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NATIONAL DAM SAFETY PROGRAM. DAM A-21 (MO 10144), MISSOURI - KA--ETC(U)

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DAM A-21
LAFAYETTE COUNTY, MISSOURI
MO 10144

**PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM**

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

FOR: STATE OF MISSOURI

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DECEMBER 1978

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

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

IN REPLY REFER TO

SUBJECT: Dam A-21 (Mo. 10144) Phase I Inspection Report

This report presents the results of field inspection and evaluation of Dam A-21 (Mo. 10144):

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

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

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

SIGNED

19 MAR 1979

SUBMITTED BY:

Chief, Engineering Division

Date

SIGNED

20 MAR 1979

APPROVED BY:

Colonel, CE, District Engineer

Date

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DAM A-21
LAFAYETTE COUNTY, MISSOURI
MISSOURI INVENTORY NO. 10144

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Prepared By
Anderson Engineering, Inc., Springfield, Missouri
Hanson Engineers, Inc., Springfield, Illinois

For
The Governor of Missouri

December, 1978

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam: Dam A-21
State Located: Missouri
County Located: Lafayette County
Stream: Unnamed Tributary to Big Sni-A-Bar Creek
Date of Inspection: 3 August 1978

Dam A-21 was inspected by an interdisciplinary team of engineers from Anderson Engineering, Inc. of Springfield, Missouri and Hanson Engineers, Inc. of Springfield, Illinois. 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.

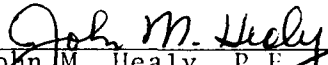
The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers and they have been developed with the help of several Federal and State agencies, professional engineering organizations, and private engineers. Based on these guidelines, this dam has been classified by the St. Louis District Corps of Engineers as an intermediate size dam with a high downstream hazard potential. Their estimate of the damage zone extends 4 miles downstream of the dam. Within the damage zone are seven houses, two farm complexes, one business, one unimproved road crossing, one improved road bridge, one U.S. highway bridge and one railroad bridge.

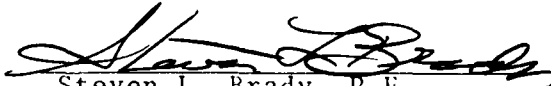
Our inspection and evaluation indicates that the combined spillways do not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. The combined spillways will pass 33 percent of the Probable Maximum Flood without overtopping. The Probable Maximum Flood is defined 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 guidelines require

that a dam of intermediate size with a high downstream hazard potential pass 100 percent of the PMF without overtopping. Fifty percent of the PMF was also routed through the spillways resulting in a dam overtopping of 0.83 ft. The combined spillways will pass a 100 year flood event, without overtopping. A 100 year flood is one that has a 1 percent chance of being exceeded in any given year.

The embankment and appurtenances are generally in good condition. Deficiencies, including erosion and tree growth were noted and should be corrected by the owner. Wet areas were noted on the lower berm on the downstream face. It could not be determined whether these areas represented seepage or just poor drainage. Further evaluation of this condition was recommended after the downstream face is cleared of overgrowth. Another deficiency was the lack of seepage analysis records.

A detailed report is attached to be submitted to the owners and to the Governor of Missouri.


John M. Healy, P.E.
Hanson Engineers, Inc.


Steven L. Brady, P.E.
Anderson Engineering, Inc.

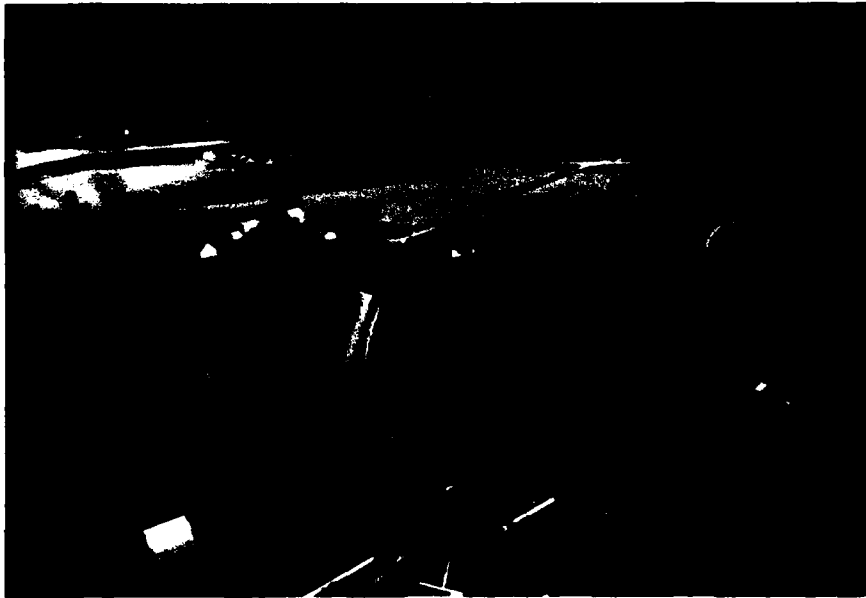
PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
DAM A-21 - ID NO. 10144

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Aerial View of Dam and Lake

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL:

A. Authority:

The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection of Dam A-21 in Lafayette County, Missouri 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 a 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, "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:

Dam A-21 is an earth fill structure approximately 52 ft high and 520 ft long at the crest. The appurtenant works consist of a concrete drop inlet and reinforced concrete pipe primary spillway, which is located near the center of the dam, and a grass covered emergency spillway, which is located at the north abutment. Sheet 4 of Appendix A shows a plan of the embankment and spillways and a typical section of the embankment.

B. Location:

The dam is located in the northwest part of Lafayette County, Missouri on a small tributary of Big Sni-A-Bar Creek. The lake formed by the dam is shown on the Lexington West, Camden, Bates City and Odessa North, Missouri quadrangle

maps in the SW 1/4 of the NW 1/1 of Section 21, T50N, R28W. Sheet 1 of Appendix A shows the general vicinity and Sheets 2 and 3 of Appendix A shows a plan of the immediate area of the dam and lake.

C. Size Classification:

With an embankment height of 52 ft and a maximum storage capacity of approximately 485 acre-ft, the dam is in the intermediate size category.

D. Hazard Classification:

The St. Louis District, Corps of Engineers has classified this dam as a high hazard dam. Their estimate of the damage zone extends 4 miles downstream of the dam. Within the damage zone are seven houses, two farm complexes, one business, one unimproved road crossing, one improved road bridge, one U.S. highway bridge and one railroad bridge.

E. Ownership:

The dam was designed by the Soil Conservation Service (SCS) but the property upon which the dam and lake are located is retained by the property owner or owners. The As-Built plans indicate the primary owners to be Robert Riesmeyer, Raymond Wieligman and Mamie Breuer. These owners granted an easement to the Wellington-Napolean Watershed Subdistrict to construct, operate, and maintain this structure. The subdistrict is the owner and is responsible for the structure. The address of the Subdistrict is 120 W 19th Street, Higginsville, Missouri 64037.

F. Purpose of Dam:

The purpose of this dam according to the PL-566 watershed program is to provide watershed protection and flood prevention. The purpose of these structures is for grade stabilization with flood water retarding features. These lakes may be stocked with fish but not by the Soil Conservation Service. They may be stocked with fish from the Federal and State Fisheries in cooperation with individual landowners.

G. Design and Construction History:

The dam was designed by the Soil Conservation Service and constructed under their inspection supervision (inspection handled by the Higginsville District Office). The

dam was completed in 1966. As-Built plans are available and have been used to prepare this report. No significant problems in regards to seepage through or stability of the embankment are reported to have occurred since the dam was built. According to SCS district personnel, no modifications have been made to the dam.

H. Normal Operating Procedure:

Normal flows will be passed by an uncontrolled drop inlet spillway, whereas a grassed emergency spillway would come into operation for major floods. A local resident indicated that the maximum water depth ever experienced was 1 ft to 2 ft above the primary spillway crest in 1973. The emergency spillway has apparently never come into service.

1.3 PERTINENT DATA:

Pertinent data about the dam, appurtenant works, and reservoir are presented in the following paragraphs. Sheet 4 of Appendix A is a plan of the embankment and spillways with a typical cross section of the dam. Sheet 5 presents a plan and profile of the primary spillway. Sheet 6 presents a profile and cross section of the foundation drainage system.

A. Drainage Area:

The drainage area for this dam, as obtained from the As-Built plans, is equal to approximately 426 acres.

B. Elevations (Feet Above M.S.L.):

- (1) Top of dam (measured): north end 768.0; center 768.5;
south end 768.0.
Top of Dam (As-Built Plans): north end 767.7;
center 769.0; south end 767.7.
- (2) Principal Spillway Crest: As-Built Plans 762.0;
measured 761.5.
- (3) Emergency Spillway Crest: As-Built Plans 764.5;
measured 764.2.

- (4) Primary Spillway Outlet Pipe Invert: As-Built Plans 719.0; measured 719.0.
- (5) Maximum Design Pool (As Built Plans): 767.2.
- (6) Pool on Date of Inspection: measured 761.7.
- (7) Streambed at Primary Spillway Outlet: As-Built Plans 715.5; measured 714.1.
- (8) Maximum Tailwater: Unknown.

C. Discharge at Dam Site:

- (1) All discharge at the dam site is through uncontrolled spillways.
- (2) Estimated Discharge Capacity at Top of Dam (El. 768.0): 3246 cfs.

D. Reservoir Surface Areas:

- (1) At Principal Spillway Crest: As Built Plans 20.8 acres.
- (2) At Top of Dam: As Built Plans 28.8 acres.

E. Storage Capacities:

- (1) At Principal Spillway Crest: 543 acre-ft.
- (2) At Top of Dam (El. 768.0): 485 acre-ft.

F. Reservoir Lengths:

- (1) At Principal Spillway Crest (Estimated from As-Built Plans): 3500 ft.
- (2) At Top of Dam (Estimated from As-Built Plans): 3500 ft.

G. Dam:

- (1) Type: rolled earth.
- (2) Length at Crest: 520 ft.
- (3) Height: 52 ft.

- (4) Top Width: 14 ft.
- (5) Side Slopes: 2.5 H: 1 V.
- (6) Zoning: homogeneous silts and clays.
- (7) Cutoff: shallow core trench.

H. Principal Spillway:

- (1) Location: center of dam--Station 4+50
- (2) Type: 2 ft by 6 ft drop inlet concrete structure (crest elevation 761.5, 12 ft in length) with a 24 in. diameter reinforced concrete outlet pipe through the dam. The outlet pipe is 204 ft long, supported on a type A3 cradle with 5 concrete antiseep collars. The pipe inlet invert is at El. 750.00 and the outlet invert is at El. 719.00 (see Sheet 5 Appendix A). A plunge pool has been created at the end of the outlet pipe and dissipates the energy of the flow.

I. Emergency Spillway:

- (1) Location: south abutment.
- (2) Type: grass covered earth with 50 ft crest length and 3 H: 1 V side slopes.

SECTION 2 - ENGINEERING DATA

2.1 GENERAL:

Available design computations and reports for Dam A-21 include a geology and soils report which contains soils testing information for the foundation and borrow materials (includes soil classifications, grain size analyses, shear strength tests, consolidation tests and permeability tests). Based on this information, design recommendations were made regarding site preparation, foundation drainage and embankment configurations. The As-Built plans contain a summary of the hydrologic and hydraulic design data used for the primary and emergency spillways. No documentation of construction inspection records have been obtained. There are no documented maintenance and operation data to our knowledge.

2.2 DESIGN:

A. Surveys:

The As-Built drawings show the topography of the immediate dam site area (Sheet 4 of Appendix A). A bench mark in the form of a bolt in the center of a bronze plate is located on the outlet end of spillway (BM No. 2 - Elev. = 760.05).

B. Geology and Subsurface Materials:

Physiographically, the site is located in the Missouri River loess hills area, which is characterized by gently rolling topography. The subsurface materials in upland areas generally consist of in excess of 20 ft of loess underlain by a Kansan Age glacial till material. Geological maps of the area indicate that the bedrock is the Marmaton group of the upper Desmoinesian series of the Pennsylvanian system. The Marmaton group consists of a succession of shale, limestone, clay and coal beds.

A publication entitled "Evaluation of Missouri's Coal Resources" by the Missouri Geological Survey indicates that the "Lexington Coal Bed" was mined extensively in this area. The maps associated with this publication indicate that the dam site lies near the southern boundary of the undermining activity and that the coal seam mined was approximately 20 in. thick in the area. The U.S.G.S. quad sheet for the area

(Camden, Missouri, 1950) indicates an inactive mine shaft approximately one mile northwest of the dam (see Sheet 1 of Appendix C). The Coal Resources publication previously mentioned indicates that the depth to the coal seam at that location is approximately 32 ft and that the thickness of the seam is 18 in. If the coal seam is horizontal, then it would be at a depth of approximately 50 ft below the stream bed at the center of the dam (coal seam at elevation 660 to 665).

A boring plan and description of the soils encountered in the borings (Sheets 14 and 15 of the As-Built plans) are presented as Sheets 1 and 2 of Appendix B. Sheets 3, 4 and 5 of Appendix B present a description of the surface geology and physiography, and interpretations and conclusions regarding the soils encountered in the boring program (from geology and soils report by SCS). The soils encountered in the borings are generally low plasticity clays and silts. Dry density determinations on "core" samples were between 1.04 g/cc (64.8 pcf) and 1.59 g/cc (86.7 pcf), and estimated "blow counts" were between 5 and 10. Sand layers (1 ft to 3 ft thick) were encountered in several of the borings between elevations 700 and 710. One deeper sand layer (7 ft thick) was encountered in boring 303 at about elevation 690. "Refusal" was encountered in borings 6 and 301 at elevation 675 to 680 (probable elevation of bedrock).

C. Foundation and Embankment Design:

Reference should be made to Sheets 6 through 9 of Appendix B which contain a summary of the soil test data and recommendations for the foundation and embankment design (from geology and soils report by SCS). Because of the existance of sand layers a foundation drainage system was developed (includes a drainage trench and vertical drains penetrating to elevation 700). The foundation drainage system is shown on Sheets 5 and 6 of Appendix A (from As-Built Plans). A shallow core trench apparently was constructed at the base of the dam along its entire length.

An abutment drain was constructed in the south abutment as shown on Sheets 5 and 6 of Appendix A. This was apparently not part of the original design but may have been required to control ground water or "springs" during construction. The landowner mentioned that several "springs" existed in the stream valley before the dam was built.

Borrow material for the dam was obtained from the reservoir area upstream of the embankment. Stability analyses based on the use of this material were performed by SCS. It was recommended that the embankment materials be compacted to 95 percent of the maximum dry density as obtained by the Standard Proctor Compaction Test and at a moisture content wet of optimum. There is apparently no particular zoning of the embankment, and no internal drainage features (except for the previously described foundation drainage system) are known to exist. No construction inspection test results have been obtained.

D. Hydrology and Hydraulics:

Design data, storage curves and routing curves for the "emergency spillway" and "freeboard" hydrographs are presented on Sheets 10 through 12 of Appendix B (from As-Built plans by SCS). Based on this data, a field check of spillway dimensions and embankment elevations, and a check of the drainage area on U.S.G.S. quad sheets, a hydrologic analysis using U.S. Army Corps of Engineers guidelines was performed and appears in Appendix C, Sheets 1 to 8. It was concluded that the primary and emergency spillways combined will pass 33 percent of the Probable Maximum Flood.

E. Structure:

Structural design computations for appurtenant structures were not obtained. Details of all concrete structural elements (riser structure, etc.) are shown on the As-Built plans.

2.3 CONSTRUCTION:

No construction inspection data has been obtained. Construction supervision was accomplished by the Soil Conservation Service district office in Higginsville, Missouri.

2.4 OPERATION AND MAINTENANCE:

On this structure, there is an operation and maintenance agreement between the Soil Conservation Service and the Wellington-Napolean Watershed Subdistrict. The operation and maintenance agreement spells out the operation and maintenance requirements and the inspection procedures. District SCS office personnel indicated that a yearly questionnaire is sent to land owners inquiring as to maintenance problems. It was reported that inspection stops are made on an irregular basis by SCS district personnel (Higginsville office).

2.5 EVALUATION:

Slope stability analyses were performed, but seepage analyses comparable to the Recommended Guidelines were not available. The foundation drainage system shown on Sheet 6 of Appendix A would indicate that a seepage analysis has been performed. The owner should either locate these analyses or have them performed by an engineer experienced in the design of dams.

The engineering data available were inadequate to make a detailed assessment of the design and particularly the construction of the dam. No valid engineering data on the construction of the embankment were found.

SECTION 3 - VISUAL INSPECTION

3.1 GENERAL:

The field inspection was made on 3 August 1978. The inspection team consisted of personnel from Anderson Engineers, Inc. of Springfield, Missouri and Hanson Engineers, Inc. of Springfield, Illinois. The team members were:

Mike Gray - Anderson Engineers
(Instrument Man)

Steve Brady - Anderson Engineers
(Civil Engineer)

Jack Healy - Hanson Engineers
(Geotechnical & Structural Engineer)

Gene Wertepny - Hanson Engineers
(Hydraulics Engineer)

Dave Daniels - Hanson Engineers
(Geotechnical & Hydraulics Engineer)

3.2 DAM:

The dam is an earth fill embankment constructed from borrow obtained from the emergency spillway area and the reservoir area below normal pool. Based on the soil borings, the fill material would be expected to consist of low plasticity clays and silts.

The embankment appeared to be in generally good condition except for the following deficiencies: (1) Slight erosion on upstream face 50 ft north of primary spillway; (2) Erosion channels on downstream abutment-dam contacts (both abutments) primarily from upper berm downward; (3) Scattered growth of locust trees up to 5 in. in diameter on the downstream face.

No sloughing of the embankment or seepage through or under the embankment was evident. The foundation drain outlet was flowing (estimated flow less than 0.5 gpm). The south abutment drain was also flowing (estimated flow less than 1 gpm).

Some water was standing in the middle of the lower berm on the downstream side of the dam. Because of high grass and brush, it could not be determined whether this was seepage water or merely due to poor drainage of the inward sloping berm.

The horizontal alignment appeared as constructed. No surface cracking or unusual movement was obvious. It should be noted, however, that elevations of the primary spillway crest and the center of the dam which were obtained in the field were approximately 0.5 ft lower than as indicated on the As-Built Plans (see Section 1.3.B of this report). All other elevations obtained in the field agreed fairly well with those indicated on the As-Built Plans. The discrepancy at the center of the dam might be explained by the possibility of some post construction settlement of the center portion of the dam.

No instrumentation (monuments, peizometers, etc.) were observed.

A. Primary Spillway and Outlet:

The riser structure was in good condition--no cracking or spalling of concrete was noted. The intake structure was surrounded by heavy grass and some wood debris. Water was flowing into the riser structure on the day of inspection.

The outlet pipe was also in good condition. The flow from the outlet pipe was estimated to be less than 1 cfs. A plunge pool has been created at the end of the outlet pipe and acts as an energy dissipator. A 4 ft deep erosion channel was noted along the south side of the primary spillway outlet pipe.

The outlet channel is overgrown with small trees and brush near the primary spillway outlet pipe. The outlet channel side slopes are in good condition except for one small slough 20 to 50 ft downstream on the north bank.

Along the last portion of the primary spillway outlet pipe, there is a 6 in. diameter corrugated iron pipe (Class II, Type A), which is the outlet of the foundation drainage system for the embankment. The pipe has a length of 80 ft and a slope of 0.010. It is shown on Sheets 5 and 6 of Appendix A.

B. Emergency Spillway:

The emergency spillway is in good condition. It measures 50 ft in width with 3 H: 1 V side slopes. The base and side slopes of the emergency spillway are grass covered. No erosion was noted and it appears that the emergency spillway has never been used.

