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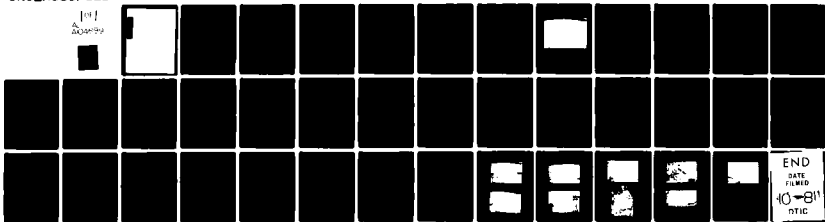
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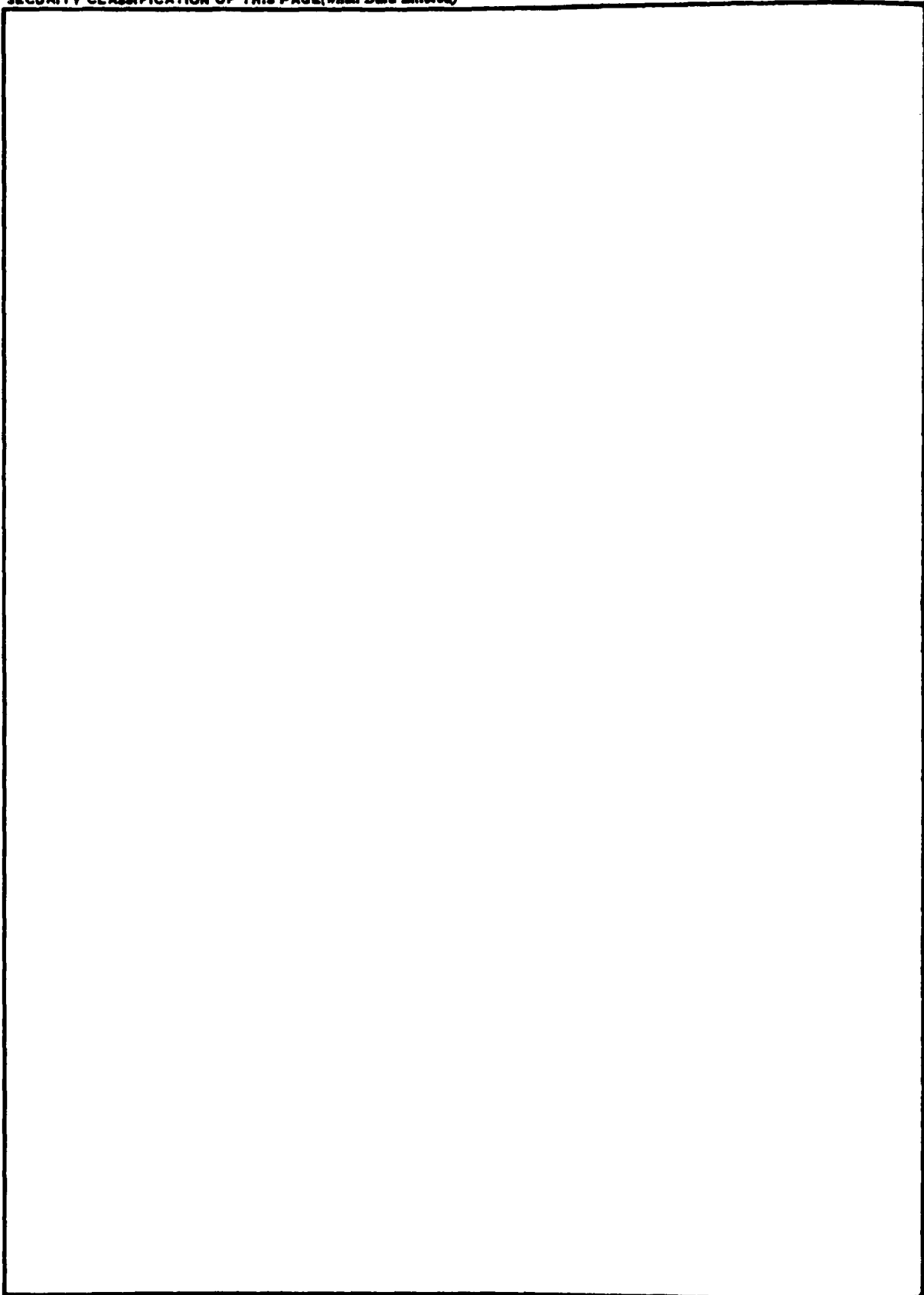
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MADDOX LAKE DAM
 WAYNE COUNTY, MISSOURI
 MISSOURI INVENTORY NO. 30024

⑥ ~~PHASE I INSPECTION REPORT~~
 NATIONAL DAM SAFETY PROGRAM

Maddox Lake Dam (MO 30024), Lower
 Mississippi - St. Francis Basin, Wayne
 County, Missouri. Phase I Inspection Report.

① Final Report

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PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam	Maddox Lake Dam
State Located	Missouri
County Located	Wayne County
Stream	Unnamed tributary to Rings Creek
Date of Inspection	10 & 11 July 1978

Maddox Lake Dam was inspected by an interdisciplinary team of engineers from the Memphis District, U.S. Army Corps of Engineers. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers and developed with the help of several Federal and State agencies, professional engineering organizations, and private engineers. Based on these guidelines, this dam is classified as a small size dam with a high downstream hazard potential. Failure would threaten the life and property of approximately 3 families downstream of the dam and cause appreciable damage to highway FF, approximately 800 feet downstream of the dam.

The inspection and evaluation indicate that the spillway does not meet the criteria set forth in the guidelines for a dam having the above mentioned size classification and hazard potential. According to the guidelines, the spillway is required to pass the Probable Maximum Flood (PMF) without the dam embankment being overtopped. The spillway will only pass 38 percent of the PMF before the dam embankment is overtopped. Because the spillway will not pass 1/2 of the PMF without overtopping, the dam is classified as "unsafe non-emergency." The spillway will pass the 100-year flood without overtopping, which is a flood that has a 1 percent chance of being exceeded in any given year.

Other deficiencies visually observed by the inspection team were bushes, small trees, and seepage on the downstream embankment slope. Another deficiency found was the lack of seepage and stability analysis records.

It is recommended that the owner take action to correct or control the deficiencies described. Corrective works should be in accordance with analyses and design performed by an engineer experienced in the design and construction of dams.



