrology has not been considered.

HYDROLOGY AND HYDRAULIC ANALYSIS
DATA BASE

NAME OF DAM: ZINC DAM

PROBABLE MAXIMUM PRECIPITATION (PMP) = 24.1 INCHES/24 HOURS[1]

STATION	1	2	3	4	5
Station Description	ZINC DAM				
Drainage Area (square miles)	0.95				
Cumulative Drainage Area (square miles)	0.95				
Adjustment of PMF for Drainage Area (%)[2]	ZONE 7				
6 Hours	102				
12 Hours	120				
24 Hours	130				
48 Hours	140				
72 Hours	-				
Snyder Hydrograph Parameters					
Zone [3]	28				
C_p/C_t [4]	0.57/1.7				
L (miles) [5]	1.53				
L_{ca} (miles)[5]	0.77				
$t_p = C_t (L \cdot L_{ca})^{0.3}$ (hours)	1.79				
Spillway Data					
Crest Length (ft)	50.0				
Freeboard (ft)	0.7				
Discharge Coefficient	2.80				
Exponent	1.5				

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

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

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

(4) Snyder's Coefficients.

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

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS
Box 280
Beaver, Pa. 15009

Subject ZINC DAM S.O. No.
Sheet No. 2 of 25
Drawing No.
Computed by WLS Checked by WDL Date

HYDRAULIC AND HYDROLOGIC DATA:

DRAINAGE AREA ABOVE DAM = 0.95 MI^2 (MEASURED ON AVELLA, PA. QUAD)

L_{ca} = 4090 Ft = 0.77 MI.

L = 8,100 Ft = 1.53 MI.

STORAGE COMPUTATIONS:

ELEVATION VS. SURFACE AREA DATA (MEASURED ON QUADS)

ELEVATION (Ft)	AREA (ACRES)
1053.0	10.101
1060.0	15.917
1080.0	37.649

NOTE: NORMAL POOL ASSUMED TO BE AT ELEV. 1053.0

STORAGE AT NORMAL POOL:

$$V = \frac{h}{3}\left(A_1 + A_2 + \sqrt{A_1 A_2}\right)$$

A_1 = AREA AT NORMAL POOL ELEV. = 10.101 ACRES

A_2 = AREA OF BOTTOM OF RESERVOIR = 0.83 ACRES (ESTIMATED FROM SIDE SLOPES AND DEPTH)

h = AVERAGE DEPTH = 5 Ft (ESTIMATED FROM SOUNDINGS)

V = 47.29 Ac-Ft

STORAGE AT TOP OF DAM:

V_{TOD} = $V_{NORMAL\ POOL}$ + VOLUME BETWEEN ELEV. 1053.0 AND 1053.7

$$V_{\substack{1053.0 \\ 1053.7}} = \frac{h}{3}\left(A_1 + A_2 + \sqrt{A_1 A_2}\right)$$

= 7.21 Ac-Ft.

h = 0.7 Ft

A_1 = AREA NORMAL POOL = 10.101 Ac.

A_2 = AREA AT 1053.7 = 10.50 Ac. (ESTIMATED FROM SURVEY AREA DATA)

V_{TOD} = 47.29 + 7.21 = 54.50 Ac-Ft

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject ZINC DAM S.O. No.
HYDRAULIC DATA Sheet No. 3 of 26
Drawing No.
Computed by WDL Checked by MED Date 1/8/80

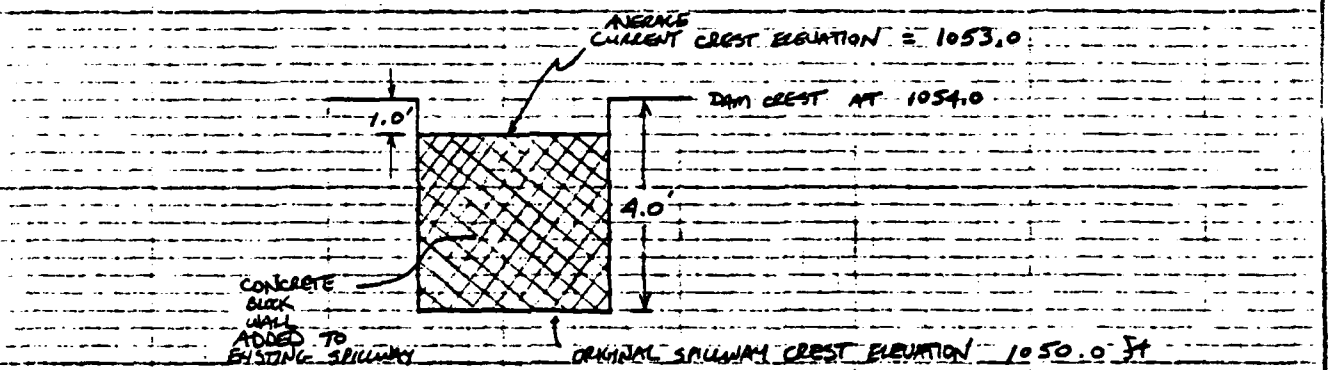
POOL LEVEL AT TIME OF INSPECTION = 1048.0

APPROXIMATE DEPTH OF WATER AT OUTLET TOWER = 2.4'

SEDIMENT DEPTH = 8 Ft AT THE OUTLET TOWER

THE UPPER 1/4 OF THE RESERVOIR HAS BEEN ALMOST COMPLETELY FILLED IN WITH SEDIMENT.

NORMAL POOL LEVEL IS ASSUMED TO BE THE ELEVATION OF THE SPILLWAY CREST (INCLUDING THE ADDITION TO THE CREST WHICH REDUCED THE FREEBOARD FROM 4' TO 1.0')



ADDITIONAL DEBRIS (EARTH, ROCK, AND CONCRETE SLAB REMNANTS) HAS BEEN DUMPED ON THE SPILLWAY. FOR PURPOSES OF FLOOD ROUTING THROUGH THE SPILLWAY, IT IS ASSUMED THAT THIS DEBRIS WILL BE WASHED OUT, THEREBY HAVING NO APPRECIABLE AFFECT ON THE FUNCTIONING OF THE SPILLWAY.

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject: ZINC DAM — S.O. No.:
HYDROGRAPH AND RAINFALL DATA — Sheet No. 9 of 25
Drawing No.:
Computed by: WDL — Checked by: MRD — Date: 12/31/79

HYDROGRAPH DATA: (FROM BALTIMORE DISTRICT, U.S. ARMY CORPS of ENGINEERS)

DRAINAGE AREA IS LOCATED IN ZONE 28

$C_p = 0.57$

C_T = PLATE P

$t_p = 1.7 (L L_{ca})^{0.3}$ $L = 1.53$ mi

$L_{ca} = 0.77$ mi

$t_p = 1.7 [(1.53)(0.77)]^{0.3} = 1.79$ HRS

RAINFALL DATA: (FROM HMR-33)

DAM AND DRAINAGE AREA LOCATED IN ZONE 7

PMP $(24\ HR)_{200\ mi^2} = 24.1$ IN

DRAINAGE AREA = 0.95 mi^2

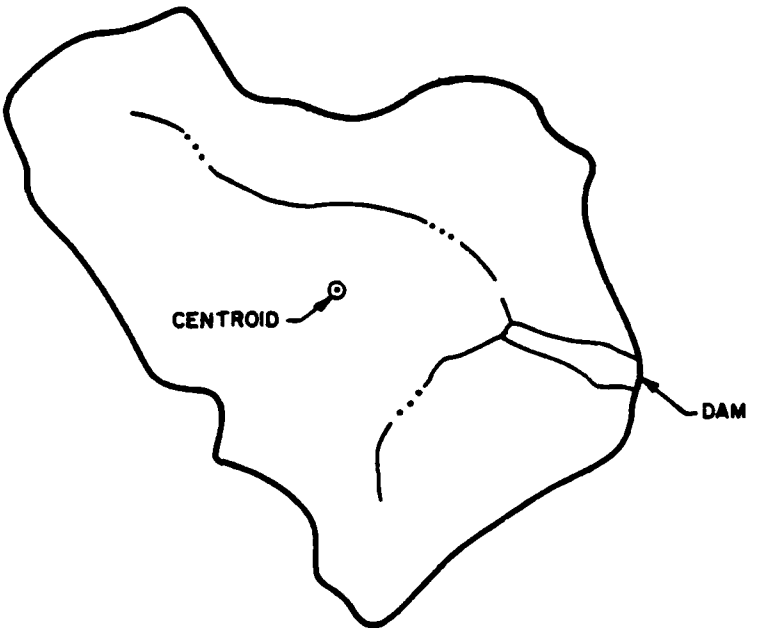
PMP (6 HR) = 102% PMP $(24\ HR)_{200\ mi^2}$

