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NATIONAL DAM SAFETY PROGRAM. NEW DRESSER NUMBER 4 DAM (MO 31124--ETC(U)
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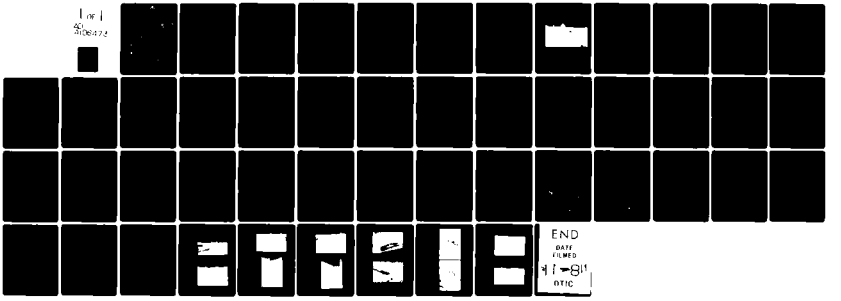

LEVEL II

MISSISSIPPI-KASKASKIA-ST. LOUIS BASIN

NEW DRESSER NO. 4 DAM
WASHINGTON COUNTY, MISSOURI
MO 31124

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

United States Army
Corps of Engineers
... Serving the Army
... Serving the Nation

St. Louis District

PREPARED BY: U. S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

JUNE 1979

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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Dam Safety, Lake, Dam Inspection, Private Dams

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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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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

IN REPLY REFER TO

22 August 1979

SUBJECT: New Dresser No. 4 Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the New Dresser No. 4 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:

1. Spillway will not pass 50 percent of the Probable Maximum Flood.

2. Overtopping of the dam and/or significant erosion of the spillway could result in failure of the dam.

3. Dam failure significantly increases the hazard to loss of life downstream.

4. Excessively steep downstream slope.

SUBMITTED BY: SIGNED
Chief, Engineering Division

25 SEP 1979
Date

SIGNED

APPROVED BY:
Colonel, CE, District Engineer

25 SEP 1979
Date

NEW DRESSER NO. 4 DAM
WASHINGTON COUNTY, MISSOURI

MISSOURI INVENTORY NO. 31124

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED BY
INTERNATIONAL ENGINEERING COMPANY, INC.
CONSULTING ENGINEERS
SAN FRANCISCO, CALIFORNIA

UNDER DIRECTION OF
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
FOR
GOVERNOR OF MISSOURI

JUNE 1979

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam	New Dresser No. 4 Dam
State	Missouri
County	Washington
Stream	Tributary to Mill Creek
Date of Inspection	26 March 1979

New Dresser No. 4 Dam was inspected by a civil engineer and an engineering geologist from International Engineering Company, Inc. of San Francisco, California. This dam is owned by Dresser Minerals Division of Potosi, Missouri. The purpose of the inspection was to assess the general condition of the dam with respect to safety. The assessment was based on an evaluation of the available data, a visual inspection and an evaluation of the hydrology and hydraulics of the site to determine if the dam poses hazards to human life or property. The purpose of the dam is to impound tailings from a barite separation and beneficiation operation.

New Dresser No. 4 Dam was inspected using the "Recommended Guidelines for Safety Inspection of Dams" furnished by the Department of the Army, Office of the Chief of Engineers. Based on these Guidelines, this dam is classified as intermediate size. The U.S. Corps of Engineers has classified it as having a high downstream hazard potential to indicate that failure of this dam could threaten life and property. The damage zone, estimated by the U.S. Corps of Engineers, extends approximately 4 miles downstream of the dam. Several dwellings, low-water bridges and railroad bridges are within this damage zone.

The results of the inspection and evaluation indicate that the spillway does not meet the criteria given in the Guidelines for a dam with the size and hazard potential of New Dresser No. 4 Dam. As an intermediate size dam with a high hazard potential, it is required by the Guidelines to pass the Probable Maximum Flood (PMF) without overtopping the crest. The PMF is the flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that is reasonably possible in the region. It was calculated that the spillway could pass a 100-year flood (a flood having a 1 percent chance of being equalled or exceeded in any 1 year) without overtopping the dam. It was also estimated that the spillway could pass 11 percent of the PMF without significant erosion of the spillway or embankment. However, the spillway cannot pass 50 percent of the PMF without overtopping and without significant erosion of the spillway and embankment.

The spillway should be enlarged and/or adequate freeboard provided so that the PMF can be passed without overtopping the dam. Also, no erosion protection has been provided in the spillway channel. Adequate erosion protection should be provided so that it can pass the PMF without significant erosion of the embankment and spillway channel.

The soils immediately downstream of the dam were soft and saturated. Seepage was observed in that area of the damsite. This soft soil condition and the steep downstream slope of the dam could adversely affect the stability of the dam. Also, construction of the dam over soft soil debris of a previous slide could adversely affect stability.

Seepage and stability analyses of the dam are not available. These studies should be performed by a professional engineer experienced in the design and construction of tailings dams and should be made a matter of record. The necessary data for these analyses should be obtained from additional investigations. The investigations should consist of field exploration and soil sampling, a laboratory testing program and an engineering study to evaluate the stability of the dam.

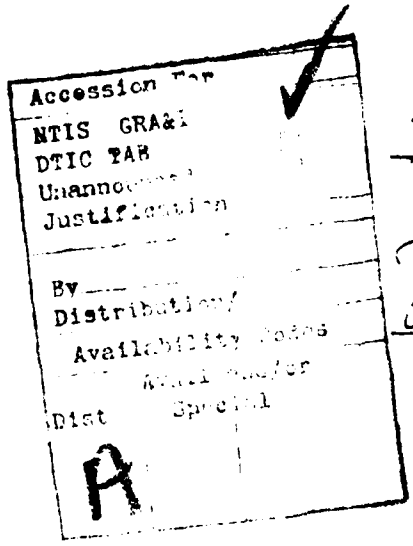
An inspection and maintenance program should be initiated. Periodic inspections should be made and documented by qualified personnel to observe the performance of the dam and spillway.

It is recommended that the owner take action to correct the deficiencies described.

Kenneth B. King, P.E.

Michael P. Forrest, P.E.

Donald R. Sanders, R.G.



OVERVIEW OF NEW DRESSER NO.4 DAM FROM RIGHT ABUTMENT

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
NEW DRESSER NO. 4 DAM
ID NO. 31124

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LIST OF PLATES

PHOTOGRAPHS

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
NEW DRESSER NO. 4 DAM - ID NO. 31124

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 New Dresser No. 4 Dam be made and authorized International Engineering Company, Inc. to make the inspection.

b. Purpose of Inspection. The purpose of the inspection was to assess the general condition of the dam with respect to safety, based on available data and visual inspection, 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) New Dresser No. 4 Dam is an L-shaped earthfill dam that is used to impound tailings from a barite separation and beneficiation operation. The dam is being continually raised to provide storage for tailings. The tailings consist of red-brown soft silty clay which are being deposited as a slurry in a water environment.

(2) The spillway, located on the left abutment, consists of an open channel cut into natural clayey soil. The spillway, roughly trapezoidal in cross-section, is about 12 feet wide at the bottom and is 3 feet deep.

b. Location. The dam is located in the eastern portion of Washington County, Missouri, as shown in Plate 1. The dam (shown in Plate 2) is located in Section 11, Township 38 North, Range 3 East.

c. Size Classification. This dam is greater than 40 feet and less than 100 feet high and is therefore in the intermediate size classification according to the "Recommended Guidelines for Safety Inspection of Dams".

d. Hazard Classification. The U.S. Corps of Engineers has classified this dam in the high hazard potential category. The estimated damage zone, as provided by the Corps of Engineers, extends about 4 miles downstream of the dam. There are several dwellings, low-water bridges, and Missouri-Pacific railroad bridges within this distance.

e. Ownership. This dam is owned by:

Dresser Minerals Division
Dresser Industries, Inc.
P.O. Box 8
Potosi, Mo. 63664

f. Purpose of Dam. The purpose of the dam is to impound the tailings from a barite separation and beneficiation operation.

g. Design and Construction History. Construction of the dam began in about 1977. The dam is being continually raised to provide additional tailings storage capacity. The design and construction information is discussed in Section 2.

h. Normal Operating Procedures. The outflow of surface water runoff would pass through an uncontrolled spillway located on the left abutment. Fine tailings are discharged in a slurry from the mill into the impoundment near the upstream face of the dam at the right abutment. Water from the upstream end of the pond is recycled back to the mill.

1.3 PERTINENT DATA

Field surveys were made by Booker Associates, Inc. of St. Louis, Missouri. The date of the survey is 28 March 1979. Since the dam is being continually raised, the data gathered during the survey applies only to the time that the survey was made. The survey data are shown in Plates 3 through 6.

a. Drainage Area. 62 acres (Topographic Quadrangle, 7.5 minute series, Tiff, Missouri, 1937).

b. Discharge at Damsite.

(1) Outlet pipe. There is no outlet pipe at this dam. Not applicable.

(2) Spillway capacity for pool at top of dam (El. 762.0) - 200 cfs.

(3) Maximum experienced outflow at damsite - no available information.

c. Elevation (Feet Above M.S.L.)[1/]

(1) Top of dam - Varies from El. 760.5 (between Stations 10+00 and 11+00) to El. 765.5 along the crest roadway (see Plate 4). Since there is a wide upstream berm approximately between Stations 7+00 and 11+85 (see Photo No. 3) which was about 3 to 4 feet higher than the crest roadway on the date of the survey, the effective crest level is at El. 763.0 along this section, as shown in Plate 4. The minimum dam crest level is at El. 762.0, at Stations 2+40 and 6+00.

(2) Streambed downstream of toe of dam - El. 717 ±.

(3) Spillway crest - El. 760.0.

(4) Tailings surface adjacent to south portion of dam - El. 760.5 (on date of survey).

(5) Water surface adjacent to north portion of dam - El. 759.7 (on date of survey).

d. Reservoir. Length of existing impoundment - Approximately 1000 feet (Topographic Quadrangle; 7.5 minute series, Tiff, Missouri, 1937).

e. Storage.

(1) Spillway crest (El. 760.0) - 111 acre-feet.

(2) Top of dam (El. 762.0) - 127 acre-feet.

f. Reservoir Surface Area.

(1) Spillway crest (El. 760.0) - 7.8 acres.

(2) Top of dam (El. 762.0) - 8.5 acres.

[1/] Elevations are based on a reference datum of 778.00 M.S.L. at the temporary bench mark (see Plate 3). This elevation was estimated from the topographic quadrangle.

g. Dam.

(1) Type - Earthfill.

(2) Length - 1010 feet ±.

(3) Height (maximum above streambed) - 45 feet ±.

(4) Top width - 20 to 30 feet.

(5) Side slopes -

(a) Downstream: Varies between 1.5(H) to 1.0(V) and 1.8(H) to 1.0(V).

(b) Upstream: Unknown.

(6) Zoning - The zoning of the dam consists of a clay starter dam, which is overlain by sands and angular gravels. The sands and gravels are from the barite ore milling process and the gravels are finer than 7/8-inch.

