AD-A107 487   BLACK AND VEATCH KANSAS CITY MO   F/G 13/13

NATIONAL DAM SAFETY PROGRAM. KEHR'S MILL TRAIL UPPER DAM (MO 11--ETC(U)

NOV 80   E R BURTON, H L CALLAHAN   DACW43-80-C-0074

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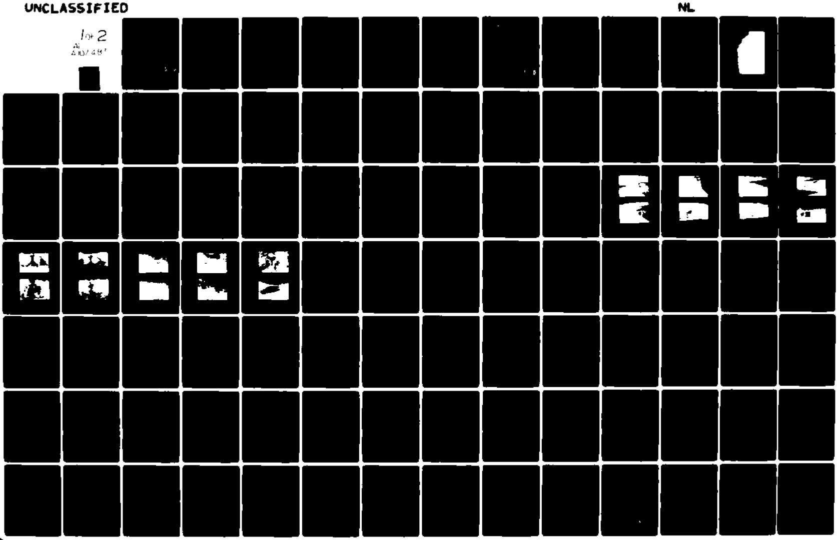

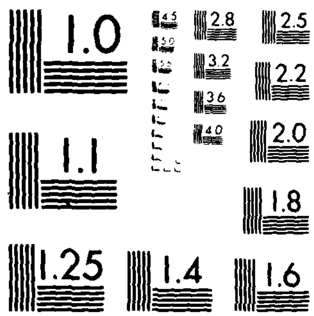

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4 MISSOURI-KANSAS CITY BASIN

AD A107487

2 KEHR'S MILL TRAIL UPPER DAM
5 ST. LOUIS COUNTY, MISSOURI
3 MO 11636

6 PHASE 1 INSPECTION REPORT NATIONAL DAM SAFETY PROGRAM

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St. Louis District

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

FOR: STATE OF MISSOURI

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National Dam Safety Program
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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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MISSOURI-KANSAS CITY BASIN

KEHR'S MILL TRAIL UPPER DAM
ST. LOUIS COUNTY, MISSOURI
MO 11636

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

United States Army
Corps of Engineers
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St. Louis District

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

FOR: STATE OF MISSOURI

NOVEMBER 1980

DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 TUCKER BOULEVARD, NORTH
ST. LOUIS, MISSOURI 63101

REPLY TO
ATTENTION OF

SUBJECT: Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Kehr's Mill Trail Upper Dam (MO 11636).

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:

a. Spillway will not pass 50 percent of the Probable Maximum Flood without overtopping the dam.

b. Overtopping of the dam could result in failure of the dam.

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

SUBMITTED BY: SIGNED
Chief, Engineering Division
4 JUN 1981
Date

APPROVED BY: SIGNED
Colonel, CE, District Engineer
5 JUN 1981
Date

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KEHR'S MILL TRAIL UPPER DAM

ST. LOUIS COUNTY, MISSOURI

MISSOURI INVENTORY NO. 11636

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

PREPARED BY:

BLACK & VEATCH
CONSULTING ENGINEERS
KANSAS CITY, MISSOURI

UNDER DIRECTION OF

ST. LOUIS DISTRICT CORPS OF ENGINEERS

FOR

GOVERNOR OF MISSOURI

NOVEMBER 1980

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam	Kehr's Mill Trail Upper Dam
State Located	Missouri
County Located	St. Louis County
Stream	Tributary of Caulks Creek
Date of Inspection	18 November 1980

Kehr's Mill Trail Upper Dam was inspected by a team of engineers from Black & Veatch, Consulting Engineers for the St. Louis District, 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 were 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. According to the St. Louis District, Corps of Engineers, failure would threaten lives and property. The estimated damage zone extends approximately two miles downstream of the dam. One dwelling and an 18-acre lake are located immediately downstream of the dam. Three dwellings are located downstream of the lower lake. Contents of the estimated downstream damage zone were verified by the inspection team.

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 not pass the probable maximum flood without overtopping the dam but will pass 10 percent of the probable maximum flood. The spillway will not pass the flood which has a one percent chance of occurrence in any given year (100-year flood) but will pass the flood which has a ten percent chance of occurrence in any given year (10-year flood). The spillway design flood recommended by the guidelines is 50 to 100 percent of the probable maximum flood. Considering the downstream hazard and the volume of water stored in the reservoir, the spillway design flood should be 50 percent of the probable maximum flood. The probable maximum flood is defined as the flood discharge which may be expected from the most severe combination of critical meteorologic and hydrologic conditions which are reasonably possible in the region.

Based on visual observations, this dam appears to be in satisfactory condition. Deficiencies visually observed by the inspection team were erosion of the upstream face, crest, and downstream toe, trees on the downstream face, undercutting and cracking of the concrete spillway chute, and poor vegetal cover on the embankment.

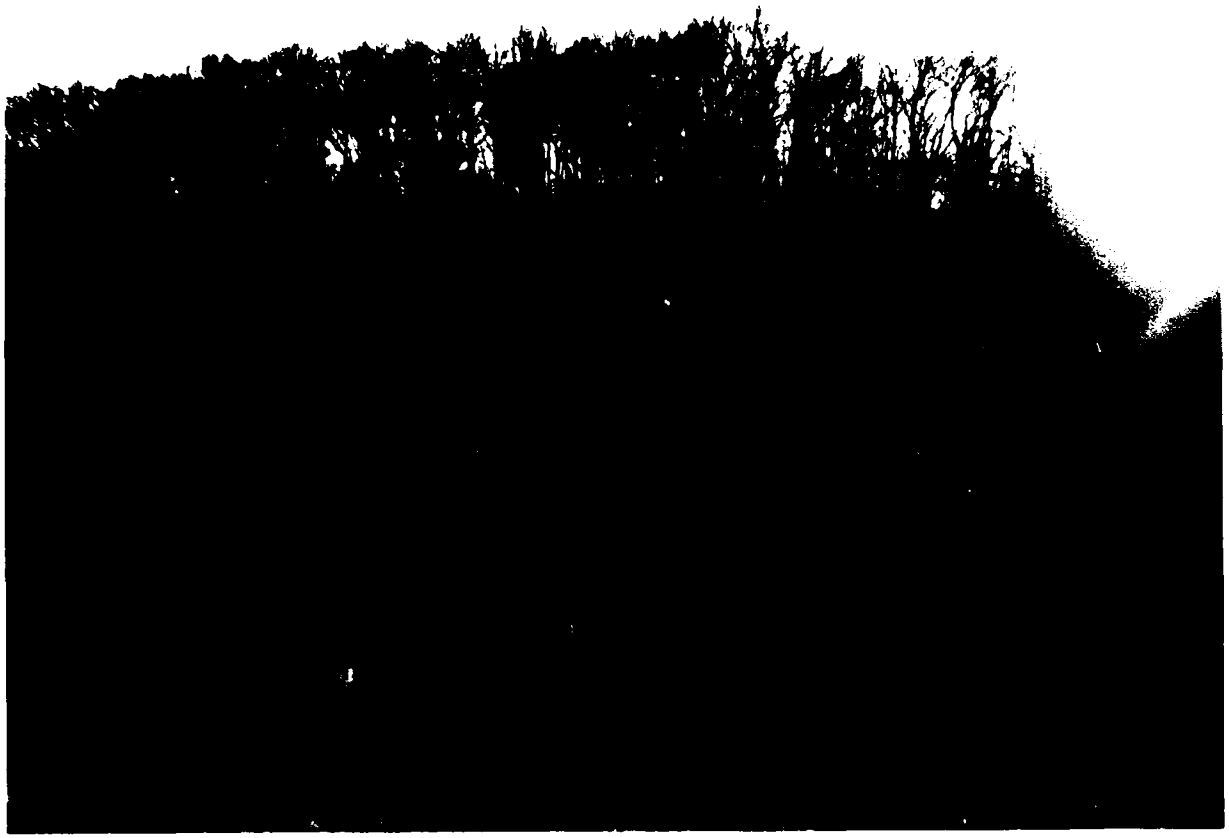
The lake water level was very low at the time of the inspection. There was no evidence to indicate that the water level had ever reached the spillway. There were no observed deficiencies or conditions existing at the time of the inspection which would indicate an immediate safety hazard. Future corrective action and regular maintenance will be required to correct or control the described deficiencies. In addition, detailed seepage and stability analyses of the existing dam, as required by the guidelines, should be performed. A detailed report discussing each of these deficiencies is attached.

Edwin R Burton

Edwin R. Burton, PE
Missouri E-10137

Harry L Callahan

Harry L. Callahan, Partner
Black & Veatch



OVERVIEW OF DAM

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
KEHR'S MILL TRAIL UPPER DAM

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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 District Engineer of the St. Louis District, Corps of Engineers, directed that a safety inspection of the Kehr's Mill Trail Upper 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 located in the valley of a tributary to Caulks Creek (~~see Plate 1).~~ The watershed is an area of low hills with fairly steep rugged terrain consisting of about 80 percent timber and 20 percent large lot residential development. The dam is approximately 450 feet long along the curved alignment of the crest and is 30 feet high. The dam crest is 47 feet wide. The upstream face of the dam slopes nearly uniformly from the crest to the water surface of the lake. The downstream face of the dam has a fairly uniform slope from the crest to the water surface of the lower lake.

(2) The spillway consists of twin 36-inch corrugated metal pipes with beveled ends installed through the embankment. The beveled inlet and outlet ends of the pipes are encased in unformed poured concrete (Photos 8-11). Flow through the pipes will discharge onto a 12-foot wide concrete chute to the lower lake. The chute is constructed of unformed concrete poured over limestone riprap placed on the downstream face of the dam. The chute has a slightly concave cross section and has no side walls (~~Photos 10 & 12).~~ There is no emergency spillway for this dam.

(3) One 12-inch polyvinyl chloride drain pipe and valve has been installed through the embankment. This pipe and valve were reported by Dick Manlin of the Charles Liebert Construction Company, but was not observed.

(4) One 12-inch corrugated metal pipe located along the toe of the dam at the right abutment carries drainage from the road to the lower lake.

(5) Pertinent physical data are given in paragraph 1.3.

b. Location. The dam is located in western St. Louis County, Missouri, as indicated on Plate 1. The lake formed by the dam is in an area shown on the United States Geological Survey 7.5 minute series quadrangle map for Chesterfield, Missouri, 100 feet north and 2,900 feet east of the southwest corner of survey #886 in Township 45N, Range 04E.

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, the dam and impoundment are in the small size category. A small size dam is classified as having a height less than 40 feet, but greater than or equal to 25 feet and/or a storage capacity less than 1,000 acre-feet, but greater than or equal to 50 acre-feet.

d. Hazard Classification. The hazard classification assigned by the Corps of Engineers for this dam is as follows: The Kehr's Mill Trail Upper Dam has a high hazard potential, meaning that the dam is located where failure may cause loss of life, and serious damage to homes, agricultural, industrial and commercial facilities, and to important public utilities, main highways, or railroads. For the Kehr's Mill Trail Upper Dam the estimated flood damage zone extends approximately two miles downstream of the dam. One dwelling and an 18-acre lake are located immediately downstream of the dam. Three dwellings are located downstream of the lower lake. Contents of the estimated downstream damage zone were verified by the inspection team.

e. Ownership. The dam is owned by the Kehr's Mill Trail Homes Association, c/o Mr. Warren Rusgis, 1607 Broken Reins Court, Chesterfield, Missouri 63017.

f. Purpose of Dam. The dam was designed to form a 16-acre lake to be used for recreation within a residential subdevelopment.

g. Design and Construction History. The developer for the Kehr's Mill Trail subdevelopment is the Charles Liebert Construction Company according to Dick Manlin of that firm. The dam was constructed in late

1976 by the J.H. Berra Construction Company. Brucker & Associates, and the Mueller Engineering and Surveying Company were involved in the design of the dam.

h. Normal Operating Procedure. Under normal operation, rainfall, runoff, transpiration, evaporation, and overflow through the uncontrolled spillway will combine to maintain a relatively stable water surface elevation. There is a valved drain pipe according to Dick Manlin. At the time of the inspection, the lake level was much lower than the spillway invert elevation. Dick Manlin stated that the lake had never been full.

1.3 PERTINENT DATA

a. Drainage Area - 510 acres

b. Discharge at Damsite.

(1) Normal discharge at the damsite is through the uncontrolled, twin 36-inch spillway pipes.

(2) Estimated experienced maximum flood at damsite - Unknown.

(3) Estimated ungated spillway capacity at maximum pool elevation 130 cfs (50 Percent Probable Maximum Flood Pool El. 531.6).

c. Elevation (Feet above m.s.l.) (Approximate elevations based on estimated tie to USGS contour map).

(1) Top of dam - 529.8 (see Plate 3)

(2) Spillway pipe inlet invert - 524.8

(3) Spillway pipe outlet invert - 523.1

(4) Streambed at toe of dam - 500.0 ±

(5) Maximum tailwater - Unknown, Top of Lower Dam 509.6

d. Reservoir.

(1) Length of maximum pool - 2,600 feet ± (50 Percent Probable maximum flood pool level)

(2) Length of normal pool - 2,200 feet ± (Spillway inlet invert)

e. Storage (Acre-feet).

(1) Top of dam - 252

(2) Spillway pipe inlet invert - 160

(3) Design surcharge - Not available.

f. Reservoir Surface (Acres).

(1) Top of dam - 20.4

(2) Spillway pipe inlet invert - 16.4

g. Dam.

(1) Type - Earth embankment.

(2) Length - 450 feet

(3) Height - 30 feet ±

(4) Top width - 47 feet

(5) Side slopes - upstream face varies from 1.0 V on 2.7 H to 1.0 V on 2.9 H, downstream face varies from 1.0 V on 2.7 H to 1.0 V on 3.2 H *(see Plate 4)*

(6) Zoning - Unknown.

(7) Impervious core - Unknown.

(8) Cutoff - Unknown.

(9) Grout curtain - Unknown.

h. Diversion and Regulating Tunnel - None.

i. Spillway.

(1) Type - Uncontrolled, twin 36-inch corrugated metal pipes through embankment with discharge to 12-feet wide concrete chute on downstream slope of dam.

(2) Spillway pipe inlet invert elevation - 524.8

(3) Spillway pipe outlet invert - 523.1

(4) Spillway chute lower end invert elevation - 505.0 ±

(5) Gates - None.

(6) Upstream channel - None.

(7) Downstream channel - Concrete chute discharge to lower lake.

j. Emergency Spillway - None.

k. Valved Outlet - One 12-inch polyvinyl chloride drain pipe and valve was reported by the developer.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

A geologic investigation of the dam site was conducted by the Geology and Land Survey section of the Missouri Department of Natural Resources. Recommendations resulting from this investigation are presented in an engineering geology report, Appendix B. A subsurface exploration and soils testing program was carried out by Brucker & Associates, soils engineers. Recommendations and boring logs are presented in a report of this exploration work, Appendix C. The dam design and hydrologic analyses were prepared by Mueller Engineering & Surveying Company. No design information was made available.

2.2 CONSTRUCTION

The dam was constructed by the J.H. Berra Construction Company in late 1976. Construction records were unavailable.

2.3 OPERATION

Operational records and documentation of past floods were unavailable.

2.4 GEOLOGY

The site of the dam and reservoir is located in a moderately-deep, steep-sided valley. The dam impounds a small, intermittent stream tributary to Caulks Creek.

Published information was not available on the soils in the area of the dam and reservoir. The engineering geology report on the dam site indicates that the soils consist of silty clay and clayey silt. The soils developed in residuum and colluvium.

The engineering geology reports indicate that the bedrock consists of limestone of the Burlington formation of the Osage Series of the Mississippian system. The limestone is deeply weathered with extensive solutioning along vertical joints and bedding planes. Numerous outcrops of limestone are present in the valley walls. One spring was observed approximately 2,500 feet downstream of the dam on the left side of the valley. The reports are presented in Appendix B and C of this report.

The boring logs in the report on the subsurface investigation of the area of the dam and reservoir indicate that the subsurface materials consist of alluvial silt and silty clay of low plasticity (ML and CL materials) overlying residual clay (CH material). Neither water nor rock were encountered in the borings. However, the report states that thin soils overlie limestone throughout the reservoir area.

2.5 EVALUATION

a. Availability. No engineering data were made available.

b. Adequacy. 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. The validity of the design, construction, and operation could not be determined because engineering data were not made available.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. A visual inspection of Kehr's Mill Trail Upper Dam was made on 18 November 1980. The inspection team consisted of Edwin Burton, team leader; Robert Pinker, geologist; Gary Van Riessen, geotechnical engineer; and John Ruhl, hydrologist. The dam appeared to be in satisfactory condition. Specific observations are discussed below. No observations were made of the condition of the upstream face of the dam below the pool elevation at the time of the inspection.

b. Dam. The inspection team observed the following conditions at the dam. The embankment has a wide crest and reasonable upstream and downstream slopes. There were no noticeable signs of settlement or instability such as sinkholes, cracking, sliding or sloughing. No toe drains or relief wells were observed.

Erosion protection on the embankment consisting of uncut weeds and thin grass is considered to be in poor condition. There is no riprap on the embankment. Erosion was beginning to develop gullies on the upstream face of the dam due to runoff from the crest. One gulley down the upstream face near the right end of the dam varied from 6 to 24 inches wide and was about 18 inches deep (Photo 13). Erosion on the downstream face was beginning to undercut the concrete spillway chute (Photo 16). Erosion of the downstream toe at the right end of the embankment was occurring at the outlet end of the corrugated metal drainage pipe. Minor erosion was occurring in the vehicle tracks along the crest. Right and left are used herein to provide directional reference while looking downstream.

There were no trees on the embankment except two small (1-inch) willows that had been planted on the downstream face. No animal burrows were observed. No seepage was observed.

There was no evidence that the dam has ever been overtopped. The lake level was extremely low at the time of the inspection. From observation of water marks and the wash line along the upstream face, it appears that the lake level may have never reached the spillway inlet.

c. Appurtenant Structures. The only appurtenant structure observed was the twin pipe spillway and concrete chute. The pipes appear to be in good condition. The inlet and outlet ends of the pipes were observed and the pipe interiors and alignment were observed from both ends. The observed pipe joints appeared to be tight without leakage into or out of the pipes. There was no visible distortion of the pipes or their alignment.

Erosion of the embankment along the edges of the concrete spillway chute was beginning to undercut the chute (Photo 16). Several cracks in the chute were observed (Photo 12). Discharges through the spillway would flow from the concrete chute into the lower lake. However, there was no evidence to indicate that the upper lake level had ever been high enough to generate a flow through the spillway.

d. Geology. The soils in the area of the dam and reservoir consisted of silt and clay. The soils were developed in residuum and colluvium. For engineering purposes, the soils were visually classified as clayey silt and silty clay of low plasticity (ML and CL). Samples of the embankment material were taken near the center of the downstream crest using an Oakfield sampler. The samples were visually classified for engineering purposes as clayey silt of low plasticity (ML). Based on these samples, it is surmised that the embankment is constructed of clayey silt.

No outcrops of bedrock were observed. The pool in the reservoir was extremely low and appeared to have never reached the spillway. This may indicate that the water is seeping out through the bottom of the reservoir into the weathered and solutioned Burlington limestone or through the embankment into the tailwaters of the lower lake.

e. Reservoir Area. The engineering geology report, Appendix B, suggested the possibility of water loss through lake bed leakage. The inspection team believes that this could be one reason for the low water level. The water in the lake was extremely muddy on the day of the inspection. This is probably due to construction activities in the watershed. Due to the muddy water conditions of the lake, an assessment of the degree of siltation could not be made. No slumping or slides of the reservoir banks were observed. The area upstream of the lake was clear of trees and debris with no defined channel. The left bank of the lake is wooded.

f. Downstream Channel. The spillway discharges to a lower lake which is formed by the Kehr's Mill Trail Lower Dam.

3.2 EVALUATION

The various deficiencies observed at the time of the inspection are not believed to represent an immediate safety hazard. They do, however, warrant corrective action.

The erosion that is developing on the upstream face, the crest, and the downstream toe of the embankment is primarily due to the lack of a good growth of protective vegetal cover. Erosion will continue on the embankment until protective cover has been established. The absence of riprap on the upstream slope has not led to any problems because of the lack of an appreciable reservoir pool. Riprap protection should be provided to reduce the potential for wave induced erosion. Undercutting of the concrete spillway chute will continue until erosion protection is established. The undercutting can lead to further cracking and breaking up of the concrete chute which could become displaced when subjected to flow through the spillway.

The two trees on the downstream face of the dam are not presently a problem because they are small. Willows grow very rapidly and can develop extensive root systems that will loosen the embankment material and also leave voids in the embankment through which water can pass. Trees also inhibit the growth of grass whose roots are effective in protecting the surface soil of the slope from erosion.

No seepage problems were observed at this dam. Close monitoring of the embankment should be maintained as the reservoir fills.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

Under normal conditions the pool will be primarily controlled by rainfall, runoff, evaporation, transpiration, and the capacity of the uncontrolled spillway. At the time of inspection, water loss by leakage is a big factor in controlling the pool level. There is a valved drain pipe according to Dick Manlin.

4.2 MAINTENANCE OF DAM

There was no evidence that a maintenance program was in effect. The thin grass/weed cover on the embankment slopes was uncut and rainfall runoff was beginning to erode small gullies down the slopes.

4.3 MAINTENANCE OF OPERATING FACILITIES

According to Dick Manlin leakage from the lake was occurring through a bad valve in a 12-inch PVC drain line. The valve has been repaired.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

There is no existing warning system or preplanned scheme for alerting downstream residents for this dam.

4.5 EVALUATION

A maintenance program should be developed which includes the repair of erosion and the establishment of a suitable vegetal cover on the embankment for erosion protection.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. No design data were available.

b. Experience Data. The drainage area and lake surface area are developed from USGS Chesterfield quadrangle map. The dam layout is from a survey made during the inspection.

c. Visual Observations.

(1) The spillway pipes are in good condition. The concrete chute had several cracks and was being undercut by erosion of the embankment. Under full pipe flow it is possible that flow could spill over the sides of the chute onto the embankment slope and cause erosion.

(2) There is no emergency spillway for this dam.

(3) Spillway discharges could endanger the integrity of the dam if flow spills over onto the embankment slope.

d. Overtopping Potential. The spillway will not pass the probable maximum flood without overtopping the dam. The probable maximum flood 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. The spillway will pass 10 percent of the probable maximum flood without overtopping the dam. The spillway will not pass the one percent chance flood estimated to have a peak outflow of 121 cfs developed by a 24-hour, one percent chance rainfall. The spillway will pass the ten percent chance flood estimated to have a peak outflow of 69 cfs developed by a 24-hour, ten percent chance rainfall. According to the recommended guidelines from the Department of the Army, Office of the Chief of Engineers, a high hazard dam of small size should pass 50 to 100 percent of the probable maximum flood. Considering the downstream hazard, and the volume of water stored in the reservoir, the appropriate spillway design flood should be 50 percent of the probable maximum flood. The portion of the estimated peak discharge of 50 percent of the probable maximum flood overtopping the dam would be 1,890 cfs of the total discharge from the reservoir of 2,020 cfs. The estimated duration of overtopping is 8.7 hours with a maximum height of 1.8 feet. The portion of the estimated peak discharge of the probable maximum flood overtopping the dam would be 3,940 cfs of the total discharge from the reservoir of 4,080 cfs. The estimated duration of overtopping is 13.0 hours with a maximum height of 2.7 feet. The embankment could be jeopardized should overtopping occur for these periods of time.

