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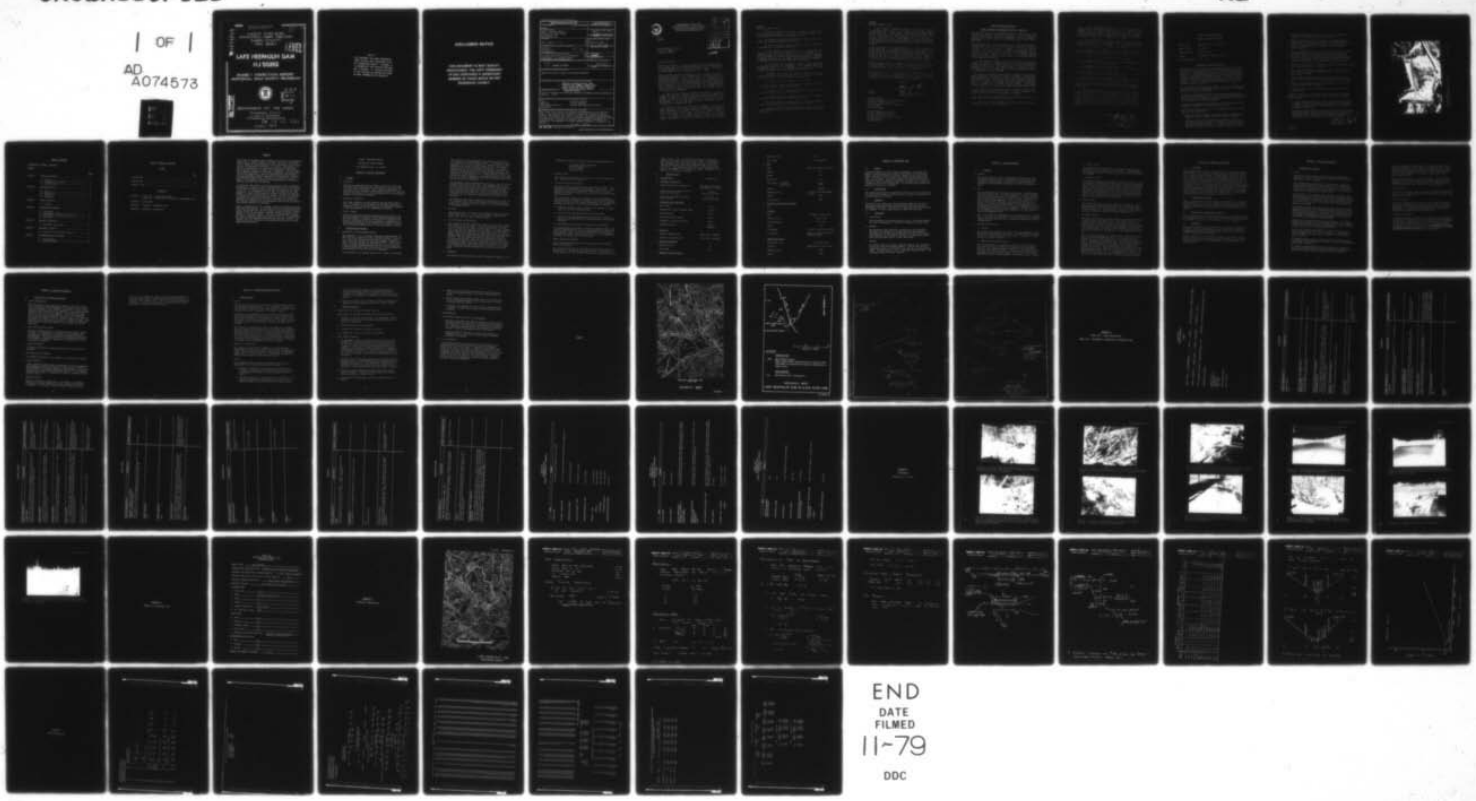

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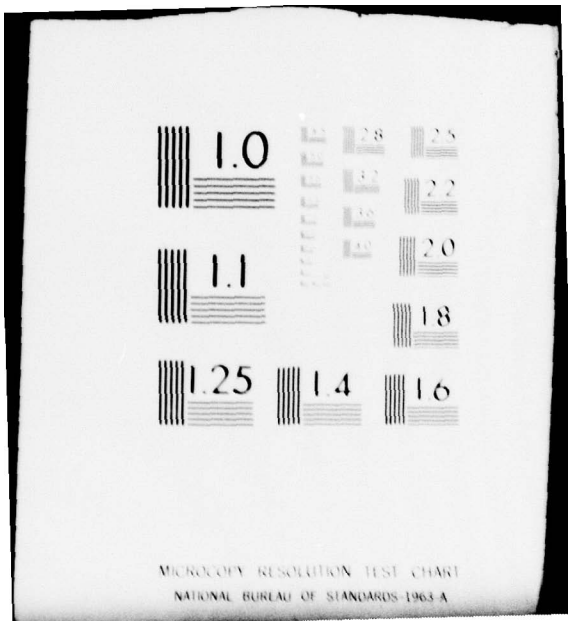
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HUDSON RIVER BASIN
PAPAKATING CREEK TRIBUTARY
SUSSEX COUNTY
NEW JERSEY

LEVEL II

# LAKE NEEPAULIN DAM
# NJ 00282

## PHASE 1 INSPECTION REPORT
## NATIONAL DAM SAFETY PROGRAM





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



August, 1979

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## REPORT DOCUMENTATION PAGE

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| 1. REPORT NUMBER: NJ00282 | 2. GOVT ACCESSION NO. |
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| 4. TITLE (and Subtitle): Phase I Inspection Report<br>National Dam Safety Program<br>Lake Neepaulin Dam<br>Sussex County, N.J. | 5. TYPE OF REPORT & PERIOD COVERED: (9) FINAL rept's |
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| 7. AUTHOR(s): Posch, Anthony G. P.E. | 8. CONTRACT OR GRANT NUMBER(s): (15) DACW61-79-C-0011 |
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| 11. CONTROLLING OFFICE NAME AND ADDRESS: U.S. Army Engineer District, Philadelphia<br>Custom House, 2d & Chestnut Streets<br>Philadelphia, Pennsylvania 19106 (11) | 12. REPORT DATE: August 1979<br>13. NUMBER OF PAGES: 35 |
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16. DISTRIBUTION STATEMENT (of this Report)

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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

(6) **National Dam Safety Program. Lake Neepaulin Dam (NJ00282), Hudson River Basin, Papakating Creek Tributary, Sussex County, New Jersey. Phase I Inspection Report.**

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
Spillways
Lake Noopaulin Dam, N.J.
Embankments
Structural Analysis
Visual inspection
National Dam Inspection Act Report

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.

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



IN REPLY REFER TO

NAPEN-D

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

25 SEP 1979

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Lake Neepaulin Dam in Sussex 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, Lake Neepaulin 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 since 23 percent of the Spillway Design Flood--SDF - would overtop the dam. (The SDF, in this instance, is one half of the Probable Maximum Flood). To insure 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 six months from the date of approval of this report. Any remedial measures necessary to insure the adequacy of the spillway and to prevent overtopping should be initiated within calendar year 1980.

b. Within six months from the date of approval of this report, engineering studies and analyses should be performed to determine the dam's embankment and foundation condition and structural stability. This should include test borings to determine material properties relative to stability and seepage and installation of observation wells or piezometers to facilitate seepage studies. Any remedial measures found necessary should be initiated within calendar year 1980.

c. Within three months from the date of approval of this report develop specific guidelines for valve operation procedures and reinstate the annual lake lowering program (in winter).

d. The following remedial actions should be completed within six months from the date of approval of this report:

(1) The existing dam plans and drawings should be annotated and updated to form a coherent as-built set.

(2) The embankment material that has been eroded from the downstream face, particularly adjacent to the left wingwall of the spillway, should be replaced with quarry-process stone or gravel. Slopes should be reconstructed with keying and compaction of material to improve stability and to support the abutments and wingwalls. Slopes should be protected with riprap near the spillway.

(3) All brush and trees should be removed from the downstream and upstream slopes of the embankment to avoid problems which may develop from their roots. The embankment face should then be seeded to develop a growth of grass for surface erosion protection.

(4) Repair all cracked and spalled concrete with epoxy cement. Rebuild the left wingwall and upstream and downstream channel walls and resurface the ogee spillway to a smooth finish.

(5) Rehabilitate the footbridge across the spillway.

e. The following remedial actions should be completed within one year from the date of approval of this report.

(1) Remove the silt blocking the spillway and outlet pipe and clear the discharge channel of all major debris.

(2) Build a protected discharge channel up to its junction with the main downstream channel to avoid bank erosion.

(3) A safe means of emptying the lake should be provided. Provide slope protection under the existing outlet discharge.

(4) A program should be developed to monitor any increase in seepage through or under the dam, and corrective measures undertaken if necessary.

(5) A formalized program of annual inspection of the dam by an experienced party should be initiated, utilizing the standard visual check list in this report. Headwater and tailwater gages should be installed in the dam, and read out during severe rain storms and at routine operating and maintenance visits to the dam. A permanent log should be kept of all maintenance and operating events of the dam, the lake and the outlet passages. Movement and settlement of the embankment should be monitored regularly by means of surveying monuments.

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 James A. Courter of the Thirteenth 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.

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 Safety 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,

James G. Ton

1 Incl
As stated

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

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 Management
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. Box CN029
Trenton, NJ 08625

## LAKE NEEPAULIN DAM (NJ000282)

## CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 7 May 1979 by Frederic R. Harris, 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.

Lake Neepaulin 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 since 23 percent of the Spillway Design Flood--SDF - would overtop the dam. (The SDF, in this instance, is one half of the Probable Maximum Flood). To insure 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 six months from the date of approval of this report. Any remedial measures necessary to insure the adequacy of the spillway and to prevent overtopping should be initiated within calendar year 1980.

b. Within six months from the date of approval of this report, engineering studies and analyses should be performed to determine the dam's embankment and foundation condition and structural stability. This should include test borings to determine material properties relative to stability and seepage and installation of observation wells or piezometers to facilitate seepage studies. Any remedial measures found necessary should be initiated within calendar year 1980.

c. Within three months from the date of approval of this report develop specific guidelines for valve operation procedures and reinstate the annual lake lowering program (in winter).

d. The following remedial actions should be completed within six months from the date of approval of this report:

(1) The existing dam plans and drawings should be annotated and updated to form a coherent as-built set.

(2) The embankment material that has been eroded from the downstream face, particularly adjacent to the left wingwall of the spillway, should be replaced with quarry-process stone or gravel. Slopes should be reconstructed with keying and compaction of material to improve stability and to support the abutments and wingwalls. Slopes should be protected with riprap near the spillway.

(3) All brush and trees should be removed from the downstream and upstream slopes of the embankment to avoid problems which may develop from their roots. The embankment face should then be seeded to develop a growth of grass for surface erosion protection.

(4) Repair all cracked and spalled concrete with epoxy cement. Rebuild the left wingwall and upstream and downstream channel walls and resurface the ogee spillway to a smooth finish.

(5) Rehabilitate the footbridge across the spillway.

e. The following remedial actions should be completed within one year from the date of approval of this report.

(1) Remove the silt blocking the spillway and outlet pipe and clear the discharge channel of all major debris.

(2) Build a protected discharge channel up to its junction with the main downstream channel to avoid bank erosion.

(3) A safe means of emptying the lake should be provided. Provide slope protection under the existing outlet discharge.

(4) A program should be developed to monitor any increase in seepage through or under the dam, and corrective measures undertaken if necessary.

(5) A formalized program of annual inspection of the dam by an experienced party should be initiated, utilizing the standard visual check list in this report. Headwater and tailwater gages should be installed in the dam, and read out during severe rain storms and at routine operating and maintenance visits to the dam. A permanent log should be kept of all maintenance and operating events of the dam, the lake and the outlet passages. Movement and settlement of the embankment should be monitored regularly by means of surveying monuments.

APPROVED: James G. Ton

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

DATE: 24 Sep 1979

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam: Lake Neepaulin, I.D. NJ00282

State Located: New Jersey

County Located: Sussex County

Stream: Tributary to Papakating Creek

Date of Inspection: May 7, 1979

## Assessment of General Condition

Lake Neepaulin Dam is an earthfill embankment approximately 290 feet long and 22 feet high, and has an 11 foot wide concrete ogee spillway near the right abutment. The general condition of Lake Neepaulin Dam is poor. The dam embankments were poorly constructed and have undergone considerable surface deterioration. The spillway structure is partly damaged and its structural adequacy is in doubt. Major erosion of fill has occurred beside and downstream of the spillway structure. There is no operable low-level outlet, but there is an operable high-level outlet.

The footbridge has been partly demolished. There is considerable tree and brush growth on the embankment, impairing stability. The hazard potential is rated as "significant."

The safety of Lake Neepaulin Dam is considered questionable in view of its lack of spillway capacity to pass one half the PMF without overtopping the dam. The spillway is capable of passing a flood equal to 11% of the PMF, and is rated "inadequate."

At present, the engineering data available is not sufficient to make a definitive statement on the stability of the dam.

The following actions, therefore, are recommended along with a timetable for their completion.

1. Existing plans and drawings of the dam should be annotated and updated to form a coherent as-built set, within six months.

2. Carry out a more precise hydrologic and hydraulic analysis of the dam within six (6) months, to determine the need and type of mitigating measures necessary. If required, conduct a study of the means of increasing spillway discharge capacity and develop

alternative schemes for construction. This should include the installation of headwater and tailwater gages.

3. Install observation wells or piezometers in the downstream embankment, and perform borings to determine engineering properties of the dam fill and foundation material. This program and a stability analysis based on the findings should be completed within six months.

4. Carry out remedial measures to the dam structure within six months, including addition of fill material to both faces and rip-rap protection; repair of all cracked concrete with epoxy cement; rebuilding of the left wingwall and upstream and downstream channel walls; resurfacing of the spillway with concrete to a smooth finish; rehabilitation of the footbridge across the spillway.

5. Remove the silt blocking the spillway and clear the discharge channel of all major debris within 12 months.

6. Build a protected discharge channel up to its junction with the main downstream channel to avoid bank erosion. This is to be done within 12 months.

7. A safe means of emptying the lake should be provided within 12 months. Provide slope protection under existing outlet discharge.

8. Remove trees and vegetation from the embankment and seed exposed faces with grass within 12 months.

9. Lower the lake level every winter about two (2) feet below the spillway crest.

Furthermore, while of a less urgent nature, the following additional action is recommended and should be carried out within a reasonable period of time.