3.3 RESERVOIR AND WATERSHED:

The immediate periphery of the lake was grass covered with moderate slopes. No sloughing of the reservoir banks were noted. A few areas of minor erosion were noted.

3.4 EVALUATION:

Tree growths noted on the dam should be removed and all future growth should be removed on a yearly basis. Grass should be cut and debris should be removed from around the primary spillway crest. Excessive growths and debris in this area could cause entrance restrictions. Visually observed erosional areas are deficiencies which, if left uncontrolled or uncorrected, could lead to serious problems in the future. These deficiencies should be able to be corrected by normally scheduled routine maintenance. The wet areas noted on the lower berm should be investigated more thoroughly after excess brush and overgrowth is removed to be sure that these areas are not associated with seepage through the dam.

Photographs of the dam, appurtenant structures, and the reservoir and watershed are presented in Appendix D.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES:

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

4.2 MAINTENANCE OF DAM:

Based on the amount of brush and the size of trees on the downstream slope it has been several years since the vegetation on the dam has been cut. Maintenance in terms of tree and brush removal and mowing of the grass is apparently the responsibility of the land owner. A yearly questionnaire is sent to land owners inquiring as to maintenance problems. Inspection stops are reported to be made on an irregular basis by SCS district personnel.

4.3 MAINTENANCE OF OPERATING FACILITIES:

No operating facilities exist at this dam.

4.4 DESCRIPTION OF ANY WARNING SYSTEM AND AFFECT:

The inspection team is unaware of any existing warning system for this dam.

4.5 EVALUATION:

Tree and brush growth should be removed from the dam on a yearly basis. Erosional areas at abutment-dam contacts and other areas should be repaired. The use of riprap to prevent future erosion in these areas is a possibility.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES:

A. Design and Experience Data:

Design data used by the Soil Conservation Service to design this dam are shown on the As-Built plans and presented as Sheets 10 through 12 of Appendix B of this report. Based on this information, a field check of spillway dimensions and embankment elevations, and a check of the pool and drainage areas from U.S.G.S. quad sheets, a hydrologic analysis using U.S. Army Corps of Engineers guidelines was performed and appears in Appendix C, Sheets 1 to 8.

B. Visual Observations:

The riser structure and outlet pipe for the primary spillway appear in good condition. The earth and grass covered emergency spillway is in good condition. The primary spillway was flowing on the day of inspection (estimated flow less than 1 cfs). The emergency spillway has apparently never been used. A 4 ft deep erosion channel was noted along the south side of the primary spillway outlet pipe. A plunge pool has been created at the end of the primary spillway outlet pipe to dissipate the energy. The outlet channel is overgrown with small trees and brush.

No facilities are available to draw down the pool. The primary spillway is located near the center of the dam and the emergency spillway is located on the south abutment. Spillway releases would not be expected to endanger the integrity of the dam.

C. Overtopping Potential:

Based on the hydrologic and hydraulic analysis as presented in Appendix C, the combined primary and emergency spillways will not pass the Probable Maximum Flood without overtopping. The Probable Maximum Flood (PMF) is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The recommended guidelines from the Department of the Army, Office of the Chief of Engineers, require that this structure (intermediate size with high downstream hazard potential) pass 100 percent of the PMF, without overtopping.

The routing of the PMF through the spillways and Dam, indicated that the Dam will be overtopped by 1.99 ft at reservoir elevation 769.99. The duration of the overtopping will be 4.08 hrs. and the maximum outflow 6744 cfs. Fifty percent of the PMF was also routed through the spillways, resulting in a maximum reservoir elevation of 768.83, 0.83 ft above the top of the dam (768.00). The peak outflow was 2879 cfs. The portion of the PMF that will just reach the top of the dam is about 53 percent. The spillway's system will be able to pass the 100 year frequency flood without overtopping.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY:

A. Visual Observations:

No serious deficiencies which would affect the structural stability of this dam were noted during the field inspection. However, if left unchecked, tree growth and the erosion at abutment-dam contact areas could cause stability problems in the future. The wet areas noted on the lower berm of the downstream face (Section 3.2) should be checked after the overgrowth is removed to be sure that this is not associated with a seepage condition through the dam.

B. Design and Construction Data:

Stability analyses were performed by the Soil Conservation Service and recommendations were made regarding side slopes, berm widths and compaction densities (see Sheets 6 through 9 of Appendix B). Our site inspection indicated that the side slopes and berm widths were as recommended. If the embankment was placed in relatively thin lifts at the recommended density of 95 percent of the Standard Proctor maximum dry density (no laboratory testing records available to verify this), then the embankment should remain stable.

A seepage analysis comparable to the requirements of the guidelines was not available, which is considered a deficiency and should be corrected.

C. Operating Records:

No appurtenant structures requiring operation exist at this dam.

D. Post-Construction Changes:

To our knowledge, no post-construction changes have been made.

E. Seismic Stability:

Considering the seismic zone (I) in which this dam is located, an earthquake of this magnitude is not expected to cause a structural failure to this dam.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT:

A. General:

This Phase I inspection and evaluation should not be considered as being comprehensive since the scope of work contracted for is far less detailed than would be required for an in-depth evaluation of dams. Latent deficiencies, which might be detected by a totally comprehensive investigation, could exist.

B. Safety:

The embankment appeared to be in generally good condition except for the following deficiencies: (1) Slight erosion on upstream face 50 ft north of primary spillway; (2) Erosion channels on downstream abutment-dam contacts (both abutments) primarily from upper berm downward; (3) A 4 ft deep erosion channel along the south side of the primary spillway outlet pipe; (4) Scattered growth of locust trees up to 5 in. in diameter on the downstream face; (5) overgrowth of trees and brush near the primary spillway outlet pipe; and (6) Lack of available seepage analyses.

Wet areas were noted in the middle of the lower berm on the downstream side of the dam. Because of the high grass and overgrowth, it could not be determined for certain whether these areas were associated with seepage through the dam or were merely the result of poor drainage (inward sloping berm, high grass, etc). This condition should be evaluated again after the trees and overgrowth have been removed.

The existing spillway system is inadequate to pass the PMF without overtopping the embankment. The dam will be overtopped by flows in excess of 53 percent of the Probable Maximum Flood. The Probable Maximum Flood (PMF) is defined as the flood discharge that may be expected from the most severe combination of meteorologic and hydrologic conditions that are reasonably possible in the region. Overtopping of an earthen embankment could cause serious erosion and could possibly lead to failure of the structure. The existing spillway system will be able to pass the 100 year frequency flood without overtopping.

C. Adequacy of Information:

The conclusions in this report were based on review of the As-Built plans, the geologic and soil mechanics report prepared by the Soil Conservation Service, the performance history as related by others, and visual observation of external conditions. The inspection team considers that these data are sufficient to support the conclusions herein.

D. Urgency:

The remedial measures recommended in paragraph 7.2 should be accomplished in the near future. If the deficiencies listed in paragraph B are not corrected and if good maintenance is not provided, the embankment condition will continue to deteriorate and it could become serious in the future. Top priority should be given to correcting inadequate spillways.

E. Necessity for Phase II:

Based on the result of the Phase I inspection, no Phase II inspection is recommended.

F. Seismic Stability:

This dam is located in Seismic Zone 1. An earthquake of this magnitude is not expected to be hazardous to this dam.

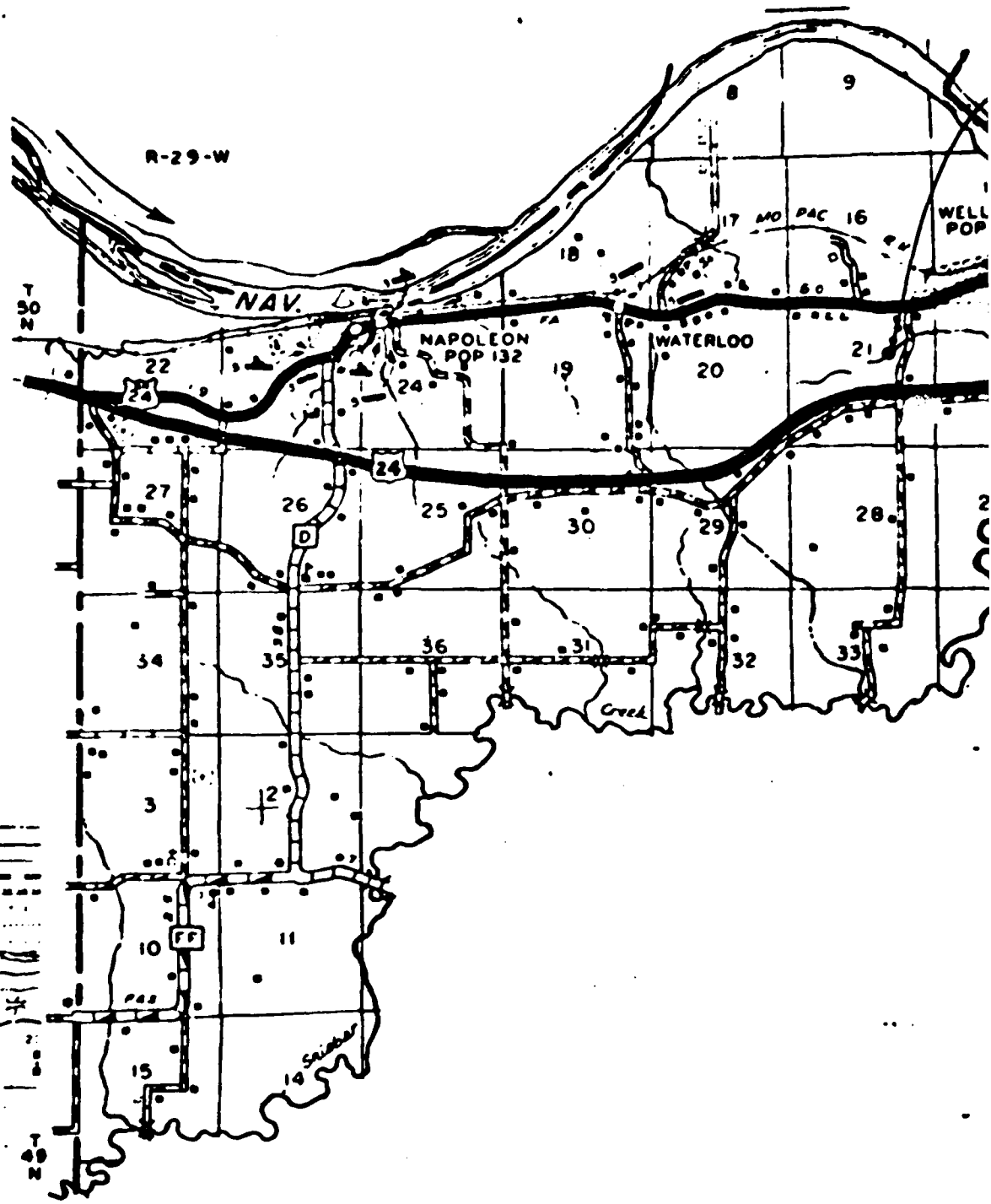
7.2 REMEDIAL MEASURES:

The following remedial measures and maintenance procedures are recommended and should be performed under the guidance of a professional engineer experienced in the design and construction of dams.

- (1) Spillway size and/or height of dam should be increased to pass the PMF. In either case, the spillway should be protected to prevent erosion.
- (2) Seepage analyses comparable to the requirements of the guidelines were not available, which is considered a deficiency and should be corrected.

- (3) Remove existing tree growth on the downstream face of the dam and remove all future tree and brush growth on a yearly basis. Cut the high grass and remove the debris around the primary spillway to prevent restrictions.
- (4) Correct the erosion activity at the embankment-abutment contacts on the downstream side of the dam and along the south side of the primary spillway outlet and place riprap in these areas to minimize erosion in the future.
- (5) Clear the outlet channel of the brush and tree growth for a distance of at least 50 ft beyond the end of the outlet pipe.
- (6) Check the downstream slope periodically for seepage and stability problems. If wet areas or seepage flows are observed, or if sloughing is noted, then the dam should be inspected and the situation evaluated by an engineer experienced in design and construction of dams.
- (7) A detailed inspection of the dam should be made at least every 5 years by an engineer experienced in the design and construction of dams. More frequent inspections may be required if slides, seeps, or other items of distress are observed.

APPENDIX A

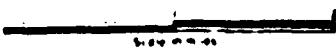


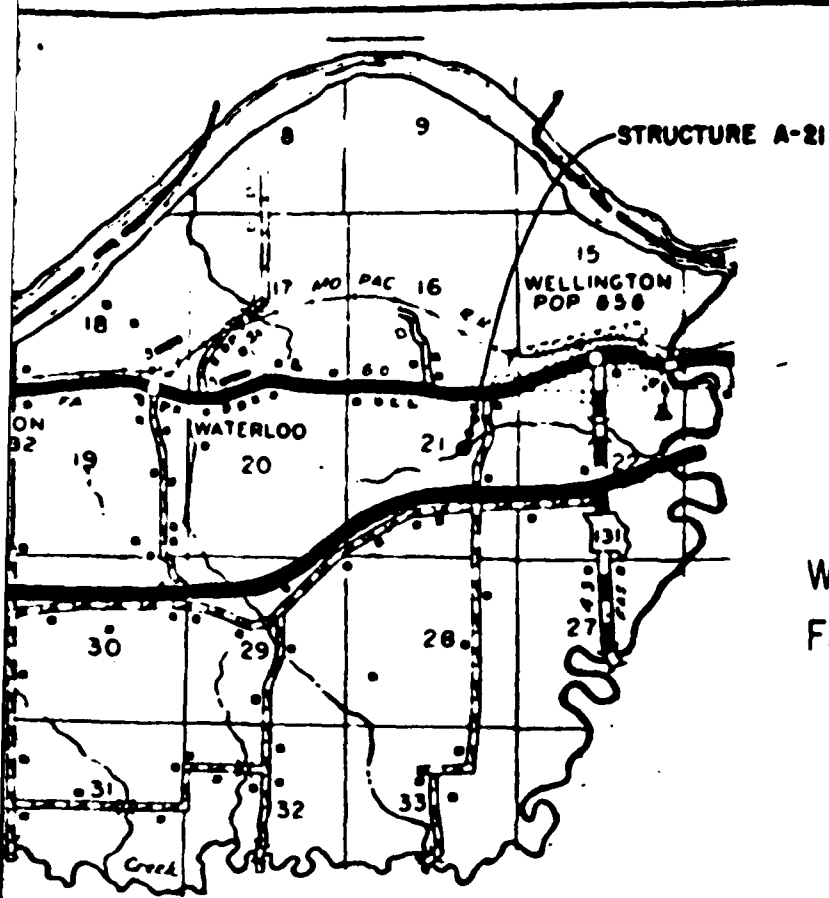
LEGEND

- COUNTY LINE
- SECTION LINE
- PAVED ROAD
- GRADED ROAD
- DIRT ROAD
- PRIVATE ROAD
- RAIL ROAD
- WATER
- PERENNIAL STREAM
- INTERMITTENT STREAM
- BRIDGE ROAD
- WATER SHED POINT
- SECTION NUMBER
- HOUSE
- CHURCH
- CEMETERY
- CITY



LOCATION IN MISSOURI





INDEX OF DRAWINGS	
TYPE	SHEET NO.
Site Plan	1
General Plan of Reception	2
General Plan of Roadway	3
Plan of Embankment and Earthworks	4
General Layout	5
Foundation Drainage System	6
Plot Requirements	7
Struct. Support Details	8
Architect. Color Details	9
Light Details	10
Trash Rack Details	11
Fence Details	12
Structural Details	13
Plan-Geologic Investigation	14
Site	15
100% Sections (with 1% Investigation)	16

U S DEPARTMENT OF AGRICULTURE
 SOIL CONSERVATION SERVICE

**DETAIL PLANS FOR
 WELLINGTON-NAPOLEON
 WATERSHED PROTECTION AND
 FLOOD PREVENTION PROJECT**

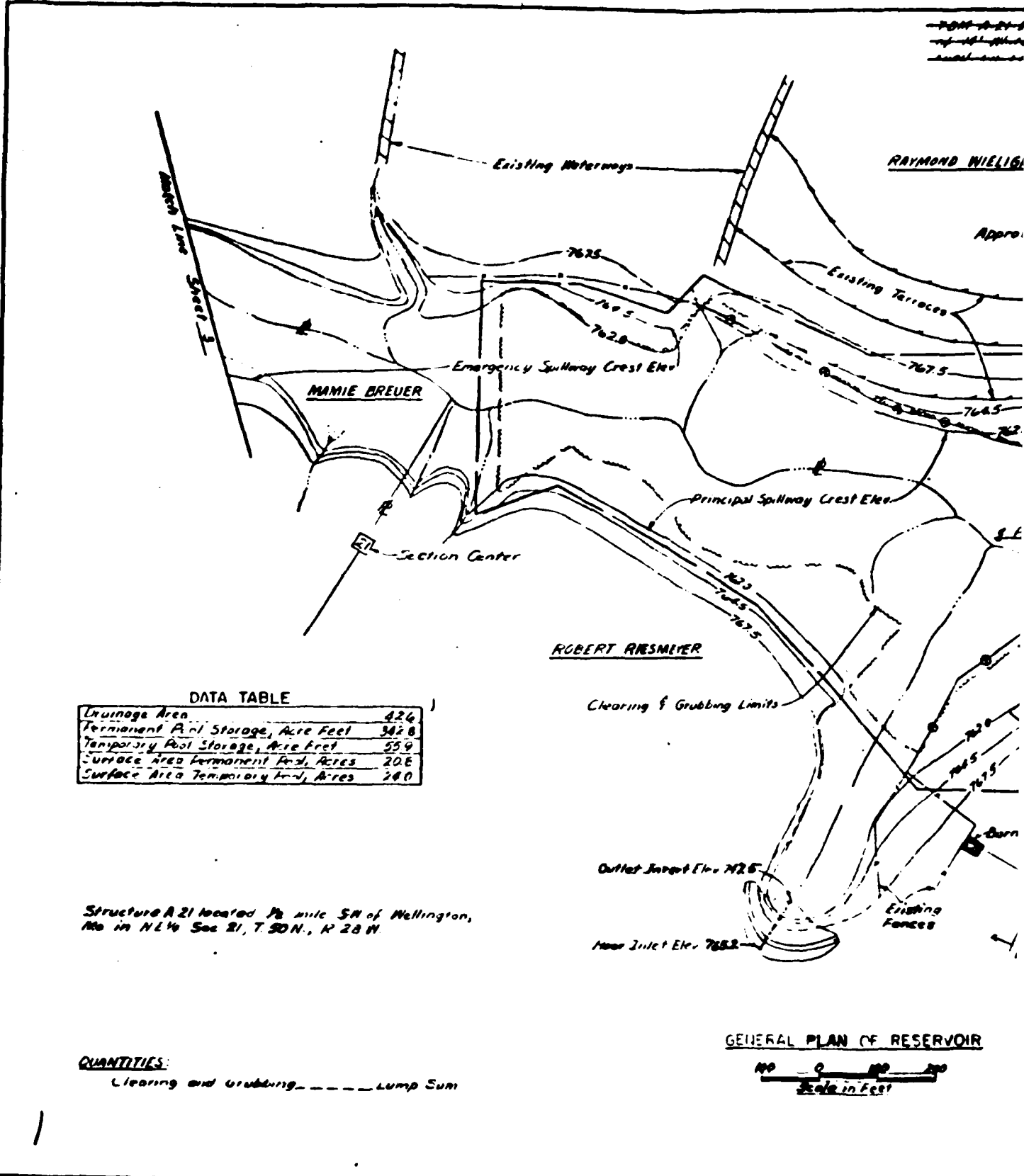
LAFAYETTE COUNTY, MISSOURI
 IN COOPERATION WITH
 SOIL AND WATER CONSERVATION DISTRICT
 OF LAFAYETTE COUNTY
 LAFAYETTE COUNTY COURT

STRUCTURE A-21

AS BUILT

<i>James H. ...</i>	5-6-66
<i>Angela S. ...</i>	5-10-66

SHEET I APPENDIX A



DATA TABLE

Drainage Area	426
Permanent Pond Storage, Acre Feet	342.8
Temporary Pond Storage, Acre Feet	559
Surface Area Permanent Pond, Acres	20.6
Surface Area Temporary Pond, Acres	28.0

Structure A 21 located 1/2 mile SW of Wellington,
Mo in NE 1/4 Sec 21, T. 50 N., R. 28 W.