PMP (12 HR) = 120% PMP $(24\ HR)_{200\ mi^2}$

PMP (24 HR) = 130% PMP $(24\ HR)_{200\ mi^2}$

PMP (48 HR) = 140% PMP $(24\ HR)_{200\ mi^2}$

100 YR - 24 HR RAINFALL (from TP-40) = 5.1 IN.



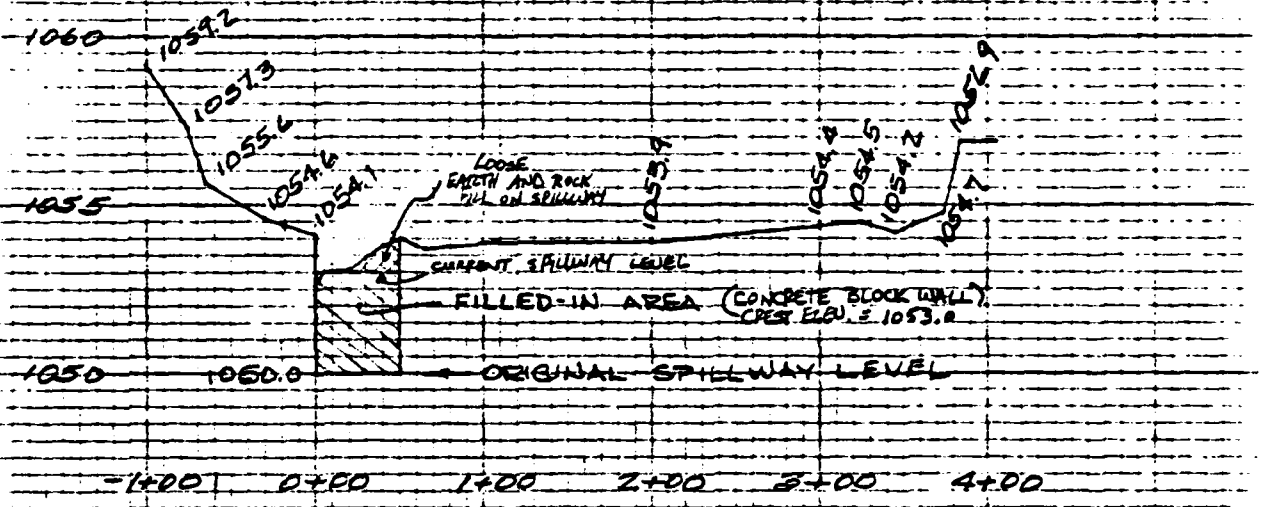
QUAD:
I. AVELLA
DRAINAGE AREA 0.95 SQ. MI.

SCALE 1:24000
DRAINAGE AREA
AT
ZINC DAM

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject ZINC DAM S.O. No.
PROFILE ALONG DAM CREST Sheet No. 6 of 25
Drawing No.
Computed by WLS Checked by WDL Date



NOTE:

FOR HEC-1 ANALYSIS, THE DAM CREST LENGTH WHICH IS SUBJECT TO ACTIVE OVERTOPPING IS USED (343 FT, FROM STATION 0+50 TO STA. 3+73)

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

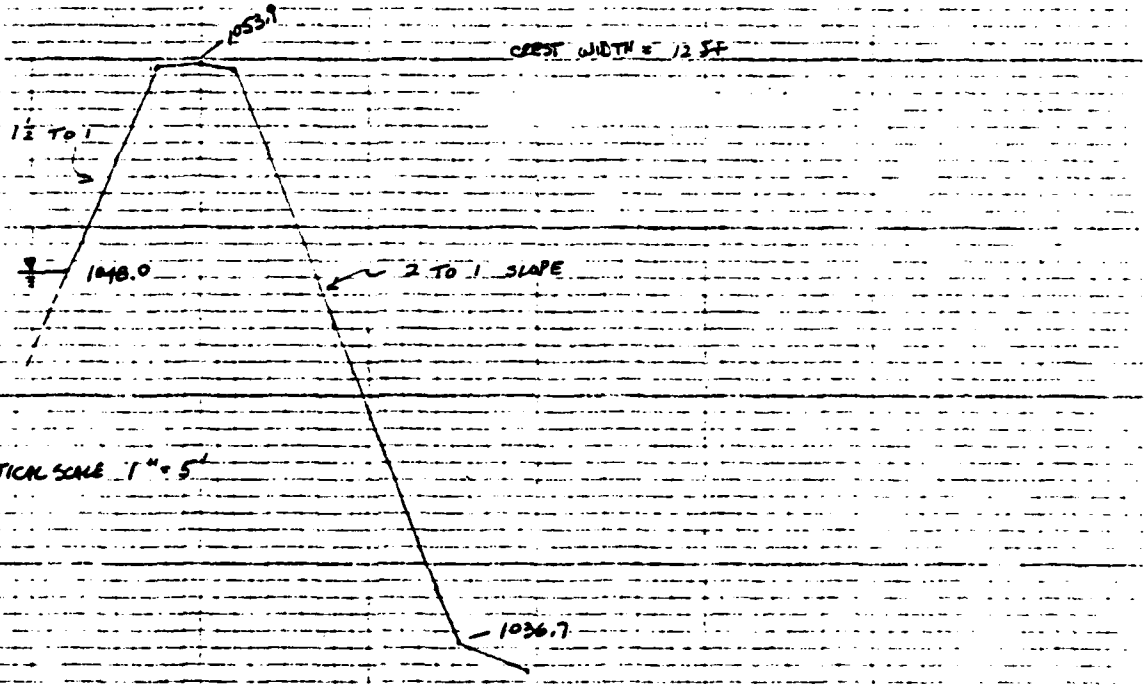
Subject ZINC DAM — S.O. No. ____

CROSS SECTION OF DAM — Sheet No. 7 of 25

Drawing No. ____

Computed by WDL — Checked by MED — Date 12/28/79

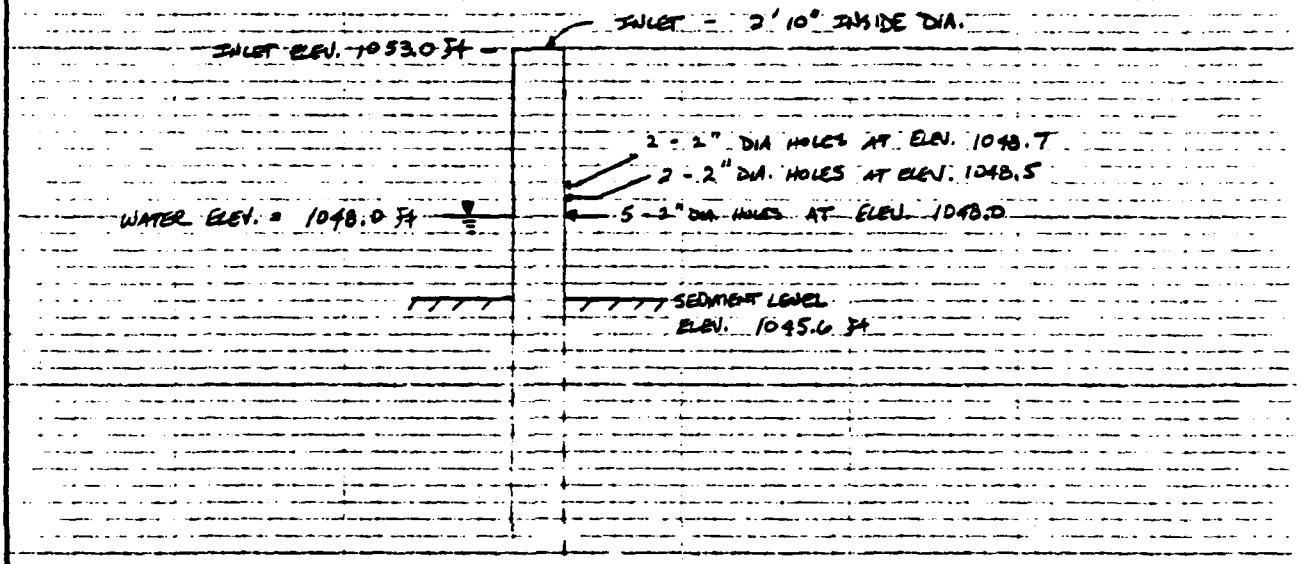
PROFILE AT STA 2+00



MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject ZINC DAM — S.O. No.
OUTLET WORKS — Sheet No. 8 of 25
Drawing No.
Computed by WDG — Checked by MED — Date 1/9/80



2" DIA. HOLES DRILLED INTO OUTLET PIPE DURING INSPECTION ON 20 NOV. 1979

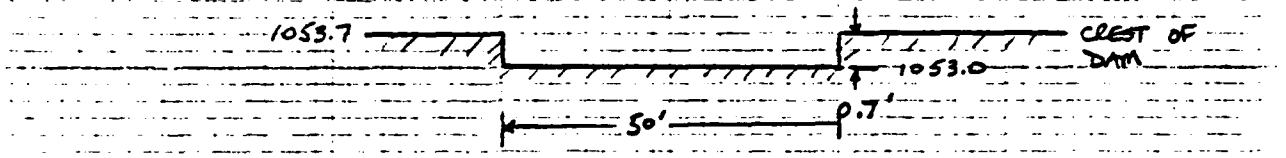
OUTLET WORKS LOCATED AT STATION 2+00

THE OUTLET WORKS ARE IN EXTREMELY POOR CONDITION AND ARE ONLY CAPABLE OF HANDLING A MINIMUM AMOUNT OF FLOW. BECAUSE OF THIS, THEY WERE NOT INCLUDED IN ROUTING FLOODWATERS THROUGH THE DAM.