According to the St. Louis District, Corps of Engineers, the effect from rupture of the dam could extend approximately two miles downstream of the dam. One dwelling and an 18-acre lake are located immediately downstream of the dam. Three dwellings are located downstream of the lower lake. Damage to the lower dam and four dwellings could occur and lives could be lost should failure of the dam occur. Contents of the estimated downstream damage zone were verified by the inspection team. Flood plain regulations under the National Flood Insurance Program restrict development in the flood plain of Caulks Creek which is downstream of the Kehr's Mill Trail Lower Dam. Caulks Creek has been designated as a flood insurance zone A6 in this area.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations. Visual observations of conditions which affect the structural stability of this dam are discussed in Section 3, paragraph 3.1b.

b. Design and Construction Data. No design data relating to the structural stability of the dam were found. 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.

c. Operating Records. No operational records were available.

d. Postconstruction Changes. Dick Manlin of the Charles Liebert Construction Company reported that the valve to the drain pipe in the embankment has been repaired to prevent a leak. The lake was drained and the lake bottom was compacted at the same time.

e. Seismic Stability. The dam is located in Seismic Zone 2 which is a zone of moderate seismic risk. A properly designed and constructed earth dam using sound engineering principles and conservatism should pose no serious stability problems during earthquakes in this zone. The seismic stability of an earth dam is dependent upon a number of factors: embankment and foundation material classifications and shear strengths; abutment materials, conditions, and strengths; embankment zoning; and embankment geometry. Adequate descriptions of embankment design parameters, foundation and abutment conditions, or static stability analyses to assess the seismic stability of this embankment were not available and therefore no inferences will be made regarding the seismic stability. An assessment of the seismic stability should be included as part of the stability analysis required by the guidelines.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. Several conditions observed during the visual inspection by the inspection team should be monitored and/or controlled. These are erosion on the crest, the upstream face and the downstream toe, undercutting and cracking of the concrete spillway chute, the poor vegetal cover on the embankment, and two trees on the downstream face. 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.

b. Adequacy of Information. Due to the unavailability of engineering design data, the conclusions in this report were based only on performance history and visual conditions. The inspection team considers that these data are sufficient to support the conclusions herein. However, it has been reported that the dam has not experienced full reservoir conditions. 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.

c. Urgency. It is the opinion of the inspection team that a program should be developed as soon as possible to implement remedial measures recommended in paragraph 7.2b. If the safety deficiencies listed in paragraph 7.1a are not corrected, they will continue to deteriorate and lead to a serious potential of failure. The item recommended in paragraph 7.2a should be pursued on a high priority basis.

d. Necessity for Phase II. The Phase I investigation does not raise any serious questions relating to the safety of the dam nor does it identify any serious dangers which would require a Phase II investigation. However, the additional analyses noted in paragraph 2.5b are necessary for compliance with the guidelines.

e. Seismic Stability. This dam is located in Seismic Zone 2. Adequate description of embankment design parameters, foundation and abutment conditions, or static stability analyses to assess the seismic stability of this embankment were not available and therefore no inferences will be made regarding the seismic stability. An assessment of the seismic stability should be included as part of the recommended stability analysis.

7.2 REMEDIAL MEASURES

a. Alternatives. The spillway size and/or storage volume would need to be increased or the lake level would need to be maintained at a low level to increase available flood storage in order to effectively pass the recommended spillway design flood. Spillway capacity could be increased by providing an emergency spillway. The storage volume could be increased by raising the low areas of the dam crest.

b. Operation and Maintenance Procedures. The following operation and maintenance procedures are recommended and should be carried out under the direction of a professional engineer experienced in the design, construction, and maintenance of earth dams.

(1) The erosion damage on the upstream face of the embankment; crest and around the concrete spillway chute should be repaired. Riprap should be placed on the upstream face of the dam to an elevation above normal lake level to prevent erosion of the embankment material.

(2) The embankment should be protected from further erosion by the establishment of a suitable vegetal cover on the crest and slopes.

(3) The concrete spillway chute should be monitored to determine if cracking continues or if cracks become larger. If so, remedial repairs should be undertaken. It should be determined if discharge over the sides of the chute occurs during full pipe flow. If so, the chute should be reconstructed to confine the flow.

(4) The two trees on the downstream face of the embankment should be removed.

(5) Erosion protection on the embankment should be provided at the outlet of the drain pipe along the toe of the dam.

(6) Seepage and stability analyses should be performed.

(7) A detailed inspection of the dam should be made periodically. More frequent inspections should be performed during the reservoir filling process to ascertain that leakage, seepage, slope instability, etc. do not go undetected. If these types of problems occur, an engineer experienced in earth dams should be engaged to assist in formulating corrective measures. Findings of the inspection should be documented and made a matter of record.

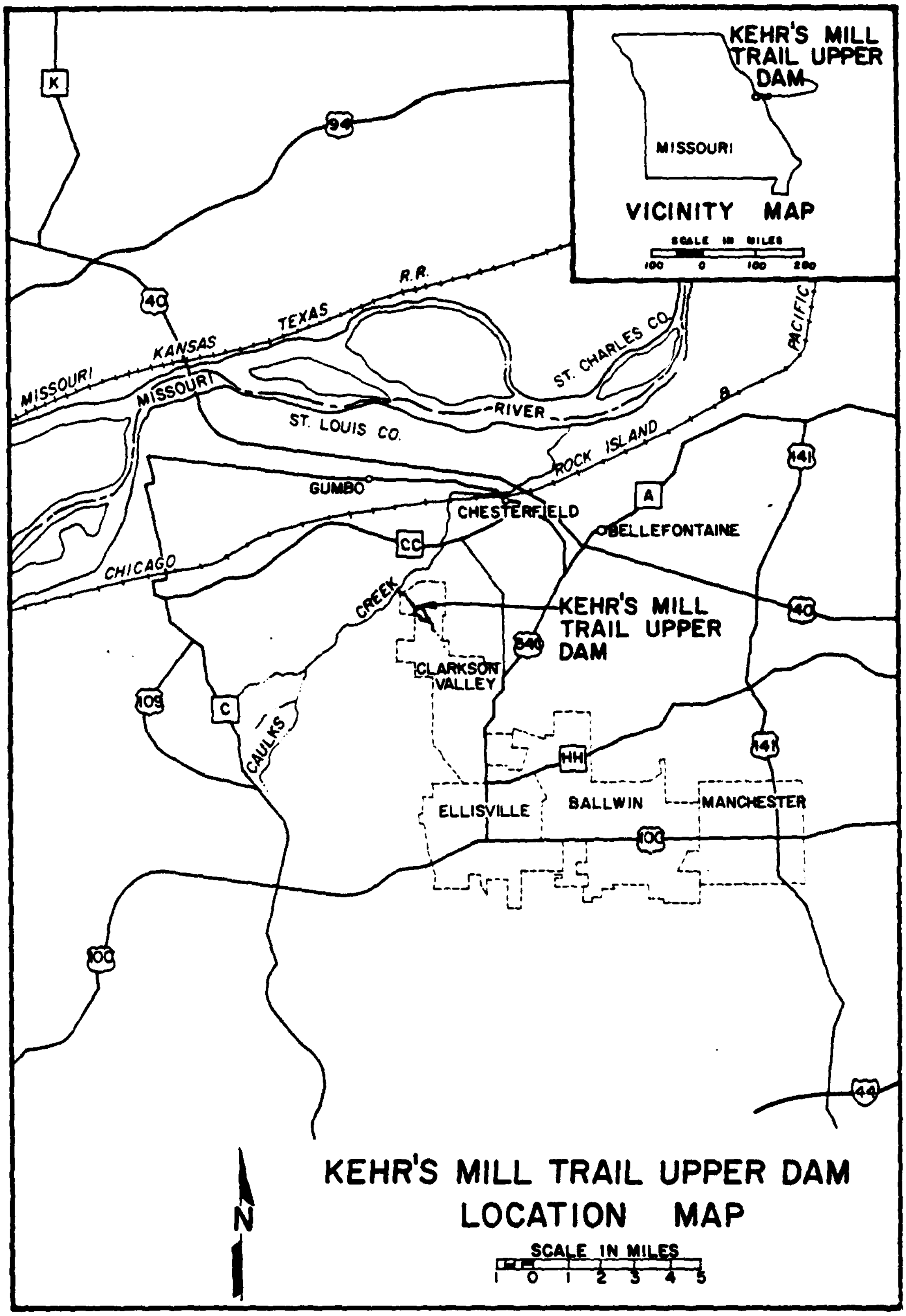

KEHR'S MILL TRAIL UPPER DAM
MISSOURI
VICINITY MAP
SCALE IN MILES
100 0 100 200
K
94
40
MISSOURI KANSAS TEXAS R.R.
MISSOURI RIVER
ST. CHARLES CO.
ST. LOUIS CO.
PACIFIC
ROCK ISLAND
GUMBO
CHESTERFIELD
BELLEFONTAINE
A
141
CC
CHICAGO
CREEK
KEHR'S MILL TRAIL UPPER DAM
340
CLARKSON VALLEY
109
C
CAULKS
HH
ELLISVILLE
BALLWIN
MANCHESTER
100
44
N
KEHR'S MILL TRAIL UPPER DAM
LOCATION MAP
SCALE IN MILES
1 0 1 2 3 4 5

PLATE 1

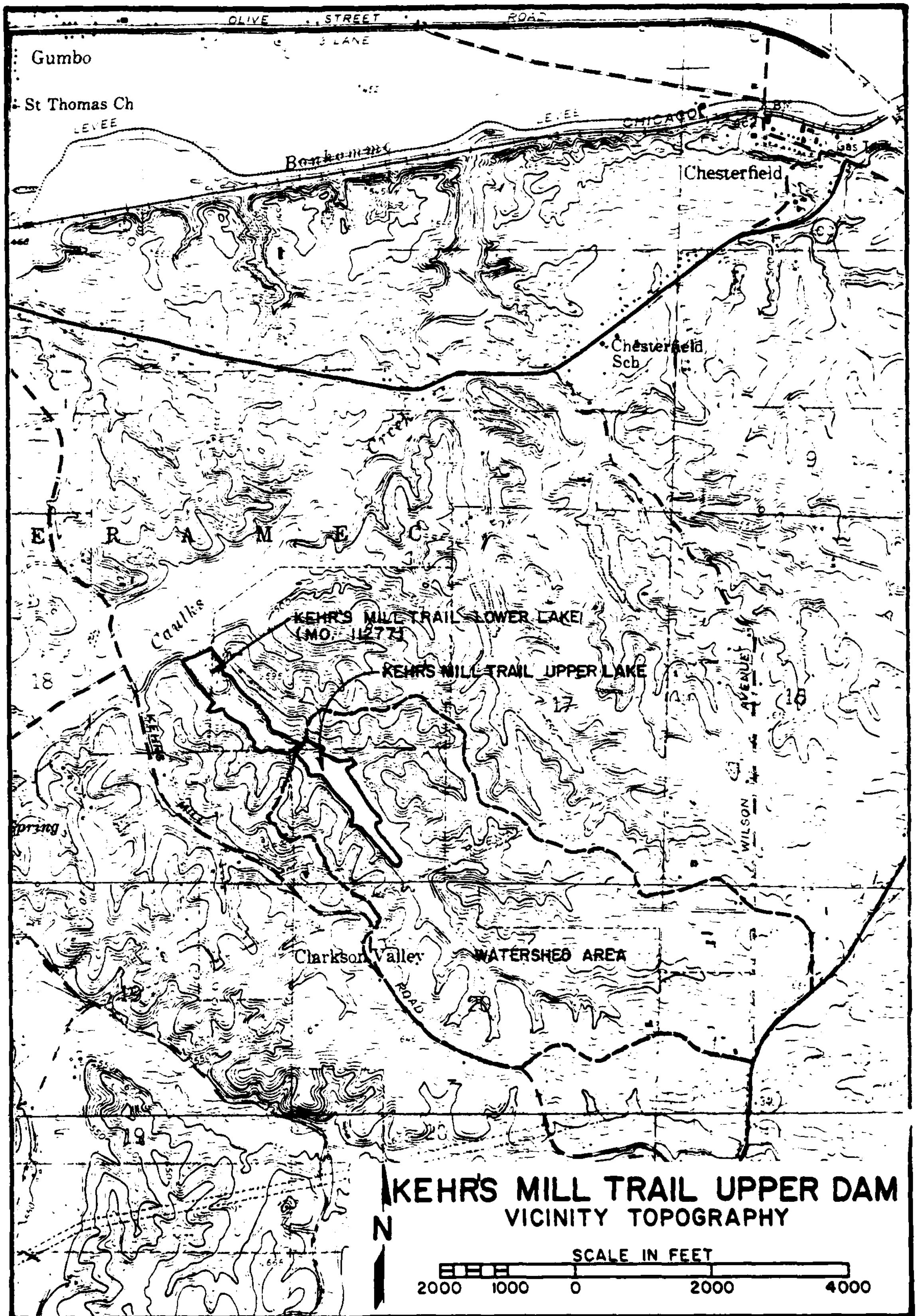
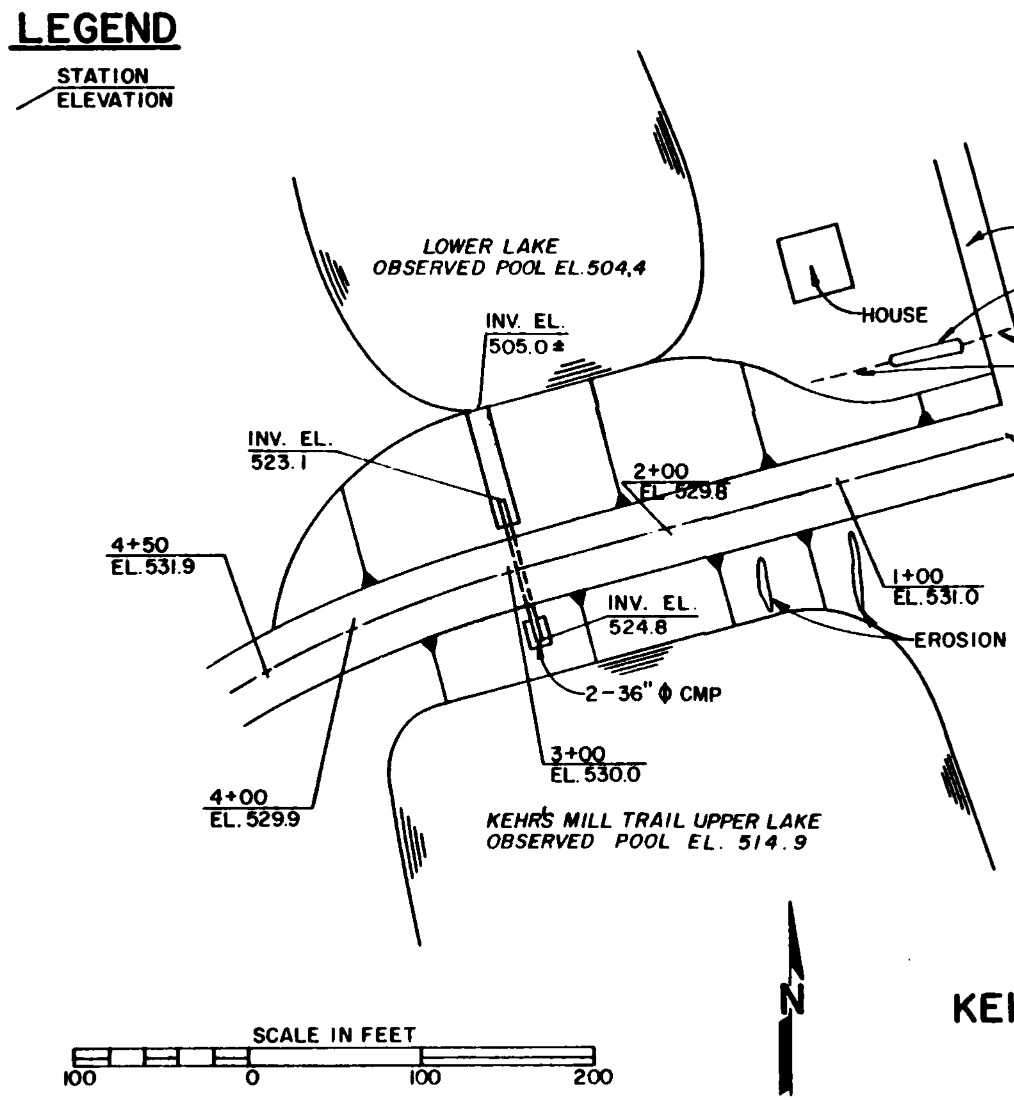
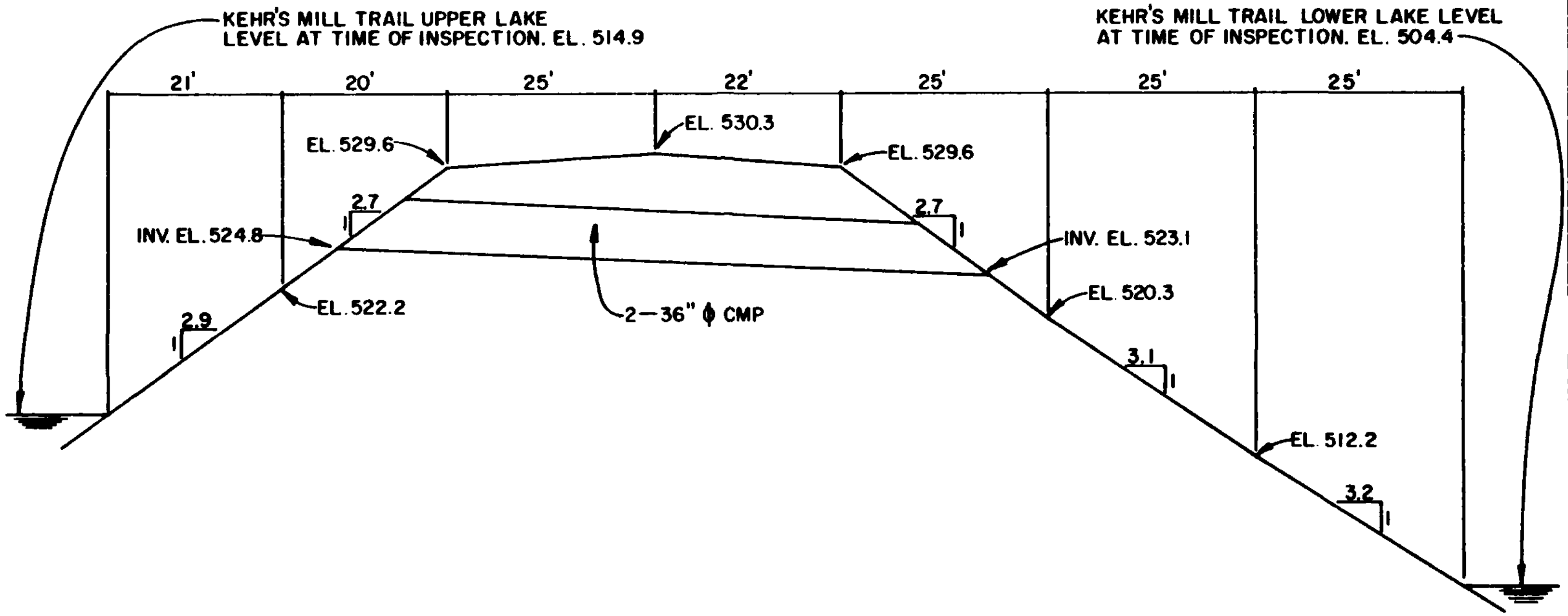

OLIVE STREET ROAD
Gumbo
St Thomas Ch
LEVEE
CHICAGO
Chesterfield
Chesterfield Sch
Creek
9
E R A M E C
Caulks
KEHR'S MILL TRAIL LOWER LAKE (MO. 11277)
KEHR'S MILL TRAIL UPPER LAKE
18
17
16
WILSON AVENUE
Clarkson Valley
WATERSHED AREA
ROAD
20
19
KEHR'S MILL TRAIL UPPER DAM
VICINITY TOPOGRAPHY
SCALE IN FEET
2000 1000 0 2000 4000
N

PLATE 2



KEHR'S MILL TRAIL UPPER DAM
DAM PLAN

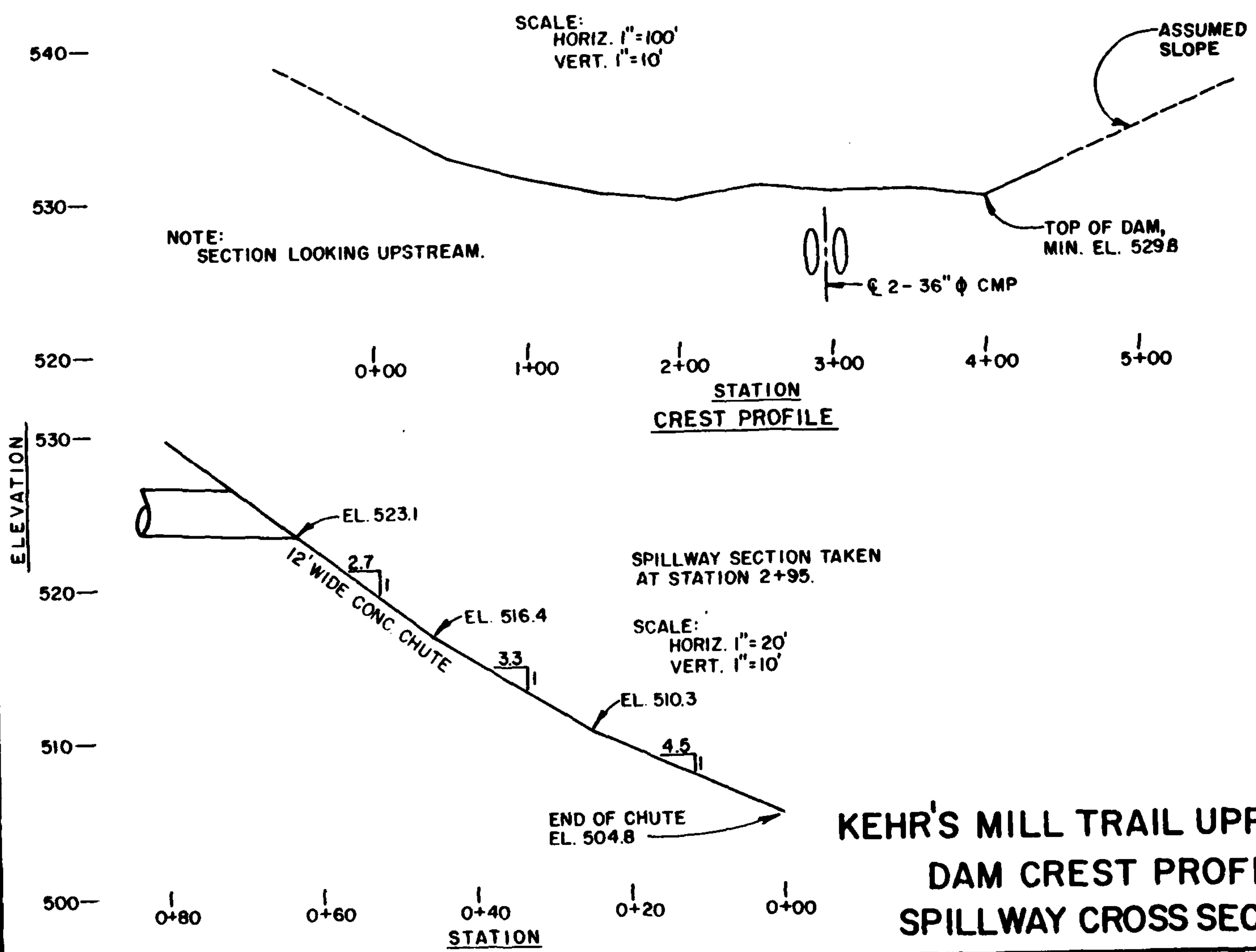
PLATE 3



NOTE:
CROSS SECTION TAKEN AT STATION 2+75.