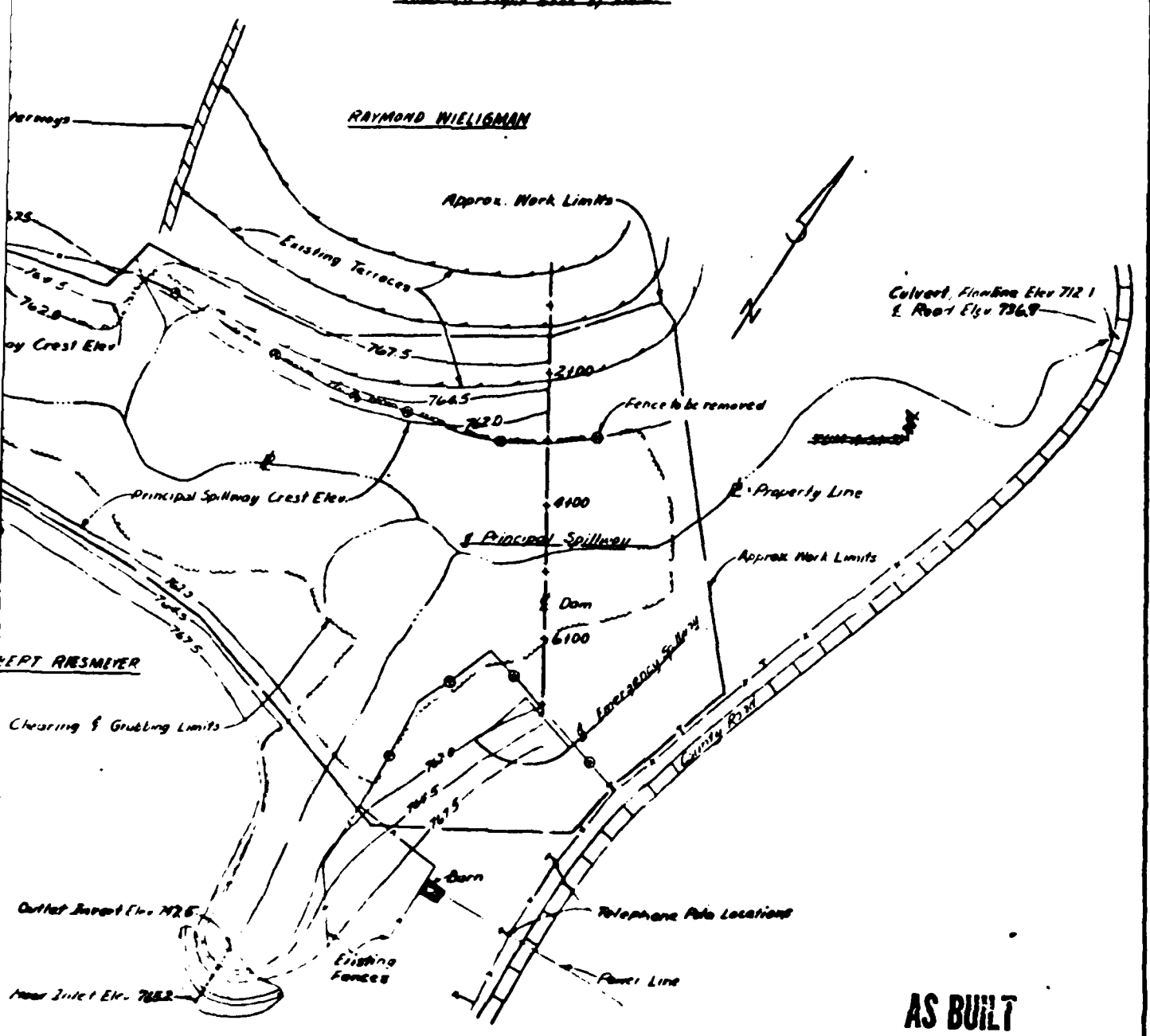
QUANTITIES:

Clearing and Grubbing ----- Lump Sum

GENERAL PLAN OF RESERVOIR



~~From A-21-E Elev 734.65. Ground limits in south part of all plots are trees, approx 236' upstream from actual right bank of stream~~



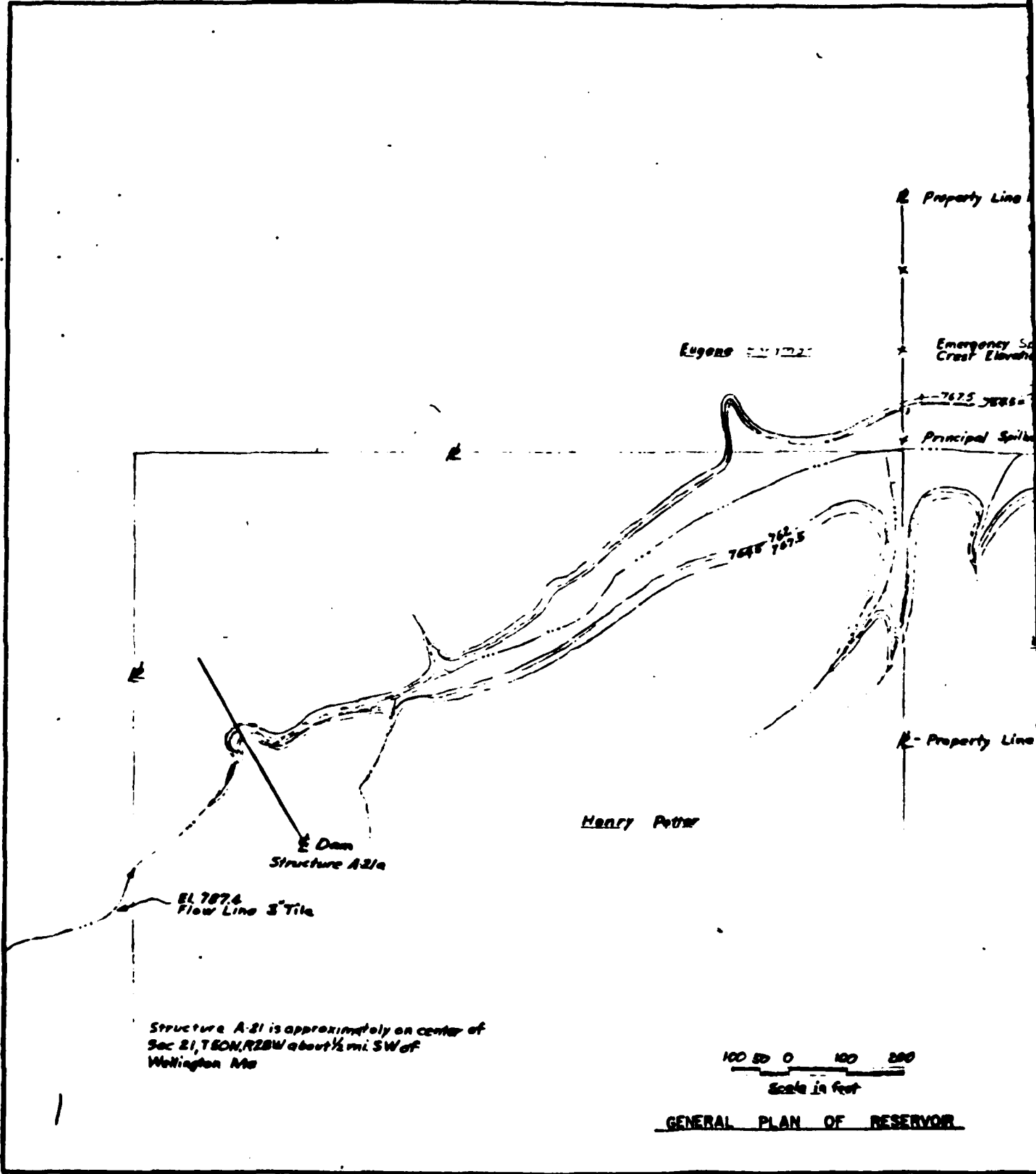
GENERAL PLAN OF RESERVOIR

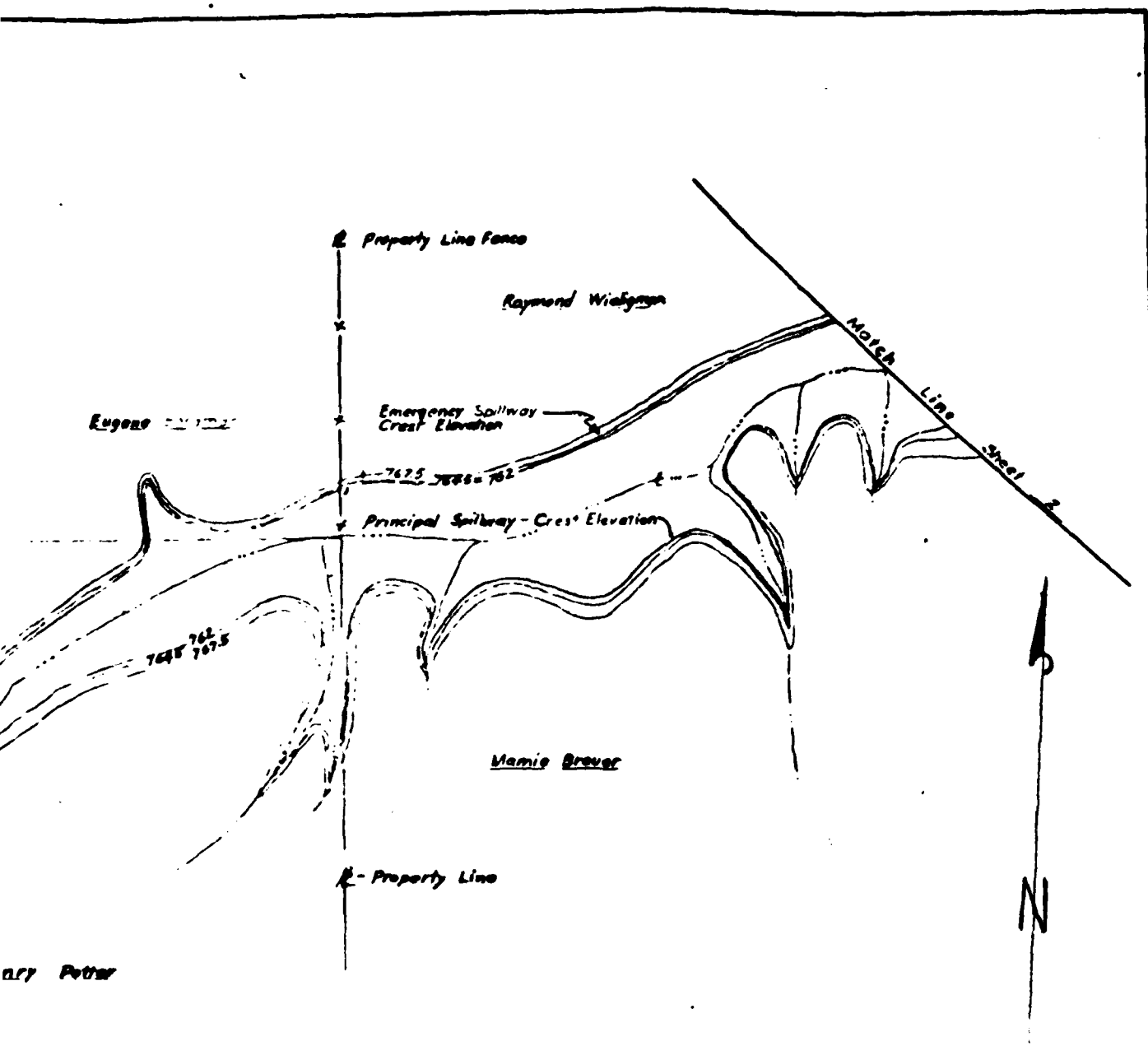


2

AS BUILT

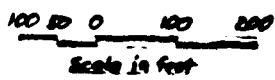
STRUCTURE A-21	
WELLINGTON-LAFOLEON WATERSHED E1555	
LAFAYETTE COUNTY, MISSOURI	
U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE	
Project A E 10-10	247
Draw J A 10-10-101	247
Draw B E 5-11	1/84
... I T 10-10	1/66
S.C.-23,170	





AS BUILT

PL. 566 STRUCTURE A-21	
WELLINGTON-NAPOLEON WATERSHED	
LAFAYETTE COUNTY, MISSOURI	
U.S. DEPARTMENT OF AGRICULTURE	
SOIL CONSERVATION SERVICE	
A. E. Larkin	5/85
J. A. Mummel	2/85
N. H. Randall	2/00
	58-23,170



GENERAL PLAN OF RESERVOIR

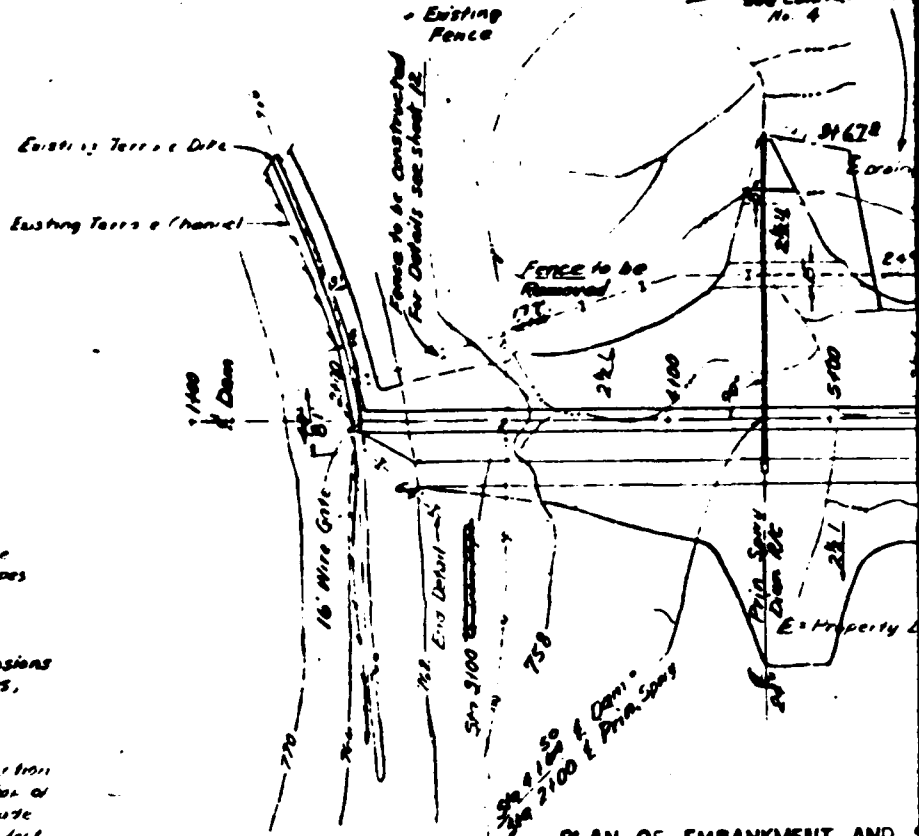
2

SHEET 3 APPENDIX A

KAYMOUL W. ELIEMAN

KAYMOUL W. ELIEMAN

ROBERT R. ESMEIER



NOTES: Topsoil

A minimum of 6 inches topsoil to be placed on all compacted earth fill slopes

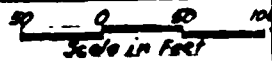
EMERGENCY

Emergency Spillway diversion dimensions 18' effective height, 3:1 side slopes, minimum base width 12'

Existing Terrace Dike

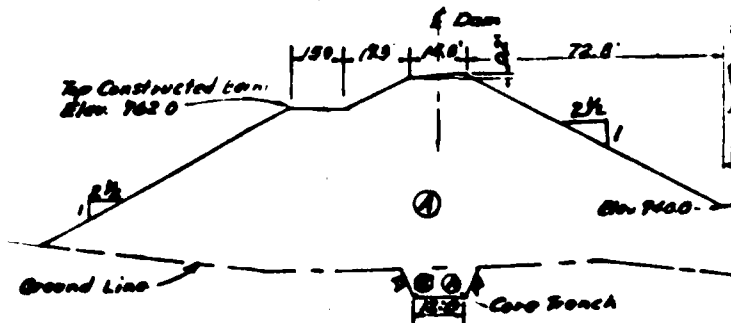
Construct terrace dike per cross section shown. At E dam the elevation of top of dike shall be 767.7. The dike will grade out at elevation 767.5, approx 165 feet downstream from E dam. This item to be subsidiary to "Earth Fill, Class A"

PLAN OF EMBANKMENT AND DAM



TYPICAL CROSS SECTION TERRACE DIKE

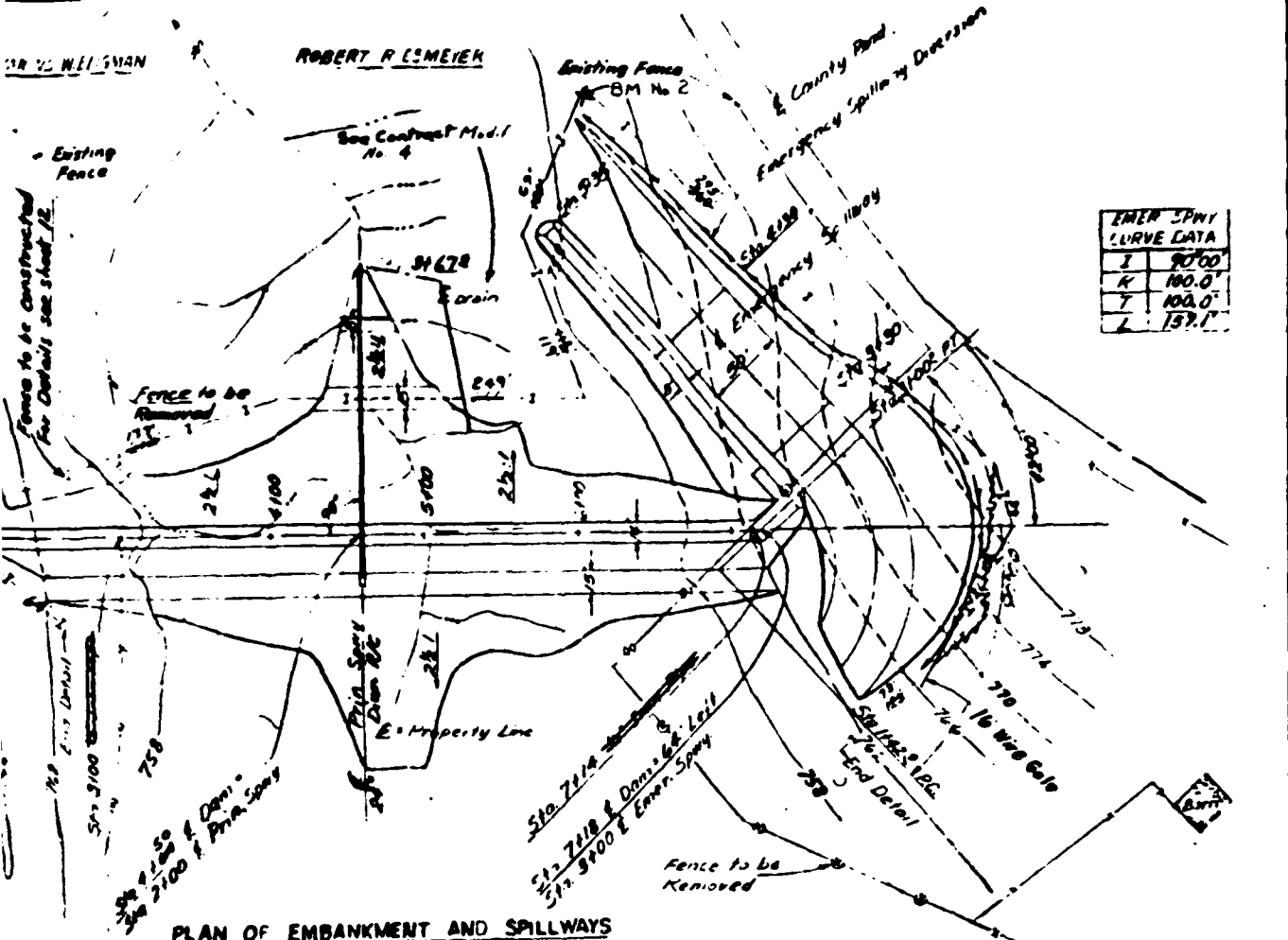
BM No. 2 ELEV. 760.05
Top of bolt in center of bronze plate stamped BM NO. 2 - 1967 - WELL NAP WATERSHED, located 1.5' from Corner Post in NE fence corner on Outlet end of emergency Spillway of Str. A-21 NE 1/4 Sec. 21, T30N, R70W



