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Embankment Criteria and Performance Report

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Ms. Lori L. Lynch-Project Engineer
Mr. Francke C. Walberg-Asst.Ch., Geotechnical Br.
Mr. Robert G. Dimmitt-Ch.,Dams & Foundations Sect.

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Control Determination: This report conforms to the intent of the exempt report catagories as set forth in AR 335-15 and under the paragraph 7-2y of the AR.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report provides the significant design, construction and operational information which can be used by engineers to (1) familiarize themselves with the project (2) reevaluate the embankment in the event unsatisfactory performance occurs and (3) provide guidance for designing comparable future projects.

Best
Available
Copy

CEMRD-EP-C (CECW-EP-W/8 May 91) (10-1-7a) 1st End
Mr. Galligan/sg/7306
SUBJECT: Longview Lake, Missouri, Embankment Criteria and Performance Report

DA, Missouri River Division, Corps of Engineers, P.O. Box 103,
Downtown Station, Omaha, Nebraska 68101-0103 16 MAY 1991

FOR Commander, Kansas City District, ATTN: CEMRK-ED-GD

1. For appropriate action.

2. Please note the requested 30-day suspense.

FOR THE COMMANDER:

JOSEPH J. GRASSO, P.E.
Acting Director, Engineering and
Planning Directorate

CEMRK-ED-GD (CECW-EP-W/8 May 91) 1110-2-1150a 2d End
Ms. Lynch/sj/FTS 867-5352
SUBJECT: Longview Lake Missouri, Embankment Criteria and Performance Report

DA, Kansas City District, Corps of Engineers, 700 Federal Building, Kansas City, Missouri 64106-2896 11 June 1991

21 JUN 1991

~~THRU Commander, Missouri River Division, ATTN: CEMRD-EP-G~~ JJG

FOR Commander, Directorate of Civil Works, ATTN: CECW-EP-W

The following are like-numbered responses to CECW-EP-W comments provided in the memorandum dated 8 May 1991 referenced in the 1st End to Longview Lake, Missouri, Embankment Criteria and Performance Report.

a. The impervious blanket was constructed on the upstream right abutment to control seepage at the abutment. The majority of the seepage was expected to occur through the highly jointed Bethany Falls limestone which exists on both abutments. An impervious blanket was required for the right abutment since the upstream bedrock was exposed. A clay blanket was not necessary for the left abutment because the upstream bedrock is covered with overburden which acts as a natural clay blanket. For a complete description of the operation and performance of the abutments see paragraphs 7-05, 9-01c, and 9-01d.

b. Excavation details and foundation treatment for the abutments are discussed in more detail in the Longview Lake Construction Foundation Report dated February 1986.

c. A banded riprap design was used on the upstream slope to minimize the amount of stone protection required. Flatter grassed slopes (1 on 50) were also used between the upstream riprap zones. The riprap extends from elevation 878 to 898 corresponding to the zone of most frequent pool level roughly the 10 year drawdown and 10 year flood and elevation 915 to 925. The information used to determine the stone protection zones is provided on plate 32.

d. Reference paragraph 8-04f. Construction details for the upstream impervious blanket are provided on plate 30.

CEMRK-ED-GD
SUBJECT: Longview Lake Missouri, Embankment Criteria and Performance Report

e. The 10 abandoned open tube piezometers were cut off slightly below the ground, filled with grout and capped.

FOR THE COMMANDER:

PAUL D. BARBER
Chief, Engineering Division

CECW-EP-W (CECW-EP-W/8 May 1991) 3rd End WALLACE/tf/(202)272-8890
SUBJECT: Longview Lake Missouri Embankment Criteria and Performance Report

20 AUG 1991

HQ, U.S. Army Corps of Engineers, Washington, DC 20314-1000

FOR Commander, Missouri River Division, ATTN: CEMRD-EP-C

The responses provided in the preceding endorsement satisfactorily response to the concerns set forth in the basic letter.

FOR THE DIRECTOR OF CIVIL WORKS:

Douglas J. Kamien

JOHN A. McPHERSON
Acting Chief, Engineering Division
Directorate of Civil Works

CEMRD-EP-C (CECW-EP-W/8 May 91) (11-2-240a) 4th End
Mr. Galligan/sg/7306
SUBJECT: Longview Lake Missouri Embankment Criteria and Performance Report

DA, Missouri River Division, Corps of Engineers, P.O. Box 103, Downtown Station, Omaha, Nebraska 68101-0103 28 August 1991

FOR Commander, Kansas City District, ATTN: CEMRK-ED-GD

Forwarded for your information.

FOR THE COMMANDER:

For Kenneth D. [illegible]
R. HARVE WIETHOP, P.E.
Chief, Cost & Gen. Engrg. Division
Engineering and Planning Directorate

DEPARTMENT OF THE ARMY
U.S. Army Corps of Engineers
WASHINGTON, D.C. 20314-1000

REPLY TO
ATTENTION OF:

CECW-EP-W

08 MAY 1991

MEMORANDUM FOR Commander Missouri River Division, ATTN: CEMRD-EP-C

SUBJECT: Longview Lake, Missouri, Embankment Criteria and Performance Report

1. Reference memorandum CEMRK-ED-GD, 27 February 1991, subject as above with CEMRD-EP-C, 21 March 1991, first endorsement thereon.

2. The following comments on the subject report are furnished for action. Request response within 30 days as to the disposition of these comments.

3. Geotechnical concerns.

a. Paragraph 4-01.b. Documentation should be provided to confirm the need for the impervious blanket.

b. Paragraph 4-02.c. Design details respecting the abutment treatment should be provided.

c. Paragraph 4-04, subparagraph 4. Clarify what slope details were selected in order to minimize slope protection requirements.

d. Paragraph 5-02.c. Include construction details such as thickness, zones and filters for the upstream impervious blanket.

e. Paragraph 7.02.a. The abandonment procedures for the ten open tube piezometers should be provided.

FOR THE DIRECTOR OF CIVIL WORKS:

for Doug J. Kamien

JOHN A. MCPHERSON
Acting Chief, Engineering Division
Directorate of Civil Works

OPERATION AND MAINTENANCE MANUAL
LONGVIEW LAKE
LITTLE BLUE RIVER, MISSOURI

APPENDIX V

EMBANKMENT CRITERIA AND PERFORMANCE REPORT

FEBRUARY 1991

DEPARTMENT OF THE ARMY
Kansas City District, Corps of Engineers
Kansas City, Missouri

OPERATION AND MAINTENANCE MANUAL
LONGVIEW LAKE
LITTLE BLUE RIVER BASIN
LITTLE BLUE RIVER, MISSOURI

APPENDIX V
EMBANKMENT CRITERIA AND
PERFORMANCE REPORT

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1	Analysis of Stage I Embankment
2	Gas Sample Analysis
3	Water Sample Analysis

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Photo No.	Title

1. March 1990. Overview of completed embankment.

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2. 1983. Two Caterpillar D-9s loading Cat 631 scrapers in upstream valley borrow area.
3. 09 October 1981. Cat 5310 scraper.
4. 26 July 1983. Cat D-9H compacting haul road ramp with tandem sheepsfoot roller.
5. 10 July 1983. Compacting impervious fill around sump in cutoff trench with a "BARCO" gas powered compactor.
6. 06 July 1983. Spreader box mounted on a Cat D3 used for placing the 6-foot wide pervious drain.
7. June 1980. Raygo "Rascal" 410-A 5 ton vibratory roller used to compact pervious fill.
8. 07 June 1983. "Wacker" DVU4001 small vibratory plate compactor used to compact pervious fill in restricted areas.
9. 07 May 1981. Small 4 wheel "Wacker" vibratory roller.
10. 11 June 1981. Backhoe mounted vibratory plate used to compact pervious fill along the right side of the conduit.
11. 18 September 1981. Wheel rolling upstream cutoff trench contact with left abutment Sni-A-Bar Limestone with Cat 920 front end loader.
12. 18 July 1983. Record control sample being taken.

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14. 29 May 1980. Curtain grouting in cutoff trench.
15. July 1980. Removal of unacceptably wet impervious fill material and excavation for placement of pervious on the downstream side of the cutoff trench.
16. July 1980. Impervious and pervious fill placed in cutoff trench against right abutment.
17. 21 July 1980. Outlet works ogee section and 45 degree bend of twin sewer conduits.
18. 14 August 1980. Stair stepped surface of heavily fractured Middle Creek limestone of right abutment after excavation and cleaning.
19. 14 August 1980. Placement of dental concrete and slush grout to seal the surface of Middle Creek limestone.
20. 21 October 1980. Overview of fill placement, conduit construction, and left abutment cutoff trench.

PHOTOGRAPHS

PHOTOGRAPHS

LONGVIEW EMBANKMENT CRITERIA REPORT

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PLATE LIST CONT'D

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SUPPLEMENT A

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PERTINENT DATA

GENERAL

Location of Dam	One mile south of I-470 and 1/2 mile east of Raytown Road. In SW 1/4 NW 1/4, Sec. 4, T. 47 N., R. 32 W., Jackson County, Missouri, at approximately 109th Street, Kansas City, Missouri, and at mile 42.9 on the Little Blue River.
Purposes	Flood control, recreation, water quality fish and wildlife.
Authorization	Flood Control Act of 1968 (Public Law 90-483, 13 August 1968)
Operating Agency	Corps of Engineers, Project Manager offsite
Drainage Area Above Longview Dam	50.3 square miles
Approximate Length of Lake	At multipurpose level (El. 891.0 ft., m.s.l.): from the dam, about 3.5 miles in a southeasterly direction.
Approximate Length of Shoreline	24 miles in length at multipurpose level (elevation 891.0 ft. m.s.l.)
Time of Water Travel at Bank-full Rates	13 hours to the Lake City gauge. 21 hours to the Missouri River.
Maximum Flood of Record Near Damsite	42,300 c.f.s., 13 August 1982
Channel Capacity	1,000 c.f.s.
Top of Dam Elevation	926.6 feet, m.s.l.
Length	1,900 feet
Type of Construction	Rolled earthfill
Fill Quantity	1,028,000 cubic yards impervious 915,000 cubic yards randon
Freeboard	3.71 feet
Maximum Height Above Valley Floor	100 feet
Top Width	74 feet
Maximum Base Width	900 feet

PERTINENT DATA (CON.)

Date of Closure	16 June 1983
Date Storage Began	16 September 1985
Date Multipurpose Pool Initially Filled	23 September 1986

SPILLWAY

Type	Uncontrolled limited service
Location	Left abutment
Crest Elevation	911.3 feet, m.s.l.
Width	200 feet
Discharge Capacity	Top, surcharge pool El. 922.9 feet NGVD 22,970 c.f.s.

OUTLET WORKS

Location	Left abutment
Type	Uncontrolled hooded drop inlet
Conduit	5.5 foot by 5 foot arch
Length	916 feet
Invert Elevation at Intake	816.0 feet, m.s.l.
Invert Elevation at Outlet	812.0 feet, m.s.l.
Discharge Capacity at Elevation 922.9 (Top Surcharge Pool)	1,040 c.f.s.
Discharge Capacity at Elevation 909.0 (Top of Flood Control Pool)	990 c.f.s.
Emergency Drawdown Gate	1-6.0 foot by 7.0 foot hydraulically operated slide gate
Low Flow Intake	2-2.0 foot Dia knife gate valve
Low Flow Outlet	2-2.0 foot Dia knife gate valve

The outlet works also contain dual 54-inch sewers with two 54- by 54-inch sewer gates and two 54- by 54-inch crossover gates.

PERTINENT LAKE ELEVATION

Storage Designation	Elevations (feet m.s.l.)		Storage Capacity* (acre-feet)		Area (acres)
	From	To	Initial	100-year	Top of Pool
Surcharge	909.0	922.9	35,400		3,200
Flood Control	891.0	909.0	24,800	24,300	1,960
Multipurpose	816.0	891.0	22,100	20,600	930
Gross Storage	816.0	909.0	46,900	44,900	
Sedimentation Reserve			2,000		
Annual Sediment Inflow			20		

*100-year sediment allocation initially allocated 1/4 (500 acre-feet) to flood control zone and 3/4 (1,500 acre-feet) to the multipurpose zone. Sediment allocation computed by 40 acre-feet per square mile per 100-year.

Fee Taking Line	Elevation 914.0 feet, m.s.l.
Fee Lands Acquired	4,762 acres
Easement Lands Acquired	63 acres

OPERATION AND MAINTENANCE MANUAL

LONGVIEW LAKE

LITTLE BLUE RIVER BASIN

LITTLE BLUE RIVER, MISSOURI

APPENDIX V

CHAPTER 1

INTRODUCTION

1-01. Purpose and Scope of Report. The purpose of this report is to provide in one volume the significant information needed by engineers to familiarize themselves with Longview Lake, reevaluate the embankment in the event unsatisfactory performance occurs, and provide guidance for designing comparable earth dams. The scope of this report provides a summary record of significant design data, design assumptions, specification requirements, construction equipment, construction procedures, construction experience, field control and record control test data, and embankment performance monitored by instrumentation during construction and during initial lake filling.

1-02. Project Purpose. Longview Lake is a multipurpose project realizing benefits from flood control, water quality control, recreation, and fish and wildlife.

1-03. Project Authorization. Longview Lake was authorized by the Flood Control Act of 1968 as a part of the "project for flood control and other purposes on the Little Blue River in the vicinity of Kansas City, Missouri, was authorized substantially in accordance with the recommendations of the Chief of Engineers in House Document No. 169, Ninetieth Congress First Session."

CHAPTER 2

PROJECT DESCRIPTION

2-01. Project Location. The Longview damsite is located on the Little Blue River at approximately 109th Street, Kansas City, Missouri. The entire lake is located in Jackson County, Missouri. Location and vicinity map are shown on Plate 1.

2-02. Dam Description. The dam is a zoned, compacted earthfill embankment with a crest length of approximately 1,900 feet and approximately 110 feet in height. The crest width is 74 feet to accommodate the 109th Street which is a 4-lane divided highway. A central impervious core with an impervious cutoff trench to bedrock was used for the total length of the dam. The embankment includes an inclined pervious drain as well as a pervious blanket across the valley and up the abutments. Compacted random zones and berm zones are used to support the impervious zones and add stability to the embankment. The theoretical top of dam is 926.6 which provides for 3.9 feet of freeboard above the maximum surcharge pool. However, the dam was constructed to elevation 925.7 with the remainder of the freeboard being provided by the New Jersey type concrete median barrier. The upstream slope is designed to have graded riprap in the zone of frequent fluctuation (elevations 878-898) and at the top 10 feet of the dam (elevations 915-925). Slope protection consists of 18-inch riprap on 9-inch of bedding. Between elevations 898 and 915 a grassed slope protects the embankment. The general embankment plan and sections are shown on Plates 2 and 22 through 25, respectively. A clay blanket was constructed on the right upstream abutment between elevations 848 and 898. A small dike was constructed west of Raytown Road near Elm Avenue to fill in a saddle in the left abutment. This dike is only about 3 to 4 feet high with a crest width of 10 feet.

2-03. Spillway. The spillway is an uncontrolled limited service spillway 200 feet wide with 1V on 6H side slopes cut in the left abutment overburden. The invert elevation is 911.3 which is 2.3 feet above the full pool elevation.

2-04. Outlet Works. The outlet works consist of an intake tower with a covered uncontrolled service drop-inlet, an arch-shaped conduit through the embankment, a parabolic drop into a stilling basin with an end sill and an outlet channel to the Little Blue River. The conduit crosses the dam centerline at station 98+70 and is skewed 3 degrees towards the downstream right abutment from the perpendicular to the dam axis. The concrete arch-shaped conduit is 4.83 foot wide and 5.5 foot high. Two 54-inch diameter sewer pipes encased in concrete are located below the conduit. The tower becomes submerged at elevations above 900 and a bridge at that elevation provides access to the tower from Service Road A.

2-05. Construction History. Since Longview Dam was located in a very urbanized area, there were many utility relocations which had to be completed prior to construction of the dam. The most extensive relocation was the existing 48-inch diameter sewer within the reservoir area which also crossed the dam centerline. It had to remain in service throughout the construction of the dam. It was unknown during the design phase exactly when the Little Blue Sewer District would complete their portion of the new sewer line within the reservoir area. Because of the uncertainty and the need to ensure closure was not made until the sewer construction was complete within the reservoir area, construction of the dam was divided into two stages. The Stage I construction began in September 1979 and was completed October 1982. It consisted of foundation excavation for the cutoff trench and the outlet works including the outlet channel; foundation grouting; construction of the intake tower, conduit-sewer structure, and stilling basin; existing sewer relocation, diversion, and removal; placement of portions of the embankment on both sides of the river; and a 200,000 cubic yards impervious stockpile to be used for the Stage II contract. (See Plate 17 for Stage I construction.) The Stage II construction began in August 1982 and was completed September 1985. This contract included diversion of the river and embankment closure, completing the embankment, excavation the spillway, and construction of access and service roads. A 6-month construction halt was also included in the Stage II contract when the embankment reached elevation 890.

2-06. Lake Filling. After closure was made but before the embankment was topped out a lake formed several times due to excess runoff in the drainage basin. The highest lake level recorded during construction was elevation 865 on 10 June 1984 with the embankment at approximately elevation 885. This lake level was reached in less than 24 hours with the gates fully open. The embankment was topped out in September 1984 and the gates were closed to begin impoundment on 16 September 1985. The Initial Reservoir Filling Plan DM No. 20 was used as a guide during filling. The desired filling rate was 5 feet per month after the pool reached elevation 850. In October 1985 and November 1985 the pool rose faster than was acceptable and the emergency drawdown gate was opened to draw the lake down to the desired filling curve. On 23 September 1986 the lake reached multipurpose pool. The projected and actual filling curves are shown on Plate 45.

CHAPTER 3

GEOLOGY

3-01. Regional Geology and Physiography. Longview Lake is located in the extreme northern part of the Osage Plains Section of the Central Lowlands Physiographic Province. The Osage Plains Section is characterized by old scarp plains beveling faintly inclined strata. The Dissected Till Province which borders immediately to the north of the project is characterized by submaturely to maturely dissected till plains. A maturely dissected drainage pattern developed during pestilences time trends north into Missouri River. The project is located on the southern boundary of the Kansan Age Glacial Stage. Scattered loess deposits up to 7 feet thick are present on the uplands in the area. These deposits thicken to up to 90 feet along the Missouri River bluffs.

3-02. Site Geology. Gently rolling uplands surround Longview Lake. The Little Blue River flows generally north in a meandering, incised channel cut through alternating limestone and shale strata. At the damsite the valley is 1,800 feet wide from bluff top to bluff top and topographic relief is about 120 feet. The Bethany Falls limestone member of the Kansas City Group, Missourian Series, Pennsylvanian System is a prominent scarp forming ledge in the reservoir area. Its thickness is about 18 feet and it dips gently from elevation 885 on the right abutment to elevation 876 on the left abutment. Bedrock on the lower valley walls and valley floor is made up of less resistant shale and siltstone of the Pleasanton Group.

3-03. Description of Overburden. Overburden on the uplands in the general area consists of up to 30 feet of residual clay and scattered deposits of wind blown loess up to 20 feet thick. No loess deposits were encountered at the damsite. Overburden on the valley side slopes consists of residual clays and colluvium with clayey gravel at the base of the slopes. Alluvium in the valley ranges from 12 to 29 feet with the greatest thickness occurring in the terrace on the left side of the valley. The alluvium consists of predominately lean clay with lesser amounts of fat clay and silty, sandy gravel, in the basal 7 feet, resting on shale and siltstone bedrock. Generally the clays have medium to stiff consistencies although some soft clays were encountered in a few borings.

3-04. Bedrock. Bedrock at the damsite consists of alternating beds of limestone and shale of the Kansas City Group overlying a more massive section of less resistant clayey and silty shale, siltstone and sandstone beds of the Pleasanton Group. These rocks are classified as lower Pennsylvania Series. Underlying the Pennsylvanian rocks are about 2,200 feet of older sedimentary strata. Only the lower one-half of the Kansas City Group and the upper one-third of the Pleasanton group are exposed at the damsite. See the General Geologic Column and Legend on Plate 6. The regional dip of the bedrock ranges from 10 to 20 feet per mile west, northwest, but local variations in dip and strike occur. At the damsite bedrock dips 1 foot in 300 feet to the east into the right abutment and 1 foot in 65 feet to the west into the left abutment.

Jointing of beds may be very intense locally, due to dome-related flexures. Primary joints are generally vertical and strike north 50 degrees east spaced 5 to 35 feet apart. Secondary joints are generally, vertical, tight, strike North 75 degrees West and spaced about 2 feet apart. A series of faults are known to exist in the road cut along a one mile reach of Highway I-470, located about 3/4 mile north of the damsite. However, faulting could not be traced into the soil profile and no evidence of faulting was found in the cutoff trench or foundation excavations during construction.

Depth and degree of weathering vary considerably with rock type and thickness of soil cover. The limestones are softened and stained to depths of a few inches to 5 feet below their surface. The Bethany Falls crops out prominently along the valley wall and partially filled joints, up to 5 feet in width, are apparent at the outcrop. By 50 feet into the abutment the effects of weathering of the Bethany Falls appears to have been moderated by the presence of overlying shale. Large blocks of Bethany Falls measuring up to 15 feet or so in their greatest dimension became detached at the joints due to the weathering and erosion processes with some blocks moving down slope. Neither the Winterset nor the Sniabar limestone formed prominent outcrops in the abutments and were commonly mantled by a 1 foot to 8 foot depth of overburden. Weathering effects extended as much as 12 feet beneath the bedrock surface of the interbedded limestones and shale. A more detailed description of the bedrock and bedrock units can be found in the Construction Foundation Report.

3-05. Subsurface Investigations Prior to Construction. Geological investigation of the damsite included field reconnaissance, review of geologic literature, analysis of air photos, survey of water wells, review of gas and oil well logs and exploratory drilling. A total of 339 borings and 11 test pits were completed by government drill crews prior to Stage I construction. Overburden exploration included 2-inch, 4-inch, and 6-inch diameter drive holes; 3-inch and 5-inch Shelby tube samples, auger samples, and samples obtained from test pits. The bedrock investigation included NQ, NX, 4-inch and 6-inch cores. Eleven NX, angled, core holes were drilled on the left abutment and five were drilled on the right abutment. Thirty-three bedrock borings were hydraulically pressure tested. Natural gas was encountered in hole DC-10 and C-145A between elevations 762 and 768. Gas pressure measured 11 psi with the packer set at elevation 801. A 5-minute pressure test with 35 psi yielded a "take" of 0.2 gallons per minute. The gas in both holes was found to be at low pressures and limited in volume as it quickly dissipated during drilling. A .5-foot cavity was logged in siltstone 13 feet below the top of the bedrock surface in hole UC-9. Two additional holes were drilled in the vicinity of the void; however, neither the cavity nor the evidence as to the geologic cause could be found.

CHAPTER 4

FOUNDATION AND EMBANKMENT

4-01. General. The main embankment consists of a compacted earthfill approximately 1,900 feet long with an outlet works and an uncontrolled limited service spillway (200 feet base width) located in the left abutment. The maximum height of the embankment above the valley floor is 110 feet. Theoretical top of dam is 926.6, but the embankment was only constructed to elevation 925.7 and the remaining freeboard is achieved by the New Jersey type median barrier. The dam was constructed with a centrally located impervious core to prevent seepage through the embankment. The impervious core is supported on either side with random and berm zones. The various embankment zones were designed to utilize the available borrow material. An inclined pervious drain was constructed on the downstream side of the impervious core and is connected to a horizontal blanket which extends along the base of the embankment and exits at the downstream toe. Any seepage which may occur through the impervious core is intercepted by the inclined drain and carried out the embankment through the horizontal blanket. The foundation overburden was relatively shallow with a layer of clayey or silty sandy gravel located directly above the bedrock. In order to cutoff any water flowing through the basal gravels an impervious cutoff trench was constructed into rock for the full length of the dam. Various foundation bedrock formations were highly jointed and fractured. A grout curtain was installed below the cutoff trench for the full length of the dam in order to control the seepage through the bedrock. A plan view is shown on Plate 2.

a. Valley Section. (Station 90+00 to 97+00) The embankment across the main valley varies from 100 to 120 feet in height with an average height of 110 feet above the valley floor. Zoning consists of centrally located impervious core supported by random and berm zones. Typical valley section is shown on Plate 23. The foundation overburden consisted of between 12 and 29 feet of alluvium which was predominantly lean clay with lesser amounts of fat clay. A clayey or silty sandy gravel was common in the basal portion (1 to 7 feet) of the alluvium. The underlying bedrock surface was Pleasanton Zone E (argillaceous siltstone).

b. Right Abutment. (Station 86+25 to 90+00) The right abutment embankment section is similar to the valley section except that the downstream slope is flattened to 1V on 6H, there is no downstream berm zone, and an impervious clay blanket was placed upstream on the far right portion of the abutment. Typical right abutment sections are shown on Plates 22 and 23. The natural slope of the upper portion of the abutment between approximate stations 86+00 and 87+50 was about 1V on 8H. From approximate station 87+50 to the toe of the abutment at station 90+00 the slope was irregular and considerably steeper, averaging 1V on 2.8H. The foundation overburden on the slopes consisted of residual clays and colluvium, while at the base of the abutment clayey gravel underlaid alluvial clay. Thickness of the overburden ranged from zero at the Bethany Falls outcrop to a maximum of about 15 feet at the base of the valley wall. The foundation bedrock consists of 12 stratigraphic units of interbedded limestone and shales (Plate 7).

c. Conduit Section. (Station 98+00 to 100+00) The conduit section is located basically at the toe of the left abutment (Plate 24). The centerline of the conduit crosses the dam axis at station 98+70 and is skewed 3 degrees towards the downstream right abutment from perpendicular to the dam axis. The conduit section is constructed of impervious material with no random or berm zones. Since an all impervious zone with higher strength clays was used, the embankment slopes were steepened allowing for a shorter sewer-conduit structure. The overburden thickness on the right side of the conduit varied from 16 to 27 feet and consisted of alluvium similar to that in the valley section. At the toe of the left abutment from approximate station 99+00 to 100+00, the overburden was colluvium and clay alluvium consisting of clay, and fragments of shale and limestone ranging in size from gravel and cobbles to slabs and large blocks. The overburden rested on Pleasanton Zone C (argillaceous limestone) from the upstream end of the approach channel to near the dam axis. Except for a short horizontal extension of the Pleasanton Zone D (calcareous siltstone) the top of bedrock from the dam centerline to the downstream end of the outlet channel was Pleasanton Zone E (argillaceous siltstone). The outlet works profile is shown on Plate 8.

d. Left Abutment. (Station 100+00 to 107+00) This section is similar to the valley section except there is no upstream or downstream berm zone and the downstream slope is flattened to 1V on 6H. A typical left abutment section is shown on Plate 24. The natural slopes of the left abutment were generally not as steep as those of the right abutment. Between approximate stations 100+00 and 100+65, the average slope was 1V on 4H and it flattened to 1V on 6.5H between stations 100+70 and 103+00. The natural slope became progressively flatter between station 103+00 and the end of the embankment. From approximate station 100+00 to station 100+65 overburden ranged in thickness from 6 to 22 feet and consisted essentially of colluvium similar to that in the conduit section and residual clays. From the top of the Bethany Falls outcrop at approximate station 100+70 to the end of the embankment at station 107+00, the overburden consisted of residual soils of essentially lean and fat clays. Thickness of overburden ranged from 2 to 16 feet with the greater depths underlying the flatter upland slope. The foundation bedrock consists of the same 12 stratigraphic units of interbedded shales and limestones found on the right abutment (Plate 7).

4-02. Foundation Treatment.

a. Valley section. All of the embankment foundation was stripped of boulders, sod, roots, tree stumps, etc. and the overburden disked to a minimum depth of 8 inches and compacted with a minimum of three passes of a rubber tired roller. The 48-inch diameter reinforced concrete sewer pipe and pipe bedding, which crossed the dam axis at station 97+95, was removed under the entire embankment. Cleanup of the sewer excavation was accomplished and the backfill consisted of impervious under the impervious zone and random elsewhere.

b. Outlet Works Foundation. All overburden below the outlet works was excavated and backhoes and airspades were used to excavate the rock. A rock saw was used at the tower to excavate the vertical sides of the tower foundation. The final foundation in the outlet works except for the intake tower and stilling basin was excavated with a "roto mill" which consisted of a large track-mounted cutting roller. Air water jets were used to clean the final bedrock surface prior to placing a 6-inch layer of lean concrete. Lean concrete was also used downstream of the centerline of the dam in order to meet the required grade for the outlet works. The lean concrete was as much as 4-feet thick at the lower end of the outlet works and stilling basin.

c. Abutment Foundations. The subcrop faces of several limestone ledges were trimmed back to either a 1V on 1H or 1V on .5H slope not only at the centerline but for a distance of as much as 400 upstream and 235 downstream. In some areas concrete bulkheads were placed against the bedrock faces to seal open bedding planes and vertical joints to achieve the desired slope to place fill (Photo 35). In other areas the open joints on top of the horizontal benches were gravity grouted (Photo 19). A total of 279.75 sacks of cement were used to dry pack joints or as poured grout at 35 separate locations. A total of 342.1 cubic yards of lean concrete was placed behind forms to seal joints and maintain the required slopes.

d. Cutoff Trench. In order to control seepage through the foundation overburden and to facilitate foundation grouting, the cutoff trench was excavated to bedrock from station 86+00 on the right abutment to station 104+00 on the left abutment. Side slopes in the overburden are 1V on 2H and in the bedrock are excavated to 1V on 1H. The floor of the cutoff trench is 30 feet which allows 24 feet of impervious and a 6 foot pervious drain backfill. Prior to curtain grouting, the cutoff trench was excavated to grade with the exception of the exposed shales which were left 2 feet high in order to protect the final shale surface from weathering or drying out. Grouting was performed from the floor of the cutoff trench through 2-3/4 inch steel pipes cemented 2 feet into the bedrock. Once the curtain grouting was complete the steel grout pipes were removed. The upper 2 feet of grout holes in the limestone were gravity grouted while the upper 2 feet of shale was removed to bring the shale surface to final grade. The final bedrock surface was cleaned with air-water jets. The cutoff trench backfill was performed in the dry utilizing small gasoline pumps in sumps. The main sources of seepage were small areas encountered within the basal clayey gravels. Details of the dewatering efforts are included in Chapter 8.

4-03. Embankment Materials. The embankment zoning was designed to economically use the available material from required excavation and upstream borrow, to provide seepage control, and to provide slope stability. Because of the distribution of materials in the borrow area and the need to maximize the strength of fill placed in the conduit section and in the lower portions of the embankment considerable effort was expended in defining quantities of various liquid limit materials in the borrow. For the most part the easily available lower liquid limit materials were in the low lying areas and were used in the Stage I embankment or were stockpiled to avoid inundation after closure. The remainder of the borrow had CL and CH materials interlayed and had to be differentiated to insure optimum use of higher strength material. See also Chapter 8.

a. Impervious. The specifications for Stage I and II required the impervious material consist of soil classified as CL and CH with the material placed upstream of the dam axis having no more than 5 percent gravel. For Stage I, the maximum liquid limit specified for all impervious material was 55. The maximum liquid limit specified for the Stage II impervious material varied from 55 to 65 depending on the embankment feature and elevation. Generally, the lower liquid limit material was placed in the lower portions of the embankment. The Stage II impervious zone liquid limits are shown on the table below:

STAGE II IMPERVIOUS ZONE LIQUID LIMITS

Area	Maximum Liquid Limit
Below elevation 867, including cutoff trench	55
Between stations 97+00 and 101+00 - Below elevation 887	55
Cutoff Trench above elevation 867	60
Inspection Trench	60
Between stations 97+00 and 101+00 - Above elevation 887	60
Impervious Clay Blanket	65
Above elevation 867, excluding cutoff trench, inspection trench, and between stations 97+00 and 101+00	65

Typical cross sections showing the impervious zone liquid limits are on Plate 46. The allowable moisture content at the time of placement ranged from 2 percent below optimum to 3 percent above optimum. It was required that the impervious material be compacted to at least 95 percent maximum density obtained by the standard Proctor compaction test. Most of the impervious material was placed in 8-inch lifts and compacted with 6 passes of a sheepsfoot roller except the material directly over the foundation rock. (See Chapter 8 for procedure used.) A total of 1,028,528 cubic yards of impervious were placed in the dam with 509,866 cubic yards being placed in Stage I and 518,662 being placed in Stage II.

b. Random. The random material consisted of overburden material except that soil classified as OH, PT, MH, and OL. The random material came from the required excavations and upstream borrow. Some of the random zone consisted of gravelly material not suitable for the impervious zone. Maximum liquid limit in the Stage I contract was 60, but varied between 60 and 70 in the Stage II contract. Lower maximum liquid limits were required in the lower portions of the embankment. The Stage II liquid limits are listed below:

RANDOM ZONE LIQUID LIMITS

Area	Maximum Liquid Limits
Below elevation 867 upstream of dam axis	60
Below elevation 867 downstream of dam axis	65
Above elevation 867	70
Spillway Dike and Elm Avenue Dike	*

* No liquid limit requirement but shall be a CL or CH material.

Plate 46 shows the various liquid limit zones on typical cross sections. Moisture requirements for random were the same as for impervious and compaction was either six passes with a sheepsfoot roller on 8-inch lifts or three passes with a rubber-tired roller on 12-inch lifts. A total of 914,813 cubic yards of random material was placed in the dam with 215,552 cubic yards being placed in the Stage I contract and 699,261 cubic yards being placed in the Stage II contract.

c. Berm. The upstream and downstream berm consisted primarily of fat clay (CH), however, according to the specifications could have been shale and other materials from the required excavations and borrow areas unsuitable for or in excess of the requirements for impervious, random, or rockfill. Fat clay (CH) was used in the upper 5 feet of berm normal to the upstream slope and for the closure Phase I and II cofferdams. The only moisture content requirements for Stage I was to the extent required for unassisted movement of compaction equipment. For Stage II the requirements were the same as Stage I on the wet side of optimum but on the dry side of optimum were limited to no more than 4 percent below optimum. On Stage I, the berm was compacted using two passes of a rubber-tired roller with 24-inch lifts or two passes of a sheepsfoot roller with an 8-inch lift. For the Stage II contract compaction was performed with either four passes of a sheepsfoot roller on an 8-inch lift or two passes of a rubber-tired roller on a 12-inch lift. A total of 965,971 cubic yards of berm were placed with 344,467 cubic yards being placed in Stage I and 621,504 cubic yards being placed in the Stage II contract.

d. Pervious. The pervious material was clean free-draining, durable, natural sand obtained from a commercial Missouri River sand plant having the following gradation:

Sieve Size	Percent by Weight Passing
No. 4	90-100
No. 16	55-85
No. 50	5-20
No. 200	0-5

The majority of the sand had less than .5 percent passing the 200 sieve. Stage I required the pervious material be compacted using 3 passes of a vibratory roller on 12-inch lifts. For hand compacted (special backfill) a plate vibratory roller on 4-inch lifts to obtain 80 percent relative density was required. During construction this was reduced to 70 percent (see paragraph 8.02 d.(2)). The compaction procedures for Stage II were the same as Stage I and based on the previous experience the required relative density was reduced to 70 percent for a plate vibratory compactor with 6-inch lifts. Moisture content of the sand was controlled such that the sand was saturated during compaction. A total of 104,584 cubic yards of pervious was placed with 30,387 cubic yards being placed in the Stage I contract and 74,197 cubic yards being placed in the Stage II contract. The outlet of the pervious zone is protected with a 12-inch thick layer of bedding which was placed using a track-mounted backhoe. The bedding has the following gradation:

12-Inch Bedding

Dimension Sieve Size	Percent by Weight Passing
6-inch	maximum allowable
3-inch	70-90
1-1/2-inch	55-75
1/2-inch	35-55
#4	15-35
#10	0-20
#20	0-5

e. Rockfill. The better quality limestone excavated from the abutments was used as rockfill (photo 21) to add stability and protection to the upstream clay blanket. The specification required the rockfill be reasonably well graded with a maximum size stone of 300 pounds and no more than 10 percent passing the 2-inch sieve. Shale and other soft friable particles were limited to 10 percent. The rockfill was placed in 36-inch lifts with no moisture control or compaction requirements except when the rockfill was placed within 2 feet of bedrock, berm or impervious clay blanket, at which time it was to be wheel-rolled with approved equipment.

f. Special Backfill. Special backfill is placed in the bedrock irregularities or other confined areas adjacent to structures where rollers could not operate effectively. The 2-foot thick zone of material against the bedrock surfaces was also considered as special backfill. This included the impervious and pervious zones for Stage I and the impervious and random zones for Stage II. The specifications required the special backfill be placed in 3-inch lifts. The impervious and random material was compacted with a power tamper to 95 percent of standard Proctor density, and the pervious was compacted with a plate vibrator to 80 percent relative density which was later reduced to 70 percent. The moisture requirements for Stage I were the same as the corresponding zone of material and for Stage II were between optimum and 3 percent above optimum. The rate of placement was controlled so that the relatively thin hand-compacted zones were covered with equipment-compacted material as soon as possible to prevent drying, excess wetting, or freezing and thawing.

g. Channel Fill. Material from required excavation and stockpiles which were not suitable for the embankment were used as channel fill. Rock excavation including shale was also allowed as channel fill as long the rock was covered with at least 2 feet of soil material. This material was placed in the old river channel downstream of the embankment with no moisture control except that required to allow traffic compaction of the 24-inch maximum lifts.

4-04. Stone Protection. The upstream stone protection consists of 18-inch riprap overlaying 9-inch bedding located between elevations 878 to 898 and 915 to 925. The bedding and riprap gradations are as follows:

9-Inch Bedding

Dimension Sieve Size	Percent by Weight Passing
5-inch	maximum allowable
3-inch	75-95
1-inch	40-60
1/2-inch	20-40
#4	0-20

18-Inch Riprap

Weight in Pounds Per Stone	Percent of Total Weight Lighter Than
400	100
200	60-90
100	30-50
25	0-15

All of the riprap and bedding was placed during the Stage II contract using either a track-mounted backhoe or a track-mounted front-end loader. (This equipment was not allowed on the placed stone.) (See Photos 54 and 55.) The upstream riprap is Bethany Falls limestone which was obtained from the Orrick Stone Co. Quarry in Clay County, Missouri. The upper 4.5 feet of material in the quarry was not used because of the poor quality rock.

The upstream riprap was designed in accordance with "Criteria for Riprap Wave Protection in Missouri River Division" dated June 1974 and ETL 1110-2-221 (29 Nov 76). The riprap design and the basis for the riprap limits are shown on Plate 32. The riprap was sized based on the design wave height (HD) which is equal to the significant wave height (HS) multiplied by 1.4. Significant wave height (HS) for the lower slope protection was 2.2 feet generated from 59 m.p.h. wind with a 20 minute duration. The critical combination for the upper area of stone protection is 56 m.p.h. wind for 30 minutes causing a significant wave height (HS) of 2.9 feet. The theoretical riprap necessary for the upper riprap zone is 21-inch, however, 18-inch was used instead since there is a very remote possibility the design condition will ever occur.

Based on economics, the embankment slope was designed to minimize the amount of required slope protection. The upstream riprap was placed between elevations 878 and 898 and elevations 915 and 925. These stone protection zones were determined from the Pool Elevation-Duration Curve, Lake Stage Frequency Curve and the chart showing the number of day per hundred years the pool is within the wave-height of a given elevation. In addition the upper slope has riprap to reduce wave run-up and protect the upper embankment during a full flood pool event.

The stilling basin riprap was also 18-inch and was placed similarly to the upstream slope. The stilling basin riprap is Winterset limestone from the lower 8.5 feet of the Courtney Road Quarry in Jackson County, Missouri. The riprap was designed based on methods described in ETL 1110-2-8 and ETL 1110-2-221. The design parameters used were an average flow velocity of 5.6 ft./sec. over the end sill, a design wave height of 2.8 feet, a safety factor of 1.5, and a specific gravity of 2.6. The riprap was designed based on wave height requirements, since the waves would cause more damage than the velocities.

4-05. Settlement. Settlement analyses were performed on the foundation overburden based on consolidation test results of select samples. These studies indicated a maximum total settlement of 2.2 feet in the valley foundation overburden and 1.9 feet in the terrace overburden. It was anticipated the majority of this settlement would occur during construction with only minor amounts occurring after construction. A 0.6 foot overbuild was constructed to compensate for post-construction settlement. During Stage

II construction, three settlement plates were installed in the valley section to measure settlement during and after construction. Two of the settlement plates are installed in the foundation overburden and one is installed in the embankment just above the pervious blanket in the random zone. As of April 1990, the maximum settlement in the two foundation plates is .71 foot with .66 foot occurring during construction and the settlement in the lower embankment plate is .8 foot with .54 foot occurring during construction. Also seven crest settlements monuments were installed to monitor settlement after construction. The crest settlement monuments indicate uniform settlement across the valley no more than .35 foot.

CHAPTER 5

SEEPAGE CONTROL

5-01. Through Seepage. Seepage through the embankment is controlled by a combination of embankment zoning and an inclined pervious drain. The impervious core prevents excessive seepage through the embankment. The random zones also assist in preventing through seepage since it was constructed primarily of impervious material. Any seepage which does occur is intercepted by the inclined pervious drain located on the downstream edge of the impervious core. The inclined pervious drain is connected to the horizontal sand blanket and together they will draw the phreatic surface down well within the embankment.

5-02. Underseepage. Seepage beneath the embankment is controlled by a cutoff trench, grout curtain and the extension of the sand blanket up the abutment. The impervious cutoff trench extends through the overburden and weathered rock down to firm bedrock. The grout curtain was constructed from the bottom of the cutoff trench and extends the full length of the dam.

a. Cutoff Trench. The cutoff trench was constructed to control seepage through the foundation overburden and weathered rock. It extends the full length of the embankment from station 86+00 on the right abutment to 104+00 on the left abutment. The trench is 30 feet wide along the bottom with excavated side slopes of 1V on 2H in the overburden and 1V on 1H in the bedrock. The cutoff trench was backfilled with impervious material to prevent seepage under the embankment. However, a 6 foot wide pervious drain which is connected to the horizontal sand blanket was placed on the downstream side of the trench to intercept any seepage which may occur.

b. Grout Curtain. The grout curtain was constructed to prevent underseepage through the bedrock. It consists of three lines of grout holes in the abutments and a single line of grout holes in the valley. Grouting was performed from the floor of the cutoff trench through 2 3/4-inch diameter steel pipe cemented about 2 feet into bedrock. The grout holes were drilled the total depth using rotary drilling methods. After drilling, the grout holes were washed through the drill rods, pressure tested, and grouted through a packer which was set at successively shallower depths. The grout pressure was not allowed to exceed the estimated vertical stress at the packer depth. All the grout holes were inclined 30 degrees from vertical and drilled parallel to the dam centerline into the abutments. The grouting plan and profile are shown on Plates 14, 15 and 16. Some variations to this plan were made during construction. A more detailed description of the actual grouting plan and operations are provided in the Construction Foundation Report. Line A is 10 feet downstream of the dam axis and actually extends from station 86+25 to 89+65 on the right abutment and between station 100+05 and 103+85 on the left abutment. Line B is located 10 feet upstream of the dam axis and was constructed from station 86+20 to 89+65 on the right abutment and 100+05 to 103+85 on the left abutment. Line C is along the dam axis and extends from station 84+00 to 112+00.

c. Abutment Seepage. In addition to the cutoff trench the grout curtain, and the sand blanket which extend up the abutments, the embankment slopes at the abutments were flared and a clay blanket was constructed on the right abutment to control underseepage at the abutments. Excess rock from required excavation was used in an outer rockfill zone to protect the clay blanket. The majority of the abutment seepage was expected to occur through the Bethany Falls limestone rather than the relatively tight lower bedrock units. Therefore, additional readily available rockfill was placed along the abutment up to elevation 848. The clay blanket was then placed on top of the rockfill and carried up to elevation 898.

CHAPTER 6

SLOPE STABILITY

6-01. General. This chapter discusses slope stability investigations. It presents the design analysis and consists of slope stability which was performed in conjunction with establishing embankment slopes and internal zoning. The results of the design analysis were originally presented in Design Memorandum No. 5, Soil Data and Embankment Design dated June 1978. A stability analysis of the left embankment which was performed after Stage I construction when high construction induced pore water pressures were measured in the embankment is discussed in Chapter 8 and Enclosure 1. A stability analysis was also conducted after Stage II construction for the conduit section when movements were detected in a lower zone of the embankment.

6-02. Design Strength Testing. Laboratory tests to determine strength parameters for design were performed on samples of materials from the required excavations, proposed borrow areas, and from the foundation. The testing consisted of laboratory tests on undisturbed samples of foundation material and on remolded samples from required excavation and potential borrow material. The tests generally followed procedures outlined in EM 1110-2-1906 entitled "Laboratory Soils Testing", 30 November 1970. Compaction of remolded or disturbed strength test specimens of cohesive soils was in accordance with EM 1110-2-1902, "Engineering and Design Stability of Earth and Rockfill Dams", 1 April 1970. Test loads generally covered the range anticipated in the embankment or foundation.

a. Triaxial Compression Tests. Triaxial "Q" and "R" tests were performed on representative undisturbed and compacted samples under confining chamber pressures ranging from 0.5 to 6.0 tsf. Pore pressures were measured in some of the "R" tests for the purpose of determining the effective strength of the soil. The general procedure involved strain controlled tests on two or three specimens trimmed from a single sample horizon. Composite specimens were compacted in eight layers by kneading to the range of densities and moisture contents expected during construction. Specimen dimensions were 1.4 inch by 3.0 inch height. No attempt was made to saturate the "Q" test specimens. "R" tests were saturated with back pressure ranging from 1.9 to 6.0 tsf. The strain rates were 0.5 percent per minute for the "Q" tests and 0.12 percent per minute for the "R" tests. In "R" tests, consolidation under the assigned chamber pressure was continued until a plot of volume change versus log time indicated that primary consolidation was complete. Peripheral filter paper strips were used to accelerate drainage. The deviator stress at 15 percent strain was assumed to be the maximum if it had not peaked beforehand.

b. Direct Shear Tests. Direct shear tests were performed on representative undisturbed and compacted soil specimens and on undisturbed shale specimens. Composites were compacted by kneading to the assigned density and moisture content, generally 95 percent of standard effort maximum dry density at a moisture content 3 percent greater than optimum. Normally, two specimens were sheared under a normal load of 4, 5, or 6 tsf. Before shear, the specimens were allowed to consolidate under the applied normal load until primary consolidation was complete. Specimens were sheared at a constant rate of 0.0003 inches per minute. Normally, this rate of deformation met the $50t_{50}$ criterion. Residual shear tests on intact and pre-cut samples were performed with a direct shear machine capable of shearing the specimen, then reversing the direction of shear 180 degrees and shearing the specimen again without releasing the normal load in the process. In order to obtain the strength at large strain, this procedure was repeated until no reduction in shear strength occurred from additional shearing.

6-03. Selection of Design Strengths. In selecting design values, considerations were given to 1) stress-strain compatibility, 2) the relationship of maximum shear strength to ultimate shear strength, 3) the number of tests, 4) the nature of the material, and 5) the location of the material with respect to potential failure surfaces. Design shear strengths were selected with two-thirds of the test values exceeding the design values.

a. Foundation Overburden. Test results of the terrace and valley reaches showed that one design strength was appropriate for the entire valley section. The following shear strengths were selected.

TYPE OF STRENGTH	c (TSF)	Tan Ø
Q	0.60	0.00
R	0.20	0.20
S	0.00	0.50

b. Foundation Shales. Only "S" strengths were used for shales in the design. Unconfined compression tests indicate that the "Q" strength is substantially greater than the overburden and therefore is not a factor in the stability analysis. Past experience in the Kansas City District indicates that because these shales are highly overconsolidated, "R" strength is generally greater than "S" strength over the range of normal stresses encountered. The design "S" strength for the shales in the abutments and valley is c = 0, tan Ø = 0.60. A residual "S" strength of c = 0, tan Ø = 0.30 was also used.

c. Compacted Embankment Material. In the original DM analysis higher strength lean and fat clays with liquid limit less than 55 from the low-lying borrow were to be used in the impervious zone and in the conduit section between stations 97+00 and 101+00. The higher liquid limit fat clays (with LL generally less than 70) from the upper borrow areas were expected to be used in both the impervious and the random zones for the remainder of the embankment. Thus the same strengths were assigned to the impervious and random zones for these reaches. (As a result of comments from higher authority, this was changed during the plans and specifications so that the lower liquid limit materials were used in the impervious zone to the extent possible and liquid limit restrictions were also applied to the random zone. The objective was to use the lowest available liquid limit materials in the lower part of the embankment to optimize strength and stability of the embankment. For a distribution of material requirements developed during the plans and specification phase of the design see Chapter 4.) The design strengths used in the DM stability analysis are shown in the following table. The pervious zone had a higher strength than the random or impervious but because of the limited extent of this zone the higher strength was ignored in the stability analysis.

RANDOM AND IMPERVIOUS

TYPE OF STRENGTH	c (TSF)	Tan Ø
Q	0.90	0.00
R	0.20	0.20
S*	0.00	0.50
S**	0.00	0.36

* Liquid limit less than 55, conduit section.

** Higher liquid limit material from higher elevation borrow areas.

BERM ZONE

TYPE OF STRENGTH	c (TSF)	Tan Ø
Q	0.45	0.00
R	0.10	0.20
S	0.00	0.30

6-04. Design Stability Analysis. The embankment was analyzed for stability at three locations in an effort to cover the various conditions existing in the dam. Those locations are the valley section, conduit section, and the cofferdam.

a. Method of Analysis. A force equilibrium wedge method was used to analyze the slope stability of the Longview embankment. A computer program titled "Stability Analysis - Wedge Method" (File No. 741-F5-c1020), commonly known as KC Wedge, was used to perform the stability analysis. This program satisfies force equilibrium only using an analytical technique discussed on Plate 86. It searches for the shear surface with the minimum factor of safety. The results were checked by searching from more than one starting point to make sure that the program did not miss potential failure areas. The slope of the effective "E" force was assumed to be one-half the average outer embankment slope. The computer program is compatible with Appendix VI of EM 1110-2-1902, except for: (1) the slope of the "E" force is assumed to be constant throughout the active wedge, and (2) the angle of the shear surface was assumed to be the same for each material in the active wedge. The critical shear surfaces were checked manually. In all cases, the manual checks confirmed the computer factors of safety. Typical analyses for the end of construction, partial pool, rapid drawdown from maximum surcharge and full pool, and steady seepage cases are discussed below and are shown on Plates 87 and 88.

b. Construction Case. The design analyses assumed that neither the embankment nor the foundation consolidates during construction. Submerged weights were used below and moist weights above the line of saturation, which was assumed near the ground surface. Upstream and downstream slopes were analyzed using "Q" (unconsolidated-undrained) shear strengths and were designed for a minimum factor of safety of 1.3. In order to meet the required 1.3 factor of safety in the valley section a construction halt at elevation 915 was needed to allow consolidation of the foundation clay. This was later changed to elevation 890 and embankment fill placement rate restrictions were established (see Chapter 8).

c. Partial Pool Case. The upstream slopes were analyzed for pool elevations ranging from near the valley floor to near full pool to determine the critical pool level. The intermediate shear envelope (S, (R+S)/2) was used. The saturation line was assumed to be horizontal at the pool elevation being considered. Submerged weights were used below and moist weights above the saturation line. The slopes were designed for a minimum factor of safety of 1.5 for a slide in the impervious and random zone. In the valley section a partial pool slide in the berm had a 1.22 factor of safety with the pool at elevation 855. The upstream berm slope was not flattened because of the improbability of the pool being at this elevation long enough for full saturation of the embankment to occur.

d. Steady Seepage Case. The downstream slopes were analyzed for a spillway crest pool, steady seepage case. Vertical equipotential lines were assumed. The shear envelopes and design factors of safety were the same as for the partial pool case. The slopes were also analyzed using residual strengths for the foundation shales, with a minimum factor of safety of 1.0 being required.

e. Sudden Drawdown Case. The upstream slopes were analyzed for a sudden drawdown condition, both from the spillway crest and from maximum surcharge. In both studies, it was assumed that the lake was drawn down to multipurpose pool. The combined "S" and "R" strength shear envelope was used. The analyses assumed that the embankment was saturated as shown and that the pool was instantaneously lowered with no dissipation of pore pressure occurring during drawdown. Slopes were designed for a minimum factor of safety of 1.2 for a drawdown from the spillway crest and a minimum factor of safety of 1.0 for a drawdown from the maximum pool.

f. Earthquake Case. The slopes of the embankment were subjected to a pseudo-static earthquake analysis during design. Longview Dam is located near the border between seismic zones 1 and 2. ER 1110-2-1806 requires the evaluation of potential liquefaction for all existing projects in zone 2 where embankment or foundation materials are present that are suspect of being susceptible to liquefaction or excessive deformation. Since the clay soils encountered are not vulnerable to liquefaction, a psuedo-static analysis was conducted.

q. Results. The results of the stability analyses performed for the design memorandum on the valley section, conduit section, and the cofferdam are shown on Plates 89 through 91.

6-05. Stage II Stability Analysis. Because of high construction induced pore pressures in the conduit embankment and a zone which developed deformation during Stage II construction, additional stability studies were made for the end of construction conditions. Analysis was performed on the upstream slope of the conduit section where both inclinometer data and observed bridge movements showed movement was occurring. The zone of movement roughly corresponded with the area of highest pore pressure. While pore pressures were experienced at the closure section and the right embankment, no significant movement was detected at other locations and the pore pressures were some what less and tended to be confined to the cutoff trench backfill (See Plate 44). Although there was some indication that placement water contents were farther above optimum than indicated by the field test data (see Chapter 8), it is believed the left embankment experienced unusually high pore pressure response because of its differential foundation conditions and its relatively small size as constructed in Stage I. The pore pressure was concentrated in that portion of the embankment which was placed on relatively rigid rock foundations or conduit. The left embankment foundation has a considerable portion placed on rock or concrete: the conduit excavation, the old sewer trench excavation and the cutoff trench. It appears that the backfill, being some what stiffer than adjacent overburden, probably carries load from surrounding fill areas which would increase stresses and thus pore pressure. Both total and effective stress analyses were performed. The effective stress analysis used both a pore water pressure coefficient, Bishop's r_u, and pore pressure contours developed from measured induced construction pore pressures. Inclinometers showed a zone of movement occurring at approximately elevation 827 at range approximately 1+80 upstream and analyses were performed with the shear surface through this zone.

a. Method of Analysis. The computer program SSTAB2 (Spencer's method) was used for the Stage II analysis. It satisfies all requirements of static equilibrium by varying the safety factor and side force inclination simultaneously. This program was written by Stephen Wright, University of Texas, Austin.

b. Revised Soil Parameters. The shear strength for the soil was determined from field compaction results, record control testing, and from testing on undisturbed samples taken both during the installation of instrumentation and from the side walls of two large diameter auger holes installed at the end of Stage I construction. The unit weight used was 125 pcf. The "S" strength for the effective stress analyses was determined from record control direct shear and triaxial "R" tests with pore pressure measurements. An envelope of c = 0.1 tsf and tan Ø = 0.5 was selected. "S" strengths were believed appropriate because of the movement experienced and that shear stress induced pore pressures were being measured. For the total stress analysis it was assumed a soft zone existed in the zone of movement. No attempt was made to specifically sample and test this zone since the embankment had been investigated previously during Stage I and no defined soft zone was found. Some strength test results showed strengths lower than the design value but a continuous layer was no identified. A reduced strength of 0.5 tsf was assumed for comparison purposes.

c. Results. Initial stability analysis was made using a simplifying assumption for the pore pressure of r_u = .65. This analysis showed F = 1.10 which was verified with a hand solution. It was believed that the pore pressure was not this high especially in the outer and upper 25 feet of the embankment. An analysis was conducted using pressure contours developed from the piezometer readings. A circular search showed a minimum F = 1.63 with the surface passing through a portion of the zone of movement. A wedge shaped shear surface through the zone showed F = 1.87. A total stress analysis with a the shear surface passing through the zone of movement shows F = 1.24 using the conservative strength assumption (c =.5 tsf) in the zone of movement. Results of these analyses are shown on Plate 92.

CHAPTER 7

INSTRUMENTATION

7-01. General. The initial installation plan for observation devices included instrumentation to monitor pore pressure in the embankment and the foundation clays and shales, the effectiveness of the cutoff trench and grout curtain, the foundation and embankment settlement, and the horizontal and vertical movement of the embankment. The piezometers were to be installed in three lines at stations 93+00 (valley section), 97+00 (closure section), and 98+70 (conduit section). Based on previously experienced high construction pore pressures in the foundations at other dams in the Kansas City District, the majority of the instrumentation devices were open tube and gas operated piezometers installed in the foundation overburden and shales. Piezometers were also installed in the foundation overburden upstream and downstream of the cutoff trench to check its effectiveness and in the embankment to monitor construction pore pressure. Alignment monuments were installed to detect slope movement as the embankment was being topped out while crest settlement monuments were installed soon after the embankment was topped out to monitor vertical movement. The initial instrumentation plan included 14 open tube piezometers, 12 gas operated pore pressure cells, 7 crest settlement monuments, 3 foundation settlement plates, and 21 alignment monuments total in one upstream and one downstream line. However, because of high construction induced pore pressures in the left embankment which developed during Stage I construction, additional observation devices were installed to monitor movements and pore water pressures particularly in the embankment. The monitoring program was expanded and further complicated by the development of gas in the open tube devices and concerns for the reliability of the devices. A discussion is included in Chapter 8 and Enclosure 1. It should be noted that all devices are thought to be influenced by gas and that the magnitude of the measuring error has no been determined although considerable effort has been directed to that end. At the time of this report, the instrumentation includes: 52 open tube piezometers of various design, 22 gas operated pressure cells, one vibrating wire piezometer, 23 alignment monuments total in 3 lines, 3 foundation settlement plates, 7 crest settlement monuments, and 4 inclinometers. The locations of these devices are shown in plan view and cross section on Plates 35 through 41.

7-02. Piezometers.

a. Open Tube Piezometers. A total of 62 open tube piezometers have been installed in the embankment, foundation, and abutments of Longview Dam since construction began. Ten of these instruments were abandoned; 8 because they were to be submerged upon reservoir filling, one because it was on the embankment centerline and could not be read after embankment completion, and one because it was broken 29-feet below the top of the riser and could not be repaired. There are a total of 52 open tube piezometers remaining on the project of three basic types. There are forty-one 3/4-inch PVC piezometers with slotted tips, four 3/4-inch PVC piezometers with 1/16-inch perforations, and seven 2-inch PVC piezometers with slotted tips. The open tube piezometer installation details are shown on Plate 42.

The 3/4-inch piezometers with slotted tips consist of 6.5-foot long sections of 3/4-inch inside diameter, schedule 80, PVC pipe. On early installations, the sections of pipe were connected with stainless steel threaded couplings whereas the later installations utilized flush joint PVC pipe. All of the 3/4-inch piezometers terminate in sensing tips consisting either of a 1.5-inch diameter by 18-inch long, #20 (0.020-inch) slotted PVC pipe or a 2-inch diameter by 24-inch long, #10 (0.010-inch) slotted PVC pipe. Sand surrounds each tip and fills the borehole so as to be in contact with the zone or zones to be monitored. Where a single zone was to be monitored, a 4-foot seal of bentonite balls was placed above the sand with a 5 percent bentonite-cement grout filling the remainder of the hole. Piezometers installed to monitor several strata are all located on the right abutment and have a one-foot seal of bentonite balls above the sand with the remainder of the hole (3-foot minimum) filled with a 1 to 1 sand and granular bentonite backfill.

The 3/4-inch piezometers with 1/16-inch perforations are similar to those described above with the exception that, on 6-foot centers, 1-foot long sections of the schedule 80 PVC riser pipe were patterned with 1/16-inch holes. This pattern of perforations and the sand backfill around the riser was continued to within approximately 14 feet of the ground surface where a 1-foot thick bentonite ball seal was placed. The remainder of the hole was then filled with a 1 to 1 granular bentonite and sand backfill. All of the 3/4-inch piezometers with perforated risers are located on the abutments.

The 2-inch diameter piezometers with slotted tips are also similar to the 3/4-inch piezometers with slotted tips with the exception that, regardless of slot size, all of the tips are 2 inches in diameter. All of the 2-inch piezometers except PPE92-2 are located in the foundation overburden downstream of the right abutment and carry the prefix "W-". PPE92-2, the only 2-inch open tube piezometer in the embankment is made of glued joint PVC pipe.

Where 3/4-inch piezometers were brought up through the embankment, 5-foot lengths of 2-inch I.D. PVC protective pipe surround the 3/4-inch pipe above the original installation borehole (Plate 43). The fill was compacted directly against the protective pipe. The 5 foot sections are joined using double bell slip couplings with rubber sealing rings to accommodate movement and settlement.

Several open tube piezometers produce large quantities of gas which makes evaluation of data difficult due to widely and rapidly fluctuating water levels. The presence of gas in open tube piezometers was identified early in construction and an investigation to identify the type of gas was undertaken. The collection and identification processes are documented in Enclosure 1. The piezometers that have experienced problems with gas are PPE92-1, PPE95-1, PPE97-13, PPE97-14, PPE99-10, and PPE99-13, all of which are located either in the upstream or downstream random or impervious zones. A 2-inch diameter open tube piezometer (PPE92-2 data plots shown on Plates 109 and 110) was installed adjacent to a 3/4-inch open tube piezometer (PPE92-1 data plots shown on Plates 107 and 108) which had been giving inconsistent data due to gas. Both devices were installed with the tips at the same elevation. The 3/4-inch device had a water level at the top of the riser and would periodically overflow and would erupt after a pressure gauge was removed. The 2-inch piezometer stabilized at a level about 20-feet below the ground surface and showed a steady decrease in water level as would be expected. In attempts to prevent the 3/4-inch devices from overflowing and to stabilize the fluctuating water levels, pressure gauges and air release valves were installed on the risers. Although 3/4-inch risers should de-air themselves, the air release valves have not proven entirely effective and in several cases the pressures indicated by the piezometers increase substantially when a gauge and air release valve are added due to gas partially displacing water in the riser (Plates 107 and 108). The existence of gas in the piezometers and its effect on water levels is not as extreme as it has been in the past, although it does continue to be a problem.

b. Gas Operated Piezometers. A total of 32 gas operated (pneumatic) piezometers have been installed in the embankment and foundation of Longview Dam, of which, 22 remain functional. Three instruments were destroyed by a 1982 flood, two were destroyed by construction equipment, four were abandoned because of water in the pressure leads or a diaphragm failure, and one indicated pressures above the range of the readout device. Of the 22 remaining gas operated piezometers at Longview, 18 are Sinco Model 51471 pore pressure transducers (2-tube) with "Norton" (low air entry) filters, 3 (PPE99-8, PPE99-12, and PPE99-15) are Petur model P-100 pneumatic piezometers (low air entry filter), and 1 (PPE99-11) is a Sinco Model 51471 pore pressure transducer with a "Coors" (high air entry) filter. PPE99-8 and PPE99-11 were installed within 5-feet horizontally and 12-feet vertically of each other for comparison purposes (Plates 116 through 119).

Each of the three types of gas operated piezometers were installed differently and the installation details are shown on Plate 42. The standard Sinco 51471 transducers were installed in 3.5 feet of saturated sand in a 6-inch diameter borehole. Above the sand, the hole was sealed with 4.5 feet of bentonite balls. The remainder of the hole was then filled with a 1 to 1 mixture of sand and granular bentonite. The Petur P-100 pressure cells were installed in existing 3/4-inch I.D. PVC open tube piezometers. The transducer was placed in the PVC riser and 8 feet of saturated sand was placed in the riser. A 1-foot thick plug was then formed around the pressure leads inside the riser using a water sensitive expanding polymer. The riser was cut off 1 foot below the surface of the fill under construction and the remainder of the riser was filled with sand. A 1-foot thick bentonite ball seal was placed over the top of the cut off PVC riser and embankment construction continued over the bentonite seal. The Sinco 51471 with the high air entry Coors filter was installed in an existing 2-inch diameter PVC piezometer. The 2-inch riser was filled with saturated sand to within 8 feet of the surface of the embankment. Bentonite balls were then placed in the remaining 8 feet of riser to form a seal. Again, embankment construction continued above the bentonite seal.

Five of the existing gas operated piezometers have begun, or continue, to provide erratic readings and have water in the pressure tubing at least intermittently. These problems are believed to be due to the piezometers and the associated tubing approaching the end of their useful life expectancy. The possibility of continuing to obtain useful readings from these devices is questionable. Difficulties have been encountered in reading the following devices: PPE93-1, PPE93-6A, PPF97-9, PPF99-1, and PPE99-6.

c. Vibrating Wire Pressure Cell. The vibrating wire piezometer, PPE99-18, is a Geokon Model 4500. The vibrating wire piezometer cell was placed in a 1.5-inch diameter vertically slotted PVC pipe filled with

11 pounds per gallon kaolinite slurry (Plate 42). The leads to the cell were extended from the top of the 1.5-inch diameter pipe through a length of 3/4-inch PVC pipe. This length of pipe was also filled with kaolinite slurry and sealed 4.7-feet above the piezometer tip with a plug of water sensitive expanding polymer. A 6-inch diameter leather collar was placed around the 3/4-inch pipe at the same location as the polymer seal. This entire assembly was then lowered to the bottom of a 6-inch borehole filled partially with the kaolinite slurry using a 0.4-foot long length of 3/4-inch PVC pipe to keep the unit off of the bottom of the borehole. A 4-foot seal of bentonite balls was placed above the leather plug and a 1.5-foot layer of saturated sand placed above that. The remainder of the borehole around the 3/4-inch pipe containing the piezometer leads was filled to the ground surface with a 5 percent bentonite-cement grout. The readout leads for this device are entirely encased in 3/4-inch PVC pipe between the top of the 1.5-inch diameter slotted pipe and monitor box 5 on the downstream crest road shoulder.

7-03. Embankment Piezometric Devices. Following completion of the Stage I left embankment, high pore pressures were measured in the lower part of the embankment. Between the Stage I and Stage II contracts, overflowing water levels and quick recoveries after pumping were found in the protective casings of several devices in the closure section. It appeared that the protective casings and the risers were acting as separate measuring devices. The protective casings were apparently registering higher pore pressures at points higher in the embankment, possibly near the mid-height. These pressure levels apparently exceeded 50 percent response. An extensive investigation was undertaken to determine the extent of the high pore pressures and the adequacy, including stability, of the embankment. The investigation involved undisturbed sampling and testing, inspection of in place embankment material from two large diameter auger holes, installation of additional instrumentation to monitor pore pressures and slope movement, dye injection, and pump tests. A complete discussion of the investigation is contained in Enclosure 1. The investigation revealed construction induced pore pressures in the left embankment backfilled excavations below approximate elevation 810 ranging up to about 75 percent. Between approximate elevations 820 and 830, above the backfilled excavations, pore pressure responses were between 50 and 60 percent. No pore pressures were present in the top 20 feet of the Stage I fill.

Most of the piezometers installed in the embankment measured induced construction pore pressures after completion of the embankment and continue to do so. In general, piezometers located in the cutoff trench and adjacent to the conduit registered the highest pore pressure levels upon embankment completion with some indicating pore pressure of up to 63 percent, or about 65-feet above the top of the dam.

Construction pressures in the embankment remain high especially in the cutoff trench and around the conduit (40 to 55 percent pore pressure response). Most of the piezometers are showing a pressure dissipation of about 1 to 5-feet per year in the embankment although some have not begun to show pore pressure dissipation.

Piezometers installed in the embankment indicate pore pressure levels above the pool elevation, therefore the effect of pool filling on the embankment piezometers has yet to be determined.

All piezometers on the project are currently being read quarterly.

