AD-A103 759 NEW JERSEY DEPT OF ENVIRONMENTAL PROTECTION TRENTON --ETC F/G 13/13
NATIONAL DAM SAFETY PROGRAM. HELMETTA DAM (NJ 00794) RARITAN RI--ETC(U)
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LEVEL II

RARITAN RIVER BASIN
TRIBUTARY TO MANALAPAN BROOK,
MIDDLESEX COUNTY
NEW JERSEY

HELMETTA DAM
NJ 00794

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

DEPARTMENT OF THE ARMY
Philadelphia District
Corps of Engineers
Philadelphia, Pennsylvania

REPT. NO: DAEN/NAP-53842/NJ00794-81/08
AUGUST 1981

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

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17. DISTRIBUTION STATEMENT (of the abstract entered in B

18. SUPPLEMENTARY NOTES

Copies are obtainable from National Technical Information Service, Springfield, Virginia 22151.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Dams	National Dam Safety Program	Erosion
Embankments	Helmetta Dam, N.J.	
Visual Inspection	Seepage	
Structural Analysis	Spillways	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report cites results of a technical investigation as to the dam's adequacy. The inspection and evaluation of the dam is as prescribed by the National Dam Inspection Act, Public Law 92-367. The technical investigation includes visual inspection, review of available design and construction records, and preliminary structural and hydraulic and hydrologic calculations, as applicable. An assessment of the dam's general condition is included in the report.

page 1

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
CUSTOM HOUSE—2 D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

IN REPLY REFER TO
NAPEN-N

Honorable Brendan T. Byrne
Governor of New Jersey
Trenton, New Jersey 08621

25 AUG 1981

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Helmetta Pond Dam in Middlesex County, New Jersey which has been prepared under authorization of the Dam Inspection Act, Public Law 92-367. A brief assessment of the dam's condition is given in the front of the report.

Based on visual inspection, available records, calculations and past operational performance, Helmetta Pond Dam, initially listed as a high hazard potential structure, but reduced to a significant hazard potential structure as a result of this inspection, is judged to be in poor overall condition. The dam's spillway is considered inadequate because a flow equivalent to 12 percent of the Spillway Design Flood - SDF - would cause the dam to be overtopped. (The SDF, in this instance, is one half of the Probable Maximum Flood). To ensure adequacy of the structure, the following actions, as a minimum, are recommended:

a. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures and studies within three months from the date of approval of this report. Within three months of the consultant's findings remedial measures to ensure spillway adequacy should be initiated.

b. Within three months from the date of approval of this report the owner should engage a qualified professional consultant to perform the following:

(1) Investigate the cause of the seepage and wet, soft areas at the downstream toe of the dam.

(2) Design and oversee procedures for the removal of trees, from the upstream and downstream slopes and the one tree near the center of the dam which is approximately 15 ft. downstream from the toe.

(3) Design and oversee repairs for the erosion of the upstream slope of the dam and design and specify erosion protection for the upstream slope of the dam.

(4) Design and oversee repairs for the eroded areas on the downstream slope adjacent to the spillway.

(5) Investigate the reasons for the uneven surface of the crest, and design remedial measures as needed.

(6) Oversee filling of the animal burrows on the embankment.

(7) Design and oversee repairs to the concrete spillway and walls.

(8) Design and oversee reconstruction of the outlet works.

c. Within three months from the date of approval of this report the following remedial actions should be initiated:

(1) Start a program of checking the condition of the dam periodically and monitoring the seepage and wet areas along the toe of the downstream slope.

(2) Start a program for maintaining the embankment free of weeds and brush and filling animal burrows as they occur.

(3) Control trespassing on dam.

d. Within six months from the date of approval of this report the following remedial actions should be initiated:

(1) After repair of eroded areas on the dam, re-establish and maintain grassy vegetation on the dam.

(2) Repair deteriorated portions of service bridge.

e. The owner should develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam, within one year from the date of approval of this report.

f. An emergency action plan and warning system should be developed which outlines actions to be taken by the owner to minimize the downstream effects of an emergency at the dam within six months from the date of approval of this report.

A copy of the report is being furnished to Mr. Dirk C. Hofman, New Jersey Department of Environmental Protection, the designated State Office contact for this program. Within five days of the date of this letter, a copy will also be sent to Congressman Smith of the Fourth District. Under the provision of the Freedom of Information Act, the inspection report will be subject to release by this office, upon request, five days after the date of this letter.

NAPEN-N
Honorable Brendan T. Byrne

Additional copies of this report may be obtained from the National Technical Information Services (NTIS), Springfield, Virginia 22161 at a reasonable cost. Please allow four to six weeks from the date of this letter for NTIS to have copies of the report available.

An important aspect of the Dam Inspection Program will be the implementation of the recommendations made as a result of the inspection. We accordingly request that we be advised of proposed actions taken by the State to implement our recommendations.

Sincerely,

Roger Baldwin

ROGER L. BALDWIN
Lieutenant Colonel, Corps of Engineers
Commander and District Engineer

Incl
As stated

Copies furnished:
Mr. Dirk C. Hofman, P.E., Deputy Director
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. Box CN029
Trenton, NJ 08625

Mr. John O'Dowd, Acting Chief
Bureau of Flood Plain Regulation
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. Box CN029
Trenton, NJ 08625

HELMETTA POND DAM (NJ00794)

CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 20 April 1981 by Anderson-Nichols and Co. Inc., under contract to the State of New Jersey. The State, under agreement with the U.S. Army Engineer District, Philadelphia, had this inspection performed in accordance with the National Dam Inspection Act, Public Law 92-367.

Helmetta Pond Dam, initially listed as a high hazard potential structure, but reduced to a significant hazard potential structure as a result of this inspection, is judged to be in poor overall condition. The dam's spillway is considered inadequate because a flow equivalent to 12 percent of the Spillway Design Flood - SDF - would cause the dam to be overtopped. (The SDF, in this instance, is one half of the Probable Maximum Flood). To ensure adequacy of the structure, the following actions, as a minimum, are recommended:

a. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures and studies within three months from the date of approval of this report. Within three months of the consultant's findings remedial measures to ensure spillway adequacy should be initiated.

b. Within three months from the date of approval of this report the owner should engage a qualified professional consultant to perform the following:

(1) Investigate the cause of the seepage and wet, soft areas at the downstream toe of the dam.

(2) Design and oversee procedures for the removal of trees, from the upstream and downstream slopes and the one tree near the center of the dam which is approximately 15 ft. downstream from the toe.

(3) Design and oversee repairs for the erosion of the upstream slope of the dam and design and specify erosion protection for the upstream slope of the dam.

(4) Design and oversee repairs for the eroded areas on the downstream slope adjacent to the spillway.

(5) Investigate the reasons for the uneven surface of the crest, and design remedial measures as needed.

(6) Oversee filling of the animal burrows on the embankment.

(7) Design and oversee repairs to the concrete spillway and walls.

(8) Design and oversee reconstruction of the outlet works.

c. Within three months from the date of approval of this report the following remedial actions should be initiated:

(1) Start a program of checking the condition of the dam periodically and monitoring the seepage and wet areas along the toe of the downstream slope.

(2) Start a program for maintaining the embankment free of weeds and brush and filling animal burrows as they occur.

(3) Control trespassing on dam.

d. Within six months from the date of approval of this report the following remedial actions should be initiated:

(1) After repair of eroded areas on the dam, re-establish and maintain grassy vegetation on the dam.

(2) Repair deteriorated portions of service bridge.

e. The owner should develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam, within one year from the date of approval of this report.

f. An emergency action plan and warning system should be developed which outlines actions to be taken by the owner to minimize the downstream effects of an emergency at the dam within six months from the date of approval of this report.

APPROVED: Roger Baldwin

ROGER L. BALDWIN
Lieutenant Colonel, Corps of Engineers
Commander and District Engineer

DATE: 25 Aug 81

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Helmetta Pond
Identification No.:	Fed ID No. NJ00794
State Located:	New Jersey
County Located:	Middlesex
Stream:	Manalapan Brook
River Basin:	Raritan
Date of Inspection	April 20, 1981

ASSESSMENT OF GENERAL CONDITIONS

Helmetta Pond Dam is a horseshoe shaped, low earthen embankment, 653 feet long, at least 70 years old, small in size and in poor overall condition. The soft wet area and seepage at the downstream toe is indicative of seepage through and under the dam. If not properly controlled, it could lead to failure of the dam by piping and sloughing of the downstream slope. Serious erosion on the upstream slope of the dam at the waterline, if allowed to continue, could result in eventual breaching of the embankment. The crest of the dam is uneven, the cause of which cannot be determined by visual inspection alone, but may be indicative of a potential stability problem. Continued deterioration of the concrete spillway and steel plate covers over the outlet pipe could lead to a sudden release of water. The spillway can handle a storm about 11 percent the size of the Spillway Design Flood of one-half PMF and is considered inadequate. Because of the depression downstream behind the factory buildings, controlled by a 42-inch RCP culvert, failure of the dam would cause flooding from ponded water from 1 to 6-1/2 feet deep in the warehouses and factory. The economic loss would be appreciable but with little threat of loss of lives. Therefore, the hazard classification should be downgraded to Significant.

It is recommended that the owner retain the services of a professional engineer, qualified in the design and inspection of dams, to accomplish the following tasks very soon: Evaluate further the inadequate spillway capacity and also consider the hydraulic conveyance downstream; investigate the cause of the seepage and wet, soft areas at the downstream toe of the dam; design and oversee procedures for the removal of trees from the upstream and downstream slopes and the one tree near the center of the dam which is approximately 15 feet downstream from the toe; design and oversee repairs for the erosion of the upstream slope of the dam and design and specify erosion protection for the upstream slope of the dam; design and oversee repairs for the eroded areas on the downstream slope adjacent to the spillway; investigate the reasons for the uneven surface of the

crest, and design remedial measures as needed; oversee filling of the animal burrows on the embankment; design and oversee repairs to the concrete spillway and walls; and design and oversee reconstruction of the outlet works.

It is further recommended that the owner undertake the following as part of operating and maintenance procedures. Starting very soon: begin a program of checking the condition of the dam periodically and monitoring the seepage and wet areas along the toe of the downstream slope; start a program for maintaining the embankment free of weeds and brush, and filling animal burrows as they occur; control trespassing on the dam. Starting soon: develop an emergency action plan which outlines actions taken by the owner to minimize downstream effects of an emergency at the dam; after repair of eroded areas on the dam, re-establish and maintain grassy vegetation on the dam; repair deteriorated portions of service bridge; and in the near future: develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam.

ANDERSON-NICHOLS & COMPANY, INC.

Warren A. Guinan

Warren A. Guinan, P.E.
Project Manager
New Jersey Number 16848

April 20, 1981

OVERVIEW PHOTO

HELMETTA POND DAM

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. 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 continued care and inspection can there be any chance that unsafe conditions be detected.

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

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY REPORT

HELMETTA POND DAM FED ID NO. NJ00794

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY INSPECTION PROGRAM
HELMETTA POND DAM
FED ID NO. #NJ00794

SECTION 1
PROJECT INFORMATION

1.1 General

a. Authority. Authority to perform the Phase I Safety Inspection of Helmetta Pond Dam was received from the State of New Jersey, Department of Environmental Protection, Division of Water Resources by letter dated 12 December 1980 under Basic Contract No. FPM-39 and Contract No. A01093 dated 10 October, 1979. This Authority was given pursuant to the National Dam Inspection Act, Public Law 92-367 and by agreement between the State and the U.S. Army Engineers District, Philadelphia. The inspection discussed herein was performed by Anderson-Nichols & Company, Inc.

b. Purpose: The purpose of the Phase I Investigation is to develop an assessment of the general conditions with respect to the safety of Helmetta Pond Dam and appurtenances. Conclusions are based upon available data and visual inspection. The results of this study are used to determine any need for emergency measures and to conclude if additional studies, investigations, and analyses are necessary and warranted.

1.2 Project Description

a. Description of Dam and Appurtenances. Helmetta Pond Dam is a horseshoe shaped, 653 foot long earth embankment dam with a hydraulic height of 5.6 feet and a structural height of 7.2 feet. The spillway type is concrete overflow with a 7.2-foot long weir. The dam's crest width ranges from 8 to 14 feet. There are tire ruts in a very wide road on the right (west) side of the crest and a 28-inch diameter tree is growing on the left (east) side of the crest. The dam's upstream face has a 3H:1V slope and a 20-foot wide erosion feature near the right abutment with trees growing in the area. The downstream slope varies from 3H:1V to 8H:1V. There is a large 2-foot diameter tree at the downstream toe of the dam. A large area of seepage has developed, over-grown with wetlands-type species of vegetation, downstream of the dam near the right abutment. Animal burrows are evident on the dam crest, as well as on the upstream and downstream faces.

b. Location. The dam is located in Helmetta Borough, New Jersey on Manalapan Brook. The dam is at 40° 22.7' north latitude and 74° 25.7' west longitude on the New Brunswick Quandrangle. The dam may be reached by exiting from the New Jersey Turnpike at Interchange 8A, turning east on Forsgate Drive, turning left on Possum Hollow Road, turning right on Bordentown - South Amboy Turnpike and continuing on Spotswood - Cranbury Road (Main Street in the Borough of Helmetta) to the dam site behind Helme Tobacco Co. Plant, a total distance of about 1.3 miles. A location map has been included as Figure 3.

c. Size Classification. Helmetta Pond Dam is classified as being small in size on the basis of storage at the dam crest of 142 acre-feet, which is less than 1000 acre-feet but more than 50 acre-feet, and on the basis of its structural height of 7.2 feet, which is less than 40 feet, in accordance with criteria given in the Recommended Guidelines for Safety Inspection of Dams.

d. Hazard Classification. The spillway at Helmetta Pond Dam will not pass the SDF of one-half PMF. Approximately 300 feet downstream of the dam, and next to the left (east) abutment are warehouses. About 200 feet further downstream are the factories of the Helme Tobacco Company. The downstream area is a depression with only a 42-inch RCP culvert to convey the water from the depression under the factory to the 500-foot open channel leading to Manalapan Brook. Breaching of the dam would fill the depression (about 63 acre-foot) and cause ponded water to inundate buildings from 1 to 6-1/2 feet. The economic loss would be appreciable but no serious threat to loss of life is apparent. Therefore, the hazard classification should be downgraded to significant.

e. Ownership. The dam is owned by Middlesex County. Information may be obtained by writing Middlesex County Council at 303 George Street, Plaza 1, 3rd Floor, New Brunswick, New Jersey 08901, or by calling (201) 745-3228.

f. Purpose. The purpose of construction of Helmetta Pond Dam was for fire protection for Helme Tobacco Company; this is also the present purpose.

g. Design and Construction History. No information regarding the original plan or design of the dam was available.

h. Normal Operational Procedure. No operational procedures were disclosed for the dam.

i. Site Geology. No site specific information (such as borings) was available at the time the dam was inspected. Information derived from the Geologic Map of New Jersey (Kummel and Johnson, 1912) indicates soils within the immediate site consists of coastal plain sediments which includes sand and clay deposits.

The depth to bedrock at the dam site is unknown and outcrops were not observed during the dam inspection. No information was available on the bedrock in this area based on the previously mentioned reports.

1.3 Pertinent Data

a. Drainage Area

.69 square miles

b. Discharge at Damsite (cfs)

Maximum flood at damsite - unknown

Total ungated spillway capacity at maximum pool elevation (at top of dam) - 41

c. Elevation (ft. above NGVD)

Top of dam - low point 45.2
high point 46.8

Test flood (1/2 PMF) - 46.6

Recreation pool (at time of inspection) - 43

Spillway crest - 43.7

Streambed at centerline of spillway - 39.6

Maximum tailwater (estimated) 41.0

d. Reservoir (length in feet)

Length of maximum pool - 3000 (estimated)

Spillway crest - 2800

e. Storage (acre-feet)

Spillway crest - 64

Top of dam - 142

Test Flood (1/2 PMF) - 267

f. Reservoir Surface (acres)

Top of dam - 72 (estimated)

Spillway crest - 32

g. Dam

Type - earth

Length - 653 feet

Height - 5.6 feet (hydraulic)

- 7.2 feet (structural)

Top width - ranges from 8 to 14 feet

Side slopes - upstream 3H:1V, downstream varies 3H:1V to 8H:1V

Zoning - unknown

Impervious core - unknown

Cutoff - unknown

Grout curtain - unknown

h. Spillway

Type - Concrete overflow

Length of weir - 7.2 feet

Crest elevation - 43.7' NGVD

Low level outlet - 36-inch clay pipe

U/S Channel - Approach channel, about 35 feet wide and 150 feet long from Helmetta Pond.