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Chief, Engineering Division

22 SEP 1978

Date

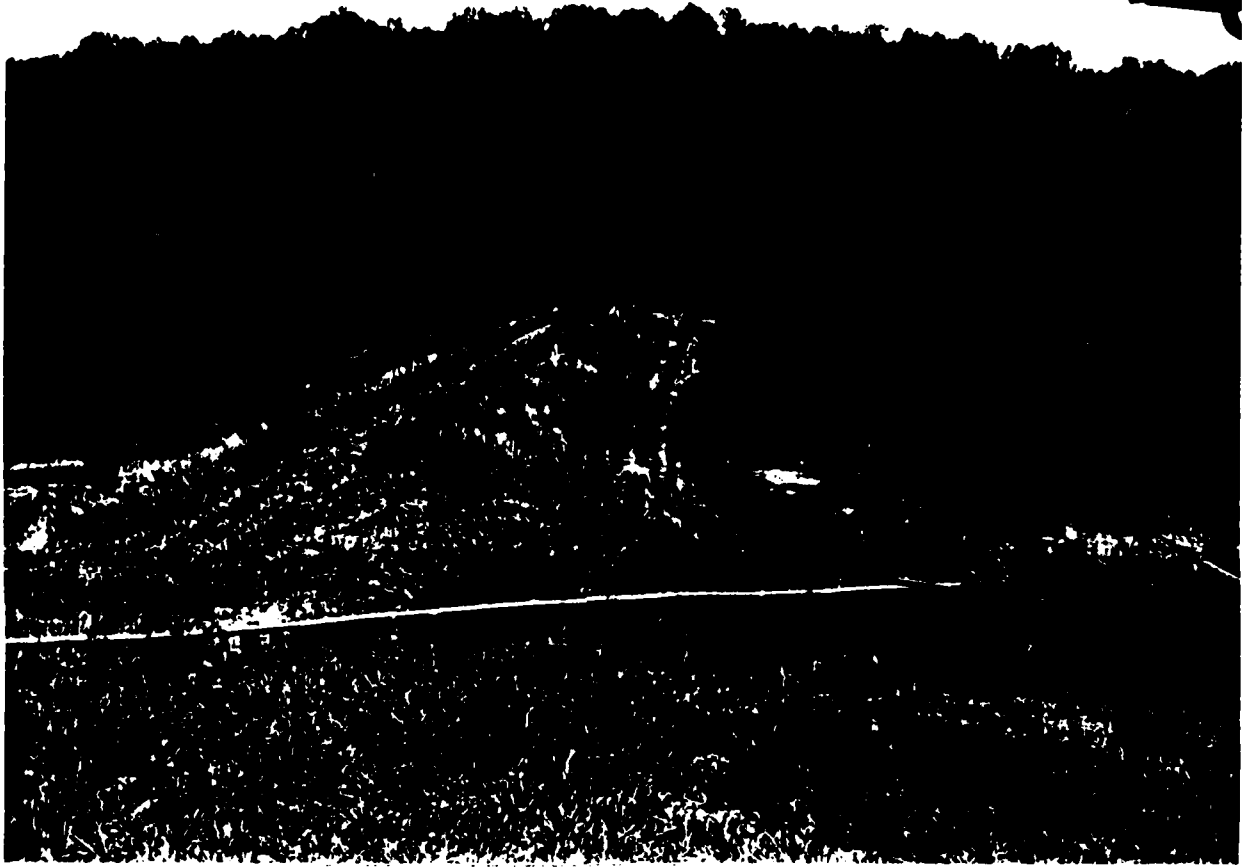
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APPROVED BY:

Colonel, CE, District Engineer

22 SEP 1978

Date



Overview of Lake and Dam

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
MADDOX LAKE DAM - ID NO. 30024

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SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection of the Maddox Lake Dam be made.

b. Purpose of Inspection. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

c. Evaluation Criteria. Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams." These guidelines were developed with the help of several Federal agencies and many State agencies, professional engineering organizations, and private engineers.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances.

(1) The dam is an earth structure built in a narrow valley in the uplands which border the Mississippi Embayment. Topography adjacent to the valley is rolling to steep. Soils in the area are formed of red silty clays with fragments of dolomite and chert. Topography in the vicinity of the dam is shown on Plate 2.

(2) A vertical inlet constructed of 24-inch diameter, bituminous coated, corrugated metal pipe junctioned with an 18-inch diameter, bituminous coated, corrugated metal pipe is the primary means of discharge. An earth, emergency spillway is cut in the left abutment. The spillway is a trapezoidal section with a 35-foot bottom width and side slopes of approximately 1V on 3H. The spillway is 55 feet long from the dam centerline.

(3) Pertinent physical data are given in paragraph 1.3 below.

b. Location. The dam is located in the central portion of Wayne County, Missouri, as shown on Plate 1. The lake formed by the dam is shown on the Patterson, Missouri Quadrangle sheet in Section 30, Township 29 North, Range 5 East.

c. Size Classification. Criteria for determining the size classification of dams and impoundments are presented in the guidelines referenced in paragraph 1.1 c above. Based on these criteria, this dam and impoundment is in the small size category.

d. Hazard Classification. Guidelines for determining hazard classification are presented in the same guidelines as referenced in paragraph c above. Based on referenced guidelines, this dam is in the High Hazard Classification.

e. Ownership. This dam is owned by Mr. Ernest Maddox of Route 1, Patterson, Missouri 63956.

f. Purpose of Dam. The dam forms an 11-acre recreational lake.

g. Design and Construction History. The dam was designed by the U.S. Department of Agriculture Soil Conservation Service. Readily available design data **were limited to a set of drawings dated 27 June 1966.** The drawings consist of a hydraulic and hydrologic design, a location plan, a typical embankment cross-section (see Plate 5) and a section through dam centerline including two soil borings (see Plate 4). Whether or not slope stability and seepage analyses were performed using suitable loading conditions is unknown. Porter-DeWitt Construction Company, Inc. of Poplar Bluff, Missouri constructed the dam in two weeks during the summer of 1966. Location of borrow areas and the effort utilized in compacting the borrow material is unknown. The 1966 drawings specified a "core trench" with a 12-foot bottom width to be excavated to a depth as shown on Plate 4. A typical embankment cross-section from the 1966 drawings showing the primary features of the vertical inlet and discharge system is presented on Plate 5. Based on the inspection survey, an average 1V on 2.4H downstream embankment slope was used instead of 1V on 2H slope specified in the 1966 drawings.

h. Normal Operating Procedure. Normal rainfall, runoff, transpiration, and evaporation all combine to maintain a relatively stable water surface elevation. The emergency spillway was reportedly used only once with the maximum experienced depth of approximately one half of a foot **occurring on 28 March 1977.**

1.3 PERTINENT DATA

- a. Drainage Area - 210 acres (1973 inventory).
205 acres (1966 Drawings).
- b. Discharge at Damsite.
 - (1) Discharge can take place both through a vertical pipe inlet and an emergency spillway.
 - (2) Estimated experienced maximum flood at the damsite - 56 cfs.
- c. Elevation (Feet above M. S. L.)
 - (1) Top of dam - 547.5 + (Existing, see Plate 4).
- 545.3 + (1966 Design, see Plate 4).
 - (2) Top of vertical inlet - 542.5.
 - (3) Invert of discharge pipe at the stilling basin - 513.6.
 - (4) Spillway crest - 544.5 + (Existing).
- 544.3 + (1966 Design)
 - (5) Streambed at centerline of dam - 513.2 (1966 drawings).
 - (6) Maximum tailwater - unknown.
- d. Reservoir. Length of maximum pool - 1300 feet (1966 drawings).
- e. Storage (Acre-feet).
 - (1) Maximum - 166 (1973 inventory).
- 212 (1966 drawings and 146 acre-feet as normal storage).
 - (2) Normal - 146 (1973 inventory).
- f. Reservoir Surface (Acres).
 - (1) Top of dam - 15.1.
 - (2) Spillway crest - 13.5.

g. Dam.

- (1) Type - earth embankment.
- (2) Length - 550 ± feet.
- (3) Height - 34 feet maximum.
- (4) Top width - 12 ± feet.
- (5) Side slopes -
 - (a) Downstream - 1V on 2.4H (Average).
 - (b) Upstream - 1V on 3.2H (Average).
- (6) Upstream berm - el. 542 ± feet m.s.l. and 12 feet wide (All Average existing conditions.)
- (7) Zoning - unknown.
- (8) Impervious core - unknown.
- (9) Cutoff - 12-foot wide trench with depths as shown on Plate 4.
- (10) Grout curtain - unknown.

h. Diversion and Regulating Tunnel. None.

i. Primary Discharge System.

