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DELAWARE RIVER BASIN
POND CREEK, MONROE COUNTY

PENNSYLVANIA
NDI NO. PA.00993
DER NO. 45-148

RAKES DAM

OWNER: W. ADOLPH RAKE, SR.

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ELECTE
DEC 31 1981

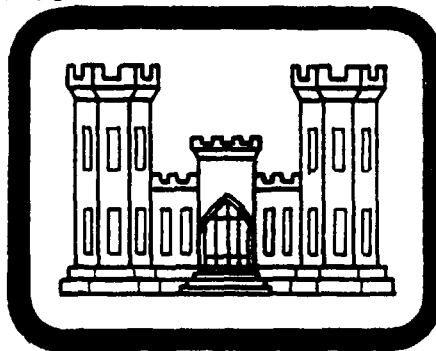
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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

prepared by

Woodward-Clyde Consultants

DACW31-81-C-0025



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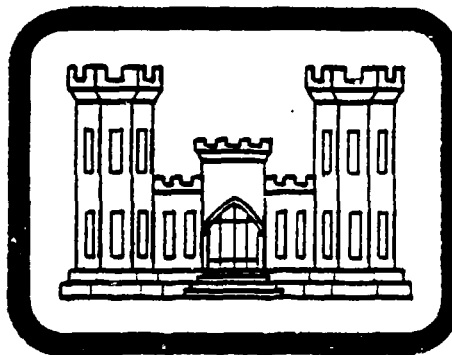
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PHASE I INSPECTION REPORT
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Prepared by:

WOODWARD-CLYDE CONSULTANTS
5120 Butler Pike
Plymouth Meeting, Pennsylvania 19462

Submitted to:

DEPARTMENT OF THE ARMY
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Baltimore, Maryland 21203

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams for Phase I Investigations. Copies of these guidelines may be obtained from the Office of 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 estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

Name of Dam:	Rakes Dam
County Located:	Monroe County
State Located:	Pennsylvania
Stream:	Pond Creek
Coordinates:	Latitude 41° 3.4' Longitude 75° 6.2'
Date of Inspection:	March 18, 1981

Rakes Dam is a privately owned dam used for recreational purposes. The dam is currently in fair condition and is poorly maintained and the spillway and pond drain are in poor condition requiring maintenance.)

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 limited downstream development the 100-year event has been selected as the spillway design flood.

Hydrologic and hydraulic computations presented in Appendix D indicate that the spillway structure is capable of discharging the 100-year event without overtopping the embankment. >The structure is considered to have an "Adequate" spillway capacity.

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

- (1) Repair or replace all deteriorated concrete.
- (2) Remove all trees and woody vegetation on the upstream embankment slope, crest and downstream embankment slope and return the slopes to their original condition. Because of the lack of freeboard, the embankment elevation adjacent to the right spillway wall should be increased consistent with the rest of the embankment and the crest should be protected with erosion resistant materials such as a well established and well maintained grass cover.

RAKES DAM NDI NO. 00993

- (3) The operational status of the pond drain sluice gate should be investigated and repairs made, if necessary.

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

July 17, 1981
Date

John H. Frederick, Jr.
John H. Frederick, Jr., P.E.
Maryland Registration 7301
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July 17, 1981
Date

APPROVED BY:

James W. Peck
James W. Peck
Colonel, Corps of Engineers
Commander and District Engineer

28 July 81
Date



OVERVIEW
RAKES DAM, MONROE COUNTY, PENNSYLVANIA

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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
RAKES DAM
NATIONAL ID NO. PA 00993
DER NO. 45-148

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. Rakes Dam is an earthfill dam with, according to design drawings, a timber cutoff wall and upstream puddled clay core wall 4 feet thick. The dam is about 10 feet high and about 330 feet long with a 100-foot wide spillway at the left end of the embankment. About 220 feet to the right of the spillway, the embankment deflects upstream through an angle of about 45°. The upstream embankment slope is protected with hand-placed riprap which is nearly vertical in some locations, but which is typically about 2H:1V, the design slope of the embankment. The eight foot wide embankment crest is protected with grass. The downstream embankment slope ranges from 2.35H:1V to 2.9H:1V.

The spillway consists of a concrete weir contained between two concrete and stone masonry spillway walls. The height of both walls was increased by a cap of stone masonry. About 18 feet downstream of the weir is a concrete cutoff toe wall. Originally, grouted stone paving was between the weir and the cutoff wall. About 150 feet to the right of the spillway is the pond drain conduit, a 30-inch I.D. diameter pipe encased in six inches of concrete. The intake is underwater at the upstream embankment toe and the outlet is at the downstream embankment toe. Flow through the conduit is controlled by a sluice gate located upstream of the cutoff wall.

b. Location. The dam is located across Pond Creek in Smithfield Township, Monroe County, Pennsylvania. The dam site is about 1.5 miles northeast of Marshalls Creek. The site is

shown on the USGS Quadrangle map titled "Bushkill, Pennsylvania - New Jersey" at coordinates N 41° 3.4' W 75° 6.2'. A Regional Location Plan of Rakes Dam is enclosed as Plate 1, Appendix E.

c. Size Classification. The dam is classified as a "Small" size structure by virtue of its 9.6-foot height and less than 1000 acre-foot reservoir capacity to the top of the dam.

d. Hazard Classification. A "Significant" hazard classification is assigned consistent with the potential for economic damage, but few or no lives lost downstream along Pond Creek. See Section 3.1, paragraph e.

e. Ownership. The dam is owned by Mr. W. Adolph Rake, Sr. All correspondence should be sent to Mr. Rake at R.D. #6, Box 84, East Stroudsburg, Pennsylvania 18301.

f. Purpose of the Dam. This dam is used for private recreational purposes.

g. Design and Construction History. The dam was designed in 1931 by Edward C. Hess, Civil Engineer and Surveyor. The "Report Upon the Application of A.L. Rake", the present Owner's father, indicated the upstream fill would be of compacted select material and the downstream fill of compacted material. The ground surface under all fill was to be cleared and grubbed. The core wall was to extend from a level two feet below the design top of embankment to impervious material or at least four feet below the natural ground surface. The gate well located upstream of the puddled clay core wall was to have outside dimensions of 7 by 7.5 feet with 18-inch thick walls. The sluice gate is at the downstream side of the gate well with grooves for stop logs or screens on the upstream side of the box. The blow-off pipe intake was to be protected with a trash rack.

In August 1931, the original dam design was altered to confine the reservoir to Mr. Rake's property. This was accomplished by lowering the spillway crest elevation by 2.3 feet. The original plan was also altered to include the upstream deflection of the embankment to avoid relocating a portion of a public road.

In September 1931, the engineer requested an inspection of the foundation excavation. Inspection by the State disclosed that "good clay" was exposed at the bottom of the open excavation. Part of the trench had been backfilled but only to a width of 18 inches, less than the four feet specified in the approved plans. Stripping for the rest of the embankment disclosed clay as a foundation material for practically the entire length of the dam. The outlet pipe and gate had been

constructed in a workmanlike manner. The cutoff trench was only 2 to 2.5 feet deep instead of the required four feet minimum depth below the natural ground surface. The State directed that the dam core wall be constructed according to the approved plans.

A new core trench was excavated upstream of the one already in place so that the bottom would slope or step-down from the present core trench to the depth specified in the plan. The new trench was to be backfilled with a good quality of puddled clay similar to that which was already placed. Excavation for the new trench to the left of the gate well was carried between five and eight feet below the original ground surface. The excavation disclosed that the shallow cutoff trench was founded about at the bottom of the surficial clay layer and beneath the clay was a stratum several feet thick of a mixture of "rotten" shale and clay with occasional pockets of gravel. The new trench was founded in an impervious, tough, blue clay. A small spring was encountered emerging from the rock near the end of the trench. The construction superintendant stated "he expected to either follow this back beyond the end of the wall, or box it off and pour the wall upstream from it". Excavation for the new cutoff core trench to the right of the gate well disclosed that the rock foundation was nearer the ground surface than in the trench to the left of the gate well.

By November 1931, the State inspector noted that fill had been carried to about the top of the plank cutoff and seemed to be of fair quality. The construction superintendent stated that there would be extra fill which would be placed on the downstream slope, making it flatter than the design slope.

By April 1932, the dam was nearly complete with riprap being placed in the upstream face nearly to the top.

The June 1932 State inspection disclosed that the embankment crest had been raised about 18 inches higher than the final approved plans and an 18-inch stone masonry cap had been placed on the spillway abutment walls. Since the crest width was decreased, the State directed that additional fill be placed on the downstream embankment slope to maintain the design crest width. Trees had also been planted downstream of the dam, the nearest of which were on the toe of the fill. The final spillway drawings submitted to the State restored the flow line to the original design elevation, but included three notches 10 feet long and 2.3 feet deep in the weir provided with removable boards and 18-inch high fish screens across the spillway.

By September 1932, the requested additional fill had been placed on the downstream embankment slope, completing the dam to its full height and width. The downstream slope was also riprapped.

The State inspection in June 1933 disclosed slight seepage in the roadside ditch at the bend at the right end of the dam, and also stated, "Near right end and lower edge of waste paving, water bubbles from several small holes in the paving." The same seepage was noted in the following year's inspection. The 1941 inspection indicated the crest was about 4 inches low over its entire length and seepage was again noted in the wasteway channel and at the drainage ditch at the right end of the dam. The right spillway wall was beginning to show disintegration, as was the wasteway pavement. The State directed Mr. Rake to determine the source of leakage under the pavement and to stop the leakage to prevent the pavement from being destroyed. In 1949, the Owner was directed to increase the height of the embankment to the original design elevation, remove all trees and vegetation from the embankment slopes, and to remove the flashboards that replaced the original fish screens on the spillway. A 1957 inspection noted no leakage at the toe or through the spillway and noted that maintenance was good. In 1966, the spillway crest was noted as having broken flashboards. In addition to trees and brush on both the upstream and downstream embankment slopes and on the crest, there was a collection of debris in the spillway discharge channel. In 1966, Mr. W. A. Rake was notified that "trees and brush growing on the dam should be removed" in addition to removing the flashboards and clearing away the wasteway channel debris. Later that year Mr. Rake replied that "he complied with the directions" with the exception of removing the flashboards.

h. Normal Operating Procedures. Under normal conditions, all flow is discharged over the spillway. There are no minimum flow requirements downstream of this dam.

1.3 Pertinent Data.

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

a.	Drainage Area (square miles)	6.31
b.	Discharge at Dam Site (cfs)	
	Maximum Known Flood (in 1950)	Unknown
	At Minimum Embankment Crest	2400
c.	Elevation (feet above MSL) ⁽¹⁾	
	Top of Dam	
	Existing minimum	498.6
	Final Design	498.9±
	Spillway Weir Crest (average)	494.8
	Pond Drain Outlet Invert	489.0

(1) Water surface elevation assumed to be 495 from USGS map. All other elevations are relative to this elevation.

d.	Reservoir (feet)	
	Length at Normal Pool	1,800
	Length at Maximum Pool (est)	1,810
e.	Storage (acre-feet)	
	Normal Pool (est)	23
	Top of Dam (est)	185
f.	Reservoir Surface (acres)	
	Normal Pool	14.7
	Top of Dam (est)	95
g.	Dam Data	
	Type	Earth fill with timber and puddled clay core wall
	Length (excluding spillway)	330 feet
	Side Slopes	
	Upstream (above water line)	2H:1V
	Downstream	2.35:1V to 2.9:H:1V
	Volume	2500 cu. yd.
	Height Above pond drain outlet invert	9.6 feet
	Crest Width	8 feet
	Cutoff	Timber plank and puddled clay core wall
	Grout Curtain	None
h.	Spillway	
	Type	Concrete weir
	Average Crest Elevation	494.8 feet
	Length	100 feet
i.	Pond Drain	
	Type	30-inch RCP encased in concrete, gated upstream of core wall
	Length	44 feet
	Inlet Invert Elevation	Unknown
	Outlet Invert Elevation	489.0

SECTION 2 ENGINEERING DATA

2.1 Design.

a. Data Available. Original engineering data for Rakes Dam are limited to plans drawn by the Owner's engineer. Hydrologic/hydraulic data are limited to the State's required minimum spillway capacity and an evaluation by the State of the spillway capacity.

b. Design Features. Plan and profile views of the dam are shown on Plates 2 through 5, Appendix E. Reference datum for the drawings is unknown. A summary of the features of the dam is included in Section 1.3.

2.2 Construction.

The known construction history is presented in Section 1.2, paragraph g.

2.3 Operational Data.

There are no operational records maintained for this dam.