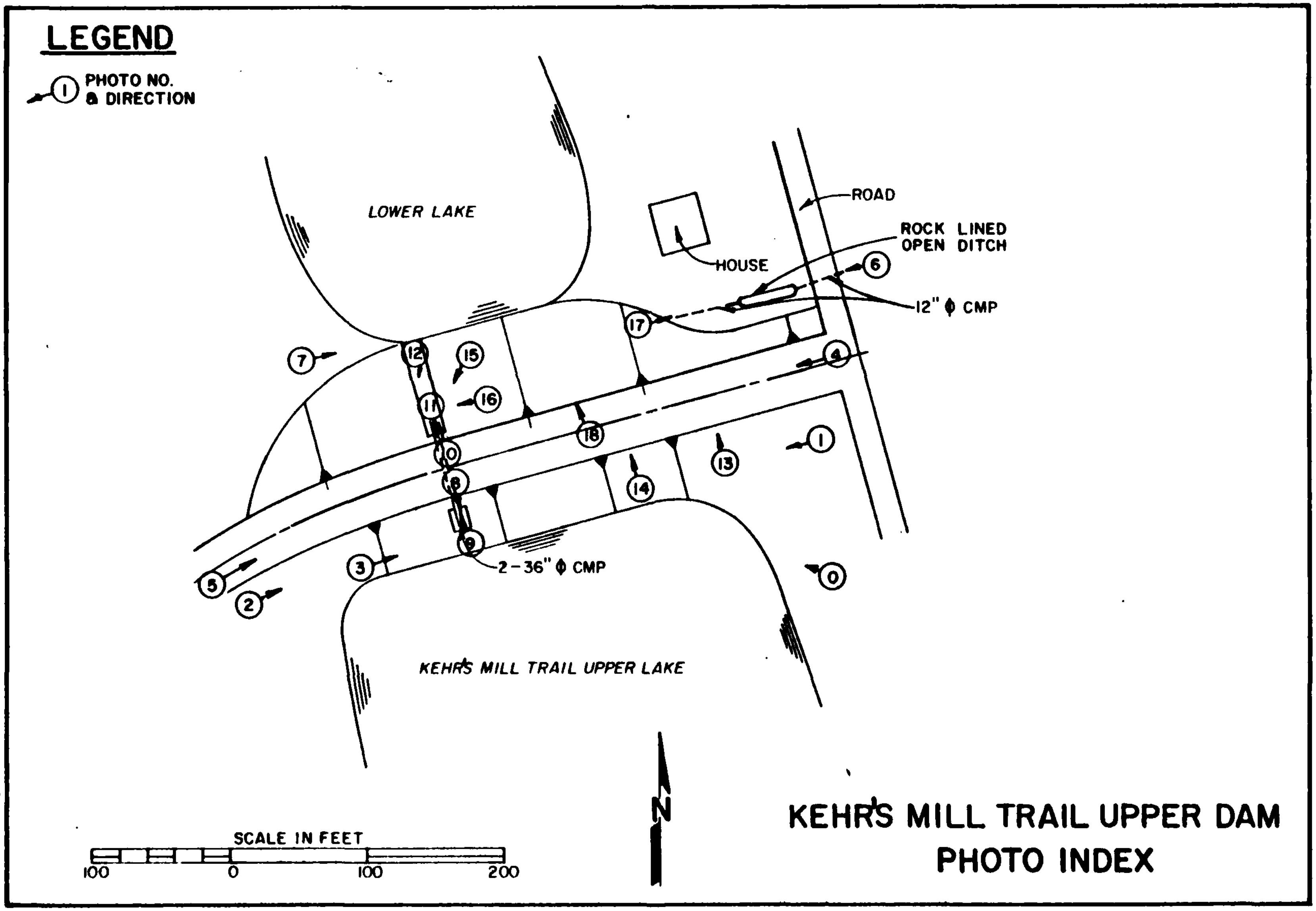
SCALE:
HORIZ. 1" = 20'
VERT. 1" = 10'

KEHR'S MILL TRAIL UPPER DAM
DAM CROSS SECTION



KEHR'S MILL TRAIL UPPER DAM
DAM CREST PROFILE
SPILLWAY CROSS SECTION

PLATE 5



KEHR'S MILL TRAIL UPPER DAM
PHOTO INDEX

PLATE 6

PHOTO 1: UPSTREAM FACE OF DAM LOOKING SOUTH

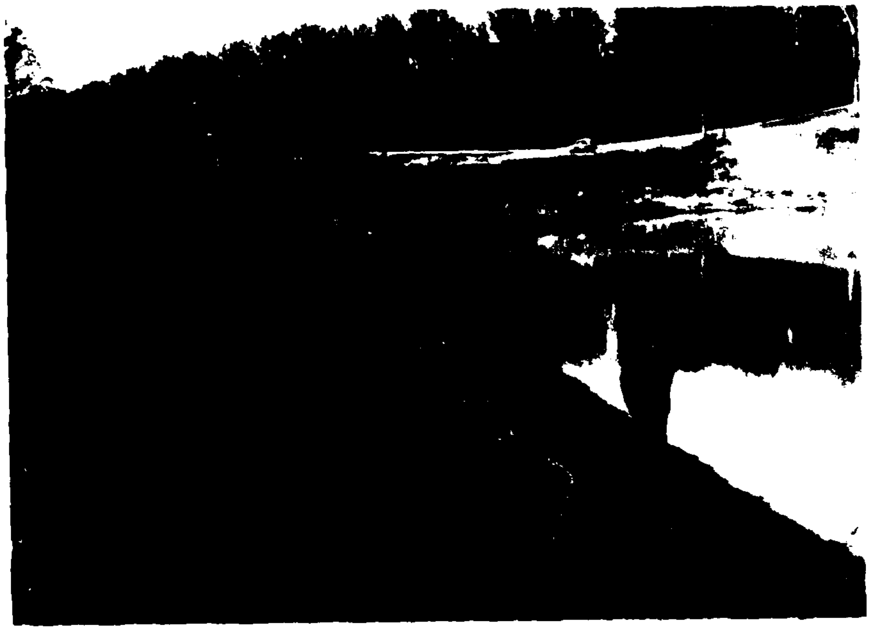


PHOTO 2: UPSTREAM FACE OF DAM LOOKING NORTH

PHOTO 3: UPSTREAM FACE OF DAM AT WATERLINE

PHOTO 4: CREST OF DAM LOOKING SOUTH

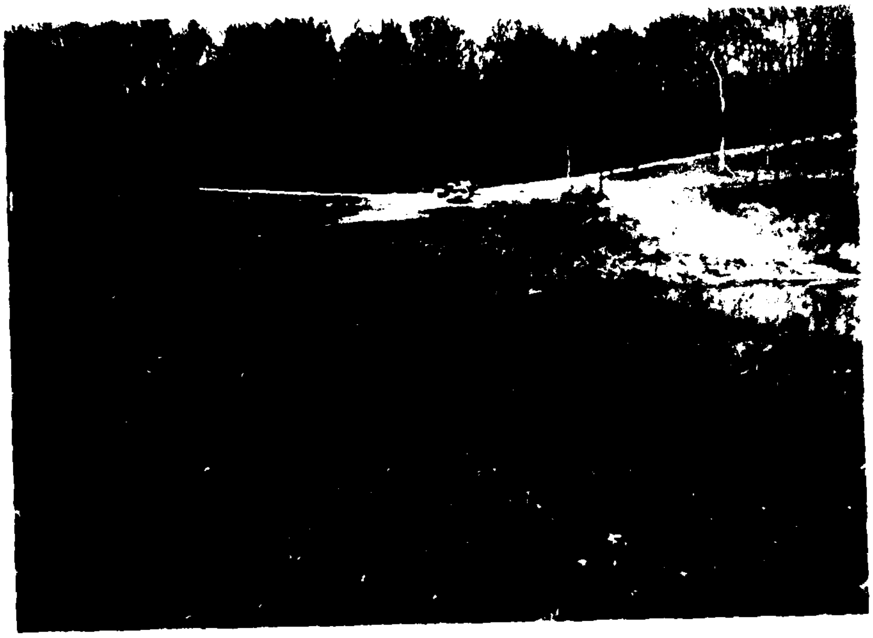


PHOTO 5: CREST OF DAM LOOKING NORTH

PHOTO 6: DOWNSTREAM FACE OF DAM LOOKING SOUTH

PHOTO 7: DOWNSTREAM FACE OF DAM LOOKING NORTH

PHOTO 8: SPILLWAY INLET LOOKING UPSTREAM

PHOTO 9: INLET TO SPILLWAY PIPES

PHOTO 10: SPILLWAY OUTLET LOOKING DOWNSTREAM

PHOTO 11: OUTLET TO SPILLWAY PIPES

PHOTO 12: CONCRETE CHUTE BELOW SPILLWAY PIPES

PHOTO 13: EROSION OF UPSTREAM FACE NEAR RIGHT END

PHOTO 14: EROSION OF UPSTREAM FACE

PHOTO 15: EROSION OF DOWNSTREAM FACE NEAR SPILLWAY

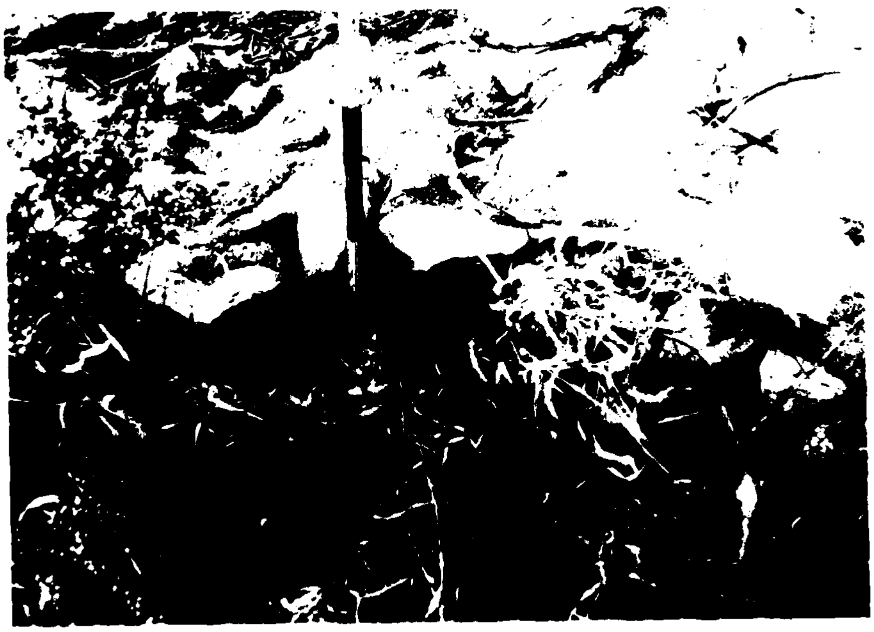


PHOTO 16: UNDERCUTTING OF CONCRETE CHUTE

PHOTO 17: OUTLET OF DRAIN PIPE AT DOWNSTREAM TOE OF DAM

PHOTO 18: LOWER LAKE AND DAM VIEWED FROM UPPER DAM

APPENDIX A

HYDROLOGIC AND HYDRAULIC ANALYSES

HYDROLOGIC AND HYDRAULIC ANALYSES

To determine the overtopping potential, flood routings were performed by applying the Probable Maximum Precipitation (PMP) to a synthetic unit hydrograph to develop the inflow hydrograph. The inflow hydrograph was then routed through the reservoir and spillway. The overtopping analysis was determined using the computer program HEC-1 (Dam Safety Version) (1).

The PMP was determined from regional charts prepared by the National Weather Service in "Hydrometeorological Report No. 33" (HMR-33) (2). Reduction factors were not applied. The rainfall distribution for the 24-hour PMP storm was determined according to the procedures outlined in HMR-33 and EM 1110-2-1411 (3). The St. Louis County, Missouri rainfall distribution (5 min. interval - 24 hours duration), as provided by the St. Louis District, Corp of Engineers, was used when the one percent chance and ten percent chance probability floods were routed through the reservoir and spillway.

The synthetic unit hydrograph for the watershed was developed by the computer program using the Soil Conservation Service (SCS) method (1 and 4). The parameters for the unit hydrograph are shown in Table 1. The time of concentration (T_c) was computed using the SCS method and verified by using the Kirpich method.

The SCS curve number (CN) method was used in computing the infiltration losses for the rainfall-runoff relationship. The CN values used, and the result from the computer output, are shown in Table 2.

The reservoir routing was performed using the modified Puls method. The initial reservoir pool elevation for the routing of each storm was determined to be equivalent to the inlet invert elevation of the spillway at elevation 524.8 feet m.s.l. in accordance with antecedent storm conditions AMC II and AMC III preceding the one percent probability, ten percent probability, and probable maximum storms outlined by the U.S. Army Corps of Engineers, St. Louis District (5). The hydraulic capacity of the spillway and the storage capacity of the reservoir were defined by the elevation, surface area, storage, and discharge relationships shown in Table 3.

The rating curve for the spillway is shown in Table 4. The flow over the crest of the dam was determined using the non-level dam crest option ($L and $V cards) of the HEC-1 program. The program assumes critical flow over a broad-crested weir. The flow through the spillway was determined from Hydraulic Charts for the Selection of Highway Culverts (6).

The result of the routing analysis indicates that the spillway will pass a flood equivalent to 10 percent of the PMF without overtopping the dam.

A summary of the routing analysis for different ratios of the PMF is shown in Table 5.

The computer input data and a summary of the output data are presented at the back of this appendix.

TABLE 1

SYNTHETIC UNIT HYDROGRAPH

Parameters:

Drainage Area (A)	510 acres	
Hydraulic Length of Watercourse (ℓ)	7,300 feet	
Hydrologic Soil Cover Complex Number (CN')	86 (AMC III)	72 (AMC II)
Average Watershed Land Slope (Y)	1.8%	
Lag Time (L_g)	0.95 hours (AMC III)	1.47 hours (AMC II)
Time of concentration (T_c)	1.59 hours (AMC III)	2.45 hours (AMC II)
Duration (D)	12.7 min. (AMC III) (use 5 minutes in each case to be consistent with duration of the storm used for the downstream lake)	19.5 min. (AMC II)

Time (Min.) *	Discharge (cfs) * AMC II	AMC III
0	0	0
5	4	10
10	9	30
15	19	57
20	30	91
25	43	133
30	58	186
35	75	248
40	96	302
45	119	344
50	145	372
55	171	387
60	194	389
65	214	386
70	230	368

* From HEC-1 computer output

(TABLE 1)
(Continued)

Time (Min.) *	Discharge (cfs) * AMC II	AMC III
75	242	346
80	250	321
85	254	293
90	255	259
95	254	220
100	253	187
105	244	162
110	235	141
115	225	122
120	215	107

* From HEC-1 computer output

FORMULAS USED:

$$L_g = \frac{\ell^{0.8} \times (S + 1)^{0.7}}{1,900 \times Y^{0.5}} \qquad (4)$$

$$S = \frac{1000}{CN'} - 10$$

$$T_c = L_g/0.6$$

$$D = 0.133\ T_c$$

TABLE 2

RAINFALL-RUNOFF VALUES

Selected Storm Event	Storm Duration Hours	Rainfall (Inches)	Runoff (Inches)	Loss (Inches)
PMP	24	32.45	30.57	1.88
50% PMP	24	17.10	15.29	1.81
1% Probability	24	6.97	3.81	3.16
10% Probability	24	4.91	2.13	2.78

Additional Data:

1) No information on soil associations was available for this watershed.
   100 percent of drainage area in hydrologic soil group C.
   80 percent of the land use was timberland.
   20 percent of the land use was large residential lots.
2) SCS Runoff Curve CN = 86 (AMC III) for the PMF.
3) SCS Runoff Curve CN = 72 (AMC II) for the one percent and ten percent probability floods (4 and 7).

TABLE 3

ELEVATION, SURFACE AREA, STORAGE, AND DISCHARGE RELATIONSHIPS

Elevation (feet-MSL)	Lake Surface Area (acres)	Lake Storage (acre-ft)	Spillway Discharge (cfs)
*524.8	16.4	160	0
527.3	18.4	203	51
**529.8	20.4	252	110

*Spillway Inlet Invert Elevation
**Top of Dam Elevation

The relationships in Table 3 were developed from the Chesterfield, Missouri 7.5 minute quadrangle map and the field measurements.

TABLE 4

SPILLWAY RATING CURVE

Reservoir Elevation (ft-msl)	Primary Spillway Discharge (cfs)
*524.8	0
526.8	36
527.8	70
528.8	86
**529.8	110

*Spillway Inlet Invert Elevation
**Top of Dam Elevation

METHOD USED:

Spillway release rates are based on nomographs for a pipe culvert with inlet and outlet control (6).

TABLE 5

RESULTS OF FLOOD ROUTINGS

Ratio of PMF	Peak Inflow (cfs)	Peak Lake Elevation (ft.-msl)	Total Storage (AC.-ft.)	Peak Outflow (cfs)	Depth Over Top of Dam (ft.)	Duration Over Top of Dam (hrs.)
-	0	*524.8	160	0	-	-
0.10	413	529.6	248	106	0	0
0.50	2,066	531.6	291	2,022	1.8	8.7
1.00	4,132	532.5	311	4,079	2.7	13.0

*Spillway Inlet Invert Elevation

```
**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  01 APR 80
**********************************
    1            A1MISSOURI DAM INSPECTION PROGRAM
    2            A2ST LOUIS DISTRICT US ARMY CORPS OF ENGINEERS
    3            A3UPPER AND LOWER KEHR'S MILL TRAIL LAKE DAMS
    4            B    288      0      5      0      0      C      0      0      0      0
    5            B1     5
    6            J      1      6      1
    7            J1   .05    .10    .15    .20    .50    1.0
    8            K      0      1                          1      1
    9            K1   UPPER KEHR'S MILL TRAIL LAKE DAM (24 HR. PROBABLE MAXIMUM RUNOFF)
   10            M      1      2    .08                   1
   11            P          25.20    101    120    130
   12            T                                               -1    -86
   13            W2          0.55
   14            X                    1
   15            K      1      2                                 1
   16            K1   ROUTING THROUGH UPPER KEHR'S MILL TRAIL LAKE DAM
   17            Y                           1      1
   18            Y1     1                                     -524.8     -1
   19            Y4 524.8  526.3  527.8  527.?  527.?  528.?  528.?  530.8  532.8  534.8
   20            Y4 536.?
   21            Y5     0.    24.    ?6.    ?2.    7?.    86.   110.   120.   144.   164.
   22            Y5  184.
   23            $A     0.    4.7    ?.9   12.6   ?0.6   32.4
   24            $E   49?.   510.  514.9   52?.   5??.   540.
   25            $S 524.8
   26            $D 529.8
   27            $L     0.    33.    95.   207.   275.   32?.   3??.   4?7.   535.
   28            $V 526.5  529.6  530.0  530.1  530.3  531.0  531.0  532.?  535.2
   29            K     99
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**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION       JULY 1978
  LAST MODIFICATION  01 APR 80
**********************************
                    MISSOURI DAM INSPECTION PROGRAM
                    ST LOUIS DISTRICT US ARMY CORPS OF ENGINEERS
                    UPPER AND LOWER KENR'S MILL TRAIL LAKE DAMS

                                  JOB SPECIFICATION
          NO     NHR     NMIN    IDAY     IHR    IMIN   METRC    IPLT    IPRT   NSTAN
         288       0       5       0       6       0       0       0       0       0
                                JOPER     NWT   LROPT   TRACE
                                    5       0       0       0

                          MULTI-PLAN ANALYSES TO BE PERFORMED
                               NPLAN= 1 NRTIO= 6 LRTIO= 1
            RTIOS=    .05     .10     .15     .20     .50    1.00

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

                               SUB-AREA RUNOFF COMPUTATION

         UPPER KENR'S MILL TRAIL LAKE DAP (20 HA. PROBABLE MAXIMUM RUNOFF)

                   ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                       1       0       0       0       0       3       1       0       0

                                    HYDROGRAPH DATA
        IHYDG    IUHG   TAREA    SNAP   TRSDA   TRSPC   RATIO   ISNOW   ISAME   LOCAL
            1       2     .09     .00     .09    1.00    .000       0       0       0

                                      PRECIP DATA
                    SPFE     PMS      R6     R12     R24     R48     R72     R96
                     .00   25.20  101.00  120.00  130.00     .00     .00     .00

                                       LOSS DATA
      LROPT   STRKR   DLTKR   RTIOL   ERAIN   STRKS   RTIOK   STRTL   CNSTL   ALSMX   RTIMP
          0     .00     .00    1.00     .00     .00    1.00   -1.00  -86.00     .00     .00

          CURVE NO =  -86.00  WETNESS =   -1.00  EFFECT CN =   86.00

                                  UNIT HYDROGRAPH DATA
                               TC=    .00     LAG=    .95

                                     RECESSION DATA
                     STRTQ=     .00     QRCSN=     .00     RTIOR= 1.00

          UNIT HYDROGRAPH 59 END OF PERIOD ORDINATES, TC=     .00 HOURS, LAG=    .95   VOL= 1.00
      17.      37.      57.      91.     153.     197.     247.     302.     344.     372.
     367.     340.     366.     269.     246.     321.     297.     259.     220.     187.
     162.     141.     122.     107.      95.      87.      73.      67.      54.      48.
      41.      36.      32.      29.      24.      21.      19.      16.      14.      12.
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```
      11.       9.       8.       7.       6.       5.       5.       4.       4.       3.
```

B L A C K & V E A T C H PROJECT 9166: DATE 16 JAN [illegible] PAGE 5

FLOOD HYDROGRAPH PACKAGE - HEC-1 PROGRAM H21/02-1V TIME 18:02:51 CASE PMF

11.	9.	8.	7.	6.	5.	5.	4.	4.	3.
3.	1.	2.	2.	1.	1.	1.	0.	0.	