7-04. Foundation Piezometric Devices. During construction, little pore pressure developed in the foundation shale or overburden. During reservoir filling, piezometers located in the foundation overburden on the upstream side of the cutoff trench indicated nearly full reservoir head which was apparently being transmitted through the basal gravel layers. The piezometers located in the upstream foundation overburden still indicate nearly full reservoir head, however, no significant pressures are being transmitted downstream. The only other foundation piezometer to show high pressures was PPF99-4 with its tip in the Pleasanton Zone E formation (Plates 114 and 115). It built up pore pressure to an elevation of 880 shortly after construction was completed and has dropped to elevation 837 as of the fall of 1990. Since filling of the reservoir in 1986, all of the piezometers in the Pleasanton Zone E siltstone on the upstream side of the grout curtain have shown a slow, but constant, increase in piezometric level. These increases have been anywhere from 8 to 14 feet with PPF86-1A on the upstream right abutment showing the largest increase (Plate 102). The piezometers in the Pleasanton Zone E siltstone on the downstream side of the grout curtain have shown general decreases in measured pore pressure from 1 to 14 feet except for PPF87-3 as noted in the "Abutment Piezometric Devices" section below.

7-05. Abutment Piezometric Devices. Piezometers located in the right abutment bedrock, downstream of the grout curtain, rose as the pool filled lagging the pool generally on the order of 14 feet. This prompted the installation of piezometers in various geologic members to determine which ones were transmitting pressure. Some pressure testing and bail tests were done as the holes were being drilled. It was found the formations transmitting the high pressures included the Pleasanton Zones A & B, as well as the Middle Creek limestone and Hushpuckney shale. Piezometers were also installed in the pervious drain after excessive water was noted exiting the pervious blanket. Piezometer readings indicated the pervious blanket was completely saturated and even pressurized in some areas. It was concluded that the excessive water was coming from seepage through the right abutment bedrock. No other problems have surfaced due to these high pressures and it appears that seepage through the right abutment is being controlled and collected by the pervious blanket.

The piezometers in the Pleasanton Zone E siltstone on the downstream side of the grout curtain have shown general decreases in measured pore pressure from 1 to 14 feet except for PPF87-3 (Plate 103). PPF87-3 has shown a 3 foot increase in the measured piezometric level in the Pleasanton siltstone since 1986. This increase is most likely due to migration of high pressures from the overlying Hushpuckney shale, Middle Creek limestone, and the Pleasanton Zones A and B.

Seepage pressures remain high in the right abutment bedrock and are influenced by the pool. A steady flow continues to exit the pervious blanket as a result of this seepage. This causes the toe ditch to remain wet and causes a maintenance problem in this area. No other problems have surfaced due to these high pressures.

7-06. Inclinometers. There are three inclinometers installed through the upstream slope and one through the downstream slope. All are between stations 97+00 and 99+00 (Plate 36). All of the inclinometers are constructed of 3.38-inch outside diameter, grooved aluminum casing (Plate 43A). The casing was installed in 10-foot lengths and joined with 3.63-inch outside diameter by 12-inch long telescoping aluminum couplings. The casings were pop-riveted to the couplings with aluminum rivets and a gap was left between subsequent casings to allow for settlement of the foundation or embankment. In the foundation overburden, a 12-inch gap was left between casings while a 6-inch space was left between casings that passed through the embankment. Each inclinometer is sealed at the bottom with a pop-riveted plastic cap and protected at the surface of the fill by a 6-inch diameter, lockable, galvanized steel pipe.

I-97-1 and I-99-2 were installed in 7-inch flight augured boreholes through the partially completed embankment and foundation overburden. The bases of the inclinometers are seated in holes drilled using a 5-5/8 inch rock bit in the foundation rock. Pea gravel was used as backfill material in the annulus around the inclinometer casings. A short length of 6-inch diameter steel pipe filled with pea gravel was placed around the inclinometer at the surface of the fill. As the embankment was brought up, the fill was compacted directly against the 6-inch pipe. After each few lifts, the pipe was raised to the new fill surface leaving the pea gravel in direct contact with the compacted embankment material. This process was repeated until the final surface of the fill was reached where a 1 to 1 cement grout seal was placed. I-99-1 was installed after completion of the embankment at the device, in a borehole drilled entirely with a 6-1/8 inch rockbit through the embankment, foundation, and into the foundation rock. Pea gravel was placed in the annulus around the inclinometer casing and a 4-foot long seal of bentonite balls was placed around each coupling. I-99-3 was also installed after completion of the embankment adjacent to the bridge abutment and the borehole was made using a 5-7/8 inch rockbit exclusively. A 1:1 cement grout fills the annulus between the inclinometer casing and the borehole walls.

Inclinometer I-99-1 was installed at station 95+40, range 2+57 downstream (Plate 41) in September of 1984, one month prior to topping out of the embankment. This device has shown a total movement of 4.7 inches most of which occurred between elevations 803 and 829 prior to September of 1986 (Plate 121 and 122).

Inclinometers I-97-1 (station 97+49, range 1+89 upstream) and I-99-2 (station 98+25, 0+85 upstream) were installed after the Stage I embankment was completed and were extended through the embankment as it was constructed (Plate 41). I-97-1 has shown a total upstream movement of 7.5 inches most of which occurred between elevations 823 and 842 (Plate 124).

I-99-2 has shown approximately 8.2 inches of upstream displacement, most of which took place in the top 4 feet of the fill and between elevations 819 at the bottom of the inclinometer and 856 (Plate 122). Most of the movement at the base of the device occurred as the embankment was being topped out or shortly after completion of the embankment. The movement shown in the top 4 feet of the embankment is attributable to the placement of a concrete work pad on the up slope (downstream) side of the device. The concrete pad was in contact with the protective pipe around the inclinometer and has caused the top section of the inclinometer to lean upstream. Neglecting the movement shown in the top 4 feet of the embankment, I-99-2 shows 6 inches of total upstream movement.

Since October of 1987, I-99-2 has been experiencing a problem with "silting in". Between October of 1987 and September of 1990, the sounded depth of this inclinometer decreased 15 feet from 108.8 to 93.8 feet. This "silting in " is reflected by the progressive upward shifting of the bottom of the readings on the movement versus depth plots shown on Plate 122. The loss of the lower 15 feet of the instrument is also evidenced by the shifting of the data plots to the right as the incremental movement shown in the lower portion of the instrument is lost. The exact nature of the material in the inclinometer and the cause for the silting is currently unknown. Flushing of the casing and sampling of the material is planned. If it is found that substantial quantities of embankment materials are found in the instrument, it will be abandoned by grouting the casing full.

I-99-3 was installed at station 98+50, range 1+80 upstream adjacent to the tower bridge abutment (Plate 41). During and after construction, this device indicated lateral spreading of the embankment in the conduit section on the order of 4.5 inches (Plates 123 and 124). This spreading resulted in movement of the control tower bridge abutment and complete closure of the expansion joints at both the bridge abutment and pier. Most of the movement occurred between elevations 816 and 837 with a fairly concentrated zone of 1.9 inches of incremental movement at elevation 826.3. As a result of this movement the embankment stability was checked (see Chapter 6). Repair of the bridge abutment and reestablishment of the tower bridge expansion joints was accomplished by contract in the spring of 1990.

No substantial movement has been shown by any of the inclinometers since 1987. All four inclinometers are currently being read twice a year.

7-07. Alignment Monuments. The alignment monuments on the downstream line "A" and upstream line "B" consist of 18-inch diameter by 8-foot deep reinforced concrete monuments (Plate 43). Alignment line "A" is located 200-feet downstream of centerline between stations 87+50 and 101+00 and contains 8 monuments on 200-foot centers. Line "B" is located 170-feet upstream of the embankment centerline between stations 87+00 and 103+50 and contains 9 monuments on 200-foot centers (Plate 36). In addition to alignment monuments, each line has two instrument monuments; one on each abutment.

As previously noted, lateral spreading of the embankment in the conduit section caused movement of the control tower bridge abutment and complete closure of the expansion joints at both the bridge abutment and pier. Alignment line "C" was installed to monitor the tower bridge abutment movement and consists of only one alignment plate and two instrument monuments (Plate 43). The alignment plate is located at station 98+66, range 1+77 upstream, and is installed on the north end of the east bridge parapet over the abutment. There is not a concrete monument installed at that location, only a stainless steel instrument plate mounted on the bridge parapet. Line "C" uses the same left abutment instrument monument as the upstream line "B". A separate instrument monument for line "C" exists on the right abutment upstream of the monument for line "B" to allow a straight shot across the bridge abutment.

Initial readings on all three lines were taken three times and the results averaged to establish a zero reading. The initial readings of lines "A" and "B" were taken in July of 1985. The initial reading of line "C" was taken in March of 1986 after installation of the alignment plate. "A" on the downstream slope has experienced the most overall movement with a maximum total movement of 1.7 centimeters at monuments A-5 and A-6 at stations 95+00 and 97+00 respectively (Plate 98). The maximum total movement of 1.4 centimeters of the upstream line is shown by monument B-3 at station 91+00 (Plate 98). Vertical surveys taken on each monument indicate maximum settlements since installation on the downstream line at monument A-6 which shows a total settlement of 0.19 feet (Plate 99). The maximum settlement on the downstream line is 0.14 feet at monument B-4 at station 93+00 (Plate 100). Line "C" has indicated no movement or settlement since installation since all bridge abutment movement took place prior to installation of the monuments. All alignment monuments on the project are currently being surveyed semiannually.

7-08. Foundation Settlement Plates. Three mechanical foundation settlement plates were installed during construction in 1983. These devices were installed at stations 91+00, 93+00, and 96+00 and are downstream of the embankment centerline 40, 50, and 75 feet respectively (Plate 36). SPPF91-1 and SPPF93-7 consist of a 36-inch square, 1/2-inch thick steel plate set approximately 1-foot below the embankment/foundation contact (Plate 43). The plate of SP96-1 is also a 36-inch square steel plate but it is installed approximately 10-feet above the pervious blanket as opposed to below the blanket at the foundation contact as is the case with the other settlement plate installations. The location of the plate allows SP96-1 to monitor settlement in approximately the lower 13 feet of the embankment. To allow monitoring of changes in elevation of the plates, a 1-inch diameter standard galvanized pipe is connected to a flange bolted to the plate. The 10 inches of galvanized pipe immediately above the plate is perforated with 12, 1/16-inch holes to allow monitoring of pore pressures as well as settlement. (The use of all three settlement plates to monitor pore pressures was discontinued in May of 1986 due to the presence of heavy oil in the riser.)

As noted on the plots, there was no reliable settlement data recorded between August of 1984 and May of 1985 since the contractor failed to record a riser extension (Plate 97). It was assumed that no settlement took place during this period. The three settlement plates indicate that the bulk of foundation consolidation had occurred by October of 1984 with only small settlements since that time. The range of settlements indicated is between 0.5 and 0.8 feet with SPPF96-1 showing the greatest settlement. The maximum current rate of settlement shown by the settlement plates is less than 0.1-foot per year. See section "Crest Settlement Monuments" below for discussion and comparisons of the foundation settlement plates and crest settlement monuments. All foundation settlement plates on the project are currently being surveyed annually.

7-09. Crest Settlement Monuments. On completion of the dam in 1985, seven crest settlement monuments (CSM's) were installed in a single line on 200-foot centers along the crest of the dam (Plate 36). The monument line runs along the inside edge of the downstream guardrail of 109th street at approximate range 0+36 downstream. The monuments are 6-inch diameter by 6-foot deep auger holes filled with reinforced concrete. The monuments are capped with a standard brass monument cap set flush with the bituminous roadway surface (Plate 43). Four of the brass monument caps were damaged by snowplows in 1987 and it may become necessary to relocate the crest settlement monuments to the downstream side of the guardrail to prevent this type of damage from recurring.

As noted above, the crest settlement monuments were installed in July of 1985 and have since shown between 0.1 and 0.35 feet of settlement (Plates 95 and 96). CSM-4 at station 94+50 over the old river channel shows the maximum crest settlement. The crest settlement monuments are currently being read once a year and currently indicate settlement rates of less than 0.1-foot per year.

CSM's 2, 3, and 5 are located at roughly the same respective stations as settlement plates SP91-1, SP93-7, and SP96-1. Comparisons of the total settlements shown by CSM's 2 and 3 and settlement plates SP91-1 and SP93-7 indicate that approximately 70 percent of the total settlement that has occurred since 1985 has been embankment settlement. As noted above, the plate for SP96-1 is installed approximately 10-feet above the pervious blanket which allows it to monitor settlement in approximately the lower 13 feet of the embankment. Settlements indicated by CSM-5 and SP-96-1 are closer in agreement than the other comparisons and it is indicated that approximately 90 percent of the embankment settlement shown by the crest settlement monuments is occurring in the lower portions of the embankment which are not monitored by SP91-1 and SP93-7.

7-10. Top of Dam Profiles. Surveys are made annually of the top of the New Jersey barriers and the top of the dam at the downstream edge of the barriers between the lanes of 109th street across the dam (Plate 94). As noted previously, the roadway surface across the dam is below the theoretical top of dam elevation of 926.6 by approximately 1.2 feet and the New Jersey barriers are considered to account for the remaining required freeboard. The elevations taken after the September 1989 repair of the low spot on the left abutment are shown in the top plot on Plate 94.

The maximum settlement shown by the top of dam surveys occurs at station 94+50 over the old river channel and is approximately 0.3 feet. This data confirms the location and magnitude of settlement shown by the crest settlement monuments.

CHAPTER 8

CONSTRUCTION NOTES

8-01. General. Major sewer construction work in the reservoir area was a significant concern in planning for the construction of the dam. Closure of the embankment could not occur until the sewer was complete because of the potential to inundate the sewer construction area within the reservoir. Since it was unknown at the time of preparation of plans and specification when the sewer construction would be complete, the District decided to construct the dam in two stages. This created some problems with trying to minimize the number of temporary slopes and "tie-ins," however, a construction plan was developed with this objective in mind. The plan was complicated not only by the existing sewer which crossed the proposed foundation and the necessity for the sewer to remain in service at all times, but also by the relatively narrow valley and the fact that the best available upstream borrow was located in low-lying areas next to the river channel. To minimize "tie-ins" the plan proposed building the minimum embankment necessary in Stage I prior to diversion and closure in Stage II. This embankment was to be only that necessary for the cofferdam (except the closure section). Stage I required construction of the outlet works (conduit and sewer), diversion of the sewer, and removal of the existing sewer. It required excavations for the outlet works including the outlet channel and a river diversion channel. Cutoff trench excavation and foundation grouting was included in Stage I as well as backfilling the cutoff trench for the right and left embankments. To minimize the amount of low-lying impervious material that had to be stockpiled, it was decided to include placement of the downstream conduit embankment to elevation 867. Stage II construction included diversion of the river, construction of the closure cofferdam, the remaining portions of the downstream embankment, and raising the entire embankment to final elevation. The construction plan allowed a considerable portion of the Stage II embankment to be constructed without temporary slopes or "tie-ins." However, the configuration of the Stage I embankment and the cofferdam was not ideal since it consisted of many small pieces.

8-02. Stage I Contract. The Stage I contract, DACW41-79-C-0114, was awarded to W. A. Ellis Construction Company, Kansas City, Missouri, on August 24, 1979, for the low bid of $11,865,103.00. Construction began in September 1979 and was completed in October 1982. Ellis Construction Company's previous experience was primarily in highway and sewer construction projects, they had never constructed a dam, nor did anyone with the company have any dam building experience. This lack of experience was compounded, especially early in the contract, by the fact that the Government did not have a resident engineer on the job full-time. The project was administered by an area engineer who visited the project only periodically and an inadequate staff. This led to immediate problems with rock excavation, foundation treatment and preparation, care of rock surfaces and especially material usage. Early in the project the specifications were often totally ignored. After these administrative problems became apparent a full-time resident engineer was assigned to the project and was given a very capable staff. The project ran much better in that the specifications were being enforced; however, the early problems led to hostile relations between the contractor and the resident office. Strict interpretation and enforcement of the specifications led to a substantial claim involving a variety of issues, the most significant of which related to material usage from the borrow. Additionally, because of these problems and unexplained observations of the left embankment and instrument monitoring devices, serious concerns for the integrity of the Stage I embankments surfaced. The embankment experienced relatively high pore pressures apparently related to fill placement which tended to be wet of optimum and the rather complex configuration of the embankment pieces. The high pore pressures were complicated by an unexplainable accumulation of gas in the monitoring devices. An extensive investigation was conducted to determine the stability and adequacy of the Stage I embankments. The borrow area problems, embankment investigation and other pertinent features are discussed below.

a. Borrow. Much of the low liquid limit material needed for the impervious fill and the stockpile for Stage II was easily available only in, close-in, low-lying areas along the river. The other areas of the borrow contained some low liquid limit material however, it was usually overlain by high liquid limit material unacceptable for use as impervious. On previous dam construction projects, as on this one, the Government had done enough exploratory work to ensure that sufficient quantities of the desired material were available in the borrow; but usually this exploratory work was not sufficiently detailed for the actual construction. Detailed explorations were expected of the contractor; specifications clearly state this as the contractor's responsibility. However, the contractor did no exploratory work to classify material in the borrow and placed a large quantity of the close-in low liquid limit materials in the berm and random fill zones early in the job. He then began experiencing problems finding acceptable material for use in the remaining impervious zone in the left embankment and to complete the impervious stockpile required for Stage II construction. This material could not be readily classified visually because there was not a discernible difference in color and the material typically ranged in liquid limit between about 45 and 60. Visual classification techniques using toughness of the PL thread are not precise enough for most individuals to differentiate between materials with LL just below 55 from those just above 55. The contractor was directed to do exploratory work in the borrow; however, not enough quantity was found to complete either the left embankment or the impervious stockpile. An analysis of the borrow area, and of materials placed in the berm and random zones for the claim revealed that more than enough impervious had been available in the borrow to meet the fill quantities required. In fact, the analysis showed that some 180,000 cubic yards of impervious was placed in the berm zone, and 75,000 cubic yards in the random zone. Only 40,000 cubic yards had to be deleted from the Stage I contract quantities for the left embankment and the impervious stockpile.

b. Outlet Works Excavation.

(1) Conduit-Sewer. The conduit-sewer excavation began in the fall of 1979. The floor of the excavation was 25-feet wide upstream of the cutoff trench and 30-feet wide downstream of the cutoff trench (see Plate 12 for excavation plan). The overburden excavation averaged 20-feet deep with 1V on 2.5H slide slopes. The majority of the excavated overburden was used for the impervious stockpile. The rock excavation averaged only 2 to 4-feet deep and was performed with backhoes, jackhammers, or dozers with the exception of the intake tower area where a rock saw was used to make the necessary vertical cuts. The rock surface was brought to final grade using a "roto mill," a large track-mounted cutting roller. Air-water jets were used to clean off the

final bedrock surface prior to placing the specified 6 inches of fill concrete. It was required the bedrock be excavated to firm rock, so in some places additional fill concrete had to be placed to bring the final fill concrete surface to grade. The contractor elected to over excavate the east slope to provide for a 30-foot wide workbench along the tower area (O.W. station 45+00 to 46+00) and 20-foot wide bench along the conduit section. During the conduit-sewer excavation several slides occurred along the left abutment.

(a) Sewer Excavation Slide. On November 18, 1979 a slide occurred on the left side of the sewer excavation between outlet works (O.W.) stations 55+00± to 57+00±. The slide moved on a slickensided surface in the weathered shale which underlies the talus. The horizontal movement at the head of the scarp was in excess of 8 feet and the depth to the failure plane varied from a few feet to 8 or 10 feet. The failure took place just after the excavation had been made at the toe of the natural abutment slope. (See Photo 13.) After the initial failure, additional exploratory holes were drilled and the slide area was analyzed and monitored. Through the winter of 1980, additional movement was experienced and the slide area increased. Because of the continued movements, there were concerns regarding long-term stability of the area. It was felt the slide would not adversely effect the stilling basin or the outlet works; however, continued movement would not be tolerable to the relatively rigid new sanitary sewer pipe to be located on the left side of the outlet works. Therefore, the proposed new sanitary sewer was relocated to the right side of the outlet works by Modification 6. The new sewer alignment is shown on Plate 12. The slide area was repaired by removing the slide material from the excavation and backfilling the sewer excavation to elevation 820 with the excavated overburden from the left abutment as part of Modification 16. The backfill was placed in 8-inch lifts, compacted with even routing of hauling equipment and the final surface sloped to drain away from the abutment.

(b) Left Abutment Slides. During the winter of 1980, three additional shallow slides occurred in overburden on the abutment side of the conduit excavation between O.W. stations 50+00 and 52+00. These slides were each about 50-feet wide and extended about halfway up the slope from the base of the excavation. Then again in December 1980 another slide occurred in the same area. In order to prevent further sliding of the left abutment overburden, the contract was modified to require all left abutment overburden between the cutoff trench and the downstream toe of the embankment be excavated to rock.

(2) Outlet Channel. In the late summer of 1980, the outlet channel alignment was modified to avoid the guy wires of a newly relocated power line. The outlet channel was moved toward the east downstream of O.W. station 60+41. This new alignment also eliminated the need to relocate an existing gas line.

(3) Approach Channel. The approach channel parallels the new sewer relocation which was constructed under separate contract concurrently with Stage I construction. Originally the entire approach channel excavation was to be performed during Stage II to prevent the confusion of having separate contracts in the same area. However, the majority of the approach

channel excavation was performed by the sewer contractor during the installation of the adjacent sewer. Therefore, only minor excavation was necessary during Stage II to bring the approach channel to grade.

c. Sewer Relocation. Prior to constructing the embankment, the existing 48-inch sanitary sewer located on the right and parallel to the outlet works had to be diverted through the relocated sewer beneath the conduit without interrupting service and then removed. Construction of the dual 54-inch sewer pipes located under the conduit and the removal of the existing sewer pipe within the limits of the dam were included in the Stage I contract. The remaining sewer relocation work in the reservoir area and downstream from the dam was performed under a separate sewer contract. As previously discussed, the new sewer alignment originally located on the left side of the stilling basin was moved to the right side by Modification 6. Because of this alignment change the new and existing sewers crossed. Therefore, prior to constructing the new sewer, the existing sewer had to be temporarily taken under the new sewer by an inverted siphon which was added to the contract by Modification 37. The conduit-sewer structure was completed by the fall of 1980 but the actual sewer diversion did not take place until July 1981. The existing sewer and all of the bedding material was removed shortly after diversion. The majority of the existing sewer was located on bedrock so the excavation and foundation cleanup performed was similar to the cutoff trench. The contractor excavated and cleaned up to 50 feet at a time and used air jetting for final cleanup of the shale. The sewer excavation was to be backfilled with impervious (LL$\leq$55), however, the contractor was also allowed to use fat clay. The downstream pervious blanket was placed directly over the sewer backfill rather than along the excavation limits. All of the existing sewer pipe was removed except the inverted siphon. It was left in-place and pumped full of sand to prevent the water flowing through the sand blanket adjacent to the conduit from building up pressure upstream of the new sewer.

d. Cutoff Trench.

(1) Excavation. The cutoff trench was excavated to bedrock between station 86+00 and 104+00. The floor of the excavated trench is 30-feet wide and the side slopes are 1V on 2H in the overburden and 1V on 1H in the bedrock. (See Plate 11). The contractor began excavating the trench along the valley, then proceeded to the left abutment and finished the trench excavation with the right abutment. The overburden thickness varies from 0 feet on the abutments to as much as 29 feet in the valley. The majority of the excavated overburden was placed in the impervious stockpile or temporarily stockpiled for future use in Stage I. The rock excavation was performed primarily by backhoes or presplit blasting to minimize damage to the rock surface. The specifications restricted blasting within 100 feet of concrete or grout less than 7 days old or within 50 feet regardless of age. Therefore, the majority of the blasting along the cutoff trench was completed prior to curtain grouting and all of the blasting on the left abutment cutoff trench was completed prior to placing the outlet works structural concrete. As previously mentioned the cutoff trench was excavated to grade prior to grouting with the exception of the shales which were left 2-feet high to protect the underlying shale from drying out and weathering. All curtain grouting was performed from the floor of the cutoff trench (Photo 14) and is discussed in more detail in the Construction Foundation Report. The cutoff trench excavation and curtain grouting was performed in the dry. The river

had to be temporarily diverted to perform cutoff trench excavation and curtain grouting within the river channel. The contractor made little or no effort to control surface runoff or groundwater in the cutoff trench between grouting operations and backfilling.

(2) Backfilling. The cutoff trench was backfilled with impervious fill and a 6-foot wide pervious drain on the downstream side of the trench (see Photo 16). In mid June 1980, the contractor began backfilling the cutoff trench at approximately station 93+60 and proceeded towards the right abutment. There were several areas along the upstream slope where water was seeping from the clayey gravel zone directly above the shales. Initially the contractor only had two pumps with sumps located wherever low areas existed which resulted in the contractor chasing water from location to location. The first lift of backfill placed on the shale was 1 to 2-feet thick and in some cases was placed in standing water. Two test pits were dug between station 91+00 and 92+00 to observe the fill-shale contact and the overall backfill condition. They indicated a zone of very soft wet fill existed at the shale contact, varying in thickness from 1/4 inch to 1 inch. The contractor was required to remove and replace this unacceptable lift. The removal of this lift is shown in Photo 15. After these initial problems, the contractor's operation improved. In order to control lift thickness and ensure an adequate fill-shale contact, the contractor was directed to use special backfill for the initial shale covering which required 3-inch lift hand compacted. The backfill was brought up to a depth of 6 inches, then the next lift was compacted with a rubber tired loader. The seepage along the basal gravel was easily handled with additional pumps and pump pits.

Between station 90+10 and 91+10 several 5 gallon cans with the bottoms removed were used to collect the more concentrated seepage from the gravel zone directly above the bedrock. The 5-gallon cans were placed directly on bedrock and as the backfill progressed, additional cans with the tops and bottoms removed were placed on the initial cans. The water that collected in the cans was pumped out. After three layers of cans were installed (4.5 feet of head) the cans were filled with sand and the impervious fill placement continued.

The contractor was allowed to place fat clay rather than lean clay in the lower 5 to 6 feet of the cutoff trench (below the water table). The liquid limit restrictions were reportedly raised in this area because the excavation was wet and lean clay absorbs water more easily than fat clay, thus, the lean clay was thought to be more likely to become unworkable than fat clay. Prior to changing the liquid limit requirements the effect of the potentially lower shear strength on stability analyses was considered. It was determined that weaker material in this location near the top of rock at the centerline would not adversely affect the stability of the embankment.

The original specification required the pervious fill be placed in 12-inch lifts and compacted with three passes of a 5-ton vibratory roller or 4-inch lifts and compacted to 80 percent relative density with a plate vibratory compactor. The three passes with a vibratory roller were only achieving 75 to 80 percent relative density and the 80 percent relative density was extremely difficult to obtain using a hand compactor. Therefore, the compaction requirements for the plate vibratory compactor were reduced to 70 percent relative density for the pervious fill placement.

e. Abutments. Originally, only that portion of the excavation and foundation treatment within 75 feet of the cutoff trench and within the limits of the Stage I embankment was to be performed under Stage I. The excavation and foundation treatment was similar for both abutments. The excavation was performed with backhoes and presplit blasting to minimize damage to the rock surface. Dental concrete was used to fill joints along the excavated limestone slopes and gravity grouting was used to fill the joints along the horizontal ledges. In many places formed concrete was placed against the irregular bedrock face in order to achieve the desired slope and to seal the bedding planes and vertical joints. When the contractor began working on the left abutment it became evident the weathering extended further into the abutments then originally anticipated, therefore requiring additional excavation into the abutment to reach sound rock. Knowing the right abutment was steeper and more weathered, it became necessary to modify the contract and extend the right abutment excavation above the original limits of the top of the embankment (elevation 887). Modification 2 required the overburden and rock be excavated between station 86+00 and 87+40 above elevation 887 upstream and downstream of the cutoff trench within the final embankment limits. This additional excavation provided an adequate workbench for drilling the Bethany Falls limestone and flattened the hazardous near vertical slopes in the Winterset limestone. After the upper right abutment was excavated, the shale formations were covered with a 3-foot minimum layer of soil to protect it from drying out prior to Stage II embankment placement.

The Middle Creek limestone was present in both abutments but was more predominate on the right abutment. This formation was only about 1.5-feet thick and consisted of three distinct beds, two limestone beds with a thin shale bed in between. The upper layer of limestone was extremely jointed and had the appearance of precut limestone blocks thus requiring special care during the foundation treatment adjacent to the random and impervious zones. In order to minimize the disturbance of the rock to remain in-place, the final rock excavation was performed by equipment located on the fill not the bedrock. The three beds were stair stepped and cut to a relatively smooth vertical face. See Photos 18 and 19. The existing joints along the face of the slope were mortar treated and the joints on the top limestone surface were cleaned with air jetting and filled with grout. No heavy equipment was allowed over the Middle Creek formation until 2 feet of special backfill had been placed over it.

The Sniabar limestone was presplit in an effort to make a smoother face to compact fill against and to remove rock with solution cavities. However, on the right abutment the blasting badly fractured the formation resulting in the need for additional foundation treatment. The existing joints were opened and the upper ledge was lifted and broken up. The final treatment of the formation included the removal of upper ledge which caused undercutting of the underlying shales at various locations. The loose material was removed from the fractured face and dental concrete was placed against the irregular surface. Formed concrete was to be placed against the formation where shale undercutting occurred. The initial concrete placed against the Sniabar within the upstream random zone was placed too stiff and was not formed or vibrated. The concrete was simply dumped on the slope and towelled smooth. The contractor was required to remove and replace this concrete due to the voids and the inadequate bonding between the rock and the concrete.

f. Right Embankment. The first embankment to be placed in Stage I was on the right side of the river and was completed in 1980. Prior to any fill placement the diversion channel was excavated and the river was straightened to allow for construction of the embankment on both sides of the river. The Stage I right embankment included the upstream berm and random zones which were placed to elevation 887 and tied into the abutment at the top of the Bethany Falls limestone. It also included a small portion of impervious and downstream random zones. A plan view at the end of Stage I is shown on Plate 17 and the embankment sections are shown on Plates 23 and 24. Photo 22 shows an overall view of the right embankment. The contractor obtained the majority of the material for the right embankment from the nearby low lying borrow areas along the river which created considerable difficulty later in the contract. As previously discussed, the low lying borrow areas were the best source of the lean clay and should have been saved for the impervious zone (LL≤55) in the conduit section and the stockpile. However, the contractor elected to place the lean clay in the random (LL≤60) and berm (LL-unspecified) zones.

Because several bedrock zones along the right abutment had open joints or were highly fractured a 10-foot zone of clayey gravel was placed directly against the abutment to act as a filter. As the fill placement progressed the supply of clayey gravel diminished. At which time the clayey gravel was only placed against the jointed and broken up limestone formation.

g. Left Embankment. The conduit structure was completed in the fall of 1980 enabling placement of the adjacent embankment upstream of the centerline to begin. Embankment placement downstream of the centerline did not begin until the following spring, and that portion to the right of the conduit section until after removal of the sewer. The conduit section zoning extends from station 97+00 to 101+00 and consists of impervious material with the exception of the pervious blanket and inclined drain. See Plate 24. The internal zoning between station 101+00 and the left abutment originally included both berm and random zones. The contract was modified to change the upstream and downstream berm fill to random fill between stations 101+00 and 102+00. This allowed better utilization of available material, provided a better contact with the limestone surface and eliminated the need for separate zones in an isolated area.

The embankment was brought up evenly on both sides of the conduit. Downstream of the inclined pervious drain, the 3-foot thick pervious blanket was placed in contact with the foundation along the outlet channel excavation and around the conduit. Initially, the contractor had some difficulty obtaining relative density even after the requirements had been lowered to 70 percent. But once an adequate amount of water was placed in front of the compaction equipment, meeting the compaction requirements became easier.

Initially the impervious material (LL≤55) for the conduit section was taken from the remaining low lying borrow areas along the river. As the impervious fill placement progressed, the contractor began to deplete the easily identified lean clay sources and had to utilize material from the higher borrow areas upstream of Longview Road. As previously discussed, the material in the higher borrow areas consisted of intermixed lean and fat clay which were difficult to distinguish visually without testing. The contractor did not have an adequate method of classifying and identifying the suitable impervious material at the borrow pit resulting in the continual direction by the Contracting Officer to remove unsuitable material after placement in the embankment. The problem of identifying suitable material prior to its placement in the embankment and the need for extensive testing continued throughout the remaining fill placement and eventually was the basis for a major claim. Due to the contractor's mismanagement of the borrow areas, there was an insufficient amount of impervious material remaining which could be practically excavated. Therefore, the downstream portion of the embankment was topped out at elevation 867 and the upstream portion at elevation 870 even though the original plan called for a small portion of the upstream left embankment to extend to elevation 887.

h. Impervious Stockpile. As part of Stage I an impervious stockpile was constructed downstream in order to ensure the Stage II contractor a ready source of impervious after closure (Photo 25). This was necessary since the majority of the impervious (LL$\leq$55) material was located in the low lying borrow areas along the river which could periodically become inundated after closure. The contractor began working on the impervious stockpile very early in the contract utilizing the majority of the required overburden excavation from the outlet works and cutoff trench. Placement of stockpile material continued off an on throughout the length of the contract. As discussed previously, the contractor misused most of the easily accessible impervious borrow material and had to use the upper borrow areas where the impervious material was not easily identifiable. As with the impervious zone for the left embankment, extensive testing was performed both at the borrow area and in the stockpile to ensure the material placed had a liquid limit less than 55. Any material found which did not meet these requirements was removed and replaced. The specification for the gravel percentage in the stockpile was not specific and the contractor was allowed to utilize lean clay with more than 5 percent gravel. In the spring of 1982, it was discovered the impervious stockpile was located too far upstream (approximately 120 feet) within the Stage II embankment limits. The contractor was required to remove and relocate about 30,000 cubic yards of material so that it would not interfere with the Stage II embankment. The original stockpile was to be 200,000 cubic yards; however the final stockpile was actually only 170,000 cubic yards. This quantity was reduced at the end of the contract because there was very little impervious material (LL$\leq$55) remaining in the designated Stage I borrow areas. This shortage of impervious was basically due to the contractor's mismanagement of the borrow areas as previously discussed.

i. Modifications. A total of 60 modifications were made to Stage I contract. Only the following 16 pertained to the construction of the embankment.

No. 2	Required additional overburden and rock excavation on the right abutment above elevation 887 upstream and downstream of the cutoff trench within the embankment toe trace.
No. 6	Changed the sewer alignment from the left side of stilling basin to the right side.
No. 14	Required the excavation and backfill of test pit in cutoff trench at station 90+70$\pm$.

No. 16	Required 1.) The removal of the slide material near O.W. station 52+00 and all left abutment overburden to rock downstream of the cutoff trench to the embankment toe 2.) sewer excavation adjacent to the stilling basin be backfilled with excavated overburden.
No. 17	Required the removal of additional limestone at station 102+98.
No. 19	Required two presplit blasting test section in the Sniabar limestone on the left abutment.
No. 20	Change the outlet channel alignment to miss existing powerline guy wires.
No. 22	Required the removal of two overhangs in the Bethany Falls limestone on the right abutment approximately 125-feet and 147-feet upstream of the dam axis.
No. 25	Required the removal of overhang and the adjacent vertical face of Bethany Falls limestone at station 87+35±, 90-feet ± upstream of the dam axis.
No. 26	Required removal of fractured rock and resetting nipples for grouting in the cutoff trench between station 89+50 and 88+90.
No. 33	Required the Sniabar limestone upstream of the cutoff trench be fractured and removed using a non-explosive demolition agent on a 1V on 1H slope.
No. 40	Required the additional rock excavation of the Sniabar limestone in Modification 33 be extended downstream through the cutoff trench using the same non-explosive demolition agent.
No. 41	Changed the upstream and downstream internal embankment zoning from berm fill to random fill between station 101+00 and 102+00.
No. 46	Provided additional compensation to the contractor for slower rate of placement during curtain grouting due to a tighter rock formation.
No. 48	Required additional presplit and production shooting of Bethany Falls limestone upstream of cutoff trench at approximate station 87+75.
No. 55	Required the additional excavation of the unsuitable material below the bottom of the existing 48-inch sewerline and backfilling excavation with impervious fill.

8-03. Stage I Embankment Analysis. Dur ng construction of the Stage I left embankment, high pore pressures (up to about 75 percent response) were measured in the lower part of the embankment primarily in the cutoff trench, sewer trench and conduit excavation backfills. When overflowing water levels and quick recoveries after pumping were found in the protective casing of several devices, an extensive investigation was undertaken to determine the extent of the high pore pressures and the adequacy, including stability, of the embankment. The investigation involved undisturbed sampling and testing, inspection of in-place embankment material from two large diameter auger holes OH-1 and OH-2, installation of additional instrumentation to monitor pore pressures and slope movement, and dye injection and pump tests. The investigation revealed high pore pressures in excess of 50% in the lower half of the embankment. Equipment induced shear planes or other fractures or surfaces discovered during the investigation were determined to be discontinuous. It was determined that gas escaping from the open tube devices was not from anaerobic decomposition in the fill but was apparently natural gas from deposits in the foundation rock, or might possibly have originated from gas trapped in the low lying borrow deposit. The results of the gas sample analysis are provided in Enclosure 2. Slope stability studies conducted with both total and effective stress (using measured pore pressures) analyses showed an adequate safety factor for the embankment slopes. The steepest existing slope, 1V on 3H, was found to have a safety factor of 1.8 and a safety factor of greater than 2 was found for the embankment constructed to the construction halt elevation 890. It was further concluded the embankment should perform satisfactorily as a water retention structure. A more detailed description of the investigation and it's findings are provided in the "Analysis of Stage I Embankment" published in April 1983. An updated version of the write-up only is included in this report as Enclosure 1.

8-04. <u>Stage II Contract</u>. The Stage II contract, DACW41-82-C-0204, was awarded in August 1982 to the second low bidder, W.A. Ellis Construction Company for the amount of $9,181,143.00, after the low bidder, Jack B. Anglin Company claimed an error and withdrew his bid. Construction began in August 1982 and was completed in September 1985. This contract included the spillway excavation, diversion and closure, completion of the embankment, construction of the service bridge, and the construction of the access and service roads. Because of the experiences in the Stage I contract and the concerns for the embankment stability, considerable effort was expended in revising and tightening the specifications and investigating the quantities of specific types of fill material available in the borrow. Based on these quantities and stability considerations, liquid limit requirements were established in detail for the embankment zones. A 6-month construction halt was scheduled in the Stage II contract when the embankment reached elevation 890. This construction halt elevation was originally specified in the DM as elevation 915; however, the construction halt was later changed because of the high pore pressures which developed in the left embankment, the actual timing of the 6-month construction halt and the relative fill quantities involved before and after the halt. In addition to the construction halt, fill placement rates were established which limited placement to 5 feet per 7-day period and no more than two lifts of fill in any 24-hour period.

a. <u>Stage II Borrow Study</u>. During the preparation of the Stage II plans and specifications an extensive re-analysis of the Stage II borrow area was completed. Additional drilling, sampling and testing was necessary to reanalyze the borrow area to assure that sufficient quantities of the necessary liquid limit material were available to complete the Stage II embankment. The liquid limit requirements in the embankment zones were adjusted consistent with shear strength requirements to make best use of the material available in the borrow.

A total of 59 additional borings were completed in the west borrow area located west of old Raytown Road and 8 borings were completed in the east borrow area located south of old Longview Road. (See Plate 3.) All borings were 6-inch drive borings with a jar sample taken every 2 feet. Liquid limit, plastic limit and moisture tests were conducted to classify the material. An additional 421 liquid limit tests were completed on samples from the west borrow and 87 were completed on samples from the east borrow. The specifications called for additional testing by the contractor and placed responsibility on him to determine proper disposition of materials.

b. Diversion and Closure. The diversion and closure plan consisted of diverting the river and constructing a cofferdam in two phases. The Phase I cofferdam was to be constructed after diversion in the upstream closure area berm and random zones to elevation 878. The Phase II cofferdam was to be constructed downstream of the Phase I cofferdam and consisted of berm, random and impervious fill including backfill of the cutoff trench to elevation 887. The diversion and closure plan including sections of the Phase I and II cofferdam are shown on Plate 19.

The cofferdam heights were established in the DM based on routing various floods through the lake with the outlet works gates completely opened. The DM recommended the Phase I cofferdam height to be elevation 867 based on the October 1949 flood (fourth highest flood) which would create a lake of elevation 862.5. However, comments from MRD resulted in the height of the Phase I cofferdam being increased to elevation 878 which would protect against the second largest flood (September 1961) or lake elevation 874.4. This change was made because of the high degree of development downstream and the potential damage which could occur if the cofferdam were to fail. The height of the Phase II cofferdam, elevation 887, was designed to protect against the record flood of July 1951 which would have resulted in a lake elevation 882.3.

The contract required that diversion of the river be made between June 15, 1983 and August 1, 1983 and the Phase II cofferdam be completed by December 15, 1983. Prior to diversion the contractor had to complete the following items:

1. The left embankment cofferdam to elevation 887 as originally included in Stage I.

2. The outlet channel, including: placing bedding and riprap, grouting riprap, constructing access walk and stairs; and the removal of the protection dike adjacent to the outlet channel.

3. Final approach channel excavation.

4. The stilling basin inspection.

Within the contract there was also a list of optional items which could be completed prior to diversion. Of this list, the contractor only completed the placement of the pervious blanket and the overlying 3 feet of the corresponding embankment zones on the right side of the river.

The contractor diverted the river and began closure operations on June 16, 1983. The diversion and closure operation was performed in the following sequence:

1. The protective dike downstream of the stilling basin across the outlet channel was excavated.

2. On June 16, construction of the upstream diversion dike began and the river was diverted through the outlet works after the approach channel plug was removed.

3. The remainder of the upstream diversion dike was rapidly placed to elevation 823.

4. A portion of the fill for service road "D" between station 23+60 and 24+70 was constructed to elevation 810 to serve as a downstream cofferdam.

5. Within the Phase I cofferdam area, the material from the river channel was excavated and foundation preparation was performed on the exposed bedrock surfaces.

6. The Phase I cofferdam was rapidly constructed of berm and random material to elevation 878. Aerial views of this phase is shown in Photos 37 and 38.

7. The cutoff trench in the closure area which was not completed during Stage I (between approximately stations 93+45 and 95+80) was excavated to final grade (excavation for grouting and grouting operations were performed during Stage I) and foundation preparation was performed. The foundation treatment and fill placement in the cutoff trench closure section is shown in Photo 39.

8. The next step was to construct the Phase II cofferdam to elevation 887 before December 15, 1983. However, since diversion was made fairly early and the Phase I closure operations had gone rather quickly, the contractor elected to bring the remaining embankment up all at once rather than just the Phase II cofferdam. This fill placement is shown in Photos 43 and 46

Shortly after diversion, heavy rains caused the Little Blue River to overtop the Phase I cofferdam which, at the time, was only a few feet above the existing ground surface adjacent to the old river channel. Some embankment material was washed away and a considerable amount of cleanup was required. The contract was modified to provide for the flood damage repair which restored the permanent work to the field conditions which existed prior to the flood damage.

Within the closure section, the pervious blanket was placed in direct contact with the foundation after the river channel was cleaned up, while the river channel downstream of embankment was backfilled with channel fill. Photo 41 shows the pervious fill placement in the old river channel and Photo 42 shows the tie-in between the adjacent pervious blanket and the pervious fill in the old river channel. The embankment toe detail within the river channel is shown on Plate 25. Downstream between station 91+00 and 93+50 an old river meander was discovered and the contract had to be modified (Modification 12) to require the removal of the debris and the low strength material. This excavation was then backfilled to the approximate adjacent ground surface with gravelly random material. The pervious blanket was then placed over the backfill rather than the foundation material.

By early November 1983, the upstream Phase II cofferdam was at the required elevation 887 while the downstream embankment averaged about elevation 880. Throughout November, adverse weather conditions prevailed and it appeared there would not be enough good working days remaining in the 1983 construction season to bring the embankment to the required construction halt elevation 890. The contractor requested the 6-month construction halt elevation be changed to elevation 880± beginning December 1983. The Government approved the request but required the contractor do the following items prior to the construction halt: level up the embankment at station 93+00; raise the abutment contacts to provide positive drainage; level and seal the upstream cofferdam; provide erosion control for right abutment drainage ditch; and cover all pervious material with 1-foot of cover similar to the adjacent embankment material.

c. Embankment. The six month construction halt ended on June 1, 1984. The contractor had requested an early start-up date, however this was rejected because of continued high pore pressures in the embankment. In early June, heavy rains caused a lake to form which peaked at elevation 865. Although the borrow areas were inundated and numerous gullies formed on the embankment, no major damage or abnormal seepage occurred. After the high pool, the contractor removed the 1-foot impervious cover from the pervious drain and began placing fill on the downstream side. The contractor continued placing more fill on the downstream side of the embankment until the pervious drain became the highest part of the embankment and positive drainage away from the pervious drain was established. The rate of placement for fill above elevation 867 was restricted to only 5 feet of compacted fill in a 7-day period and no more than two lifts of fill in any 24-hour period. The embankment was topped out in September 1984.

d. Spillway. The 200-foot wide spillway located on the left abutment has a crest elevation 911.3 which is 2.3-feet above full pool and has a predicted use of once in 200 years. The left abutment location was selected in lieu of the right abutment due to the reduced amount of required excavation. The contractor began excavating the spillway after making diversion. The entire 550-foot length of spillway excavation was overburden consisting of relatively high liquid limit fat clay with a maximum depth of 14 feet and 1V on 6H side slopes. The contractor utilized the excavated overburden as road fill, berm or random fill. The spillway was over excavated 9 inches and brought back to grade with topsoil.

e. Service Bridge. The service bridge as shown on Plates 33 and 34 was constructed when the embankment fill reached elevation 899 (bridge deck elevation). As the fill placement progressed, the embankment began moving outward causing the service bridge expansion joints to close. Photo 63 shows a closed expansion joint and the tilted rocker. Daily monitoring of the service bridge expansion joints began in early September 1984. The movement averaged about .05-inches per day until there was concrete to concrete contact at all three expansion joints. This movement began spalling the concrete at the bridge abutment expansion joint. The joints were not repaired until the Spring 1990. A separate contract was awarded to restore the expansion joints at the abutment and the pier. Plate 34A shows the service bridge after the expansion joint repair.

f. Clay Blanket. A clay blanket was placed on the right abutment as shown on Plate 30. The clay blanket was placed between elevations 848 and 898 to control seepage thru the Bethany Falls and the Winterset limestone. To utilize excess rock from the required excavations, rockfill was placed against the bedrock formations below elevation 848. Rockfill was also used to protect the upstream slope of the clay blanket (see Photo 47). Once the rockfill sources were depleted, the contract was modified (modification 26) to require 9-inch bedding and 18-inch riprap be placed between elevation 884 to 898 on the remaining face of the clay blanket slope. The complete right abutment clay blanket can be seen in Photo 72.

g. Stage II - Modifications. A total of 38 modifications were made to Stage II contract. Only the following 16 pertained to the construction of the embankment.

No. 1	Required that all material in the impervious stockpile be reserved for use after closure.
No. 8	Provided payment for the rock excavation overrun.
No. 10	Required the repair of flood damage which occurred June 28, 1983 when heavy rains caused the Little Blue River to overtop the partially completed Phase I cofferdam, and flood the old river channel.
No. 11	Required the construction of a concrete headwall at the west end of the grouted riprap drainage ditch adjacent to service road "C".
No. 12	Required the area of the embankment between station 91+00 and 93+50 (downstream of the centerline which had been excavated to remove debris and low strength material from the old slough) be backfilled with gravelly random material to approximately natural ground prior to placing the pervious blanket.
No. 13	Required: The open tube piezometers PPE 99-13, PPE 97-13, PPE 97-14, PPE 99-10, PPE 89-2, PPE 89-3, PPE 93-10A and inclinometers I-97-1, and I-99-2 be extended thru the embankment; PPE 93-4 be changed from a pneumatic piezometer to an open tube piezometer; the location of PPE 93-4A be

changed from station 93+00 R0+40U to station 93+00 R 2+30U; the construction of tubing ditches and the extention of tubing for 11 pneumatic piezometers; the extensions for PPE 90-1, PPE 90-2, and PPE 93-10 be deleted; and steel protective casing be installed for 9 new piezometers.

No. 14 Changed the downstream "V" grouted gutter to a 4-foot wide flat bottom grouted toe gutter between station 87+00 and 91+00.

No. 17 Required the borrow areas below elevation 891 be cleared completely except for the area west of Raytown Road and south of Pittenger Road; and the small area located southeast of the river immediately east of Raytown Road be cleared only to the extent necessary to obtain material.

No. 20 Provided four lean concrete cutoff walls across the 4-foot flat bottom toe gutter on the right abutment.

No. 22 Required: the extension of piezometers PPE 92-1, PPE 95-1, and PPE 97-16 thru the embankment and the installation of steel protective casing for each; the construction of tubing ditches and the installation of tubing for piezometers PPE 97-17, PPE 98-1, PPE 99-17, PPE 99-16.

No. 23 Provided payment for foundation clean up overrun.

No. 25 Required the following changes on the instrumentation monuments: changed concrete compression strength from 4000 psi to 5000 psi in 28 days; changed surface sealer from 2-inch thickness of black roofing cement to 1-inch thickness of Dow Corning 100% Silcon Rubber 795 Construction Sealant; changed rebar from 2-#4 rebars and 2-#8 rebars to 6-#4 vertical rebars equally spaced and #3 rebar circumferential horizontal ties on 8-inch centers.

No. 26 Required 9-inch bedding and 18-inch riprap be placed on the face of the impervious clay blanket above elevation 884.

No. 29 Required the repair of flood damage that occurred in May 1983 when rains caused the Little Blue River to overflow its banks and damage the pervious zone between stations 91+00 and 93+50.

No. 30 Provide compensation for grouted riprap overrun.

No. 32 Deleted the requirements [illegible] toe gutter to elevation 887± on the upstream side of the dam near the left abutment and other minor changes.

8-05. Embankment Materials Inspection and Testing. An Excavation, Embankment, and Grouting Manual and a Field and Laboratory Testing Manual were prepared for both stages. These manuals were based on the plans and specifications and were intended as a technical guide to the Government

Inspectors and the Resident Engineer. They provided a means to better monitor the contractors work and included instructions pertaining to inspection requirements. The embankment manual also served to further explain the intent of the specification to the field inspectors. The Government inspection staff was present to witness all pertinent operation procedures and to conduct field tests. Design engineering personnel made periodic inspections, particularly during critical operations such as initial excavations, exposure of foundation surfaces, initial fill placement, diversion, and instrumentation installation.

a. Field Control Tests. Field control tests were performed to monitor moisture content, gradation, compacted density, and classification of fill material to ensure the specification requirements were satisfied. These tests were performed by the Government after the fill was compacted. The contractor was responsible for all sampling and testing to assure that materials met specified requirements prior to compaction. Monthly summaries of the field control tests were sent through Construction Division to Engineering Division and reported to MRD. Tests were performed on all material types.

(1) Impervious, Random and Berm. The field control testing for the impervious, random and berm zones consisted primarily of liquid limit and field compaction determinations. The sand cone method was used for determining the compacted density. The maximum density and optimum water content were determined in accordance with EM 1110-2-1906, Appendix VI, Standard Compaction Tests. A family of compaction curves was developed for each material source. Subsequent field tests then relied on a one-point compaction test to determine which compaction curve was appropriate. Although no fill density was specified, it was required that the fill be compacted to a minimum of 95 percent of that obtained from the standard effort compaction test. Experience had indicated that the specified moisture content and number or roller passes would achieve these densities. If the desired compaction was not achieved additional rolling was required. Due to the previously discussed problems with liquid limits on this project, liquid limits were performed on all field control samples to check compliance of the material in the various zones. If Government tests showed noncompliance with the specifications it was the contractor's responsibility to do additional testing to define limits of the "out of spec" area and to remove and replace it. The area was then rechecked by the Government.

(2) Pervious. The pervious field control testing consisted of a combination of gradation testing and in place relative density determinations. The relative density value represents a density ratio defined as the extent compaction has progressed from the loosest state toward the densest state. The minimum density was determined by placing the material dry in its loosest practical state. The maximum density was then found by vibrating the sample at a given frequency for a set time period. The detailed procedure was presented in EM 1110-2-1906 (10 May 1965).

b. Record Control Tests. Record control samples were obtained periodically from the impervious, random and berm zones. They served the purpose of checking the physical properties of the materials actually used in the dam against those properties assumed for design. Schedules of the record control sample locations and testing are shown on Plates 50 and 51 respectively. Most of the record control samples consisted of one sack and one hand trimmed undisturbed sample 6-inches in diameter by 6-inches long (Photo 12). These samples were sent to the Missouri River Division laboratories for testing. This testing included compaction, Atterberg limits, gradations including hydrometer, moisture content, density, and shear strength determinations. Summaries of these test results are provided on Plates 52 through 85. While the actual test results are provided on half-size plates as Supplement A. The inspection staff performed standard field control tests at each record control test location. The duplication of testing by the Division laboratory and the field laboratory served to check the accuracy of the field results. A comparison between laboratories can be made by reviewing the compaction test summaries presented on Plates 79 through 85. There were some substantial variations between the laboratories in-place moisture content, compacted density, optimum moisture content and maximum dry density values. The majority of these variations are probably due to minor material changes and slightly different laboratory procedures or equipment. There is, however, a very interesting consistent variation between the laboratories' optimum moisture content results. As shown on Plates 80 and 84, the field laboratory's optimum moisture content was consistently higher than the Division laboratory's results. All of the embankment material was placed within the specified compaction requirements based on the field laboratory's standard Proctor compaction test results (95 percent maximum dry density at a moisture content between 2 percent below and 3 percent above optimum). According to the graphs on Plates 82 and 85, 26 percent of the Stage I field tests and 20 percent of the Stage II field test were outside the specified moisture range based on the field laboratory's standard Proctor test results. All of this material was supposedly removed or reworked to meet the specifications. However, these plates also show that 54 percent of the Stage I record control tests and 14 percent of the Stage II record control tests were outside the required moisture range based on the Missouri River Division laboratory's standard Proctor test results. The Division laboratory results are believed to be accurate and indicate some of the embankment material may have been placed 3 to 6 percent above optimum moisture which could have contributed to the high embankment pore pressure that developed during construction.

CHAPTER 9

OPERATIONAL NOTES

9-01. Embankment.

a. Upstream Slope. During initial filling some erosion and undercutting of the riprap occurred on the 1 on 4 slope of the conduit section. Overall, the 18-inch riprap has held up relatively well with only some minor breakdown along the waterline at multipurpose pool elevation. During the high pool in October 1986 as shown in Photo 70, the water was near the top of the lower riprap (elevation 898). Wave action displaced the riprap leaving the bedding exposed between stations 89+00 and 92+00. In August 1989, this 300 foot section was repaired with the same Bethany Falls limestone that was used for the emergency rock stockpiles. During the May 1990 record pool (elevation 897.2) no damage was caused to the lower riprap or grassed slopes because the pool rose and fell rapidly.

b. Crest. The crest road remains in good condition except for some longitudinal cracking along the downstream shoulder caused by lack of lateral support along the pavement edge. Shortly after construction, the upstream edge of the road near the right abutment grouted gutter ravelled back past the guard rail. In 1989, the edge of the road had to be repaired to prevent any undermining of the grouted gutter. After completion of the embankment, a low area in the dike on the left abutment at approximately station 104+00 was noted. This low area was approximately elevation 925.2, 1.4 feet below the design elevation of 926.6. During the spring 1990, this low area was filled and brought up to the design elevation.

c. Downstream Slope. Since completion of the embankment, the grass cover has become established with only a few sparse areas remaining (Photo 74). There are several areas along the upper interceptor ditch which do not drain properly, causing overtopping of the ditch and the formations of erosion gullies. The lower interceptor ditch at the entrance to the left abutment grouted gutter is too low causing water to pond in the interceptor ditch. This area and a few other areas along both the upper and lower interceptor ditches have been filled to provide proper drainage. Shortly after construction, erosion control fabric was installed in the toe ditch as shown in Photo 60. Since then some silting of the ditch has occurred due to runoff from the embankment and Foreman Road. After initial filling, the sand blanket between station 91+00 and 95+50 began to seep more than initially expected. This is believed to be caused by abutment seepage. See the paragraph below. During construction, the bedding covering the sand blanket was contaminated with fines washing down the slope prior to establishing grass cover. The contractor only removed and replaced the upper 6-inches of bedding material. In 1987, drains (6-inch perforated pipe) were installed through the bedding in order to reduce the head of water exiting the sand blanket. This drain installation can be seen in Photos 65 and 66. Although all drains flow, this had no effect on the piezometer level in the sand blanket. Flow from the drains and excess seepage have caused a maintenance problem in this area. The installation of a french drain between the sand blanket and the toe ditch has been recommended to monitor the seepage and alleviate the maintenance problem.

d. Abutments. Since initial filling high piezometric levels have existed in the right abutment bedrock upstream and downstream of the grout curtain. The pressurized zones appeared to be limited to the Pleasanton Zone A, B, and Middle Creek limestone/Hushpuckney shale. The seepage is probably making its way through the grout curtain, however, with the Pleasanton Zones A and B in direct contact with the upstream rockfill zone, the seepage could also be coming around the end of the grout curtain. The seepage in any case is being intercepted by the sand blanket which extends up the abutment slope. It appears the sand blanket is adequately controlling the seepage and no other problems have developed due to those high pressures. (See previous discussion in Chapter 7.) Since completion of the dam, numerous seeps from the Winterset limestone along the right abutment have caused wet areas on the impervious clay blanket. Although this is not a dam safety concern it became a maintenance problem. In 1987, a french drain was installed to dry up the area (Photo 67). However, the french drain did not extend into the draw far enough and does not intercept all of the drainage. Therefore, some wet areas in the impervious blanket still exist. The downstream right abutment grouted gutter has held up well since end of construction because it was constructed with concrete cutoff walls every 50 feet. These cutoff walls were added as a modification during construction which widen the gutter to intercept a natural draw coming down the right abutment. The downstream left abutment grouted gutter was not constructed with cutoff walls and consequently began undermining. In September 1989, concrete head walls were constructed on the left and right abutment grouted gutter where the interceptor ditches flow into the grouted gutters. Also, concrete cutoff walls were installed about every 75 feet along the left abutment grouted gutter to prevent the undermining.

9-02. Emergency Rock Stockpile. The construction of two emergency rock stockpiles were completed in March 1990, on both abutments. Photo 75 shows the completed left abutment emergency rock stockpile. The stockpiles consist of 8,084 tons of Type "A" rock 1,826 tons on the left abutment and 6,259 tons on the right abutment, and 3,231 tones of Type "B" rock, 747 tons on the left abutment and 2,484 tons on the right abutment. Rock for the stockpiles was produced from the 16-foot ledge of Bethany Falls limestone in Carefree Quarries on the northeast corner of the intersection of Highway 291 and Kentucky Road in Sugar Creek, Missouri. Listed below is the specified rock gradations:

Type "A" (Riprap)

Weight	Specified Percent of Weight Lighter Than
760#	100
570#	75-95
190#	30-50
55#	0-2

Type "B" (Bedding)

Sieve Size	Specified Percent By Weight Passing
6"	100
4"	82-95
2"	62-83
1"	32-64
3/8"	0-20

ENCLOSURES

ENCLOSURES

ENCLOSURE 1

LONGVIEW DAM
ANALYSIS OF STAGE I EMBANKMENT

TABLE OF CONTENTS

TABLES

I. Introduction

1. The purpose of this report is to present the results of a geotechnical investigation of the Longview Stage I embankment. At the completion of embankment construction, high pore pressures were known to exist in the lower part of the embankment. However, when overflowing water levels and quick recoveries following pumping were found in the protective casing of several devices an investigation was undertaken to determine the extent of the high pore pressures and the adequacy, including stability, of the embankment.

2. Longview Dam is constructed on the Little Blue River in southeast Kansas City, Missouri. The dam, an earthfill zoned embankment, was built in two stages. The Stage I contract, completed in the fall of 1982 (see Photos 32 and 33), consisted of foundation excavation and preparation including grouting; construction of the intake tower, conduit, relocated sewer, and stilling basin; excavation of the outlet channel; and placement of a portion of the embankment on both sides of the river. Stage II includes diversion and closure, and completion of the embankment.

3. The Stage I contract began in late summer of 1979 with the outlet works excavation. The right embankment and cutoff trench were completed during the 1980 construction season. By fall of 1980 the outlet works conduit was completed which enabled placement of impervious backfill upstream of centerline. In the spring of 1981, the outlet works backfill downstream of centerline began. Sewer diversion through the conduit took place in July and was followed by excavation and removal of the old sewer line and backfill of the excavation. Heavy rainfall throughout the spring and summer delayed work, but the fill had been raised above the conduit, El. 822+, by the end of August. By mid-November the downstream embankment was topped out to El. 867 and the upstream cofferdam to El. 870. The finished height of the Stage I cofferdam was reduced from El. 887 because of a shortage of impervious borrow for the Stage I contract.

II. Embankment Pore Pressures, End-of-Construction

4. During the Stage I construction period, 19 pore pressure devices were installed in the left embankment and foundation area (see table 1). Five of these, PPE97-1, PPE97-6, PPE99-2, PPE99-5, and PPE99-6, whose tips were located in the embankment clay showed pore pressure responses of 78, 68, 53, 13, and 56 percent, respectively, following the embankment construction in October 1981. PPE99-5 is located near the inclined sand drain which probably accounts for its lower response. It was concluded at the time (fall of 1981) that even though the responses were 50 percent and above, the tips were located within the backfill of the excavations and these pressures did not extend into the upper part of the embankment where they might contribute to slope instability. Pore pressures in the overburden and foundation shale were low or nonexistent, with one exception. PPF99-4 showed about 50 percent response. Its tip was located deep in the foundation shale and did not influence stability.

5. In January 1982, ice was observed at the top of the protective casing around PPE99-2. This was concluded to be either communication between the riser and the protective casing (since at that time the water level in the riser was higher than in the protective casing) or that water could have

TABLE 1
LISTING OF INSTRUMENTATION

Number	Station	Range	Type	Installation Date	Material Type	Tip Elevation	Zone of Sand Backfill	Bottom of Protective Casing	Ground Elevation at Installation	Ground Elevation Present	Remarks
Left Embankment											
PPE97-1	97+00	325' US	Pneumatic	3 Sep 81	Embankment-Sewer Backfill	820.2	819.6-822.2	—	829.2	870 ±	dry hole (1)
PPF97-2	97+00	210' US	Pneumatic	3 Sep 81	Embankment-Sewer Backfill/Fdn Overburden	820.6	819.6-822.6	—	827.6	870 ±	dry hole (1)
PPF97-3	97+00	200' US	Open Tube	4 Sep 81	Fdn Shale	794.8	794.5-797.5	801.5	827.5	866 ±	groundwater at El. 810.8 (2)
PZF97-4	97+00	90' US	Open Tube	25 Feb 80	Fdn Gravel	810.5	810.2-813.3	817.7	828.2	844 ±	dry hole (3)
PPF97-5	97+00	40' US	Open Tube	2 Sep 81	Fdn Shale	785.0	784.8-788.0	792.0	825.5	839 ±	no water noted (3)
FPE97-6	97+00	15' US	Pneumatic	3 Sep 81	Embankment-Cutoff Trench	807.0	805.2-809.0	—	825.2	839 ±	dry hole (1)
PPF97-8	97+00	85' DS	Open Tube	25 Feb 80	Fdn Overburden	817.8	817.4-820.4	821.0	823.4	839 ±	dry hole (3)
PPF97-9	97+00	100' DS	Pneumatic	24 Sep 81	Fdn Shal	789.9	789.5-792.5	—	836.9	839 ±	no water noted (1)
PZF97-10	97+00	120' DS	Open Tube	2 Oct 80	Fdn Gravel	805.0	803.4-808.0	812.0	825 ±	839 ±	no water noted (3)
PZE97-11	97+00	180' DS	Open Tube	22 Sep 81	Embankment-Imp./Sand Drain	824.6	824.5-827.6	831.5	834.5	839 ±	dry hole (3)
PPE97-12	97+00	200' US	Open Tube	29 Oct 82	Embankment-Impervious	853.6	853.4-855.6	866.6	869.6	869.6	.9' of rainwater in hole overnight; water added to fill riser to top
PPE97-13	97+00	198' US	Open Tube	30 Oct 82	Embankment-Impervious	839.9	839.5-842.2	867.9	869.7	869.7	dry hole; water added to fill riser to top

TABLE 1 (Cont'd)

Number	Station	Range	Type	Installation Date	Material Type	Tip Elevation	Zone of Sand Backfill	Bottom of Protective Casing	Ground Elevation at Installation	Ground Elevation Present	Remarks
PPE97-14	97+00	195' US	Open Tube	1 Nov 82	Embankment-Impervious	829.7	829.2-832.0	867.7	869.7	869.7	dry hole; water added to fill riser to top
PPE97-15	97+00	202' US	2" O.T.	6 Nov 82	Embankment-Impervious	825.4	824.9-842.7	—	869.7	869.7	dry hole; added 12 gal. of water
PPF99-1	98+51	220' US	Pneumatic	19 Aug 81	Fdn Shale	800.0	799.5-802.5	—	825.7	872	no water noted (1)
PPE99-2	98+44	80' US	Open Tube	18 Aug 81	Embankment-Impervious	812.0	811.3-814.3	818.8	824.3	867 ±	dry hole; 5 ga. water added
PPF99-3	98+42	40' US	Open Tube	20 Aug 81	Fdn Shale	789.7	789.4-792.7	796.7	824.7	867 ±	no water noted (3)
PPF99-4	98+38	40' DS	Open Tube	21 Aug 81	Fdn Shale	772.8	770.8-773.9	777.9	823.9	867 ±	water encountered at sand blanket El. 811.9 ± (2)
PPE99-5	98+37	60' DS	Pneumatic	21 Aug 81	Embankment-Impervious	818.0	817.5-820.6	—	823.5	867 ±	no water noted (1) located near inclined sand drain
PPE99-6	99+12	220' US	Pneumatic	18 Aug 81	Embankment-Impervious	822.5	822.0-824.0	—	826.5	867 ±	no water noted (1)
PPF99-7	98+40	70' US	Open Tube	11 Jan 82	Fdn Overburden/ Fdn Shale	810.3	808.5-811.0	816.5	866.5	866.5	no water noted (2)
PPE99-8	98+45	80' US	Open Tube	27 Oct 82	Embankment-Impervious	823.8	823.0-834.2	863.8	867.0	867.0	9' of water in hole after 35 min.; water added to fill riser to top
PPE99-9	99+00	50' US	Open Tube	3 Nov 82	Embankment-Impervious	823.4	823.3-832.2	865.2	867.2	867.2	dry hole (4)
PPE99-10	99+00	150' DS	Open Tube	5 Nov 82	Embankment-Impervious	823.0	822.9-832.9	863.5	866.9	866.9	.1' water overnight (4)

TABLE 1 (Cont'd)

Number	Station	Range	Type	tallation Date	Material Type	Tip Elevation	Zone of Sand Backfill	Bottom of Protective Casing	Ground Elevation at Installation	Ground Elevation Present	Remarks
PPE99-11	98+44	85' US	2" O.T.	8 Nov 82	Embankment-Impervious	821.2	820.5-839.2	—	867.2	867.2	water in hole but depth not noted (2)
PPE99-12	98+40	℄	Open Tube	12 Nov 82	Embankment-Impervious	838.6	838.6-849.0	864.0	867.0	867.0	4' of water 30 minutes after drilling (4)
PPE99-13	98+40	200' US	Open Tube	16 Nov 82	Embankment-Impervious	824.8	824.5-834.9	865.9	868.9	868.9	.1' water 30 minutes after drilling (4)
*PPE99-14	98+40	280' US	Open Tube	17 Nov 82	Embankment-Impervious	823.2	823.1-833.1	864.1	867.1	867.1	trace of water 45 minutes after drilling (4)
PPE99-15	98+35	℄	Open Tube	13 Nov 82	Embankment-Impervious	823.2	823.1-832.9	864.0	867.0	867.0	dry hole (4)
*PPF100-1	99+70	200' US	Open Tube	10 Nov 82	Fdn/Overburden Fdn Shale	815.7	813.9-825.7	866.7	869.7	869.7	.5' water in hole 30 Min. after drilling (2)
PPF 61	99+85	400' US	Open Tube	13 Apr 71	Fdn Shale	805.1	804.6-808.6	809.6	842.6	851 ±	no water noted (4)
PPF 61A	99+95	400' US	Open Tube	16 Apr 71	Fdn Overburden	813.1	812.6-816.6	817.6	842.6	851 ±	no water noted (4)
PPF 359	99+99	295' US	Open Tube	26 Feb 80	Fdn Overburden/ Top of Fdn Limestone	816.0	814.5-835.0	838.0	840.0	862 ±	no water noted (4) (5)
*CH-1	98+00	143' US	4" O.T.	24 Nov 82	Embankment-Impervious	825.0	825.0-864.0	—	870.0	870.0	38" auger hole backfilled with compacted sand
CH-2	98+12	℄	4" O.T.	6 Dec 82	Embankment-Impervious	820.0	820.0-861.8	—	867.0	867.0	38" auger hole backfilled with compacted sand

TABLE 1 (Cont'd)

Number	Station	Range	Type	Installation Date	Material Type	Tip Elevation	Zone of Sand Backfill	Bottom of Protective Casing	Ground Elevation at Installation	Ground Elevation Present	Remarks
Right Embankment											
PZF 229	91+60	80' US	Open Tube	16 Dec 75	Fdn Gravel/ Fdn Shale	805.5	804.5-811.5	812.5	820.0	848 ±	groundwater at El. 810.2 (2)
PPE89-1	89+50	199' US	Open Tube	29 Nov 82	Embankment-Random	835.1	834.8-838.8	884.0	886.8	886.8	dry hole (3)
PPE89-2	89+45	199' US	Open Tube	20 Nov 82	Embankment-Berm	862.2	862.0-866.1	884.4	886.8	886.8	dry hole (3)
PPF89-3	89+55	199' US	Open Tube	1 Dec 82	Fdn Overburden	814.3	813.3-818.1	883.4	887.3	887.3	dry hole (3)
Inclinometers											
I 97-1	97+49	189' US	Inclinometer	11 Nov 82	Fdn Shale	797.8	Top of bedrock -	807.8	870 ±	870 ±	water encountered at El. 827
I-99-1	98+36	256' DS	Inclinometer	15 Jan 82	Fdn Shale	796.5	Top of bedrock -	800.0	867 ±	867 ±	dry hole
I-99-2	98+25	95' US	Inclinometer	20 Nov 82	Fdn Shale	797.8	Top of bedrock -	809.6	867 ±	867 ±	water encountered at El. 835.5

(1) Pneumatic cell filter stone was saturated prior to installation and sand surrounding cell was saturated prior to sealing off cell.
(2) Wet installation, no additional water added to riser.
(3) Sand surrounding device saturated after riser installed.
(4) Dry installation, no water added to riser.
(5) Station and Range as of February 1983
* Abandoned as of March 1983

Legend

PPE	Pore Pressure Device - Embankment
PPF	Pore Pressure Device - Foundation
PZE	Piezometric Device - Embankment
PZF	Piezometric Device - Foundation
OH	Observation Hole - Large Diameter (38") Auger Hole
I	Inclinometer

entered the casing by a number of external sources such as rainfall, or by someone inadvertently or deliberately pouring water down the casing.