2.4 Evaluation.

a. Availability. All information presented herein was obtained from reports and correspondence from Pennsylvania Department of Environmental Resources files and supplemented by conversations with the Owner.

b. Adequacy. The available file data prior to the Phase 1 Inspection 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. Observations and comments of the field inspection team are contained in the checklist enclosed herein as Appendix A, and are summarized and evaluated in the following subsections. In general, the appearance of the facilities indicates that the dam is currently in fair condition and is poorly maintained and that the spillway and pond drain are in poor condition, requiring maintenance.

b. Dam. The vertical alignment of the dam crest was checked, and the profile is shown on Sheet 5C, Appendix A. There are no distortions in alignment that would be indicative of deep-seated movements of the embankment or foundation. The upstream embankment slope is protected by riprap which has been displaced by brush and trees. Measurements indicated that the upstream slope above the waterline is about 2H:1V. There appeared to be some displacement of riprap at the waterline, possibly the result of wave and/or ice action. Some slight erosion/foot traffic damage was evident adjacent to the upstream side of the gate well. The embankment crest is protected with vegetation and is generally cleared of woody vegetation. No wheel ruts or foot traffic damage was noted. The downstream embankment slope is protected by riprap. In most areas the downstream slope is 2.9H:1V. Trees up to 18 inches in diameter are growing adjacent to the downstream toe and most of the downstream embankment slope is covered with brush and trees. All junctions between the embankments and abutments appeared in good condition and no evidence of damage by foot traffic was noted either at the junctions or on the embankment itself.

No seepage was located either at or beyond the downstream toe of the embankment, in spite of the historical reference to seepage contained in the Department of Environmental Resources' files, see Section 1.2, paragraph g. Backwater from the downstream stream is 8 inches deep in the pond drain conduit. No motion or current within the water could be detected. No seepage was observed in the channel downstream of the weir, although such seepage has been noted in State reports from 1933 to 1949.

c. Appurtenant Structures. The stone and concrete spillway is in poor condition and the flow over the spillway crest was not uniform. The original concrete has experienced deterioration, causing the downstream edge of the weir to be slightly rounded, while the concrete filling in the three original notches appears to be relatively intact, see Photograph

2. There are some cracks in the weir with possible slight displacement of concrete. Approximately half of the sloping grouted stone paving between the weir and the downstream cutoff wall has disintegrated and been displaced, see Photograph 2. Considerable brush and some small trees are growing in the channel, Photographs 1 and 2. The left spillway wall has experienced considerable deterioration, including broken concrete, at the upstream end, Photograph 3. Downstream of the weir, the exposed face of the concrete wall displays surficial concrete deterioration. The right spillway wall has suffered extensive concrete deterioration in the vicinity of the junction of the weir and wall, Photograph 5, and the extreme upstream portion of the wall has broken off. A large portion of the stone masonry cap has broken and been displaced at least three inches toward the spillway, Photograph 4.

The pond drain inlet is under water and could not be inspected. The original concrete gate well was capped by a row of stones and the wooden enclosure shown in Photograph 6 placed on top. The concrete has suffered considerable erosion and deterioration, Photograph 7. There is an opening, not shown on the design drawings, through the upstream wall just above the normal pool elevation. This opening appears to be few inches high and about 3 feet long. The slots for stop-logs have deteriorated and the steel supports supporting the gate hoist stand are unattached. It is not known if the gate is operational. The Owner reported he did not know the last time the gate was operated, although in 1968 he received a drawdown permit from the State. The pond drain discharges at the downstream toe through a structure with an end wall and side walls. The side wall concrete has completely deteriorated in the vicinity of the waterline as shown in Photograph 9.

d. Reservoir. The reservoir side slopes in the vicinity of the dam are moderate to steep and generally vegetated to the water's edge with light woods and grass.

There are four major impoundments and numerous smaller ponds upstream of Rakes Dam. Several extensive marshy or swampy areas will also afford considerable detention to surface runoff. About 1,500 feet upstream of the upper end of Rakes Dam Reservoir is the beginning of an extensive marshy area. Meadow Lake, DER 45-47, discharges into this marshy area and then to Rakes Dam. Meadow Lake Dam is about 14 feet high with a normal reservoir capacity of approximately 60 acre-feet. Approximately two miles upstream of Meadow Lake is Pocono Highlands Lake, DER No. 45-131. Pocono Highlands Dam is approximately 20 feet high with an estimated normal capacity of 48 acre-feet. Emptying into the marshy area upstream of Rakes Dam reservoir is also Coolbaugh Lake, DER No. 45-46. Coolbaugh Lake Dam is listed as 3 feet high. About 2,000 feet further

upstream from Coolbaugh Lake is Echo Lake, DER No. 45-NL1, a natural lake. The above information was obtained from the Commonwealth of Pennsylvania Water Resources Bulletin No. 5, "Dams, Reservoirs and Natural Lakes." The Bulletin also indicates that an additional dam, DER No. 45-123, also drains into Rakes Dam watershed. However, visual observation of the watershed disclosed that the Hidden Lake outflow does not flow into Rakes Dam watershed.

e. Downstream Channel. About 100 feet downstream of the dam, Pond Creek passes under a public highway through a bridge crossing whose clear span opening is approximately 12 feet wide by three feet high. Pond Creek then flows through a flat, moderately wide valley for about 4,500 feet to the first downstream damage center, a sports camp complex. On an island in the stream is a motel like complex about 4.5 feet above the normal water level, Photograph 17. On the right bank is a dormitory at a slightly higher elevation. About 4000 feet further downstream is Marshall's Dam, DER No. 45-52, which is about eight feet high. The Phase I Inspection Report for this dam is dated July 1981. About 200 feet downstream of Marshall's Dam, Pond Creek enters Marshall Creek. At the confluence of the two streams are buildings which appear to be sufficiently high above Pond Creek so as not to be affected by failure of Rakes Dam. Therefore, a "Significant" hazard classification for this structure is indicated.

3.2 Evaluation.

Inspection of the dam and appurtenant facilities indicates that little or no routine maintenance has been provided to the structure, and that the spillway and pond drain are in poor condition, requiring extensive repairs. Woody vegetation, trees and brush on the upstream embankment slope, crest and downstream embankment slope of the dam are undesirable. All such vegetation should be removed and the embankment slopes returned to their original condition. Thereafter, any woody vegetation should be removed on an annual basis.

Records in the Department of Environmental Resources files indicate that from 1933 through 1949 seepage at the downstream toe of the embankment and the spillway was observed. The more recent inspection reports do not note such seepage, nor was it observed during the Phase I inspection.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedure.

Operation of the dam does not require a dam tender. All flow discharges directly over the spillway crest and downstream into Pond Creek.

4.2 Maintenance of the Dam.

In recent years maintenance of the dam has been limited to the cutting of woody vegetation on the embankment crest and is performed by the Owner.

4.3 Maintenance of Operating Facilities.

No maintenance of the operating facilities has been provided.

4.4 Warning Systems In Effect.

There are no formal warning systems or procedures to be followed during periods of exceedingly heavy rainfalls.

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 facilities of Rakes Dam. There are no written operational or maintenance procedures or any type of warning system. Maintenance and operational 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 that dangerous conditions are developing.

SECTION 5
HYDROLOGY/HYDRAULICS

5.1 Evaluation of Features.

a. Design/Evaluation Data. There are no original design calculations for this structure, and subsequent evaluation data are limited to a Statement in the State's "Report Upon the Application" that this spillway capacity is 2,700 cfs. The drainage pattern within the watershed is complex as a result of pre-historic glaciation and of man's activities. The four major upstream dams or impoundments are described in Section 3.1, paragraph d. The watershed is about three miles long and approximately 1.6 miles wide, having a total area of 6.31 square miles. Elevations range from a high of about 1,520 feet to the normal pool level of about 495 feet. The watershed is approximately 70 percent wooded with extensive marshy areas and numerous small ponds. Residential development is limited to less than 10 percent of the watershed. While some residential development has recently occurred in 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 small capacity of the reservoir and the fact that no loss of life is likely during 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. The Owner could provide no estimates of previous high water levels.

c. Visual Observations. At the time of the inspection, the only condition observed that would indicate a reduced spillway capacity during an extreme event was the settlement adjacent to the right spillway wall. 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 by comparing the peak inflow value during 100-year event to the spillway capacity. Calculations for this investigation indicate that the maximum spillway capacity is 2,400 cfs, with the reservoir level at the low point of the embankment crest. Under design conditions the maximum spillway discharge would be about 2,600 cfs. The 100-year peak

inflow rate was calculated 1,750 cfs according to procedures contained in the Department of Environmental Resources Bulletin No. 13, "Floods in Pennsylvania". All upstream impoundments were conservatively neglected in computing the peak inflow values.

e. Spillway Adequacy. The spillway for this structure is considered to be "Adequate" as it will pass the spillway design storm without overtopping the embankment under existing conditions.

f. Downstream Conditions. Pond Creek flows under a public road which is about 100 feet downstream of the dam. During the spillway design storm it is estimated that the road will be flooded, but the tailwater will not submerge the weir. Downstream of the highway, the flood plain opens up somewhat but is fairly flat for about 4,500 feet to the first downstream damage center, the sports camp complex. It is estimated that the motel-like structure on the island in the creek would become flooded during spillway design event and property damage would occur as a result of failure of the dam either during or without the spillway design storm. Pond Creek then flows through Marshall's Dam Reservoir. The three buildings shown on Plate 1 at the waters edge are actually far enough above the water surface so as not to be damaged during a flood or failure of the dam. Therefore, a "Significant" hazard potential classification is indicated.

SECTION 6 STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability.

a. Visual Observations. Evidence of existing spillway instability detected by visual observations included the concrete spalling on the left spillway wall and the erosion and deterioration of concrete at the water line on both spillway walls, the weir crest, the gate well and outlet structures. A large portion of the stone masonry concrete cap on the right spillway wall has been displaced towards the spillway and the upstream ends of both spillway walls have disintegrated. The embankment slope has suffered minor effects of wave/ice action over the years and considerable brush and trees are growing on both the upstream and downstream embankment slopes. At the time of the Phase I Inspection no seepage was observed either in the spillway or pond drain discharge channels or at any location along the embankment toe.

b. Design and Construction Data. Design drawings and as-built drawings of the spillway were available for review. Other construction data available for review are limited to the State's construction reports and photographs. Thus, there are no stability analyses of the embankment available. The maximum height of the dam is about 9.6 feet above the pond drain invert. The upstream slope averages about 2H:1V and the downstream embankment slope is flatter, 2.35H:1V to 2.9H:1V. Based on the geometric configuration of the embankment and the fact that the downstream embankment slope is also protected by riprap, the embankment is assessed to be stable at this time.

Detrimental to the long-term stability of earthen embankments is the presence of extensive root systems within the embankments. The long-term stability of the embankment could be adversely affected when trees with well established root systems die and the roots rot, forming channels for water to percolate through the dam. If the trees are allowed to fall over, large craters could be formed, possibly leading to a breach of the dam. The birch trees on the upstream embankment slope have deep root systems and are short-lived trees. Thus, they should be removed and the embankment returned to its original condition.

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

d. Post-Construction Changes. Post-construction modifications or changes to the dam are limited to the removal of the fish screens and flashboards and the concreting in of the original three low-flow notches.

e. 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. As the dam is qualitatively assessed to be stable at the present time under static loading conditions, it can reasonably be assumed to be stable under seismic loading conditions.

SECTION 7
ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment.

a. Evaluation. Visual inspection indicates that Rakes Dam is in fair condition, although the spillway structure and pond drain are currently 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 (PMF). 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 that the spillway structure is capable of discharging the 100-year event without overtopping the embankment. The structure is considered to have an "Adequate" spillway capacity.

b. Adequacy of Information. The combined visual inspection and simplified calculations presented in Appendix D were sufficient to indicate that major repairs are required for this structure.

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. All items should be performed under the supervision of a registered professional engineer experienced in the design and construction of dams.

- (1) Repair or replace all deteriorated concrete.
- (2) Remove all trees and woody vegetation on the upstream embankment slope, crest and downstream embankment slope and return the slopes to their original condition. Because of the lack of free-board, the embankment elevation adjacent to the right spillway wall should be increased consistent with the rest of the embankment, and the crest should be protected with erosion resistant materials such as a well established and well maintained grass cover.

- (3) The operational status of the pond drain sluice gate should be investigated and repairs made, if necessary.

b. Operation and Maintenance Procedures. 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 be developed to insure that all pertinent items are carefully inspected on a regular basis and maintained in the best possible condition.

APPEND . X

A

CHECK LIST
VISUAL INSPECTION
PHASE I

Name Dam Rakes Dam
County Monroe State Pennsylvania
NDI# PA 00993 DER# 45-148 Type of Dam Earth
Hazard Category Significant
Date(s) Inspection March 18, 1981
Weather Partly Sunny Temperature 30's
Pool Elevation at Time of Inspection 495.0 M.S.L.
Tailwater at Time of Inspection 490± M.S.L.

