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NEW JERSEY DEPT OF ENVIRONMENTAL PROTECTION TRENTON
NATIONAL DAM SAFETY PROGRAM. HADDON LAKE DAM (NJ 00395), DELAWA--ETC(U)
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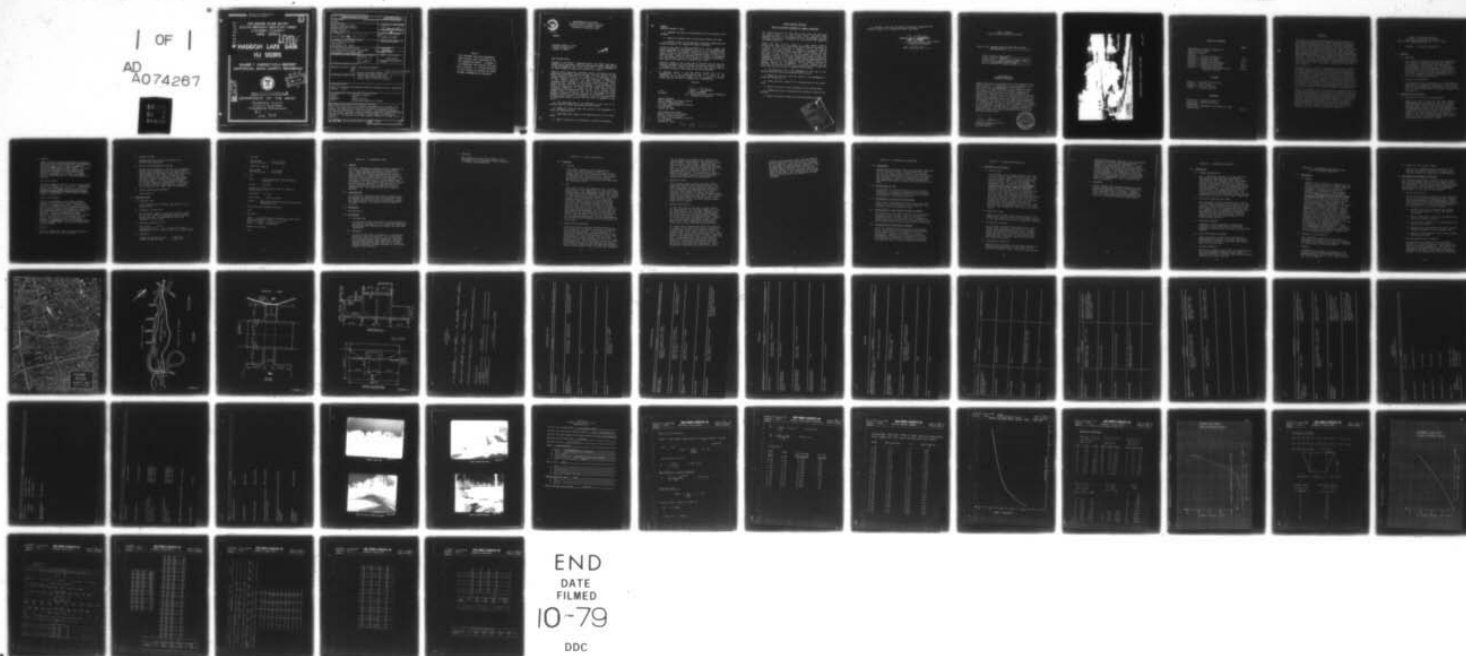
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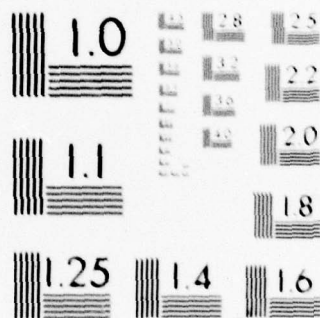
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DELAWARE RIVER BASIN
SOUTH BRANCH NEWTON CREEK,
CAMDEN COUNTY
NEW JERSEY

LEVEL II

HADDON LAKE DAM

NJ 00395

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM



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DEPARTMENT OF THE ARMY

Philadelphia District
Corps of Engineers
Philadelphia, Pennsylvania

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June, 1979

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER NJ00395	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Phase I Inspection Report National Dam Safety Program Haddon Lake Dam Camden, County, N.J.	5. TYPE OF REPORT & PERIOD COVERED 9 FINAL / Rept.	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) 10 Jolls, F. Keith	8. CONTRACT OR GRANT NUMBER(s) 15 DACW61-79-C-0011	
9. PERFORMING ORGANIZATION NAME AND ADDRESS Louis Berger & Associates 100 Halstead St. East Orange, N.J. 07019	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS	
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Engineer District, Philadelphia Custom House, 2d & Chestnut Streets Philadelphia, Pennsylvania 19106	12. REPORT DATE 11 June 1979	13. NUMBER OF PAGES 35
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) 12 59p.	15. SECURITY CLASS. (of this report) Unclassified	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited.		
17. DISTRIBUTION STATEMENT (of the abstract) 6 National Dam Safety Program. Haddon Lake Dam (NJ 00395), Delaware River Basin, South Branch Newton Creek, Camden County, New Jersey. Phase 1 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) Spillway Structural analysis Riprap Safety Embankment Visual inspection Joints 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 ade- quacy. 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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NAPEN-D

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

17 SEP 1978

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Haddon Lake Dam in Camden 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, Haddon Lake 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 fair overall condition. The dam's spillway is considered inadequate since 38 percent of the Spillway Design Flood--SDF - would overtop the dam. (The SDF, in this instance, is the One Hundred Year Flood.) The decision to consider the spillway "inadequate" instead of "seriously inadequate" is based on the dam's reduced hazard classification and expectation that failure of the structure would probably result in no loss of life. For the same reasons no further studies or increase of spillway capacity are recommended. To insure adequacy of the structure, the following actions, as a minimum should be accomplished within one year from the date of approval of this report:

- a. The downstream face of the embankment on each side of the spillway should be further protected with slope paving.
- b. Remove the trees and dead root systems on the embankments to lessen the piping potential.
- c. Place additional riprap at the downstream end of the culvert invert.
- d. Refill the gullies on the backslopes and seed the new areas.

NAPEN-D

Honorable Brendan T. Byrne

e. Sandblast and gunite the deteriorated concrete surfaces on the spillway.

f. Repoint the masonry joints on the bridge parapets and curbs.

g. Develop a check list for periodic maintenance inspections and maintain records of all findings and repairs undertaken.

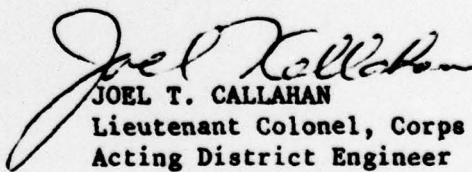
A copy of the report is being furnished to Mr. Dirk C. Hofman, New Jersey Department of Environmental Protection, the designated State Office contact for this program. Within five days of the date of this letter, a copy will also be sent to Congressman James J. Florio of the First District. Under the 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,

1 Incl
As stated


JOEL T. CALLAHAN
Lieutenant Colonel, Corps of Engineers
Acting District Engineer

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

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

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HADDON LAKE DAM (NJ00395)

CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 1 May 1979 by Louis Berger and Associates, 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.

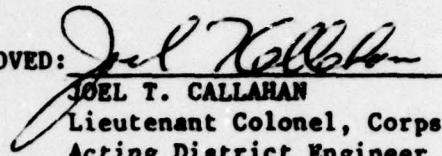
Haddon Lake Dam, initially listed as a high hazard potential structure, but reduced to a significant hazard potential structure, as a result of this inspection, is judged to be in fair overall condition. The dam's spillway is considered inadequate since 38 percent of the Spillway Design Flood--SDF - would overtop the dam. (The SDF, in this instance, is the One Hundred Year Flood.) The decision to consider the spillway "inadequate" instead of "seriously inadequate" is based on the dam's reduced hazard classification and expectation that failure of the structure would probably result in no loss of life. For the same reasons no further studies or increase of spillway capacity are recommended. To insure adequacy of the structure, the following actions, as a minimum should be accomplished within one year from the date of approval of this report:

- a. The downstream face of the embankment on each side of the spillway should be further protected with slope paving.
- b. Remove the trees and dead root systems on the embankments to lessen the piping potential.
- c. Place additional riprap at the downstream end of the culvert invert.
- d. Refill the gullies on the backslopes and seed the new areas.
- e. Sandblast and gunite the deteriorated concrete surfaces on the spillway.
- f. Repoint the masonry joints on the bridge parapets and outfalls.

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g. Develop a check list for periodic maintenance inspections and maintain records of all findings and repairs undertaken.