TYPICAL SECTION OF EMBANKMENT

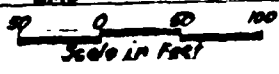
DR. WELLSMAN

ROBERT F. LEMEIER

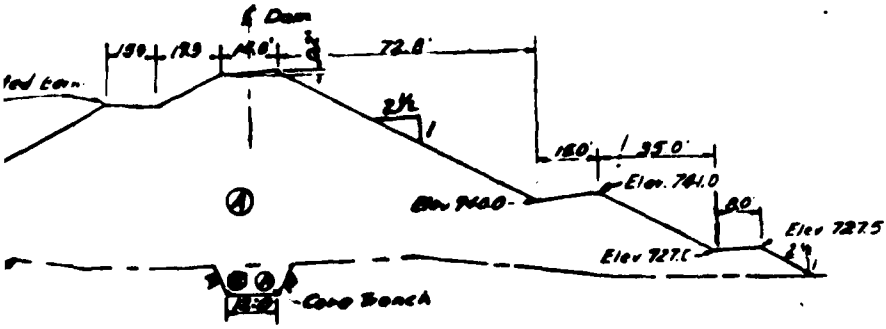


I	90.00
R	100.0'
T	100.0'
L	157.1'

PLAN OF EMBANKMENT AND SPILLWAYS



Excavation Common	206	Cu Yds
Core trench	3298	Cu Yds
Total Foundation	3504	Cu Yds
Earth Fill	49,757	Cu Yds
Fence - Heavy Wire	1,244	Lbs Fp



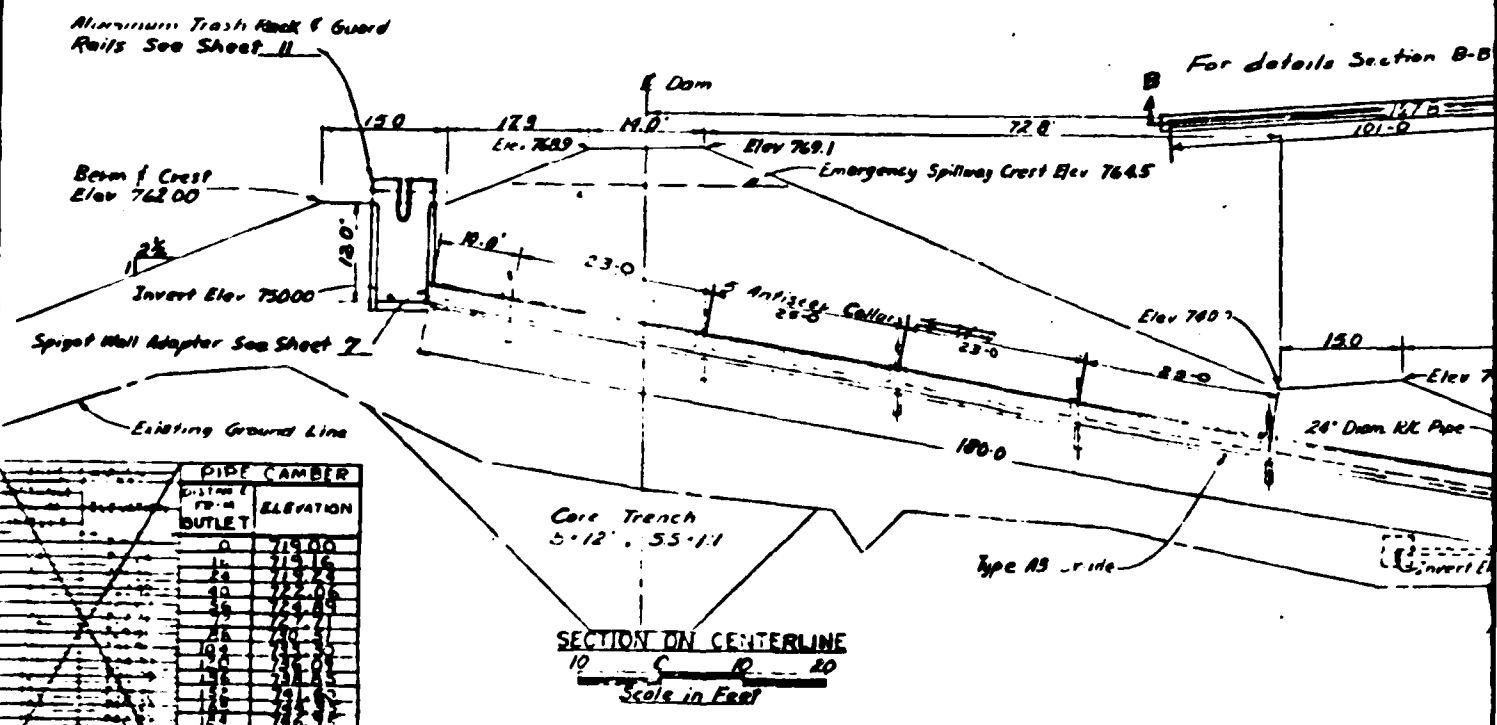
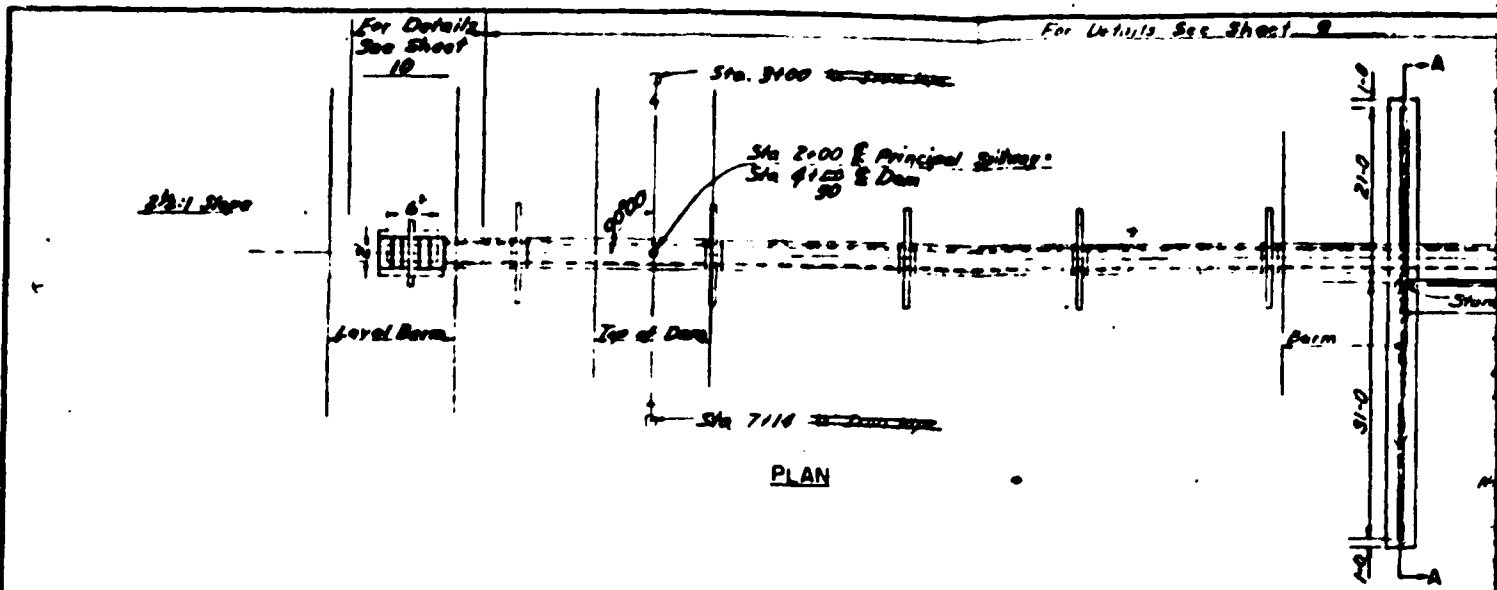
TYPICAL SECTION OF EMBANKMENT

AS BUILT

STRUCTURE A-21
WELLINGTON-NAPOLEON WATERED PL 566
LAFAYETTE COUNTY, MISSOURI
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Drawn by: H. E. Smith 1/56
Checked by: E. P. Hogg 2/56

Sheet No. 5E-23,179



PIPE CAMBER	
DISTANCE FROM BUTLET	ELEVATION
0	75.00
16	75.16
32	75.32
48	75.48
64	75.64
80	75.80
96	75.96
112	76.12
128	76.28
144	76.44
160	76.60
176	76.76
192	76.92
208	77.08
224	77.24
240	77.40
256	77.56
272	77.72
288	77.88
304	78.04
320	78.20
336	78.36
352	78.52
368	78.68
384	78.84
400	79.00
416	79.16
432	79.32
448	79.48
464	79.64
480	79.80
496	79.96
512	80.12
528	80.28
544	80.44
560	80.60
576	80.76
592	80.92
608	81.08
624	81.24
640	81.40
656	81.56
672	81.72
688	81.88
704	82.04
720	82.20
736	82.36
752	82.52
768	82.68
784	82.84
800	83.00
816	83.16
832	83.32
848	83.48
864	83.64
880	83.80
896	83.96
912	84.12
928	84.28
944	84.44
960	84.60
976	84.76
992	84.92
1008	85.08
1024	85.24
1040	85.40
1056	85.56
1072	85.72
1088	85.88
1104	86.04
1120	86.20
1136	86.36
1152	86.52
1168	86.68
1184	86.84
1200	87.00
1216	87.16
1232	87.32
1248	87.48
1264	87.64
1280	87.80
1296	87.96
1312	88.12
1328	88.28
1344	88.44
1360	88.60
1376	88.76
1392	88.92
1408	89.08
1424	89.24
1440	89.40
1456	89.56
1472	89.72
1488	89.88
1504	90.04
1520	90.20
1536	90.36
1552	90.52
1568	90.68
1584	90.84
1600	91.00
1616	91.16
1632	91.32
1648	91.48
1664	91.64
1680	91.80
1696	91.96
1712	92.12
1728	92.28
1744	92.44
1760	92.60
1776	92.76
1792	92.92
1808	93.08
1824	93.24
1840	93.40
1856	93.56
1872	93.72
1888	93.88
1904	94.04
1920	94.20
1936	94.36
1952	94.52
1968	94.68
1984	94.84
2000	95.00

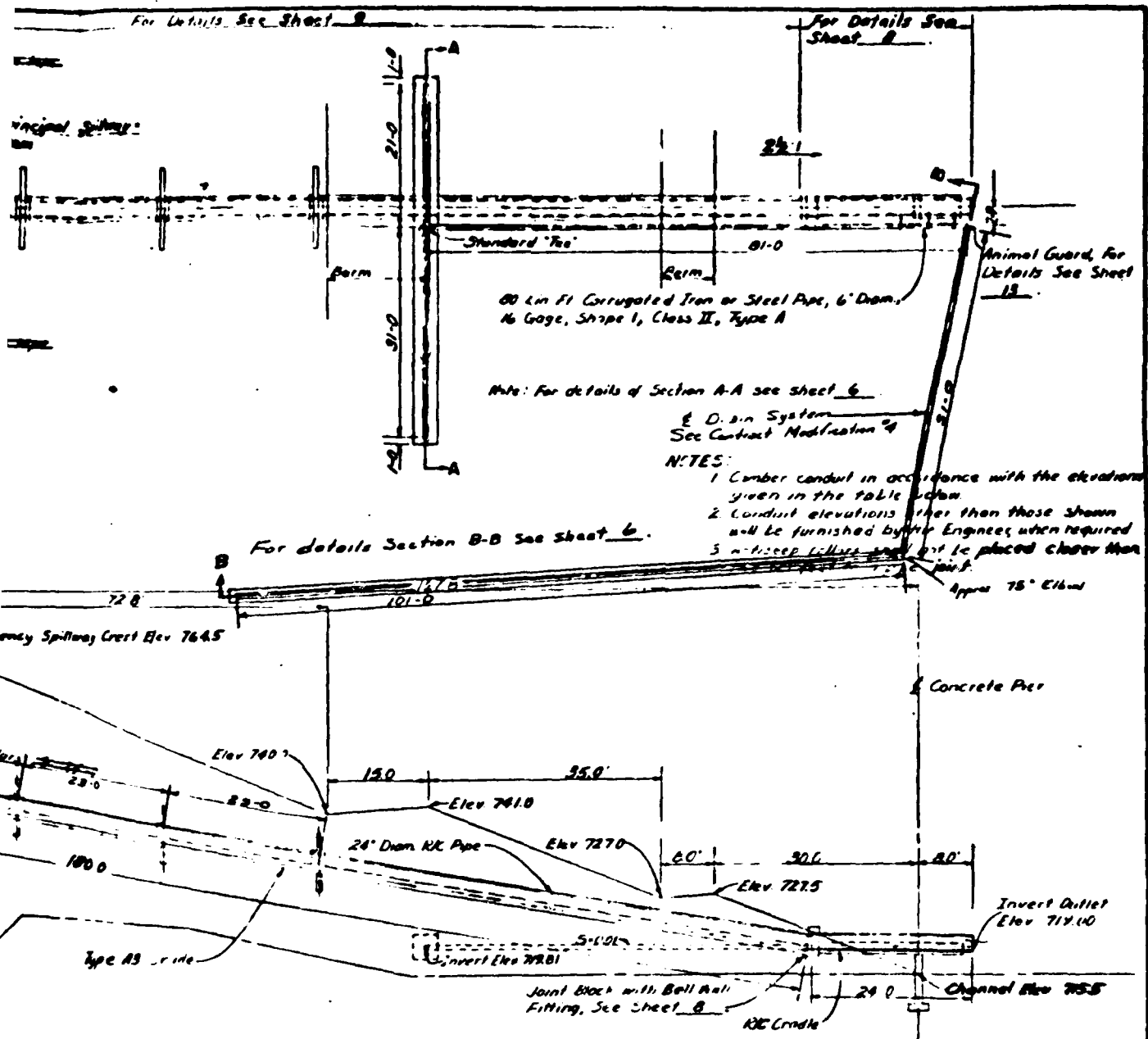
QUANTITIES

- Concrete - Class 2500, Plain
- Concrete - Class 3000, Reinforced
- Steel Bar Reinforcement
- Pipe Conduit Reinforced Concrete (Pressure) 24" Diam, Steel Ring Type Joint and Rubber Gasket
- Aluminum Trash Rack & Guard Rails
- Pipe - Corrugated Iron or Steel, 6" Diam, 16 Gage, Shape 1, Class II, Type A, Perforated
- Pipe - Corrugated Iron or Steel, 6" Diam, 16 Gage, Shape 1, Class II, Type A
- Basin 8" - Fine Filter
- Pipe - Corrugated Iron or Steel, 6" Diam, 16 Gage, Shape 1, Class II, Type A, Perforated
- Pipe - Corrugated Iron or Steel, 6" Diam, 16 Gage, Shape 1, Class II, Type A
- Basin 8" - Fine Filter

Contract Modification # 4

For Details See Sheet 8

For Details See Sheet 8



- NOTES:
1. Camber conduit in accordance with the elevations given in the table above.
 2. Conduit elevations other than those shown will be furnished by the Engineer when required.
 3. 6" deep fillers shall not be placed closer than 12" apart.