Inspection Personnel:

<u>Mary F. Beck</u>	<u>Paul F. Mareno</u>
<u>Raymond S. Lambert</u>	<u>Vincent McKeever</u>
<u>Richard E. Mabry</u>	<u>John H. Frederick, Jr., Principal</u>

Mary F. Beck Recorder

Remarks:

Mr. W. Adolph Rake, Sr., 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	<i>None observed</i>	
----------------	----------------------	--

UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	<i>None observed</i>	
---	----------------------	--

SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	<i>Up- and downstream embankment slopes are irregular but appear stable. Slight erosion or foot traffic damage of crest adjacent to downstream side of gate well.</i>	
---	---	--

VERTICAL AND HORIZONTAL ALIGN- MENT OF THE CREST	<i>See Sheets 5A and 5C</i>	
--	-----------------------------	--

RIPRAP FAILURES	<i>Stone appears slightly benched at waterline.</i>	
-----------------	---	--

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
-----------------------	--------------	----------------------------

VEGETATION

Up- and downstream slopes are covered with brush and trees up to 18 inches in diameter. Embankment crest had been cleared of brush several years ago but brush is beginning to encroach on it. Crest is protected by grass.

JUNCTION OF
EMBANKMENT
AND ABUTMENT,
SPILLWAY AND
DAM

All junctions of embankment and abutment or spillway appear to be in good condition.

ANY NOTICE-
ABLE SEEPAGE

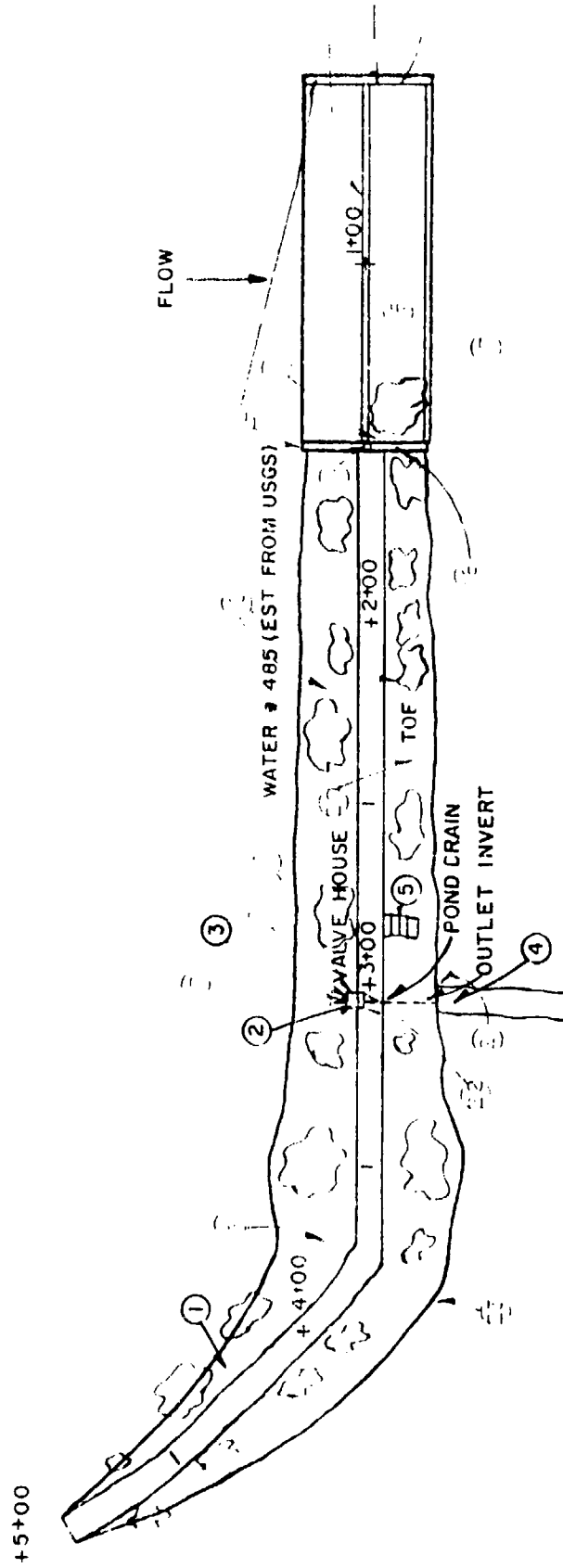
None

STAFF GAGE
AND RECORDER

None

DRAINS

None

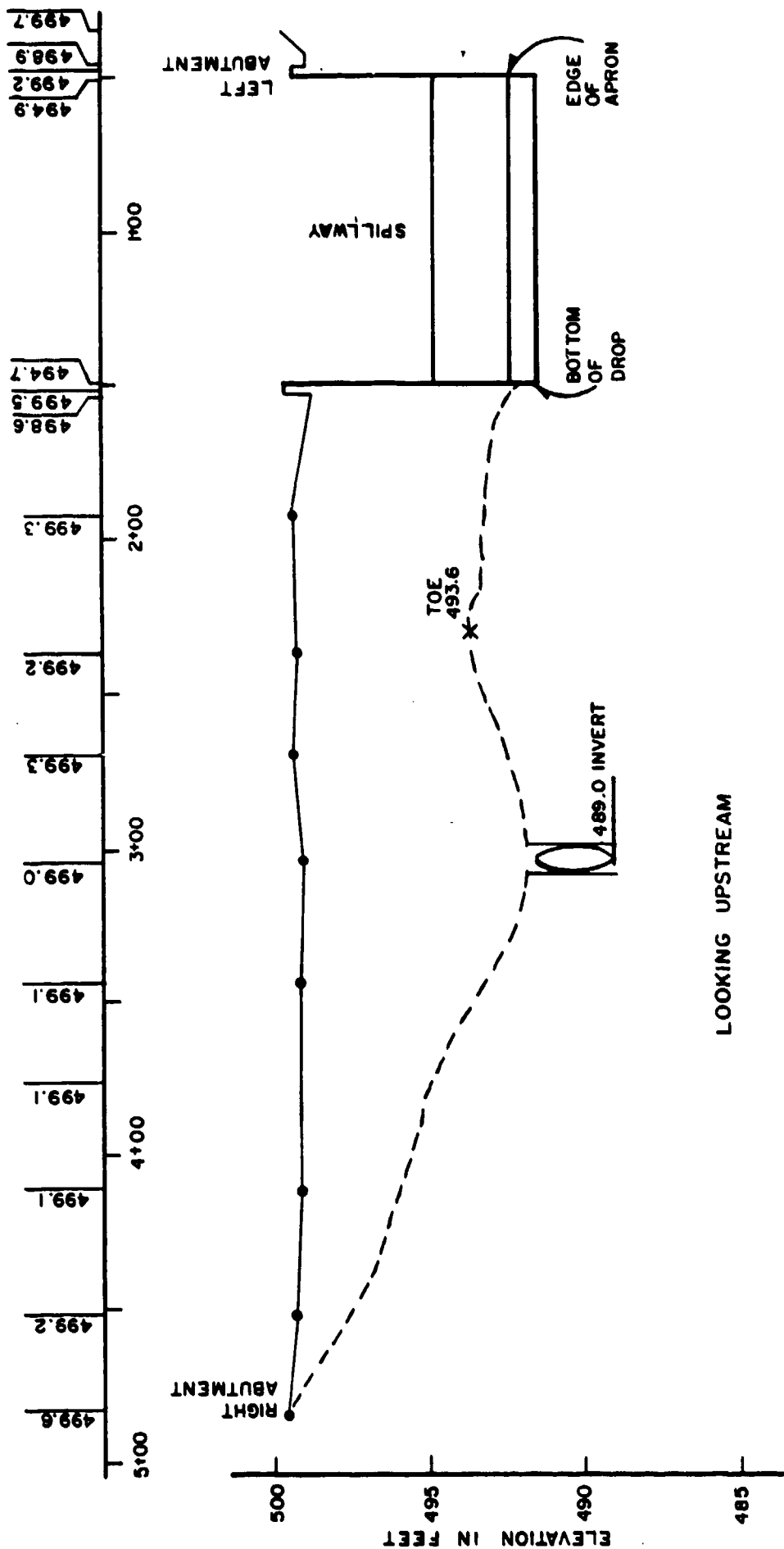


SCALE IN FEET
 0 50

FIELD OBSERVATION PLAN
 RAKES DAM

1. Remnant of vertical stone wall facing.
2. Gate appears seated.
3. Opening through upstream wall just above waterline (3/18/81).
4. No flow in channel.
5. Stone steps on embankment, which is protected with stone.
6. Stone on upstream face irregular, possible benching at waterline.
7. Slots inside of upstream face for stop-logs have deteriorated.
8. Gate well has deteriorated concrete and missing stone.
9. Supports for gate hoist not attached.
10. Brush and trees up to 18 inches in diameter on up- and downstream embankment slopes.
11. Deteriorated concrete.
12. Upstream end of spillway walls are broken.
13. Flow over spillway crest not uniform.
14. Spalling concrete.
15. Concrete erosion along waterline.
16. Sloping rock and concrete apron deteriorated and displaced.
17. Brush growing in channel.
18. Wall tilts toward spillway.
19. Stone masonry cap displaced toward spillway.
20. Stone on downstream embankment is irregular.
21. Pond drain outlet structure side walls have disintegrated at waterline.
22. Slight erosion/foot traffic damage adjacent to upstream side of gate well.
23. Utility pole guy anchored in embankment.

Notes for Field
Observation Plan
Rakes Dam
Sheet 5B



HORIZONTAL SCALE: 1"=50'
VERTICAL SCALE: 1"=5'

PROFILE ALONG CREST
RAKES DAM
SHEET 5C OF 11

WATER ELEVATION ASSUMED 495.0
FROM USGS MAP, ALL OTHER
ELEVATIONS RELATIVE

LOOKING UPSTREAM

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	<i>None observed from downstream end of 30-inch RCP.</i>	
INTAKE STRUCTURE	<i>Considerable concrete deterioration, particularly of upstream face. Members supporting gate hoist not attached to structure at one end.</i>	
OUTLET STRUCTURE	<i>The side wall concrete has completely deteriorated in the vicinity of the waterline.</i>	
OUTLET CHANNEL	<i>In good condition.</i>	
EMERGENCY GATE	<i>Not operated during inspection, unknown when last operated. There was no visible evidence to indicate gate cannot be operated.</i>	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
-----------------------	--------------	----------------------------

CONCRETE WEIR

Flow over weir is uneven as a result of concrete deterioration. Although the weir is cracked, no lateral displacement was observed. Spillway walls are cracked, distorted, and have spalled areas requiring repair.

APPROACH CHANNEL

None

DISCHARGE CHANNEL

The channel downstream of the spillway end sill is in good condition with no excessive erosion of channel banks.

BRIDGE AND PIERS

None

GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
TYPE	None	
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

Reservoir side slopes are moderate and vegetated to water's edge (in vicinity of dam) with trees and brush.

SEDIMENTATION

Sedimentation not reported to be a problem.

WATERSHED

The watershed is composed of hills and valleys, wider valleys are generally swampy. Three upstream dams and one natural lake provide significant storage and there are numerous smaller ponds/dams providing negligible flood storage.

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	<i>The downstream channel is about 18 feet wide with 2-foot high banks. The banks are brush covered and appear stable. No large debris was noted between the dam and the first downstream bridge.</i>
SLOPES	<i>The valley gradient is on the order of 0.0009.</i>
APPROXIMATE NO. OF HOMES AND POPULATION	<i>Approximately 4500 feet downstream of the dam is a sports camp. A motel-like structure is located about 4.5 feet above normal water level on an island in Pond Creek. A dormitory is at a higher elevation on the right stream bank.</i>

APPENDIX

B

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM Rakes Dam

NDI NO. PA 00993 DER NO. 45-148

ITEM	REMARKS
------	---------

AS-BUILT DRAWINGS	Limited to a drawing of the spillway
----------------------	--------------------------------------

REGIONAL VICINITY MAP	See Plate 1, Appendix E
-----------------------------	-------------------------

CONSTRUCTION HISTORY	See Section 1.2 of the text
-------------------------	-----------------------------

TYPICAL SECTIONS OF DAM	See Plate 2, Appendix E
----------------------------	-------------------------

OUTLETS - PLAN	Plate 3, Appendix E
DETAILS	Plate 3, Appendix E
CONSTRAINTS	Plate 3, Appendix E
DISCHARGE RATINGS	None