APPROVED:


JOEL T. CALLAHAN

Lieutenant Colonel, Corps of Engineers
Acting District Engineer

DATE: 13 Sep 79

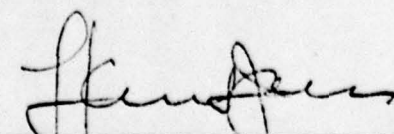
PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

Name of Dam Haddon Lake Dam Fed ID# NJ 00395
NJ ID# 31-45

State Located New Jersey
County Located Camden
Coordinates Lat. 3951.8 - Long. 7505.1
Stream South Branch Newton Creek
Date of Inspection May 1, 1979

ASSESSMENT OF
GENERAL CONDITIONS

Haddon Lake Dam is assessed to be in an overall fair condition and is recommended to be downgraded from a high hazard to a significant hazard category. A failure of the dam would not significantly increase the danger of loss of life but could endanger the sewage disposal operation and bridge immediately downstream. Remedial actions recommended to be undertaken in the future are to 1) regrade and protect the downstream embankment area each side of the spillway and backfill the gullies on the embankment backslope, 2) sandblast and gunite the exposed concrete surfaces of the spillway, 3) remove trees and dead root systems on the embankment slopes and 4) repoint the spillway stone masonry. The dam has an inadequate spillway capacity, being able to accommodate only 37% of the 100 year design flood.



F. Keith Jolls P.E.
Project Manager





OVERVIEW OF HADDON LAKE DAM

MAY, 1979

TABLE OF CONTENTS

	<u>Page</u>
Assessment of General Conditions	
Overall View of Dam	
Table of Contents	
Preface	
Section 1 - Project Information	1-4
Section 2 - Engineering Data	5-6
Section 3 - Visual Inspection	7-9
Section 4 - Operational Procedures	10
Section 5 - Hydraulic/Hydrologic	11-12
Section 6 - Structural Stability	13
Section 7 - Assessments/Recommendations/ Remedial Actions	14-15

FIGURES

- Figure 1 - Regional Vicinity Map
- Figure 2 - Plan of Dam
- Figure 3 - Plan of Spillway
- Figure 4 - Spillway Details

APPENDIX

Check List - Visual Inspection	
Check List - Engineering Data	
Photographs	
Check List - Hydrologic and Hydraulic Data	
Computations	A1-A13

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 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 INSPECTION PROGRAM
NAME OF DAM: HADDON LAKE DAM FED ID # NJ 00395

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority

This report is authorized by the Dam Inspection Act, Public Law 92-367, and has been prepared in accordance with Contract FPM-36 between Louis Berger & Associates, Inc. and the State of New Jersey and its Department of Environmental Protection, Division of Water Resources. The State, in turn, is under agreement with the U.S. Army Engineer District, Philadelphia, to have this inspection performed.

b. Purpose of Inspection

The purpose of this inspection is to evaluate the structural and hydraulic condition of the Haddon Lake Dam and appurtenant structures, and to determine if the dam constitutes a hazard to human life or property.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances

Haddon Lake Dam is a 62-year old earth roadway embankment approximately 350 feet long with a concrete drop inlet spillway and arch bridge located about 50 feet from the west abutment. The embankment carries the two-lane Valley Drive across the north end of Haddon Lake and has a height of 10 feet adjacent to the spillway bridge. The three-sided spillway, whose center wall consists of a movable timber gate, has an effective crest length of 21 feet.

b. Location

Haddon Lake Dam is located approximately four-tenths of a mile due north of the intersection of Black Horse Pike and Kings Highway in the boroughs of Audubon, Mt. Ephraim and Haddon Heights, Camden County. It is built across the South Branch of Newton Creek and lies approximately one-half mile downstream from the partially demolished King's Run Dam. The borough boundary between Mount Ephraim and Audubon bisects the dam axis.

c. Size Classification

The maximum height of the dam is 20 feet and the maximum storage is estimated to be 175 acre-feet. Therefore the dam is placed in the small category as defined by the Recommended Guidelines for Safety Inspection of Dams (maximum storage less than 1,000 acre-feet and maximum height less than 40 feet).

d. Hazard Classification

The site is surrounded by densely developed urban residential areas but all are above flood elevation. Flooding in the downstream channel is confined to the tidal flats of Newton Creek but collapse could endanger the substandard culvert at Black Horse Pike, about 1,200 feet downstream, and possibly cause serious traffic disruption. There is a sewage disposal plant immediately downstream and because the outfall is quite low, a release of silt from the dam might bury the outfall. Therefore, the hazard classification is downgraded to significant; except for the above, there is little danger to human life or property damage should the dam collapse.

e. Ownership

The dam is owned by the Camden County Park Commission, Park Drive, Cherry Hill, New Jersey 08054.

f. Purpose of Dam

Haddon Lake Dam is used principally for recreational purposes.

g. Design and Construction History

The dam was designed in 1917 by J.J. Albertson, Camden County Engineer, for the Haddon Lake Land Company of Philadelphia and was originally called Tumbling Lake Dam. The design was reviewed by Mr. C.C. Vermoule for the State Geologist and the Department of Conservation and Development. It was constructed under the county engineer's supervision. There are no records of major modifications since the Park Commission has taken over the ownership.

h. Normal Operating Procedures

See Section 4.

1.3 PERTINENT DATA

a. Drainage Area

The drainage area of Haddon Lake Dam is 1.43 square miles.

b. Discharge at Dam Site

The spillway capacity with the reservoir level at the top of dam is calculated to be approximately 834 cfs. No discharge records are available at this site.

c. Elevation (Above M.S.L.)

Top of dam - +17.77
Recreation pool - +11.77 (spillway crest)
Streambed at center line of dam - +1 (tidal basin)

d. Reservoir

Length of recreation pool - 2,200 feet
Length of maximum pool - 2,600 feet

e. Storage

Top of dam - 175 acre-feet
Recreation pool - 87 acre-feet

f. Reservoir Surface

Top of dam - 19.0 acres
Recreation pool - 10.2 acres

g. Dam

Type - Earth embankment with concrete
spillway

Length - 350 feet

Structural height (top of dam to bottom of
outlet slab) = 20'

Top Width - 50 feet

Side slopes - 1H:1V (varies)

Cutoff - Plowed and grooved sheeting throughout
embankment area.

h. Diversion and Regulating Tunnel

None

i. Spillway

Type - 3 sided narrow crested weir (drop inlet)
Overall effective length - 21 feet
Crest elevation - +11.77 M.S.L.
Gates - Timber flashboards

j. Regulating Outlets

None

Section 2 - ENGINEERING DATA

2.1 DESIGN

The only information available was one drawing of the concrete bridge structure as conceived in 1917. This depicted the footing layout, wall thicknesses and reinforcing details as well as a detail of the 3" timber sheeting driven across the full width of the natural river channel. The sheeting is braced with 4 x 6 inch whalers and supported by 6" butt timber piles at 8'-0" centers. No construction drawings for the embankment or design computations were located but the plan indicated that the sheeting was driven down to hardpan.

2.2 CONSTRUCTION

No information regarding the actual construction, maintenance or modifications was available. From the NJDEP records, the work was carried out under the supervision of the County and was completed in 1917.

2.3 OPERATION

See Section 4.

2.4 EVALUATION

a. Availability

In view of the dam assessment and recommendations set forth in Section 7, it is believed sufficient design data was available to render the enclosed assessment.

b. Adequacy

In view of the dam's assessment and recommendations set forth in Section 7, it is believed the field inspection and information furnished by the Camden County Park Commission provides adequate engineering data upon which to base a cogent assessment without recourse to additional research and analysis.

c. Validity

The validity of the record plans is not challenged and is accepted without recourse to further investigations.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General

The visual inspection was conducted on 1 May 1979 and revealed the dam to be in a stable condition with several inches of water discharging over the drop inlet. The history of the dam was reviewed with engineering personnel of the Park Commission who furnished the available plans.

b. Dam

The slopes of the dam embankment are overgrown with mature trees, especially on the right downstream slope. The embankment slopes have eroded and been modified considerably since the initial construction and are very irregular. The crest is quite level and covered with a two lane asphalt pavement which is in good condition. Its width varies between 45 and 60 feet and contains minor settlement cracks and eroded gullies where the street run-off is carried over the edge of the crest. There are several naturally formed ditches 1 to 1.5 feet deep on the downstream embankment and some seepage was observed on the downstream toe in the vicinity of the right abutment. Due to the regrading of the lakeside approaches and park development, the grassed slopes adjacent to the reservoir are quite flat.

c. Appurtenant Structures

Serious concrete spalling and deterioration of the insides of the culvert opening was observed on the spillway bridge. The reinforcing is exposed and completely corroded although it was noted that this has occurred mainly in the areas of temperature steel and does not seriously endanger the integral strength of the 7'-0" wide arch structure. The arch appears to be of a very conservative design but has numerous settlement and shrinkage cracking and the upstream wingwalls have shifted several inches towards the reservoir.