(7) Cutoff - A clay core trench to bedrock is shown on a design drawing for the starter dam.

h. Spillway.

(1) Type - uncontrolled open channel spillway.

(2) Control section - 12-foot bottom width, 3-foot depth, 45-foot ± top width, and approximate side slopes of 6(H) : 1(V).

(3) Crest elevation - El. 760.0 M.S.L.

(4) Upstream channel - None.

(5) Downstream channel - Clear, shallow channel.

i. Regulating Outlets. None.

j. Diversion Ditches. None.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

Documentation of the design of the starter dam is shown on a drawing by Dresser Minerals entitled "No. 4 Starter Dam, Plan and Sections, Washington County, Missouri" dated 14 February 1978. This drawing was in the Dresser Minerals office near Mineral Point, Missouri. Information from that drawing is summarized as follows:

Crest Width - 40 feet

Downstream slope - 2 (H) to 1 (V)

Upstream slope - 3 (H) to 1 (V)

Crest length of dam - 650 feet

Cutoff trench depth - 6 feet

Width of spillway channel bottom - 12 feet

Calculations for runoff and spillway channel hydraulics made by Dresser Minerals are shown in a record entitled "Spillway for Dam at Washer No. 4, Washington County, Missouri", dated February 1978. These computations were available at the Dresser Minerals office. Watershed runoff was computed as follows:

$Q = AcI$

where, $A = 125$ acres
$C = 0.5$
$L = 3.5$ inches/hour

therefore, $Q = 125 \times 0.5 \times 3.5 = 219$ cfs

The discharge capacity of the spillway was calculated by Dresser Minerals using Manning's Equation to equal 307 cfs for a 12-foot wide channel flowing 3 feet deep with side slopes of 2 (H) to 1 (V) on one side and 1 to 1 on the other side.

2.2 CONSTRUCTION

No construction records were available. Mr. A. E. Williams, a representative of Dresser Minerals, indicated that construction of New Dresser No. 4 Dam began in 1977. He stated that the damsite was cleared of vegetation before the clay starter dam was constructed. After construction of the starter dam, sand and angular gravels (finer than 7/8-inch) from the mill were hauled to the crest of the dam by truck, end-dumped,

and spread by dozer or grader, and excess material was pushed over the upstream and downstream faces of the dam. The sands and gravels placed in this manner are in a loose state and are at their natural angle of repose on the downstream face. The material pushed over the upstream side rests on the tailings. The center-line of the dam remains approximately at the same position as the embankment is raised. Material on the crest was compacted by construction equipment. Presently, construction is proceeding in the same manner.

2.3 OPERATION

No operating records are known to exist. The outflow of surface runoff would pass through an uncontrolled spillway. Tailings are being conveyed as a slurry to the impoundment. Water is separated from the tailings by a filtering process through a gravel dike located at the upper end of the impoundment. The water is then pumped back to the mill.

2.4 EVALUATION

a. Availability. Limited design records and construction information were available. The starter dam design and runoff/spillway calculations were prepared for documentation purposes after construction began. The only construction information available to the inspection team was a verbal communication with the owner's representative.

b. Adequacy. The field surveys and visual inspections presented herein are considered adequate to support the conclusions of this report. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available; the lack of this information 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. Available information pertaining to the starter dam could not be confirmed by the visual inspection because the starter dam is almost completely covered by the embankment sands and gravels. According to the Guidelines, the computed runoff of 219 cfs is not adequate for the dam, as indicated in Section 5 - Hydraulic and Hydrologic Analyses.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. The dam was inspected by a civil engineer and an engineering geologist from International Engineering Company, Inc. on 26 March 1979. Mr. A. E. Williams, a representative of Dresser Minerals, met with the inspection team on 21 March and 23 March 1979. The impoundment created by New Dresser No. 4 Dam is currently in use as a barite tailings storage site. The dam is being continually raised to provide additional tailings storage capacity. Photographs taken during the inspection are included in this report. The field locations of the photographs are shown in Plate 7.

b. Project Geology. Bedrock in the reservoir area consists of chert dolomite of Cambrian Age. The bedrock is covered by a red-brown clayey soil. The clayey soil contains resistent nodules and fragments of chert. Both dam abutments are covered by 1 to 3 feet of brown clayey silty soil, which overlies red-brown clayey soil with gravel and rock fragments. These soils were observed in the excavation at the left abutment and in the tailings discharge channel at the right abutment. These same soil types were also observed downstream of the dam.

c. Dam. The plan of the dam is shown in Plate 3. The profile and cross-sections of the dam and spillway are shown in Plates 4, 5 and 6.

No vegetation was observed to be growing on the dam. Grass cover was observed downstream of the dam in the foundation area for the embankment as it is raised.

No detrimental settlement, sinkholes or animal borrows were observed in the embankment; however, it is doubtful such features would be apparent because of the continual addition of new gravel fill. A slide mass consisting of soft wet clayey soil with gravels and boulders (diameter less than 24 inches) was observed at the downstream toe of the dam (see Plate 7 and Photos 7 and 8). The slide mass was estimated to be about 30 to 40 feet wide. Numerous tension cracks were observed in the slide material. The owner's representative stated that clayey soil was dumped on the downstream slope which subsequently slid. This could not be verified, however. During the field inspection, gravels used to raise the dam were pushed over the crest of the dam onto the top of the soft slide mass (see Photos 5 and 6).

A spring was observed emerging from the toe of the north side of the dam at Station 10+00, as shown on Plates 3 and 7. The flow rate was estimated at 10 to 15 gpm; the emerging water was clear and no evidence of piping was observed. The top 6 inches of ground was soft, but the ground appeared to be firm below this depth. Numerous seeps were observed emerging from the toe of the clay starter dam and also just downstream of the toe of the north-south section of the dam, as shown on Plate 7. The

ground between Stations 3+00 and 7+00 is soft and marshy with water oozing from the clay soils. Numerous small erosion rills were also observed. A seep was observed emerging from the slide mass; the flow was estimated at about 1 gpm and the flow was turbid.

The difference in elevation between the water surface and the dam crest ranged from about 2 to 5 feet on the date that the survey was made (28 March 1979). The elevation difference from the spillway crest to the low point in the dam crest was about 2 feet on the date of the survey.

d. Appurtenant Structures. The only appurtenant structure associated with the dam is the spillway at the left abutment. The spillway consists of an unlined open channel excavated in natural soil. The east side of the spillway channel abuts on the dam embankment and the bottom of the spillway consists of soft clayey soil. The spillway extends downstream about 190 feet from the centerline of the dam and directs flow to a small pond located north of the impoundment.

e. Reservoir Area. The drainage basin above the reservoir slopes gently downward to the southeast. No evidence of landsliding was observed in the reservoir area. Some localized erosion was observed near the impoundment. The tailings in the impoundment consist of soft silty clay that are being deposited by hydraulic methods. Minimal consolidation of the tailings has probably taken place. There are no upstream structures within the watershed of this dam that would be subjected to backwater flooding.

f. Downstream Channels. A small settling pond is located about 400 to 500 feet east of the dam. The channel downstream of this settling pond is choked with uprooted trees and brush. The channel enters a tributary of Mill Creek about 0.5 mile downstream of New Dresser No. 4 Dam. This tributary enters Mill Creek near the town of Tiff, approximately 1 mile southeast of the dam.

3.2 EVALUATION

Minimal consolidation of the clay tailings has probably taken place and, therefore, the dam is effectively retaining a material with very low strength. The tailings exert a high pressure which the dam must resist.

The embankment is a relatively porous granular structure above the tailings surface. If the water level were to rise above the tailings surface due to flood runoff, there could be significant seepage through the embankment which could adversely affect the stability of the dam.

The soils located downstream of the north-south section of the dam were soft and saturated. Currently, the dam is being constructed over these soft foundation soils. The gravels used to raise the dam were also dumped onto the soft soil debris of a previous slide. These soft soil conditions and the steep downstream embankment slope could cause potential instability of the embankment as the dam is raised.

The spillway consists of an unlined cut in clayey soil. The soft clayey soils are subject to erosion. Since the spillway channel abuts on the dam, flood flows could also erode the embankment materials.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

No regulating procedures are known to exist for this dam. The dam is continually being raised to provide additional tailings storage capacity. Surface runoff passes through an uncontrolled spillway channel on the left abutment. Water used to transport tailings from barite separation to the impoundment is being recycled back to the mill from the upstream end of the pond. Water is separated from the tailings by a filtering process through a gravel dike located at the upper end of the impoundment.

4.2 MAINTENANCE OF DAM

The embankment is currently being enlarged to provide additional tailings storage capacity and, therefore, maintenance of the dam is not strictly practiced. Sand and gravel materials are being dumped in the upstream and downstream directions.

4.3 MAINTENANCE OF OPERATING FACILITIES

There are no operating facilities at this dam. Not applicable.

4.4 DESCRIPTION OF WARNING SYSTEM IN EFFECT

Information available to the inspection team indicates that there is no warning system for this dam.

4.5 EVALUATION

The behavior of the dam should be monitored periodically to observe any indications of instability, such as cracks in the dam, sloughing, sudden settlement, erosion of the dam or spillway, or an increase in the volume or turbidity of emerging seepage.

SECTION 5 - HYDRAULIC AND HYDROLOGIC ANALYSES

5.1 EVALUATION OF FEATURES

a. Design Data. The significant dimensions of the dam and spillway are presented in Section 1 - Project Information and in the accompanying field survey drawings, Plates 3 through 6. Hydrologic or hydraulic design information is not available.

For this evaluation, the watershed drainage area, stream lengths, and reservoir areas were measured from the 1937, 7-1/2-minute, USGS Tiff, Missouri, Quadrangle, which has a 20-foot contour interval. The soil group for this watershed is classified as Clarksville Gravelly Loam, equivalent to a hydrologic soil group B classification, which has a moderate rate of water transmission.

The drainage area, as shown on Plate 2, is about 62 acres (0.1-square mile). Land use and vegetation patterns in the watershed were determined from field observations and aerial photographs of the project area, and are divided into the following categories:

Type of Cover	Approximate Percent of Watershed
Woodlands	45
Old Mined Areas	22
Lands with Sparse Vegetation	20
Reservoir Area (tailings and water)	13

Based on the above, the estimated curve numbers (CN) weighted for the entire watershed are CN 56 for the antecedent moisture condition (AMC) II condition, and CN 75 for the AMC III condition.

Within the watershed, the old mined areas and lands with sparse vegetation are mostly abandoned barite mining sites. For the estimation of basin runoff curve numbers, these areas were assigned a lower curve number for the computation of the weighted basin CN. Also, 13 percent of the total watershed area is comprised of tailings and water impounded in the reservoir. This area was assigned a CN of 100 (impervious) in the overall weighting of basin CN, rather than entering as 13 percent impervious area on the "T" card as input. Other input data and computed parameters, such as basin lag time, unit hydrograph, probable maximum precipitation, and the reservoir elevation-area-capacity, data are in Appendix A.