D/S Channel - Three-foot wide channel open for 400 feet leading into a 42-inch pipe that passes flow under building and thence downstream for about 500 feet into Manalapan Brook.

i. Regulating Outlets

Type - 36-inch clay pipe with steel plate covers serving as a gate over upstream pipe inlet

Invert elevation - 40.1 feet NGVD

Length - about 3 feet

Access - Bridge deck over spillway

SECTION 2
ENGINEERING DATA

2.1 Design

No hydraulic, hydrologic, or other engineering data were disclosed.

2.2 Construction

No recorded data concerning construction of the Helmetta Pond Dam were found.

2.3 Operation

No written operational data were found.

2.4 Evaluation

a. Availability. A search of the New Jersey Department of Environmental Protection files revealed no information.

b. Adequacy. Data obtained in the visual inspection are deemed adequate to complete this Phase 1 Inspection Report

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. Dam. Trees are growing on the upstream and downstream slopes of the dam near the right and left abutments. Extensive erosion has taken place on the upstream slope at and above the waterline. Near the center of the dam, the upstream slope has been flattened considerably which may be due to wave action.

The crest of the dam is uneven and is partially covered with depression tracks up to 4 inches deep caused by vehicular traffic. Several animal burrows, up to 10 inches in diameter and 2.5 feet deep, were observed on the crest and on the upstream slope near the crest. At the crest, a surface depression, 2 feet in diameter and 1 foot deep, had developed around one of the animal burrows. The area at the downstream toe of the dam is generally wet and soft. Wetlands-type species of vegetation, primarily cattails, is located everywhere along the toe of the slope. Seepage is flowing from a large swamp area on the right side of the dam in the vicinity of the right abutment. The visible water contained some orange colored flocs but no evidence of suspended soil fines in the water was observed.

Erosion has occurred on the downstream slope on either side of the concrete spillway wingwalls. On the right side, railroad ties have been placed on the slope in an attempt to minimize the erosion on the slope. An animal burrow, 6 in. in diameter and 2 ft. deep, has been developed beneath the ties.

b. Appurtenant Structures. The ungated spillway at the left end of the dam is in generally poor condition. The concrete abutment walls are badly eroded and undermined on the downstream side and the concrete is eroded at the water line on the upstream side. The makeshift steel plates used for gating the outlet pipe are leaking and are rusting. Some planks on the service bridge over the spillway are deteriorated.

c. Reservoir Area. The watershed above the lake is gently sloping and wooded. Some open fields were evident along the west side of the reservoir and low lying swamps exist on the north end of the reservoir. Slopes on the shore of the lake appear stable. No evidence of significant sedimentation was observed.

d. Downstream Channel. The channel downstream of the spillway makes a lefthand turn and joins the seepage flow from the right side of the dam. The channel bottom is in soil and there is no erosion protection on the sides of the channel. Considerable sloughing and erosion have occurred along the banks. After passing flow through a 48-inch CMP under a haul road, the open channel passes flow into a 42-inch RCP beneath the buildings egressing downstream beyond the building and enters Manalapan Brook 500 feet downstream of the buildings.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedures

No formal operating procedures were revealed.

4.2 Maintenance of Dam

No formal maintenance procedures for the dam were found.

4.3 Maintenance of Operating Facilities

No formal maintenance procedures for the operating facilities were discovered.

4.4 Warning System

No description of any warning system was found.

4.5 Evaluation of Operational Adequacy

Because of the lack of operation and maintenance procedures, the remedial measures described in Section 7.2 should be implemented as described.

SECTION 5
HYDROLOGIC/HYDRAULIC

5.1 Evaluation of Features

a. Design Data. Because no original hydrologic design data were revealed, an evaluation of such data could not be performed.

b. Experience Data. No experience data were found.

c. Visual Inspection. The invert of the low-level outlet is estimated to be located well above the deeper parts of the reservoir. The dam has the appearance of a low earth berm added to increase stored water in an existing lake. The steel covers over the 36-inch clay pipe appear to be 9 makeshift arrangement; no lifting mechanism was noted. Considerable erosion and spalling of the concrete around the spillway at the end of the approach channel was observed.

d. Helmetta Pond Dam Overtopping Potential. The hydraulic/hydrologic evaluation for the dam is based on a selected Spillway Design Flood (SDF) equal to one-half the Probable Maximum Flood (PMF) in accordance with the range of test floods given in the evaluation guidelines, for dams classified as significant hazard and small in size. The PMF was determined by application of a 24-hour Probable Maximum Precipitation of 22.9 inches to the SCS dimensionless unit hydrograph. Hydrologic computations are given in Appendix 3. The routed half-PMF peak inflow to the reservoir is 849 cfs; the peak outflow is 267 cfs.

Water will rise to a depth of 1.5 foot above the spillway crest before overtopping the low point on the dam embankment crest. Under this head the spillway capacity is 41 cfs, which is less than the selected SDF.

Flood routing calculatiions indicate that Helmetta Pond Dam will be overtopped for 9.8 hours to a maximum depth of 1.4 feet under half-PMF conditions. It is estimated that the spillway can pass the inflow from a storm about 11 percent the size of the half-PMF without overtopping the dam; thus, the spillway is considered inadequate.

e. Draw-down Capacity. It is estimated that the lake can be drained down to elevation 41.1 feet in approximately 2.5 days assuming no significant inflow. This time period is considered adequate for draining the reservoir in an emergency situation. However, some water probably would remain in the pond, as the low-level outlet is believed not to be at or near the bottom of the reservoir.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations. The soft, wet area and seepage at the downstream toe of the dam is indicative of seepage through and under the dam, which, if not properly controlled, could lead to failure of the dam by piping and sloughing of the downstream slope. Serious erosion on the upstream slope of the dam at the waterline, if allowed to continue, could result in eventual breaching of the embankment. Most of the crest of the dam which is bare of vegetation would be susceptible to erosion if the dam were overtopped, which might, in turn, lead to breaching of the dam. Trees growing on the upstream and downstream slopes may cause seepage and erosion problems if the tree blows over and pulls out its roots, or if a tree dies or its roots rot.

The crest of the dam is uneven. Although the cause of the unevenness cannot be determined on the basis of the visual inspection alone, it may be a sign of a potential stability problem. The presence of several large depressions at the upstream edge of the crest and on the upstream slope may be a result of internal erosion of the embankment which, if not stopped, could lead to breaching of the dam.

Continued deterioration of the concrete spillway and steel plates over the outlet pipe could lead to a sudden release of water.

6.2 Design and Construction Data. No design or construction data pertinent to the structural stability of the dam are available.

6.3 Operating Records. No operating records pertinent to the structural stability of the dam were available.

6.4 Post-Construction Changes. No record of post-construction changes was available.

6.5 Seismic Stability - This dam is in Seismic Zone 1. According to the Recommended Guidelines, dams located in Seismic Zone 1 "may be assumed to present no hazard from earthquake, provided static stability conditions are satisfactory and conventional safety margins exist". The visual observations made during the inspection are possible indicators of unstable embankments as mentioned in Section 6.1. However, because no data are available concerning the engineering properties of the embankment and foundation materials for this dam, it is not possible to make an engineering evaluation of the stability of the slopes or the factor of safety under static conditions.

SECTION 7
ASSESSMENT, RECOMMENDATIONS/REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition. Helmetta Pond Dam is estimated to be at least 70 years old and is in poor condition.

b. Adequacy of Information. The information available is such that the assessment of the dam must be based on the results of the visual inspection.

c. Urgency. The recommendations made in 7.2.a and 7.2.b should be implemented by the owner as prescribed.

d. Necessity for Additional Data/Evaluation. The information available from the visual inspection is adequate to identify the potential problems which are listed in 7.2.a. These problems require the attention of a professional engineer who will have to make additional engineering studies to design or specify remedial measures to rectify the problems. If left unattended, the problems could lead to failure of the dam.

7.2 Recommendation/Remedial Measures

a. Recommendations. The owner should engage a professional engineer qualified in the design and construction of dams to accomplish the following very soon:

(1) Evaluate further the inadequate spillway capacity and also consider the hydraulic conveyance downstream.

(2) Investigate the cause of the seepage and wet, soft areas at the downstream toe of the dam.

(3) Design and oversee procedures for the removal of trees, from the upstream and downstream slopes and the one tree near the center of the dam which is approximately 15 ft. downstream from the toe.

(4) Design and oversee repairs for the erosion of the upstream slope of the dam and design and specify erosion protection for the upstream slope of the dam.

(5) Design and oversee repairs for the eroded areas on the downstream slope adjacent to the spillway.

(6) Investigate the reasons for the uneven surface of the crest, and design remedial measures as needed.

(7) Oversee the repair of animal burrows on the embankment slope.

(8) Design and oversee repairs to the concrete spillway and walls.

(9) Design and oversee reconstruction of the outlet works.

b. Alternatives. None recommended if fire protection remains high priority purpose.

c. Operating and Maintenance Procedures. The owner should accomplish the following in the time periods specified:

Beginning very soon:

(1) Start a program of checking the condition of the dam periodically and monitoring the seepage and wet areas along the toe of the downstream slope.

(2) Start a program for maintaining the embankment free of weeds, brush, and filling animal burrows (add to brief assessment) as they occur.

(3) Control trespassing on dam.

Starting soon:

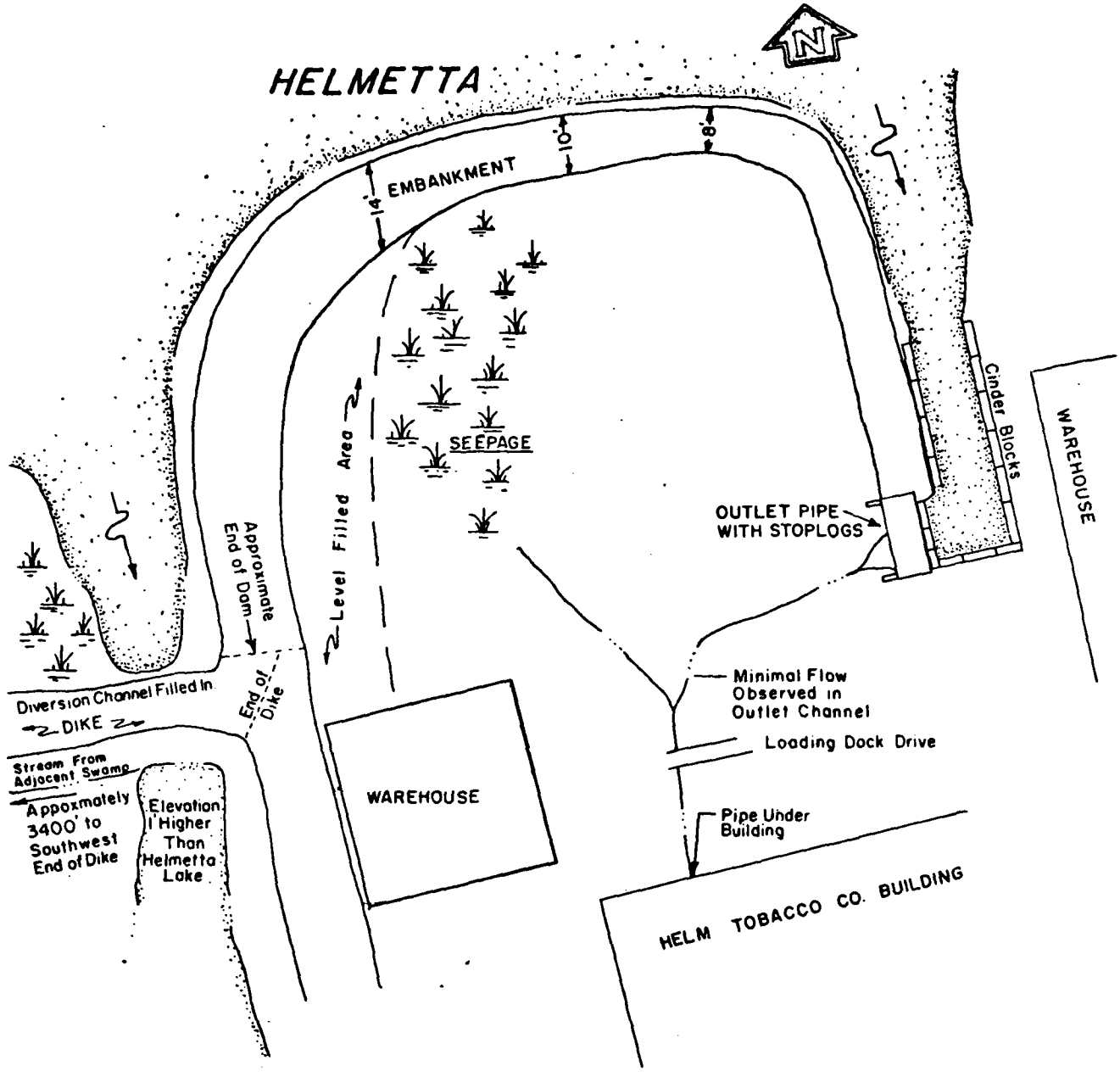
(1) Develop an emergency action plan which outlines actions taken by the owner to minimize downstream effects of an emergency at the dam.

(2) After repair of eroded areas on the dam, re-establish and maintain grassy vegetation on the dam.

(3) Repair deteriorated portions of service bridge.

In the near Future:

Develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam.



Anderson-Nichols & Co, Inc. BOSTON MASSACHUSETTS	U.S. ARMY ENGINEER DIST PHILADELPHIA CORPS OF ENGINEERS PHILADELPHIA, PA

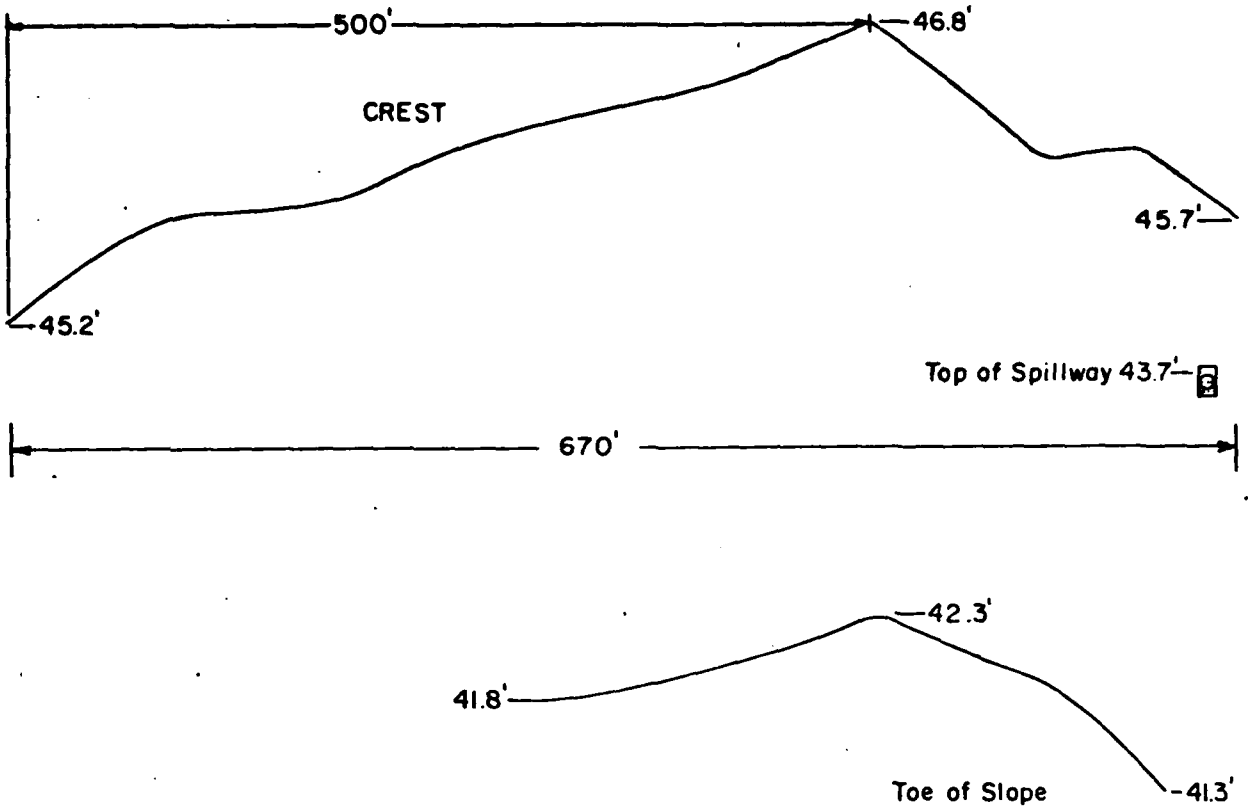
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

HELMETTA POND DAM PLAN

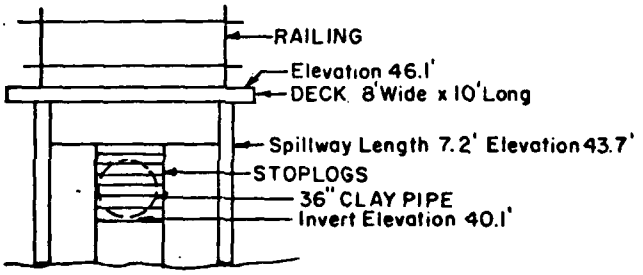
TRIB. TO MANALAPAN BROOK NEW JERSEY

			SCALE: NOT TO SCALE
			DATE: JUNE 1981

FIGURE - 1



PROFILE



OUTLET ELEVATION

Anderson-Nichols & Co, Inc. BOSTON MASSACHUSETTS	U.S. ARMY ENGINEER DIST. PHILADELPHIA CORPS OF ENGINEERS PHILADELPHIA, PA.
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS	
HEL'METTA POND DAM PROFILE & ELEVATION	
TRIB. TO MANALAPAN BROOK NEW JERSEY	
	SCALE NOT TO SCALE
	DATE JUNE 1981

FIGURE-2

SCALE IN MILES

0 — 4 — 8

MAP BASED ON STATE OF NEW JERSEY OFFICIAL MAP & GUIDE.