- (1) Type - An uncontrolled 24-inch diameter inlet pipe junctioned with an 18-inch diameter discharge pipe (see paragraph 1.2 a).
- (2) Length of 24-inch diameter pipe - 15 feet (1966 drawings).
- (3) Length of 18-inch diameter pipe - 100 feet (1966 drawings).
- (4) Top elevation of vertical inlet - 542.5 feet m.s.l.
- (5) Invert of discharge pipe at stilling basin - 518.6 feet m.s.l.

j. Emergency Spillway.

- (1) Type - Uncontrolled earth

- (2) Width of weir - 35 feet (Bottom width).
 - (3) Length of weir - 55 + feet (From centerline of Dam).
 - (4) Crest elevation - 544.5 + feet m.s.l.
- k. Regulating Outlet. None

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

The dam was designed by the U.S. Department of Agriculture Soil Conservation Service. Readily available design data were limited to a set of drawings dated 27 June 1966. The drawings consist of a hydraulic and hydrologic design, a location plan, a typical embankment cross-section (see Plate 5), and a center-line section through the dam including two soil borings (see Plate 4). Whether or not slope stability and seepage analyses were performed using suitable loading conditions is unknown.

2.2 CONSTRUCTION

The dam was constructed in a two week period during the summer of 1966 by the Porter-DeWitt Construction Company, Inc. of Poplar Bluff, Missouri. The earth embankment was probably constructed of a red silty clay with varying amounts of dolomite and chert fragments. The location of the borrow areas and the effort utilized in compacting the borrow material is unknown. The 1966 drawings specified a "core trench" with a 12-foot bottom width to be excavated to a depth as shown on Plate 4. A typical embankment cross-section from the 1966 drawings showing the primary features of the vertical inlet and discharge system is presented on Plate 5. Based on the inspection survey an average 1V on 2.4H downstream embankment slope was used instead of the 1V on 2H slope specified in the 1966 drawings.

2.3 OPERATION

The emergency spillway was reportedly used only once with the maximum experienced depth of approximately one half of a foot occurring on 28 March 1977 during a 36 hour period of rain.

2.4 EVALUATION

a. Availability. The only engineering data available were mentioned in paragraphs 2.1-2.3 above.

b. Adequacy. The design data are adequate to make a detail assessment of the hydraulic and hydrologic design. This assessment of the hydraulic and hydrologic design is presented in paragraph 2.4 c below. **Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These**

seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

c. Validity. A portion of the hydrology and hydraulic design presented on the 1966 drawings appears to be erroneous. There seems to be an error in the elevation-discharge computations. The weir formula was used to calculate the flow ("weir flow") into the vertical inlet at low stages which is correct. However, the length of the weir is 6.28 feet rather than 19 feet as presented on the 1966 drawings. This results in a 66 percent reduction of the 1966 design calculated flow out of the lake by "weir flow". Also for routing purposes, the flow through the discharge pipe is governed by the hydraulic losses of "conduit flow" after a head of 1.1 feet covers the vertical outlet. As the head (or lake level) increases from 1.1 feet, the flow through the vertical inlet will be governed by "conduit flow." Erroneously, the 1966 computations show the flow into the vertical inlet governed by "weir flow". No routing exist on the 1966 drawings for flow through the emergency spillway since the incorrectly calculated vertical inlet discharges passed the design storm (25 yr. frequency) without utilizing the emergency spillway.

The other engineering data which were presented in paragraphs 2.1 - 2.3 appear to be valid.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. Visual inspection of Maddox Lake Dam was performed on 10 and 11 July 1978. Personnel making the inspection were employees of the Memphis District, Corps of Engineers, and included a geologist, hydraulic engineer, and soils engineer. Also the owner accompanied the inspection team. Specific observations are discussed below.

b. Project Geology. The dam is located on the uplands which border the Mississippi Embayment. The dam is located on the Eminence Formation of the Upper Cambrian. The Eminence is a tan to light brown, fine to medium grained, massively bedded, moderately hard, calcareous dolomite. The residual soil in the area is terra rossa which represents the Recent.

As the dam was built of local material it probably consist of red silty clay with fragments of dolomite and chert. The dam is located in a Seismic Zone 2.

c. Dam. No detrimental settlement, cracking, slides or animal burrows were observed in or near the earth embankment. Typical existing cross-sections of the embankment are shown on Plate 6. These sections are consistent with the cross-section presented in the Soil Conservation Service 1966 drawings (see Plate 5) except the existing downstream slope is a 1V on 2.4H instead of the specified 1V on 2H. The dam embankment appears to be well maintained except for several 3 to 4-foot high bushes and trees growing on the downstream slope (see Photo 4).

Seepage was observed flowing at an estimated 5 gpm from the right abutment in the area shown on Plate 3. The seep water was reddish in color, indicating flow through a high iron content soil (see Photo 5) and had a temperature of 63°F. The owner of the dam stated that before the dam was constructed, a spring flowed from this area with reddish water and another spring flowed from an area approximately 500 feet downstream of the right abutment. He also stated that there are iron deposits in the hill which the right abutment adjoins. The downstream spring was located flowing from the hill with clear water having a temperature of 70°F. A temperature profile of the lake was performed with the following results:

<u>Depth (ft.)</u>	<u>Temperature (°F)</u>
0	81
1	81
5	81
10	76
14	66
19	60
21	58
23	56

Based on the above information, the source of seepage existing from the right abutment is unknown. But spring or seepage flow could pipe material from the embankment and/or weaken the embankment soils.

d. Appurtenant Structures. A vertical inlet constructed of 24-inch diameter, bituminous coated, corrugated metal pipe junctioned with 18-inch diameter, bituminous coated, corrugated metal pipe is the primary means of discharge. A corrugated metal baffle is mounted on the vertical inlet. A trash rack composed of timber **posts and** strands of wire surrounds the inlet (see Photo 6). The outlet pipe discharges into an earth stilling basin located approximately 84 feet downstream of the dam centerline (see Photo 7). The stilling basin area is overgrown with **vegetation** (see Photo 8).

An earth, emergency spillway is cut in the left abutment. The spillway is a trapezoidal section with a 35-foot bottom width and side slopes of approximately 1V on 3H. The spillway is covered with grass or chert fragments and is highly resistant to erosion. The spillway is 55 feet long from the dam centerline (see Photo 9).

e. Reservoir Area. No wave wash, excessive erosion or slides were observed along the shore of the reservoir.

f. Downstream Channel. The downstream channel is overgrown with trees and brush.

3.2 EVALUATION

None of the conditions observed are significant enough to indicate a need for immediate remedial action or a serious potential of failure. Visually observed seepage and **the continued growth of trees and large bushes on the downstream slope are deficiencies which left uncontrolled or uncorrected could lead to the development of potential problems.**

SECTION 4 - OPERATION

4.1 PROCEDURES

There are no controlled outlet works for this dam; therefore, no regulating procedures exist. The pool is controlled by rainfall, runoff, evaporation, and capacity of the uncontrolled spillway.

4.2 MAINTENANCE OF DAM

The dam embankment and structures appear well maintained except for the 3 to 4-foot high bushes and trees growing on the downstream slope.

