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HOSKINS-WESTERN-SONDEREGGER INC LINCOLN NE
NATIONAL DAM SAFETY PROGRAM. BERNDT LAKE DAM (MO 10472), MISSOU--ETC(U)
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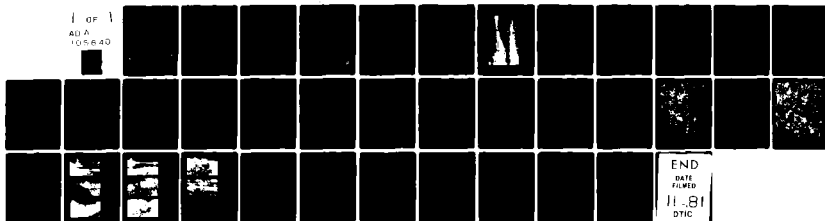
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BERNDT LAKE DAM

MERCER COUNTY, MISSOURI

MO 10472

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

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PREPARED BY: HOSKINS-WESTERN-SONDEREGGER, INC.
FOR: STATE OF MISSOURI

JULY, 1978

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.		

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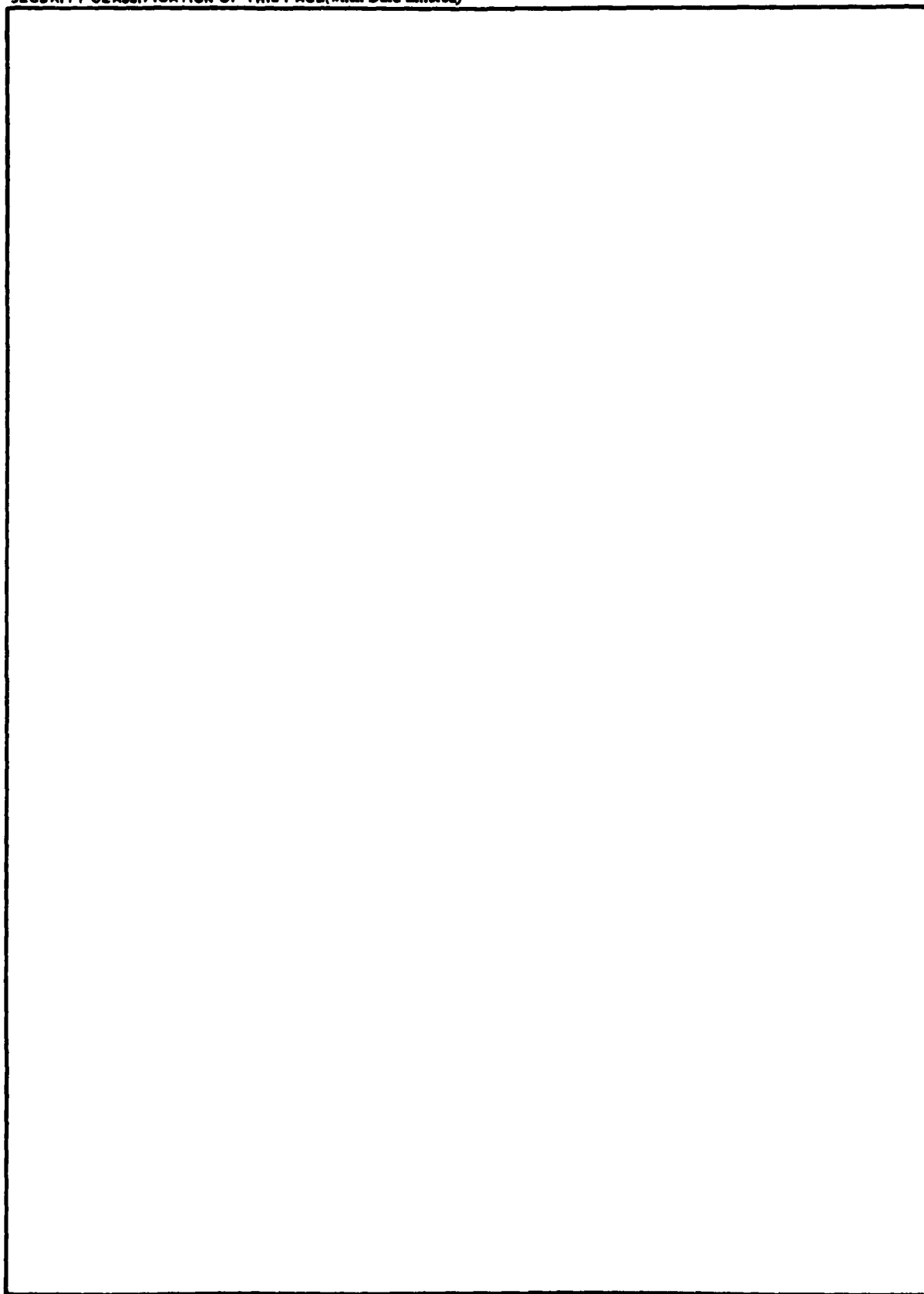
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DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 NORTH 12TH STREET
ST. LOUIS, MISSOURI 63101

IN REPLY REFER TO

SUBJECT: BERNDT LAKE DAM PHASE I INSPECTION REPORT

This report presents the results of field inspection and evaluation of the Berndt Lake Dam:

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

Hydraulic/Hydrologic

- 1) Spillway will not pass 50 percent of the Probable Maximum Flood
- 2) Overtopping could result in dam failure.
- 3) Dam failure significantly increases the hazard to loss of life downstream

Structural Stability

- 1) Erosion at the outlet of the spillway pipe
- 2) Excessively steep slopes
- 3) Seepage on the downstream slope.