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject: ZINC DAM — S.O. No.:
SPILLWAY CAPACITY — Sheet No. 9 of 25
Drawing No.:
Computed by: WDL — Checked by: MED — Date: 1/11/80



$Q = C L H^{3/2}$

$= 2.80(50)(0.7)^{3/2}$

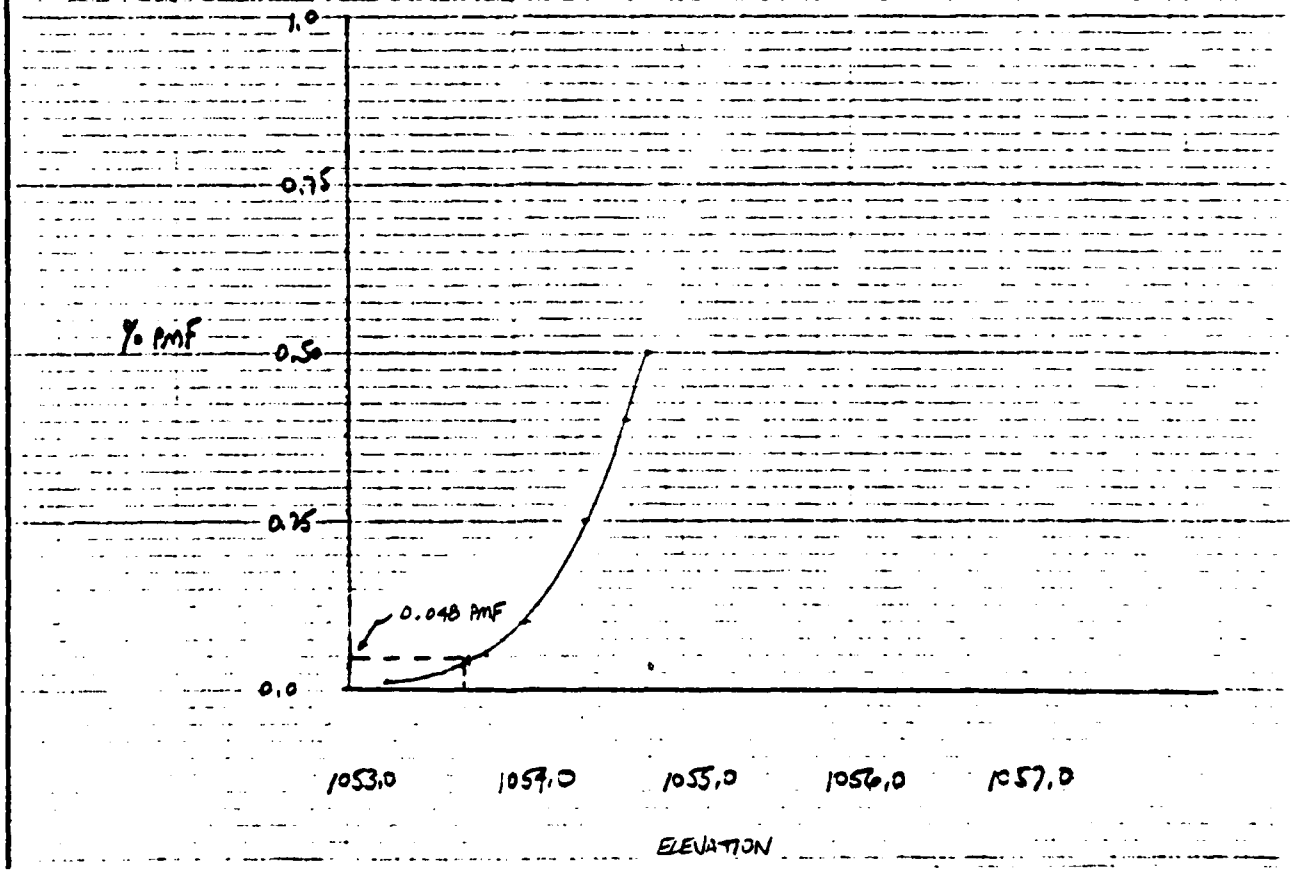
$= 81.99 \text{ cfs}$

= MAXIMUM DISCHARGE OF SPILLWAY BEFORE OVERTOPPING BEGINS

FOR $b = 1'$ AND $H = 0.7'$

$C = 2.80$

0.7 = Δ ELEVATION BETWEEN LOW SPOT ON DAM CREST AND SPILLWAY CREST



MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS
Box 280
Beaver, Pa. 15009

Subject ZINC DAM — S.O. No. ____
DAM FAILURE ASSUMPTIONS — Sheet No. 10 of 25
AND RESULTS — Drawing No. ____
Computed by WDL — Checked by MED — Date ____

ASSUME:

1. FAILURE OCCURS WHEN POOL LEVEL REACHES TOP OF DAM (1053.7 Ft)
2. FAILURE DURATION IS 0.5 HRS
3. DAM WILL FAIL ALONG CREST WHICH IS SUBJECT TO ACTIVE OVERTOPPING (FROM STA. -0+20 TO STA. 3+73, MINUS 50' SPILLWAY). FAILURE DEPTH IS TO LEVEL OF CONCRETE COLLIAR; CONCRETE BLOCKS IN SPILLWAY ASSUMED NOT TO FAIL.

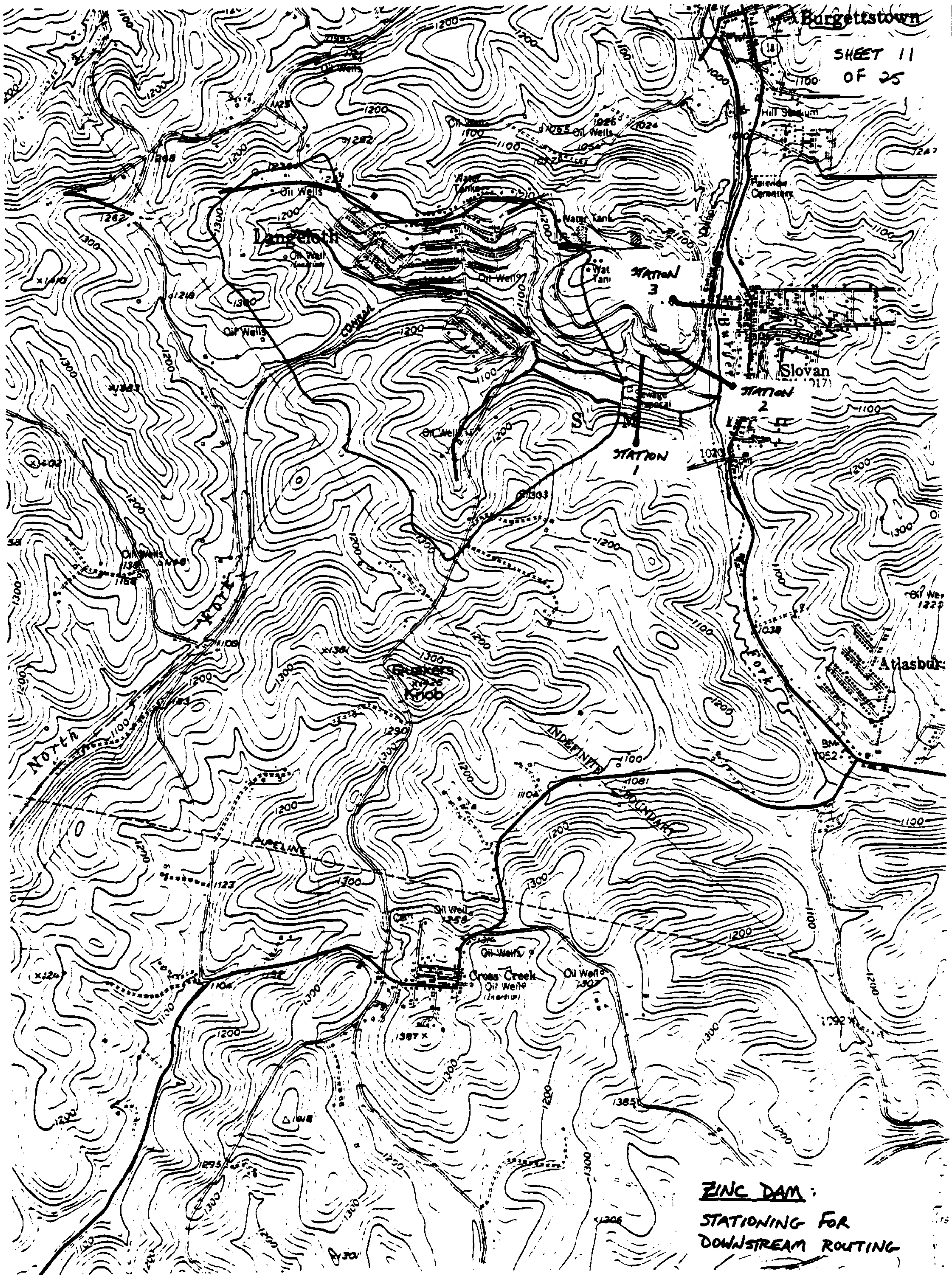
ROUTING REACHES:

DAMAGE CENTER (IN SLOVAN) IS APPROXIMATELY 2000 TO 3200 Ft. DOWNSTREAM OF DAM.