Anderson-Nichols & Co., Inc. BOSTON MASSACHUSETTS	U.S. ARMY ENGINEER DIST. PHILADELPHIA CORPS OF ENGINEERS PHILADELPHIA, PA.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

HELMETTA DAM
LOCATION MAP

TRIB. TO MANALAPAN BROOK — NEW JERSEY

SCALE: 1" = 4 Miles Approx.

DATE: JUNE 1981

FIGURE -

APPENDIX 1

CHECK LIST

VISUAL INSPECTION

HELMETTA POND DAM

Check List
Visual Inspection
Phase 1

Name Dam Helmetta Pond Dam County Middlesex State NJ (00794) Coordinators NJDEP

Date(s) Inspection 2/19/81, 4/20/81 Weather Overcast, warm / Clear Temperature 40° / 45°

Pool Elevation at Time of Inspection 43 NGVD Tailwater at Time of Inspection 39.6 NGVD

Inspection Personnel:

Guinan	Stuart
Gilman	Deane
Murdock	

Stuart/Gilman/Murdock Recorder

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None observed	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Significant erosion and sloughing along upstream face	Repair erosion and provide adequate erosion protection
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Horizontal alignment - good vertical alignment - crest exhibits a slight undulation in elevation	
RIPRAP FAILURES	No riprap evident above water level. Small trees and brush growing on upstream face.	Remove trees and brush and provide adequate erosion protection on upstream face.

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
RAILINGS	None	
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Erosion evident on either side of spillway structure	Repair erosion
ANY NOTICEABLE SEEPAGE	Ground is wet and soggy downstream of the dam. Seepage and standing water evident in many locations along the toe.	Investigate origin of seepage
STAFF GAGE AND RECORDER	None	
DRAINS	None observed	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	Poor condition - Substantial spalling and erosion on u/s face, approximately 8" below weir. D/s face has evidence of surface erosion. Much debris.	Repair eroded and deteriorated concrete. Clean inlet area.
APPROACH CHANNEL	Clear of brush or weeds. Much trash debris. Mortared cinder block training wall on left side in good condition.	Clear trash
DISCHARGE CHANNEL	Defined channel. Weeds and trash.	Clear trash
BRIDGE AND PIERS OVER SPILLWAY	Evidence of deterioration of wood. Some planks show rot. Wooden footbridge with railing on d/s side only. Deck in fair condition. Railing well painted.	Add railing on u/s side. Repair deteriorated plank and paint.

OUTLET WORKS (Located at Ungated Spillway)

See Ungated Spillway

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	See outlet channel. See outlet pipe.	
INTAKE STRUCTURE	U/s face of spillway wall. Considerable surface erosion and spalling of concrete. Concrete block wall has minor cracking.	Repair concrete and concrete block wall.
OUTLET PIPE	3 ft smooth clay pipe exits face of spillway. Invert 4 ft below spillway crest.	
OUTLET CHANNEL	Poor condition. Substantial erosion and deterioration of concrete wall at base.	Repair or rebuild channel.
EMERGENCY GATE	Gate appears to be 2 steel plates which together cover, outlet pipe and may be held in place by water pressure from u/s. Some leakage. Steel plates are rusting.	Refit with new gate and stop logs.

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Stream flows perpendicular to spillway crest for approx. 100 yards then takes right angle towards factory. It then flows: approx. 50 yards d/s; under the loading dock driveway 15-foot long, 48-inch diameter BCCNP; 20± feet more d/s; into a 42-inch concrete pipe; and then under the mill to Manalapan Brook across the street.	
SLOPES	Gentle	
APPROXIMATE NO. OF HOMES AND POPULATION	Helme Tobacco Co. located immediately downstream.	Failure of this dam could cause flooding to the basements of two warehouses.

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Slightly wooded, gradual slopes, some homes situated adjacent to reservoir.	
SEDIMENTATION	No evidence of significant sedimentation observed.	

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM	REMARKS
PLAN OF DAM	None found.
REGIONAL VICINITY MAP	Prepared for this report
CONSTRUCTION HISTORY	None found
TYPICAL SECTIONS OF DAM	None found
HYDROLOGIC/HYDRAULIC DATA	None found
OUTLETS - PLAN - DETAILS - CONSTRAINTS - DISCHARGE RATINGS	None found
RAINFALL/RESERVOIR RECORDS	None found

ITEM	REMARKS
DESIGN REPORTS	None found
GEOLOGY REPORTS	None found
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	None found
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	None found
POST-CONSTRUCTION SURVEYS OF DAM	None found
BORROW SOURCES	Unknown

ITEM	REMARKS
MONITORING SYSTEMS	None found
MODIFICATIONS	None found
HIGH POOL RECORDS	None found
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None found
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	None found
MAINTENANCE OPERATION RECORDS	None found

ITEMS	REMARKS
SPILLWAY PLAN	
SECTIONS	None found
DETAILS	
OPERATING EQUIPMENT PLANS & DETAILS	None found

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: .69 square miles, gentle slope, wooded area, and wet lands

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 43.7 NGVD (64 acre-feet)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY) Not applicable

ELEVATION MAXIMUM TEST FLOOD POOL: 46.6 feet NGVD

ELEVATION TOP DAM: 45.2 feet NGVD (142 acre-feet)

SPILLWAY CREST: free overflow concrete spillway

a. Elevation 43.7 feet NGVD

b. Type flat

c. Width 8 inches

d. Length 7.2 feet

e. Location Spillover left dam abutment

f. Number and Type of Gates None

OUTLET WORKS: One 36 inches pipe with upstream steelplate covers (gate)

a. Type clay pipe

b. Location Directly below spillway through wall

c. Entrance Invert 41.1 feet NGVD

d. Exit Invert 41.1 feet NGVD

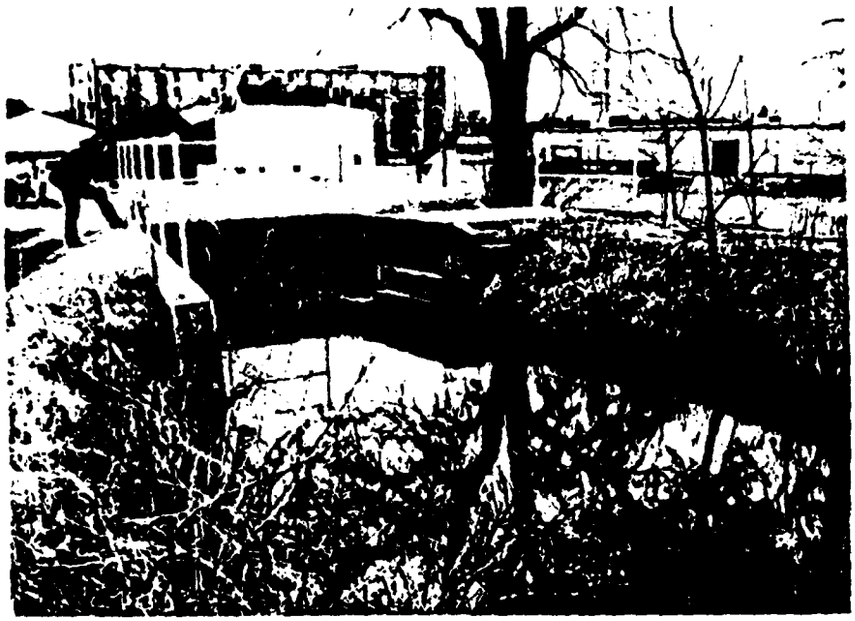
HYDROMETEOROLOGICAL GAGES: None

MAXIMUM NON-DAMAGING DISCHARGE: 41 cfs

APPENDIX 2

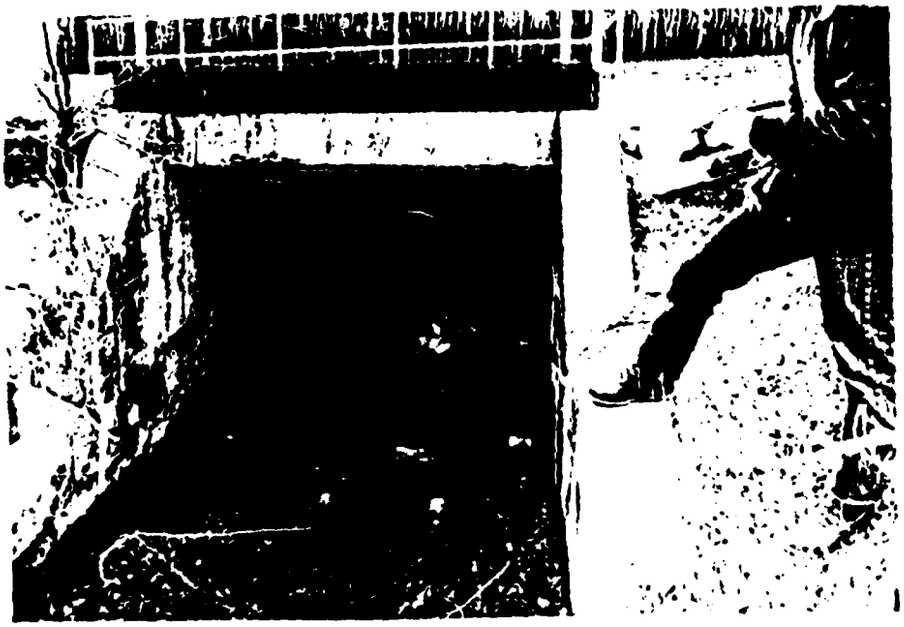
PHOTOGRAPHS

HELMETTA POND DAM



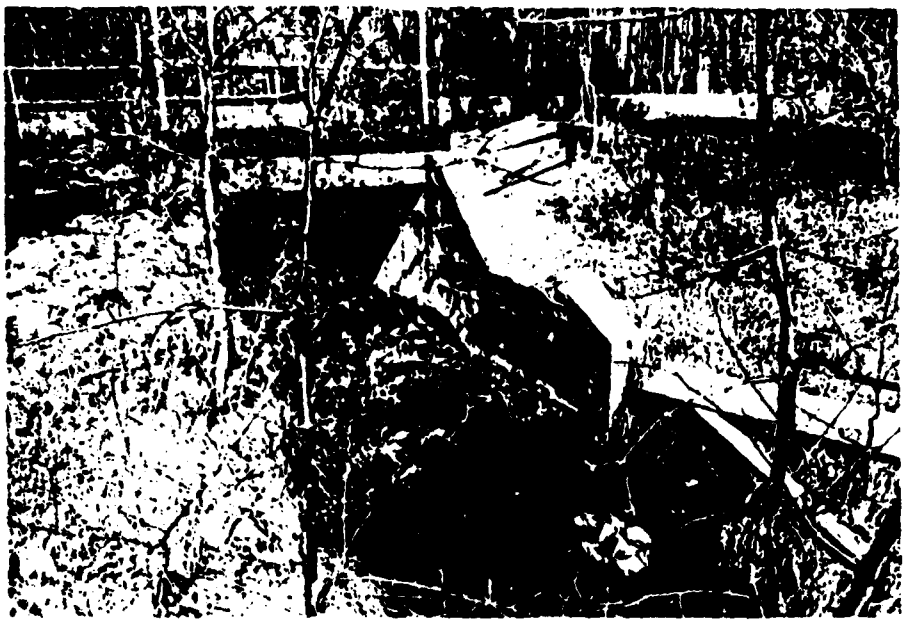
February 19, 1981

View from u/s looking into overflow channel at u/s end of pipe section spillway on left bank (circular cover at u/s end of pipe.)



February 19, 1981

Looking u/s at d/s end of circular pipe spillway - note debris.



April 20, 1981

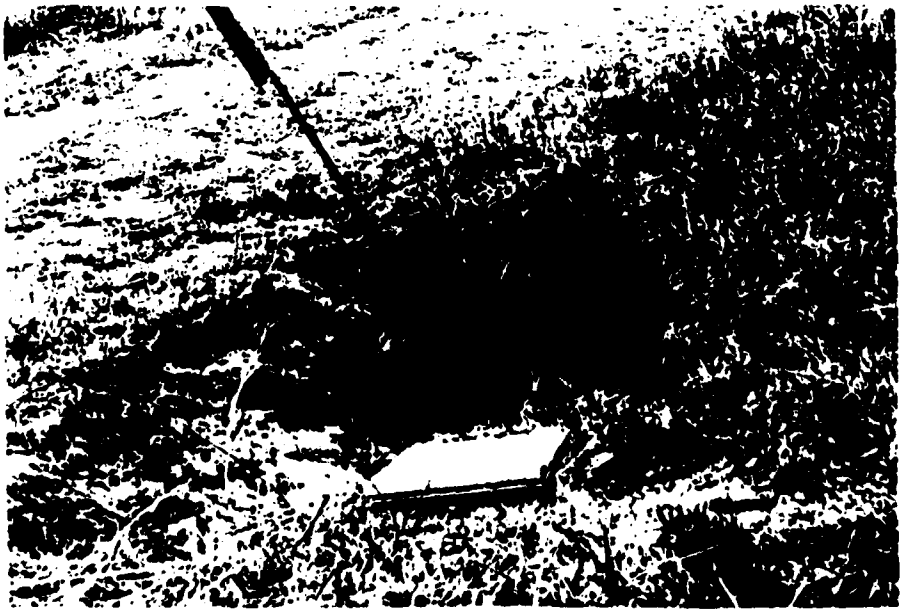
View of left training wall. Note deteriorated and eroded, spalled concrete along left training wall and debris in channel.

February 19, 1981

View looking across dam d/s face. Very large tree growing on dam crest.

April 20, 1981

View from location of large concrete block on upstream face looking toward left side of dam. Note extensive erosion along upstream face.



April 20, 1981

View of animal burrow on crest, 8-inches in diameter, 2.5 feet deep, surface depression 2-feet in diameter, and 1 foot deep.

April 20, 1981

View of seepage area across most of the dam face. Flow estimated at 1-2 gal/min.

February 19, 1981

View looking d/s at retreat channel from bridge over spillway.

