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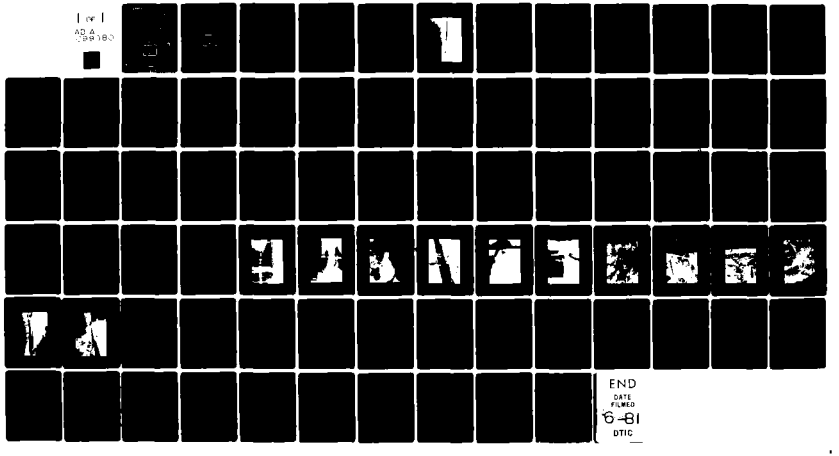

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DELAWARE RIVER BASIN

TRIBUTARY TO JACOBY CREEK, NORTHAMPTON COUNTY

PENNSYLVANIA

NDI NO. PA.00957

DER NO.48-3

ECHO LAKE DAM

OWNER: ECHO LAKE DEVELOPMENT COMPANY INC.

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

Echo Lake Dam (NDI Number PA-00957, DER Number 48-3) Delaware River Basin, Tributary to Jacoby Creek, Northampton County, Pennsylvania.

prepared by

Woodward-Clyde Consultants

DACW31-81-C-0025

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Marc F. Beck

John H. Frederick, Jr.

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DEPARTMENT OF THE ARMY

Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

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DELAWARE RIVER BASIN

TRIBUTARY TO JACOBY CREEK

ECHO LAKE DAM
NORTHAMPTON COUNTY, PENNSYLVANIA

NDI NO. 00957
DER NO. 48-3

PHASE I INSPECTION PROGRAM
NATIONAL DAM INSPECTION PROGRAM

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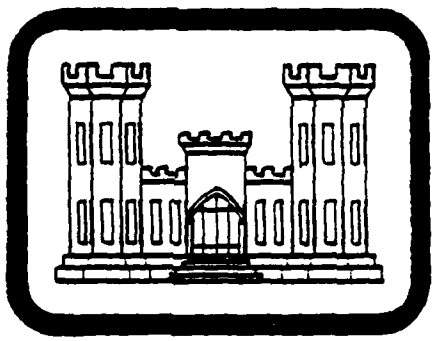

Prepared by:

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Submitted to:

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

March 1981

DISTRIBUTION STATEMENT A
Approved for public release;

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 the Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to expeditiously identify 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 investigations, testing and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify the need for more detailed studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

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

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the size and hazard classifications. The selected spillway design flood can range from the 100 Year Flood to the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff). The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

Name of Dam:	Echo Lake Dam
County Located:	Northampton County
State Located:	Pennsylvania
Stream:	Tributary to Jacoby Creek
Coordinates:	Latitude 40° 54.2' Longitude 75° 8.7'
Date of Inspection:	November 20, 1980

Echo Lake Dam and Peservoir are used for recreational purposes. The dam and spillway structure of Echo Lake are currently in fair condition and the outlet structure is in poor condition.

In accordance with criteria established by Federal (OCE) Guidelines, the recommended spillway design flood for this "Small" size dam and "Significant" hazard potential classification is the 100 Year Flood to one-half the Probable Maximum Flood. Based on the small capacity of the reservoir and the fact that no loss of life is likely during failure of the structure, the 100 Year Event has been selected as the spillway design flood.

Hydrologic and hydraulic computations presented in Appendix D indicate the spillway structure is not capable of discharging the 100 Year Event while confining dam outflow to the designed spillway. With the spillway notch closed (normal pool level), the right abutment area overtops by about 0.3 feet for an estimated five hours. Thus the spillway is considered "Inadequate". If the spillway notch is permanently open, the spillway would be considered "Adequate".

It is recommended that the following measures be undertaken immediately. Item (1) should be performed under the supervision of a registered professional engineer experienced in the design and construction of dams.

(1) The right abutment area would be the first area to experience overtopping; it should be evaluated from the standpoint of functioning as an emergency spillway. Alternatively, the stop log could be removed permanently.

(2) Cracks in the spillway walls and slabs should be sealed to prevent further damage.

(3) All trees and brush should be removed from the downstream embankment face.

(4) The pond drain pipe should be fitted with an operational control device at its upstream end.

(5) Seepage through the dam should be monitored for the development of turbidity and increase in quantity.

Because of the potential for property damage in the event of failure, a formal procedure of observation and warning during periods of high precipitation should be developed and implemented for this facility. This procedure should be coordinated with local authorities and should include a method of warning downstream residents that high flows are expected. In addition, an operation and maintenance procedure should also be developed to insure that all pertinent items are carefully inspected on a regular basis and maintained in the best possible condition.

Mary F. Beck — 3/19/81

Mary F. Beck, P.E. — Date
Pennsylvania Registration 27447E
Woodward-Clyde Consultants

John H. Frederick, Jr., P.E. — Date
Maryland Registration 7301
Woodward-Clyde Consultants

APPROVED BY:

James W. Peck — 2 APR 81

JAMES W. PECK — Date
Colonel, Corps of Engineers
District Engineer

OVERVIEW
ECHO LAKE DAM, NORTHAMPTON COUNTY, PENNSYLVANIA

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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
ECHO LAKE DAM
NATIONAL I.D. NO. PA 00957
DER NO. 48-3

SECTION 1
PROJECT INFORMATION

1.1 General.

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

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

1.2 Description of Project.

a. Dam and Appurtenances. Echo Lake Dam is an earth and rockfill dam approximately 10 feet high across the West Fork of Jacoby Creek. The approximately 550-foot long dam impounds a reservoir with an estimated total capacity of 80 acre-feet. The dam crest ranges from 11 to 16 feet wide and is covered by well maintained grass. The crest elevation ranges from 560.7 to 561.4. Surficial upstream embankment materials are broken shale and sod above the waterline. Wave erosion has created a near vertical face, exposing the underlying riprap. The upstream embankment slope below the waterline appears to be fairly flat. The downstream embankment slope ranges from 1.25H:1V to 2.25H:1V, typically about 1.65H:1V. Weeds and light brush are growing between the exposed rock. Small to moderate size trees are growing in the downstream area immediately adjacent to the toe of the dam.

A 49.4-foot wide spillway is located about the middle of the dam. The concrete broad-crest weir located at approximately the dam centerline has a low-flow notch approximately 2.5 feet wide by 14 inches deep. Downstream of the weir the spillway is concrete paving over rockfill. The spillway discharges into the stream bed at the downstream toe. A steel foot bridge crosses the spillway on the downstream side of the weir.

About five feet to the right of the spillway is a 12-inch diameter cast iron pipe. Discharge through the pond drain is controlled by a gate valve at the downstream end of the pipe. Pond drain discharge would impact directly upon the ground surface at the toe of the dam. The inlet to this pipe is underwater to the right of the right spillway wall.

The abutments of Echo Lake Dam merge into lawn areas of residences around the lake. There is little topographic relief between the embankment crest and the left abutment. The right abutment is lower than the dam crest. Large flows would be expected to flow around the embankment before overtopping the embankment.

b. Location. The dam is located approximately 2.6 miles northeast of East Bangor in Upper Mount Bethel Township, Northampton County, Pennsylvania. Echo Lake is located on a tributary to Jacoby Creek approximately 3.3 miles upstream from its confluence with the Delaware River. The dam site and reservoir are shown on the USGS Quadrangle Map entitled "Stroudsburg, Pennsylvania-New Jersey" at coordinates North 40° 54.2', West 75° 8.7'. A Regional Location Plan is enclosed as Plate 1, Appendix E.

c. Size Classification. The dam is classified as a "Small" size structure by virtue of its less than 40-foot height and less than 1000 acre-foot total storage capacity.

d. Hazard Classification. A "Significant" hazard classification is assigned consistent with the potential for damage to downstream commercial and residential properties, but with few or no lives lost.

e. Ownership. The dam is owned by the Echo Lake Development Company, Inc. All correspondence should be addressed to Mr. Ralph L. Schlough, President, Echo Lake Development Company, Inc., RD #1, Box 1145, Bangor, Pennsylvania 18013.

f. Purpose of Dam. The dam and reservoir are used for recreational purposes.

g. Design and Construction History. Echo Lake Dam was built by the Portland Ice Company sometime before 1911. The "Report on the Condition of the Dams along Jacoby Creek," dated 1912, described Echo Lake Dam as about 600 feet long, a maximum height of 10 feet and with a spillway at the center of the embankment. The embankment was constructed of earth and field stones with side slopes of 1.5H:1V. The upstream face was riprap with loose stones and the crest of the dam was eight to 10 feet wide. It was noted that the reservoir area was previously

a swamp and encompassed approximately 27 acres. The spillway was 49 feet long and two feet below the dam crest. It was reported that in 1911 the spillway had been rebuilt with a concrete upstream apron, weir crest and spillway walls. Downstream of the weir, the spillway was timber planking over rockfilled cribs. No leakage was noted and it was concluded that the dam appeared to be safe.

A 1919 inspection of the dam disclosed no evidence of embankment settlement but both spillway walls were cracked, with serious cracking at the left spillway wall. The timber planking on the downstream side of the spillway was rotted with missing planks. A small amount of leakage was noted and the downstream toe area of the embankment was described as being wet and swampy. A large tree on the downstream embankment slope immediately to the left of the spillway had blown over leaving a large hole. It was recommended that the hole be filled with clay or impervious material. The 1921 inspection report noted the hole filled with loose rock and stone.

Subsequent inspection reports of Echo Lake Dam noted swampy conditions downstream from the dam, seepage at various points along the embankment, poor condition of the spillway planking and also of spillway abutments. By 1934 the timber planking was replaced with concrete. The inspection report of 1938 noted leakage to the left of the spillway and a small stream flowing along the toe of the dam. In 1941, the inspection report noted settlement of the dam crest approximately 12 feet left of the spillway. It was commented that this settlement might be the result of leakage through the embankment.

h. Normal Operating Procedures. Under normal conditions, all flow is discharged over the spillway. The reservoir level is lowered in the late fall by removing the wooden stop log from the notch. Periodically, the lake level is lowered to permit maintenance to the bathing beach area.