AS BUILT

STRUCTURE A-21

R/C DROP INLET FOR 24" DIAM PIPE
GENERAL LAYOUT
WELLSVILLE WATERSHED PL 555
LAFAYETTE COUNTY, MISSOURI

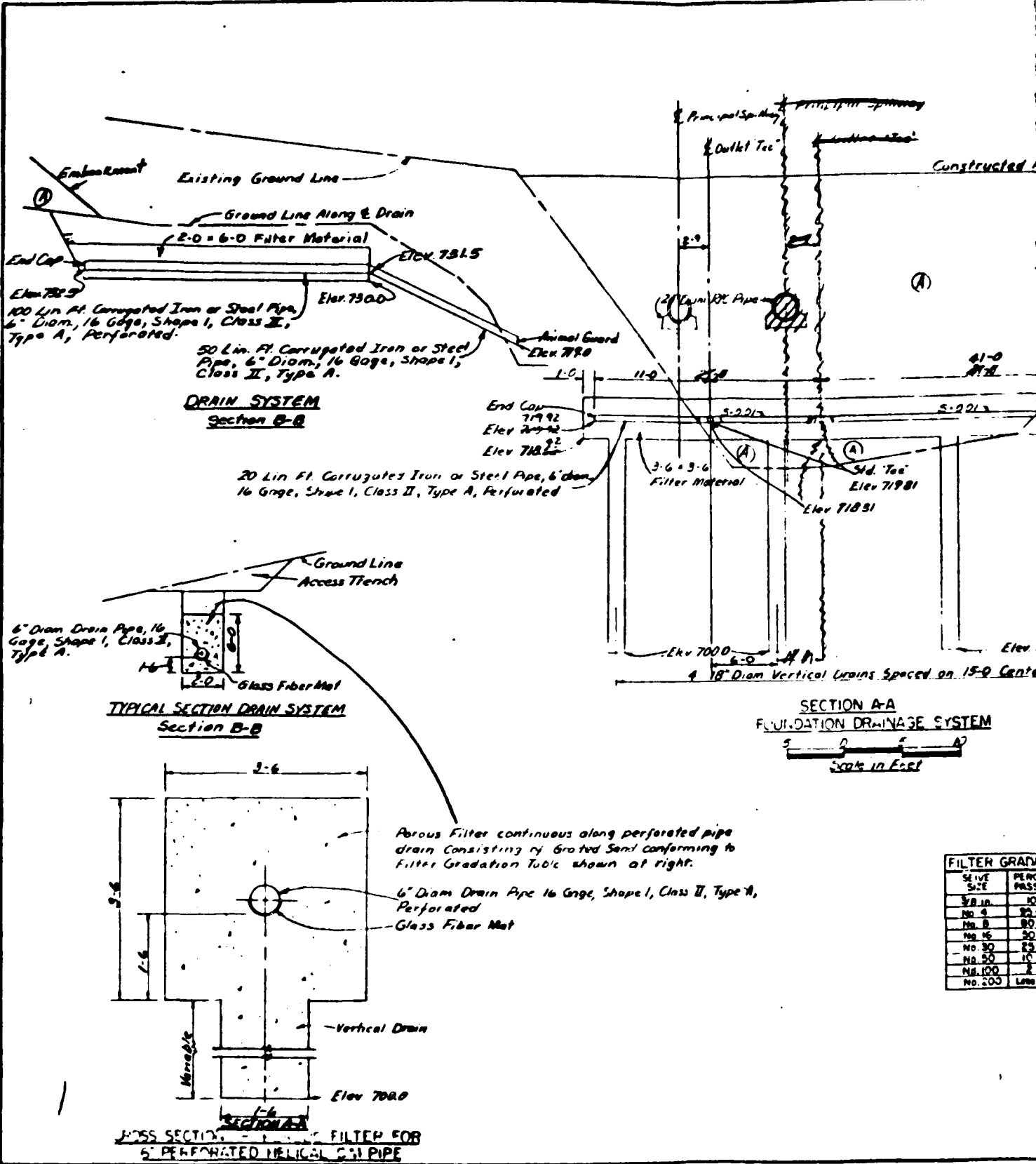
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Prepared by	H. M. Irwin	Date	12/82
Checked by	D. E. Smith	Date	1/85
Drawn by	D. D. Rose	Date	5/86
Project No.		Sheet No.	5
		Project Name	S, E-28, 179

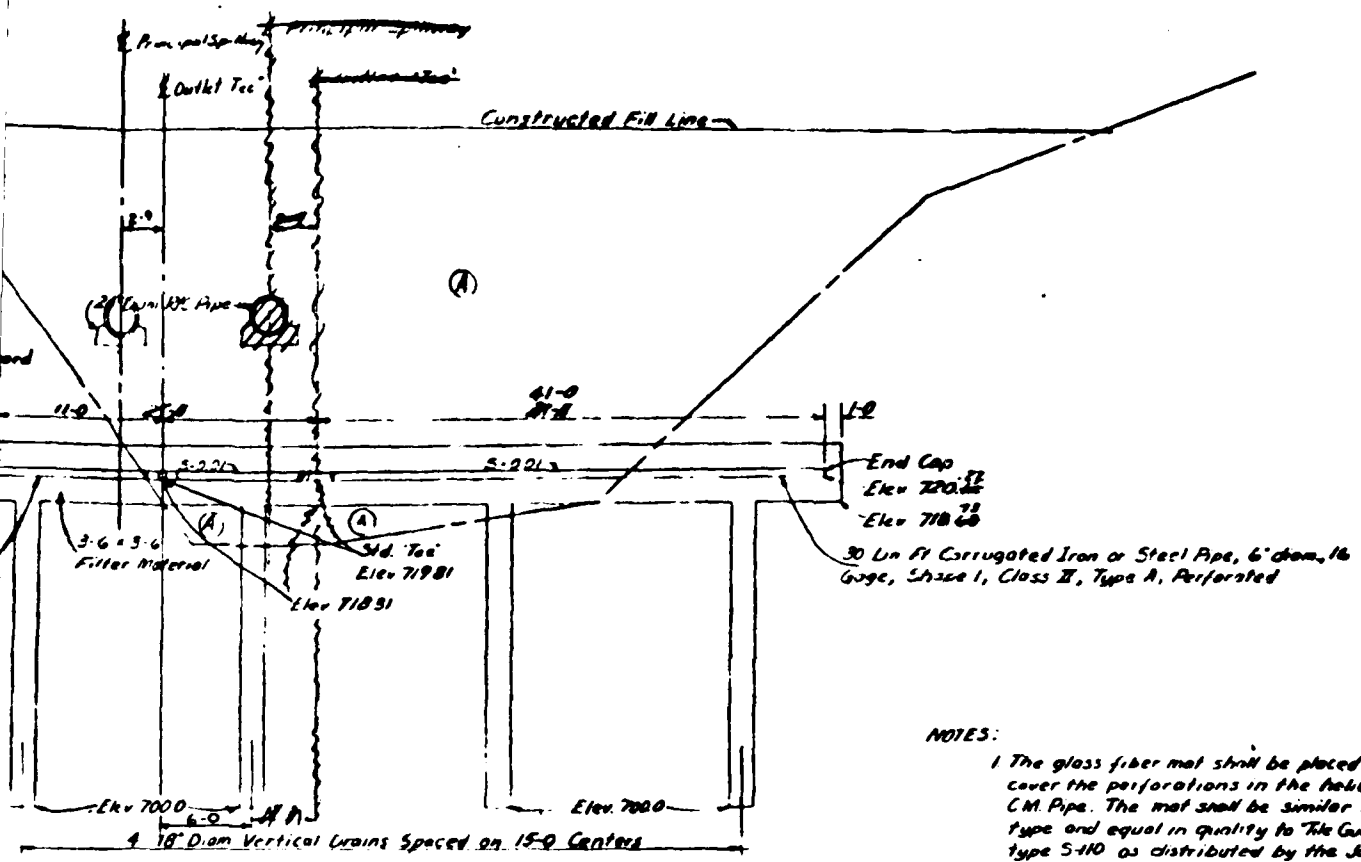
QUANTITIES

24" Diam, Steel King Type Joint and Rubber Gasket	213 Cu Yds
Shape 1, Class II, Type A, Perforated	262 Cu Yds
Shape 1, Class II, Type A	2541 Mins
24" Diam, Steel King Type Joint and Rubber Gasket	264 Lin Ft
Lump Sum	
Shape 1, Class II, Type A, Perforated	50 Lin Ft
Shape 1, Class II, Type A	80 Lin Ft
Shape 1, Class II, Type A	30 Cu Yds
Shape 1, Class II, Type A, Perforated	100 Lin Ft
Shape 1, Class II, Type A	50 Lin Ft
Shape 1, Class II, Type A	25 Cu Yds

SHEET 5 APPENDIX A



SEIVE SIZE	PERC PASS
3/8 in.	10
No. 4	22
No. 8	30
No. 16	35
No. 30	38
No. 50	40
No. 100	42
No. 200	45



SECTION A-A
 FOUNDATION DRAINAGE SYSTEM
 Scale in Feet

- NOTES:
- The glass fiber mat shall be placed to cover the perforations in the tubular C.M. Pipe. The mat shall be similar in type and equal in quality to 'Tite Guard' type S-10 as distributed by the Johns-Manville Corporation. Payment for furnishing and installation of glass fiber mat will be subsidiary to the item 'Drain Fill'.
 - For drain support detail see sheet 13.

ing perforated pipe
 1 Sert conforming to
 an at right.
 Shape 1, Class II, Type A,

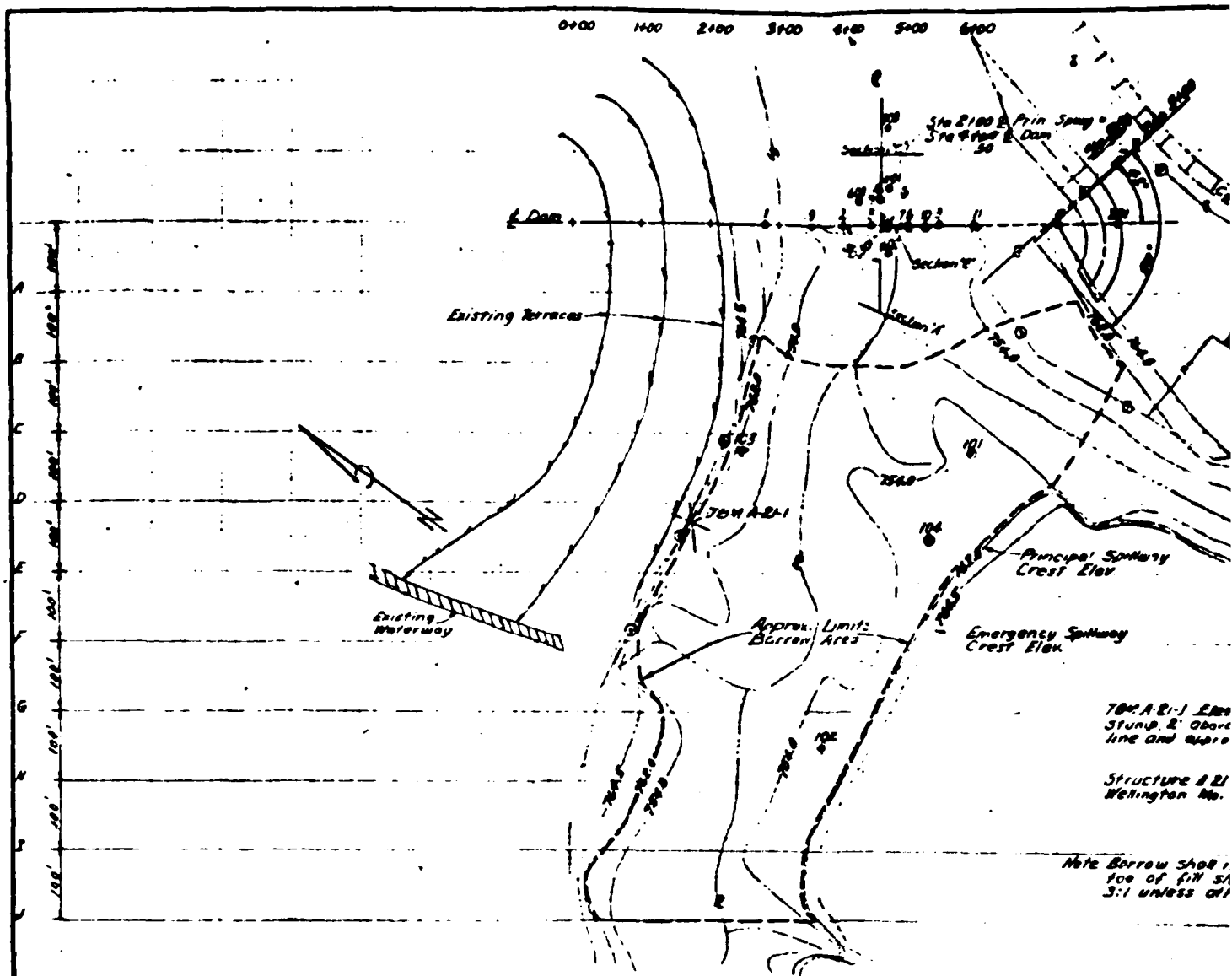
FILTER GRADATION	
SEIVE SIZE	PERCENT PASSING
3/8 in.	100
No. 4	82-100
No. 8	80-100
No. 16	50-88
No. 30	22-60
No. 50	10-30
No. 100	2-10
No. 200	Less Than 8

2

AS BUILT

STRUCTURE A-21 FOUNDATION DRAINAGE SYSTEM WELLINGTON/NAPOLEON WATERSHED PL. 566 LAFAYETTE COUNTY, MISSOURI	
U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE	
By: N. H. Remondt	DATE: 1/66
By: B. E. Smith	DATE: 1/66
By: N. H. Remondt	DATE: 2/66
S.C.-28,179	

APPENDIX B



PLAN OF DAM, EMERGENCY SPILLWAY AND BORROW AREA (S)

Sta. 6+00
Grid C125

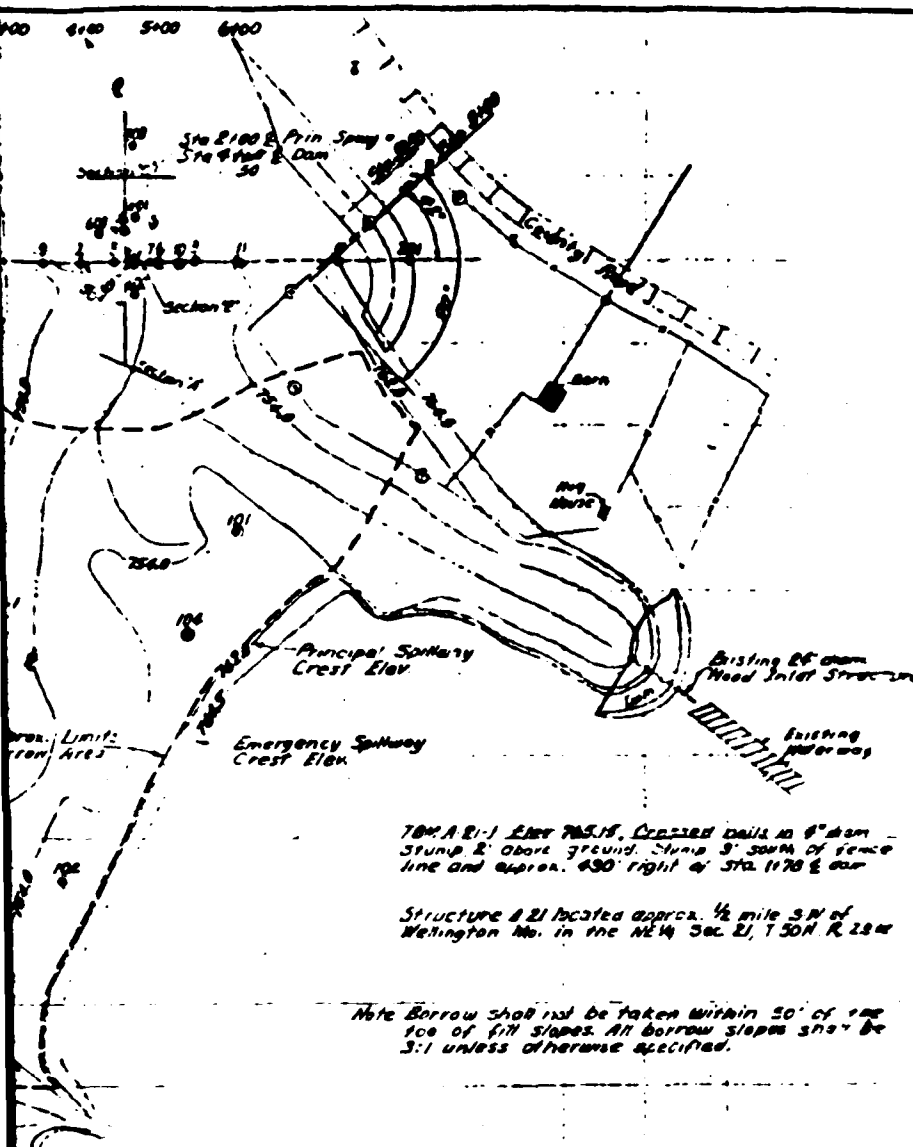
Sta. 5+70
Grid G150

Sta. 1
Grid I



GEOLOGIC CROSS SECTIONS OF BORROW AREA (S)

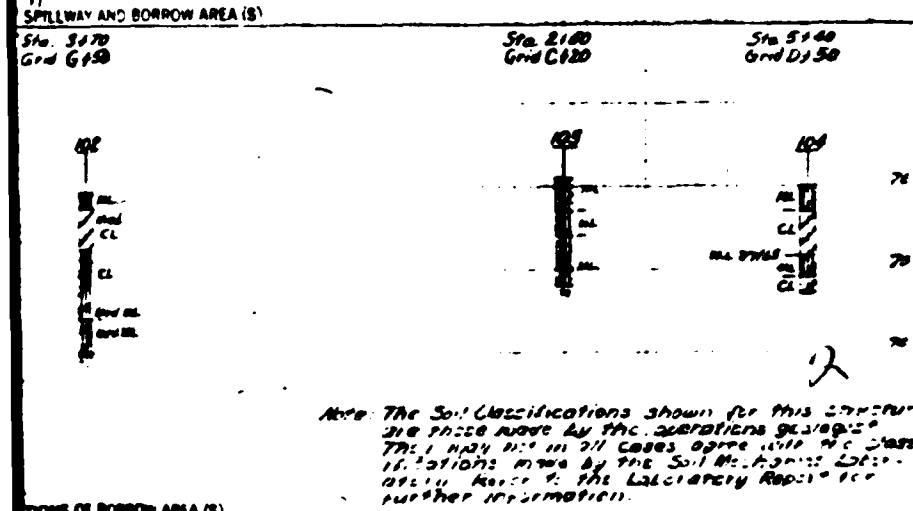
Note: The Soil Classifications shown above may be in violation of the Soil Classification Manual, 1952, unless otherwise shown.



704 A 2-1 Elev 705.18, Crossed dam at 8' diam
 stump 2' above ground, stump 3' S.W.M. of fence
 line and approx. 450' right of Sta. 1170 E. dam

Structure 21 located approx. 1/2 mile S.W. of
 Wellington Mo. in the NE 1/4 Sec 21, T50N R. 28W

Note Borrow shall not be taken within 50' of any
 toe of fill slopes. All borrow slopes shall be
 3:1 unless otherwise specified.



LEGEND

SYMBOLS

UNCONSOLIDATED MATERIAL

Blank	Diagonal lines /	Diagonal lines \	Horizontal lines	Vertical lines	Stippled
Diagonal lines /	Diagonal lines \	Horizontal lines	Vertical lines	Stippled	Other symbols

CONSOLIDATED MATERIAL

Sedimentary Rocks

Blank	Diagonal lines /	Diagonal lines \	Horizontal lines	Vertical lines	Stippled
-------	------------------	------------------	------------------	----------------	----------

Metamorphic Rocks

Blank	Diagonal lines /	Diagonal lines \	Horizontal lines	Vertical lines	Stippled
-------	------------------	------------------	------------------	----------------	----------

Other Symbols

- Circle with dot: Not logged only
- Circle with cross: Not sampled
- Circle with slash: Other and dry
- Circle with asterisk: Wet or moist

ABBREVIATIONS

100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141

TEST HOLE NUMBERING SYSTEM

Continuity of dam	1 00	Stream channel	001 - 009
Borrow area	101 - 199	Rebel wells	100 - 200
Emergency spillway	201 - 299		001 - 009
Continuity of outlet structure	301 - 399		701 - 799