SUBMITTED BY:

SIGNED

Chief, Engineering Division

26 SEP 1979

Date

APPROVED BY:

SIGNED

Colonel, CE, District Engineer

26 SEP 1979

Date

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PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam	Berndt Lake Dam
State Located	Missouri
County Located	Mercer County
Stream	Pops Branch
Date of Inspection	July 14, 1978

Berndt Lake Dam was inspected by an interdisciplinary team of engineers from Hoskins-Western-Sonderegger, Inc. 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 an intermediate size dam with a high downstream hazard potential. Failure would threaten life and property. The estimated damage zone extends five miles downstream of the dam. Twin Lake Dam (MO 10476) is approximately one mile downstream of Berndt Lake Dam. Hidden Valley Lake Dam (MO 10665) is approximately one-half mile downstream of Twin Lake Dam. Within the damage zone are Twin Lake Dam, a sewage lagoon located at the foot of Twin Lake Dam, four mobile homes located on Hidden Valley Lake, Hidden Valley Lake Dam, five mobile homes and one farmhouse with outbuildings located downstream from Hidden Valley Lake Dam.

Our inspection and evaluation indicates that the spillway does not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. The spillway will pass the 100 year frequency storm and also the storm equal to 30% of the Probable Maximum Flood without overtopping the dam. The Probable Maximum Flood (PMF) is defined as the flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. Additional deficiencies, in accordance with the guidelines, are the lack of seepage and stability analysis. These analyses should be obtained in the future.

Other deficiencies visually observed by the inspection team were wave erosion of the upstream slope of the dam, trees and shrubs growing on the upstream slope, a dense growth of trees and brush covering the downstream slope, severe erosion under and around the outlet of the pipe spillway, severe erosion in the downstream channel, seepage water ponded in the old railroad culvert and the old channel, and steep embankment slopes.

Several items of preventive maintenance need to be initiated by the owner. These are described in detail in the body of the report. Copies of the report have been furnished the dam owner and the Governor of Missouri.

H. P. Hoskins E 8696
Harold P. Hoskins, P.E.
Hoskins-Western-Sonderegger, Inc.
Lincoln, Nebraska

SUBMITTED BY	<u>SIGNED</u>	<u>26 SEP 1978</u>
	Chief, Engineering Division	Date
APPROVED BY	<u>SIGNED</u>	<u>26 SEP 1978</u>
	Colonel, CE, District Engineer	Date



PHOTO NO. 1
OVERVIEW TAKEN
FROM LEFT ABUTMENT

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
BERNDT LAKE DAM - MO 10472

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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 Berndt 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 old railroad fill that was converted to an impounding dam by plugging the culvert through the fill. Topography adjacent to the site is rolling to moderately steep. Soils on the slopes are derived from fine grained, plastic glacial till.

(2) The spillway consists of a 24-inch diameter corrugated metal pipe located in a cut through the old railroad grade on the right (west) end of the dam.

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

b. Location. The dam is located in the north central portion of Mercer County, Missouri, as shown on Plate 2. The lake formed by the dam is shown on Plate 1 in the W 1/2 of Section 30, T66N, R23W. The lake is also shown on the Princeton NE Orthophotograph (Plate 3).

c. Size Classification. Criteria for determining the size classification of dams and impoundments are presented in the guidelines referenced in paragraph 1.1c above. Based on these criteria, this dam and impoundment is in the intermediate 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. The estimated damage zone extends five miles downstream of the dam. Twin Lake Dam (MO 10476) is approximately one mile downstream of Berndt Lake Dam. Hidden Valley Lake Dam (MO 10665) is approximately one-half mile downstream of Twin Lake Dam. Within the damage zone are Twin Lake Dam, a sewage lagoon located at the foot of Twin Lake Dam, four mobile homes located on Hidden Valley Lake, Hidden Valley Lake Dam, five mobile homes and one farmhouse with outbuildings located downstream from Hidden Valley Lake Dam.

e. Ownership. This dam is owned by Hubert Berndt, Mercer, Missouri, 64661.

f. Purpose of Dam. The dam forms a 21 acre recreational lake.

g. Design and Construction History. No design or construction data were available. The owner supplied the following information. The railroad fill was constructed in the late 1800's. Drainage through the embankment was provided by means of a culvert 10 feet wide by 12 feet high constructed of hand cut and fitted stone. Stones placed in the culvert are not mortared. The culvert was plugged in 1946 and the reservoir filled in 1947. After the reservoir filled, seepage emerged through the ceiling of the rock culvert. In 1949 the entrance of the culvert was blocked by placing a concrete curtain wall in the entrance of the culvert. The concrete was four feet thick and keyed into the periphery of the culvert. An earth fill was placed in front of the concrete wall. This fill had a top width of 12 feet and extended 8 to 10 feet above the top elevation of the culvert and covered the wing walls of the culvert entrance. It was constructed of sandy and silty clays (SC and CL) and compacted by equipment travel.

h. Normal Operating History. It was reported that the lake level is relatively stable. The highest lake levels occurred in 1959 and 1978 when water approached the top elevation of the spillway pipe and discharged through the spillway for 10 to 14 days. The lowest levels of the lake occurred in 1954 and 1977 when the water surface was approximately 2.5 feet below the normal elevation.

1.3 PERTINENT DATA

a. Drainage Area - 193 acres.

b. Discharge at Damsite.

(1) All discharge at the damsite is through an uncontrolled corrugated metal pipe spillway.

(2) Estimated maximum flood at damsite - $360 \pm$ c.f.s. which occurred in 1959 and again in 1978.

(3) Estimated ungated spillway capacity at maximum pool elevation ($1010 \pm$) - 32 c.f.s.

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

(1) Top of dam - $1016 \pm$ on the left end and $1010 \pm$ on the right end.

(2) Spillway crest - $1005.5 \pm$.

(3) Streambed at centerline of dam - $952 \pm$.

(4) Maximum tailwater - unknown.

d. Reservoir. Length of maximum pool - 2200 feet $\pm$.

e. Storage (Acre-feet). Top of dam ($1010 \pm$) - 410.

f. Reservoir Surface (Acres).

(1) Top of dam ($1010 \pm$) - $27 \pm$.

(2) Spillway invert elevation - $21 \pm$.

g. Dam.

(1) Type - earth embankment constructed for railroad grade.

(2) Length - 1000 feet $\pm$ (measured).

(3) Height - maximum = 64 feet $\pm$, minimum = 58 feet $\pm$ (measured).

(4) Top width - 15 to 24 feet (measured).

(5) Side Slopes -

(a) Downstream - 1.5 to 1.7H on 1V (measured by stadia and angle).