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.05	1	.01	.00	.01	0.	1.01	12.05	145	.21	.20	.01	384.
1.01	.10	2	.01	.00	.01	0.	1.01	12.10	146	.21	.20	.01	[illegible]
1.01	.15	3	.01	.00	.01	0.	1.01	12.15	147	.21	.20	.01	397.
1.01	.20	4	.01	.00	.01	0.	1.01	12.20	148	.21	.20	.01	410.
1.01	.25	5	.01	.00	.01	0.	1.01	12.25	149	.21	.20	.01	429.
1.01	.30	6	.01	.00	.01	0.	1.01	12.30	150	.21	.20	.01	[illegible]
1.01	.35	7	.01	.00	.01	0.	1.01	12.35	151	.21	.20	.01	491.
1.01	.40	8	.01	.00	.01	0.	1.01	12.40	152	.21	.20	.01	534.
1.01	.45	9	.01	.00	.01	0.	1.01	12.45	153	.21	.21	.01	592.
1.01	.50	10	.01	.00	.01	0.	1.01	12.50	154	.21	.21	.01	675.
1.01	.55	11	.01	.00	.01	0.	1.01	12.55	155	.21	.21	.01	689.
1.01	1.00	12	.01	.00	.01	0.	1.01	13.00	156	.21	.21	.01	745.
1.01	1.05	13	.01	.00	.01	0.	1.01	13.05	157	.25	.25	.01	[illegible]
1.01	1.10	14	.01	.00	.01	0.	1.01	13.10	158	.25	.25	.01	[illegible]
1.01	1.15	15	.01	.00	.01	0.	1.01	13.15	159	.25	.25	.01	[illegible]
1.01	1.20	16	.01	.00	.01	0.	1.01	13.20	160	.25	.25	.01	955.
1.01	1.25	17	.01	.00	.01	0.	1.01	13.25	161	.25	.25	.01	1007.
1.01	1.30	18	.01	.00	.01	0.	1.01	13.30	162	.25	.25	.01	[illegible]
1.01	1.35	19	.01	.00	.01	0.	1.01	13.35	163	.25	.25	.01	[illegible]
1.01	1.40	20	.01	.00	.01	0.	1.01	13.40	164	.25	.25	.01	[illegible]
1.01	1.45	21	.01	.00	.01	0.	1.01	13.45	165	.25	.25	.00	[illegible]
1.01	1.50	22	.01	.00	.01	0.	1.01	13.50	166	.25	.25	.00	1207.
1.01	1.55	23	.01	.00	.01	0.	1.01	13.55	167	.25	.25	.00	[illegible]
1.01	2.00	24	.01	.00	.01	0.	1.01	14.00	168	.25	.25	.00	[illegible]
1.01	2.05	25	.01	.00	.01	0.	1.01	14.05	169	.32	.31	.00	[illegible]
1.01	2.10	26	.01	.00	.01	0.	1.01	14.10	170	.32	.31	.00	[illegible]
1.01	2.15	27	.01	.00	.01	0.	1.01	14.15	171	.32	.31	.00	[illegible]
1.01	2.20	28	.01	.00	.01	0.	1.01	14.20	172	.32	.31	.00	1395.
1.01	2.25	29	.01	.00	.01	0.	1.01	14.25	173	.32	.31	.00	1425.
1.01	2.30	30	.01	.00	.01	0.	1.01	14.30	174	.32	.31	.00	[illegible]
1.01	2.35	31	.01	.00	.01	1.	1.01	14.35	175	.32	.31	.00	1487.
1.01	2.40	32	.01	.00	.01	1.	1.01	14.40	176	.32	.31	.00	[illegible]
1.01	2.45	33	.01	.00	.01	1.	1.01	14.45	177	.32	.31	.00	[illegible]
1.01	2.50	34	.01	.00	.01	2.	1.01	14.50	178	.32	.31	.00	1589.
1.01	2.55	35	.01	.00	.01	2.	1.01	14.55	179	.32	.31	.00	[illegible]
1.01	3.00	36	.01	.00	.01	3.	1.01	15.00	180	.32	.31	.00	[illegible]
1.01	3.05	37	.01	.00	.01	3.	1.01	15.05	181	.19	.19	.00	[illegible]
1.01	3.10	38	.01	.00	.01	4.	1.01	15.10	182	.39	.38	.00	1715.
1.01	3.15	39	.01	.00	.01	5.	1.01	15.15	183	.39	.38	.00	1742.
1.01	3.20	40	.01	.00	.01	6.	1.01	15.20	184	.58	.58	.00	1769.
1.01	3.25	41	.01	.00	.01	6.	1.01	15.25	185	.68	.67	.01	1800.
1.01	3.30	42	.01	.00	.01	7.	1.01	15.30	186	1.44	1.43	.01	[illegible]
1.01	3.35	43	.01	.00	.01	8.	1.01	15.35	187	2.71	2.69	.02	[illegible]
1.01	3.40	44	.01	.00	.01	9.	1.01	15.40	188	1.06	1.06	.01	[illegible]
1.01	3.45	45	.01	.00	.01	10.	1.01	15.45	189	.68	.67	.00	[illegible]
1.01	3.50	46	.01	.00	.01	11.	1.01	15.50	190	.58	.58	.00	[illegible]
1.01	3.55	47	.01	.00	.01	12.	1.01	15.55	191	.39	.39	.00	[illegible]
1.01	4.00	48	.01	.00	.01	13.	1.01	16.00	192	.39	.39	.00	[illegible]
1.01	4.05	49	.01	.00	.01	14.	1.01	16.05	193	.30	.30	.00	[illegible]
1.01	4.10	50	.01	.00	.01	15.	1.01	16.10	194	.30	.30	.00	[illegible]

1.01	4.15	51	.01	.00	.01	16.	1.01	16.15	195	.30	.30	.00	3644.
1.01	4.20	52	.01	.00	.01	17.	1.01	16.20	196	.30	.30	.00	4007.
1.01	4.25	53	.01	.01	.01	18.	1.01	16.25	197	.30	.30	.00	[illegible]
1.01	4.30	54	.01	.01	.01	19.	1.01	16.30	198	.30	.30	.00	[illegible]
1.01	4.35	55	.01	.01	.01	20.	1.01	16.35	199	.30	.30	.00	4196.
1.01	4.40	56	.01	.01	.01	21.	1.01	16.40	200	.30	.30	.00	[illegible]
1.01	4.45	57	.01	.01	.01	22.	1.01	16.45	201	.30	.30	.00	3901.
1.01	4.50	58	.01	.01	.01	23.	1.01	16.50	202	.30	.30	.00	[illegible]
1.01	4.55	59	.01	.01	.01	24.	1.01	16.55	203	.30	.30	.00	3582.
1.01	5.00	60	.01	.01	.01	25.	1.01	17.00	204	.30	.30	.00	3377.
1.01	5.05	61	.01	.01	.01	26.	1.01	17.05	205	.23	.23	.00	3184.
1.01	5.10	62	.01	.01	.01	27.	1.01	17.10	206	.23	.23	.00	3000.
1.01	5.15	63	.01	.01	.01	27.	1.01	17.15	207	.23	.23	.00	2841.
1.01	5.20	64	.01	.01	.01	28.	1.01	17.20	208	.23	.23	.00	2702.
1.01	5.25	65	.01	.01	.01	29.	1.01	17.25	209	.23	.23	.00	2576.
1.01	5.30	66	.01	.01	.01	30.	1.01	17.30	210	.23	.23	.00	2470.
1.01	5.35	67	.01	.01	.01	31.	1.01	17.35	211	.23	.23	.00	2372.
1.01	5.40	68	.01	.01	.01	31.	1.01	17.40	212	.23	.23	.00	2280.
1.01	5.45	69	.01	.01	.01	32.	1.01	17.45	213	.23	.23	.00	2197.
1.01	5.50	70	.01	.01	.01	33.	1.01	17.50	214	.23	.23	.00	2111.
1.01	5.55	71	.01	.01	.01	34.	1.01	17.55	215	.23	.23	.00	2036.
1.01	6.00	72	.01	.01	.01	34.	1.01	18.00	216	.23	.23	.00	1969.
1.01	6.05	73	.07	.03	.03	35.	1.01	18.05	217	.02	.02	.00	1904.
1.01	6.10	74	.07	.04	.03	37.	1.01	18.10	218	.02	.02	.00	1842.
1.01	6.15	75	.07	.04	.03	39.	1.01	18.15	219	.02	.02	.00	[illegible]
1.01	6.20	76	.07	.04	.03	42.	1.01	18.20	220	.02	.02	.00	1711.
1.01	6.25	77	.07	.04	.03	47.	1.01	18.25	221	.02	.02	.00	1644.
1.01	6.30	78	.07	.04	.03	53.	1.01	18.30	222	.02	.02	.00	1569.
1.01	6.35	79	.07	.04	.02	61.	1.01	18.35	223	.02	.02	.00	1486.
1.01	6.40	80	.07	.04	.02	71.	1.01	18.40	224	.02	.02	.00	1356.
1.01	6.45	81	.07	.05	.02	83.	1.01	18.45	225	.02	.02	.00	1300.
1.01	6.50	82	.07	.05	.02	95.	1.01	18.50	226	.02	.02	.00	1202.
1.01	6.55	83	.07	.05	.02	107.	1.01	18.55	227	.02	.02	.00	1103.
1.01	7.00	84	.07	.05	.02	123.	1.01	19.00	228	.02	.02	.00	1005.
1.01	7.05	85	.07	.05	.02	138.	1.01	19.05	229	.02	.02	.00	910.
1.01	7.10	86	.07	.05	.02	152.	1.01	19.10	230	.02	.02	.00	[illegible]
1.01	7.15	87	.07	.05	.02	166.	1.01	19.15	231	.02	.02	.00	777.
1.01	7.20	88	.07	.05	.02	179.	1.01	19.20	232	.02	.02	.00	[illegible]
1.01	7.25	89	.07	.05	.02	192.	1.01	19.25	233	.02	.02	.00	591.
1.01	7.30	90	.07	.05	.01	205.	1.01	19.30	234	.02	.02	.00	529.
1.01	7.35	91	.07	.05	.01	216.	1.01	19.35	235	.02	.02	.00	477.
1.01	7.40	92	.07	.05	.01	226.	1.01	19.40	236	.02	.02	.00	433.
1.01	7.45	93	.07	.05	.01	236.	1.01	19.45	237	.02	.02	.00	394.
1.01	7.50	94	.07	.05	.01	245.	1.01	19.50	238	.02	.02	.00	360.
1.01	7.55	95	.07	.05	.01	253.	1.01	19.55	239	.02	.02	.00	331.
1.01	8.00	96	.07	.05	.01	261.	1.01	20.00	240	.02	.02	.00	305.
1.01	8.05	97	.07	.06	.01	268.	1.01	20.05	241	.02	.02	.00	281.
1.01	8.10	98	.07	.06	.01	275.	1.01	20.10	242	.02	.02	.00	261.
1.01	8.15	99	.07	.06	.01	282.	1.01	20.15	243	.02	.02	.00	242.
1.01	8.20	100	.07	.06	.01	288.	1.01	20.20	244	.02	.02	.00	227.
1.01	8.25	101	.07	.06	.01	293.	1.01	20.25	245	.02	.02	.00	213.
1.01	8.30	102	.07	.06	.01	298.	1.01	20.30	246	.02	.02	.00	201.
1.01	8.35	103	.07	.06	.01	303.	1.01	20.35	247	.02	.02	.00	192.
1.01	8.40	104	.07	.06	.01	308.	1.01	20.40	248	.02	.02	.00	183.
1.01	8.45	105	.07	.06	.01	312.	1.01	20.45	249	.02	.02	.00	176.
1.01	8.50	106	.07	.06	.01	316.	1.01	20.50	250	.02	.02	.00	170.

1.01	8.55	107	.07	.06	.01	320.	1.01	20.55	251	.02	.02	.00	[illegible]

B L A [illegible] & V E A T C H   PROJECT 9160:   DATE 30 JAN [illegible]   PAGE 7

FLOOD HYDROGRAPH PACKAGE - HEC-1   PROGRAM H21/02-1V   TIME 10:02:51   CASE PRF

1.01	8.55	107	.07	.06	.01	320.	1.01	20.55	251	.02	.02	.00	[illegible]
1.01	9.00	108	.07	.06	.01	324.	1.01	21.00	252	.02	.02	.00	[illegible]
1.01	9.05	109	.07	.06	.01	327.	1.01	21.05	253	.02	.02	.00	[illegible]
1.01	9.10	110	.07	.06	.01	331.	1.01	21.10	254	.02	.02	.00	[illegible]
1.01	9.15	111	.07	.06	.01	334.	1.01	21.15	255	.02	.02	.00	14?.
1.01	9.20	112	.07	.06	.01	336.	1.01	21.20	256	.02	.02	.00	[illegible]
1.01	9.25	113	.07	.06	.01	339.	1.01	21.25	257	.02	.02	.00	[illegible]
1.01	9.30	114	.07	.06	.01	342.	1.01	21.30	258	.02	.02	.00	14?.
1.01	9.35	115	.07	.06	.01	344.	1.01	21.35	259	.02	.02	.00	140.
1.01	9.40	116	.07	.06	.01	346.	1.01	21.40	260	.02	.02	.00	138.
1.01	9.45	117	.07	.06	.01	349.	1.01	21.45	261	.02	.02	.00	137.
1.01	9.50	118	.07	.06	.01	351.	1.01	21.50	262	.02	.02	.00	136.
1.01	9.55	119	.07	.06	.01	353.	1.01	21.55	263	.02	.02	.00	135.
1.01	10.00	120	.07	.06	.01	355.	1.01	22.00	264	.02	.02	.00	134.
1.01	10.05	121	.07	.06	.01	356.	1.01	22.05	265	.02	.02	.00	133.
1.01	10.10	122	.07	.06	.01	358.	1.01	22.10	266	.02	.02	.00	133.
1.01	10.15	123	.07	.06	.01	360.	1.01	22.15	267	.02	.02	.00	132.
1.01	10.20	124	.07	.06	.01	361.	1.01	22.20	268	.02	.02	.00	131.
1.01	10.25	125	.07	.06	.01	363.	1.01	22.25	269	.02	.02	.00	131.
1.01	10.30	126	.07	.06	.01	364.	1.01	22.30	270	.02	.02	.00	131.
1.01	10.35	127	.07	.06	.01	366.	1.01	22.35	271	.02	.02	.00	130.
1.01	10.40	128	.07	.06	.00	367.	1.01	22.40	272	.02	.02	.00	130.
1.01	10.45	129	.07	.06	.00	368.	1.01	22.45	273	.02	.02	.00	130.
1.01	10.50	130	.07	.06	.00	369.	1.01	22.50	274	.02	.02	.00	130.
1.01	10.55	131	.07	.06	.00	370.	1.01	22.55	275	.02	.02	.00	130.
1.01	11.00	132	.07	.06	.00	372.	1.01	23.00	276	.02	.02	.00	130.
1.01	11.05	133	.07	.06	.00	373.	1.01	23.05	277	.02	.02	.00	130.
1.01	11.10	134	.07	.06	.00	374.	1.01	23.10	278	.02	.02	.00	130.
1.01	11.15	135	.07	.06	.00	375.	1.01	23.15	279	.02	.02	.00	130.
1.01	11.20	136	.07	.06	.00	375.	1.01	23.20	280	.02	.02	.00	130.
1.01	11.25	137	.07	.06	.00	376.	1.01	23.25	281	.02	.02	.00	130.
1.01	11.30	138	.07	.06	.00	377.	1.01	23.30	282	.02	.02	.00	130.
1.01	11.35	139	.07	.06	.00	378.	1.01	23.35	283	.02	.02	.00	130.
1.01	11.40	140	.07	.06	.00	379.	1.01	23.40	284	.02	.02	.00	130.
1.01	11.45	141	.07	.06	.00	380.	1.01	23.45	285	.02	.02	.00	130.
1.01	11.50	142	.07	.06	.00	380.	1.01	23.50	286	.02	.02	.00	130.
1.01	11.55	143	.07	.06	.00	381.	1.01	23.55	287	.02	.02	.00	130.
1.01	12.00	144	.07	.06	.00	382.	1.02	.00	288	.02	.02	.00	130.

SUM 32.76 30.78 1.88 169370.
(832.)(784.)(48.)(5362.36)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	4132.	2288.	657.	657.	189265.
CMS	117.	65.	19.	19.	5369.
INCHES		24.05	30.57	30.57	30.57
MM		610.91	776.54	776.54	776.54
AC-FT		1025.	1304.	1304.	1304.
THOUS CU M		1265.	1608.	1608.	1608.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 1

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	227.	137.	75.	75.	9465.

CMS	6.	3.	1.	1.	268.
INCHES		1.20	1.53	1.53	1.53
MM		30.54	38.87	38.83	38.83
AC-FT		51.	65.	65.	65.
THOUS CU M		63.	80.	80.	80.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 2

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	413.	207.	46.	46.	18931.
CMS	12.	6.	2.	2.	536.
INCHES		2.40	3.06	3.06	3.06
MM		61.09	77.65	77.65	77.65
AC-FT		103.	130.	130.	130.
THOUS CU M		126.	161.	161.	161.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 3

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	620.	310.	90.	90.	28396.
CMS	18.	9.	3.	3.	804.
INCHES		3.61	4.59	4.59	4.59
MM		91.62	116.48	116.48	116.48
AC-FT		154.	196.	196.	196.
THOUS CU M		190.	241.	241.	241.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 4

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	826.	414.	131.	131.	37861.
CMS	23.	12.	4.	4.	1072.
INCHES		4.81	6.11	6.11	6.11
MM		122.16	155.31	155.31	155.31
AC-FT		205.	261.	261.	261.
THOUS CU M		253.	322.	322.	322.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 5

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2066.	1034.	329.	329.	94651.
CMS	59.	29.	9.	9.	2680.
INCHES		12.02	15.29	15.29	15.29
MM		305.41	388.27	388.27	388.27
AC-FT		513.	652.	652.	652.
THOUS CU M		632.	804.	804.	804.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 6

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 5

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	4172.	2045.	657.	657.	189705.
CMS	117.	58.	19.	19.	5361.
INCHES		26.05	30.57	30.57	30.57
MM		510.51	776.54	776.54	776.54
AC-FT		1026.	1304.	1304.	1304.
THOUS CU M		1265.	1608.	1608.	1608.

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HYDROGRAPH ROUTING

ROUTING THROUGH UPPER KEHR'S MILL TRAIL LAKE DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
.0	.000	.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	.000	.000	.000	-525.	-1

STAGE	524.80	526.30	526.80	527.30	527.80	528.80	529.80	530.80	532.80	534.80
	534.80									
FLOW	.00	10.00	35.00	52.00	75.00	86.00	110.00	120.00	140.00	164.00
	164.00									

SURFACE AREA=	0.	4.	7.	13.	21.	37.
CAPACITY=	0.	17.	42.	91.	250.	519.
ELEVATION=	499.	510.	515.	520.	530.	540.

CREL	SPWID	COQW	EXPW	ELEVL	COOL	CAREA	EXPL
524.8	.0	.0	.0	.0	.0	.0	.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
529.5	.0	.0	0.

CREST LENGTH	.	37.	95.	207.	275.	328.	380.	417.	535.
AT OR BELOW ELEVATION	529.5	529.9	530.0	530.1	530.3	531.0	531.9	532.5	535.2

STATION 2, PLAN 1, RATIO 1

END-OF-PERIOD HYDROGRAPH ORDINATES

524.8	524.8	524.8	524.8	524.8	524.8	524.8	524.8	524.8	524.8
524.8	524.8	524.8	524.8	524.8	524.8	524.8	524.8	524.8	524.9
524.9	524.9	524.9	524.9	524.9	524.9	524.9	524.9	524.9	524.9
524.9	525.0	525.0	525.0	525.0	525.0	525.0	525.0	525.0	525.0
525.1	525.1	525.1	525.1	525.1	525.1	525.1	525.2	525.2	525.2
525.2	525.3	525.3	525.3	525.4	525.5	525.5	525.6	525.7	525.7
525.8	525.9	526.0	526.1	526.2	526.3	526.3	526.4	526.5	526.6
526.7	526.8	526.9	527.0	527.1	527.2	527.3	527.4	527.5	527.6
527.7	527.8	527.9	528.0	528.1	528.2	528.3	528.4	528.5	528.6
528.7	528.8	528.9	529.0	529.1	529.2	529.3	529.4	529.5	529.6
529.6	529.7	529.8	529.9	530.0	530.1	530.2	530.2	530.3	530.3
530.4	530.4	530.4	530.4	530.4	530.5	530.5	530.5	530.5	530.5
530.5	530.5	530.6	530.6	530.7	530.7	530.8	530.8	530.9	530.9
531.0	531.0	531.0	531.0	531.1	531.1	531.1	531.2	531.2	531.2
531.2	531.2	531.3	531.3	531.3	531.3	531.3	531.4	531.4	531.4
531.4	531.4	531.5	531.5	531.5	531.5	531.5	531.6	531.6	531.7
531.8	531.9	532.0	532.2	532.3	532.4	532.5	532.5	532.5	532.5
532.5	532.5	532.4	532.3	532.3	532.2	532.1	532.1	532.0	531.9
531.9	531.8	531.8	531.7	531.7	531.7	531.6	531.6	531.6	531.5
531.5	531.5	531.4	531.4	531.3	531.3	531.2	531.2	531.1	531.0
531.0	530.9	530.9	530.8	530.7	530.7	530.6	530.6	530.6	530.5
530.5	530.5	530.4	530.4	530.4	530.4	530.3	530.3	530.3	530.3
530.3	530.2	530.2	530.2	530.2	530.2	530.2	530.2	530.2	530.2
530.2	530.1	530.1	530.1	530.1	530.1	530.1	530.1	530.1	530.1
530.1	530.1	530.1	530.1	530.1	530.1	530.1	530.1	530.1	530.1
530.1	530.1	530.1	530.1	530.1	530.1	530.1	530.1		

PEAK OUTFLOW IS 4079. AT TIME 16.59 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	4079.	2063.	608.	608.	175242.
CMS	115.	58.	17.	17.	4962.
INCHES		23.98	28.30	28.30	28.30
MM		609.19	718.85	718.85	718.85
AC-FT		1023.	1207.	1207.	1207.
THOUS CU M		1262.	1489.	1489.	1489.