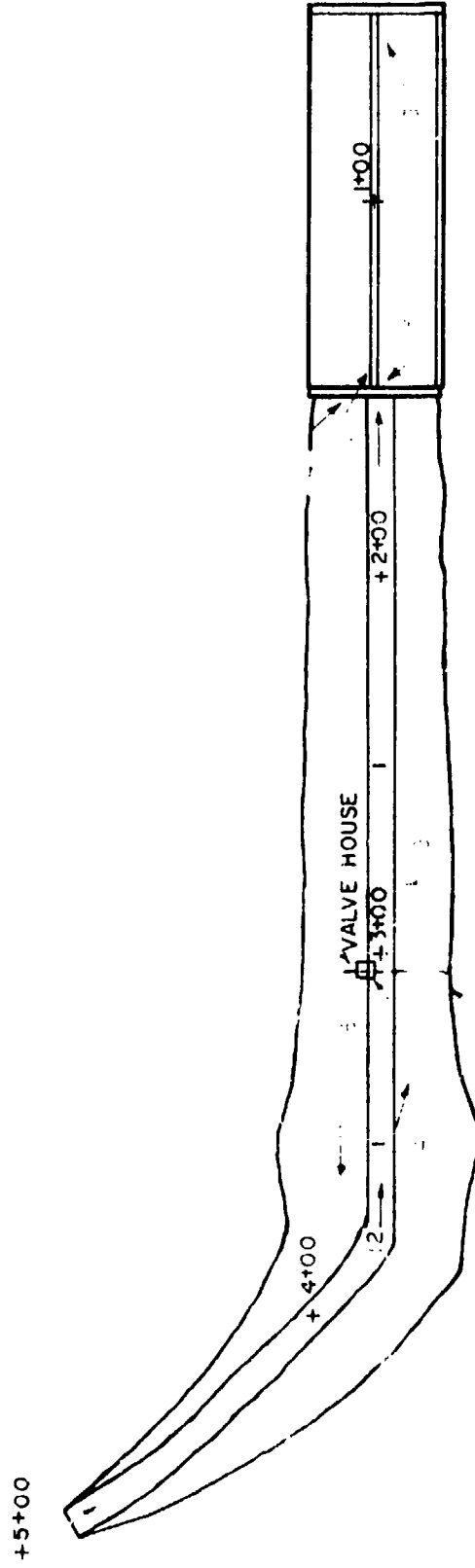
ITEM	REMARKS
RAINFALL/ RESERVOIR RECORDS	<i>None maintained by Owner</i>
DESIGN REPORTS	<i>None</i>
GEOLOGY REPORTS	<i>See Appendix F</i>
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	<i>No original design computations</i>
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	<i>None</i>
POST CONSTRUCTION SURVEYS OF DAM	<i>Limited to visual surveys by the State</i>

ITEM	REMARKS
BORROW SOURCES	<i>Unknown</i>
MONITORING SYSTEMS	<i>None</i>
MODIFICATIONS	<i>Limited to eliminating low flow notches in spillway weir</i>
HIGH POOL RECORDS	<i>None</i>
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	<i>Limited to visual inspection reports by State</i>
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	<i>None known</i>
MAINTENANCE OPERATION RECORDS	<i>None</i>

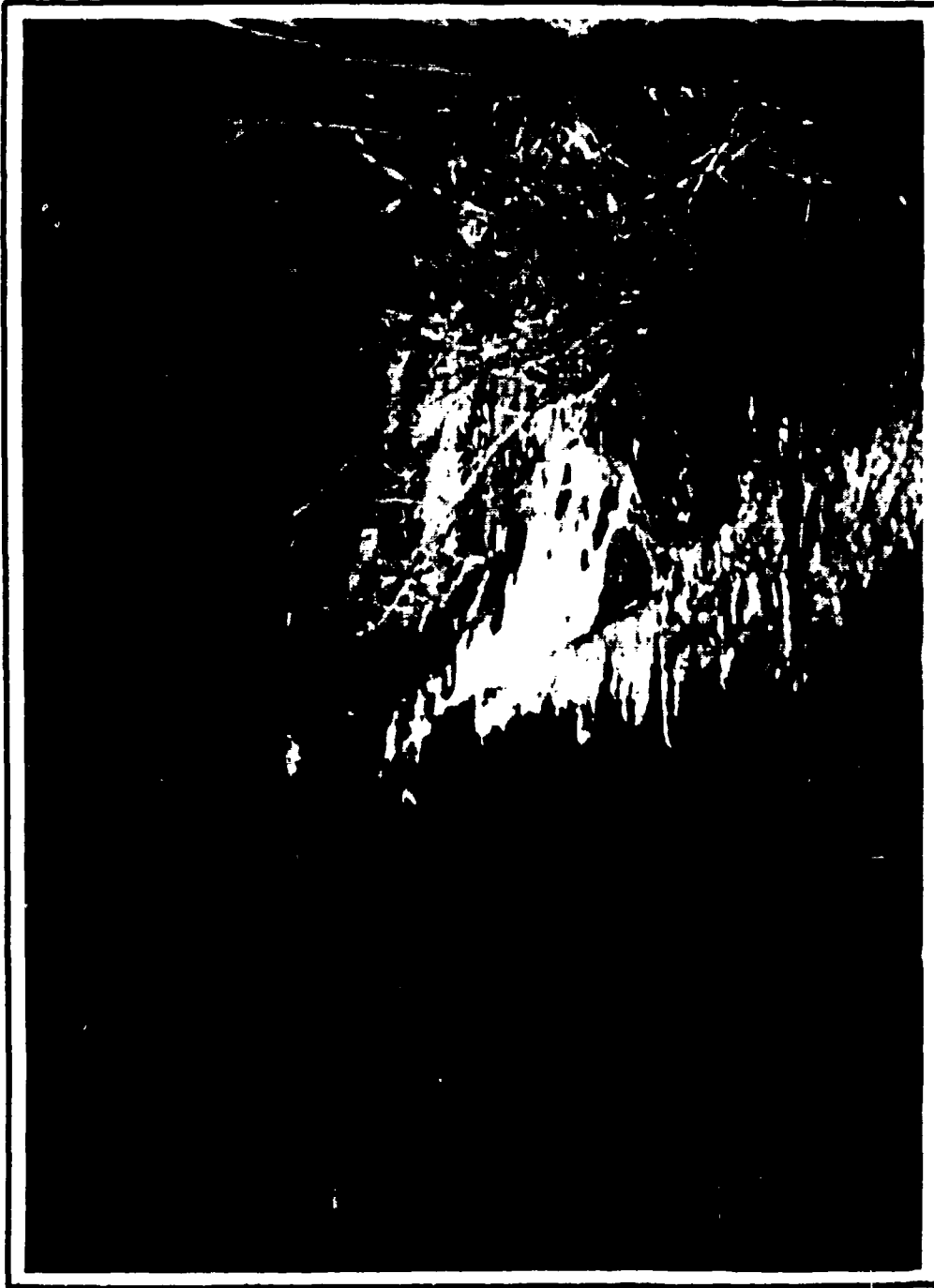
ITEM	REMARKS
SPILLWAY PLAN	<i>See Appendix E</i>
SECTIONS	<i>See Appendix E</i>
DETAILS	<i>See Appendix E</i>
OPERATING EQUIPMENT PLANS AND DETAILS	<i>See Appendix E</i>
MISCELLANEOUS	<p><i>The following information is located in DER files.</i></p> <ol style="list-style-type: none"><i>1. Design drawings</i><i>2. Application for permit dated April 28, 1931</i><i>3. Report upon the Application, dated May 20, 1931</i><i>4. Permit</i><i>5. Correspondence between the Owner's engineer and the State</i><i>6. Construction reports, by the State</i><i>7. Correspondence between the State and the Owner</i><i>8. State inspection reports</i><i>9. Five black and white photographs taken by the State.</i>

APPENDIX

C



PHOTOGRAPH LOCATION PLAN
RAKES DAM
PLATE C-1



VIEW OF SPILLWAY FROM EMBANKMENT.
BRUSH IS GROWING IN SPILLWAY

PHOTOGRAPH NO. 1



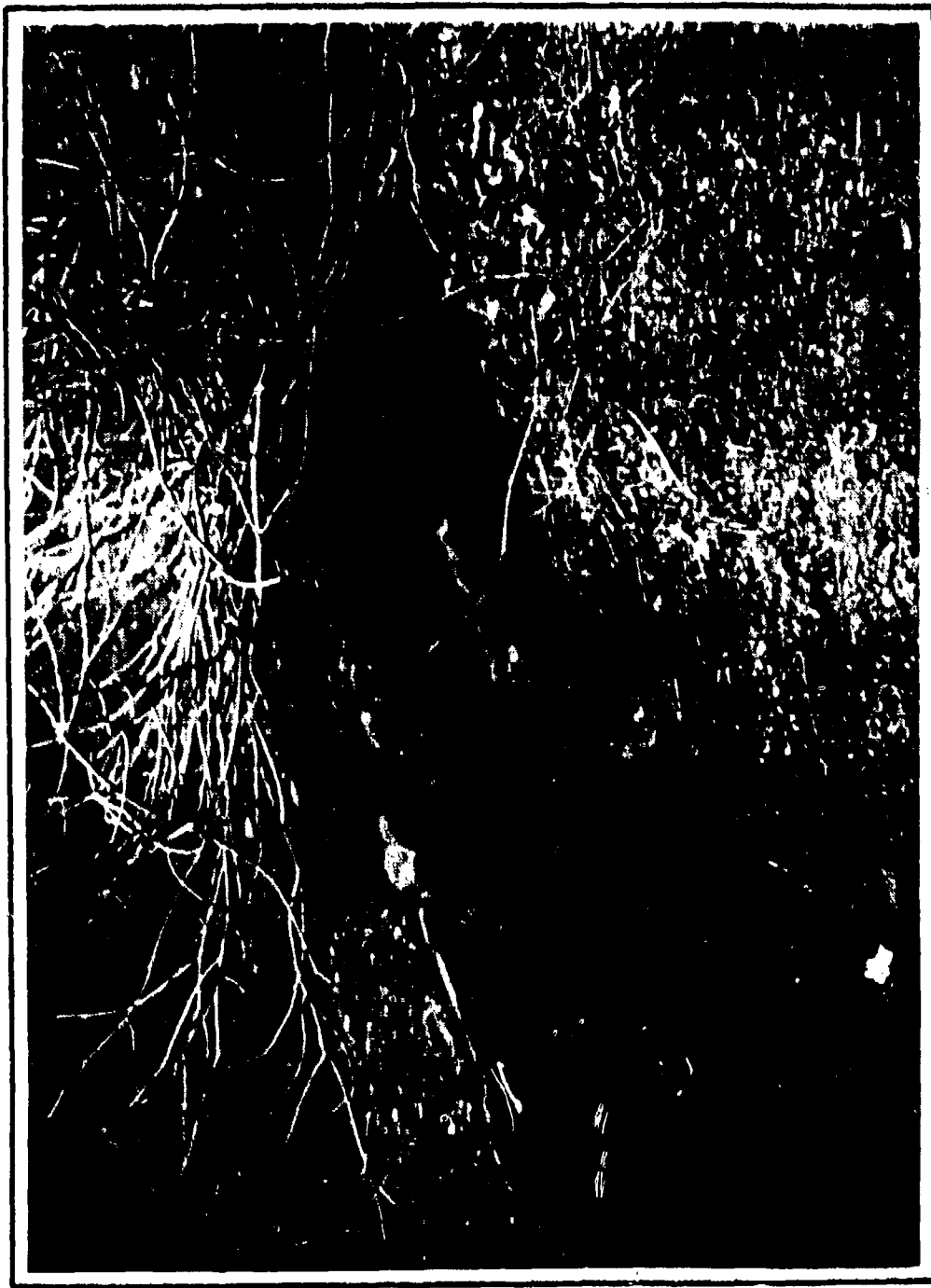
ORIGINAL NOTCHES IN SPILLWAY FILLED
IN. REMNANT OF GROUTED STONE APRON
VISIBLE IN UPPER PART OF PICTURE