1.3 Pertinent Data.

A summary of pertinent data for Echo Lake Dam is presented as follows.

a.	Drainage Area (square miles)	0.38
b.	Discharge at Dam Site (cfs)	
	Maximum Known Flood	50
	Tropical Storm Agnes, June 1972	
	At Minimum Embankment Crest	134
	At Minimum Abutment Elevation	150

c.	Elevation (feet above MSL)[1]	
	Top of Dam	560.7
	Right Abutment Area	
	Along dam centerline	560.1
	Upstream of dam centerline	560.3
	Spillway Crest (average)	559.9
	Spillway Notch	558.6
	Stream Bed at Spillway	550.6
d.	Reservoir (feet)	
	Length at Normal Pool	1300
	Length at Maximum Pool (est)	1350
e.	Storage (acre-feet)	
	Normal Pool (est)	62
	Right Abutment Elevation (est)	70
	Top of Dam (est)	80
f.	Reservoir Surface (acres)	
	Normal Pool	20.8
g.	Dam Data	
	Type	Earth and rockfill
	Length	545 feet
	Slopes	
	Upstream (above water line)	Near vertical
	Downstream (Average)	1.65H:1V
	Volume (est)	2100 cu. yd.
	Height (above stream bed)	10.1 feet
	Crest Width	11 to 16 feet
	Cutoff	Unknown
	Grout Curtain	Unknown
h.	Spillway	
	Type	Concrete over rock
	Elevation at Crest (Average)	559.9 feet
	Notch	558.6 feet
	Length	49.4 feet
i.	Pond Drain	
	Type	12-inch conduit with gate valve at downstream end.
	Length	Unknown
	Inlet Invert Elevation	Unknown
	Outlet Invert Elevation	551.9

(1) Right end of spillway weir assumed 560 feet from USGS map, all other elevations relative.

SECTION 2
ENGINEERING DATA

2.1 Design.

a. Availability. There are no original engineering data for Echo Lake Dam. A summary of subsequent evaluation data is presented on the checklist attached as Appendix B. Principal documents containing pertinent data used for this report are limited to periodic state inspection reports, correspondence and photographs. All of these data are contained within the Department of Environmental Resources (DER) files.

b. Design Features. A plan view and section of the dam are presented in Appendix E and profile is presented in Appendix A. This information was obtained from visual inspection. A summary of the design features is included in Section 1.3.

2.2 Construction.

Nothing is known concerning the construction history beyond the information given in Section 1.2, paragraph g.

2.3 Operational Data.

There are no operational records maintained for this dam beyond the periodic applications for permits to draw down the reservoir level.

2.4 Evaluation.

a. Availability. All information presented herein was obtained from DER files and supplemented by conversations with the owner's representative.

b. Adequacy. The available data are not adequate to evaluate the engineering aspects of this dam.

c. Validity. There is no reason to question the validity of the limited available data.

SECTION 3
VISUAL INSPECTION

3.1 Findings.

a. General. The observations and comments of the field inspection team are contained in a checklist presented in Appendix A and are summarized and evaluated in the following subsections. In general, the appearance of the facilities indicates that the embankment and spillway is currently in fair condition and the outlet works are in poor condition.

b. Dam. The vertical alignment of the dam crest was checked and the profile is shown on Sheet 5B, Appendix A. There were no distortions in alignment or grade that would be indicative of movement within the embankment or foundation. The crest elevation ranges from 560.7 to 561.4. The minimum elevation of 560.1 is in the right abutment area beyond the embankment. The minimum elevation in the right abutment area upstream of the dam which must be overtopped before water can flow over the right abutment is 560.3. The crest width ranges from 11 to 16 feet and supports a well maintained growth of grass. It was reported that broken shale covered with topsoil and seeded, has been placed on low areas of the embankment crest and on damaged areas at the waterline. A bench, created by wave erosion, was observed at the summer water line on the upstream embankment face, occasionally exposing underlying riprap. A flatter upstream embankment slope covered with broken shale was observed below the water level.

Light brush and weeds were growing between rocks on the downstream slope. The downstream slope is about 1.65:1V. Steeper slopes (1.25H:1V) occur in areas appearing to have more boulders and cobbles exposed. Flatter slopes (2.25H:1V) were observed as the downstream face transitioned into the abutments.

Midway between the spillway and left abutment at the downstream toe was a wet area with lush grass and standing water. Another wet area with ponded water and swampy vegetation was observed approximately 50 feet to the left of the spillway. This area extended to the spillway and about 50 feet downstream. Approximately 75 feet to the right of the spillway, another wet area was noted with standing water and lush grass. Near the downstream toe and slightly up the slope of the dam there were several trees growing ranging in size up to 12 inches in diameter.

c. Appurtenant Structures.

1. Spillway. The spillway is a concrete structure 49.4 feet wide. The upstream slope is concrete and underwater. The downstream slope is concrete over rock fill. A concrete weir 18.5 inches wide and 16 inches high controls spillway discharge, Plate 3, Appendix E. The weir crest ranges in elevation from 560 to 559.8 and appears to be in good condition. Flow through a notch approximately 30 inches wide by 14 inches deep is controlled by a wooden stop log. A foot bridge across the spillway is about 18.5 inches above the weir crest. The original concrete upstream spillway walls were extended as diving board platforms and the phases of construction can be seen. The spillway walls are cracked. Only the anchor bolts remain. The largest crack in the right spillway wall is approximately one-inch wide, Photograph 5. The downstream spillway walls also showed occasional cracks. The downstream slab of the spillway has a five-inch step at about its mid-height. There are several cracks noted in the spillway slab and pieces of concrete have apparently been broken off at the lower end of the slab. Cobbles and boulders underlie the spillway slab, Photograph 7. The spillway discharges directly into the downstream channel. No evidence of channel erosion or undermining of the spillway resulting from spillway discharge was noted.

2. Outlet Works. A 12-inch diameter metal pipe exits the downstream face of the dam approximately five feet to the right of the spillway. Discharge from the pipe impacts directly upon the ground surface at the downstream embankment toe. It was reported that the upstream end of this pipe is near to the right spillway wall and is protected by a screen. During the inspection, the downstream gate valve was exercised and found to be functional although the valve did not seat completely when in a closed position. Also a small crack was noted in the upper valve case such that small streams of water were spurting out. The crack was reported to be at least two years old.

d. Reservoir. The side slopes of the reservoir are at a moderate to gentle slope and are vegetated to the water's edge with grass and trees. There was very little debris noted along the shore line and very little sediment was observed entering the lake. The maximum depth was reported as six feet indicating sedimentation within the reservoir.

e. Downstream Channel. The channel downstream from the dam flows through a broad, flat, wooded, and occasionally swampy, flood plain. Immediately downstream from the dam, the channel is about 11 feet wide and the banks are approximately one-foot high. The valley gradient in the vicinity of the dam

is about 0.008. There are a few cottages located on the flood plain downstream of the dam. The closest residence is downstream of the embankment near the left abutment and has a floor level at approximately the dam crest elevation. About 3000 feet downstream from Echo Lake is Lake Poco, DER No. 48-4, which is formed by an earth dam approximately six feet high. About 1000 feet downstream from Lake Poco, the stream valley is constricted by an abandoned railroad embankment, such that flood flows would be confined to a small portion of the valley where a few residential dwellings are located. With the constriction on the valley, it is possible that a failure of Echo Lake Dam and, possibly, a consequent failure of Lake Poco Dam would cause damage to homes and buildings. Since no loss of life is envisioned, a "Significant" hazard classification for this structure is indicated.

3.2 Evaluation.

In summary, the visual inspection of the dam disclosed no evidence of incipient failure of the embankment. The embankment is judged to be in fair condition consistent with the trees and brush on the downstream slope and the wet and ponded areas at the downstream toe. Consistent with the reports in the DER file, this seepage is assessed to represent an apparently long-term condition which only requires monitoring for development of turbidity and increase in flow. Although the upstream embankment slope is damaged at the waterline, reported maintenance practices (see Section 4) have resulted in a minimum 11-foot top width, more than adequate for a 10-foot high dam.

The spillway structure appears to be in generally fair condition. This assessment is based upon the lack of any large scale dislocations or structural deficiencies although spillway cracking should be sealed to prevent further deterioration. The channel immediately downstream of the spillway should be checked after large flows for signs of channel erosion or spillway undermining. The outlet works are in poor condition consistent with the cracked valve case and the location of the valve at the downstream end of the outlet conduit.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedures.

Normal operating procedures of Echo Lake Dam do not require a dam tender. The reservoir level is lowered during the winter by removing the stop log from the spillway notch. All flow is discharged over the spillway into a tributary of Jacoby Creek. There is no minimum downstream flow requirement.

4.2 Maintenance of Dam.

Dam maintenance provided by the Owner consists of mowing the grass and removing debris as required. Periodically, additional material is dumped on the upstream embankment face to restore the slope at the water line and protect against further wave erosion.

4.3 Maintenance of Operating Facilities.

The operating facilities associated with this structure are the stop log and the gate valve on the outlet conduit. Maintenance to these facilities is provided as needed and the valve is kept oiled and operational. The gate valve is scheduled for repair this spring (1981). The Owner provides the required maintenance.

4.4 Warning Systems in Effect.

There are no formal warning systems or procedures established to be followed during periods of exceedingly heavy rainfall. If potentially dangerous conditions are observed, the Owner's representative reported that the local police would be notified.

4.5 Evaluation.

It is judged that the current operating procedure, which does not require a dam tender, is a realistic means of operating the relatively simple control facilities of Echo Lake Dam.

There are no written operational or maintenance procedures or any type of warning system. Maintenance and operating procedures should be developed, including a checklist of items to be observed, operated, and inspected on a regular basis.

Since a formal warning procedure does not exist, one should be developed and implemented during periods of extreme rainfall. This procedure should consist of a method of notifying residents downstream that potentially high flows are imminent or dangerous conditions are developing.