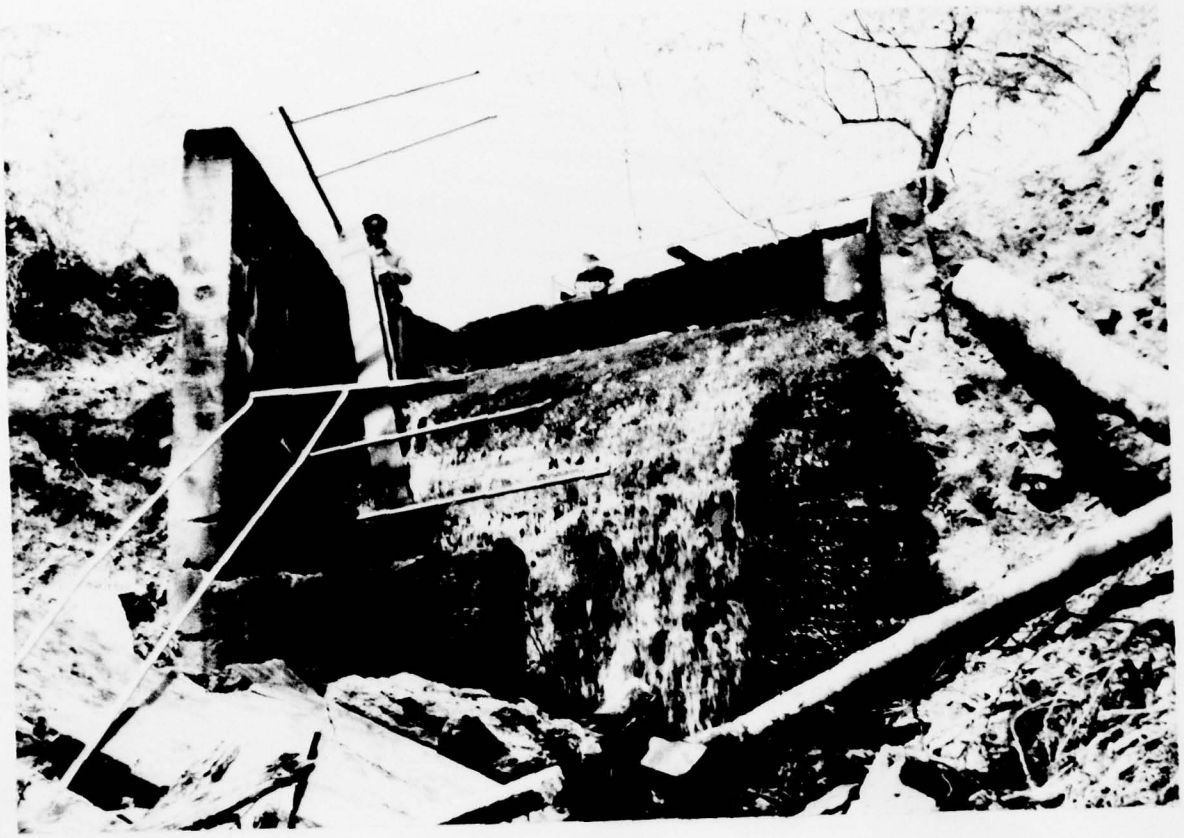
1. A program should be developed to monitor any significant increase in seepage through or under the dam. Depending on the information provided, the need for corrective measures can be considered and, if necessary, undertaken.

2. A program of annual inspection and maintenance should be initiated. This should include lowering the lake, and updating the operation and maintenance log. Movement and settlement of the embankment should also be monitored by means of surveying monuments.

A.G. Posch

Anthony G. Posch, P.E.

AGP/REJ/ck



Lake Neepaulin Dam
View of spillway, downstream face.

May 7, 1979

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PLATES



APPENDICES

## 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 reasonably 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.

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

LAKE NEEPAULIN DAM, I.D. NJ00282

## SECTION 1: PROJECT INFORMATION

### 1.1 General

a. Authority

The National Dam Inspection Act (Public Law 92-367, 1972) provides for the National Inventory and Inspection Program by the U.S. Army Corps of Engineers. This inspection was made in accordance with this authority under Contract C-FPM No. 35 with the State of New Jersey who, in turn is contracted to the Philadelphia District of the Corps of Engineers.

b. Purpose of Inspection

The visual inspection of Lake Neepaulin Dam was made on May 7, 1979. The purpose of the inspection was to make a general assessment as to the structural integrity and operational adequacy of the dam embankment and its appurtenant structures.

c. Scope of Report

The report summarizes available pertinent data relating to the project; presents a summary of visual observations made during the Field Inspection; presents an evaluation of hydrologic and hydraulic conditions at the site; presents an evaluation as to the structural adequacy of the various project features; and assesses the general condition of the dam with respect to safety.

### 1.2 Description of Project

a. Description of Dam and Appurtenances

Lake Neepaulin Dam is an earthfill embankment approximately 290 feet long and 22 feet high, with a concrete corewall. There is an 11 foot wide concrete ogee spillway structure towards the right of the dam, fitted with rectangular shaped concrete wingwalls. The left wingwall has been broken off. A 5-foot wide steel and timber footbridge passes over the spillway providing a continuous footpath across the dam crest. A 4-car parking lot has been formed at the left end of the embankment.

At the bottom of the spillway structure is a short, low concrete

wall acting as a plunge deflector, for directing the spillway flow sideways into the discharge channel. The discharge channel was shown in the original drawing as running parallel to the embankment toe having a grouted boulder bottom. The channel boulder bed was never constructed, and erosion of the channel sides and bottom, as well as below the spillway structure, has caused the discharge channel to join the downstream channel approximately 20 feet below the toe. Forming the left side of the original discharge channel is a low concrete retaining wall along the toe of the left embankment. This wall terminates on the left bank of the original stream bed.

The embankement extends approximately 200 feet to the left of the spillway and 80 feet to the right. The embankment was to have a slope of 2H:1V on both faces, as shown in the original drawing, but the downstream face was constructed with a slope of about 1H:1V and never fully completed. This is evidenced from photographs taken shortly after construction of the dam in 1927 and is verified by the inspector's records which were made in the same year.

The Papakating Creek branch immediately downstream of the dam, is in a V-shaped narrow valley, which opens into the wide and flat flood plain of Papakating Creek, about 1/2 of a mile downstream of Lake Neepaulin Dam.

b. Location

Lake Neepaulin Dam is located in the Township of Wantage, Sussex County, New Jersey. It is reached by a small access road off Sussex Route No. 639, near to Sussex Airport.

c. Size and Hazard Classification

Lake Neepaulin Dam has a structural height of 22 feet and a reservoir storage of 123 acre-feet. Since its storage is less than 1,000 acre-feet and its height is less than 40 feet, it is classified in the dam size category as being "small." A hazard potential classification of "significant" has been assigned to the dam because in the event of dam failure, there would not be any extensive property damage nor would there be more than a few lives lost at the most. The only important properties downstream are about 5/8 miles from the dam. There are two roads built on fill, and beyond them, Sussex Airport; all located on the wide flood plain of Papakating Creek. Downstream, and beyond Route No. 639, there is an inhabited farmhouse and two farms to the left of the flood paths, and several airport buildings to the right of the flood path.

d. Ownership

Lake Neepaulin Dam is presently owned by Neepaulin Community, Inc.,

a residential community located around the aforementioned lake.

Mr. George D'Amato, President
Neepaulin Community, Inc.
P. O. Box 456
Sussex, NJ 07461

e. Purpose of Dam

Lake Neepaulin Dam was built to provide a lake for recreational use. It serves no other purpose.

f. Design and Construction History

The present dam was designed in 1926 and built in 1926-27. The Department of Conservation and Development, Trenton, N.J., coordinated and approved the design and construction of the dam. Permission to build the dam was also granted by the Sussex County Board of Directors.

The final report, written by an engineer from the Department of Conservation and Development, was made in 1927 after the contractor had left the site. The report recommended that, although the structure was safe and for all practical purposed completed,:

1. Excavation should be made in front of the spillway to remove some fill that was obstructing flow.

2. Fill should be completed behind the spillway walls.

3. The top of the embankment should be brought up to grade because fill had settled badly, leaving the top of the corewall uncovered.

4. The upstream slope should be dressed and rip-rap added.

A photograph taken at the time of inspection shows the top of the core wall exposed and the slope of the downstream faces about the same as today. There is no record showing that the inspector's recommendations were followed, although the top of the embankment now covers the entire top of the core wall.

g. Normal Operating Procedures

The discharge from the lake is over the concrete ogee spillway, which is unregulated.

Up to the winter of 1977-78, the lake was lowered every fall on a regular basis. Lowering was done by opening a valve located at the upstream end of the high-level pipe outlet, permitting the lake

level to drop 2 feet. The pipe was left open all winter and closed in the spring to allow the lake to fill. The community was informed in 1977 that a permit was required to lower the lake and consequently the outlet remained closed in the winter of 1977-78. The resulting build-up of ice is responsible for most of the damage to the spillway and bridge. Operation of the outlet is controlled by the owners.

1.3 Pertinent Data

| | |
|---|---|
| a. Drainage Area | 1.0 square mile |
| b. Discharge at Dam Site | |
| Maximum known flood at dam site: | Not above top of dam. (Discharge not recorded) |
| Ungated spillway capacity at elevation of top of dam: | 274 cfs (elev. 505.2' MSL) |
| Total peak discharge at maximum pool elevation: | 2193 cfs (elev. 506.94 MSL) |
| c. Elevation (Feet above MSL) | |
| Top of dam: | 505.2' |
| Maximum pool design surcharge (SDF): | 506.94' |
| Spillway crest: | 501.5' |
| High-level outlet (invert) | 499.5' |
| Streambed at centerline of dam | 483.0' |
| Maximum tailwater: | 486.0' (estimate) |
| d. Reservoir | |
| Length of maximum pool: | 1800 ± feet (estimate) |
| Length of recreation pool: | 1500 ± feet (estimate) |
| e. Storage (Acre-feet) | |
| Recreation pool: | 67 |
| Top of dam: | 123 |
| f. Reservoir Surface (Acres) | |

| | |
|---|---|
| Recreation pool: | 13.4 |
| Top of dam: | 17 (estimated) |

g. Dam

| | |
|---|---|
| Type: | Earth fill, concrete spillway. |
| Length: | 290' |
| Height: | 22' |
| Top width: | 10' |
| Side slopes - Upstream: | 1H:1V |
| - Downstream: | 1H:1V |
| Zoning: | Unknown |
| Impervious core: | Concrete core wall founded on clay. |
| Cutoff: | None |
| Grout curtain: | None |

h. Diversion and Regulating Tunnel

N/A

i. Spillway

| | |
|---|---|
| Type: | Dropped concrete ogee. |
| Length of weir: | 11 feet (net) |
| Crest elevation: | 501.5' MSL |
| Gates: | N/A |
| U/S Channel: | 10' wide, silted under bridge. |
| D/S Channel: | Plunge pool/deflector before entering channel. |

j. Regulating Outlets

| | |
|---|---|
| High-level outlet | 24" diameter CMP |
| Controls: | Hand-operated closure valve. |
| Emergency gate: | None |
| Outlet: | None |

## SECTION 2: ENGINEERING DATA

### 2.1 Design

No design computations for the dam are available. A drawing dated August, 1926 gives the plan, elevation and sections of the dam and outlet structures (spillway, discharge channel and low-level outlet pipe). No data from soil borings, soil tests or other geotechnical tests are available. Clay was encountered throughout the excavation of the core wall's foundation, according to a report by the inspecting engineer at the time of construction. No cross sections suitable for assessing stability are available.

### 2.2 Construction

The construction history is presented in Section 1.2.f. No data exist of construction methods or borrow sources, nor other data pertinent to the construction of the dam.

### 2.3 Operation

Operation of the outlet pipe valve was discontinued in 1977 when it was learned that a permit was required before lake water could be discharged downstream. Operation of the gate valve had been performed by a plumber. No other data relating to operation was found.

### 2.4 Evaluation

a. Availability

The availability of engineering data is poor. The stated drawing and some correspondence on the dam are available from the NJDEP.

b. Adequacy

The engineering data available, together with that obtained in the field, were adequate to perform hydrologic and hydraulic computations. The data was insufficient to perform even approximate computations of the dam's stability, but preliminary evaluation could be made based on visual observation.

c. Validity

The present spillway structure discharge channel, and outlet pipe are not as shown on the design drawing. The spillway has been constructed closer to the center of the dam and a plunge deflector added. The pipe outlet is only 2 feet below reservoir level. The discharge channel was never completed.

## SECTION 3: VISUAL INSPECTION

### 3.1 Findings

a. General

The visual inspection made of Lake Neepaulin Dam revealed that the dam and spillway are in a deteriorated condition, and that substantial initial repairs followed by a regular program of inspection and maintenance and required to make the dam serviceable.

b. Dam

The dam embankment does not appear to be stable. The downstream face has a 1H:1V slope. The left embankment is severely eroded at the downstream face next to the spillway, to a nearly vertical slope along the top 11 feet for 25 feet of length. Similarly, the face of the upstream embankment, above the lake surface is on a 1H:1V slope and no rip-rap protection was placed on this face. However, no cracking is visible anywhere on the embankment, and no misalignment has been noted. On top of the upstream face, trees are growing uncontrolled to 8-inch diameters. Brush and trees, to 9-inch diameters are also growing uncontrolled on left and right downstream embankment faces.

Part of the downstream embankment toe is retained by a low concrete wall. This wall is cracked and distorted in many places, and minor seepage was noted under the wall. No animal burrows were found in the embankment.

c. Appurtenant Structures

1. Spillway

The concrete ogee spillway shows signs of surface weathering, with erosion along the construction joints. The left wingwall is broken off where it intersects the spillway surface. Erosion is visible around the concrete structure.

2. Approach and Discharge Channels

The concrete walls of the approach channel are severely cracked and displaced. There is high silt accumulation at the channel entrance. The discharge channel consists of a short deflecting wall, directing flow to the left. It appears that there was once a plungepool in the discharge channel, but this no longer exists because a retaining wall has broken. The channel is full of debris.

3. Bridge & Piers

The downstream steel stringer of the footbridge has been dislodged by ice, and is resting on the spillway. Timber planking of the remaining bridge is deteriorated and the small bridge piers are cracked.

4. High-level Outlet

A low-level outlet was not provided for draining the lake. A 24-inch diameter corrugated metal pipe, with its invert 2 feet below the spillway crest elevation, and located on the right embankment, serves to lower the lake. A closure valve is fitted at its upstream end and siltation was noted at the intake. The valve was last used in the winter of 1977-78, and is believed to be still operable. The pipe discharges directly onto the embankment face, and no surface protection has been provided. However, erosion under the pipe discharge is not excessive.

d. Reservoir Area

The slopes around the rim of the reservoir are moderate. They are grassed and wooded with deciduous trees. Residential development extends around the entire lake. There is no indication of slope instability. Sedimentation has occurred in the reservoir and heavy silting is visible at the dam's upstream face.

e. Downstream Channel

The downstream channel is shallow beyond the discharge channel and is full of debris and fallen trees. The channel flows in a V-shaped valley having 3H:1V to 4H:1V side slopes. At the discharge channel, however, the side slopes on both sides are steeper, with slopes of up to 1H:1V next to the embankment. The entire valley downstream of the dam is wooded. Minor seepage was noted in the right channel bank, approximately 100 feet downstream of the toe.

About 1/2 mile downstream, the valley widens to meet the wide and flat flood plain of Papakating Creek. At this location, the channel runs into a pond retained by a low concrete wall with a weir at its midpoint. Beyond this pond, the channel branches into several smaller channels in deep grass. About 1/8 mile beyond, is Route No. 639 which runs perpendicular to the channels on slightly raised fill. Behind the highway is the north end of the Sussex Airport runway. There are no residential buildings in the flood path before Route No. 639. Beyond Route No. 639 and to the left of the flood path, there are a farmhouse and 2 barns. To the right of the flood path, there are several airport buildings.

## SECTION 4: OPERATIONAL PROCEDURES

### 4.1 Procedures

Lake Neepaulin Dam is used to impound water for recreational purposes. The discharge from the lake is normally over the ungated ogee spillway. A gated, 24 inch diameter corrugated metal outlet pipe located on the right embankment is used to lower the lake level by 2 feet. Until 1977, this valve was opened every autumn to lower the lake level. At the beginning of the summer, the valve was then closed to allow the lake level to rise again to the level of the spillway crest. In the winter of 1977-78, the valve was left closed and the water remained at reservoir level. As a result, the ice crust on the lake surface pushed the downstream walkway stringer and handrailing off its piers. It was reported that the valve was not opened because it was learned that a permit was first required. For some reason, no permit was obtained and the valve has remained closed since then.