6. To determine the source of this water and to obtain additional undisturbed record control samples, PPF99-7, an open tube device, was installed in early January 1982 in the foundation overburden/foundation shale contact 10 feet downstream from PPE99-2. By the end of the month, water had filled the casing of PPF99-7. On this basis, it was concluded the water was coming from unknown external sources and not from the fill itself. Communication between the riser and the casing was not likely since the water level in the riser was 45 feet lower than in the casing. In addition, water had not been observed in the casings on other KCD projects unless the riser had overflowed. It was believed that the casing with slip joint couplings supplied with "O" rings would be watertight. In addition, it was not believed possible that pore water in an impervious fill could accumulate that fast in the casing when the usual experience is that a large amount of water must be added to open tube devices to bring them to equilibrium.

7. By fall of 1982 the devices began showing varying degrees of dissipation of pore pressure. However, in September 1982 in preparation for winter, the water levels in the casings of PPE99-2 and PPF99-7 were lowered as much as 10 feet to prevent freezing, but one week later the water had recharged to its original level in PPE99-2 and had recharged halfway in PPE99-7. In addition gas bubbles were being released from the casing water of PPE99-2. There was no known external source of water. It appeared that the protective casings and the risers were acting as separate measuring devices. The protective casings were apparently registering higher pore pressures at points higher in the embankment, possibly near the mid-height. These pressure levels apparently exceeded 50 percent response.

8. An extensive investigation was undertaken to determine: 1) the extent and magnitude of pore pressure levels in the embankment, and 2) the source of apparently excess water in the impervious zone of the embankment.

III. Field Geotechnical Investigation

9. Starting on 25 October 1982, twelve open tube pore pressure devices were installed at various locations and depths in the left embankment between station 97+00 and station 101+00 to determine if a zone of high pore pressure did exist near the mid-height of the fill and if it did, to define its limits. All instrumentation holes were continuously sampled with a 5-inch Hvorsley Shelby tube sampler. Since it was suspected that use of drilling fluid may have caused hydraulic fracturing of the fill at PPF99-7, all succeeding holes were cleaned after each push with a 6-inch box auger and no drilling fluid was used. Some squeezing of the hole occurred after the holes had been advanced to about 30 feet. (This was also about the same depth water was encountered in several of the holes.) In taking the undisturbed sample the driller lowered the Hvorsley sampler usually until a slight seating resistance was encountered (normally .2 to .3 feet above the clean-out depth). This allowed space for any material reamed from the hole sides by the sampler. Inspection of the samples (some were sliced thin and air dried) did reveal a few cases of disturbance at the top of the sample which may have been caused by seating or heaving of the hole. Generally the quality of the undisturbed samples was excellent.

10. Drilling started with hole PPE99-6, located about 11 feet from PPF99-7. Free water was encountered while it was being drilled. Thirty-five minutes after drilling was completed, the hole had 9 feet of water in it. There was concern the fill was cracked or had been hydraulically fractured from the earlier use of drilling fluid in hole PPF99-7.

11. To investigate the lateral extent of these fractured zones dye was added to piezometers PPE99-8 and to subsequently drilled PPE97-13 on 3, 4, and 5 November. Drilling began on PPE99-11 located 5 feet from PPE99-8 on 7 November 1982. Free water was encountered in drilling this hole, however no dye was found, either in the water or in the undisturbed samples. When the water was bailed to the bottom of the hole, water levels in adjacent devices PPE99-8 and PPE99-2 were affected. The casing water level in PPE99-2 (about 6 feet from PPE99-11) dropped 3.1 feet and the riser water level in PPE99-8 dropped 8 feet. PPE97-15, located 5-1/2 feet from PPE97-13, was drilled on 6 November. No free water or dye was encountered. No trace of dye was found in any of the undisturbed samples.

12. In addition, after adding water to the top of the riser in PPE99-8 shortly after installation, the water was observed surging up and flowing out the riser. This phenomenon was not understood at the time, however it was speculated this could have been sudden movement (shearing) of the fill or could possibly be associated with the escape of gas from the riser since the fluid was very "bubbly." Gas bubbles were observed escaping from several of the devices. There was also speculation the fill might contain a shear zone or cracks from differential settlement over the conduit and the adjacent alluvium, but it was still considered more likely that this area of the fill had been hydraulically fractured. There was also concern that the gas was an indication of organic material in the fill.

13. The undisturbed samples from all holes were closely examined to determine if shear surfaces, cracks, free water, or organic material could be found. The samples usually had a tendency to break on both smooth horizontal planes (see Photo 27) and on more irregular surfaces which had a raindrop-type texture (see Photo 28), as if they had been wet at one time However, no free water was found, except from one sample from hole PPE99-14, El. 835.3, where a slight indication of free water was found, and from one sample from PPE97-13, El. 839.3, which appeared even wetter. More samples were examined from other holes and these planes were found in most samples examined except to perhaps a lesser extent in those from near the ground surface. Some of the planes could be lift surfaces, however close spacing and orientation precluded others from being lift planes. Most of the planes did not give any indication that free water had traveled over their surfaces. The planes often seemed to be coated with silt or appeared to be a silt parting. No organic material was found in any of the samples. A high angle fracture was found in sample 8 from PPE97-14, depth 40.0' to 40.5', El. 829.2-829.7. This fracture did not extend to any adjacent holes and may have been caused by drilling and sampling procedures.

14. Two inclinometers in addition to I-99-1 (previously installed in January of 1982 on the downstream slope) were installed to determine if any significant slope movement was taking place on the temporary 1V on 3H and 1V on 3.5H slopes parallel to the river. To date, these devices have not shown any indication of significant movement.

15. The open tube devices with tips below a depth of about 30 feet began showing water levels either close to the top of the riser or began overflowing. In several installations (PPE99-9, PPE99-10, PPE99-11, PPE99-13, PPE99-14, and PPE99-15) the tip was installed dry. No water was added to bring the device to equilibrium. Yet, the water level in the riser rose typically 1 to 2 feet per day. PPE99-13 rose at a rate of about 9 feet per day. As noted previously, this is contrary to behavior observed previously at KCD projects. Those which overflowed, PPE97-14 PPE99-9, PPE99-10, and PPE99-13, were equipped with pressure gauges and air eliminator valves. The pressure began approaching and in some cases exceeded previously monitored pore pressures in the lower portion of the embankment. However, the air eliminator valves were later found not to be effective in completely removing gas from the devices. It was later concluded the readings were higner than the actual pore pressures since gas partially displaced the water in the riser.

16. The right embankment area was originally instrumented with only one piezometer located in the foundation gravels. When these higher pore pressures were found on the left embankment, three pore pressure devices were installed in November 1982. Their tips were located in the foundation overburden, the random fill zone, and the berm fill zone. The berm shows no evidence of pore pressure. Pore pressure response in the random zone was 30 percent, while the response in the foundation was 25 percent.

17. In order to be sure the embankment was suitable and in fact stable, it was considered prudent to auger two large diameter (38-inch) holes to allow detailed inspection of the fill (see Photo 26). The locations were selected at station 98+00, range 143 u/s and at centerline near the edge of the intersection of the 1V on 3H and 1V on 3.5H slopes. This was considered the most likely location for differential settlement cracks or for a shear zone associated with slope instability to appear. Holes OH-1 and OH-2 (see Plate 49) were drilled in ten foot increments to depths of 45 and 47 feet, El. 825 and El. 820 respectively. Temporary casing was installed to allow personnel to safely enter for inspection and sampling (both jars and hydraulically jacked 5-feet diameter undisturbed samples were taken).

18. In OH-1, water seeps were observed at 22 feet, El. 848 (see Photos 29 and 30); 24 feet, El. 846; and 34 feet, El. 836 (see Photo 31). Gas bubbles were observed forming on some of the wet surfaces. At a depth of 32 feet the air in the auger hole contained 10 percent combustible gas according to measurements from a portable gas "sniffer." Although the quantity of water coming from the seeps was not large enough to collect, after about a week the sidewalls had become wet below the seep areas. Concentric cracking also had developed and these cracks had free water on the surfaces.

19. The second hole, OH-2, was drilled on the centerline to determine if any fracturing extended through the central impervious core of the dam. Water was encountered only at 23 feet, El. 844. A thin, very silty lean clay zone was encountered at 37.3 feet, El. 829.7. The rest of the embankment material seem to be well placed and well compacted with only the usual material color changes taking place along with minor variations in stiffness. The planes or fractures were not as evident as they had been in the undisturbed Shelby tube samples. It appeared some planes on the side wall and in the cuttings (similar to ones previously observed) were in fact caused by mechanical

shearing from the auger. It is considered likely that many of planes observed in the undisturbed samples were caused by mechanical shearing from construction equipment (e.g. scraper pan, motor patrol blade, or pumping action from heavily loaded scraper tires), or could be related in some way to the drilling and sampling procedures. Similar planes were observed at Blue Springs Dam following stripping operations performed with scrapers. These planes were of limited extent (equipment width) and tended to dip only slightly from horizontal and in the direction of equipment movement. They appeared to have been caused by shearing action of the scraper pan. Their length was relatively short, generally 5 feet or less.

20. Gas samples were collected from the open tube devices after the observation of gas in the instrumentation risers and casing and after combustible gas was detected in the auger hole. Initial attempts were made with a small neoprene balloon. A local commercial lab analyzed the gas as a "50 percent methane/50 percent air" mixture. (See Enclosure 2.) Since no organic material other than undecomposed small roots was found in any drill hole the source of the methane was unexplained. The flammability of the gas in all the open tubes which had pressure gauges was checked by holding the air release valve open. In all cases where a quantity of gas had built up, the gas could be ignited (see Photo 34). Taking care to avoid dilution or contamination, two additional gas samples were taken in stainless steel "bombs" and analyzed by the Environmental Lab at the Waterways Experiment Station. These were taken from PPE99-9 and PPE99-10. Both have tips located in the impervious embankment, but PPE99-10 is isolated by the sand blanket from other suspected sources of gas such as the abutment, the foundation, and the relocated sewer. It is also isolated from the impervious core and upstream fill by the inclined sand drain.

21. Results of the WES tests on samples from both locations show the content of methane (percentage by volume) varies from 65 to 70 percent and that of carbon dioxide varies from 16 to 20 percent. An aerobic decomposition of organic material normally results in a lower methane content and a much higher carbon dioxide content than was found in the samples. The gas analysis showed that the fill was not producing methane as a result of decomposition of organic material. The results of the gas tests are provided as Enclosure 2. Analysis of water samples from the devices showed no indication of treated water or sewage. The results from the water analysis are provided in Enclosure 3. It was initially hypothesized that the gas was present in the soil voids in the low lying borrow deposit, either as a result of underlying gas fields or overflow of sewerage. It is difficult to believe the gas could escape from the foundation or the sewer, pass through the pervious zone and into the impervious fill, considering the high pore pressures present in the latter as opposed to no excess pressures in the former. However, if enough capillary tension existed in the sand fill it may be possible for the gas to pass through the pervious zone.

22. In addition to dye injection, pump tests were conducted at two of the installations (PPE97-15 and PPE99-11) which were installed with 2-inch diameter PVC risers and a 15-foot section of 2-inch slotted well screen. Each were located adjacent to piezometers to provide monitoring of drawdown. Initial pump testing drew the water level down only 12 feet, the drawdown being limited by the pump suction. This had no discernible effect on adjacent devices. Subsequent "pump testing" was actually done by bailing rather than

pumping in order to draw the water surface down farther. Pumping PPE97-15 affected the water level only in PPE97-13 (5.5 feet away). It did not affect PPE97-12 (7 feet away), and PPE97-14 at (8 feet away). Pumping PPE99-11 immediately affected the water level in PPE99-8 (5.0 feet away) and the casing water level of PPE99-2 (6.5 feet away). Casing and tip water levels in PPE99-7 (approximately 17 feet away) were not affected. This data and data from the dye injection indicate some fractures or cracks do exist over at least limited areas and may be capable of transmitting water only short distances, say less than about 10 feet.

23. Coefficients of permeability were determined. Using the results of dye injection, field falling head permeability tests conducted in conjunction with the dye injection, and recharge data from pump tests. Dye injection showed a seepage velocity of .0019 cm/sec or a k of 10^{-3} cm/sec. Falling head permeability data yield a k on the order of about 10^{-5} to 10^{-6}; recharge data shows a range from about 10^{-4} to 10^{-6}. These permeability values are also consistent with the rather rapid rise of the water level in several of the installations at station 99+00. It is difficult to believe this quantity of water could flow at this rate (about .5 gallons per day) from a compacted "impervious" fill. It can only be theorized that the presence of fractures or cracks increase the area of the drainage boundary. This allows faster collection of water produced from consolidation or pore pressure dissipation in the area surrounding the borings. Since the induced construction pore pressures obviously have only dissipated slightly these numbers can be indicative of only localized areas

IV. Laboratory Testing

24. The laboratory investigation consisted of classification testing of both jar and undisturbed samples; and strength and permeability testing of undisturbed samples. Jar samples were obtained both during the installation of instrumentation and from the side walls of the two large diameter auger holes. Undisturbed samples along with sack samples were obtained for record control testing during construction. Additional undisturbed samples were obtained from push samples taken both during the installation of instrumentation and from the side walls of the two large diameter auger holes. Testing was also done on a sack sample taken from a small seep area located on the 1V on 3.5H slope of the left embankment.

25. Water content, Atterberg limits, and/or mechanical analysis tests were performed on representative jar samples. Specifications for the left embankment between station 97+00 and station 101+00 required a liquid limit of less than 55 and a moisture content between 2 percent below and 3 percent above the standard Proctor optimum moisture content. Very few of the liquid limit results exceeded the liquid limit requirement. A review of the field compaction data compiled as the embankment was constructed indicates a mean moisture content of 1.2 percent above optimum with a standard deviation of $\pm$ 1.4 percent. (See also paragraph 8-04.b. for discussion of moisture content vs optimum water content.)

26. Testing of undisturbed samples consisted of unconsolidated-undrained triaxial compression "Q" tests; consolidated-undrained (with pore pressure measurement during shear) triaxial compression $\bar{R}$ tests, drained direct shear "S" tests, and constant head permeability tests. The record control samples

taken during construction had "Q", "R" and direct shear "S" tests run on each sample. At the time of this report there had been a total 14 "Q", 20 "R", 15 "R̄" and 16 direct shear "S" tests performed on material from the left embankment. The results of the "Q" tests confirm the design strength of c = .9 tsf (see Plate 54). The effective stress "R̄" or "S" strength envelope developed from record control and recent testing indicated strength parameters of c = .15 tsf and tan Ø = .49. This compares with the design strength envelope of c = 0.0, tan Ø = .50 shown on Plate 54.

27. Three horizontal constant head permeability tests were performed on samples from OH-2 with the first sample being oriented with existing planes. The two other tests were run on a silty lean clay material encountered deeper in hole. The permeability of the first sample was 1.9 X 10^{-7} cm/sec while the permeability of the two samples in the silty material was 2.2 X 10^{-8} and 2.6 X 10^{-8} cm/sec.

28. Moisture density tests were run on a sack sample obtained from a seep area on the 1V on 3.5H slope at station 97+35, range 60' u/s, El. 848. Triaxial "Q" and "R̄" testing was done on samples remolded with a water content of 3 percent above optimum. Results from the "Q" test were slightly below design strength. Effective stress data from the "R̄" testing indicated a strength above the design envelope.

V. Analysis of Instrumentation Data

A. Embankment Pore Pressure Measurements

29. The pore pressure in the devices installed in the embankment during construction peaked shortly after the cessation of Stage I fill placement in November 1981 and dissipated slowly until resumption of construction. Pressure in PPE97-1, installed in the old sewer-excavation backfill, peaked at a level of almost 28 feet above the top of the embankment, El. 898, and dissipated 10 feet. Pressure in PPE99-6, installed near the foundation, upstream of centerline and left of the conduit, rose to 6 feet above the fill and dissipated 3 feet. The water level in PPE99-2, the only open tube with its tip installed in the fill, peaked at a level of 3 feet above the fill and dissipated 16 feet.

30. The twelve additional open tube pore pressure devices, installed in the left embankment area since October 1982 were all in the embankment impervious zone. Two devices (PPE97-12, PPE99-12) installed in the upper 20-30 feet of the fill showed no pore pressure. PPE97-13 (tip at about 30 feet) showed about 30 percent response.

31. Three pore pressure devices stabilized with their water level within about 10 feet or less below the top of the embankment. They include PPE99-8, PPE99-11, PPE97-15. These devices had tips at elevations of about 821 to 832. The remaining six devices (PPE97-14, PPE99-9, PPE99-10, PPE99-13, PPE99-14, and PPE99-15) had pore pressures in excess of 50 percent. All had tips in a zone from about El. 823 to 833. All were equipped with pressure gauges and air eliminator valves. Although these valves have been used successfully in the past on other KCD projects to remove gas from piezometers they have not worked well here. As long as the gas accumulated slowly and at relatively low pressures, the air eliminator system worked. However, when gas accumulated

rapidly and at higher pressures the valve did not release the gas and allowed it to build up and cause an abnormally high gauge reading making the magnitude of the pore pressure impossible to determine. When the gauges were removed a mixture of both water and gas bubbles would overflow the riser. Some of these bubbles were from gas coming out of solution as the pressure was reduced. However the earlier described phenomenon with the piezometer surging, then overflowing had occurred prior to the installation of a gauge. It is believed possible that gas was somehow trapped in the riser and had to develop a certain volume or pressure before it would rise to the top. Evidently a larger diameter riser (e.g. PPE99-11 and PPE97-15) allows gas that collects in the riser to escape more easily with less effect on the water column. It appears, therefore, that the column of water in the riser was not all water but a mixture of water and highly concentrated trapped gas bubbles.

32. This was further evidenced when gauges were initially removed from PPE99-9, PPE99-10, and PPE97-14, and a collector was fabricated to catch any overflow from the risers. The collector allowed the monitoring of both the amount of overflow and the fluctuation of the water level in the riser. The devices do not overflow at a constant rate over any given period of time. As an example, PPE99-10 overflowed 38 ounces between 14 February and 17 February. By 18 February it had overflowed an additional 18 ounces. On 1 March, the collector contained 99 ounces after just 4 days but the water level in the riser had fallen to a depth of 29 feet. The next day, 2 March, the water level had come up 10 feet to a depth of 19 feet. By 3 March it had come up an additional 5.5 feet and was rising at a rate 1/4-foot per hour. It was rechecked on 11 March and found that it had overflowed and was frozen. Fluctuations of the water level in the other riser are not as extreme, but all devices have shown fluctuations up to 2 feet within a few minutes.

33. The water level in the casings of PPE99-2, PPF99-7, PPF99-3, and PPF99-4 are also acting as separate devices. All water levels are slightly above the top of the embankment. Both PPF99-3 and PPF99-4 casings have consistently bubbled with escaping gas.

34. Based on the above data it is believed the pore pressure response in this zone between El. 820± to 830± is probably on the order of 50 to 60 percent.

B. Inclinometers

35. Three inclinometers have been installed in the left embankment. I-99-1, installed in January 1982, is located on the downstream 1V on 4H slope adjacent to the river closure section. The maximum movement indicated has been to 1/10-inch downstream and 4/10-inch riverward. Movement is toward the river where the embankment slope is 1V on 3.5H. I-99-2 and I-97-1 were installed in November 1982 near the riverward slope of the embankment, upstream of centerline. I-99-2, on the 1V on 3.5H slope, has indicated a maximum movement of approximately 1/10-inch in the downstream direction and essentially no movement toward the river. I-97-1 has indicated a maximum movement of approximately 1/10-inch both in the downstream direction and the riverward direction.

VI. Slope Stability

36. Stability studies were made for the end-of-construction condition using both total stress and effective stress methods. The computer program used was STABR developed by the University of California at Berkeley which uses Bishop's modified method of analysis and a circular failure surface. The program contains a searching routine which varies both the center of the circle and the radius of the circle until the minimum safety factor is found. Critical minimum slides were checked by a hand analysis to verify the computer safety factor. Pore pressure contours developed from measured induced construction pore pressures were used for the effective stress analysis. The shear strength for the soil was determined from record control testing and from testing on undisturbed samples taken during the field investigations. The total stress analysis used "Q" strength and the effective stress analysis used drained "S" and undrained "$\bar{R}$" strength with pore pressure measurements.

37. Two slope configurations have been studied on the left embankment: (1) the 1V on 3H slope along the closure area with the embankment at El. 871 which is the existing condition, and (2) the upstream 1V on 4H slope in the conduit section with the embankment completed to the construction halt, El. 890. Pore pressures used for this latter case were based on measured pore pressures and the assumption that the additional embankment load would cause a pore pressure response of 50 percent. A 50 percent response is reasonable based on previous KCD experience where pore pressure has been allowed to dissipate after a construction halt. Generally the additional response should be less after some dissipation (consolidation) has occurred.

38. Initial studies begun in December 1982 (with construction induced pore pressures reflecting the highest pressure gauge readings) showed a minimum safety factor of 1.47 for the temporary 1V on 3H slope. Both a total stress and an effective stress analysis was conducted for the 1V on 4H upstream slope constructed to El. 890. The minimum safety factor for the effective stress analysis was 1.23 while the minimum safety factor for the same slide for a total stress analysis resulted in a safety factor of 2.1. Later it was concluded the high pore pressures indicated by the pressure gauges were not valid because of the influence of gas and further analyses were conducted with the pore pressure contours believed to be more representative of actual conditions. Minimum safety factors for the 1V on 3H slope were found to be 1.8 and for the 1V on 4H upstream slope were found to be 2.3 (compared with the total stress safety factor of 2.1).

VII. Conclusions and Recommendations

39. Conclusions from the investigation are as follows:

a. Induced construction pore pressures in the left embankment ranged up to about 75 percent in a zone within backfilled excavations, El. 810$\pm$. Above this area, El. 820$\pm$ to 830$\pm$, pore pressure responses were about 50 to 60 percent. No pore pressures are present in the top 20$\pm$ feet of the fill. Pore pressures induced in the foundation overburden and shale are generally low or nonexistent.

b. Shear planes or other fractures or surfaces do not affect the integrity of the embankment. These fractures or planes apparently are a major factor in the relatively fast response in some of the open tube devices and in the protective casings. However, all evidence, (dye tests, pump tests, the very existence of high pore pressure in the fill, and the conclusion that the fractures or planes were mechanically induced by construction equipment or in some cases by drilling and sampling procedures) suggests these planes, while numerous, are of limited extent and are not continuous.

c. The gas sampled from the fill is not coming from decaying organic material in the fill, or from the sewer in the conduit structure. The exact source of the gas is unknown but may have been present in the soil as it came from the low lying borrow deposit or may be coming from the foundation. The presence of the gas makes it very difficult to determine the magnitude of the pore pressure with open tube devices.

d. Inclinometers installed at the most critical locations indicate no significant movement of any of the slopes.

e. Stability analyses show an adequate safety factor (1.8) for the steepest existing slope and current pore pressure conditions. An adequate safety factor (2.1 to 2.3) was also found for the embankment constructed to the construction halt elevation.

f. In summary the embankment is found to be stable and is expected to perform satisfactorily as a water retention structure.

40. As a result of the investigation the following recommendations were made:

a. Given the relatively high construction pore pressures close monitoring of pore pressure and slope movement (inclinometers) should continue as the Stage II embankment is constructed. In addition because of the presence of fractures, continued close monitoring will be necessary during initial reservoir filling.

b. To facilitate ease of construction (i.e. to reduce the number or risers brought up with fill) and to resolve problems with the effect of gas on measured pore pressures, small diameter pneumatic air cells should be installed at the tips of the 3/4-inch open tube risers.

c. Stability should be reanalyzed at the time of the construction halt.

ENCLOSURE 2
LANGSTON LABORATORIES, INC.

Laboratory Report

Date Received: December 8, 1982
Time Received: 10:30 am
Date Completed: Decem·· r 15, 1982

Submitted by: U.S. Army Corps of Engineers
700 Federal Building
Kansas City, MO 64110
Attn: Mr. Robert Dimmitt

LLI Project No.: 82-9415

Sample Description: Balloon

Sample Identification	Analysis	Results
Gas in Balloon	Methane	approximately 50%
	Air	approximately 50%

Comments:

Approved: [signature]
Alan Kerschen
Laboratory Director

DEPARTMENT OF THE ARMY
WATERWAYS EXPERIMENT STATION. CORPS OF ENGINEERS
P. O. BOX 631
VICKSBURG, MISSISSIPPI 39180

18 January 1983

REPLY TO
ATTENTION OF:
Environmental Laboratory

Mr. Robert Dimmitt
USCE, Kansas City District
Room 816
700 Federal Building
601 E. 12th Street
Kansas City, MO 64106

Dear Mr. Dimmitt:

The analysis of the gas samples taken at wells 99-9 and 99-10 are enclosed (enclosure). The analytical results shown are averages of duplicate gas chromatographic runs.

The ratio of gases in the samples is not what has normally been observed in gas mixture formed by anaerobic decomposition of organic matter. Most decomposition gases would have less methane and greater proportion of carbon dioxide. This suggests gas is not forming in the fill material itself. If there are any questions regarding the analyses please contact Richard A. Shafer at FTS 542-3943.

Sincerely,

Philip G. Malone

Philip G. Malone, Ph.D.
Geologist
Water Supply & Waste
Treatment Group

Encl 2

RESULTS OF GAS ANALYSES FROM
PIEZOMETERS AT LONGVIEW DAM

% By Volume

Sample	Oxygen	Nitrogen	Methane	Carbon Dioxide
99-9-1	0.24	13.4	69.3	16.5
99-9-2	0.20	13.0	66.5	19.5
99-10-1	1.46	17.0	65.0	16.0
99-10-2	6.04	32.0	51.0	10.0

APPENDIX

Gas Sample Collection

Pertinant Data:

PPE 99-9	PPE 99-10
Station 99+00	Station 99+00
Range 50' US	Range 1+50' DS
Bottom of Hole El. 823'	Bottom of Hole El. 823'
Zone of sand backfill at tip 8.9'	Zone of sand backfill at tip 10'
Installation Date: 3 November 1982	Installation Date: 5 November 1982
No water encountered during drilling.	No water encountered during drilling.
No water added after backfill.	Sand backfill saturated with 4.0 gallons of water (initial water level convert to El. 831.3)

A water trap device was assemblied to aid in obtaining gas samples. The unit used two pressure gages, one on the line leading from the piezometer riser into the water trap and the other attached to the water trap chamber. Four valves are used to regulate flow through the device. One valve was located between the riser and the water chamber, one between the water trap chamber and the sampling tube, and two located at the bottom and top of chamber to aid in the filling and de-airing of the chamber. The chamber was filled with water to minimize the amount of air that would have to be chased out of the system to obtain a pure sample.

The procedure used to obtain gas samples is as follows:

1. If the piezometer has been winterized, remove as much diesel as possible.
2. Fill riser to the top with water.
3. Fill water trap with water removing as much trapped air as possible.
4. Attach metal connect to open tube riser using teflon tape or other sealer.
5. With all valves closed attach water trap to riser.

83/27

ENCLOSURE 3
DEPARTMENT OF THE ARMY
MISSOURI RIVER DIVISION, CORPS OF ENGINEERS
DIVISION LABORATORY
OMAHA, NEBRASKA 68102

MRD Lab. No. 717

13 JAN 1983

Subject: Tests of Water

Project:

Intended Use:

Source of Material: Longview PJ 97-3

Submitted by:

Date Sampled: , Date Received:

Method of Test or Specification: APHA Standard Methods

References:

Tests Run	Test Result (1)
COD	24
pH	7.8
Suspended Solids	28
Dissolved Solids	324
Alkalinity to Phenolphthalein as $CaCO_3$	0
Alkalinity to Methyl Orange as $CaCO_3$	198
Bicarbonate (HCO_3)	242
Carbonate (CO_3)	0
Total Hardness as $CaCO_3$	153
Calcium (Ca)	30
Magnesium (Mg)	19
Carbonate Hardness as $CaCO_3$	198
Non-carbonate Hardness as $CaCO_3$	0
Sulfate (SO_4)	55
Chloride (Cl)	13
Nitrate (NO_3)	0.02
Sodium (Na)	55
Potassium (K)	3
Iron (Fe) } dissolved .024 ppm total }	1.936
Manganese (Mn) } 0 ppm }	1.3
Silica	13
Ammonia (NH_3)	0.13

Remarks

(1) All values shown except pH are expressed as parts per million

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DEPARTMENT OF THE ARMY
MISSOURI RIVER DIVISION, CORPS OF ENGINEERS
DIVISION LABORATORY
OMAHA, NEBRASKA 68102

MRD Lab. No. 718

13 JAN 1983

Subject: Tests of Water

Project:
Intended Use:
Source of Material: Rouquious P2-99-2

Submitted by:
Date Sampled: , Date Received:
Method of Test or Specification: APHA Standard Methods

References:

Tests Run		Test Result (1)
COD		79
PH		7.3
Suspended Solids		275
Dissolved Solids		1170
Alkalinity to Phenolphthalein as $CaCO_3$		0
Alkalinity to Methyl Orange as $CaCO_3$		785
Bicarbonate (HCO_3)		956
Carbonate (CO_3)		0
Total Hardness as $CaCO_3$		1025
Calcium (Ca)		314
Magnesium (Mg)		58
Carbonate Hardness as $CaCO_3$		785
Non-carbonate Hardness as $CaCO_3$		240
Sulfate (SO_4)		3
Chloride (Cl)		18
Nitrate (NO_3)		0.00
Sodium (Na)		24
Potassium (K)		7
Iron (Fe)	dissolved 0.146 ppm	total 43.02
Manganese (Mn)	0.649 ppm	10.6
Silica		18
Ammonia (NH_3)		1.06

Remarks

(1) All values shown except pH are expressed as parts per m[illegible]
(2) See back

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83/27

DEPARTMENT OF THE ARMY
MISSOURI RIVER DIVISION, CORPS OF ENGINEERS
DIVISION LABORATORY
OMAHA, NEBRASKA 68102

MRD Lab. No. 719

13 JAN 1983

Subject: Tests of Water

Project:
Intended Use:
Source of Material: Longview P2 99-4

Submitted by:
Date Sampled: , Date Received:
Method of Test or Specification: APHA Standard Methods

References:

Tests Run	Test Result①
COD	77
pH	8.1
Suspended Solids	93
Dissolved Solids	680
Alkalinity to Phenolphthalein as $CaCO_3$	0
Alkalinity to Methyl Orange as $CaCO_3$	486
Bicarbonate (HCO_3)	593
Carbonate (CO_3)	0
Total Hardness as $CaCO_3$	286
Calcium (Ca)	83
Magnesium (Mg)	19
Carbonate Hardness as $CaCO_3$	486
Non-carbonate Hardness as $CaCO_3$	0
Sulfate (SO_4)	53
Chloride (Cl)	26
Nitrate (NO_3)	0.00
Sodium (Na)	107
Potassium (K)	16
Iron (Fe) } dissolved 0.171 ppm total }	1.29
Manganese (Mn) } 1.233 ppm }	3.0
Silica	22
Ammonia (NH_3)	0.00

Remarks

① All values shown except pH are expressed as parts per million

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83/27

DEPARTMENT OF THE ARMY
MISSOURI RIVER DIVISION, CORPS OF ENGINEERS
DIVISION LABORATORY
OMAHA, NEBRASKA 68102

MRD Lab. No. 720

13 JAN 1983

Subject: Tests of Water

Project:
Intended Use:
Source of Material: Longview P2-99-3

Submitted by:
Date Sampled: , Date Received:
Method of Test or Specification: APHA Standard Methods

References:

Tests Run	Test Result ①
COD	63
PH	7.3
Suspended Solids	155
Dissolved Solids	632
Alkalinity to Phenolphthalein as $CaCO_3$	0
Alkalinity to Methyl Orange as $CaCO_3$	550
Bicarbonate (HCO_3)	671
Carbonate (CO_3)	0
Total Hardness as $CaCO_3$	516
Calcium (Ca)	158
Magnesium (Mg)	30
Carbonate Hardness as $CaCO_3$	550
Non-carbonate Hardness as $CaCO_3$	0
Sulfate (SO_4)	26
Chloride (Cl)	16
Nitrate (NO_3)	0.00
Sodium (Na)	19
Potassium (K)	4
Iron (Fe) } dissolved 0.073 ppm total }	57.36
Manganese (Mn) } 9.51 ppm }	12.0
Silica	14
Ammonia (NH_3)	0.20

Remarks

① All values shown except pH are expressed as parts per million

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DEPARTMENT OF THE ARMY
MISSOURI RIVER DIVISION, CORPS OF ENGINEERS
DIVISION LABORATORY
OMAHA, NEBRASKA 68102

MRD Lab. No. 721

13 JAN 1983

Subject: Tests of Water

Project:
Intended Use:
Source of Material: Rongview P2-99-7

Submitted by:
Date Sampled: , Date Received:
Method of Test or Specification: APHA Standard Methods

References:

Tests Run	Test Result ①
COD	68
PH	7.8
Suspended Solids	33
Dissolved Solids	1010
Alkalinity to Phenolphthalein as $CaCO_3$	0
Alkalinity to Methyl Orange as $CaCO_3$	872
Bicarbonate (HCO_3)	1064
Carbonate (CO_3)	0
Total Hardness as $CaCO_3$	477
Calcium (Ca)	137
Magnesium (Mg)	33
Carbonate Hardness as $CaCO_3$	872
Non-carbonate Hardness as $CaCO_3$	0
Sulfate (SO_4)	75
Chloride (Cl)	50
Nitrate (NO_3)	0.00
Sodium (Na)	200
Potassium (K)	11
Iron (Fe) } dissolved 0.805 ppm	total } 0.8
Manganese (Mn) } 5.80 ppm	} 5.8
Silica	28
Ammonia (NH_3)	0.96

Remarks

① All values shown except pH are expressed as parts per million
H_2S Smell

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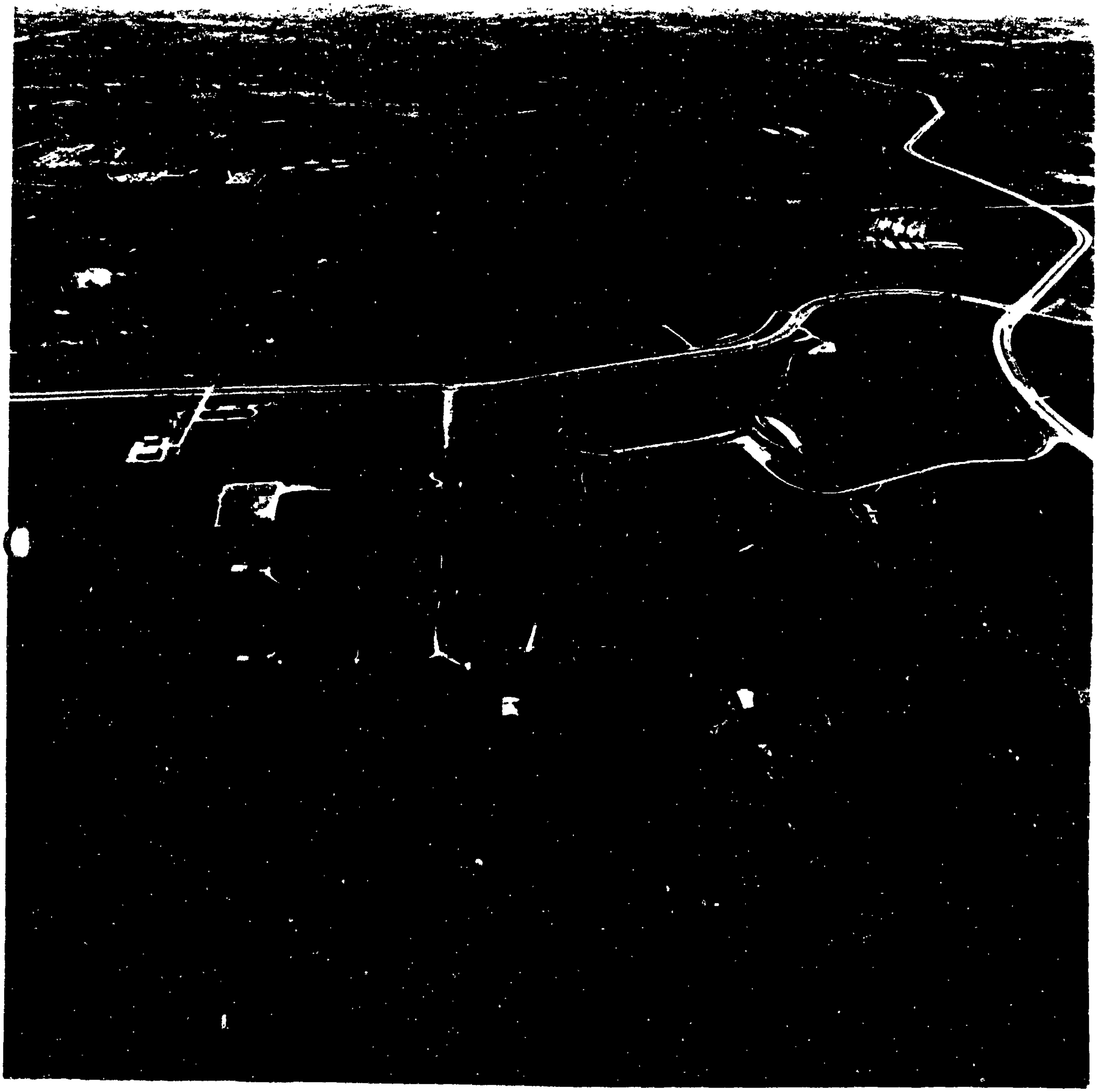
Encl 3

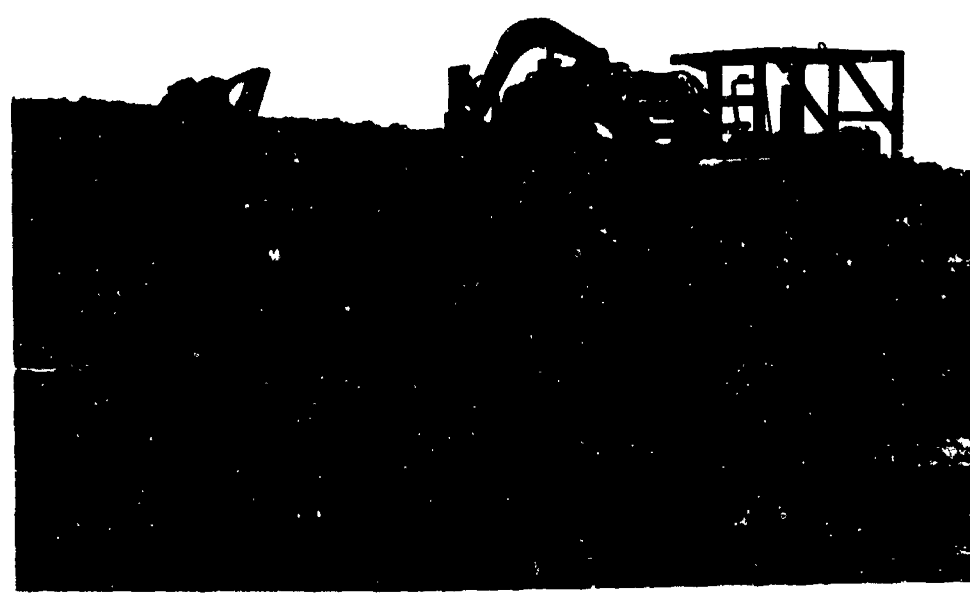
PHOTOGRAPHS

PHOTOGRAPHS

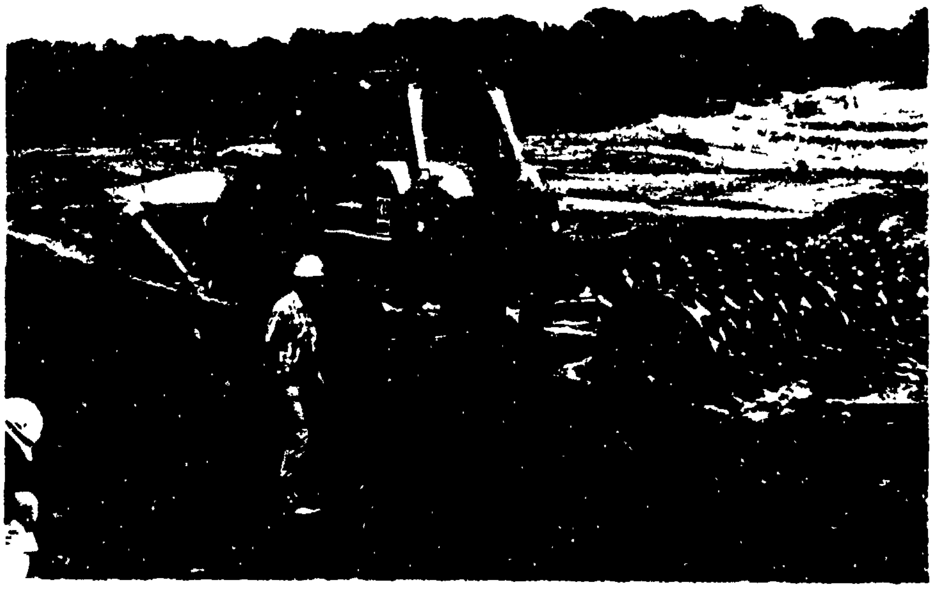


1. March 1990. Overview of completed embankment from downstream of right abutment.

2. 1983. Two Caterpillar D-9s loading Cat 631 scrapers in upstream valley borrow area.

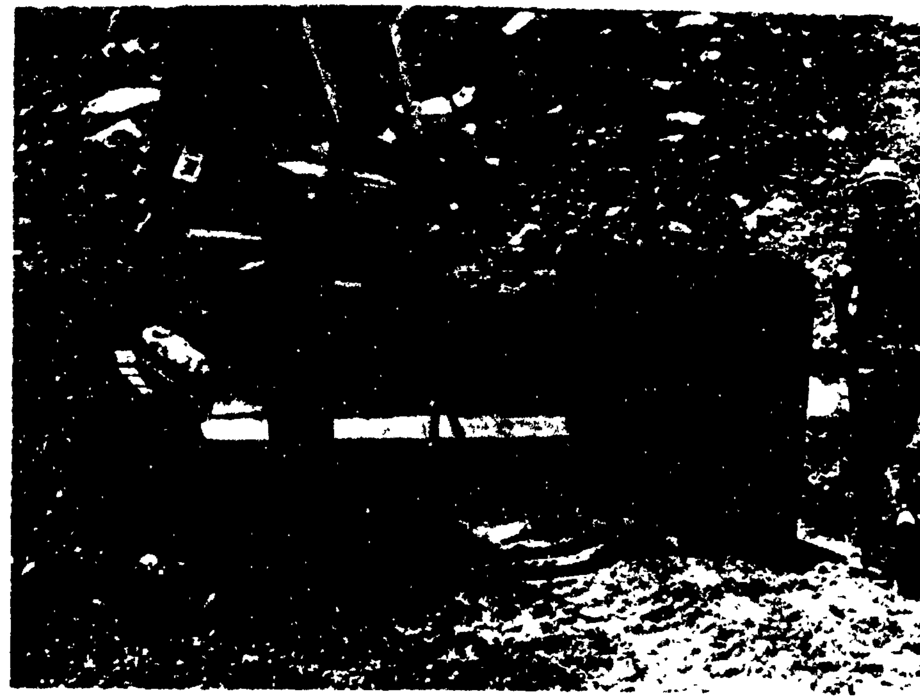


3. 09 October 1981. Cat 5310 scraper.

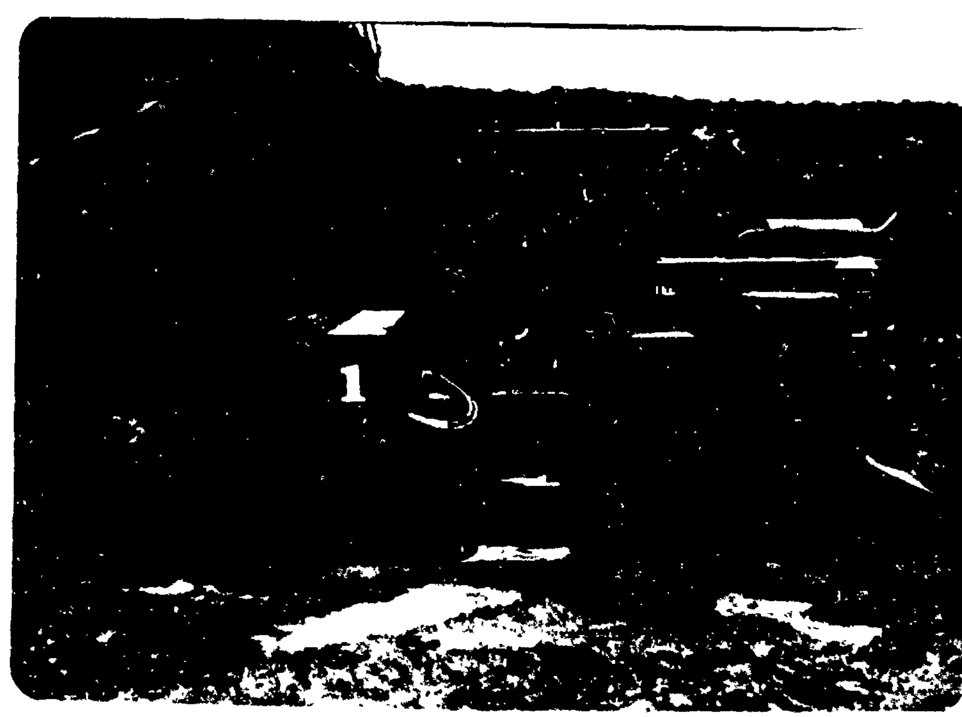


4. 26 July 1983. Cat D-9H compacting haul road ramp with tandem sheepsfoct roller Looking toward downstream right abutment.

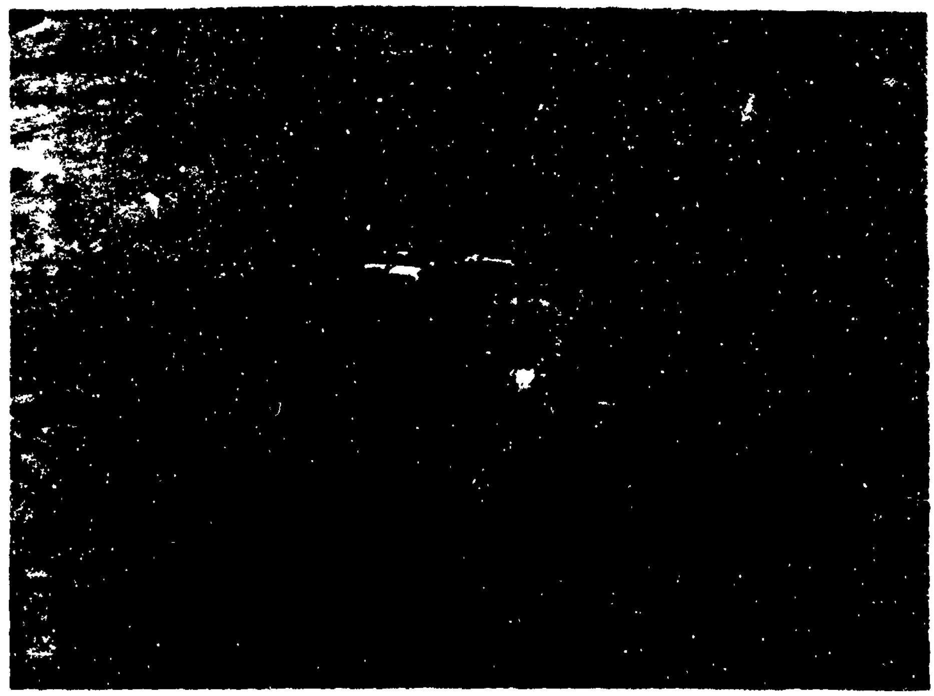
5. 10 July 1983. Compacting impervious fill around sump in cutoff trench with a "BARCO" gas powered compactor.



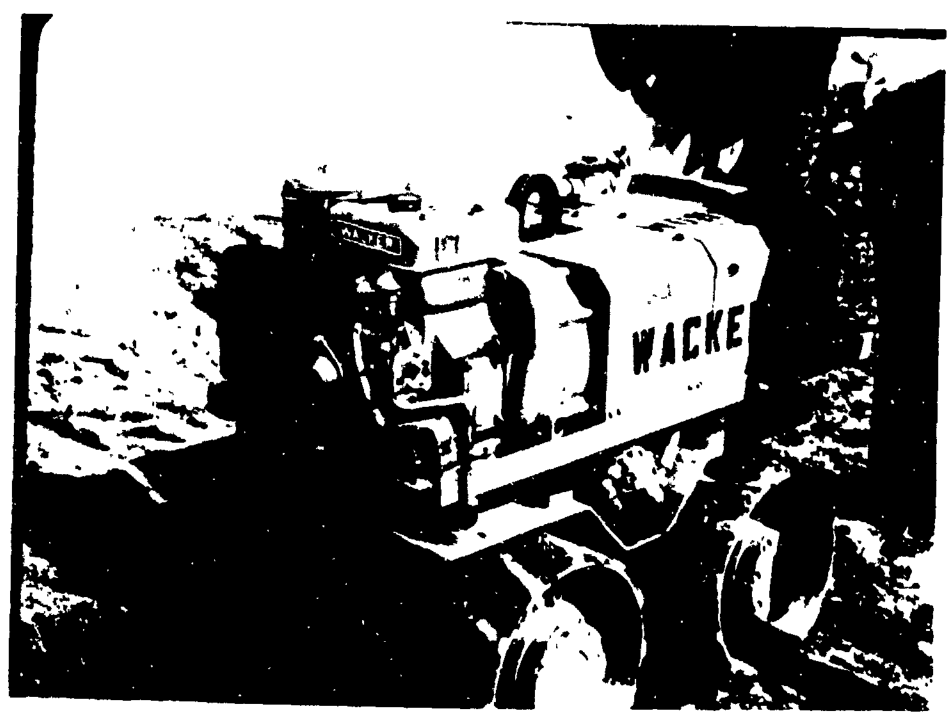
6. 06 July 1983. Spreader box mounted on a Cat D3 used for placing the 6 foot wide pervious drain.



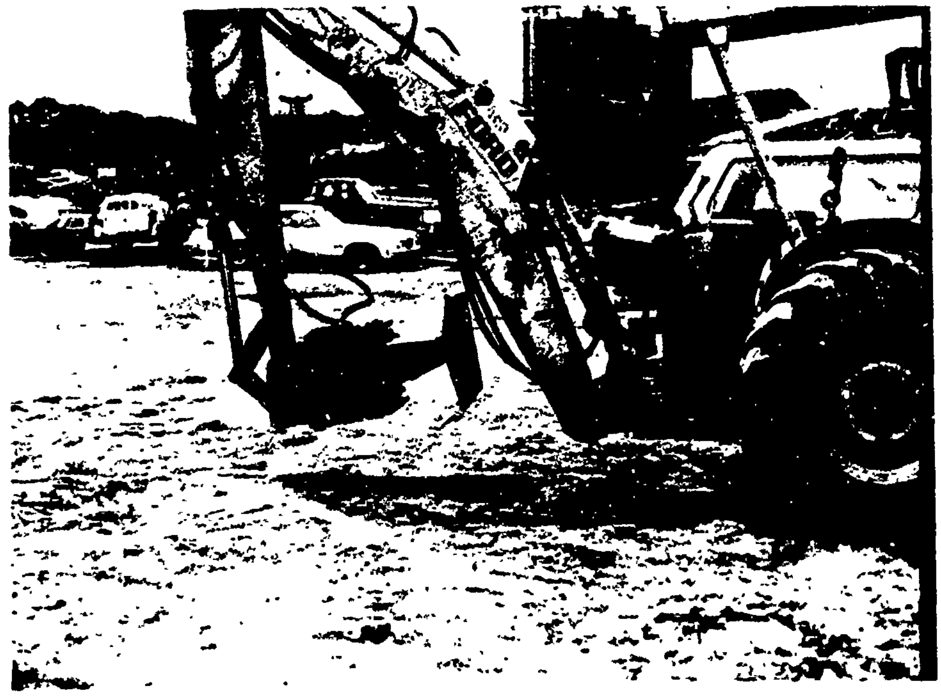
7. June 1980. Raygo "Rascal" 410-A 5 ton vibratory roller used to compact pervious fill. Looking downstream in cutoff trench.



8. 07 June 1983. "Wacker" DVU4001 small vibratory plate compactor used to compact pervious fill in restricted areas.



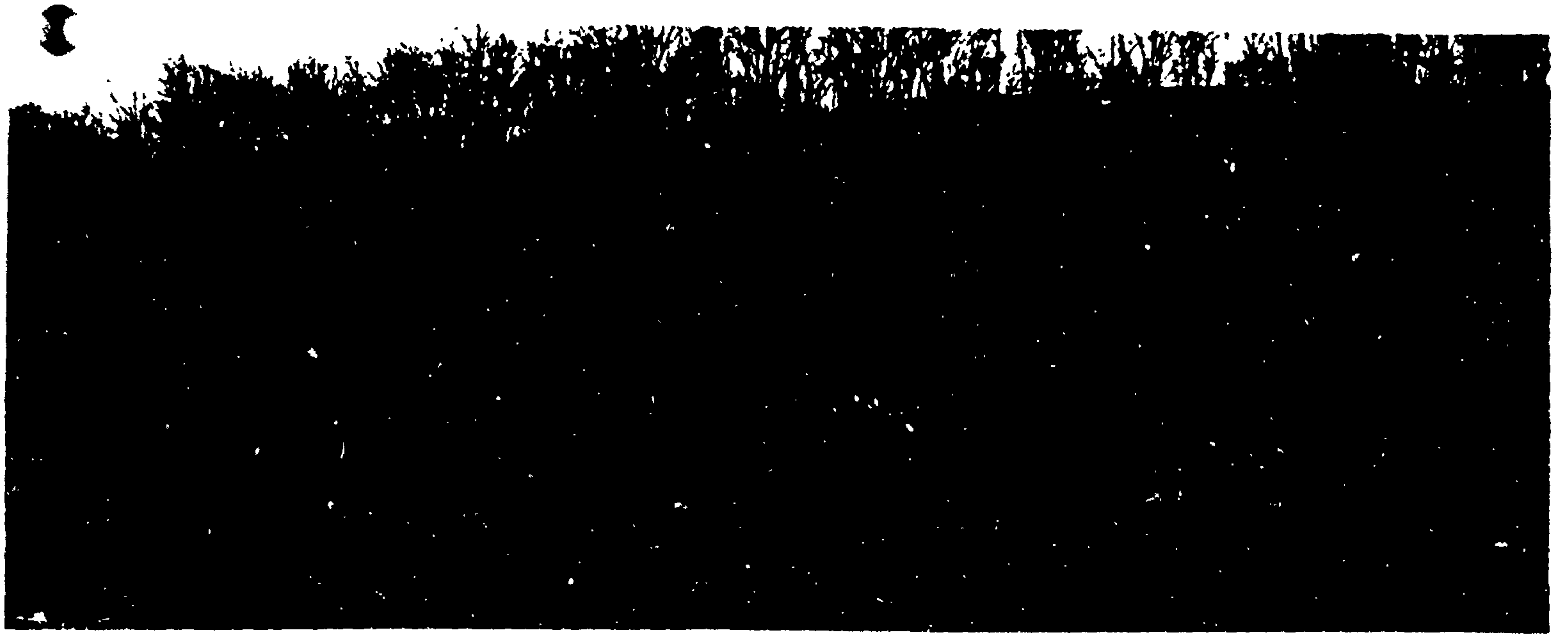
9. 07 May 1981. Small 4 wheel "Wacker" vibratory roller. Attempts were made to use this roller to compact pervious around conduit. Roller buried itself frequently and could not be used.



10. 11 June 1981. Backhoe mounted vibratory plate used to compact pervious fill along the right side of the conduit.

11. 18 September 1981. Wheel rolling upstream cutoff trench contact with left abutment Sni-A-Bar Limestone with Cat 920 front end loader.

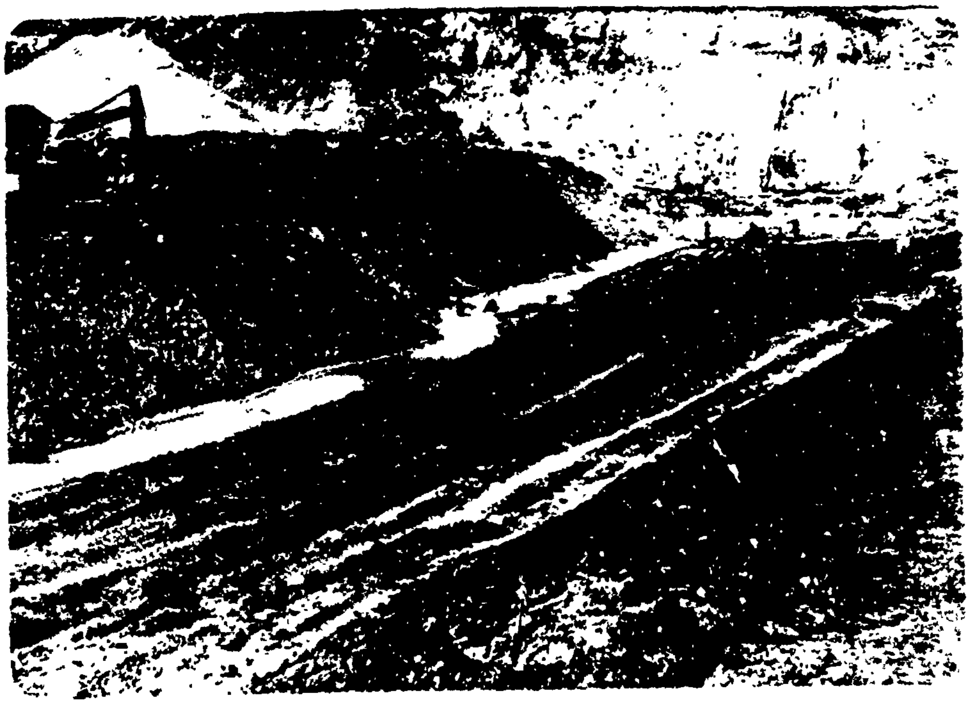
12. 18 July 1983. Record control sample being taken.
STAGE I EMBANKMENT CONSTRUCTION



13. 05 March 1980. Looking west at slide on left side of outlet works excavation. Slide occurred on 18 November 1979 between approximate outlet works stations 55+00 and 57+50. Estimated volume approximately 39000 cubic yards.

14. 29 May 1980. Curtain grouting in cutoff trench. Looking toward downstream left abutment.

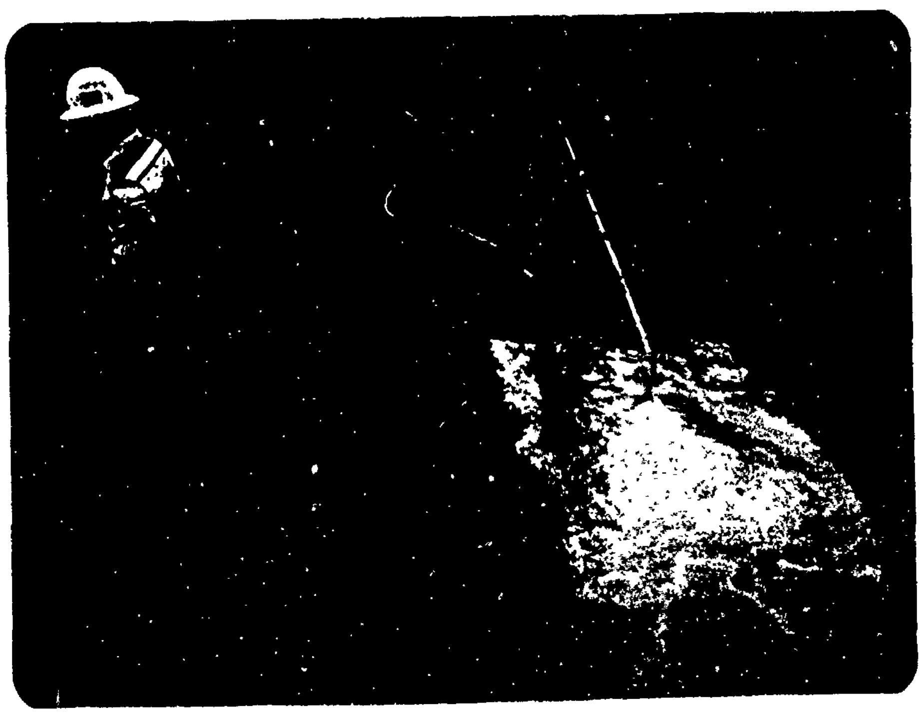
15. July 1980. Removal of unacceptably wet impervious fill material and excavation for placement of pervious on the downstream side of the cutoff trench. Looking toward left abutment from right abutment.



16. July 1980. Impervious and pervious fill placed in cutoff trench against right abutment. Looking toward right abutment.

17. 21 July 1980. Outlet works ogee section and 45 degree bend of twin sewer conduits. Looking downstream.

18. 14 August 1980. Stair stepped surface of heavily fractured Middle Creek limestone of right abutment after excavation and cleaning. Looking downstream.

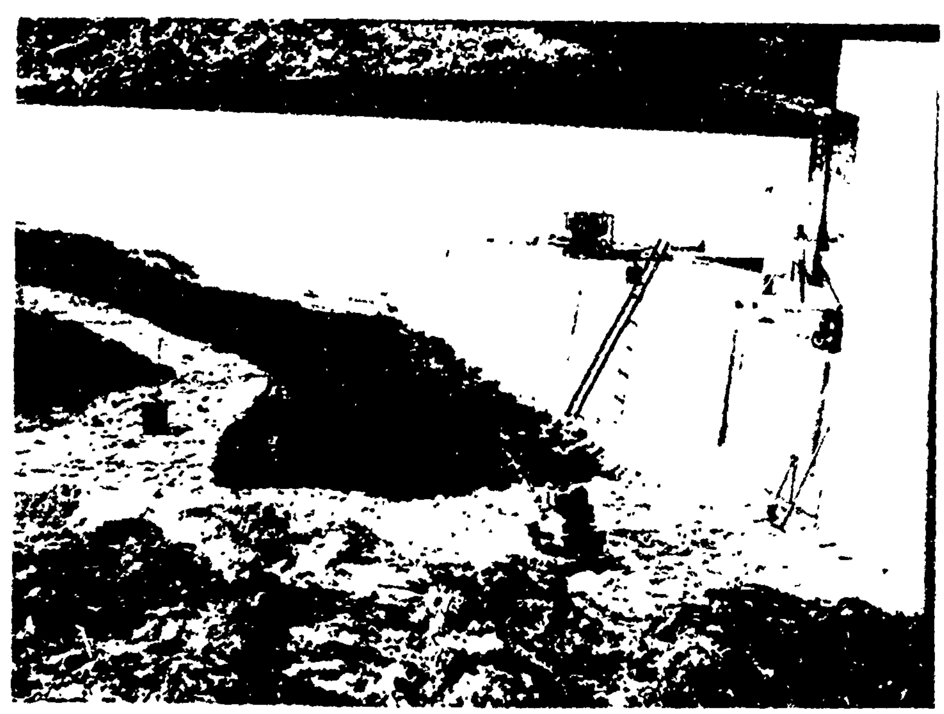


19. 14 August 1980. Placement of dental concrete and slush grout to seal the surface of Middle Creek limestone of the right abutment. Looking downstream.

20. 21 October 1980. Overview of fill placement, conduit construction, and left abutment cutoff trench from right abutment.

21. 06 May 1981. Selective loading with rock rake of left abutment Sni-A-Bar limestone to make rockfill.