(b) Upstream - 1.5H on 1V (exposed).

(6) Zoning - unknown.

(7) Impervious core - unknown.

(8) Cutoff - unknown.

(9) Grout curtain - unknown.

(10) Upstream riprap - none.

h. Diversion and Regulating Tunnel. None.

i. Spillway.

(1) Type - 24-inch diameter corrugated metal pipe with concrete headwalls.

(2) Length of conduit - 20 feet.

(3) Invert elevation - 1005.5± feet m.s.l.

j. Regulating Outlets. None.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

No design data, other than reported by owner, were available. Topographic data to evaluate reservoir stage-volume relationships were taken from U.S.G.S. 15 minute Quad sheets, enlarged to the equivalent of 7.5 minute Quads, with 20 foot contour intervals.

2.2 CONSTRUCTION

The railroad grade embankment was converted to an impounding dam in 1946. No other construction data were available.

2.3 OPERATION

The maximum water elevation in the reservoir was reported to be approximately 1008 feet in 1959 and 1978. The lowest water elevation was approximately 1003 feet in 1954 and 1977.

2.4 EVALUATION

a. Availability. The only data available were reported by the owner.

b. Adequacy. The data available were not adequate to make a detailed assessment of the design and construction of the dam. Topographic data for reservoir volume relationships and flood routings are approximate. The use of these data could result in at least 20 percent variance in the maximum reservoir level developed by any given flood.

c. Validity. The information provided by the owner is considered to be valid.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. A visual inspection of Berndt Lake Dam was made on July 14, 1978. The following engineers from Hoskins-Western-Sonderegger, Inc., made the inspection: Rey Decker, Geology and Soil Mechanics, Garold Ulmer, Civil Engineer and Richard Walker, Hydrology. Specific observations are discussed below.

b. Dam. A number of small trees and shrubs are growing on the upstream slope. It was reported that wave action on the upstream slope has formed a berm or beaching slope just below the normal water surface. The presence of this flat slope was observed. About 75 percent of the upstream face is eroded to near vertical slopes ranging from 2 to 5 feet above the water surface.

The crest of the dam grades from the left (east) end to the right (west) end. A difference of about 6 feet was measured from one end to the other (see Appendix C). No cracks or slides were noted on the crest of the dam. Soils on the crest of the dam consist of lean to fat clays (CL and CH) and railroad ballast.

The downstream slope is covered with a rank growth of trees (several dead elms) up to 12 inches in diameter, multiflora rose and other brush. Most of the large trees are along the toe of the dam. This vegetation made it impossible to observe conditions of the downstream slope.

The toe of the downstream slope was traversed with difficulty. Water is ponded about 2 feet deep in the old railroad culvert. It was reported that seepage water discharges continuously from the culvert. The seepage discharge was clear. Water was also ponded in the old channel. No seeps, slides or deformations were noted along the downstream toe in the limited areas where observations could be made through the vegetation.

Materials in both abutments consist of plastic glacial till (SC, CL and CH). Hills at both ends of the dam were excavated to form the railroad grade. This material was obviously used to construct the present embankment. The railroad fill was exposed to a depth of 8 to 10 feet in the eroded spillway channel discussed in paragraph c, below. This section of the fill was constructed in lifts about 6 inches in thickness and seemed to be well compacted.

c. Appurtenant Structures. The uncontrolled spillway consists of a corrugated metal pipe 24 inches in diameter and 20 feet long which has been placed through the old railroad grade. The upstream concrete headwall appeared to be sound. The approach channel to the spillway is approximately 35 feet wide across the top and about 3 feet deep. It is not obstructed. Severe erosion was noted under and around the outlet of the spillway.

d. Reservoir Area. No significant erosion was noted along the shoreline of the reservoir.

e. Downstream Channel. The exit channel for the spillway has a slope of about 25 percent. The bottom is plated with loose limestone rocks up to 15 inches in diameter for a distance of about 75 to 100 feet downstream from the spillway outlet. The right bank of the exit channel is severely eroded adjacent to and downstream from the outlet of the pipe. The spillway from Berndt Lake discharges into Twin Lakes about 500 feet downstream from Berndt Lake spillway.

3.2 EVALUATION

The wave erosion and uncontrolled vegetation on both upstream and downstream slopes of the dam and the size and condition of the spillway could lead to serious potential of failure. It was not possible to evaluate the condition of the downstream slope nor the nature and location of seepage into the old railroad culvert.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

There are no controlled outlet works for this dam.

4.2 MAINTENANCE

The number of trees on the upstream slope and the amount of brush and the size of trees on the downstream slope would indicate that it has been several years since the vegetation has been controlled. The erosion on the upstream face of the dam and the condition of the spillway indicate the lack of regular maintenance operations.

4.3 MAINTENANCE OF OPERATING FACILITIES

There are no operating facilities 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

A serious potential of failure may develop if conditions discussed in paragraph 4.2 above are allowed to progress.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. No original hydrologic design data were received from the owner.

b. Experience Data. The drainage area and lake surface area are developed from USGS Princeton, Mo. (15') Quadrangle. The spillway and dam layout are from surveys made during the inspection (see paragraphs 2.1 and 2.4).

c. Visual Observations.

(1) The approach channel to the spillway was clear of obstructions.

(2) The concrete headwall on the upstream side appeared to be sound, however, the area under and around the spillway outlet was badly eroded.

(3) No drawdown facilities are available to evacuate the pool.

(4) The spillway and exit channel are located at the immediate right abutment of the dam through a cut in the old railroad grade.

d. Overtopping Potential. The spillway is too small to pass the probable maximum flood without overtopping. One-half the PMF will overtop the dam by 1.12 feet for a period of 4.5 hours. The spillway will pass 30% of the PMF without overtopping. The existing spillway will pass the 100-year frequency flood without overtopping. The results of the routings through the dam are tabulated in regard to the following conditions.