SECTION 5
HYDROLOGY/HYDRAULICS

5.1 Evaluation of Features.

a. Design Evaluation Data. There are no original design data for this construction nor subsequent evaluation data for the existing spillway section. The small irregularly shaped watershed is about 1.1 miles long and 0.3 mile wide having a total drainage area of about 0.38 square mile. Elevations range from a high of about 788 in the upper reaches to the normal reservoir level of about 559.9. The watershed is about 65 percent wooded with moderate residential development. While some residential development has recently occurred within the watershed, runoff characteristics are not expected to change significantly in the near future.

In accordance with criteria established by Federal (OCE) Guidelines, the recommended Spillway Design Flood for this "Small" size dam and "Significant" hazard classification is the 100 Year Flood to one half the Probable Maximum Flood. Based on the relatively small capacity of the reservoir and the fact that no loss of life is likely during the failure of this structure, the 100 Year Event has been selected as the Spillway Design Flood.

b. Experience Data. No reservoir level records or rainfall records are maintained for this dam by the Owner. During Tropical Storm "Agnes" in 1972, the reservoir level was reported to just barely reach the top of the right abutment.

c. Visual Observations. At the time of the inspection there were no conditions observed that would indicate a reduced spillway capacity during an extreme event. Overtopping of the right abutment area could be detrimental to the embankment if discharge through the abutment area flows against the downstream toe causing erosion. Other observations regarding the condition of the downstream channel, spillway and reservoir are located in Appendix A and discussed in greater detail in Section 3.

d. Overtopping Potential. The overtopping potential of this dam was estimated using the HEC-1 Dam Safety Version Computer Program. A brief description of the program is included in Appendix D. Calculations for this investigation indicate a maximum spillway capacity of 134 cfs with the stop log in place and 151 cfs without the stop log when the reservoir level is at 560.7, the minimum embankment elevation. Spillway discharge is reduced to 33 and 50 cfs, respectively, when the reservoir level is at 560.3, the elevation at which the right abutment area overtops. The 100 year peak inflow rate was calculated by the computer program as about 188 cfs. This value

was checked against the peak inflow value as determined according to procedures contained in "Regional Frequency Study, Upper Delaware and Hudson River Basins, New York District" which resulted in an estimated peak inflow value of about 197 cfs. The computer program indicates that the 100 Year Event will not overtop the embankment. However, the low area at the right abutment, noted on Sheet 5B, Appendix A, will overtop by about 0.3 feet for an estimated five hours with the stop log in the spillway notch. The abutment will not overtop if the notch is left open.

e. Spillway Adequacy. The reservoir level with the spillway notch closed is considered the normal pool level. The spillway is considered to be "Inadequate" as it will not pass the spillway design storm while dam outflow is confined to designed spillways. If the spillway notch is permanently open, the spillway would be considered "Adequate".

f. Downstream Conditions. Immediately downstream of the dam are a few cottages located on the flood plain. About 3,000 feet downstream of Echo Lake is Lake Poco Dam whose spillway is 36.5 feet wide and 23 inches deep with an estimated maximum capacity of 210 cfs. The top of Lake Poco Dam is about two and one-half feet above the first floor of a house downstream of the dam. About 1,000 feet downstream from Lake Poco Dam the stream valley is constricted by an abandoned railroad embankment, thus, flood flows would be confined to a small portion of the valley where residential dwellings are located. It is considered likely an Echo Lake Dam failure and possibly a Lake Poco Dam failure would cause damage to the homes and buildings. Since no loss of life is envisioned, a "Significant" hazard classification for this structure is indicated.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability.

a. Visual Observations. Visual observations indicate no evidence of existing or pending embankment instability other than that which would result from overtopping. The visual portions of the upstream face and downstream face of the dam appeared to be in fair condition. The concrete spillway cracking does not appear to be serious. The cracks should be sealed to prevent further damage. Although there is no energy dissipator at the spillway discharge, no channel erosion or spillway undermining was noted. The area should be checked after large spillway discharges for signs of undermining or erosion.

Evidence of seepage was observed during the visual inspection. Seepage has been noted in the state inspection reports since 1919. As no evidence of migration of fines through the embankment was noted, the seepage is assessed to represent a long-standing condition for this dam.

b. Design and Construction Data. No design or construction data exist other than the observations and reports concerning spillway reconstruction in the Department of Environmental Resources files. All data concerning the physical features of the dam were obtained from these reports, visual observations of the dam and conversations with the Owner's representative.

c. Operating Records. There are no operational records for this structure.

d. Post-Construction Changes. As discussed in Section 1.2, paragraph g, post-construction changes to Echo Lake Dam are limited to reconstruction of the spillway. No reference is made to a pond drain until 1923, therefore, the 12-inch pond drain may not be original.

e. Embankment Stability. There were no embankment stability evaluations in the files. Based on the low dam height, fairly wide crest (11 feet minimum), even when combined with fairly steep (up to 1.25H:1V) embankment slopes, the dam appears to be stable at the present time, provided that significant overtopping does not occur and that seepage conditions do not change.

f. Seismic Stability. The dam is located in seismic zone 1. Normally it can be considered that if a dam in this zone is stable under static loading conditions, it can be assumed

safe for any expected earthquake conditions. Since the dam is qualitatively assessed to be stable at the present time under static loading conditions, it can also reasonably be considered to be stable under seismic loading conditions.

SECTION 7
ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment.

a. Evaluation. Visual inspection indicates that Echo Lake Dam and spillway is in fair condition. The outlet works are in poor condition.

In accordance with criteria established by Federal (OCE) Guidelines, the recommended Spillway Design Flood for this "Small" size dam and "Significant" hazard classification is the 100 Year Flood to one half the Probable Maximum Flood. Based on the small capacity of the reservoir and the fact that no loss of life is likely during failure of the structure, the 100 Year Event has been selected as the Spillway Design Flood.

Hydrologic and hydraulic computations presented in Appendix D indicate the spillway structure is not capable of discharging the 100 Year Event while confining dam outflow to the designed spillway. With the spillway notch closed (normal pool level), the right abutment area overtops by about 0.3 feet for an estimated five hours. Thus the spillway is considered "Inadequate". If the spillway notch is permanently open, the spillway would be considered "Adequate".

b. Adequacy of Information. The combined visual inspection and simplified calculations presented in Appendix D were sufficient to indicate that further investigations are required for this structure if the use of stop logs is continued.

c. Urgency. It is recommended that the measures presented in Section 7.2 be implemented as specified.

7.2 Remedial Measures.

a. Facilities. It is recommended that the following measures be undertaken immediately. Item 1 should be performed under the supervision of a Registered Professional Engineer experienced in the design and construction of dams.

(1) The right abutment area would be the first area to experience overtopping; it should evaluated from the standpoint of functioning as an emergency spillway. Alternatively, the stop log could be removed permanently.

(2) Cracks in spillway and slab walls should be sealed to prevent further damage.

(3) All trees and brush should be removed from the downstream embankment face.

(4) The pond drain pipe should be fitted with an operational control device at its upstream end.

(5) Seepage through the dam should be monitored for the development of turbidity and increase in quantity.

b. Operation and Maintenance Procedures. Because of the potential for property damage in the event of a failure, a formal procedure of observation and warning during periods of high precipitation should be developed and implemented for this facility. This procedure should be coordinated with local authorities and should include a method of warning downstream residents that high flows are expected. In addition, an operation and maintenance procedure should also be developed to insure that all pertinent items are carefully inspected on a regular basis and maintained in the best possible condition.

APPENDIX

A

CHECK LIST
VISUAL INSPECTION
PHASE I

Name Dam *Echo Lake Dam*

County *Northhampton* State *Pennsylvania*

NDI# *PA 00957* DER# *48-3* Type of Dam *Earth and Rockfill*

Hazard Category *Significant*

Date(s) Inspection *Nov. 20, 1980*

Weather *Sunny* Temperature *40's*

Pool Elevation at Time of Inspection *559.9* M.S.L.

Tailwater at Time of Inspection *552.7* M.S.L.

Inspection Personnel:

Mary F. Beck (Hydrologist)	*Vincent McKeever (Hydrologist)*
Richard E. Mabry (Geotechnical)	*John H. Frederick, Principal (2/9/81)*
Raymond S. Lambert, (Geologist)	

Mary F. Beck Recorder

Remarks:

Mr. Ralph L. Schlough, President of Echo Lake Development Company, Inc., was on site and provided assistance to the inspection team.

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	N/A	
STRUCTURE TO ABUTMENT/ EMBANKMENT JUNCTIONS	N/A	
DRAINS	N/A	
WATER PASSAGES	N/A	
FOUNDATION	N/A	

CONCRETE/MASONRY DAMS

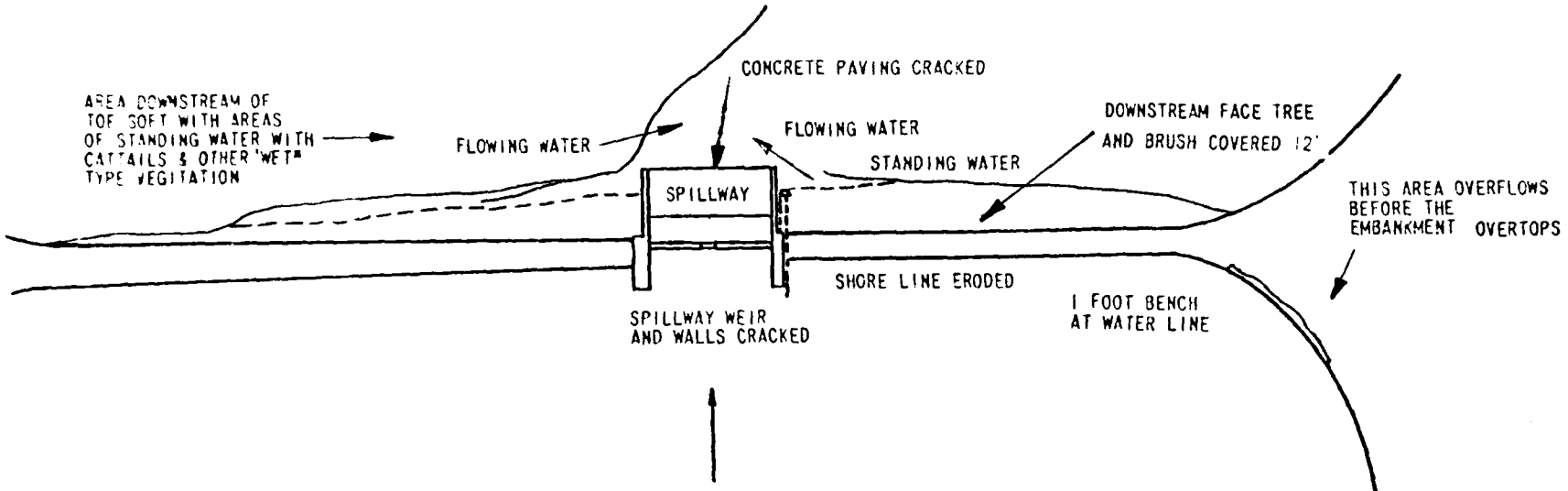
VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	N/A	
STRUCTURAL CRACKING	N/A	
VERTICAL AND HORIZONTAL ALIGNMENT	N/A	
MONOLITH JOINTS	N/A	
CONSTRUCTION JOINTS	N/A	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	*None observed*	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	*None observed*	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	*None observed*	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	*Vertical alignment shown on Sheet 5B.*	
RIPRAP FAILURES	*Riprap at water line has been covered with small shale fragments, covered with soil and grass established. Upstream slope has a one-foot bench at water line. Waves have eroded shale and exposed some underlying riprap.*	