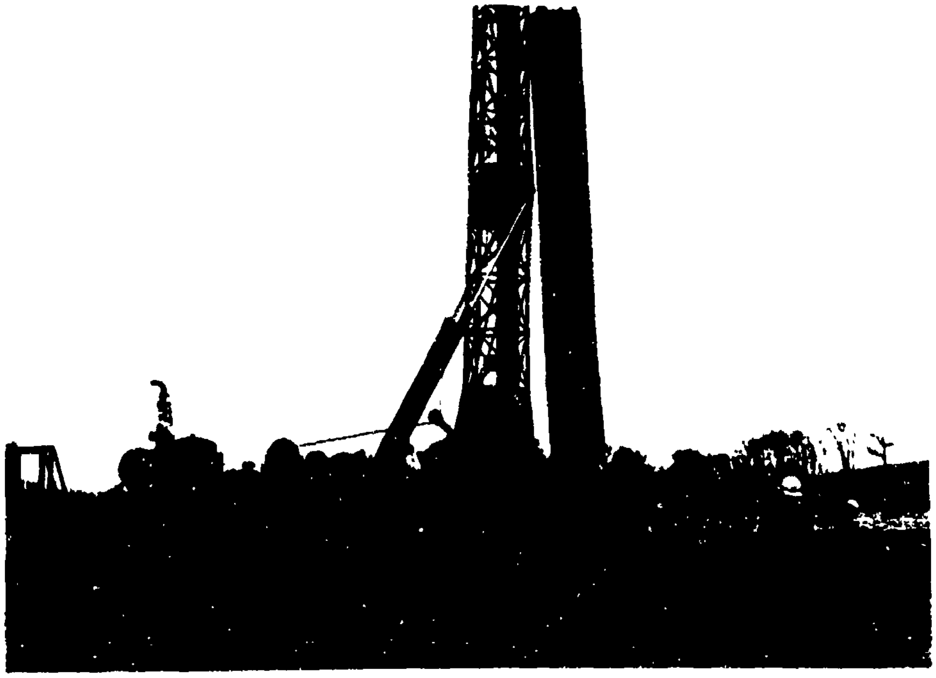
22. 21 May 1981. Overview of conduit backfill, fill placement, and right abutment from left abutment.



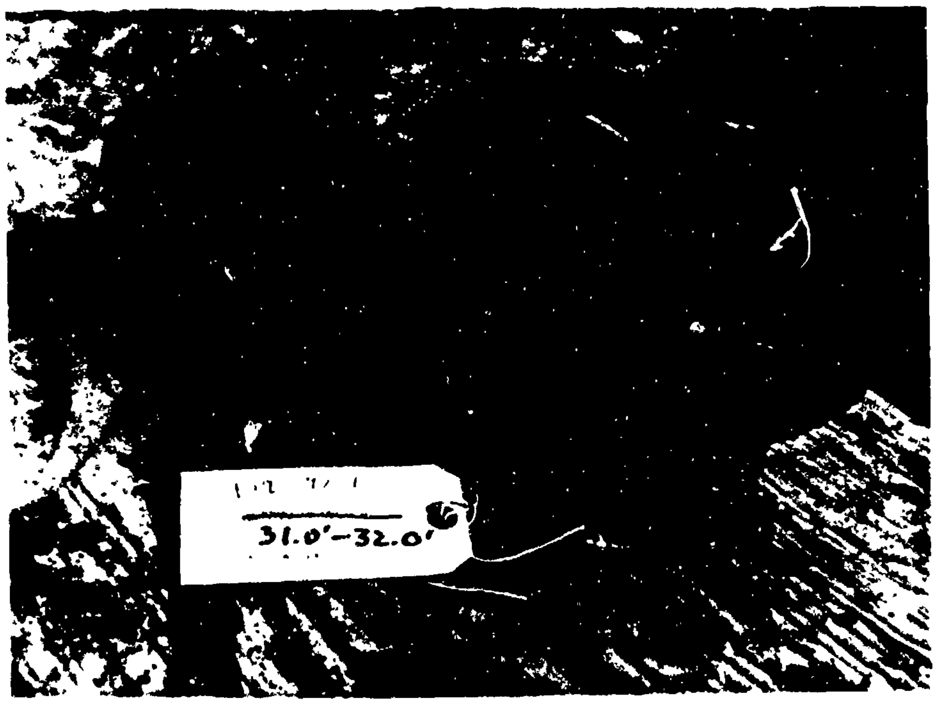
23. 21 July 1981. First lift of impervious fill being placed over pervious on upstream side of bend in twin sewer conduits at approximate outlet works station 54+00. Looking toward left abutment.

24. 18 September 1982. Left abutment and cutoff trench.

25. 21 October 1982. Downstream impervious stockpile. Looking downstream of right abutment.

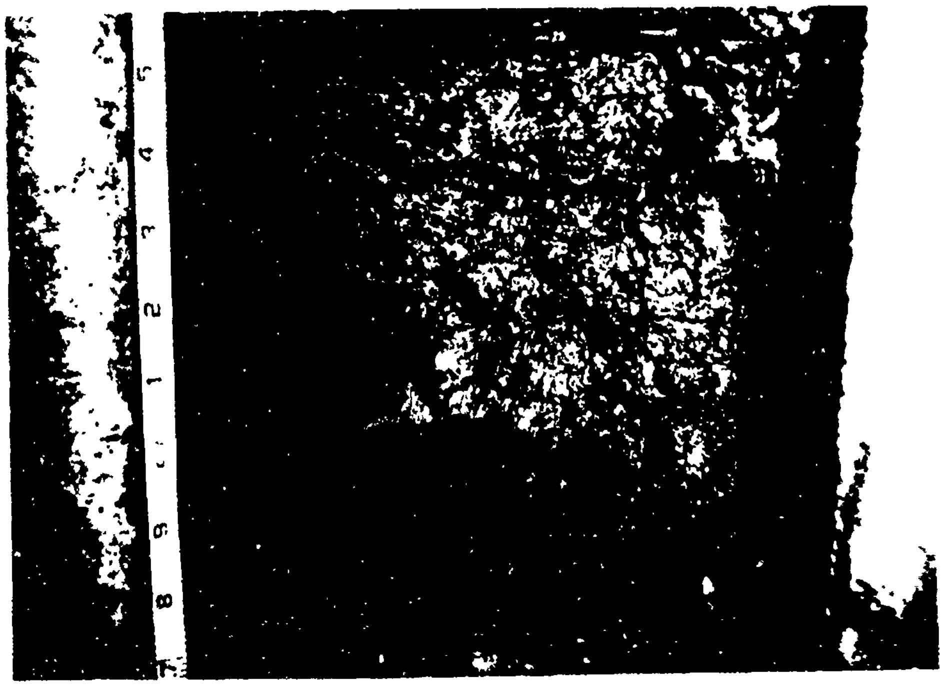


26. 16 November 1982. Stage I embankment investigation. Lowering inspection casing into 30 inch diameter observation hole (OH). Looking toward downstream right abutment.

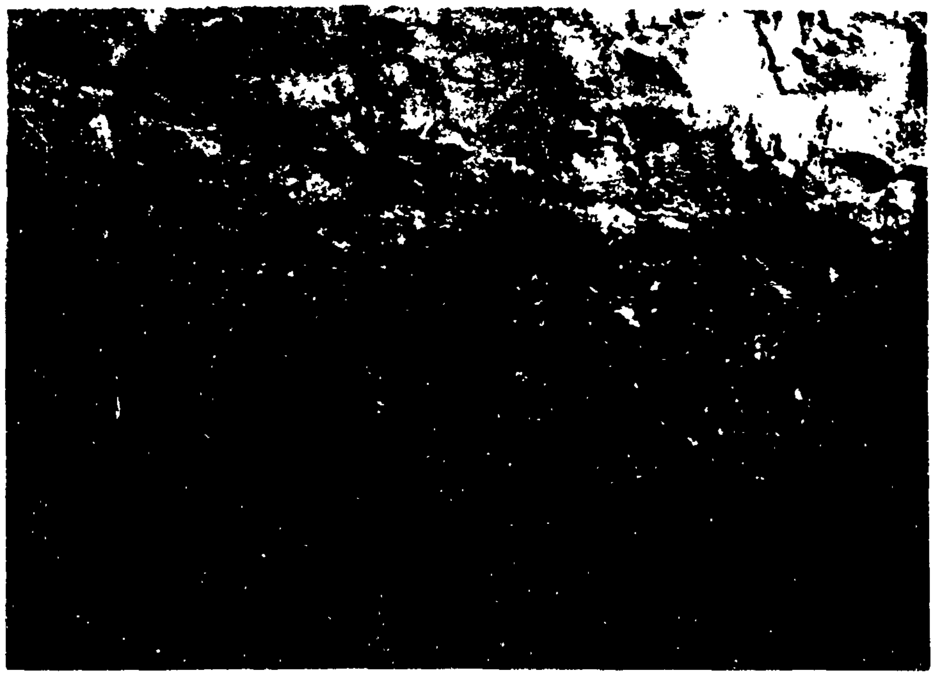


27. November 1982. Sample showing typical smooth surface texture, probably caused by pumping action of loaded scraper; PPE-97-15, Depth 31-32 feet; Elevation 837.7 to 838.7.

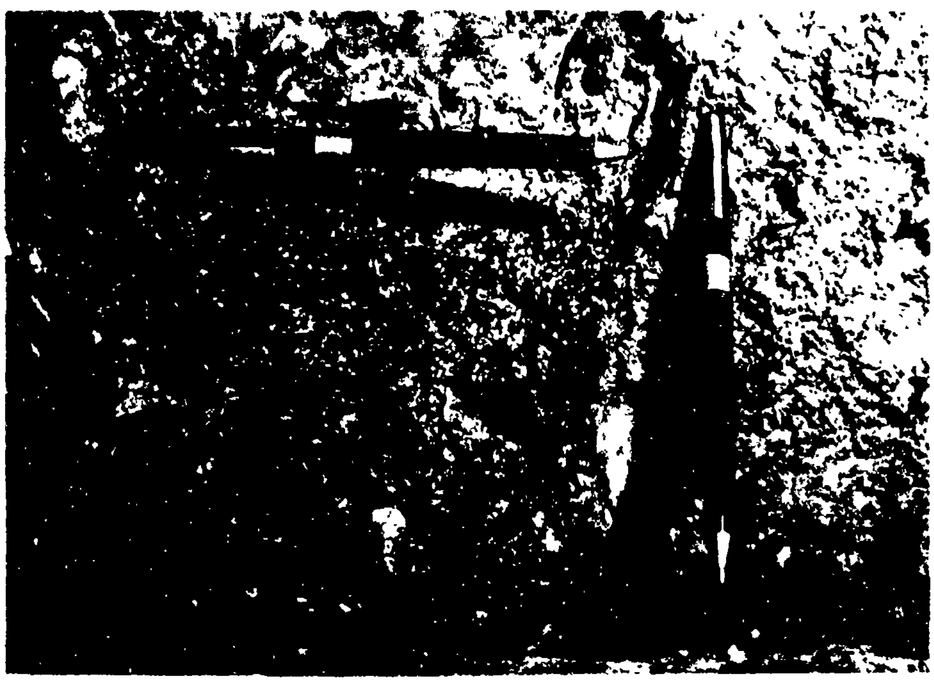
28. November 1982. Sample showing typical raindrop-type texture, probably mechanically induced from construction equipment; PPE-97-15; Depth 29.0 to 30.8 feet; Elevation 838.9 to 840.7.



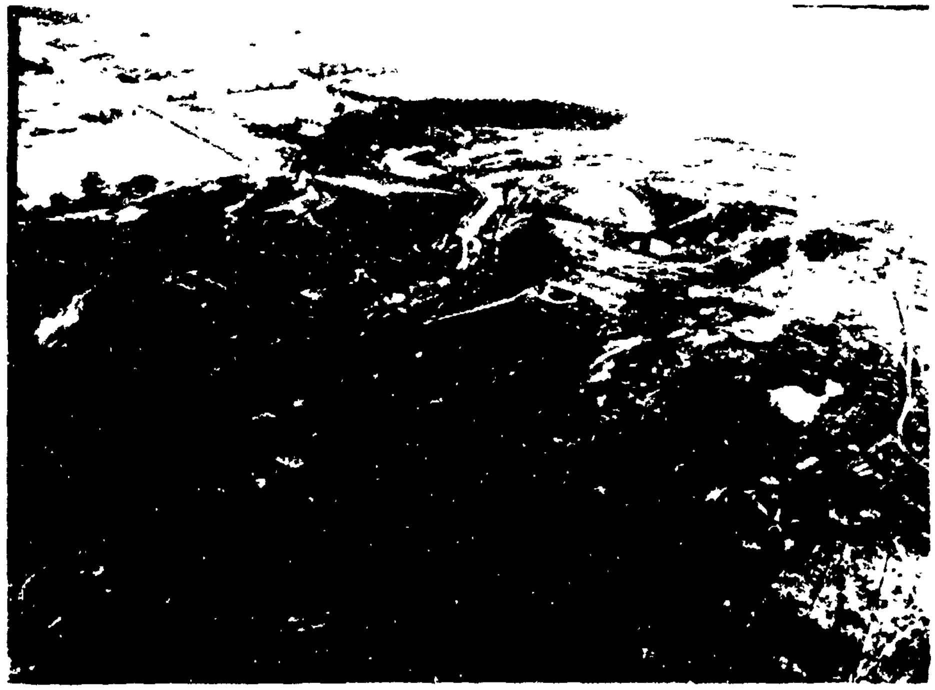
29. November 1982. First wet area encountered in OH-1; Depth 23 feet; Elevation 847.



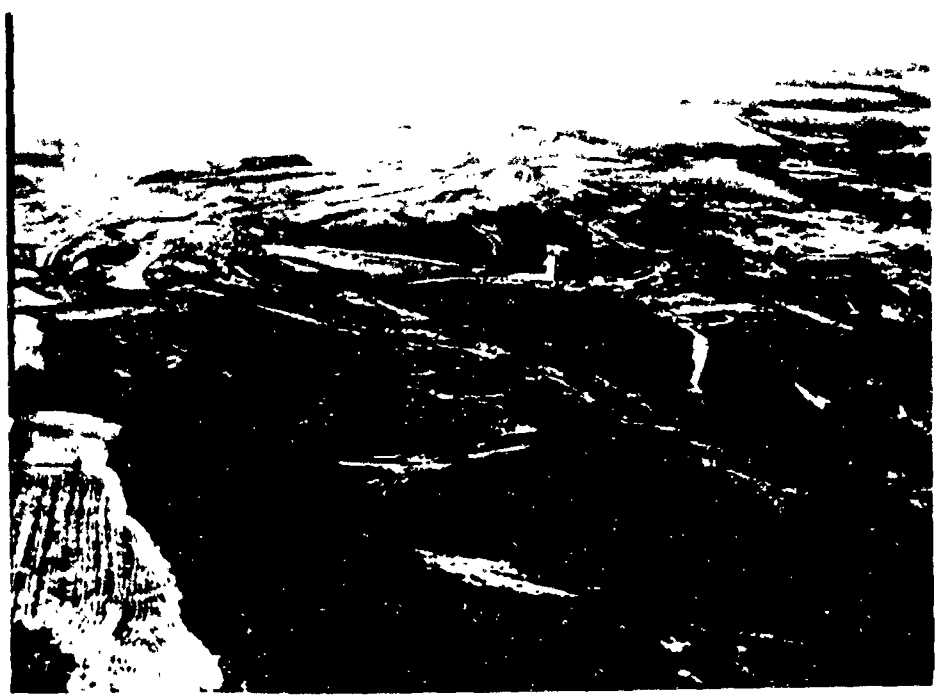
30. November 1982. One foot above area in previous photo; exposed boundary layer with the upper material moist and seepage exiting from lower material; OH-1; Depth 22 feet; Elevation 848.



31. November 1982. Wet area encountered in OH-1; Depth 34 feet; Elevation 836.



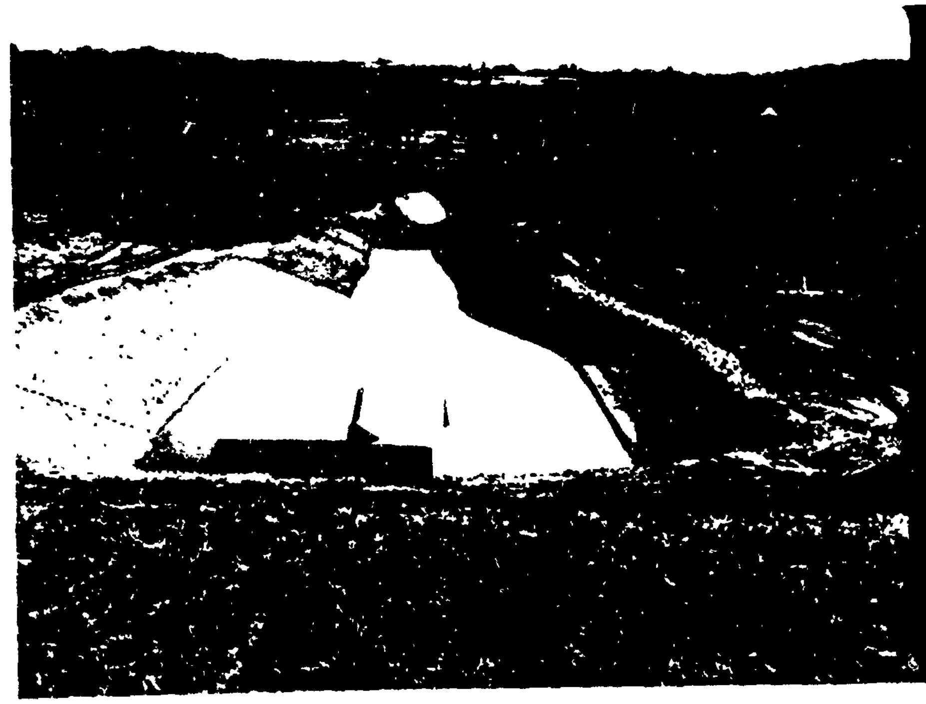
32. 24 November 1982. End of Stage I construction. Aerial view of construction from downstream of left abutment looking southeast.



33. 24 November 1982. End of Stage I construction. Aerial view of construction from downstream of right abutment looking southwest.

34. January 1983. Ignition of gas from PPE99-9.

35. 10 June 1983. Impervious blanket against upstream right abutment.



36. 17 June 1983. Completed outlet works and stilling basin. Looking downstream.

37. 06 July 1983. Aerial view of embankment, cofferdam, and closure section construction frpm downstream of right abutment.

38. 06 July 1983. Aerial view of embankment and closure section construction from upstream left abutment.

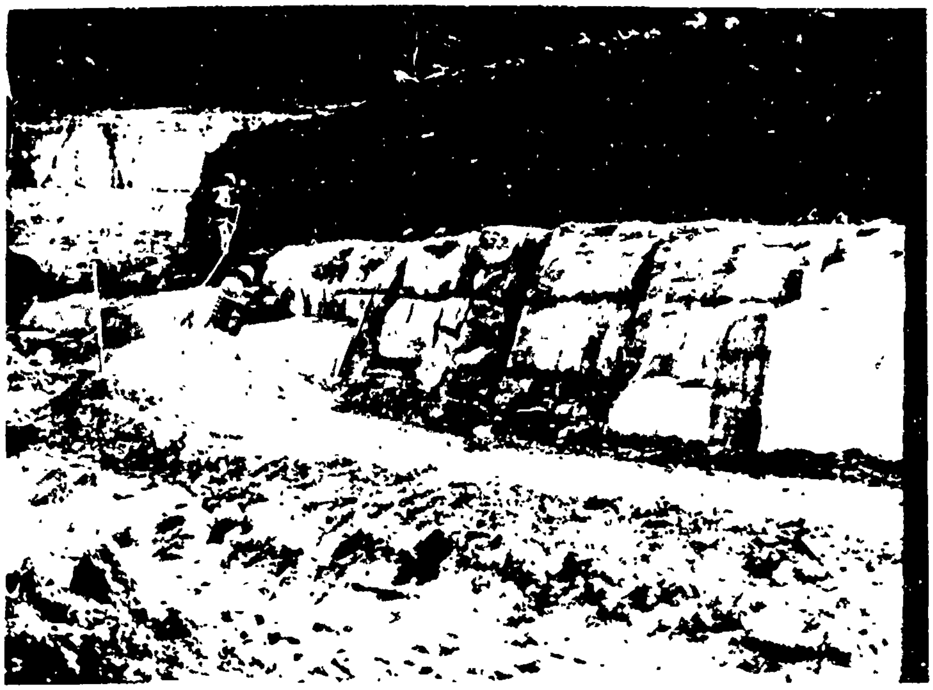
39. 09 July 1983. Cleanup of cutoff trench and impervious placement in closure section.

40. 12 July 1983. Pervious placed at downstream edge of cutoff trench in closure section. Looking toward right embankment.

41. 18 July 1983. View of closure section showing pervious placement at downstream side of cutoff trench and in old river and diversion channels. Looking downstream.

42. 22 July 1983. Pervious blanket placed over old river channel in closure section. Looking downstream.

43. September 1983. Closure section embankment construction. Looking toward downstream right abutment from left abutment.

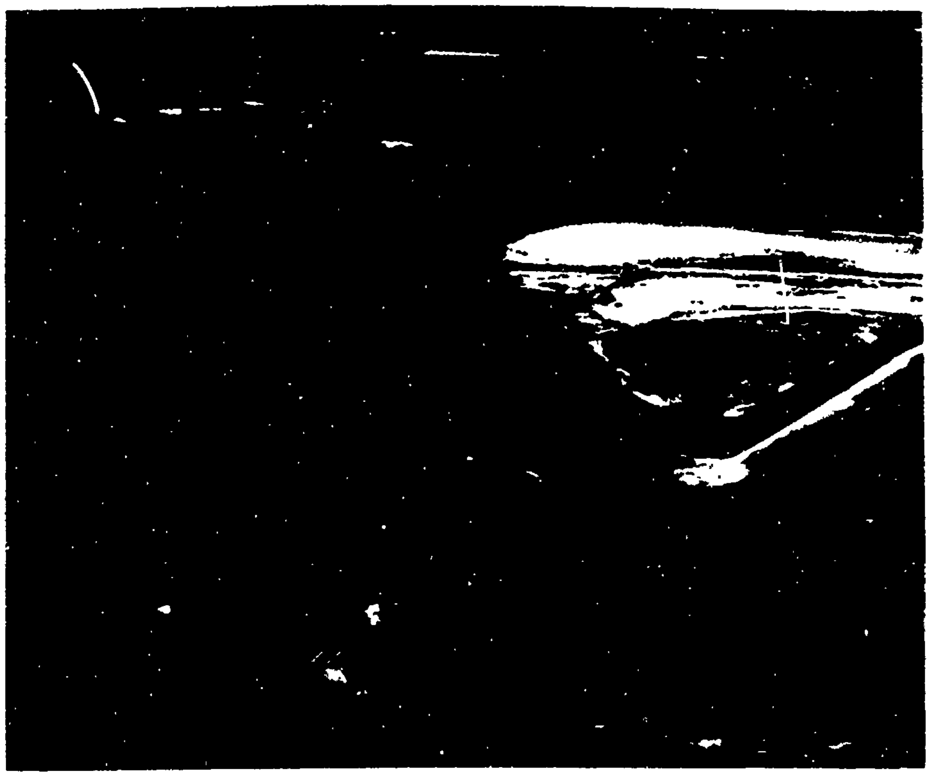


44. 13 September 1983. Downstream right abutment.

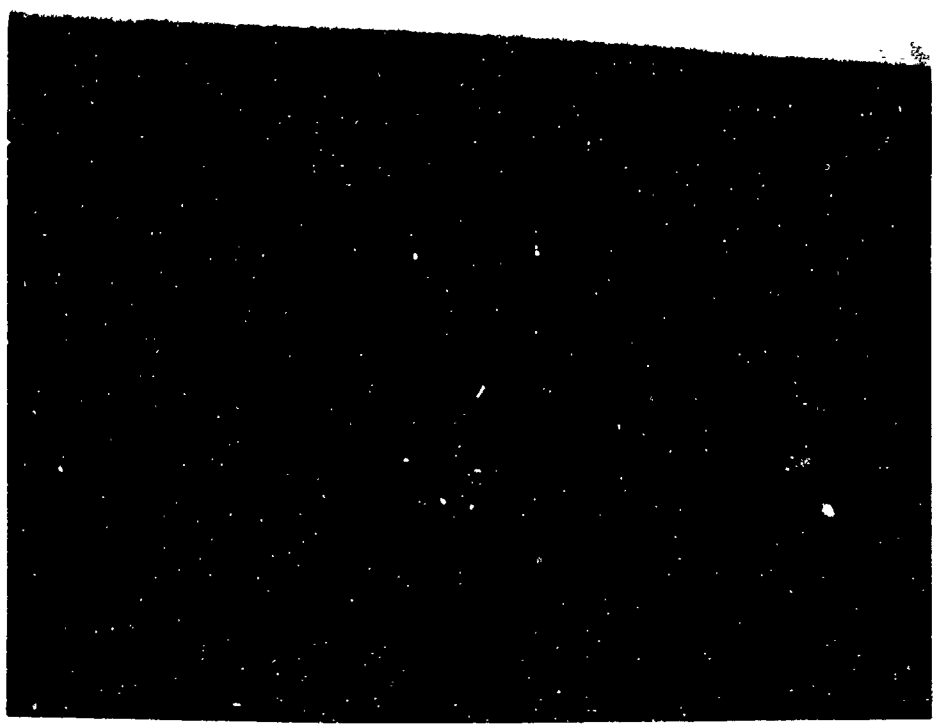
45. 13 September 1983. Upstream right abutment.

46. 26 October 1983. Fill placement in closure section. Looking toward right abutment.

47. 24 May 1984. Rockfill in clay blanket area on upstream right abutment. Looking upstream.



48. May 1984. Aerial view of embankment after completion of closure section fill placement. From above left abutment looking toward right abutment.



49. May 1984. Aerial view of embankment looking upstream from downstream of the right abutment. The east borrow is visible in the center of the photo and the west borrow is at the upper right center.

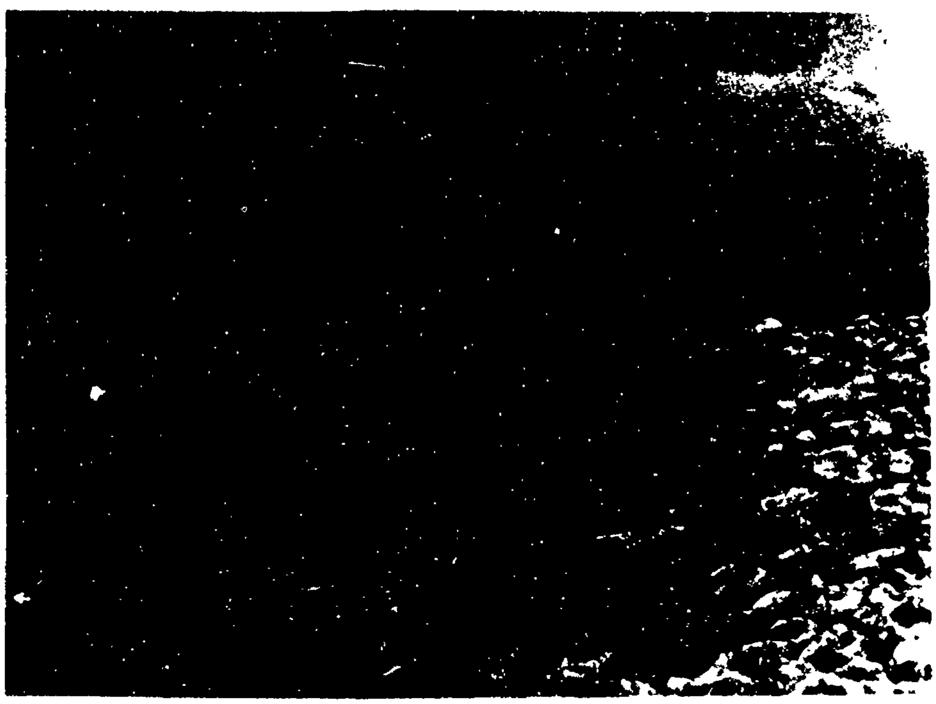
50. May 1984. Aerial view of borrow areas from south of the west borrow area looking north toward the east borrow area and the embankment.

51. 16 July 1984. Upstream and downstream random zone fill placement. Looking toward right abutment.

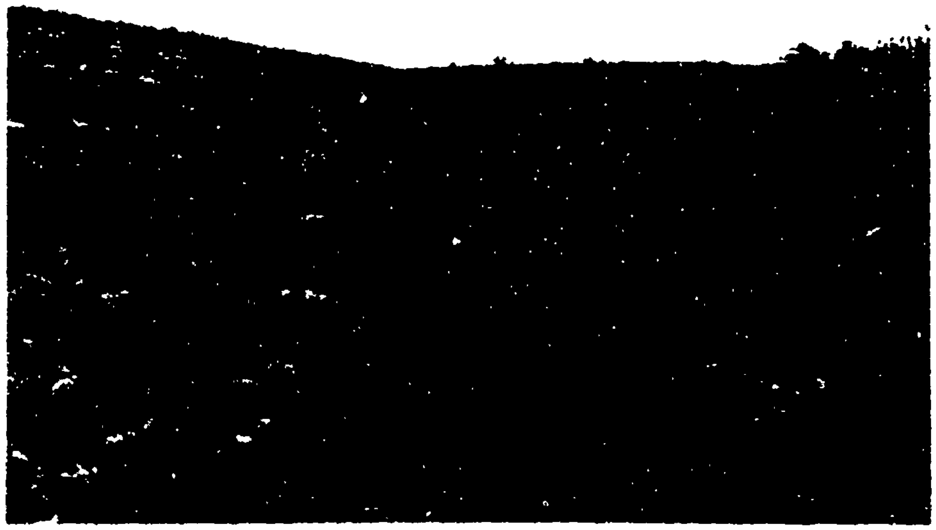
52. 18 September 1984. Upstream slope before final grading. Looking toward upstream left abutment.

53. 26 November 1984. Downstream left abutment grouted gutter construction. Looking upstream.

54. 25 March 1985. Front end loaders placing riprap on upstream face of embankment. Looking downstream.

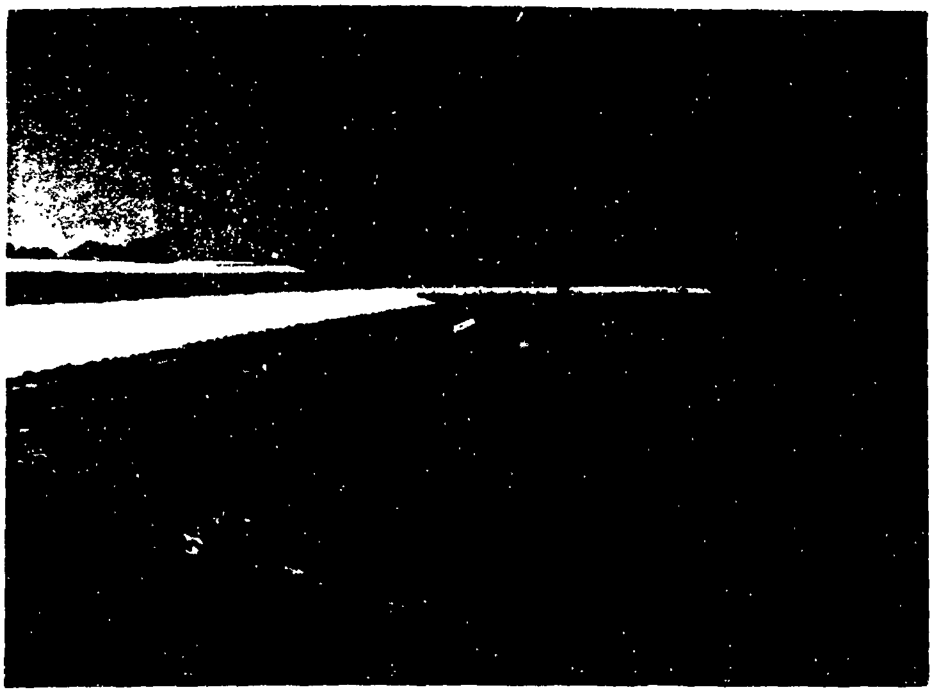


55. 26 March 1985. Dressing of riprap adjacent to bridge abutment using large backhoe.



56. 26 March 1985. Completed upstream slope protection. Looking toward upstream right abutment.

57. 23 May 1985. Completed slope protection at crest of embankment. Looking toward left abutment.



58. September 1985. Completed upstream slope from tower bridge. Looking toward upstream right abutment.

59. September 1985. Completed downstream right abutment from stilling basin parking lot.

60. 24 September 1985. Eight foot flat bottom toe ditch. Looking toward stilling basin.

61. 24 September 1985. "Enka-mat" erosion control fabric lined ditch above grouted gutter on downstream left abutment.

62. 05 March 1986. Downstream right abutment contact showing cleared sewer line alignment at upper left.

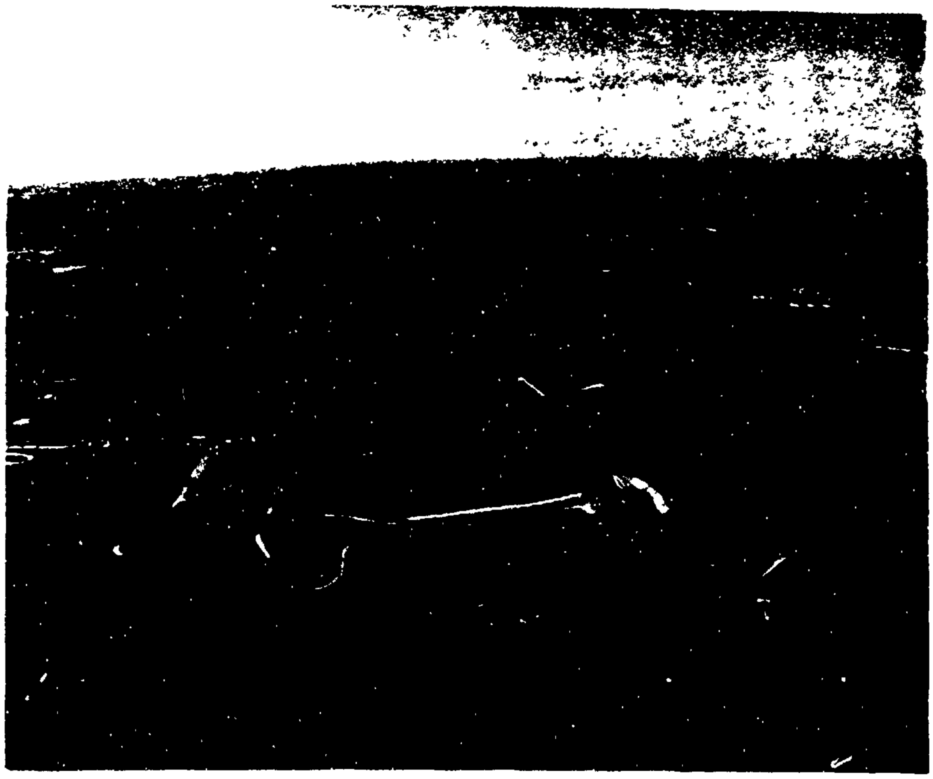
63. 22 April 1986. Closed expansion joint and tilted rocker due to movement of tower bridge abutment.

64. April 1986. Crown crack and leakage along left wall at monolith joint between tower and conduit.

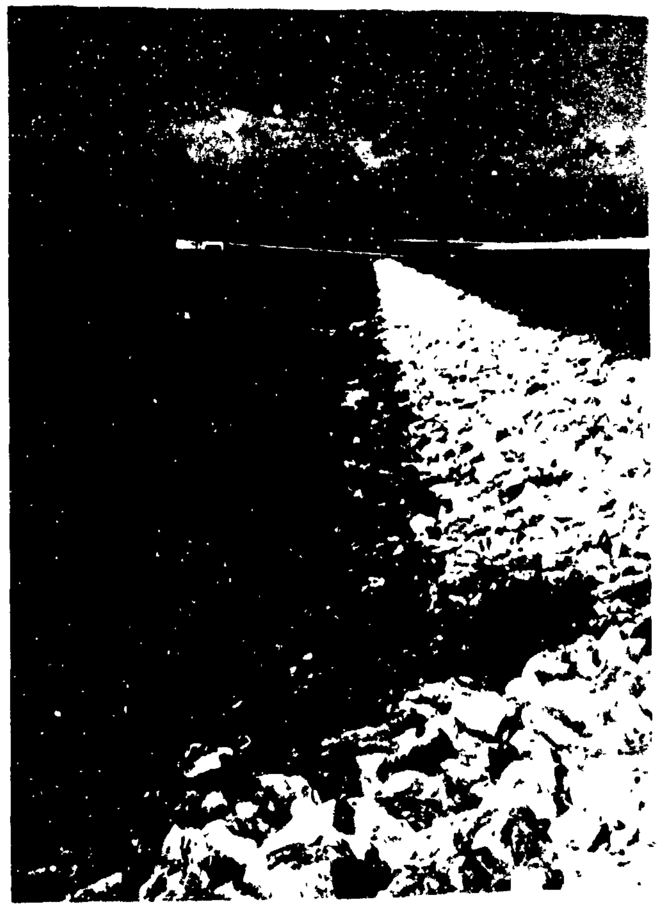
65. 19 May 1986. Installation of finger drains into pervious blanket at embankment toe.

66. 19 May 1986. Compl ted finger drain installation at embankment toe..

67. 10 July 1986. Completed french drain installed in upstream right abutment clay blanket to intercept seepage from limestone.

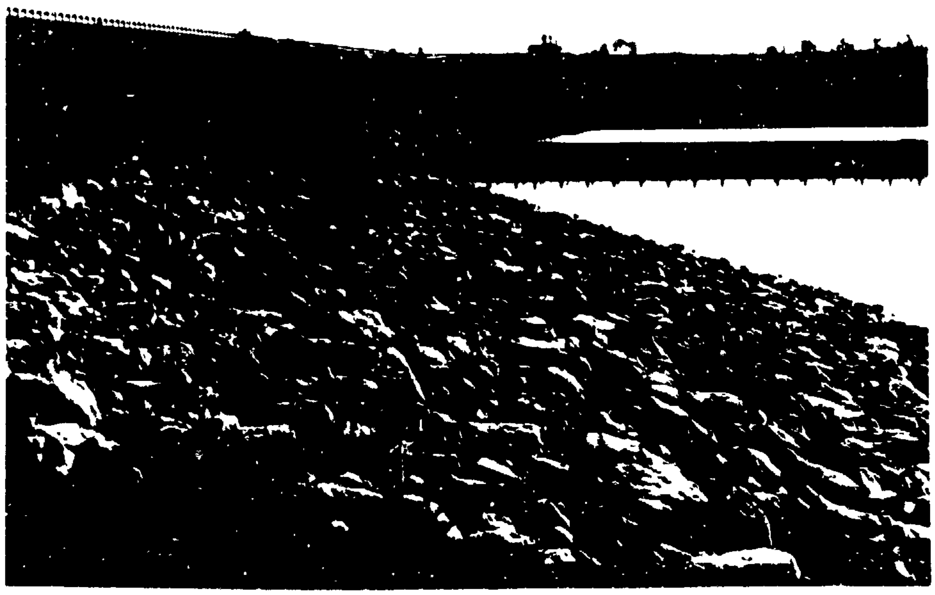


68. 18 July 1986. Aerial view of completed embankment. Looking upstream from downstream of the right abutment.



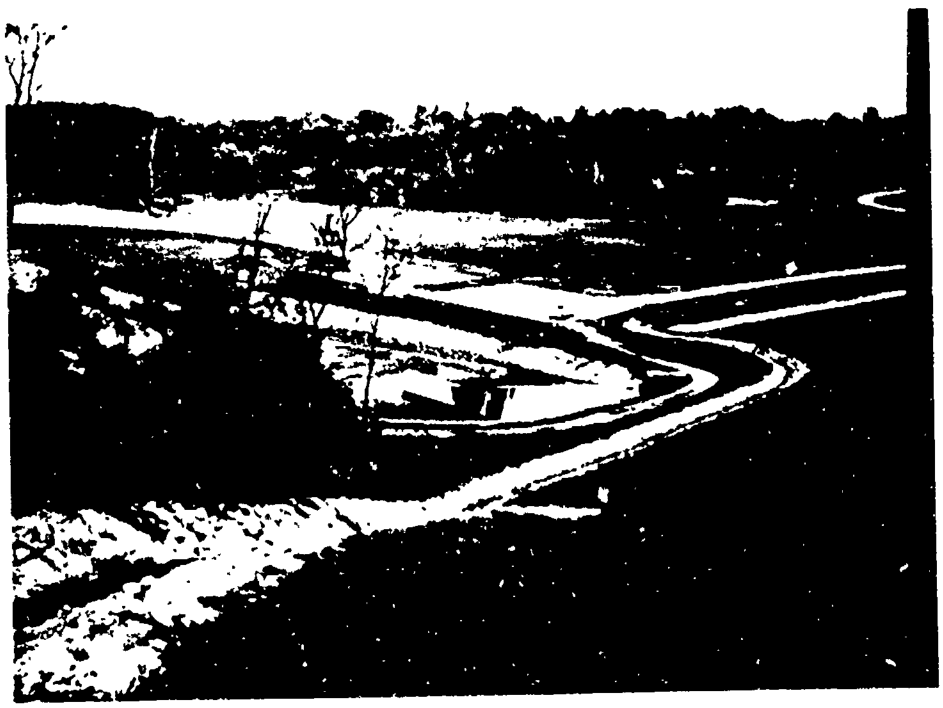
69. 19 September 1986. Upstream slope protection with pool at multipurpose elevation 891. Looking toward upstream left abutment from right abutment.

70. 04 October 1986. Upstream slope with pool at elevation 897. Looking toward right abutment from left abutment.



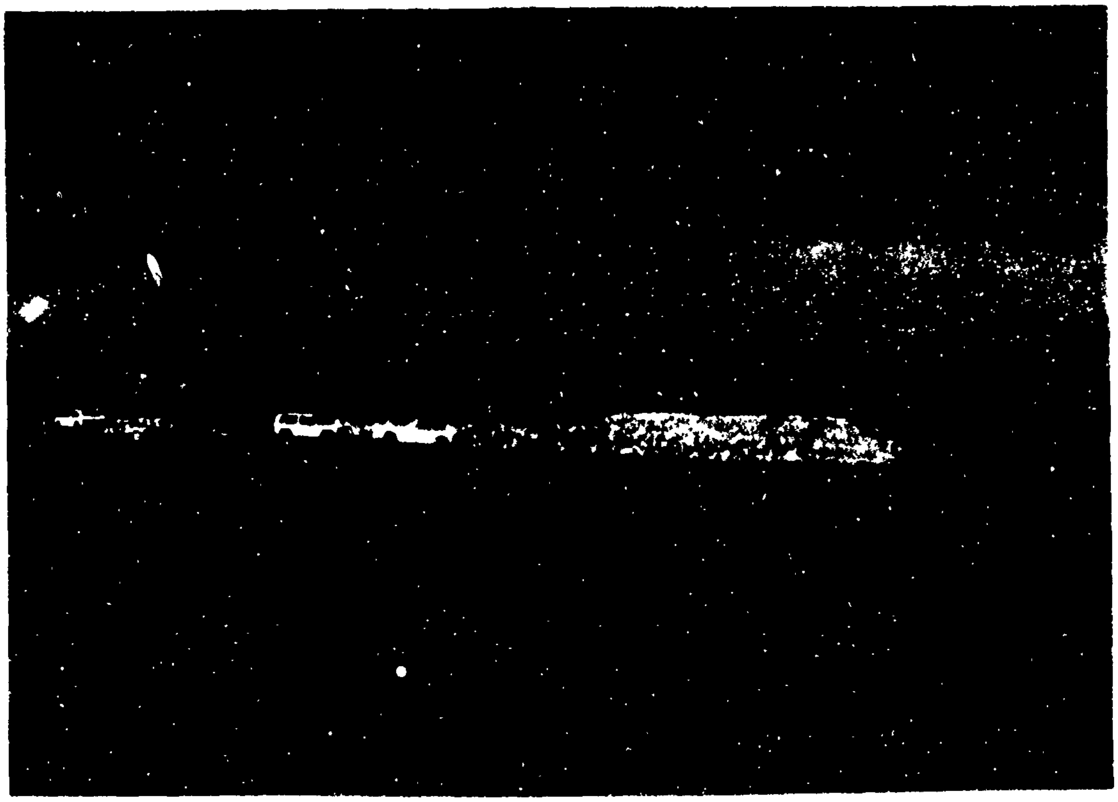
71. 07 April 1987. Left abutment slope protection with the pool at multipurpose elevation 891.

72. 07 April 1987. Completed upstream right abutment clay blanket area.



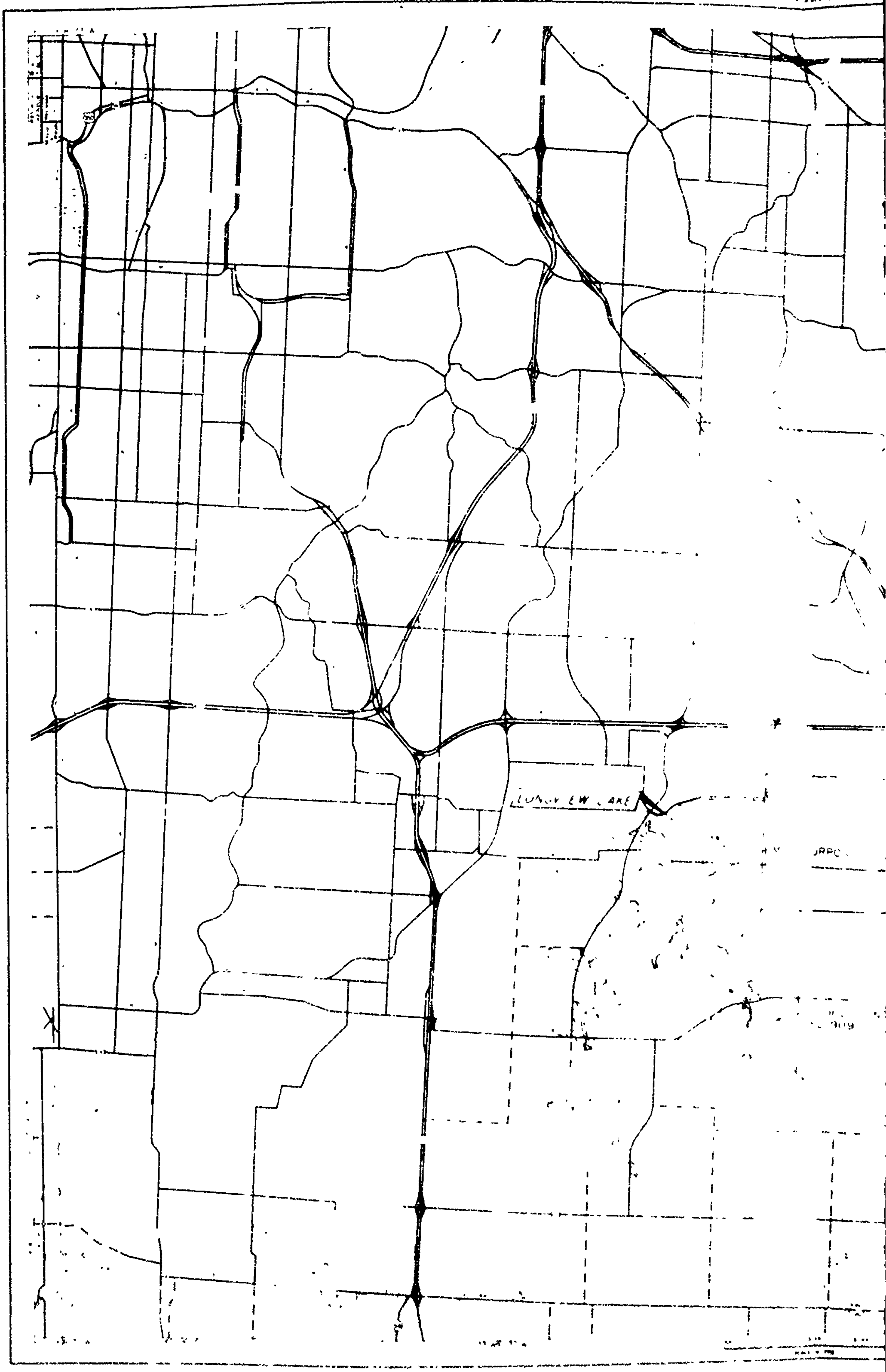
73. 19 September 1986. Downstream left abutment contact and stilling basin.

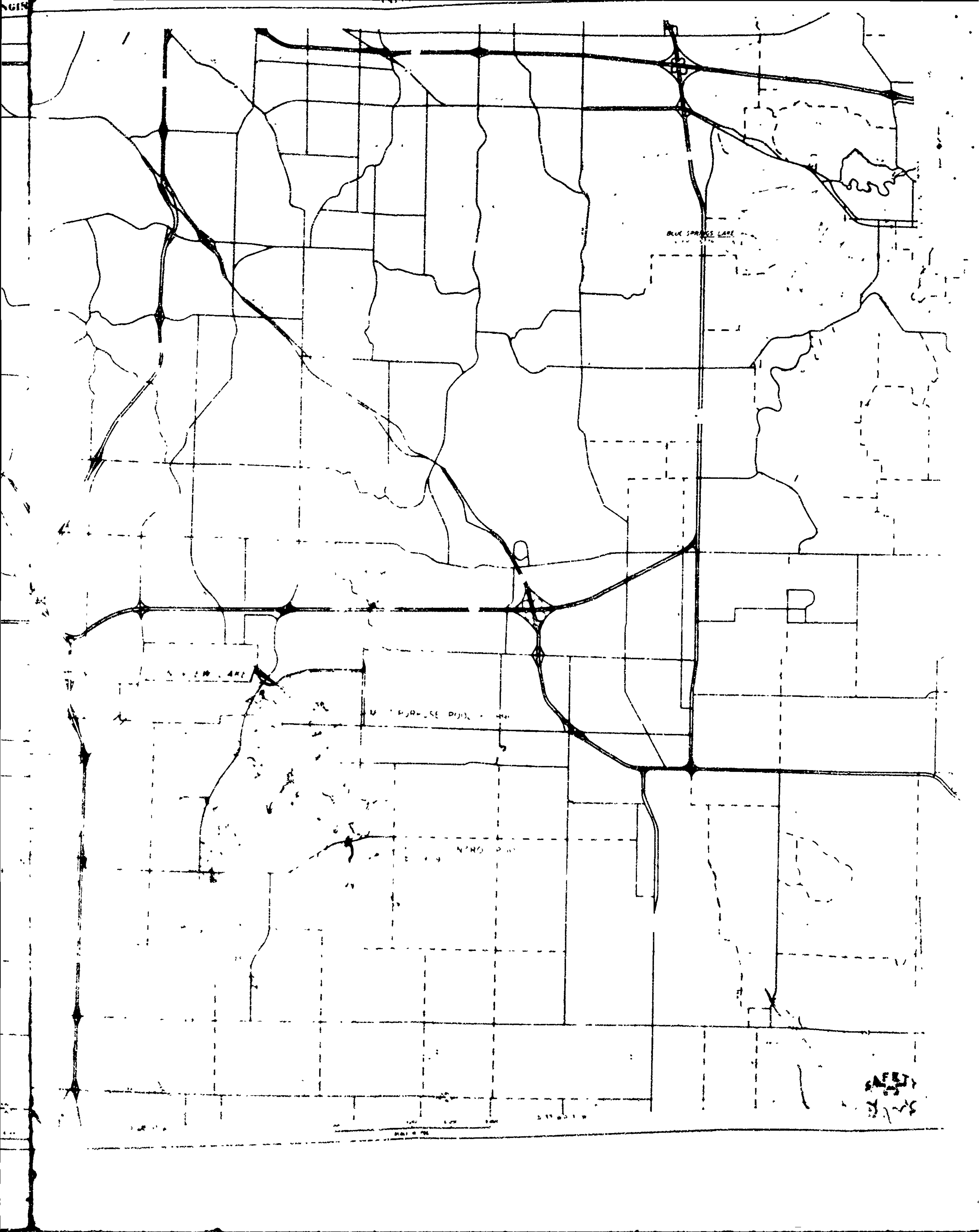
74. 07 April 1987. Completed downstream slope. Looking toward downstream left abutment.



75. March 1990. Completed emergency rock stockpile on downstream left abutment. Looking northwest.

DRAWINGS


LONGVIEW LAKE


BLUE SPRINGS LAKE

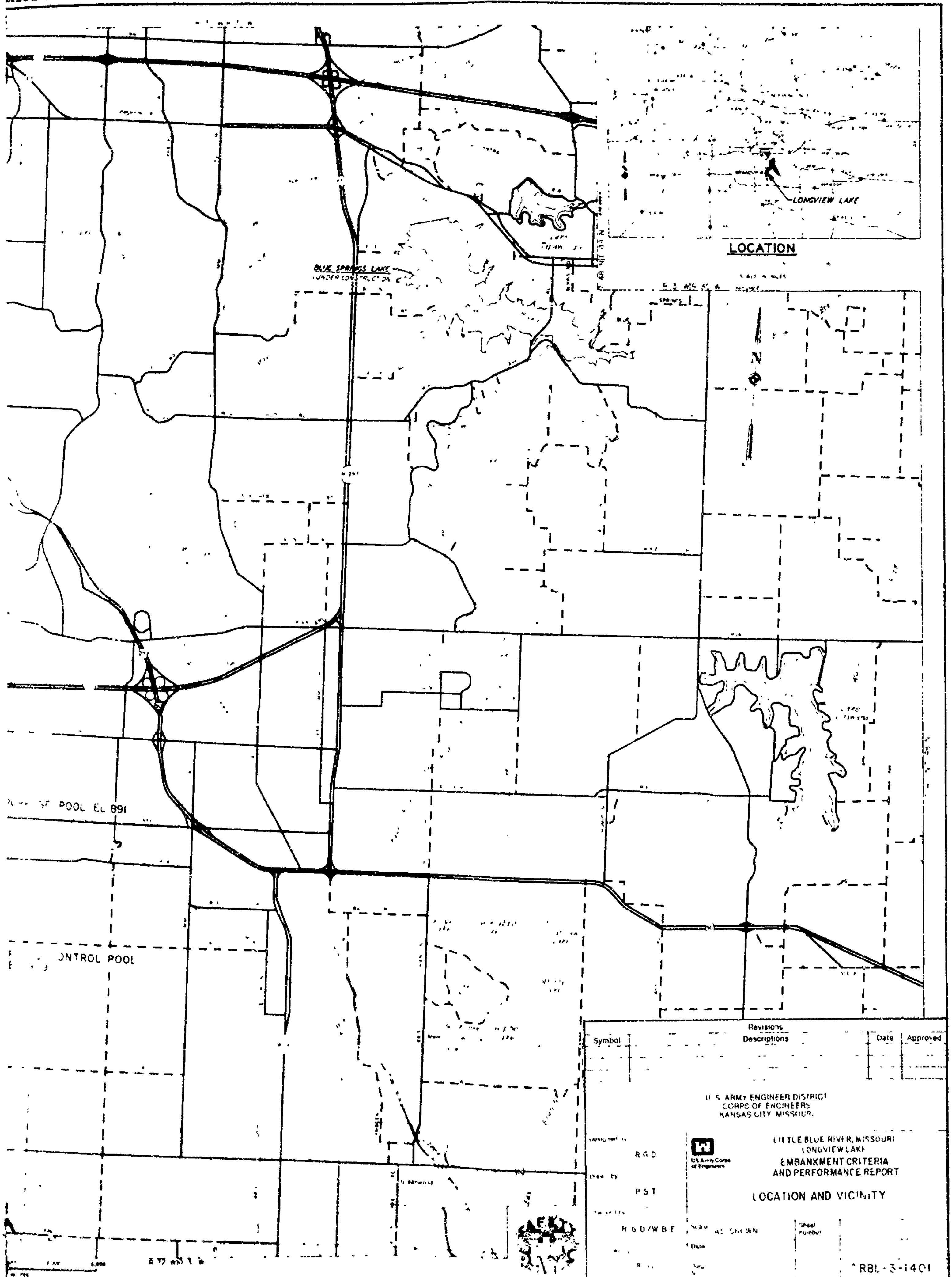
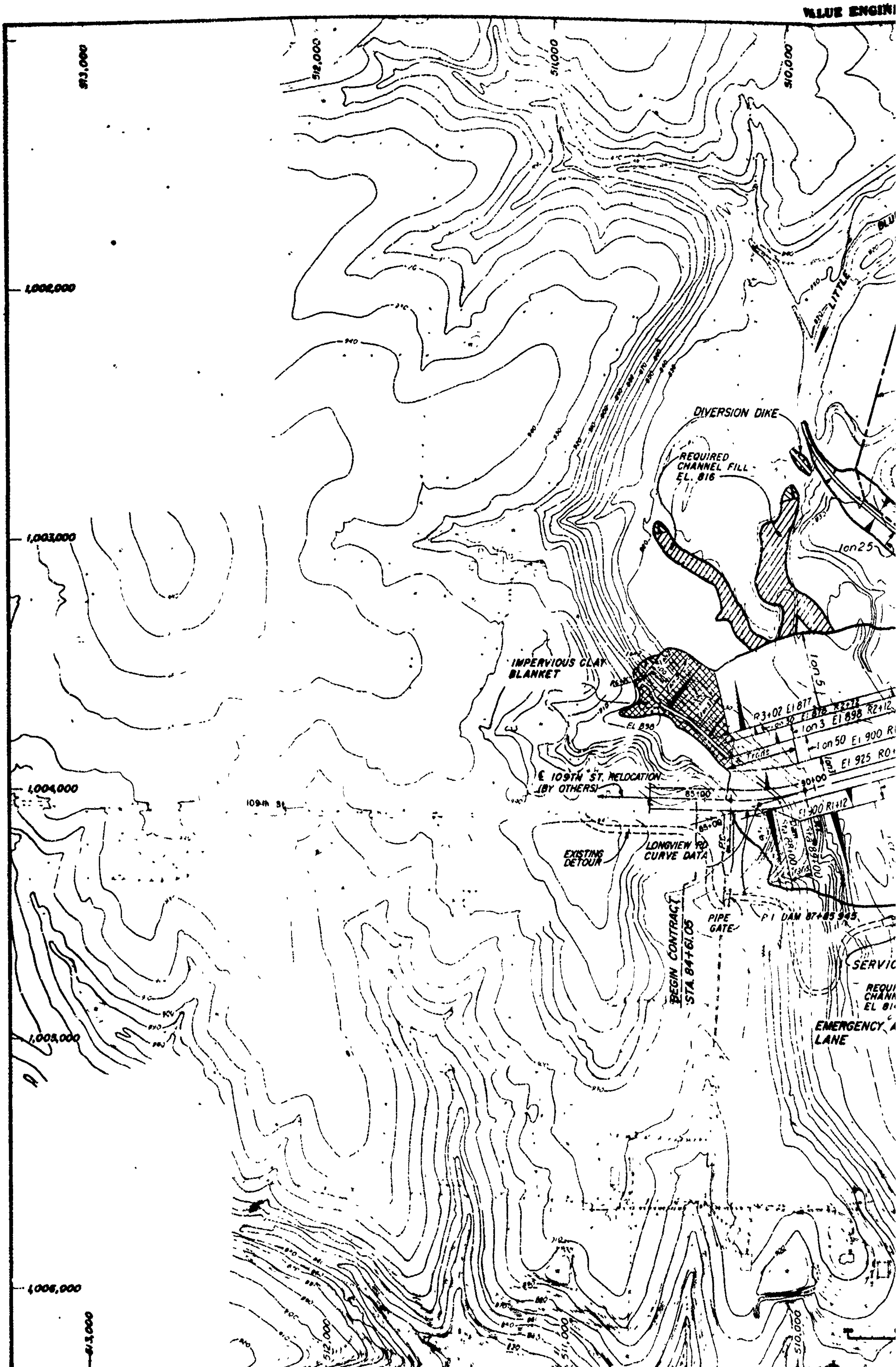
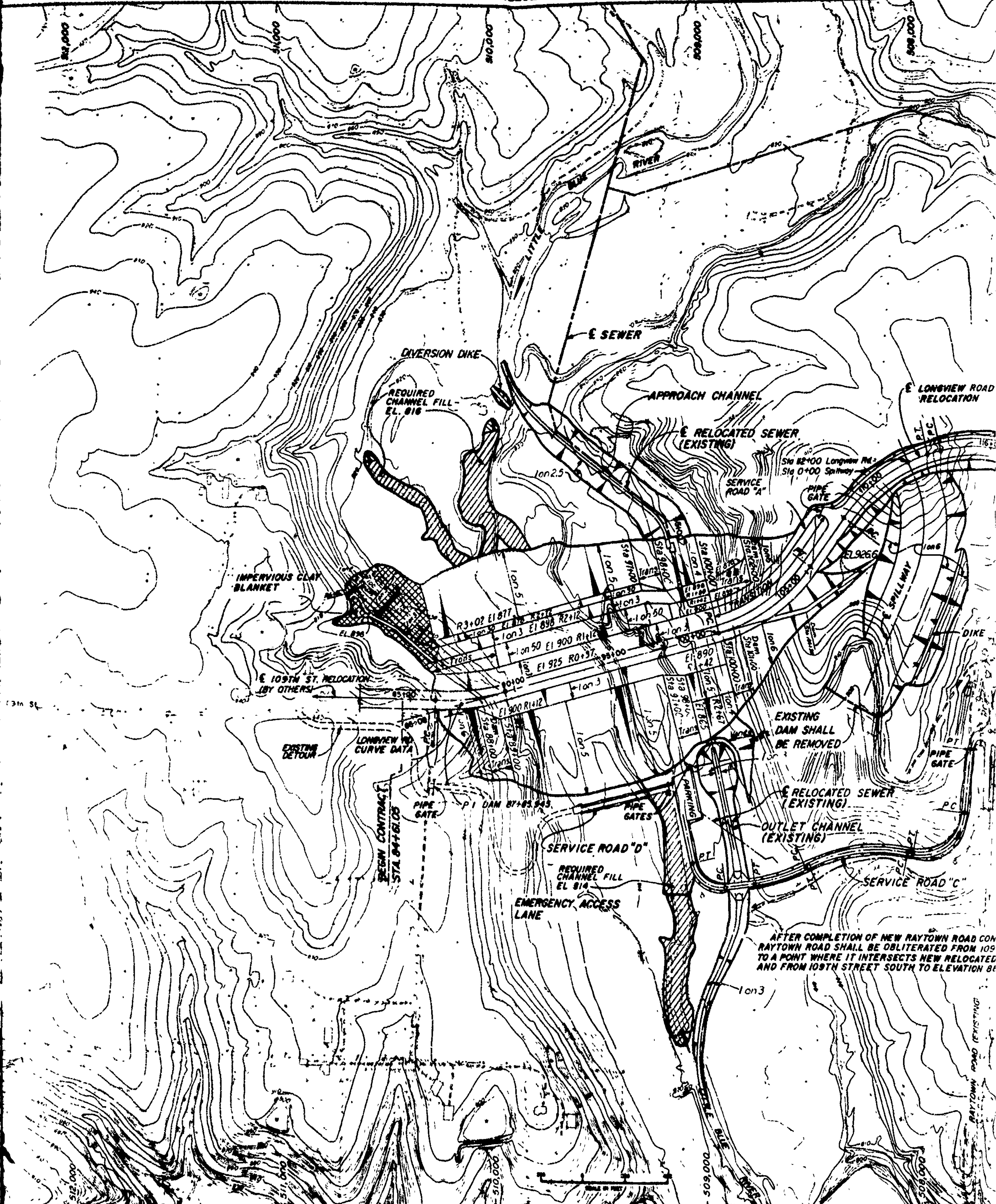
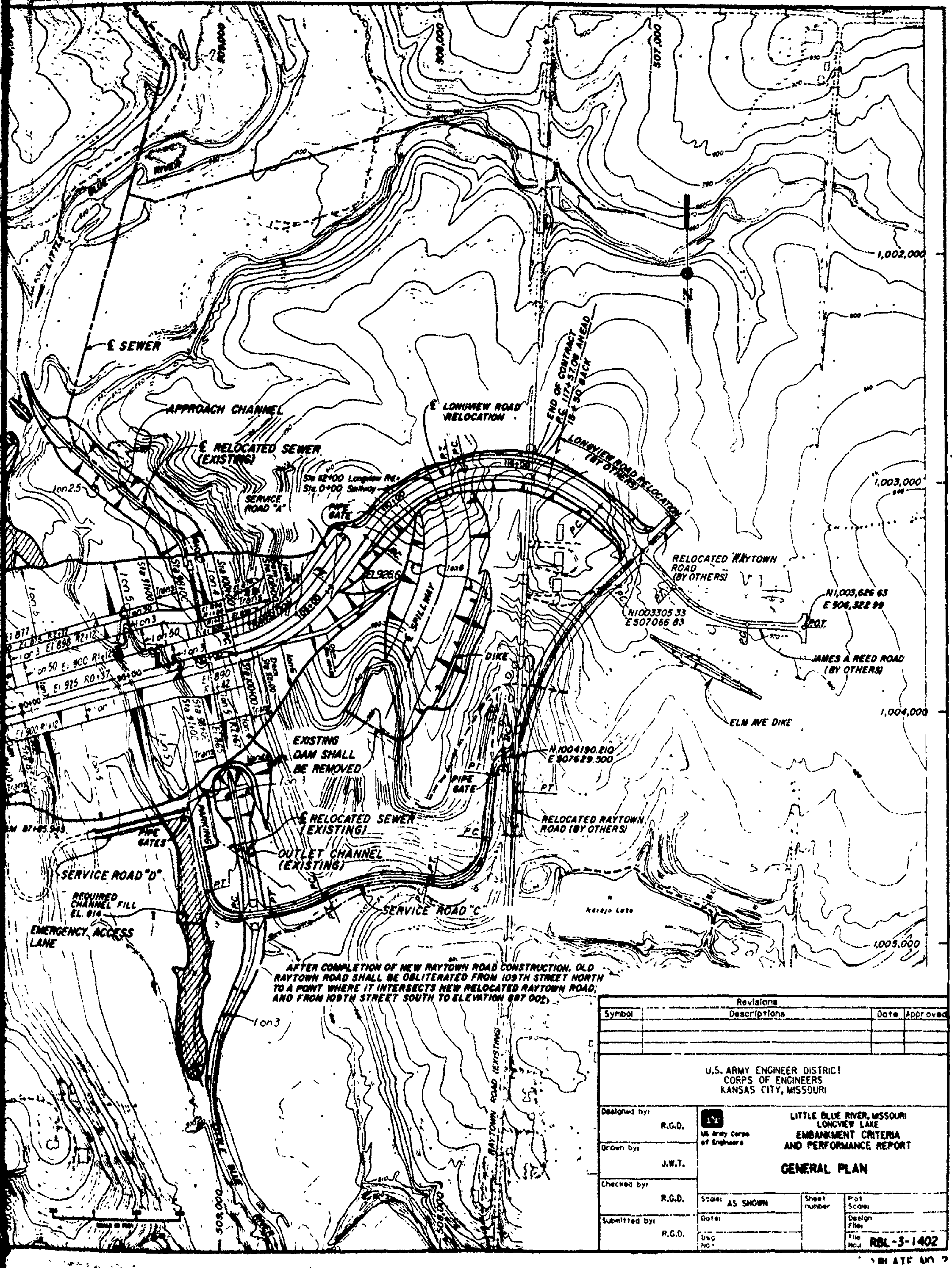

LOCATION
LONGVIEW LAKE
BLUE SPRINGS LAKE
N
POOL EL 891
CONTROL POOL
Revisions
Symbol
Descriptions
Date
Approved
U. S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI
R G D
P S T
R G D / W B E
US Army Corps of Engineers
LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA
AND PERFORMANCE REPORT
LOCATION AND VICINITY
Scale AS SHOWN
Date
Sheet number
RBL-3-1401