The wingwalls and parapets are faced with a random ashlar stone masonry and several areas are in need of repointing. Asphalt slope protection has been placed around the drop inlet. A 12" thick concrete floor slab protects the arch culvert invert but could not be observed due to the depth of water in the downstream channel. It appears that there is little likelihood that any of the concrete spread footings have been undermined.

d. Reservoir Area

The reservoir area has well defined stable banks but appears to be heavily silted. The Park Commission recently has prepared plans for the dredging of approximately 60,000 c.y. from the lake (under the 314 Clean Lakes Program) to alleviate a current uplands sewage infiltration problem in the area. At the upper reach of the lake, the natural terrain rises quite abruptly where the South Branch passes under King's Highway.

e. Downstream Channel

On the left side of the dam, a large amount of construction fill has been dumped but this does not obtrude into the main channel area. The downstream toe is situated approximately at normal high tide elevation which extends up to the dam from the Delaware River. Except for the previously mentioned culvert under Black Horse Pike (immediately downstream), there are no other obstructions downstream.

The tidal flats immediately below the dam are in excess of 150 feet wide and are composed of a decomposed organic mat underlain by highly organic sand, silt, clayey silt and clay. The depth to the Precambrian and Paleozoic "basement" bedrock throughout the area is greater than 100 feet. Unconsolidated, stratified alluvial deposits of sand, silty and clayey sand and sandy silt intermixed with gravel surround the dam to the north, east and south. These Pennsauken formations are underlain by the

Cohansey Sand formation with varying amounts of silt and sand. The thinness of the overlying formation (less than 10 feet) produces an imperfect to good drainage condition. The Woodbury Clay formation with its clay and varying amounts of silt and sand sits to the west of the dam. This formation of Tertiary, heavily textured soil has imperfect to good drainage.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

Operational procedures were not physically observed by the inspection team. From discussions with Mr. John E. Kern, Superintendent of the Camden County Park Commission, it was learned that except for the removal of debris blocking the spillway and sluiceways, there are no formal operational procedures presently in effect or required at this dam.

4.2 MAINTENANCE OF DAM

Maintenance is carried out as part of the Park Commission's continuous program whereby periodic inspections are conducted and repairs undertaken as allowed by funding limitations.

4.3 MAINTENANCE OF OPERATING FACILITIES

There are no operational facilities at this dam except for the flashboards which apparently have not been removed in several years.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

Park Commission personnel monitor the area during periods of heavy storms. They do not have a formalized plan for contacting civil defense or other authorities but rely on their own monitoring and in-house methods of alerting local authorities.

4.5 EVALUATION OF OPERATIONAL ADEQUACY

Since the drawdown facilities are hydraulically poor, in the event of an emergency the stability of the dam could be in jeopardy if it were overtopped. However, the present operational procedures are deemed to be adequate in view of the physical and hydraulic aspects of the location and the lack of serious downstream hazards.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data

The spillway is a 3-sided concrete weir with a set of timber flashboards set in the sides of the concrete crest. Two feet above the spillway crest, there is a maintenance slab which restricts the inflow for greater hydraulic heads. Based on the Recommended Guidelines for Safety Inspection of Dams, a spillway design flood (SDF) of 100-year frequency was selected by the inspection team. Inflow to the reservoir for the selected 100-year storm was computed utilizing precipitation data from Technical Publication 40 and NOAA Tech. Memo NWS - Hydro 35 by the HEC-1 program which gave a peak inflow of 2,637 cfs. Routing this storm through the reservoir reduced the peak discharge to 2,230 cfs. The spillway has a calculated capacity of 834 cfs and can thus accommodate only 37% of the design flood.

b. Experience Data

There are no stream flow records available for Haddon Lake Dam but there are no heresay records of the dam having ever been in hydraulic distress.

c. Visual Observations

As a result of visual inspections and in view of the small drainage area, there is little danger from overtopping except that it would occur immediately at the ends of the bridge wingwalls and would tend to concentrate flows there and quite possibly cause erosion along the downstream slopes.

d. Overtopping Potential

Employing the discharge and spillway capacities, overtopping would occur in the event of the 100-year frequency storm. Since the SDF greatly

exceeds the spillway capacity, the overtopping potential of the SDF was determined by calculating the overbank discharge. In this manner it was determined that the SDF would overtop the dam by slightly more than one foot on the average. As pointed out in the preceding paragraph, the overtopping flow would be concentrated at the low points on the dam crest and most probably erode the downstream face of the embankment near the end of the bridge wingwalls.

e. Drawdown

At the present time complete drawdown is not easily accommodated as there is no practical method of removing the stoplogs. However, in an emergency with the planking removed by force, the lake would take approximately one half day to drawdown from the normal pool.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION

a. Visual Observations

Due to the heavy siltation in the reservoir and numerous architectural landscaping revisions to the lakeside slope, the embankment portions of the dam are no longer of primary significance as retaining structures, and the spillway is acting principally as an uncontrolled weir. In its present condition and position, its structural stability is felt to be in an adequate condition. The eroded condition and irregular grading of the backslopes are felt to be of minor importance.

b. Design and Construction Data

The structural review concludes that there is little concern regarding the stability of the spillway. The original design appears to have been carried out on a conservative basis and the elements are in remarkably good condition considering their age except the concrete faces inside the culvert require surficial patching as does the stone masonry on the architectural parapets.

c. Operating Records

According to Park Commission engineering personnel, there have been no structural problems in maintaining this dam in operational fitness.

d. Post Construction Changes

There have been no major post construction modifications although it appears the bridge superstructure parapets have been modified at some time in the past.

e. Seismic Stability

Experience indicates that dams in Seismic Zone 1 will have adequate stability under dynamic loading conditions if stable under static loading conditions (as this dam is).

SECTION 7 - ASSESSMENTS/RECOMMENDATIONS
PROPOSED REMEDIAL MEASURES

7.1 ASSESSMENT

a. Safety

Subject to the inherent limitations of the Phase I visual inspection, Haddon Lake Dam is evaluated as being in a fair overall condition, although the spillway is incapable of transmitting the 100-year frequency design flood. In accordance with the Recommended Guidelines for Safety Inspection of Dams criteria, only 37% can be transmitted before overtopping occurs. However, it is felt the structure can sustain considerable flooding conditions without detrimental consequences. As there are minimal downstream hazards to life or property, a collapse would cause little damage except to the dam itself. However, until such time as the presently planned lake dredging is completed, the resultant mudwave from a partial breaching could block up the culvert at Black Horse Pike (which is already partially blocked) and result in a flooding of this important highway. In view of the above, the hazard category is recommended to be downgraded from a high to a significant classification. No detrimental findings were revealed in this inspection to render a questionable judgement as to the structural adequacy.

b. Adequacy of Information

The information gathered for the Phase I inspection is deemed to be adequate regarding the structural stability of the dam. However, no recent surveys have been made.

c. Urgency

No urgency is attached to implementing the remedial measures enumerated below and it is recommended that they be taken under advisement in the future.

d. Necessity for Further Study

Due to the recommended classification of the dam and its present condition, further engineering studies are deemed to be unnecessary.

7.2 RECOMMENDATIONS/REMEDIAL MEASURES

The attached calculations indicate that the spillway can accommodate only 37% of the design flood but widening of the present spillway does not appear to be feasible. Any overtopping will initially be concentrated at the low point in the embankment immediately to the right of the bridge.