### 4.2 Maintenance of the Dam

There is no program of regular inspection and maintenance of the dam and appurtenant structures. The present owners have only performed minimal maintenance on the dam, although they are responsible for this function. No records were uncovered of any maintenance since construction.

### 4.3 Maintenance of Operating Facilities

The operating facilities of the dam consist only of the closure valve at the upstream end of the outlet pipe. This valve had been maintained by a plumber until 1977. It is believed to be still operable.

### 4.4 Evaluation

The present procedures are not conducive to satisfactory operation of the dam. The level of maintenance is particularly poor, and should be amended by substantial initial repairs followed by a program of regular inspection and maintenance.

It was good practice to lower the lake level in the winter, and the permit to carry out this function should be obtained. The ice crust on the lake evidently is very destructive to the spillway and the landing stages.

## SECTION 5: HYDRAULIC/HYDROLOGIC

### 5.1 Evaluation of Features

a. Design

The drainage area above Lake Neepaulin Dam is approximately 1.0 square mile. A drainage map of the watershed of the dam site is presented on plate 1, Appendix D.

The topography within the basin is mildly sloped. Elevations range from approximately 760 feet above MSL at the north end of the watershed to about 485 feet at the dam site. Land use patterns within the watershed are mostly woodland with concentrated residential development about the lake area.

The evaluation of the hydraulic and hydrologic features of the dam and lake was based on criteria set forth in the Corps Guidelines and additional guidance provided by the Philadelphia District, Corps of Engineers. The Spillway Design Flood (SDF) for the dam is 1/2 PMF, the upper end of the "significant" hazard potential range for small dams.

The probable maximum flood (PMF) was calculated from the probable maximum precipitation using Hydrometeorological Report No. 33 with standard reduction factors. Due to the small drainage area, the SCS triangular hydrograph transformed to a curvilinear hydrograph was adopted for developing the unit hydrograph, with the aid of the HEC1-DB Flood Hydrograph Computer Program.

Initial and infiltration loss rates were applied to the Probable Maximum Storm rainfall to obtain rainfall excesses. The rainfall excesses were applied to the unit hydrographs to obtain the PMF and various ratios of PMF utilizing program HEC1-DB.

The SDF peak outflow calculated for the dam is 2193 cfs. This value is derived from the 1/2 PMF, and results in overtopping of the dam, assuming that the lake was originally at the spillway crest elevation.

The stage-outflow relation for the spillway was determined from the geometry of the spillway and dam, and is shown in the Hydrologic Computations (Appendix D).

The reservoir stage-storage capacity relationship was computed directly by the conic method, utilizing the HEC1-DB program. The conic method assumes that the reservoir capacity resembles a

series of vertically stacked cones. The reservoir surface areas at various elevations were measured by planimeters from U.S.G.S. Quadrangle topographic maps. Reservoir storage capacity included surcharge levels exceeding the top of the dam, and the spillway rating curve was based on the assumption that the dam remains intact during routing.

The reservoir level can only be lowered about 2 feet below the spillway crest, by means of the 24-inch outlet pipe on the right embankment. There is no low-level outlet for emergency draining of the reservoir, and such an outlet should be provided.

b. Experience Data

No records of reservoir stage or spillway discharge are maintained for this site. Nobody questioned could recall the dam being overtopped in its history.

c. Visual Observation

The valley immediately below the dam is undeveloped and wooded. One half mile downstream, the channel enters a wide flood plain. The slopes of the reservoir are mild and do not exhibit signs of instability. The drainage area is wooded, mildly sloped and developed for residential use around the lake.

d. Overtopping Potential

A storm of magnitude equivalent to the SDF would cause overtopping of the dam to a height of 1.74 feet. Computations indicate that the dam can pass approximately 11% of the PMF without overtopping the dam crest. Since one half the PMF is the Spillway Design Flood (SDF) for this dam, according to the Recommended Guidelines for Safety Inspection of Dams by the Corps of Engineers, the spillway capacity of the dam is assessed as "Inadequate."

## SECTION 6: STRUCTURAL STABILITY

### 6.1 Evaluation of Structural Stability

a. Visual Observations

The observations made during the inspection give cause for concern. Although the dam embankments do not appear to have undergone major movement, their improper construction, lack of rip-rap protection and advanced stage of weathering on the downstream face adversely affect the static stability. The excessively steep slopes (1H:1V) and the large diameter trees on the embankment faces are particularly hazardous. The siltation of the reservoir has reduced its capacity, but the reservoir banks are stable. Non-operation of the high-level pipe outlet, to reduce the lake level during winters, could cause damage to the walkway and spillway structures.

b. Design and Construction Data

No design computations were uncovered during the report preparation phase. No embankment or foundation soil parameters are available for carrying out a conventional stability analsysis on the embankment. No construction data or specifications relating to the degree of embankment compaction are available for use in the stability analysis.

c. Operating Records

No operating records are available relating to the stability of the dam.

d. Post-Construction Changes

No changes significant to the stability of the dam are on record.

e. Static Stability

Static stability analyses were not performed for the Lake Neepaulin Dam embankment and spillway because the lack of data, on which to base assumptions of material properties and embankment and spillway cross-sections, might produce misleading results. The recommended remedial actions must be implemented in order to decrease the risk of local failure.

f. Seismic Stability

The dam is located in Seismic Zone 1, as defined in Recommended Guidelines for Safety Inspection of Dams, prepared by the Corps of Engineers. In general, projects located in Seismic Zones 0,

1 and 2 may be assumed to present no hazard from earthquake, provided the static stability conditions are satisfactory and conventional safety margins exist. Until the last two conditions are confirmed, the seismic stability must be considered questionable. The geology of the area is shown on Plate 2.

## SECTION 7: ASSESSMENT/REMEDIAL MEASURES

### 7.1 Dam Assessment

a. Safety

The dam has been inspected visually and a review has been made of the available engineering data. This assessment is subject to the limitations inherent in the visual inspection procedures stipulated by the Corps of Engineers for a Phase I report.

The safety of Lake Neepaulin Dam is in question because the dam does not have adequate spillway capacity to pass one-half of the PMF without overtopping. Overtopping of the dam carries with it the danger of possible progressive failure of the dam or spillway. The dam's present spillway capacity can pass only about 11% of the PMF.

No definitive statement pertaining to the safety of the embankment can be made without acquisition of embankment and foundation material engineering properties. However, the dam was improperly constructed with 1H:1V slopes on the downstream face instead of the 2H:1V slopes called for in the original drawing. Furthermore, the lack of rip-rap protection on the upstream face and the heavy tree growth on the embankment compounds the precarious condition of the dam, and the possibility of a sudden failure.

b. Adequacy of Information

The information uncovered was adequate to perform hydrologic and hydraulic computations, although the depth of the lake is not known. The data was insufficient to perform even an approximate computation of the dam's stability. A preliminary assessment of the dam could be made by visual observation only.

c. Urgency

All recommended studies should be performed by an Engineer, experienced in the design and construction of dams.

- Studies to augment the spillway discharge capacity or to determine the hydrologic and hydraulic ability of the dam to withstand overtopping should be undertaken within 6 months.

- Observation wells or piezometers should be installed in the downstream embankment to determine the location of the phreatic surface. The borings should be logged according

to the Unified Soil Classification system by qualified personnel and samples taken to determine the values of pertinent soil parameters, and stability analyses should be performed in accordance with Chapter 4.4 of the Corps Guidelines.

- The existing dam plans and drawings should be annotated and updated to form a coherent as-built set within 6 months.

7.2 Remedial Measures

a. Alternatives for Increasing Spillway Capacity

Alternatives for increasing spillway capacity are as follows:

1. Increase the dam and bridge height, thus permitting a higher discharge to pass over the spillway and reducing the possibility of overtopping.

2. Lower the spillway crest elevation.

3. Increase the effective spillway crest length.

4. A combination of any of the above alternatives.

b. Other Remedial Measures

1. The embankment material that has been eroded from the downstream face, particularly adjacent to the left wingwall of the spillway, should be replaced with quarry-process stone or gravel. Slopes should be reconstructed with keying and compaction of material to improve stability and to support the abutments and wingwalls. Slopes should be as determined by the stability analysis, and should be protected with riprap near the spillway. This work should be undertaken within six months.

2. All brush and trees should be removed from the downstream and upstream slopes of the embankment to avoid problems which may develop from their roots. The embankment face should then be seeded to develop a growth of grass for surface erosion protection. This program should be started within six months.

3. Repair all cracked and spalled concrete with epoxy cement within six months. Rebuild the left wingwall and resurface the ogee spillway to a smooth finish.

4. Rehabilitate the footbridge across the spillway within six months.

5. Remove the silt blocking the spillway and outlet pipe and clear the discharge channel of all major debris within 12 months.

6. Build a protected discharge channel up to its junction with the main downstream channel to avoid bank erosion. This is to be done within 12 months.

7. A safe means of emptying the lake should be provided within 12 months. Provide slope protection under existing outlet discharge.

c. Recommendations

The following additional action is recommended:

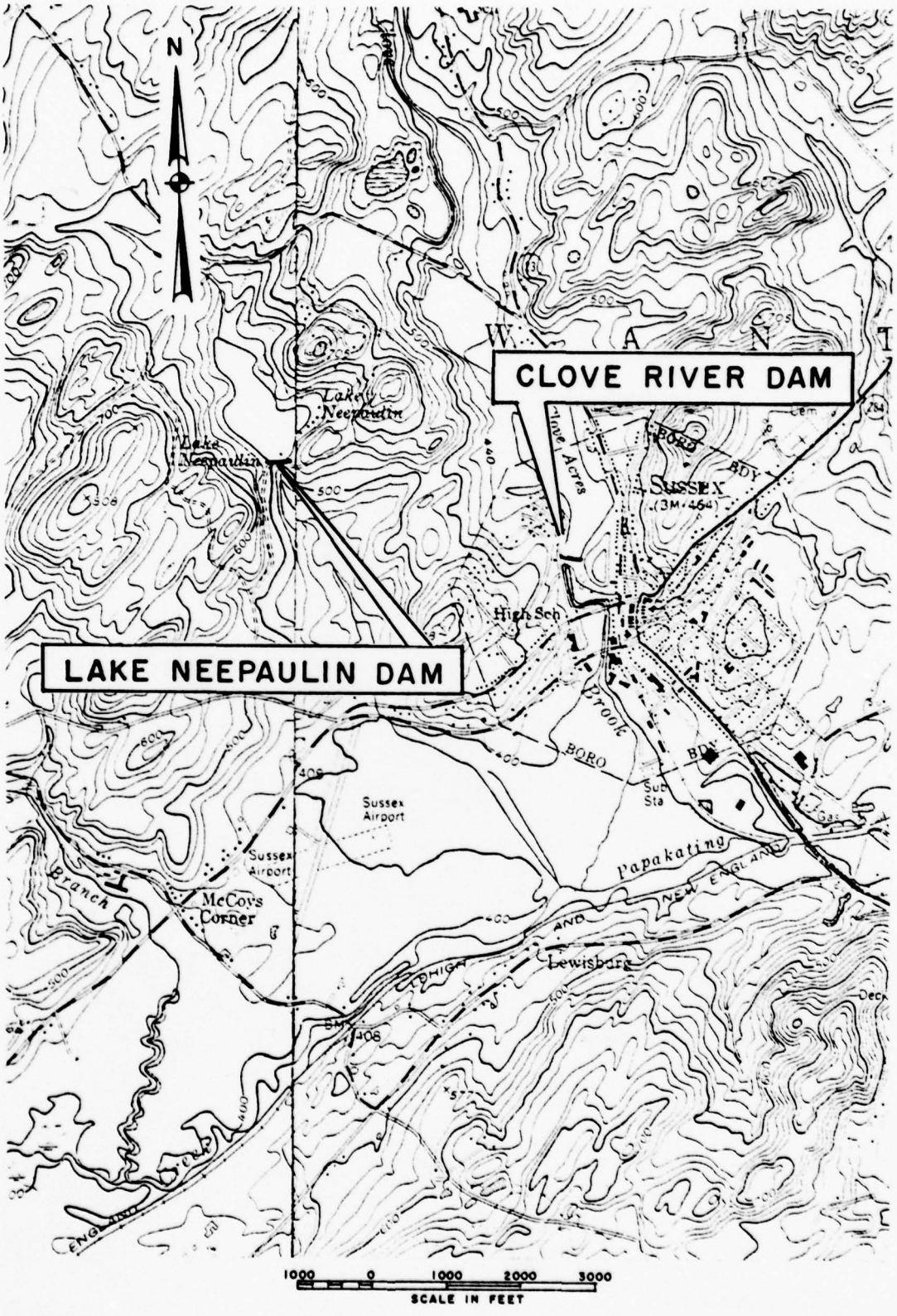
1. Reinstate the annual lake lowering program (in winter) after developing specific guidelines for valve operation procedures. The guidelines, to be agreed upon by Neepaulin Lake Community, Inc., downstream property owners, and the proper regulatory agencies, should be implemented within three months.

2. A program should be developed to monitor any increase in seepage through or under the dam, and corrective measures undertaken if necessary.

d. O & M Procedures

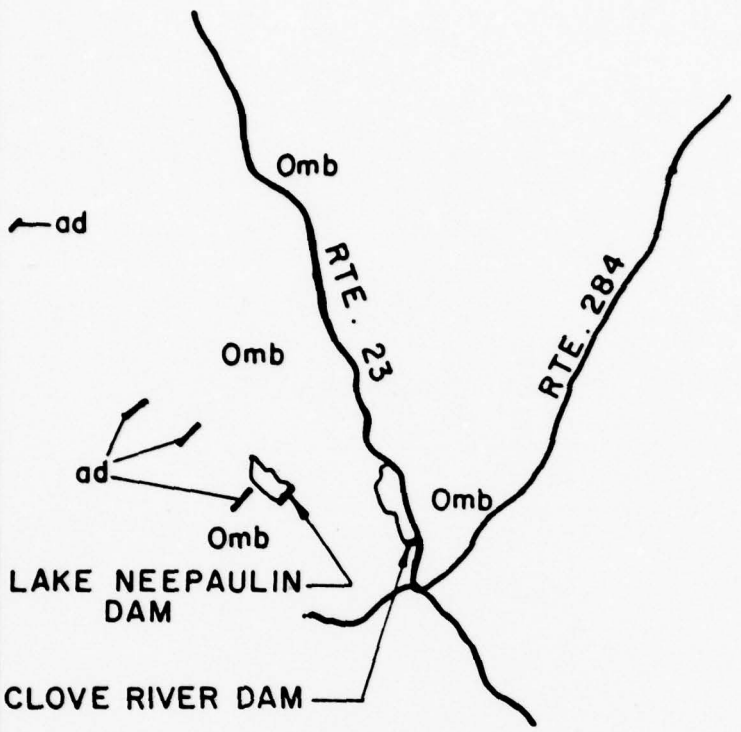
A formalized program of annual inspection of the dam by an experienced party should be initiated, utilizing the standard visual check list in this report. Headwater and tailwater gages should be installed in the dam, and read out during severe rain storms and at routine operating and maintenance visits to the dam. A permanent log should be kept of all maintenance and operating events of the dam, the lake and the outlet passages. Movement and settlement of the embankment should be monitored regularly by means of surveying monuments.