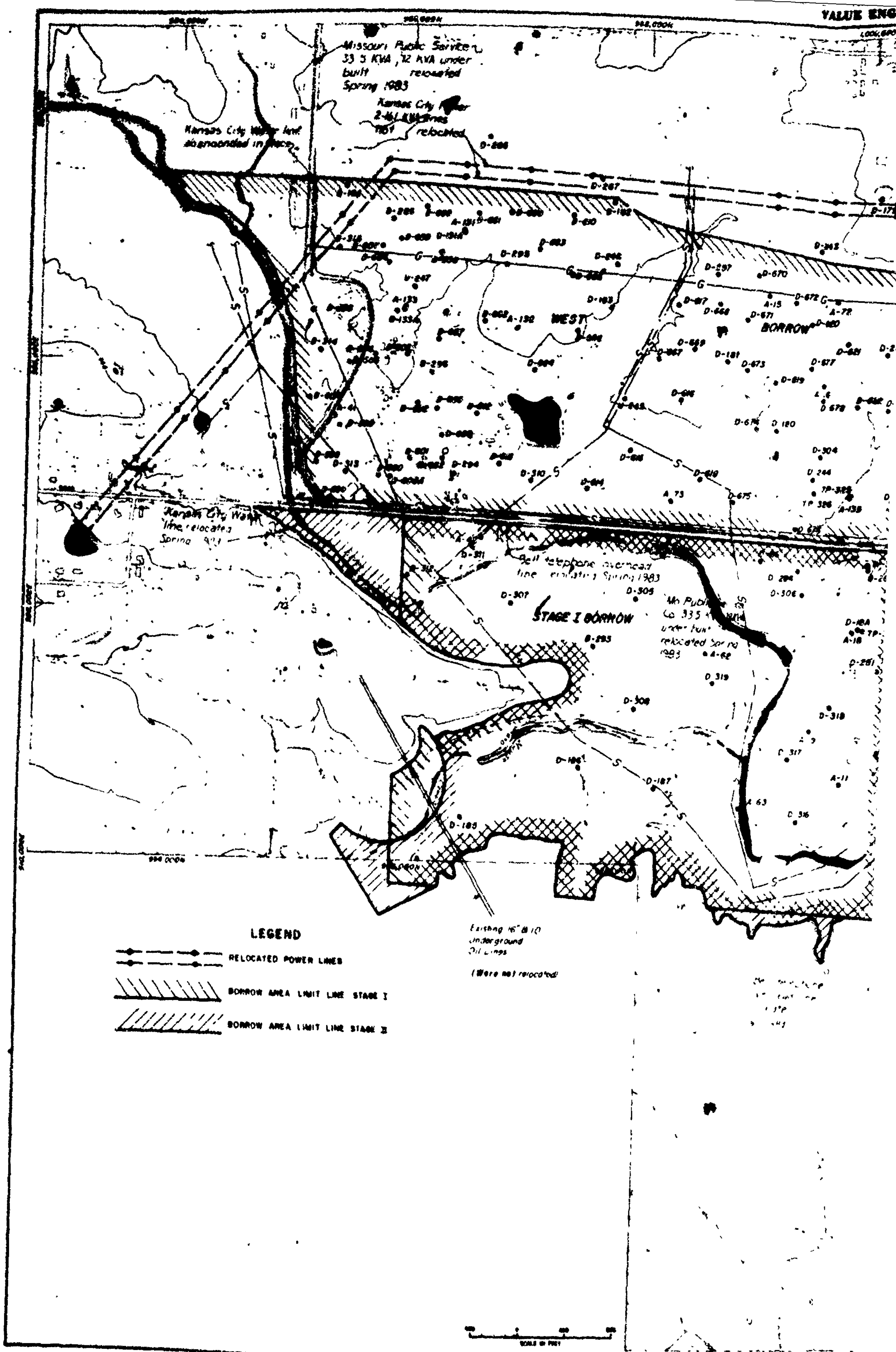
PLATE NO. 1


513,000
512,000
511,000
510,000
1,002,000
1,003,000
1,004,000
1,005,000
1,006,000
DIVERSION DIKE
REQUIRED CHANNEL FILL EL. 816
IMPERVIOUS CLAY BLANKET
EL 898
℄ 109TH ST. RELOCATION (BY OTHERS)
109th St.
EXISTING DETOUR
LONGVIEW RD CURVE DATA
BEGIN CONTRACT STA. 84+61.05
PIPE GATE
EMERGENCY
LANE

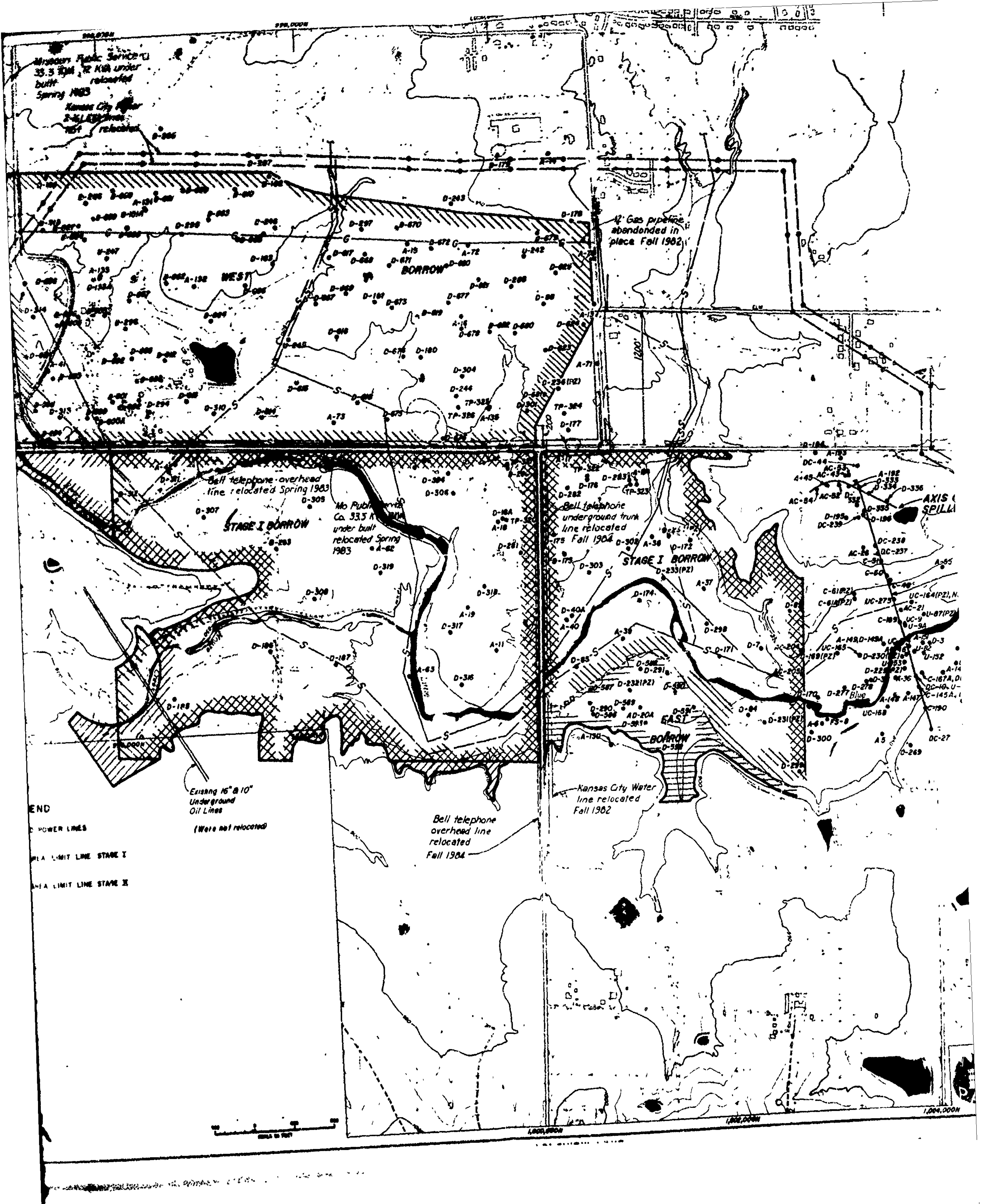

DIVERSION DIKE
REQUIRED CHANNEL FILL EL. 816
℄ SEWER
APPROACH CHANNEL
℄ RELOCATED SEWER (EXISTING)
℄ LONGVIEW ROAD RELOCATION
SERVICE ROAD "A"
PIPE GATE
IMPERVIOUS CLAY BLANKET
TRANSITION
SPILLWAY
DIKE
℄ 109TH ST. RELOCATION (BY OTHERS)
EXISTING DETOUR
LONGVIEW RD. CURVE DATA
EXISTING DAM SHALL BE REMOVED
PIPE GATE
BEGIN CONTRACT STA. 84+61.05
P I DAM 87+85.945
PIPE GATES
PARKING
℄ RELOCATED SEWER (EXISTING)
OUTLET CHANNEL (EXISTING)
SERVICE ROAD "D"
REQUIRED CHANNEL FILL EL 814
EMERGENCY ACCESS LANE
SERVICE ROAD "C"
AFTER COMPLETION OF NEW RAYTOWN ROAD CON
RAYTOWN ROAD SHALL BE OBLITERATED FROM 109
TO A POINT WHERE IT INTERSECTS NEW RELOCATED
AND FROM 109TH STREET SOUTH TO ELEVATION 8
RAYTOWN ROAD (EXISTING)
LITTLE BLUE RIVER
BLUE
SERVICE
REQUIRED CHANNEL EL. 814
ENCY AC



LITTLE BLUE RIVER
℄ SEWER
APPROACH CHANNEL
℄ RELOCATED SEWER (EXISTING)
℄ LONGVIEW ROAD RELOCATION
END OF CONTRACT P.C. 117+57.08 AHEAD 15+50 BACK
LONGVIEW ROAD RELOCATION (BY OTHERS)
Sta 52+00 Longview Rd.= Sta. 0+00 Spillway
SERVICE ROAD "A"
PIPE GATE
℄ SPILLWAY
RELOCATED RAYTOWN ROAD (BY OTHERS)
N1003305.33 E507066.83
N1,003,626.63 E506,322.99
JAMES A. REED ROAD (BY OTHERS)
DIKE
ELM AVE DIKE
N1004190.210 E507629.300
EXISTING DAM SHALL BE REMOVED
PIPE GATE
℄ RELOCATED SEWER (EXISTING)
RELOCATED RAYTOWN ROAD (BY OTHERS)
PIPE GATES
OUTLET CHANNEL (EXISTING)
SERVICE ROAD "D"
REQUIRED CHANNEL FILL EL. 816
SERVICE ROAD "C"
EMERGENCY ACCESS LANE
PARKING
Navajo Lake
RAYTOWN ROAD (EXISTING)
1,002,000
1,003,000
1,004,000
1,005,000
508,000
507,000
506,000
505,000
AFTER COMPLETION OF NEW RAYTOWN ROAD CONSTRUCTION, OLD RAYTOWN ROAD SHALL BE OBLITERATED FROM 109TH STREET NORTH TO A POINT WHERE IT INTERSECTS NEW RELOCATED RAYTOWN ROAD; AND FROM 109TH STREET SOUTH TO ELEVATION 887.00.
Revisions
Symbol
Descriptions
Date
Approved
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI
Designed by: R.G.D.
Drawn by: J.W.T.
Checked by: R.G.D.
Submitted by: R.G.D.
US Army Corps of Engineers
LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA
AND PERFORMANCE REPORT
GENERAL PLAN
Scale: AS SHOWN
Sheet number
Date:
Dwg No.:
Plot Scale:
Design File:
File No.: RBL-3-1402

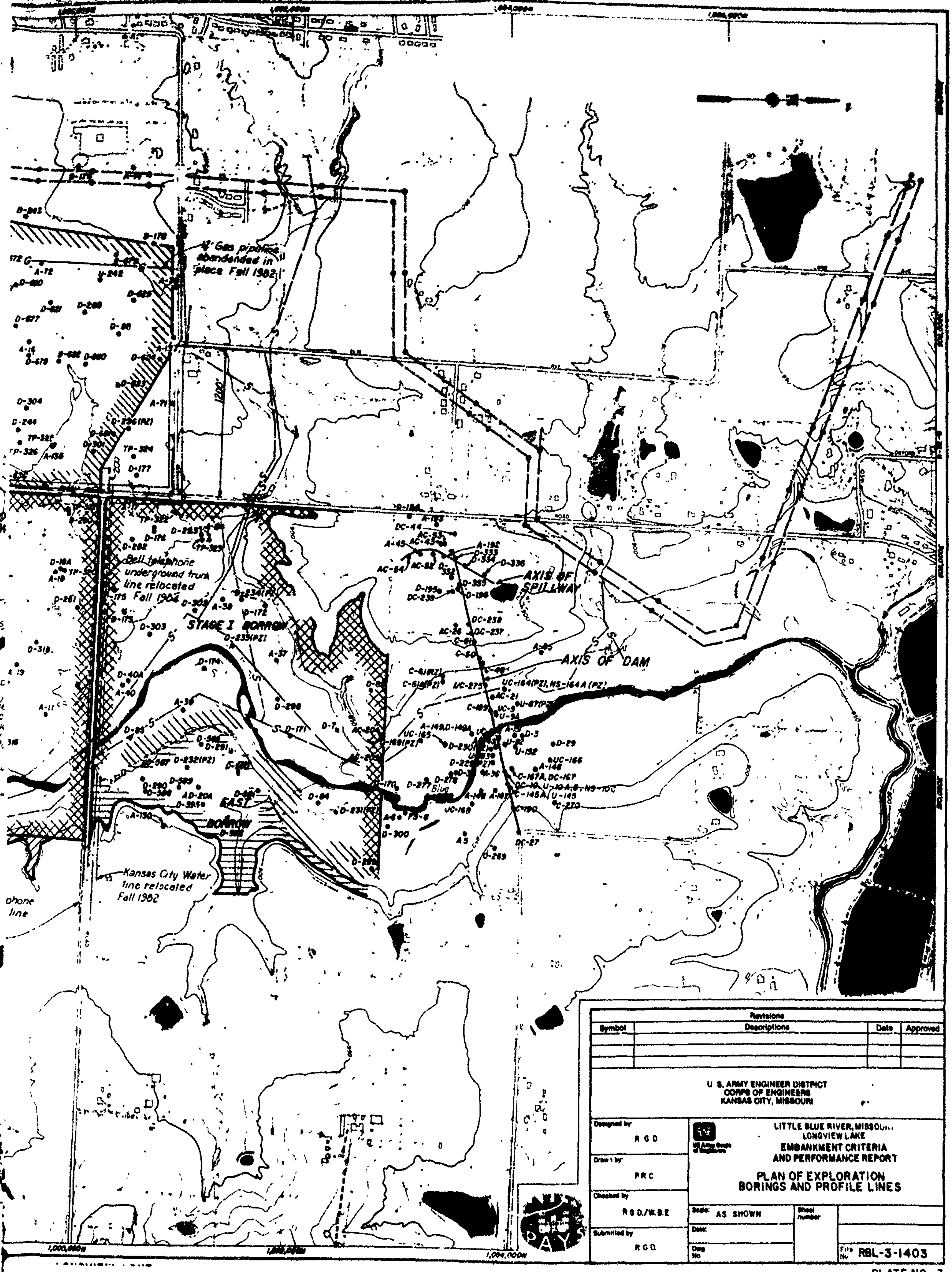


VALUE ENGIN
Missouri Public Service
33.5 KVA, 12 KVA under
built relocated
Spring 1983
Kansas City Power
2-161 KV lines
relocated
Kansas City Water line
abandoned in place
WEST
BORROW
Kansas City Water
line relocated
Bell telephone overhead
line
STAGE I BORROW
Existing 16" & 10"
Underground
Oil Lines
(Were not relocated)
LEGEND
RELOCATED POWER LINES
BORROW AREA LIMIT LINE STAGE I
BORROW AREA LIMIT LINE STAGE II
SCALE IN FEET



Missouri Public Service
33.3 KV under built relocated Spring 1983
Kansas City Power
relocated
WEST
BORROW
12" Gas pipeline abandoned in place Fall 1982
Bell telephone overhead line relocated Spring 1983
Mo Public Service Co. 33.3 KV under built relocated Spring 1983
STAGE I BORROW
Bell telephone underground trunk line relocated Fall 1984
STAGE I BORROW
EAST
BORROW
AXIS
SPILL
Existing 16" & 10" Underground Oil Lines
(Were not relocated)
Bell telephone overhead line relocated Fall 1984
Kansas City Water line relocated Fall 1982
END
POWER LINES
AREA LIMIT LINE STAGE I
AREA LIMIT LINE STAGE II
1,000,000N
1,002,000N
1,004,000N

VALUE ENGINEERING PAYS

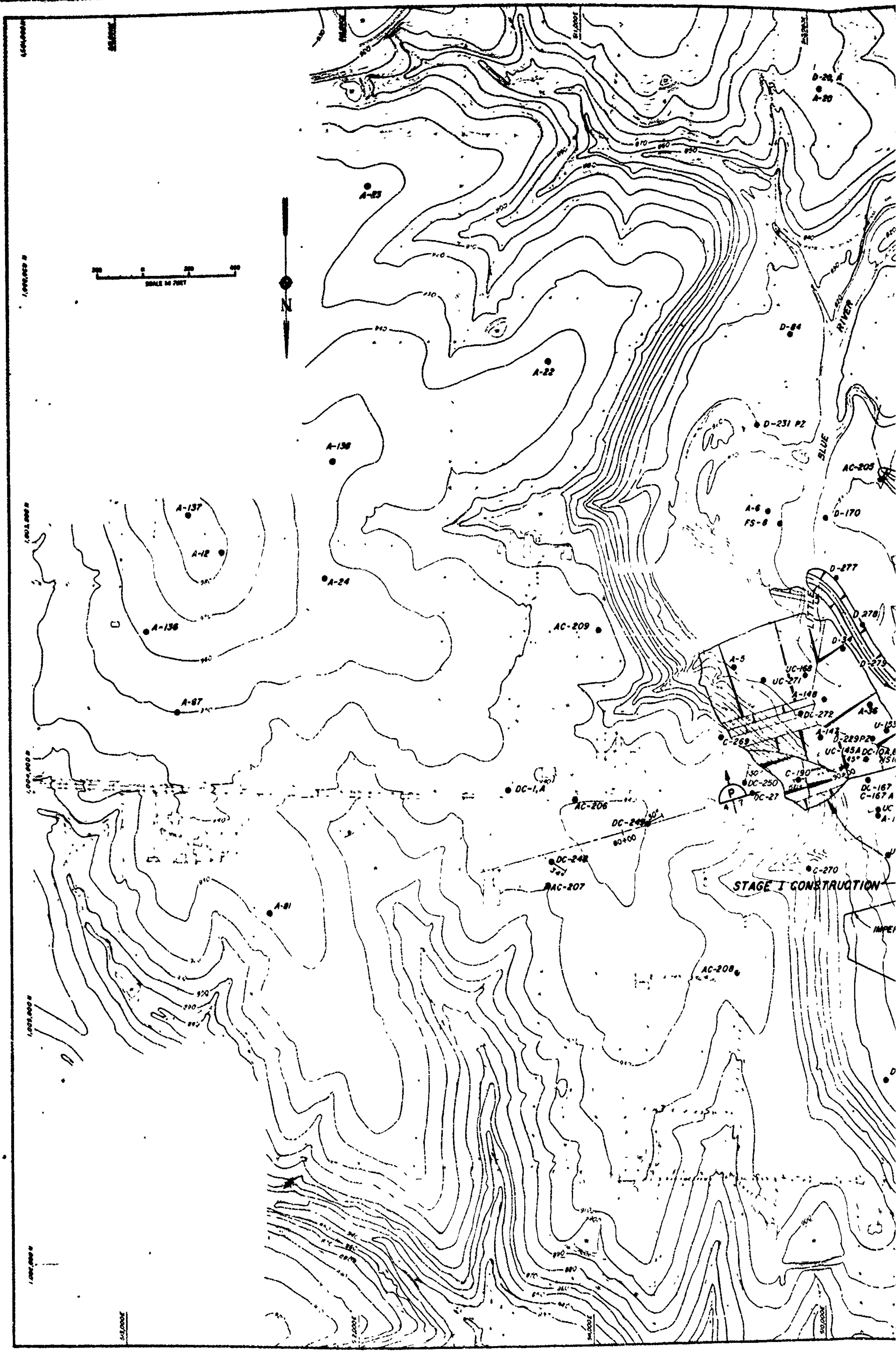


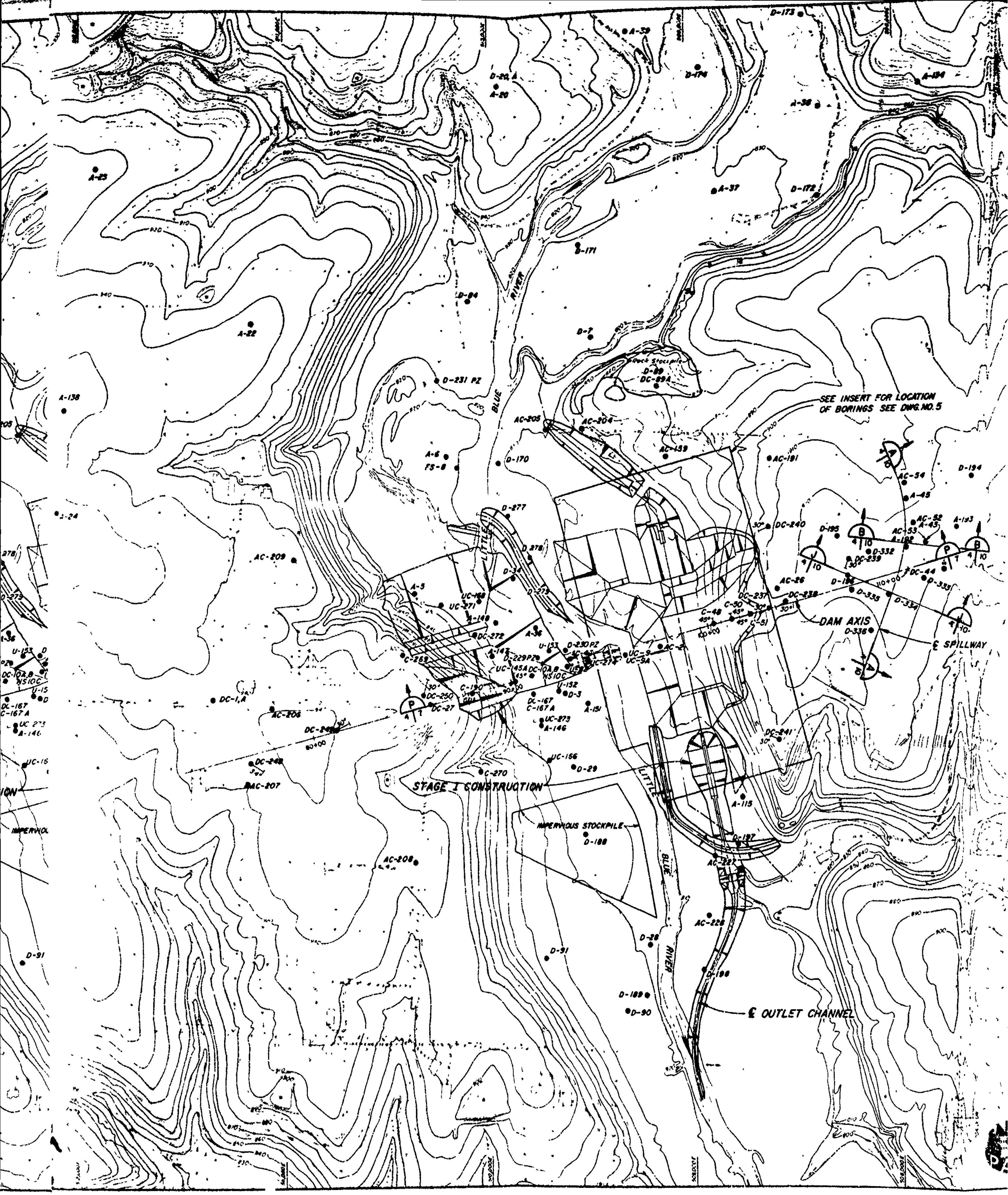
Revisions			
Symbol	Descriptions	Date	Approved

U. S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

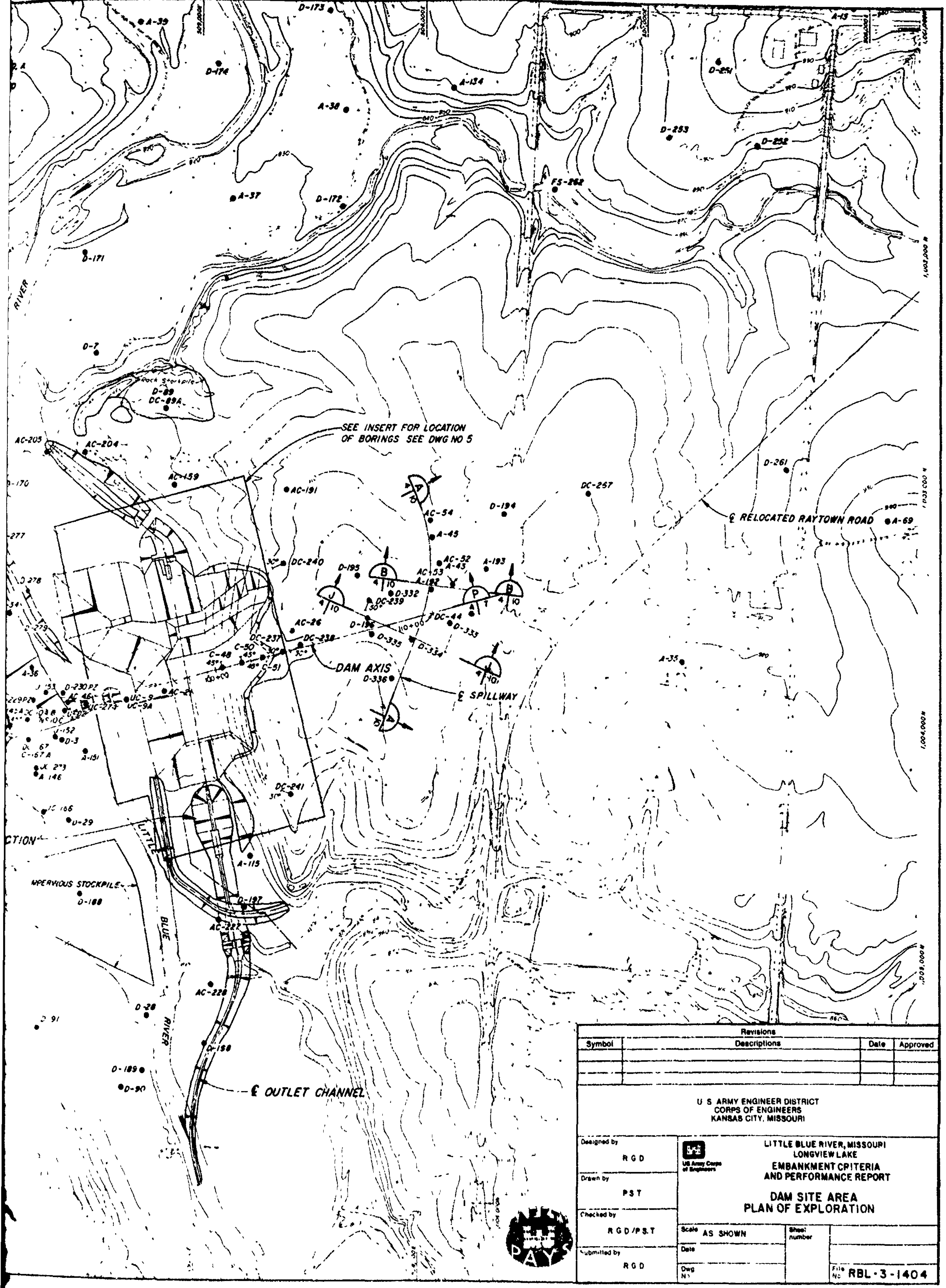
Designed by: RGD	LITTLE BLUE RIVER, MISSOURI LONGVIEW LAKE EMBANKMENT CRITERIA AND PERFORMANCE REPORT
Drawn by: PRC	PLAN OF EXPLORATION BORINGS AND PROFILE LINES
Checked by: RGD/W.B.E	Scale: AS SHOWN — Sheet number:
Submitted by: RGD	Date: — Dwg No: — File No: RBL-3-1403

PLATE NO. 3


N
SCALE IN FEET
A-23
A-22
A-138
A-137
A-12
A-24
A-136
A-87
A-81
AC-209
AC-206
AC-207
AC-208
AC-205
D-84
D-231 PZ
A-6
FS-8
D-170
D-277
D-278
BLUE
RIVER
LITTLE
A-5
UC-168
UC-271
A-148
DC-272
C-269
DC-1,A
DC-250
DC-27
C-190
DC-167
C-167A
DC-248
C-270
STAGE I CONSTRUCTION



SEE INSERT FOR LOCATION OF BORINGS SEE DWG. NO. 5
DAM AXIS
℄ SPILLWAY
STAGE I CONSTRUCTION
IMPERVIOUS STOCKPILE
℄ OUTLET CHANNEL
LITTLE BLUE RIVER
LITTLE
BLUE
RIVER
Rock Stockpile
D-173
A-39
D-174
A-194
A-38
D-20, A
A-20
A-23
A-37
D-172
D-171
D-84
A-22
D-7
D-89
DC-89A
D-231 PZ
A-138
AC-205
AC-204
AC-159
AC-191
A-6
FS-6
D-170
D-194
AC-54
A-45
D-277
DC-240
D-195
AC-52
AC-53
A-192
A-193
D-332
DC-239
AC-209
A-5
UC-168
UC-271
D-34
AC-26
D-136
DC-238
DC-237
D-335
D-334
D-333
DC-44
C-48
C-50
C-51
D-336
A-149
DC-272
A-36
D-230 PZ
D-229 PZ
UC-145A
DC-10A,B
NS10C
UC-9
UC-9A
C-259
C-190
DC-250
DC-27
DC-1,A
AC-206
U-152
D-3
DC-167
C-167A
A-151
UC-273
A-146
DC-241
UC-156
D-29
C-270
DC-248
AC-207
A-115
D-188
D-197
AC-227
AC-208
AC-228
D-91
D-28
D-196
D-189
D-90
A-24
100+00
110+00
80+00

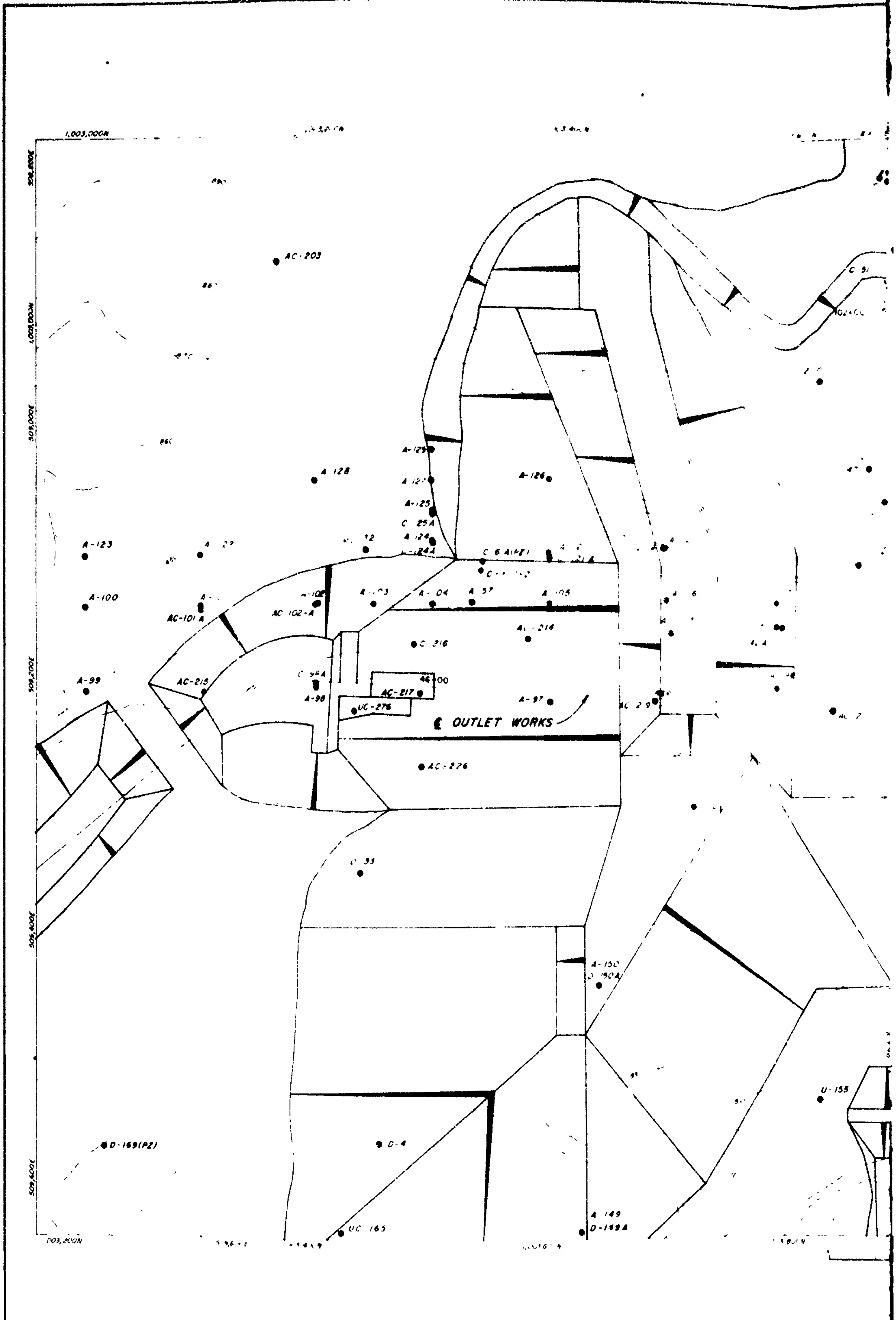


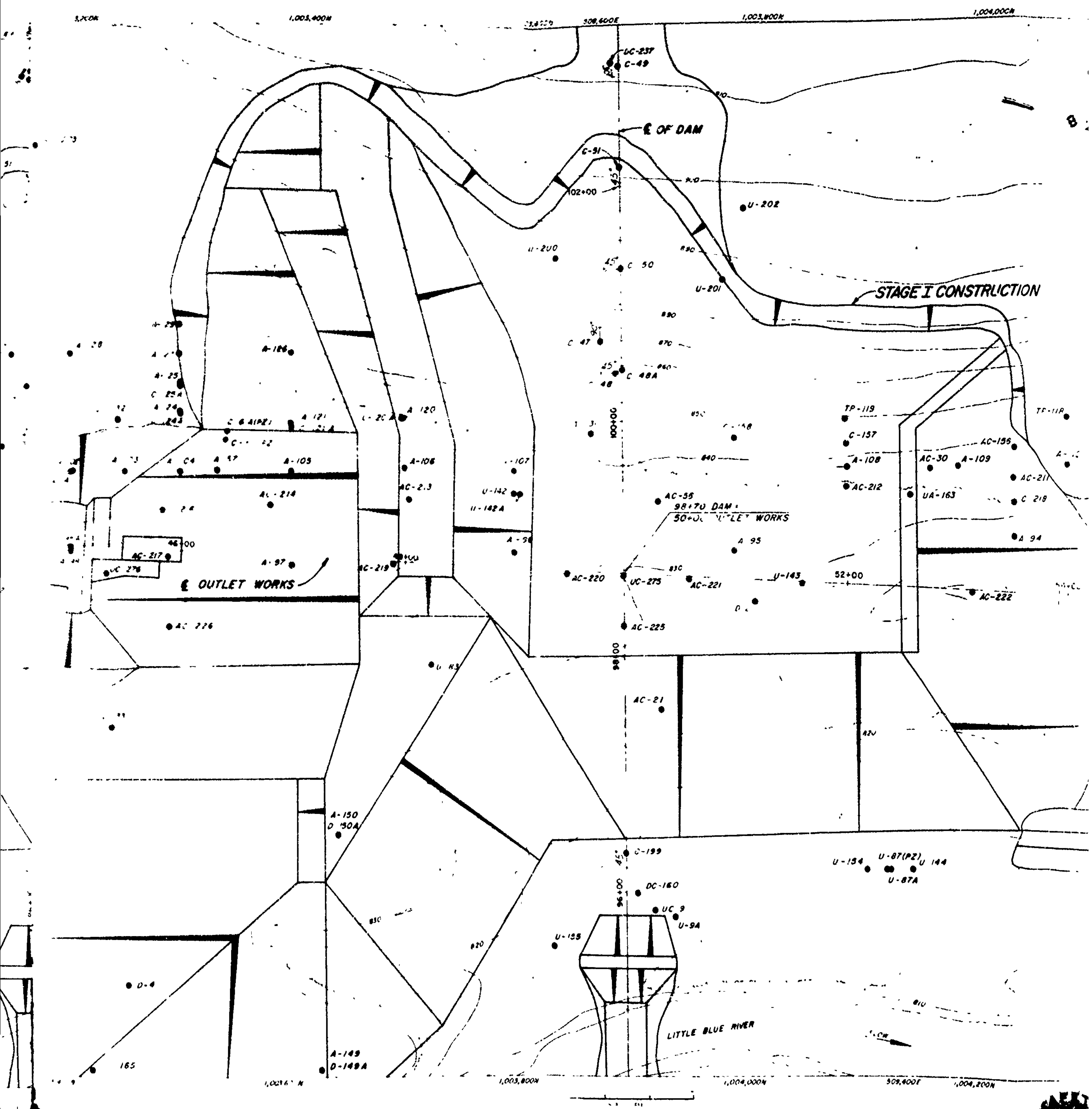
Revisions			
Symbol	Descriptions	Date	Approved

U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

Designed by RGD	US Army Corps of Engineers — LITTLE BLUE RIVER, MISSOURI LONGVIEW LAKE EMBANKMENT CRITERIA AND PERFORMANCE REPORT
Drawn by PST	DAM SITE AREA PLAN OF EXPLORATION
Checked by RGD/PST	Scale AS SHOWN · Sheet number
Submitted by RGD	Date · Dwg No · File No RBL-3-1404

PLATE NO 4


1,003,000N
AC-203
A-129
A 128
A-126
A-125
A-123
A-100
AC-101 A
AC 102-A
C 216
AC-214
A-99
AC-215
A-98
UC-276
AC-217
A-97
OUTLET WORKS
AC-276
D-169(PZ)
D-4
UC 165
A-150
D-150A
A 149
D-149A
U-155
003,200N



1,003,400N
1,003,800N
1,004,000N
309,600E
UC-237
C-49
℄ OF DAM
C-51
102+00
U-202
U-200
C 50
U-201
STAGE I CONSTRUCTION
C 47
C 48A
A-186
A 120
A-105
A-106
AC-214
A-97
℄ OUTLET WORKS
AC-219
U-142
U-142A
AC-55
98+70 DAM
A 95
AC-220
UC-275
AC-221
U-143
52+00
AC-222
AC-225
TP-119
C-157
A-108
AC-212
AC-30
A-109
AC-155
AC-211
UA-163
C 218
A 94
AC-217
AC 226
AC-21
A-150
D 150A
C-199
DC-160
UC 9
U-9A
U-155
U-154
U-87(PZ)
U 144
U-87A
D-4
LITTLE BLUE RIVER
A-149
D-149A
165
1,003,800N
1,004,000N
309,400E
1,004,200N

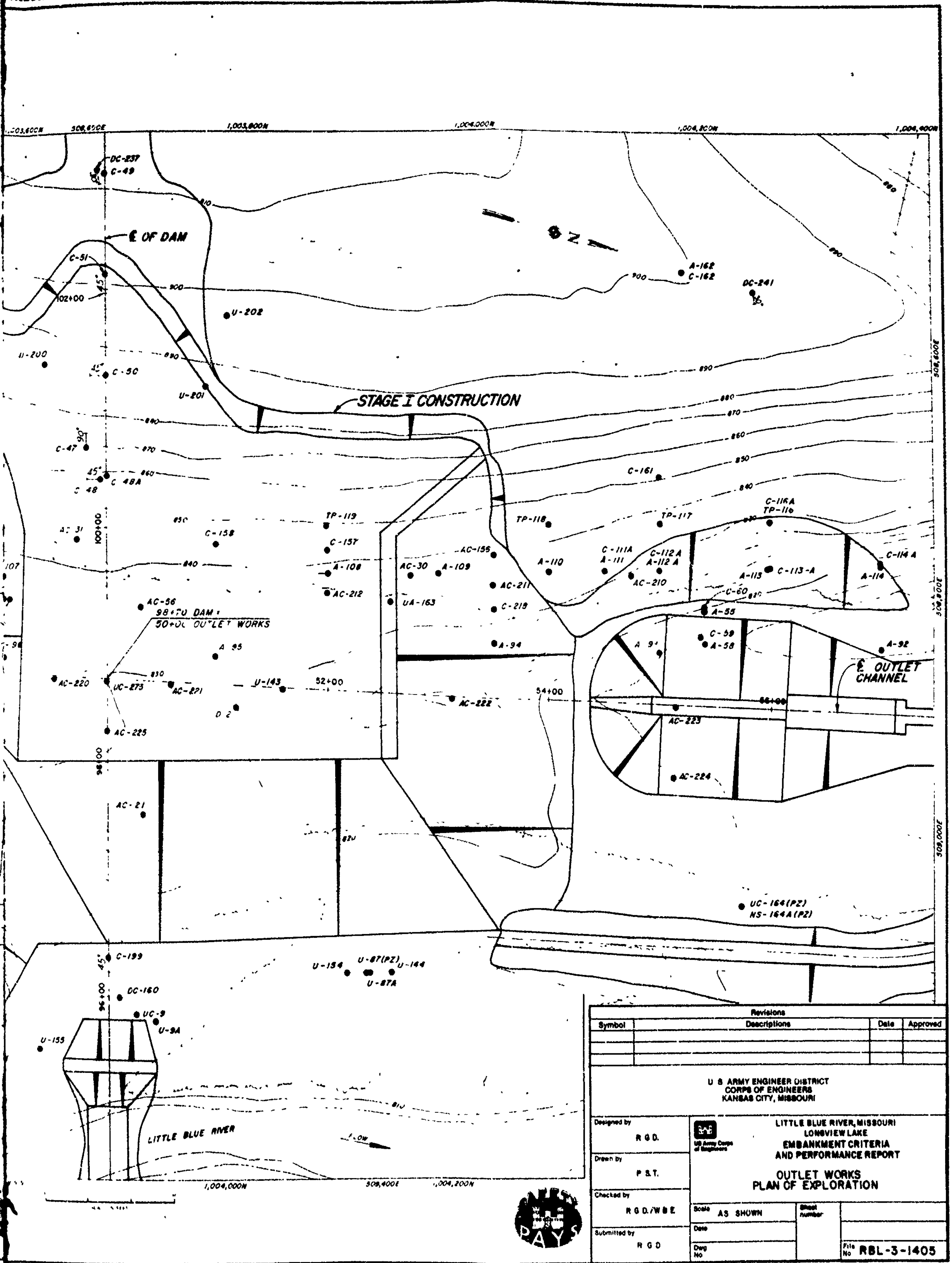

℄ OF DAM
STAGE I CONSTRUCTION
98+70 DAM =
50+00 OUTLET WORKS
℄ OUTLET
CHANNEL
LITTLE BLUE RIVER
FLOW
1,003,600N
1,003,800N
1,004,000N
1,004,200N
1,004,400N
1,004,000N
509,400E
508,600E
508,800E
509,000E
102+00
100+00
98+00
96+00
52+00
54+00
56+00
900
890
880
870
860
850
840
830
820
810
C-51
C-50
C-49
DC-237
U-200
U-201
U-202
C-47
C-48
C 48A
AC 31
C-158
TP-119
C-157
A-108
AC-212
AC-30
A-109
AC-155
AC-211
C-215
A-94
UA-163
AC-56
A 95
AC-220
UC-273
AC-221
U-143
D 2
AC-222
AC-225
AC-21
TP-118
A-110
C-111A
A-111
C-112 A
A-112 A
AC-210
TP-117
C-116A
TP-116
A-113
C-113-A
C-114 A
A-114
C-60
A-55
C-59
A-58
A-92
AC-223
AC-224
A-162
C-162
DC-241
C-161
UC-164(PZ)
NS-164A(PZ)
C-199
DC-160
UC-9
U-9A
U-155
U-154
U-87(PZ)
U-87A
U-144
Revisions
Symbol
Descriptions
Date
Approved
U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI
Designed by
R G D.
Drawn by
P S.T.
Checked by
R G D./W B E
Submitted by
R G D
LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA
AND PERFORMANCE REPORT
OUTLET WORKS
PLAN OF EXPLORATION
Scale AS SHOWN
Sheet number
Date
Dwg No
File No RBL-3-1405
VALUE ENGINEERING PAYS

PLATE NO. 5

GENERAL GEOLOGIC COLUMN

SYSTEM	GROUP	FORMATION	MEMBER OR ZONE	SYMBOL	APPROX. THICKNESS	GENERALIZED DESCRIPTION
PENNSYLVANIAN	KANSAS CITY	[illegible]	WESTERVILLE	[illegible]	[illegible]	LIMESTONE [illegible]
			[illegible]	[illegible]	[illegible]	SHALE [illegible] ARGILLACEOUS LIMESTONE [illegible]
			[illegible]	[illegible]	[illegible]	LIMESTONE [illegible]
			FONTANA	[illegible]	[illegible]	SHALE [illegible]
		DENNIS	[illegible]	[illegible]	[illegible]	LIMESTONE [illegible]
			STARK	[illegible]	[illegible]	SHALE [illegible]
		GALESBURG				
		SWOPE	BETHANY FALLS	[illegible]	[illegible]	LIMESTONE [illegible]
			HUSHPUCKNEY	[illegible]	[illegible]	SHALE [illegible]
			MIDDLE CREEK	[illegible]	[illegible]	LIMESTONE [illegible]
		LADORE		[illegible]	[illegible]	SHALE [illegible]
		HERTHA	SNIABAR	[illegible]	[illegible]	LIMESTONE [illegible]
			MOUND CITY	[illegible]	[illegible]	SHALE [illegible]
			[illegible]	[illegible]	[illegible]	SHALE [illegible] LIMESTONE [illegible]
	PLEASANTON	UNDIFFERENTIATED	ZONE [illegible]	[illegible]	[illegible]	LIMESTONE [illegible]
			ZONE [illegible]	[illegible]	[illegible]	SHALE [illegible]
			ZONE [illegible]	[illegible]	[illegible]	ARGILLACEOUS [illegible]
			ZONE [illegible]	[illegible]	[illegible]	ARGILLACEOUS [illegible]
			ZONE [illegible]	[illegible]	[illegible]	ARGILLACEOUS LIMESTONE [illegible]
			ZONE [illegible]	[illegible]	[illegible]	SHALE [illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible] moderately hard, thin bedded, gray [illegible]
			[illegible]	[illegible]	[illegible]	SHALE [illegible] moderately hard, thin bedded to massive, dark gray to black [illegible] beds

* Maximum thickness [illegible] thickness not penetrated

...IC COLUMN

GENERALIZED DESCRIPTION

... crystalline to cryptocrystalline, medium to thick bedded, fossiliferous ...

... brown, sticky clayey to silty, calcareous, dark grey ...

... moderately hard dense to finely crystalline ...

... thin beds of dark grey shale ...

... thin partings and occasional thin beds of dark grey shale ...

... moderately hard, thin bedded, grey to dark grey with ...

... thin bedded to massive, dark grey to black, ...

UNIFIED SOIL CLASSIFICATION SYSTEM

GW	Well graded gravels, gravel sand mixtures, little or no fines	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts w. slight plasticity
GP	Poorly graded gravels or gravel sand mixtures, little or no fines	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
GM	Silty gravels, gravel sand silt mixtures	OL	Organic silts and organic silty clays of low plasticity
GC	Clayey gravels, gravel sand clay mixtures	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
SW	Well graded sands, gravelly sands, little or no fines	CH	Inorganic clays of high plasticity, fat clays
SP	Poorly graded sands or gravelly sands, little or no fines	OH	Organic clays of medium to high plasticity, organic silts
SM	Silty sands, sand silt mixtures	Pt	Peat and other highly organic soils
SC	Clayey sands, sand clay mixtures		

Classification from actual laboratory tests where LL and PI are shown.
Dual classification where used is in accordance with the Unified Soil Classification System.
For details on the Unified Soil Classification System, see Waterways Experiment Station Technical Memorandum No. 3 357 dated March 1953 and revised in 1960.

TERMS FOR CONSISTENCY OF SOIL AND HARDNESS OF BEDROCK

SOIL

Consistency	Estimated Unconfined Compressive Strength (Tons per square foot)
Very soft	< 0.25
Soft	0.25 - 0.5
Medium	0.5 - 1.0
Stiff	1.0 - 2.0
Very stiff	2.0 - 4.0
Hard	> 4.0

BEDROCK
SCALE OF HARDNESS

Very soft or plastic	Can be indented easily with thumb
Soft	Can be scratched with fingernail
Moderately hard	Can be scratched easily with knife; cannot be scratched with fingernail
Hard	Difficult to scratch with knife
Very hard	Cannot be scratched with knife

LEGEND FOR L...

Plasticity index
Liquid limit
Hole number
*Offset to Station and Range in Mi & Coordinates
Vertical Angle and Direction
Elevation of (Detached) Boring

Moisture content - per cent
Elevation and date (elapsed time after drilling) water level observed
Water Depth encountered during drilling
Unified soil classification determined in laboratory
Field classification only
Sample
... Recovery ... Borings
Percent Lost Drill Water
Lost Core (Bedrock)
Percent core recovered in bedrock
Drilling completion date
Diameter of sample
*Offset from profile or section may be Upstream ... or Riverward (Land or River) or Right or Left ...

TYPE OF ...

MAP SYMBOL

● Vertical boring
● Inclined boring showing direction and vertical angle

ABBREVIATIONS

[illegible]	[illegible]	dmp	damp	lea	leached	rnd (d)	round (rounded)
[illegible]	[illegible]	[illegible]	[illegible]	lg	lignite	sat	saturated
[illegible]	[illegible]	ext	extremely	ls	limestone	scat	scattered
[illegible]	[illegible]	[illegible]	fine (finely)	lt	light	sd (y)	sand (sandy)
[illegible]	... bedding	fe	[illegible]	[illegible]	[illegible]	sev	several
[illegible]	[illegible]	[illegible]	[illegible]	L C	lost core	sh (y)	shale (shaly)
bky	blocky	fm	[illegible]	L D W	lost drill water	s (y)	silt (silty)
b	blue	fos (s)	fossil (fossiliferous)	med	medium	sls	siltstone
[illegible]	boulder	frac (d)	fractures (fractured)	mic	micaceous	sl	slightly
[illegible]	[illegible]	frag (d)	fragment (fragmented)	min	mineralized	slcs	siliceous
[illegible]	... brecciated	fr	friable	mod (ly)	moderate (moderately)	slks	slickensides
[illegible]	[illegible]	[illegible]	[illegible]	mot	mottled	so	soft
[illegible]	brown	gr	grain	mss	massive	sol (d)	solution (solutionized)
[illegible]	[illegible]	gra	gradation	mst	[illegible]	ss	sandstone
[illegible]	calcareous	grn	green	mtl	material	st (g)	stained (staining)
[illegible]	carbonaceous	grv (y)	gravel (gravelly)	mtx	matrix	stf	stiff
[illegible]	[illegible]	gry	gray	nod	nodules	sty	stylolitic
[illegible]	cobble	gyp	gypsum	num	numerous	v	very
[illegible]	[illegible]	ha	high angle	occ (ly)	occasional (occasionally)	vert	vertical
[illegible]	...cavation	hd	hard	op	open	vgy	vuggy
[illegible]	clay (clayey)	hld	healed	or	orange	w	water
[illegible]	closed	hor	horizontal	org	organic	w	with
[illegible]	cemented	intbd	interbedded	par	partially	wth	weathered
[illegible]	[illegible]	incl	inclusions	pt	pit, pitted, pitting	wht	white
[illegible]	concretions	interlam	interlaminated	pl	plast	x bdd	crossed bedded
[illegible]	conglomerate	irr	irregular	pla	platy	xln	crystalline
[illegible]	crumbly	jts	joints	pln	plane	y	yellow
d	dense	la	low angle	ptg (s)	parting (partings)	When used as log symbol	
dk	dark	lam (d)	laminae (laminated)	qtz (ite)	quartz (quartzite)	first letter is capitalized	

Symbol	

Designed by
Drawn by
Checked by
Submitted by

PAYS

UNIFIED SOIL CLASSIFICATION SYSTEM

GW	Well graded gravels gravel sand mixtures, little or no fines	ML	Inorganic silts and very fine sands rock flour, silty or clayey fine sands or clayey silts w slight plasticity
GP	Poorly graded gravels or gravel sand mixtures little or no fines	CL	Inorganic clays of low to medium plasticity gravelly clays sandy clays silty clays, lean clays
GM	Silty gravels, gravel sand silt mixtures	OL	Organic silts and organic silty clays of low plasticity
GC	Clayey gravels gravel sand clay mixtures	MH	Inorganic silts micaceous or diatomaceous fine sandy or silty soils elastic silts
SW	Well-graded sands gravelly sands little or no fines	CH	Inorganic clays of high plasticity fat clays
SP	Poorly graded sands or gravelly sands little or no fines	OH	Organic clays of medium to high plasticity organic silts
SM	Silty sands sand silt mixtures	Pt	Peat and other highly organic soils
SC	Clayey sands sand clay mixtures		

Classification from actual laboratory tests where LL and PI are shown
Dual classification where used is in accordance with the Unified Soil Classification System
For details on the Unified Soil Classification System See Waterways Experiment Station Technical Memorandum No 3 357 dated March 1953 and revised in 1960

TERMS FOR CONSISTENCY OF SOIL AND HARDNESS OF BEDROCK

SOIL

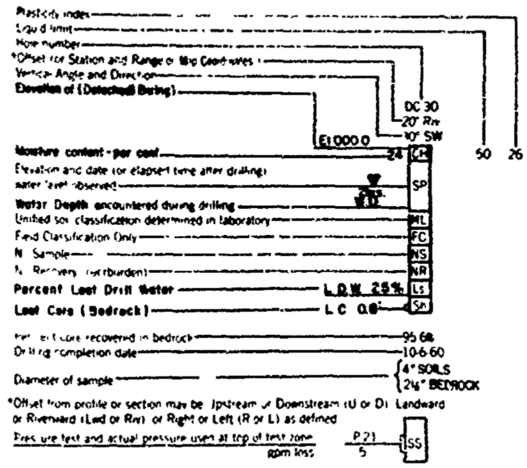
Consistency	Estimated Unconfined Compressive Strength Tons per square foot
Very soft	< 0 25
Soft	0 25 0 5
Medium	0 5 1 0
Stiff	1 0 2 0
Very stiff	2 0 4 0
Hard	> 4 0

BEDROCK

SCALE OF HARDNESS

Very soft or plastic	Can be indented easily with thumb
Soft	Can be scratched with fingernail
Moderately hard	Can be scratched easily with knife Cannot be scratched with fingernail
Hard	Difficult to scratch with knife
Very hard	Cannot be scratched with knife

LEGEND FOR LOGS OF BORINGS



TYPE OF EXPLORATION

MAP SYMBOL	CODE DESIGNATION
● Vertical boring	D Drive sample hole
30° ● Inclined boring showing direction and vertical angle	C Core hole
	TP Test pit (includes power auger 24" or larger diameter)
	U Undisturbed sample hole
	A Auger hole hand or power auger less than 24" diameter
	NS Not Sampled (Field Classification from cuttings only)
	FS Field Section of outcrop
	VC Visual Classification

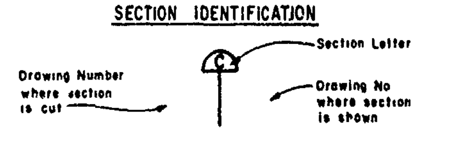
ABBREVIATIONS

[illegible]	alternating	dmp	damp	rea	reached	rnd (d)	round (rounded)
[illegible]	[illegible]	dol (c)	dolomite (dolomitic)	lig	lignite	sat	saturated
[illegible]	anhydrite	ext	extremely	ls	limestone	scat	scattered
[illegible]	argillaceous	f (y)	fine (finely)	lt	light	sd (y)	sand (sandy)
[illegible]	[illegible] bedded bedding	fe	iron	lo	loose	sev	several
[illegible]	[illegible]	fld	filled	LC	lost core	sh (y)	shale shaly
[illegible]	[illegible]	fm	firm	LDW	lost drill water	si (ty)	silt (silty)
[illegible]	blue	fos (s)	fossil (fossiliferous)	med	medium	sls	siltstone
[illegible]	boulder	frac (d)	fractures (fractured)	mic	micaceous	sl	slightly
[illegible]	[illegible]	frag (d)	fragments (fragmented)	min	mineralized	slcs	siliceous
[illegible]	brecciated	fr	friable	mod (ly)	moderate (moderately)	slks	slickensides
[illegible]	[illegible]	fs	fissile	mot	mottled	so	soft
[illegible]	brown	gr	grain	mss	massive	so (d)	solution (solutioned)
[illegible]	[illegible]	gra	gradation	mst	moist	ss	sandstone
[illegible]	calcareous	grn	green	mtl	material	st'g	stained staining
[illegible]	carbonaceous	grv (y)	gravel (gravelly)	mtx	matrix	stf	stiff
[illegible]	cavity	gry	gray	nod	nodules	sty	stylolite
[illegible]	[illegible]	gyp	gypsum	num	numerous	v	very
[illegible]	chert	ha	high angle	occ (ly)	occasional (occasionally)	vert	vertical
[illegible]	circulation	hd	hard	op	open	vgy	vuggy
[illegible]	clay (clayey)	hld	healed	or	orange	w	water
[illegible]	[illegible]	hor	horizontal	org	organic	w	with
[illegible]	cemented	ibd	interbedded	par	partially	wth	weathered
[illegible]	columnar	inc	inclusions	pit	pit pitted pitting	wht	white
[illegible]	concretions	ilam	interlaminated	pl	plastic	xbdd	crossed bedded
[illegible]	conglomerate	irr	irregular	pla	platy	xln	crystalline
[illegible]	crumbly	jt (s)	joint (joints)	pln	plane	y	yellow
[illegible]	dense	la	low angle	ptg (s)	parting (partings)	When used as log symbol first letter is capitalized	
[illegible]	dark	lam (d)	lamina (laminated)	qtz (e)	quartz quartzite		

BEDROCK UNIT THICKNESS

Parting	<0 02'
Band	0 02 to 0 2'
Thin bed	0 2 to 0 5'
Medium bed	0 5 to 1 0'
Thick bed	1 0 to 2 0'
Massive	>2 0'

SECTION IDENTIFICATION

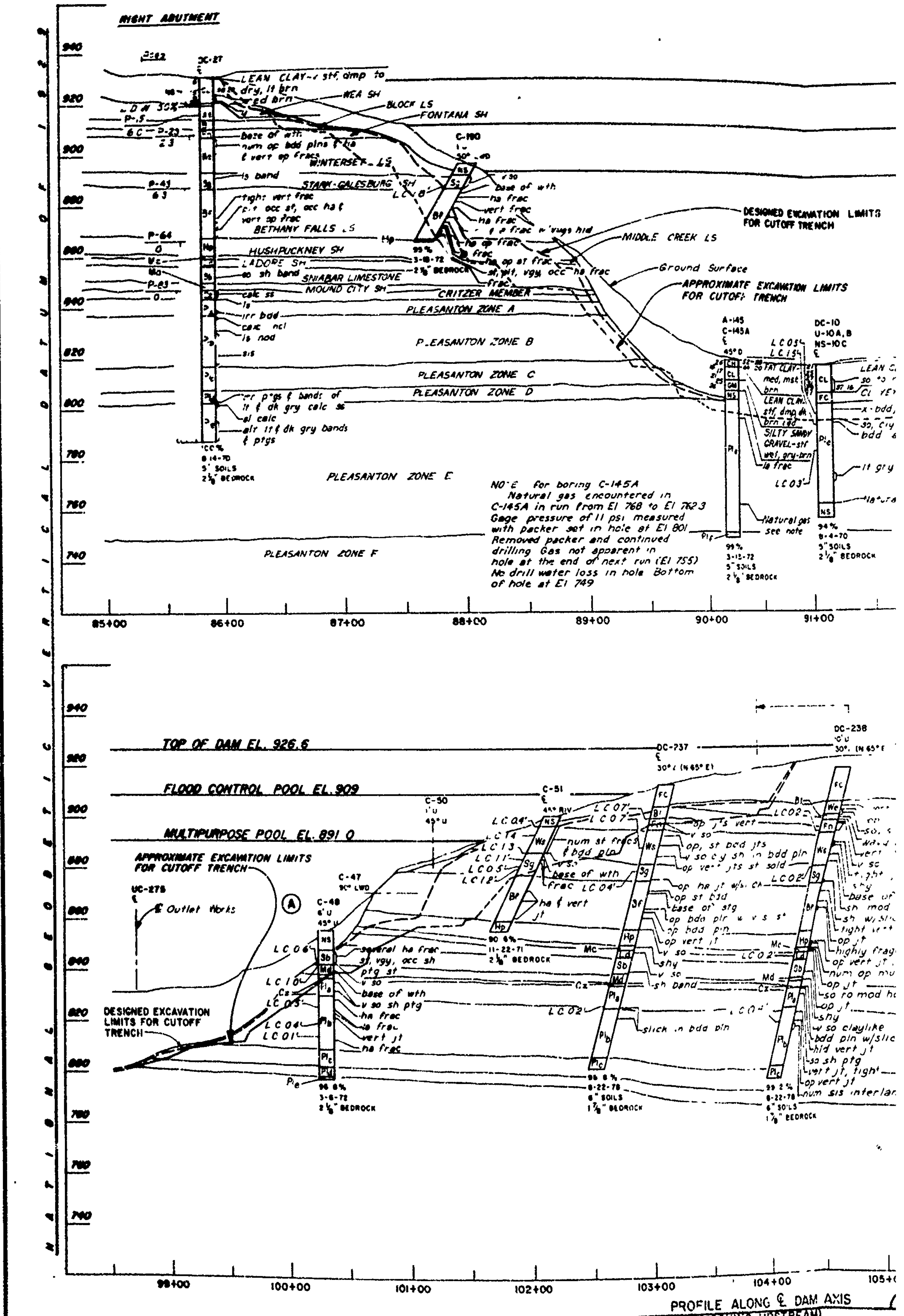


Revisions			
Symbol	Descriptions	Date	Approved

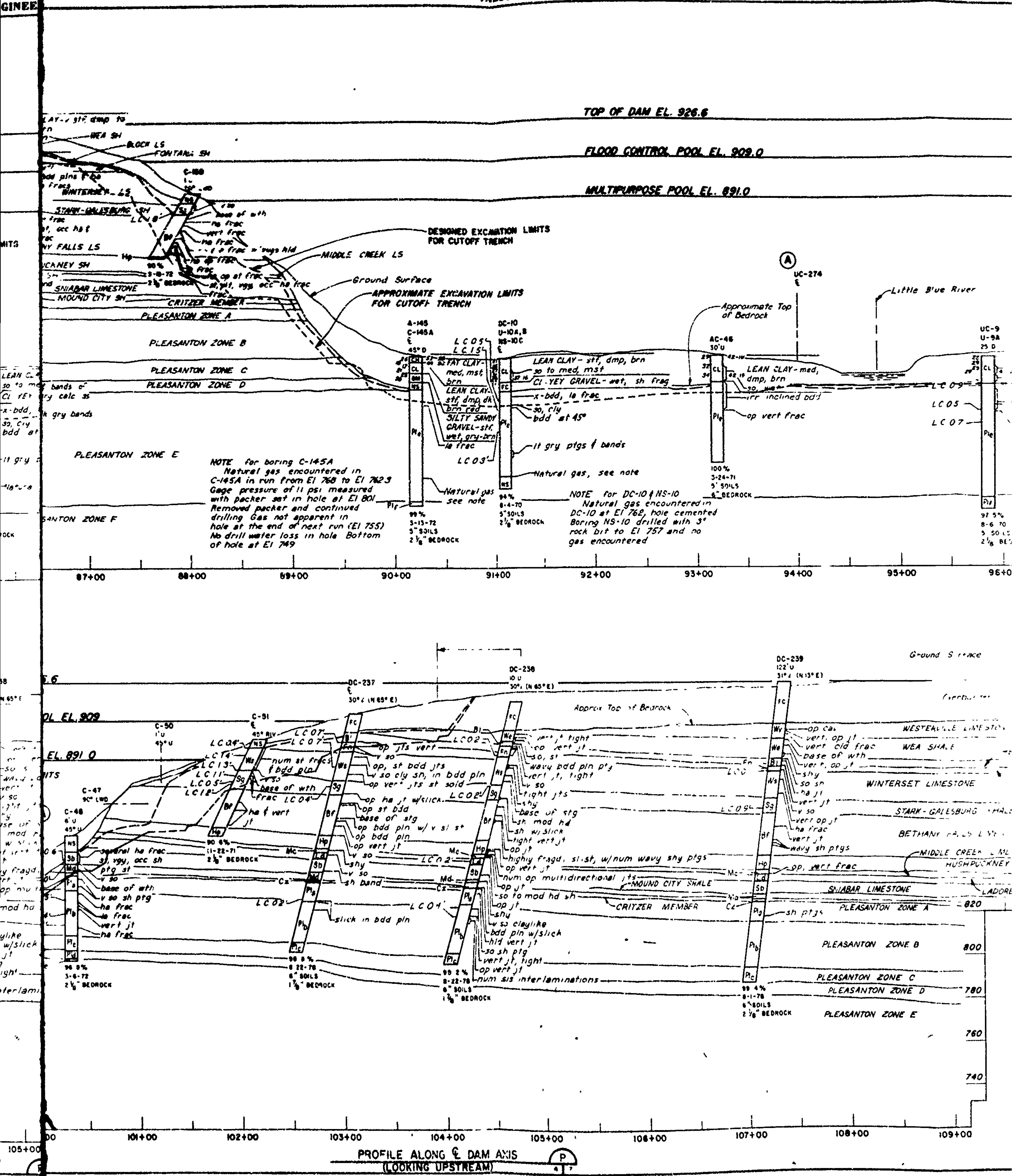
U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

Designed by R. G. D.	LITTLE BLUE RIVER, MISSOURI LONGVIEW LAKE EMBANKMENT CRITERIA AND PERFORMANCE REPORT
Drawn by P R C	GENERAL GEOLOGIC COLUMN & LEGEND
Checked by R G D/W B E	Scale AS SHOWN / Sheet number
Submitted by R G D	Date / Dwg No / File No RBL-3-1406

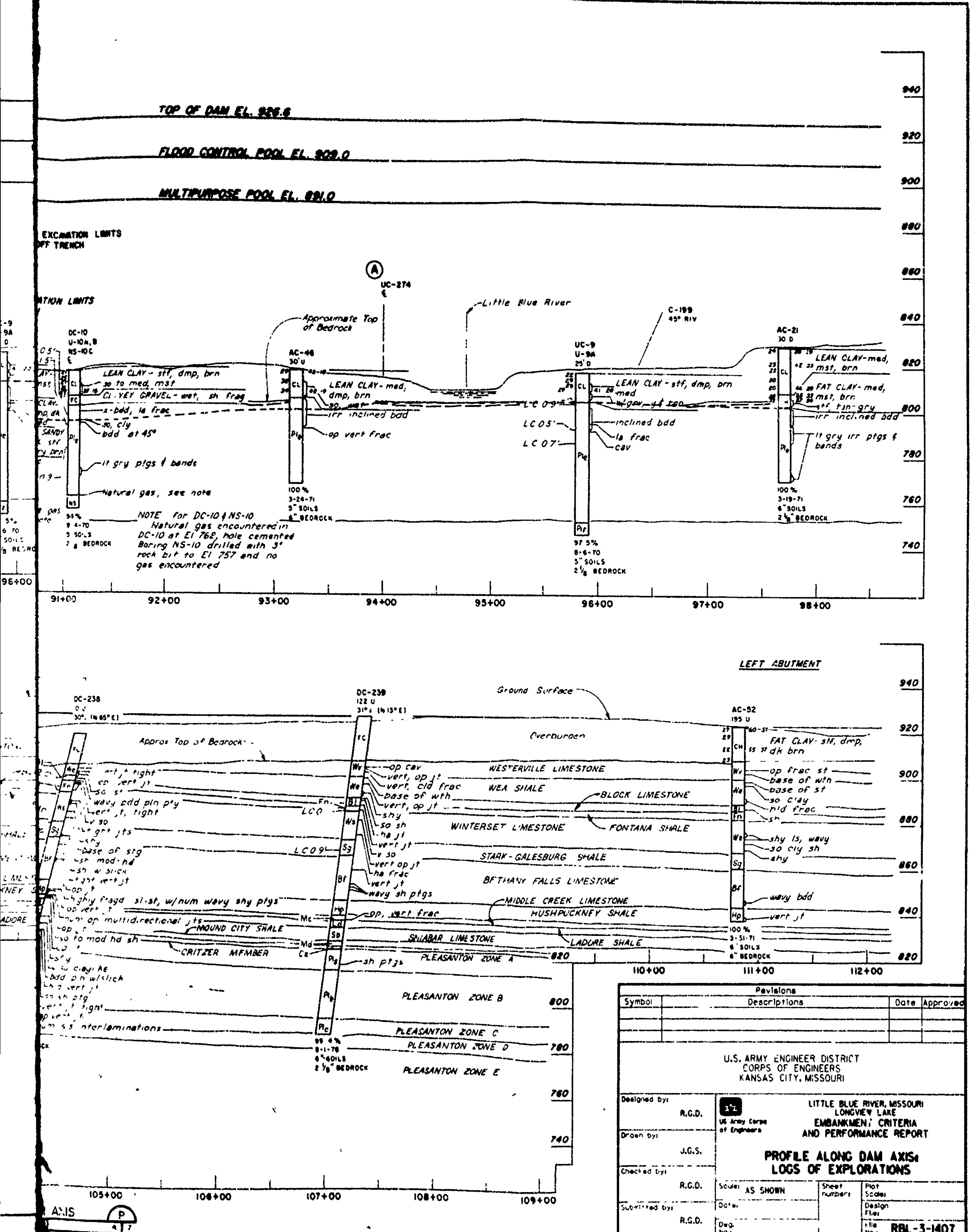
VALUE ENGINEERING PAYS



PROFILE ALONG ℄ DAM AXIS
(LOOKING UPSTREAM)



PROFILE ALONG ℄ DAM AXIS
(LOOKING UPSTREAM)



Symbol	Revisions Descriptions	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

Designed by: R.G.D.
Drawn by: J.G.S.
Checked by: R.G.D.
Submitted by: R.G.D.