4.3 MAINTENANCE OF OPERATING FACILITIES

No operating facilities exist at this dam.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

The inspection team is not aware of any existing warning system for this dam.

4.5 EVALUATION

The maintenance of the dam appears adequate if the 3 to 4-foot high bushes and trees growing on the downstream slope are cut soon.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. The available hydraulic and hydrological design was not valid for evaluating the features (see SECTION 2).

b. Experience Data. The drainage area was developed using USGS Patterson Quadrangle. The lake surface area and storage values were determined using the 1966 drawings furnished by the Soil conservation Service. The spillway and dam layout are made from surveys conducted by the inspecting team. Comparisons were made with the 1966 drawings and the inspection surveys. All relative elevations are compatible with the elevations on the 1966 drawings.

c. Visual Observations.

(1) The vertical shaft and earthen spillway are in excellent condition.

(2) The vertical shaft is located approximately 165 feet from the right abutment while the spillway is located in the left abutment. Releases from either structure will not endanger the integrity of the dam.

d. Overtopping Potential. The spillway will pass 38 percent of the Probable Maximum Flood (PMF), without overtopping the dam. The Probable Maximum Flood (PMF) is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. For its size and hazard category, this dam is required by the guidelines to pass from one-half PMF to PMF. However, considering the high hazard potential to life and property of approximately 3 families downstream of the dam, the spillway size and/or height of dam should be increased to pass the PMF, without overtopping the dam. Because the spillway will not pass one-half of the PMF without overtopping, the dam is classified as "unsafe non-emergency." The spillway will pass the 100-year flood without overtopping, which is a flood that has a one percent chance of being exceeded in any given year.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

- a. Visual Observations. Visual observations of the dam and appurtenant structures are discussed and evaluated in SECTIONS 3 and 5.
- b. Design and Construction Data. The design and construction data were limited to that information discussed in SECTION 2.
- c. Operating Records. There have been no known operations which have affected the structural stability of the dam.
- d. Post Construction Changes. No post construction changes exist which will affect the structural stability of the dam.
- e. Seismic Stability. This dam is located in Seismic Zone 2. However, it is located very near the boundary between Seismic Zones 2 and 3. Since this dam is located in Seismic Zone 2 and in the proximity of Seismic Zone 3, it is possible that an earthquake could occur of sufficient intensity to cause severe damage or failure of the dam.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. A few items were noted during the visual inspection by the inspection team which should be corrected or controlled. These items, which exist on the downstream slope are seepage, trees and bushes. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record. Also these analyses should be utilized to detail the corrective actions called for in paragraph 7.2. The Probable Maximum Flood (the design flood) and one-half of the Probable Maximum Flood (PMF) will both overtop the dam. Because the spillway will not pass one-half of the PMF without overtopping the dam, the dam is classified as "unsafe non-emergency."

b. Adequacy of Information. Due to the lack of engineering design and construction data, the conclusions in this report were based on performance history and external visual conditions. The inspection team considers that these data are sufficient to support the conclusions herein.

c. Urgency. The remedial measures recommended in paragraph 7.2 should be accomplished in the near future. If the deficiencies listed in paragraph 7.1a are not corrected in a timely manner, they could lead to the development of potential problems.

d. Necessity for Phase II. Based on the results of the Phase I inspection, no Phase II inspection is recommended.

e. Seismic Stability. This dam is located in Seismic Zone 2. However, it is located very near the boundary between Seismic Zones 2 and 3. Since this dam is located in Seismic Zone 2 and in the proximity of Seismic Zone 3, it is possible that an earthquake could occur of sufficient intensity to cause severe damage or failure of the dam.

7.2 REMEDIAL MEASURES

a. Alternatives. Spillway size and/or height of dam should be increased to pass the probable maximum flood without overtopping the dam.

b. Perform seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams." These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record. Use the results of these analyses to design appropriate corrective measures.

c. O & M Maintenance and Procedures. The following O & M maintenance and procedures are recommended:

- (1) Cut the bushes and trees growing on the downstream slope.
- (2) Check the downstream slope periodically for seepage. If seepage flows are observed, the dam should be inspected and the situation evaluated by an engineer experienced in design and construction of dams.
- (3) A detailed inspection of the dam should be made at least every 5 years by an engineer experienced in design and construction of dams.

APPENDIX A
HYDROLOGIC COMPUTATIONS

HYDROLOGIC COMPUTATIONS

1. HEC-1 was used to develop the inflow hydrograph for PMF and hydrologic characteristic of drainage basin.
2. HEC-1 uses Snyder Method for developing synthetic unit hydrographs with Clarks Modification.

Final Variables

Drainage Area	0.32 sq. mi.
Travel Time of Runoff	30 min.
Initial Loss of Rainfall	0.5 in.
Average Loss Rate	0.05 in./hr.
C _t	0.50
C _p	0.693
PMF Rainfall	26.9 in.
PMF Percentages	6 hr. 102
	12 hr. 120
	24 hr. 130

3. The inflow hydrograph was routed through the reservoir using HEC-1's modified Puls option. Releases were calculated for both the pipe and spillway. The pipe was assumed flowing full and the broadcrested weir equation was used to calculate spillway discharges. Variables for the pipe and spillway discharges are listed below.

<u>Horizontal Pipe</u>		<u>Vertical Pipe</u>	
n	.025	n	.025
L	104 ft.	L	15 ft.
D	1.5 ft.	D	2.0 ft.