<u>Frequency</u>	<u>Inflow Discharge c.f.s.</u>	<u>Outflow Discharge c.f.s.</u>	<u>Maximum Pool Elevation</u>	<u>Freeboard Top of Dam Min. Elev. 1010</u>	<u>Time Dam Overtopping Hr.</u>
100 Yr.	400	0	1008.7	1.3	0
1/2 PMF	900	600	1011.1	-1.1	4.5
PMF	1900	1700	1012.2	-2.2	11.5
0.30 PMF	500	0	1010.0	0.0	0

According to the recommended guidelines from the Department of the Army, Office of the Chief of Engineers, this dam is classified as intermediate by height and has a high hazard classification. Therefore, the PMF is the test for the adequacy of the dam and its spillway.

The estimated damage zone extends five miles downstream of the dam. Twin Lake Dam (MO 10476) is approximately one mile downstream of Berndt Lake Dam. Hidden Valley Lake Dam (MO 10665) is approximately one-half mile downstream of Twin Lake Dam. Within the damage zone are Twin Lake Dam, a sewage lagoon located at the foot of Twin Lake Dam, four mobile homes located on Hidden Valley Lake, Hidden Valley Lake Dam, five mobile homes and one farmhouse with outbuildings located downstream from Hidden Valley Lake Dam.

This information was furnished by the St. Louis District, Corps of Engineers, in a letter dated 13 July, 1978.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual. Visual observations which adversely affect the structural stability of this dam are discussed in Section 3. These include the following features: dense vegetation and many trees on both slopes of the embankment; steep embankment slopes; wave erosion on the upstream slope; impounded water along the downstream toe of the dam and seepage into the old railroad culvert, severe erosion around and downstream from the emergency spillway.

b. Design and Construction Data. No design or construction data relating to the stability of the dam were available.

c. Operating Records. There are no operating structures for this dam.

d. Post Construction Changes. There are no post construction changes, other than those discussed in Section 1.2, paragraph g., that affect the stability of this structure.

e. Seismic Stability. This dam is located in Seismic Zone 1. An earthquake of this low magnitude could amplify the potential structural instability of this dam caused from some of the adverse features listed in paragraph "a" above.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. Several items were noted during the visual inspection which should be controlled or corrected. These items are trees and brush growing on both slopes of the dam, erosion on the upstream face, and erosion at the outlet of the spillway pipe. The stability and possible seepage conditions on the downstream slope should be investigated after the slope has been cleared. The inadequacy of the spillway for this dam is as stated in paragraph 5.1d.

b. Adequacy of Information. No engineering design or construction data were available for this dam. The conclusions in this report were based on visual inspection and performance history which are considered sufficient to support such conclusions. Neither seepage nor stability analysis were found which is a deficiency that should be corrected in the future.

c. Urgency. The remedial and maintenance measures recommended in paragraph 7.2 should be accomplished in the near future. If not corrected or controlled, they could lead to serious potential of failure.

d. Necessity for Phase II. Phase II investigation is not called for. Additional engineering data should be obtained at the owner's expense to determine the source and consequences of water observed downstream of the dam and to assess the stability of the downstream slope. The rank vegetative growth as described in paragraph 3.1b should be removed prior to engineering investigations. The engineering investigations should be done by a professional engineer who is experienced and competent in earth dam design.

e. Seismic Stability. This dam is located in Seismic Zone 1. (See paragraph 6.1e.)

7.2 REMEDIAL MEASURES

a. Alternatives.

(1) The size of the spillway should be increased and/or the crest of the dam should be raised to a uniform elevation equal to the elevation at the east end in order to pass the probable maximum flood without overtopping the dam.

(2) Assess the stability of the downstream slope after it has been cleared.

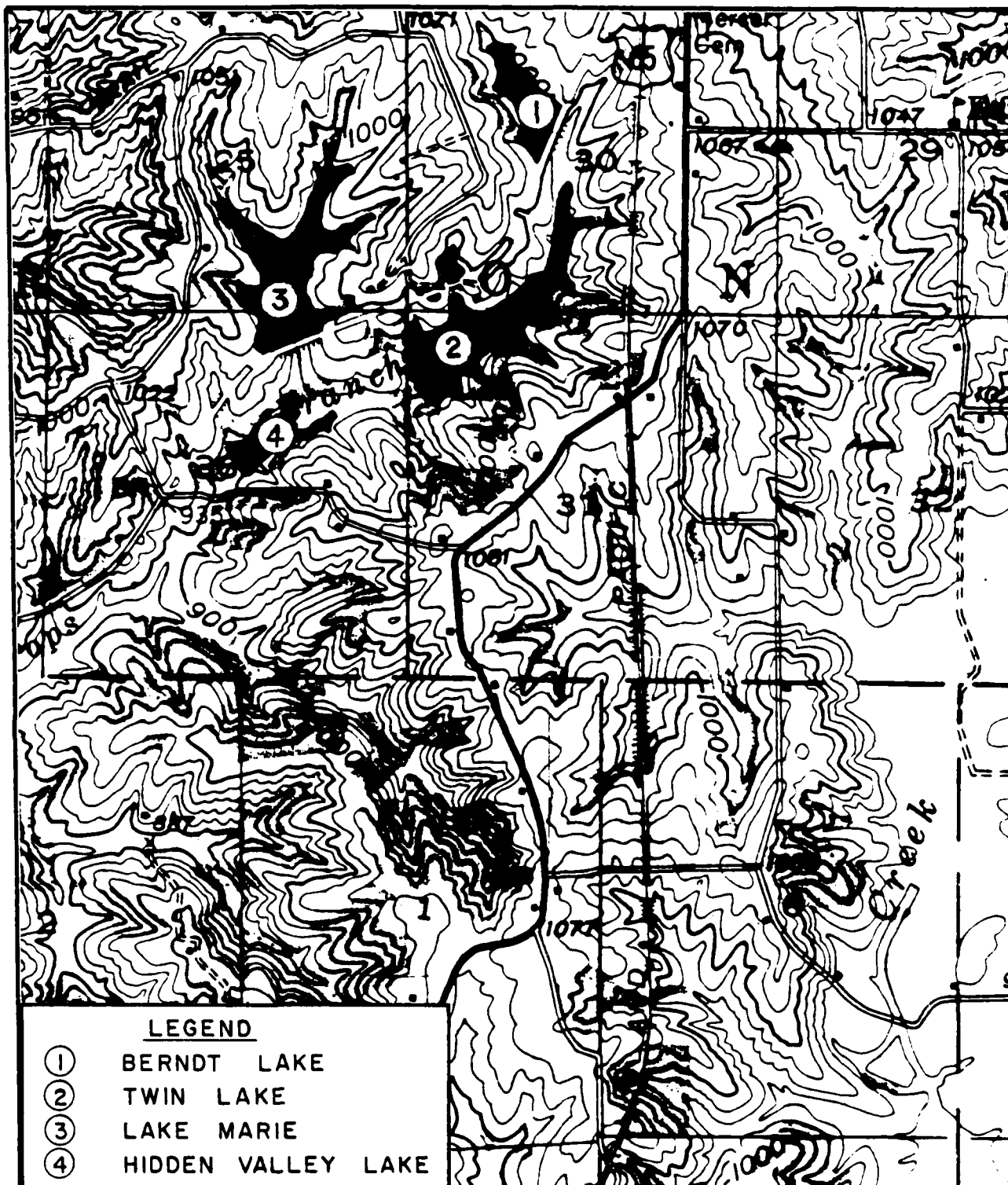
(3) All remedial measures should be performed by a professional engineer who is experienced and competent in earth dam design.