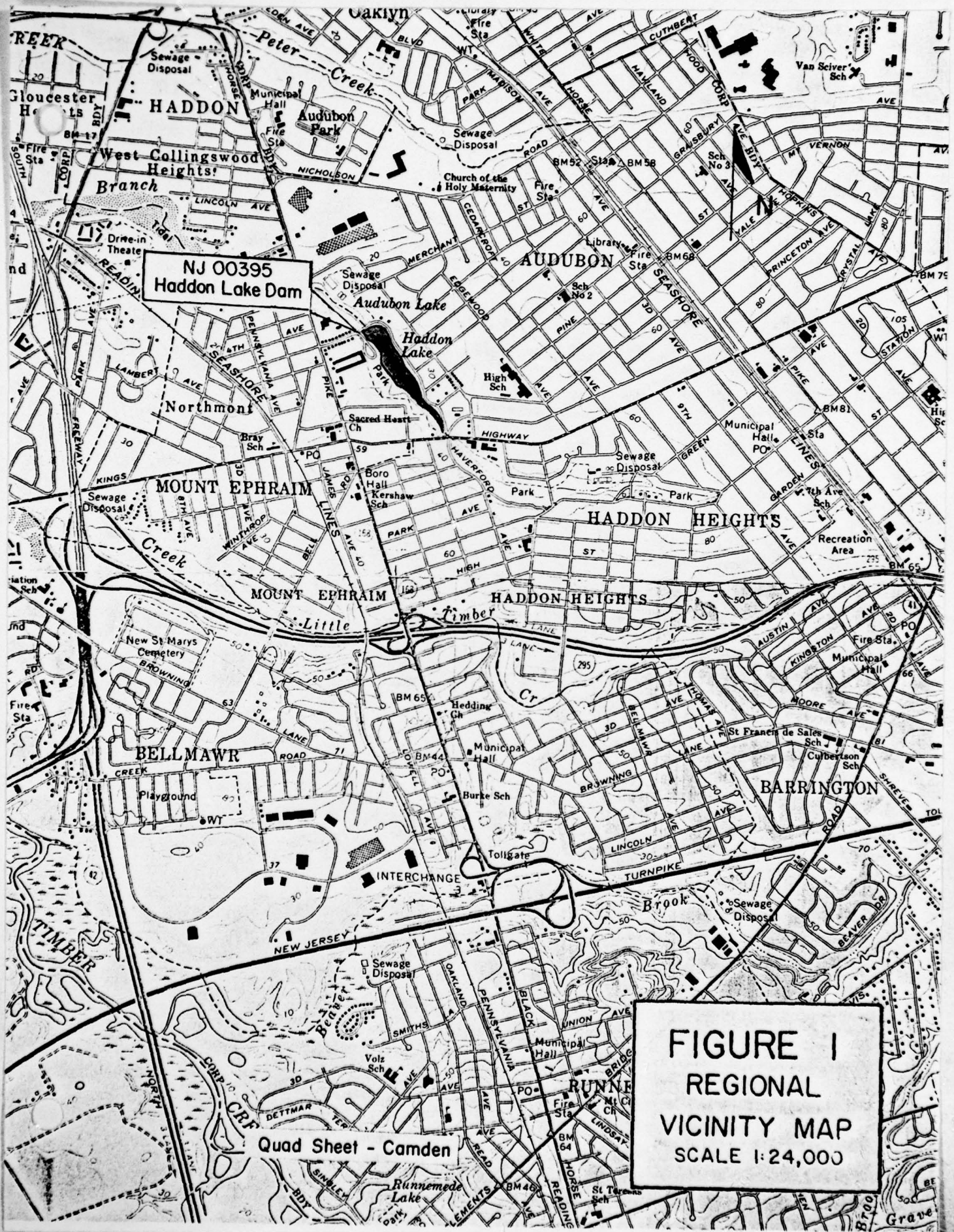
a. Recommended Actions

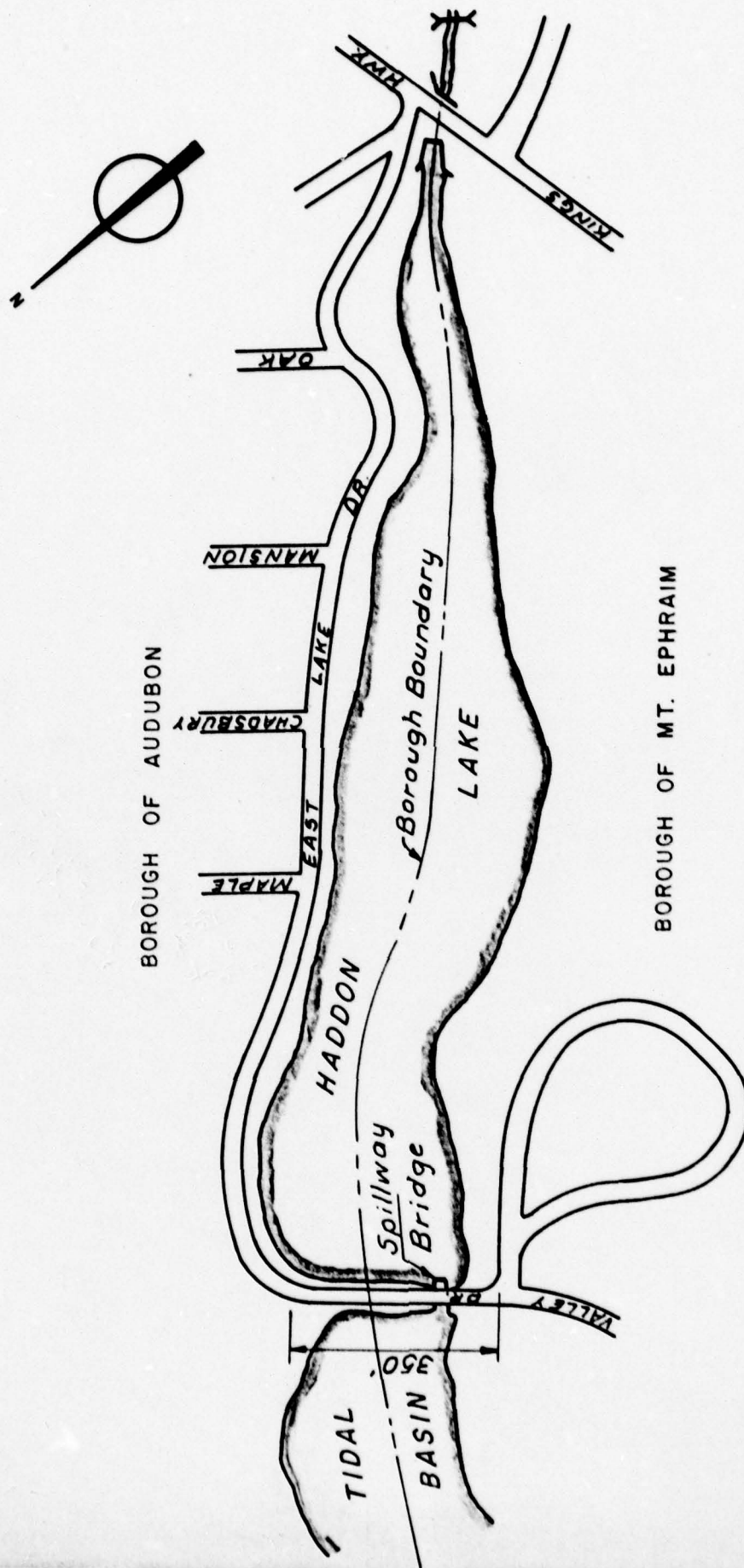
In the opinion of the inspection team, improvements to the present spillway are not warranted. The downstream face of the embankment on each side of the spillway should be further protected with slope paving. Other remedial measures to be implemented in the future include:

- 1) removing the trees and dead root systems on the embankments to lessen the piping potential;
- 2) placing additional riprap at the downstream end of the culvert invert,
- 3) refilling the gullies on the backslopes and seed the new areas;
- 4) sandblasting and guniting the deteriorated concrete surfaces on the spillway; and
- 5) repointing the masonry joints on the bridge parapets and curbs.

b. O&M Maintenance and Procedures

No additional procedures other than those presently in effect appear to be warranted in view of the above assessment. The County Park Commission should develop a check list for periodic maintenance inspections and maintain records of all findings and repairs undertaken.





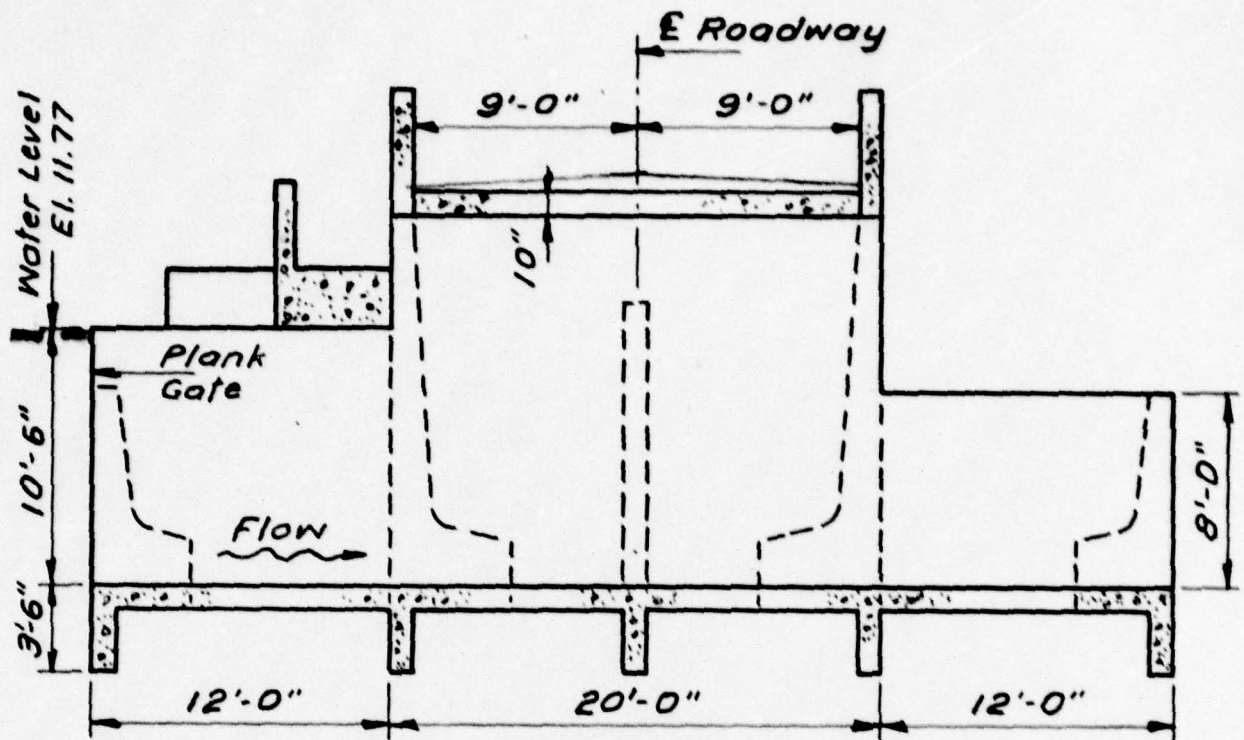
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PLAN