THREE ROUTING REACHES WHICH ARE 300 Ft., 2000 Ft., AND 3200 Ft. DOWNSTREAM OF DAM ARE USED FOR ROUTING IN HEC-1.

PEAK STAGES FOR EACH CASE ARE SHOWN BELOW

	STAGES (Ft) AT EACH STATION DOWNSTREAM OF DAM FOR 1/2 PMF ROUTING		
	300 Ft DOWNSTREAM	2000 Ft DOWNSTREAM	3200 Ft DOWNSTREAM
OVERTOPPING WITH NO FAILURE	1038.2	1017.7	1013.9
OVERTOPPING WITH FAILURE	1038.2	1017.7	1013.9


SHEET 11 OF 25
Burgettstown
Hill Stadium
Fairview Cemetery
Langeloth
Water Tanks
Water Tank
Oil Wells
STATION 3
STATION 2
STATION 1
Slovan
Sewage Disposal
Quakers Knob
Atlasburg
North Fork
INDEFINITE BOUNDARY
PIPELINE
Cross Creek
ZINC DAM:
STATIONING FOR
DOWNSTREAM ROUTING

SPILLWAY CAPACITY ANALYSIS

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**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  26 FEB 79
  MBJ UPDATE         04 JUN 79
**********************************
    1              A1       NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
    2              A2       HYDROLOGIC AND HYDRAULIC ANALYSES OF ZINC DAM
    3              A3       UNIT GRAPH BY SNYDERS METHOD
    4              B     500        0        5        0        0        0        0        0       -4        0
    5              B1      5
    6              J       1        5        1
    7              J1   0.50     0.25     0.10     0.05     0.01
    8              K       0        1                                          1
    9              K1       RUNOFF HYDROGRAPH TO DAM
   10              M       1        1     0.95
   11              P               24.1      102      120      130      140
   12              T                                                    1.0     0.05
   13              W    1.72     0.57
   14              X    -1.5    -0.05      2.0
   15              K       1        2                                          1
   16              K1       ROUTING FOR ZINC DAM
   17              Y                                          1        1
   18              Y1      1                                                -1053.0
   19              $A      0     10.1     15.9     37.6
   20              $E   1039     1056     1060     1080
   21              $$1053.0       50     2.80      1.5
   22              $D1053.7     3.08      1.5      343
   23              $L      0       52      200      225      363      415      445      455
   24              $V1053.7   1053.8   1053.9   1054.0   1054.4   1055.0   1056.0   1056.9
   25              K      99
```

SHEET 12 OF 25

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**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION   26 FEB 79
  MBJ UPDATE          04 JUN 79
**********************************

RUN  DATE 02/14/80
     TIME    14.51
```

NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
HYDROLOGIC AND HYDRAULIC ANALYSES OF ZINC DAM
UNIT GRAPH BY SNYDERS METHOD

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
500	0	5	0	0	0	0	0	-4	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 5 LRTIO= 1
RTIOS= 0.50 0.25 0.10 0.05 0.01

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

RUNOFF HYDROGRAPH TO 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	0.95	0.0	0.95	0.0	0.0	0	0	0

PRECIP DATA

SPEE	PMS	R6	R12	R24	R48	R72	R96
0.0	24.10	102.00	120.00	130.00	140.00	0.0	0.0

TRSPC COMPUTED BY THE PROGRAM IS 0.800

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= 1.72 CP=0.57 NTA= 0

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

UNIT HYDROGRAPH100 END-OF-PERIOD ORDINATES, LAG= 1.72 HOURS, CP= 0.57 VOL= 0.98

2.	8.	17.	28.	40.	53.	67.	81.	96.	112.
128.	144.	158.	171.	182.	192.	199.	205.	209.	212.
212.	208.	201.	193.	184.	176.	168.	161.	154.	147.

SHEET 13 OF 25

```
  90.     86.     83.     79.     76.     72.     69.     66.     63.     61.
  58.     55.     53.     51.     49.     46.     44.     42.     41.     39.
  37.     36.     34.     33.     31.     30.     28.     27.     26.     25.
  24.     23.     22.     21.     20.     19.     18.     17.     17.     16.
  15.     15.     14.     13.     13.     12.     12.     11.     11.     10.
  10.      2.      9.      9.      8.      8.      8.      7.      7.      7.

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

                                                                              SUM  26.99   24.57    2.42   173789.
                                                                                 ( 686.)( 624.)(  61.)( 4921.16)

          **********          **********          **********          **********          **********

                                         HYDROGRAPH ROUTING

                    ROUTING FOR ZINC 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  -1053.       0

 SURFACE AREA=        0.        10.        16.        38.

     CAPACITY=        0.        50.       128.       648.

    ELEVATION=     1039.      1054.      1060.      1080.

                   CREL   SPWID    COQW    EXPW   ELEVL    COQL   CAREA    EXPL
                 1053.0    50.0     2.8     1.5     0.0     0.0     0.0     0.0

                                           DAM DATA
                                   TOPEL    COQD    EXPD  DAMWID
                                  1053.7     3.1     1.5    343.

   CREST LENGTH          0.      52.     200.     225.     343.     415.     445.     455.
   AT OR BELOW
   ELEVATION         1053.7   1053.8   1053.9   1054.0   1054.4   1055.0   1056.0   1056.9

 PEAK OUTFLOW IS      1225. AT TIME  41.33 HOURS

 PEAK OUTFLOW IS       612. AT TIME  41.33 HOURS

 PEAK OUTFLOW IS       243. AT TIME  41.42 HOURS

 PEAK OUTFLOW IS       114. AT TIME  41.75 HOURS

 PEAK OUTFLOW IS        21. AT TIME  42.25 HOURS

          **********          **********          **********          **********          **********
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SHEET 19 OF 25

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 0.50	RATIO 2 0.25	RATIO 3 0.10	RATIO 4 0.05	RATIO 5 0.01
HYDROGRAPH AT	1	0.95	1	1228.	614.	246.	123.	25.
		(2.46)		(34.78)(	17.39)(	6.96)(	3.48)(	0.70)(
ROUTED TO	2	0.95	1	1225.	612.	243.	114.	21.
		(2.46)		(34.70)(	17.33)(	6.87)(	3.22)(	0.58)(

SHEET 15 OF 25

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1053.00	1053.00	1053.70
STORAGE	41.	41.	48.
OUTFLOW	0.	0.	82.

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
0.50	1054.83	1.13	59.	1225.	15.25	41.33	0.0
0.25	1054.44	0.74	55.	612.	10.17	41.33	0.0
0.10	1054.08	0.38	51.	243.	6.08	41.42	0.0
0.05	1053.84	0.14	49.	114.	3.00	41.75	0.0
0.01	1053.28	0.0	44.	21.	0.0	42.25	0.0

SHEET 16 OF 25

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  26 FEB 79
  MBJ UPDATE         04 JUN 79
**********
    1              A1       NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
    2              A2       HYDROLOGIC AND HYDRAULIC ANALYSES OF ZINC DAM
    3              A3       UNIT GRAPH BY SNYDERS METHOD
    4              B    500        0         5         0         0         0         0         0        -4         0
    5              B1     5
    6              J      2        1         1
    7              J1  0.50
    8              K      0        1                                              1
    9              K1       RUNOFF HYDROGRAPH TO DAM
   10              M      1        1      0.95                                                        1
   11              P             24.1       102       120       130       140
   12              T                                                          1.0      0.05
   13              W   1.72     0.57
   14              X   -1.5    -0.05       2.0
   15              K      1        2                                              1
   16              K1       ROUTING FOR ZINC DAM
   17              Y                                            1         1
   18              Y1     1                                                  -1053.0
   19              $A     0     10.1      15.9      37.6
   20              $E  1039     1054      1060      1080
   21              $$1053.0       50      2.80       1.5
   22              $D1053.7     3.08       1.5       343
   23              $L     0       52       200       225       343       415       445       455
   24              $V1053.7  1053.8    1053.9    1054.0    1054.4    1055.0    1056.0    1056.9
   25              $B   343        0      1051       0.5    1053.0    1053.7
   26              $B   343        0      1051       0.5    1053.0    2000.0
   27              K      1        3                                              1
   28              K1       ROUTE TO SECTION 300 FEET DOWNSTREAM OF DAM
   29              Y                                            1         1
   30              Y1     1                                                          0
   31              Y6 0.060    0.040     0.060      1032      1058       300      0.01
   32              Y7     0     1058        50      1041     297.5      1036       298      1032       302      1032
   33              Y7 302.5     1036       410    1037.2       470      1060
   34              K      1        4                                              1
   35              K1       ROUTE TO SECTION 2000 FEET DOWNSTREAM OF DAM
   36              Y                                            1         1
   37              Y1     1                                                          0
   38              Y6 0.060    0.040     0.060      1012      1039      1700    0.0118
   39              Y7     0     1037        20      1020     197.5      1016       198      1012       202      1012
   40              Y7 202.5     1016       460      1017       700      1030
   41              K      1        4                                              1
   42              K1       ROUTE TO SECTION 3200 FEET DOWNSTREAM OF DAM
   43              Y                                            1         1
   44              Y1     1                                                          0
   45              Y6 0.060    0.040     0.060    1007.2      1030      1200     0.004
   46              Y7     0     1035        40      1019      97.5    1011.2        98    1007.2       102    1007.2
   47              Y7 102.5    1011.2       470      1014       900      1030
   48              K     99
```