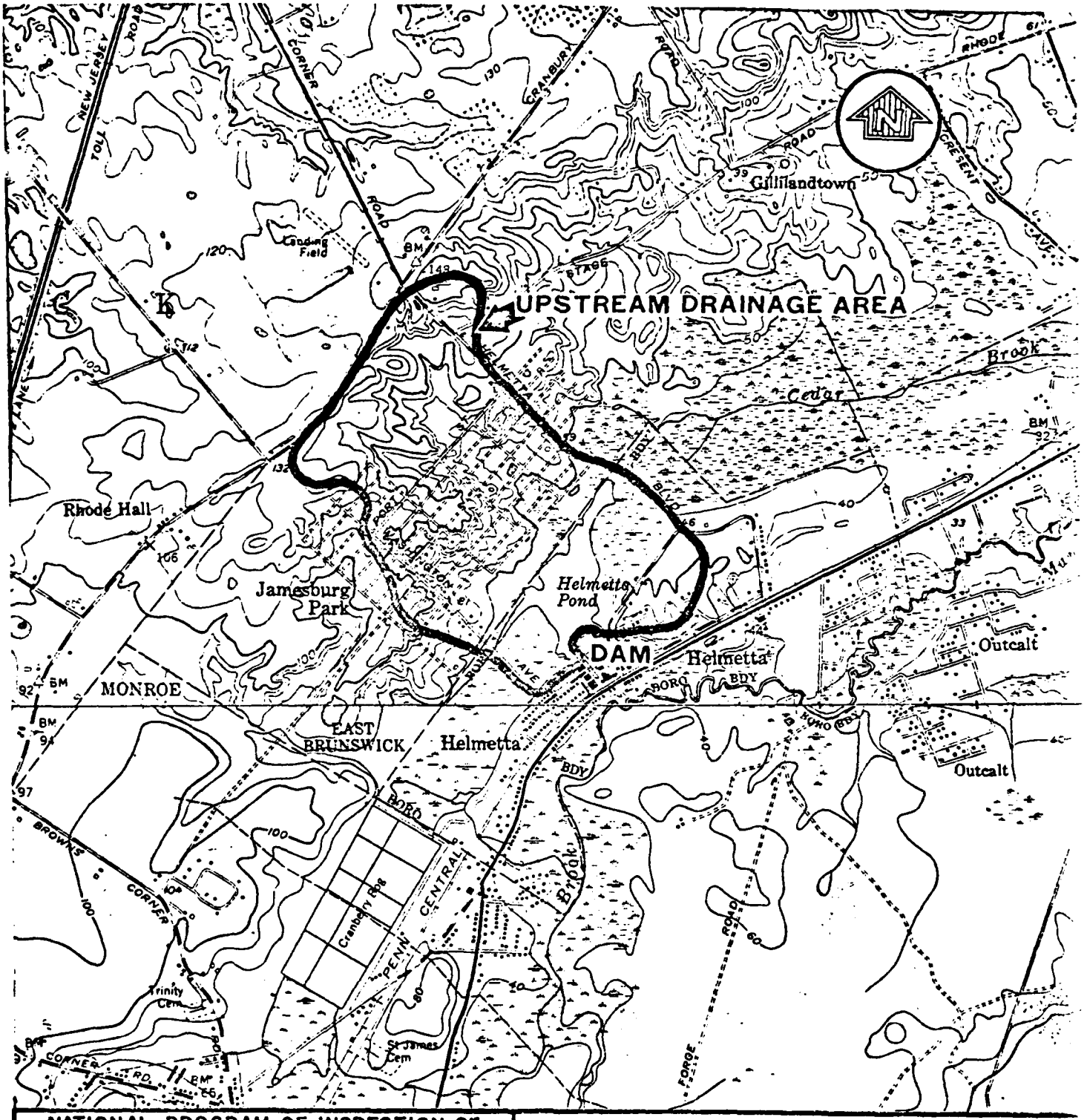
April 20, 1981

View of pipe outlet from retreat channel looking d/s at second pipe that carries normal flows beyond buildings but beneath them.

APPENDIX 3

HYDROLOGIC COMPUTATIONS

HELMETTA POND DAM



NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

HELMETTA POND DAM
BRUNSWICK TOWNSHIP, NEW JERSEY

REGIONAL VICINITY MAP

DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
PHILADELPHIA, PENNSYLVANIA

Andersen-Nichols & Company, Inc. BOSTON, MA.

SCALE IN MILES

0 1/2

MAP BASED ON U.S.G.S. 7.5 MINUTE QUADRANGLE SHEET NEW BRUNSWICK, N.J. 1954, AND JAMESBURG, N.J. 1953, REVISED 1954.

SQUARES 1/4 IN. SCALE 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

TIME OF CONCENTRATION

① Texas Highway Method

all overland - longest flowpath = 4,700 ft.

Slope = $\frac{130-43}{4700} = 0.019 = 1.9\%$

Velocity = 1.0 fps for woodlands

TIME = overland = $\frac{4700}{1} = 4700 \text{ sec} = 1.31$ hours

② Soil & Water Conservation

$$L = 0.6 T_c = \frac{\ell^{0.8}(s+1)^{1.67}}{9{,}000\, y^{0.5}} \qquad S = \frac{1{,}000}{CN} - 10$$

$y = 1.9\%$
$\ell = 4{,}700$
$CN = 70$ for good condition woods class C

$S = \frac{1{,}000}{70} - 10 = 4.3$

$$T_L = \frac{L}{0.6} = \frac{4{,}700^{0.8}(5.3)^{1.67}}{9000\,(1.9)^{0.5}(0.6)} = 1.89 \text{ hours}$$

③ Weston or SCS T.R. #55

all overland:
slope = 1.9%, length = 4700 feet

from T.R. 55 graph, V = 0.33 fps

Time = $\frac{4{,}700}{0.33} = 14{,}240$ seconds = 3.96 hours

④ Kerby

Overland $T_c = 0.83 \left(\frac{Nl}{\sqrt{s}} \right)^{0.467}$

$N = 0.7$ (timber land), $S = 0.019$, $L = 4,700$ feet

$T_c = 0.83 \left(\frac{0.7\ 4,700}{\sqrt{0.019}} \right)^{0.467} = 91.94 \text{ min} = 1.53 \text{ hours}$

Average of 4 methods $= \frac{1.31 + 1.89 + 3.96 + 1.53}{4} = 2.17$ hours

Lag $= 0.6\ T_c = 1.30$ hours

SQUARES 1/4 IN. SCALE

Stage-Discharge Curve

A hydraulic profile of Helmetta dam is given on page 4. E = water surface elevation (ft. msl).

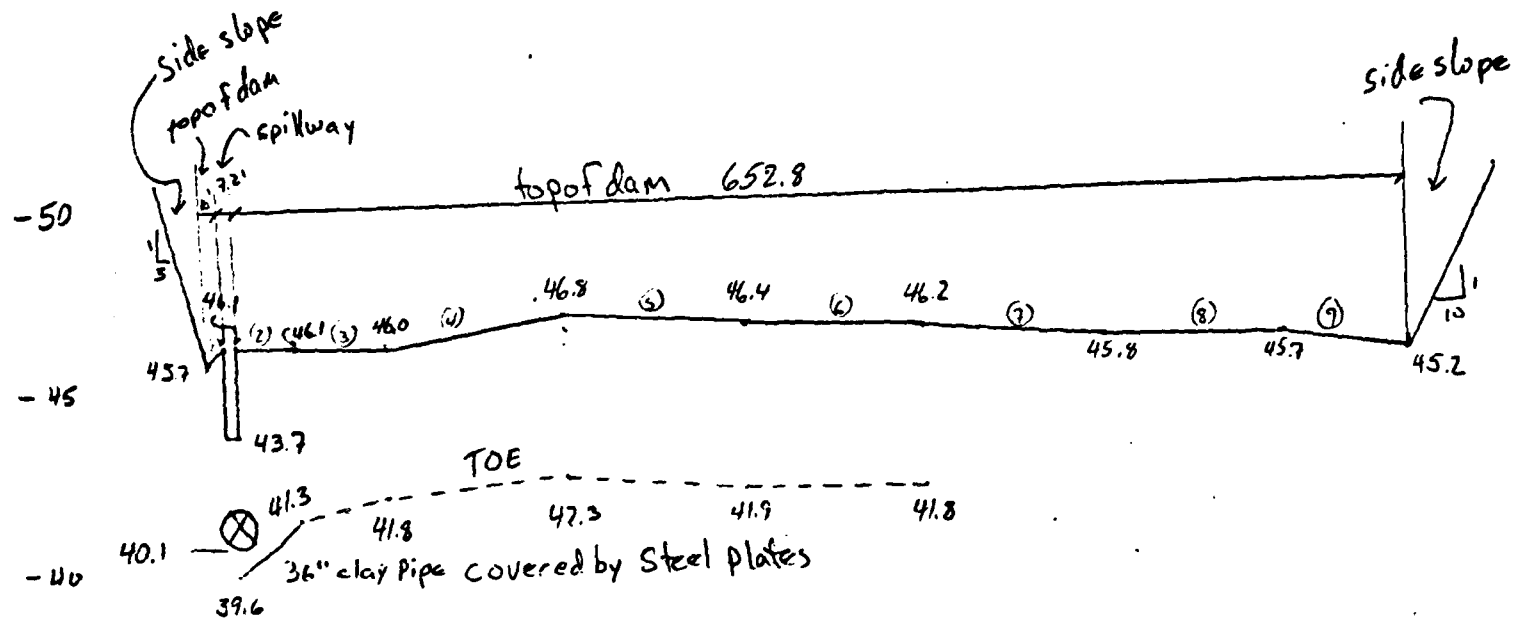
for the spillway, $Q = 3.1\ (7.2)\ (E - 43.7)^{3/2}$

for the top of dam, assume each section (① through ⑨) is a broad-crested weir ($C = 2.6$) with its crest at the average elevation of the section. Thus:

$$Q_{TOP} = 2.6\ (10)\ (E-45.9)^{3/2} + 2.6\ (32.8)\ (E-46.1)^{3/2} + 2.6\ (50)\ (E-46.05)^{3/2}$$
$$+ 2.6\ (100)\ (E-46.4)^{3/2} + 2.6\ (100)\ (E-46.6)^{3/2} + 2.6\ (100)\ (E-46.3)^{3/2}$$
$$+ 2.6\ (100)\ (E-46.0)^{3/2} + 2.6\ (100)\ (E-45.75)^{3/2} + 2.6\ (70)\ (E-45.45)^{3/2}$$

for side slopes, use sloping weir equation ($Q = C\,L\,H_{avg}^{3/2}$) with $C = 2.5$

$$Q_{sides} = 2.5\ (5\,(E-45.7))\ [0.5\,(E-45.7)]^{3/2} + 2.5\ (10\,(E-45.2))\ [0.5\,(E-45$$



ANDERSON-NICHOLS		
VERNON	BOSTON	CONCORD
HYDRAULIC PROFILE HELMETTA DAM		
DATE 6/18/81	SCALE: 1" = 100' H 1" = 5' V	JOB NO.
SHEET NO. P. 4 OF 15		

TCG

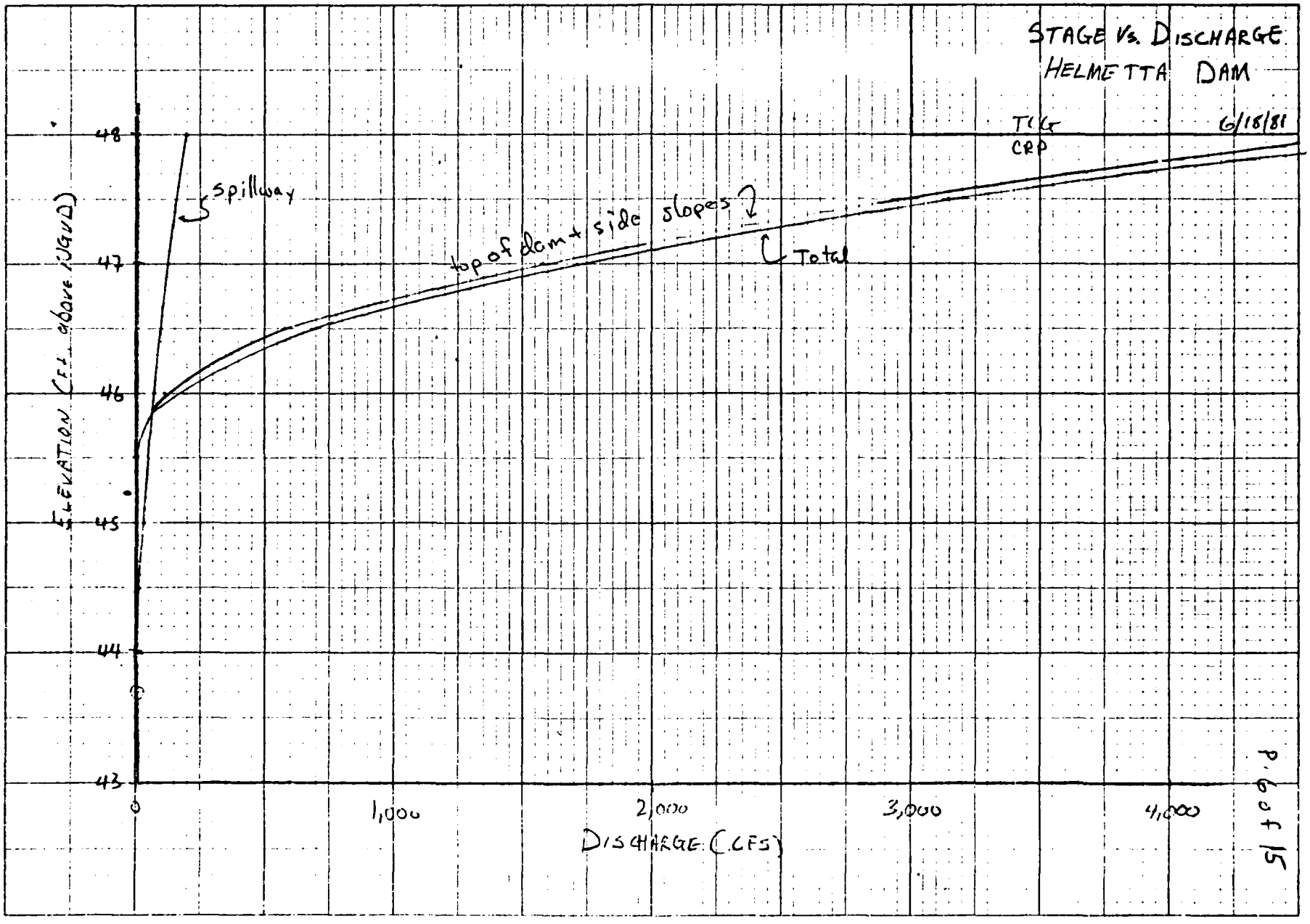
Anderson-Nichols & Company, Inc.

Subject HELMETTA DAM

Sheet No. 5 of 15
Date 6/18/81
Computed TCG
Checked CBP

JOB NO.