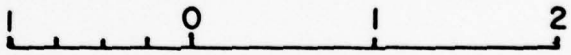
PLATES




# VICINITY MAP

PLATE 1




Scale: 1" = 1 Mile

## LEGEND

### ORDOVICIAN

**Omb** Martinsburg Shale
Black Slaty Shale (Roofing Slate in places) with Thin Beds of Sandstone (Flagstone) Especially in Upper parts.

### QUATERNARY

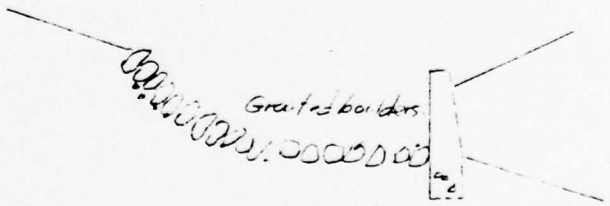
**ad** Stratified Drift (Wisconsin).

# GEOLOGIC MAP
# LAKE NEEPAULIN DAM & CLOVE RIVER DAM

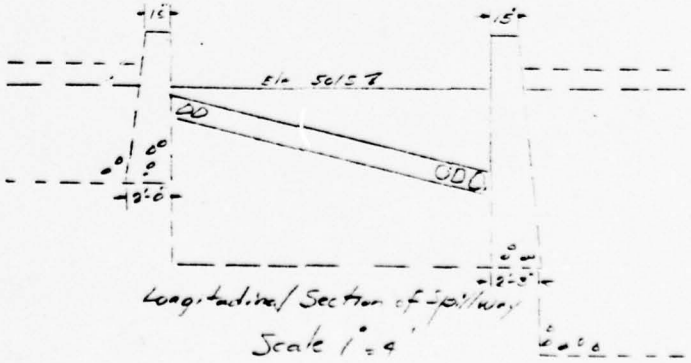
PLATE 2



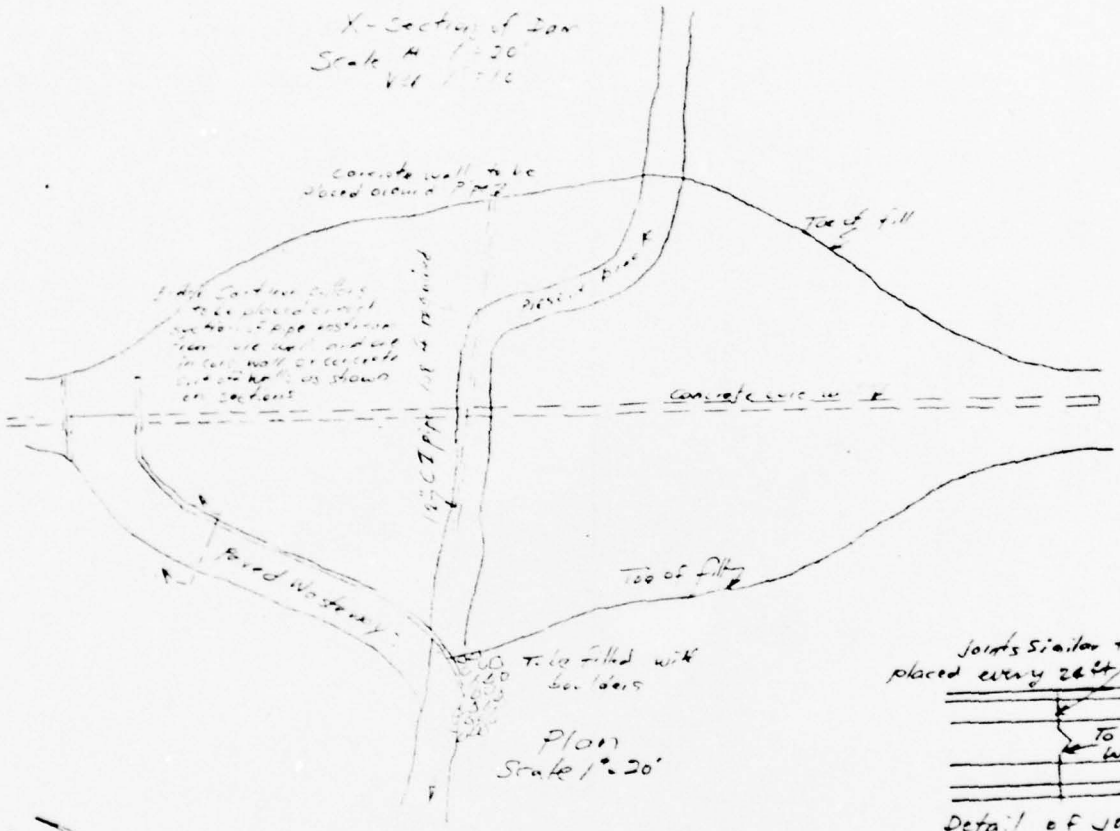
Cross Section of Spillway
Scale 1" = 4'




Section at A-A'
Scale 1" = 4'

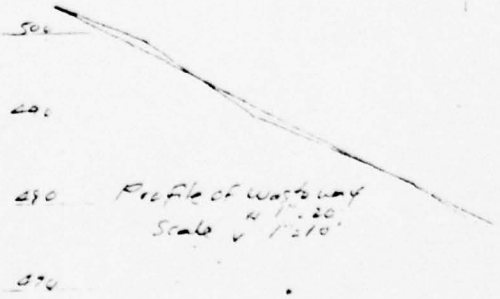



Longitudinal Section of Spillway
Scale 1" = 4'








2

APPROVED OCT 13, 1926

PLAN of DAM
LAKE NEEPAULLIN
Wantage Twp Sussex Co. NJ
Scale as shown May 1926.
Snook & Hardin Engr's
Newton, NJ

PLATE 3

# APPENDIX A

CHECK LIST - VISUAL OBSERVATIONS

CHECK LIST - ENGINEERING, CONSTRUCTION, MAINTENANCE DATA

CHECK LIST
VISUAL INSPECTION

PHASE I

Name of Dam Lake Neepaulin County Sussex State New Jersey Coordinators NJDEP

Date(s) Inspection May 7, 1979 Weather Fair/Sunny Temperature 75°F

Pool elevation at Time of Inspection 501.6' M.S.L. Tailwater at time of Inspection 483.4' M.S.L.

Inspection Personnel:

Seymour Roth
Ron Ernest-Jones
Eugene Koo
Henry King
Chuck Chin

Owner/Representative:

Local resident

## EMBANKMENT

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS AND RECOMMENDATIONS |
|---|---|---|
| **SURFACE CRACKS** | None. | |
| **UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE** | No unusual movements. Small concrete retaining wall at toe of left embankment is cracked, tilted and displaced. | Rebuild wall. |
| **SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES** | Erosion of downstream face of left embankment is severe. Top 11 feet is scoured to a nearly vertical slope along a 25 foot width next to spillway. At the right embankment, where the original slope was 1H:1V, erosion has not occurred or has been slight. | Add quarry run stone fill and build up downstream slopes to 2H:1V, as shown in the original drawing. |
| **VERTICAL & HORIZONTAL ALIGNMENT OF THE CREST** | The vertical and horizontal alignments are acceptable. | |
| **RIPRAP FAILURES** | There is no rip-rap protection on the upstream face, whose slope is 1H:1V above the water surface. | Provide a 2H:1V slope with quarry run stone and add rip-rap. |

## EMBANKMENT

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS AND RECOMMENDATIONS |
|---|---|---|
| VEGETATION | Trees are growing uncontrolled on top of upstream face, to 8-inch diameter, and on downstream face to 9-inch diameter. | Remove trees. |
| JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM | Erosion is severe around spillway structure on upstream face. On th- downstream face to the left of the spillway, erosion has produced a dan-gerously small cross-section. | Add quarry run stone and protect with rip-rap. |
| ANY NOTICEABLE SEEPAGE | Slight seepage under retaining wall at toe of left embankment. Part of the eroded face near spillway was damp, but seepage was not flowing. | Provide new concrete retaining wall for new discharge channel after placing additional quarry stone on embankment. Check for seepage. Monitor all seepage reg. |
| STAFF GAGE AND RECORDER | None. | |
| DRAINS | None. | |

## UNGATED SPILLWAY

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS AND RECOMMENDATIONS |
|---|---|---|
| **CONCRETE WEIR** | 11-foot wide ogee. Concrete surface is weathered about 1 inch, with 8 inch holes along construction joints. The left wingwall is broken off. The displaced bridge stringer is resting on the spillway face. | Reconstruct left wingwall and resurface ogee surface with smooth concrete. |
| **APPROACH CHANNEL** | 12 feet wide at entrance, narrowing to 10 feet of width under footbridge. Concrete walls are severely cracked and displaced. High silt accumulation on upstream side of the sill. | Rebuild approach channel. Remove silt to clear spillway. |
| **DISCHARGE CHANNEL** | Discharge from spillway is deflected to the left by a small wall. Erosion has shifted the discharge channel course downstream. | Build a discharge channel as shown in the original drawing. |
| **BRIDGE AND PIERS** | 1" x 4" timber planks at center panel of footbridge, and 2"x 12" timber sills, are in deteriorated condition. All other deck timber is missing. Downstream steel stringer and handrailing were knocked off their concrete piers. Concrete piers are cracked. | Rehabilitate entire bridge. Reinstall fallen steel stringer and restore handrailing and concrete piers. |
| CONSTRUCTION JOINTS | Generally poor in right wingwall and approach channel. | Repair or provide new construction as required. |

## OUTLET WORKS

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS AND RECOMMENDATIONS |
|---|---|---|
| **CRACKING & SPALLING OF CONCRETE SURFACES IN STILLING BASIN** | What appears to be a small plunge pool below the spillway has been made ineffective, due to half the containing wall being washed away. | No action. |
| **INTAKE STRUCTURE** | None. | |
| **OUTLET STRUCTURE** | None. | |
| **OUTLET FACILITIES** | 24-inch diameter corrugated metal pipe in right embankment, fitted with closure valve at upstream end. Erosion protection not provided below outlet on embankment face. Upstream end partly silted. Invert of pipe about 2 feet below spillway crest elevation. | Remove silt at upstream end and provide erosion protection on rehabilitated downstream face of dam. |
| **EMERGENCY GATE** | None. | |

INSTRUMENTATION

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS AND RECOMMENDATIONS |
|---|---|---|
| MONUMENTATION/SURVEYS | | |
| None. | | Provide bench mark in vicinity of dam. |
| OBSERVATION WELLS | | |
| None. | | Install as required. |
| WEIRS | | |
| None. | | |
| PIEZOMETERS | | |
| None. | | Install as required. |
| OTHERS | | |
| None. | | |

## RESERVOIR

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS AND RECOMMENDATIONS |
|---|---|---|
| **SLOPES** | Gentle slopes all around (3H:1V to 4H:1V). Slopes are grassed and wooded with deciduous trees. There are no signs of slope instability. | |
| **SEDIMENTATION** | There appears to be considerable sedimentation on upstream face of dam. | |
| USE | Recreational only. | |
| SHORELINE BUILDINGS | Residential properties surround the lake. Many small-boat landing stages. An access road runs around the lake, ending at the car park on the left embankment. | Properties adjacent to dam are on higher ground. |

## DOWNSTREAM CHANNEL

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS AND RECOMMENDATIONS |
|---|---|---|
| CONDITION (OBSTRUCTIONS, DEBRIS, ETC.) | Abundant debris and fallen trees below spillway. A small area of seepage was noted in the right channel bank, approximately 100 feet downstream of the toe. | Clear all debris and fallen trees. |
| SLOPES | Stream drops through a V-shaped valley with lightly wooded slopes of 3H:1V. No erosion visible. Within 1/2 mile downstream, the valley broadens out into a wide flood plain. | |
| APPROXIMATE NUMBER OF HOMES AND POPULATION | There are no buildings immediately below the dam. About 1/2 mile downstream, the stream is impounded by a low straight wall, from where it emerges through a weir and flows into a wide flat valley to join Papakating Creek. About 1/8 of a mile beyond the low wall, two roads run at right angles to the stream, and beyond them is the north end of the Sussex Airport runway. | |

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

| ITEM | REMARKS |
|---|---|
| PLAN OF DAM | One drawing, dated August, 1926, included. |
| REGIONAL VICINITY MAP | U.S.G.S. Quadrangle sheets for Branchville & Hamburg, N. J. |
| CONSTRUCTION HISTORY | On Microfiche at NJDEP. |
| TYPICAL SECTIONS OF DAM | One drawing, included. |
| HYDROLOGIC/HYDRAULIC DATA | None available. |
| OUTLETS - PLAN | None available. |
| - DETAILS | None available. |
| - CONSTRAINTS | None available. |
| - DISCHARGE RATINGS | None available. |
| RAINFALL/RESERVOIR RECORDS | None kept. |

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
(continued)

| ITEM | REMARKS |
|---|---|
| DESIGN REPORTS | None available. |
| GEOLOGY REPORTS | None available. |
| DESIGN COMPUTATIONS<br>HYDROLOGY & HYDRAULICS<br>DAM STABILITY<br>SEEPAGE STUDIES | The only computations available (from NJDEP) were related to maximum flow through the spillway, where the length was assumed as 15 feet. |
| MATERIALS INVESTIGATIONS<br>BORING RECORDS<br>LABORATORY<br>FIELD | The only soils report (from NJDEP) was on a cursory inspection of the soil uncovered by the core wall excavation. |
| POST-CONSTRUCTION SURVEYS OF DAM | May 25 and November 2, 1927, with 2 photographs, (available at NJDEP). These indicated the upstream face was not protected and the downstream face had a slope of about 1H:1V. |
| BORROW SOURCES | Not known. |
| SPILLWAY PLAN - SECTIONS | One drawing, included. |
| - DETAILS | One drawing, included. |

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
(continued)

| ITEM | REMARKS |
|---|---|
| OPERATING EQUIPMENT PLANS AND DETAILS | None. |
| MONITORING SYSTEMS | None. |
| MODIFICATIONS | Brief information on microfiche NJDEP. |
| HIGH POOL RECORDS | None kept. |
| POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS | See surveys. |
| PRIOR ACCIDENTS OF FAILURE OF DAM - DESCRIPTION | Verbal reports of damage to spillway, 1978. |
| - REPORTS | |
| MAINTENANCE OPERATION RECORDS | None kept. |

## APPENDIX B

PHOTOGRAPHS

(Taken on May 7, 1979)

Photo No. 1 - Overall view of dam from upstream. The spillway and footbridge are at the right, where only the handrailing is visible. Note the trees growing on embankment.

Photo No. 2 - Overall view of dam from downstream. Spillway is at center. Note upper-level outlet pipe on the left, debris in channel, and trees growing on embankment. Half of the plunge-pool retaining wall has been washed away.

Photo No. 3 - View of left downstream face near spillway showing severely eroded embankment slope and fallen trees. Note also the retaining wall at toe.