Spillway

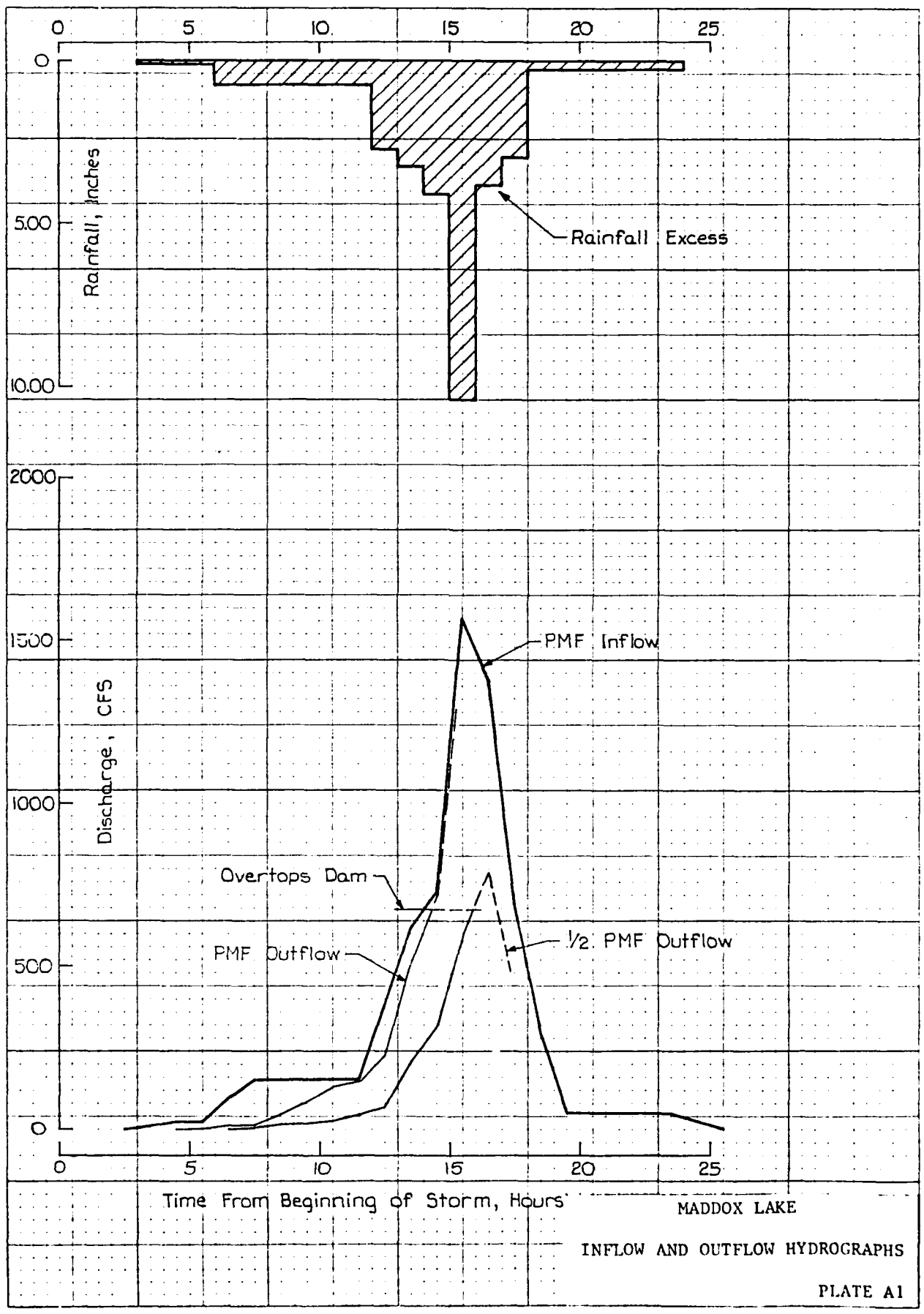
C	2.75
L	35 ft. (bottom width)*

- * Used actual area from crest of spillway to depth under questions.

Top of Dam

C 2.5
L 550 ft.