ELEVATION (Ft. above NGVD)	H (Ft. above s/w crest)	$Q_{spillway}$ (CFS)	$Q_{TOP\ of\ DAM}$ (CFS)	$Q_{side\ slopes}$ (CFS)	Q_{TOTAL} (CFS)
39.6	-	0	0	0	0
43.7	0	0	0	0	0
44	0.3	4	0	0	4
44.5	0.8	16	0	0	16
45	1.3	33	0	0	33
45.2	1.5	41	0	0	41
46	2.3	78	108	5	191
46.5	2.8	105	561	20	686
47	3.3	134	1,537	47	1,718
47.5	3.8	165	2,898	90	3,153
48	4.3	199	4,544	151	4,894

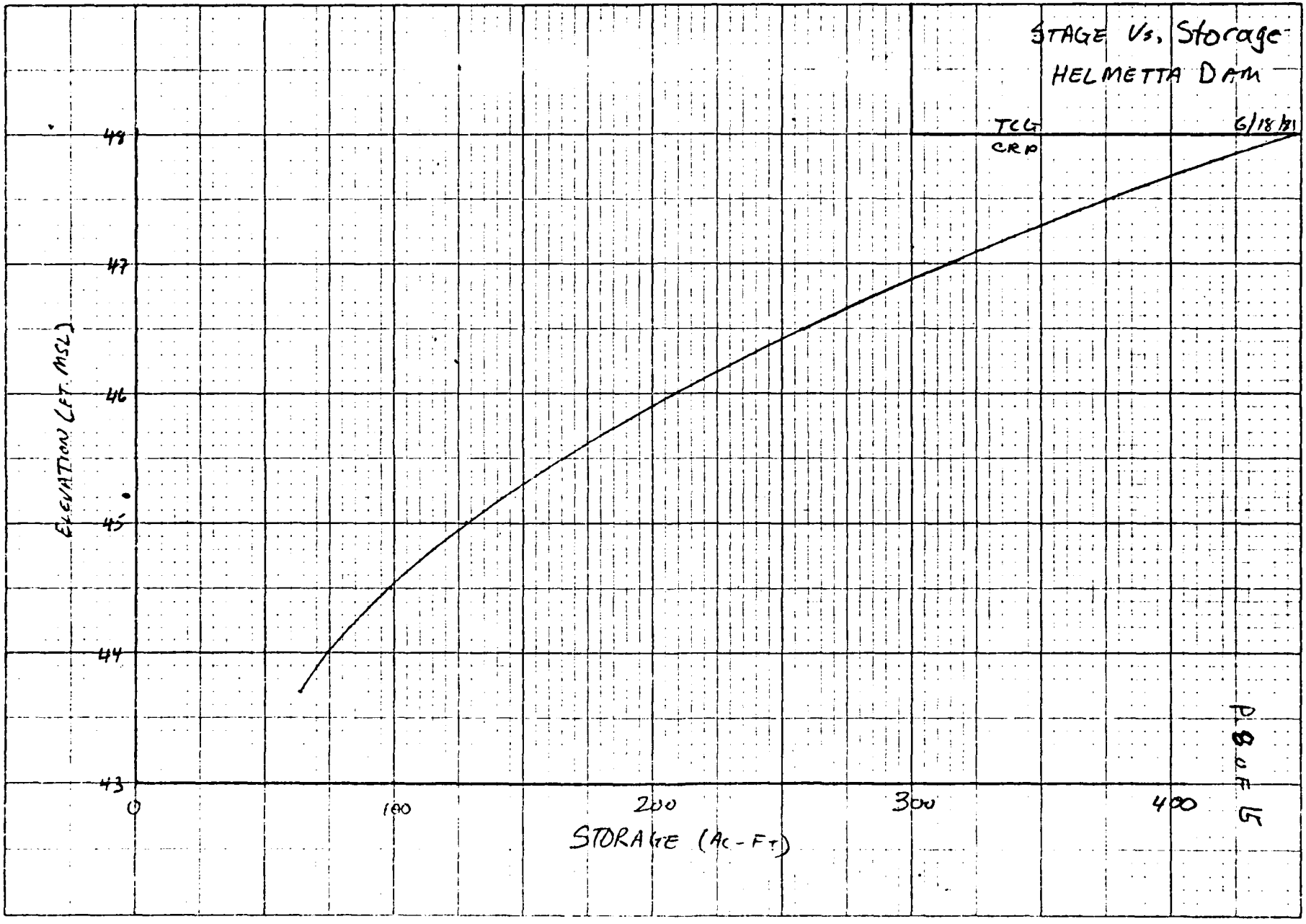


Anderson-Nichols & Company, Inc. Subject HELMETTA DAM Sheet No. 7 of 15
Date 6/18/81
Computed TLG
Checked CRP
JOB NO.

Stage-Storage Determination

The surface area at normal pool, 43.7 ft. above NGVD, is 32 acres. At 50 ft above NGVD, Area is about 200 acres. Assume a linear increase in surface area with elevation. Also assume 0 storage at 39.6 ft msl, and 64 acre-feet storage at 43.7 ft msl (avg. sept = 2 feet).

ELEVATION (Ft. above NGVD)	ΔH (Ft)	SURFACE AREA (Acres)	AVG. S.A. (Acres)	INCREMENTAL STORAGE (Ac-Ft)	CUMULATIVE STORAGE (Ac-Ft)
39.6		–			0
	4.1		–	–	
43.7		32			64
	0.3		36	10.8	
44		40			74.8
	0.5		46.5	23.3	
44.5		53			98.1
	0.5		59.85	29.9	
45		66.7			128.0
	0.2		69.35	13.9	
45.2		72			141.9
	0.8		82.65	66.1	
46		93.3			208
	0.5		100.15	50.1	
46.5		107			258.1
	0.5		113.5	56.8	
47		120			314.9
	0.5		126.5	63.2	
47.5		133			378.1
	0.5		140	70	
48		147			448.1



Anderson-Nichols & Company, Inc.

Subject HELMETTA DAM

Sheet No. 9 of 15
Date 6/15/91
Computed JCT
Checked CRP

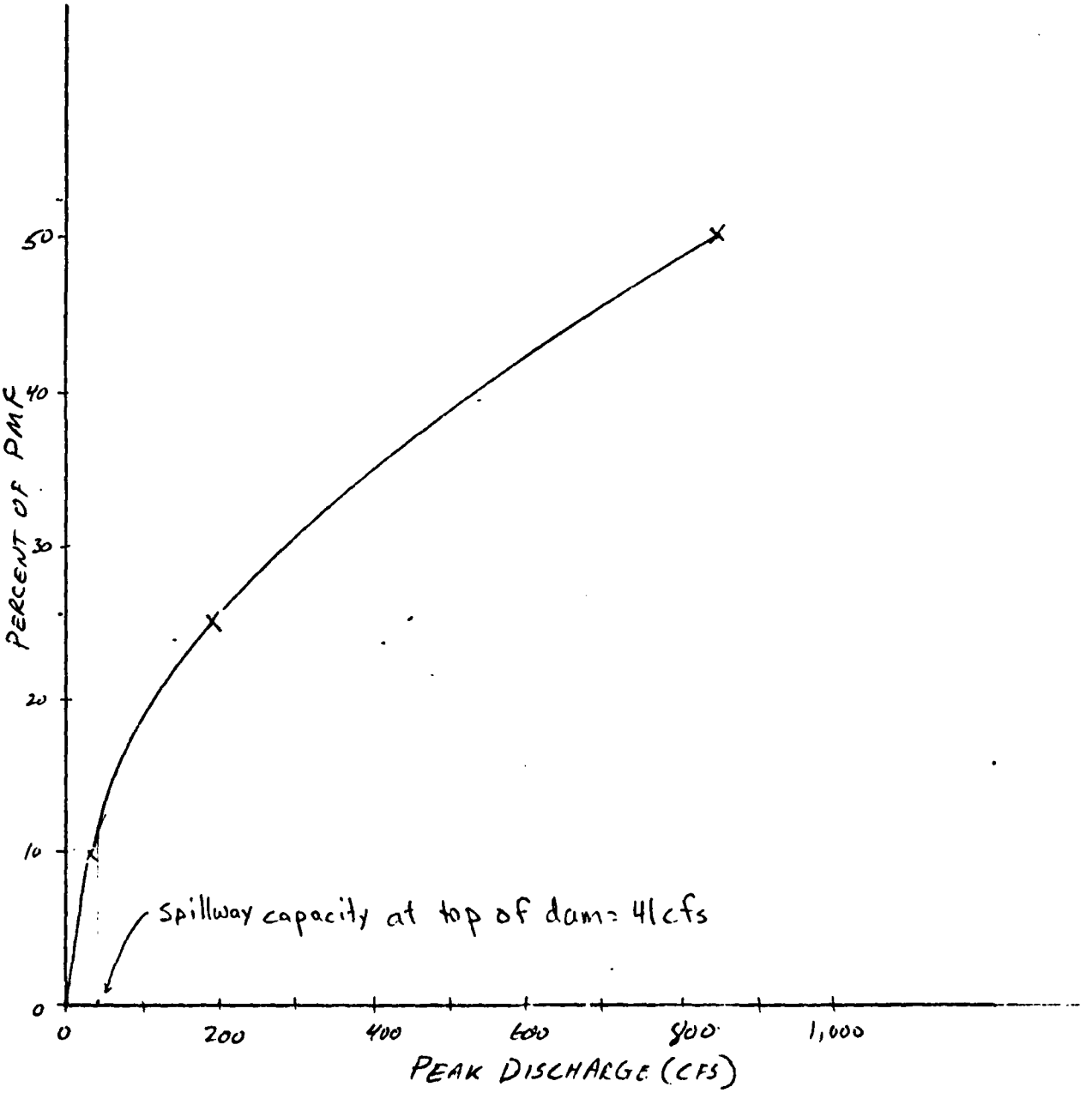
JOB NO.

SQUARES 1/4 IN. SCALE

OVERTOPPING ANALYSIS

DONE using HEC-1, dam top at 45.2, HEC-1 output attached

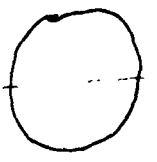
OVERTOPPING POTENTIAL



SQUARES 1/4 IN. SCALE

DRAWDOWN TIME

Use 36" clay pipe with steel covers. ① Above 43.1, the pipe has pressure flow. Say $Q = C A \sqrt{2g} \sqrt{E - 41.6}$



$C = 0.61$, $A = \pi (1.5)^2 = 7.1$. So,

$Q = 0.61 (7.1) (\sqrt{64.4}) \sqrt{E - 41.6} = 34.76 \sqrt{E - 41.6}$

Below 43.1, use mannings formula for open channel flow. Get a at 41.6.

$$Q = A V = A \frac{1.49}{n} \left(\frac{A}{W.P.}\right)^{2/3} S^{\frac{1}{2}}$$

A = Area $= \frac{7.1}{2} = 3.55 \text{ ft}^2$

$n = 0.015$

$WP = \pi R = \pi (1.5) = 4.71 \text{ ft}$

$S = 0.001$

$$Q = 3.55 \left(\frac{1.49}{0.015}\right) \left(\frac{3.55}{4.71}\right)^{2/3} (0.001)^{1/2} = 9.2 \text{ cfs}$$

② Storage elev.

64 AF	43.7
47 AF	43.1
20 AF	41.6
4 AF	40.1
0 AF	39.6

③ $\text{Ac-Ft/day} = 1.99 \times Q_{AVG}$

④ Days = Δ storage / Ac-Ft/day

Anderson-Nichols & Company, Inc.

Subject HELMETA

Sheet No. 11 of 15
Date 6/18/81
Computed ---
Checked C.R.P

JOB NO.

SQUARES 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
1/4 IN. SCALE

ELEV. (Ft. above NGVD)	STORAGE (Ac-Ft)	Δ Storage (Ac-Ft)	Q (CFS)	Q_{AVG} (CFS)	Ac-Ft/Day	DAYS
43.7	64		50.4			
		17		46.5	92.1	0.18
43.1	47		42.6			
		27		26.9	51.3	0.53
41.6	20		9.2			
		16		4.6	9.1	1.76
40.1	4		0			

Σ = 2.47 Days

Note- Some storage left in pond below pipe invert.

SQUARES 1/4 IN. SCALE

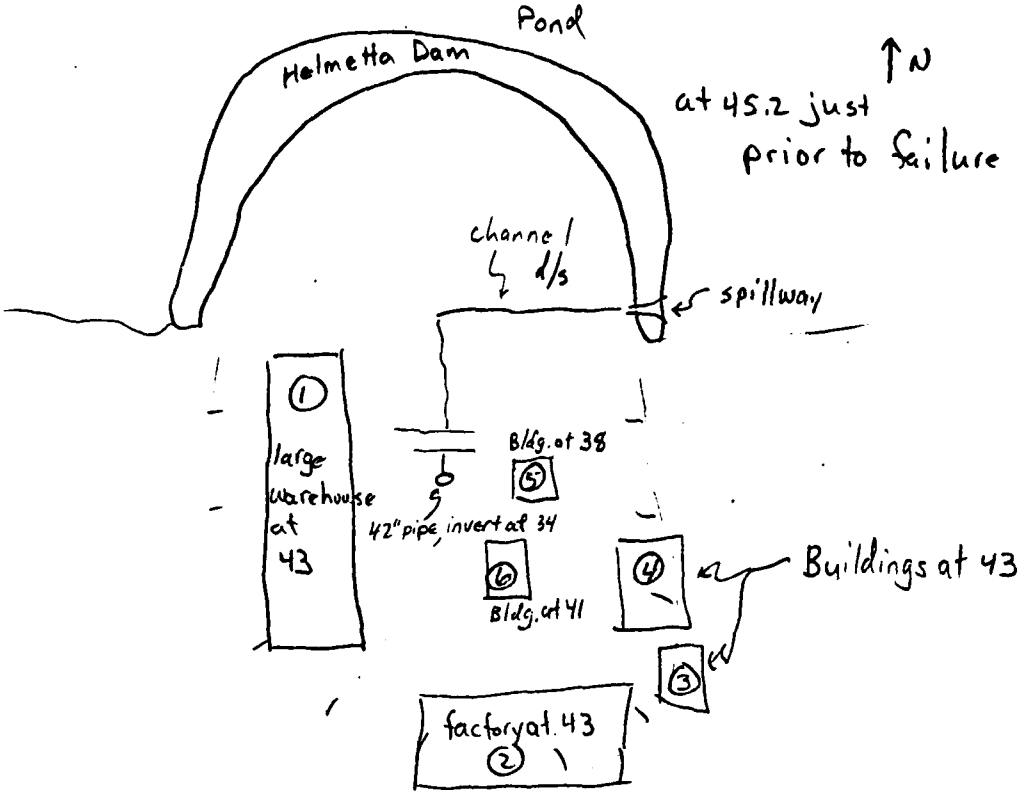
Breach Analysis

Immediately downstream of Helmetta Dam there is a large depression, with warehouses and factory buildings on its edges. The depression shows to have an area of 6 acres below 40 feet NGVD on the USGS quad. The only outlet below 43 feet NGVD or so is a 42" rcp leading under the factory, etc. Its invert is at about 34 feet NGVD.

Immediately prior to overtopping, Helmetta Dam would have a stage of 45.2 feet and an outflow of 41 cfs. This outflow would cause pooling but no appreciable damage downstream.

Upon dam failure, water stored from Helmetta Pond would fill the depression downstream, causing still-water flooding and damage to factories and warehouses. There would be some threat to the lives of workers in basements. The ground floor of one building downstream is at about 38 feet msl, another at about 41', and the main factory and warehouse buildings are at 43'.

See the sketch on p. 13



To estimate the impact of a breach to Helmetta Dam, assume the storage available at failure (141.9 acre-feet) spreads over the depression, thus lowering the stage in the pond while raising that downstream until they are equal and they store a combined total of 141.9 acre-feet. This assumes:

1. negligible outflow during breach development from the depression. A reasonable assumption given only a 42" rcp outlet.
2. All flooding due to breach - effects of higher later inflows not considered.

The stage-storage relationship for Helmetta Pond is given on page 7. For the depression, surface area = 0 at 34 feet, 6 acres at 40 fee

Assume a linear relationship, $SA = (E - 34)\left(1 \frac{Ac}{ft.}\right)$

Storage at $E_{current} = \int_{34}^{E_{current}} (E - 34)\, dE$

$$= \frac{E^2}{2} - 34E + C$$

at 34, $\frac{E^2}{2} - 34E + C = 0$

$$\frac{34^2}{2} - 34(34) + C = 0$$

$$C = \frac{34(34)}{2} = 578$$

So Storage at $E = \frac{E^2}{2} - 34E + 578$

elevation (Ft. above NGVD)	Helmetta[1] Storage (Ac-Ft)	Depression Storage (Ac-Ft)	Total Storage (Ac-Ft)
39.6	0	15.7	15.7
43.7	64	47.0	111
44	74.8	50.0	124.8
44.5	98.1	55.1	153.2
45	128.0	60.5	188.5
45.2	141.9	62.7	204.6

From our assumptions the final stage would be that yielding a total storage of 141.9 ac. ft, which is 44.3 feet msl. This would cause 1-½ feet of flooding at the main buildings downstream, 3-3½ feet

1. from p. 7

building ⑥, and 6-6½ feet at building ⑤. In reality, stages would be somewhat less due to outflow during breach development. However serious economic damage would result from dam failure. Due to low velocities, there would be no serious threat to lives.