PHOTOGRAPH NO. 2



DETERIORATION OF UPSTREAM END OF
LEFT SPILLWAY WALL. NOTE STONE
MASONRY CAP ON THE CONCRETE WALL

PHOTOGRAPH NO. 3



RIGHT SPILLWAY WALL. MASONRY IN
FOREGROUND HAS BEEN DISPLACED TOWARD
SPILLWAY

PHOTOGRAPH NO. 4



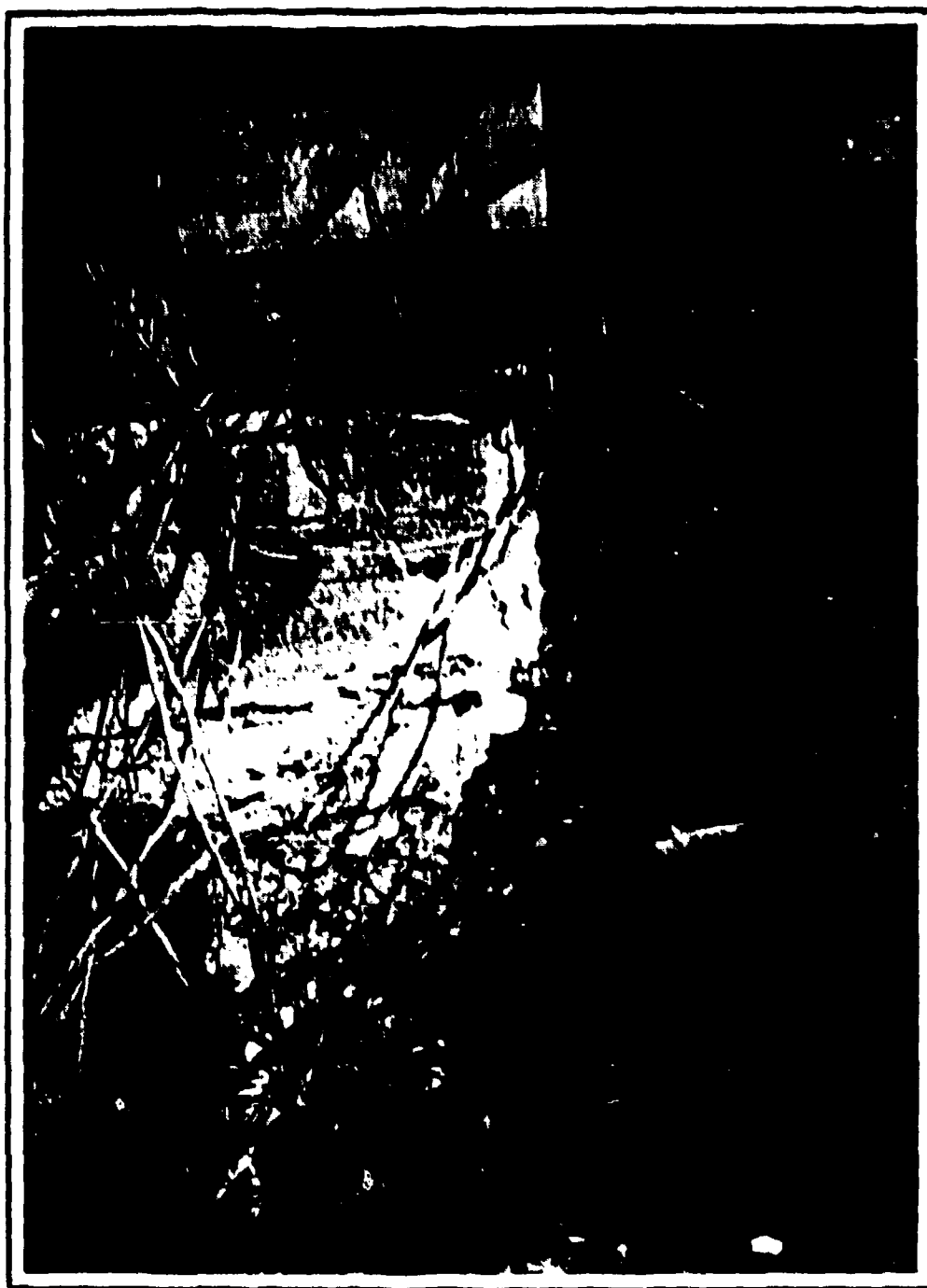
JUNCTION OF WEIR AND WALL HAS
DETERIORATED

PHOTOGRAPH NO. 5



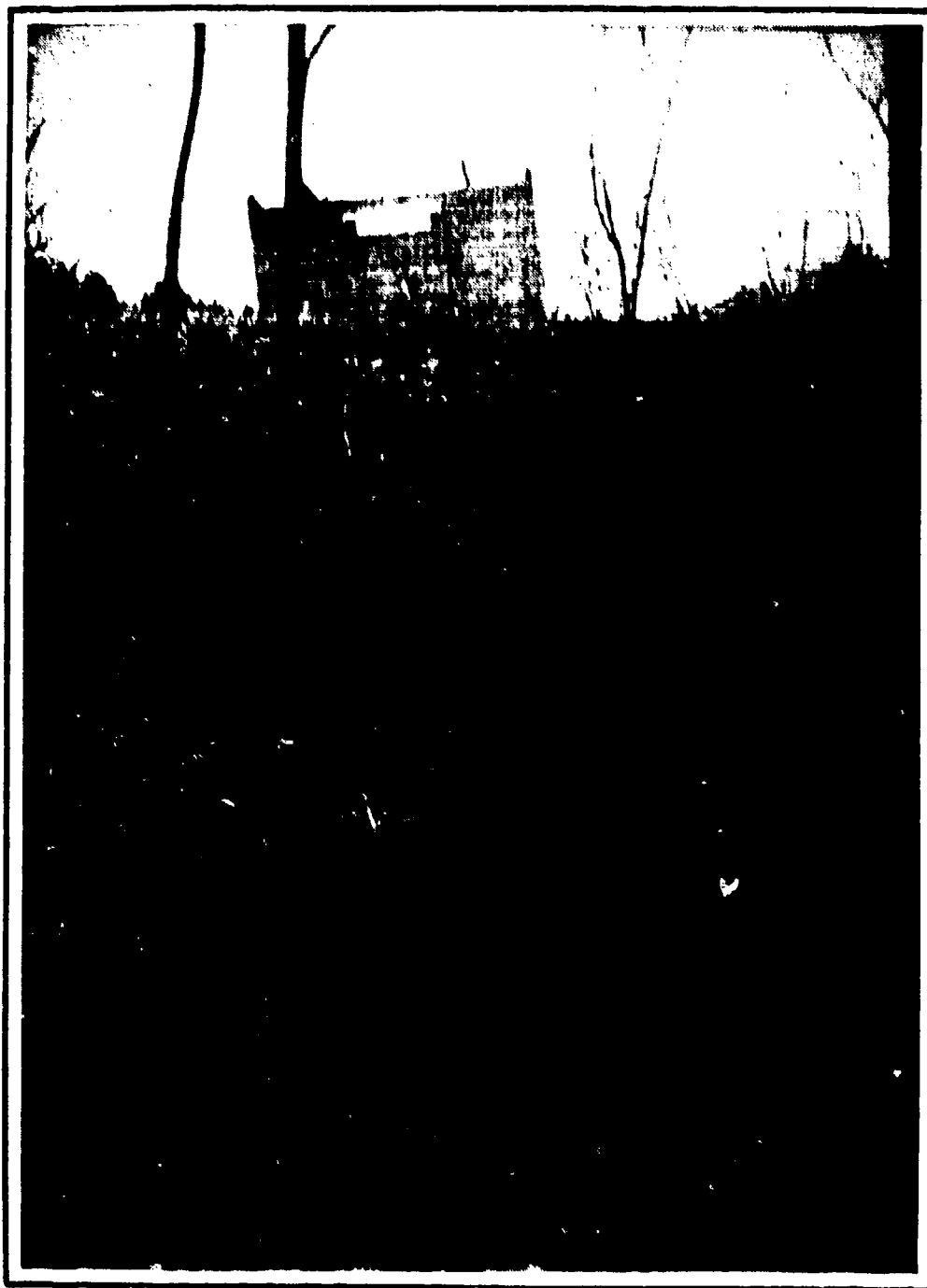
GATE WELL ON UPSTREAM
EMBANKMENT SLOPE

PHOTOGRAPH NO. 6



CONCRETE DETERIORATION ABOVE
WATERLINE ON UPSTREAM SIDE OF
GATE WELL

PHOTOGRAPH NO. 7



VIEW OF GATE WELL AND OUTLET

PHOTOGRAPH NO. 8



POND DRAIN OUTLET. CONCRETE HAS
DISINTEGRATED BELOW WATERLINE.