Three sections of the spillway channel at the spillway entrance were surveyed. The spillway section along the centerline of the dam profile, as shown in Plate 4, was chosen as the control section.

At the spillway entrance, channel geometry does not show any definite weir control section. Therefore, the weir flow formula does not apply for the computation of a spillway discharge rating curve. Two methods were employed in deriving the spillway rating curve:

- Critical flows at different critical flow depths were computed using the critical flow formula.
- Manning's equation for uniform flow, using the beginning portion of the spillway slope as the average bottom slope (S = 0.043) and a Manning's "n" of 0.045.

The results computed by the critical flow formula were considered more representative of the critical flow conditions that exist at the spillway entrance and the control section. Computations of the discharge rating curve for flows over the dam crest were made by using the weir flow formula with weir coefficient of C = 3.0 for the dam crest. The combined discharge rating curve data for flows in the spillway and over the dam crest is in Appendix A, under the input data listing as Y4 and Y5 cards, and also in the computer printouts.

b. Experience Data. Recorded rainfall, runoff or other experience data are not available. There is no available evidence of previous overtopping.

c. Visual Observations. Specific information on the visual observations is presented in Section 3 - Visual Inspection.

d. Overtopping Potential. The 100-year flood, probable maximum flood (PMF), and floods expressed as a percent of the PMF were computed and routed through the reservoir and spillway. The PMF is defined as the hypothetical flood event that would result from the most severe combination of critical meteorologic and hydrologic conditions that is reasonably possible at a particular location or region. The Modified Puls Method of spillway routing was employed. For all cases of the spillway flood routing, the level of the reservoir surface was set at El. 760 (the spillway crest elevation) at the start of the flood routing. It was assumed that erosion of the earth channel and/or spillway-embankment section will not occur as flood discharges increase. Therefore, the spillway discharge rating curve was computed for a specific cross-section and configuration.

Results of the overtopping analyses indicate that the spillway is able to pass the 100-year flood. Routing studies indicate that the spillway cannot pass the 50 percent PMF. It was calculated that the spillway can pass about 35 percent of the PMF without overtopping the embankment. At 35 percent PMF, the peak spillway outflow is about 200 cfs, with a flow depth of 1.5 feet and flow velocity of about 5.8 feet per second.

Discharge velocities, such as those at 35 percent PMF peak outflow, could cause significant erosion of the spillway and embankment.

A major consideration in evaluating the safety of the dam is assessing the potential for overtopping and the subsequent failure of the embankment as a result of erosion. Since the spillway is composed of erodible materials, high velocity discharges through the spillway will lead to significant erosion of the spillway and embankment even if the dam is not overtopped. Based on the Corps of Engineers Manual EM 1110-2-1601, "Hydraulic Design of Flood Control Channels", the maximum permissible velocity for the materials found in the spillway section is about 4 feet per second. Using this as a criterion, the spillway can pass the 100-year flood. The results also indicate that the spillway can pass about 11 percent of the PMF without significant erosion. The 11 percent PMF routed outflow is 36 cfs, with a flow depth of 0.6 feet. Thus, for determining the embankment erosion potential, flow velocities in the spillway channel greater than 4 feet per second and flow depths exceeding 0.6-foot in the spillway control section are considered to produce the effects of embankment failure.

The results of the overtopping analyses are reported in Appendix A and summarized on the following page.

Flood	Peak Inflow (cfs)	Peak Outflow (cfs)	Max Res WS Elev (ft)	Spillway Flow Depth (ft)	Spillway Flow Velocity (ft/sec)	Duration Spillway Vel. over 4 ft/sec (hr)
10% PMF	92	35	760.8	0.6	3.9	-
20% PMF	183	78	761.4	1.0*	4.9*	3.3
30% PMF	275	145	761.8	1.4*	5.6*	5.2
50% PMF	459	322	762.4**	1.7**	6.2**	6.9
75% PMF	688	623	762.6**	2.0**	6.6**	7.8
PMF	917	854	762.8**	2.1**	6.8**	8.5

* These flow depths and velocities are considered to produce the effects of significant erosion.

** Dam overtopped (Minimum Dam Crest El. 762.0 feet).

Note: Reservoir water surface elevations include the velocity heads corresponding to the velocities computed at the various flow depths for the spillway section.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations. Conditions that adversely affect the structural stability of this dam are discussed in Section 3.

b. Design and Construction Data. No design or construction data pertaining to the structural stability of the dam were available. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, and lack of this information 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. Operating Records. No appurtenant structures requiring operation exist at this dam and no records were located.

d. Post-Construction Changes. The dam is currently being raised. Not applicable.

e. Seismic Stability. The dam is located in Seismic Zone 2, as defined in the Uniform Building Code. Some ravelling of the gravels could occur during seismic shaking because the slopes are at or near the natural angle of repose. Because of the soft saturated clay foundation soil, there appears to be a potential for instability caused by ground shaking during earthquakes.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. There are several deficiencies that should be corrected. (1) No erosion protection has been provided in the spillway channel. (2) The discharge capacity of the spillway was computed to be inadequate to pass 50 percent of the Probable Maximum Flood (PMF) without overtopping the dam and without significant erosion of the spillway and embankment. The PMF is the flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that is reasonably possible in the region. The "Recommended Guidelines for Safety Inspection of Dams," specify that the spillway design flood for this dam should be the PMF. (3) The seepage and soft soil conditions downstream of the toe of the dam could adversely affect the stability of the dam. Also, construction of the embankment over the soft soil debris of a previous slide could adversely affect stability. (4) Seepage and stability analyses were not available, and they should be made a matter of record.

b. Adequacy of Information. No detailed design or construction data were available. Seepage and stability analyses comparable to the requirements of "Recommended Guidelines for Safety Inspection of Dams" were not available, and this lack of information is considered a deficiency.

Results of the hydrologic studies could be changed if larger scale topographic maps with smaller contour intervals were used. The only available topographic map is the 7.5-minute, 1:24,000 scale, 20-foot contour interval USGS quadrangle. All measurements made on this map, such as drainage area, stream lengths, river slopes and reservoir area-capacity data, are insufficient in details, but the map suffices for the Phase I inspection. The use of the USGS quadrangle for the hydrologic studies results in an approximate evaluation of the spillway flood discharge capacity.

c. Urgency. The Phase I inspection indicated apparent deficiencies in the condition of the dam and spillway. Seepage and stability analyses and measures to increase the spillway capacity and provide the spillway with adequate erosion protection should be given priority.

d. Necessity for Phase II. No phase II investigation is recommended; however, additional investigations are recommended as outlined in Section 7.2.c.

7.2 REMEDIAL MEASURES

The following remedial measures are recommended:

a. Adequate erosion protection should be provided on the spillway channel bottom and side slopes. Erosion protection should also be provided on the upstream face of the dam adjacent to the spillway. The erosion protection should be adequate to withstand the peak discharge velocity resulting from the PMF.

b. The existing spillway capacity was calculated to be adequate to pass 11 percent of the PMF without significant erosion of the spillway and embankment and without overtopping the dam crest. To comply with the guidelines for a dam of this size and hazard potential, the spillway should be enlarged and/or the freeboard increased so that the PMF can be passed without overtopping the dam crest and without significant erosion of the spillway or embankment.

c. Seepage and stability analyses should be performed by a professional engineer experienced in the design and construction of tailings dams. The necessary data for these analyses would be obtained from additional investigations. The investigations should consist of subsurface exploration and soil sampling and a laboratory testing program to obtain the necessary engineering parameters of the dam and foundation materials. These parameters should be used in an engineering study to evaluate the stability of the dam. The embankment is a relatively porous granular structure above the tailings surface. If the impoundment water level were to rise above the tailings surface, there could be significant seepage through the embankment which could adversely affect the stability of the dam. Included in these analyses, therefore, seepage and stability computations should also be performed with the reservoir water surface set at the top of the dam for the maximum planned height of the embankment. Concurrent with the exploratory work, groundwater monitoring wells should be installed in the drill holes to obtain water level data that would be used in the stability studies. Based on the results of the stability studies, remedial measures may become necessary. Remedial work should be done under the direction of an engineer experienced in tailings dam design and construction.

d. An inspection and maintenance program should be initiated. Periodic inspections should be made by qualified personnel to observe the performance of the dam and spillway. Observations should include indications of instability, such as cracks in the embankment, sloughing, erosion, sudden settlement or an increase in the volume or turbidity of the seepage areas. Records should be kept of these inspections and of any corrective maintenance made to the dam and spillway.

APPENDIX A

HYDROLOGIC AND HYDRAULIC ANALYSES

The hydrologic and hydraulic analyses were accomplished by using the computer program "Flood Hydrograph Package, HEC-1, Dam Safety Investigations Version, July 1978". This program was developed by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California. The criteria and methodology used are briefly discussed below:

- Probable Maximum Precipitation (PMP) - The 24-hour PMP was obtained from Hydrometeorological Report No. 33. The 6-hour and the 1-hour depth-duration distributions followed Corps of Engineers EM 1110-2-1411 criteria.

- 100-year and/or 10-year storms - The 24-hour storm amounts and distributions were supplied by Corps of Engineers, St. Louis District, Missouri.

- Unit Hydrograph - The Soil Conservation Service (SCS) curvelinear unit hydrograph method was used. Basin lag time was computed by using the SCS Curve Number Method and equation.

- Hydrologic Soil Group, Antecedent Moisture Condition (AMC) and Curve Number (CN) - The predominant hydrologic soil group for the watershed was obtained from an agricultural soil classification map prepared by the University of Missouri Agricultural Experiment Station. For the PMF and floods expressed as a percent of PMF, AMC III conditions were used. For the 100-year and/or 10-year floods, AMC II conditions were assumed. Watershed CN was estimated from field observations and from aerial photos.

- Reservoir Area-Capacity - Areas were measured from U.S.G.S. topographic maps. Reservoir elevations and corresponding surface areas were input in the computer program, which determined the reservoir capacities by the Conic Method.