4. PMF rainfall distribution, inflow hydrograph, and outflow hydrograph are shown on Plate A1.

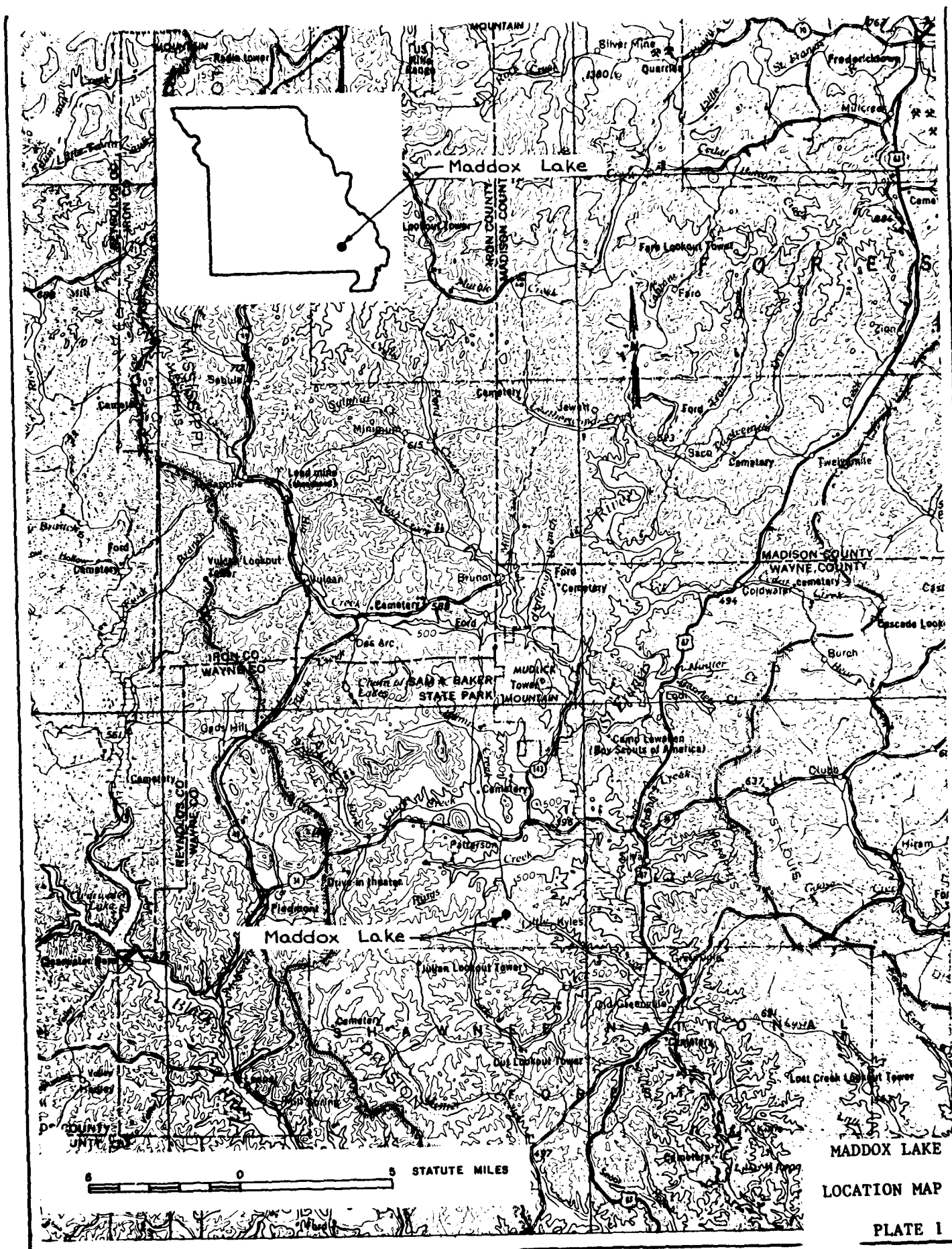


Time From Beginning of Storm, Hours

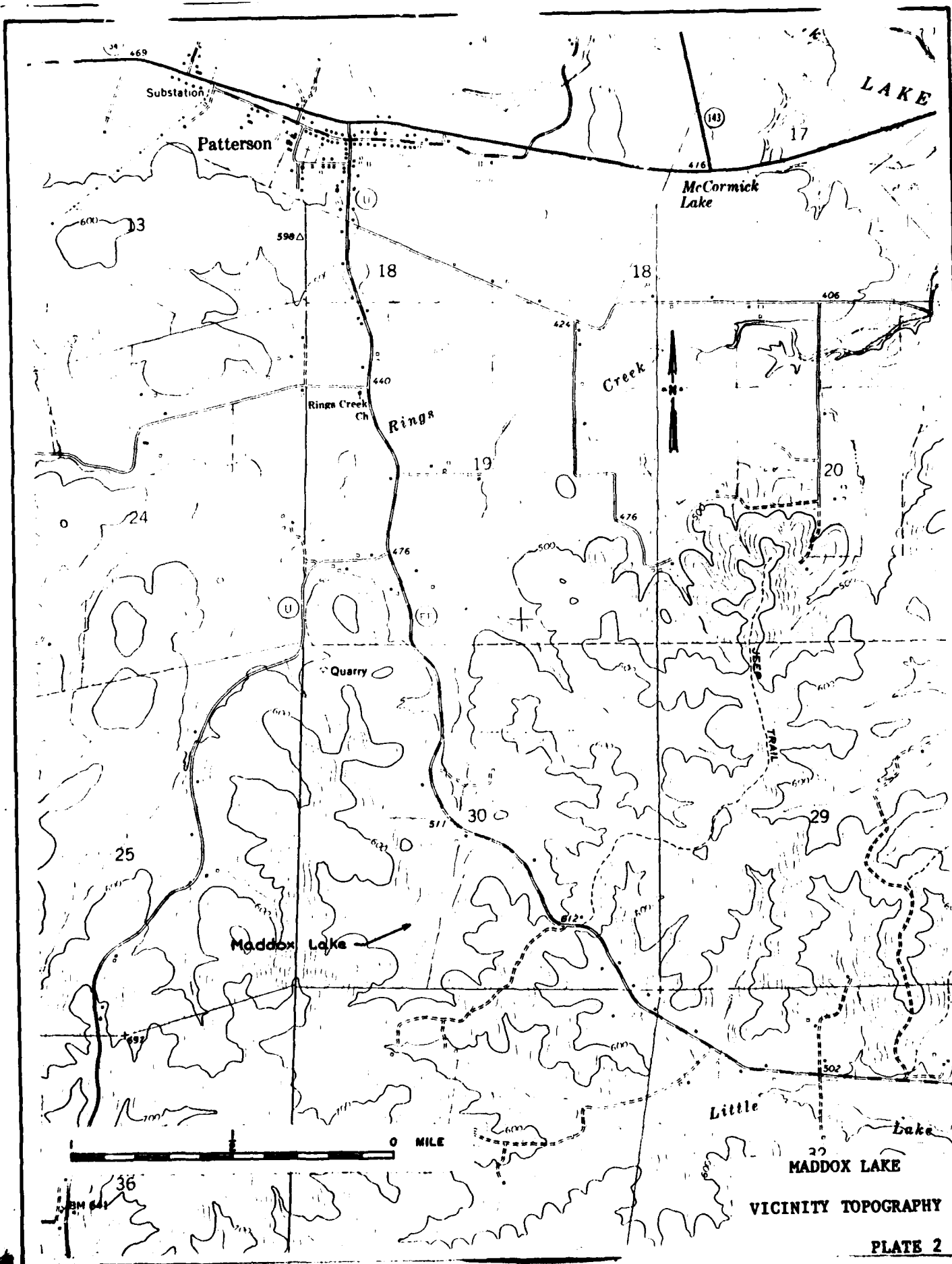
MADDOX LAKE

INFLOW AND OUTFLOW HYDROGRAPHS

PLATE A1



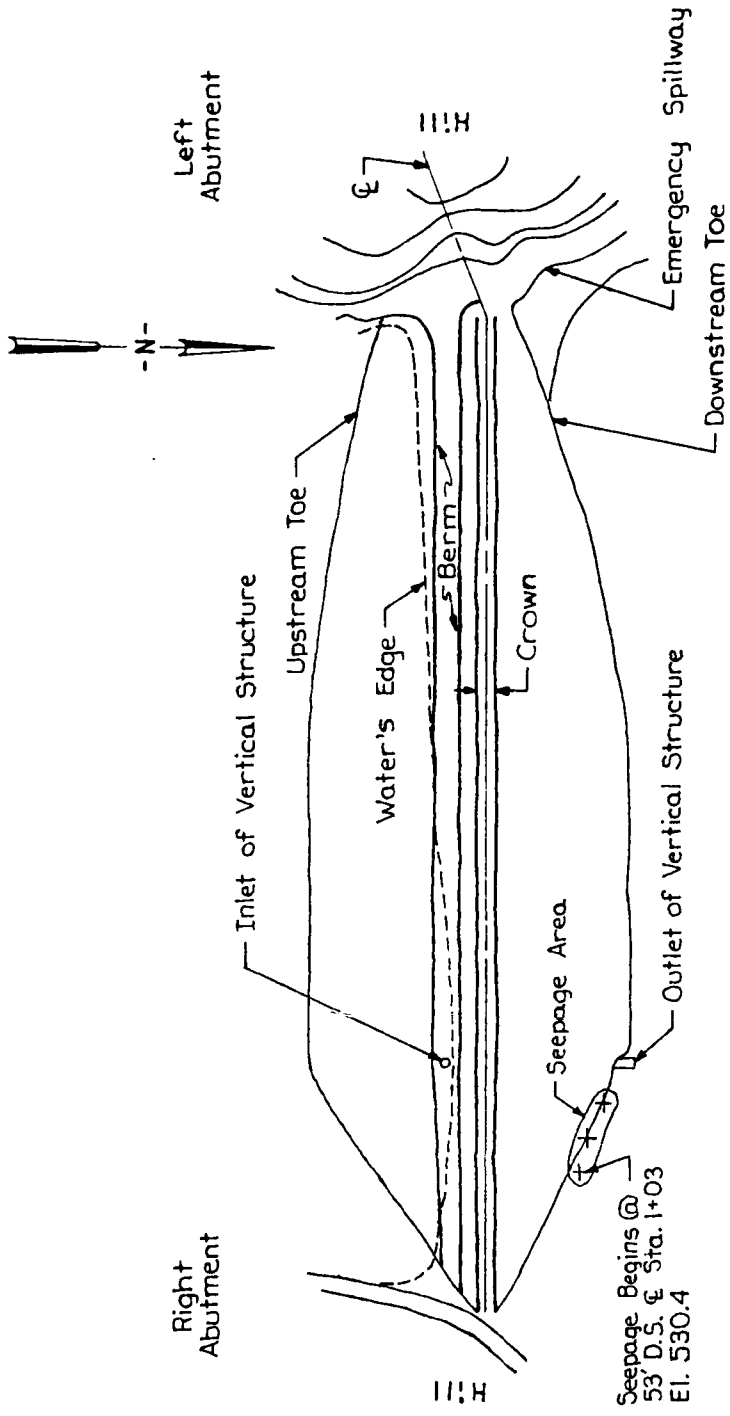