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

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

OPERATION	STATION	AREA	PLAN	RATIO 1	RATIO 2	RATIO 3	RATIO 4	RATIO 5	RATIO 6
				RATIOS APPLIED TO FLOWS					
				.05	.10	.15	.20	.50	1.00

FLOOD HYDROGRAPH PACKAGE - HEC-1 PROGRAM H21/02-1V TIME 18:02:51 CASE PMF

HYDROGRAPH AT	1	.80	1	207.	413.	620.	826.	2066.	4132.
	(	2.07)	(	5.85)(	11.70)(	17.55)(	23.40)(	58.50)(	116.99)(
ROUTED TO	2	.80	1	55.	104.	392.	732.	2022.	4079.
	(	2.07)	(	1.57)(	2.99)(	11.11)(	20.74)(	57.25)(	115.49)(

SUMMARY OF DAM SAFETY ANALYSIS

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	524.80	524.80	529.80
STORAGE	160.	160.	252.
OUTFLOW	0.	0.	110.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.05	527.39	.00	225.	55.	.00	16.92	.00
.10	529.62	.00	241.	104.	.00	16.92	.00
.15	530.50	.70	248.	392.	4.00	17.42	.00
.20	530.83	1.03	273.	732.	4.83	16.92	.00
.50	531.67	1.87	291.	2022.	8.67	16.67	.00
1.00	532.52	2.72	311.	4079.	13.00	16.58	.00

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*********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION       JULY 1978
  LAST MODIFICATION  21 APR 80
*********************************
   1          A1MISSOURI DAM INSPECTION PROGRAM
   2          A2ST LOUIS DISTRICT US ARMY CORPS OF ENGINEERS
   3          A3UPPER AND LOWER KEHR'S MILL TRAIL LAKE DAMS
   4          B    [illegible]   0      0      0      0      0      0      0      0      0
   5          B1     3
   6          K      0      1                                  3      1
   7          K1   UPPER KEHR'S MILL TRAIL LAKE DAM (24 HR. 100-YEAR INFLOW)
   8          M      0      2    .50                           1
   9          O   [illegible]  6.274
  10          01  .007   .007   .007   .007   .007   .007   .007   .007   .007   .007
  11          01  .007   .007   .007   .007   .007   .007   .007   .007   .007   .007
  12          01  .007   .007   .007   .007   .007   .007   .007   .007   .007   .007
  13          01  .007   .007   .007   .007   .007   .007   .007   .007   .007   .007
  14          01  .007   .007   .007   .007   .007   .007   .007   .007   .007   .007
  15          01  .007   .007   .007   .007   .007   .007   .007   .007   .007   .007
  16          01  .007   .007   .007   .007   .007   .007   .007   .007   .007   .007
  17          01  .007   .007   .012   .012   .012   .012   .012   .012   .012   .012
  18          01  .012   .012   .012   .012   .012   .012   .012   .012   .012   .012
  19          01  .012   .012   .012   .012   .012   .012   .012   .012   .012   .012
  20          01  .012   .012   .012   .012   .012   .012   .012   .012   .023   .023
  21          01  .023   .023   .023   .023   .023   .023   .023   .023   .023   .023
  22          01  .023   .023   .023   .023   .023   .023   .030   .030   .030   .030
  23          01  .030   .030   .049   .049   .049   .049   .049   .049   .134   .134
  24          01  .134   .255   .255   .565   .617   .780   .255   .134   .134   .134
  25          01  .049   .049   .049   .049   .049   .049   .030   .030   .030   .030
  26          01  .030   .030   .023   .023   .023   .023   .023   .023   .023   .023
  27          01  .023   .023   .023   .023   .023   .023   .023   .023   .023   .023
  28          01  .012   .012   .012   .012   .012   .012   .012   .012   .012   .012
  29          01  .012   .012   .012   .012   .012   .012   .012   .012   .012   .012
  30          01  .012   .012   .012   .012   .012   .012   .012   .012   .012   .012
  31          01  .012   .012   .012   .012   .012   .012   .007   .007   .007   .007
  32          01  .007   .007   .007   .007   .007   .007   .007   .007   .007   .007
  33          01  .007   .007   .007   .007   .007   .007   .007   .007   .007   .007
  34          01  .007   .007   .007   .007   .007   .007   .007   .007   .007   .007
  35          01  .007   .007   .007   .007   .007   .007   .007   .007   .007   .007
  36          01  .007   .007   .007   .007   .007   .007   .007   .007   .007   .007
  37          01  .007   .007   .007   .007   .007   .007   .007   .007   .007   .007
  38          01  .007   .007   .007   .007   .007   .007   .007   .007
  39          T                                                 -1    -77
  40          W7            1.47
  41          X                           1
  42          K      1      2                                         1
  43          K1   ROUTING THROUGH UPPER KEHR'S MILL TRAIL LAKE DAM
  44          Y                                     1
  45          Y1     1                                         -526.8     -1
  46          Y4 524.5  526.2  527.0  527.3  527.8  528.8  529.8  530.8  532.8  534.8
  47          Y4 537.8
  48          Y5    0.    22.    36.    52.    70.    86.   110.   120.   144.   166.
  49          Y5  184.
  50          $$    0.    4.2    4.9   12.4   20.5   32.4
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 51             SE 4[illegible].   510.   514.9   520.   5[illegible].   560.
 52             SS 524.9
 53             SD 52[illegible]
 54             SL    0.    73.     95.    207.    275.    328.    390.    417.    535.
 55             SV 52[illegible]  529.0   530.0   530.1   530.3   531.0   531.9   532.5   535.2
 56             K    99
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FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  01 APR 80
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MISSOURI DAM INSPECTION PROGRAM
ST LOUIS DISTRICT US ARMY CORPS OF ENGINEERS
UPPER AND LOWER KEHR'S MILL TRAIL LAKE DAMS

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
288	0	5	0	0	0	0	0	0	0

JOPER	NWT	LROPT	TRACE
3	0	0	0

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

SUB-AREA RUNOFF COMPUTATION

UPPER KEHR'S MILL TRAIL LAKE DAM (24 HR. 100-YEAR INFLOW)

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	3	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
0	2	.62	.00	.62	1.00	.000	0	0	0

PRECIP DATA

NP	STORM	DAJ	DAK
288	6.97	.00	.00

PRECIP PATTERN

.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.02	.02
.02	.02	.02	.02	.02	.02	.02	.02	.02	.02
.02	.02	.02	.02	.02	.02	.03	.03	.03	.03
.03	.03	.05	.05	.05	.05	.05	.05	.13	.13
.13	.25	.25	.55	.52	[illegible]	.25	.13	.13	.13
.05	.05	.05	.05	.05	.05	.03	.03	.03	.03
.03	.03	.02	.02	.02	.02	.02	.02	.02	.02
.02	.02	.02	.02	.02	.02	.02	.02	.02	.02
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01

.01 .01 .01 .01 .01 .01 .01 .01 .01 .01

.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01		

LOSS DATA

LRUPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	.00	.00	1.00	.00	.00	1.00	-1.00	-72.00	.00	.00

CURVE NO = -72.00   WETNESS = -1.00   EFFECT CN = 72.00

UNIT HYDROGRAPH DATA
TC= .00   LAG= 1.47

RECESSION DATA
STRTQ= .00   QRCSN= .00   RTIOR= 1.00

UNIT HYDROGRAPH 90 END OF PERIOD ORDINATES, TC= .00 HOURS, LAG= 1.47 VOL= 1.00

4.	[illegible]	19.	30.	43.	59.	78.	96.	119.	145.
171.	194.	214.	232.	247.	257.	254.	255.	254.	253.
[illegible]	[illegible]	228.	215.	204.	191.	177.	160.	144.	129.
118.	[illegible]	97.	69.	81.	74.	68.	67.	58.	[illegible]
49.	[illegible]	40.	36.	33.	31.	28.	26.	23.	21.
19.	1[illegible].	16.	15.	13.	12.	11.	10.	9.	9.
8.	7.	7.	6.	6.	5.	5.	4.	4.	4.
3.	3.	3.	3.	2.	2.	2.	2.	2.	2.
1.	1.	1.	1.	1.	1.	1.	0.	0.	0.

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.05	1	.01	.00	.01	0.	1.01	12.05	145	.82	.55	.27	61.
1.01	.10	2	.01	.00	.01	0.	1.01	12.10	146	.38	.28	.11	76.
1.01	.15	3	.01	.00	.01	0.	1.01	12.15	147	.26	.19	.05	96.
1.01	.20	4	.01	.00	.01	0.	1.01	12.20	148	.13	.10	.03	119.
1.01	.25	5	.01	.00	.01	0.	1.01	12.25	149	.13	.10	.03	147.
1.01	.30	6	.01	.00	.01	0.	1.01	12.30	150	.13	.10	.03	176.
1.01	.35	7	.01	.00	.01	0.	1.01	12.35	151	.05	.04	.01	214.
1.01	.40	8	.01	.00	.01	0.	1.01	12.40	152	.05	.04	.01	254.
1.01	.45	9	.01	.00	.01	0.	1.01	12.45	153	.05	.04	.01	297.
1.01	.50	10	.01	.00	.01	0.	1.01	12.50	154	.05	.04	.01	343.
1.01	.55	11	.01	.00	.01	0.	1.01	12.55	155	.05	.04	.01	388.
1.01	1.00	12	.01	.00	.01	0.	1.01	13.00	156	.05	.04	.01	430.
1.01	1.05	13	.01	.00	.01	0.	1.01	13.05	157	.03	.02	.01	469.
1.01	1.10	14	.01	.00	.01	0.	1.01	13.10	158	.03	.02	.01	502.
1.01	1.15	15	.01	.00	.01	0.	1.01	13.15	159	.03	.02	.01	530.
1.01	1.20	16	.01	.00	.01	0.	1.01	13.20	160	.03	.02	.01	551.
1.01	1.25	17	.01	.00	.01	0.	1.01	13.25	161	.03	.02	.01	566.
1.01	1.30	18	.01	.00	.01	0.	1.01	13.30	162	.03	.02	.01	575.
1.01	1.35	19	.01	.00	.01	0.	1.01	13.35	163	.02	.02	.00	580.
1.01	1.40	20	.01	.00	.01	0.	1.01	13.40	164	.02	.02	.00	580.
1.01	1.45	21	.01	.00	.01	0.	1.01	13.45	165	.02	.02	.00	574.
1.01	1.50	22	.01	.00	.01	0.	1.01	13.50	166	.02	.02	.00	564.

1.01	1.55	23	.01	.00	.01	0.	1.01	13.55	167	.02	.02	.00	550.
1.01	2.00	24	.01	.00	.01	0.	1.01	14.00	168	.02	.02	.00	534.
1.01	2.05	25	.01	.00	.01	0.	1.01	14.05	169	.02	.02	.00	516.
1.01	2.10	26	.01	.00	.01	0.	1.01	14.10	170	.02	.02	.00	494.
1.01	2.15	27	.01	.00	.01	0.	1.01	14.15	171	.02	.02	.00	471.
1.01	2.20	28	.01	.00	.01	0.	1.01	14.20	172	.02	.02	.00	445.
1.01	2.25	29	.01	.00	.01	0.	1.01	14.25	173	.02	.02	.00	419.
1.01	2.30	30	.01	.00	.01	0.	1.01	14.30	174	.02	.02	.00	394.
1.01	2.35	31	.01	.00	.01	0.	1.01	14.35	175	.02	.02	.00	371.
1.01	2.40	32	.01	.00	.01	0.	1.01	14.40	176	.02	.02	.00	350.
1.01	2.45	33	.01	.00	.01	0.	1.01	14.45	177	.02	.02	.00	330.
1.01	2.50	34	.01	.00	.01	0.	1.01	14.50	178	.02	.02	.00	312.
1.01	2.55	35	.01	.00	.01	0.	1.01	14.55	179	.02	.02	.00	295.
1.01	3.00	36	.01	.00	.01	0.	1.01	15.00	180	.02	.02	.00	281.
1.01	3.05	37	.01	.00	.01	0.	1.01	15.05	181	.01	.01	.00	268.
1.01	3.10	38	.01	.00	.01	0.	1.01	15.10	182	.01	.01	.00	255.
1.01	3.15	39	.01	.00	.01	0.	1.01	15.15	183	.01	.01	.00	244.
1.01	3.20	40	.01	.00	.01	0.	1.01	15.20	184	.01	.01	.00	233.
1.01	3.25	41	.01	.00	.01	0.	1.01	15.25	185	.01	.01	.00	222.
1.01	3.30	42	.01	.00	.01	0.	1.01	15.30	186	.01	.01	.00	213.
1.01	3.35	43	.01	.00	.01	0.	1.01	15.35	187	.01	.01	.00	203.
1.01	3.40	44	.01	.00	.01	0.	1.01	15.40	188	.01	.01	.00	195.
1.01	3.45	45	.01	.00	.01	0.	1.01	15.45	189	.01	.01	.00	187.
1.01	3.50	46	.01	.00	.01	0.	1.01	15.50	190	.01	.01	.00	179.
1.01	3.55	47	.01	.00	.01	0.	1.01	15.55	191	.01	.01	.00	172.
1.01	4.00	48	.01	.00	.01	0.	1.01	16.00	192	.01	.01	.00	165.
1.01	4.05	49	.01	.00	.01	0.	1.01	16.05	193	.01	.01	.00	156.
1.01	4.10	50	.01	.00	.01	0.	1.01	16.10	194	.01	.01	.00	151.
1.01	4.15	51	.01	.00	.01	0.	1.01	16.15	195	.01	.01	.00	145.
1.01	4.20	52	.01	.00	.01	0.	1.01	16.20	196	.01	.01	.00	139.
1.01	4.25	53	.01	.00	.01	0.	1.01	16.25	197	.01	.01	.00	133.
1.01	4.30	54	.01	.00	.01	0.	1.01	16.30	198	.01	.01	.00	128.
1.01	4.35	55	.01	.00	.01	0.	1.01	16.35	199	.01	.01	.00	123.
1.01	4.40	56	.01	.00	.01	0.	1.01	16.40	200	.01	.01	.00	118.
1.01	4.45	57	.01	.00	.01	0.	1.01	16.45	201	.01	.01	.00	114.
1.01	4.50	58	.01	.00	.01	0.	1.01	16.50	202	.01	.01	.00	109.
1.01	4.55	59	.01	.00	.01	0.	1.01	16.55	203	.01	.01	.00	105.
1.01	5.00	60	.01	.00	.01	0.	1.01	17.00	204	.01	.01	.00	102.
1.01	5.05	61	.01	.00	.01	0.	1.01	17.05	205	.01	.01	.00	98.
1.01	5.10	62	.01	.00	.01	0.	1.01	17.10	206	.01	.01	.00	95.
1.01	5.15	63	.01	.00	.01	0.	1.01	17.15	207	.01	.01	.00	92.
1.01	5.20	64	.01	.00	.01	0.	1.01	17.20	208	.01	.01	.00	89.
1.01	5.25	65	.01	.00	.01	0.	1.01	17.25	209	.01	.01	.00	87.
1.01	5.30	66	.01	.00	.01	0.	1.01	17.30	210	.01	.01	.00	85.
1.01	5.35	67	.01	.00	.01	0.	1.01	17.35	211	.01	.01	.00	83.
1.01	5.40	68	.01	.00	.01	0.	1.01	17.40	212	.01	.01	.00	81.
1.01	5.45	69	.01	.00	.01	0.	1.01	17.45	213	.01	.01	.00	79.
1.01	5.50	70	.01	.00	.01	0.	1.01	17.50	214	.01	.01	.00	78.
1.01	5.55	71	.01	.00	.01	0.	1.01	17.55	215	.01	.01	.00	77.
1.01	6.00	72	.01	.00	.01	0.	1.01	18.00	216	.01	.01	.00	75.
1.01	6.05	73	.01	.00	.01	0.	1.01	18.05	217	.01	.01	.00	74.
1.01	6.10	74	.01	.00	.01	0.	1.01	18.10	218	.01	.01	.00	73.
1.01	6.15	75	.01	.00	.01	0.	1.01	18.15	219	.01	.01	.00	72.
1.01	6.20	76	.01	.00	.01	0.	1.01	18.20	220	.01	.01	.00	71.
1.01	6.25	77	.01	.00	.01	0.	1.01	18.25	221	.01	.01	.00	70.
1.01	6.30	78	.01	.00	.01	0.	1.01	18.30	222	.01	.01	.00	69.

[illegible]	[illegible]	[illegible]	.01	.00	.01	0.	1.01	18.35	[illegible]	.01	.01	.00	69.

B L A C K & V E A T C H — PROJECT 9166: — DATE 16 JAN [illegible] — PAGE 8

FLOOD HYDROGRAPH PACKAGE - HEC-1 — PROGRAM H21/22-1V — TIME 1?:02:51 — CASE 100

1.01	6.35	79	.01	.00	.01	0.	1.01	18.35	223	.01	.01	.00	75.
1.01	6.40	80	.01	.00	.01	0.	1.01	18.40	224	.01	.01	.00	[illegible]
1.01	6.45	81	.01	.00	.01	0.	1.01	18.45	225	.01	.01	.00	[illegible]
1.01	6.50	82	.01	.00	.01	0.	1.01	18.50	226	.01	.01	.00	[illegible]
1.01	6.55	83	.01	.00	.01	0.	1.01	18.55	227	.01	.01	.00	64.
1.01	7.00	84	.01	.00	.01	0.	1.01	19.00	228	.01	.01	.00	62.
1.01	7.05	85	.01	.00	.01	0.	1.01	19.05	229	.01	.01	.00	61.
1.01	7.10	86	.01	.00	.01	0.	1.01	19.10	230	.01	.01	.00	60.
1.01	7.15	87	.01	.00	.01	0.	1.01	19.15	231	.01	.01	.00	58.
1.01	7.20	88	.01	.00	.01	0.	1.01	19.20	232	.01	.01	.00	57.
1.01	7.25	89	.01	.00	.01	0.	1.01	19.25	233	.01	.01	.00	55.
1.01	7.30	90	.01	.00	.01	0.	1.01	19.30	234	.01	.01	.00	54.
1.01	7.35	91	.01	.00	.01	0.	1.01	19.35	235	.01	.01	.00	53.
1.01	7.40	92	.01	.00	.01	0.	1.01	19.40	236	.01	.01	.00	51.
1.01	7.45	93	.01	.00	.01	0.	1.01	19.45	237	.01	.01	.00	50.
1.01	7.50	94	.01	.00	.01	0.	1.01	19.50	238	.01	.01	.00	49.
1.01	7.55	95	.01	.00	.01	0.	1.01	19.55	239	.01	.01	.00	48.
1.01	8.00	96	.01	.00	.01	0.	1.01	20.00	240	.01	.01	.00	47.
1.01	8.05	97	.01	.00	.01	0.	1.01	20.05	241	.01	.01	.00	46.
1.01	8.10	98	.01	.00	.01	0.	1.01	20.10	242	.01	.01	.00	45.
1.01	8.15	99	.01	.00	.01	0.	1.01	20.15	243	.01	.01	.00	44.
1.01	8.20	100	.01	.00	.01	0.	1.01	20.20	244	.01	.01	.00	44.
1.01	8.25	101	.01	.00	.01	0.	1.01	20.25	245	.01	.01	.00	43.
1.01	8.30	102	.01	.00	.01	0.	1.01	20.30	246	.01	.01	.00	42.
1.01	8.35	103	.01	.00	.01	0.	1.01	20.35	247	.01	.01	.00	42.
1.01	8.40	104	.01	.00	.01	0.	1.01	20.40	248	.01	.01	.00	41.
1.01	8.45	105	.01	.00	.01	0.	1.01	20.45	249	.01	.01	.00	41.
1.01	8.50	106	.01	.00	.01	0.	1.01	20.50	250	.01	.01	.00	41.
1.01	8.55	107	.01	.00	.01	0.	1.01	20.55	251	.01	.01	.00	40.
1.01	9.00	108	.01	.00	.01	0.	1.01	21.00	252	.01	.01	.00	40.
1.01	9.05	109	.02	.00	.02	0.	1.01	21.05	253	.01	.01	.00	40.
1.01	9.10	110	.02	.00	.02	1.	1.01	21.10	254	.01	.01	.00	39.
1.01	9.15	111	.02	.00	.02	1.	1.01	21.15	255	.01	.01	.00	39.
1.01	9.20	112	.02	.00	.02	1.	1.01	21.20	256	.01	.01	.00	39.
1.01	9.25	113	.02	.00	.02	1.	1.01	21.25	257	.01	.01	.00	39.
1.01	9.30	114	.02	.00	.02	1.	1.01	21.30	258	.01	.01	.00	[illegible]
1.01	9.35	115	.02	.00	.02	2.	1.01	21.35	259	.01	.01	.00	[illegible]
1.01	9.40	116	.02	.00	.02	2.	1.01	21.40	260	.01	.01	.00	38.
1.01	9.45	117	.02	.00	.02	2.	1.01	21.45	261	.01	.01	.00	[illegible]
1.01	9.50	118	.02	.00	.02	3.	1.01	21.50	262	.01	.01	.00	38.
1.01	9.55	119	.02	.00	.02	3.	1.01	21.55	263	.01	.01	.00	38.
1.01	10.00	120	.02	.00	.02	4.	1.01	22.00	264	.01	.01	.00	38.
1.01	10.05	121	.02	.00	.02	5.	1.01	22.05	265	.01	.01	.00	[illegible]
1.01	10.10	122	.02	.00	.02	5.	1.01	22.10	266	.01	.01	.00	[illegible]
1.01	10.15	123	.02	.00	.02	6.	1.01	22.15	267	.01	.01	.00	37.
1.01	10.20	124	.02	.01	.02	7.	1.01	22.20	268	.01	.01	.00	37.
1.01	10.25	125	.02	.01	.02	8.	1.01	22.25	269	.01	.01	.00	37.
1.01	10.30	126	.02	.01	.02	9.	1.01	22.30	270	.01	.01	.00	37.
1.01	10.35	127	.02	.01	.02	10.	1.01	22.35	271	.01	.01	.00	37.
1.01	10.40	128	.02	.01	.02	11.	1.01	22.40	272	.01	.01	.00	37.
1.01	10.45	129	.03	.01	.02	12.	1.01	22.45	273	.01	.01	.00	37.
1.01	10.50	130	.03	.01	.02	13.	1.01	22.50	274	.01	.01	.00	37.
1.01	10.55	131	.03	.01	.02	14.	1.01	22.55	275	.01	.01	.00	37.
1.01	11.00	132	.03	.01	.02	15.	1.01	23.00	276	.01	.01	.00	37.
1.01	11.05	133	.03	.01	.03	17.	1.01	23.05	277	.01	.01	.00	37.
1.01	11.10	134	.03	.02	.03	[illegible]	1.01	23.10	278	.01	.01	.00	37.

1.01	11.15	135	.05	.02	.03	19.	1.01	23.15	279	.01	.01	.00	37.
1.01	11.20	136	.05	.02	.03	21.	1.01	23.20	280	.01	.01	.00	37.
1.01	11.25	137	.05	.02	.03	23.	1.01	23.25	281	.01	.01	.00	37.
1.01	11.30	138	.05	.02	.03	25.	1.01	23.30	282	.01	.01	.00	37.
1.01	11.35	139	.11	.05	.06	27.	1.01	23.35	283	.01	.01	.00	37.
1.01	11.40	140	.13	.06	.08	30.	1.01	23.40	284	.01	.01	.00	37.
1.01	11.45	141	.13	.06	.07	33.	1.01	23.45	285	.01	.01	.00	37.
1.01	11.50	142	.26	.13	.13	37.	1.01	23.50	286	.01	.01	.00	37.
1.01	11.55	143	.26	.14	.12	42.	1.01	23.55	287	.01	.01	.00	37.
1.01	12.00	144	.55	.33	.22	50.	1.02	.00	288	.01	.01	.00	37.

SUM 6.97 3.81 3.17 22740.
(177.)(97.)(80.)(643.93)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	590.	265.	79.	79.	22726.
CMS	16.	7.	2.	2.	644.
INCHES		3.06	3.67	3.67	3.67
MM		77.77	93.22	93.22	93.22
AC-FT		131.	157.	157.	157.
THOUS CU M		161.	193.	193.	193.

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HYDROGRAPH ROUTING

ROUTING THROUGH UPPER KEMP'S MILL TRAIL LAKE DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP		LSTR
.0	.000	.00	1	0	0	0		0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	.000	.000	.000	-525.	-1

STAGE	524.80	526.30	526.80	527.30	527.80	528.80	529.80	530.80	532.80	534.80
	536.80									
FLOW	.00	20.00	36.00	52.00	70.00	84.00	110.00	120.00	144.00	164.00
	164.00									

SURFACE AREA=	0.	4.	7.	13.	21.	32.
CAPACITY=	0.	15.	42.	91.	256.	518.
ELEVATION=	492.	510.	515.	520.	530.	540.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
524.8	.0	.0	.0	.0	.0	.0	.0

DAM DATA

B L A C K & V E A T C H　　　PROJECT 9166?　　DATE 16 JAN ?　　PAGE 10

FLOOD HYDROGRAPH PACKAGE - HEC-1　　PROGRAM #2?/02-1V　TIME 1?:02:51　CASE 100

DAM DATA

TOPEL	COQD	EXPD	DAMWID
529.5	.0	.0	0.