FIGURE 2

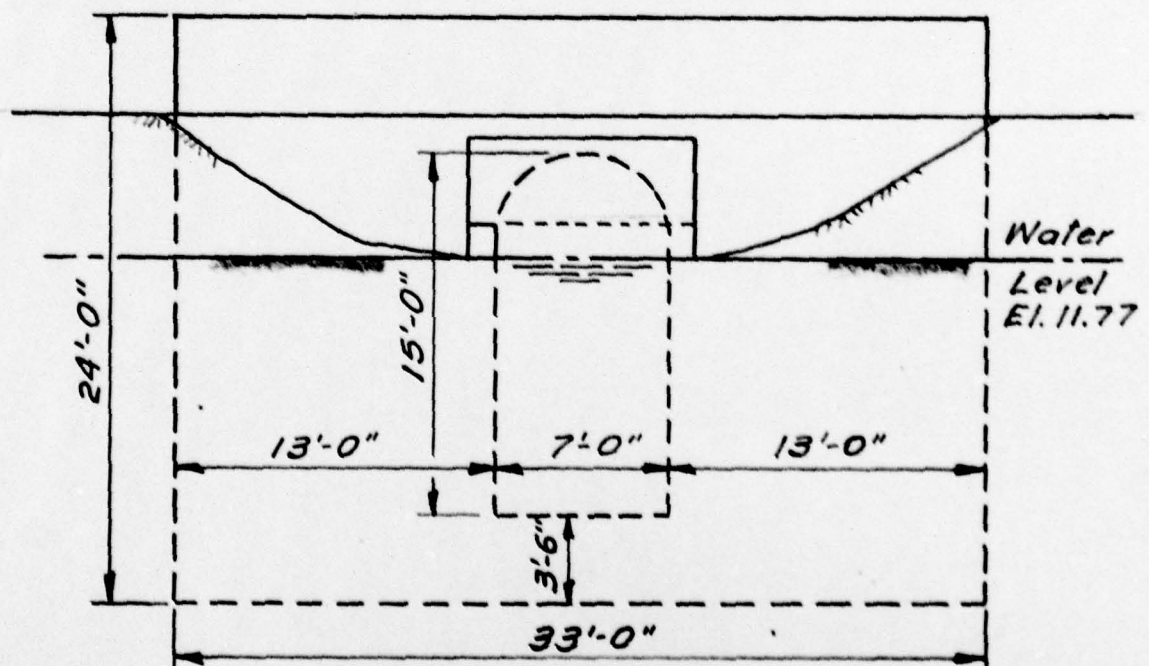
Plan view of a bridge structure. The diagram shows a cross-section of the bridge with various dimensions and labels. At the top, a "Plank Gate" is indicated with an arrow pointing right towards "A". The bridge deck is divided into sections with dimensions: 12'-0" on the left, 9'-0" in the middle, and 12'-0" on the right. The middle section is further divided into 9'-0" and 1'-0" segments. The total width of the bridge deck is 33'-0". The bridge is supported by two main piers, each 12'-0" wide. The distance between the piers is 7'-0". The bridge is labeled "E Rdwy" on the left side. The word "PLAN" is written at the bottom.

FIGURE 3



SECTION A-A

Not to Scale



INLET ELEVATION

FIGURE 4

Check List
Visual Inspection
Phase 1

Name Dam Haddon Lake County Camden State New Jersey Coordinators NJDEP

Date(s) Inspection 1 May 1979 Weather Clear Temperature 60°

Pool Elevation at Time of Inspection 11.77 M.S.L. Tailwater at Time of Inspection 2.77 M.S.L.

Inspection Personnel:

<u>L. Baines</u>	<u>K. Jolls</u>
<u>E. Simone</u>	<u></u>
<u>K. Greenfield</u>	<u></u>

K. Jolls Recorder

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SEE PAGE ON LEAKAGE		
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	Satisfactory. Roadway pavement extends across bridge.	Ill-defined abutment areas (very flat slope).
DRAINS	None	
WATER PASSAGES	None	
FOUNDATION	Unknown except at culvert structure. Old roadway embankment.	

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	Numerous cracks. Some rebars exposed (especially on culvert sidewalls).	
STRUCTURAL CRACKING	Numerous areas in wingwalls. Heavy spalls (6" +) on culvert walls and arch.	Face of concrete in arch should be replaced.
VERTICAL AND HORIZONTAL ALIGNMENT	Satisfactory. Top of roadway level at bridge.	
MONOLITH JOINTS	None	
CONSTRUCTION JOINTS	None (faced with random ashlar stone masonry).	Bridge parapet needs repair in several areas (architectural).

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None observed. Roadway asphalt - good condition.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None observed.	
SLOUCHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Only minor. 1'± above normal water level.	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Flat.	
RIPEAP FAILURES	None observed.	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
EXCESSIVE SHRUB GROWTH, TREES, ETC.	Numerous trees on backslope.	
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Satisfactory. Very flat, ill-defined slopes.	
ANY NOTICEABLE SEEPAGE	None observed. High tide at time of inspection (toe of downstream slope submerged).	
STAFF GAGE AND RECORDER	None	
DRAINS	None	

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	↓	
INTAKE STRUCTURE	Minor cracking.	
OUTLET STRUCTURE	None.	
OUTLET CHANNEL	Discharges directly into tidal flats approximately 150' wide.	
EMERGENCY GATE	None	

UNCATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	Concrete drop inlet. Asphalt slope paving on right side.	Concrete on sidewalls deteriorated but integral. Should be patched with epoxy or gunite.
APPROACH CHANNEL	None (main lake body).	
DISCHARGE CHANNEL	Clear box culvert under roadway.	
BRIDGE AND PIERS	Stone masonry wingwalls and wall on slab over drop inlet.	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Flat and clear up to tree line. Several small storm drains feed into lake.	Sewage effluent from upstream plant. Flow into lake.
SEDIMENTATION	6'-7' sedimentation Sewage effluent (untreated)	Small amount of gravel and sand in front of drop inlet.

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Tidal marsh.	Clear of debris. Well maintained.
SLOPES	Heavily wooded banks. Flat slopes - well grassed. Edge of lake - well defined.	Appears to have constant water level.
APPROXIMATE NO. OF HOMES AND POPULATION	None	Sewage treatment plant. Outfall low and could be covered or buried by release of silt if dam collapsed.
		Downstream culvert at Rt. 168 is old, completely submerged and silted up to top slab (hydraulically blocked).

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM	REMARKS
PLAN OF DAM	Not available
REGIONAL VICINITY MAP	Available (U.S.G.S.)
CONSTRUCTION HISTORY	Not available
TYPICAL SECTIONS OF DAM	Not available
HYDROLOGIC/HYDRAULIC DATA	Not available
OUTLETS - PLAN	Available (NJDEP)
- DETAILS	Available (NJDEP)
-CONSTRAINTS	Not available
-DISCHARGE RATINGS	Not available
RAINFALL/RESERVOIR RECORDS	Not available

ITEM	REMARKS
SPILLWAY PLAN	Available (NJDEP)
SECTIONS	Available (NJDEP)
DETAILS	Not available
OPERATING EQUIPMENT PLANS & DETAILS	Not available

ITEM

REMARKS

DESIGN REPORTS

None available.

GEOLOGY REPORTS

None available.

DESIGN COMPUTATIONS
HYDROLOGY & HYDRAULICS
DAM STABILITY
SEEPAGE STUDIES

None available.
None available.
None available.
None available.

MATERIALS INVESTIGATIONS
BORING RECORDS
LABORATORY
FIELD

None available.
None available.
None available.
None available.

POST-CONSTRUCTION SURVEYS OF DAM

None available.

BORROW SOURCES.

Unknown.

ITEM	REMARKS
MONITORING SYSTEMS	None
MODIFICATIONS	Some known
HIGH POOL RECORDS	None available
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None available
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	Not Available
MAINTENANCE OPERATION RECORDS	None available



Haddon Lake Dam

May, 1979



View of Crest Looking Southwest

May, 1979



View of Intake Structure

May, 1979



View of Outlet Structure

May, 1979

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 1.43 square miles

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): +11.77 (87 acres-ft)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): 17.77 (175 acre-ft)

ELEVATION MAXIMUM DESIGN POOL: Unknown

ELEVATION TOP DAM: 17.77 M.S.L.