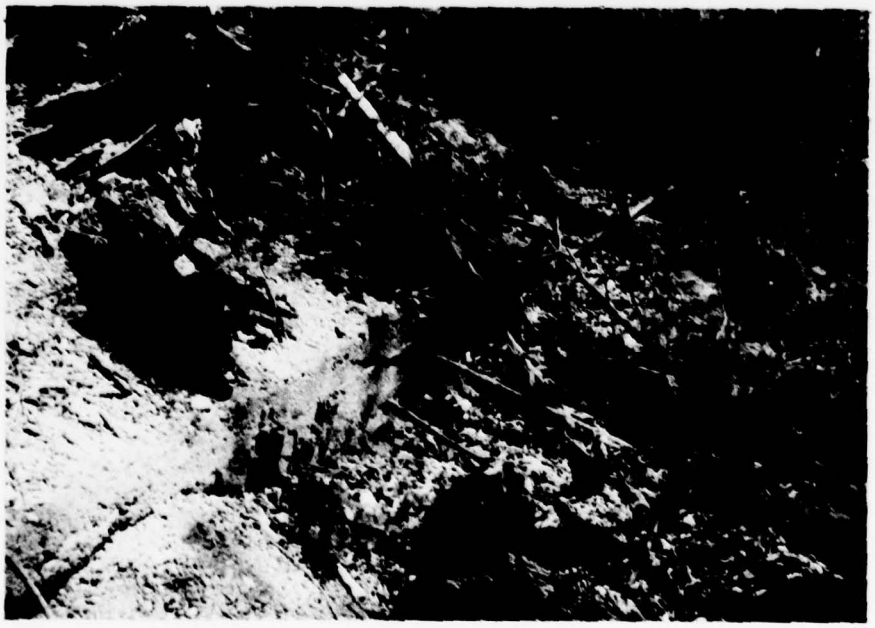


Photo No. 4 - Detail of low retaining wall on left side of channel. The wall is cracked and sheared in several places.

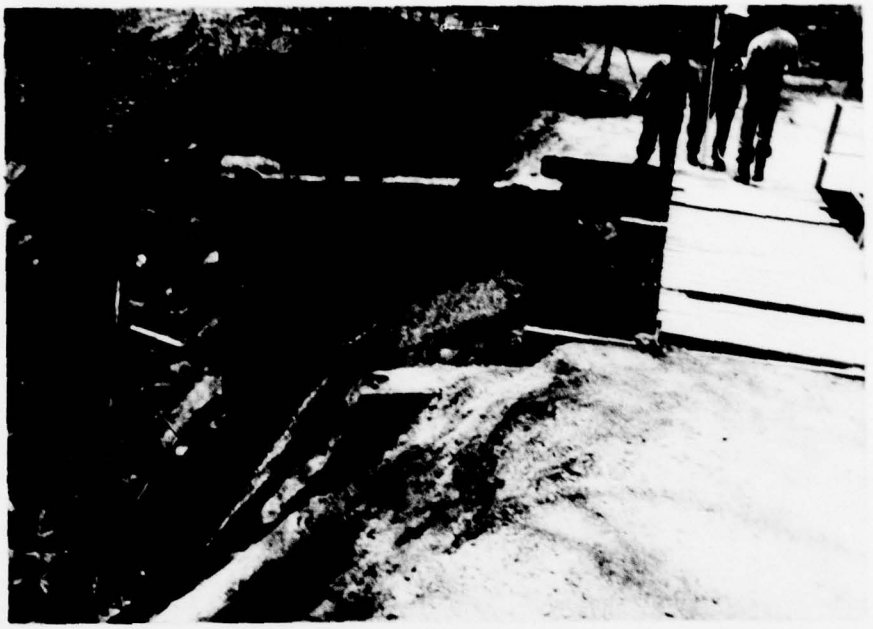


Photo No. 5 - View of top of dam showing footbridge, spillway structure, and right embankment. Note fallen stringer and hand-railing. Outlet pipe discharge is partially visible beyond right wingwall.

Photo No. 6 - View of top of dam showing spillway and left embankment. Note eroded downstream slope, spillway, the broken left wingwall and footing of fallen stringer.

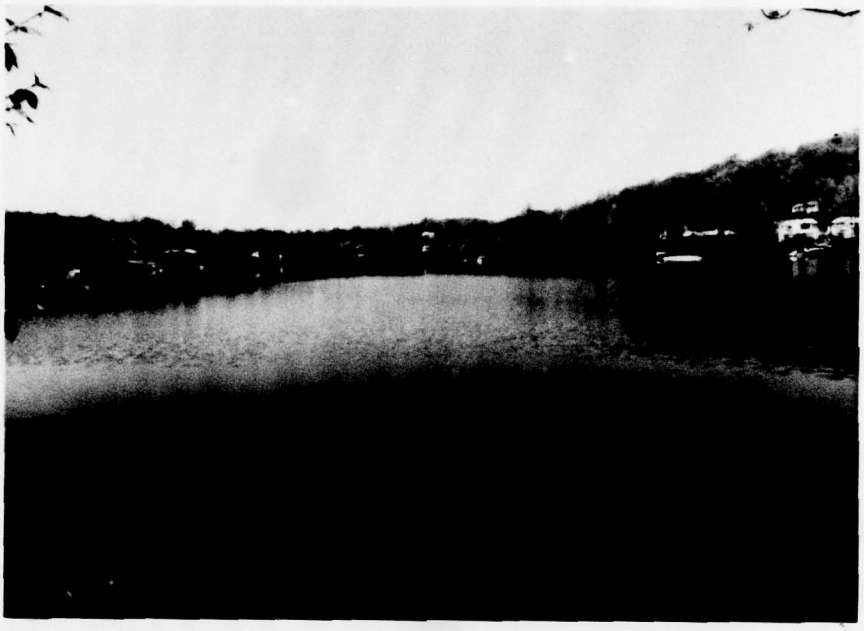


Photo No. 7 - View upstream from top of dam, showing lake and lakefront properties. Note moderate, wooded slopes.

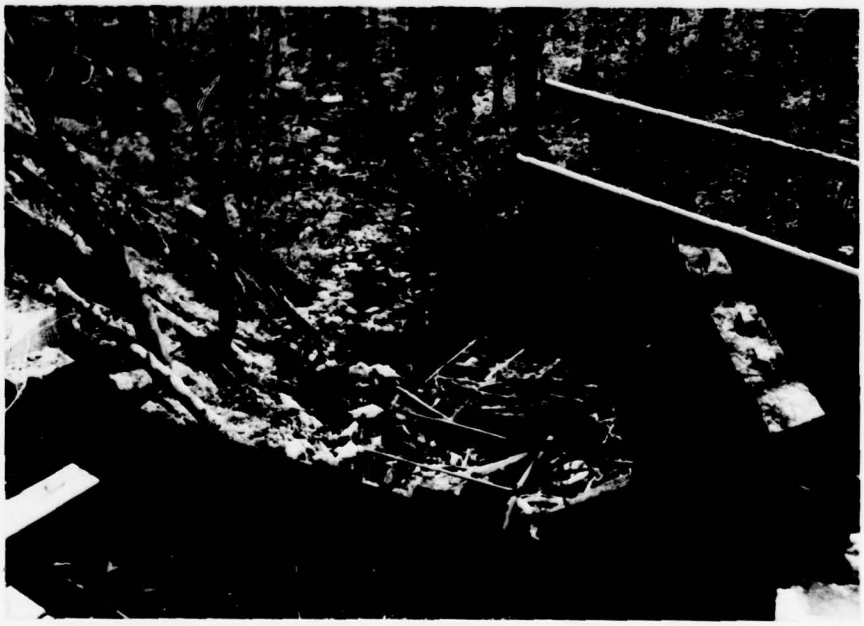


Photo No. 8 - Overall view of downstream channel from top of dam. showing spillway in foreground. Note the steep, wooded valley sides, and the debris in the channel.

Photo No. 9 - Small pond located about 1/2 mile downstream from Lake Neepaulin Dam, where downstream channel widens out into a broad floodplain. The view is upstream.

Photo No. 10 - Retaining structure of downstream pond.

Photo No. 11 - View of Papakating Creek valley below downstream pond. Highway No. 639 embankment crosses the creek and Sussex Airport runway is visible at top center.

# APPENDIX C

## SUMMARY OF ENGINEERING DATA

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

Name of Dam: Lake Neepaulin

Drainage Area Characteristics: Woodland, with residential development.

Elevation Top Normal Pool (Storage Capacity): 501.6' MSL (67 acre-feet)

Elevation Top Flood Control Pool (Storage Capacity): N/A

Elevation Maximum Design Pool: 506.34' MSL (143 acre-feet)

Elevation Top Dam: 505.2' MSL (123 acre-feet)

SPILLWAY CREST

a. Elevation 501.5'

b. Type Dropped concrete ogee.

c. Width 5'

d. Length 11'

e. Location Spillover Full length.

f. No. and Type of Gates None.

OUTLET WORK

a. Type N/A

b. Location N/A

c. Entrance Inverts N/A

d. Exit Inverts N/A

e. Emergency Draindown Facilities 24" CMP on right side of dam (approx. invert EL 499.5')

HYDROMETEOROLOGICAL GAGES

a. Type N/A

b. Location N/A

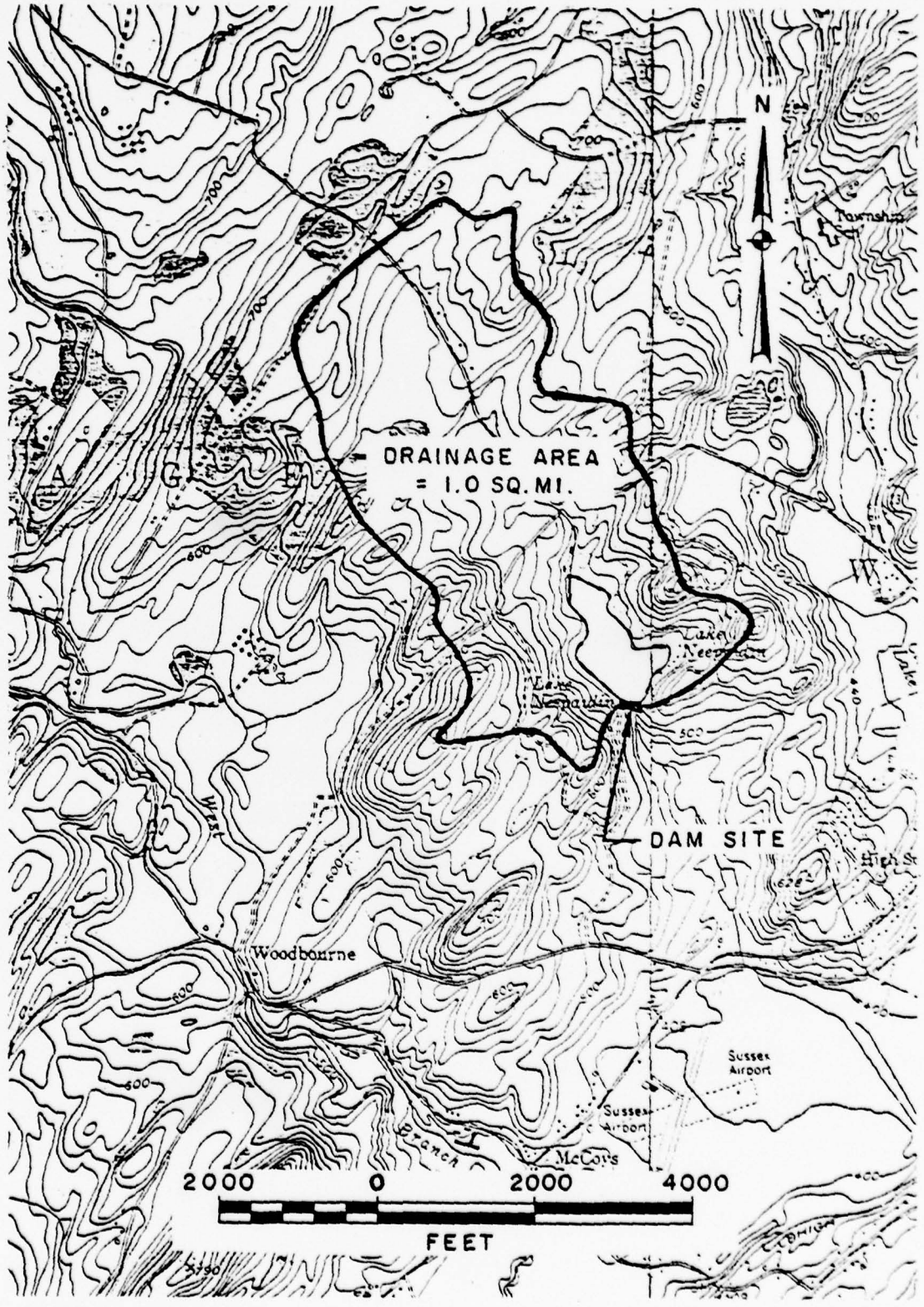
c. Records N/A

MAXIMUM NON-DAMAGING DISCHARGE 274 cfs

# APPENDIX D

## HYDROLOGIC COMPUTATIONS

PLATE I APPENDIX D




LAKE NEEPAULIN DAM
DRAINAGE BASIN

FREDERIC R. HARRIS, INC.
CONSULTING ENGINEERS

SUBJECT N. J. DAM INSPECTION — SHEET NO. 1 OF 9
LAKE NEEPAULIN DAM — JOB NO. 10-A20-01
COMPUTED BY L. LAFONTE CHECKED BY ____ — DATE JULY 1979

## SIZE CLASSIFICATION

| | |
|---|---|
| SURFACE AREA OF MAIN IMPOUNDMENT | 13.4 ACRES |
| AVERAGE DEPTH OF LAKE | * 15 EST |
| STRUCTURAL HGT OF DAM | 22 FT |
| SIZE CLASSIFICATION | SMALL |
| DRAINAGE AREA | 1.0 mi.² |

## HAZARD POTENTIAL CLASSIFICATION

AS THE D/S AREA WIDENS INTO A A WIDE FLAT FLOODPLAIN - SIGNIFICANT

RECOMMENDED SDF 100 YEAR TO 1/2 PMF

USE 1/2 PMF, The high side of "Significant Hazard" classification.

## PRECIPITATION

USING "HM - REPORT No. 33", FIGURE 1 - PROBABLE MAXIMUM PRECIPITATION FOR 200 $mi^2$ - 24 hr (THE ALL SEASONS ENVELOPE I:

PMP = 22 in (IN ZONE 6)

| DURATION (IN Hr) | % PMP (FOR 1050 mi) |
|---|---|
| 6 | 114 |
| 12 | 124 |
| 24 | 133 |
| 48 | 143 |

## INFILTRATION DATA

USING "ENGINEERING SOIL SURVEY of NEW JERSEY" - RUTGERS UNIVERSITY JANUARY 1954

| | | HSG* | % of D.A | CN | |
|---|---|---|---|---|---|
| SOIL CLASSIFICATION | Sh-2ge | B | 25 | 80 | 20 |
| | Sh-2dg | C | 25 | 85 | 21.25 |
| | GM-24/SN ge | B | 60 | 61 | 36 |
| | | | | AVG CN | 77 |

$S = \frac{1000}{CN} - 10 = 2.99$ $\quad I_a = .2\,S = .6$ IN

CN FOR A SATURATED CONDITION = 89 (SCS HYDROLOGY HANDBOOK 147)

USING FIG ID-1 INFILTRATION RATE = .02 IN/HR

* SCS HYDROLOGIC SOIL GROUP

# ESTIMATION OF TIME OF CONCENTRATION

1. FROM SCS HYDROLOGY HANDBOOK USING VELOCITY ESTIMATES AND WATER COURSE LENGTH (FIG 15.2)

| | SLOPE | VELOCITY (FIG 15.2) |
|---|---|---|
| OVERLAND FLOW | 700-580/4000 | .86 fps |
| CHANNEL REACH | 580-500/4000 | 2.5 fps |

$$T_c = \left[\frac{4000}{.86} + \frac{4000}{2.5}\right]\frac{1}{3600} = 1.73 \text{ HRS}$$

2. USING ABOVE METHOD WITH $V_{OVERBANK} = V_{CHANNEL}$

$$T_c = \frac{8000}{2.5}\cdot\frac{1}{3600} = .88 \text{ HR}$$

3. FROM THE NOMOGRAPH IN "DESIGN OF SMALL DAMS" - U.S.D.I. (Pg 47)

$$T_c = \left[\frac{11.9\,L^3}{H}\right]^{.385}$$

$L = 8000/5280$

$H = 700 - 500$

$= .55$ HR.