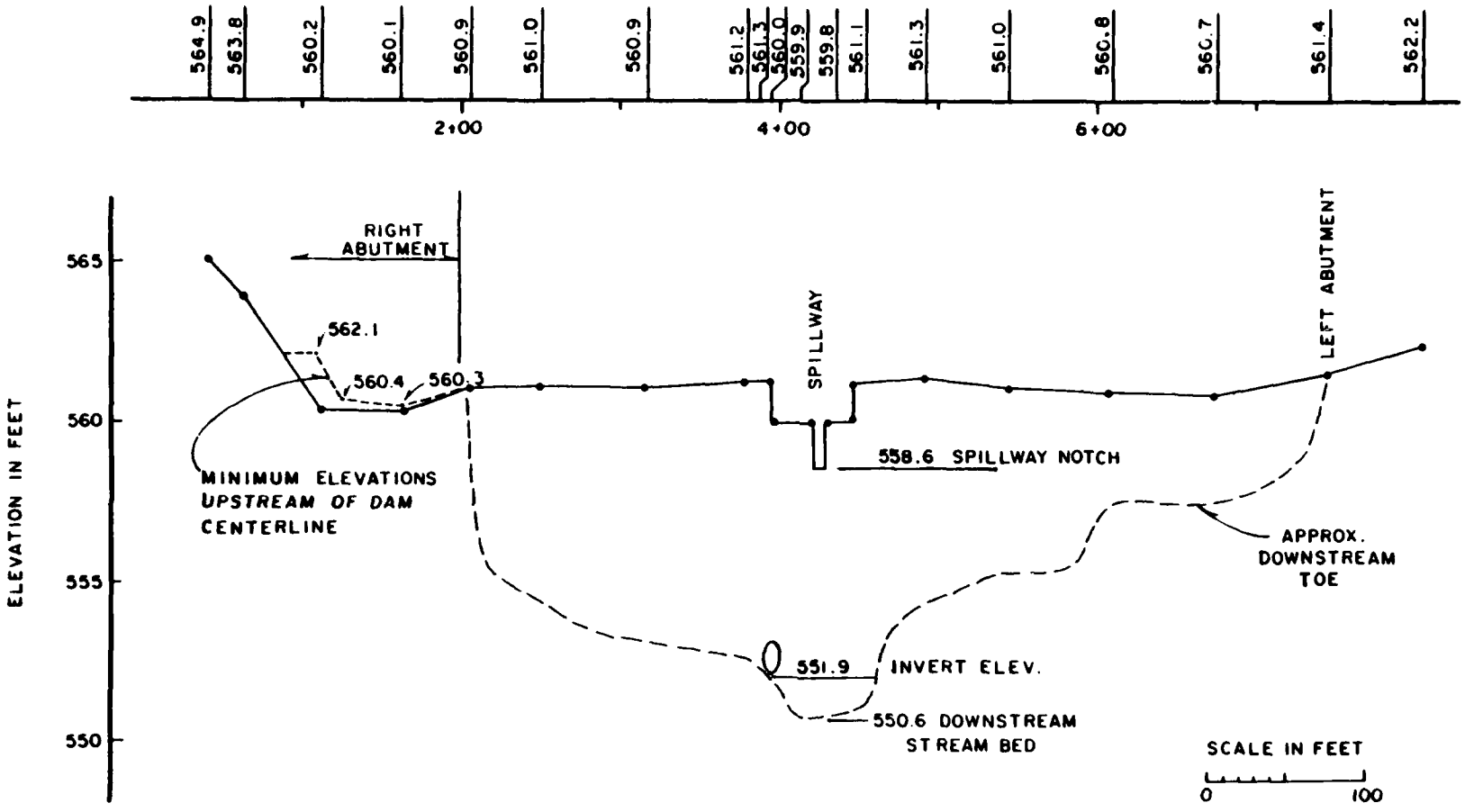
EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS REMARKS OR RECOMMENDATIONS
Vegetation	The crest is protected by a good grass cover. The downstream slope is brush and tree covered. Some brush has been cut.
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Good condition
ANY NOTICE-ABLE SEEPAGE	Yes, see sheet 5A
STAFF GAGE AND RECORDER	None
DRAINS	None



FIELD OBSERVATION PLAN
ECHO LAKE DAM

SHEET 5A OF 11



LOOKING UPSTREAM

PROFILE ALONG CREST
ECHO LAKE DAM

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	*N/A*	
INTAKE STRUCTURE	*Upstream end of conduit is under water and could not be seen.*	
OUTLET STRUCTURE	*A 12-inch gate valve is at the downstream end of the conduit. The gate valve operated easily. Valve does not completely seat. The upper part of the Crane valve was cracked with water jetting out.*	
OUTLET CHANNEL	*The conduit discharges into the channel below the spillway.*	
EMERGENCY GATE	*The above.*	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	*The concrete broad crested weir has a 30-inch wide, 14-inch deep low flow notch. At the time of the inspection, a wooden board was in the notch. The lake level is lowered for the winter months.*
APPROACH CHANNEL	*None*
DISCHARGE CHANNEL	*The spillway discharges directly into the downstream channel.*
BRIDGE AND PIERS	*A foot bridge is 18.5 inches above the concrete weir. The bridge is supported by two sets of steel angle members.*

GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
TYPE	N/A	
APPROACH CHANNEL	N/A	
DISCHARGE CHANNEL	N/A	
BRIDGE AND PIERS	N/A	
GATES AND OPERATION EQUIPMENT	N/A	

INSTRUMENTATION

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/ SURVEYS	*None*	
OBSERVATION WELLS	*None*	
WEIRS	*None*	
PIEZOMETERS	*None*	
OTHER	*None*	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	*The reservoir side slopes are moderate and generally grassed to water's edge. Very little debris along shore line.*	
SEDIMENTATION	*Little sediment is coming into the lake.*	
WATERSHED	*About 65 percent wooded with moderate residential development.*	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	*The downstream channel flows through a broad, wooded flood plain. The channel is about 10 feet wide with one-foot high banks.*
SLOPES	*The valley gradient is approximately 0.013.*
APPROXIMATE NO. OF HOMES AND POPULATION	*About 3000 feet downstream of Echo Lake Dam is Lake Poco, a 6 foot high earth dam. About 1000 feet downstream of Lake Poco, the downstream valley is constricted by an abandoned railroad embankment, thus flood flows are confined to a small portion of the valley and it is considered likely an Echo Lake Dam failure, and possibly a Lake Poco failure, would cause additional damage to homes and buildings.*

APPENDIX

B

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM *Echo Lake Dam*

NDI NO. *PA 00957* DER NO. *48-4*

ITEM	REMARKS
AS-BUILT DRAWINGS	*None available*
REGIONAL VICINITY MAP	*Plate 1, Appendix E*
CONSTRUCTION HISTORY	*See text, Section 1.2*
TYPICAL SECTIONS OF DAM	*None available*
OUTLETS - PLAN	
DETAILS	
CONSTRAINTS	*No data available*
DISCHARGE RATINGS	

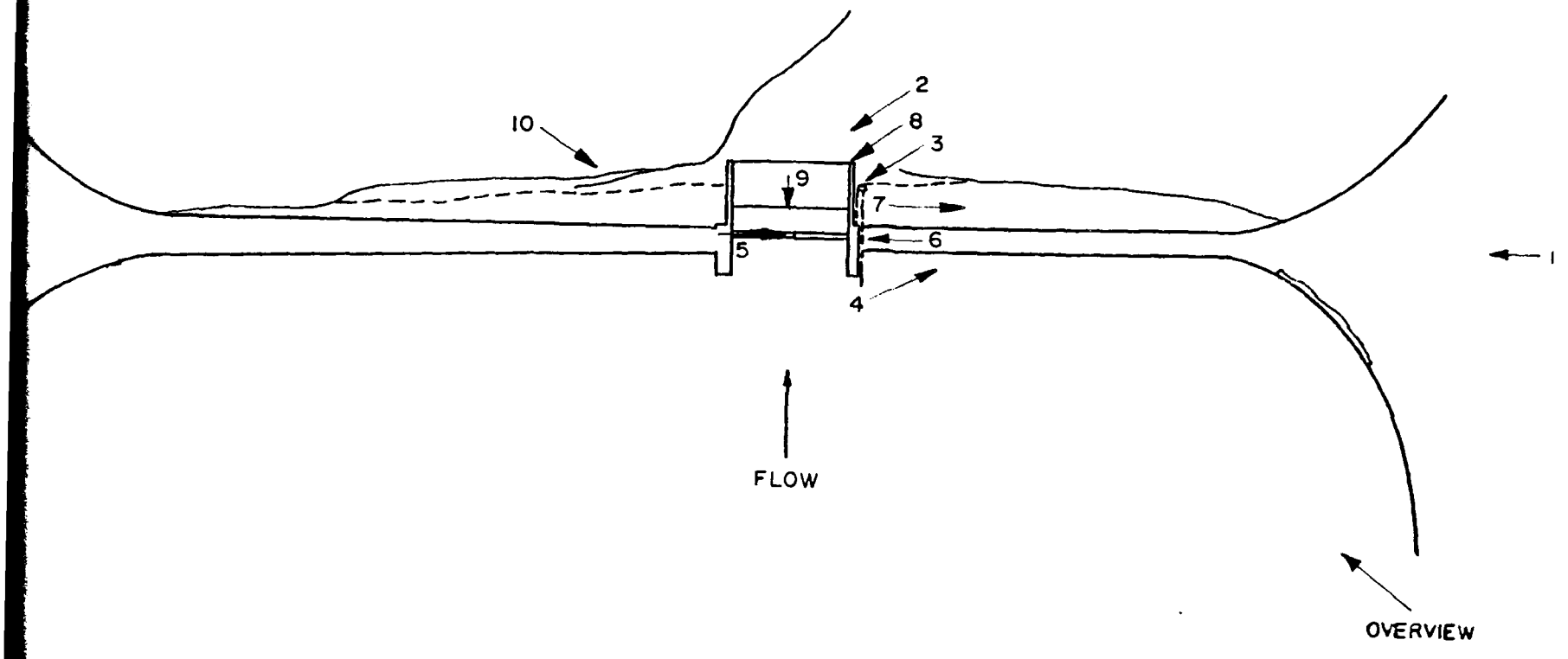
ITEM	REMARKS
RAINFALL/ RESERVOIR RECORDS	*None maintained by Owner*
DESIGN REPORTS	*None*
GEOLOGY REPORTS	*See Appendix F*
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	*No original studies, see Appendix D for Hydrology/ Hydraulics evaluation.*
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	*None*
POST CONSTRUCTION SURVEYS OF DAM	*None known*