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b. O&M Maintenance and Procedures. The following operation and maintenance measures are recommended:

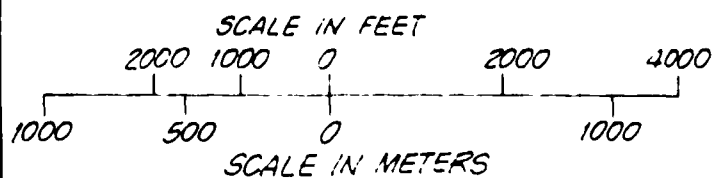
- (1) Clear the brush and trees from the dam and initiate a program to prevent their recurrence.
- (2) Stabilize the outlet section of the spillway to control erosion.
- (3) Riprap or otherwise stabilize the upstream slope of the dam to prevent wave erosion.

APPENDIX A
MAPS

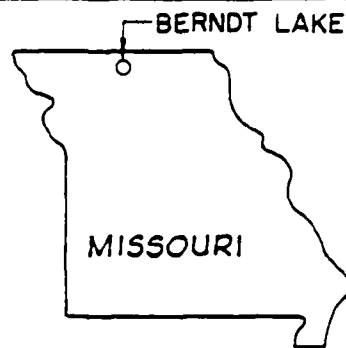


LEGEND

- ① BERNDT LAKE
- ② TWIN LAKE
- ③ LAKE MARIE
- ④ HIDDEN VALLEY LAKE

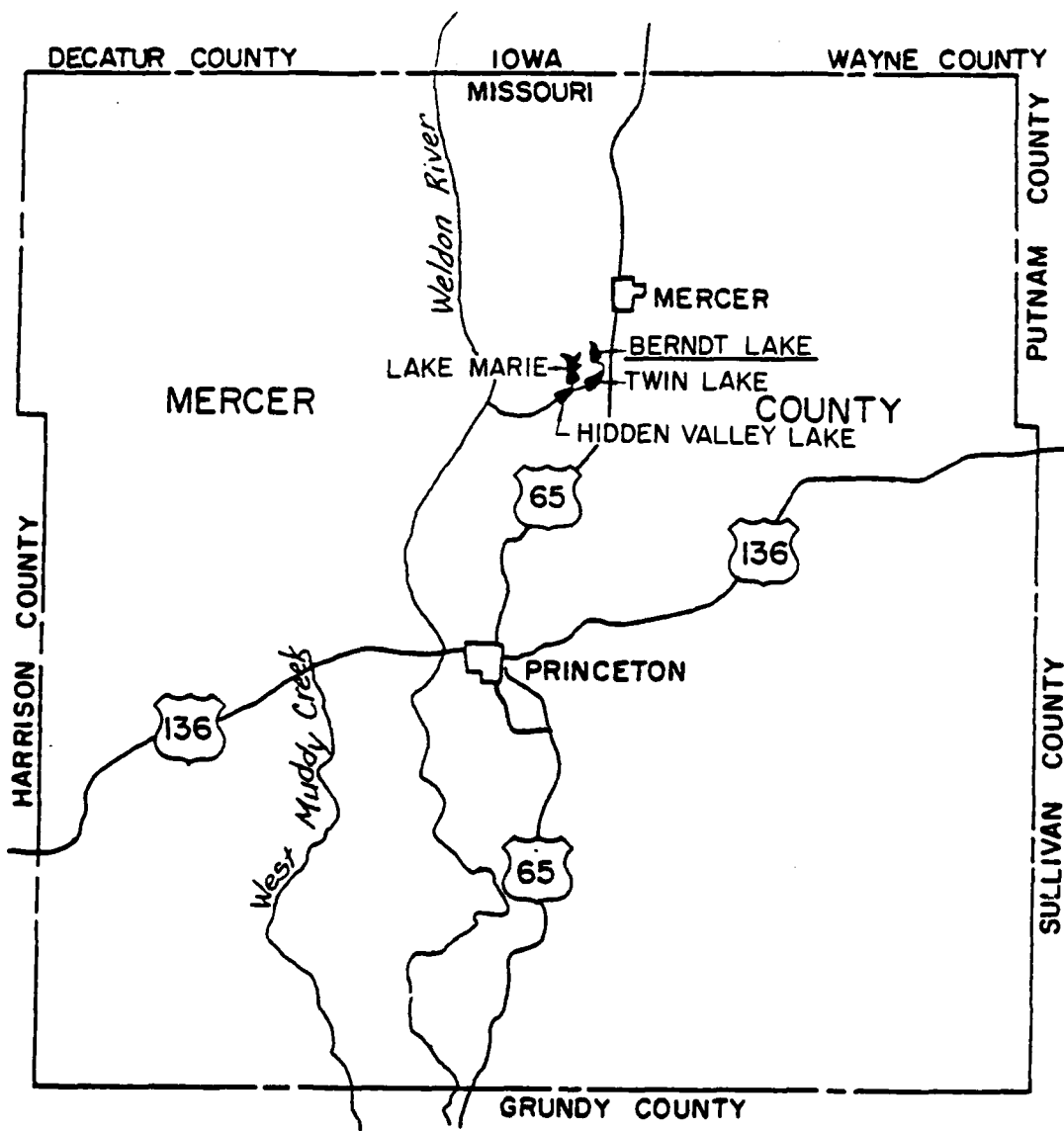
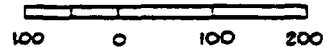