DOWNSTREAM ROUTING ANALYSIS - FAILURE AND NON-FAILURE CASES

PLAN 1 = FAILURE
PLAN 2 = NON-FAILURE

SHEET 17 OF 35

****
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 26 FEB 79
MBJ UPDATE 04 JUN 79
****

RUN DATE 02/14/80
TIME 13.35

NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
HYDROLOGIC AND HYDRAULIC ANALYSES OF ZINC DAM
UNIT GRAPH BY SNYDERS METHOD

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
500	0	5	0	0	0	0	0	-4	0

JOPER	NWT	LROPT	IRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 2 NRTIO= 1 LRTIO= 1
RTIOS= 0.50

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

RUNOFF HYDROGRAPH TO 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	0.95	0.0	0.95	0.0	0.0	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.0	24.10	102.00	120.00	130.00	140.00	0.0	0.0

TRSPC COMPUTED BY THE PROGRAM IS 0.800

LOSS DATA

LRUPT	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= 1.72 CP=0.57 NTA= 0

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

UNIT HYDROGRAPH 100 END-OF-PERIOD ORDINATES, LAG= 1.72 HOURS, CP= 0.57 VOL= 0.98

2.	8.	17.	28.	40.	53.	67.	81.	96.	112.
128.	144.	158.	171.	182.	192.	199.	205.	209.	212.
212.	208.	201.	193.	184.	176.	168.	161.	154.	147.
141.	135.	129.	124.	118.	113.	108.	104.	99.	95.

SHEET 10 OF 25

```
     90.        86.        83.        79.        76.        72.        69.        66.        63.        61.
     58.        55.        53.        51.        49.        46.        44.        42.        41.        39.
     37.        36.        34.        33.        31.        30.        28.        27.        26.        25.
     24.        23.        22.        21.        20.        19.        18.        17.        17.        16.
     15.        15.        14.        13.        13.        12.        12.        11.        11.        10.
     10.         9.         9.         9.         8.         8.         8.         7.         7.         7.

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

                                                                             SUM  26.99  24.57   2.42  173789.
                                                                                ( 686.)( 624.)(  61.)( 4921.16)


           **********          **********          **********          **********          **********

                                              HYDROGRAPH ROUTING

                        ROUTING FOR ZINC 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    IRES   ISAME    IOPT    IPMP            LSTR
                          0.0     0.0     0.0       1       1       0       0               0

                                NSTPS   NSTOL     LAG   AMSKK       X     TSK   STORA  ISPRAT
                                    1       0       0     0.0     0.0     0.0  -1053.       0

   SURFACE AREA=        0.        10.        16.        38.

       CAPACITY=        0.        50.       128.       648.

      ELEVATION=     1039.      1054.      1060.      1080.

                             CREL   SPWID    COQW    EXPW   ELEVL    COQL   CAREA    EXPL
                           1053.0    50.0     2.8     1.5     0.0     0.0     0.0     0.0

                                                       DAM DATA
                                               TOPEL    COQD    EXPD   DAMWID
                                              1053.7     3.1     1.5     343.

      CREST LENGTH        0.        52.       200.       225.       343.       415.       445.       455.
      AT OR BELOW
      ELEVATION       1053.7     1053.8     1053.9     1054.0     1054.4     1055.0     1056.0     1056.9

                                                     DAM BREACH DATA
                                          BRWID       Z    ELBM    TFAIL     WSEL   FAILEL
                                           343.     0.0 1051.00     0.50  1053.00  1053.70

  BEGIN DAM FAILURE AT 32.83 HOURS

  PEAK OUTFLOW IS     1226. AT TIME  41.25 HOURS

                                                     DAM BREACH DATA
                                          BRWID       Z    ELBM    TFAIL     WSEL   FAILEL
                                           343.     0.0 1051.00     0.50  1053.00  2000.00

  PEAK OUTFLOW IS     1225. AT TIME  41.33 HOURS
```

SHEET 19 OF 25

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTE TO SECTION 300 FEET DOWNSTREAM OF DAM

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	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	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
0.0600	0.0400	0.0600	1032.0	1058.0	300.	0.01000

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

0.0 1058.00 50.00 1041.00 297.50 1036.00 298.00 1032.00 302.00 1032.00
302.50 1036.00 410.00 1037.20 470.00 1060.00

STORAGE	0.0	0.04	0.08	0.13	1.19	3.28	6.05	9.43	12.98	16.61
	20.30	24.07	27.91	31.83	35.81	39.87	43.99	48.19	52.47	56.81
OUTFLOW	0.0	19.00	51.33	92.13	476.48	1879.81	4375.84	8298.46	13723.56	20265.88
	27852.79	36433.68	45971.33	56437.39	67809.94	80071.75	93209.31	107211.38	122070.13	137778.38
STAGE	1032.00	1033.37	1034.74	1036.11	1037.47	1038.84	1040.21	1041.58	1042.95	1044.32
	1045.68	1047.05	1048.42	1049.79	1051.16	1052.53	1053.89	1055.26	1056.63	1058.00
FLOW	0.0	19.00	51.33	92.13	476.48	1879.81	4375.84	8298.46	13723.56	20265.88
	27852.79	36433.68	45971.33	56437.39	67809.94	80071.75	93209.31	107211.38	122070.13	137778.38

MAXIMUM STAGE IS 1038.2

MAXIMUM STAGE IS 1038.2

SHEET 38 OF 56

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTE TO SECTION 2000 FEET DOWNSTREAM OF DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
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   NSTDL     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
           0.0600  0.0400  0.0600  1012.0  1030.0   1700. 0.01180

            CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
                0.0  1037.00    20.00 1020.00   197.50 1016.00   198.00 1012.00   202.00 1012.00
              202.50 1016.00   460.00 1017.00   700.00 1030.00

     STORAGE        0.0         0.15         0.31         0.48         0.66         4.04        15.55        29.58        45.81        64.02
                   83.05      102.78       123.20       144.30       166.09       188.56       211.73       235.58       260.12       285.35

     OUTFLOW        0.0        11.97        33.05        58.80        88.14       243.09      1243.63      3183.44      6004.18      9857.30
                14699.10    20385.07     26889.91     34198.29     42301.27     51194.17     60875.50     71345.94     82608.13     94665.94

       STAGE     1012.00     1012.95      1013.89      1014.84      1015.79      1016.74      1017.68      1018.63      1019.58      1020.53
                 1021.47     1022.42      1023.37      1024.31      1025.26      1026.21      1027.16      1028.10      1029.05      1030.00

        FLOW        0.0        11.97        33.05        58.80        88.14       243.09      1243.63      3183.44      6004.18      9857.30
                14699.10    20385.07     26889.91     34198.29     42301.27     51194.17     60875.50     71345.94     82608.13     94665.94

   MAXIMUM STAGE IS    1017.7

   MAXIMUM STAGE IS    1017.7


             **********          **********          **********          **********          **********

                                                 HYDROGRAPH ROUTING

                             ROUTE TO SECTION 3200 FEET DOWNSTREAM OF DAM

                                 ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                                     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   NSTDL     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
           0.0600  0.0400  0.0600  1007.2  1030.0   1200. 0.00400

            CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
                [illegible]
```

SHEET 21 OF 25

102.50 1011.20 470.30 1014.00 900.00 1030.00

STORAGE	0.0	0.14	0.28	0.44	1.83	8.41	20.26	34.38	49.87	66.71
	84.91	104.35	124.94	146.71	169.63	193.73	218.99	245.41	273.00	301.75
OUTFLOW	0.0	9.91	26.96	47.75	115.15	550.78	1756.19	3918.47	6843.22	10520.51
	14967.07	20229.04	26267.15	33094.76	40728.10	49185.25	58485.39	68648.38	79694.88	91645.81
STAGE	1007.20	1008.40	1009.60	1010.80	1012.00	1013.20	1014.40	1015.60	1016.80	1018.00
	1019.20	1020.40	1021.60	1022.80	1024.00	1025.20	1026.40	1027.60	1028.80	1030.00
FLOW	0.0	9.91	26.96	47.75	115.15	550.78	1756.19	3918.47	6843.22	10520.51
	14967.07	20229.04	26267.15	33094.76	40728.10	49185.25	58485.39	68648.38	79694.88	91645.81

MAXIMUM STAGE IS 1013.9

MAXIMUM STAGE IS 1013.9

********** ********** ********** ********** **********

SHEET 20 OF 35

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 0.50
				RATIOS APPLIED TO FLOWS
HYDROGRAPH AT	1	0.95	1	1228.
	(	2.46)	(	34.78)(
			2	1228.
			(	34.78)(
ROUTED TO	2	0.95	1	1226.
	(	2.46)	(	34.71)(
			2	1225.
			(	34.70)(
ROUTED TO	3	0.95	1	1226.
	(	2.46)	(	34.72)(
			2	1225.
			(	34.70)(
ROUTED TO	4	0.95	1	1218.
	(	2.46)	(	34.49)(
			2	1217.
			(	34.45)(
ROUTED TO	4	0.95	1	1212.
	(	2.46)	(	34.33)(
			2	1212.
			(	34.31)(

SHEET 43 OF 55

SUMMARY OF DAM SAFETY ANALYSIS

		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
	ELEVATION	1053.00	1053.00	1053.70
	STORAGE	41.	41.	48.
	OUTFLOW	0.	0.	82.

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
0.50	1053.70	0.00	48.	1226.	0.11	41.25	32.83

PLAN 2

		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
	ELEVATION	1053.00	1053.00	1053.70
	STORAGE	41.	41.	48.
	OUTFLOW	0.	0.	82.

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
0.50	1054.83	1.13	59.	1225.	15.25	41.33	0.0

PLAN 1 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.50	1226.	1038.2	41.33