ITEM	REMARKS
BORROW SOURCES	*Unknown*
MONITORING SYSTEMS	*None*
MODIFICATIONS	*Limited to replacement of spillway*
HIGH POOL RECORDS	*None*
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	*None except state dam inspection reports*
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	*None*
MAINTENANCE OPERATION RECORDS	*None*

ITEM	REMARKS
SPILLWAY PLAN SECTIONS DETAILS	*See Appendix E*
OPERATING EQUIPMENT PLANS AND DETAILS	*None*
MISCELLANEOUS	*The following are located in DER files.* 1. *"Report on the Condition of the Dams along Jacoby Creek", Dated April 9, 1912.* 2. *"Inspection Report Dams" from 1919 to 1964.* 3. *Correspondence between the state and various owners of the dam.* 4. *Several "Application for Permit to Draw Dam"* 5. *Seven black and white photographs.*

APPENDIX

C

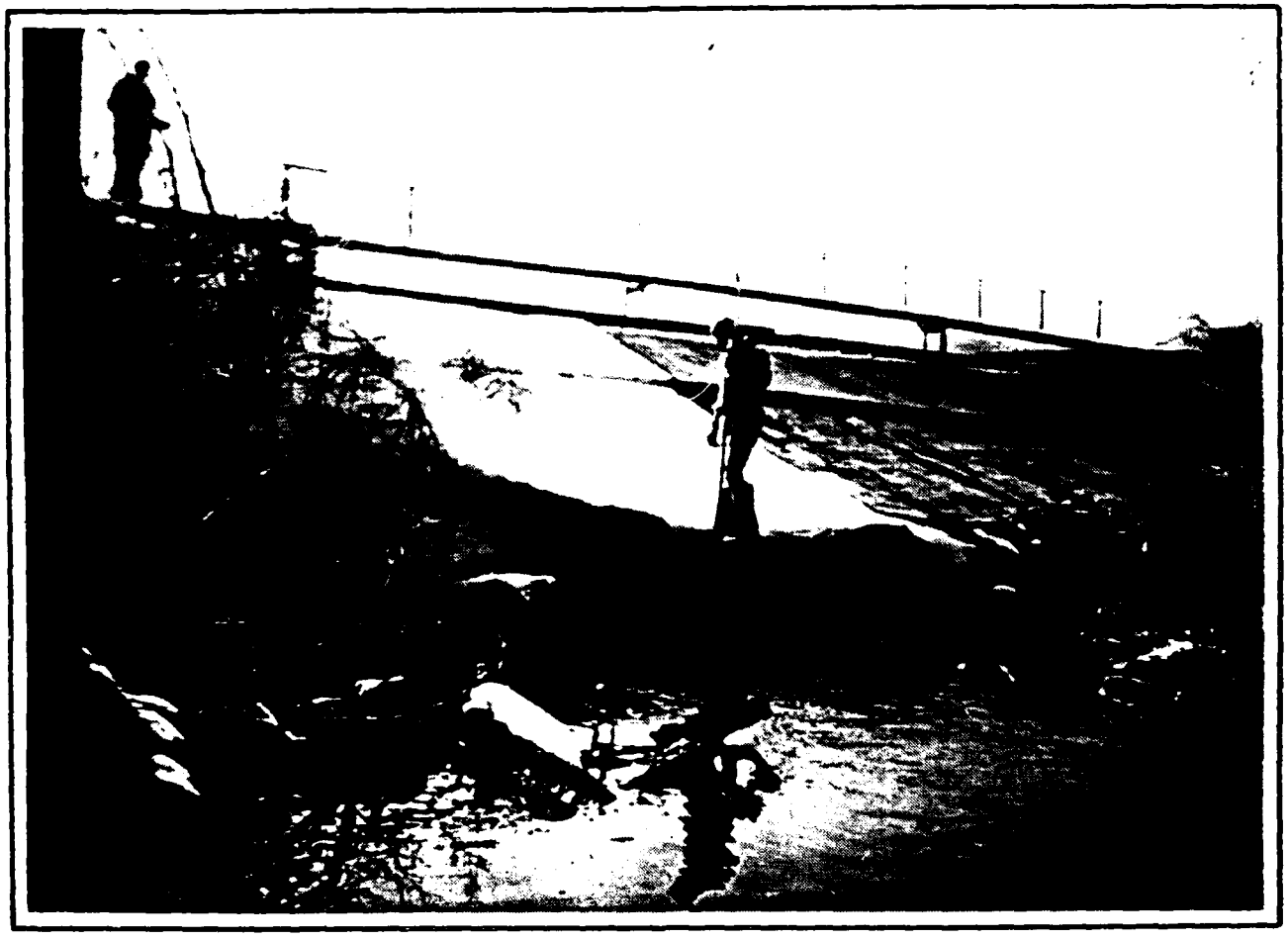


PHOTOGRAPH LOCATION PLAN
ECHO LAKE DAM

PLATE C-1

THE RIGHT ABUTMENT AREA REFERRED TO IN
THE TEXT IS SHOWN IN THIS PICTURE.

PHOTOGRAPH NO. 1



VIEW OF DOWNSTREAM SIDE OF SPILLWAY.
POND DRAIN GATE VALVE ADJACENT TO
NEAR SIDE OF SPILLWAY.

PHOTOGRAPH NO. 2

12-INCH GATE VALVE AT DOWNSTREAM POR

PHOTOGRAPH NO.

UPSTREAM EMBANKMENT SLOPE AT WATER LINE.
UNDERLYING RIPRAP EXPOSED.

PHOTOGRAPH NO. 4

VIEW SHOWING SPILLWAY WEIR, FOOTBRIDGE AND EMBANKMENT CREST.

PHOTOGRAPH NO. 1

SPILLWAY CREST SHOWING LOW FLOW NOTCH.
NOTE CRACK IN SPILLWAY WALL.

PHOTOGRAPH NO. 6

TYPICAL DOWNSTREAM EMBANKMENT SLOPE.
ROCK FILL SHOWS THROUGH SNOW.

PHOTOGRAPH No. .

SPILLWAY CONCRETE PAVING CRACKS.

PHOTOGRAPH NO. 10

STANDING WATER AT DOWNSTREAM TOE NEAR SPILLWAY

PHOTOGRAPH NO. 10

36.5 FOOT WIDE SPILLWAY AT DOWNSTREAM DAM.

PHOTOGRAPH NO. 11

HOUSES DOWNSTREAM OF LAKE POCO. STREAM IS TO RIGHT OF PICTURE. ABANDONED RAILROAD EMBANKMENT AND NATURAL TOPOGRAPHY CREATE NARROW VALLEY IMMEDIATELY UPSTREAM OF THESE HOUSES.

PHOTOGRAPH NO. 12

APPENDIX

D

ECHO LAKE DAM
CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: *About 65% wooded with moderate residential development*

ELEVATION NORMAL POOL (STORAGE CAPACITY): *559.9* feet (62 Acres-feet)*

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): *560.3 feet (70 Acre-feet)*

ELEVATION MAXIMUM DESIGN POOL: -

ELEVATION TOP DAM: *560.7 feet*

SPILLWAY

a. Elevation: *560 feet*

b. Type: *Concrete weir, with concreted fockfill chute*

c. Width: *49.4 feet*

d. Length: *36.5 feet*

e. Location Spillover: *Approximately 330 feet from right abutment*

f. Number and Type of Gates: *None*

OUTLET WORKS:

a. Type: *12-inch pipe with gate valve at downstream end*

b. Location: *adjacent to right spillway wall*

c. Entrance inverts: *Unknown, under water*

d. Exit inverts: *541.9 feet*

e. Emergency draindown facilities: *the 12-inch pipe*

HYDROMETEOROLOGICAL GAGES:

a. Type: *None*

b. Location: *N/A*

c. Records: *N/A*

MAXIMUM NON-DAMAGING DISCHARGE: *Not determined*

**Right end of weir estimated as 560.0 feet from USGS map, all other elevations relative.*

ECHO LAKE DAM
CHECK LIST
HYDROLOGIC AND HYDRAULIC

DRAINAGE AREA:(1) *0.38 sq. miles*

100 YEAR PRECIPITATION (2)

30 MINUTES	*2.3 inches*
1 Hour	*3.0*
2 Hours	*3.7*
3 Hours	*4.1*
6 Hours	*5.0*
12 Hours	*6.0*
24 Hours	*7.0*

SNYDER HYDROGRAPH PARAMETERS:(3)

Zone	*1*
C_p, C_t	*0.45, 1.23*
L (4)	*1.37 miles*
L_{ca} (5)	*0.61 miles*
$t_p = C_t (L \cdot L_{ca})^{0.3}$	*1.16*

SPILLWAY CAPACITY AT MAXIMUM WATER LEVEL (6) *134 cfs*

(1) Measured from USGS maps.
(2) TP 40 - Rainfall Frequency Atlas of the United States
(3) Information received from Corps of Engineers, Baltimore District.
(4) Length of longest water course from outlet to basin divide, measured from USGS maps.
(5) Length of water course from outlet to point opposite the centroid of drainage area, (see Plate 1, Appendix E) measured from USGS maps.
(6) See Sheet *11* of this Appendix.