PHOTOGRAPH NO. 9



UPSTREAM EMBANKMENT SLOPE PROTECTED
BY HAND PLACED RIPRAP

PHOTOGRAPH NO. 10



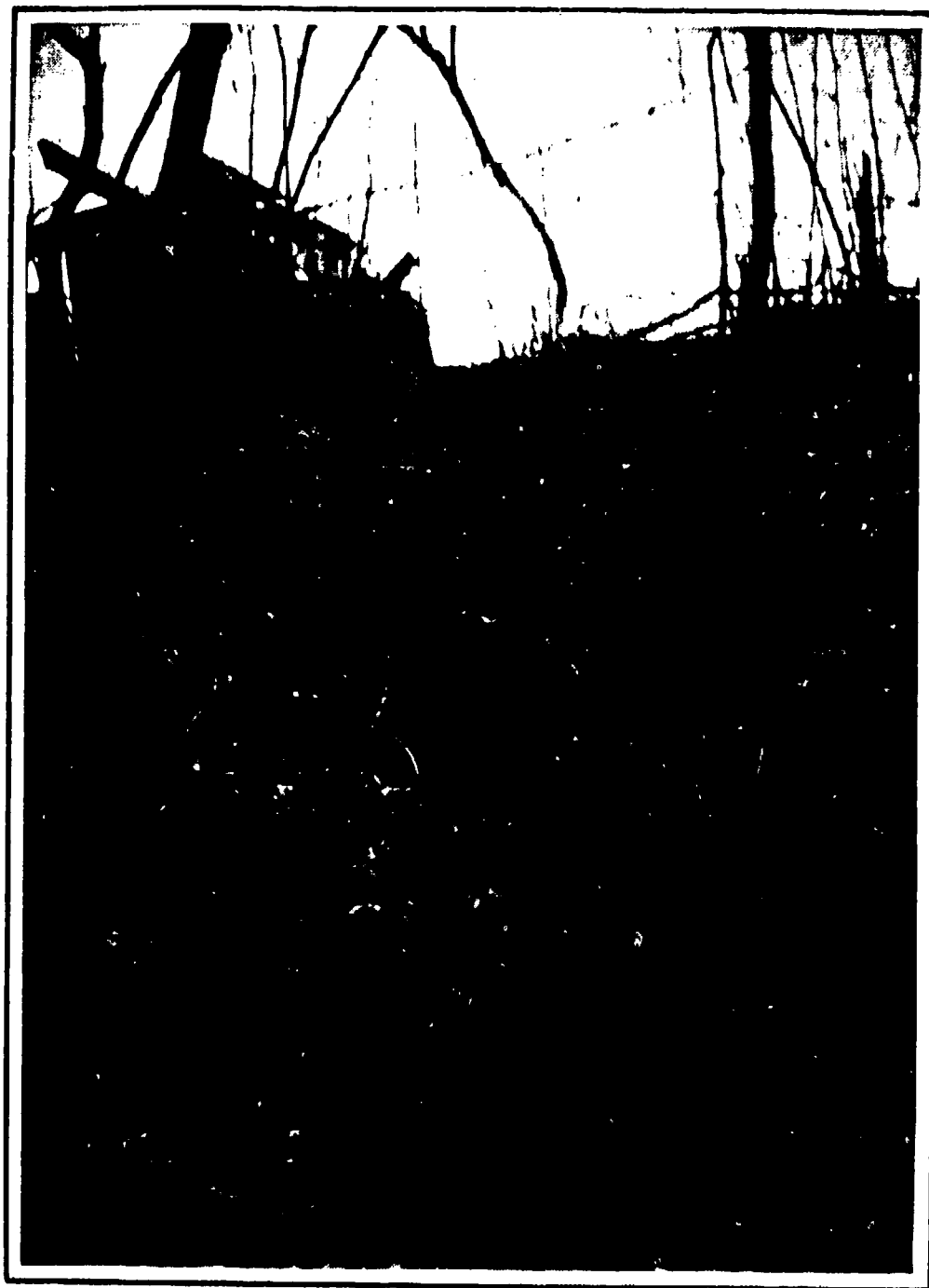
VIEW ALONG CREST NEAR RIGHT END

PHOTOGRAPH NO. 11



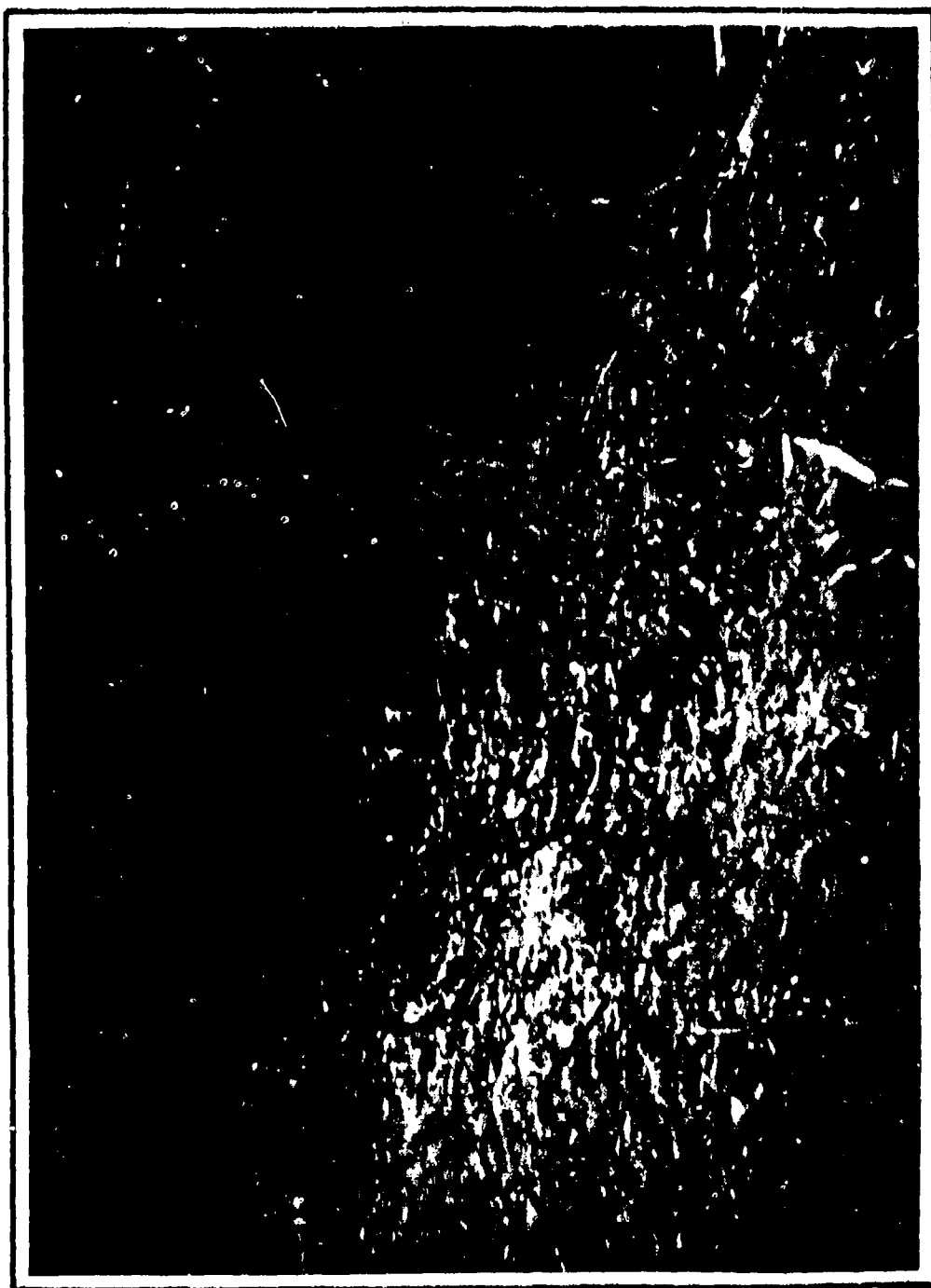
VIEW ALONG CREST SHOWING TREES ON
UP-AND DOWNSTREAM EMBANKMENT SLOPES

PHOTOGRAPH NO. 12



STEPS ON DOWNSTREAM EMBANKMENT SLOPE

PHOTOGRAPH NO. 13



OVERALL VIEW OF DOWNSTREAM
EMBANKMENT SLOPE

PHOTOGRAPH NO. 14



UPSTREAM POCONO HIGHLANDS DAM
SPILLWAY

PHOTOGRAPH NO. 15



UPSTREAM MEADOW LAKE DAM SPILLWAY

PHOTOGRAPH NO. 16



DOWNSTREAM DAMAGE CENTER AT A
SPORTS CAMP COMPLEX

PHOTOGRAPH NO. 17

APPENDIX

D

RAKES DAM
CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

Sheet 1 of 4

DRAINAGE AREA About 70% wooded with moderate residential development
CHARACTERISTICS 3 upstream dams with significant flood water storage capacity
and one natural lake.

ELEVATION NORMAL
POOL (STORAGE CAPACITY): 494.8 feet*

ELEVATION TOP FLOOD CONTROL POOL
(STORAGE CAPACITY): 498.6 feet

ELEVATION MAXIMUM DESIGN POOL: --

ELEVATION TOP DAM: 498.6 feet

SPILLWAY

- a. Elevation 494.8 feet
- b. Type Concrete and stone weir with grouted cobble apron
- c. Width 100 feet
- d. Length 18 feet
- e. Location Spillover Left end of dam
- f. Number and Type of Gates None

OUTLET WORKS:

- a. Type 30-inch concrete pipe, gated upstream of clay core wall
- b. Location 155 feet from right edge of spillway
- c. Entrance inverts Unknown, under water
- d. Exit inverts 489.0 feet
- e. Emergency draindown facilities the 30-inch pipe

HYDROMETEOROLOGICAL GAGES:

- a. Type None
- b. Location N/A
- c. Records N/A

MAXIMUM NON-DAMAGING DISCHARGE: Not Determined

* Water surface elevation estimated as 495.0 feet from USGS map, all other elevations relative.

BY _____ DATE _____ SUBJECT _____ SHEET 2 OF 4
CHKD. BY _____ DATE _____ Rakes Dam JOB No. _____
Hydrology / Hydraulics

Drainage Area 6.31 sq. miles, measured from USGS map.

Spillway Design Storm - 100yr event

Peak Inflow Value 1750 cfs - sheet 4

Spillway Capacity - 2400 cfs - sheet 3

BY MEB DATE 4/9/81
CHKD. BY REM DATE 6/1/81

SUBJECT Pates Dam
Hydrology / Hydraulics

SHEET 3 OF 4
JOB No. _____

Classification (Ref. Recommended Guidelines for Safety Inspection of Dams)

1. The hazard classification is "Significant" as there would be appreciable economic loss with few lives lost in the event of a dam failure.
2. The size classification is "Small" based on its 9.6 ft. height and 185 Ac-Ft capacity to the top of the dam.
3. The selected spillway design flood, based on size and hazard classification, is the 100-year event.

Hydrology and Hydraulic Analysis

1. Original Data

Limited to the state's evaluation:

For a drainage area of 6.4 sq. miles, the spillway discharge of 2700 cfs (for a 4-foot deep, 100-foot long spillway) would be adequate.

2. Spillway Data

Crest elevation - 494.7 to 494.9 (Sheet SC, App. A)
use 494.8

$$Q = CLH^{3/2}$$

where:

L = 100 ft, field measured
C ≈ 3.25 Table 5-13

Handbook of Hydraulics
Brater & King, 1976

$$= 2407 \text{ cfs, say } 2400 \text{ cfs}$$

$$\text{for } H = (498.6 - 494.8) = 3.8 \text{ ft}$$

3. Elevation-Storage Data

Normal pool surface (147 Ac.) and area within the 500 ft contour (126 Ac.) were measured from USGS map. Normal pool elevation was estimated from contours on USGS map as original drawings used an assumed datum. The reservoir volume was estimated by the conic method

$$\Delta V = \frac{h}{3} (A_1 + A_2 + \sqrt{A_1 A_2}) \text{ where } h = \text{the vertical dist. between two surface areas}$$

BY MFB DATE 7/14/81
 CHKD. BY R.M. DATE 7/14/81

SUBJECT Rakes Dam
Hydrology/Hydraulics

SHEET 4 OF 4
 JOB No. _____

Elev. ft	Surface Area Ac	Capacity Ac-Ft
490	0	0
495	14.7	25
500	126	93.1

Normal Pool 83 Ac-Ft
 Top of Dam 185 Ac-Ft

4. 100-Yr Peak Inflow Value - ref. DER Water Resources Bulletin
 No. 13, Floods in Pennsylvania
 for Region No. 5 (plate 1)

$$Q_{100} = C A^x P_1^p$$

where: $C = 42.2$ - p. 4

$A = 6.31$ sq. miles - USGS map

$x = 0.751$ - p. 4

$P_1 = (49 - 25.7)$ - plate 2

$p = 0.744$ - p. 4

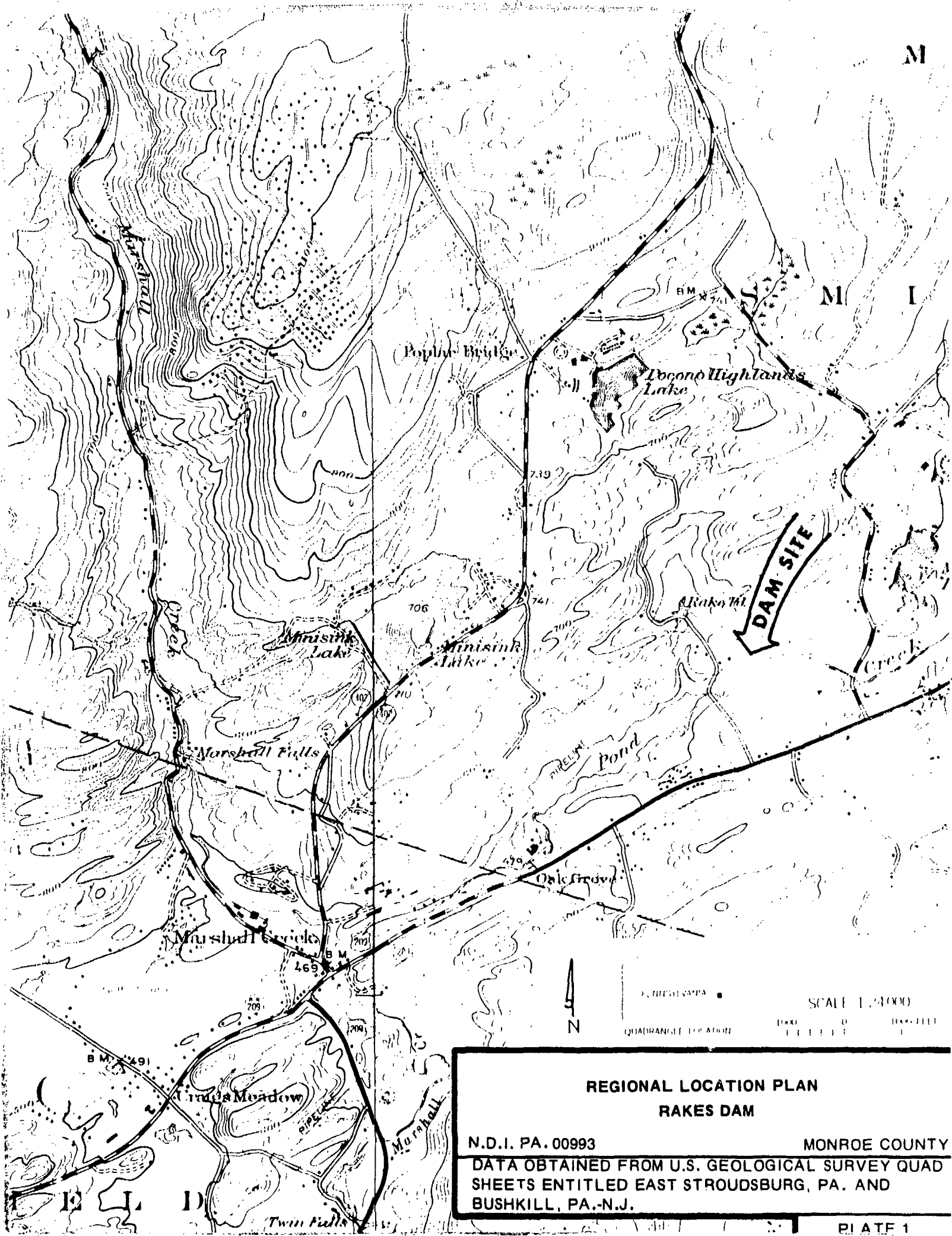
$$Q_{100} = 1752, \text{ say } 1750 \text{ cfs}$$

5. Spillway Adequacy

As the maximum spillway capacity is greater than
 the peak inflow during the spillway design flood, the
 spillway is considered "Adequate".

APPENDIX

E

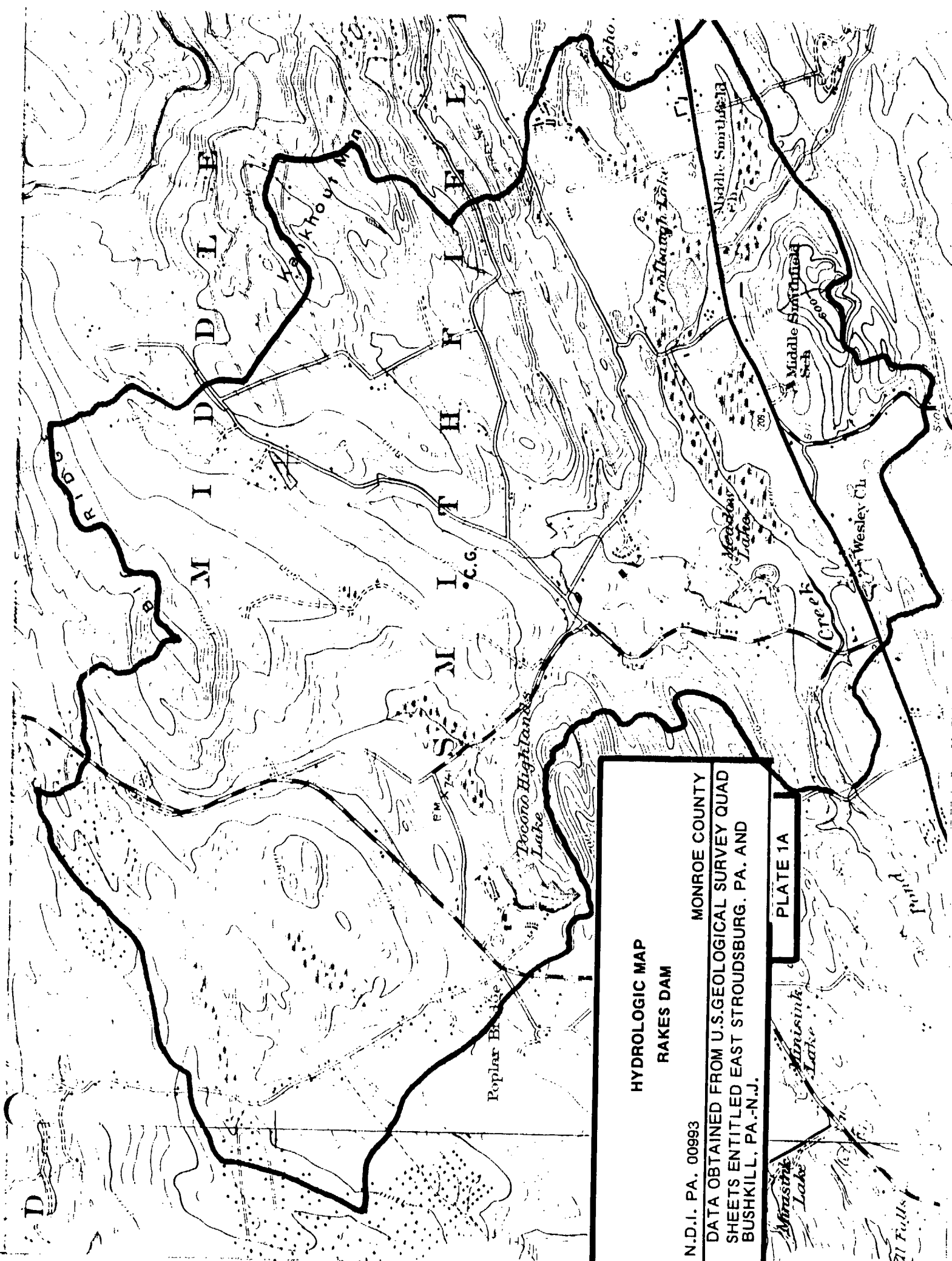


REGIONAL LOCATION PLAN
RAKES DAM

N.D.I. PA. 00993

MONROE COUNTY

DATA OBTAINED FROM U.S. GEOLOGICAL SURVEY QUAD SHEETS ENTITLED EAST STROUDSBURG, PA. AND BUSHKILL, PA.-N.J.