CREST LENGTH AT OR BELOW	0.	33.	95.	207.	275.	328.	383.	417.	535.
ELEVATION	529.5	529.9	530.0	530.1	530.3	531.0	531.9	532.5	535.2

END-OF-PERIOD HYDROGRAPH ORDINATES

MO.DA	HR.MN	PERIOD	HOURS	INFLOW	OUTFLOW	STORAGE	STAGE
1.01	.05	1	.08	0.	0.	160.	524.8
1.01	.10	2	.17	0.	0.	160.	524.8
1.01	.15	3	.25	0.	0.	160.	524.8
1.01	.20	4	.33	0.	0.	160.	524.8
1.01	.25	5	.42	0.	0.	160.	524.8
1.01	.30	6	.50	0.	0.	160.	524.8
1.01	.35	7	.58	0.	0.	160.	524.8
1.01	.40	8	.67	0.	0.	160.	524.8
1.01	.45	9	.75	0.	0.	160.	524.8
1.01	.50	10	.83	0.	0.	160.	524.8
1.01	.55	11	.92	0.	0.	160.	524.8
1.01	1.00	12	1.00	0.	0.	160.	524.8
1.01	1.05	13	1.08	0.	0.	160.	524.8
1.01	1.10	14	1.17	0.	0.	160.	524.8
1.01	1.15	15	1.25	0.	0.	160.	524.8
1.01	1.20	16	1.33	0.	0.	160.	524.8
1.01	1.25	17	1.42	0.	0.	160.	524.8
1.01	1.30	18	1.50	0.	0.	160.	524.8
1.01	1.35	19	1.58	0.	0.	160.	524.8
1.01	1.40	20	1.67	0.	0.	160.	524.8
1.01	1.45	21	1.75	0.	0.	160.	524.8
1.01	1.50	22	1.83	0.	0.	160.	524.8
1.01	1.55	23	1.92	0.	0.	160.	524.8
1.01	2.00	24	2.00	0.	0.	160.	524.8
1.01	2.05	25	2.08	0.	0.	160.	524.8
1.01	2.10	26	2.17	0.	0.	160.	524.8
1.01	2.15	27	2.25	0.	0.	160.	524.8
1.01	2.20	28	2.33	0.	0.	160.	524.8
1.01	2.25	29	2.42	0.	0.	160.	524.8
1.01	2.30	30	2.50	0.	0.	160.	524.8
1.01	2.35	31	2.58	0.	0.	160.	524.8
1.01	2.40	32	2.67	0.	0.	160.	524.8
1.01	2.45	33	2.75	0.	0.	160.	524.8
1.01	2.50	34	2.83	0.	0.	160.	524.8
1.01	2.55	35	2.92	0.	0.	160.	524.8
1.01	3.00	36	3.00	0.	0.	160.	524.8
1.01	3.05	37	3.08	0.	0.	160.	524.8
1.01	3.10	38	3.17	0.	0.	160.	524.8
1.01	3.15	39	3.25	0.	0.	160.	524.8
1.01	3.20	40	3.33	0.	0.	160.	524.8
1.01	3.25	41	3.42	0.	0.	160.	524.8
1.01	3.30	42	3.50	0.	0.	160.	524.8
1.01	3.35	43	3.58	0.	0.	160.	524.8
1.01	3.40	44	3.67	0.	0.	160.	524.8
1.01	3.45	45	3.75	0.	0.	160.	524.8

1.01	22.30	270	22.50	37.	89.	234.	528.9
1.01	22.35	271	22.58	37.	89.	234.	528.9
1.01	22.40	272	22.67	37.	88.	233.	528.9
1.01	22.45	273	22.75	37.	88.	233.	528.9
1.01	22.50	274	22.83	37.	87.	233.	528.9
1.01	22.55	275	22.92	37.	87.	232.	528.8
1.01	23.00	276	23.00	37.	86.	232.	528.8
1.01	23.05	277	23.08	37.	86.	232.	528.8
1.01	23.10	278	23.17	37.	86.	231.	528.8
1.01	23.15	279	23.25	37.	85.	231.	528.8
1.01	23.20	280	23.33	37.	85.	231.	528.7
1.01	23.25	281	23.42	37.	85.	230.	528.7
1.01	23.30	282	23.50	37.	85.	230.	528.7
1.01	23.35	283	23.58	37.	84.	230.	528.7
1.01	23.40	284	23.67	37.	84.	229.	528.7
1.01	23.45	285	23.75	37.	84.	229.	528.7
1.01	23.50	286	23.83	37.	84.	229.	528.6
1.01	23.55	287	23.92	37.	83.	228.	528.6
1.02	.00	288	24.00	37.	83.	229.	528.6

PEAK OUTFLOW IS 121. AT TIME 16.50 HOURS

	PEAK	5-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	121.	110.	45.	45.	12863.
CMS	3.	3.	1.	1.	365.
INCHES		1.28	2.08	2.08	2.08
MM		32.48	52.85	52.85	52.85
AC-FT		55.	89.	89.	89.
THOUS CU M		67.	109.	109.	109.

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RUNOFF SUMMARY, AVERAGE FLOW IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES(SQUARE KILOMETERS)

		PEAK	5-HOUR	24-HOUR	72-HOUR	AREA
HYDROGRAPH AT	1	580.	263.	79.	79.	.80
	(	16.43)(	7.45)(	2.23)(	2.23)(	2.07)
ROUTED TO	2	121.	110.	45.	45.	.80
	(	3.42)(	3.11)(	1.27)(	1.27)(	2.07)

SUMMARY OF DAM SAFETY ANALYSIS

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	524.80	524.80	529.80
STORAGE	160.	160.	2[illegible]2.
OUTFLOW	0.	0.	110.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	530.01	.21	256.	121.	2.92	16.58	.00

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**************************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION       JULY 1978
  LAST MODIFICATION  01 APR 80
**************************************
     1        A1MISSOURI DAM INSPECTION PROGRAM
     2        A2ST LOUIS DISTRICT US ARMY CORPS OF ENGINEERS
     3        A3UPPER AND LOWER KEHR'S MILL TRAIL LAKE DAMS
     4        B    300     0      0      0      0      0      0      0      0      0
     5        B1     5
     6        K      0      1                           3      1
     7        K1   UPPER KEHR'S MILL TRAIL LAKE DAM (24 HR. 10-YEAR INFLOW)
     8        M      0      2    .80                          1
     9        O   .005  4.935                DA #   .59
    10        01  .005   .005   .005   .005   .005   .005   .005   .005   .005   .005
    11        01  .005   .005   .005   .005   .005   .005   .005   .005   .005   .005
    12        01  .005   .005   .005   .005   .005   .005   .005   .005   .005   .005
    13        01  .005   .005   .005   .005   .005   .005   .005   .005   .005   .005
    14        01  .005   .005   .005   .005   .005   .005   .005   .005   .005   .005
    15        01  .005   .005   .005   .005   .005   .005   .005   .005   .005   .005
    16        01  .005   .005   .005   .005   .005   .005   .005   .005   .005   .005
    17        01  .005   .005   .009   .009   .009   .009   .009   .009   .009   .009
    18        01  .009   .009   .009   .009   .009   .009   .009   .009   .009   .009
    19        01  .009   .009   .009   .009   .009   .009   .009   .009   .009   .009
    20        01  .009   .009   .009   .009   .009   .009   .009   .009   .015   .015
    21        01  .015   .015   .015   .015   .015   .015   .015   .015   .015   .015
    22        01  .015   .015   .015   .015   .015   .015   .028   .028   .028   .028
    23        01  .028   .028   .041   .041   .041   .041   .041   .041   .086   .086
    24        01  .087   .165   .165   .374   .687   .260   .165   .087   .086   .086
    25        01  .041   .041   .041   .041   .041   .041   .028   .028   .028   .028
    26        01  .028   .028   .015   .015   .015   .015   .015   .015   .015   .015
    27        01  .015   .015   .015   .015   .015   .015   .015   .015   .015   .015
    28        01  .009   .009   .009   .009   .009   .009   .009   .009   .009   .009
    29        01  .009   .009   .009   .009   .009   .009   .009   .009   .009   .009
    30        01  .009   .009   .009   .009   .009   .009   .009   .009   .009   .009
    31        01  .009   .009   .009   .009   .009   .009   .005   .005   .005   .005
    32        01  .005   .005   .005   .005   .005   .005   .005   .005   .005   .005
    33        01  .005   .005   .005   .005   .005   .005   .005   .005   .005   .005
    34        01  .005   .005   .005   .005   .005   .005   .005   .005   .005   .005
    35        01  .005   .005   .005   .005   .005   .005   .005   .005   .005   .005
    36        01  .005   .005   .005   .005   .005   .005   .005   .005   .005   .005
    37        01  .005   .005   .005   .005   .005   .005   .005   .005   .005   .005
    38        01  .005   .005   .005   .005   .005   .005   .005   .005
    39        T                                          -1    -72
    40        W2           1.47
    41        K                   1
    42        K      1      2                            1
    43        K1   ROUTING THROUGH UPPER KEHR'S MILL TRAIL LAKE DAM
    44        Y                          1
    45        Y1     1                                 -524.8     -1
    46        Y4 524.0  524.3  525.8  527.3  527.3  528.9  529.8  530.8  532.8  534.8
    47        Y4 536.8
    48        Y5    0.    22.    76.    82.    76.    86.   110.   120.   144.   164.
    49        Y5  184.
    50        SA    0.    4.2    8.9   12.4   20.8   32.4
```

51	SE	[illegible]	510.	514.9	520.	530.	540.			
52	SS	526.8								
53	SD	[illegible]								
54	SL	[illegible]	73.	95.	207.	275.	328.	390.	417.	535.
55	SV	[illegible]	529.9	530.0	530.1	530.5	531.0	531.9	532.5	535.2
56	K	99								

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B L    K R V E A T C H                                              PROJECT 9166:      DATE 16 JAN       PAGE    5
=====================================================================================================================
FLOOD HYDROGRAPH PACKAGE - HEC-1                                    PROGRAM H21/02-1V  TIME  18:02:51   CASE  10

************************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  01 APR 80
************************************
                         MISSOURI DAM INSPECTION PROGRAM
                         ST LOUIS DISTRICT US ARMY CORPS OF ENGINEERS
                         UPPER AND LOWER KEHR'S MILL TRAIL LAKE DAMS

                                           JOB SPECIFICATION
              NQ     NHR    NMIN    IDAY     IHR    IMIN   METRC    IPLT    IPRT   NSTAN
             288       T       5       0       0       0       0       0       0       0
                                   JOPER     NWT   LROPT   TRACE
                                       3       0       0       0

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

                                      SUB-AREA RUNOFF COMPUTATION

               UPPER KEHR'S MILL TRAIL LAKE DAM (24 HR, 10-YEAR INFLOW)

                        ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                            1       0       0       0       0       3       1       0       0

                                          HYDROGRAPH DATA
              IHYDG    IUHG   TAREA    SNAP   TRSDA   TRSPC   RATIO   ISNOW   ISAME   LOCAL
                  2       2     .89     .00     .89    1.00    .000       0       0       0

                                            PRECIP DATA
                                   NP   STORM     DAJ     DAK
                                  288    4.51     .00     .00
                                           PRECIP PATTERN
          .01     .01     .01     .01     .01     .01     .01     .01     .01     .01
          .01     .01     .01     .01     .01     .01     .01     .01     .01     .01
          .01     .01     .01     .01     .01     .01     .01     .01     .01     .01
          .01     .01     .01     .01     .01     .01     .01     .01     .01     .01
          .01     .01     .01     .01     .01     .01     .01     .01     .01     .01
          .01     .01     .01     .01     .01     .01     .01     .01     .01     .01
          .01     .01     .01     .01     .01     .01     .01     .01     .01     .01
          .01     .01     .01     .01     .01     .01     .01     .01     .01     .01
          .01     .01     .01     .01     .01     .01     .01     .01     .01     .01
          .01     .01     .01     .01     .01     .01     .01     .01     .01     .01
          .01     .01     .01     .01     .01     .01     .01     .01     .02     .02
          .02     .02     .02     .02     .02     .02     .02     .02     .02     .02
          .02     .02     .02     .02     .02     .02     .03     .03     .03     .03
          .03     .03     .04     .04     .04     .04     .04     .04     .09     .09
          .09     .16     .16     .77     .59     .26     .16     .09     .09     .09
          .04     .04     .04     .04     .04     .04     .03     .03     .03     .03
          .03     .02     .02     .02     .02     .02     .02     .02     .02     .02
          .02     .02     .02     .02     .02     .02     .02     .02     .02     .02
          .01     .01     .01     .01     .01     .01     .01     .01     .01     .01
          .01     .01     .01     .01     .01     .01     .01     .01     .01     .01
          .01     .01     .01     .01     .01     .01     .01     .01     .01     .01
          .01     .01     .01     .01     .01     .01     .01     .01     .01     .01

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FLOOD HYDROGRAPH PACKAGE - HEC-1                                    PROGRAM H21/02-1V  TIME  18:02:51   CASE  10
          .01             .01     .01     .01     .01     .01     .01     .01     .01
```

.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01		

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	.00	.00	1.00	.00	.00	1.00	-1.00	-72.00	.00	.00

CURVE NO = -72.00 WETNESS = -1.00 EFFECT CN = 72.00

UNIT HYDROGRAPH DATA
TC= .00 LAG= 1.47

RECESSION DATA
STRTQ= .00 QRCSN= .00 RTIOR= 1.00

UNIT HYDROGRAPH 50 END OF PERIOD ORDINATES, TC= .00 HOURS, LAG= 1.47 VOL= 1.00

4.	[illegible]	19.	33.	43.	58.	75.	96.	119.	145.
171.	[illegible]	214.	233.	242.	255.	254.	255.	254.	257.
244.	[illegible]	225.	215.	204.	191.	177.	160.	144.	129.
114.	[illegible]	97.	89.	81.	74.	68.	63.	58.	53.
48.	44.	42.	36.	33.	31.	28.	26.	23.	21.
19.	[illegible]	16.	15.	13.	12.	11.	10.	9.	9.
8.	[illegible]	7.	6.	6.	5.	5.	4.	4.	4.
3.	[illegible]	3.	3.	2.	2.	2.	2.	2.	2.
1.	1.	1.	1.	1.	1.	1.	0.	0.	0.

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.05	1	.00	.00	.00	0.	1.01	12.05	145	.58	.31	.27	23.
1.01	.10	2	.00	.00	.00	0.	1.01	12.10	146	.26	.15	.10	31.
1.01	.15	3	.00	.00	.00	0.	1.01	12.15	147	.16	.10	.06	41.
1.01	.20	4	.00	.00	.00	0.	1.01	12.20	148	.09	.05	.03	53.
1.01	.25	5	.00	.00	.00	0.	1.01	12.25	149	.08	.05	.03	67.
1.01	.30	6	.00	.00	.00	0.	1.01	12.30	150	.08	.06	.02	84.
1.01	.35	7	.00	.00	.00	0.	1.01	12.35	151	.04	.03	.01	102.
1.01	.40	8	.00	.00	.00	0.	1.01	12.40	152	.04	.03	.01	123.
1.01	.45	9	.00	.00	.00	0.	1.01	12.45	153	.04	.03	.01	146.
1.01	.50	10	.00	.00	.00	0.	1.01	12.50	154	.04	.03	.01	170.
1.01	.55	11	.00	.00	.00	0.	1.01	12.55	155	.04	.03	.01	194.
1.01	1.00	12	.00	.00	.00	0.	1.01	13.00	156	.04	.03	.01	218.
1.01	1.05	13	.00	.00	.00	0.	1.01	13.05	157	.03	.02	.01	239.
1.01	1.10	14	.00	.00	.00	0.	1.01	13.10	158	.03	.02	.01	258.
1.01	1.15	15	.00	.00	.00	0.	1.01	13.15	159	.03	.02	.01	274.
1.01	1.20	16	.00	.00	.00	0.	1.01	13.20	160	.03	.02	.01	287.
1.01	1.25	17	.00	.00	.00	0.	1.01	13.25	161	.03	.02	.01	296.
1.01	1.30	18	.00	.00	.00	0.	1.01	13.30	162	.03	.02	.01	303.
1.01	1.35	19	.00	.00	.00	0.	1.01	13.35	163	.01	.01	.00	308.
1.01	1.40	20	.00	.00	.00	0.	1.01	13.40	164	.01	.01	.00	310.
1.01	1.45	21	.00	.00	.00	0.	1.01	13.45	165	.01	.01	.00	309.
1.01	1.50	22	.00	.00	.00	0.	1.01	13.50	166	.01	.01	.00	306.

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1.01	1.55	23	.00	.00	.00	0.	1.01	13.55	167	.01	.01	.00	300.
1.01	2.00	24	.00	.00	.00	0.	1.01	14.00	168	.01	.01	.00	294.
1.01	2.05	25	.00	.00	.00	0.	1.01	14.05	169	.01	.01	.00	286.
1.01	2.10	26	.00	.00	.00	0.	1.01	14.10	170	.01	.01	.00	276.
1.01	2.15	27	.00	.00	.00	0.	1.01	14.15	171	.01	.01	.00	265.
1.01	2.20	28	.00	.00	.00	0.	1.01	14.20	172	.01	.01	.00	252.
1.01	2.25	29	.00	.00	.00	0.	1.01	14.25	173	.01	.01	.00	239.
1.01	2.30	30	.00	.00	.00	0.	1.01	14.30	174	.01	.01	.00	226.
1.01	2.35	31	.00	.00	.00	0.	1.01	14.35	175	.01	.01	.00	214.
1.01	2.40	32	.00	.00	.00	0.	1.01	14.40	176	.01	.01	.00	203.
1.01	2.45	33	.00	.00	.00	0.	1.01	14.45	177	.01	.01	.00	193.
1.01	2.50	34	.00	.00	.00	0.	1.01	14.50	178	.01	.01	.00	183.
1.01	2.55	35	.00	.00	.00	0.	1.01	14.55	179	.01	.01	.00	174.
1.01	3.00	36	.00	.00	.00	0.	1.01	15.00	180	.01	.01	.00	165.
1.01	3.05	37	.00	.00	.00	0.	1.01	15.05	181	.01	.01	.00	157.
1.01	3.10	38	.00	.00	.00	0.	1.01	15.10	182	.01	.01	.00	150.
1.01	3.15	39	.00	.00	.00	0.	1.01	15.15	183	.01	.01	.00	143.
1.01	3.20	40	.00	.00	.00	0.	1.01	15.20	184	.01	.01	.00	137.
1.01	3.25	41	.00	.00	.00	0.	1.01	15.25	185	.01	.01	.00	130.
1.01	3.30	42	.00	.00	.00	0.	1.01	15.30	186	.01	.01	.00	125.
1.01	3.35	43	.00	.00	.00	0.	1.01	15.35	187	.01	.01	.00	119.
1.01	3.40	44	.00	.00	.00	0.	1.01	15.40	188	.01	.01	.00	114.
1.01	3.45	45	.00	.00	.00	0.	1.01	15.45	189	.01	.01	.00	109.
1.01	3.50	46	.00	.00	.00	0.	1.01	15.50	190	.01	.01	.00	105.
1.01	3.55	47	.00	.00	.00	0.	1.01	15.55	191	.01	.01	.00	100.
1.01	4.00	48	.00	.00	.00	0.	1.01	16.00	192	.01	.01	.00	96.
1.01	4.05	49	.00	.00	.00	0.	1.01	16.05	193	.01	.01	.00	92.
1.01	4.10	50	.00	.00	.00	0.	1.01	16.10	194	.01	.01	.00	89.
1.01	4.15	51	.00	.00	.00	0.	1.01	16.15	195	.01	.01	.00	85.
1.01	4.20	52	.00	.00	.00	0.	1.01	16.20	196	.01	.01	.00	82.
1.01	4.25	53	.00	.00	.00	0.	1.01	16.25	197	.01	.01	.00	79.
1.01	4.30	54	.00	.00	.00	0.	1.01	16.30	198	.01	.01	.00	76.
1.01	4.35	55	.00	.00	.00	0.	1.01	16.35	199	.01	.01	.00	73.
1.01	4.40	56	.00	.00	.00	0.	1.01	16.40	200	.01	.01	.00	70.
1.01	4.45	57	.00	.00	.00	0.	1.01	16.45	201	.01	.01	.00	68.
1.01	4.50	58	.00	.00	.00	0.	1.01	16.50	202	.01	.01	.00	66.
1.01	4.55	59	.00	.00	.00	0.	1.01	16.55	203	.01	.01	.00	65.
1.01	5.00	60	.00	.00	.00	0.	1.01	17.00	204	.01	.01	.00	62.
1.01	5.05	61	.00	.00	.00	0.	1.01	17.05	205	.01	.01	.00	60.
1.01	5.10	62	.00	.00	.00	0.	1.01	17.10	206	.01	.01	.00	58.
1.01	5.15	63	.00	.00	.00	0.	1.01	17.15	207	.01	.01	.00	56.
1.01	5.20	64	.00	.00	.00	0.	1.01	17.20	208	.01	.01	.00	55.
1.01	5.25	65	.00	.00	.00	0.	1.01	17.25	209	.01	.01	.00	54.
1.01	5.30	66	.00	.00	.00	0.	1.01	17.30	210	.01	.01	.00	53.
1.01	5.35	67	.00	.00	.00	0.	1.01	17.35	211	.01	.01	.00	52.
1.01	5.40	68	.00	.00	.00	0.	1.01	17.40	212	.01	.01	.00	51.
1.01	5.45	69	.00	.00	.00	0.	1.01	17.45	213	.01	.01	.00	50.
1.01	5.50	70	.00	.00	.00	0.	1.01	17.50	214	.01	.01	.00	49.
1.01	5.55	71	.00	.00	.00	0.	1.01	17.55	215	.01	.01	.00	48.
1.01	6.00	72	.00	.00	.00	0.	1.01	18.00	216	.01	.01	.00	46.
1.01	6.05	73	.01	.00	.01	0.	1.01	18.05	217	.00	.00	.00	47.
1.01	6.10	74	.01	.00	.01	0.	1.01	18.10	218	.00	.00	.00	46.
1.01	6.15	75	.01	.00	.01	0.	1.01	18.15	219	.00	.00	.00	46.
1.01	6.20	76	.01	.00	.01	0.	1.01	18.20	220	.00	.00	.00	45.
1.01	6.25	77	.01	.00	.01	0.	1.01	18.25	221	.00	.00	.00	45.
1.01	6.30	78	.01	.00	.01	0.	1.01	18.30	222	.00	.00	.00	44.

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1.01	6.35	[illegible]	[illegible]	[illegible]	[illegible]	0.	1.01	18.35	223	.00	.00	.00	44.