UNIFIED SOIL CLASSIFICATION SYSTEM SYMBOLS

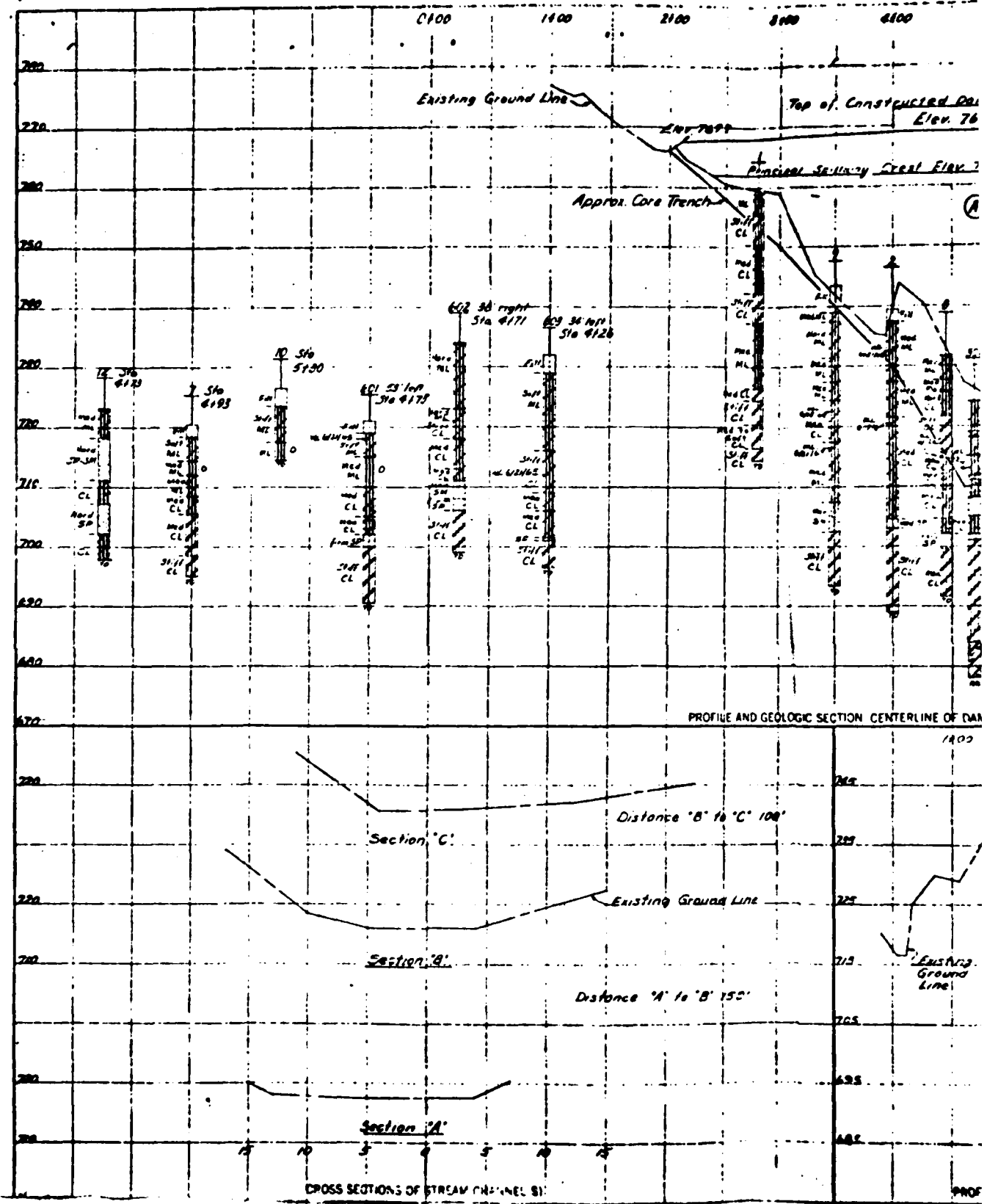
- GM: Well graded gravel, gravel sand mixture
- GP: Poorly graded gravel
- GM-SC: Silty gravel, gravel sand silt mixture
- GC: Clayey gravel, gravel sand silt mixture
- SM: Well graded sand, sand gravel mixture
- SP: Poorly graded sand
- SW: Silty sand
- SC: Clayey sand, sand-silt mixture
- ML: Silty with liquid limit of 50 or less
- MH: Silty with liquid limit above 50
- CL: Clays with liquid limit of 50 or less
- CH: Clays with liquid limit above 50
- OL: Organic silts and clays with liquid limit of 50 or less
- OH: Organic silts and clays with liquid limit above 50

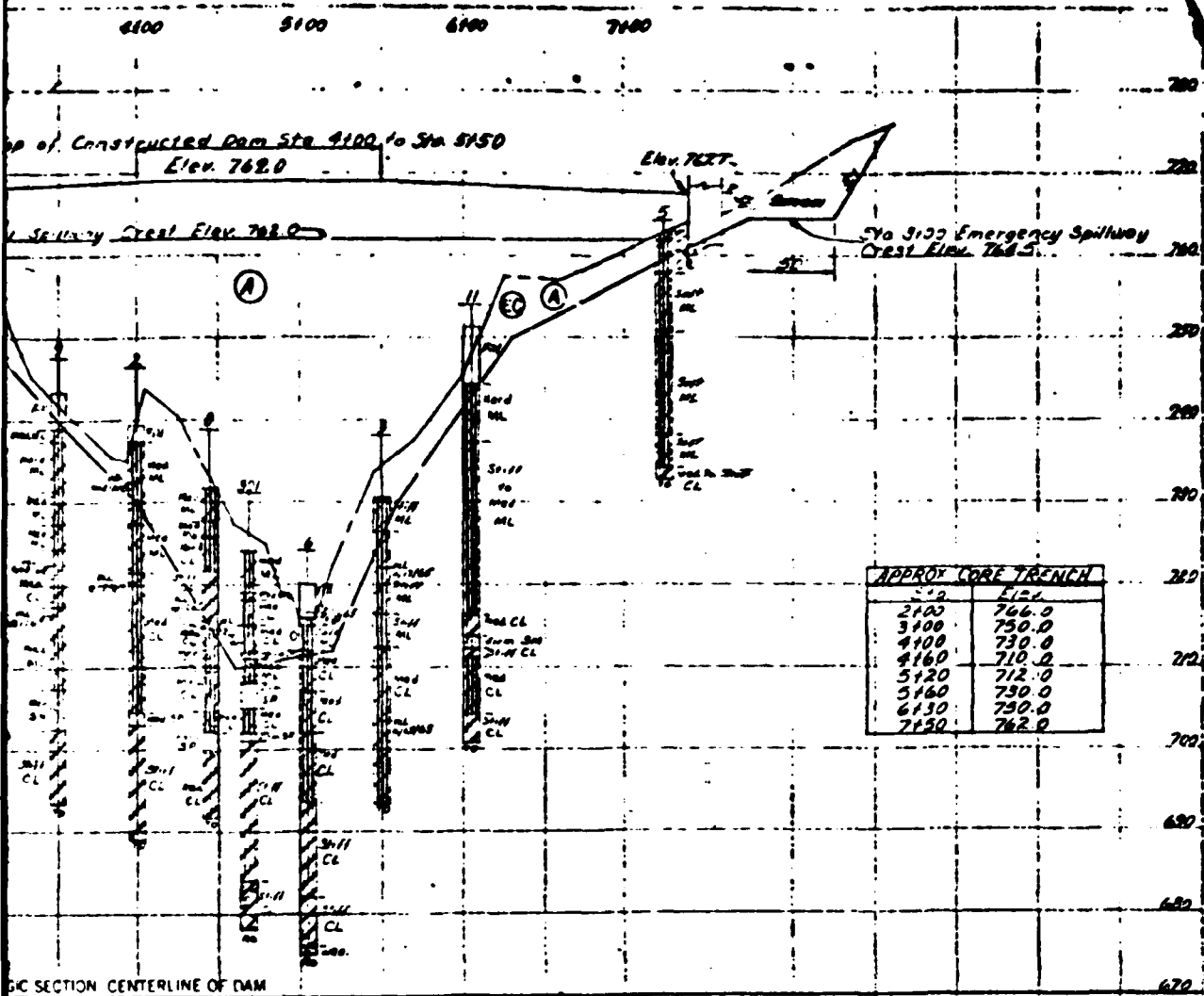
AS BUILT

PLAN AND PROFILES FOR GEOLOGIC INVESTIGATIONS

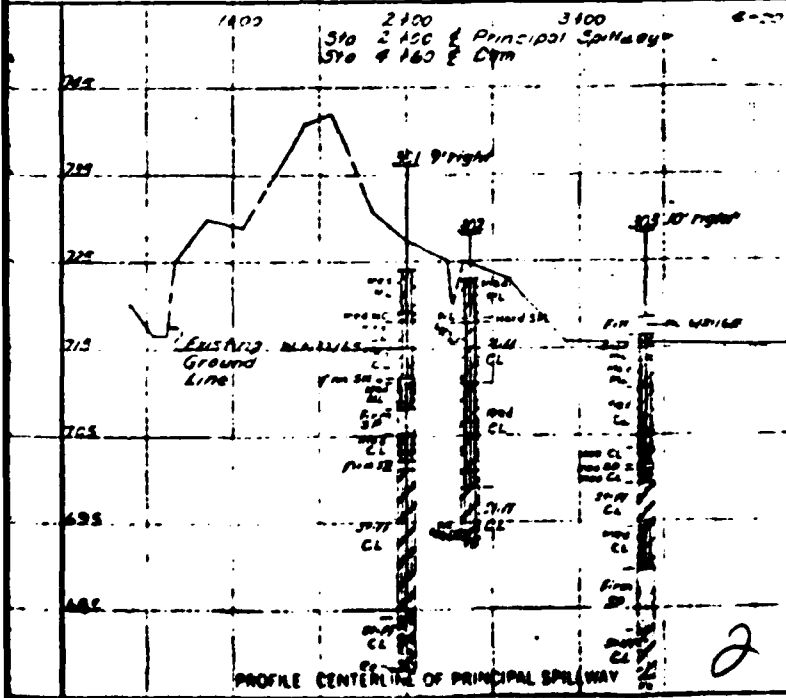
**U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE**

Station Engineer: 10 S, E-28, 170
 Date: 1/6





APPROX CORE TRENCH	
Sta	Elev
2100	766.0
3100	750.0
4100	730.0
4160	710.0
5120	712.0
5160	750.0
6130	750.0
7150	762.0



SHEET 2 APPENDIX B

PLANS AND PROFILES FOR GEOLOGIC INVESTIGATIONS
 STRUCTURE A-21
 WELLINGTON-NAPOLEON WATERSHED P.L.566
 LAFAYETTE COUNTY, MISSOURI

**U. S. DEPARTMENT OF AGRICULTURE
 SOIL CONSERVATION SERVICE**

Investigated by F. E. Edwards	Date 6/65	Approved by
Checked by W. H. Randall	Date 2/66	Drawn by
Design Engineer	Scale 1" = 10'	Project No. 5,8-28,179

DETAILED GEOLOGIC INVESTIGATION OF DAM SITES

GENERAL

State Missouri County Lafayette ; S. 1 W. 21 E. 4 Sec. 21 , T. 50 N. R. 25 W. ; Watershed Holliston-Mason
Subwatershed _____ Fund class FP-2-10 Site number A-21 Site group I Structure class A
(FP-2, WP-1, etc.)
Investigated by W. F. Edwards Equipment used 1951C-10 Date 6-15-65
(signature and title) (Type, size, make, model, etc.)

SITE DATA

Drainage area size 57 sq. mi., 425 acres. Type of structure DT DC Purpose Stabilization
Direction of valley trend (downstream) NE Maximum height of fill 50.0 feet. Length of fill 55 feet.
Estimated volume of compacted fill required 40,000 yards

STORAGE ALLOCATION

	Volume (ac. ft.)	Surface Area (acres)	Depth at Dam (feet)
Sediment	<u>343</u>	<u>20.0</u>	<u>45.0</u>
Floodwater	<u>377</u>	<u>22.7</u>	<u>47.0</u>

SURFACE GEOLOGY AND PHYSIOGRAPHY

Physiographic description Missouri Basin loess Topography Rolling hills Altitude of beds: Dip _____ Strike _____
Steepness of abutments: Left 25 percent; Right 30 percent. Width of floodplain at centerline of dam 0 feet
General geology of site: The site is located in moderately rolling land with slopes ranging from 4 to 10 percent. ridge deposits of loess range in depth from approximately 25 to 5 feet in depth and are overlying alluvium, position or bedrock. Bedrock is the Merion, Is or Desmoinesian Series of the Pennsylvanian System and consist of cyclic deposits and characterized by thin sandstone with thin coal seams of local occurrence. The drainage pattern is well developed.

DETAILED GEOLOGIC INVESTIGATION OF DAM SITES

Centerline of Dam, Principal Spillway, Emergency Spillway, The Stream Channel,

(Centerline of Dam, Principal Spillway, Emergency Spillway, Stream Channel, Investigations for Design of Structure, Borrow Area, Reservoir Basin, etc.)

DRILLING PROGRAM

Equipment Used	Number of Holes		Number of Samples Taken		
	Exploration	Sampling	Undisturbed (state type)	Disturbed Large	Small
FA, SP, T	11	9	8 Shelby	6	16
HA		1		1	
Total	11	10	8	7	16

SUMMARY OF FINDINGS
(Include only factual data)

The loess soil on the abutments is developed to a depth of approximately 11 to 12 feet and classified a medium CL. The underlying loess is classified as medium ML to low CL. The loess is underlain with alluvial deposits which vary in composition and consistency. The first zone is mostly CL material with blow counts ranging from 5 to 10. This is underlain by a stiff CL with blow counts of 10 or more. Refusal in TH #301 and #6 was at elevation 672 and 675 respectively. Gravelly clay classified CL occurs above the bedrock. Strata, pockets and lens of S, SP and CL with thin stratum of sand were found throughout the central part embankment foundation and the foundation of the principal spillway. Material classified as organic ML and HL high in organic matter occurs below the channel, in the right abutment and along the CL of the Principal Spillway.

Borrow areas located are to extend 1000 feet from the centerline of dam.

Borrow Area	Top Soil	Estimated Cubic Yards of Corrected Fill Available
101	5,625	16,875
103	2,000	5,500
Emergency Spillway	250	750

DETAILED GEOLOGIC INVESTIGATION OF DAM SITES

1-59
State Missouri County Lafayette Watershed Wellington-Napoleon Subwatershed _____
Site number A-21 Site group I Structure class A Investigated by Ruel F. Edwards Date 6-15-65
(signature and title)

INTERPRETATIONS AND CONCLUSIONS

The loess in the abutments below the developed soil profile is classified as medium PL to low CL except for the stiff CL in TH #1 from 17 to 22 feet. Estimated R/C of the medium loess is 4 to 6 and the stiff CL R/C of 10. The material on the right classified as organic PL and PL with organic matter is dark in color and partially decomposed organic material is evident. The R/C was 4 to 10 however the water level was below this zone at the end of drilling but became static at 8.5 feet. The zone was separated in the field on the basis of apparent organic content, however, shelsys were taken in representative areas for laboratory analysis. The underlying CL material had R/C of 5.7, and 9 in TH #3 and from 5 to 13 in TH #6. There was no recovery of split tube samples in TH #6 on some of the drives and blow counts of there are probably not valid. The sand pocket encountered in TH #12, CL station 4 + 75, at five feet was reported to auger hard but appeared loose, wet, and permeable and classified as SH or SP. This pocket was not in TH #301 located at CL station 4 + 69 or TH #601 located 53' down stream from CL station 4 + 73 or TH #602 located 38' upstream from CL station 4 + 71 or TH #603 located 34' downstream from CL station 4 + 26. The greenish colored sand encountered in TH #12 and classified SP at elevation 707 occurs consistently in the central part of the foundation and along the CL of the principal spillway. It occurred at elevation 700 in TH #301 which was 3 feet thick and was one foot thick from elevation 701 to 702. It is 2.5 thick at elevation 702.5 in TH #2, 1 1/2 feet thick at elevation 704.5 in TH #2, 5 feet thick, classified SM, at elevation 707.5 in TH #2. It was found at generally the same elevations in TH #601, 602, 603, and 303. Similar material classified SP was 7 feet thick at elevation 69.6 in TH #303. The gravelly clay classified CL occurring above bedrock in TH #6, #301, and 303 is not permeable.

The emergency spillway will be in loess and highly erosive. Excavations from the spillway used in the embankment will be similar and should be placed like borrow sample #103.1.

Borrow material is scarce. An estimated 10,000 cubic yard will need to be located either within the gully banks or above the crest elevation of the principal spillway. An additional 7000 cubic yards can be obtained by extending the borrow areas to the crest elevation of the emergency spillway. Top soil is normally deep on this soil area ranging up to 2 feet thick. Stone wash covers the top soil on the flatter slopes adjacent to the tiller line in the gully banks to an additional depth of approximately 2 feet. The slopes of borrow areas cut steeper than 3 : 1 will increase the hazard of sloughing and slipping on the slopes particularly with in the reservoir area during the time required for the pool to fill.

The area between the gully banks in the foundation is wooded. The root zone will be deep, estimated to be as much as 15'.

The channel is active and cutting. Minimum treatment should be required.

UNITED STATES GOVERNMENT

Memorandum

Ques

TO : W. S. Culpepper, State Conservation Engineer, SCS, Columbia, Missouri 65202 DATE: October 11, 1965

FROM : Rey S. Decker, Head, Soil Mechanics Laboratory, SCS, Lincoln, Nebraska 68508

SUBJECT: ENG 22-5, Missouri WP-08, Wellington-Napoleon, Site No. A-21 (Lafayette County)

ATTACHMENTS

1. Form SCS-354, Soil Mechanics Laboratory Test Data, 4 sheets.
2. Form SCS-128 and SCS-128A, Consolidation Data, 1 test, 3 sheets.
3. Form SCS-127, Soil Permeability, 1 sheet.
4. Form SCS-355, Triaxial Shear Test Data, 6 sheets.
5. Form SCS-152, Compaction and Penetration Resistance, 7 sheets.
6. Form SCS-357, Summary - Slope Stability Analysis, 2 sheets.
7. Form SCS-372, Recommended Use of Excavated Material, 1 sheet.

INTERPRETATION AND DISCUSSION OF DATA

FOUNDATION MATERIALS

- A. Description and Classification. The complicated geology of this site had been quite well interpreted in the report. The site has loess over preconsolidated alluviums with sands that show some evidence of past channeling. The creek channel is degrading at present but organic matter may indicate intermediate reworking.

The loess is logged as CL over soft ML. The alluvium samples which were submitted class as SP-SM, SM, ML, CL, and CH. These materials are stratified and contain pockets of organic material.

Water table is near the base of the loess in most places.

- B. Dry Unit Weight (Blow Count). Six undisturbed samples were submitted. One was a SM on which no density tests were made and the rest varied from ML to CH. The range in dry unit weight for the specimens tested was from 1.04 g/cc to 1.39 g/cc with a corresponding blow count range of 5 to 10 blows per foot. The total range in blow count was from 3 to 13 blows per foot.
- C. Consolidation: A test was made on a specimen from Sample 66W656 at an initial density of 1.53 g/cc as compared to the core opening density of 1.36 g/cc. The test results indicate a consolidation potential of less than .04 ft./ft. under the load of the proposed fill. Since the average density appears to be lower, a potential of .04 ft./ft. will be assumed for a 20-foot depth under the channel area.

2 -- W. S. Culpepper -- 10/11/65

Rey S. Decker

Subj: ENG 22-5, Missouri WP-08, Wellington-Napoleon, Site No. A-21
(Lafayette County)

At Station 4+73 (conduit location) the blow count and materials logged indicate only about half this potential, or 0.6 foot in a 26-foot depth. Based on $b = 260$ feet, $h = 42$ feet, $d = 26$ feet, a maximum horizontal strain of only .004 ft./ft. is computed.

- D. Permeability: Both horizontal and vertical tests were made on the SM sample. Rates of $k_h = 0.2$ ft./day and $k_v = .006$ ft./day were reported. During the consolidation test, a rate of $k = 0.02$ ft./day was found for the ML specimen.

Rates as high as $k = 20$ ft./day are indicated for the clean SP-SM submitted from TH No. 12. Unless it can be proven to be a very limited pocket, not extending upstream or downstream beyond the toes of the fill, it will be necessary to cut off or drain this stratum represented by Sample 66W661 (12.3) and indicated in the logs as extending from 16 feet to 21 feet in depth.

- E. Shear Strength: The following shear tests were performed:

Sample Number	Location	Material	Test	Shear Strength
66W656	Hole No. 6, 15.5'-17'	CL	Triaxial CU*	27.5° - 425
66W657	Hole No. 6, 30.5'-32'	CH	q_u	0° - 2550
66W658	Hole No. 10, 10.5'-11'	ML	Triaxial CU*	18.5° - 1050
66W659	Hole No. 11, 20.5'-22'	CL	q_u	0° - 1400

*CU - Consolidated, undrained.

The weaker shear strength indicated by the test on 66W656 may extend down as deep as 20 feet, based on blow count, in the channel area only.

EMBANKMENT MATERIALS

- A. Classification: Borrow samples submitted all class as CL and are all fine materials with LL varying from 36 to 42 and PI from 13 to 20.
- B. Compacted Dry Density: Standard Proctor tests were made on all the large-bag samples. Maximum dry densities varied from 100.5 p.c.f. to 104.5 p.c.f.
- C. Permeability: All compacted borrow like the samples submitted will be low in permeability.