CREST: Main Spillway

- a. Elevation 11.77 M.S.L.
- b. Type 3 sided concrete drop box
- c. Width 2"
- d. Length 21'
- e. Location Spillover Upstream face of arch bridge
- f. Number and Type of Gates None

OUTLET WORKS: None

- a. Type _____
- b. Location _____
- c. Entrance inverts _____
- d. Exit inverts _____
- e. Emergency draindown facilities _____

HYDROMETEOROLOGICAL GAGES: None

- a. Type _____
- b. Location _____
- c. Records _____

MAXIMUM NON-DAMAGING DISCHARGE: 834 cfs

BY D. J. M. DATE 6-79

LOUIS BERGER & ASSOCIATES INC.

SHEET NO. A1 OF

CHKD. BY _____ DATE _____

HADDON LAKE DAM

PROJECT C 234

SUBJECT _____

Time of concentration :

length along longest water course to drainage divide = 1.4 miles

= 7392 ft.

$$\Delta H = 68'$$

$$\text{Slope} = \frac{68}{7392} \approx 1\%$$

Use velocity of 2 ft. s⁻¹

$$t_c = \frac{7392}{2 \times 3600} = 1.03 \text{ hours}$$

By California Culverts Method:

$$t_c = \left(\frac{11.9 \times 1.4^3}{68} \right)^{0.385} = 0.75 \text{ hours}$$

Overland flow :

$$\text{Slope} \approx \frac{78}{7392} \approx 1.1\%$$

Assume same velocity (2 ft. s⁻¹)

$$t_c \approx 1 \text{ hour}$$

Use $t_c = 1 \text{ hour}$

BY D. J. M. DATE 6-79

LOUIS BERGER & ASSOCIATES INC.

SHEET NO. A2 OF

CHKD. BY _____ DATE _____

HARDON LAKE DAM INSPECTIONPROJECT C.234

SUBJECT _____

$$T_p = \frac{0.25}{2} + 0.6 \times 1 = 0.73 \text{ hours}$$

$$Q_p = \frac{484 \times 1.43}{0.73} = 954.7 \text{ cfs}$$

Unitgraph :

<u>Time</u> <u>hours</u>	<u>T/T_p</u>	<u>Dimensionless</u> <u>Ordinate (D₀)</u>	<u>Q (cfs)</u> <u>= Q_p × D₀</u>
0.25	0.34	0.200	191
0.50	0.68	0.736	703
0.75	1.03	0.998	953
1.00	1.37	0.777	742
1.25	1.71	0.470	449
1.50	2.05	0.298	284
1.75	2.40	0.180	172
2.00	2.74	0.107	102
2.25	3.08	0.067	64
2.50	3.42	0.040	38
2.75	3.77	0.025	24
-	-	-	-

BY D. J. M. DATE 6-79

LOUIS BERGER & ASSOCIATES INC.

SHEET NO. A3 OF

CHKD. BY _____ DATE _____

SOUTH GROUP DAMSPROJECT C 234

SUBJECT _____

Precipitation data from TP 40 & NOAA Technical Memorandum
NWS HYDRO - 35 (See depth duration curve over leaf)

Time	Precipitation	Δ	Rearrange Δ
0.25	1.7	1.7	0.06
0.50	2.4	0.7	0.06
0.75	2.8	0.4	0.06
1.00	3.1	0.3	0.07
1.25	3.4	0.3	0.08
1.50	3.7	0.3	0.09
1.75	3.86	0.16	0.11
2.00	4.00	0.14	0.14
2.25	4.11	0.11	0.30
2.50	4.22	0.11	0.30
2.75	4.31	0.09	0.70
3.00	4.40	0.09	1.70
3.25	4.49	0.09	0.40
3.50	4.57	0.08	0.30
3.75	4.64	0.07	0.16
4.00	4.71	0.07	0.11
4.25	4.78	0.07	0.09
4.50	4.84	0.06	0.09
4.75	4.90	0.06	0.07
5.00	4.96	0.06	0.07
5.25	5.02	0.06	0.06
5.50	5.08	0.06	0.06
5.75	5.14	0.06	0.06
6.00	5.20	0.06	0.06

BY D.J.M. DATE 1-79

SUBJECT

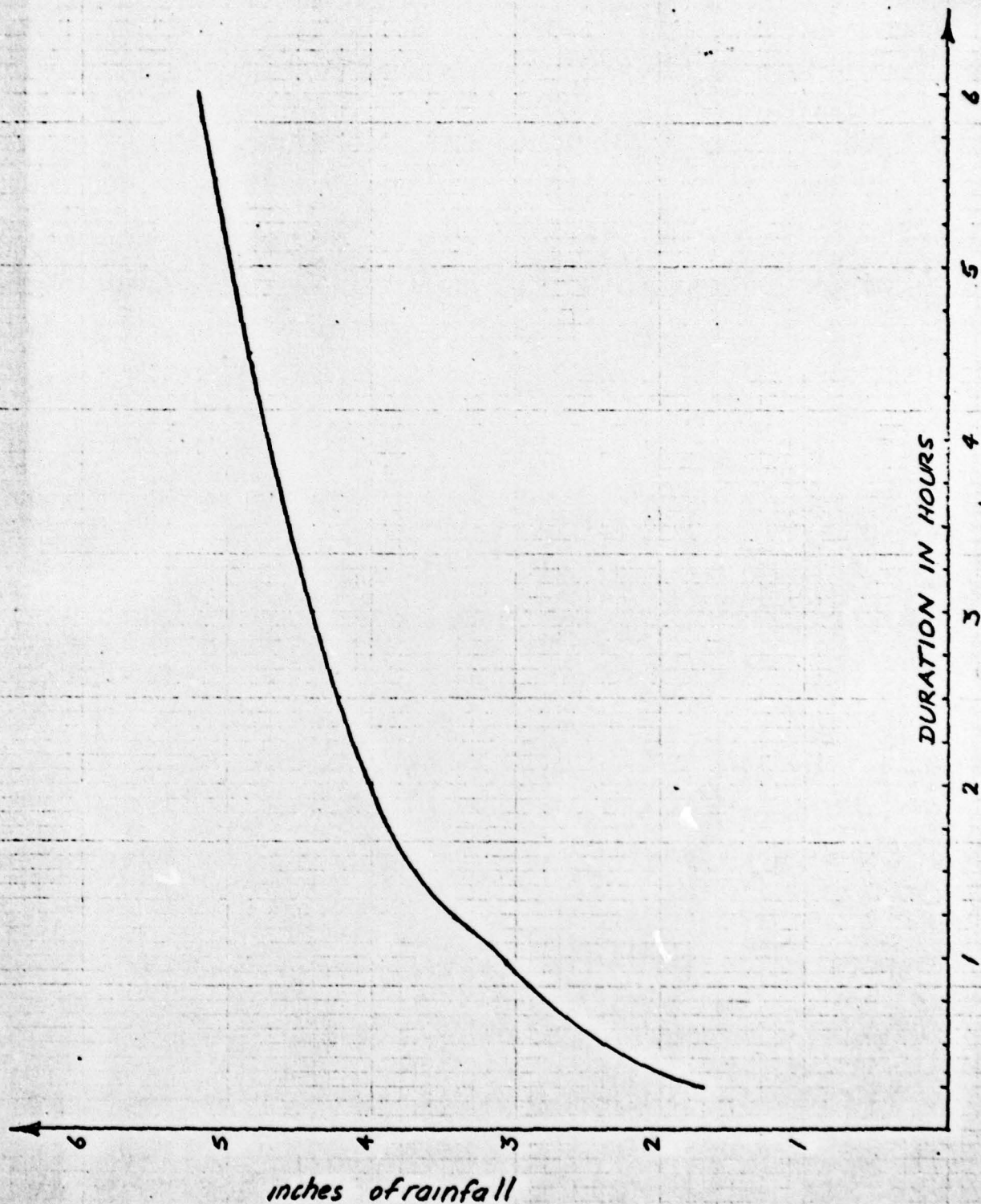
SHEET NO. A4 OF

CHKD. BY DATE

DEPTH DURATION CURVE

JOB NO. C227

T.P. 40 & NOAA Tech. Memo NWS - HYRO 35



BY D. J. M. DATE 6-79

LOUIS BERGER & ASSOCIATES INC.