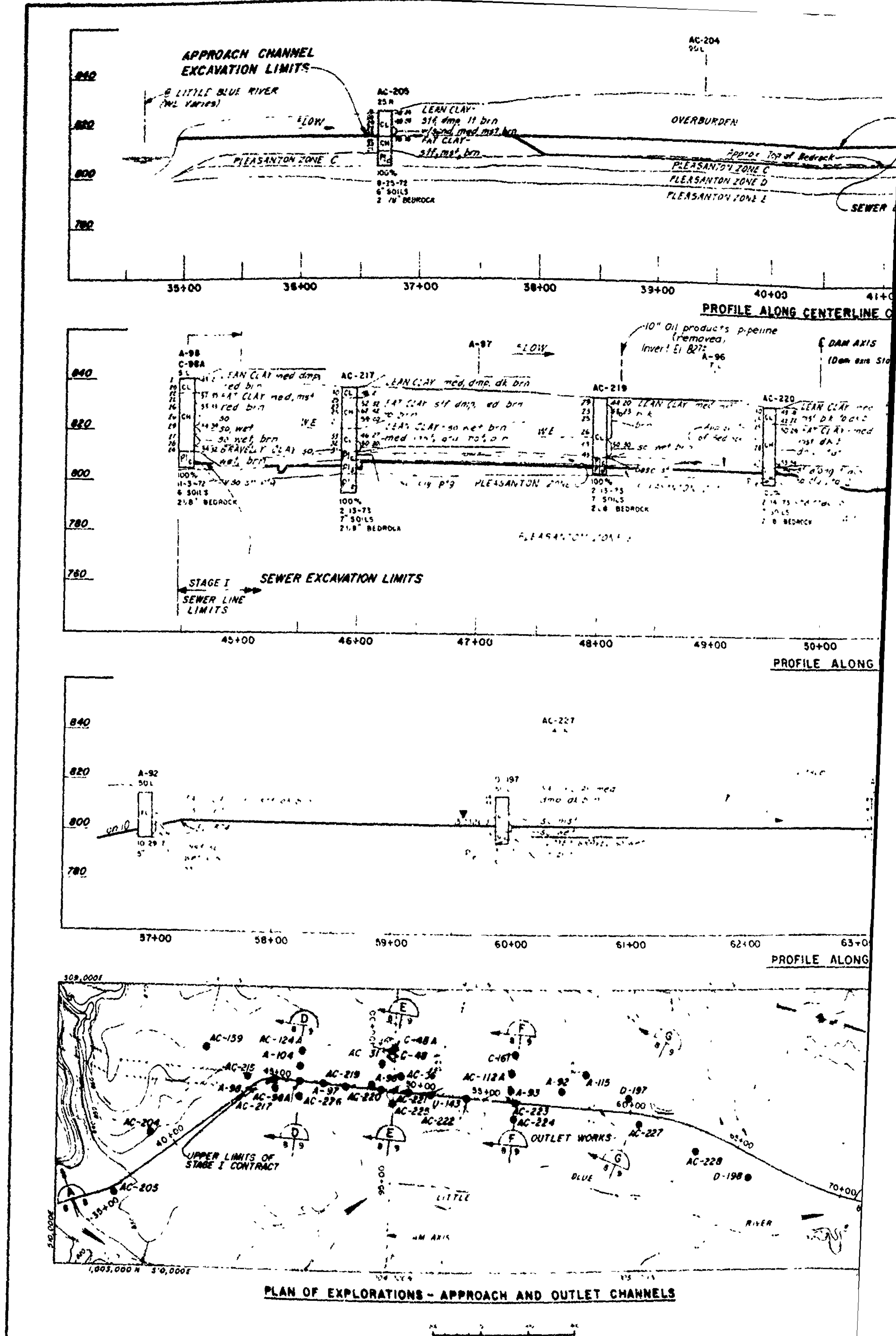
US Army Corps of Engineers

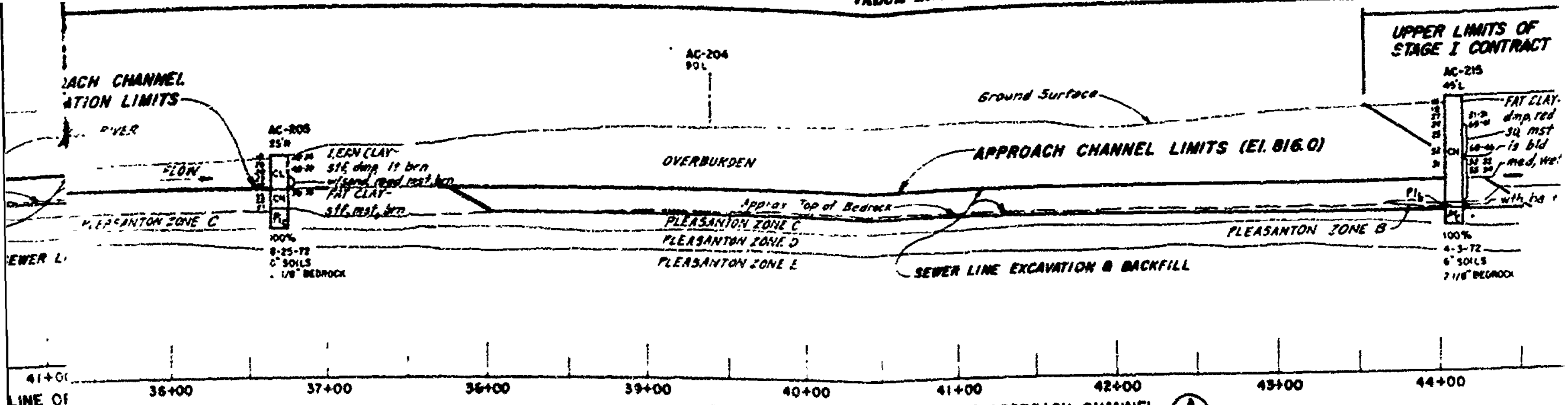
LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA
AND PERFORMANCE REPORT

PROFILE ALONG DAM AXIS: LOGS OF EXPLORATIONS

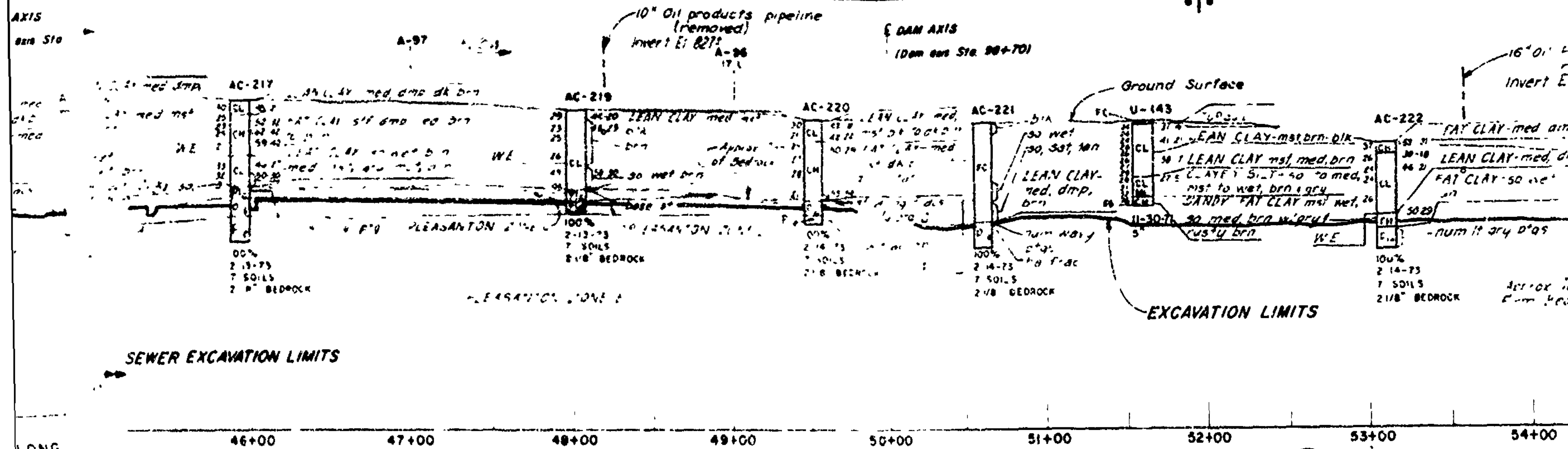
Scale: AS SHOWN
Sheet number:
Date:
Dwg. No.:
Plot Scale:
Design File:
File No.: RBL-3-1407

PLATE NO. 7

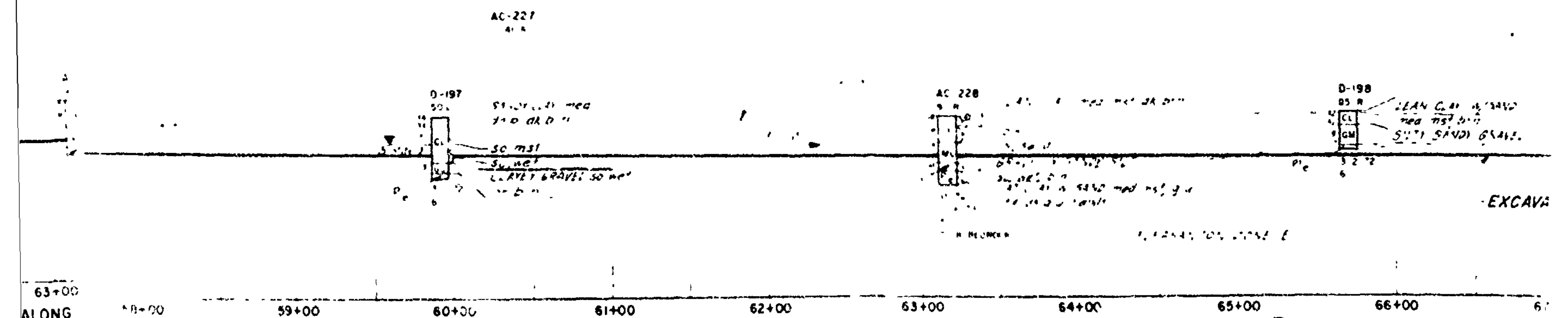

APPROACH CHANNEL EXCAVATION LIMITS
AC-205
AC-204
LEAN CLAY
FAT CLAY
OVERBURDEN
PLEASANTON ZONE C
PLEASANTON ZONE D
PLEASANTON ZONE E
Approx Top of Bedrock
FLOW
SEWER
35+00
36+00
37+00
38+00
39+00
40+00
PROFILE ALONG CENTERLINE
A-98
C-98A
AC-217
A-97
AC-219
AC-220
A-96
10" Oil products pipeline (removed) Invert El 827±
DAM AXIS
STAGE I SEWER EXCAVATION LIMITS
SEWER LINE LIMITS
45+00
46+00
47+00
48+00
49+00
50+00
PROFILE ALONG
A-92
AC-227
57+00
58+00
59+00
60+00
61+00
62+00
PROFILE ALONG
840
820
800
780
760
OUTLET WORKS
UPPER LIMITS OF STAGE I CONTRACT
LITTLE BLUE RIVER
PLAN OF EXPLORATIONS - APPROACH AND OUTLET CHANNELS



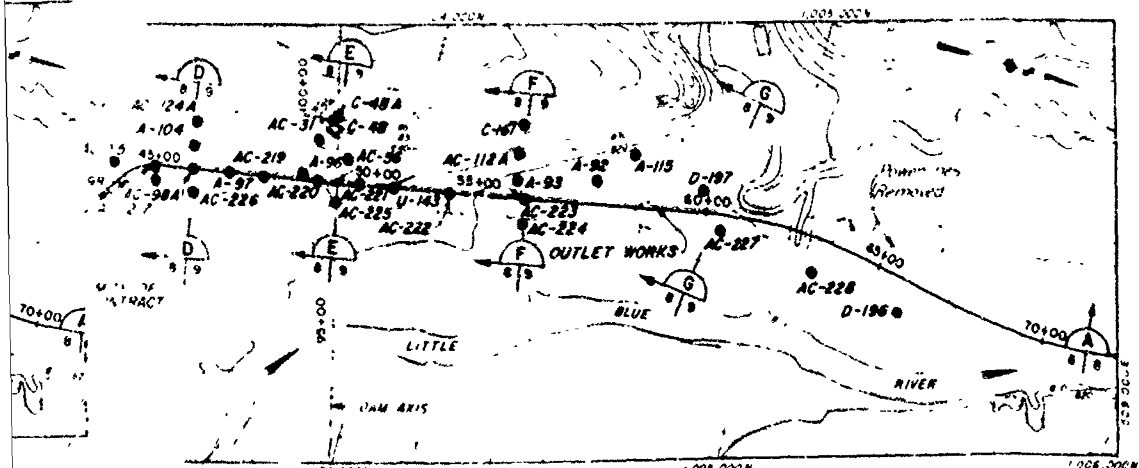
PROFILE ALONG CENTERLINE OF APPROACH CHANNEL



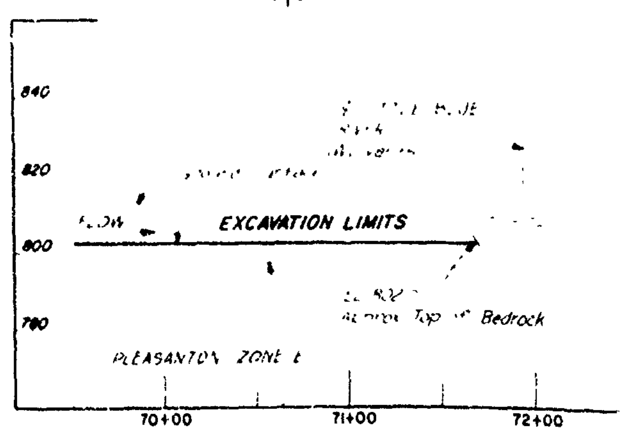
PROFILE ALONG CENTERLINE OF OUTLET WORKS



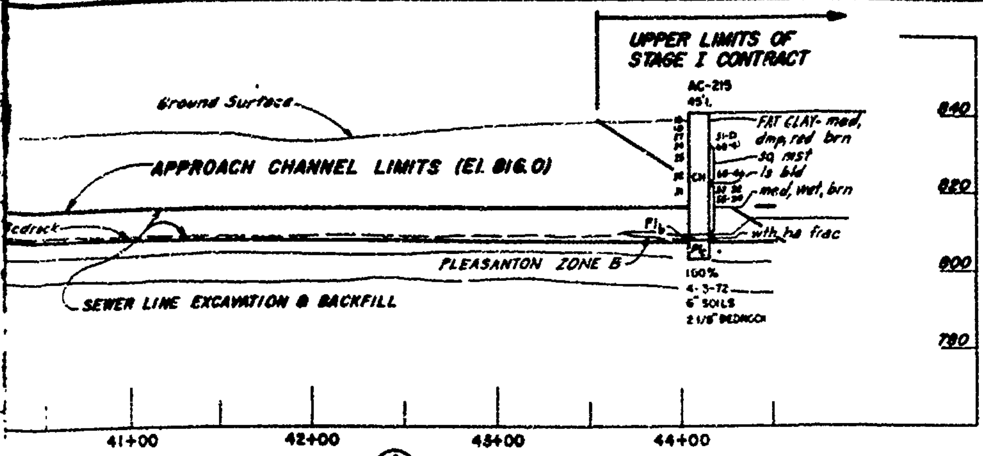
PROFILE ALONG CENTERLINE OF OUTLET CHANNEL



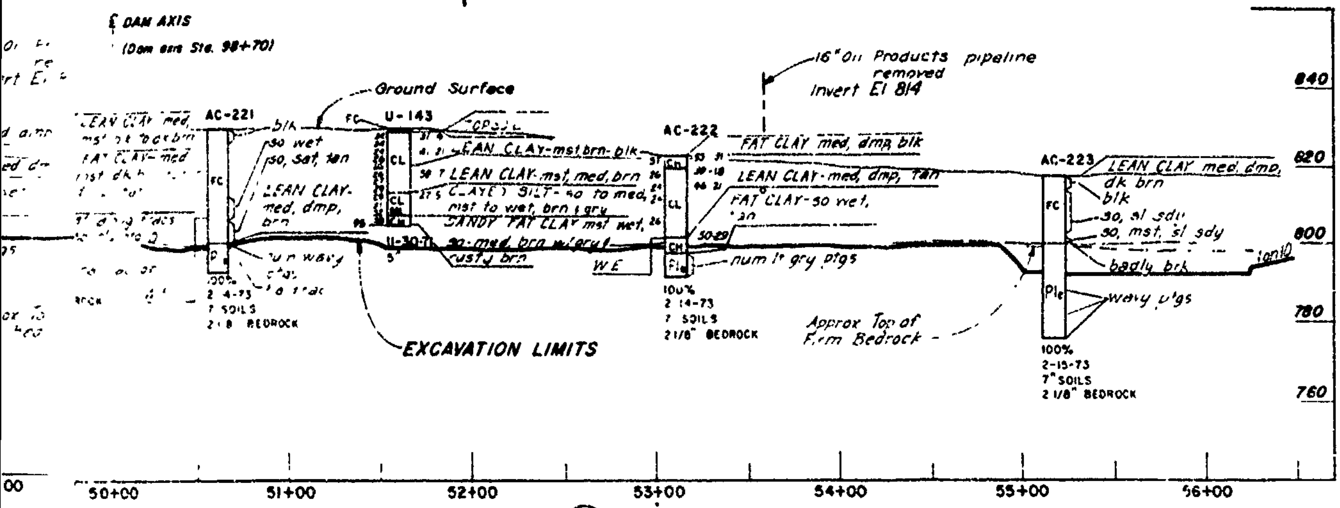
PLAN OF EXPLORATIONS - APPROACH AND OUTLET CHANNELS



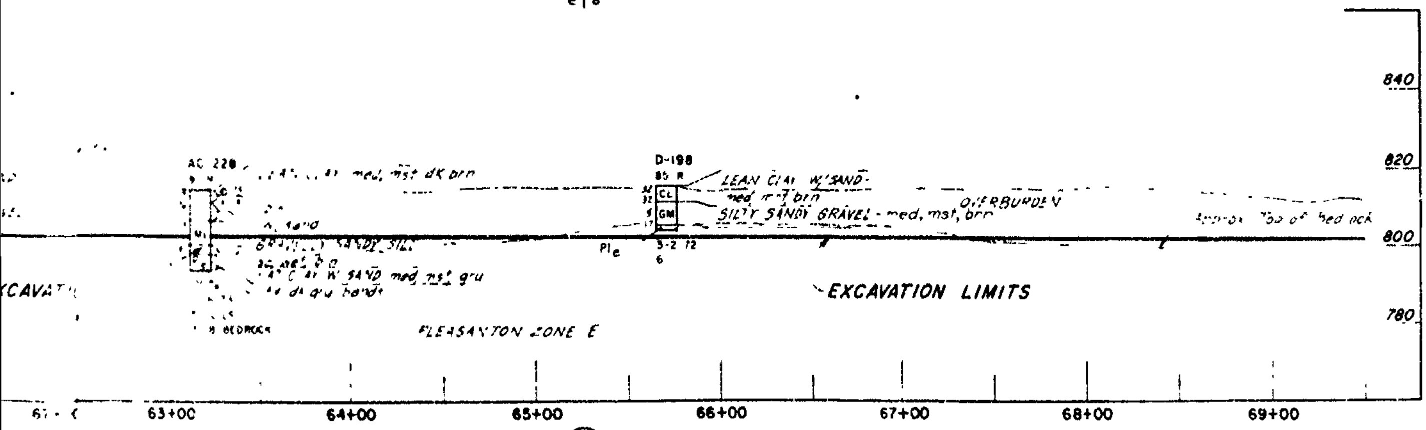
PROFILE ALONG CENTERLINE OF OUTLET CHANNE



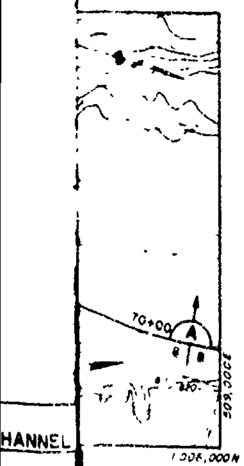
CENTERLINE OF APPROACH CHANNEL (A / 8|8)

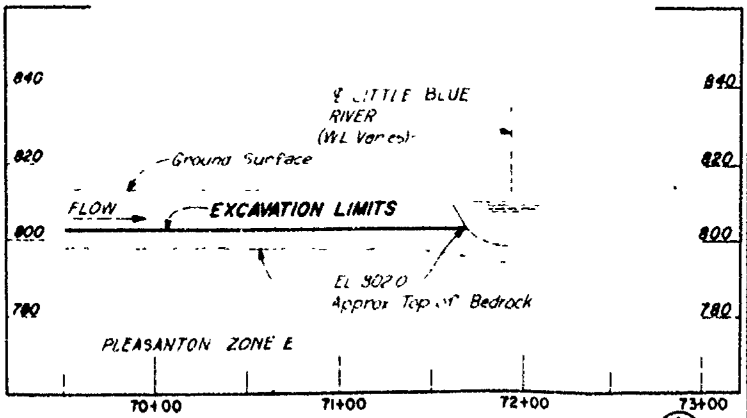


FILE ALONG CENTERLINE OF OUTLET WORKS (A / 8|8)



FILE ALONG CENTERLINE OF OUTLET CHANNEL (A / 8|8)





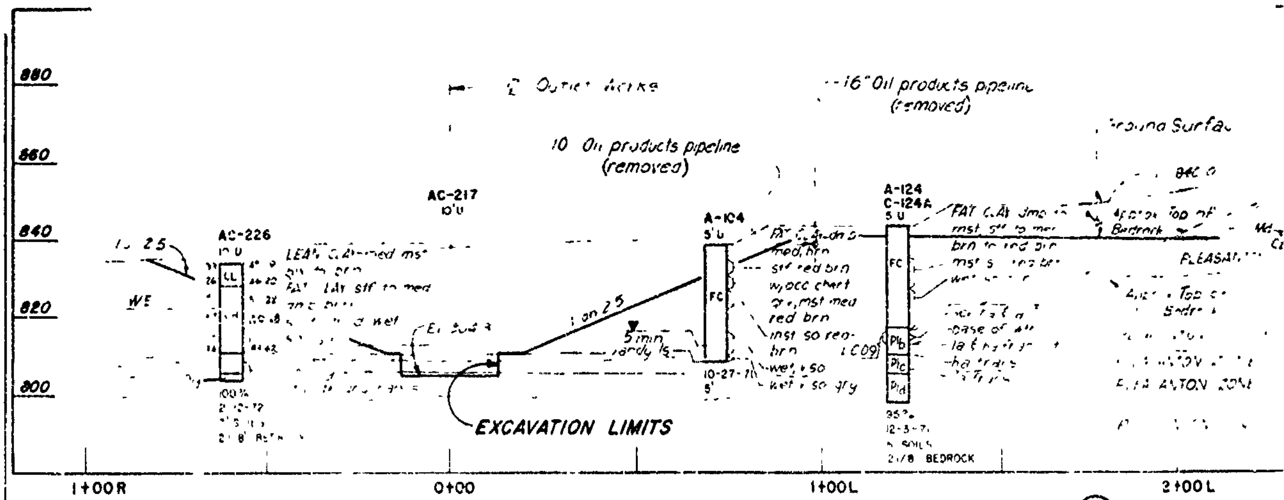
PROFILE ALONG CENTERLINE OF OUTLET CHANNEL (A / 8|8)

Revisions			
Symbol	Descriptions	Date	Approved

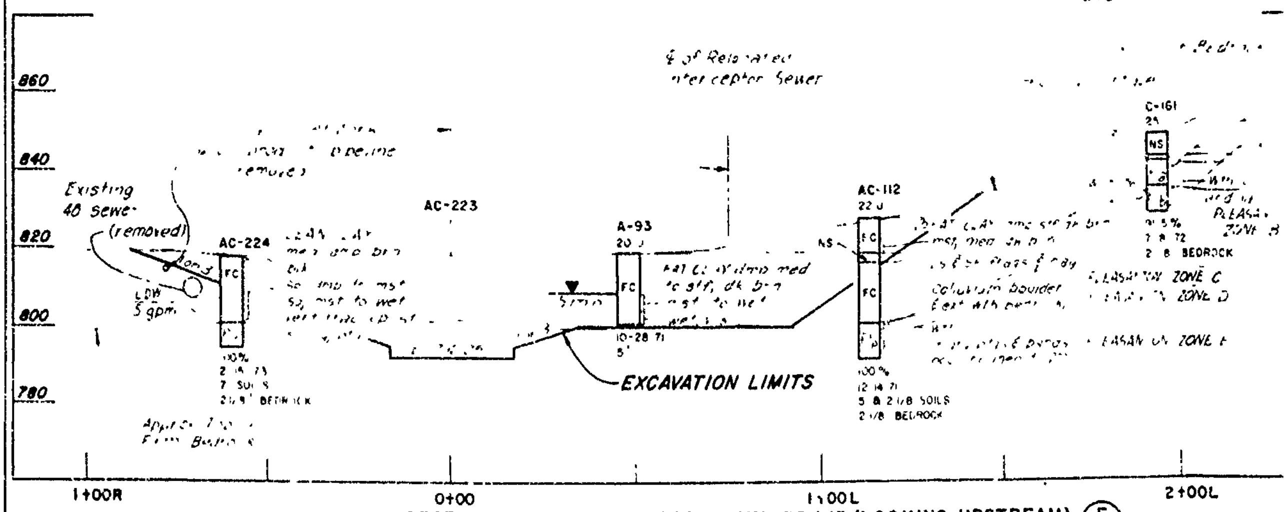
U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

Designed by: R G D.	LITTLE BLUE RIVER, MISSOURI LONGVIEW LAKE EMBANKMENT CRITERIA AND PERFORMANCE REPORT OUTLET WORKS, APPROACH, & OUTLET CHANNELS LOGS & PLAN OF EXPLORATIONS
Drawn by: J.W.J.	
Checked by: R G D / W.B.E.	Scale: AS SHOWN
Submitted by: R G D	Date
	File No. RBL-3-1408

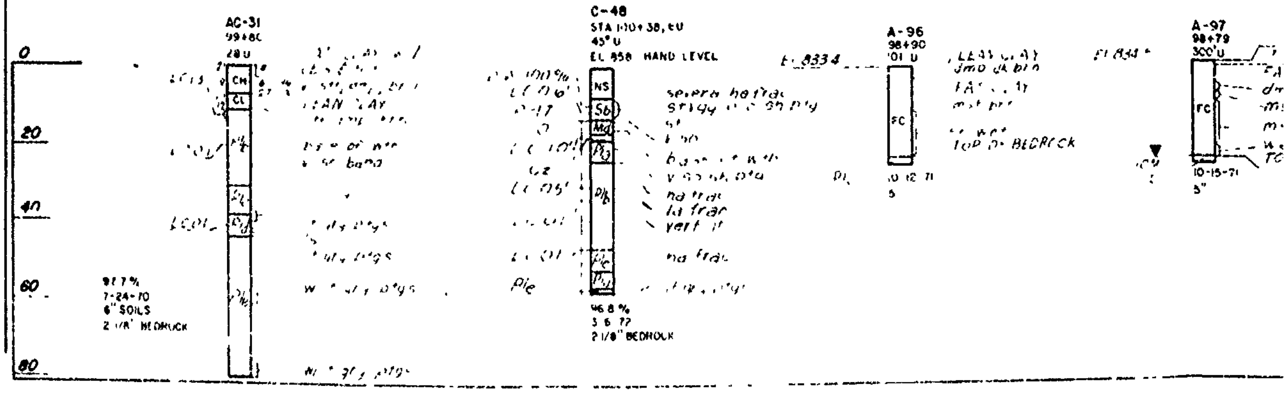
SAFETY PAYS



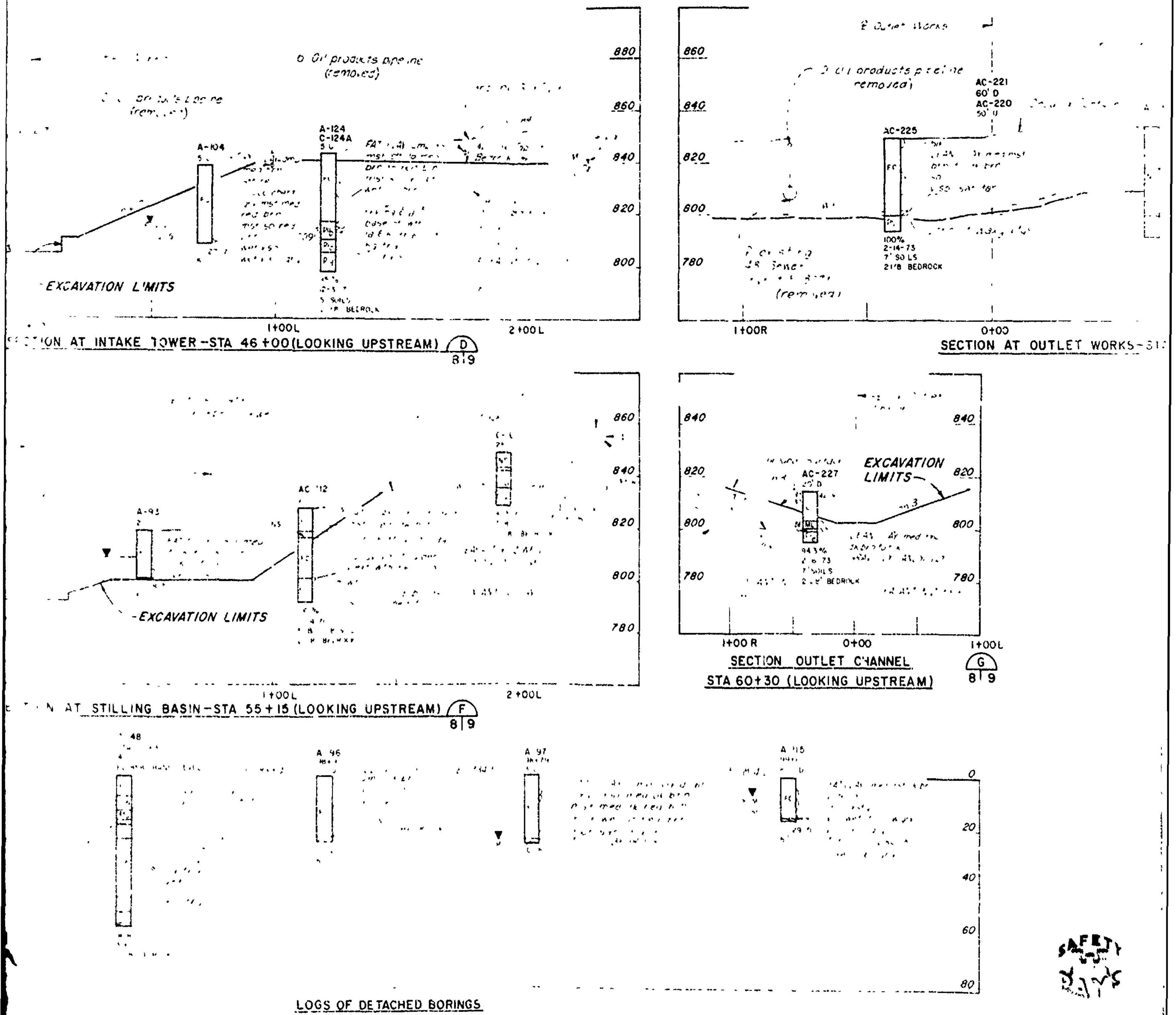
SECTION AT INTAKE TOWER - STA. 46 +00 (LOOKING UPSTREAM) D/8|9



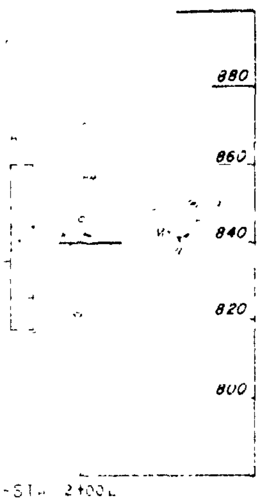
SECTION AT STILLING BASIN - STA. 55 + 15 (LOOKING UPSTREAM) F/8|9

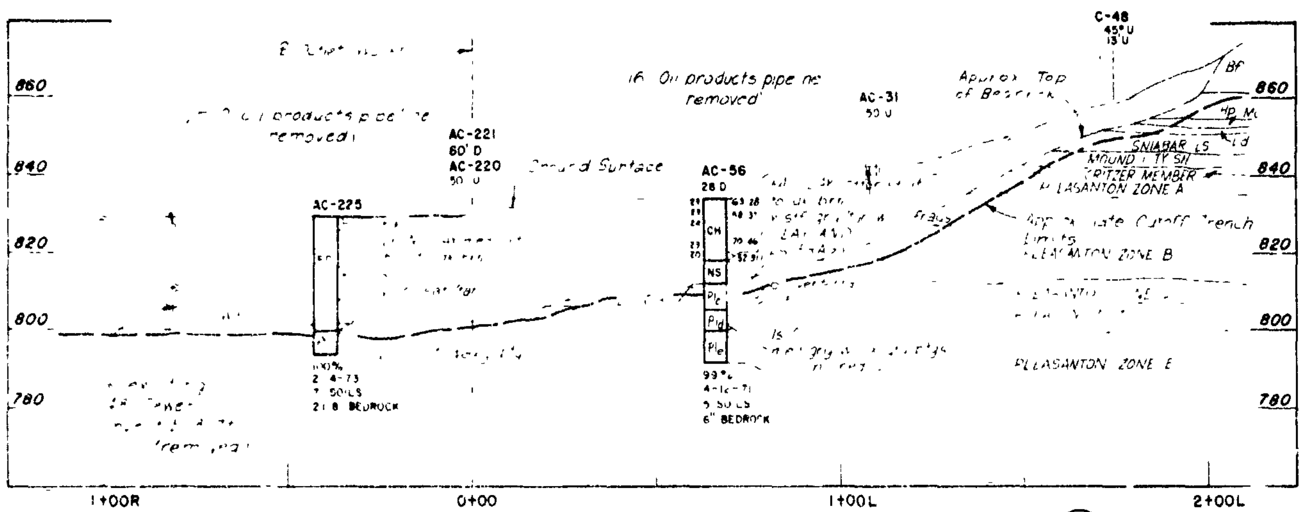


LOGS OF DETACHED BORINGS

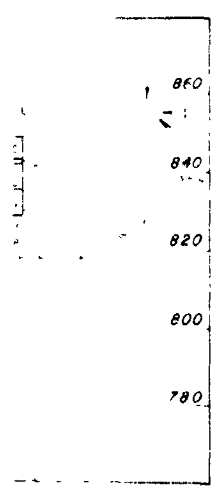


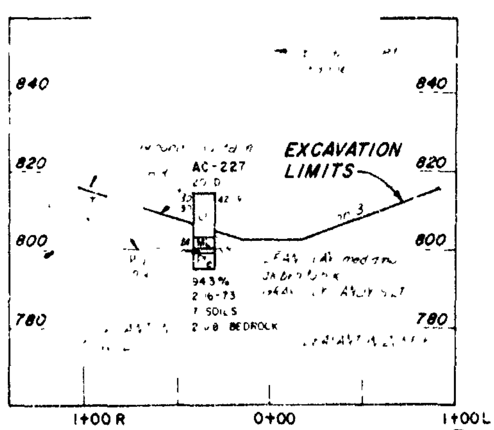
EXCAVATION LIMITS
A-104
A-124
C-124A
1+00L
2+00L
SECTION AT INTAKE TOWER-STA 46+00(LOOKING UPSTREAM)
D
8 9
AC-221
60' D
AC-220
AC-225
100%
2-14-73
7' SOILS
21'8' BEDROCK
1+00R
0+00
SECTION AT OUTLET WORKS
A-93
EXCAVATION LIMITS
1+00L
2+00L
STILLING BASIN-STA 55+15 (LOOKING UPSTREAM)
F
8 9
AC-227
EXCAVATION LIMITS
94.5%
7' SOILS
BEDROCK
1+00 R
0+00
1+00L
SECTION OUTLET CHANNEL
STA 60+30 (LOOKING UPSTREAM)
G
8 9
A-96
A-97
LOGS OF DETACHED BORINGS
SAFETY



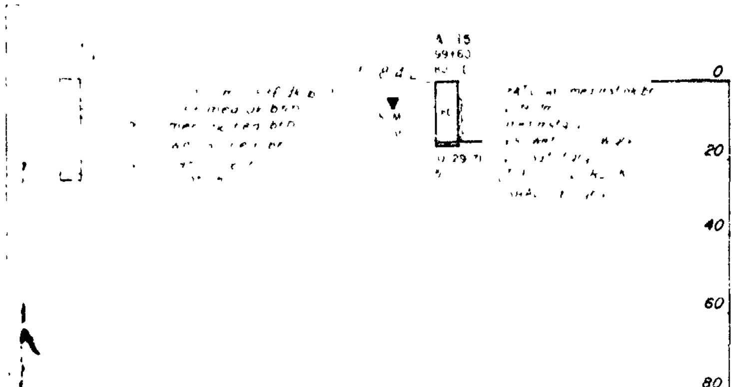


SECTION AT OUTLET WORKS–STA 50+00 (LOOKING UPSTREAM) E 8|9





SECTION OUTLET CHANNEL STA 60+30 (LOOKING UPSTREAM) G 8|9



Revisions			
Symbol	Descriptions	Date	Approved

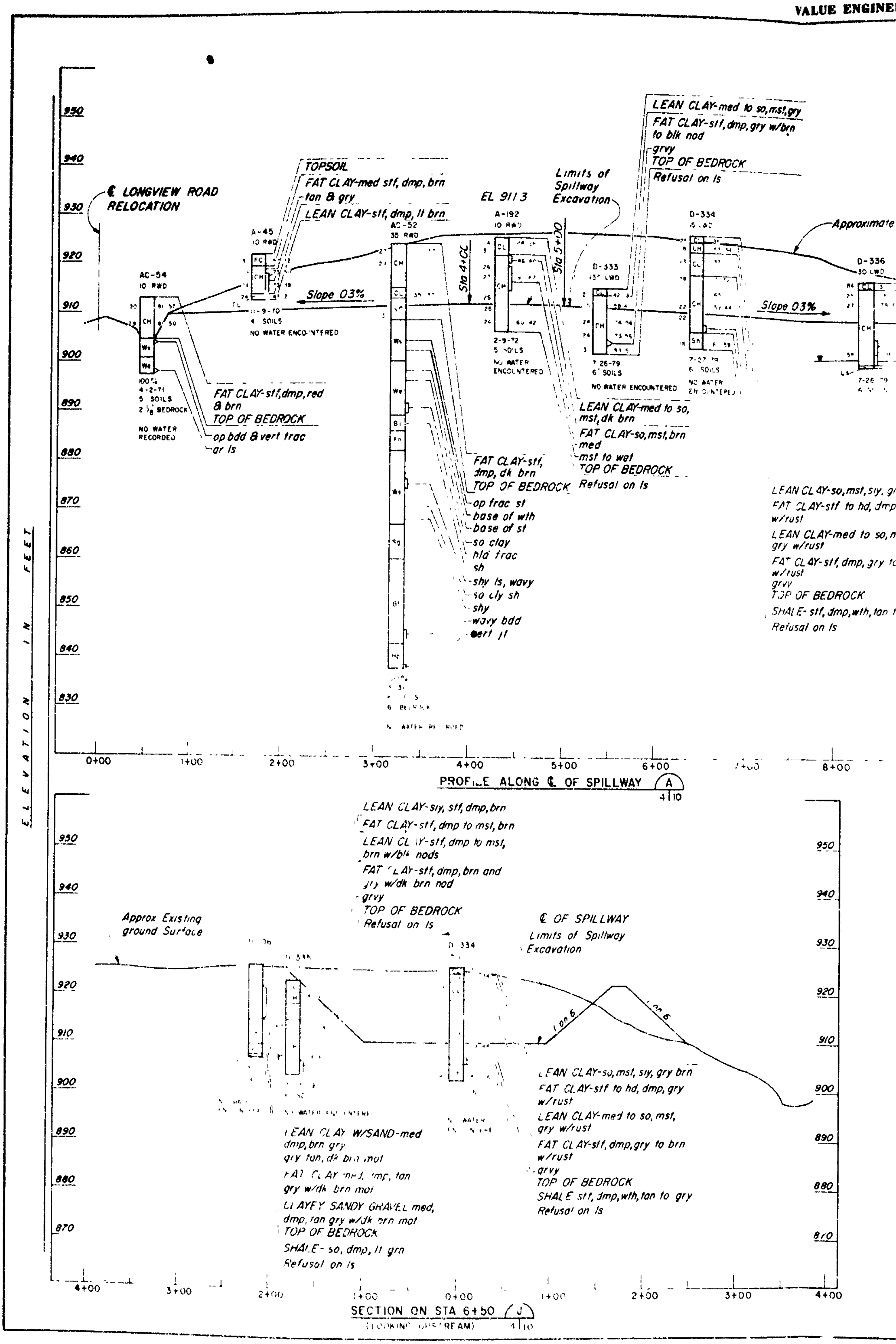
U. S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY MISSOURI

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA
AND PERFORMANCE REPORT

OUTLET WORKS, APPROACH, & OUTLET CHANNELS GEOLOGIC SECTIONS & DETACHED BORINGS

Designed by: R G D
Drawn by: C H
Checked by: R G D/W B E
Submitted: R G D
Scale: AS SHOWN
Sheet number: RBL-3-1409

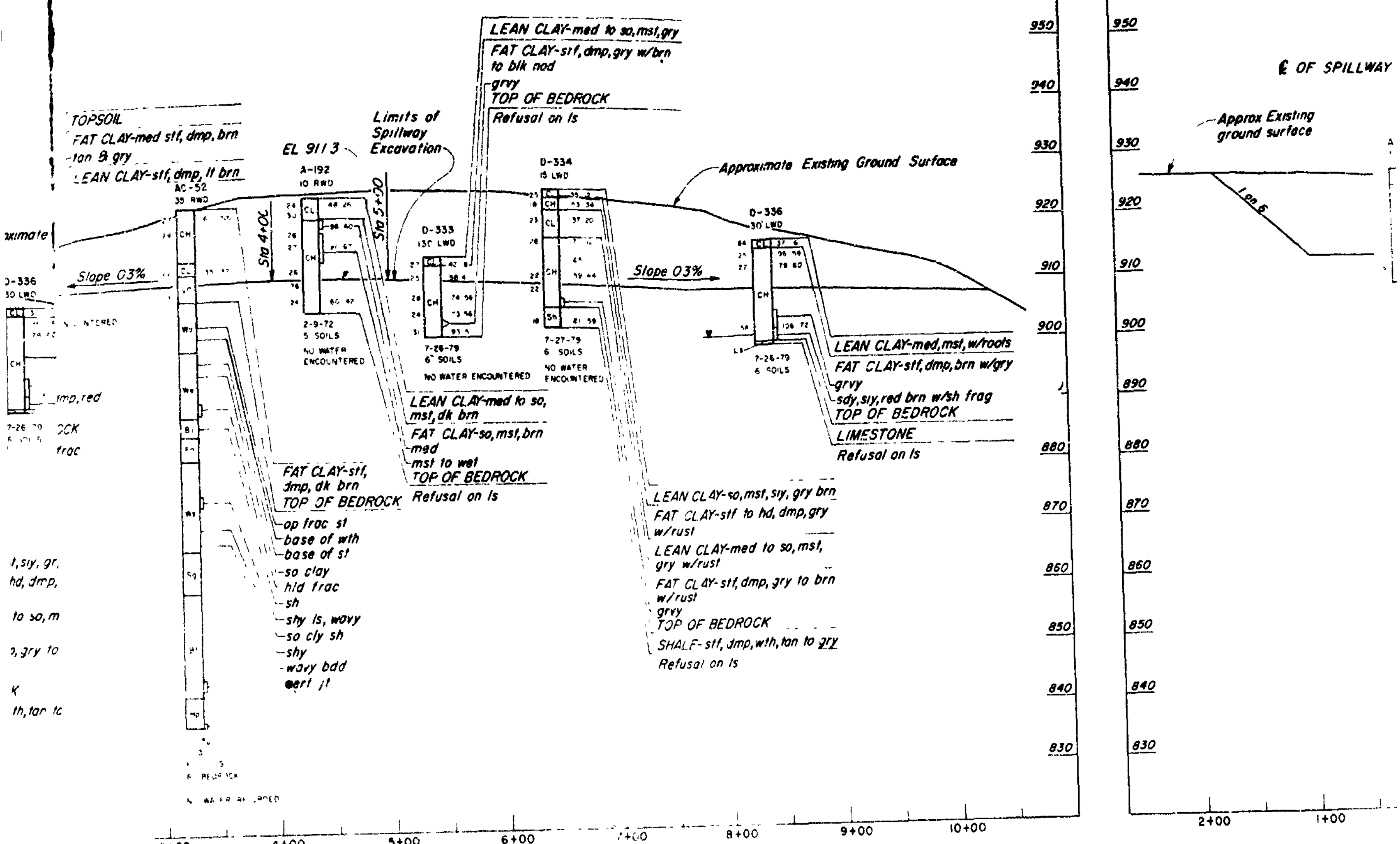
PLATE NO 9



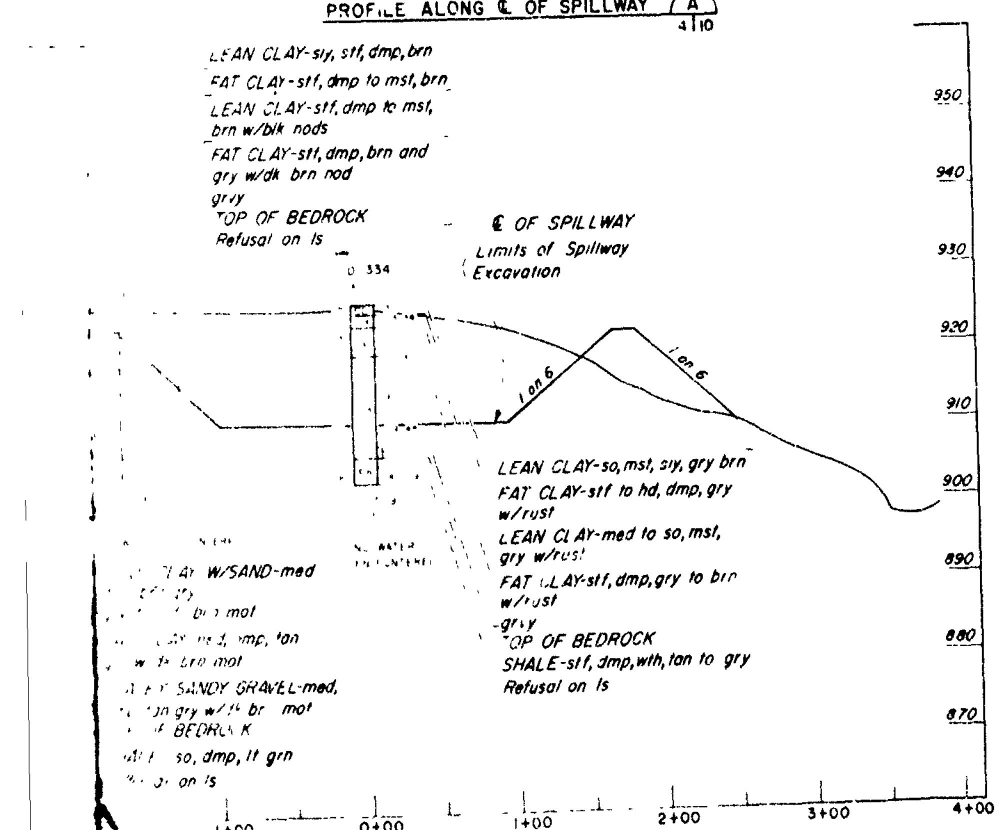
PROFILE ALONG ℄ OF SPILLWAY (A / 4|10)

SECTION ON STA 6+50 (J / 4|10)

(LOOKING UPSTREAM)



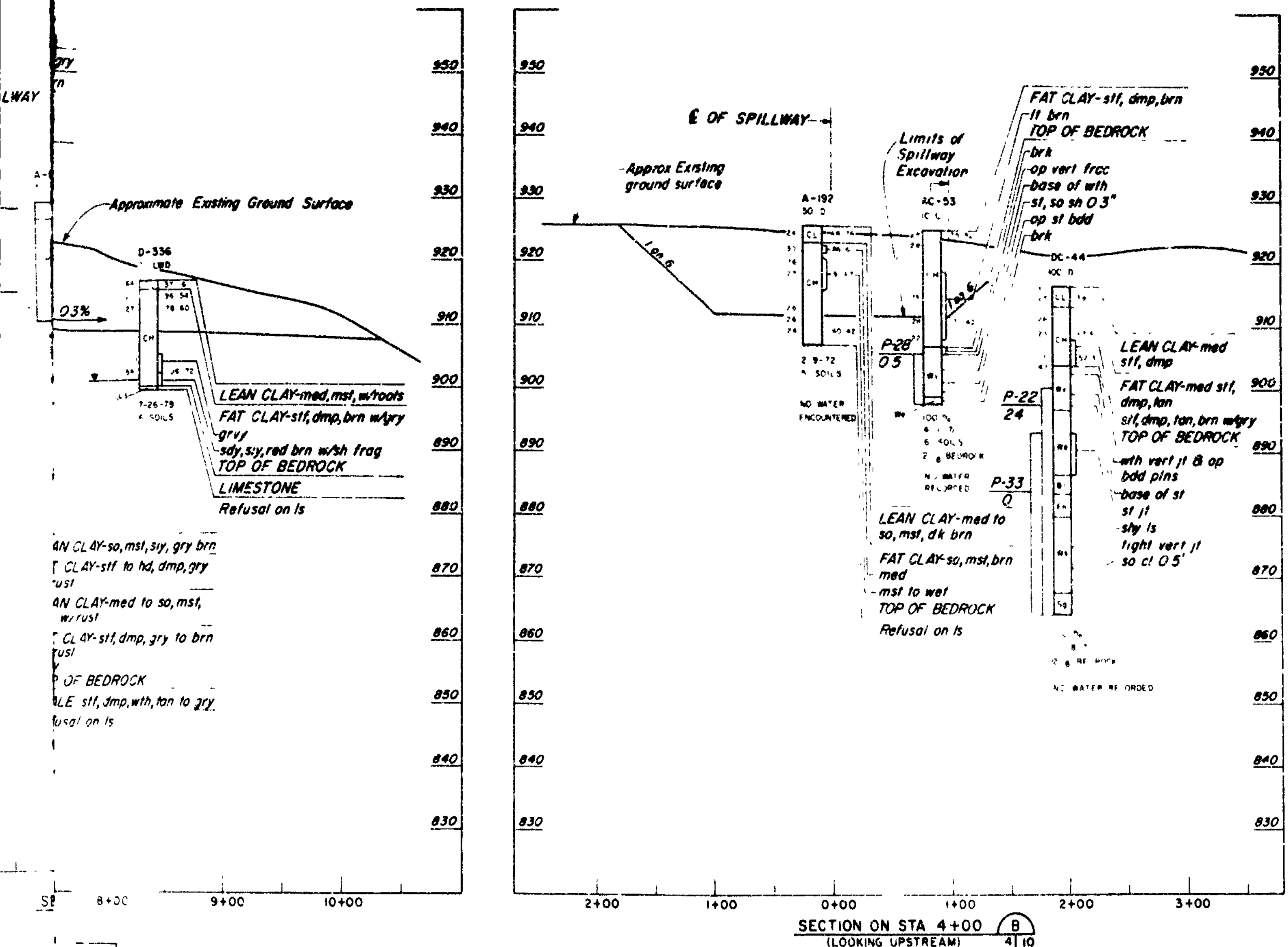
PROFILE ALONG ℄ OF SPILLWAY (A / 4|10)



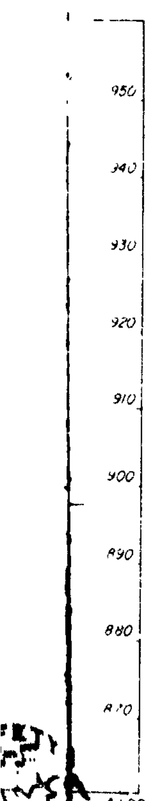
SECTION ON STA 6+50 (J / 4|10)
(LOOKING UPSTREAM)

NOTES

1. Spillway floor El 911.3 between Sta 4+00 and Sta 5+00



SECTION ON STA 4+00 (B / 4 10)
(LOOKING UPSTREAM)



NOTES

1. Spillway floor El 911 3 between Sta 4+00 and Sta 5+00

Symbol	Revisions Descriptions	Date	Approved

U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY MISSOURI

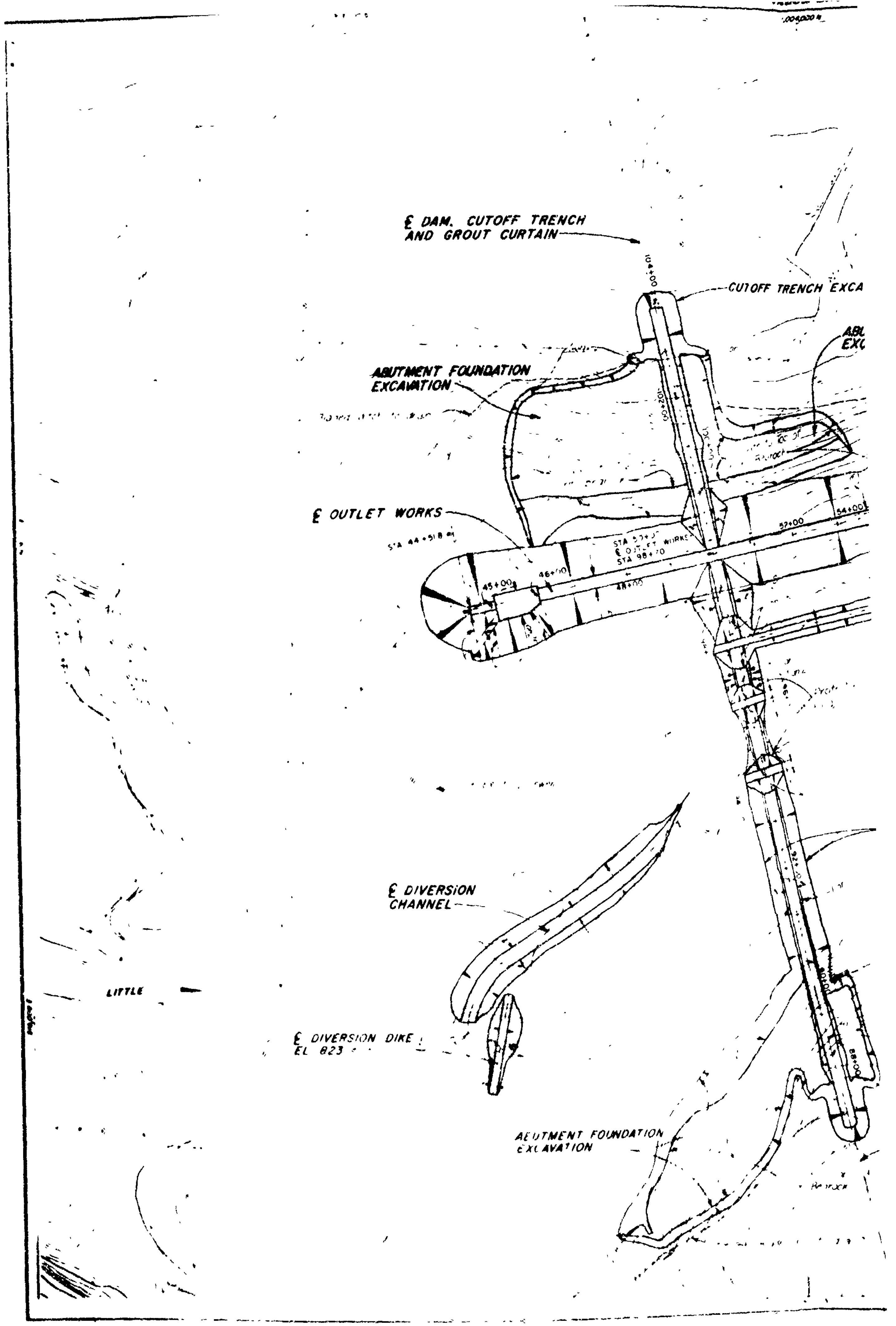
US Army Corps of Engineers

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA
AND PERFORMANCE REPORT

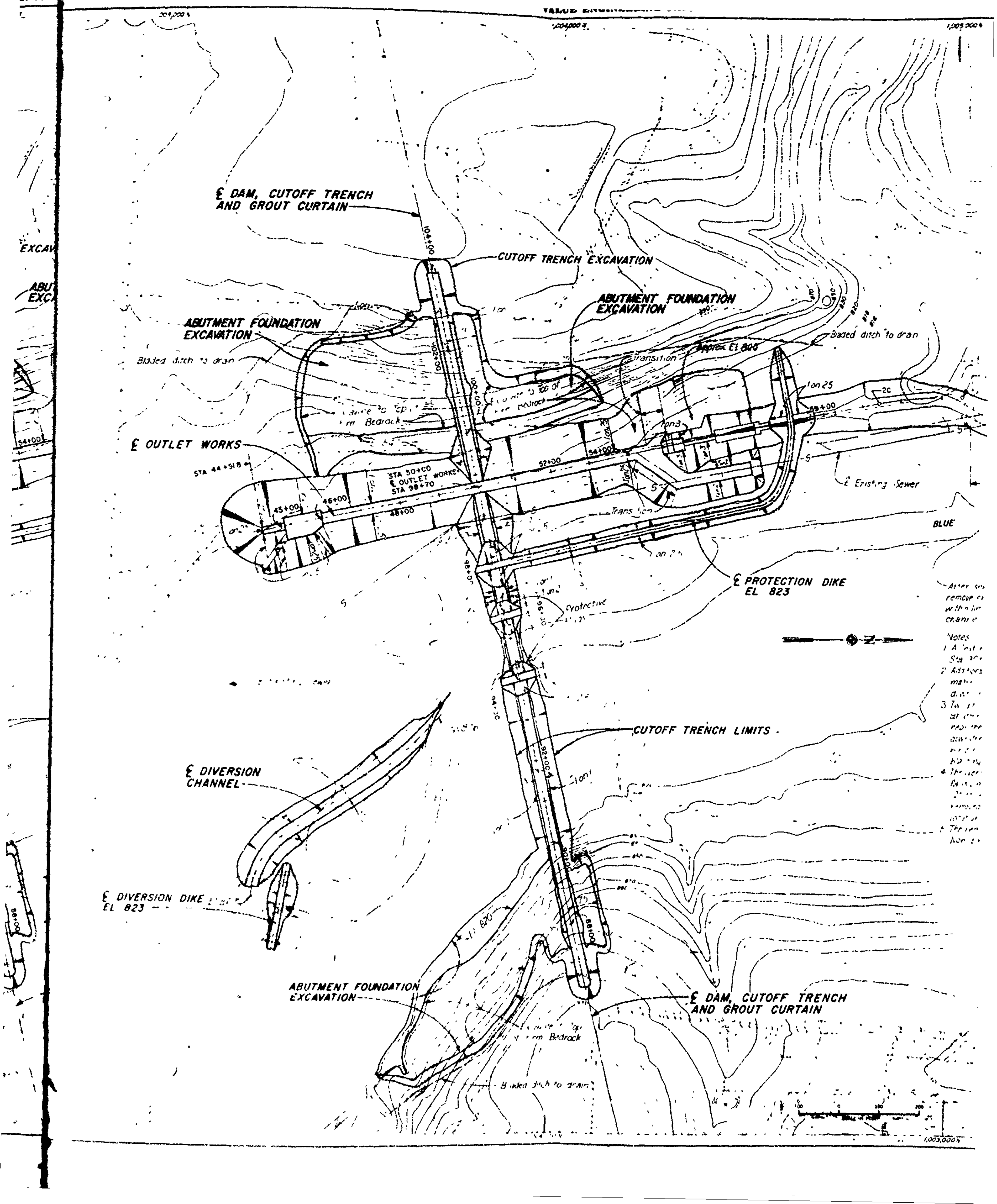
SPILLWAY PROFILE AND SECTIONS

Designed by: RGD
Drawn by: JWP
Checked by: RGD/WBE
Submitted by: RGD
Scale: AS SHOWN
Date:
Dwg No: RBL-3-1410
Sheet number:

PLATE NO. 10



℄ DAM, CUTOFF TRENCH
AND GROUT CURTAIN
CUTOFF TRENCH EXCA
ABUTMENT FOUNDATION
EXCAVATION
℄ OUTLET WORKS
℄ DIVERSION
CHANNEL
LITTLE
℄ DIVERSION DIKE
EL 823
ABUTMENT FOUNDATION
EXCAVATION



℄ DAM, CUTOFF TRENCH AND GROUT CURTAIN
CUTOFF TRENCH EXCAVATION
ABUTMENT FOUNDATION EXCAVATION
ABUTMENT FOUNDATION EXCAVATION
Bladed ditch to drain
Bladed ditch to drain
Approx EL 800
Transition
℄ OUTLET WORKS
STA 44+51.8
STA 50+00
℄ OUTLET WORKS
STA 98+70
45+00
46+00
48+00
52+00
54+00
58+00
104+00
102+00
100+00
℄ Existing Sewer
BLUE
℄ PROTECTION DIKE EL 823
Protective
CUTOFF TRENCH LIMITS
℄ DIVERSION CHANNEL
℄ DIVERSION DIKE EL 823
ABUTMENT FOUNDATION EXCAVATION
℄ DAM, CUTOFF TRENCH AND GROUT CURTAIN
Excavate to top of firm Bedrock
Bladed ditch to drain
88+00
Notes
1,005,000 N