3 -- W. S. Culpepper -- 10/11/65

Rey S. Decker

Subj: ENG 22-5, Missouri WP-08, Wellington-Napoleon, Site No. A-21
(Lafayette County)

- D. Shear Strength: Consolidated, undrained triaxial shear tests were made on two samples. The tests were made on specimens molded to 95% of standard density and soaked before shearing. Test values were $\phi = 11.5^\circ$, $c = 925$ p.s.f. for 66W662 and $\phi = 19^\circ$, $c = 850$ p.s.f. for 66W663.
- E. Consolidation: No tests were made. Based on the nature of these materials and previous tests, a residual settlement of 2.5% of the fill height at the channel is expected.

SLOPE STABILITY ANALYSIS

Slope stability was checked by a Swedish circle method. A phreatic line was assumed as developed from the emergency spillway crest and impinging on the downstream slope at the berm, elevation 740. Cracking was assumed down to the phreatic line. Weak foundation was assumed to a 22-foot depth.

Even with these severe assumptions, a minimum upstream safety factor of 1.29 against full drawdown and a downstream safety factor of 1.58 were computed.

SETTLEMENT STRAINS

Differential settlement will cause some strains but the plastic embankment materials should be able to adjust without cracking.

CONCLUSIONS AND RECOMMENDATIONS

- A. Cutoff: It appears impractical to cut off all the organic or stratified material and sand pockets noted in this foundation. A cutoff trench of moderate depth (5 feet to 8 feet) is suggested with a short drain.
- B. Principal Spillway: The proposed location has foundation conditions acceptable for a concrete pipe.

Use a pipe camber of 0.5 foot.

Base pipe joint design on a maximum horizontal strain of .004 ft./ft.

- C. Drainage: Due to the stratification, organic materials and sand pockets, it is believed desirable to provide drainage under the downstream berm from about $\frac{1}{2}$ Station 4+50 to 5+50. The drain trench should be 8 feet to 10 feet deep to contact the more permeable strata and outlet into a slotted pipe.

Unless it is proven that the deep sand pocket represented by Sample 66W661 (12.3) does not extend upstream or downstream beyond the toes of the proposed fill, it must be relieved by a well. A deep pit backfilled with filter sand would accomplish this if this would be more economical than a standard well.

4 -- W. S. Culpepper -- 10/11/65

Rey S. Decker

Subj: ENG 22-5, Missouri WP-08, Wellington-Napoleon, Site No. A-21
(Lafayette County)

Filter sand should be composed of a fine, well-graded sand like ASTM fine concrete aggregate. A coarse segment would then be required around the drain pipes.

- D. Embankment Design: A homogeneous fill of CL materials compacted to 95% of standard is recommended.

Make both slopes 2 1/2:1 with berms of 15 feet at elevation 762 upstream and 740 downstream as proposed.

Provide overfill of 1.5 feet at the maximum section to compensate for residual settlement of about 0.6 foot in the foundation and 0.9 foot in the embankment.

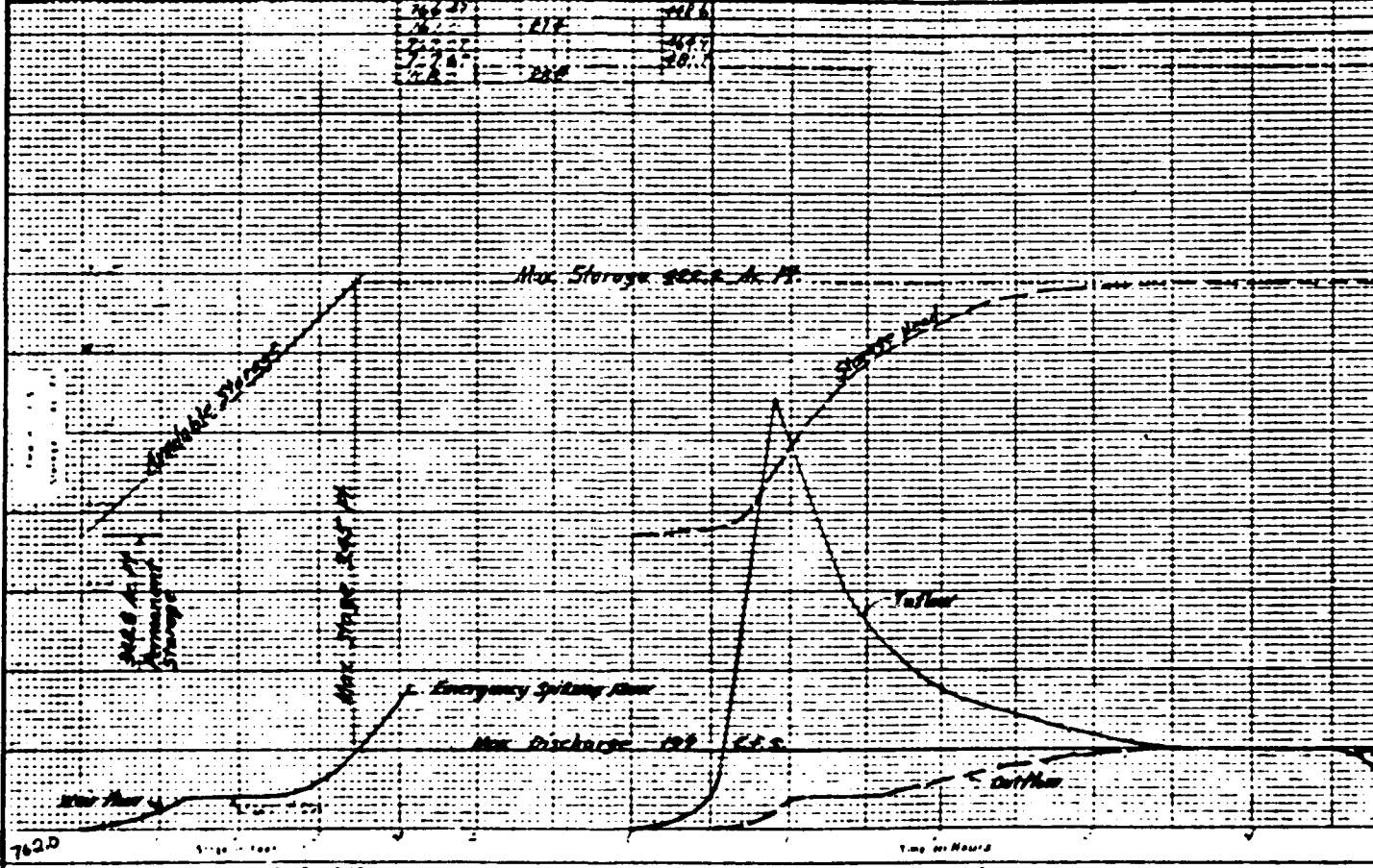
Prepared by:

R. B. Phillips
Roland B. Phillips

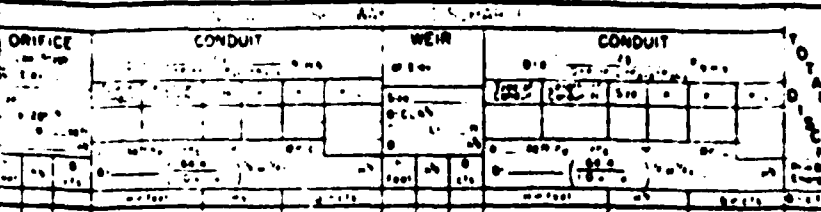
Attachments

cc: W. S. Culpepper (1)
Higg, Project Engineer
C. A. Reese, Lincoln, Nebraska
D. S. McVicker, Lincoln, Nebraska

ELEV	WEIR		ORIFICE		CONDUIT		WEIR	
762	208	342.1						
762.95		342.5						
763.0	219	342.9						
763.57		377.5						
764.0	229	390.8						
764.17		395.1						
764.37								
764.7	207	406.7						
764.81		412.5						
765.07		432.1						
766.31								
766.37	217	441.6						
766.77		447.7						
766.87		460.7						
766.9	220	480.1						

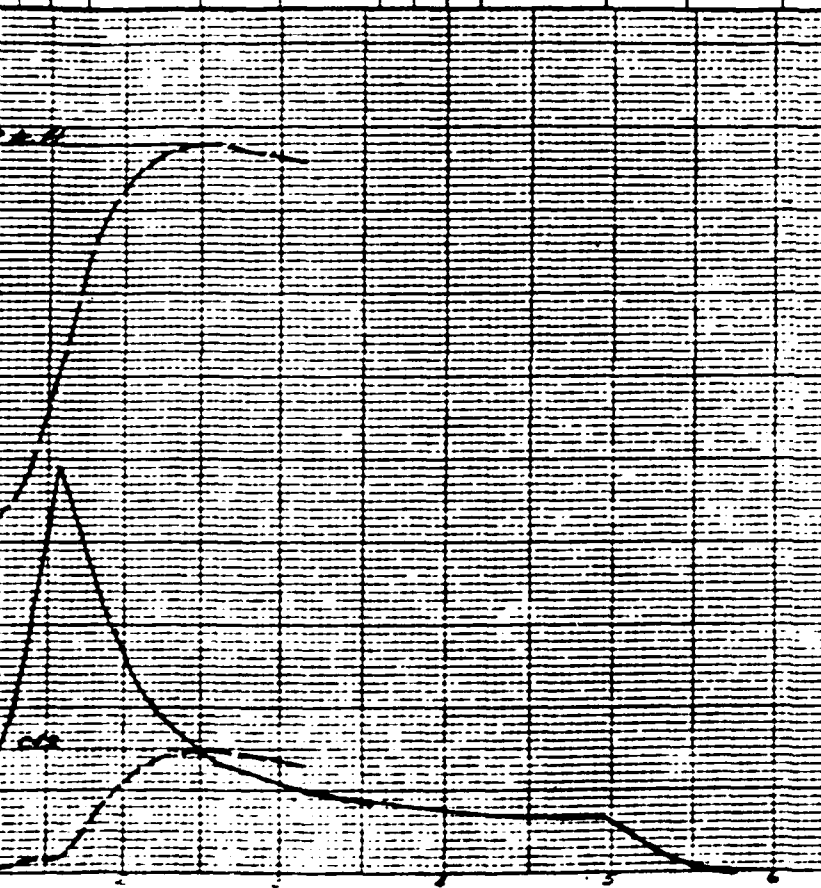


Time in Hours	Hydrograph Coordinates		
	Station	Elevation	Flow
0	762.0	0	0
1	762.1	10	10
2	762.2	20	20
3	762.3	30	30
4	762.4	40	40
5	762.5	50	50
6	762.6	60	60
7	762.7	70	70
8	762.8	80	80
9	762.9	90	90
10	763.0	100	100
11	763.1	110	110
12	763.2	120	120
13	763.3	130	130
14	763.4	140	140
15	763.5	150	150
16	763.6	160	160
17	763.7	170	170
18	763.8	180	180
19	763.9	190	190
20	764.0	200	200
21	764.1	210	210
22	764.2	220	220
23	764.3	230	230
24	764.4	240	240



100 ft. Weir

Station	Elevation	Notes
100+00	100.00	Top of Weir
100+05	98.50	Top of Conduit
100+10	97.00	Bottom of Conduit
100+15	95.50	Bottom of Weir



HYDROGRAPH DATA

Area under curve (cfs-hr) = 10,000

Peak discharge (cfs) = 1000

Time to peak (hr) = 10

WEIR DATA

Discharge (cfs) = 1000

Head (ft) = 1.0

Velocity (ft/s) = 10

Note: Show computations which show the storm duration for peak discharge occurs (10 hr duration)

HYDROGRAPH EXTENSION

Time (hr)	Discharge (cfs)	Energy (ft-hr)
0	0	0
10	1000	10,000
20	500	10,000
30	200	6,000
40	100	4,000
50	50	2,500
60	25	1,500
70	12.5	875
80	6.25	500
90	3.125	281.25
100	1.5625	156.25

AS BUILT

Inflow Hydrograph Coordinates

Time (hr)	Discharge (cfs)
0	0
1	100
2	200
3	300
4	400
5	500
6	600
7	700
8	800
9	900
10	1000
11	900
12	800
13	700
14	600
15	500
16	400
17	300
18	200
19	100
20	50
21	25
22	12.5
23	6.25
24	3.125
25	1.5625

SUMMARY DATA

Peak Discharge (cfs) = 1000

Time to Peak (hr) = 10

Area under Curve (cfs-hr) = 10,000

Velocity (ft/s) = 10

FLOOD ROUTING

WELLINGTON-NAPOLEON WATERSHED P. 506

LAFAYETTE COUNTY, MISSOURI

U.S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

5,6-23,70-N

STRUCTURE DATA

DESCRIPTION	UNIT	AMOUNT	REMARKS	STRUCTURE	SITE CODE
DESIGN NO.		A-21			
LOCATION		2100			
STRUCTURE		Imp. Inlet			
NO. OF OPENINGS		0			
UNCONTROLLED DATA		036			
TOTAL		036			
CONTROLLED DATA		0			
DESIGN		691			
DATE OF		1986			
NO. OF		2062			
TYPE		001			
		1986			
		2062			
DESIGN		80			
NO. OF		0.168			
DESIGN		117			
DESIGN		237			
		345			
		521			
DESIGN		52.7			
ESTIMATED		342.8			
STORAGE		X			
DATA		X			
		X			
		X			
		X			
		X			
		X			
		X			

CHANNEL HYDRAULICS

DESCRIPTION	UNIT	AMOUNT	REMARKS	STRUCTURE	SITE CODE
DESIGN NO.					
LOCATION					
STRUCTURE					
NO. OF OPENINGS					
UNCONTROLLED DATA					
TOTAL					
CONTROLLED DATA					
DESIGN					
DATE OF					
NO. OF					
TYPE					

STRUCTURE DATA

STRUCTURE	SITE NUMBER			A 21
	TYPE OF CONSTRUCTION	HOURS		0.327
INFLOW	RUNOFF COEFF. NUMBER			70
	MOISTURE CONDITION			X
	STORM DISTRIBUTION CURVE			B
HYDROGRAPH	HYDROGRAPH FAMILY	PRIN. PEAK		10
		SECONDARY		10
	TOT. USED	PRIN. PEAK		25
		SECONDARY		25
DESIGN	STORM DURATION	PRIN. HOURS		10
DATA	POINT RAINFALL	PRIN. INCHES		5.07
		SECONDARY		11.25
	RUNOFF C	PRIN. INCHES		2.25
		SECONDARY		7.50
	STORM FREQ. FOR SPILLWAY	YEARS		0.15
				2
	D ₅₀ MAX	FEET		1.1
EMERGENCY	D ₅₀ MAX	CFS/FT.		2.50
		FT/SEC.		0.8
SPILLWAY	D ₅₀ MAX	FT/FT.		0.039
DATA	PERMISSIBLE V ₅₀ MAX.	FT/SEC.		9.0
	D ₅₀ MAX	FT/FT.		3.61
	V ₅₀ MAX.	FT/SEC.		4.7
	DRAWDOWN TIME	HOURS		15.1
STRUCTURE	HEIGHT & STORAGE			19.837
	CLASS			4

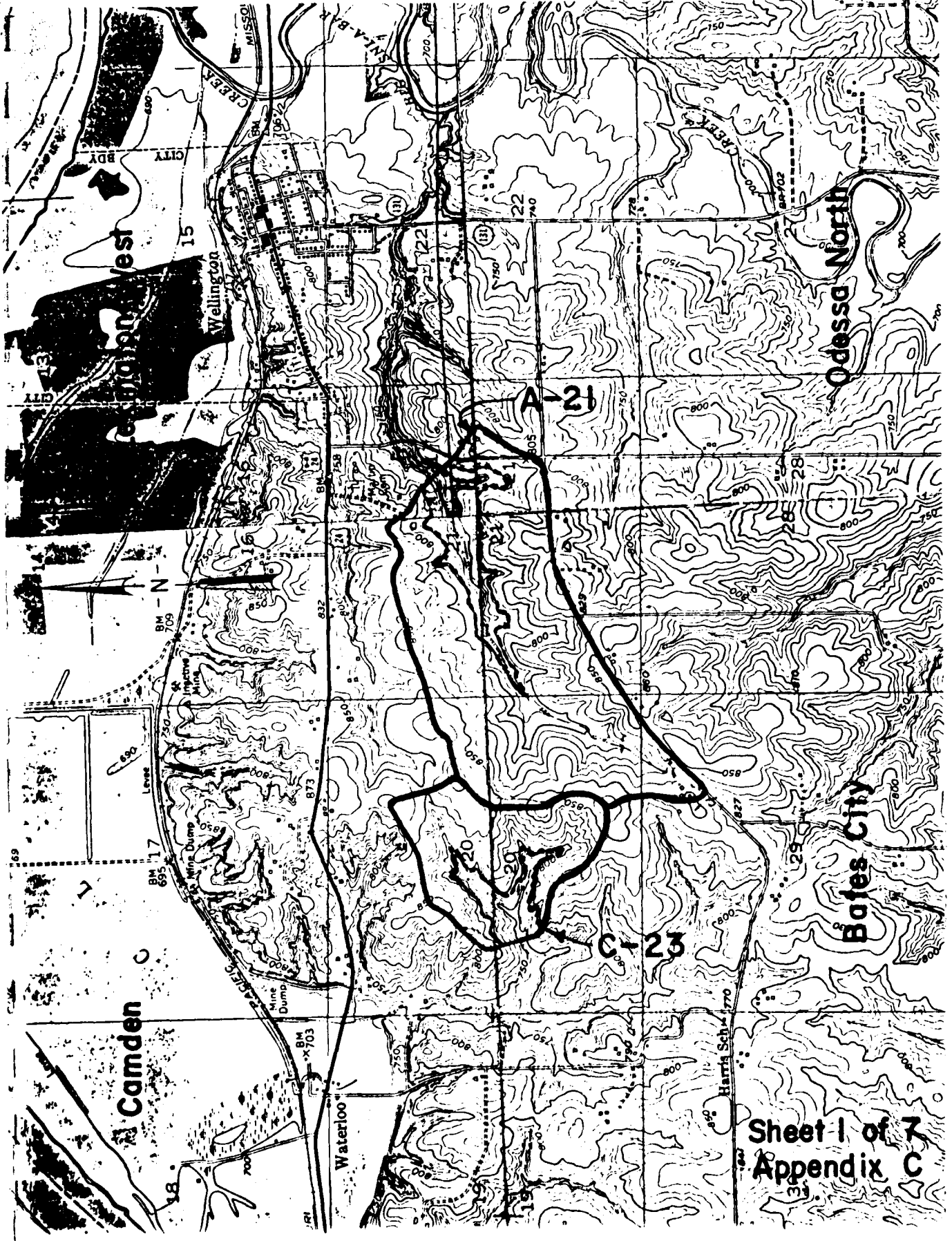
CHANNEL HYDRAULICS

AS BUILT

GENERAL DESIGN DATA	
STRUCTURE A-21	
WELLINGTON-NAPOLEON WATERSHED PL566	
LAFAYETTE COUNTY, MISSOURI	
U.S. DEPARTMENT OF AGRICULTURE	
SOIL CONSERVATION SERVICE	
Drawn by	Nov 8 Randall 1965
Checked by	Smith VES
Scale	
Sheet No.	58-29,179-N

2

APPENDIX C



Sheet 1 of 7
Appendix C

HYDRAULIC AND HYDROLOGIC DATA

DESIGN DATA From As-Built Plans and Field Measurements

EXPERIENCE DATA: No records are available. Owner stated that to his knowledge the lake normally remains at pool level elevation with some overflow. The apparent high water mark is at elevation 764.0 ft which is about 0.2 ft below the emergency spillway crest of 764.2.

VISUAL INSPECTION: At the time of inspection, the reservoir pool elevation was 761.7, which is about 0.2 ft above the measured crest elevation of 761.5.