SHEET NO. A5 OF

CHKD. BY _____ DATE _____

HADDON LAKE DAMPROJECT C 234SUBJECT Spillway discharge capacitySpillway discharge:flow over spillway
crest (front) $L = 7'$

El. 11.77

H	C	Q
1	3.3	23
2	3.3	65
3	3.3	120
4	3.3	185
5	3.3	258
6	3.3	339
7	3.3	428
8	3.3	523
9	3.3	624
10	3.3	730

Over crest right

 $L = 7'$

El. 12.27

H	C	Q
0.5	2.9	7
1.5	2.9	37
2.5	2.9	80
3.5	2.9	133
4.5	2.9	194
5.5	2.9	262
6.5	2.9	336
7.5	2.9	417
8.5	2.9	503
9.5	2.9	594

Over part of

crest left $L = 3'$

El. 11.77

H	C	Q
1	3.1	19
2	3.1	26
3	3.1	48
4	3.1	74
5	3.1	104
6	3.1	137
7	3.1	172
8	3.1	210
9	3.1	251
10	3.1	294

Over crest left
part $L = 4'$

El. 13.77

H	C	Q
1	3.0	12
2	3.0	34
3	3.0	62
4	3.0	96
5	3.0	134
6	3.0	176
7	3.0	222
8	3.0	272

Over dam

 $L = 350'$

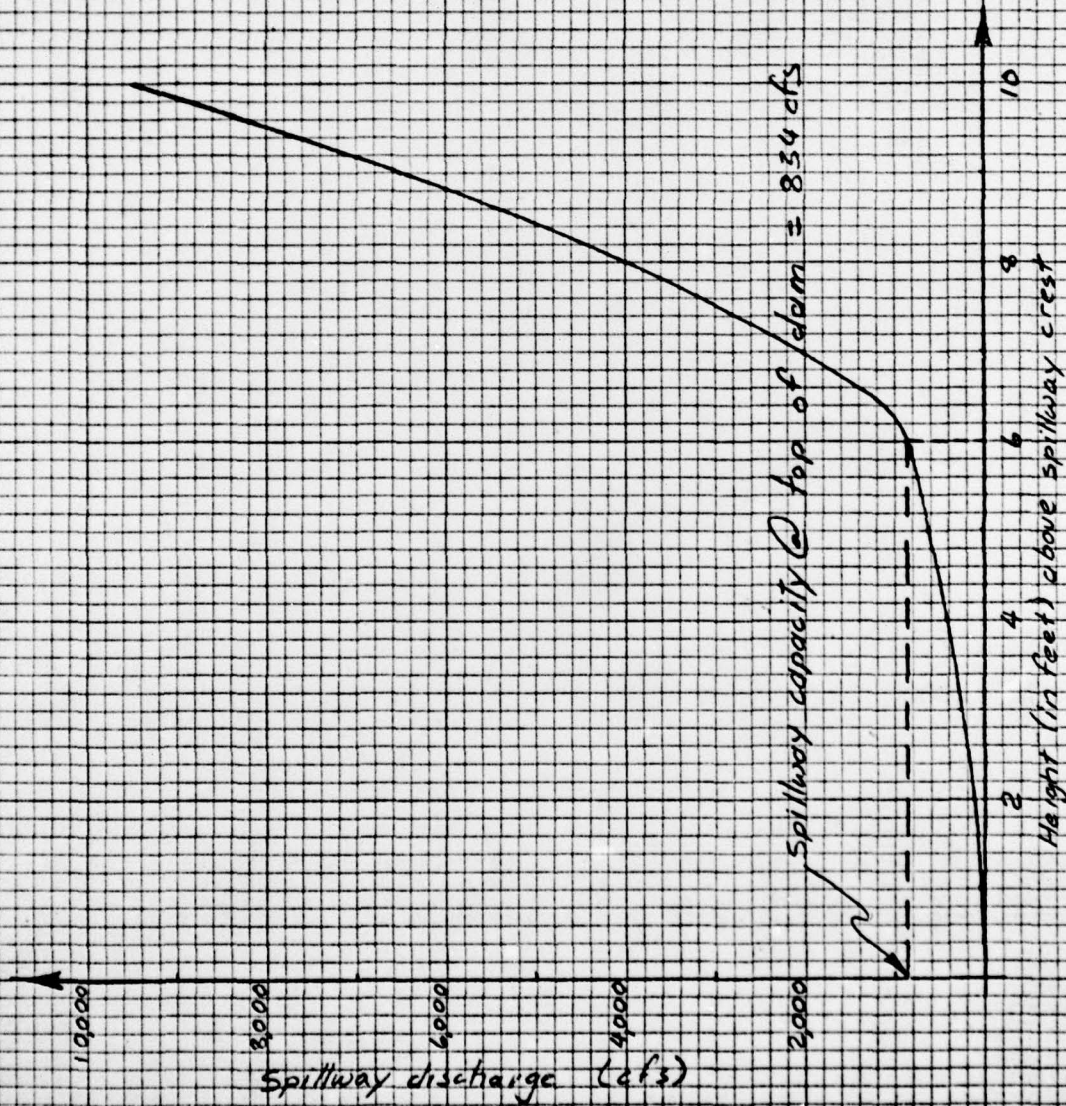
El. 17.77

H	C	Q
1	2.7	945
2	2.7	2673
3	2.7	4910
4	2.7	7560

 ΣQ

(cfs)

H	Q
1	39
2	128
3	260
4	426
5	618
6	834
7	2015
8	3999
9	6510
10	9450

HADDON LAKE DAMSTAGE DISCHARGE CURVE

BY D. J. M. DATE 6-79

CHKD. BY _____ DATE _____

SUBJECT _____

LOUIS BERGER & ASSOCIATES INC.

HADDON LAKE DAM

SHEET NO. A7 OF

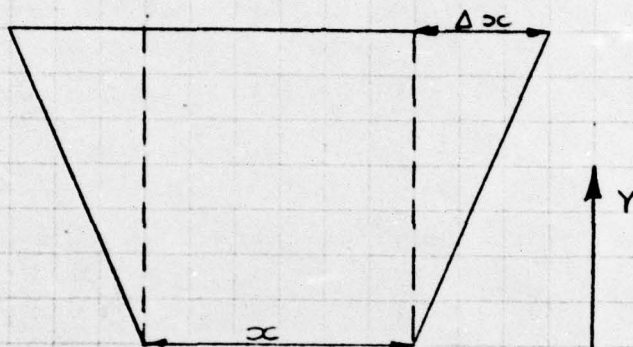
PROJECT C 234

Surcharge storage:

Area of lake @ normal pool (El. 11.77) = 10.2 acres

Area of lake @ next contour (El. 20.00) = 22.3 acres

Area @ top of dam = 19 acres



Increment in volume $\Delta V = (x + \Delta x) Y$

Height above
spillway crest
(feet)

Surcharge storage
(acre feet)

1	11
2	23
3	37
4	53
5	69
6	88
7	107
8	129
9	151
10	176

HADDON LAKE DAM
STAGE-STORAGE CURVE



BY DJM DATE JUN '77

LOUIS BERGER & ASSOCIATES INC.

SHEET NO. A9 OF

CHKD. BY _____ DATE _____

HADDON LAKE DAMPROJECT C-234

SUBJECT _____

HADDON LAKE DAM
BY D.J.M.
JUNE 21 1979

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
100	0	15	0	0	0	0	0	0	0
JOPER					NWT				
3					0				

SUB-AREA RUNOFF COMPUTATION

INFLOW TO RESERVOIR

ISTAQ	ICOMP	ICON	ITAPE	JPLT	JPRT	INAME
1	0	0	0	0	0	1

HYDROGRAPH DATA

THYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
0	-1	1.43	0.0	1.43	0.0	0.0	0	0	0

PRECIP DATA

NP	STORM	DAJ	EAK
24	0.0	0.0	0.0

PRECIP PATTERN

0.06	0.06	0.06	0.07	0.08	0.09	0.11	0.14	0.30	0.30
0.70	1.70	0.40	0.30	0.16	0.11	0.09	0.09	0.07	0.07
0.06	0.06	0.06	0.06						

LOSS DATA

STKR	DLTKR	RYIOL	ERAIN	STRS	RTIOL	STRTL	CNSTL	ALSNX	RTIMP
0.0	0.0	1.00	0.0	0.0	1.00	0.50	0.10	0.0	0.0

GIVEN UNIT GRAPH, NUHGE= 11

191.	703.	953.	742.	449.	284.	172.	102.	64.	38.
24.									

UNIT GRAPH TOTALS 3722. CFS OR 1.01 INCHES OVER THE AREA

RECESSION DATA

STRTD=	0.0	GRCSN=	0.0	RTIOL=	1.00
--------	-----	--------	-----	--------	------

END-OF-PERIOD FLOW

TIME	RAIN	EXCS	COFF Q
1	0.06	0.00	0.
2	0.06	0.00	0.
3	0.06	0.00	0.
4	0.07	0.00	0.
5	0.08	0.00	0.
6	0.09	0.00	0.
7	0.11	0.02	4.
8	0.14	0.11	38.
9	0.30	0.27	155.

BY DTM DATE _____
 CHKD. BY _____ DATE _____
 SUBJECT _____

LOUIS BERGER & ASSOCIATES INC.

HADDON LAKE DAM

SHEET NO. A10 OF _____
 PROJECT C-234

SQUARE 4 X 4 TO THE INCH 450

10	0.30	0.27	373.
11	0.70	0.67	680.
12	1.70	1.67	1319.
13	0.40	0.37	2257.
14	0.30	0.27	2637.
15	0.16	0.13	2261.
16	0.11	0.08	1679.
17	0.09	0.06	1216.
18	0.09	0.06	857.
19	0.07	0.05	614.
20	0.07	0.05	452.
21	0.06	0.04	338.
22	0.06	0.04	256.
23	0.06	0.04	185.
24	0.06	0.04	159.
25	0.0	0.0	137.
26	0.0	0.0	106.
27	0.0	0.0	69.
28	0.0	0.0	41.
29	0.0	0.0	25.
30	0.0	0.0	14.
31	0.0	0.0	8.
32	0.0	0.0	4.
33	0.0	0.0	2.
34	0.0	0.0	1.
35	0.0	0.0	0.
36	0.0	0.0	0.
37	0.0	0.0	0.
38	0.0	0.0	0.
39	0.0	0.0	0.