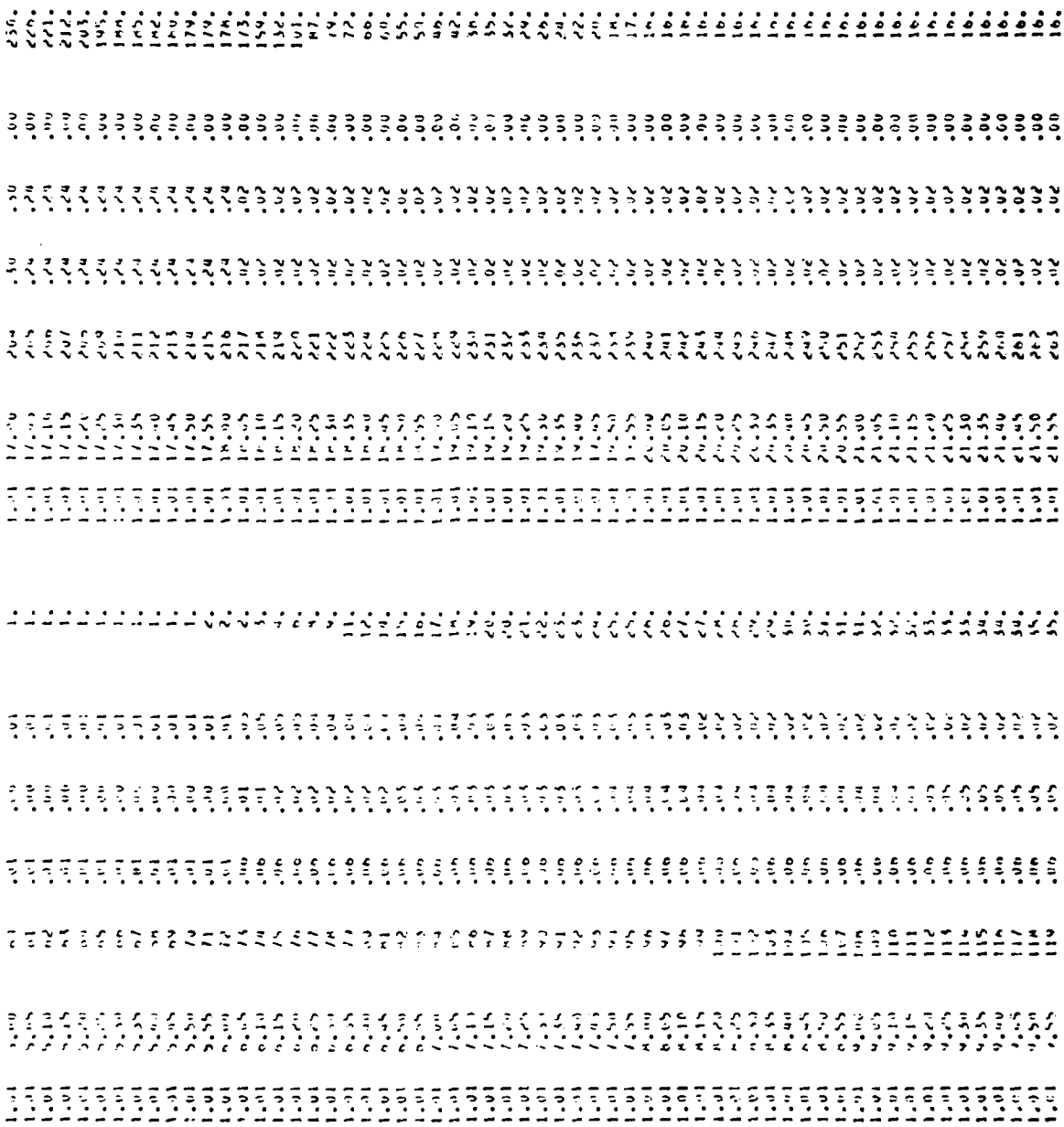
- Reservoir and Spillway Flood Routing - The Modified Puls Method was used for all flood routing through spillway and dam overtopping analyses.

The following pages present the input data listing, the computer program version and its last modification date, together with pertinent computer printouts of results. Definitions of all input and output variable names are presented in the computer program "Users Manual", September 1978, and are not explained herein.

```
A1          NEW DRESSER NO. 4 TAILINGS DAM MD. NO. 51124
A2          HEC-1  PHASE 1  DAM SAFETY INVESTIGATION
A3          RATIOS OF PMF ROUTED THROUGH RESERVOIR
B     286                   5                                                 2
H1      5
J       1         0         1
J1    .10       .20       .30       .50       .75       1.0
K       0   INFLOW                              1         1
M       1         2      .097                             1                  1
P       0      25.5       102       120       150
T                                                                 -1       -75
W2                .29
X     -10        -.1       2.5
K       1   LAKE                                2         1
Y                                       1         1
Y1      1                                                       -760.0      -1
Y4  760.0     760.4     760.8     761.1     761.5     761.8     762.4     763.1     763.7     764.0
Y5      0        12        36        60        88       138       325      1150      2851      3973
SA      0       2.3       7.8       8.0       8.5       8.8       9.1
SE    720       740       760       761       762       765       764
$S  760.0
$D  762.0
K      99
A
A
A
A
A
```

```
**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
 LAST MODIFICATION  26 FEB 79
**********************************

ON  DATE= 19780722.
    TIME= 15.56.00.

                    AEM DRESSER NO. 4 TAILINGS DAM NO. AD. 31124
                    HEC-1  PHASE I  DAM SAFETY INVESTIGATION
                    RATIOS OF PMF ROUTED THROUGH RESERVOIR

                                  JOB SPECIFICATION
     NHR     NMIN     IDAY      IHR     IMIN    METRC     IPLT     IPRT    NSTAN
      0        5        0        0        0        0        0        2        0
                      JOPER      NRT   LROPT   TRACE
                          5        0        0        0

                    MULTI-PLAN ANALYSES TO BE PERFORMED
                    NPLAN= 1  RTIO= 6 RATIO= 1
                    RTIOS=    .10    .20    .30    .50    .75   1.00

**********      **********      **********      **********      **********

                                SUB-AREA RUNOFF COMPUTATION
                    ISTAO   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                    INFLOW     0       0       0       1       1       0       0       0

                                HYDROGRAPH DATA
     IUNIT     IHOG    TAREA    SNAP    TRSDA    TRSPC    RATIO   ISAME   ISAME   LOCAL
         1        2      .10    0.00      .10     1.00    0.000       0       1       0

                                  PRECIP DATA
                    SPFE     PMS      R6      R12     R24     R48     R72     R96
                    0.10   25.50  102.00  120.00  130.00    0.00    0.00    0.00

                                  LOSS DATA
     LROPT    STRKR    DLTKR    STRTL    CNSTL    ALSMX    RTIMP    STRTL    CRVNU    RTIOR    RTIMP
         0     0.00     0.00     1.00     0.00     0.00     0.00     1.00    -1.00   -75.00     0.00     0.00

                    CURVE NO =  -75.00  RTIOEX =   -1.00  EFFECT IN =   75.00

                                UNIT HYDROGRAPH DATA
                                TC=  0.00    LAG=   .29

                                RECESSION DATA
                                STRTQ= -10.00    QRCSN=   -.10    RTIOR= 2.50

     UNIT HYDROGRAPH IN END OF PERIOD ORDINATES, TC=    0.00 HOURS, LAG=    .29  VOL= 1.00
    21.      67.     124.     141.     120.      95.      54.      39.      27.      16.
    12.       8.       5.       3.       2.       2.       1.       1.       0.

                                 END-OF-PERIOD FLOW
  0
 MO.DA  HR.MN  PERIOD   RAIN   EXCS   LOSS    COMP Q        MO.DA  HR.MN  PERIOD   RAIN   EXCS   LOSS    COMP Q
```

1.01	.05	1	.01	0.00	.01	1.	1.01	12.05	145	.22	.18	.03	42.
1.01	.10	2	.01	0.00	.01	1.	1.01	12.10	146	.22	.18	.03	51.
1.01	.15	3	.01	0.00	.01	1.	1.01	12.15	147	.22	.19	.03	67.
1.01	.20	4	.01	0.00	.01	1.	1.01	12.20	148	.22	.19	.03	88.
1.01	.25	5	.01	0.00	.01	1.	1.01	12.25	149	.22	.19	.03	103.
1.01	.30	6	.01	0.00	.01	1.	1.01	12.30	150	.22	.19	.03	116.
1.01	.35	7	.01	0.00	.01	1.	1.01	12.35	151	.22	.19	.03	125.
1.01	.40	8	.01	0.00	.01	0.	1.01	12.40	152	.22	.19	.02	130.
1.01	.45	9	.01	0.00	.01	0.	1.01	12.45	153	.22	.19	.02	135.
1.01	.50	10	.01	0.00	.01	0.	1.01	12.50	154	.22	.19	.02	138.
1.01	.55	11	.01	0.00	.01	0.	1.01	12.55	155	.22	.20	.02	140.
1.01	1.00	12	.01	0.00	.01	0.	1.01	13.00	156	.22	.20	.02	142.
1.01	1.05	13	.01	0.00	.01	0.	1.01	13.05	157	.26	.24	.02	144.
1.01	1.10	14	.01	0.00	.01	0.	1.01	13.10	158	.26	.24	.02	148.
1.01	1.15	15	.01	0.00	.01	0.	1.01	13.15	159	.26	.24	.02	153.
1.01	1.20	16	.01	0.00	.01	0.	1.01	13.20	160	.26	.24	.02	161.
1.01	1.25	17	.01	0.00	.01	0.	1.01	13.25	161	.26	.24	.02	167.
1.01	1.30	18	.01	0.00	.01	0.	1.01	13.30	162	.26	.24	.02	171.
1.01	1.35	19	.01	0.00	.01	0.	1.01	13.35	163	.26	.24	.02	176.
1.01	1.40	20	.01	0.00	.01	0.	1.01	13.40	164	.26	.24	.02	176.
1.01	1.45	21	.01	0.00	.01	0.	1.01	13.45	165	.26	.24	.02	178.
1.01	1.50	22	.01	0.00	.01	0.	1.01	13.50	166	.26	.24	.02	179.
1.01	1.55	23	.01	0.00	.01	0.	1.01	13.55	167	.26	.24	.02	180.
1.01	2.00	24	.01	0.00	.01	0.	1.01	14.00	168	.26	.25	.02	181.
1.01	2.05	25	.01	0.00	.01	0.	1.01	14.05	169	.33	.31	.02	183.
1.01	2.10	26	.01	0.00	.01	0.	1.01	14.10	170	.33	.31	.02	188.
1.01	2.15	27	.01	0.00	.01	0.	1.01	14.15	171	.33	.31	.02	196.
1.01	2.20	28	.01	0.00	.01	0.	1.01	14.20	172	.33	.31	.02	205.
1.01	2.25	29	.01	0.00	.01	0.	1.01	14.25	173	.33	.31	.02	219.
1.01	2.30	30	.01	0.00	.01	0.	1.01	14.30	174	.33	.31	.01	220.
1.01	2.35	31	.01	0.00	.01	0.	1.01	14.35	175	.33	.31	.01	224.
1.01	2.40	32	.01	0.00	.01	0.	1.01	14.40	176	.33	.31	.01	227.
1.01	2.45	33	.01	0.00	.01	0.	1.01	14.45	177	.33	.31	.01	229.
1.01	2.50	34	.01	0.00	.01	0.	1.01	14.50	178	.33	.31	.01	231.
1.01	2.55	35	.01	0.00	.01	0.	1.01	14.55	179	.33	.31	.01	232.
1.01	3.00	36	.01	0.00	.01	0.	1.01	15.00	180	.33	.31	.01	233.
1.01	3.05	37	.01	0.00	.01	0.	1.01	15.05	181	.20	.19	.01	231.
1.01	3.10	38	.01	0.00	.01	0.	1.01	15.10	182	.40	.38	.01	227.
1.01	3.15	39	.01	0.00	.01	0.	1.01	15.15	183	.40	.39	.01	225.
1.01	3.20	40	.01	0.00	.01	0.	1.01	15.20	184	.59	.55	.02	236.
1.01	3.25	41	.01	0.00	.01	0.	1.01	15.25	185	.69	.67	.02	263.
1.01	3.30	42	.01	0.00	.01	0.	1.01	15.30	186	1.68	1.60	.04	360.
1.01	3.35	43	.01	0.00	.01	0.	1.01	15.35	187	2.77	2.71	.06	483.
1.01	3.40	44	.01	0.00	.01	0.	1.01	15.40	188	1.09	1.07	.02	686.
1.01	3.45	45	.01	0.00	.01	0.	1.01	15.45	189	.69	.68	.01	852.
1.01	3.50	46	.01	0.00	.01	0.	1.01	15.50	190	.59	.58	.01	917.
1.01	3.55	47	.01	0.00	.01	0.	1.01	15.55	191	.40	.39	.01	868.
1.01	4.00	48	.01	.00	.01	0.	1.01	16.00	192	.40	.39	.01	751.
1.01	4.05	49	.01	.00	.01	0.	1.01	16.05	193	.30	.30	.00	614.
1.01	4.10	50	.01	.00	.01	0.	1.01	16.10	194	.30	.30	.00	507.
1.01	4.15	51	.01	.00	.01	0.	1.01	16.15	195	.30	.30	.00	423.
1.01	4.20	52	.01	.00	.01	0.	1.01	16.20	196	.30	.30	.00	360.
1.01	4.25	53	.01	.00	.01	0.	1.01	16.25	197	.30	.30	.00	315.
1.01	4.30	54	.01	.00	.01	0.	1.01	16.30	198	.30	.30	.00	284.
1.01	4.35	55	.01	.00	.01	0.	1.01	16.35	199	.30	.30	.00	264.
1.01	4.40	56	.01	.00	.01	0.	1.01	16.40	200	.30	.30	.00	251.
1.01	4.45	57	.01	.00	.01	0.	1.01	16.45	201	.30	.30	.00	242.
1.01	4.50	58	.01	.00	.01	1.	1.01	16.50	202	.30	.30	.00	237.
1.01	4.55	59	.01	.00	.01	1.	1.01	16.55	203	.30	.30	.00	233.