BERNDT LAKE
VICINITY TOPOGRAPHY
PLATE I



VICINITY MAP

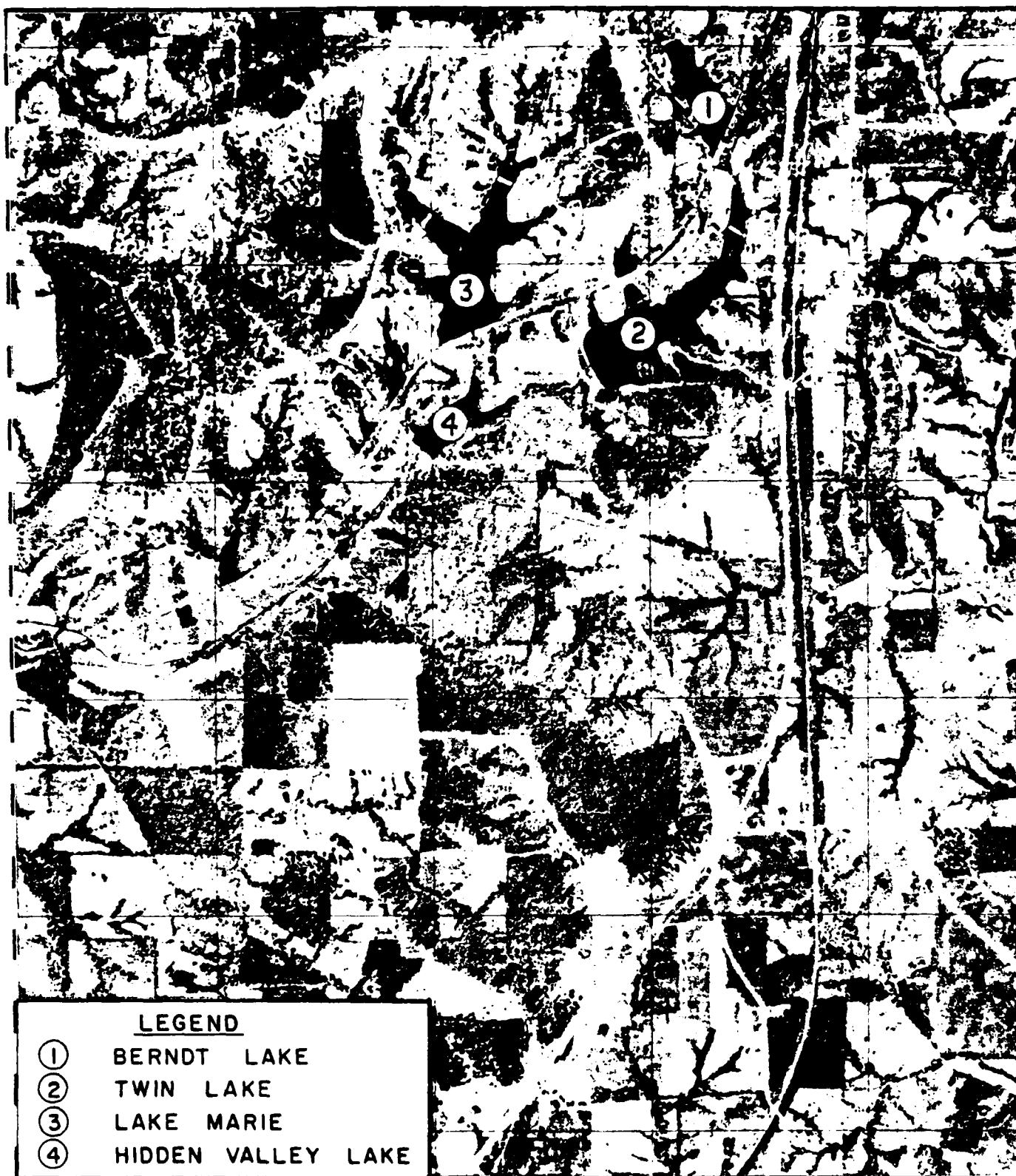
SCALE IN MILES



SCALE IN MILES



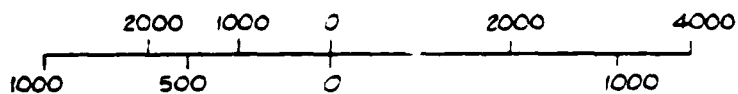
LOCATION MAP
PLATE 2



LEGEND

- ① BERNDT LAKE
- ② TWIN LAKE
- ③ LAKE MARIE
- ④ HIDDEN VALLEY LAKE

SCALE IN FEET



SCALE IN METERS



BERNDT LAKE
ORTHOPHOTOGRAPH
PLATE 3

APPENDIX B
PHOTOGRAPHS



PHOTO NO. 2
TOP OF DAM
TAKEN FROM
LEFT ABUTMENT

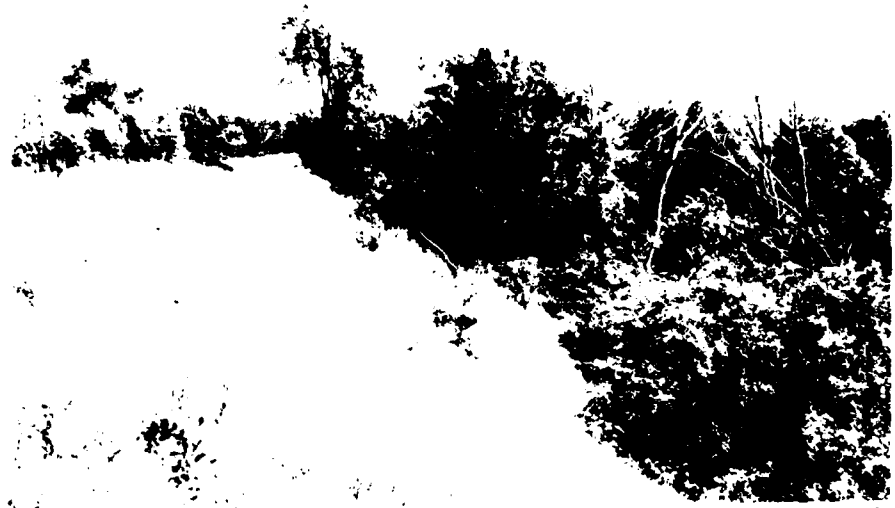


PHOTO NO. 3
DOWNSTREAM
SLOPE, LOOKING
EAST FROM
STA. 7+00



PHOTO NO. 4
DOWNSTREAM
SLOPE, LOOKING
SOUTH FROM
STA. 6+00. TWIN
LAKE BARELY
VISIBLE



PHOTO NO. 5
LOOKING NORTH
ACROSS LAKE
TAKEN FROM
STA. 7+00



PHOTO NO. 6
OUTLET END
OF ORIGINAL
RAILROAD BOX
CULVERT



PHOTO NO. 7
EROSION AT END
OF SPILLWAY



PHOTO NO. 8
SPILLWAY CHANNEL
TAKEN FROM
50' DOWNSTREAM



PHOTO NO. 9
SPILLWAY INLET
AND FOREBAY

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APPENDIX C
PLANS AND REPORTS

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APPENDIX D
HYDROLOGIC COMPUTATIONS

HYDROLOGIC COMPUTATIONS

1. The Mockes dimensionless standard curvilinear unit hydrograph and the SCS TR-20 program were used to develop the inflow hydrographs (see Plates D1 and D2).

a. Forty-eight hour, 100-year rainfall for the dam location was obtained by applying the current OCE directives furnished 3 August, 1978 with various durational increments obtained from the 100-year rainfall tables taken from NOAA Technical Paper 40. The forty-eight hour probable maximum precipitation was taken from the curves of the Hydrometeorological Report No. 33 and current OCE directives mentioned previously.

b. Drainage area = 0.302 square miles.

c. Time of concentration of runoff = 22 minutes.

d. The antecedent storm conditions were heavy rainfall and low temperatures which occurred on the previous 5 days (SCS AMC III). The initial pool elevation was assumed at the invert of the spillway.

e. The total forty-eight hour storm duration losses for the 100-year storm were 1.23 inches. The total losses for the forty-eight hour duration 1/2 PMF storm were 0.92 inches. The total losses for the PMF storm were 1.87 inches. These data are based on SCS runoff curve No. 91.6 and antecedent moisture conditions from SCS AMC III.

f. Average soil loss rates = 0.05 inch per hour approximately.

2. The combined discharge rating consisted of two components; the flow through the spillway and flow going over the top of the dam. The spillway rates are based on the full flow equation

$$Q = a \sqrt{\frac{2gH}{1 + K_e + K_b + K_p L}}$$

where a = cross-sectional area of pipe, $\text{ft}^2 = 3.14$

H = total head, ft.