APPENDIX 4

HEC 1 OUTPUT

HELMETTA POND DAM

```
LINE          ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
    1         ID    HELMETTA DAM        OVERTOPPING ANALYSIS     TOM GOOCH    ANCO
    2         ID    NEW JERSEY DAM NO. 794 - MIDDLESEX COUNTY - HELMETTA BOROUGH
    3         ID    0.1,0.25,0.5 MULTIPLES OF PMF FROM 24-HOUR PMP
    4         IT       5          0       300
    5         IO       2          1
    6         JR    FLOW      0.1     0.25      0.5

    7         KK      A1  HELMETTA POND INFLOW HYDROGRAPH
    8         KM      INFLOW FROM SCS UNIT GRAPH COMPUTATIONS
    9         BA    0.69               0
   10         BF     2.1        2.1             1
   11         PM    22.9                                NO      113      123      132
   12         LU       1        0.1
   13         UD    1.30

   14         KK      A2  ROUTE INFLOW HYDROGRAPH THROUGH HELMETTA POND
   15         RS       1       STOR      64.0
   16         SV       0         64.      74.8      98.1      128.     141.9      208.     258.1     314.9     378.1
   17         SE    39.6       43.7       44.       44.5       45.      45.2       46.      46.5       47.      47.5
   18         SQ      0.         0.         4.        16.       33.       41.      191.      686.     1718.     3153.
   19         SE    39.6       43.7       44.       44.5       45.      45.2       46.      46.5       47.      47.5
   20         SS    43.7        7.2        3.1        1.5
   21         ST    45.2      662.8        0.0        1.5
   22         ZZ
```

```
**********                                          **********
*        *                                          *        *
*  FLOOD HYDROGRAPH PACKAGE (HEC-1)                 *  U.S. ARMY CORPS OF ENGINEERS
*        FEBRUARY 1981                              *  THE HYDROLOGIC ENGINEERING CENTER
*        *                                          *        609 SECOND STREET
*        *                                          *        DAVIS, CALIFORNIA 95616
*  RUN DATE06/24/81      TIME10.04.37               *  (916) 440-3285 OR (FTS) 448-3285
*        *                                          *        *
**********                                          **********

                        HELMETTA DAM        OVERTOPPING ANALYSIS     TOM GOOCH   ANCO
                        NEW JERSEY DAM NO. 794 - MIDDLESEX COUNTY - HELMETTA BOROUGH
                        0.1,0.25,0.5 MULTIPLES OF PMF FROM 24-HOUR PMP

   5 IO          OUTPUT CONTROL VARIABLES
                       IPRNT         3  PRINT CONTROL
                       IPLOT         1  PLOT CONTROL
                       QSCAL           HYDROGRAPH PLOT SCALE
                        PMSG       YES  PRINT DIAGNOSTIC MESSAGES

     IT          HYDROGRAPH TIME DATA
                        NMIN         5  MINUTES IN COMPUTATION INTERVAL
                       IDATE     1    0  STARTING DATE
                       ITIME        0000  STARTING TIME
                          NQ         300  NUMBER OF HYDROGRAPH ORDINATES
                       NDDATE    2    0  ENDING DATE
                       NDTIME       0055  ENDING TIME

                    COMPUTATION INTERVAL      0.08 HOURS
                      TOTAL TIME BASE        24.92 HOURS

          ENGLISH UNITS
               DRAINAGE AREA            SQUARE MILES
               PRECIPITATION DEPTH      INCHES
               LENGTH, ELEVATION        FEET
               FLOW                     CUBIC FEET PER SECOND
               STORAGE VOLUME           ACRE-FEET
               SURFACE AREA             ACRES
               TEMPERATURE              DEGREES FAHRENHEIT

     JP          MULTI-PLAN OPTION
                       NPLAN         1  NUMBER OF PLANS

     JR          MULTI-RATIO OPTION
                    RATIOS OF RUNOFF
                  0.10      0.25      0.50

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

             **********
             *        *
   7 KK      *   A1   *       HELMETTA POND INFLOW HYDROGRAPH
             *        *
             **********
                              INFLOW FROM SCS UNIT GRAPH COMPUTATIONS

        SUBBASIN RUNOFF DATA

   9 BA          SUBBASIN CHARACTERISTICS
                       TAREA         0.69  SUBBASIN AREA

  10 BF          BASE FLOW CHARACTERISTICS
                       STRTQ         4.10  INITIAL FLOW
                       QRCSN         2.10  BEGIN BASE FLOW RECESSION
                       RTIOR      1.00000  RECESSION CONSTANT
```

PRECIPITATION DATA

11 PM PROBABLE MAXIMUM STORM

PMS	22.00	INDEX PRECIPITATION
TRSPC	0.80	TRANSPOSITION COEFFICIENT
TRSDA	0.69	TRANSPOSITION AREA
SWD	NO	USE SWD DISTRIBUTION

PERCENT OF INDEX PRECIPITATION OCCURRING IN GIVEN TIME

6-HR	12-HR	24-HR	48-HR	72-HR	96-HR
113.0	123.0	132.0	0.0	0.0	0.0

12 LU UNIFORM LOSS RATE

STRTL	1.00	INITIAL LOSS
CNSTL	0.10	UNIFORM LOSS RATE
RTIMP	0.0	PERCENT IMPERVIOUS AREA

13 UD SCS DIMENSIONLESS UNITGRAPH

TLAG	1.30	LAG

***

UNIT HYDROGRAPH
80 END-OF-PERIOD ORDINATES

5.	12.	22.	36.	50.	69.	91.	116.	145.	172.
197.	216.	232.	241.	247.	248.	247.	243.	234.	224.
213.	200.	187.	171.	153.	135.	120.	107.	97.	87.
79.	71.	65.	59.	54.	49.	44.	39.	35.	32.
29.	26.	24.	22.	19.	18.	16.	14.	13.	12.
11.	10.	9.	8.	7.	6.	6.	5.	5.	4.
4.	3.	3.	3.	3.	2.	2.	2.	2.	2.
2.	1.	1.	1.	1.	1.	1.	0.	0.	0.

HYDROGRAPH AT STATION A1

DA	MON	HRMN	ORD	RAIN	LOSS	EXCESS	COMP Q	DA	MON	HRMN	ORD	RAIN	LOSS	EXCESS	COMP Q
1		0000	1	0.0	0.0	0.0	2.	1		1230	151	0.17	0.01	0.16	122.
1		0005	2	0.01	0.01	0.00	2.	1		1235	152	0.17	0.01	0.16	135.
1		0010	3	0.01	0.01	0.00	2.	1		1240	153	0.17	0.01	0.16	152.
1		0015	4	0.01	0.01	0.00	2.	1		1245	154	0.17	0.01	0.16	173.
1		0020	5	0.01	0.01	0.00	2.	1		1250	155	0.17	0.01	0.16	199.
1		0025	6	0.01	0.01	0.00	2.	1		1255	156	0.17	0.01	0.16	228.
1		0030	7	0.01	0.01	0.00	2.	1		1300	157	0.17	0.01	0.16	260.
1		0035	8	0.01	0.01	0.00	2.	1		1305	158	0.21	0.01	0.20	294.
1		0040	9	0.01	0.01	0.00	2.	1		1310	159	0.21	0.01	0.20	330.
1		0045	10	0.01	0.01	0.00	2.	1		1315	160	0.21	0.01	0.20	367.
1		0050	11	0.01	0.01	0.00	2.	1		1320	161	0.21	0.01	0.20	405.
1		0055	12	0.01	0.01	0.00	2.	1		1325	162	0.21	0.01	0.20	443.
1		0100	13	0.01	0.01	0.00	2.	1		1330	163	0.21	0.01	0.20	481.
1		0105	14	0.01	0.01	0.00	2.	1		1335	164	0.21	0.01	0.20	519.
1		0110	15	0.01	0.01	0.00	2.	1		1340	165	0.21	0.01	0.20	558.
1		0115	16	0.01	0.01	0.00	2.	1		1345	166	0.21	0.01	0.20	592.
1		0120	17	0.01	0.01	0.00	2.	1		1350	167	0.21	0.01	0.20	627.
1		0125	18	0.01	0.01	0.00	2.	1		1355	168	0.21	0.01	0.20	661.
1		0130	19	0.01	0.01	0.00	2.	1		1400	169	0.21	0.01	0.20	694.
1		0135	20	0.01	0.01	0.00	2.	1		1405	170	0.26	0.01	0.25	725.
1		0140	21	0.01	0.01	0.00	2.	1		1410	171	0.26	0.01	0.25	754.
1		0145	22	0.01	0.01	0.00	2.	1		1415	172	0.26	0.01	0.25	781.
1		0150	23	0.01	0.01	0.00	2.	1		1420	173	0.26	0.01	0.25	807.

1	0155	24	0.01	0.01	0.00	2.	*	1	1425	174	0.26	0.01	0.25	833.
1	0200	25	0.01	0.01	0.00	2.	*	1	1430	175	0.26	0.01	0.25	857.
1	0205	26	0.01	0.01	0.00	2.	*	1	1435	176	0.26	0.01	0.25	882.
1	0210	27	0.01	0.01	0.00	2.	*	1	1440	177	0.26	0.01	0.25	906.
1	0215	28	0.01	0.01	0.00	2.	*	1	1445	178	0.26	0.01	0.25	930.
1	0220	29	0.01	0.01	0.00	2.	*	1	1450	179	0.26	0.01	0.25	955.
1	0225	30	0.01	0.01	0.00	2.	*	1	1455	180	0.25	0.01	0.25	979.
1	0230	31	0.01	0.01	0.00	2.	*	1	1500	181	0.26	0.01	0.25	1004.
1	0235	32	0.01	0.01	0.00	2.	*	1	1505	182	0.24	0.01	0.23	1027.
1	0240	33	0.01	0.01	0.00	2.	*	1	1510	183	0.31	0.01	0.31	1050.
1	0245	34	0.01	0.01	0.00	2.	*	1	1515	184	0.39	0.01	0.38	1073.
1	0250	35	0.01	0.01	0.00	2.	*	1	1520	185	0.47	0.01	0.46	1097.
1	0255	36	0.01	0.01	0.00	2.	*	1	1525	186	0.71	0.01	0.70	1123.
1	0300	37	0.01	0.01	0.00	2.	*	1	1530	187	1.34	0.01	1.33	1155.
1	0305	38	0.01	0.01	0.00	2.	*	1	1535	188	1.97	0.01	1.96	1199.
1	0310	39	0.01	0.01	0.00	2.	*	1	1540	189	0.87	0.01	0.86	1255.
1	0315	40	0.01	0.01	0.00	2.	*	1	1545	190	0.63	0.01	0.62	1324.
1	0320	41	0.01	0.01	0.00	2.	*	1	1550	191	0.39	0.01	0.38	1404.
1	0325	42	0.01	0.01	0.00	2.	*	1	1555	192	0.31	0.01	0.31	1496.
1	0330	43	0.01	0.01	0.00	2.	*	1	1600	193	0.24	0.01	0.23	1602.
1	0335	44	0.01	0.01	0.00	2.	*	1	1605	194	0.24	0.01	0.23	1719.
1	0340	45	0.01	0.01	0.00	2.	*	1	1610	195	0.24	0.01	0.23	1846.
1	0345	46	0.01	0.01	0.00	2.	*	1	1615	196	0.24	0.01	0.23	1976.
1	0350	47	0.01	0.01	0.00	2.	*	1	1620	197	0.24	0.01	0.23	2104.
1	0355	48	0.01	0.01	0.00	2.	*	1	1625	198	0.24	0.01	0.23	2215.
1	0400	49	0.01	0.01	0.00	2.	*	1	1630	199	0.24	0.01	0.23	2306.
1	0405	50	0.01	0.01	0.00	2.	*	1	1635	200	0.24	0.01	0.23	2375.
1	0410	51	0.01	0.01	0.00	2.	*	1	1640	201	0.24	0.01	0.23	2421.
1	0415	52	0.01	0.01	0.00	2.	*	1	1645	202	0.24	0.01	0.23	2446.
1	0420	53	0.01	0.01	0.00	2.	*	1	1650	203	0.24	0.01	0.23	2453.
1	0425	54	0.01	0.01	0.00	2.	*	1	1655	204	0.24	0.01	0.23	2444.
1	0430	55	0.01	0.01	0.00	2.	*	1	1700	205	0.24	0.01	0.23	2419.
1	0435	56	0.01	0.01	0.00	2.	*	1	1705	206	0.19	0.01	0.18	2379.
1	0440	57	0.01	0.01	0.00	2.	*	1	1710	207	0.19	0.01	0.18	2329.
1	0445	58	0.01	0.01	0.00	2.	*	1	1715	208	0.19	0.01	0.18	2271.
1	0450	59	0.01	0.01	0.00	2.	*	1	1720	209	0.19	0.01	0.18	2206.
1	0455	60	0.01	0.01	0.00	2.	*	1	1725	210	0.19	0.01	0.18	2134.
1	0500	61	0.01	0.01	0.00	2.	*	1	1730	211	0.19	0.01	0.18	2054.
1	0505	62	0.01	0.01	0.00	2.	*	1	1735	212	0.19	0.01	0.18	1969.
1	0510	63	0.01	0.01	0.00	2.	*	1	1740	213	0.19	0.01	0.18	1885.
1	0515	64	0.01	0.01	0.00	2.	*	1	1745	214	0.19	0.01	0.18	1806.
1	0520	65	0.01	0.01	0.00	2.	*	1	1750	215	0.19	0.01	0.18	1737.
1	0525	66	0.01	0.01	0.00	2.	*	1	1755	216	0.19	0.01	0.18	1674.
1	0530	67	0.01	0.01	0.00	2.	*	1	1800	217	0.19	0.01	0.18	1616.
1	0535	68	0.01	0.01	0.00	2.	*	1	1805	218	0.01	0.01	0.01	1562.
1	0540	69	0.01	0.01	0.00	2.	*	1	1810	219	0.01	0.01	0.01	1511.
1	0545	70	0.01	0.01	0.00	2.	*	1	1815	220	0.01	0.01	0.01	1463.
1	0550	71	0.01	0.01	0.00	2.	*	1	1820	221	0.01	0.01	0.01	1415.
1	0555	72	0.01	0.01	0.00	2.	*	1	1825	222	0.01	0.01	0.01	1367.
1	0600	73	0.01	0.01	0.00	2.	*	1	1830	223	0.01	0.01	0.01	1317.
1	0605	74	0.03	0.03	0.00	2.	*	1	1835	224	0.01	0.01	0.01	1266.
1	0610	75	0.03	0.03	0.00	2.	*	1	1840	225	0.01	0.01	0.01	1213.
1	0615	76	0.03	0.03	0.00	2.	*	1	1845	226	0.01	0.01	0.01	1158.
1	0620	77	0.03	0.03	0.00	2.	*	1	1850	227	0.01	0.01	0.01	1101.
1	0625	78	0.03	0.03	0.00	2.	*	1	1855	228	0.01	0.01	0.01	1041.
1	0630	79	0.03	0.03	0.00	2.	*	1	1900	229	0.01	0.01	0.01	980.
1	0635	80	0.03	0.03	0.00	2.	*	1	1905	230	0.01	0.01	0.01	920.
1	0640	81	0.03	0.03	0.00	2.	*	1	1910	231	0.01	0.01	0.01	859.
1	0645	82	0.03	0.03	0.00	2.	*	1	1915	232	0.01	0.01	0.01	799.
1	0650	83	0.03	0.03	0.00	2.	*	1	1920	233	0.01	0.01	0.01	740.
1	0655	84	0.03	0.03	0.00	2.	*	1	1925	234	0.01	0.01	0.01	683.
1	0700	85	0.03	0.03	0.00	2.	*	1	1930	235	0.01	0.01	0.01	628.
1	0705	86	0.03	0.03	0.00	2.	*	1	1935	236	0.01	0.01	0.01	576.
1	0710	87	0.03	0.01	0.01	2.	*	1	1940	237	0.01	0.01	0.01	527.
1	0715	88	0.03	0.01	0.02	2.	*	1	1945	238	0.01	0.01	0.01	481.
1	0720	89	0.03	0.01	0.02	2.	*	1	1950	239	0.01	0.01	0.01	436.
1	0725	90	0.03	0.01	0.02	3.	*	1	1955	240	0.01	0.01	0.01	390.