1.01	10.00	120	.06	.05	.02	35.	1.01	22.00	264	.02	.02	.00	16.
1.01	10.05	121	.06	.05	.02	35.	1.01	22.05	265	.02	.02	.00	16.
1.01	10.10	122	.06	.05	.02	36.	1.01	22.10	266	.02	.02	.00	16.
1.01	10.15	123	.06	.05	.01	36.	1.01	22.15	267	.02	.02	.00	16.
1.01	10.20	124	.06	.05	.01	36.	1.01	22.20	268	.02	.02	.00	16.
1.01	10.25	125	.06	.05	.01	36.	1.01	22.25	269	.02	.02	.00	16.
1.01	10.30	126	.06	.05	.01	36.	1.01	22.30	270	.02	.02	.00	16.
1.01	10.35	127	.06	.05	.01	37.	1.01	22.35	271	.02	.02	.00	16.
1.01	10.40	128	.06	.05	.01	37.	1.01	22.40	272	.02	.02	.00	16.
1.01	10.45	129	.06	.05	.01	37.	1.01	22.45	273	.02	.02	.00	16.
1.01	10.50	130	.06	.05	.01	37.	1.01	22.50	274	.02	.02	.00	16.
1.01	10.55	131	.06	.05	.01	37.	1.01	22.55	275	.02	.02	.00	16.
1.01	11.00	132	.06	.05	.01	38.	1.01	23.00	276	.02	.02	.00	16.
1.01	11.05	133	.06	.05	.01	38.	1.01	23.05	277	.02	.02	.00	16.
1.01	11.10	134	.06	.05	.01	38.	1.01	23.10	278	.02	.02	.00	16.
1.01	11.15	135	.06	.05	.01	38.	1.01	23.15	279	.02	.02	.00	16.
1.01	11.20	136	.06	.05	.01	38.	1.01	23.20	280	.02	.02	.00	16.
1.01	11.25	137	.06	.05	.01	38.	1.01	23.25	281	.02	.02	.00	16.
1.01	11.30	138	.06	.05	.01	39.	1.01	23.30	282	.02	.02	.00	16.
1.01	11.35	139	.06	.05	.01	39.	1.01	23.35	283	.02	.02	.00	16.
1.01	11.40	140	.06	.05	.01	39.	1.01	23.40	284	.02	.02	.00	16.
1.01	11.45	141	.06	.05	.01	39.	1.01	23.45	285	.02	.02	.00	16.
1.01	11.50	142	.06	.05	.01	39.	1.01	23.50	286	.02	.02	.00	16.
1.01	11.55	143	.06	.05	.01	39.	1.01	23.55	287	.02	.02	.00	16.
1.01	12.00	144	.06	.05	.01	39.	1.02	0.00	288	.02	.02	.00	16.

SUM 33.15 29.88 3.69 22304.
(842.)(759.)(94.)(634.52)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	917.	257.	74.	74.	22305.
CMS	26.	7.	2.	2.	634.
INCHES		29.88	29.88	29.88	29.88
MM		759.02	759.02	759.02	759.02
AC-FT		127.	154.	154.	154.
THOUS CU M		157.	190.	190.	190.

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

	ISTAG	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
	LAKE	1	0	0	2	1	0	0	0

Routing data

	CLOSS	AVG	IPES	ISAME	IOPT	IPRP	LSTR
OLOSS							
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTOL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-760.	-1

STAGE	760.00	760.00	760.00	761.10	761.50	761.80	762.00	762.10	763.70	764.00

FLOW	0.00	12.00	36.00	65.00	86.00	138.00	325.00	1150.00	2851.00	3973.00
SURFACE AREA=	0.	2.	8.	8.	9.	9.	9.			
CAPACITY=	0.	15.	111.	119.	127.	136.	1[illegible]5.			
ELEVATION=	720.	740.	760.	761.	762.	763.	764.			

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
760.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
762.0	0.0	0.0	0.

STATION LAKE , PLAN 1, RATIO [illegible]

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	1.	1.	1.	1.	1.	1.	2.
2.	2.	3.	3.	3.	4.	4.	4.	5.	5.
6.	6.	7.	7.	8.	8.	9.	9.	9.	10.
10.	11.	11.	12.	13.	14.	14.	15.	15.	17.
17.	18.	19.	20.	21.	21.	22.	23.	23.	24.
24.	25.	25.	25.	26.	27.	27.	28.	28.	29.
29.	30.	30.	30.	31.	31.	32.	32.	32.	33.
33.	33.	34.	34.	34.	35.	36.	39.	43.	47.
[illegible]	57.	62.	66.	73.	74.	78.	82.	86.	93.
102.	110.	118.	125.	132.	138.	148.	155.	161.	166.
172.	178.	185.	192.	197.	205.	210.	214.	218.	221.
224.	225.	225.	226.	231.	245.	279.	375.	620.	788.
[illegible]	[illegible]	730.	[illegible]	525.	439.	374.	327.	314.	302.
[illegible]	277.	265.	260.	[illegible]	247.	241.	234.	225.	219.
[illegible]	205.	200.	195.	192.	189.	180.	182.	174.	161.
[illegible]	133.	127.	114.	112.	105.	[illegible]	92.	87.	84.
82.	77.	75.	73.	71.	68.	65.	63.	60.	57.
52.	52.	49.	47.	45.	43.	41.	40.	38.	36.
35.	33.	33.	33.	32.	31.	30.	29.	27.	28.
27.	27.	26.	26.	25.	25.	24.	24.	23.	23.
23.	22.	22.	22.	21.	21.	21.	21.	20.	20.
20.	20.	19.	17.	19.	19.	19.	19.		

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOW IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIO 1 .10	RATIO 2 .25	RATIOS APPLIED TO FLOWS RATIO 3 .50	RATIO 4 .50	RATIO 5 .75	RATIO 6 1.00
HYDROGRAPH AT	DOLAN	.10	1	96.	183.	275.	459.	688.	917.
		(.25)	(	2.72)(	5.19)(	7.79)(	12.99)(	19.48)(	25.97)(
ROUTED TO	LAKE	.10	1	35.	75.	145.	322.	625.	854.
		(.25)	(	.99)(	2.21)(	4.11)(	9.13)(	17.69)(	24.19)(