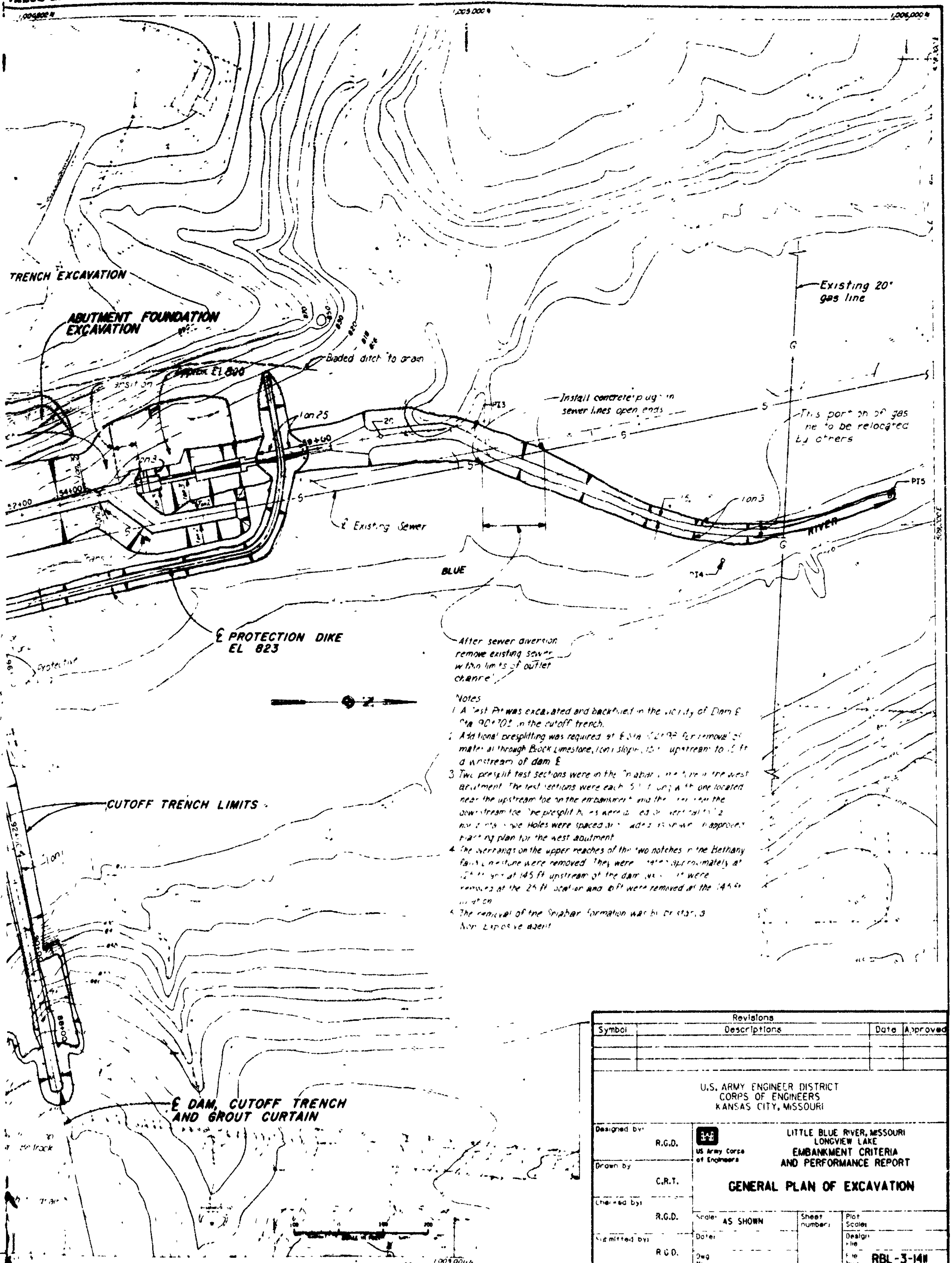
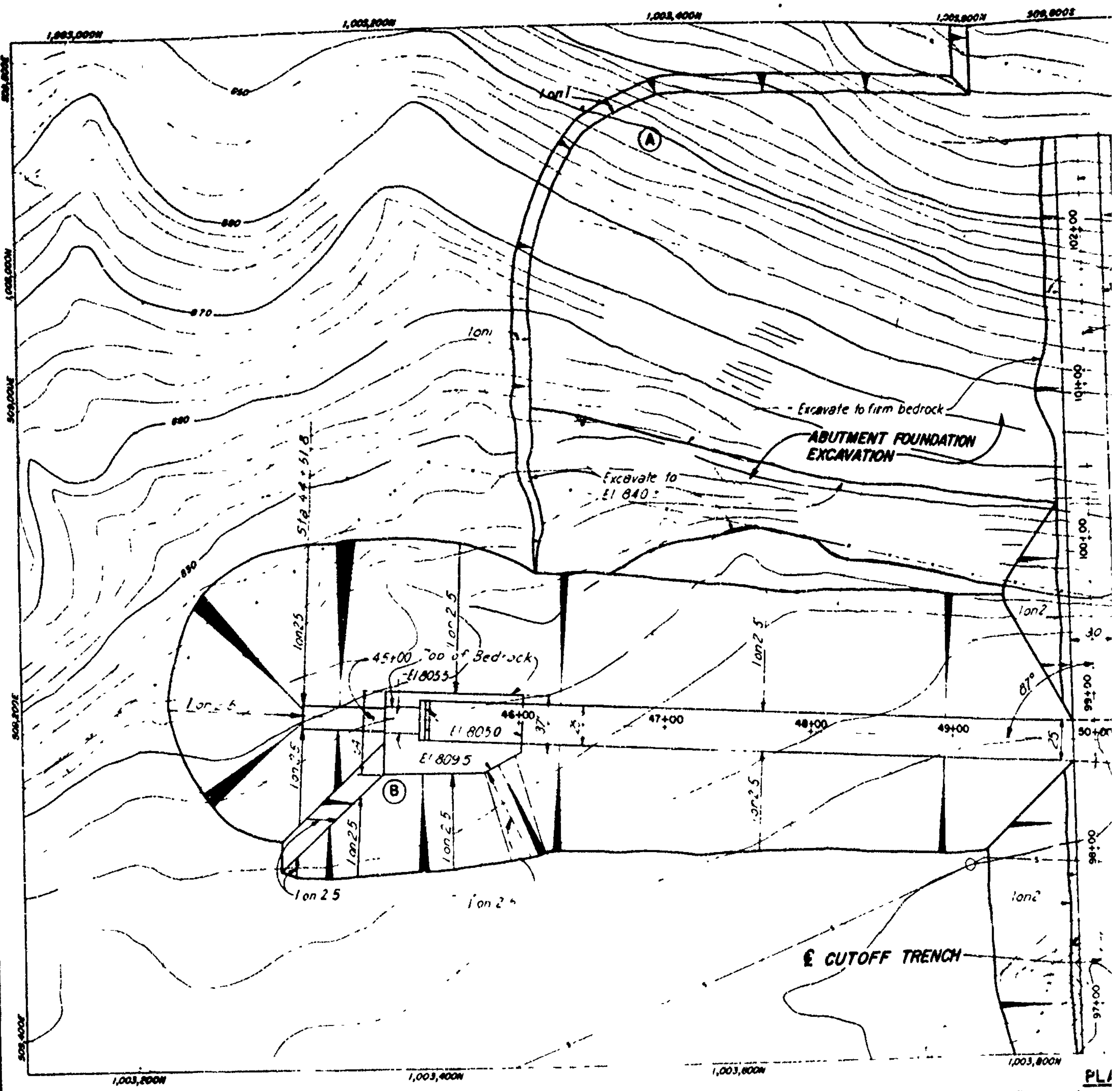
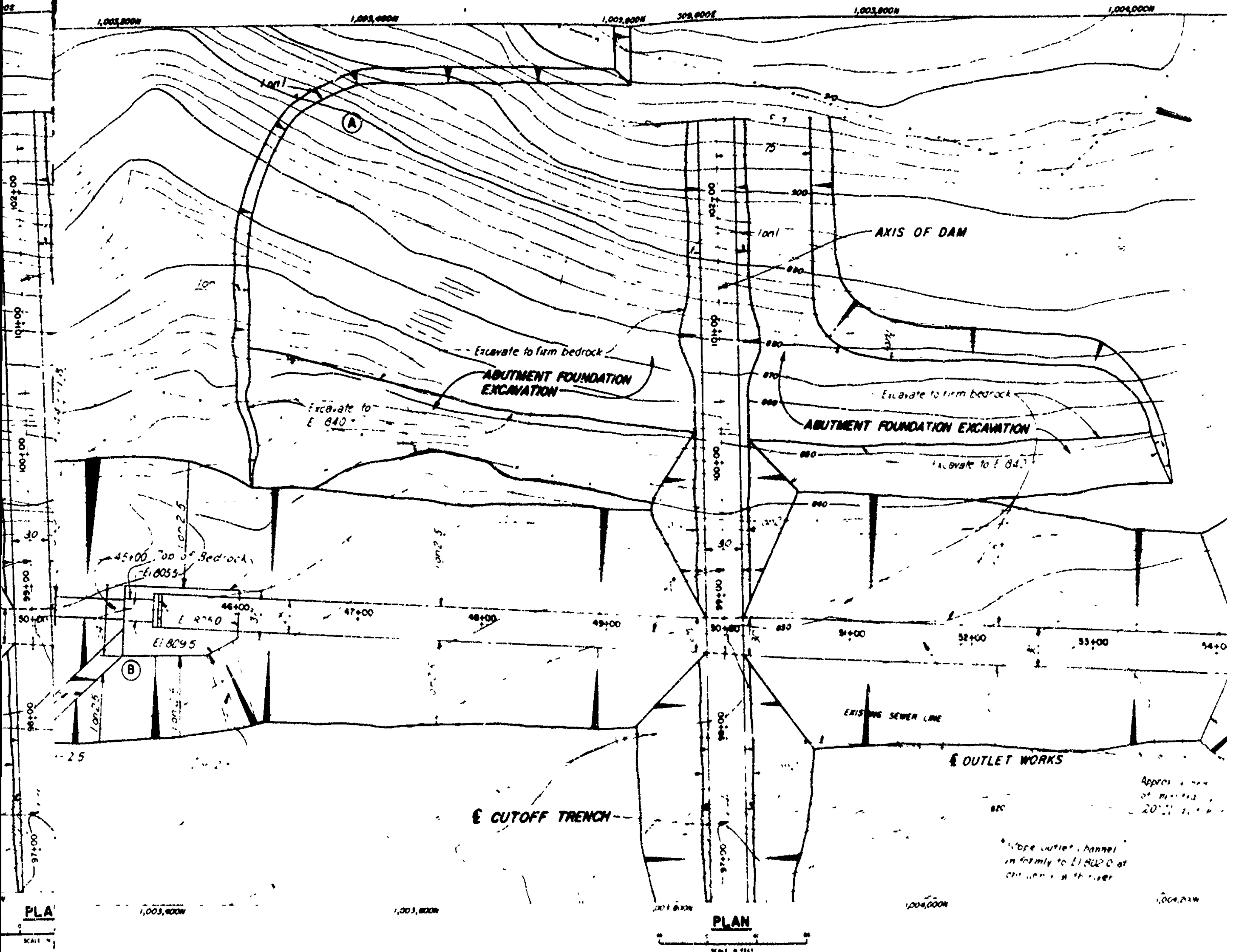

TRENCH EXCAVATION
ABUTMENT FOUNDATION EXCAVATION
Graded ditch to drain
Install concrete plug in sewer lines open ends
Existing 20" gas line
This portion of gas line to be relocated by others
Existing Sewer
RIVER
BLUE
PROTECTION DIKE EL 823
After sewer diversion remove existing sewer within limits of outlet channel
Notes
1 A Test Pit was excavated and backfilled in the vicinity of Dam Sta 90+70± in the cutoff trench.
2 Additional presplitting was required
3 Two presplit test sections were in the west abutment.
4 The overhangs on the upper reaches of the two notches in the Bethany Falls Limestone were removed.
5 The removal of the Formation was by Non Explosive agent
CUTOFF TRENCH LIMITS
DAM, CUTOFF TRENCH AND GROUT CURTAIN
Revisions
Symbol
Descriptions
Date
Approved
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI
Designed by: R.G.D.
Drawn by: C.R.T.
Checked by: R.G.D.
Submitted by: R.G.D.
US Army Corps of Engineers
LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA
AND PERFORMANCE REPORT
GENERAL PLAN OF EXCAVATION
Scale: AS SHOWN
Sheet number:
Plot Scale:
Date:
Design File:
Dwg No:
File No: RBL-3-14I

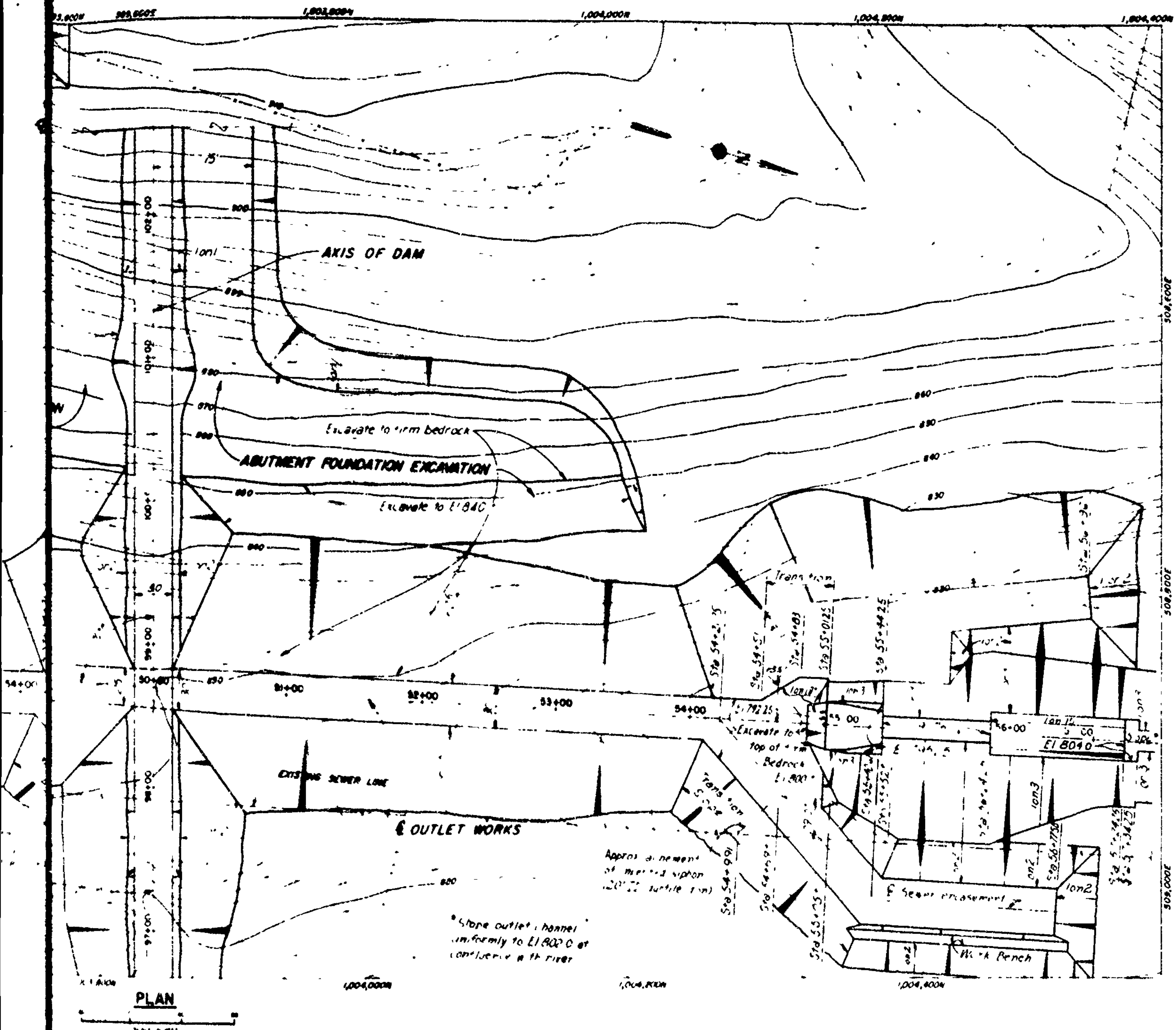
PLATE NO. 11



1,003,200N
1,003,400N
1,003,600N
1,003,800N
Excavate to firm bedrock
ABUTMENT FOUNDATION EXCAVATION
Excavate to El 840 ±
1 on 1
1 on 2
1 on 2.5
Top of Bedrock
45+00
El 805.5
El 805.0
El 809.5
46+00
47+00
48+00
49+00
50+00
97+00
98+00
99+00
100+00
101+00
102+00
A
B
€ CUTOFF TRENCH



Notes
Additional excavation was required in the [illegible] of Outlet works Sta 52+00, left
Bank, to remove the [illegible] slide material



Notes

1 *Additional excavation was required in the vicinity of Outlet works Sta 52+00, left Bank, to remove the land slide material*

A [illegible]0,000 *cu yds of slide material removed*

B 20,000 *cu yds of additional impervious backfill*

C *Additional clearing and grubbing required*

Symbol	Descriptions	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

Designed by: R.G.D.
Drawn by: J.E.K.
Checked by: R.G.D.
Submitted by: R.G.D.

US Army Corps of Engineers

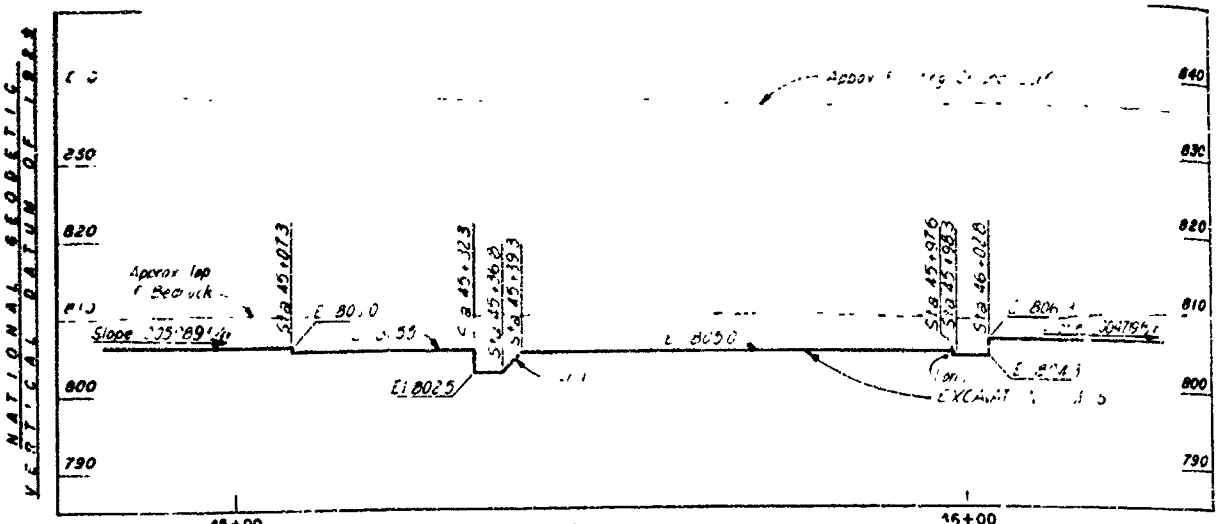
LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA
AND PERFORMANCE REPORT

OUTLET WORKS
PLAN OF EXCAVATION

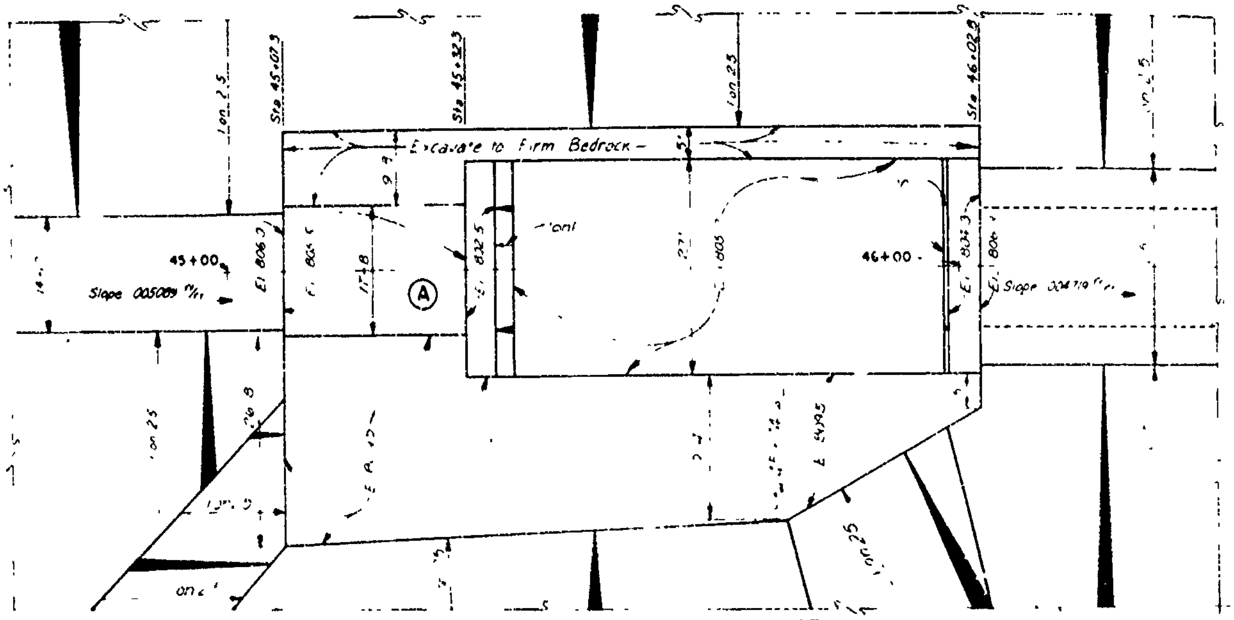
Scale: AS SHOWN

File No.: RBL-3-1412

PLATE NO. 12[illegible]

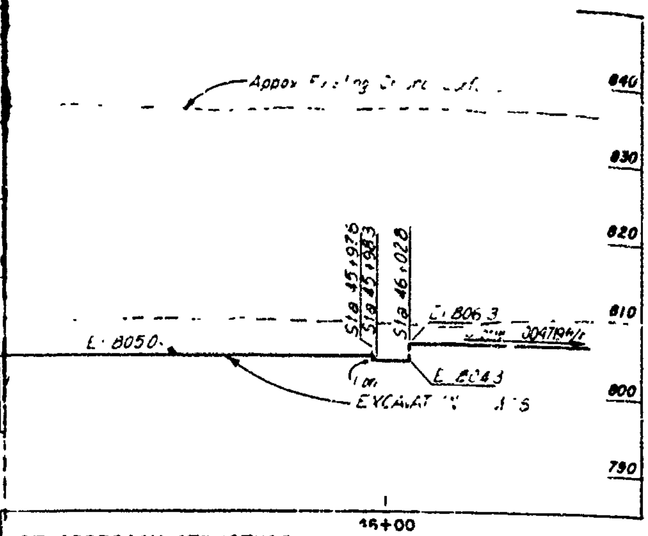


PROFILE ALONG ℄ OF APPROACH STRUCTURE

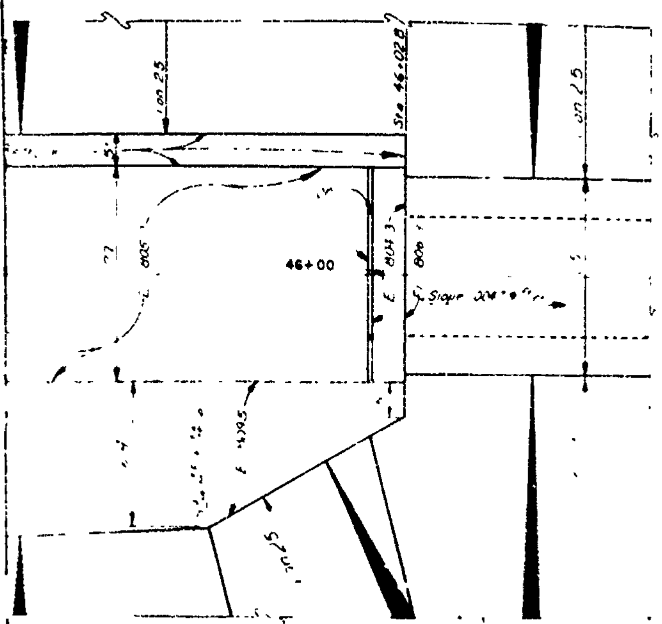


PLAN OF EXCAVATION FOR APPROACH STRUCTURE

NATIONAL GEODETIC VERTICAL DATUM OF 1929

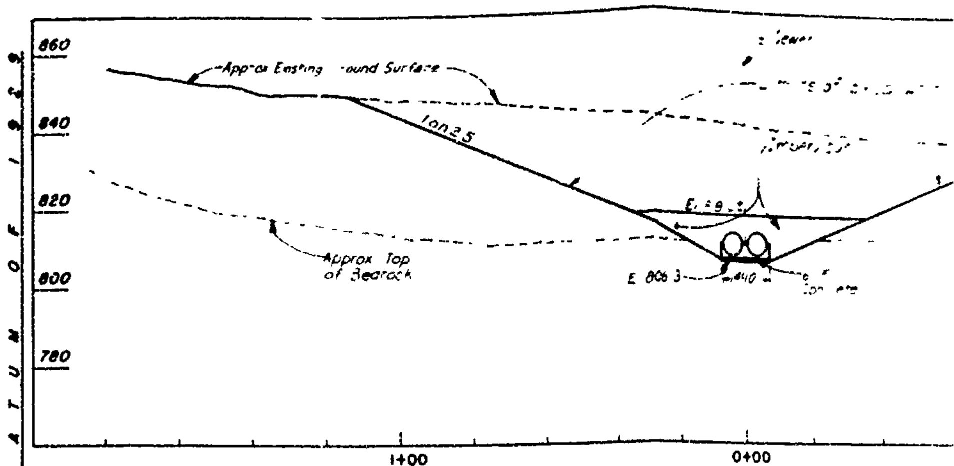


OF APPROACH STRUCTURE

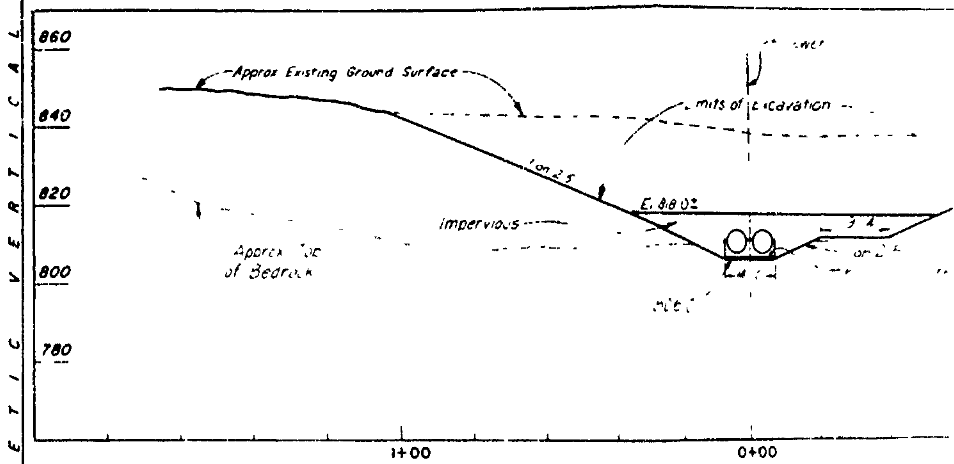


APPROACH STRUCTURE

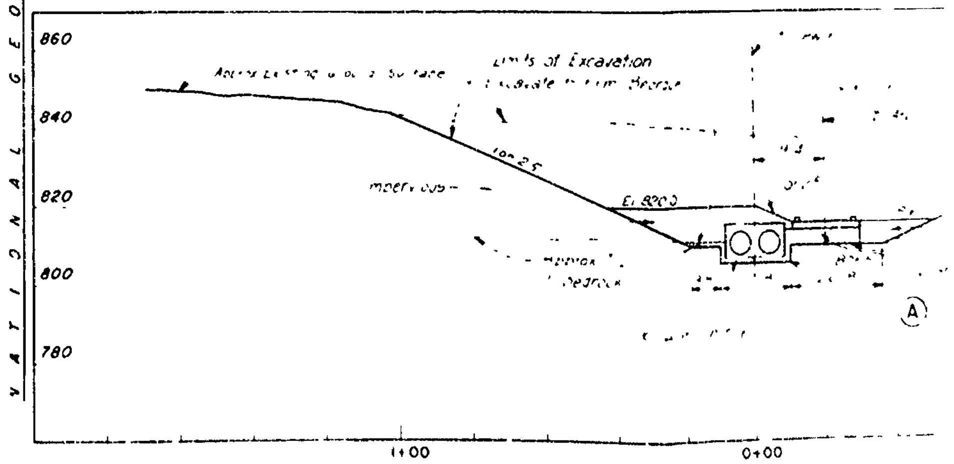
NATIONAL GEODETIC VERTICAL DATUM OF 1929



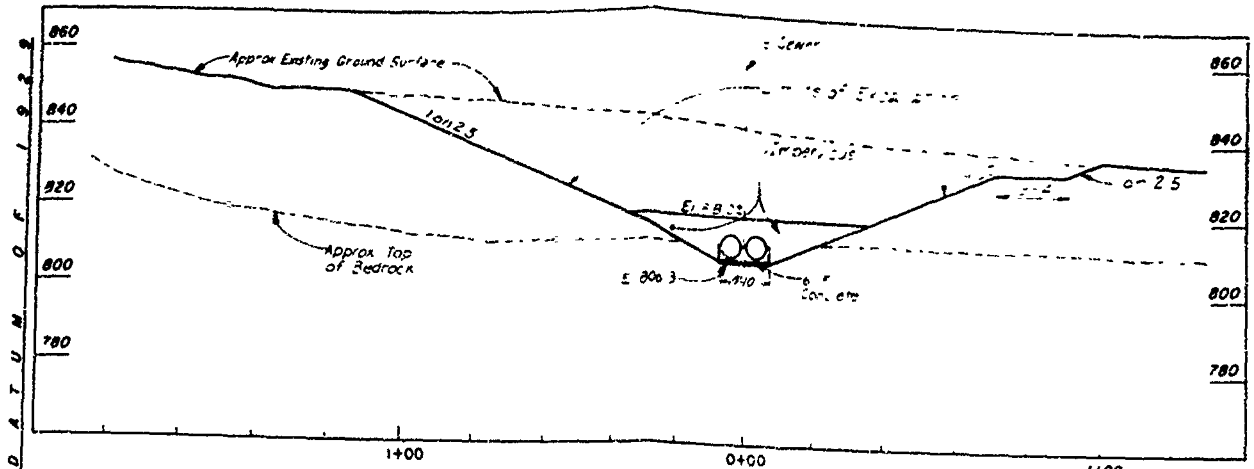
SECTION **STA. 44+51.8**



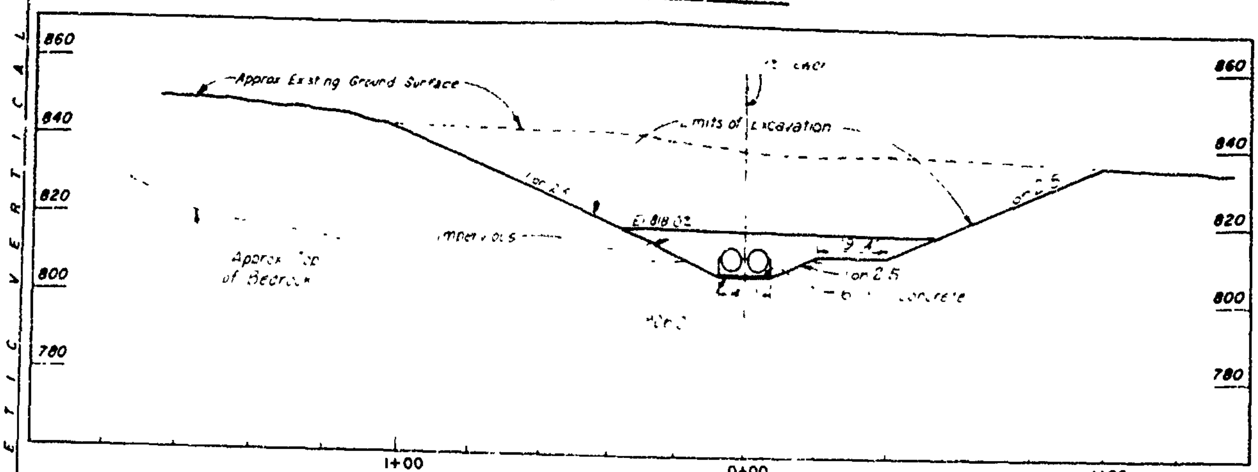
SECTION **STA. 45+00**



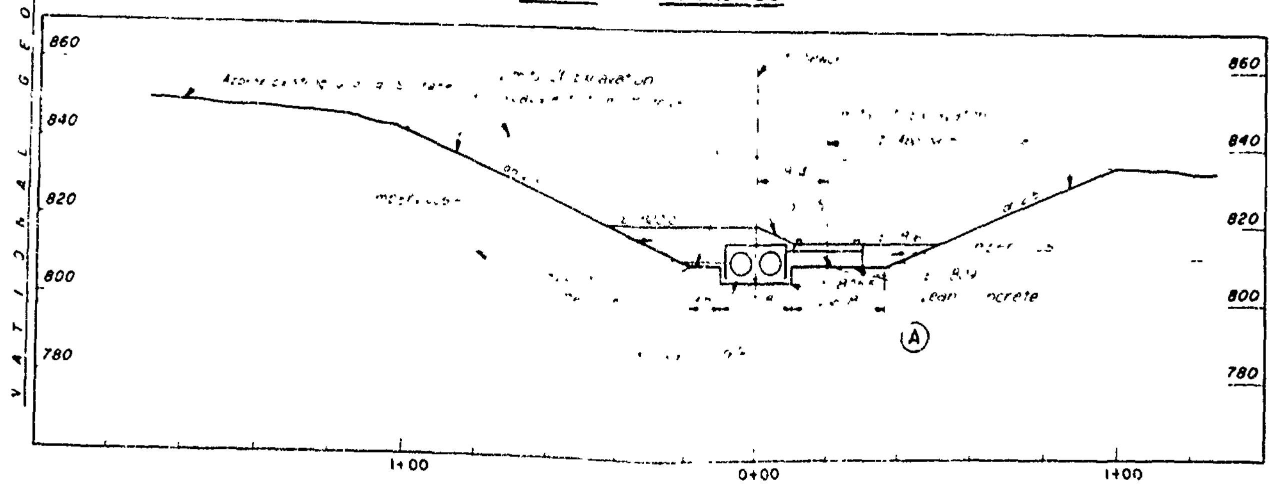
SECTION **STA. 45+07.3**



SECTION STA. 44+51.8



SECTION STA. 45+00



SECTION STA. 45+073

VERTICAL GEODETIC DATUM OF 1929

Symbol	Revisions Descriptions	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

Designed by: R.G.D.
Drawn by: J.G.S.
Checked by: R.G.D.
Submitted by: R.G.D.

US Army Corps of Engineers

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA
AND PERFORMANCE REPORT

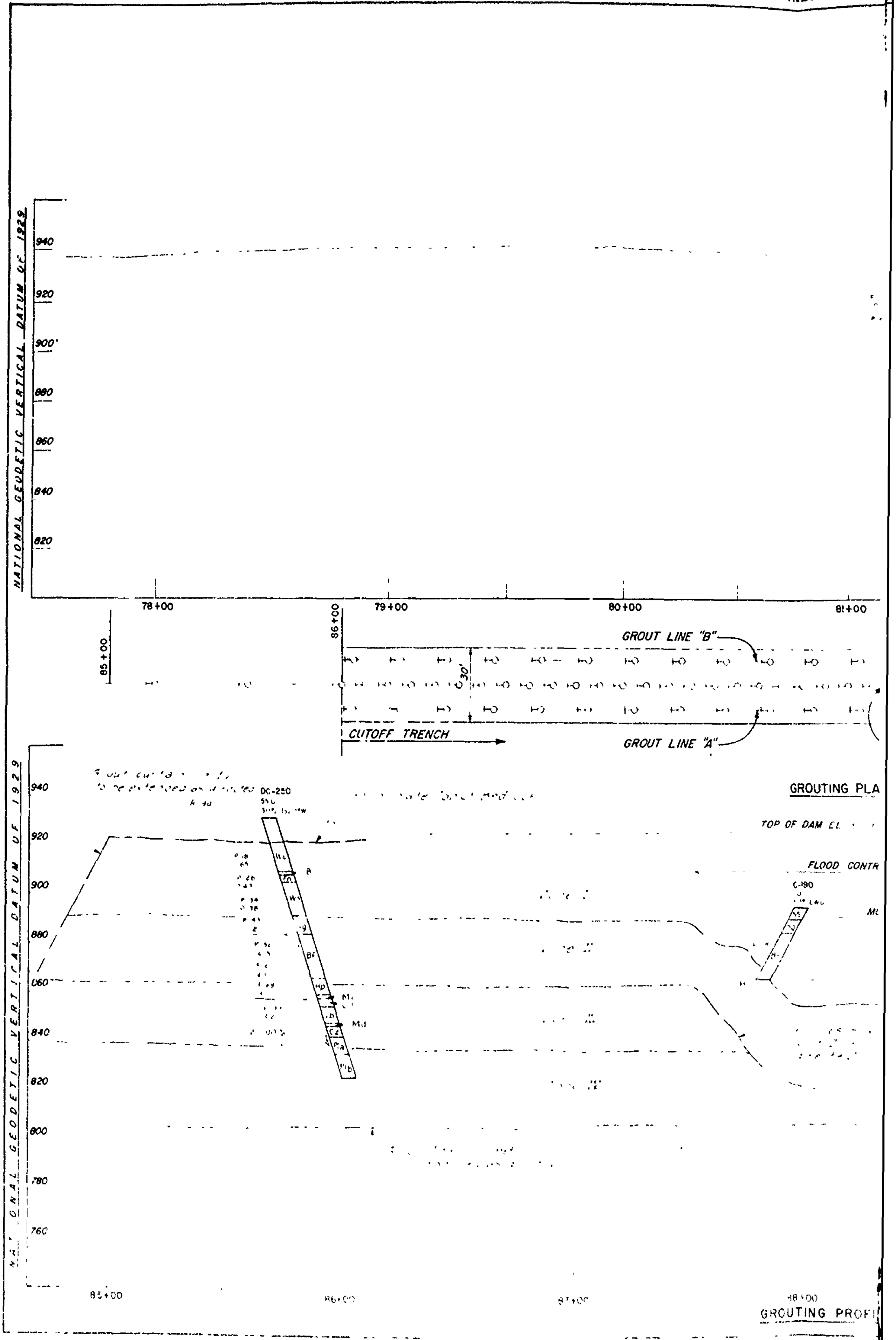
APPROACH STRUCTURES EXCAVATION PLAN, PROFILE, & SECTIONS

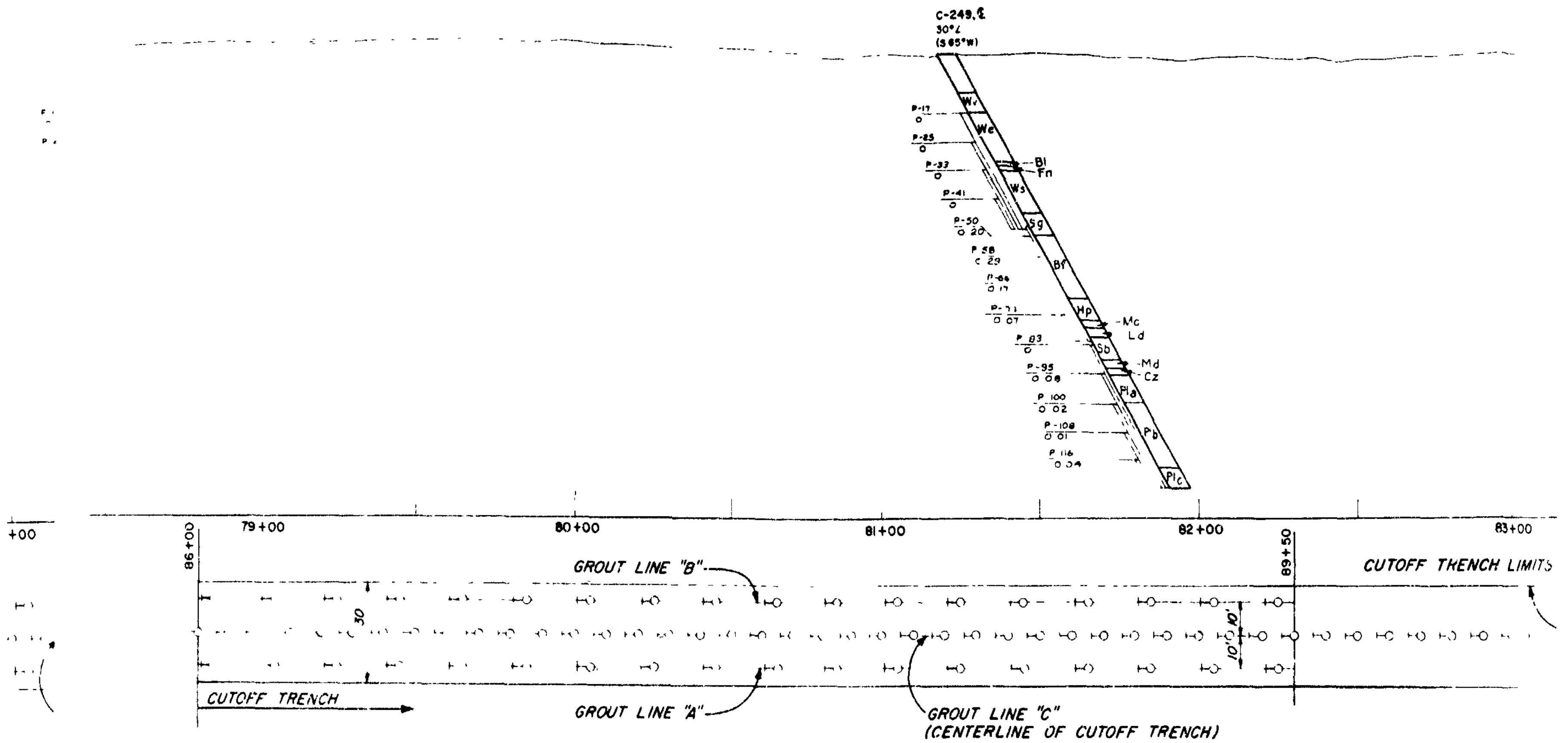
Scale: AS SHOWN

Sheet Number

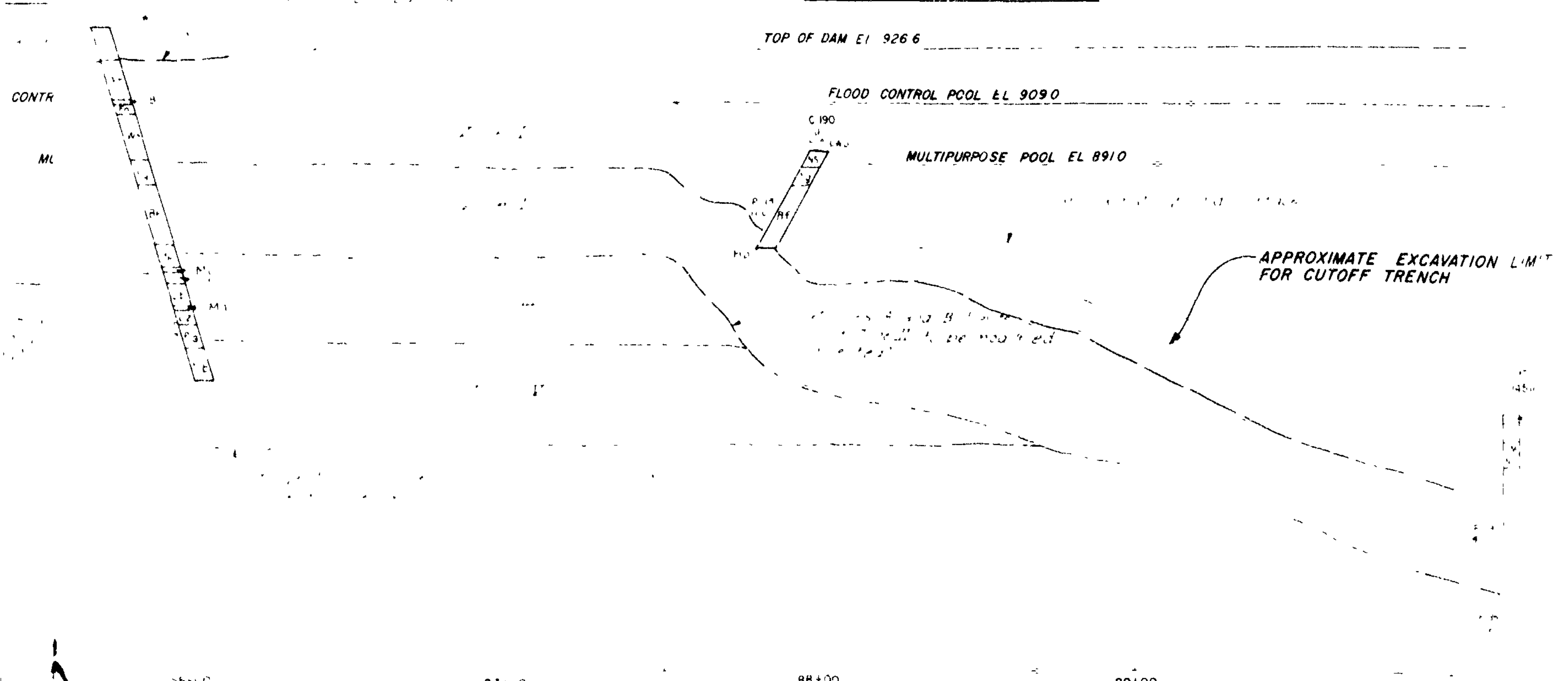
File No. RBL-3-1413

PLATE NO. 131


NATIONAL GEODETIC VERTICAL DATUM OF 1929
940
920
900
880
860
840
820
78+00
79+00
80+00
81+00
85+00
86+00
GROUT LINE "B"
30'
CUTOFF TRENCH
GROUT LINE "A"
GROUTING PLA
TOP OF DAM EL
FLOOD CONTR
DC-250
C-190
Md
780
760
85+00
86+00
87+00
88+00
GROUTING PROFI



GROUTING PLAN-RIGHT ABUTMENT



GROUTING PROFILE - RIGHT ABUTMENT

NOTES

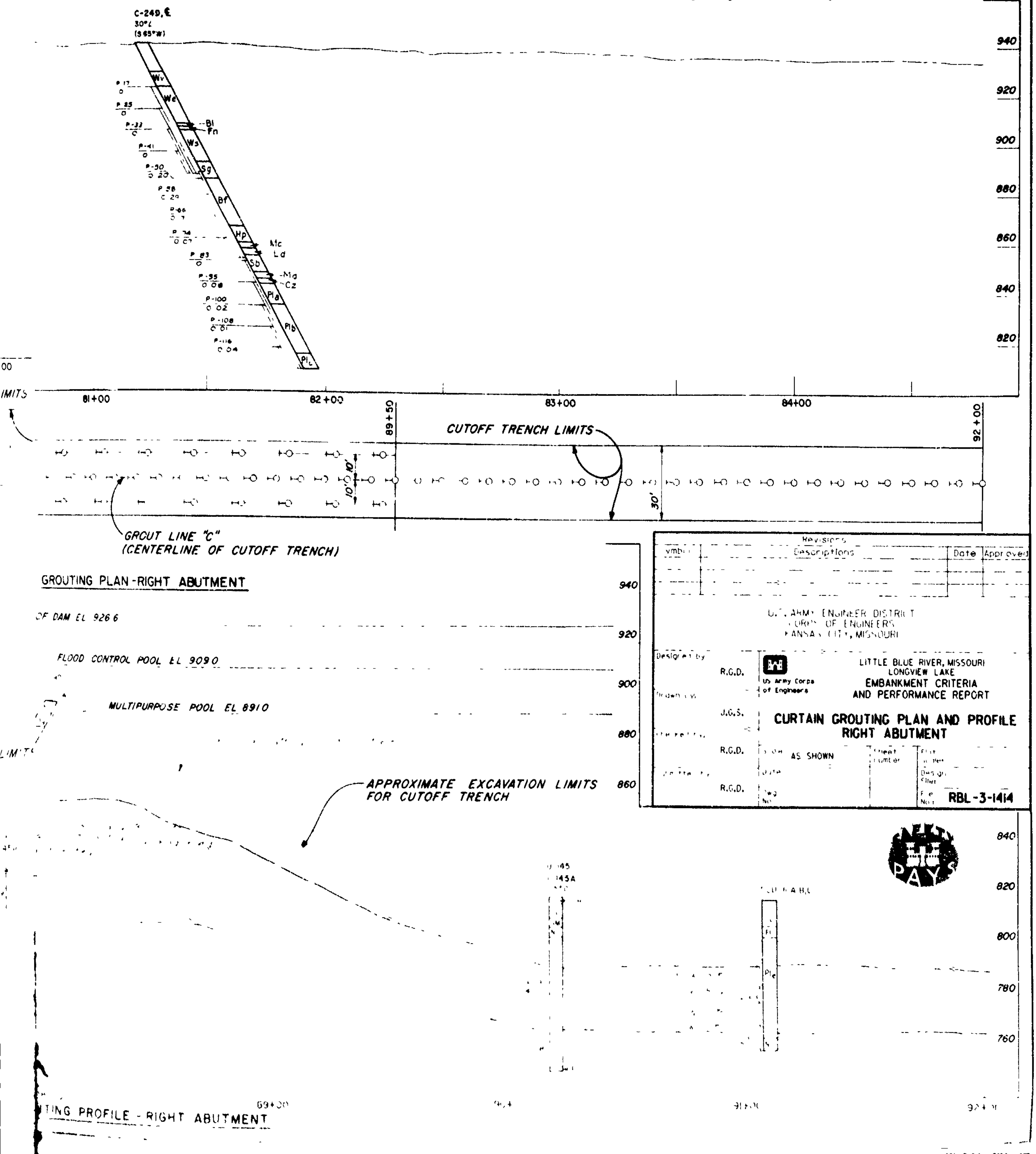
For plan of Borings, See Plate No 3

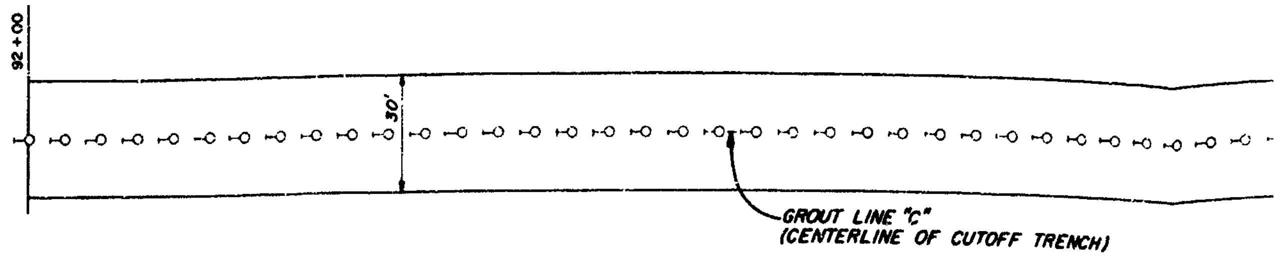
For General Geologic Column and Legend, See Plate No. 6

For boring logs showing soil and bedrock description, See Plate No 7

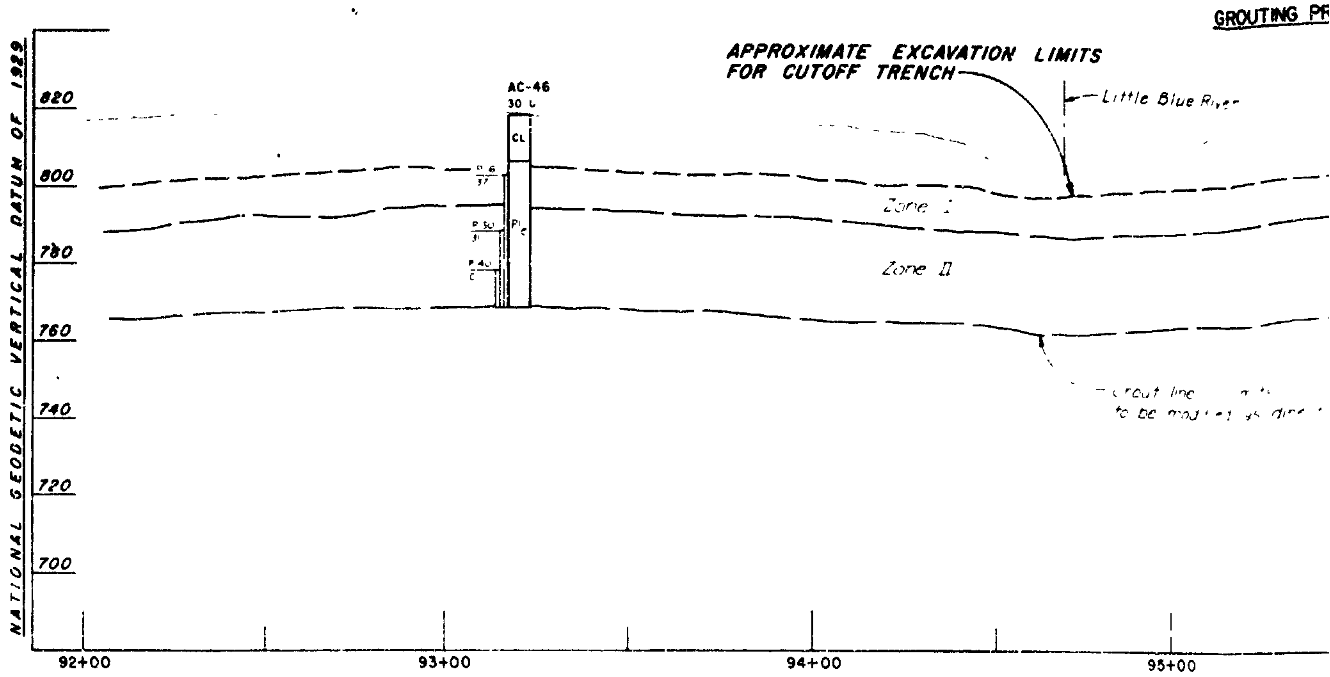
Only primary holes are shown on plans. Within the limits of the cutoff trench, secondary grout holes shall be mandatory

↘ Indicates direction of grout holes (Direction may be changed by the Contracting Officer)

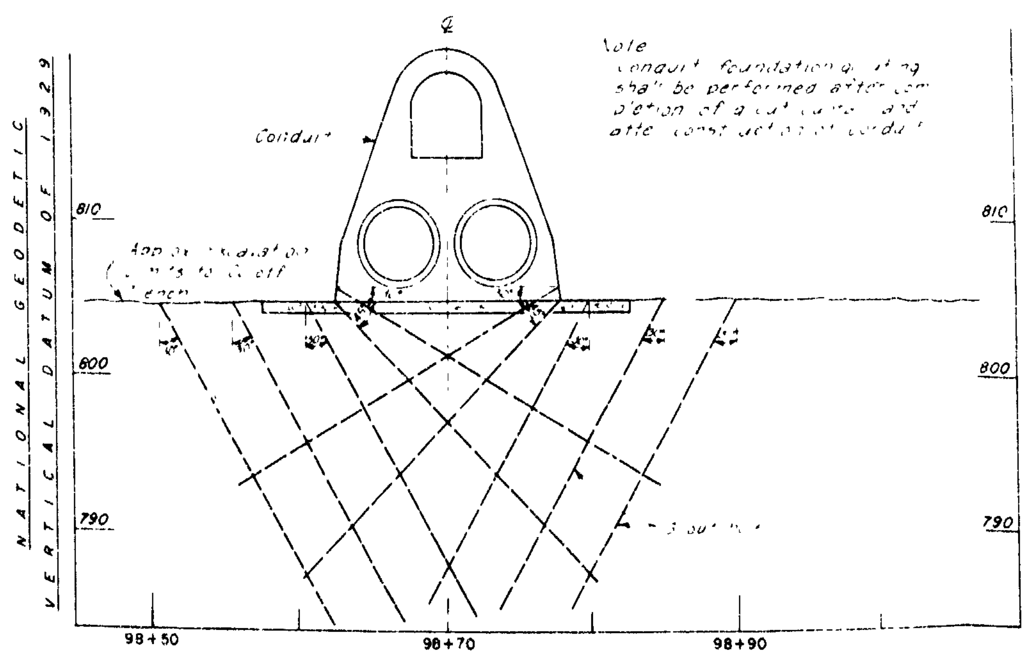




GROUTING PR

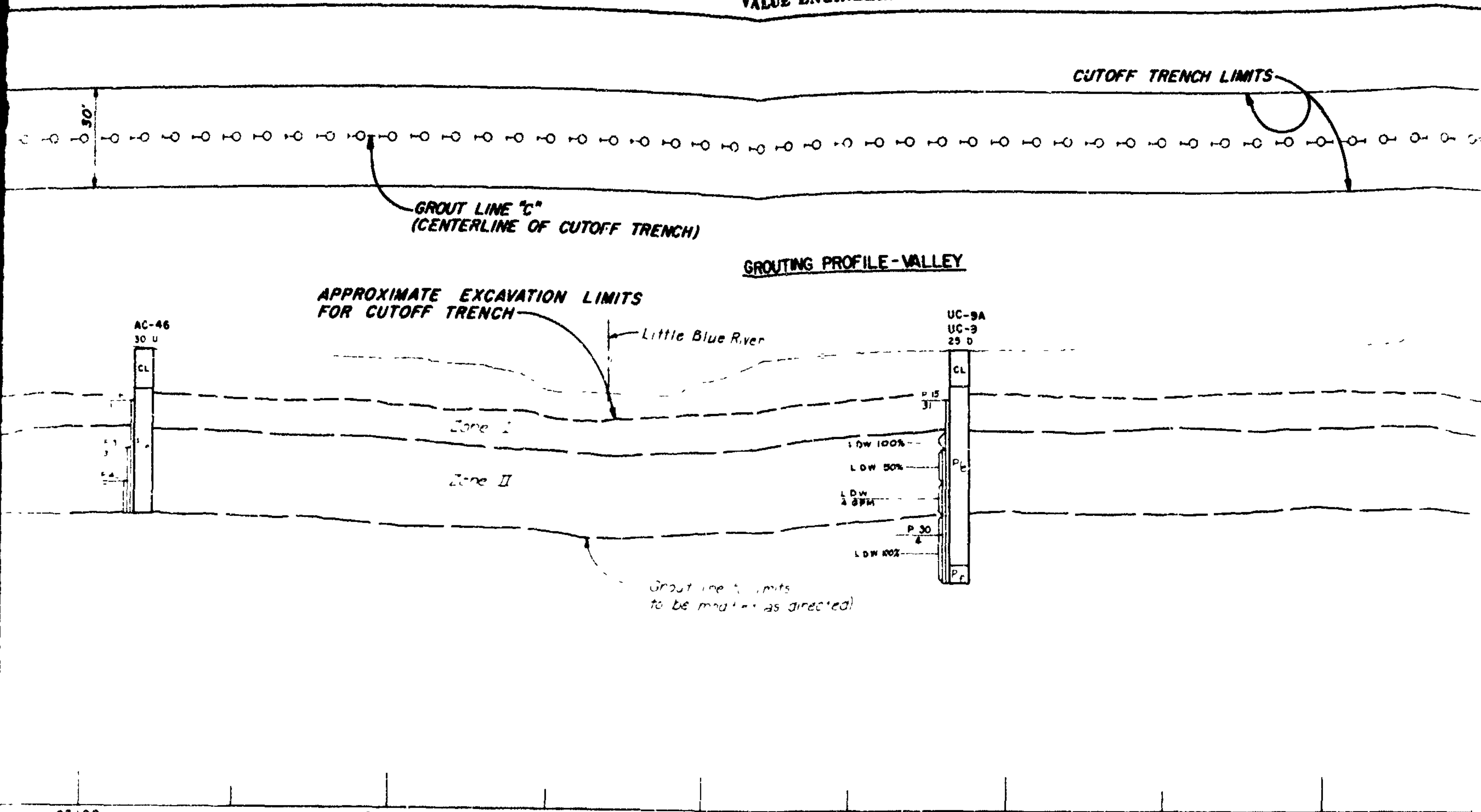


GROUTING

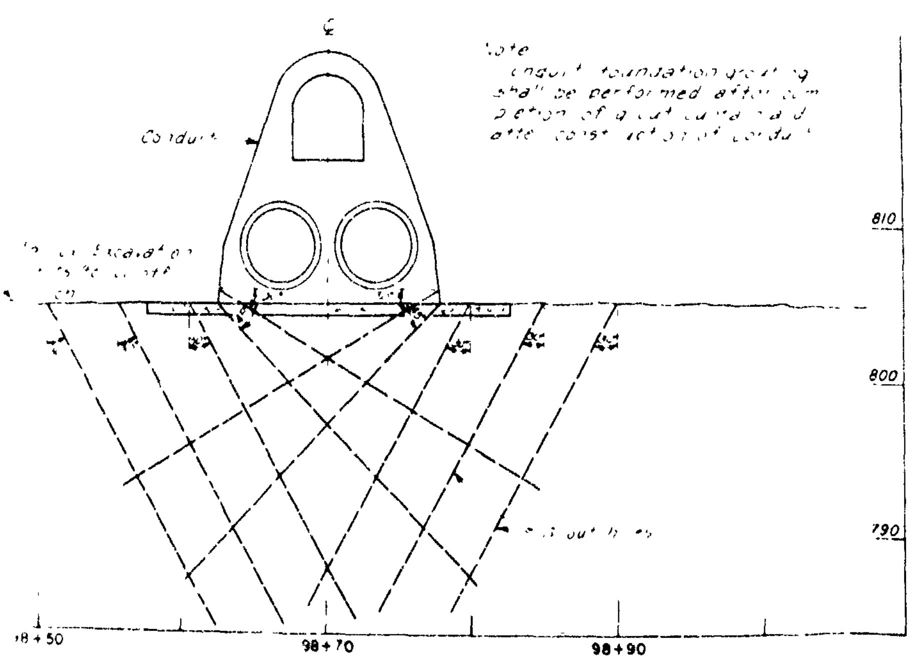


CONDUIT FOUNDATION GROUTING DETAIL

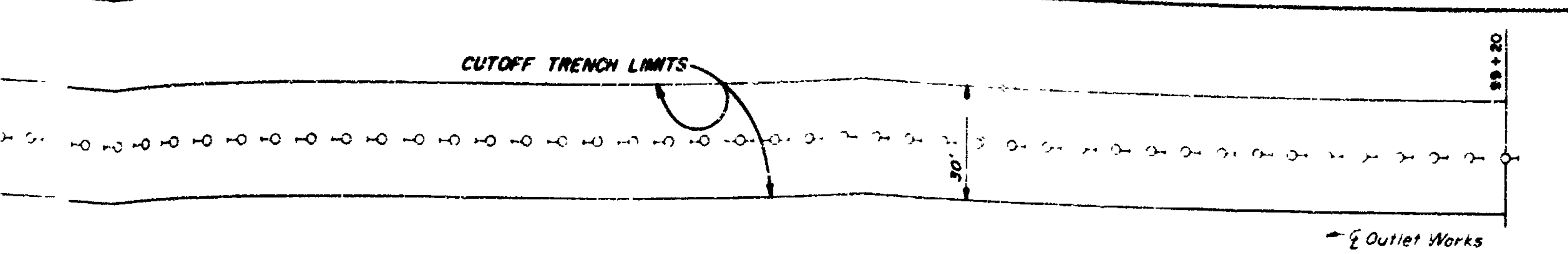
(LOOKING UPSTREAM)



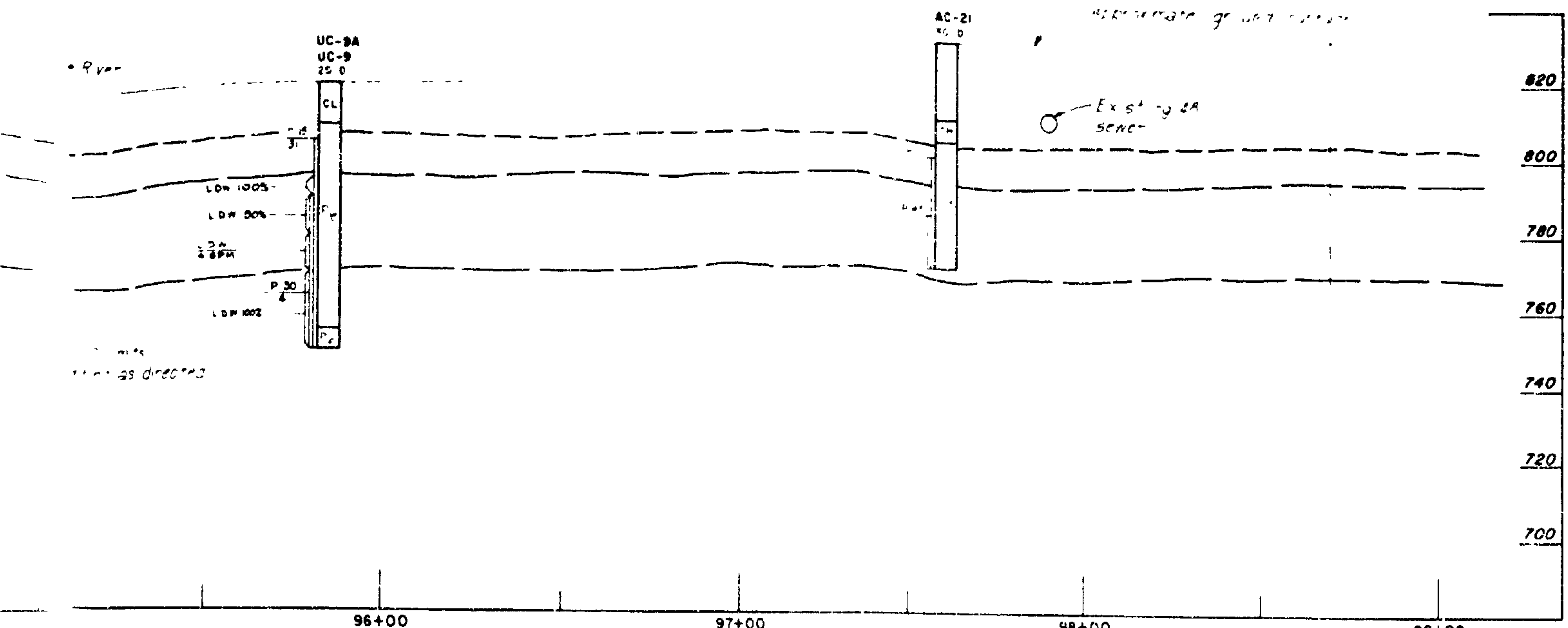
GROUTING PROFILE - VALLEY



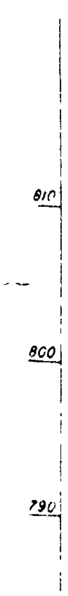
CONDUIT FOUNDATION GROUTING DETAIL
(LOOKING UPSTREAM)



GROUTING PROFILE - VALLEY



GROUTING PROFILE - VALLEY



[illegible] borings, see Plate No. 3
[illegible] Geologic Column and legend, see [illegible] 6
[illegible] boring logs showing soil and bedrock description see [illegible] No. 7
[illegible] holes are shown on plans. Within the [illegible] of the cutoff trench, secondary grout holes shall [illegible] mandatory
● [illegible] direction of grout holes (Direction may be changed by the Contracting Officer)