4. FROM G.B. WILLIAMS FLOOD COMMITTEE

$$T = .908\,L\sqrt[5]{\frac{1}{FD}}$$

$= .908(1.52)(2.5 \times 1.13)^{-.2}$

$= 1.12$ HRS

$L = 8000/5280$

$D$ = DIAMETER OF A CIRCLE OF EQUAL AREA $= [4A/\pi]^{1/2} = 1.13$

$F$ = SLOPE IN % $= 200/8000 = 2.5\%$

USE AN AVERAGE $T_c$ OF 1.1 HR

LAG TIME = 0.6 $T_c$ = .66 HR

## ELEVATION / AREA / CAPACITY RELATIONSHIP

| | | | | | | |
|---|---|---|---|---|---|---|
| ELEVATION | 486.6 * | 501.5 | 520 | 540 | 560 | 580 |
| SURFACE AREA | 0 | 13.4 | 35.8 | 68.3 | 85.1 | 132.3 |

* ESTIMATED BOTTOM OF LAKE

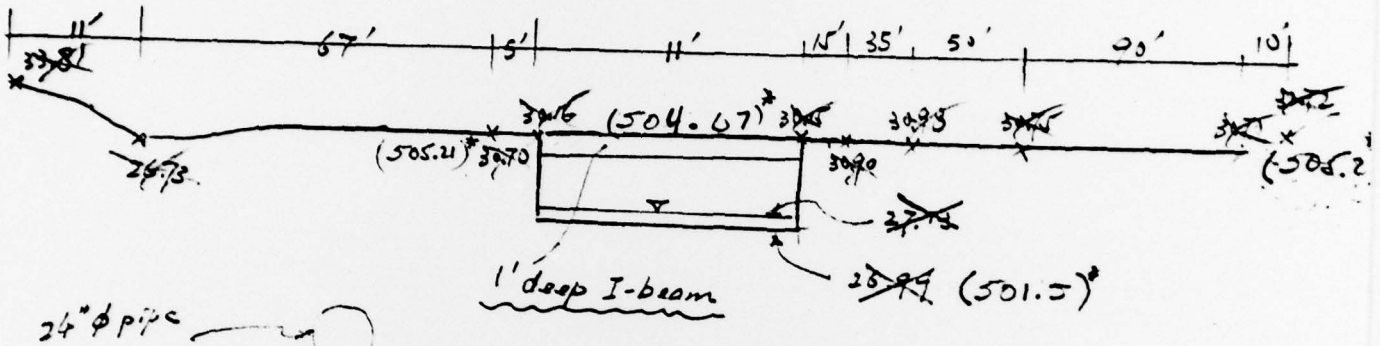
## DAM DIMENSIONS

SEE THREE ATTATCHED PAGES. SET ELEVATION AT TOP OF SPILLWAY ( 26.99 ) EQUAL TO 501.5 MSL FROM PLAN

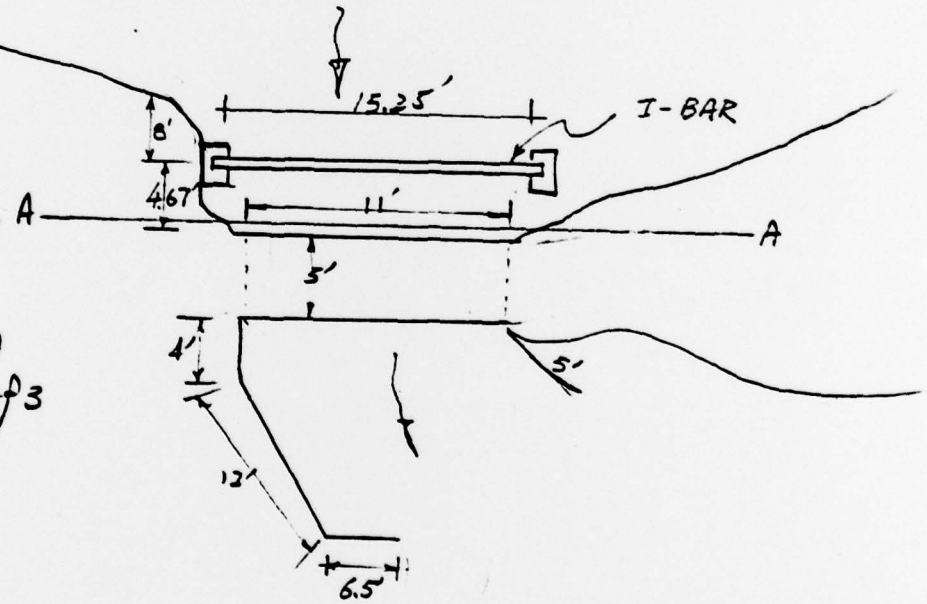
FREDERIC R. HARRIS, INC.
CONSULTING ENGINEERS

SUBJECT Neepaulin Lake Dam
FIELD NOTES
COMPUTED BY ..... CHECKED BY .....

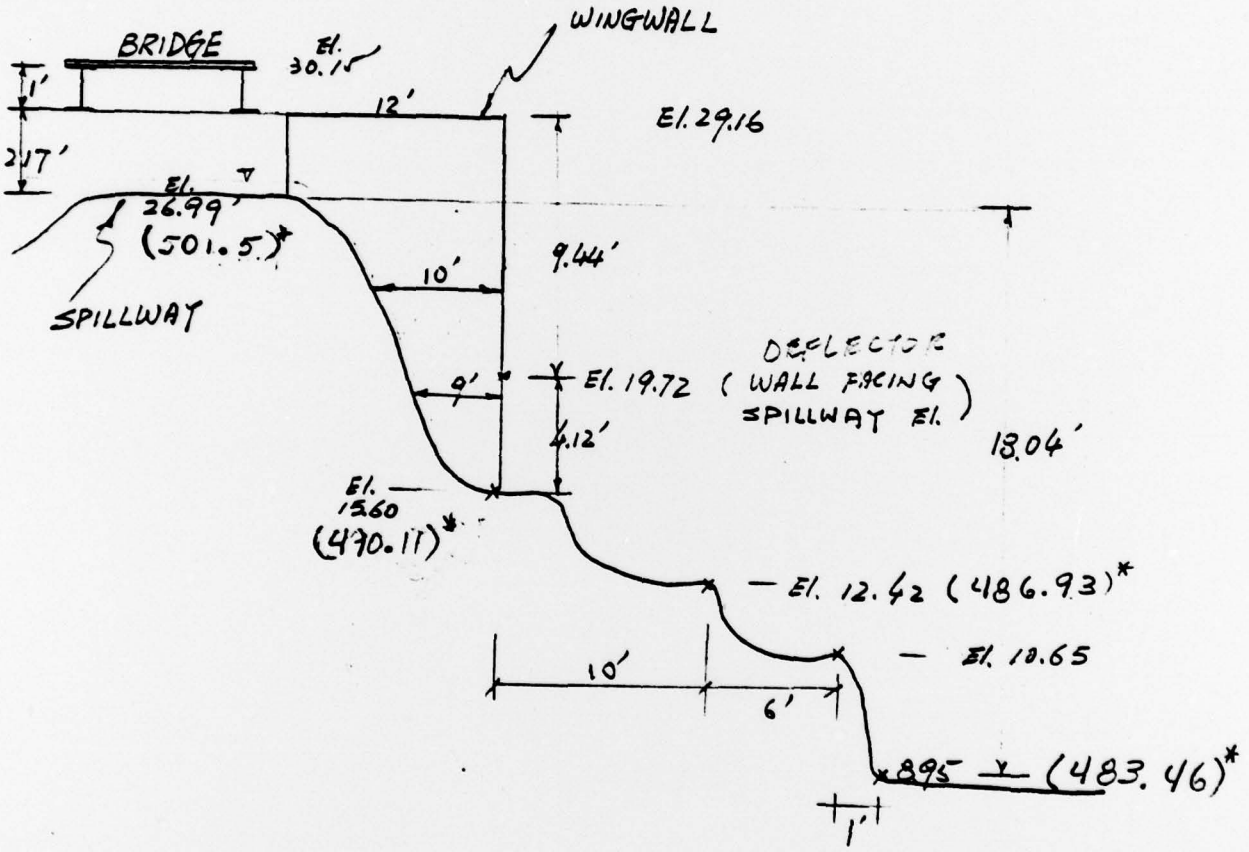
SHEET NO. 5 OF 9
JOB NO. 10-A20-01
DATE .....




24" ϕ pipe
in 2' below reservoir level (almost completely silted)




X-section A-A
see page 3 of 3




* ELEVATION TRANSPOSED FROM "PLAN OF DAM, LAKE NEEPAULIN" SNOOK & HARDIN ENGINEERS NEWTON, N.J.

| | SPILLWAY | | | | OVERBANK (DAM) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | BASE ELEV. 511.4 | | | | BASE ELEV 505.1 | | | | BASE ELEV 505.3 | | | | |
| ELEV | $C_1$ | $L_1$ | $H_1$ | $Q_1$ | $C_2$ | $L_2$ | $H_2$ | $Q_2$ | $C_3$ | $L_3$ | $H_3$ | $Q_3$ | Q TOTAL |
| 501.4 | 3.4 | 11 | 0 | 0 | | | | | | | | | 0 |
| 502 | 3.4 | 11 | 0.6 | 19.7 | | | | | | | | | 19.7 |
| 503.5 | 3.4 | 11 | 2.0 | 40.2 | | | | | | | | | 40.2 |
| 504.5 | 3.4 | 11 | 3.0 | 194.3 | | | | | | | | | 194.3 |
| 505.2 | 3.5 | 11 | 3.7 | 274 | | | | | | | | | 274 |
| 506 | 3.7 | 11 | 4.5 | 388.5 | 2.7 | 175 | 0.9 | 403.4 | 2.7 | 85 | 0.7 | 131.5 | 926 |
| 507 | 3.7 | 11 | 5.5 | 524.8 | 2.7 | 175 | 1.9 | 1237 | 2.7 | 85 | 1.7 | 508.7 | 2271 |
| 508 | 3.7 | 11 | 6.5 | 674.4 | 2.7 | 175 | 2.9 | 2333 | 2.7 | 85 | 2.7 | 1018 | 4025 |
| 509 | 3.7 | 11 | 7.5 | 836 | 2.7 | 175 | 3.9 | 3639 | 2.7 | 85 | 3.7 | 1633 | 6108 |
| 510 | 3.7 | 11 | 8.5 | 1009 | 2.7 | 175 | 4.9 | 5125 " | 2.7 | 85 | 4.7 | 2338 " | 8490 |
| 512 | 3.8 | 11 | 10.5 | 1422 | 2.7 | 175 | 6.9 | 8564 | 2.7 | 85 | 6.7 | 3980 | 13948 |
| 514 | 3.8 | 11 | 12.5 | 1847 | 2.7 | 175 | 8.9 | 12545 | 2.7 | 85 | 8.7 | 5890 | 20282 |

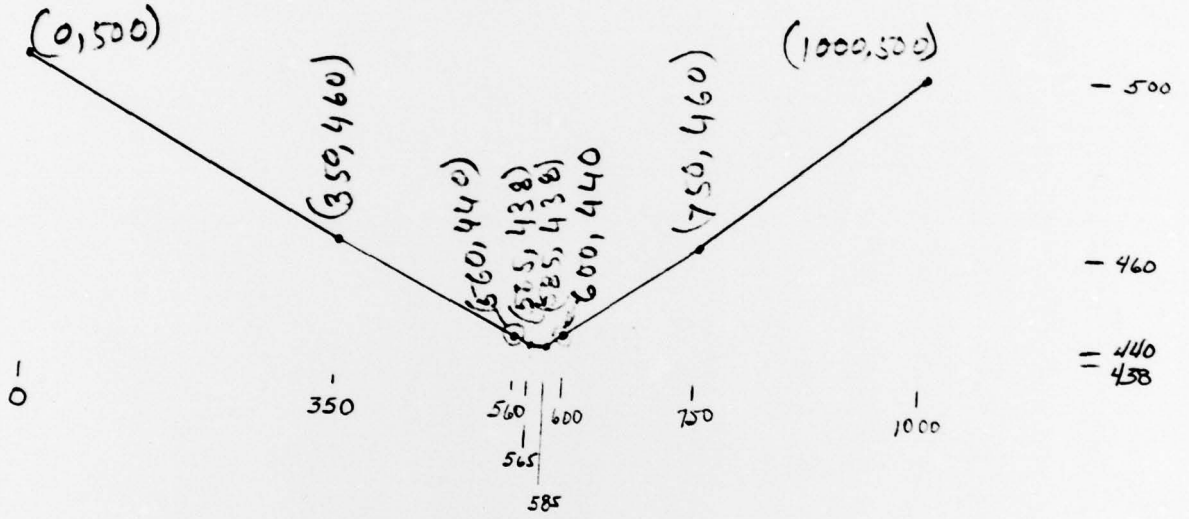
FREDERIC R. HARRIS, INC.
CONSULTING ENGINEERS

SUBJECT N. J. Dam Inspection
LAKE NEEPAUKIN DAM
COMPUTED BY SF2 CHECKED BY

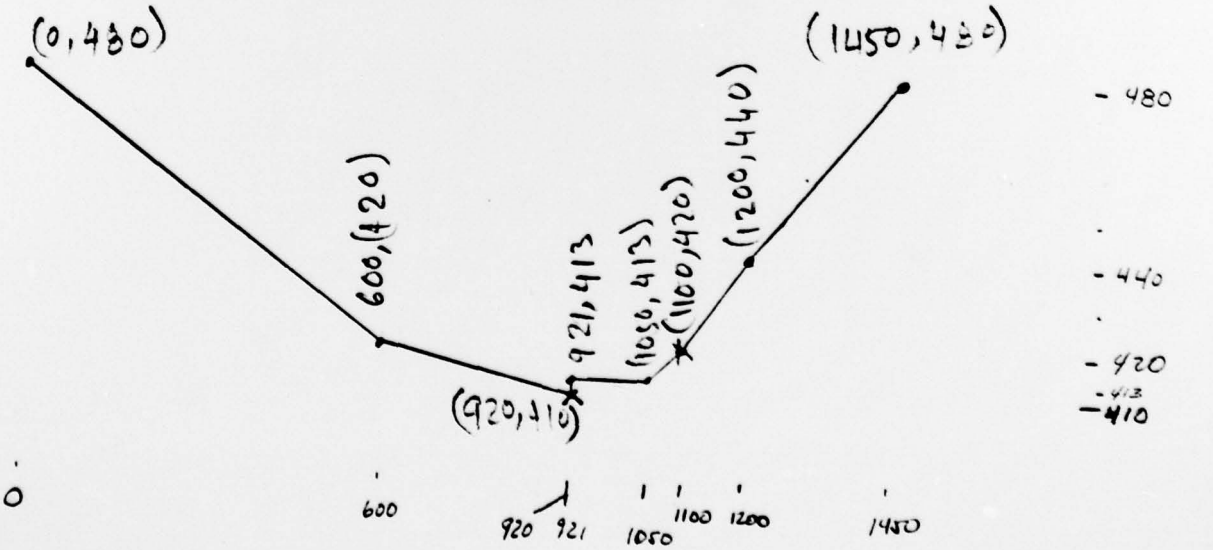
SHEET NO. 7 OF 9
JOB NO. 10 A20 51
DATE July 1979

USE TWO DOWNSTREAM SECTIONS TO DEVELOP THE HAZARD POTENTIAL DOWNSTREAM.