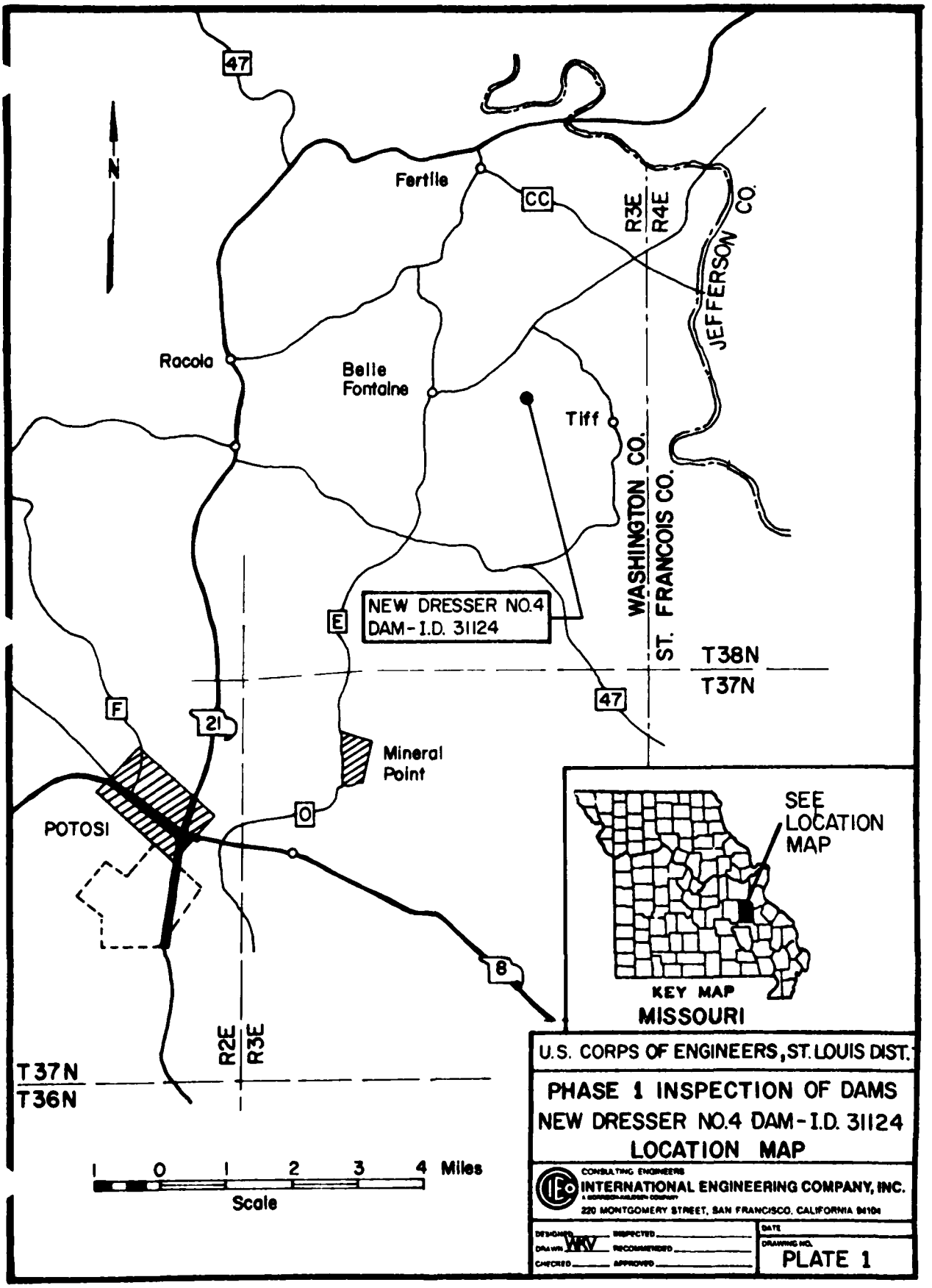
A-8

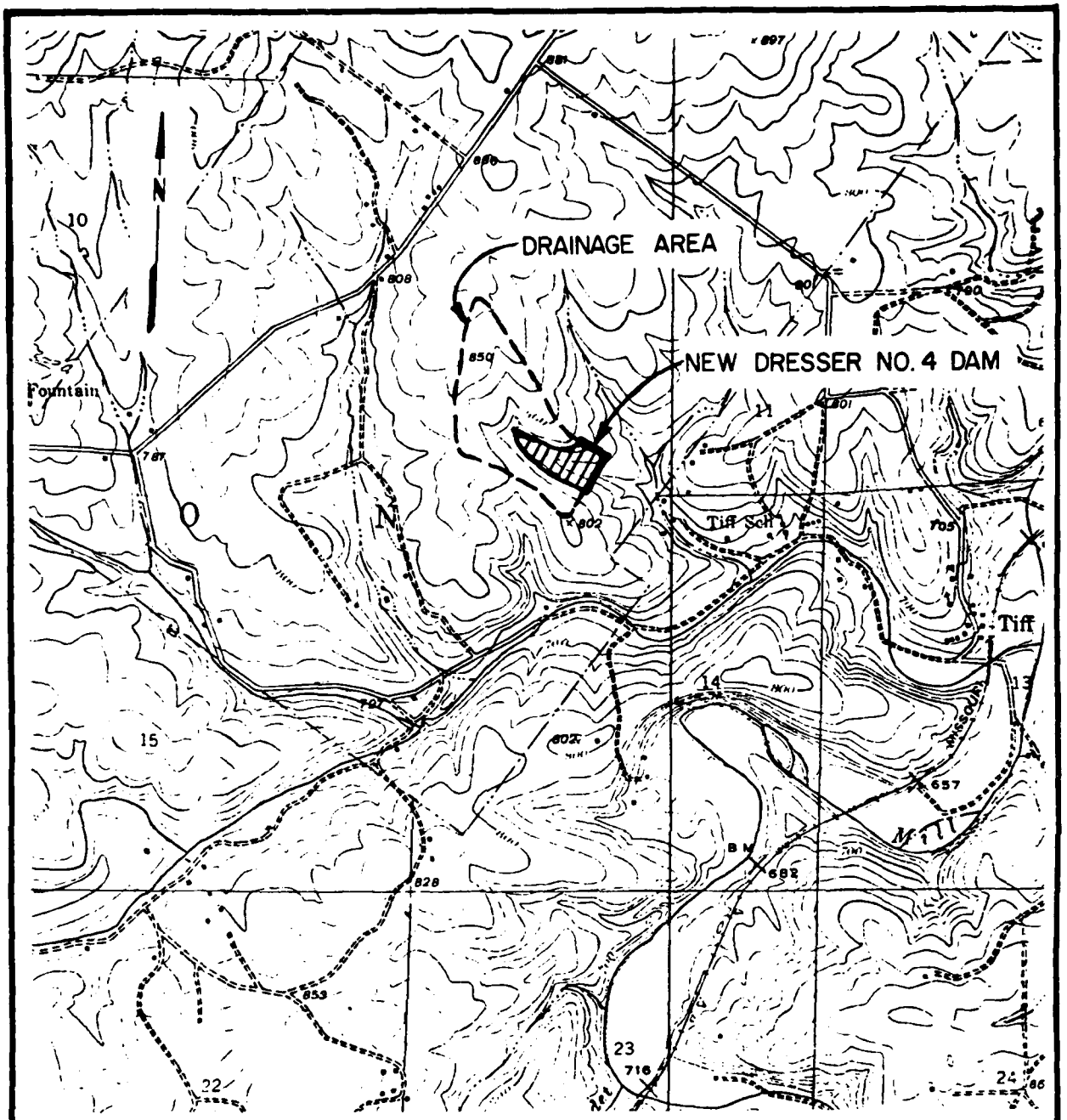
SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	760.00	760.00	762.00
STORAGE	111.	111.	127.
OUTFLOW	0.	0.	200.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE ACRE-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	760.78	0.00	117.	35.	0.00	16.33	0.00
.25	761.59	0.00	122.	78.	0.00	16.33	0.00
.50	761.92	0.00	124.	145.	0.00	16.17	0.00
.75	762.49	.49	133.	322.	.83	16.08	0.00
1.00	762.85	.85	141.	854.	5.08	15.92	0.00


47
N
Fertile
CC
R3E
R4E
JEFFERSON CO.
Racola
Belle Fontaine
Tiff
WASHINGTON CO.
ST. FRANCOIS CO.
NEW DRESSER NO.4
DAM - I.D. 31124
E
T38N
T37N
47
F
21
Mineral Point
O
POTOSI
8
R2E
R3E
T37N
T36N
0 1 2 3 4 Miles
Scale
SEE LOCATION MAP
KEY MAP
MISSOURI
U.S. CORPS OF ENGINEERS, ST. LOUIS DIST.
PHASE 1 INSPECTION OF DAMS
NEW DRESSER NO.4 DAM - I.D. 31124
LOCATION MAP
CONSULTING ENGINEERS
INTERNATIONAL ENGINEERING COMPANY, INC.
220 MONTGOMERY STREET, SAN FRANCISCO, CALIFORNIA 94104
DESIGNED
DRAWN WKV
CHECKED
INSPECTED
RECOMMENDED
APPROVED
DATE
DRAWING NO.
PLATE 1



0 2000 4000

SCALE IN FEET

U.S. CORPS OF ENGINEERS, ST. LOUIS DIST.

PHASE I INSPECTION OF DAMS
NEW DRESSER NO.4 DAM - I.D. 31124
VICINITY TOPOGRAPHY

CONSULTING ENGINEERS
INTERNATIONAL ENGINEERING COMPANY, INC.
A MORRISON-KNUDSEN COMPANY
220 MONTGOMERY STREET, SAN FRANCISCO, CALIFORNIA 94104

DESIGNED ____ INSPECTED ____
DRAWN ____ RECOMMENDED ____
CHECKED ____ APPROVED ____

DATE
DRAWING NO.
PLATE 2

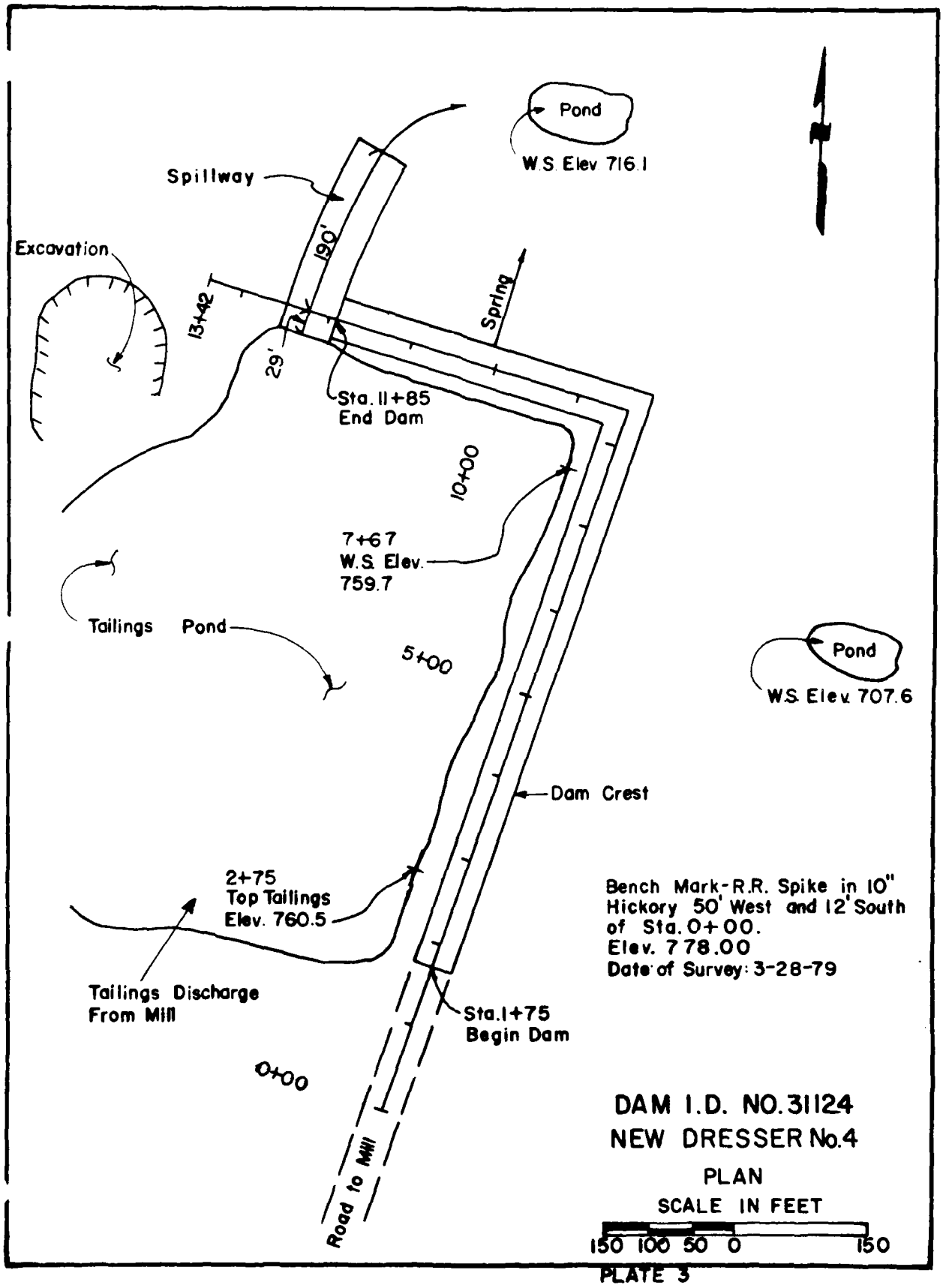

Pond
W.S. Elev 716.1
Spillway
190'
Excavation
13+42
29'
Spring
Sta. 11+85
End Dam
10+00
7+67
W.S. Elev.
759.7
Tailings Pond
5+00
Pond
W.S. Elev. 707.6
Dam Crest
2+75
Top Tailings
Elev. 760.5
Bench Mark-R.R. Spike in 10" Hickory 50' West and 12' South of Sta. 0+00.
Elev. 778.00
Date of Survey: 3-28-79
Tailings Discharge From Mill
Sta. 1+75
Begin Dam
0+00
Road to Mill
DAM I.D. NO. 31124
NEW DRESSER No. 4
PLAN
SCALE IN FEET
150 100 50 0 150