HEC-1, REVISED
FLOOD HYDROGRAPH PACKAGE

The original "Flood Hydrograph Package" (HEC-1), developed by the Hydrologic Engineering Center, Corps of Engineers, has been modified for use under the National Dam Inspection Program. The "Flood Hydrograph Package (HEC-1), Dam Safety Version", hereinafter referred to as, HEC-1, Rev., has been modified to require less detailed input and to include a dam breach analysis. The required input is obtained from the field inspection of a dam, any available design/evaluation data, relatively simple hydraulic calculations, or information from the USGS Quandrangle maps. The input format is flexible in order to reflect any unique characteristics of an individual dam.

HEC-1, Rev. computes a reservoir inflow hydrograph based on individual watershed characteristics such as: area, percentage of impervious surface area, watershed shape, and hydrograph characteristics determined from regional correlation studies by the Corps of Engineers, Baltimore District. The inflow is routed through the reservoir using spillway discharge data obtained from the field inspection or design data. Flood storage capacity is determined from USGS maps or design information and verified by the field inspection. In the event a spillway cannot discharge 0.5 PMF without overtopping and failure of the dam, downstream channel characteristics obtained from the field inspection and USGS maps are inputed and flows are routed downstream to the damage center and a dam breach analysis is performed. If the 100 year event is selected as the appropriate spillway design flood, the peak inflow value is correlated with other studies by adjusting hydrograph parameters.

Included in this Appendix are the HEC-1, Rev. pertinent input values and a summary print-out tables.

BY PFM DATE 2/25/81 SUBJECT ECHO LAKE DAM SHEET 4 OF 14

CHKD. BY MFB DATE 2/26/81 HYDROLOGY/HYDRAULICS JOB No.

CLASSIFICATION (REF. - RECOMMENDED GUIDELINES FOR SAFETY INSPECTION OF DAMS)

1. THE HAZARD CLASSIFICATION IS RATED AS "SIGNIFICANT" AS THERE WOULD BE APPRECIABLE ECONOMIC LOSS WITH FEW OR NO LIVES LOST IN THE EVENT OF FAILURE OF THE DAM.

2. THE SIZE CLASSIFICATION IS "SMALL" BASED ON ITS 10.1 FT. HEIGHT AND LESS THAN 1000 AC-FT. TOTAL STORAGE CAPACITY.

3. THE SELECTED SPILLWAY DESIGN FLOOD, BASED ON SIZE AND HAZARD CLASSIFICATION, IS THE 100 YR. EVENT

HYDROLOGY AND HYDRAULIC ANALYSIS

1. NO ORIGINAL DATA OR SUBSEQUENT EVALUATION DATA ARE KNOWN TO EXIST

2. ELEVATION - DISCHARGE DATA

SPILLWAY WIDTH 49.4 FT.
CREST OF WEIR 18.5 IN.
MAXIMUM DISCHARGE $Q = CL H^{3/2}$ *

WATER SURFACE	H	C	L	Q
559.9	0			0
560.0	0.1	2.62	49.4	4
560.1	0.2	2.62	"	12
560.9	1	2.75	"	136
561.9	2	3.03	"	423

IN WINTER, FLASH BOARD IS TAKEN OUT OF NOTCH IN SPILLWAY

NOTCH WIDTH 2.5 FT.
BOTTOM ELE. 558.6

* REF. HANDBOOK OF HYDRAULICS, BRATER AND KING, 1976, TABLE 5-3

WINTER WATER LEVEL WITH 2.5' WIDE NOTCH

WATER SURFACE	Low Flow Notch				Remainder of Spillway				TOTAL Q
	C	L	H	Q	C	L	H	Q	
558.6				0					0
559.1	2.61	2.5	0.5	3.03					3
559.9	2.9	"	1.3	10.7			0	0	11
560.5	3.03	"	1.9	19.8	2.61	46.9	0.6	56.9	77
561.2	3.03	"	2.6	31.8	2.9	"	1.3	201.6	233
562.0	3.03	"	3.4	47.5	3.03	"	2.0	401.9	449

3. EVALUATION DATA

RAINFALL AND SNYDER HYDROGRAPH PARAMETERS ARE SHOWN ON SHEET 2.

THE VALUE OF THE PEAK FLOW WAS CHECKED AGAINST THE VALUE OF THE 100 YR. INFLOW DETERMINED BY PROCEDURES CONTAINED IN "REGIONAL FREQUENCY STUDY, UPPER DELAWARE AND HUDSON RIVER BASINS, NEW YORK DISTRICT" BY THE CORPS OF ENGINEERS, NOVEMBER, 1974.

$$\log (Q_m) = C_m + 0.87 \log A$$

WHERE $C_m = 1.65$ FROM FIG. 2

$A = 0.38$ SQ. MILES FROM USGS MAP

$$\log (Q_m) = 1.284$$

$$S = C_s - 0.05 \log A$$

$C_s = 0.355$ FROM FIG. 3

$$S = 0.376$$

$g = +0.5$ FROM FIG. 5

$$\log (Q_{100}) = \log (Q_m) + K(P,g) \cdot S$$

$K(P,g) = 2.686$ FROM PEARSON TYPE III DISTRIBUTION (STANDARD TABLE FOUND IN MOST HYDROLOGY TEXTS)

$$\log (Q_{100}) = 1.284 + 2.686 \cdot 0.376$$
$$= 2.294$$

$$Q_{100} = 197 \text{ CFS}$$

ELEVATION - STORAGE DATA

ELEVATION	SURFACE AREA (ACRES)
551.0	0
559.9	21
560.0	23
562.0	25 (est)

THESE AREAS WERE OBTAINED FROM USGS MAPS.

4. RESULTS OF COMPUTER ANALYSIS

THE PEAK INFLOW (Q_{100}) CALCULATED BY THE HEC-1 PROGRAM IS 188 CFS, WITHIN 5% OF THE VALUE COMPUTED ABOVE. THE PROGRAM INDICATES THAT THE 100 YR. EVENT WILL NOT OVERTOP THE EMBANKMENT. HOWEVER, THE LOW AREA AT THE RIGHT ABUTMENT, NOTED ON SHEET 5B, APPENDIX A, WILL OVERTOP BY ABOUT 0.3 FEET FOR MORE THAN 5 HOURS WITH THE STOP LOG IN THE SPILLWAY NOTCH. THE ABUTMENT WILL NOT OVERTOP IF THE SPILLWAY NOTCH IS LEFT OPEN.

5. SPILLWAY ADEQUACY

THE RESERVOIR LEVEL WITH THE SPILLWAY NOTCH CLOSED IS CONSIDERED THE NORMAL POOL LEVEL. THE SPILLWAY IS CONSIDERED TO BE "INADEQUATE" AS IT WILL NOT PASS THE SPILLWAY DESIGN STORM WHILE DAM OUTFLOW IS CONFINED TO DESIGN SPILLWAYS. IF THE SPILLWAY NOTCH IS PERMANENTLY OPEN, THE SPILLWAY WOULD BE CONSIDERED "ADEQUATE".

MAXIMUM TAILWATER ELEVATION DURING THE SPILLWAY DESIGN FLOOD, BASED ON MAXIMUM STAGE AT DOWNSTREAM STATION DS 1, IS 549.1. THE DOWNSTREAM STAGE JUST PRIOR TO OVERTOPPING IS ABOUT 548.7.

```
1**********************************
 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION      JULY 1978
   LAST MODIFICATION  01 APR 80
 **********************************

 RUN  DATE= 81/02/24.
      TIME= 12.59.42.
```

ECHO LAKE DAM
NDI NO. PA 00957 DER NO. 48-3
OVERTOPPING ANALYSIS

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
100	0	15	0	0	0	0	0	-4	0
			JOPER	NWT	LROPT	TRACE			
			5	0	0	0			

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

RTIOS= 1.00

SHEET 7 OF 14

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH - 100 YR STORM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
IN	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
0	1	.38	0.00	.38	1.00	0.000	0	1	0

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	1.50	1.00	0.00	0.00

UNIT HYDROGRAPH DATA

TP= 1.16 CP= .45 NTA= 0

RECESSION DATA

STRTQ= -1.50 QRCSN= -.50 RTIOR= 2.00

UNIT HYDROGRAPH 43 END-OF-PERIOD ORDINATES, LAG= 1.17 HOURS, CP= .45 VOL= 1.00

8.	30.	59.	84.	93.	88.	77.	67.	59.	52.
45.	40.	35.	30.	27.	23.	20.	18.	16.	14.
12.	11.	9.	8.	7.	6.	5.	5.	4.	4.
3.	3.	2.	2.	2.	2.	1.	1.	1.	1.
1.	1.	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

0 96 7.0

01	.02	.02	.02	.02	.021	.021	.021	.021	.021	.021
01	.021	.021	.021	.021	.021	.021	.021	.021	.021	.021
01	.021	.021	.021	.021	.041	.041	.041	.041	.041	.041
01	.041	.041	.041	.041	.041	.041	.041	.041	.041	.041
01	.041	.041	.041	.041	.042	.042	.042	.042	.066	.066
01	.067	.067	.067	.067	.067	.068	.225	.225	.225	.225
01	.35	.35	1.25	1.25	.075	.075	.075	.075	.068	.067
01	.067	.067	.021	.021	.021	.021	.021	.021	.021	.021
01	.021	.021	.021	.021	.021	.021	.021	.021	.021	.021
01	.021	.021	.02	.02	.02	.02				

SUM	7.00	2.11	4.89	2514.	
	(178.0	54.0	124.0	71.19)	

HYDROGRAPH ROUTING

OUTFLOW HYDROGRAPH - EXISTING CONDITIONS

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
OUT	1	0	0	0	1	1	0	0

ROUTING DATA

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

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ITPRAT
1	0	0	0.000	0.000	0.000	560.	-1

STAGE	559.90	560.00	560.10	560.90	561.90
FLOW	0.00	4.00	12.00	136.00	423.00
SURFACE AREA=	0.	21.	23.	25.	
CAPACITY=	0.	62.	64.	112.	
ELEVATION=	551.	560.	560.	562.	

CREL	SPWID	COOW	EXPW	ELEVL	TOOL	LANTA	EXPI
559.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Dam Data

TOPEL	COOD	EXPD	DAMWID
560.7	0.0	0.0	0.