PLAN 2 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.50	1225.	1038.2	41.33

PLAN 1 STATION 4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.50	1218.	1017.7	41.42

PLAN 2 STATION 4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.50	1217.	1017.7	41.42

PLAN 1 STATION 4

SHEET 24 OF 25

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.50	1212.	1013.9	41.58

PLAN 2 STATION 4

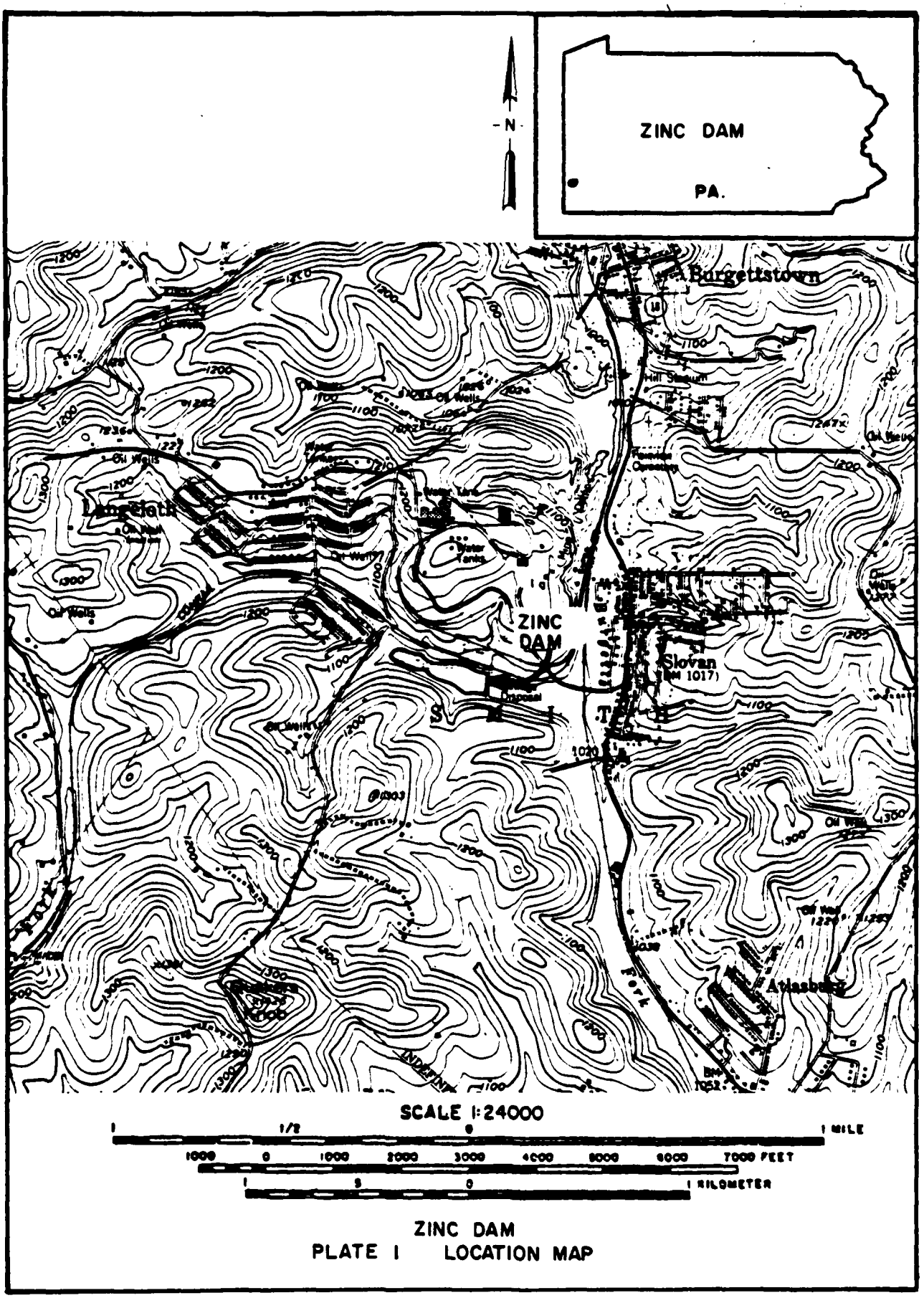
RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.50	1212.	1013.9	41.58

SHEET 25 OF 26

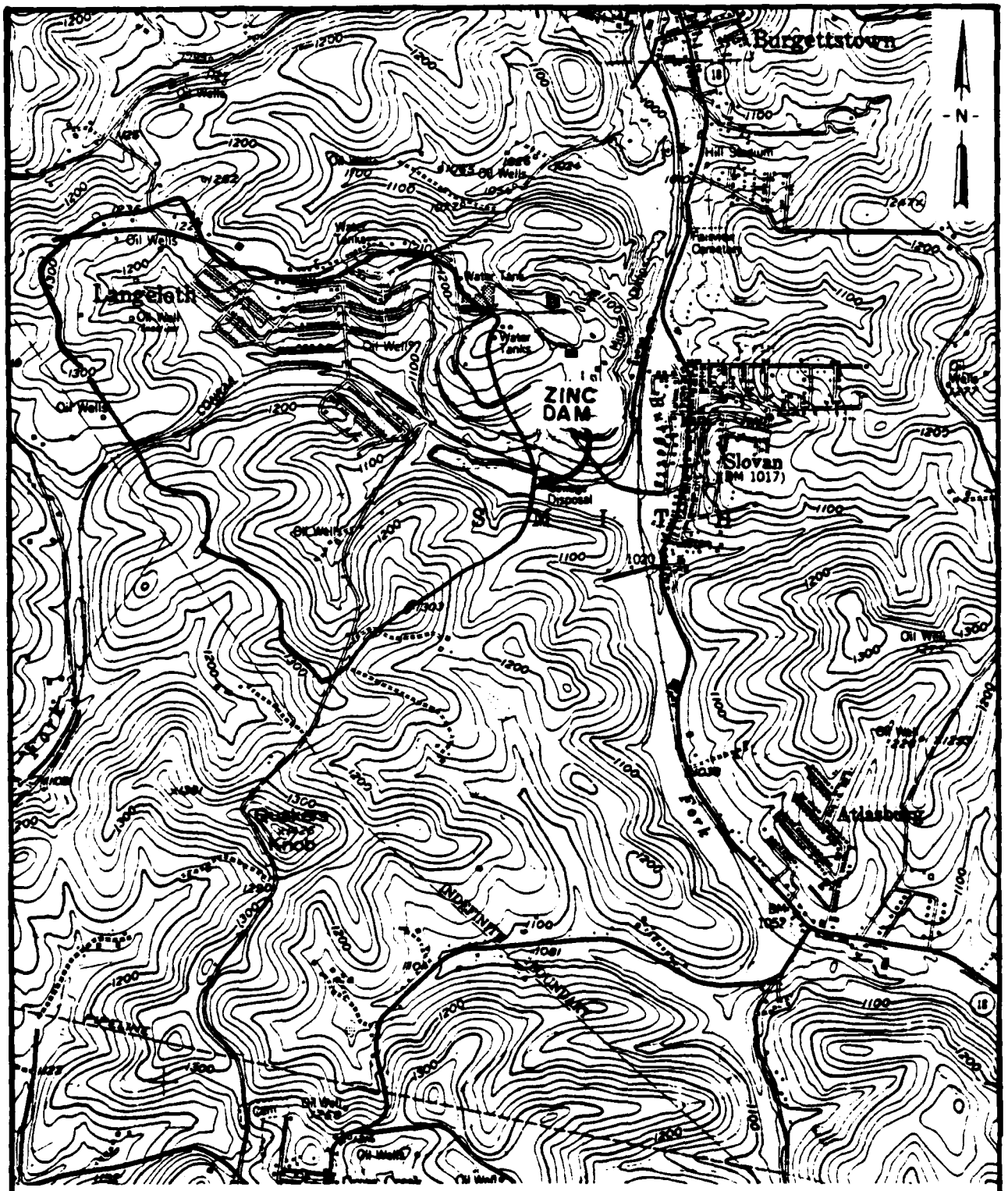
APPENDIX E

PLATES

CONTENTS

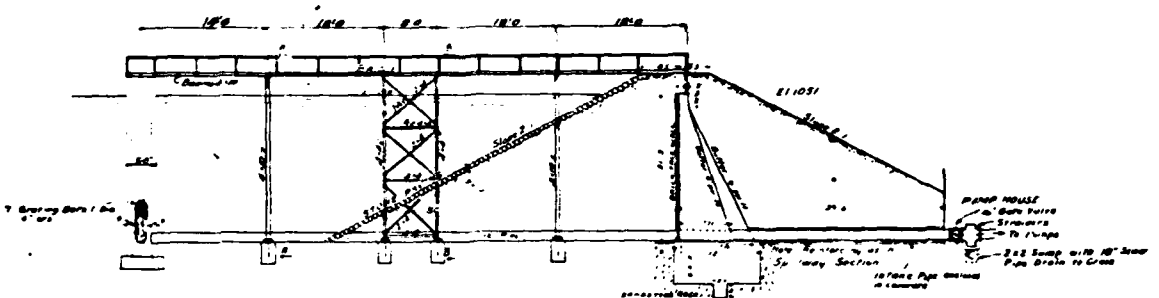


ZINC DAM
PLATE 1 LOCATION MAP



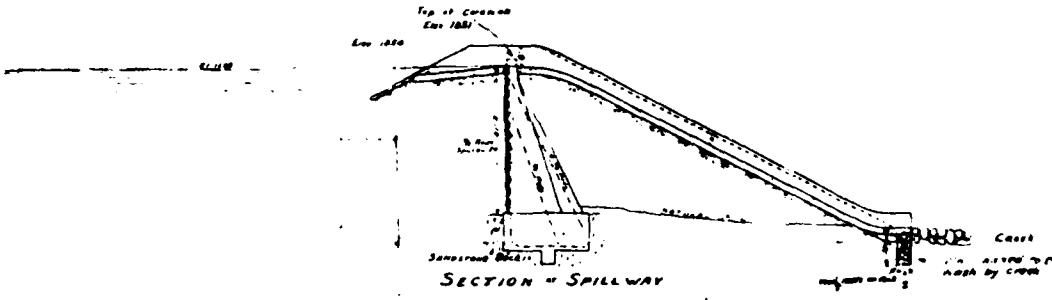
ZINC DAM

PLATE 2 WATERSHED MAP

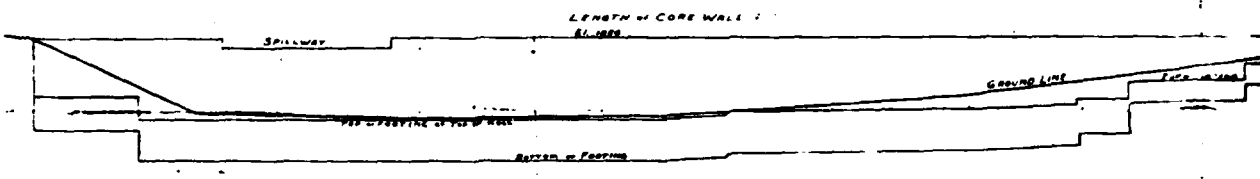


TYPICAL SECTION

1 : 2 : 4 Concrete

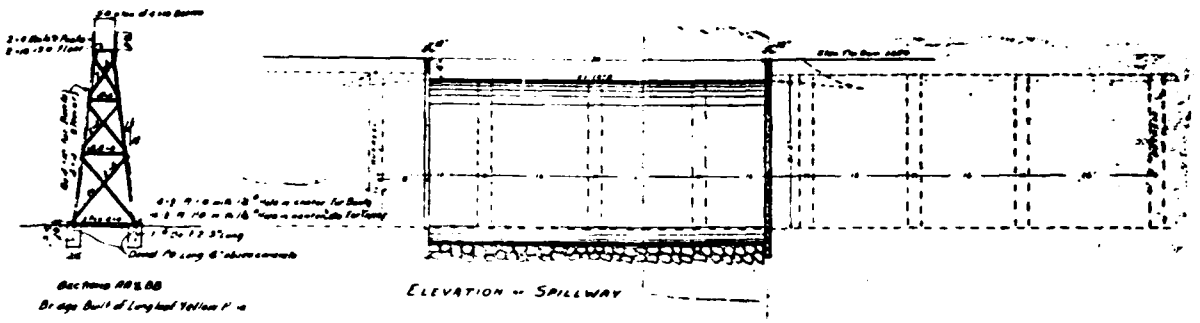


SECTION OF SPILLWAY

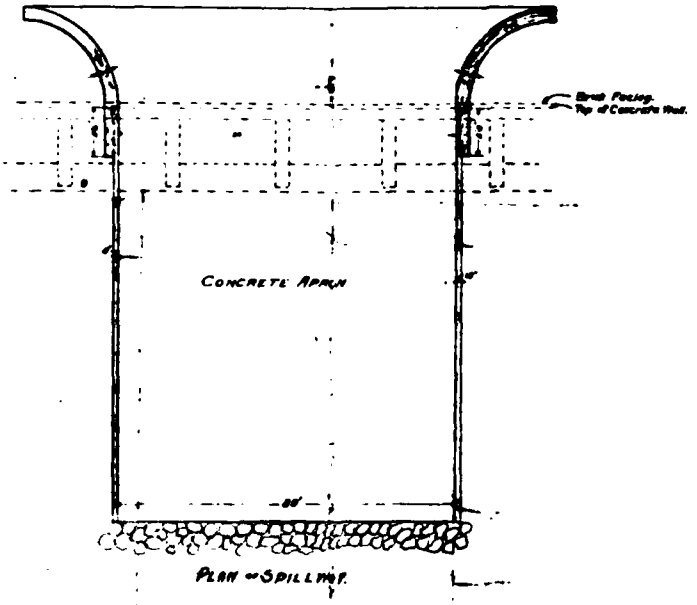


PROFILE SCALE 1"=20'

63-734



ELEVATION — SPILLWAY

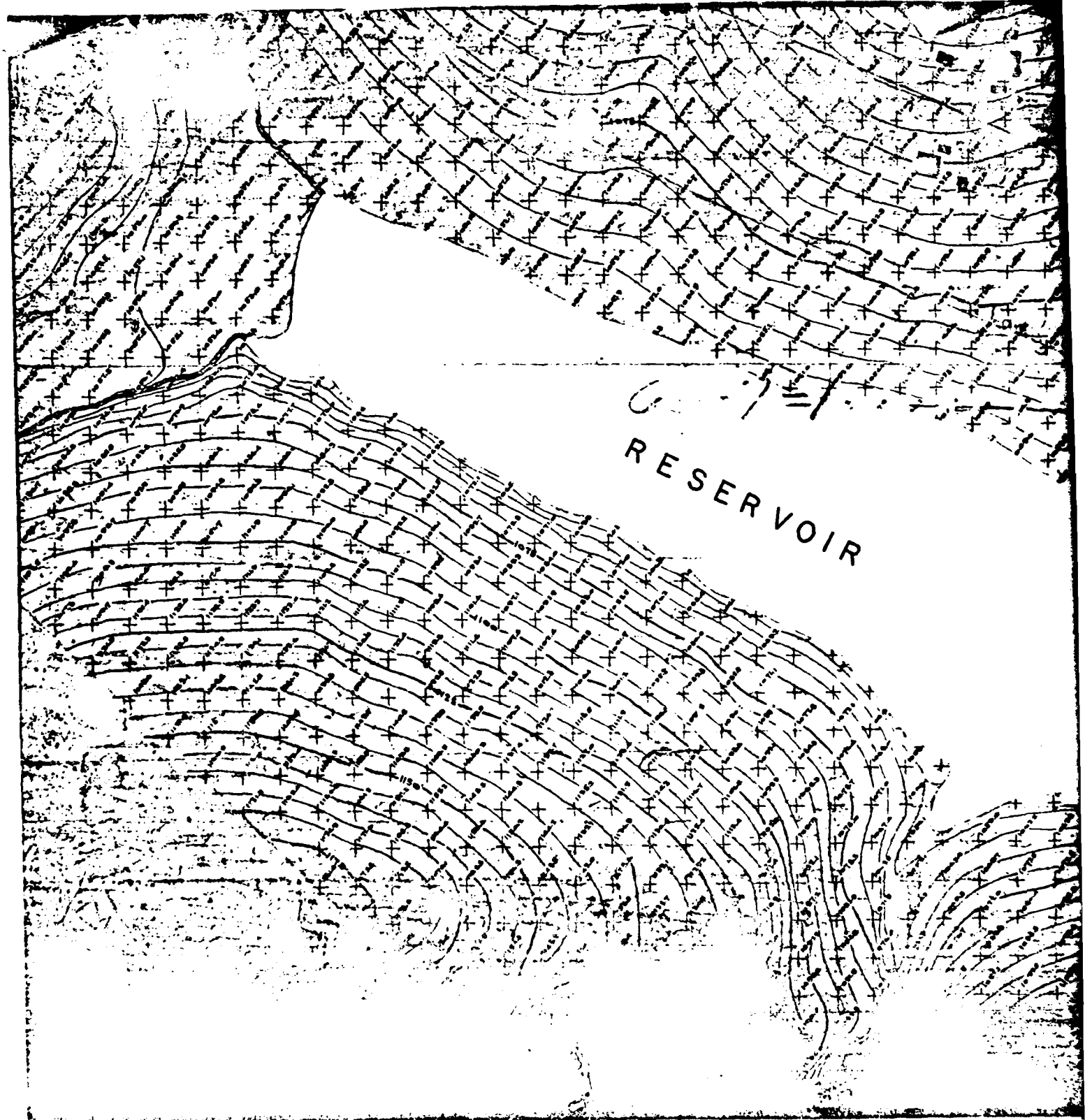


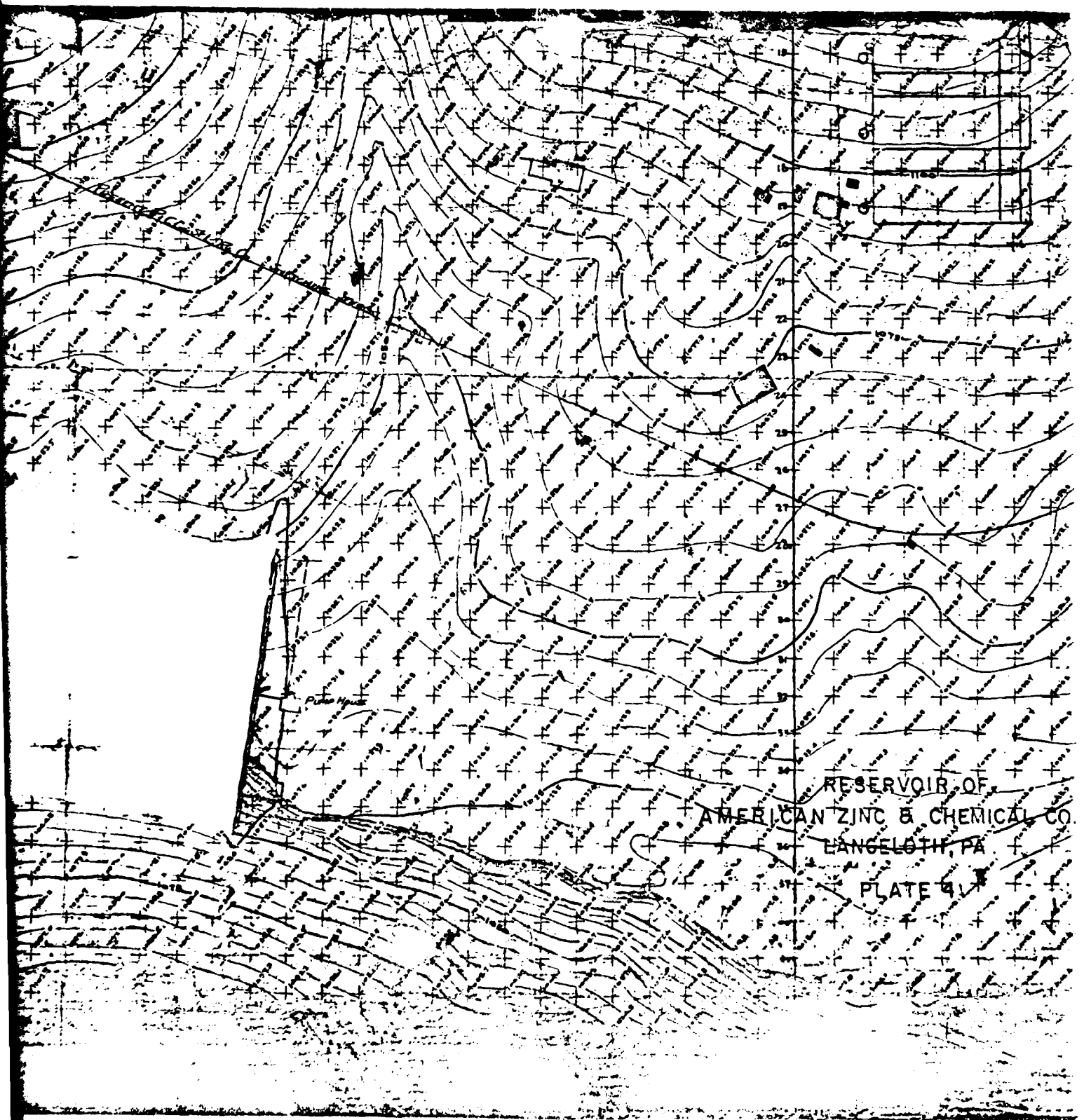
PLAN — SPILLWAY

AREA DRAINED BY DAM 660 ACRES.

PLATE 3

Revised 12-2-1914	DETAILS OF DAM AMERICAN ZINC & CHEMICAL CO. LANGELOTH, PA.
Scale 1" = 25'	B.P. ISSUED


RESERVOIR



RESERVOIR OF
AMERICAN ZINC & CHEMICAL CO.
LANGELOTH, PA
PLATE 9

APPENDIX F

REGIONAL GEOLOGY

APPENDIX F

REGIONAL GEOLOGY
ZINC DAM
NDI No. PA 00496, PennDER No. 63-7

REGIONAL GEOLOGY

The dam is located in an unglaciated area of the Appalachian Plateaus Physiographic Province. The bedrock units below the dam are members of the Monongahela Group, Pennsylvanian System. These units are typically cyclic sequences of shale, limestone, sandstone, and coal. Downstream from the dam on the right hillside above the channel there is an outcrop of approximately one foot of limestone overlain by one foot of shale. The stream channel bed consists of hard, carbonaceous and slightly calcareous sandstone.