PLATE 3

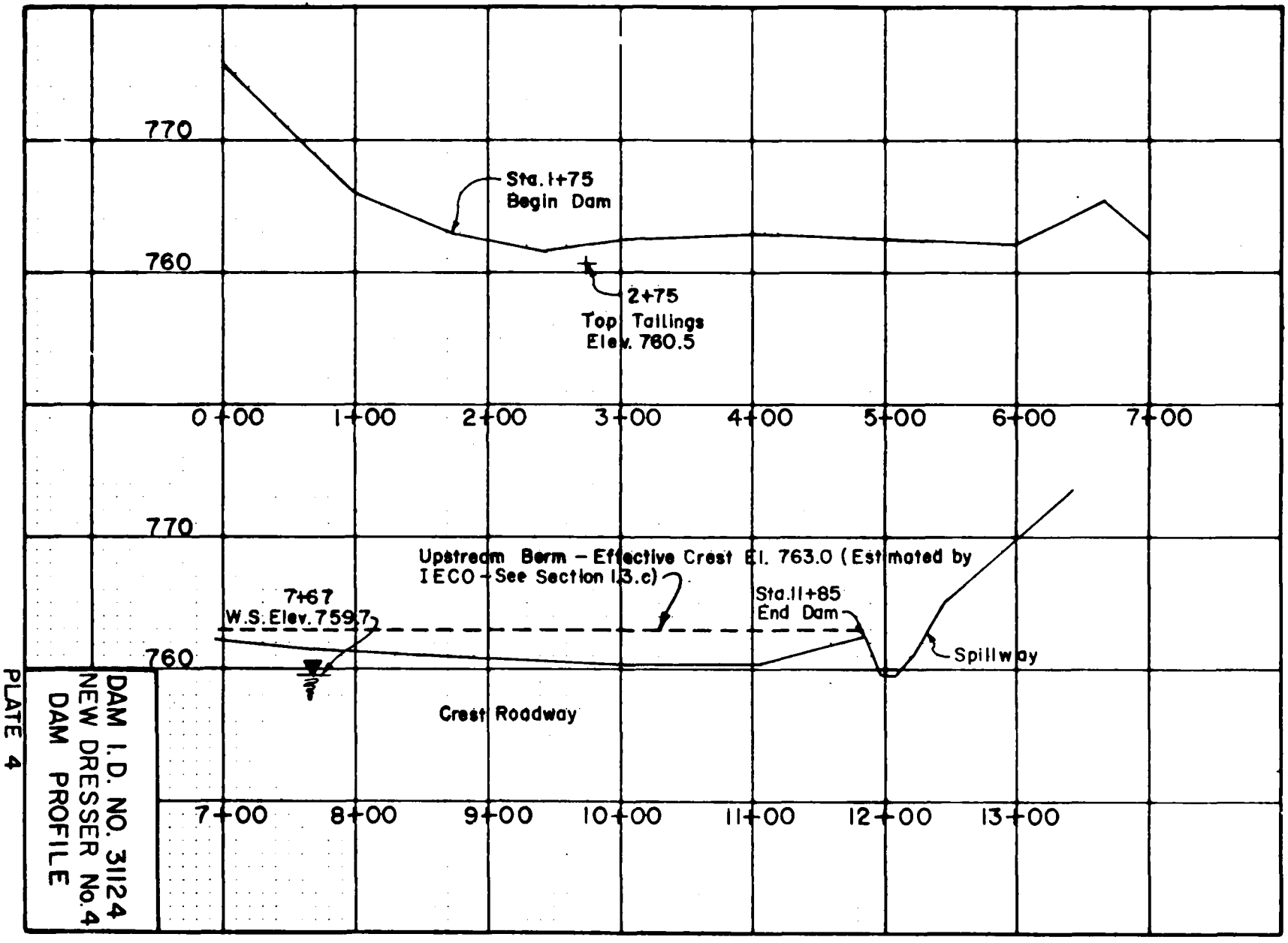
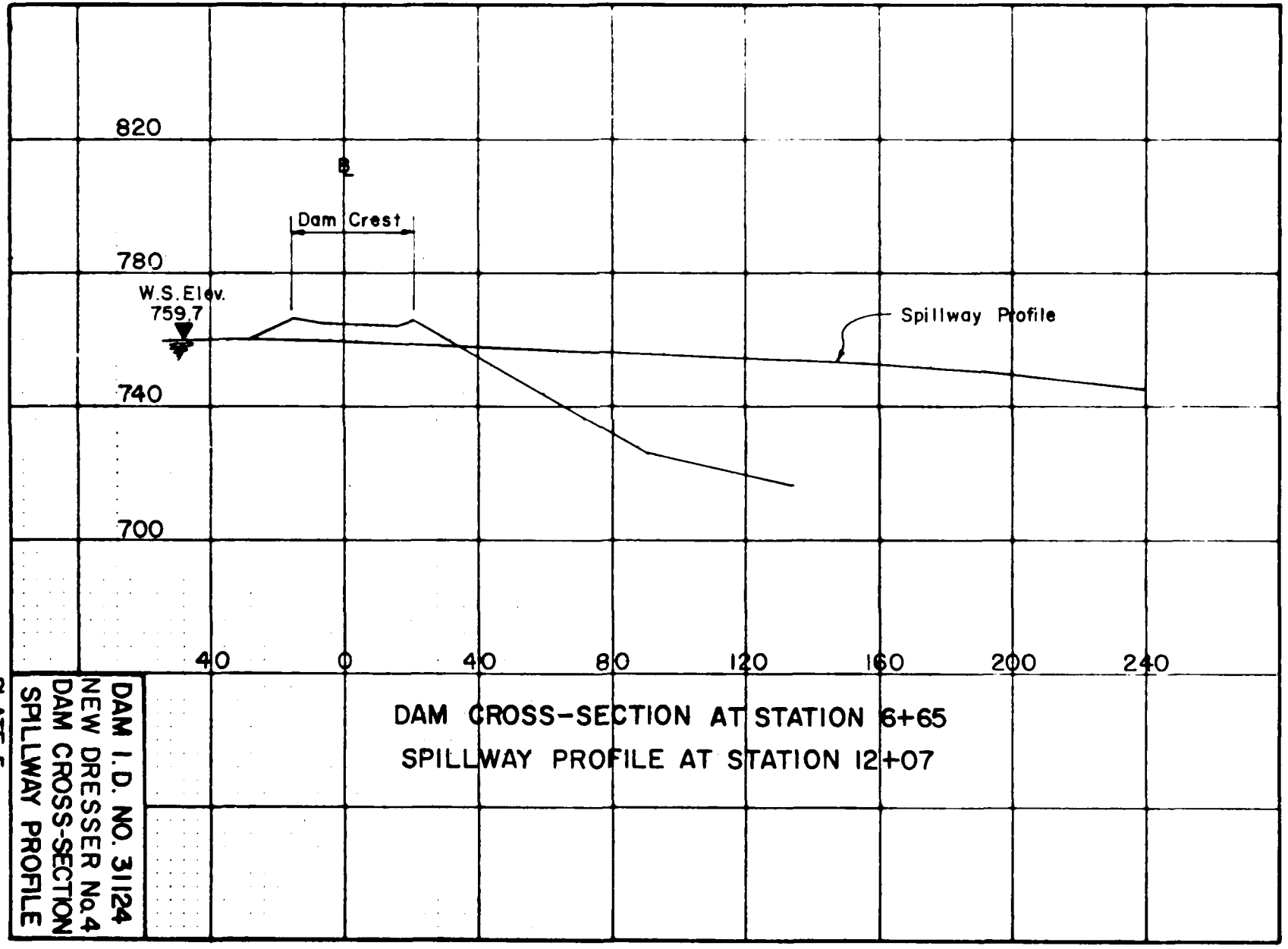