1.01	6.35	79	.01	.00	.01	0.	1.01	18.35	223	.00	.00	.00	44.
1.01	6.40	80	.01	.00	.01	0.	1.01	18.40	224	.00	.00	.00	43.
1.01	6.45	81	.01	.00	.01	0.	1.01	18.45	225	.00	.00	.00	42.
1.01	6.50	82	.01	.00	.01	0.	1.01	18.50	226	.00	.00	.00	42.
1.01	6.55	83	.01	.00	.01	0.	1.01	18.55	227	.00	.00	.00	41.
1.01	7.00	84	.01	.00	.01	0.	1.01	19.00	228	.00	.00	.00	40.
1.01	7.05	85	.01	.00	.01	0.	1.01	19.05	229	.00	.00	.00	39.
1.01	7.10	86	.01	.00	.01	0.	1.01	19.10	230	.00	.00	.00	38.
1.01	7.15	87	.01	.00	.01	0.	1.01	19.15	231	.00	.00	.00	37.
1.01	7.20	88	.01	.00	.01	0.	1.01	19.20	232	.00	.00	.00	37.
1.01	7.25	89	.01	.00	.01	0.	1.01	19.25	233	.00	.00	.00	36.
1.01	7.30	90	.01	.00	.01	0.	1.01	19.30	234	.00	.00	.00	35.
1.01	7.35	91	.01	.00	.01	0.	1.01	19.35	235	.00	.00	.00	34.
1.01	7.40	92	.01	.00	.01	0.	1.01	19.40	236	.00	.00	.00	33.
1.01	7.45	93	.01	.00	.01	0.	1.01	19.45	237	.00	.00	.00	32.
1.01	7.50	94	.01	.00	.01	0.	1.01	19.50	238	.00	.00	.00	31.
1.01	7.55	95	.01	.00	.01	0.	1.01	19.55	239	.00	.00	.00	31.
1.01	8.00	96	.01	.00	.01	0.	1.01	20.00	240	.00	.00	.00	30.
1.01	8.05	97	.01	.00	.01	0.	1.01	20.05	241	.00	.00	.00	29.
1.01	8.10	98	.01	.00	.01	0.	1.01	20.10	242	.00	.00	.00	29.
1.01	8.15	99	.01	.00	.01	0.	1.01	20.15	243	.00	.00	.00	28.
1.01	8.20	100	.01	.00	.01	0.	1.01	20.20	244	.00	.00	.00	28.
1.01	8.25	101	.01	.00	.01	0.	1.01	20.25	245	.00	.00	.00	27.
1.01	8.30	102	.01	.00	.01	0.	1.01	20.30	246	.00	.00	.00	27.
1.01	8.35	103	.01	.00	.01	0.	1.01	20.35	247	.00	.00	.00	27.
1.01	8.40	104	.01	.00	.01	0.	1.01	20.40	248	.00	.00	.00	26.
1.01	8.45	105	.01	.00	.01	0.	1.01	20.45	249	.00	.00	.00	26.
1.01	8.50	106	.01	.00	.01	0.	1.01	20.50	250	.00	.00	.00	26.
1.01	8.55	107	.01	.00	.01	0.	1.01	20.55	251	.00	.00	.00	25.
1.01	9.00	108	.01	.00	.01	0.	1.01	21.00	252	.00	.00	.00	25.
1.01	9.05	109	.01	.00	.01	0.	1.01	21.05	253	.00	.00	.00	25.
1.01	9.10	110	.01	.00	.01	0.	1.01	21.10	254	.00	.00	.00	25.
1.01	9.15	111	.01	.00	.01	0.	1.01	21.15	255	.00	.00	.00	25.
1.01	9.20	112	.01	.00	.01	0.	1.01	21.20	256	.00	.00	.00	25.
1.01	9.25	113	.01	.00	.01	0.	1.01	21.25	257	.00	.00	.00	24.
1.01	9.30	114	.01	.00	.01	0.	1.01	21.30	258	.00	.00	.00	24.
1.01	9.35	115	.01	.00	.01	0.	1.01	21.35	259	.00	.00	.00	24.
1.01	9.40	116	.01	.00	.01	0.	1.01	21.40	260	.00	.00	.00	24.
1.01	9.45	117	.01	.00	.01	0.	1.01	21.45	261	.00	.00	.00	24.
1.01	9.50	118	.01	.00	.01	0.	1.01	21.50	262	.00	.00	.00	24.
1.01	9.55	119	.01	.00	.01	0.	1.01	21.55	263	.00	.00	.00	24.
1.01	10.00	120	.01	.00	.01	0.	1.01	22.00	264	.00	.00	.00	24.
1.01	10.05	121	.01	.00	.01	0.	1.01	22.05	265	.00	.00	.00	24.
1.01	10.10	122	.01	.00	.01	0.	1.01	22.10	266	.00	.00	.00	24.
1.01	10.15	123	.01	.00	.01	0.	1.01	22.15	267	.00	.00	.00	24.
1.01	10.20	124	.01	.00	.01	0.	1.01	22.20	268	.00	.00	.00	24.
1.01	10.25	125	.01	.00	.01	0.	1.01	22.25	269	.00	.00	.00	23.
1.01	10.30	126	.01	.00	.01	0.	1.01	22.30	270	.00	.00	.00	23.
1.01	10.35	127	.03	.00	.03	0.	1.01	22.35	271	.00	.00	.00	23.
1.01	10.40	128	.02	.00	.02	1.	1.01	22.40	272	.00	.00	.00	23.
1.01	10.45	129	.02	.00	.02	1.	1.01	22.45	273	.00	.00	.00	23.
1.01	10.50	130	.02	.00	.02	1.	1.01	22.50	274	.00	.00	.00	23.
1.01	10.55	131	.02	.00	.02	1.	1.01	22.55	275	.00	.00	.00	23.
1.01	11.00	132	.02	.00	.02	1.	1.01	23.00	276	.00	.00	.00	23.
1.01	11.05	133	.04	.01	.03	2.	1.01	23.05	277	.00	.00	.00	23.
1.01	11.10	134	.04	.01	.03	2.	1.01	23.10	278	.00	.00	.00	23.

1.01	11.15	135	.04	.01	.03	3.	1.01	23.15	279	.00	.00	.00	23.
1.01	11.20	136	.04	.01	.03	4.	1.01	23.20	280	.00	.00	.00	23.
1.01	11.25	137	.04	.01	.03	4.	1.01	23.25	281	.00	.00	.00	23.
1.01	11.30	138	.04	.01	.03	5.	1.01	23.30	282	.00	.00	.00	23.
1.01	11.35	139	.05	.02	.04	6.	1.01	23.35	283	.00	.00	.00	23.
1.01	11.40	140	.08	.02	.06	8.	1.01	23.40	284	.00	.00	.00	23.
1.01	11.45	141	.09	.03	.06	9.	1.01	23.45	285	.00	.00	.00	23.
1.01	11.50	142	.16	.06	.11	11.	1.01	23.50	286	.00	.00	.00	23.
1.01	11.55	143	.18	.06	.13	14.	1.01	23.55	287	.00	.00	.00	23.
1.01	12.00	144	.37	.16	.20	16.	1.02	.00	288	.00	.00	.00	23.

SUM 4.91 2.13 2.78 12636.
(125.)(54.)(71.)(357.81)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	310.	145.	44.	44.	12629.
CMS	9.	4.	1.	1.	358.
INCHES		1.69	2.04	2.04	2.04
MM		42.97	51.80	51.80	51.80
AC-FT		72.	87.	87.	87.
THOUS CU M		89.	107.	107.	107.

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HYDROGRAPH ROUTING

ROUTING THROUGH UPPER KEMP'S MILL TRAIL LAKE DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP		LSTR
.0	.000	.00	1	0	0	0		0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	.000	.000	.000	-525.	-1

STAGE 524.80 525.80 526.80 527.30 527.80 528.80 529.80 530.80 532.80 534.80
536.80

FLOW .00 22.00 37.00 52.00 75.00 86.00 110.00 120.00 144.00 164.00
184.00

SURFACE AREA= 0. 6. 7. 13. 21. 32.

CAPACITY= 0. 15. 42. 91. 256. 518.

ELEVATION= 497. 510. 515. 520. 530. 540.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
524.8	.0	.0	.0	.0	.0	.0	.0

DAM DATA

DAM DATA

TOPEL	COOD	EXPD	DAMWID
529.8	.0	.0	0.

CREST LENGTH AT OR BELOW	0.	37.	95.	207.	275.	328.	[illegible]	417.	535.
ELEVATION	524.8	529.9	530.0	530.1	530.3	531.0	531.9	532.5	535.2

END-OF-PERIOD HYDROGRAPH ORDINATES

NO.DA	HR.MN	PERIOD	HOURS	INFLOW	OUTFLOW	STORAGE	STAGE
1.01	.05	1	.08	0.	0.	160.	524.8
1.01	.10	2	.17	0.	0.	160.	524.8
1.01	.15	3	.25	0.	0.	160.	524.8
1.01	.20	4	.33	0.	0.	160.	524.8
1.01	.25	5	.42	0.	0.	160.	524.8
1.01	.30	6	.50	0.	0.	160.	524.8
1.01	.35	7	.58	0.	0.	160.	524.8
1.01	.40	8	.67	0.	0.	160.	524.8
1.01	.45	9	.75	0.	0.	160.	524.8
1.01	.50	10	.83	0.	0.	160.	524.8
1.01	.55	11	.92	0.	0.	160.	524.8
1.01	1.00	12	1.00	0.	0.	160.	524.8
1.01	1.05	13	1.08	0.	0.	160.	524.8
1.01	1.10	14	1.17	0.	0.	160.	524.8
1.01	1.15	15	1.25	0.	0.	160.	524.8
1.01	1.20	16	1.33	0.	0.	160.	524.8
1.01	1.25	17	1.42	0.	0.	160.	524.8
1.01	1.30	18	1.50	0.	0.	160.	524.8
1.01	1.35	19	1.58	0.	0.	160.	524.8
1.01	1.40	20	1.67	0.	0.	160.	524.8
1.01	1.45	21	1.75	0.	0.	160.	524.8
1.01	1.50	22	1.83	0.	0.	160.	524.8
1.01	1.55	23	1.92	0.	0.	160.	524.8
1.01	2.00	24	2.00	0.	0.	160.	524.8
1.01	2.05	25	2.08	0.	0.	160.	524.8
1.01	2.10	26	2.17	0.	0.	160.	524.8
1.01	2.15	27	2.25	0.	0.	160.	524.8
1.01	2.20	28	2.33	0.	0.	160.	524.8
1.01	2.25	29	2.42	0.	0.	160.	524.8
1.01	2.30	30	2.50	0.	0.	160.	524.8
1.01	2.35	31	2.58	0.	0.	160.	524.8
1.01	2.40	32	2.67	0.	0.	160.	524.8
1.01	2.45	33	2.75	0.	0.	160.	524.8
1.01	2.50	34	2.83	0.	0.	160.	524.8
1.01	2.55	35	2.92	0.	0.	160.	524.8
1.01	3.00	36	3.00	0.	0.	160.	524.8
1.01	3.05	37	3.08	0.	0.	160.	524.8
1.01	3.10	38	3.17	0.	0.	160.	524.8
1.01	3.15	39	3.25	0.	0.	160.	524.8
1.01	3.20	40	3.33	0.	0.	160.	524.8
1.01	3.25	41	3.42	0.	0.	160.	524.8
1.01	3.30	42	3.50	0.	0.	160.	524.8
1.01	3.35	43	3.58	0.	0.	160.	524.8
1.01	3.40	44	3.67	0.	0.	160.	524.8
1.01	3.45	45	3.75	0.	0.	160.	524.8

1.01	22.35	270	22.50	23.	48.	201.	527.2
1.01	22.35	271	22.58	23.	48.	201.	527.2
1.01	22.40	272	22.67	23.	48.	201.	527.2
1.01	22.45	273	22.75	23.	47.	201.	527.2
1.01	22.50	274	22.83	23.	47.	200.	527.1
1.01	22.55	275	22.92	23.	47.	200.	527.1
1.01	23.00	276	23.00	23.	46.	200.	527.1
1.01	23.05	277	23.08	23.	46.	200.	527.1
1.01	23.10	278	23.17	23.	46.	200.	527.1
1.01	23.15	279	23.25	23.	46.	200.	527.1
1.01	23.20	280	23.33	23.	45.	200.	527.1
1.01	23.25	281	23.42	23.	45.	199.	527.1
1.01	23.30	282	23.50	23.	45.	199.	527.1
1.01	23.35	283	23.58	23.	45.	199.	527.1
1.01	23.40	284	23.67	23.	44.	199.	527.1
1.01	23.45	285	23.75	23.	44.	199.	527.1
1.01	23.50	286	23.83	23.	44.	199.	527.0
1.01	23.55	287	23.92	23.	44.	198.	527.0
1.02	.00	288	24.00	23.	43.	199.	527.0

PEAK OUTFLOW IS 69. AT TIME 16.75 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	69.	64.	25.	25.	7111.
CMS	2.	2.	1.	1.	201.
INCHES		.74	1.15	1.15	1.15
MM		18.81	29.17	29.17	29.17
AC-FT		32.	49.	49.	49.
THOUS CU M		39.	60.	60.	60.

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RUNOFF SUMMARY, AVERAGE FLOW IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES(SQUARE KILOMETERS)

		PEAK	6-HOUR	24-HOUR	72-HOUR	AREA
HYDROGRAPH AT	1	310.	145.	44.	44.	.80
	(	8.76)(	4.12)(	1.24)(	1.24)(	2.07)
ROUTED TO	2	69.	64.	25.	25.	.80
	(	1.95)(	1.80)(	.70)(	.70)(	2.07)

SUMMARY OF DAM SAFETY ANALYSIS

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	524.80	524.80	529.60
STORAGE	160.	160.	252.
OUTFLOW	0.	0.	110.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	527.77	.00	212.	69.	.00	16.75	.00

APPENDIX B

ENGINEERING GEOLOGIC REPORT ON THE KEHR'S MILL TRAILS LAKE SITE

ENGINEERING GEOLOGIC REPORT ON THE KEHRS MILL TRAILS LAKE SITE

St. Louis County, Mo.

LOCATION: In a northwest trending tributary to Caulks Creek paralleling Kehrs Mill Road in Sec. 17 & 18, T. 45 N., R. 4 E., Chesterfield Quadrangle.

GEOLOGIC SETTING:

Two proposed lake sites are planned for the valley. One dam is proposed at the mouth of the tributary valley with the second dam proposed at the tail waters of the first, approximately at elevation 500 in the valley bottom.

Limestone of the Burlington Formation is the parent bedrock in the lake and watershed area. The Burlington in this area is very deeply weathered with much solution work along joints and bedding planes plus creating a very permeable bedrock. The bedrock, however, is masked for the most part by thick residual soil on the lower valley slopes which in turn is covered by an unknown but relatively thick sequence of silty and silty clay soil. Numerous outcrops of limestone are observable in the lower valley walls in the vicinity of the streambed upstream of the dams. At least one spring was observed on the lower valley wall at or just downstream of the right abutment. This spring is on the base of a narrow ridge which would have a relatively low water storage capacity and thus may represent water moving down the valley from the upstream (within the lake basin) area.

The thick soil cover represented as terraces in the valley bottoms and the residual, colluvial and silty soils on the ridges should prevent much of the water from the proposed lake from reaching the bedrock. Water that does reach the bedrock, however, can be expected to escape through the ridges or into bedrock in the valley bottom and under the proposed dam.

The drainage area encompasses approximately 550 surface areas $\pm$ and would be sufficient for the 15 acre and 13 acre proposed lakes, provided no adverse leakage conditions are encountered.

SUMMARY:

In summary, the bedrock is extremely permeable and will transmit water rapidly, particularly under pressure. The relatively thick soil cover masking the bedrock should provide enough protection to prevent water from reaching the bedrock in most areas of the lake.

RECOMMENDATIONS:

1) Because of the presence of the bedrock spring just downstream of the right abutment, it is recommended that the dam site of the lower dam be moved upstream at least to where the loop of the existing driveway road is present. The soil on the north or right abutment is thicker in this area and a relatively thick sequence of soil is present in the valley bottom that will help prevent water from getting to the bedrock. If the dam is placed at the location on the plans, the chances of lake water getting to the spring system will be very high.

2) It is recommended that the core under the dam be extended to bedrock across the valley bottom and up the valley wall to where clayey soils exceed 10 feet in thickness. No water was present in the stream system on the date of this investigation and it is thought that water moving down the valley is following old channels that are now covered or is moving at the soil bedrock contact somewhere on the valley bottom. The core should penetrate to rock if at all possible if the soil is less than 15 feet thick in the valley bottom.

3) It is recommended that the streambed be filled with borrow material to at least general floodplain elevation several hundred yards upstream of the dam. The weak point in the valley bottom is the existing streambed and filling of the streambed to general floodplain elevation will help prevent water from getting to gravels and/or bedrock in the deep water portion of the lake.

4) Borrow material should not be removed from the valley bottom or valley walls unless it can be shown to exceed at least 10 feet in thickness. The soil material not the bedrock is what will impound water in this basin. Adequate quantities of borrow material can probably be removed from the higher terraces on the floodplain and/or the shoreline of the proposed lake. Bedrock should not be exposed in the borrowing operation.

5) Small collapses of the lake bottom or lower valley walls is a distinct possibility in this geologic setting. Large voids can be present in the bedrock and in the residual soil. These openings are normally masked by soil material that can collapse when they become saturated. Some grouting at a later day may be necessary if these collapses should occur.

6) Drilling information and/or backhoe test pits would be very beneficial in determining soil quality and quantity in the valley bottom and valley walls, particularly on the centerline of the proposed dam.

7) This office would be happy to help evaluate drilling information if requested.

Thomas J. Dean, Geologist
Applied Engineering & Urban Geology
Geology & Land Survey
Nov. 28, 1975

orig: Allen Dolph
Jefferson County Engineering Co.
Hillsboro Bank Building
P. O. Box 578
Hillsboro, Mo. 63050

APPENDIX C

INVESTIGATION OF SUBSURFACE CONDITIONS
KEHR'S MILL TRAILS SUBDIVISION LAKES "A" & "B"

Investigation of Subsurface Conditions

KEHRS MILL TRAILS SUBDIVISION
LAKES "A" & "B"
ST. LOUIS COUNTY, MISSOURI

At the request of Manlin and Liebert Construction Company, we have investigated the subsurface conditions in the area of proposed lakes "A" and "B" of Kehrs Mill Trails Subdivision in St. Louis County, Missouri. The locations of the dams were selected by others.

The purpose of this investigation was to determine the feasibility of using the proposed reservoir areas as a borrow area and to outline specific problems which might develop with the proposed dams as a result of the existing subsurface conditions. It is not the purpose of this report to provide a detailed design for the proposed dams, since the dam design and hydrologic studies are being handled by Mueller Surveying & Engineering Company.

Field Investigation

To investigate the subsurface conditions, six test holes were drilled at the locations shown on Figure 1. All test holes were advanced using a four-inch-diameter, truck-mounted auger. Samples in the borrow area were obtained at maximum vertical intervals of three feet or at every visible change in soil type. In Test Holes 1 and 2 split spoon samples were taken in accordance with ASTM recommended procedures. Undisturbed three-inch-diameter Shelby tube samples were obtained in Test Hole 1 at relatively shallow depths and were attempted at greater depths but due to the soft consistency of the materials it was not possible to recover samples. The type of sample was dictated by both the type of soil and location of the boring. The depth of each test hole varied depending upon the boring location and its purpose.

In the area of Lake "A", ground water was encountered in all of the test holes and it appears that a relatively stable ground water level is approximately eight feet beneath the ground surface. In the area of Lake "B", no significant quantity of water was encountered during the test drilling, although traces of water were noted at a depth of approximately 25 feet in Test Hole 5.

General Conclusions and Recommendations

Reservoir Areas

The results of these test holes indicate that for both Lakes "A" and "B" it will be feasible and economical to use the proposed reservoir areas as borrow areas. In Lake "A" the material from the ground surface to a depth of 10 to 15± feet is a low to medium plasticity silty clay and will be ideal for the construction of the embankment. At the time of our test drilling the moisture content was such that the material could be satisfactorily compacted with a minimum of effort. It is recommended that all material placed in the embankment be compacted to a minimum density of 90 percent of the Standard Density (ASTM D 698-70), and that the material be compacted with a moisture content as high as possible. This office has not made an investigation of quantities of material required to construct the dams; however, based on our subsurface investigation it appears that sufficient quantities of material in both reservoirs "A" and "B" is available. It will not be possible to excavate to a depth greater than six or seven feet in Lake "A" due to the relatively high ground water. The subsurface investigation indicates the potential problems associated with the design and construction of these dams are unique, and, consequently, each dam site is discussed individually.

Lake "A"

Four test holes were drilled for this site. Test Holes 1 and 2 are in the approximate location of the embankment while Test Holes 3 and 4 are in the reservoir area. Test Holes 3 and 4 indicate that the material in the reservoir is satisfactory for construction of the proposed embankment. We anticipate no problems associated with this material, either during or following the construction. The material will not be subject to volume change and associated changes in shear strength upon saturation. Assuming that the slopes of the embankment have been properly designed and the soil compacted, we would not anticipate any sloughing or failure of the slopes.

Test Holes 1 and 2 were drilled approximately along the centerline of the proposed embankment. In Test Hole 1 the material from the ground surface to a depth of 15' consists of a relatively low plasticity silty clay. A gravelly, rocky seam was detected at a depth of approximately 12 feet. At a depth of approximately 15 feet the material changed from a low plasticity clay to a reddish-brown, very high plasticity clay which contained abundant rock fragments. Auger refusal on rock or boulders was encountered in Test Hole 1 at a depth of 37 feet and the auger was advanced 12 inches into this material with the use of a claw tooth bit. The test hole was terminated at 38 feet. Ground water was encountered at approximately 12 feet below the existing ground surface which is consistent with the ground water level in the borrow areas.

Test Hole 2 which is located near the center of the valley was drilled to a depth of 45 feet at which depth it was arbitrarily terminated. Bedrock was not encountered throughout this depth although from 13 feet to 45 feet several thin layers of boulders or rock ledges exist which were underlain by extremely soft silts and clays. The boulders or ledges and the soft nature of the material precluded obtaining Shelby tube samples. During the drilling several zones were encountered which were so soft the augers settled under their own weight. It was not possible during the drilling to differentiate whether large gravel or boulders or ledges were present. As in Test Hole 1, a gravelly seam was detected at approximately 12 feet beneath the surface.

Based upon the information from these test holes we feel the problems associated with the design of this embankment are:

1. Unusually large total settlement in the vicinity of Test Hole 2.
2. Differential movement which may be extreme from the centerline of the existing valley to the abutments and which may cause damage to the discharge pipe.
3. Possible loss of water and subsequent lowering of the lake level due to leakage through the gravel seams.
4. Instability of the downstream embankment due to scouring and rapid drawdown associated with flood levels in Caulk's creek.

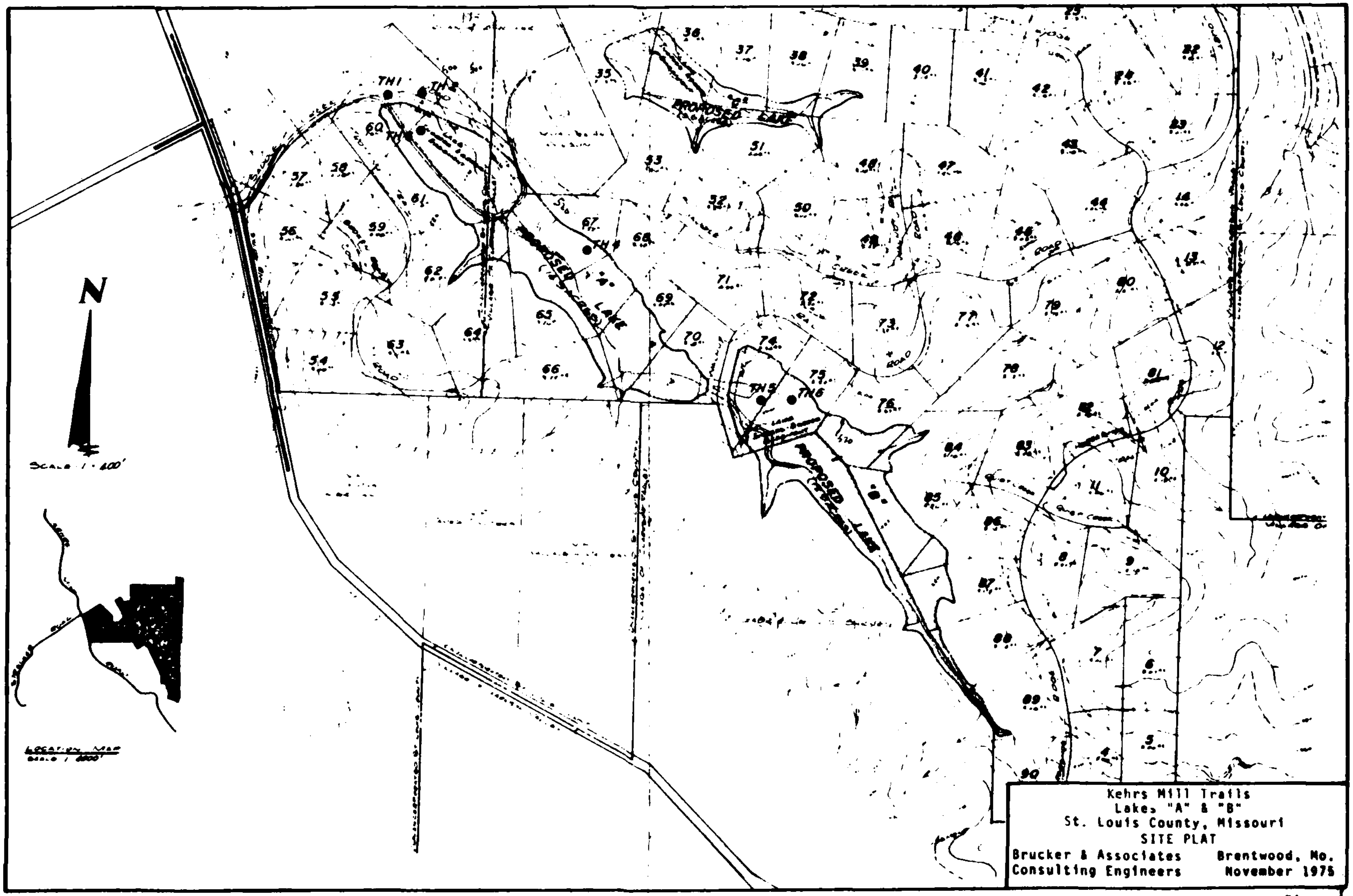
For design of the proposed embankment, and to determine satisfactory as well as economical slopes, we recommend a shear strength of 400 psf for fill material. This assumes that all material will be compacted to 90 percent of the Standard Proctor (ASTM D 698-70). To preclude the possible loss of water by leakage through what appears to be a permeable gravelly layer, we recommend the cutoff trench or key for this dam extend to a depth of 15 feet beneath the existing ground surface. This depth is based on the information obtained in the two test holes and it may be modified during the construction. There may be some seepage beneath the cutoff trench but we do not believe that it will be large enough to warrant a sheet pile cutoff wall.