MADDOX LAKE
 LOCATION MAP
 PLATE I



VICINITY TOPOGRAPHY

PLATE 2

0+00 0+50 1+00 1+50 2+00 2+50 3+00 3+50 4+00 4+50 5+00 5+50 6+00 6+50 7+00



2+00
1+60
1+20
0+80
0+40
0+00
0+40
0+80
1+20
1+60
2+00

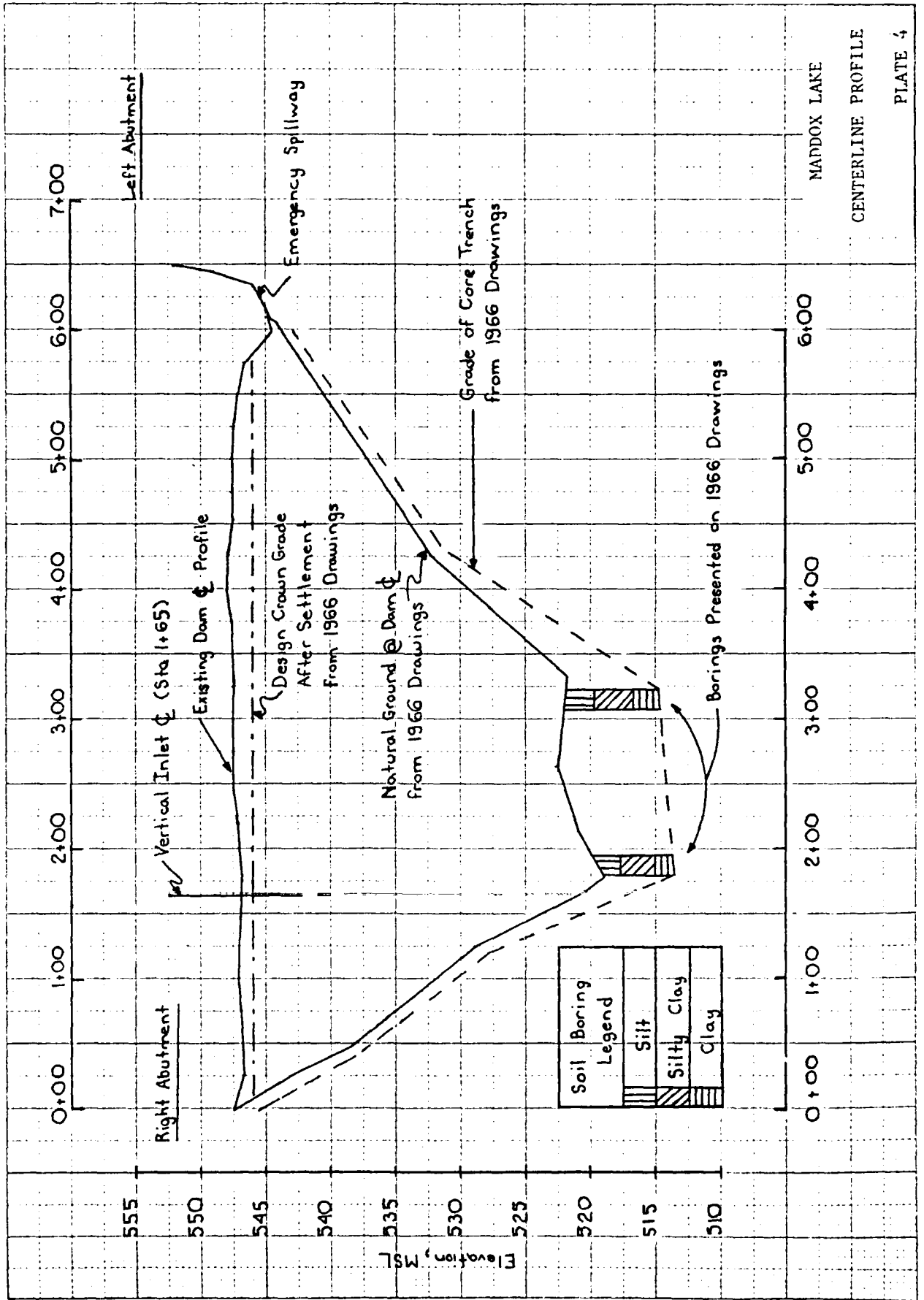
Seepage Begins @
53' D.S. & Sta. 1+03
El. 530.4