CREST LENGTH	0.	175.	350.	610.
AT OR BELOW ELEVATION	560.3	561.0	561.1	561.0

HYDROGRAPH ROUTING

SECTION 300 FEET DOWNSTREAM OF DAM

ISTAO	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
DS1	1	0	0	0	0	1	0	0

ROUTING DATA

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

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

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0750	.0750	.0750	548.0	558.0	300.	.00900

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

0.00 558.00 125.00 549.20 214.00 549.20 243.00 548.00 343.00 549.10
493.00 552.40 593.00 556.30 665.00 562.00

STORAGE	0.00	.11	.44	1.18	2.12	3.18	4.36	5.64	7.05	8.55
	10.14	11.80	13.54	15.35	17.24	19.20	21.25	23.34	25.49	27.70
OUTFLOW	0.00	12.33	78.32	274.35	637.20	1148.76	1808.91	2621.44	3591.73	4825.20
	6287.78	7927.62	9747.24	11749.27	13936.48	16311.79	18884.15	21667.60	24640.94	27804.18
STAGE	548.00	548.53	549.05	549.58	550.11	550.63	551.16	551.68	552.21	552.74
	553.26	553.79	554.32	554.84	555.37	555.89	556.42	556.95	557.47	558.00
FLOW	0.00	12.33	78.32	274.35	637.20	1148.76	1808.91	2621.44	3591.73	4825.20
	6287.78	7927.62	9747.24	11749.27	13936.48	16311.79	18884.15	21667.60	24640.94	27804.18

MAXIMUM STAGE IS 547.1

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 1.00
HYDROGRAPH AT	IN	.38	1	188.
		(.98)		(5.32)(
ROUTED TO	OUT	.38	1	104.
		(.98)		(2.94)(
ROUTED TO	DST	.38	1	104.
		(.98)		(2.94)(

SUMMARY OF DAM SAFETY ANALYSIS
SPILLWAY NOTCH CLOSED

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	559.90	559.90	560.70
STORAGE	62.	62.	80.
OUTFLOW	0.	0.	134.

RATIO OF ~~PMF~~ 100 YR. FLOOD	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
1.00	560.60	0.00	78.	104.	0.00	18.25	0.00

PLAN 1 STATION DST

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	104.	549.1	18.25

HYDROGRAPH ROUTING

OUTFLOW HYDROGRAPH - NOTCH OPEN, STOP LOGS REMOVED

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
OUT	1	0	0	0	1	1	0	0

ROUTING DATA

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

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-559.	-1

STAGE	558.60	559.10	559.90	560.50	561.20	562.00
FLOW	0.00	3.00	11.00	77.00	233.00	449.00
SURFACE AREA=	0.	21.	23.	25.		
CAPACITY=	0.	62.	64.	112.		
ELEVATION=	551.	560.	560.	562.		

CREL	SPWID	COOW	EXPW	ELEVL	COOW	CAREA	EXPL
558.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COOD	EXPD	DAMWID
580.7	0.0	0.0	0.

CREST LENGTH AT OR BELOW ELEVATION	0. 560.3	175. 561.0	350. 561.1	610. 562.0

HYDROGRAPH ROUTING

SECTION 300 FEET DOWNSTREAM OF DAM

	ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
	DS1	1	0	0	0	0	1	0	0

ROUTING DATA

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

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

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0750	.0750	.0750	548.0	558.0	300.	.00900

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

0.00 558.00 125.00 549.20 214.00 549.20 243.00 548.00 345.00 549.10
493.00 552.40 593.00 556.30 665.00 562.00

STORAGE	0.00	.11	.44	1.18	2.12	3.18	4.36	5.64	7.05	8.55
	10.14	11.80	13.54	15.35	17.24	19.20	21.25	23.34	25.49	27.70
OUTFLOW	0.00	12.33	78.32	274.35	637.20	1148.76	1808.91	2621.44	3591.73	4825.20
	6287.78	7927.62	9747.24	11749.27	13936.48	16311.79	18884.15	21667.60	24640.94	27804.18
STAGE	548.00	548.53	549.05	549.58	550.11	550.63	551.16	551.68	552.21	552.74
	553.26	553.79	554.32	554.84	555.37	555.89	556.42	556.95	557.47	558.00
FLOW	0.00	12.33	78.32	274.35	637.20	1148.76	1808.91	2621.44	3591.73	4825.20
	6287.78	7927.62	9747.24	11749.27	13936.48	16311.79	18884.15	21667.60	24640.94	27804.18

MAXIMUM STAGE IS 548.8

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)

				RATIOS APPLIED TO FLOWS
OPERATION	STATION	AREA	PLAN	RATIO 1
				1.00
HYDROGRAPH AT	IN	.38	1	188.
		(.98)		(5.32)(
ROUTED TO	OUT	.38	1	50.
		(.98)		(1.43)(
ROUTED TO	DS1	.38	1	50.
		(.98)		(1.43)(

SUMMARY OF DAM SAFETY ANALYSIS
SPILLWAY NOTCH OPEN

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	558.60	558.60	560.70
STORAGE	38.	38.	80.
OUTFLOW	0.	0.	151.

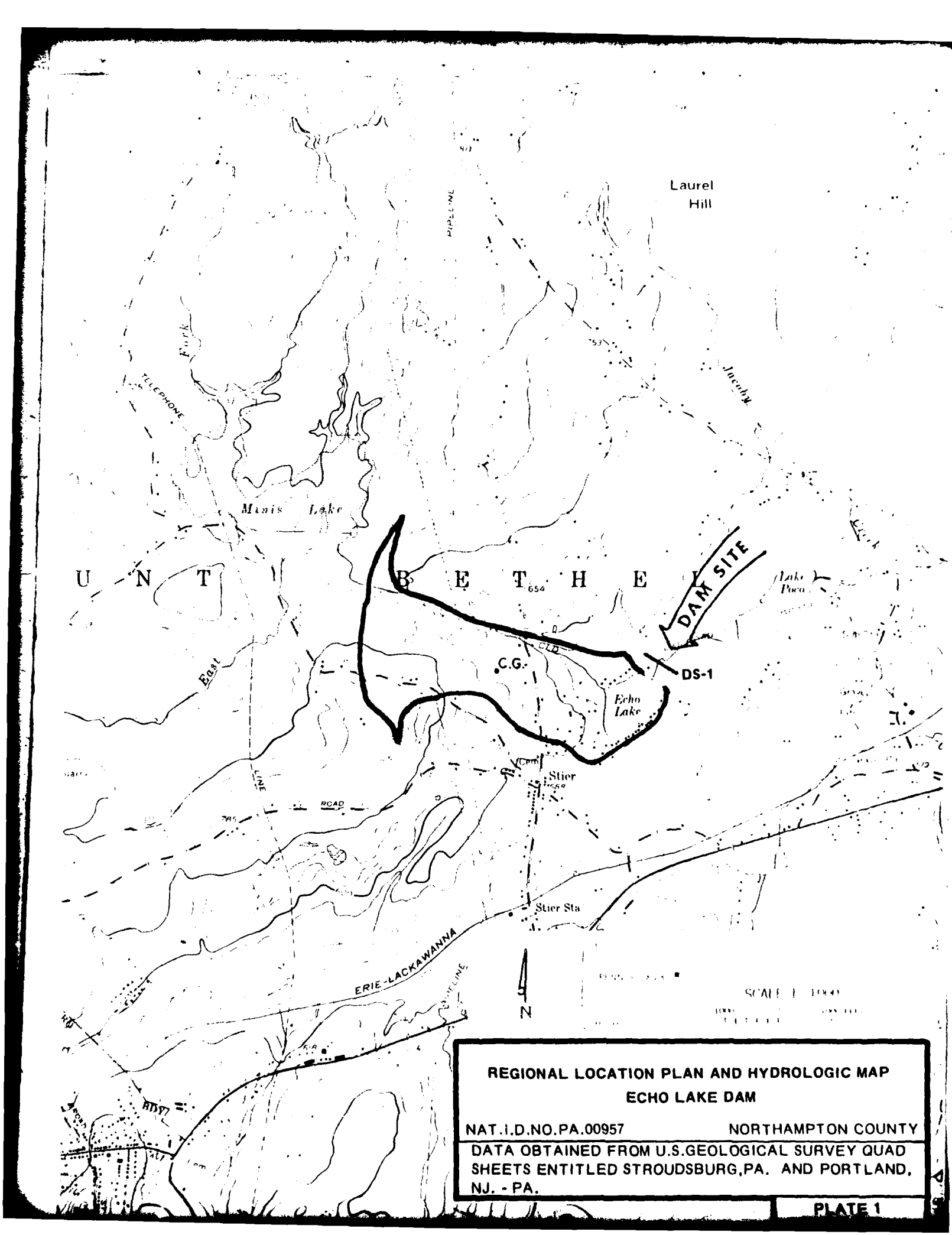
RATIO OF ~~PMF~~ 100 YR. FLOOD	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	560.26	0.00	70.	50.	0.00	20.75	0.00