1ST SECTION 850 FT D/S OF DAM TAKEN FROM QUAD




2ND SECTION TAKEN 3000 FT D/S OF DAM (@ D/S END OF SMALL POND)

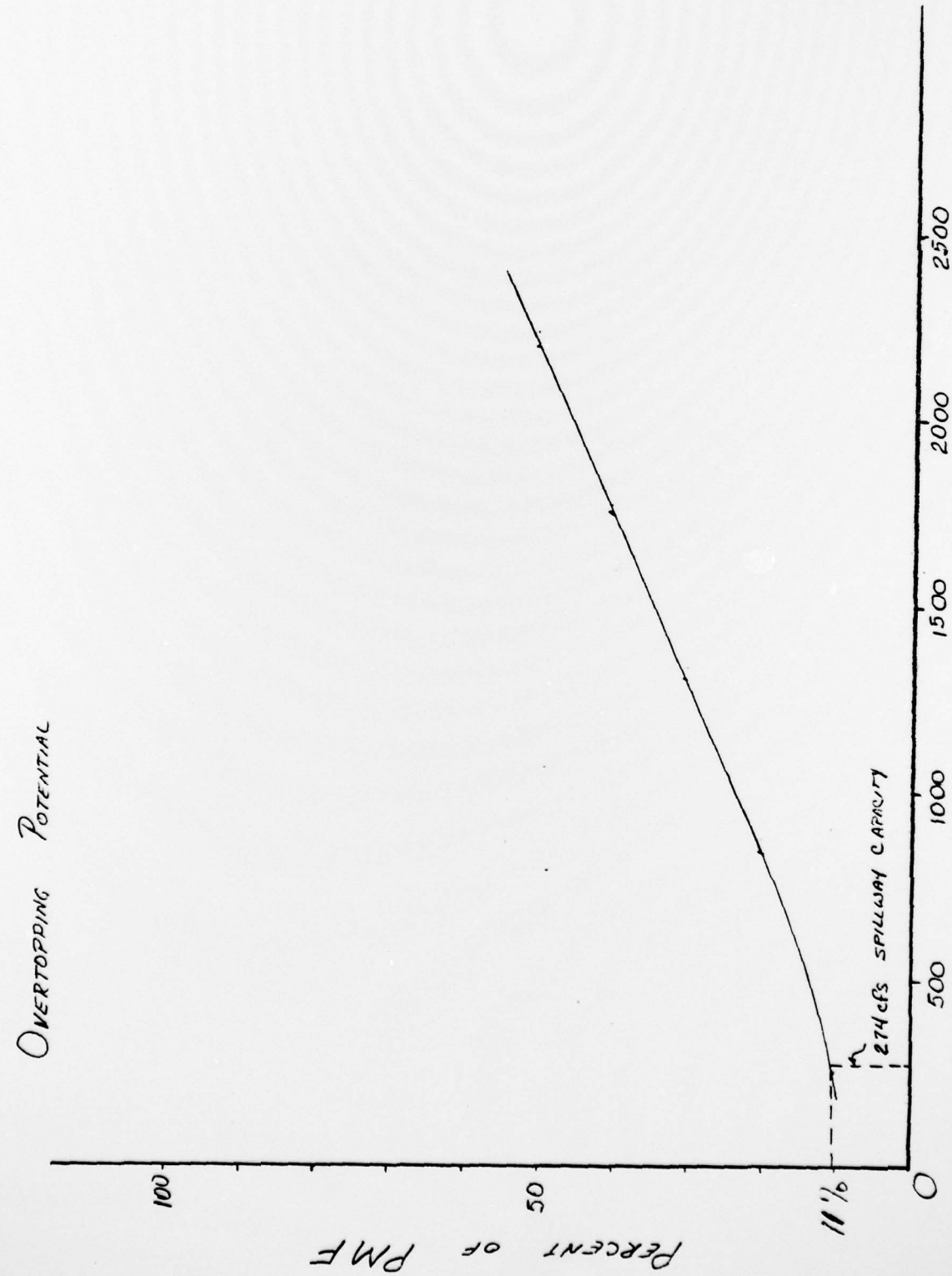



C/S DEVELOPED FROM U.S.G.S. QUADS AND PHOTOGRAPHS

**FREDERIC R. HARRIS, INC.**
CONSULTING ENGINEERS

SUBJECT N.J. DAM INSPECTION
LAKE NEEPAULIN DAM
COMPUTED BY JFZ CHECKED BY

SHEET NO 9 OF 9
JOB NO 10 A20 01
DATE AUGUST 1979



HEC1-DB

COMPUTER PRINT-OUT

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  26 FEB 79
**********
    1                 A1       N.J. DAM INSPECTION
    2                 A2       LAKE NEEPAULIN DAM
    3                 A3       MULTIRATIO PMF ROUTING
    4                 B     100        0       15        0        0        0        0        0        0        0
    5                 H1      5
    6                 J       1        5        1
    7                 J1     .5       .4       .3       .2       .1
    8                 K       0     LAKE                   1                 1
    9                 K1         INFLOW TO LAKE FROM RUNOFF
   10                 M       1        2      1.0                                                    1
   11                 P       0       22      114      124      133      143
   12                 T                                                          .6      .05
   13                 M2              .66
   14                 X      -1     -.05        2
   15                 K       1      DAM                    1                 1
   16                 K1         ROUTING THROUGH  THE DAM
   17                 Y                                     1        1
   18                 Y1      1                                                -501.5      -1
   19                 Y4  501.5      502    503.5    504.5    505.2      506      507      508      509      510
   20                 Y4    512      514
   21                 Y5      0     19.7     40.2    194.3      274      926     2271     4025     6108     8490
   22                 Y5  13748    20282
   23                 $A      0     13.4     35.8     68.3     85.1    132.3
   24                 $E  486.6      501.5      520      540      560      580
   25                 $B  501.5
   26                 $D  505.2
   27                 K       1  REACH 1                                                 1
   28                 K1         CHANNEL ROUTING MOD. PULS. REACH 1
   29                 Y                                     1        1
   30                 Y1      1
   31                 Y6   1.15      .05     1.15      438      500      850     .065
   32                 Y7      0      500      350      460      560      440      565      438      585      438
   33                 Y7    800      440      750      460     1000      500
   34                 K       1  REACH 2                                                 1
   35                 K1         CHANNEL ROUTING - MOD. PULS. - REACH 2
   36                 Y                                     1        1
   37                 Y1      1
   38                 Y6    .08     .035      .08      410      480     2150     .013
   39                 Y7      0      480      600      420      320      410      921      413     1050      413
   40                 Y7   1100      420     1200      440     1450      480
   41                 K      99
```

PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

```
RUNOFF HYDROGRAPH AT        LAKE
ROUTE HYDROGRAPH TO          DAM
ROUTE HYDROGRAPH TO       EACH 1
ROUTE HYDROGRAPH TO       EACH 2
END OF NETWORK
```

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

RUN  DATE= 79/09/18.
     TIME= 08.31.37.


                    N.J. DAM INSPECTION
                    LAKE NEEPAULIN DAM
                    MULTIRATIO PMF ROUTING

                              JOB SPECIFICATION
      NQ     NHR    NMIN    IDAY    IHR    IMIN   METRC    IPLT    IPRT   NSTAN
     100       0      15       0      0       0       0       0       0       0
                          JOPER     NRT   LROPT   TRACE
                              5       0       0       0


                         MULTI-PLAN ANALYSES TO BE PERFORMED
                             NPLAN= 1 NRTIO= 5 LRTIO= 1
            RTIOS=     .50     .40     .30     .20     .10


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

                         SUB-AREA RUNOFF COMPUTATION

              INFLOW TO LAKE FROM RUNOFF

                    ISTAG   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                     LAKE       0       0       0       1       0       1       0       0

                              HYDROGRAPH DATA
          IHYDG    IUHG   TAREA    SNAP   TRSDA   TRSPC   RATIO   ISNOW   ISAME   LOCAL
              1       2    1.00    0.00    1.00    0.00   0.000       0       1       0

                              PRECIP DATA
                    SPFE     PMS      R6     R12     R24     R48     R72     R96
                    0.00   22.00  114.00  124.00  133.00  143.00    0.00    0.00
TRSPC COMPUTED BY THE PROGRAM IS  .800

                              LOSS DATA
       LROPT   STRKR   DLTKR   RTIOL   ERAIN   STRKS   RTIOK   STRTL   CNSTL   ALSMX   RTIMP
           0    0.00    0.00    1.00    0.00    0.00    1.00     .60     .05    0.00    0.00

                         UNIT HYDROGRAPH DATA
                      TC=  0.00    LAG=   .66

                         RECESSION DATA
                    STRTQ=   -1.00    QRCSN=    -.05    RTIOR= 2.00

      UNIT HYDROGRAPH 15 END OF PERIOD ORDINATES, TC=    0.00 HOURS, LAG=    .66  VOL= 1.00
    131.     444.     614.     542.     351.     200.     122.      72.      43.      25.
     15.       9.       6.       3.       1.

                                                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

    1.01    .15       1    .00    0.00    .00       1.     1.02    .15      97    .03    .01    .01       4.
    1.01    .30       2    .00    0.00    .00       1.     1.02    .30      98    .03    .01    .01       8.
```