PLATE 4

DAM I.D. NO. 31124
NEW DRESSER No. 4
DAM PROFILE



DAM CROSS-SECTION AT STATION 6+65

SPILLWAY PROFILE AT STATION 12+07

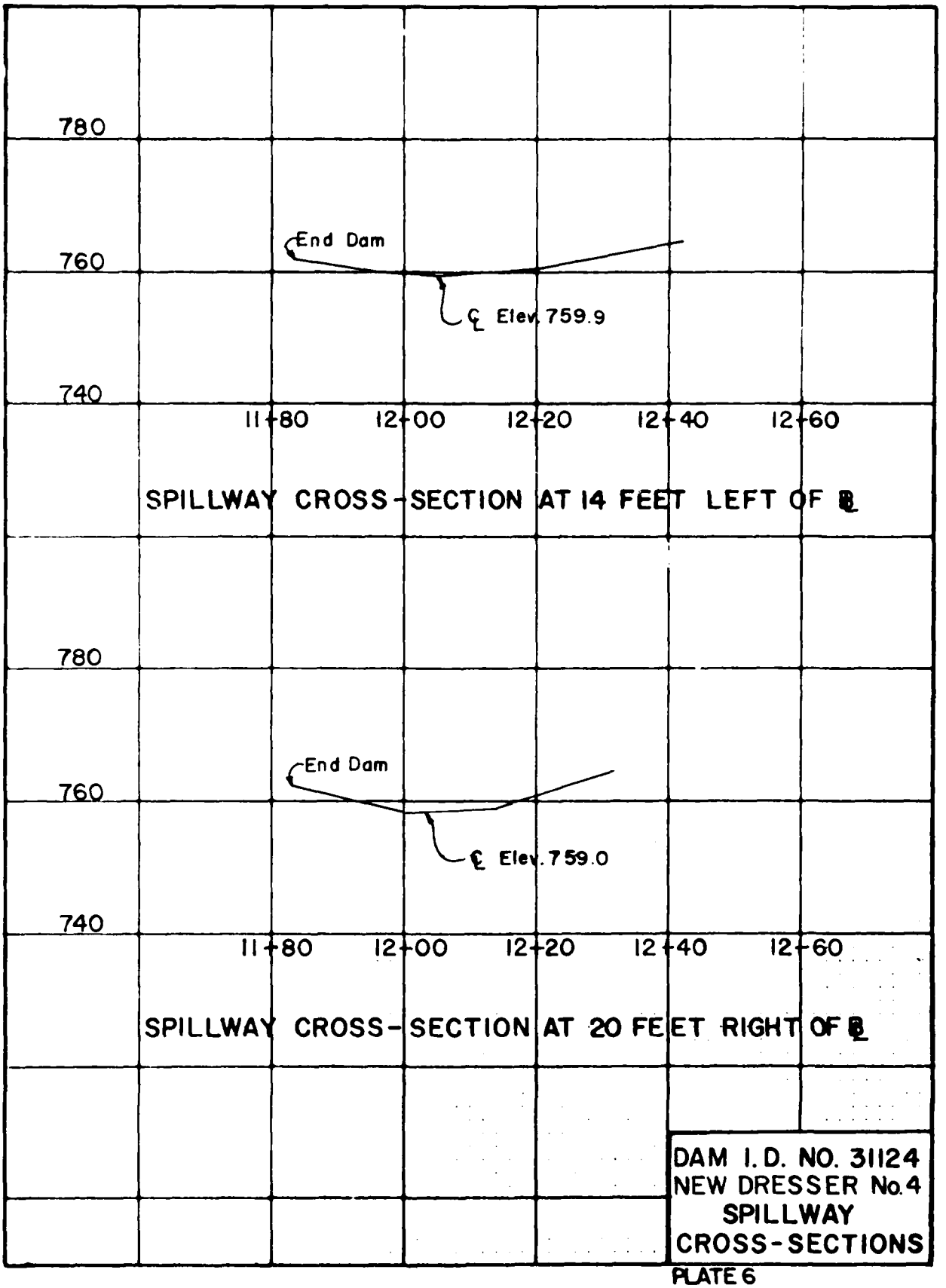
DAM I.D. NO. 31124

NEW DRESSER No.4

DAM CROSS-SECTION

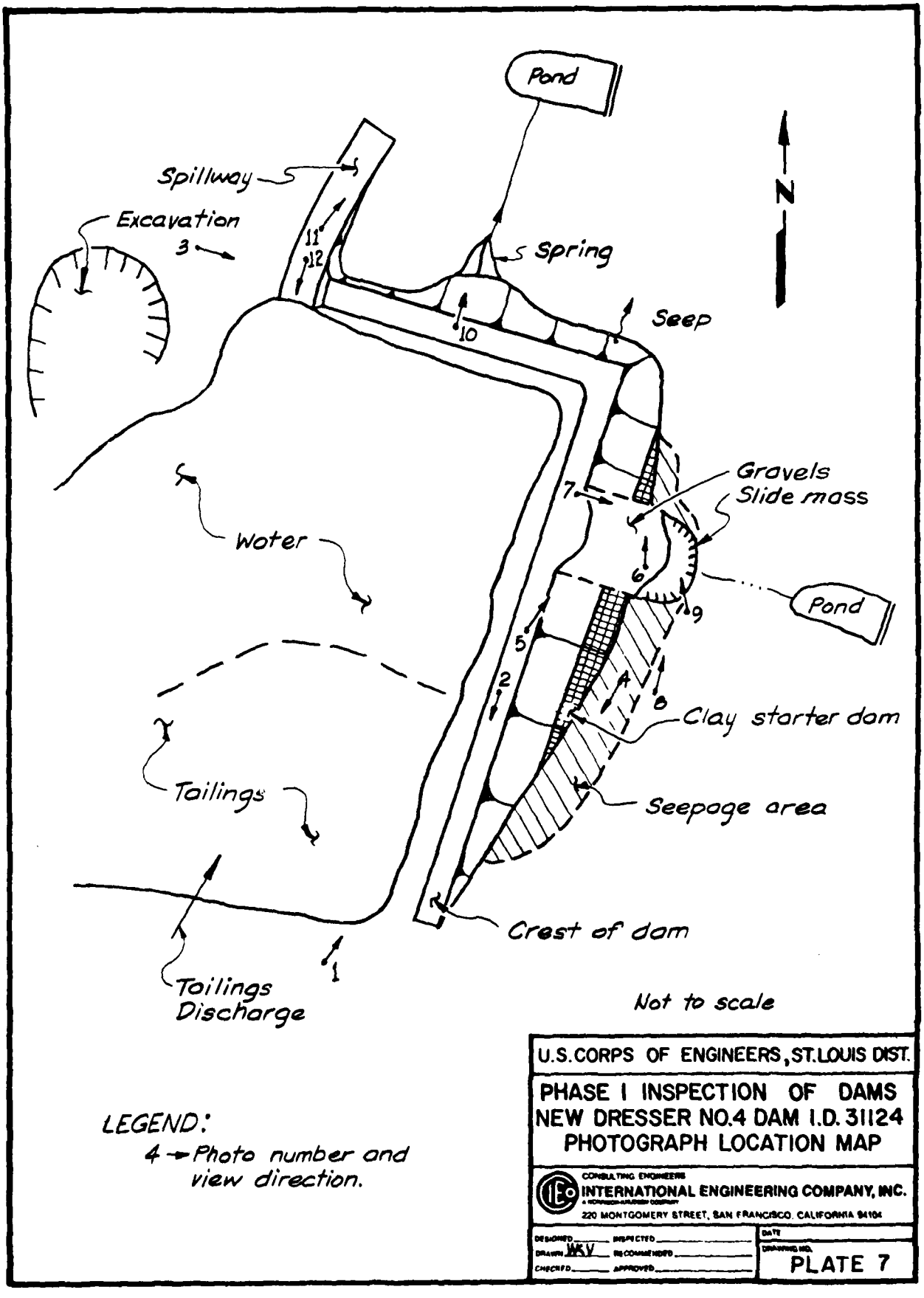
SPILLWAY PROFILE

PLATE 5



DAM I. D. NO. 31124
NEW DRESSER No. 4
SPILLWAY
CROSS-SECTIONS

PLATE 6



LEGEND:

4 → Photo number and view direction.

U.S.CORPS OF ENGINEERS, ST.LOUIS DIST.

PHASE I INSPECTION OF DAMS
NEW DRESSER NO.4 DAM I.D. 31124
PHOTOGRAPH LOCATION MAP

CONSULTING ENGINEERS
INTERNATIONAL ENGINEERING COMPANY, INC.
220 MONTGOMERY STREET, SAN FRANCISCO, CALIFORNIA 94104

DESIGNED ____ INSPECTED ____
DRAWN WKV RECOMMENDED ____
CHECKED ____ APPROVED ____

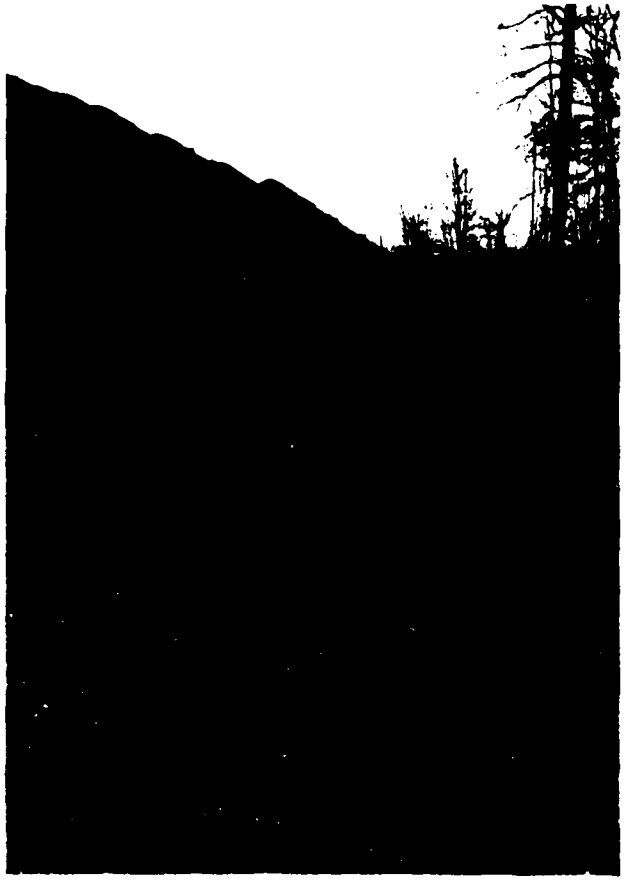
DATE ____

DRAWING NO. PLATE 7

PHOTOGRAPH RECORD

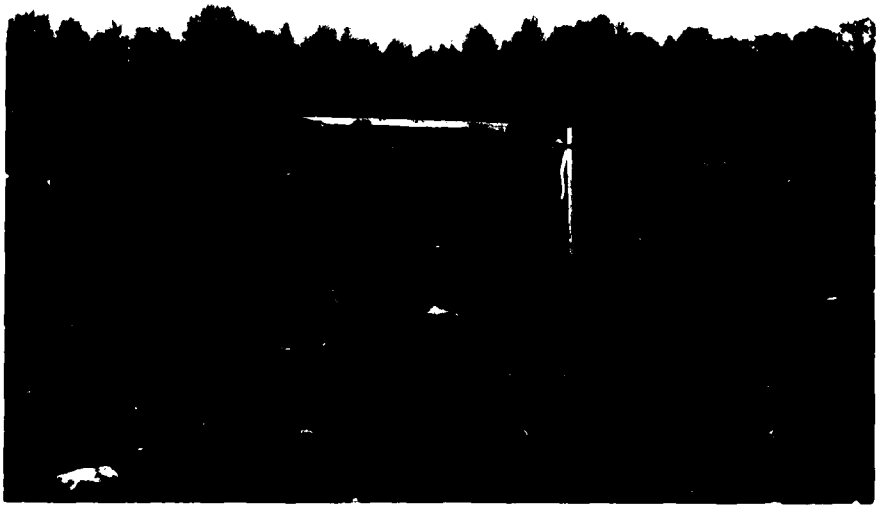
NEW DRESSER NO. 4 DAM - I.D. NO. 31124

Photo No.	Description
1.	View of upstream face of dam from right abutment. Sands and gravels are hauled from the mill to the dam where they are dumped on the dam crest.
2.	Dam crest toward right abutment.
3.	Crest of dam from left abutment showing wide upstream berm. The spillway is in the foreground.
4.	Downstream face of dam towards the right abutment. The red-brown clay with rock fragments underlying the sand and gravel is the starter dam. The grass-covered area is soft and marshy.
5.	Downstream face of dam where sand and gravel was dumped from the crest onto slide debris at toe of dam.
6.	Downstream face of dam towards the left abutment ridge. The starter dam (red-brown clay) underlies the sand and gravel. The sand and gravel in the foreground overlie the slide debris.
7.	Slide debris at the maximum section of the dam. Sand and gravel dumped from the crest of the dam overlie the clay slide debris.
8.	Slide debris at toe of dam.
9.	Soft and wet soil conditions of the slide debris.
10.	Spring at toe of dam at the north side of the impoundment. Small pond is located in background.
11.	View of spillway channel in downstream direction. Small pond is in background.
12.	Upstream end of spillway.



7

8




LME