K_e = coefficient for entrance loss = 0.5

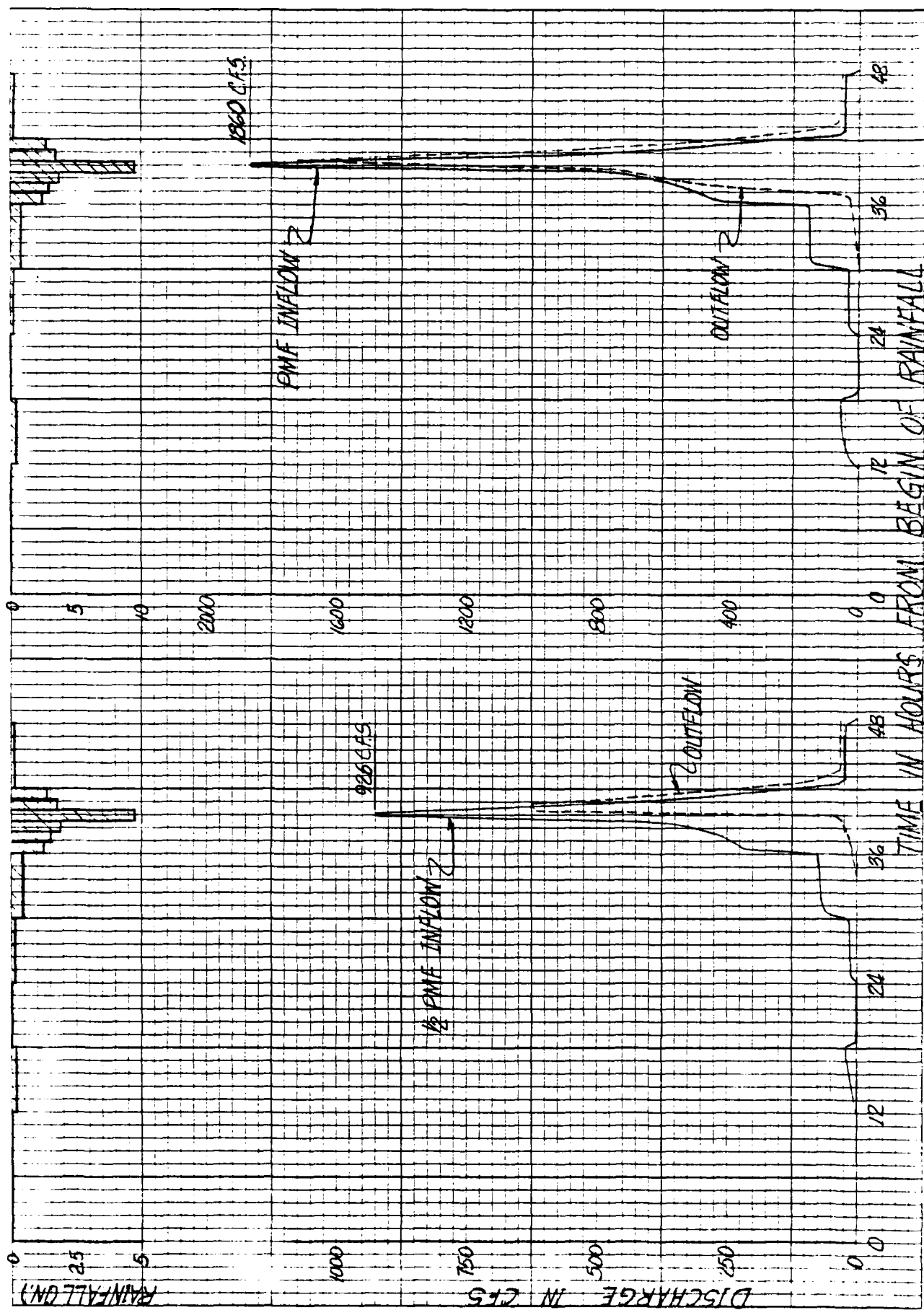
K_b = coefficient for bend loss = 0

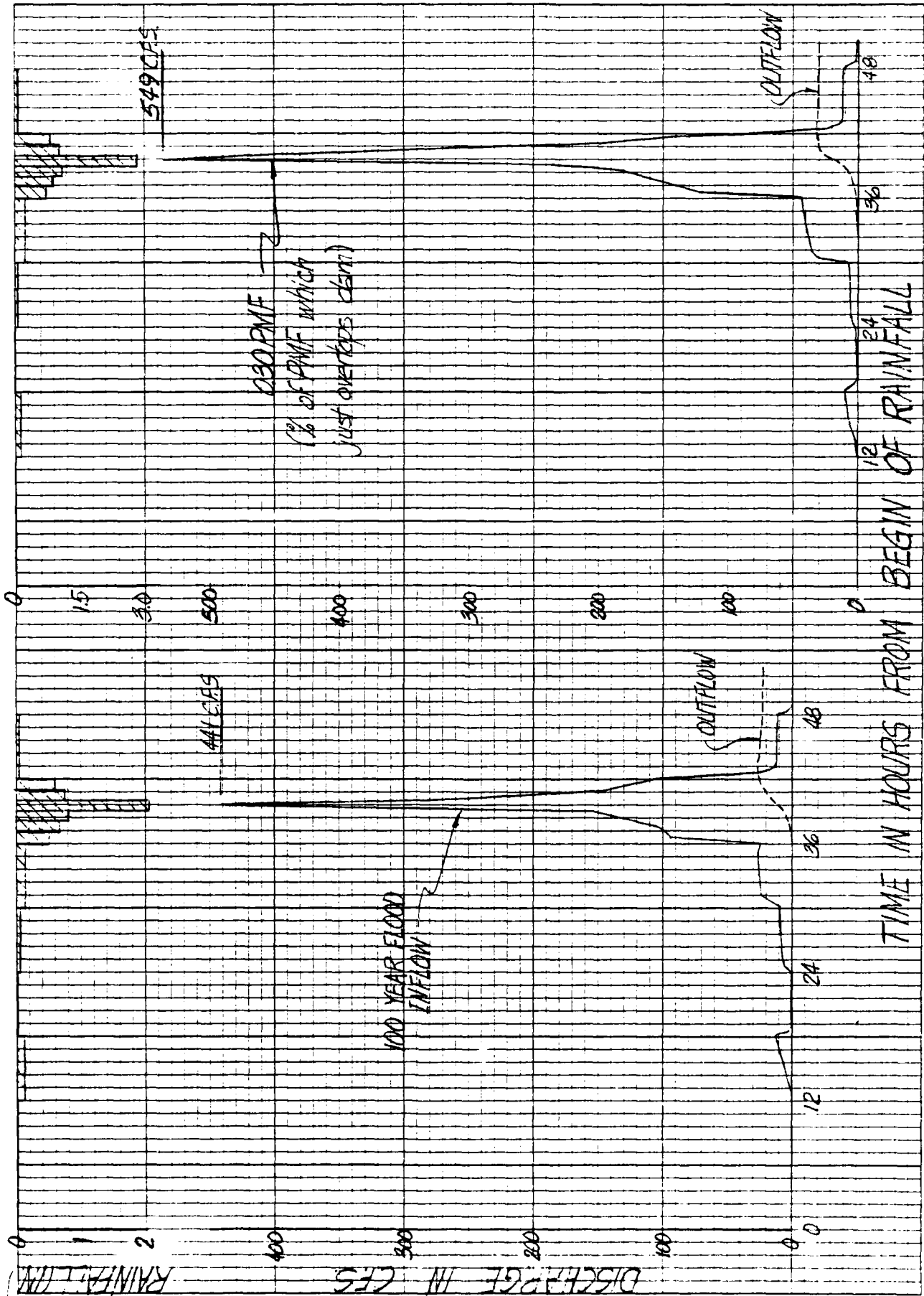
K_p = coefficient for pipe friction loss = 0.0459

L = length of pipe, ft. = 20

The flows over the dam are based on the broad-crested weir equation ($Q = CLH^{1.5}$) where H is the head on the dam crest, L is the effective length acting as a weir, and C is an appropriate weir coefficient which varies with head and is based on U.S. Geological Survey criteria. Various effective lengths were used to compensate for the slope of the old railroad grade.

3. The Probable Maximum Flood and fractions of it were routed through the dam to determine that percentage of PMF which just overtops the dam. Due to the proximity of Twin Lake (MO 10476) and Hidden Valley (MO 10665) downstream of Berndt Lake, the effects of the discharge from Berndt Lake on the other dams is of extreme importance. Therefore, the three dams plus Lake Marie (MO 10154) were routed together. The routings were made using SCS TR-20 computer program. The 100-year flood was also routed through the dams. The input rainfall distributions, reservoir inflow hydrographs, and outflow hydrographs for this dam are shown on Plates D1 and D2 for the PMF, 1/2 PMF, 100-year flood, and percentage of PMF just overtopping the dam.





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