40	0.0	0.0	0.
41	0.0	0.0	0.
42	0.0	0.0	0.
43	0.0	0.0	0.
44	0.0	0.0	0.
45	0.0	0.0	0.
46	0.0	0.0	0.
47	0.0	0.0	0.
48	0.0	0.0	0.
49	0.0	0.0	0.
50	0.0	0.0	0.
51	0.0	0.0	0.
52	0.0	0.0	0.
53	0.0	0.0	0.
54	0.0	0.0	0.
55	0.0	0.0	0.
56	0.0	0.0	0.
57	0.0	0.0	0.
58	0.0	0.0	0.
59	0.0	0.0	0.
60	0.0	0.0	0.
61	0.0	0.0	0.
62	0.0	0.0	0.
63	0.0	0.0	0.
64	0.0	0.0	0.
65	0.0	0.0	0.
66	0.0	0.0	0.
67	0.0	0.0	0.
68	0.0	0.0	0.
69	0.0	0.0	0.
70	0.0	0.0	0.
71	0.0	0.0	0.
72	0.0	0.0	0.
73	0.0	0.0	0.
74	0.0	0.0	0.
75	0.0	0.0	0.
76	0.0	0.0	0.
77	0.0	0.0	0.
78	0.0	0.0	0.
79	0.0	0.0	0.
80	0.0	0.0	0.
81	0.0	0.0	0.
82	0.0	0.0	0.
83	0.0	0.0	0.
84	0.0	0.0	0.
85	0.0	0.0	0.
86	0.0	0.0	0.
87	0.0	0.0	0.
88	0.0	0.0	0.
89	0.0	0.0	0.
90	0.0	0.0	0.
91	0.0	0.0	0.
92	0.0	0.0	0.
93	0.0	0.0	0.
94	0.0	0.0	0.
95	0.0	0.0	0.
96	0.0	0.0	0.
97	0.0	0.0	0.
98	0.0	0.0	0.
99	0.0	0.0	0.
100	0.0	0.0	0.

SUM 5.20 4.24 15887.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2637.	661.	165.	159.	15886.
INCHES		4.30	4.31	4.31	4.31
AC-FT		328.	328.	328.	328.

BY D.I.M. DATE JUN '79
CHKD. BY _____ DATE _____
SUBJECT _____

LOUIS BERGER & ASSOCIATES INC.
HADDON LAKE DAM

SHEET NO. A11 OF _____
PROJECT C-274

450 4 1 4 10 IN INCH

HYDROGRAPH ROUTING

ROUTING THROUGH RESERVOIR

ISTAG ICOMP IECUN IYAPE JPLT JPRY INAME
11 1 0 0 0 0 1

ROUTING DATA
QUNTS CLOSS AVG IRES JSAME
0.0 0.0 0.0 1 0

NSIPS NSTDL LAG AMSKK X TSK STORA
1 0 0 0.0 0.0 0.0 0.

STORAGE= 0. 23. 37. 53. 49. 88. 107. 129. 151. 176.
OUTFLOW= 0. 129. 260. 426. 618. 834. 2015. 3999. 6510. 9450.

TIME EOP STOR AVG IN EOP OUT

1	1	0.	0.	0.	0.	0.	0.	0.	0.
2	2	0.	0.	0.	0.	0.	0.	0.	0.
3	3	0.	0.	0.	0.	0.	0.	0.	0.
4	4	0.	0.	0.	0.	0.	0.	0.	0.
5	5	0.	0.	0.	0.	0.	0.	0.	0.
6	6	0.	0.	0.	0.	0.	0.	0.	0.
7	7	0.	0.	2.	21.	3.	0.	0.	0.
8	8	0.	0.	2.	97.	13.	0.	0.	0.
9	9	2.	2.	2.	264.	40.	0.	0.	0.
10	10	7.	17.	526.	93.	0.	0.	0.	0.
11	11	17.	34.	999.	232.	0.	0.	0.	0.
12	12	34.	63.	1788.	545.	0.	0.	0.	0.
13	13	63.	95.	2447.	1259.	0.	0.	0.	0.
14	14	95.	109.	2449.	2230.	0.	0.	0.	0.
15	15	109.	107.	1970.	1986.	0.	0.	0.	0.
16	16	107.	100.	1447.	1565.	0.	0.	0.	0.
17	17	100.	93.	1036.	1151.	0.	0.	0.	0.
18	18	93.	88.	735.	832.	0.	0.	0.	0.
19	19	88.	82.	533.	769.	0.	0.	0.	0.
20	20	82.	75.	395.	690.	0.	0.	0.	0.
21	21	75.	68.	297.	607.	0.	0.	0.	0.
22	22	68.	61.	220.	522.	0.	0.	0.	0.
23	23	61.	55.	172.	445.	0.	0.	0.	0.
24	24	55.	49.	148.	385.	0.	0.	0.	0.
25	25	49.	44.	122.	334.	0.	0.	0.	0.
26	26	44.	40.	88.	286.	0.	0.	0.	0.
27	27	40.	35.	55.	243.	0.	0.	0.	0.
28	28	35.	31.	33.	206.	0.	0.	0.	0.
29	29	31.	28.	19.	173.	0.	0.	0.	0.
30	30	28.	25.	11.	144.	0.	0.	0.	0.
31	31	25.	22.	6.	123.	0.	0.	0.	0.
32	32	22.	20.	3.	110.	0.	0.	0.	0.
33	33	20.	18.	2.	98.	0.	0.	0.	0.
34	34	18.	16.	0.	87.	0.	0.	0.	0.
35	35	16.	14.	0.	78.	0.	0.	0.	0.
36	36	14.	0.	0.	0.	0.	0.	0.	0.

BY DJM DATE JUN 79

CHKD. BY _____ DATE _____

SUBJECT _____

LOUIS BERGER & ASSOCIATES INC.

HADDON LAKE DAM

SHEET NO. A12 OF

PROJECT C-234

SCALE 4 1 4 TO THE INCH

450

37	12.	0.	69.
38	11.	0.	62.
39	10.	0.	55.
40	9.	0.	49.
41	8.	0.	44.
42	7.	0.	39.
43	6.	0.	35.
44	6.	0.	31.
45	5.	0.	28.
46	4.	0.	25.
47	4.	0.	22.
48	4.	0.	20.
49	3.	0.	17.
50	3.	0.	16.
51	2.	0.	14.
52	2.	0.	12.
53	2.	0.	11.
54	2.	0.	10.
55	2.	0.	9.
56	1.	0.	8.
57	1.	0.	7.
58	1.	0.	6.
59	1.	0.	6.
60	1.	0.	5.
61	1.	0.	4.
62	1.	0.	4.
63	1.	0.	3.
64	1.	0.	3.
65	0.	0.	3.
66	0.	0.	2.
67	0.	0.	2.
68	0.	0.	2.
69	0.	0.	2.
70	0.	0.	2.
71	0.	0.	1.
72	0.	0.	1.
73	0.	0.	1.
74	0.	0.	1.
75	0.	0.	1.
76	0.	0.	1.
77	0.	0.	1.
78	0.	0.	1.
79	0.	0.	1.
80	0.	0.	0.
81	0.	0.	0.
82	0.	0.	0.

BY DJM DATE JUN '79

CHKD. BY _____ DATE _____

SUBJECT _____

LOUIS BERGER & ASSOCIATES INC.

HADDON LAKE DAM

SHEET NO. A13 OF

PROJECT C-234

SQUARE 4 x 4 TO THE INCH

450

83	0.	0.	0.	
84	0.	0.	0.	
85	0.	0.	0.	
86	0.	0.	0.	
87	0.	0.	0.	
88	0.	0.	0.	
89	0.	0.	0.	
90	0.	0.	0.	
91	0.	0.	0.	
92	0.	0.	0.	
93	0.	0.	0.	
94	0.	0.	0.	
95	0.	0.	0.	
96	0.	0.	0.	
97	0.	0.	0.	
98	0.	0.	0.	
99	0.	0.	0.	
100	0.	0.	0.	
SUM		15886.		
PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
2230.	626.	165.	159.	15886.
CFS	4.07	4.31	4.31	4.31
INCHES	311.	328.	328.	328.
AC-FY				

RUNOFF SUMMARY, AVERAGE FLOW						
		PEAK	6-HOUR	24-HOUR	72-HOUR	AREA
HYDROGRAPH AT	1	2637.	661.	165.	159.	1.43
ROUTED TO	11	2230.	626.	165.	159.	1.43