1	0730	91	0.03	0.01	0.02	4.	*	1	2000	241	0.01	0.01	0.01	361.
1	0735	92	0.03	0.01	0.02	5.	*	1	2005	242	0.01	0.01	0.01	328.
1	0740	93	0.03	0.01	0.02	6.	*	1	2010	243	0.01	0.01	0.01	299.
1	0745	94	0.03	0.01	0.02	8.	*	1	2015	244	0.01	0.01	0.01	273.
1	0750	95	0.03	0.01	0.02	10.	*	1	2020	245	0.01	0.01	0.01	250.
1	0755	96	0.03	0.01	0.02	13.	*	1	2025	246	0.01	0.01	0.01	229.
1	0800	97	0.03	0.01	0.02	16.	*	1	2030	247	0.01	0.01	0.01	210.
1	0805	98	0.03	0.01	0.02	20.	*	1	2035	248	0.01	0.01	0.01	193.
1	0810	99	0.03	0.01	0.02	24.	*	1	2040	249	0.01	0.01	0.01	177.
1	0815	100	0.03	0.01	0.02	28.	*	1	2045	250	0.01	0.01	0.01	163.
1	0820	101	0.03	0.01	0.02	32.	*	1	2050	251	0.01	0.01	0.01	150.
1	0825	102	0.03	0.01	0.02	36.	*	1	2055	252	0.01	0.01	0.01	139.
1	0830	103	0.03	0.01	0.02	41.	*	1	2100	253	0.01	0.01	0.01	128.
1	0835	104	0.03	0.01	0.02	45.	*	1	2105	254	0.01	0.01	0.01	119.
1	0840	105	0.03	0.01	0.02	49.	*	1	2110	255	0.01	0.01	0.01	111.
1	0845	106	0.03	0.01	0.02	53.	*	1	2115	256	0.01	0.01	0.01	103.
1	0850	107	0.03	0.01	0.02	56.	*	1	2120	257	0.01	0.01	0.01	96.
1	0855	108	0.03	0.01	0.02	60.	*	1	2125	258	0.01	0.01	0.01	89.
1	0900	109	0.03	0.01	0.02	63.	*	1	2130	259	0.01	0.01	0.01	83.
1	0905	110	0.03	0.01	0.02	66.	*	1	2135	260	0.01	0.01	0.01	78.
1	0910	111	0.03	0.01	0.02	69.	*	1	2140	261	0.01	0.01	0.01	73.
1	0915	112	0.03	0.01	0.02	71.	*	1	2145	262	0.01	0.01	0.01	68.
1	0920	113	0.03	0.01	0.02	74.	*	1	2150	263	0.01	0.01	0.01	64.
1	0925	114	0.03	0.01	0.02	76.	*	1	2155	264	0.01	0.01	0.01	61.
1	0930	115	0.03	0.01	0.02	77.	*	1	2200	265	0.01	0.01	0.01	57.
1	0935	116	0.03	0.01	0.02	79.	*	1	2205	266	0.01	0.01	0.01	54.
1	0940	117	0.03	0.01	0.02	80.	*	1	2210	267	0.01	0.01	0.01	51.
1	0945	118	0.03	0.01	0.02	82.	*	1	2215	268	0.01	0.01	0.01	49.
1	0950	119	0.03	0.01	0.02	83.	*	1	2220	269	0.01	0.01	0.01	47.
1	0955	120	0.03	0.01	0.02	84.	*	1	2225	270	0.01	0.01	0.01	45.
1	1000	121	0.03	0.01	0.02	85.	*	1	2230	271	0.01	0.01	0.01	44.
1	1005	122	0.03	0.01	0.02	86.	*	1	2235	272	0.01	0.01	0.01	42.
1	1010	123	0.03	0.01	0.02	86.	*	1	2240	273	0.01	0.01	0.01	41.
1	1015	124	0.03	0.01	0.02	87.	*	1	2245	274	0.01	0.01	0.01	40.
1	1020	125	0.03	0.01	0.02	88.	*	1	2250	275	0.01	0.01	0.01	39.
1	1025	126	0.03	0.01	0.02	88.	*	1	2255	276	0.01	0.01	0.01	38.
1	1030	127	0.03	0.01	0.02	89.	*	1	2300	277	0.01	0.01	0.01	37.
1	1035	128	0.03	0.01	0.02	89.	*	1	2305	278	0.01	0.01	0.01	37.
1	1040	129	0.03	0.01	0.02	90.	*	1	2310	279	0.01	0.01	0.01	36.
1	1045	130	0.03	0.01	0.02	90.	*	1	2315	280	0.01	0.01	0.01	35.
1	1050	131	0.03	0.01	0.02	90.	*	1	2320	281	0.01	0.01	0.01	35.
1	1055	132	0.03	0.01	0.02	91.	*	1	2325	282	0.01	0.01	0.01	34.
1	1100	133	0.03	0.01	0.02	91.	*	1	2330	283	0.01	0.01	0.01	34.
1	1105	134	0.03	0.01	0.02	91.	*	1	2335	284	0.01	0.01	0.01	33.
1	1110	135	0.03	0.01	0.02	91.	*	1	2340	285	0.01	0.01	0.01	33.
1	1115	136	0.03	0.01	0.02	92.	*	1	2345	286	0.01	0.01	0.01	33.
1	1120	137	0.03	0.01	0.02	92.	*	1	2350	287	0.01	0.01	0.01	32.
1	1125	138	0.03	0.01	0.02	92.	*	1	2355	288	0.01	0.01	0.01	32.
1	1130	139	0.03	0.01	0.02	92.	*	2	0000	289	0.0	0.0	0.0	32.
1	1135	140	0.03	0.01	0.02	92.	*	2	0005	290	0.0	0.0	0.0	32.
1	1140	141	0.03	0.01	0.02	92.	*	2	0010	291	0.0	0.0	0.0	31.
1	1145	142	0.03	0.01	0.02	93.	*	2	0015	292	0.0	0.0	0.0	31.
1	1150	143	0.03	0.01	0.02	93.	*	2	0020	293	0.0	0.0	0.0	31.
1	1155	144	0.03	0.01	0.02	93.	*	2	0025	294	0.0	0.0	0.0	30.
1	1200	145	0.03	0.01	0.02	93.	*	2	0030	295	0.0	0.0	0.0	30.
1	1205	146	0.17	0.01	0.16	94.	*	2	0035	296	0.0	0.0	0.0	29.
1	1210	147	0.17	0.01	0.16	95.	*	2	0040	297	0.0	0.0	0.0	28.
1	1215	148	0.17	0.01	0.16	99.	*	2	0045	298	0.0	0.0	0.0	27.
1	1220	149	0.17	0.01	0.16	104.	*	2	0050	299	0.0	0.0	0.0	26.
1	1225	150	0.17	0.01	0.16	112.	*	2	0055	300	0.0	0.0	0.0	25.
							*			SUM	24.17	2.68	21.49	

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PEAK FLOW (CFS)	TIME (HR)			MAXIMUM AVERAGE FLOW 6-HR	24-HR	72-HR	24.92-HR
2453.	16.83		(CFS)	1359.	400.	385.	385.
			(INCHES)	18.663	21.553	21.557	21.557
			(AC-FT)	667.	793.	793.	793.

CUMULATIVE AREA = 0.69 SQ MI

HYDROGRAPH AT STATION A1
PLAN 1, RATIO = 0.50

DA	MON	HRMN	ORD	FLOW	DA	MON	HRMN	ORD	FLOW	DA	MON	HRMN	ORD	FLOW	DA	MON	HRMN	ORD	FLOW
1		0000	1	1.	1		0615	76	1.	1		1230	151	61.	1		1845	226	579.
1		0005	2	1.	1		0620	77	1.	1		1235	152	68.	1		1850	227	550.
1		0010	3	1.	1		0625	78	1.	1		1240	153	76.	1		1855	228	521.
1		0015	4	1.	1		0630	79	1.	1		1245	154	87.	1		1900	229	490.
1		0020	5	1.	1		0635	80	1.	1		1250	155	99.	1		1905	230	460.
1		0025	6	1.	1		0640	81	1.	1		1255	156	114.	1		1910	231	429.
1		0030	7	1.	1		0645	82	1.	1		1300	157	130.	1		1915	232	399.
1		0035	8	1.	1		0650	83	1.	1		1305	158	147.	1		1920	233	370.
1		0040	9	1.	1		0655	84	1.	1		1310	159	165.	1		1925	234	342.
1		0045	10	1.	1		0700	85	1.	1		1315	160	183.	1		1930	235	314.
1		0050	11	1.	1		0705	86	1.	1		1320	161	202.	1		1935	236	288.
1		0055	12	1.	1		0710	87	1.	1		1325	162	221.	1		1940	237	264.
1		0100	13	1.	1		0715	88	1.	1		1330	163	240.	1		1945	238	241.
1		0105	14	1.	1		0720	89	1.	1		1335	164	259.	1		1950	239	219.
1		0110	15	1.	1		0725	90	2.	1		1340	165	278.	1		1955	240	199.
1		0115	16	1.	1		0730	91	2.	1		1345	166	296.	1		2000	241	181.
1		0120	17	1.	1		0735	92	2.	1		1350	167	314.	1		2005	242	164.
1		0125	18	1.	1		0740	93	3.	1		1355	168	331.	1		2010	243	150.
1		0130	19	1.	1		0745	94	4.	1		1400	169	347.	1		2015	244	137.
1		0135	20	1.	1		0750	95	5.	1		1405	170	362.	1		2020	245	125.
1		0140	21	1.	1		0755	96	7.	1		1410	171	377.	1		2025	246	114.
1		0145	22	1.	1		0800	97	8.	1		1415	172	391.	1		2030	247	105.
1		0150	23	1.	1		0805	98	10.	1		1420	173	404.	1		2035	248	96.
1		0155	24	1.	1		0810	99	12.	1		1425	174	416.	1		2040	249	89.
1		0200	25	1.	1		0815	100	14.	1		1430	175	428.	1		2045	250	82.
1		0205	26	1.	1		0820	101	16.	1		1435	176	441.	1		2050	251	75.
1		0210	27	1.	1		0825	102	18.	1		1440	177	453.	1		2055	252	69.
1		0215	28	1.	1		0830	103	20.	1		1445	178	465.	1		2100	253	64.
1		0220	29	1.	1		0835	104	22.	1		1450	179	477.	1		2105	254	60.
1		0225	30	1.	1		0840	105	24.	1		1455	180	490.	1		2110	255	55.
1		0230	31	1.	1		0845	106	26.	1		1500	181	502.	1		2115	256	51.
1		0235	32	1.	1		0850	107	28.	1		1505	182	514.	1		2120	257	46.
1		0240	33	1.	1		0855	108	30.	1		1510	183	525.	1		2125	258	43.
1		0245	34	1.	1		0900	109	32.	1		1515	184	537.	1		2130	259	42.
1		0250	35	1.	1		0905	110	33.	1		1520	185	549.	1		2135	260	39.
1		0255	36	1.	1		0910	111	35.	1		1525	186	561.	1		2140	261	36.
1		0300	37	1.	1		0915	112	36.	1		1530	187	577.	1		2145	262	34.
1		0305	38	1.	1		0920	113	37.	1		1535	188	599.	1		2150	263	32.
1		0310	39	1.	1		0925	114	38.	1		1540	189	627.	1		2155	264	30.
1		0315	40	1.	1		0930	115	39.	1		1545	190	662.	1		2200	265	29.
1		0320	41	1.	1		0935	116	39.	1		1550	191	702.	1		2205	266	27.
1		0325	42	1.	1		0940	117	40.	1		1555	192	748.	1		2210	267	26.
1		0330	43	1.	1		0945	118	41.	1		1600	193	801.	1		2215	268	24.
1		0335	44	1.	1		0950	119	41.	1		1605	194	860.	1		2220	269	23.
1		0340	45	1.	1		0955	120	42.	1		1610	195	923.	1		2225	270	23.
1		0345	46	1.	1		1000	121	42.	1		1615	196	989.	1		2230	271	22.
1		0350	47	1.	1		1005	122	43.	1		1620	197	1052.	1		2235	272	21.
1		0355	48	1.	1		1010	123	43.	1		1625	198	1107.	1		2240	273	21.
1		0400	49	1.	1		1015	124	44.	1		1630	199	1153.	1		2245	274	20.
1		0405	50	1.	1		1020	125	44.	1		1635	200	1188.	1		2250	275	19.
1		0410	51	1.	1		1025	126	44.	1		1640	201	1210.	1		2255	276	19.
1		0415	52	1.	1		1030	127	44.	1		1645	202	1223.	1		2300	277	19.
1		0420	53	1.	1		1035	128	45.	1		1650	203	1226.	1		2305	278	18.
1		0425	54	1.	1		1040	129	45.	1		1655	204	1222.	1		2310	279	18.
1		0430	55	1.	1		1045	130	45.	1		1700	205	1209.	1		2315	280	18.
1		0435	56	1.	1		1050	131	45.	1		1705	206	1189.	1		2320	281	17.
1		0440	57	1.	1		1055	132	45.	1		1710	207	1164.	1		2325	282	17.
1		0445	58	1.	1		1100	133	45.	1		1715	208	1136.	1		2330	283	17.
1		0450	59	1.	1		1105	134	46.	1		1720	209	1103.	1		2335	284	17.
1		0455	60	1.	1		1110	135	46.	1		1725	210	1067.	1		2340	285	16.
1		0500	61	1.	1		1115	136	46.	1		1730	211	1027.	1		2345	286	16.
1		0505	62	1.	1		1120	137	46.	1		1735	212	985.	1		2350	287	16.
1		0510	63	1.	1		1125	138	46.	1		1740	213	943.	1		2355	288	16.
1		0515	64	1.	1		1130	139	46.	1		1745	214	904.	2		0000	289	16.
1		0520	65	1.	1		1135	140	46.	1		1750	215	869.	2		0005	290	16.
1		0525	66	1.	1		1140	141	46.	1		1755	216	837.	2		0010	291	16.
1		0530	67	1.	1		1145	142	46.	1		1800	217	808.	2		0015	292	15.

1	0535	68	1.	*	1	1150	143	46.	*	1	1805	218	781.	*	2	0020	293	15.
1	0540	69	1.	*	1	1155	144	46.	*	1	1810	219	756.	*	2	0025	294	15.
1	0545	70	1.	*	1	1200	145	46.	*	1	1815	220	732.	*	2	0030	295	15.
1	0550	71	1.	*	1	1205	146	47.	*	1	1820	221	708.	*	2	0035	296	14.
1	0555	72	1.	*	1	1210	147	48.	*	1	1825	222	683.	*	2	0040	297	14.
1	0600	73	1.	*	1	1215	148	49.	*	1	1830	223	659.	*	2	0045	298	14.
1	0605	74	1.	*	1	1220	149	52.	*	1	1835	224	633.	*	2	0050	299	13.
1	0610	75	1.	*	1	1225	150	56.	*	1	1840	225	607.	*	2	0055	300	12.

PEAK FLOW (CFS)	TIME (HR)		MAXIMUM AVERAGE FLOW 6-HR	24-HR	72-HR	24.92-HR
		(CFS)	643.	200.	193.	193.
1226.	16.83	(INCHES)	9.331	10.777	10.779	10.779
		(AC-FT)	343.	397.	397.	397.