MADDOX LAKE

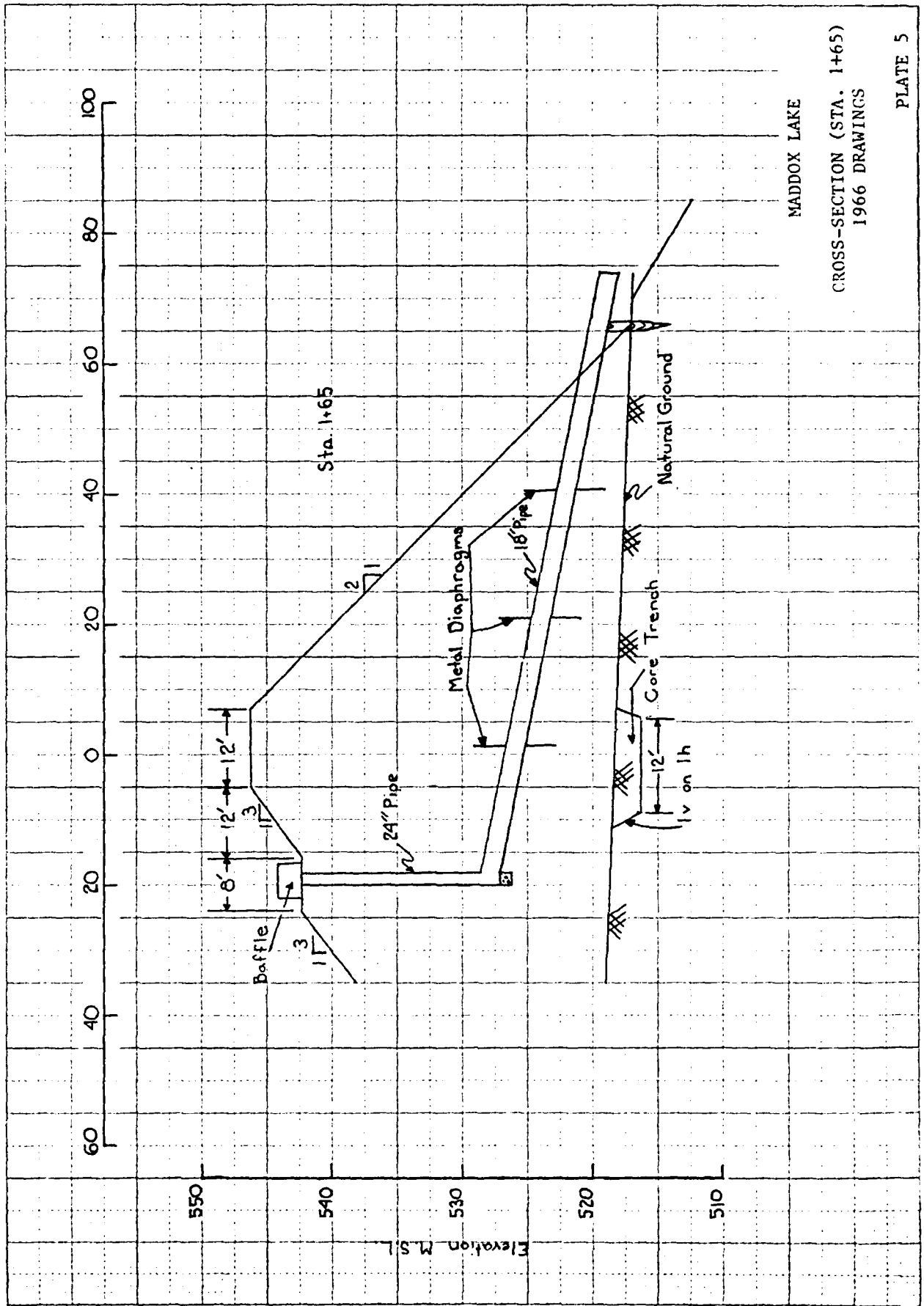
DAM PLAN VIEW

PLATE 3

10-1-66



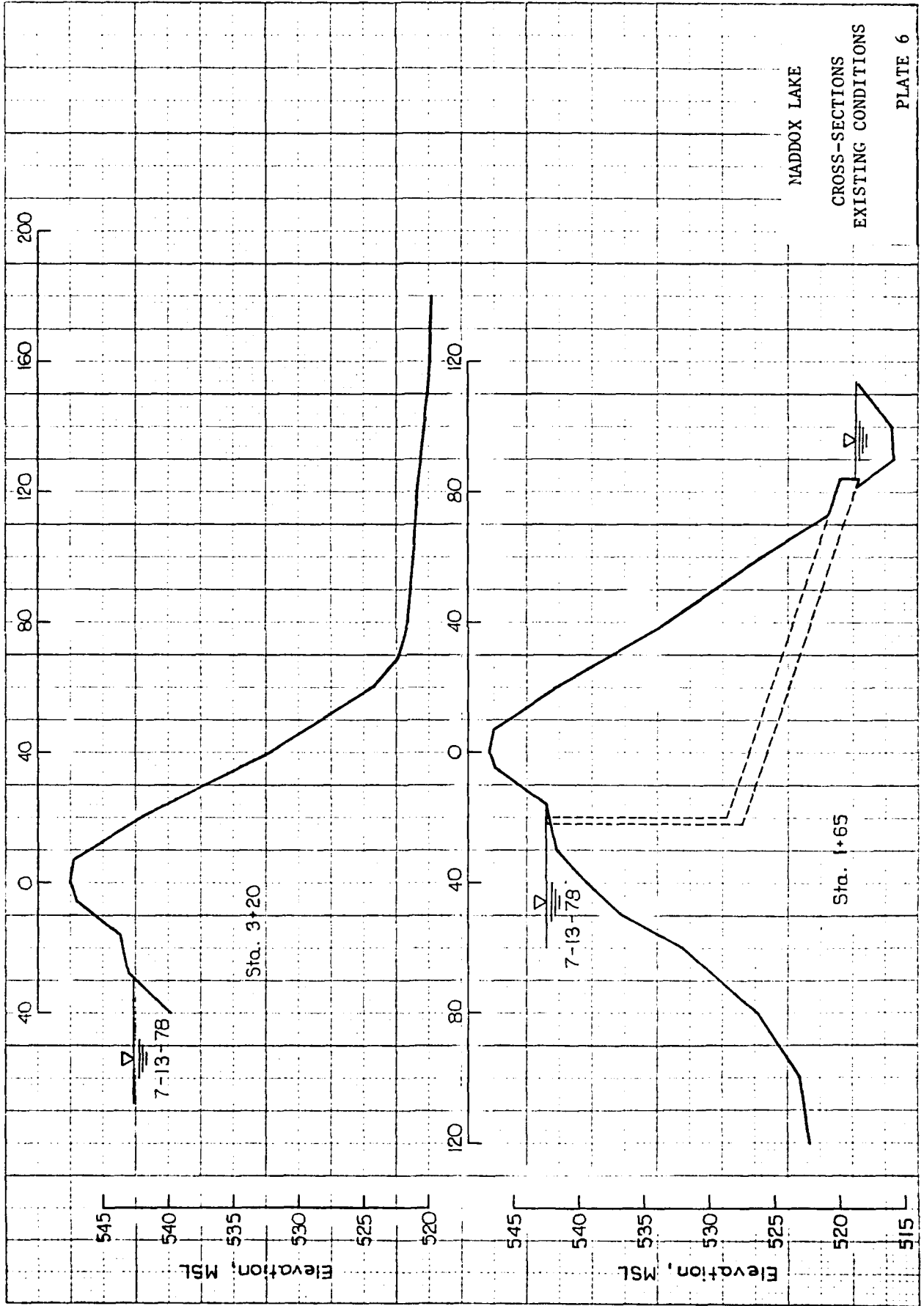
10 10 10 10



MADDOX LAKE

CROSS-SECTION (STA. 1+65)
1966 DRAWINGS

PLATE 5



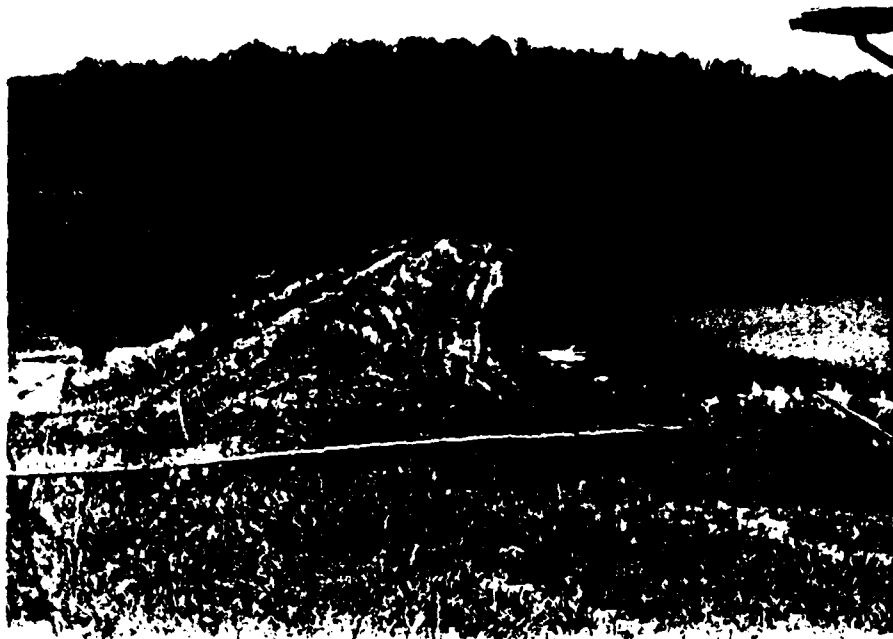


PHOTO 1: Overview of Lake and Dam



PHOTO 2: Crest of Dam



PHOTO 3: Upstream Berm



PHOTO 4: Downstream Slope



PHOTO 5: Seepage Area - Right Abutment



PHOTO 6: Inlet of Vertical Structure



PHOTO 7: Discharge of Vertical Structure



PHOTO 8: Discharge Area of Vertical Structure

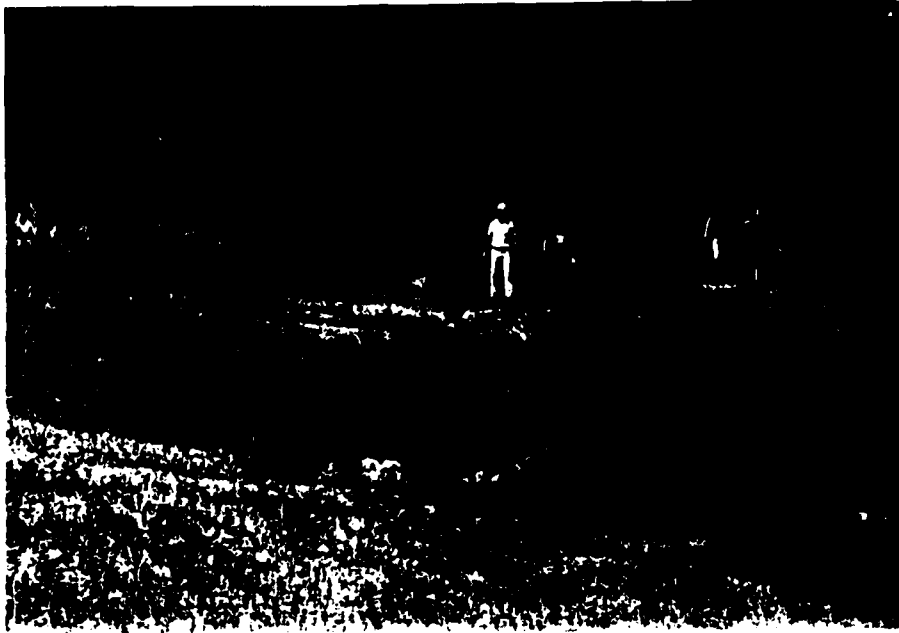


PHOTO 9: Emergency Spillway