Located approximately 155 feet (Elevation 885 feet) beneath the dam site is the Pittsburgh Coal which has been mined by the American Zinc and Chemical Company's Langeloth Mine. However, lower coals have not been extensively mined in the area.

GEOLOGIC MAP
Zinc Dam
NDI No. PA 00496 Washington County

Reproduced from
Greater Pittsburgh Region Geologic Map,
Compiled by W. R. Wagner and others, 1975

Scale: One Inch Equals Approximately Two Miles
See Legend, Next Page

GEOLOGY MAP LEGEND

GROUP	FORMATION		DESCRIPTION
	Alluvium	Qt	Sand, gravel, clay.
	Terrace deposits		Sand, clay, gravel on terraces above present rivers; includes Carmichaels Formation.
DUNKARD	Greene		Cyclic sequences of sandstone, shale, red beds, thin limestones and coals.
DUNKARD	Washington	Pw	Cyclic sequences of sandstone, shale, limestone, and coal; contains Washington coal bed at base.
DUNKARD	Waynesburg		Cyclic sequences of sandstone, shale, limestone and coal; contains Waynesburg coal bed at base.
MONONGAHELA		Pm	Cyclic sequences of shale, limestone, sandstone and coal; contains Pittsburgh coal bed at base.
CONEMAUGH	Casselman	Pcc	Cyclic sequence of sandstone, shale, red beds and thin limestone and coal.
CONEMAUGH	Ames		
CONEMAUGH	Glenshaw	Pcg	Cyclic sequences of sandstone, shale, red beds and thin limestone and coal; several fossiliferous limestone; Ames limestone bed at top.
ALLEGHENY	Vanport	Pa	Cyclic sequences of shale, sandstone, limestone, and coal; contains Brookville coal at base and Upper Freeport coal at top; within group are the commercial Vanport limestone and Kittanning and Clarion coals.
ALLEGHENY	Vanport	Pa	
POTTSVILLE		Pp	Sandstone and shale; contains some conglomerate and locally mineable coal.
Mauch Chunk		Mmc	Red and green shale with some sandstone; contains Wymps Gap and Loyalhanna limestones.
Pocono		Mp	Sandstone and shale with Burgoon sandstone at top.