| MO.DA | HR.MN | PERIOD | RAIN | EXCS | LOSS | END-OF-PERIOD FLOW COMP Q | MO.DA | HR.MN | PERIOD | RAIN | EXCS | LOSS | COMP Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.01 | .15 | 1 | .00 | 0.00 | .00 | 1. | 1.02 | .15 | 97 | .03 | .01 | .01 | 4. |
| 1.01 | .30 | 2 | .00 | 0.00 | .00 | 1. | 1.02 | .30 | 98 | .03 | .01 | .01 | 8. |
| 1.01 | .45 | 3 | .00 | 0.00 | .00 | 1. | 1.02 | .45 | 99 | .03 | .01 | .01 | 17. |
| 1.01 | 1.00 | 4 | .00 | 0.00 | .00 | 1. | 1.02 | 1.00 | 100 | .03 | .01 | .01 | 24. |
| 1.01 | 1.15 | 5 | .00 | 0.00 | .00 | 1. | 0.00 | 0.00 | 101 | .03 | .01 | .01 | 29. |
| 1.01 | 1.30 | 6 | .00 | 0.00 | .00 | 1. | 0.00 | 0.00 | 102 | .03 | .01 | .01 | 32. |
| 1.01 | 1.45 | 7 | .00 | 0.00 | .00 | 1. | 0.00 | 0.00 | 103 | .03 | .01 | .01 | 33. |
| 1.01 | 2.00 | 8 | .00 | 0.00 | .00 | 1. | 0.00 | 0.00 | 104 | .03 | .01 | .01 | 34. |
| 1.01 | 2.15 | 9 | .00 | 0.00 | .00 | 1. | 0.00 | 0.00 | 105 | .03 | .01 | .01 | 35. |
| 1.01 | 2.30 | 10 | .00 | 0.00 | .00 | 0. | 0.00 | 0.00 | 106 | .03 | .01 | .01 | 35. |
| 1.01 | 2.45 | 11 | .00 | 0.00 | .00 | 0. | 0.00 | 0.00 | 107 | .03 | .01 | .01 | 36. |
| 1.01 | 3.00 | 12 | .00 | 0.00 | .00 | 0. | 0.00 | 0.00 | 108 | .03 | .01 | .01 | 36. |
| 1.01 | 3.15 | 13 | .00 | 0.00 | .00 | 0. | 0.00 | 0.00 | 109 | .03 | .01 | .01 | 36. |
| 1.01 | 3.30 | 14 | .00 | 0.00 | .00 | 0. | 0.00 | 0.00 | 110 | .03 | .01 | .01 | 36. |
| 1.01 | 3.45 | 15 | .00 | 0.00 | .00 | 0. | 0.00 | 0.00 | 111 | .03 | .01 | .01 | 36. |
| 1.01 | 4.00 | 16 | .00 | 0.00 | .00 | 0. | 0.00 | 0.00 | 112 | .03 | .01 | .01 | 36. |
| 1.01 | 4.15 | 17 | .00 | 0.00 | .00 | 0. | 0.00 | 0.00 | 113 | .03 | .01 | .01 | 36. |
| 1.01 | 4.30 | 18 | .00 | 0.00 | .00 | 0. | 0.00 | 0.00 | 114 | .03 | .01 | .01 | 36. |
| 1.01 | 4.45 | 19 | .00 | 0.00 | .00 | 0. | 0.00 | 0.00 | 115 | .03 | .01 | .01 | 36. |
| 1.01 | 5.00 | 20 | .00 | 0.00 | .00 | 0. | 0.00 | 0.00 | 116 | .03 | .01 | .01 | 36. |
| 1.01 | 5.15 | 21 | .00 | 0.00 | .00 | 0. | 0.00 | 0.00 | 117 | .03 | .01 | .01 | 36. |
| 1.01 | 5.30 | 22 | .00 | 0.00 | .00 | 0. | 0.00 | 0.00 | 118 | .03 | .01 | .01 | 36. |
| 1.01 | 5.45 | 23 | .00 | 0.00 | .00 | 0. | 0.00 | 0.00 | 119 | .03 | .01 | .01 | 36. |
| 1.01 | 6.00 | 24 | .00 | 0.00 | .00 | 0. | 0.00 | 0.00 | 120 | .03 | .01 | .01 | 36. |
| 1.01 | 6.15 | 25 | .01 | 0.00 | .01 | 0. | 0.00 | 0.00 | 121 | .07 | .06 | .01 | 42. |
| 1.01 | 6.30 | 26 | .01 | 0.00 | .01 | 0. | 0.00 | 0.00 | 122 | .07 | .06 | .01 | 63. |
| 1.01 | 6.45 | 27 | .01 | 0.00 | .01 | 0. | 0.00 | 0.00 | 123 | .07 | .06 | .01 | 92. |
| 1.01 | 7.00 | 28 | .01 | 0.00 | .01 | 0. | 0.00 | 0.00 | 124 | .07 | .06 | .01 | 117. |
| 1.01 | 7.15 | 29 | .01 | 0.00 | .01 | 0. | 0.00 | 0.00 | 125 | .07 | .06 | .01 | 134. |
| 1.01 | 7.30 | 30 | .01 | 0.00 | .01 | 0. | 0.00 | 0.00 | 126 | .07 | .06 | .01 | 143. |
| 1.01 | 7.45 | 31 | .01 | 0.00 | .01 | 0. | 0.00 | 0.00 | 127 | .07 | .06 | .01 | 149. |
| 1.01 | 8.00 | 32 | .01 | 0.00 | .01 | 0. | 0.00 | 0.00 | 128 | .07 | .06 | .01 | 152. |
| 1.01 | 8.15 | 33 | .01 | 0.00 | .01 | 0. | 0.00 | 0.00 | 129 | .07 | .06 | .01 | 154. |
| 1.01 | 8.30 | 34 | .01 | 0.00 | .01 | 0. | 0.00 | 0.00 | 130 | .07 | .06 | .01 | 155. |
| 1.01 | 8.45 | 35 | .01 | 0.00 | .01 | 0. | 0.00 | 0.00 | 131 | .07 | .06 | .01 | 156. |
| 1.01 | 9.00 | 36 | .01 | 0.00 | .01 | 0. | 0.00 | 0.00 | 132 | .07 | .06 | .01 | 156. |
| 1.01 | 9.15 | 37 | .01 | 0.00 | .01 | 0. | 0.00 | 0.00 | 133 | .07 | .06 | .01 | 157. |
| 1.01 | 9.30 | 38 | .01 | 0.00 | .01 | 0. | 0.00 | 0.00 | 134 | .07 | .06 | .01 | 157. |
| 1.01 | 9.45 | 39 | .01 | 0.00 | .01 | 0. | 0.00 | 0.00 | 135 | .07 | .06 | .01 | 157. |
| 1.01 | 10.00 | 40 | .01 | 0.00 | .01 | 0. | 0.00 | 0.00 | 136 | .07 | .06 | .01 | 157. |
| 1.01 | 10.15 | 41 | .01 | 0.00 | .01 | 0. | 0.00 | 0.00 | 137 | .07 | .06 | .01 | 157. |
| 1.01 | 10.30 | 42 | .01 | 0.00 | .01 | 0. | 0.00 | 0.00 | 138 | .07 | .06 | .01 | 157. |
| 1.01 | 10.45 | 43 | .01 | 0.00 | .01 | 0. | 0.00 | 0.00 | 139 | .07 | .06 | .01 | 157. |
| 1.01 | 11.00 | 44 | .01 | 0.00 | .01 | 0. | 0.00 | 0.00 | 140 | .07 | .06 | .01 | 157. |
| 1.01 | 11.15 | 45 | .01 | 0.00 | .01 | 0. | 0.00 | 0.00 | 141 | .07 | .06 | .01 | 157. |
| 1.01 | 11.30 | 46 | .01 | 0.00 | .01 | 0. | 0.00 | 0.00 | 142 | .07 | .06 | .01 | 157. |
| 1.01 | 11.45 | 47 | .01 | 0.00 | .01 | 0. | 0.00 | 0.00 | 143 | .07 | .06 | .01 | 157. |
| 1.01 | 12.00 | 48 | .01 | 0.00 | .01 | 0. | 0.00 | 0.00 | 144 | .07 | .06 | .01 | 157. |
| 1.01 | 12.15 | 49 | .04 | 0.00 | .04 | 0. | 0.00 | 0.00 | 145 | .50 | .49 | .01 | 213. |
| 1.01 | 12.30 | 50 | .04 | 0.00 | .04 | 0. | 0.00 | 0.00 | 146 | .50 | .49 | .01 | 403. |
| 1.01 | 12.45 | 51 | .04 | 0.00 | .04 | 0. | 0.00 | 0.00 | 147 | .50 | .49 | .01 | 666. |
| 1.01 | 13.00 | 52 | .04 | 0.00 | .04 | 0. | 0.00 | 0.00 | 148 | .50 | .49 | .01 | 898. |
| 1.01 | 13.15 | 53 | .05 | 0.00 | .05 | 0. | 0.00 | 0.00 | 149 | .60 | .59 | .01 | 1062. |
| 1.01 | 13.30 | 54 | .05 | 0.00 | .05 | 0. | 0.00 | 0.00 | 150 | .60 | .59 | .01 | 1192. |
| 1.01 | 13.45 | 55 | .05 | 0.00 | .05 | 0. | 0.00 | 0.00 | 151 | .60 | .59 | .01 | 1306. |
| 1.01 | 14.00 | 56 | .05 | 0.00 | .05 | 0. | 0.00 | 0.00 | 152 | .60 | .59 | .01 | 1391. |
| 1.01 | 14.15 | 57 | .06 | 0.00 | .06 | 0. | 0.00 | 0.00 | 153 | .75 | .74 | .01 | 1465. |
| 1.01 | 14.30 | 58 | .06 | .02 | .04 | 3. | 0.00 | 0.00 | 154 | .75 | .74 | .01 | 1562. |
| 1.01 | 14.45 | 59 | .05 | .04 | .01 | 14. | 0.00 | 0.00 | 155 | .75 | .74 | .01 | 1674. |
| 1.01 | 15.00 | 60 | .06 | .04 | .01 | 37. | 0.00 | 0.00 | 156 | .75 | .74 | .01 | 1766. |
| 1.01 | 15.15 | 61 | .06 | .04 | .01 | 63. | 0.00 | 0.00 | 157 | .76 | .75 | .01 | 1827. |
| 1.01 | 15.30 | 62 | .11 | .10 | .01 | 91. | 0.00 | 0.00 | 158 | 1.52 | 1.51 | .01 | 1966. |
| 1.01 | 15.45 | 63 | .32 | .31 | .01 | 157. | 0.00 | 0.00 | 159 | 4.27 | 4.26 | .01 | 2690. |
| 1.01 | 16.00 | 64 | .08 | .07 | .01 | 259. | 0.00 | 0.00 | 160 | 1.07 | 1.05 | .01 | 3974. |
| 1.01 | 16.15 | 65 | .05 | .04 | .01 | 312. | 0.00 | 0.00 | 161 | .70 | .69 | .01 | 4615. |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.01 | 16.45 | 67 | .05 | .04 | .01 | 224. | 0.00 | 0.00 | 163 | .70 | .69 | .01 | 3408. |
| 1.01 | 17.00 | 68 | .05 | .04 | .01 | 174. | 0.00 | 0.00 | 164 | .70 | .69 | .01 | 2731. |
| 1.01 | 17.15 | 69 | .04 | .03 | .01 | 145. | 0.00 | 0.00 | 165 | .55 | .54 | .01 | 2334. |
| 1.01 | 17.30 | 70 | .04 | .03 | .01 | 123. | 0.00 | 0.00 | 166 | .55 | .54 | .01 | 2035. |
| 1.01 | 17.45 | 71 | .04 | .03 | .01 | 106. | 0.00 | 0.00 | 167 | .55 | .54 | .01 | 1803. |
| 1.01 | 18.00 | 72 | .04 | .03 | .01 | 93. | 0.00 | 0.00 | 168 | .55 | .54 | .01 | 1639. |
| 1.01 | 18.15 | 73 | .00 | 0.00 | .00 | 82. | 0.00 | 0.00 | 169 | .04 | .03 | .01 | 1471. |
| 1.01 | 18.30 | 74 | .00 | 0.00 | .00 | 65. | 0.00 | 0.00 | 170 | .04 | .03 | .01 | 1185. |
| 1.01 | 18.45 | 75 | .00 | 0.00 | .00 | 44. | 0.00 | 0.00 | 171 | .04 | .03 | .01 | 836. |
| 1.01 | 19.00 | 76 | .00 | 0.00 | .00 | 27. | 0.00 | 0.00 | 172 | .04 | .03 | .01 | 536. |
| 1.01 | 19.15 | 77 | .00 | 0.00 | .00 | 16. | 0.00 | 0.00 | 173 | .04 | .03 | .01 | 340. |
| 1.01 | 19.30 | 78 | .00 | 0.00 | .00 | 15. | 0.00 | 0.00 | 174 | .04 | .03 | .01 | 230. |
| 1.01 | 19.45 | 79 | .00 | 0.00 | .00 | 14. | 0.00 | 0.00 | 175 | .04 | .03 | .01 | 215. |
| 1.01 | 20.00 | 80 | .00 | 0.00 | .00 | 13. | 0.00 | 0.00 | 176 | .04 | .03 | .01 | 201. |
| 1.01 | 20.15 | 81 | .00 | 0.00 | .00 | 12. | 0.00 | 0.00 | 177 | .04 | .03 | .01 | 187. |
| 1.01 | 20.30 | 82 | .00 | 0.00 | .00 | 11. | 0.00 | 0.00 | 178 | .04 | .03 | .01 | 175. |
| 1.01 | 20.45 | 83 | .00 | 0.00 | .00 | 10. | 0.00 | 0.00 | 179 | .04 | .03 | .01 | 163. |
| 1.01 | 21.00 | 84 | .00 | 0.00 | .00 | 10. | 0.00 | 0.00 | 180 | .04 | .03 | .01 | 152. |
| 1.01 | 21.15 | 85 | .00 | 0.00 | .00 | 9. | 0.00 | 0.00 | 181 | .04 | .03 | .01 | 142. |
| 1.01 | 21.30 | 86 | .00 | 0.00 | .00 | 8. | 0.00 | 0.00 | 182 | .04 | .03 | .01 | 132. |
| 1.01 | 21.45 | 87 | .00 | 0.00 | .00 | 8. | 0.00 | 0.00 | 183 | .04 | .03 | .01 | 123. |
| 1.01 | 22.00 | 88 | .00 | 0.00 | .00 | 7. | 0.00 | 0.00 | 184 | .04 | .03 | .01 | 115. |
| 1.01 | 22.15 | 89 | .00 | 0.00 | .00 | 7. | 0.00 | 0.00 | 185 | .04 | .03 | .01 | 107. |
| 1.01 | 22.30 | 90 | .00 | 0.00 | .00 | 6. | 0.00 | 0.00 | 186 | .04 | .03 | .01 | 100. |
| 1.01 | 22.45 | 91 | .00 | 0.00 | .00 | 6. | 0.00 | 0.00 | 187 | .04 | .03 | .01 | 94. |
| 1.01 | 23.00 | 92 | .00 | 0.00 | .00 | 6. | 0.00 | 0.00 | 188 | .04 | .03 | .01 | 87. |
| 1.01 | 23.15 | 93 | .00 | 0.00 | .00 | 5. | 0.00 | 0.00 | 189 | .04 | .03 | .01 | 81. |
| 1.01 | 23.30 | 94 | .00 | 0.00 | .00 | 5. | 0.00 | 0.00 | 190 | .04 | .03 | .01 | 76. |
| 1.01 | 23.45 | 95 | .00 | 0.00 | .00 | 4. | 0.00 | 0.00 | 191 | .04 | .03 | .01 | 71. |
| 1.02 | 0.00 | 96 | .00 | 0.00 | .00 | 4. | 0.00 | 0.00 | 192 | .04 | .03 | .01 | 70. |
| | | | | | | | | | SUM | 25.17 | 23.12 | 2.05 | 60398. |
| | | | | | | | | | | ( 639.) | ( 587.) | ( 52.) | ( 1710.28) |

| | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|---|---|---|---|---|---|
| CFS | 4615. | 2041. | 603. | 314. | 60363. |
| CMS | 131. | 58. | 17. | 9. | 1709. |
| INCHES | | 18.99 | 22.43 | 23.40 | 23.40 |
| MM | | 482.31 | 569.75 | 594.28 | 594.28 |
| AC-FT | | 1012. | 1196. | 1247. | 1247. |
| THOUS CU M | | 1249. | 1475. | 1538. | 1538. |

HYDROGRAPH AT STA LAKE FOR PLAN 1, RTIO 1

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 0. | 0. | 0. | 0. | 0. | 0. | 0. | 1. | 7. | 19. |
| 32. | 46. | 78. | 130. | 156. | 143. | 112. | 87. | 73. | 61. |
| 53. | 47. | 41. | 32. | 22. | 13. | 8. | 7. | 7. | 6. |
| 6. | 6. | 5. | 5. | 4. | 4. | 4. | 4. | 3. | 3. |
| 3. | 3. | 3. | 2. | 2. | 2. | 2. | 4. | 8. | 12. |
| 14. | 16. | 17. | 17. | 18. | 18. | 18. | 18. | 18. | 18. |
| 18. | 18. | 18. | 18. | 18. | 18. | 18. | 18. | 18. | 18. |
| 21. | 31. | 46. | 59. | 67. | 71. | 74. | 76. | 77. | 78. |
| 78. | 78. | 78. | 78. | 78. | 78. | 78. | 78. | 78. | 78. |
| 78. | 78. | 78. | 78. | 107. | 202. | 333. | 449. | 531. | 596. |
| 653. | 696. | 732. | 781. | 837. | 883. | 914. | 983. | 1345. | 1987. |
| 2307. | 2124. | 1704. | 1365. | 1167. | 1017. | 902. | 820. | 736. | 592. |
| 418. | 268. | 170. | 115. | 107. | 100. | 94. | 87. | 81. | 76. |
| 71. | 66. | 62. | 58. | 54. | 50. | 47. | 44. | 41. | 38. |
| 35. | 35. | | | | | | | | |

| | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|---|---|---|---|---|---|
| CFS | 2307 | 1021 | 301 | 157 | 30182 |

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 .50 | RATIO 2 .40 | RATIO 3 .30 | RATIO 4 .20 | RATIO 5 .10 |
|---|---|---|---|---|---|---|---|---|
| HYDROGRAPH AT | LAKE | 1.00 | 1 | 2307. | 1846. | 1384. | 923. | 461. |
| | | ( 2.59) | ( | 65.34)( | 52.27)( | 39.20)( | 26.14)( | 13.07)( |
| ROUTED TO | DAM | 1.00 | 1 | 2193. | 1756. | 1314. | 835. | 253. |
| | | ( 2.59) | ( | 62.11)( | 49.72)( | 37.22)( | 23.63)( | 7.17)( |
| ROUTED TO | EACH 1 | 1.00 | 1 | 2197. | 1762. | 1322. | 827. | 253. |
| | | ( 2.59) | ( | 62.21)( | 49.89)( | 37.42)( | 23.42)( | 7.17)( |
| ROUTED TO | EACH 2 | 1.00 | 1 | 2184. | 1749. | 1307. | 802. | 252. |
| | | ( 2.59) | ( | 61.84)( | 49.53)( | 37.00)( | 22.70)( | 7.13)( |

## SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

| | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM |
|---|---|---|---|
| ELEVATION | 501.50 | 501.50 | 505.20 |
| STORAGE | 67. | 67. | 123. |
| OUTFLOW | 0. | 0. | 274. |

| 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 |
|---|---|---|---|---|---|---|---|
| .50 | 506.94 | 1.74 | 154. | 2193. | 5.75 | 40.50 | 0.00 |
| .40 | 506.62 | 1.42 | 148. | 1756. | 5.00 | 40.50 | 0.00 |
| .30 | 506.29 | 1.09 | 142. | 1314. | 4.25 | 40.50 | 0.00 |
| .20 | 505.89 | .69 | 135. | 835. | 2.75 | 40.50 | 0.00 |
| .10 | 505.02 | 0.00 | 120. | 253. | 0.00 | 41.00 | 0.00 |

PLAN 1 STATION EACH 1

| RATIO | MAXIMUM FLOW,CFS | MAXIMUM STAGE,FT | TIME HOURS |
|---|---|---|---|
| .50 | 2197. | 441.7 | 40.50 |
| .40 | 1762. | 441.3 | 40.50 |
| .30 | 1322. | 440.6 | 40.50 |
| .20 | 827. | 439.6 | 40.50 |
| .10 | 253. | 438.5 | 41.00 |

PLAN 1 STATION EACH 2

| RATIO | MAXIMUM FLOW,CFS | MAXIMUM STAGE,FT | TIME HOURS |
|---|---|---|---|
| .50 | 2184. | 414.1 | 40.50 |
| .40 | 1749. | 413.9 | 40.50 |
| .30 | 1307. | 413.8 | 40.50 |
| .20 | 802. | 412.9 | 40.75 |
| .10 | 252. | 410.9 | 41.25 |