PLAN 1 STATION DS1

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	50.	548.8	20.75

APPENDIX

E

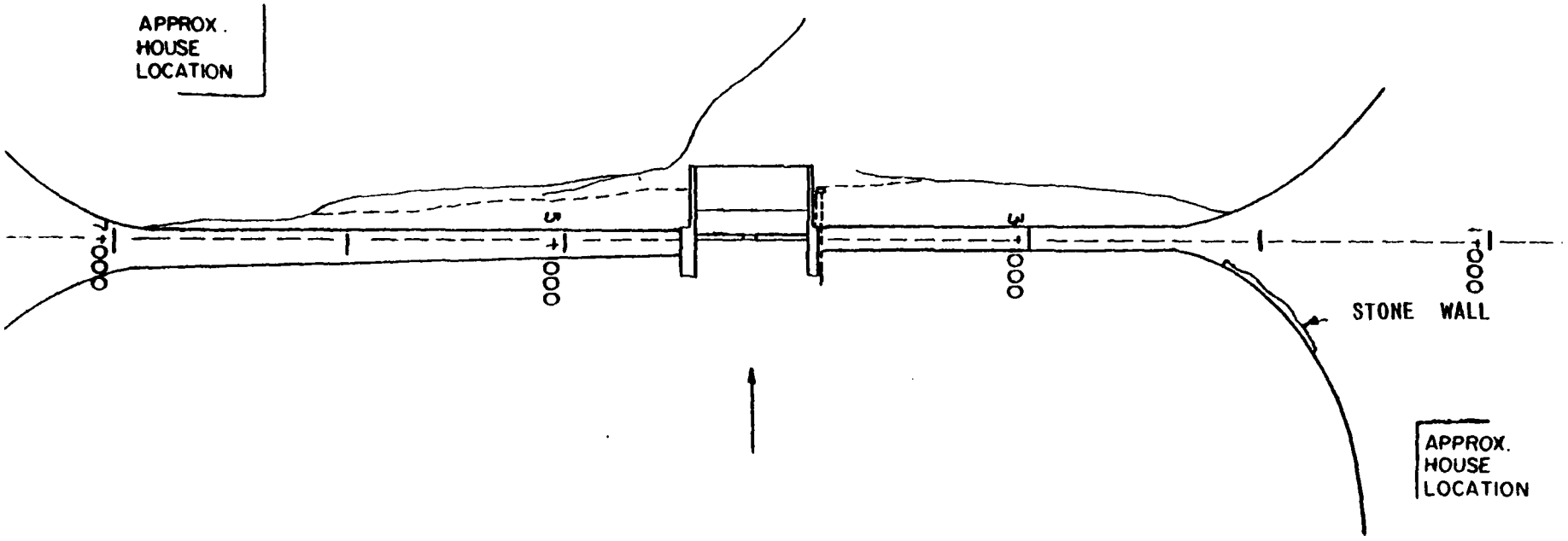


REGIONAL LOCATION PLAN AND HYDROLOGIC MAP
ECHO LAKE DAM

NAT.I.D.NO.PA.00957 NORTHAMPTON COUNTY

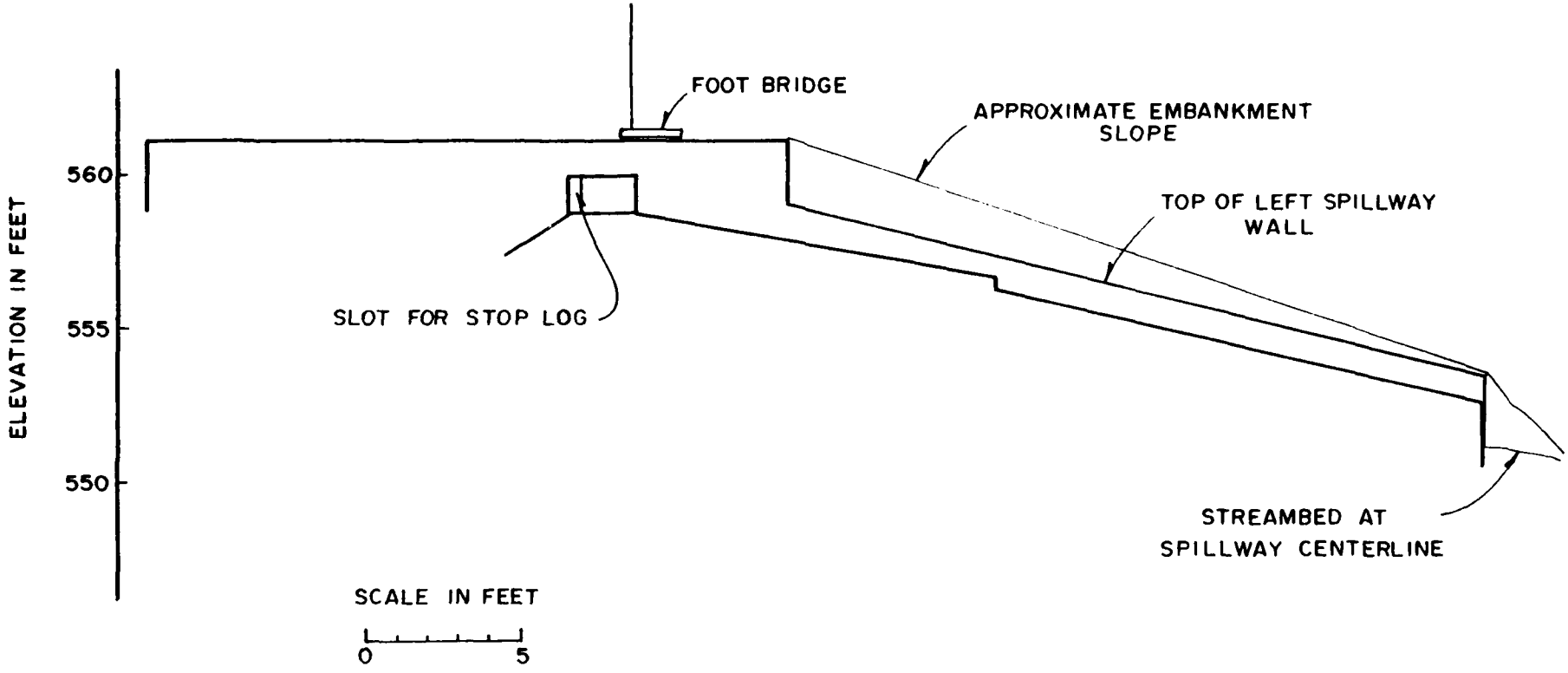
DATA OBTAINED FROM U.S.GEOLOGICAL SURVEY QUAD SHEETS ENTITLED STROUDSBURG,PA. AND PORTLAND, NJ. - PA.

PLATE 1



PLAN VIEW
ECHO LAKE DAM

PLATE 2



DATA DRAWN FROM MEASUREMENTS TAKEN ON NOV. 20, 1980

SECTION THROUGH SPILLWAY
ECHO LAKE DAM

PLATE 3

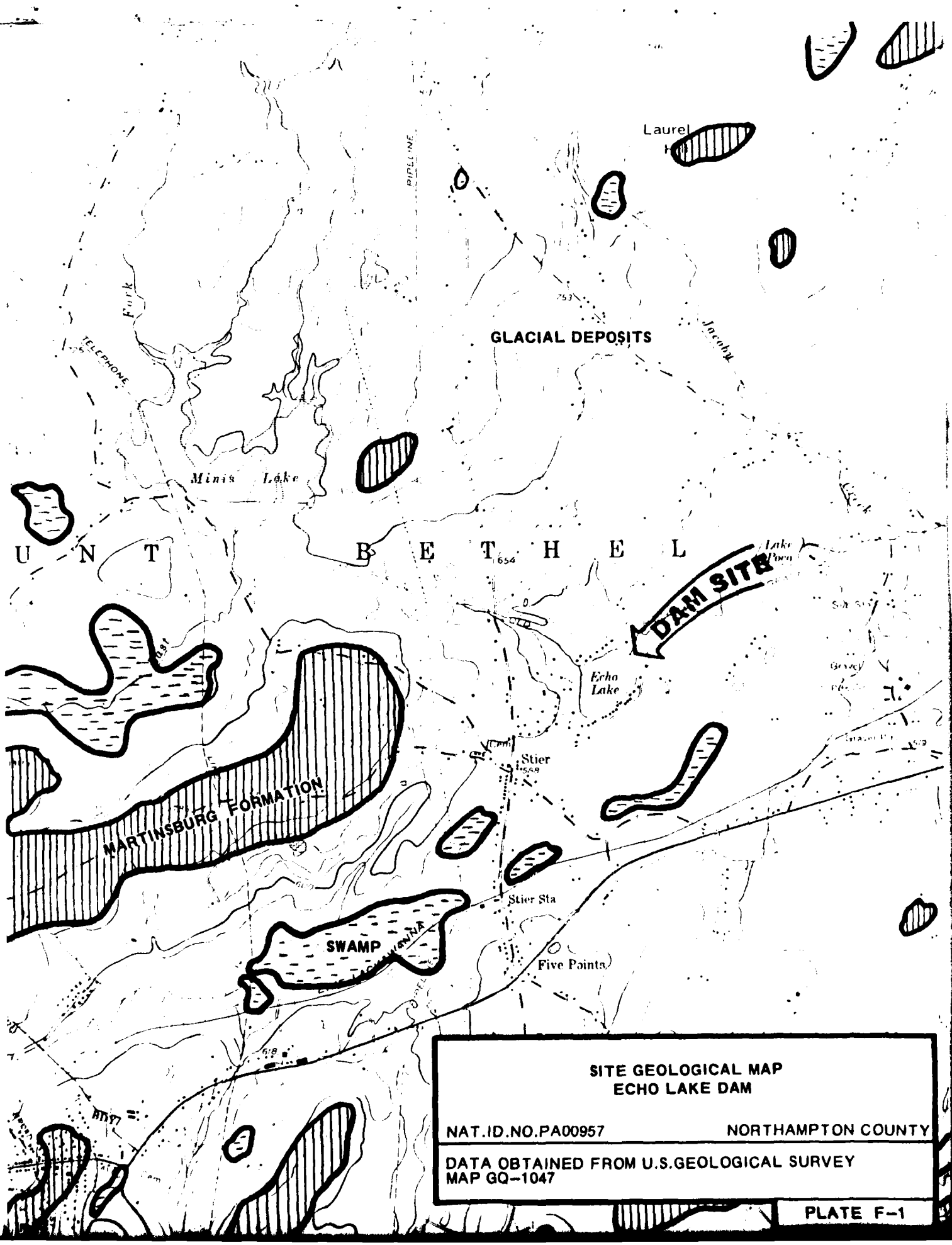
APPENDIX

F

ECHO LAKE DAM

SITE GEOLOGY

Echo Lake Dam is located in the Great Valley section of the Valley and Ridge physiographic province. As shown on Plate F-1, the dam site and much of the surrounding areas are underlain by glacial deposits of Pleistocene age. These deposits consist of varying amounts of gravel, sand, silt and clay. Locally, in the vicinity of the dam, concentrations of boulders were noted during the field inspection. No bedrock exposures were observed near the dam site. Slate and siltstone deposits of the Martinsburg Formation are exposed elsewhere in the area, however, regional geologic mapping indicates the dam site to be underlain by the limestone and dolomite of the Allentown Formation. Consistent with the variable compositional character of glacial deposits, there exists the potential for reservoir seepage through these deposits in addition to seepage along the bedrock interface if bedrock is in fact relatively close to the surface.



SITE GEOLOGICAL MAP
ECHO LAKE DAM

NAT.ID.NO.PA00957 NORTHAMPTON COUNTY

DATA OBTAINED FROM U.S.GEOLOGICAL SURVEY
MAP GQ-1047

PLATE F-1