The embankments should be designed for both a steady seepage condition and for possible rapid drawdown conditions at both the upstream and downstream faces of the embankment. Flood levels in the adjacent Caulk's Creek should be investigated and appropriate measures taken to protect the downstream toe against erosion. For stability analysis and design of the embankment the shear strength of the natural materials should not exceed 300 psf.

Lake "B"

It appears that most of the problems associated with the satisfactory performance of Lake "B" are hydrologic. Test Hole 5 was drilled near the centerline of the proposed embankment. Contrary to the conditions encountered in Lake "A" it does not appear that any major foundation problems are associated with the construction of this embankment. Ground water was not encountered in Test Hole 6 in the proposed borrow area and only a slight amount of seepage was encountered at a depth of 25± feet in Test Hole 5, therefore, it will not be a major consideration in the construction of this reservoir. The material beneath the proposed embankment is relatively high in shear strength, with moderate to high densities, and consequently we do not anticipate that either large total or differential settlement will occur beneath the proposed dam. The cutoff trench should be extended to a minimum depth of seven feet below existing (natural) grade to assure that leakage does not occur through the surficial soils. For design of the proposed embankment it is recommended that a shear strength of 500 psf be used for the virgin materials. The shear strength of the compacted soil within the embankment should be assumed as 400 psf.

In view of the relatively large watershed area and the steep slopes around this reservoir, it is anticipated that considerable erosion and subsequent silting will take place; therefore, it is recommended that consideration be given to siltation measures in the design of this reservoir. Based upon our field investigation it also appears that some slope stability problems may occur in the virgin materials particularly where the thin soils are overlying limestone which is generally the case throughout the reservoir area. These problems are best treated individually if and when they occur.



Kehrs Mill Trails
Lakes "A" & "B"
St. Louis County, Missouri
SITE PLAT
Brucker & Associates Brentwood, Mo.
Consulting Engineers November 1975

Figure

L E G E N D

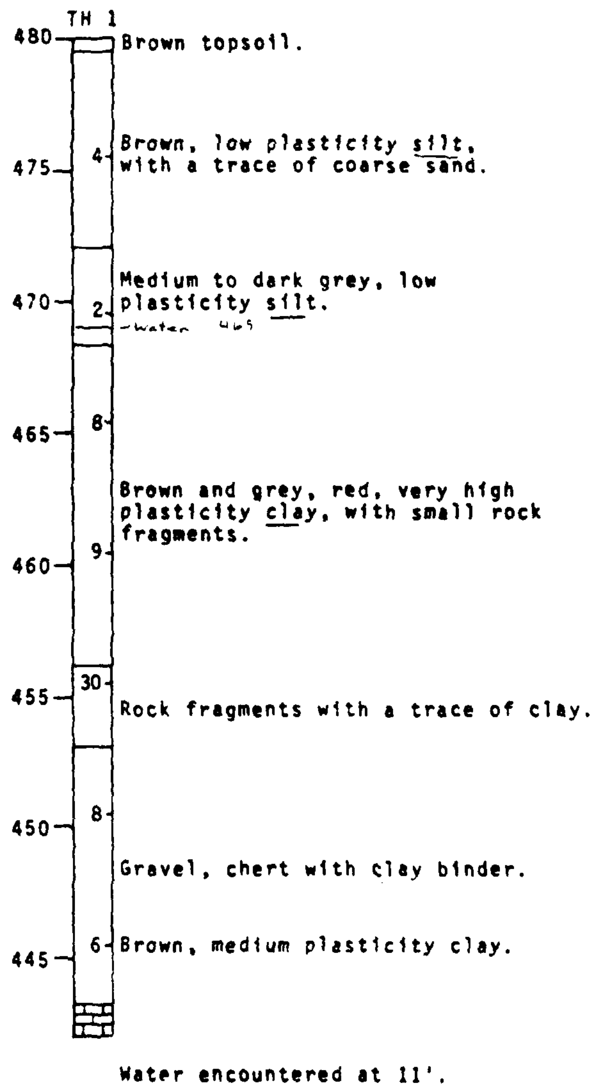
Figures within the graphical logs indicate the number of blows required to drive a 2-inch O.D. standard sampling spoon 12 inches, using a 140-pound weight falling 30 inches.

Shaded areas within graphical logs indicate topsoil.

Site drilled 11/14-17/75.

BRUCKER & ASSOCIATES

Figure 2



Kehrs Mill Trails
Lakes "A" & "B"
St. Louis County, Missouri
BORING LOG

Brucker & Associates Consulting Engineers
Brentwood, Mo.
November 1975

Figure 2-1

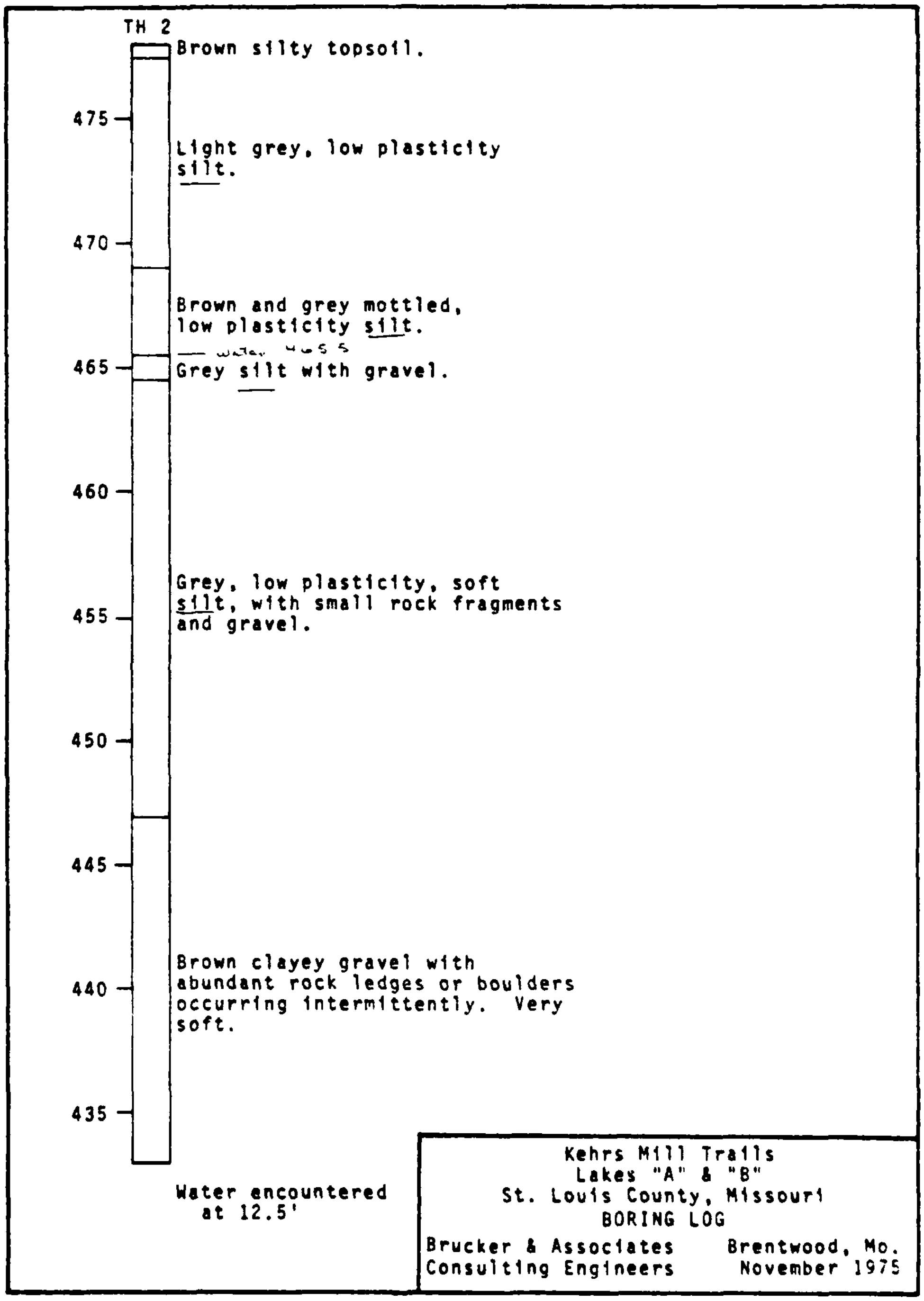

TH 2
475
470
465
460
455
450
445
440
435
Brown silty topsoil.
Light grey, low plasticity silt.
Brown and grey mottled, low plasticity silt.
Grey silt with gravel.
Grey, low plasticity, soft silt, with small rock fragments and gravel.
Brown clayey gravel with abundant rock ledges or boulders occurring intermittently. Very soft.
Water encountered at 12.5'
Kehrs Mill Trails
Lakes "A" & "B"
St. Louis County, Missouri
BORING LOG
Brucker & Associates
Consulting Engineers
Brentwood, Mo.
November 1975

Figure 2-2

AD-A107 487 BLACK AND VEATCH KANSAS CITY MO F/G 13/13
NATIONAL DAM SAFETY PROGRAM. KEHR'S MILL TRAIL UPPER DAM (MO 11--ETC(U)
NOV 80 E R BURTON, H L CALLAHAN DACW43-80-C-0074
UNCLASSIFIED NL

2 of 2

END
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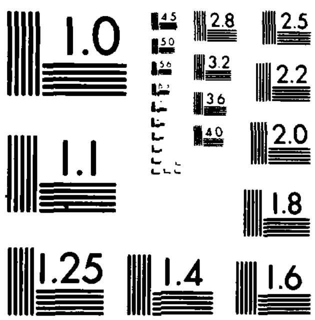


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

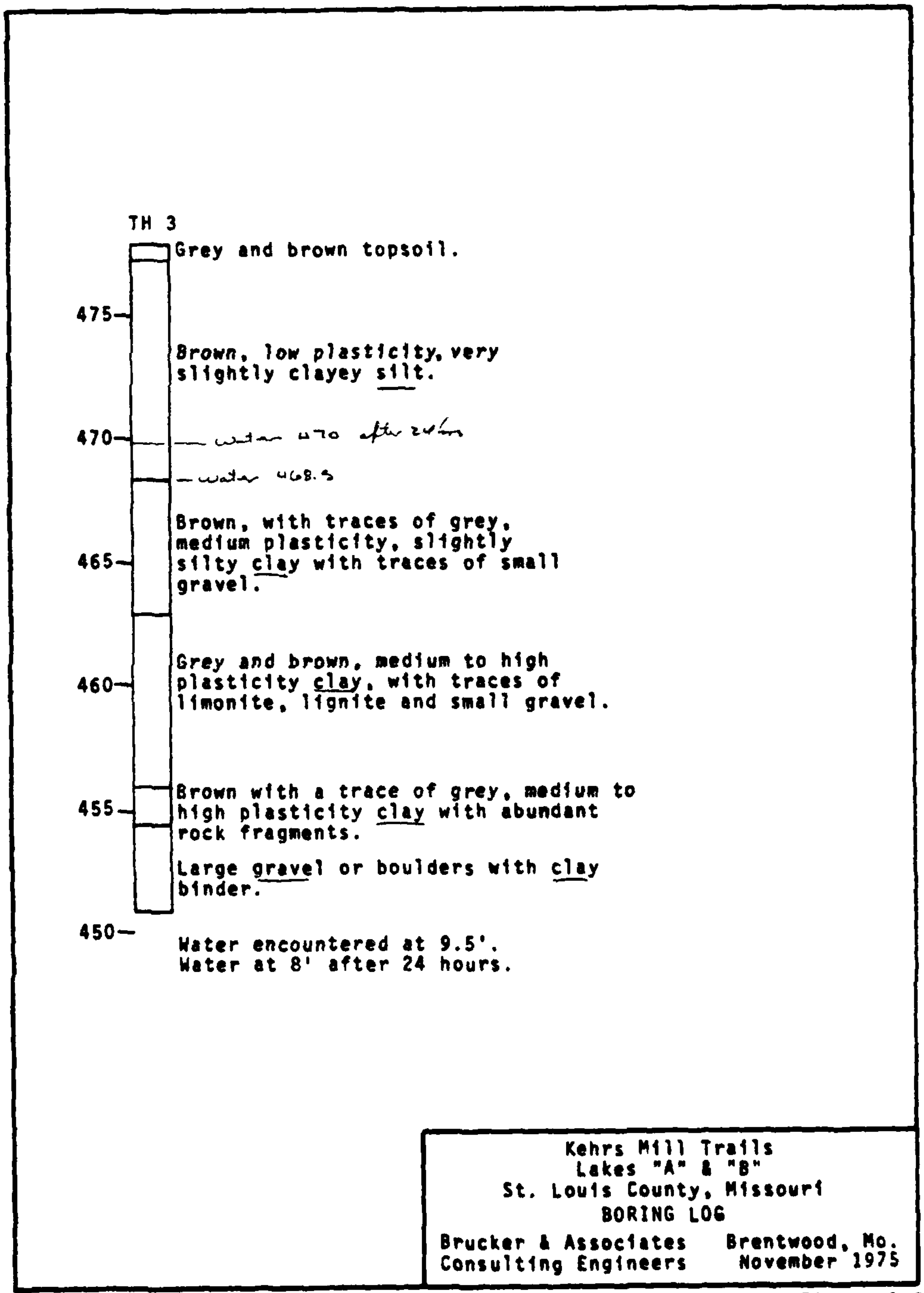
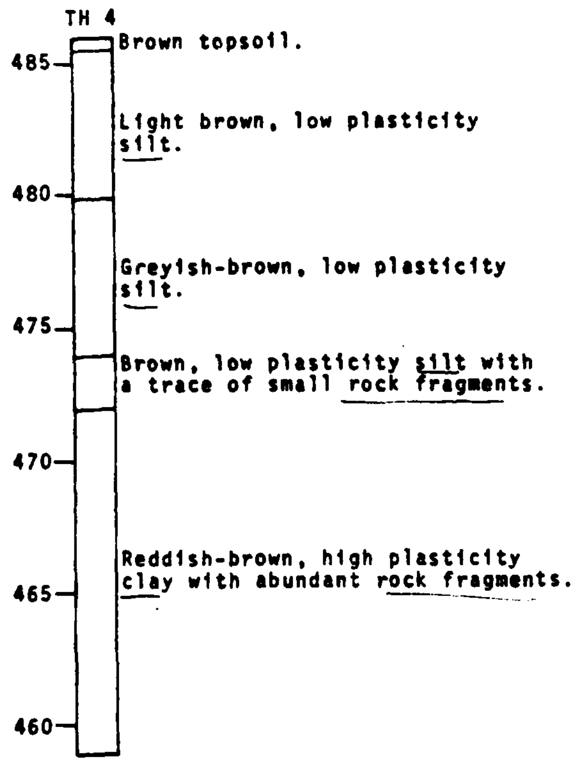

TH 3
Grey and brown topsoil.
475
Brown, low plasticity, very slightly clayey silt.
470
— water 470 after 24 hrs
— water 468.5
Brown, with traces of grey, medium plasticity, slightly silty clay with traces of small gravel.
465
Grey and brown, medium to high plasticity clay, with traces of limonite, lignite and small gravel.
460
Brown with a trace of grey, medium to high plasticity clay with abundant rock fragments.
455
Large gravel or boulders with clay binder.
450
Water encountered at 9.5'.
Water at 8' after 24 hours.
Kehrs Mill Trails
Lakes "A" & "B"
St. Louis County, Missouri
BORING LOG
Brucker & Associates Consulting Engineers
Brentwood, Mo. November 1975

Figure 2-3



No ground water encountered.

Kehrs Mill Trails
Lakes "A" & "B"
St. Louis County, Missouri
BORING LOG

Brucker & Associates Consulting Engineers — Brentwood, Mo. November 1975

Figure 2-4

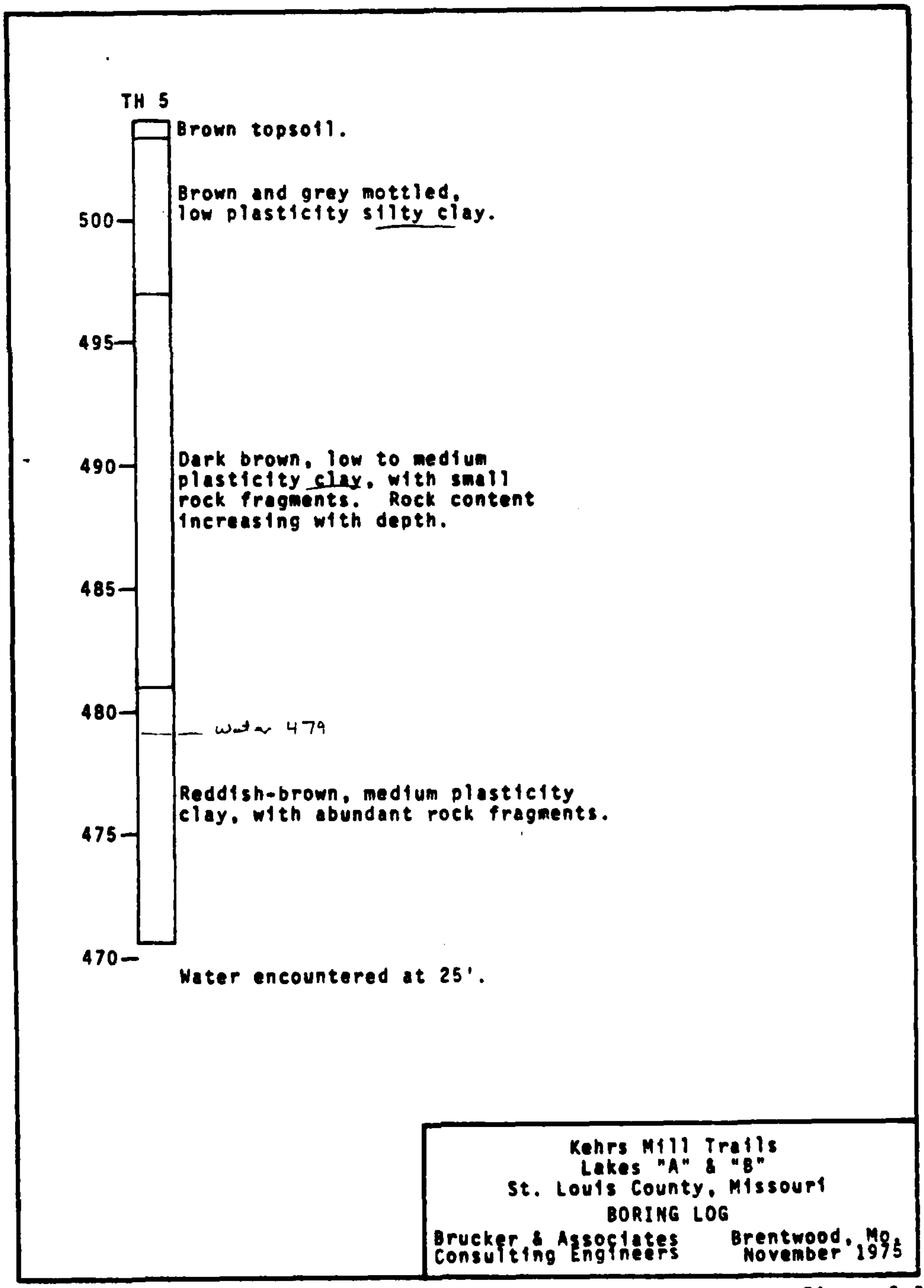
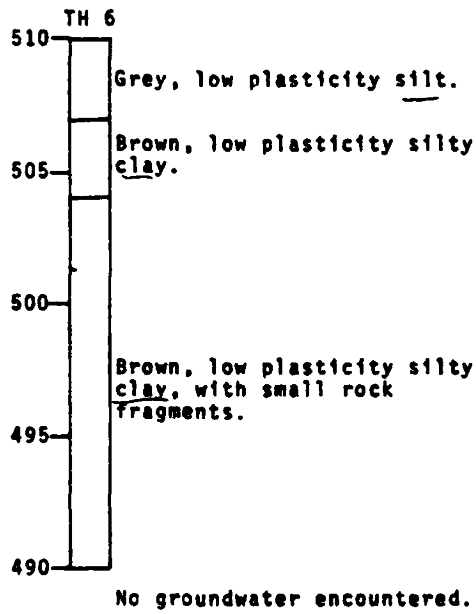

TH 5
Brown topsoil.
Brown and grey mottled, low plasticity silty clay.
500
495
Dark brown, low to medium plasticity clay, with small rock fragments. Rock content increasing with depth.
490
485
480
water 479
Reddish-brown, medium plasticity clay, with abundant rock fragments.
475
470
Water encountered at 25'.
Kehrs Mill Trails
Lakes "A" & "B"
St. Louis County, Missouri
BORING LOG
Brucker & Associates Consulting Engineers
Brentwood, Mo. November 1975

Figure 2-5



Kehrs Mill Trails
Lakes "A" & "B"
St. Louis County, Missouri
BORING LOG

Brucker & Associates   Brentwood, Mo.
Consulting Engineers   November 1975

Figure 2-6

BIBLIOGRAPHY

(1) U.S. Army Corps of Engineers, Hydrologic Engineering Center, Flood Hydrograph Package (HEC-1), Dam Safety Version, July 1978, Davis, California.

(2) HMR-33, Seasonal Variations of Probable Maximum Precipitation, East of the 105th Meridian for Areas 10 to 1000 Square Miles and Durations from 6 to 48 Hours, U.S. Department of Commerce, NOAA, National Weather Service, 1956.

(3) EM-1110-2-1411, Standard Project Flood Determinations, U.S. Army Corps of Engineers, 26 March 1952.

(4) U.S. Department of Agriculture, Soil Conservation Service, National Engineering Handbook, Section 4, Hydrology, August 1972.

(5) U.S. Army Corps of Engineers, St. Louis District, Hydrologic/Hydraulic Standards, Phase I Safety Inspection of Non-Federal Dams, 12 December 1979.

(6) U.S. Department of Commerce, Bureau of Public Roads, Hydraulic Engineering Circular, No. 5, Hydraulic Charts for the Selection of Highway Culverts, December 1965.

(7) U.S. Department of Agriculture, Soil Conservation Service, Technical Release No. 55, Urban Hydrology for Small Watersheds, January, 1975.

(8) U.S. Department of Agriculture, Soil Conservation Service, Soil Survey Interpretations and Field Maps, 1980.

(9) Mary H. McCracken, Missouri Division of Geological Survey, Geologic Map of Missouri, 1961.

(10) Missouri Department of Natural Resources, Geological Survey, Engineering Geologic Report on the Kehrs Mill Trails Lake Site, November 1975.

(11) Brucker & Associates Consulting Engineers, Investigation of Sub surface Conditions - Kehrs Mill Trails Subdivision Lakes "A" & "B", November 1975, Brentwood, Missouri.

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