OVERTOPPING POTENTIAL: Flood routings were performed to determine the overtopping potential. Since the dam is of intermediate size with a high hazard rating, a Spillway Design Storm of 100 percent of the PMF was prescribed by the guidelines. The Probable Maximum Flood (PMF) is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. Reservoir area and storage data and the watershed drainage data were obtained from the As-Built plans. A 5 minute interval unit graph was developed for this watershed area which resulted in a peak inflow of 1335 c.f.s. and a time to peak of 15 minutes. Application of the probable maximum precipitation minus losses resulted in a flood hydrograph peak inflow of 7453 c.f.s. (see Sheet 5 of 7). Rainfall distribution for the 24 hour storm was according to EM 1110-2-1411. Considering all factors, the combination of dam, spillway and storage is not sufficient to pass the PMF without overtopping. The embankment crest (El. 768.0) would be overtopped by 1.99 ft at flood pool elevation 769.99.

Fifty percent of the PMF was routed and overtopped the dam by .83 ft through the spillways. The portion of the PMF that will just reach the top of the dam at elevation 768.0 ft is about 0.33. This flood event is in excess of a 100 year frequency flood. For additional data see Summary of Dam Safety Analysis, Sheets 3 and 4 of this Appendix.

OVERTOPPING ANALYSIS FOR Dam A-21

INPUT PARAMETERS

1. Unit Hydrograph - SCS Dimensionless - Flood Hydrograph Package (HEC-1); Dam Safety Version Was Used.
Hydraulic Inputs Are As Follows:
 - a. Twenty-four Hour Rainfall of 25 Inches For 200 Square Miles - All Season Envelope
 - b. Drainage Area = 426 Acres; = .67 Sq. Miles
 - c. Travel Time of Runoff 0.33 Hrs.; Lag Time 0.2 Hrs.
 - d. Soil Conservation Service Runoff Curve No. 85 (AMC III)
 - e. Proportion of Drainage Basin Impervious 0.05
2. Spillways
 - a. Rating Curve for Primary Spillway: Drop Inlet Concrete Structure (Crest El. 761.5) with 24 in. diameter RCP Pipe
 - b. Emergency Spillway: Trapezoidal Cut-Seeded (Crest El. 764.2)
Length 50 Ft.; Side Slopes 3:1; C = 2.65
 - c. Dam Overflow
Length 520 Ft.; Side Slopes vertical; C = 3.0

Note: Combined Spillway and Dam Rating curve computed by Hanson Engineers. Data Provided To Computer on Y4 and Y5 Cards.

SUMMARY OF DAM SAFETY ANALYSIS

1. Unit Hydrograph
 - a. Peak - 1335 c.f.s.
 - b. Time to Peak 15 Min.
2. Flood Routings Were Computed by the Modified Puls Method
 - a. Peak Inflow (see Sheet 5)
50% PMF 3726 c.f.s.; 100% PMF 7453 c.f.s.

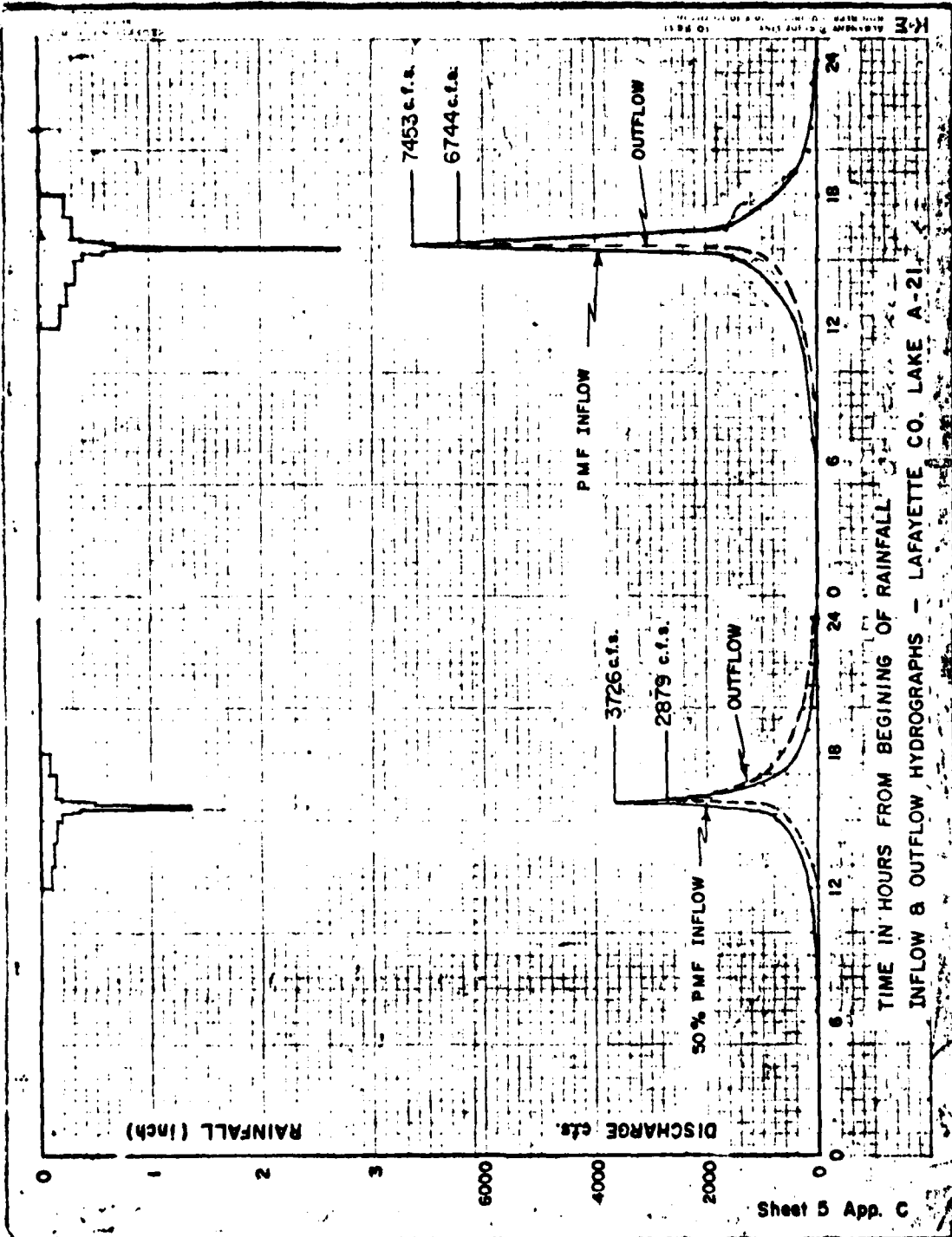
b. Maximum Reservoir Elevation

50% PMF 768.83 100% PMF 769.99

c. Portion of PMF That Will Reach Top of Dam

33 %; Top of Dam Elev. 768.0 Ft.

3. Computer Input and Output Data Sheets 6 and 7



LAFAYETTE CO DAM A-21 PROBABLE MAXIMUM FLOOD (INPUT DATA)

R ***** OVERTOPPING ANALYSIS FOR LAFAYETTE CO. DAM A-21 (HEC-1) DAM SAFETY PROGRAM
 A ***** CO. CODE 107 CO NAME LAFAYETTE STATE ID NO. NO. 10144 OWP. WELLINGTON-NAPO.
 A ***** HANSON ENGINEERS INC. DAM SAFETY INSPECTION (JOB NO. 03778) *****

B 300 0 5 0 0 0 0 4 0
 B1 5
 J 1 7 1
 J1 0 1 0 30 0.35 0.40 0.45 0.50 1.00
 K 0 1 3 1

I ***** INFLOW HYDROGRAPH COMPUTATION *****

H 1 2 0.67 1.00
 P 25.0 102 120 130
 T -1 -85 .05
 U2 0.33 20
 X 0.0 -10 2.0
 K 1 A21 0 1

I ***** RESERVOIR ROUTING BY MODIFIED PULS *****

Y 1 1
 Y1 1 343 -1
 Y4 761.5 763 764 765 766 767 768 769 770 771
 Y5 0 40 60 128 345 662 1130 3246 6765 11238
 Y6 0 343 363 386 410 435 460 485 510 535
 Y5 560 585
 YE 729 762 763 764 765 766 767 768 769 770
 YE 771 772
 Y4 761.5
 Y0 709
 Y2

(A)

(HEC-1) DAM SAFETY PROGRAM *****
10144 GWR WELLINGTON-NAPOLEON WATERSHED DISTRICT *****
B NO 03778) *****
0 4 0

-85

.05

-1		
769	770	771
3246	6765	11238
485	510	535
768	769	770

2 Sheet 6 Appendix C

LAFAYETTE CO DAM A-21 PROBABLE MAXIMUM FLOOD (OUTPUT DATA)

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

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLO			
				RATIO 1 0.10	RATIO 2 0.30	RATIO 3 0.35	RATIO 4 0.40
HYDROGRAPH AT	1	0.67	1	745.	2236.	2609.	2981.
	(	1.74)	(	21.10)(	63.31)(	73.87)(	84.42)(
ROUTED TO	21	0.67	1	114.	1017.	1487.	2017.
	(	1.74)	(	3.22)(	28.80)(	42.11)(	57.11)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1

	INITIAL VALUE	SPILLWAY CREST
ELEVATION	762.00	761.50
STORAGE	343.	338.
OUTFLOW	13.	0

RATIO OF PMF	MAXIMUM RESERVOIR W.S. ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURAT OVER HOUR
0.10	764.70	0.00	403.	114.	0.1
0.30	767.75	0.00	479.	101.	0.1
0.35	768.17	0.17	489.	1487.	0.3
0.40	768.42	0.42	495.	2017.	0.5
0.45	768.63	0.63	501.	2472.	0.6
0.50	768.83	0.83	506.	2879.	0.8
1.00	769.99	1.99	535.	6744.	4.0

UT DATA)

SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
 ET PER SECOND (CUBIC METERS PER SECOND)
 UARE MILES (SQUARE KILOMETERS)

RATIOS APPLIED TO FLOWS						
RATIO 2	RATIO 3	RATIO 4	RATIO 5	RATIO 6	RATIO 7	
0.30	0.35	0.40	0.45	0.50	1.00	
2236.	2609.	2981.	3354.	3726.	7453.	
63.31)(	73.87)(	84.42)(	94.97)(	105.52)(	211.04)(
1017.	1487.	2017.	2472.	2879.	6744.	
28.80)(	42.11)(	57.11)(	70.00)(	81.52)(	190.97)(

SUMMARY OF DAM SAFETY ANALYSIS

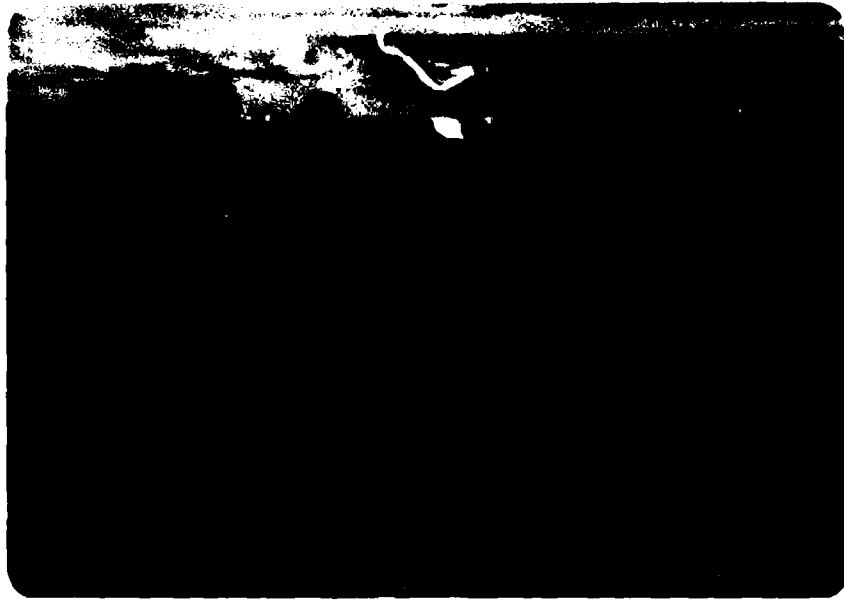
FINAL VALUE	SPILLWAY CREST	TOP OF DAM
762.00	761.50	768.00
343.	338.	485.
13.	0.	1130.

IN	MAXIMUM STORAGE	MAXIMUM OUTFLOW	DURATION OVER TOP	TIME OF MAX OUTFLOW	TIME OF FAILURE
	AC-FT	CF3	HOURS	HOURS	HOURS
	403.	114.	0.00	18.08	0.00
	479.	101.	0.00	16.08	0.00
	489.	1487.	0.33	16.00	0.00
	495.	2017.	0.50	15.92	0.00
	501.	2472.	0.67	15.92	0.00
	506.	2879.	0.83	15.92	0.00
	535.	6744.	4.08	15.83	0.00

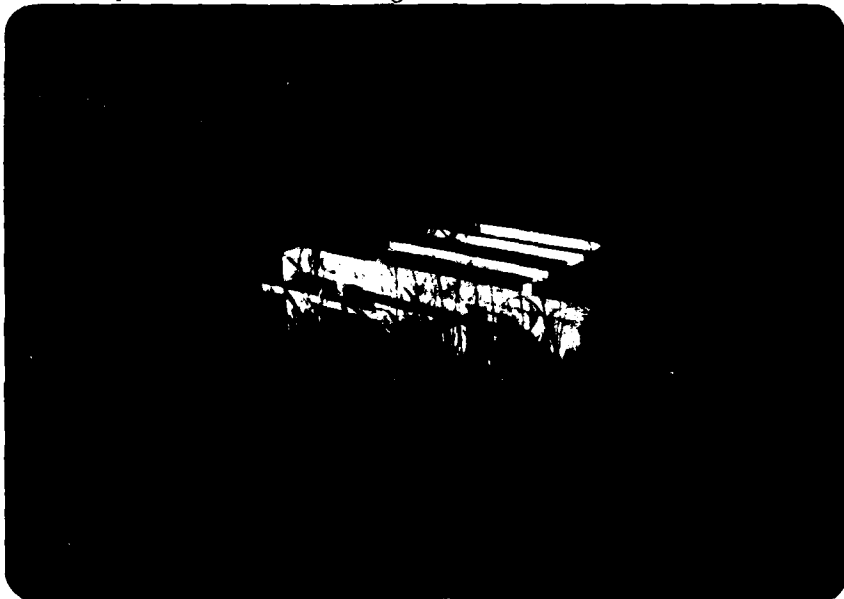
Sheet 7 Appendix C

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APPENDIX D



Top of Dam--Looking From South Abutment



Riser Structure--Primary Spillway



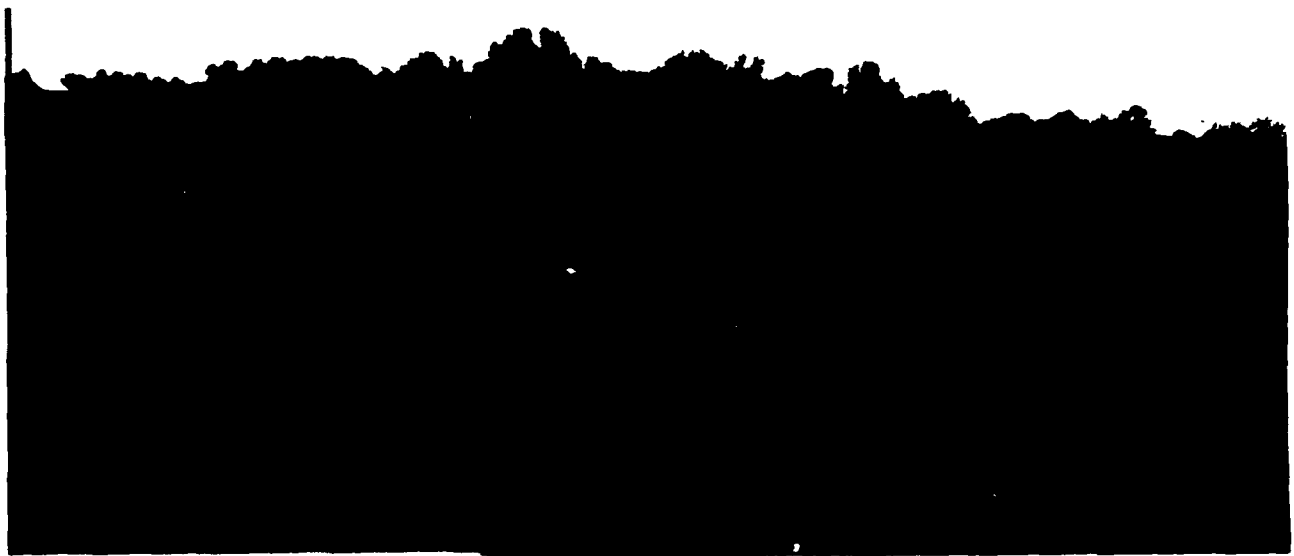
Outlet Pipe--Primary Spillway; Note Abutment Drain



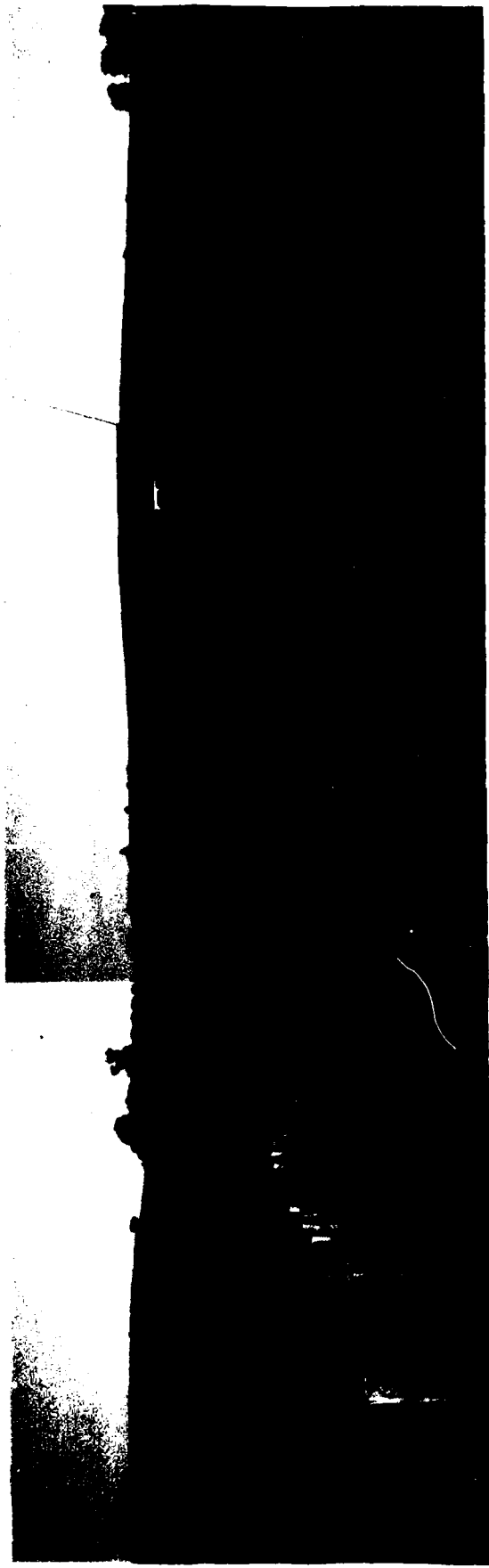
Outlet Channel--Primary Spillway



Downstream Side of Dam at Upper Berm Level--Looking North



Emergency Spillway--Looking Downstream From South Abutment



Lake and Watershed--Looking Southeast From North Abutment

END

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FILMED

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