HYDROLOGIC MAP
RAKES DAM

N.D.I. PA. 00993
MONROE COUNTY
DATA OBTAINED FROM U.S.GEOLOGICAL SURVEY QUAD
SHEETS ENTITLED EAST STROUDSBURG. PA. AND
BUSHKILL, PA.-N.J.

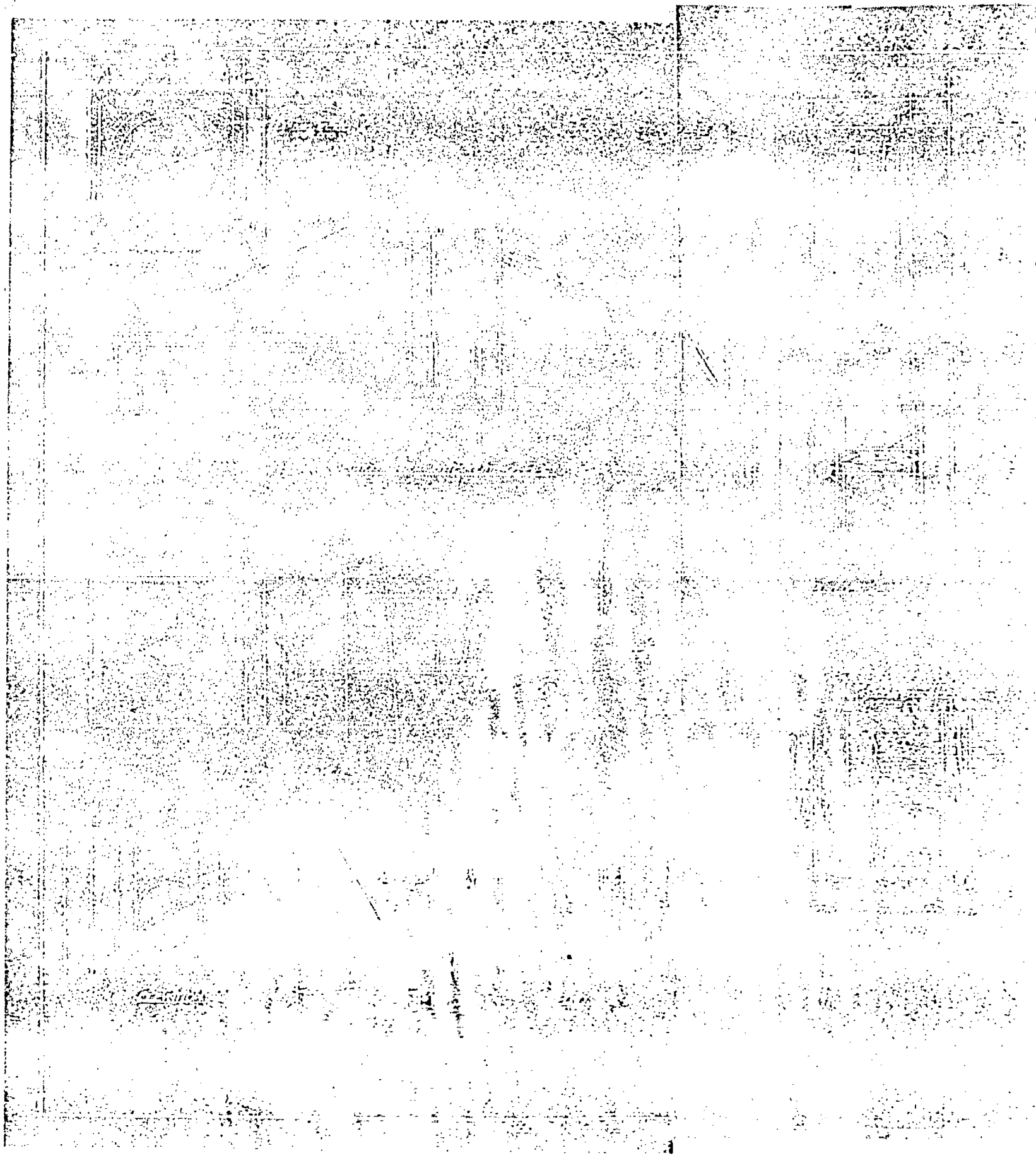
PLATE 1A

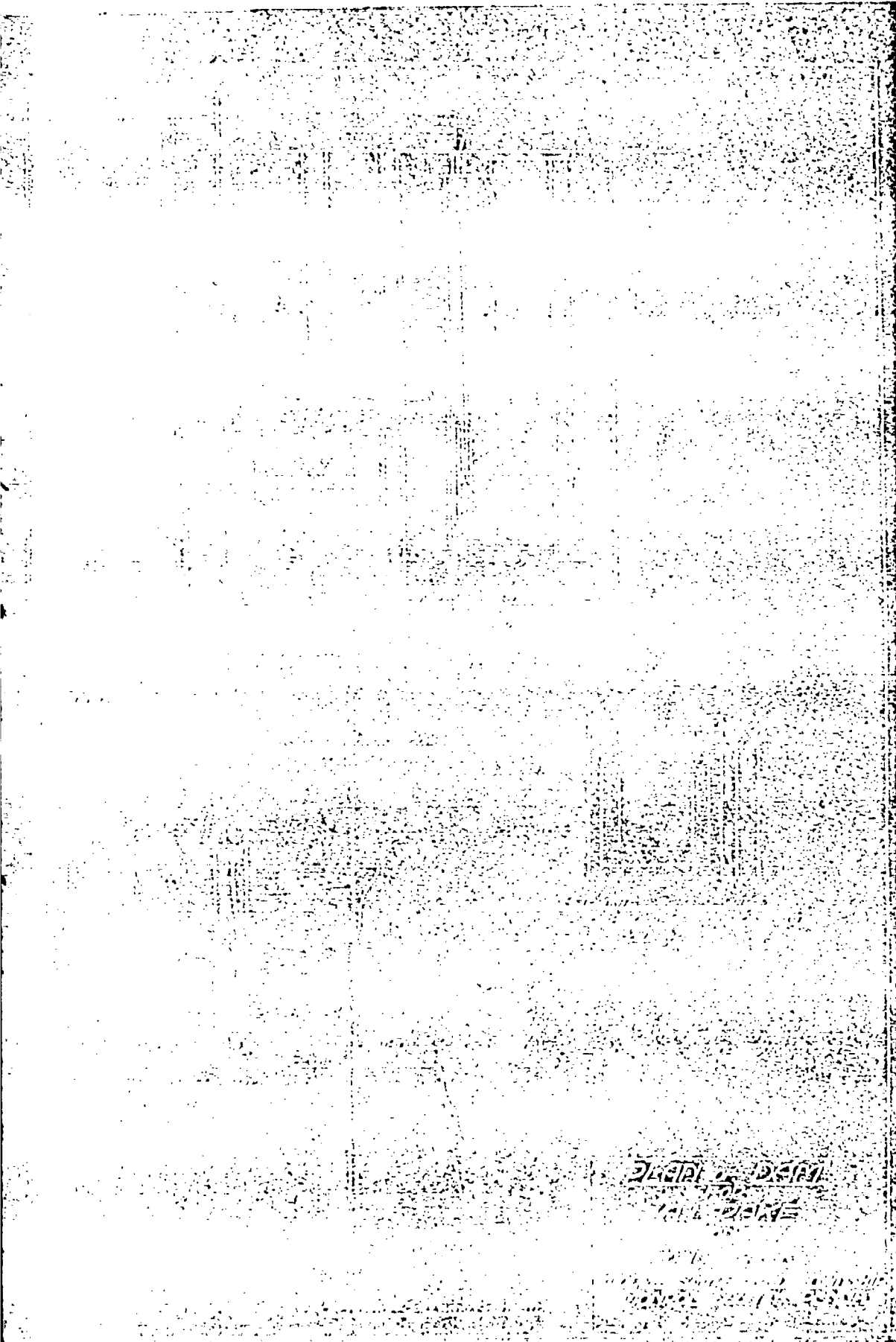
Radio Center

1015 S. 10th St. S.W.

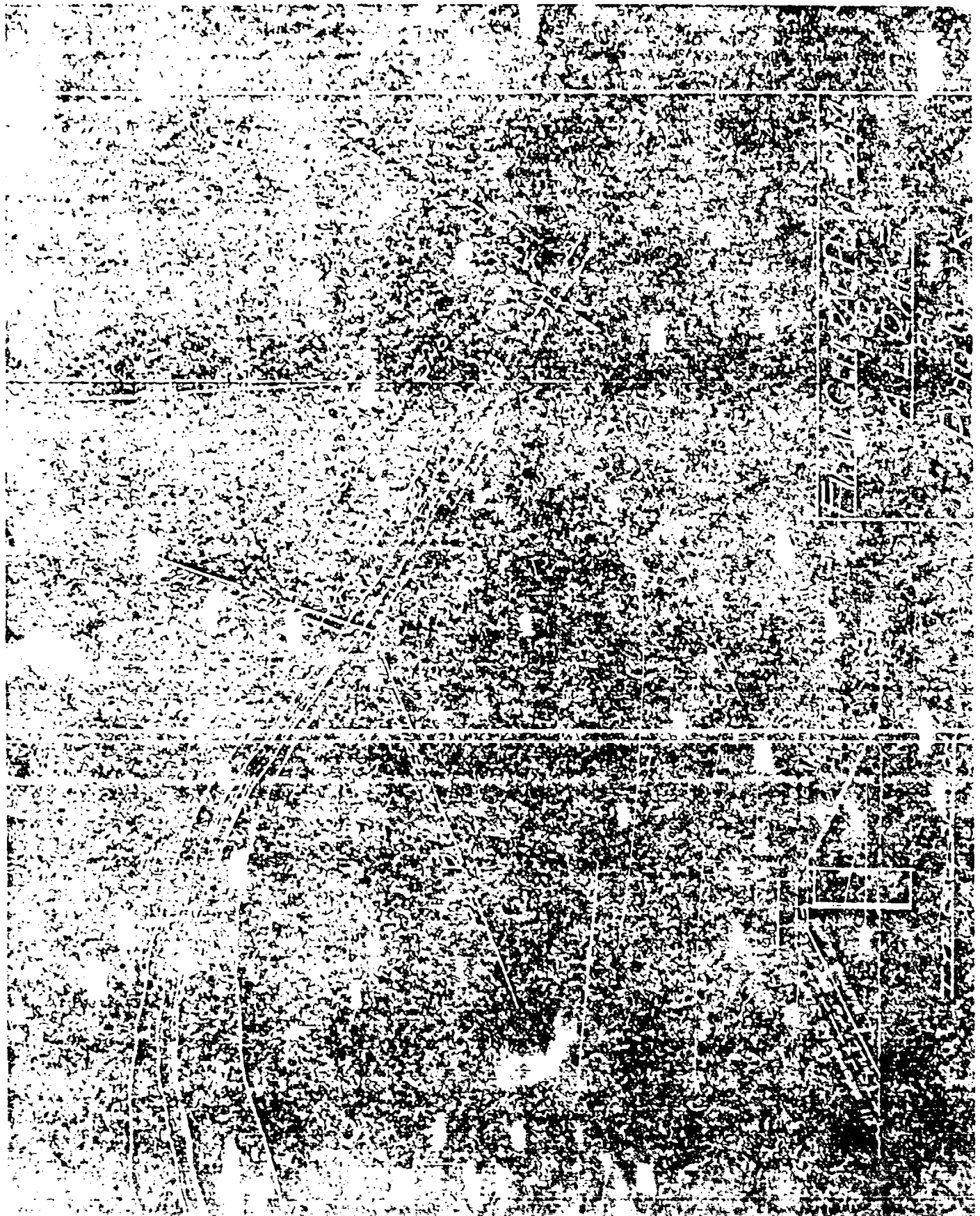
2

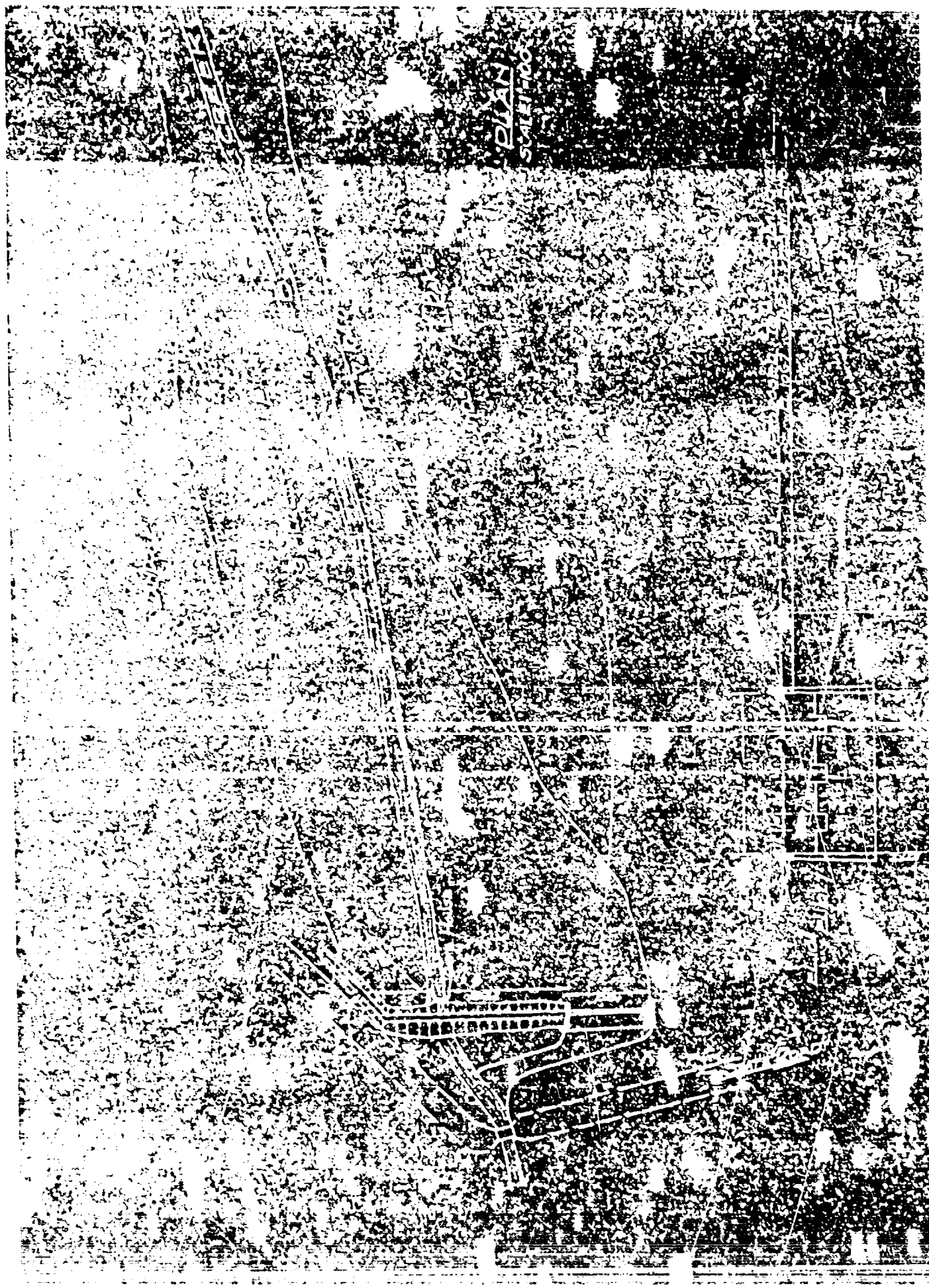
PLATE 2



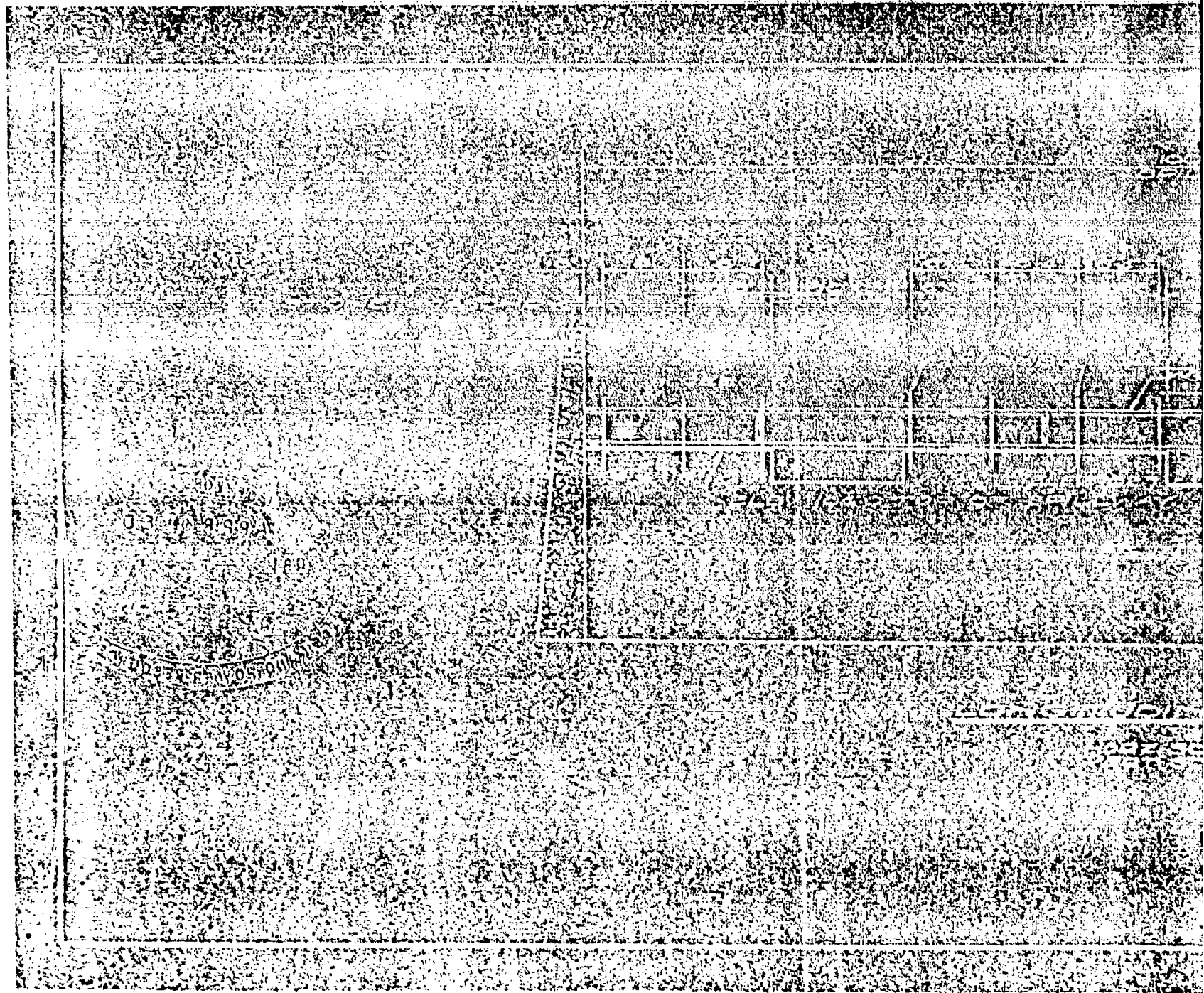


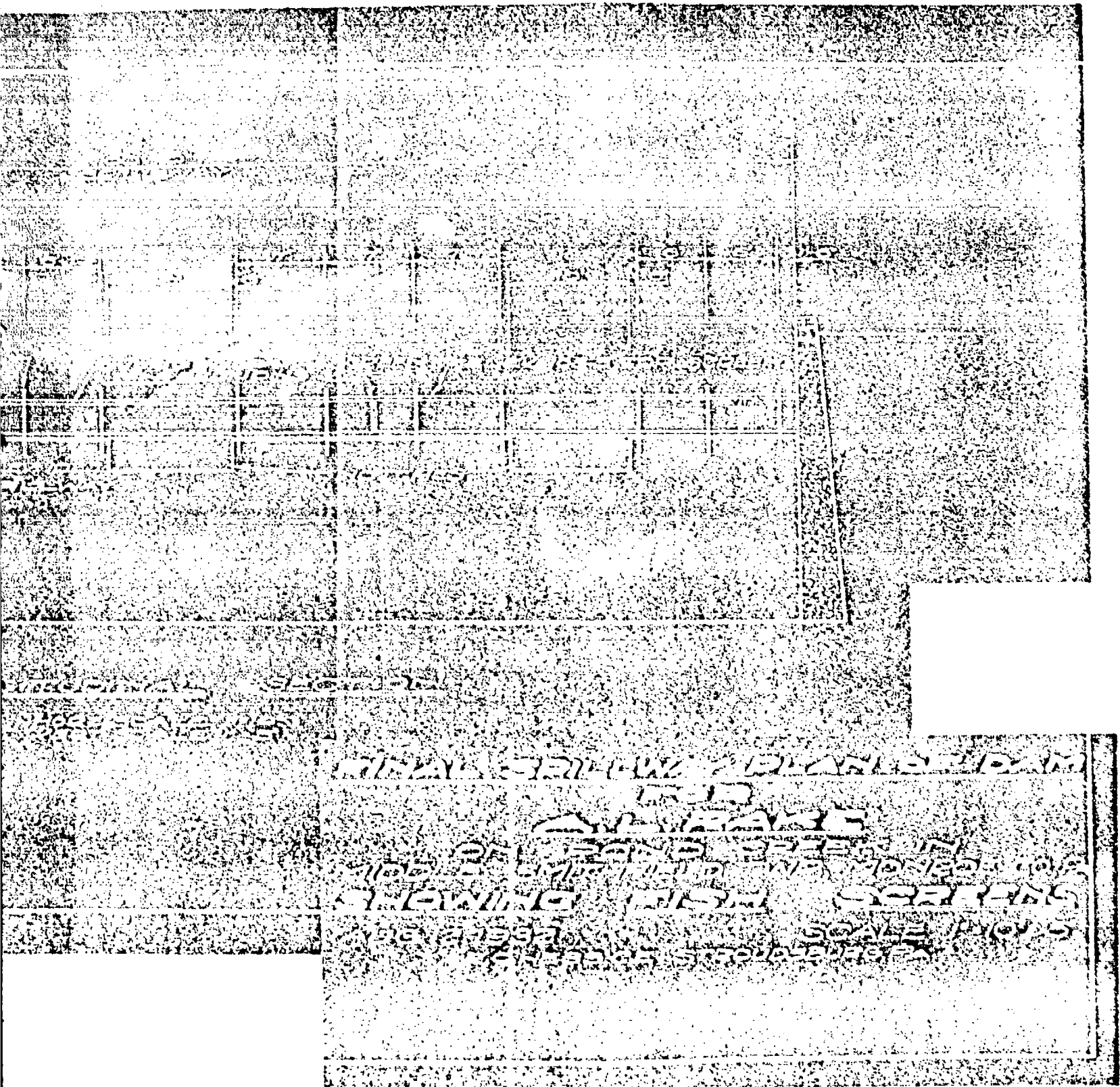
2





PLAN
SCALE 1:100





2

APPENDIX

F

RAKES DAM
SITE GEOLOGY

Rakes Dam is located in the transition zone between the Appalachian Mountain section of the Valley and Ridge physiographic province and the Glaciated Low Plateaus section of the Appalachian Plateaus physiographic province. As shown in Plate F-1, the dam site and much of the surrounding areas are underlain by a partial mantle of glacial drift deposits of Pleistocene age. These deposits consist of varying amounts of gravel, sand, silt and clay. No bedrock exposures were observed near the dam site; however, shale deposits of the Marcellus Formation are exposed immediately north of the reservoir area and would be expected to underlay the glacial drift in the vicinity of the dam. Consistent with the variable compositioned character of glacial deposits, there exists the potential for reservoir seepage through these deposits in addition to seepage along the bedrock interface.