CUMULATIVE AREA = 0.69 SQ MI

14 KK A2 ROUTE INFLOW HYDROGRAPH THROUGH HLLMETTA POND

HYDROGRAPH ROUTING DATA

15 RS STORAGE ROUTING
NSTPS 1 NUMBER OF SUBREACHES
ITYP STOR TYPE OF INITIAL CONDITION
RSVRIC 64.00 INITIAL CONDITION
X 0.0 WORKING R AND D COEFFICIENT

16 SV	STORAGE	0.0	64.0	74.8	98.1	128.0	141.9	208.0	258.1	314.9	378.1
17 SE	ELEVATION	39.60	43.70	44.00	44.50	45.00	45.20	46.00	46.50	47.00	47.50
18 SQ	DISCHARGE	0.	0.	4.	16.	33.	41.	191.	686.	1718.	3153.
19 SE	ELEVATION	39.60	43.70	44.00	44.50	45.00	45.20	46.00	46.50	47.00	47.50

20 SS SPILLWAY
CREL 43.70 SPILLWAY CREST ELEVATION
SPWID 7.20 SPILLWAY WIDTH
COQW 3.10 WEIR COEFFICIENT
EXPW 1.50 EXPONENT OF HEAD

21 ST TOP OF DAM
TOPEL 45.20 ELEVATION AT TOP OF DAM
DAMWID 662.00 DAM WIDTH
COQD 0.0 WEIR COEFFICIENT
EXPD 1.50 EXPONENT OF HEAD

***

COMPUTED STORAGE-OUTFLOW CURVE

STORAGE	0.0	64.00	74.80	98.10	128.00	141.90	208.00	258.10	314.90	378.10
OUTFLOW	0.0	0.0	4.00	16.00	33.00	41.00	191.00	686.00	1718.00	3153.00

HYDROGRAPH AT STATION A2
PLAN 1, RATIO = 0.50

DA	MON	HRMN	ORD	OUTFLOW	STORAGE	STAGE	DA	MON	HRMN	ORD	OUTFLOW	STORAGE	STAGE	DA	MON	HRMN	ORD	OUTFLOW	STORAGE	STAGE
1		0000	1	0.	64.0	43.7	1		0820	101	0.	65.0	43.7	1		1640	201	349.	224.0	46.2
1		0005	2	0.	64.0	43.7	1		0825	102	0.	65.1	43.7	1		1645	202	406.	229.7	46.2
1		0010	3	0.	64.0	43.7	1		0830	103	0.	65.2	43.7	1		1650	203	460.	235.2	46.3
1		0015	4	0.	64.0	43.7	1		0835	104	1.	65.4	43.7	1		1655	204	510.	240.3	46.3
1		0020	5	0.	64.0	43.7	1		0840	105	1.	65.5	43.7	1		1700	205	556.	245.0	46.4
1		0025	6	0.	64.0	43.7	1		0845	106	1.	65.7	43.7	1		1705	206	599.	249.3	46.4
1		0030	7	0.	64.0	43.7	1		0850	107	1.	65.9	43.8	1		1710	207	637.	253.1	46.4
1		0035	8	0.	64.0	43.7	1		0855	108	1.	66.1	43.8	1		1715	208	670.	256.5	46.5
1		0040	9	0.	64.0	43.7	1		0900	109	1.	66.3	43.8	1		1720	209	711.	259.5	46.5
1		0045	10	0.	64.1	43.7	1		0905	110	1.	66.5	43.8	1		1725	210	755.	261.9	46.5
1		0050	11	0.	64.1	43.7	1		0910	111	1.	66.7	43.8	1		1730	211	799.	263.8	46.6
1		0055	12	0.	64.1	43.7	1		0915	112	1.	67.0	43.8	1		1735	212	815.	265.2	46.6
1		0100	13	0.	64.1	43.7	1		0920	113	1.	67.2	43.8	1		1740	213	832.	266.2	46.6
1		0105	14	0.	64.1	43.7	1		0925	114	1.	67.4	43.8	1		1745	214	843.	265.7	46.6
1		0110	15	0.	64.1	43.7	1		0930	115	1.	67.7	43.8	1		1750	215	848.	267.0	46.6
1		0115	16	0.	64.1	43.7	1		0935	116	1.	68.0	43.8	1		1755	216	849.	267.1	46.6
1		0120	17	0.	64.1	43.7	1		0940	117	2.	68.2	43.8	1		1800	217	846.	266.9	46.6
1		0125	18	0.	64.1	43.7	1		0945	118	2.	68.5	43.8	1		1805	218	840.	266.6	46.6
1		0130	19	0.	64.1	43.7	1		0950	119	2.	68.8	43.8	1		1810	219	831.	266.1	46.6
1		0135	20	0.	64.1	43.7	1		0955	120	2.	69.0	43.8	1		1815	220	821.	265.5	46.6
1		0140	21	0.	64.1	43.7	1		1000	121	2.	69.3	43.8	1		1820	221	809.	264.9	46.6
1		0145	22	0.	64.1	43.7	1		1005	122	2.	69.6	43.9	1		1825	222	796.	264.1	46.6
1		0150	23	0.	64.1	43.7	1		1010	123	2.	69.9	43.9	1		1830	223	781.	263.3	46.6
1		0155	24	0.	64.1	43.7	1		1015	124	2.	70.1	43.9	1		1835	224	765.	262.4	46.6
1		0200	25	0.	64.1	43.7	1		1020	125	2.	70.4	43.9	1		1840	225	748.	261.5	46.6
1		0205	26	0.	64.2	43.7	1		1025	126	2.	70.7	43.9	1		1845	226	730.	260.5	46.6
1		0210	27	0.	64.2	43.7	1		1030	127	3.	71.0	43.9	1		1850	227	710.	259.4	46.6
1		0215	28	0.	64.2	43.7	1		1035	128	3.	71.3	43.9	1		1855	228	690.	258.3	46.6
1		0220	29	0.	64.2	43.7	1		1040	129	3.	71.6	43.9	1		1900	229	676.	257.1	46.6
1		0225	30	0.	64.2	43.7	1		1045	130	3.	71.8	43.9	1		1905	230	663.	255.7	46.6
1		0230	31	0.	64.2	43.7	1		1050	131	3.	72.1	43.9	1		1910	231	648.	254.3	46.6
1		0235	32	0.	64.2	43.7	1		1055	132	3.	72.4	43.9	1		1915	232	633.	252.7	46.6
1		0240	33	0.	64.2	43.7	1		1100	133	3.	72.7	43.9	1		1920	233	617.	251.1	46.6
1		0245	34	0.	64.2	43.7	1		1105	134	3.	73.0	44.0	1		1925	234	599.	249.3	46.6
1		0250	35	0.	64.2	43.7	1		1110	135	3.	73.3	44.0	1		1930	235	582.	247.5	46.6
1		0255	36	0.	64.2	43.7	1		1115	136	4.	73.6	44.0	1		1935	236	563.	245.7	46.6
1		0300	37	0.	64.2	43.7	1		1120	137	4.	73.9	44.0	1		1940	237	544.	243.7	46.6
1		0305	38	0.	64.2	43.7	1		1125	138	4.	74.2	44.0	1		1945	238	525.	241.8	46.6
1		0310	39	0.	64.2	43.7	1		1130	139	4.	74.4	44.0	1		1950	239	506.	239.8	46.6
1		0315	40	0.	64.2	43.7	1		1135	140	4.	74.7	44.0	1		1955	240	486.	237.9	46.6
1		0320	41	0.	64.2	43.7	1		1140	141	4.	75.0	44.0	1		2000	241	467.	235.9	46.6
1		0325	42	0.	64.2	43.7	1		1145	142	4.	75.3	44.0	1		2005	242	447.	233.9	46.6
1		0330	43	0.	64.2	43.7	1		1150	143	4.	75.6	44.0	1		2010	243	428.	232.0	46.6
1		0335	44	0.	64.3	43.7	1		1155	144	5.	75.9	44.0	1		2015	244	409.	230.1	46.6
1		0340	45	0.	64.3	43.7	1		1200	145	5.	76.2	44.0	1		2020	245	391.	228.2	46.6
1		0345	46	0.	64.3	43.7	1		1205	146	5.	76.5	44.0	1		2025	246	373.	226.4	46.6
1		0350	47	0.	64.3	43.7	1		1210	147	5.	76.7	44.0	1		2030	247	356.	224.7	46.6
1		0355	48	0.	64.3	43.7	1		1215	148	5.	77.0	44.0	1		2035	248	339.	223.0	46.1
1		0400	49	0.	64.3	43.7	1		1220	149	5.	77.4	44.1	1		2040	249	323.	221.3	46.1
1		0405	50	0.	64.3	43.7	1		1225	150	5.	77.7	44.1	1		2045	250	307.	219.7	46.1
1		0410	51	0.	64.3	43.7	1		1230	151	6.	78.1	44.1	1		2050	251	292.	218.2	46.1
1		0415	52	0.	64.3	43.7	1		1235	152	6.	78.5	44.1	1		2055	252	278.	216.6	46.1
1		0420	53	0.	64.3	43.7	1		1240	153	6.	78.9	44.1	1		2100	253	264.	215.4	46.1
1		0425	54	0.	64.3	43.7	1		1245	154	6.	79.4	44.1	1		2105	254	250.	214.0	46.1
1		0430	55	0.	64.3	43.7	1		1250	155	7.	80.0	44.1	1		2110	255	238.	212.7	46.0
1		0435	56	0.	64.3	43.7	1		1255	156	7.	80.7	44.1	1		2115	256	226.	211.5	46.0
1		0440	57	0.	64.3	43.7	1		1300	157	7.	81.5	44.1	1		2120	257	214.	210.3	46.0
1		0445	58	0.	64.3	43.7	1		1305	158	8.	82.4	44.2	1		2125	258	203.	209.2	46.0
1		0450	59	0.	64.3	43.7	1		1310	159	8.	83.4	44.2	1		2130	259	192.	208.1	46.0
1		0455	60	0.	64.3	43.7	1		1315	160	9.	84.5	44.2	1		2135	260	182.	207.1	46.0
1		0500	61	0.	64.4	43.7	1		1320	161	10.	85.8	44.2	1		2140	261	173.	206.1	47.0
1		0505	62	0.	64.4	43.7	1		1325	162	10.	87.2	44.3	1		2145	262	164.	205.0	47.0
1		0510	63	0.	64.4	43.7	1		1330	163	11.	88.7	44.3	1		2150	263	152.	204.0	46.9
1		0515	64	0.	64.4	43.7	1		1335	164	12.	90.4	44.3	1		2155	264	140.	203.0	46.9

1	0520	65	0.	64.4	43.7	*	1	1340	165	13.	92.1	44.4	*	1	2200	265	177.	202.0	45.9
1	0525	66	0.	64.4	43.7	*	1	1345	166	14.	94.0	44.4	*	1	2205	266	175.	200.9	45.9
1	0530	67	0.	64.4	43.7	*	1	1350	167	15.	96.0	44.5	*	1	2210	267	173.	199.9	45.9
1	0535	68	0.	64.4	43.7	*	1	1355	168	16.	98.1	44.5	*	1	2215	268	170.	198.9	45.9
1	0540	69	0.	64.4	43.7	*	1	1400	169	17.	100.3	44.5	*	1	2220	269	168.	197.9	45.9
1	0545	70	0.	64.4	43.7	*	1	1405	170	19.	102.6	44.6	*	1	2225	270	166.	196.9	45.9
1	0550	71	0.	64.4	43.7	*	1	1410	171	20.	105.1	44.6	*	1	2230	271	164.	195.9	45.9
1	0555	72	0.	64.4	43.7	*	1	1415	172	21.	107.5	44.7	*	1	2235	272	161.	195.0	45.9
1	0600	73	0.	64.4	43.7	*	1	1420	173	23.	110.1	44.7	*	1	2240	273	159.	194.0	45.8
1	0605	74	0.	64.4	43.7	*	1	1425	174	24.	112.8	44.7	*	1	2245	274	157.	193.0	45.8
1	0610	75	0.	64.4	43.7	*	1	1430	175	26.	115.5	44.8	*	1	2250	275	155.	192.1	45.8
1	0615	76	0.	64.4	43.7	*	1	1435	176	28.	118.3	44.8	*	1	2255	276	153.	191.2	45.8
1	0620	77	0.	64.4	43.7	*	1	1440	177	29.	121.2	44.9	*	1	2300	277	151.	190.3	45.8
1	0625	78	0.	64.4	43.7	*	1	1445	178	31.	124.2	44.9	*	1	2305	278	149.	189.4	45.8
1	0630	79	0.	64.4	43.7	*	1	1450	179	33.	127.2	45.0	*	1	2310	279	147.	188.5	45.8
1	0635	80	0.	64.4	43.7	*	1	1455	180	34.	130.3	45.0	*	1	2315	280	145.	187.6	45.8
1	0640	81	0.	64.5	43.7	*	1	1500	181	36.	133.5	45.1	*	1	2320	281	143.	186.7	45.7
1	0645	82	0.	64.5	43.7	*	1	1505	182	38.	136.7	45.1	*	1	2325	282	141.	185.9	45.7
1	0650	83	0.	64.5	43.7	*	1	1510	183	40.	140.0	45.2	*	1	2330	283	139.	185.0	45.7
1	0655	84	0.	64.5	43.7	*	1	1515	184	44.	143.4	45.2	*	1	2335	284	137.	184.2	45.7
1	0700	85	0.	64.5	43.7	*	1	1520	185	52.	146.8	45.3	*	1	2340	285	135.	183.4	45.7
1	0705	86	0.	64.5	43.7	*	1	1525	186	60.	150.2	45.3	*	1	2345	286	133.	182.5	45.7
1	0710	87	0.	64.5	43.7	*	1	1530	187	68.	153.7	45.3	*	1	2350	287	131.	181.7	45.7
1	0715	88	0.	64.5	43.7	*	1	1535	188	76.	157.3	45.4	*	1	2355	288	130.	181.0	45.7
1	0720	89	0.	64.5	43.7	*	1	1540	189	84.	160.9	45.4	*	2	0000	289	128.	180.2	45.7
1	0725	90	0.	64.5	43.7	*	1	1545	190	93.	164.8	45.5	*	2	0005	290	126.	179.4	45.7
1	0730	91	0.	64.5	43.7	*	1	1550	191	102.	168.8	45.5	*	2	0010	291	124.	178.7	45.6
1	0735	92	0.	64.5	43.7	*	1	1555	192	112.	173.0	45.6	*	2	0015	292	123.	177.9	45.6
1	0740	93	0.	64.5	43.7	*	1	1600	193	122.	177.6	45.6	*	2	0020	293	121.	177.2	45.6
1	0745	94	0.	64.6	43.7	*	1	1605	194	133.	182.4	45.7	*	2	0025	294	119.	176.5	45.6
1	0750	95	0.	64.6	43.7	*	1	1610	195	145.	187.6	45.8	*	2	0030	295	118.	175.7	45.6
1	0755	96	0.	64.6	43.7	*	1	1615	196	157.	193.1	45.8	*	2	0035	296	116.	175.0	45.6
1	0800	97	0.	64.7	43.7	*	1	1620	197	171.	199.0	45.9	*	2	0040	297	115.	174.3	45.6
1	0805	98	0.	64.7	43.7	*	1	1625	198	185.	205.2	46.0	*	2	0045	298	113.	173.6	45.6
1	0810	99	0.	64.8	43.7	*	1	1630	199	227.	211.6	46.0	*	2	0050	299	111.	173.0	45.6
1	0815	100	0.	64.9	43.7	*	1	1635	200	269.	217.9	46.1	*	2	0055	300	110.	172.3	45.6

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PEAK OUTFLOW IS 849. AT TIME 17.92 HOURS

PEAK FLOW (CFS)	TIME (HR)		6-HR	MAXIMUM AVERAGE FLOW 24-HR	72-HR	24.92-HR
849.	17.92	(CFS)	493.	145.	140.	140.
		(INCHES)	6.647	7.827	7.827	7.827
		(AC-FT)	245.	288.	288.	288.

PEAK STORAGE (AC-FT)	TIME (HR)		MAXIMUM AVERAGE STORAGE 24-HR	72-HR	24.92-HR
267.	17.92	6-HR 237.	130.	128.	128.

PEAK STAGE (FEET)	TIME (HR)		MAXIMUM AVERAGE STAGE 24-HR	72-HR	24.92-HR
46.58	17.92	6-HR 46.29	44.77	44.73	44.73

CUMULATIVE AREA = 0.69 SQ MI

PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES
TIME TO PEAK IN HOURS

OPERATION	STATION	AREA	PLAN		RATIOS APPLIED TO FLOWS RATIO 1 0.10	RATIO 2 0.25	RATIO 3 0.50
HYDROGRAPH AT	A1	0.69	1	FLOW	245.	613.	1226.
				TIME	16.83	16.83	16.83
ROUTED TO	A2	0.69	1	FLOW	34.	190.	849.
				TIME	20.08	19.33	17.92
			** PEAK STAGES IN FEET **				
			1	STAGE	45.03	46.00	46.58
				TIME	20.08	19.33	17.92

SUMMARY OF DAM OVERTOPPING/BREACH ANALYSIS FOR STATION A2

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	43.70	43.70	45.20
STORAGE	64.	64.	142.
OUTFLOW	0.	0.	41.

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
0.10	45.03	0.0	130.	34.	0.0	20.08	0.0
0.25	46.00	0.80	208.	190.	8.42	19.33	0.0
0.50	46.58	1.38	267.	849.	9.75	17.92	0.0

*** NORMAL END OF JOB ***

APPENDIX 5

REFERENCES

HELMETTA POND DAM

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HELMETTA POND DAM

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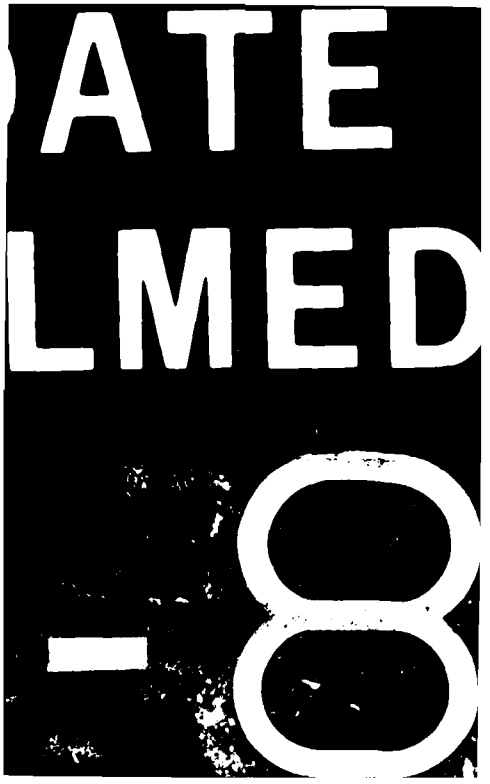
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