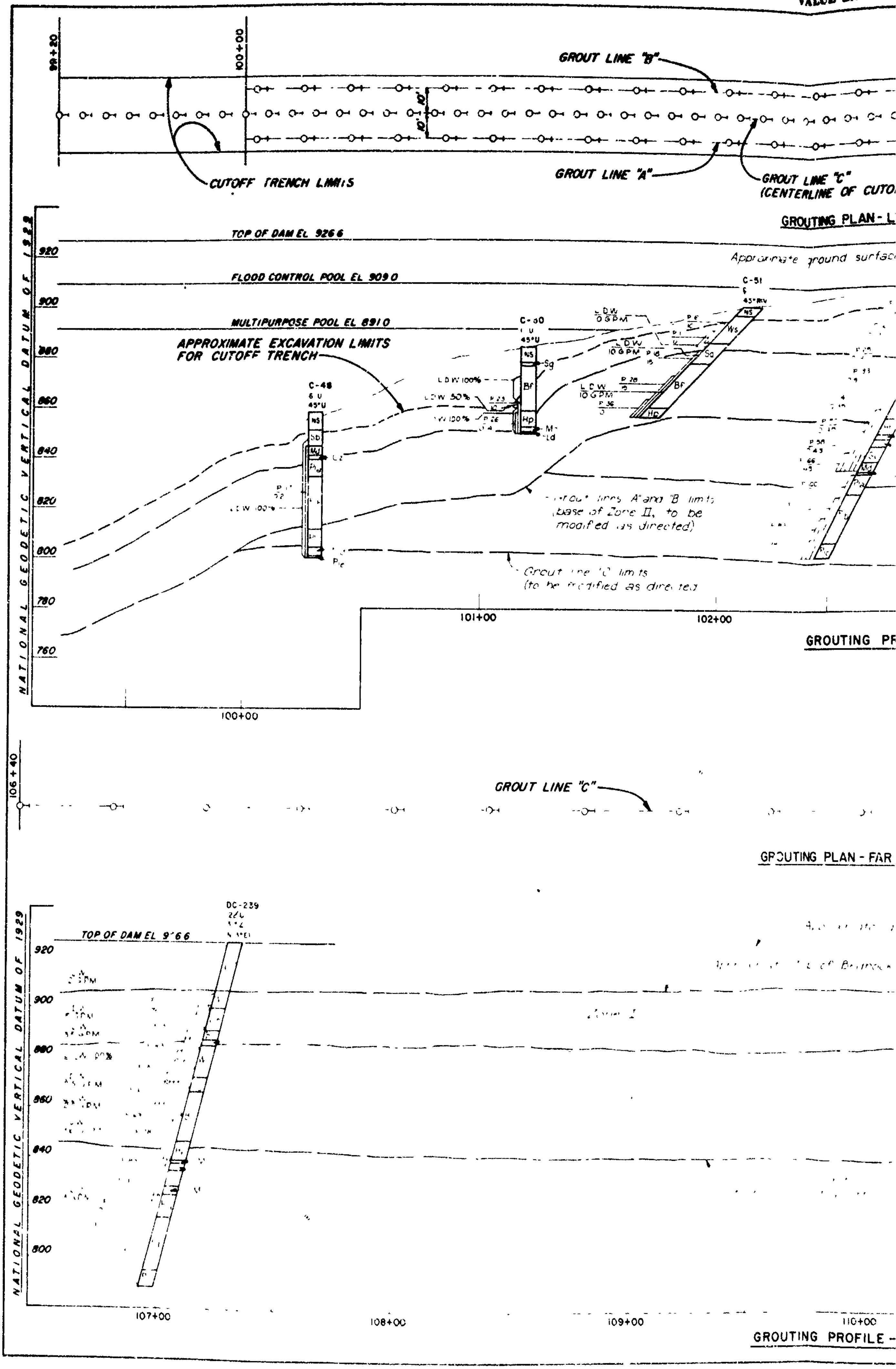
US Army Corps of Engineers

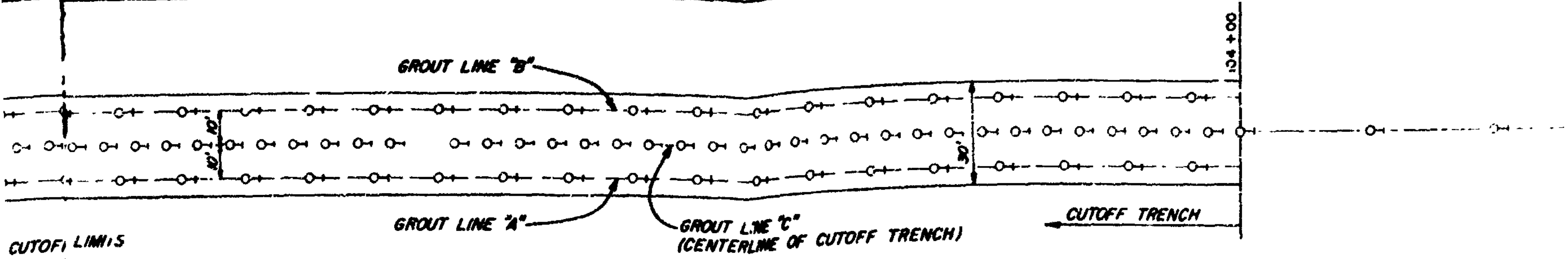
LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA
AND PERFORMANCE REPORT

CURTAIN GROUTING PLAN AND PROFILE
VALLEY AND CONDUIT FOUNDATION

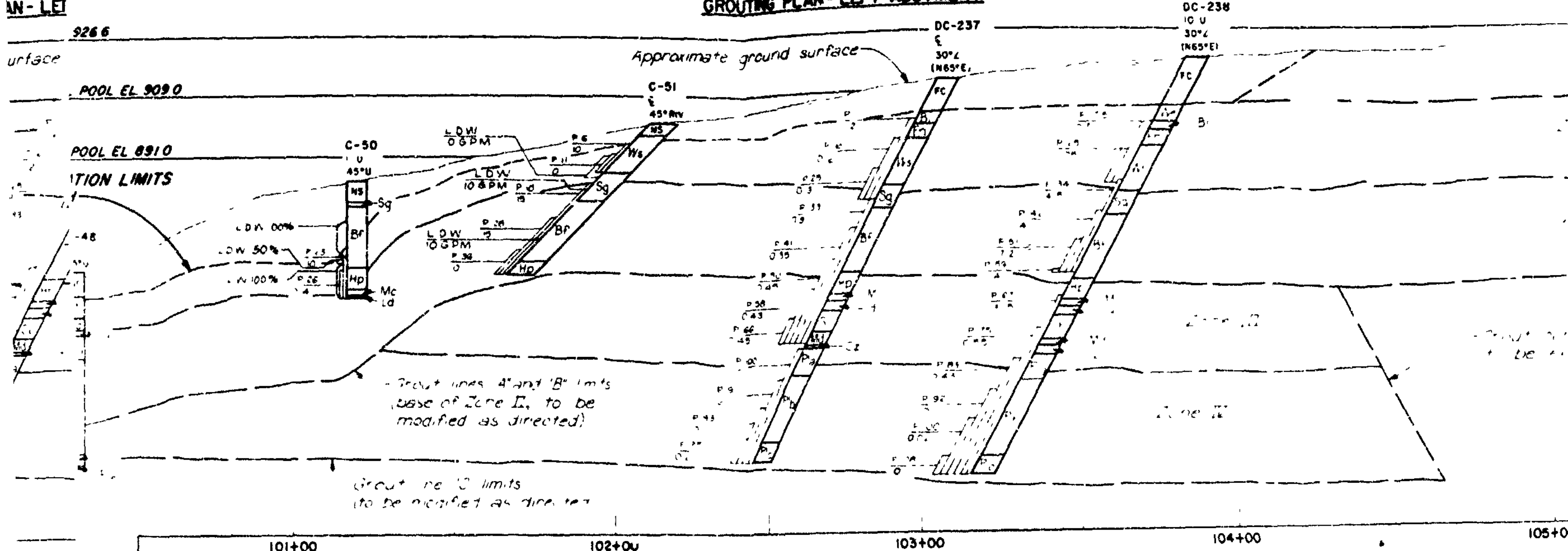
RBL-3-1415

VALUE ENGINEE

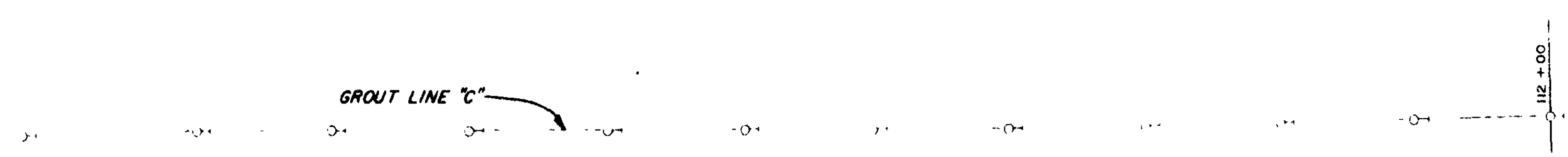




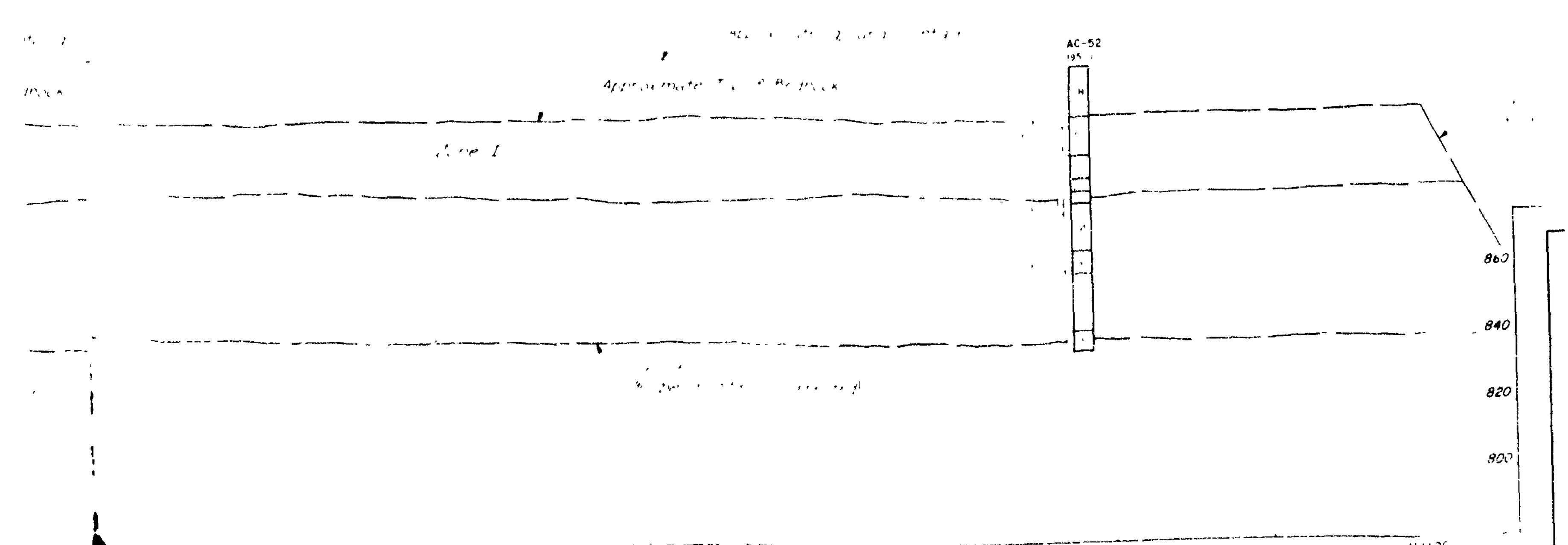
GROUTING PLAN - LEFT ABUTMENT



GROUTING PROFILE - LEFT ABUTMENT



GROUTING PLAN - FAR LEFT ABUTMENT



GROUTING PROFILE - FAR LEFT ABUTMENT

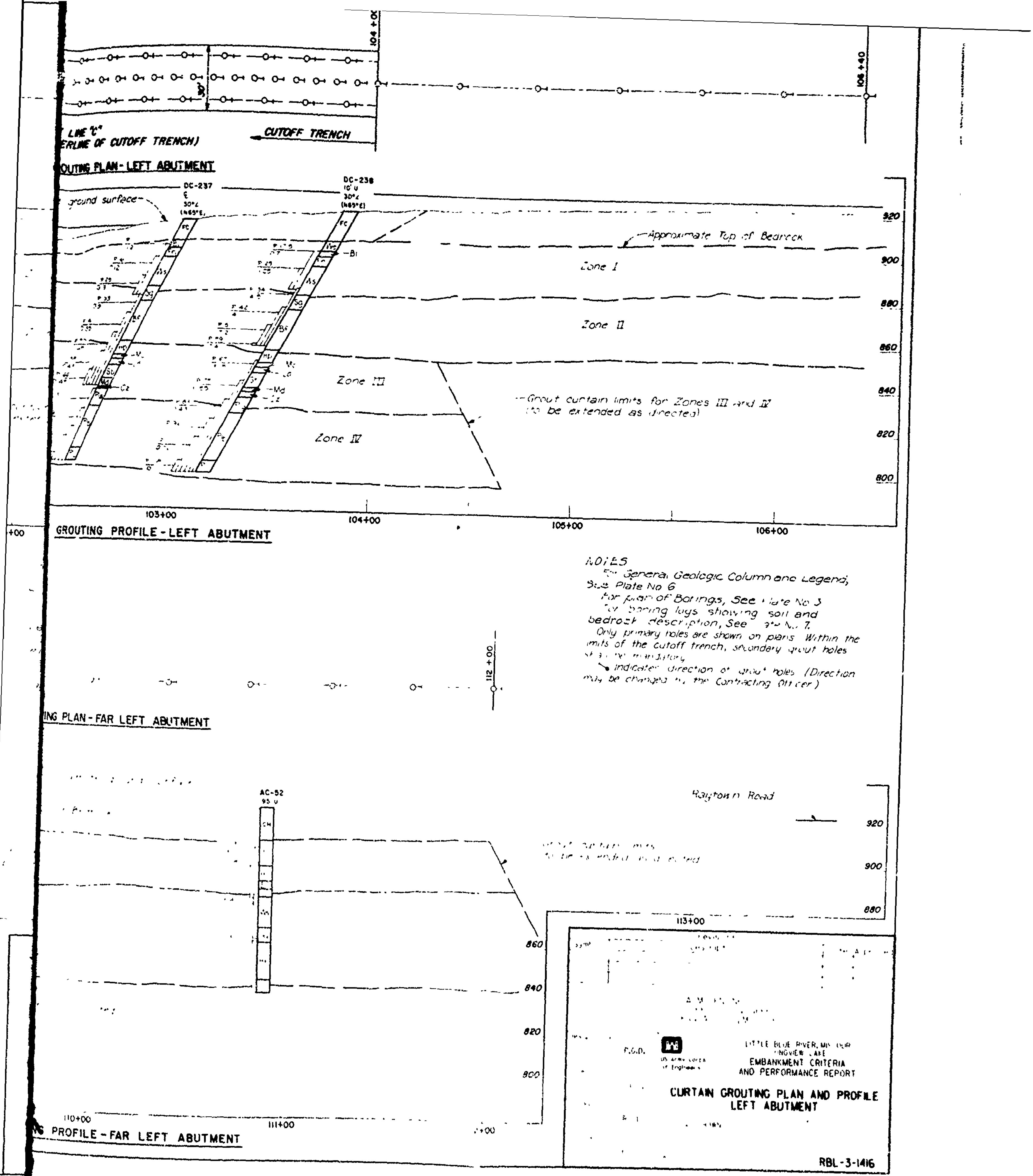
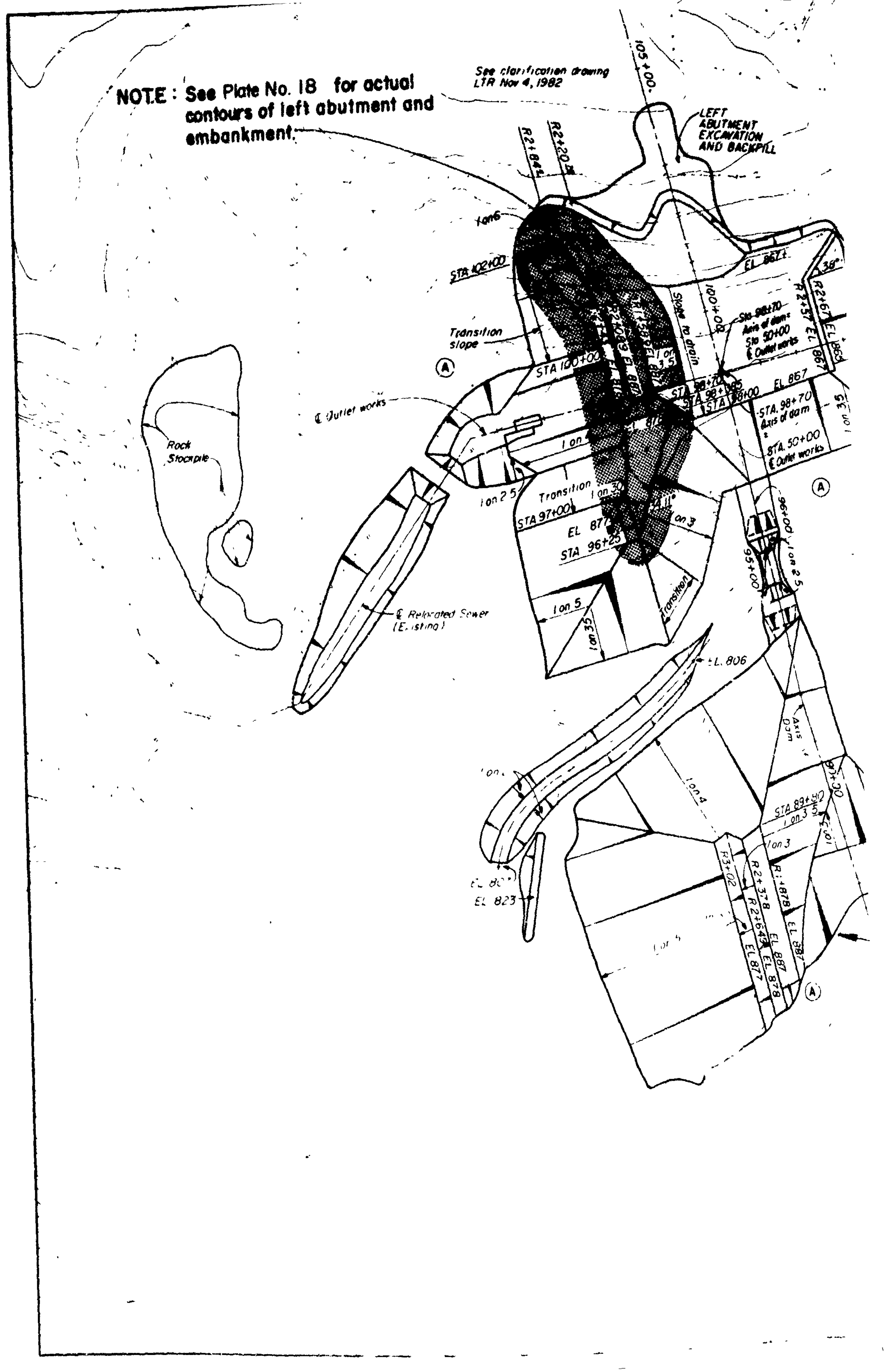
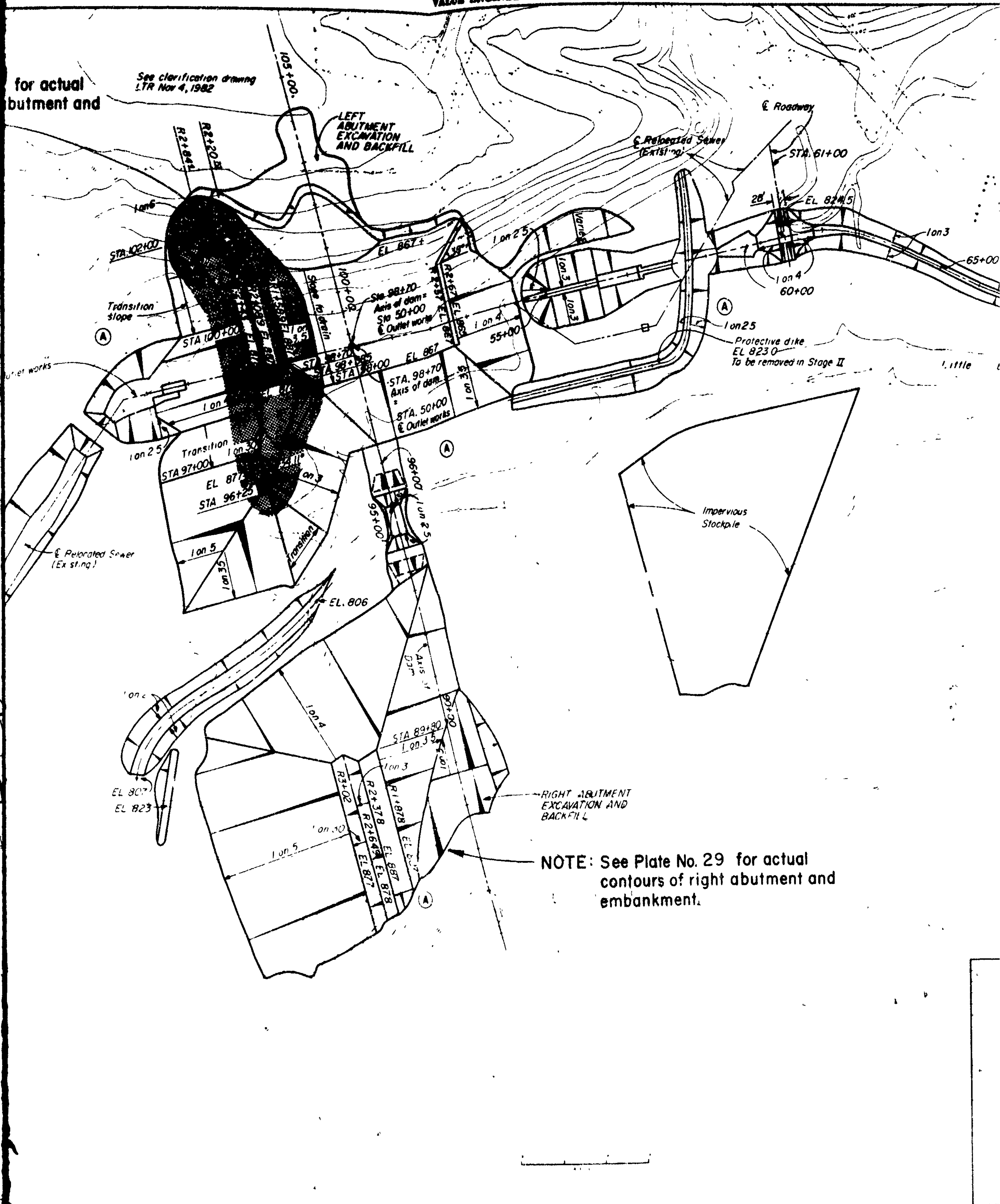

104+00
106+40
30'
LINE "C"
ERLINE OF CUTOFF TRENCH)
CUTOFF TRENCH
OUTING PLAN - LEFT ABUTMENT
DC-237
DC-238
ground surface
Approximate Top of Bedrock
Zone I
Zone II
Zone III
Zone IV
Grout curtain limits for Zones III and IV
be extended as directed)
920
900
880
860
840
820
800
103+00
104+00
105+00
106+00
GROUTING PROFILE - LEFT ABUTMENT
NOTES
General Geologic Column and Legend,
Plate No 6
For plan of Borings, See
No 3
Boring logs showing soil and
bedrock description, See
7.
Only primary holes are shown on plans Within the
imits of the cutoff trench, secondary grout holes
indicates direction of grout holes (Direction
may be changed
the Contracting Officer)
112+00
ING PLAN - FAR LEFT ABUTMENT
AC-52
Raytown Road
113+00
110+00
111+00
G PROFILE - FAR LEFT ABUTMENT
US Army Corps
of Engineers
EMBANKMENT CRITERIA
AND PERFORMANCE REPORT
CURTAIN GROUTING PLAN AND PROFILE
LEFT ABUTMENT
RBL-3-1416

PLATE NO. 16

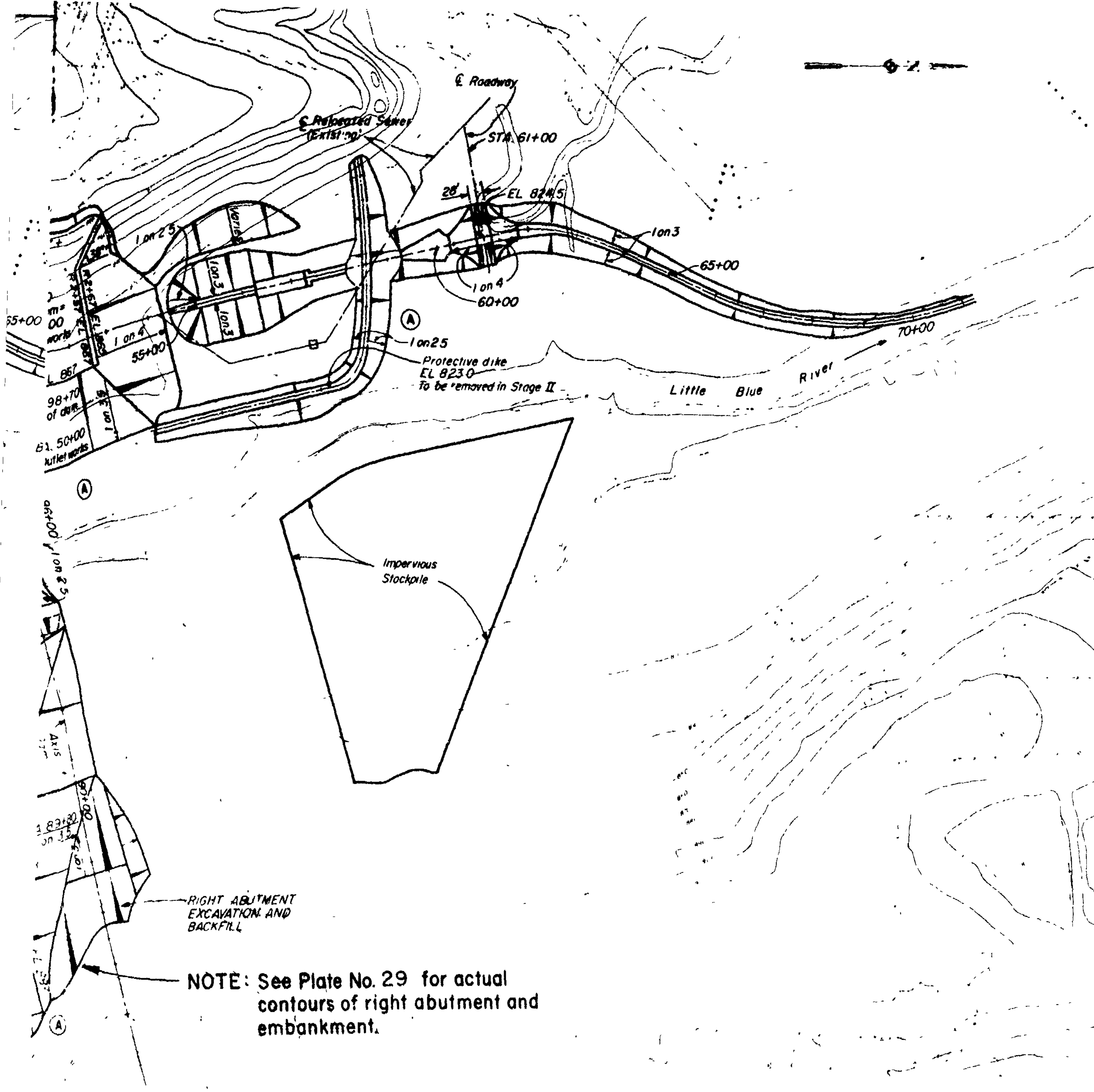


NOTE: See Plate No. 18 for actual contours of left abutment and embankment.
See clarification drawing LTR Nov 4, 1982
105+00
LEFT ABUTMENT EXCAVATION AND BACKFILL
R2+84
R2+20
1 on 6
STA 102+00
EL 867
Slope to drain
100+00
Transition slope
STA 100+00
Sta 98+70 Axis of dam = Sta 50+00 ℄ Outlet works
EL 867
STA 98+70 Axis of dam = STA 50+00 ℄ Outlet works
℄ Outlet works
Rock Stockpile
Transition
STA 97+00
EL 877
STA 96+25
1 on 3
96+00
95+00
1 on 2.5
1 on 5
1 on 3.5
Transition
℄ Relocated Sewer (Existing)
EL 806
Axis Dam
1 on 4
STA 89+30
1 on 3
EL 823
R3+02
R2+37.8
R2+64
EL 887
EL 878
EL 877

for actual
butment and



NOTE: See Plate No. 29 for actual contours of right abutment and embankment.



NOTE: See Plate No. 29 for actual contours of right abutment and embankment.

Revisions			
Symbol	Descriptions	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

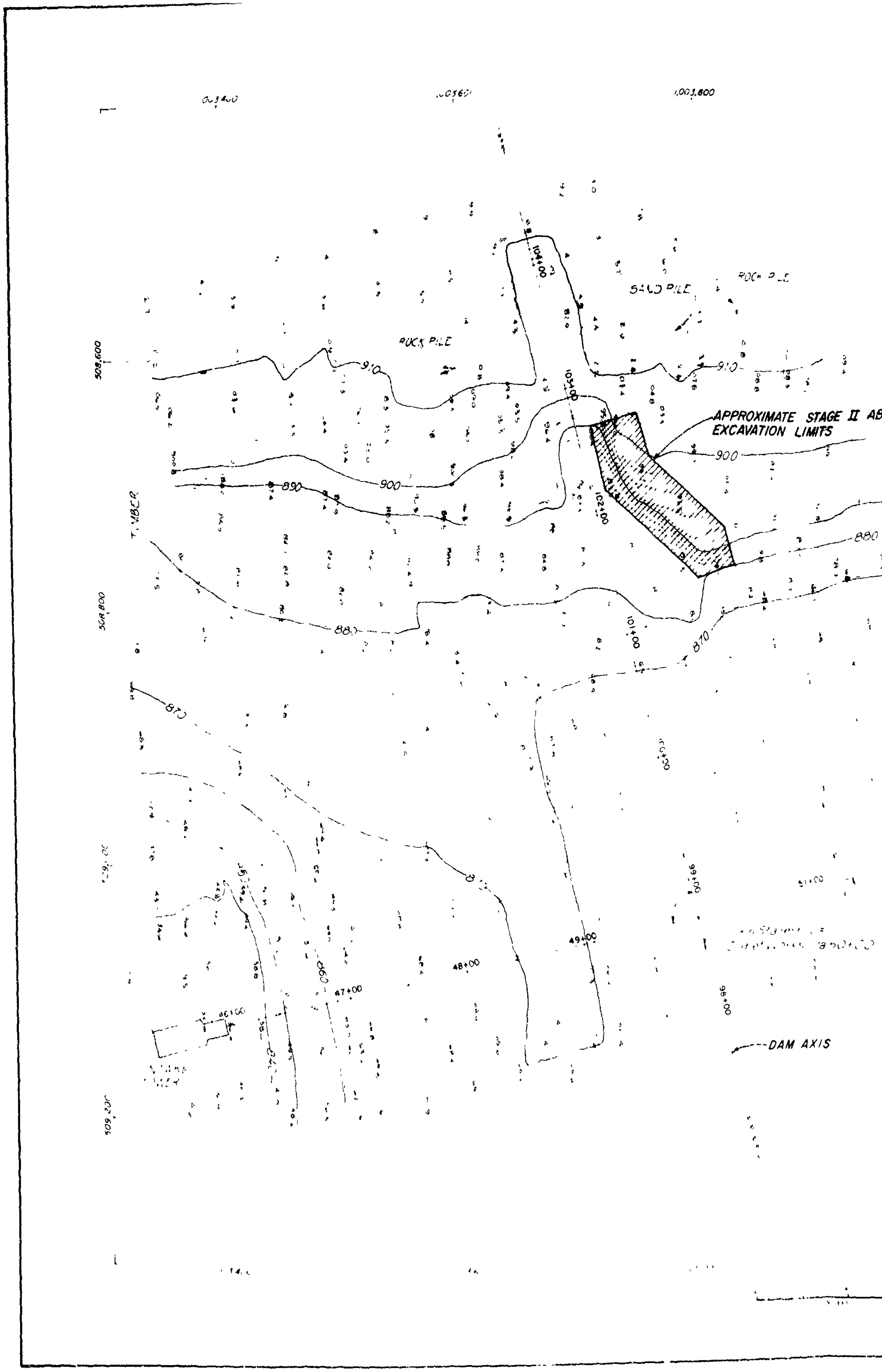
Designed by: R.G.D.
Drawn by: J.W.T.
Checked by: R.G.D.
Submitted by: R.G.D.

US Army Corps of Engineers

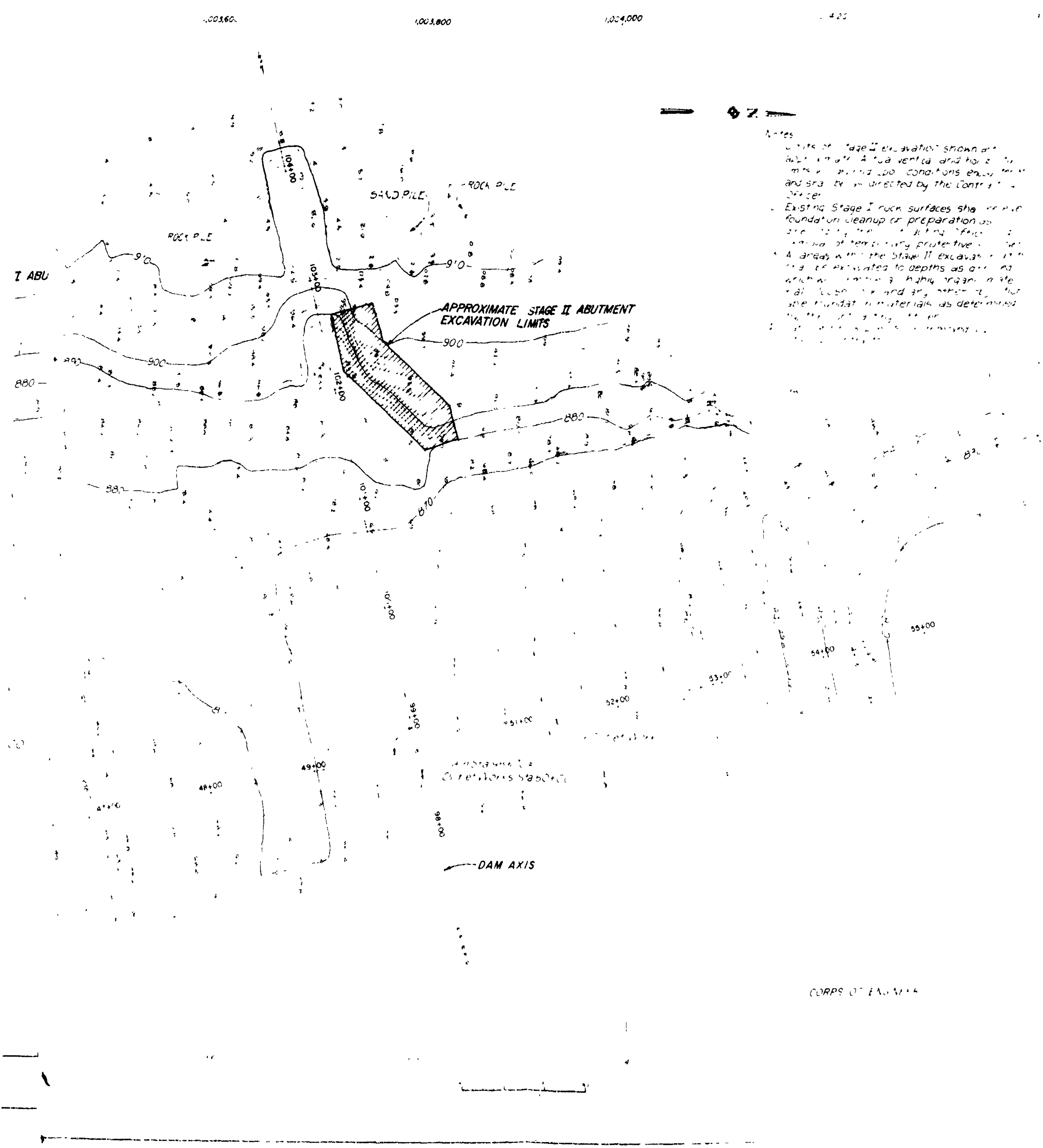
LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA
AND PERFORMANCE REPORT

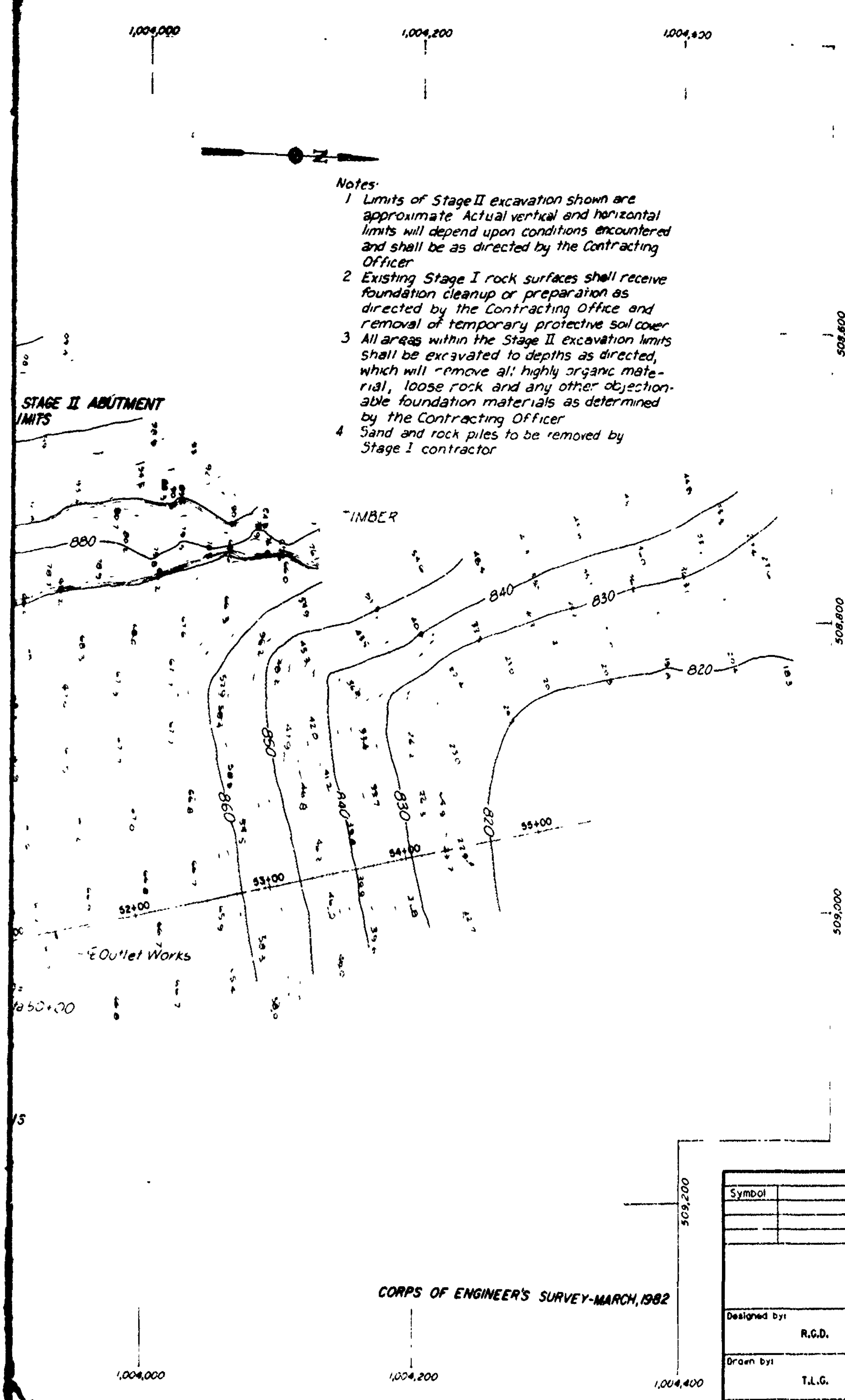
EMBANKMENT AT COMPLETION OF STAGE I

Scale: AS SHOWN
Date:
Dwg. No.:
Sheet number:
Plot Scale:
Design File:
File No.: REL-3-1417



1,003,800
508,600
508,800
ROCK PILE
SAND PILE
104+00
103+00
102+00
101+00
910
900
890
880
870
APPROXIMATE STAGE II ABU
EXCAVATION LIMITS
TIMBER
49+00
48+00
47+00
99+00
98+00
DAM AXIS


1,003,600
1,003,800
1,004,000
Notes
Existing Stage I rock surfaces
foundation cleanup or preparation
SAND PILE
ROCK PILE
ROCK PILE
APPROXIMATE STAGE II ABUTMENT
EXCAVATION LIMITS
900
880
870
104+00
103+00
102+00
101+00
100+00
99+00
98+00
55+00
54+00
53+00
52+00
51+00
49+00
48+00
DAM AXIS
CORPS OF ENGINEERS



Notes:

1. Limits of Stage II excavation shown are approximate. Actual vertical and horizontal limits will depend upon conditions encountered and shall be as directed by the Contracting Officer.
2. Existing Stage I rock surfaces shall receive foundation cleanup or preparation as directed by the Contracting Office and removal of temporary protective soil cover.
3. All areas within the Stage II excavation limits shall be excavated to depths as directed, which will remove all highly organic material, loose rock and any other objectionable foundation materials as determined by the Contracting Officer.
4. Sand and rock piles to be removed by Stage I contractor.

Revisions			
Symbol	Descriptions	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

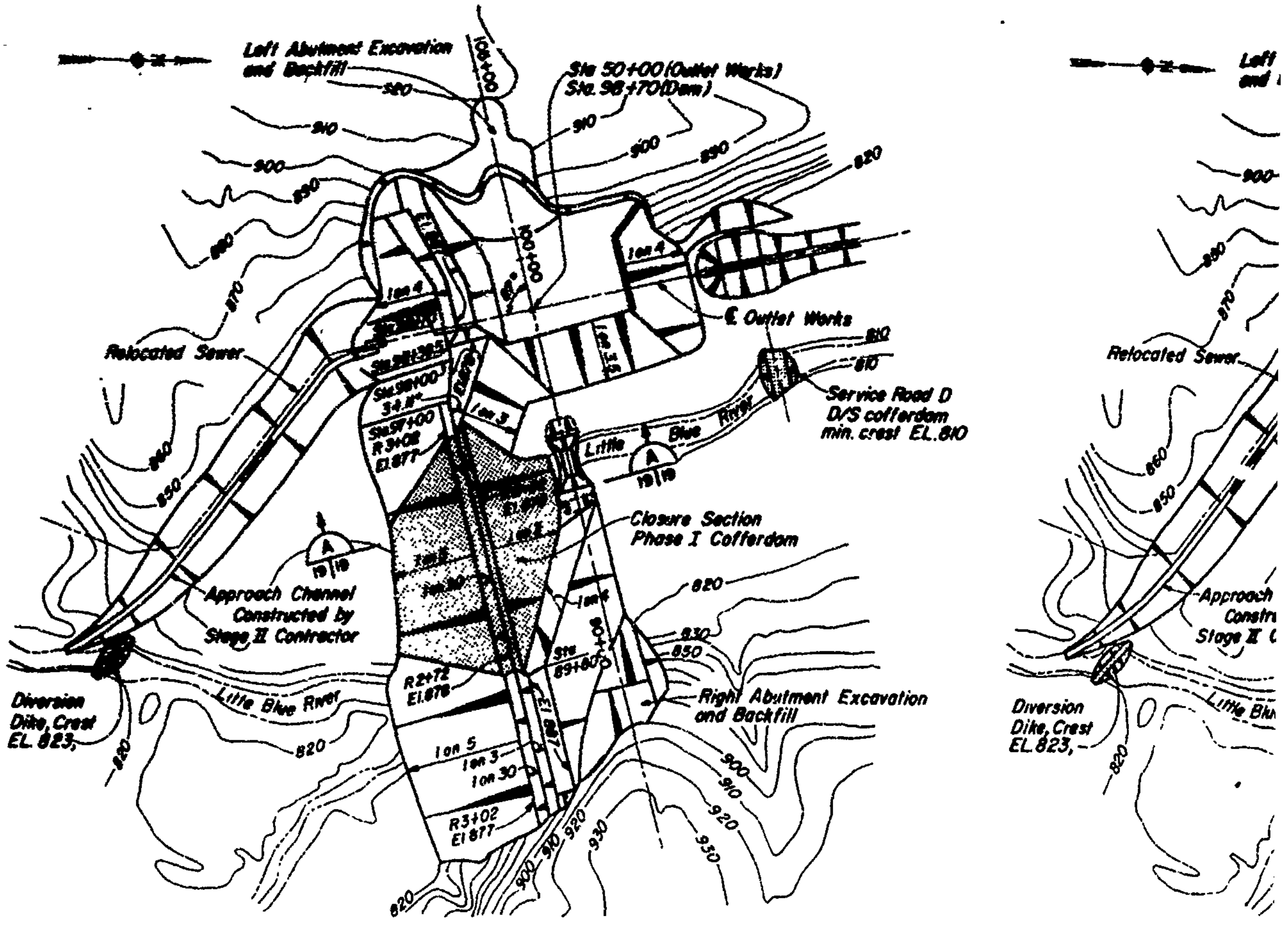
US Army Corps of Engineers

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA
AND PERFORMANCE REPORT

LEFT ABUTMENT AND EMBANKMENT TOPOGRAPHY

Designed by:	R.G.D.
Drawn by:	T.L.G.
Checked by:	R.G.D.
Submitted by:	R.G.D.

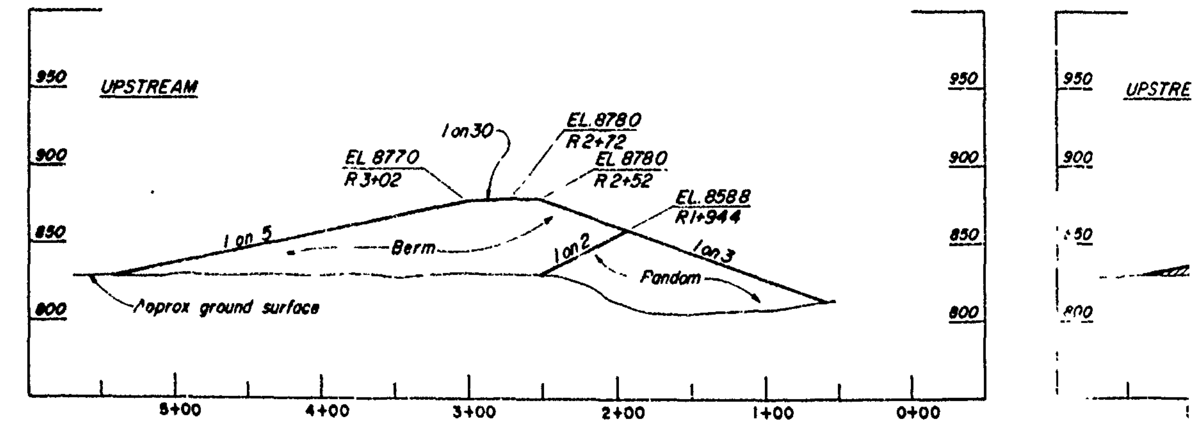
Scale: AS SHOWN
Sheet number:
Date:
Dwg. No.:
Plot Scale:
Design File:
File No.: RBL-3-1418



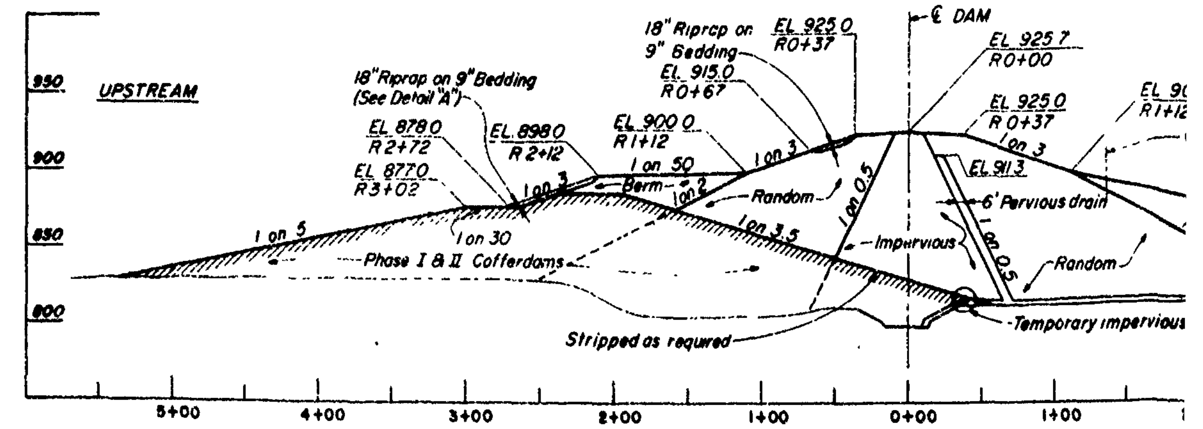
PHASE I COFFERDAM COMPLETED TO EL. 878

SCALE IN FEET

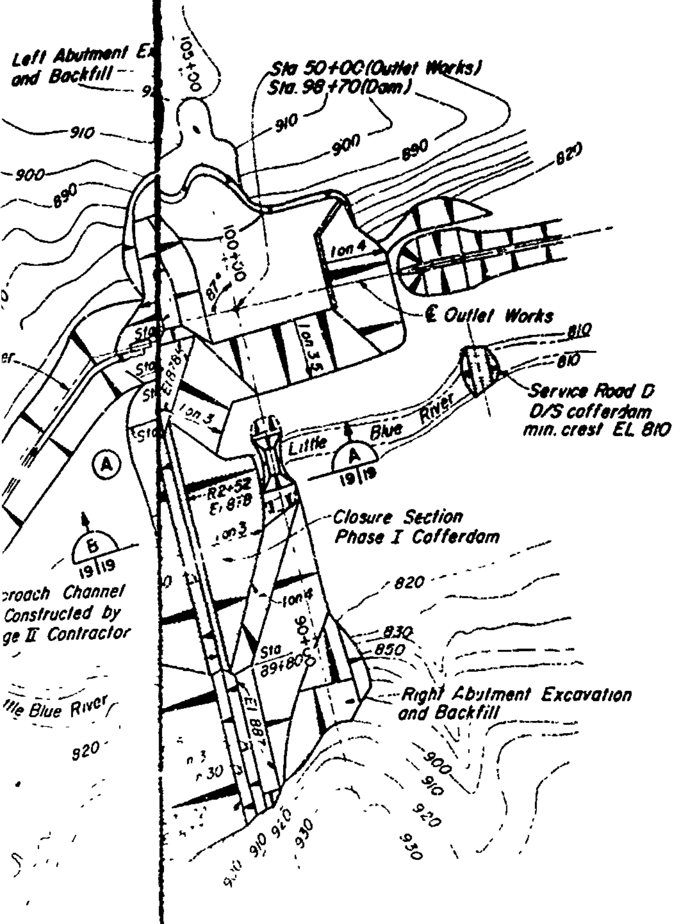
ELEVATION IN FEET BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929



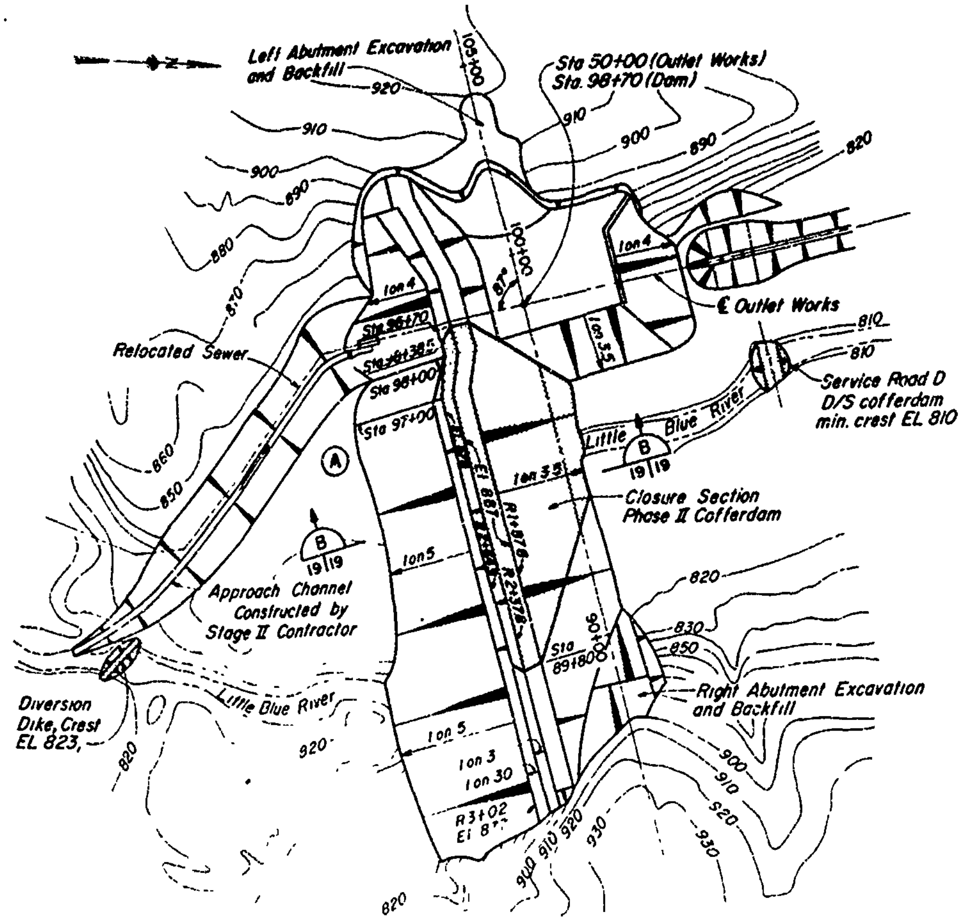
TYPICAL PHASE I COFFERDAM SECTION (A 19|19)



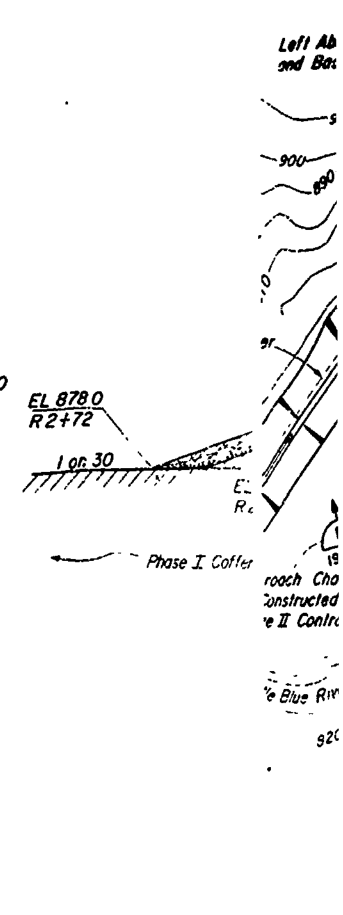
TYPICAL CLOSURE SECTION



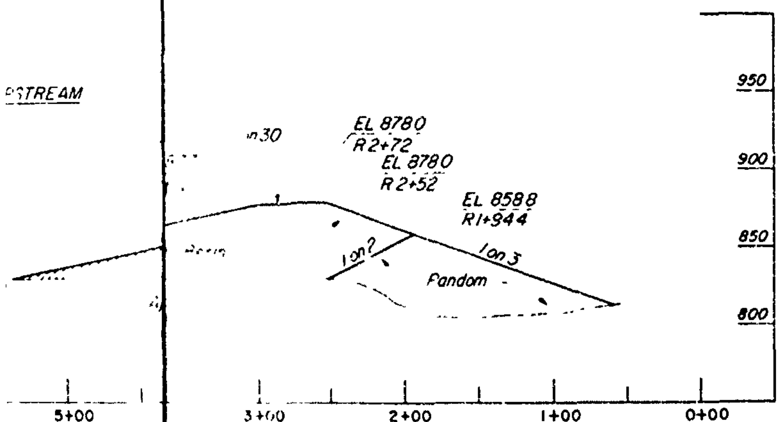
PHASE II CO[illegible]M COMPLETED TO EL 878



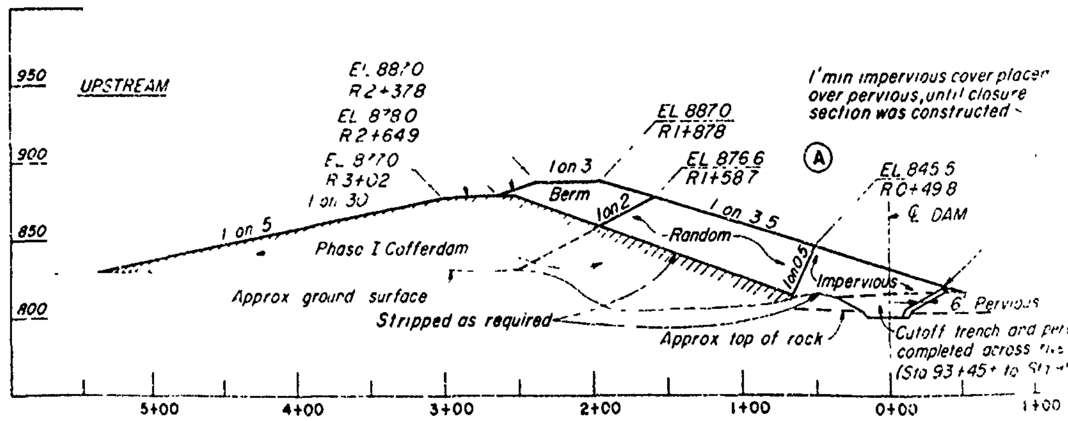
PHASE II COFFERDAM COMPLETED TO EL. 887



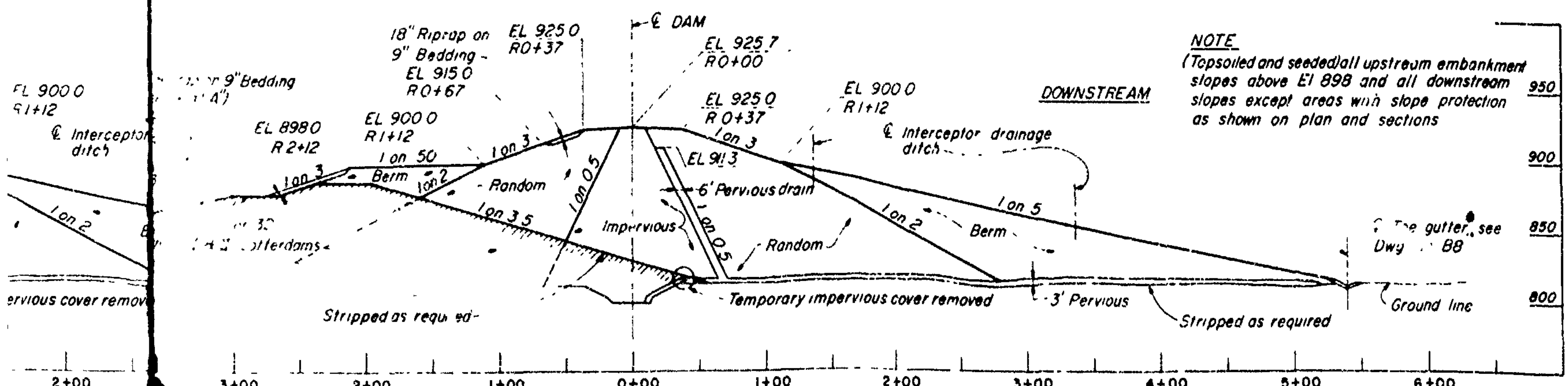
PHASE



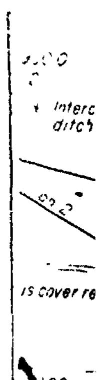
PHASE I COFFERDAM SECTION A 19|19



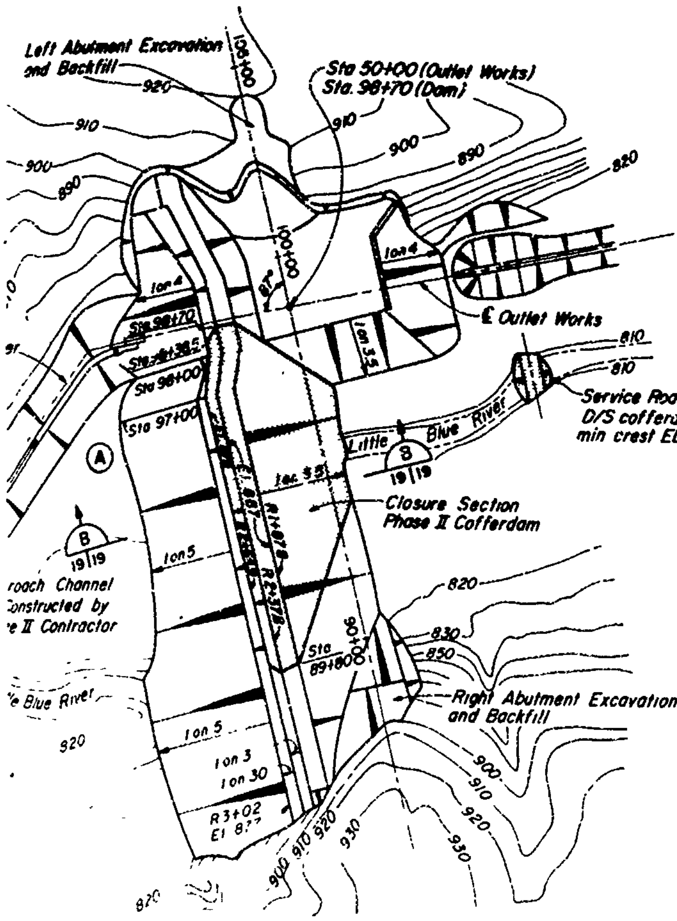
TYPICAL PHASE II COFFERDAM SECTION B 19|19



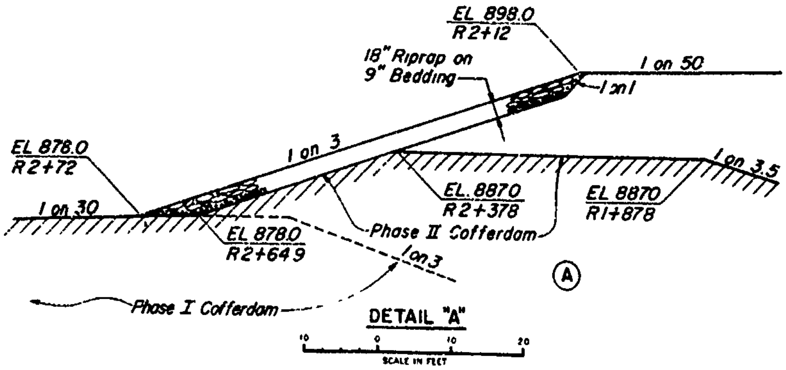
TYPICAL CLOSURE SECTION



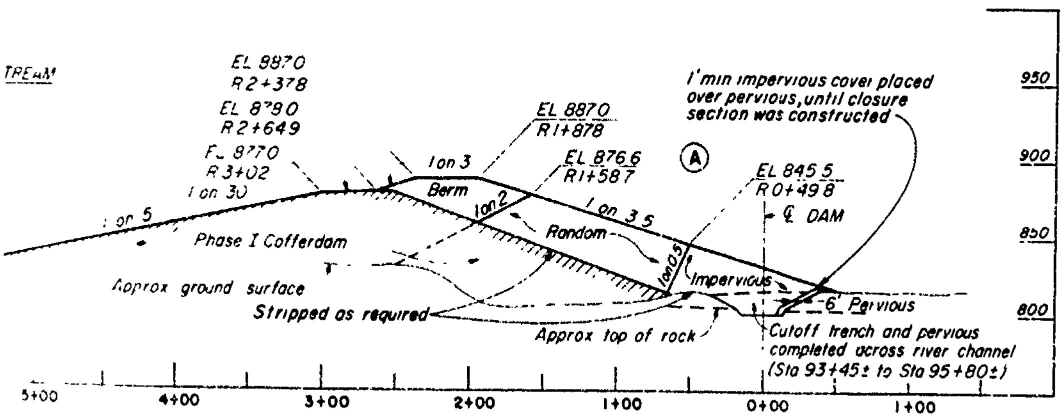
SAFETY PAYS



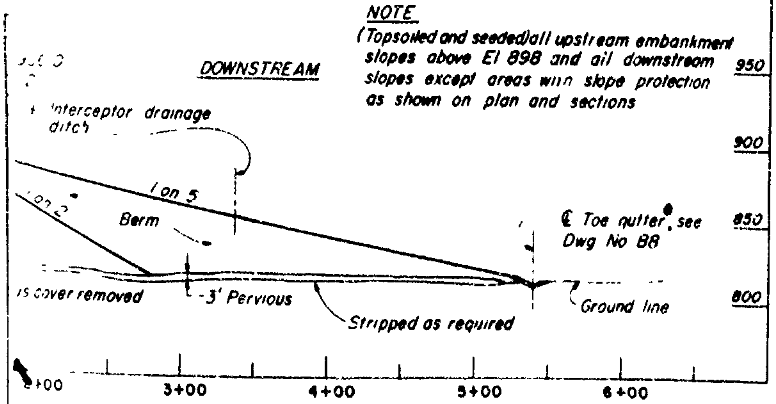
PHASE II COFFERDAM COMPLETED TO EL. 887



DETAIL "A"



TYPICAL PHASE II COFFERDAM SECTION B 19|19



NOTE

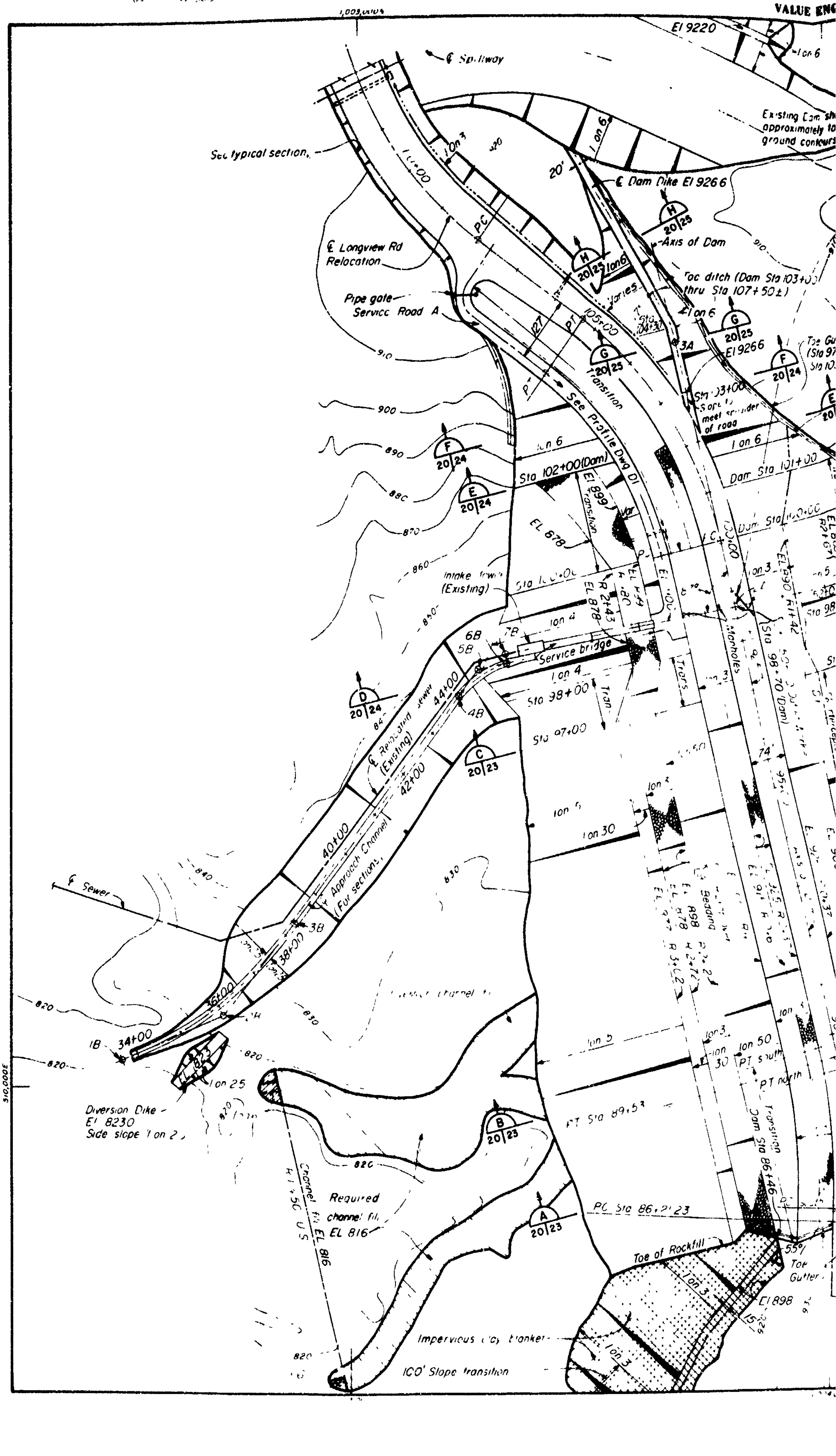
(Topsoiled and seeded) all upstream embankment slopes above El 898 and all downstream slopes except areas with slope protection as shown on plan and sections

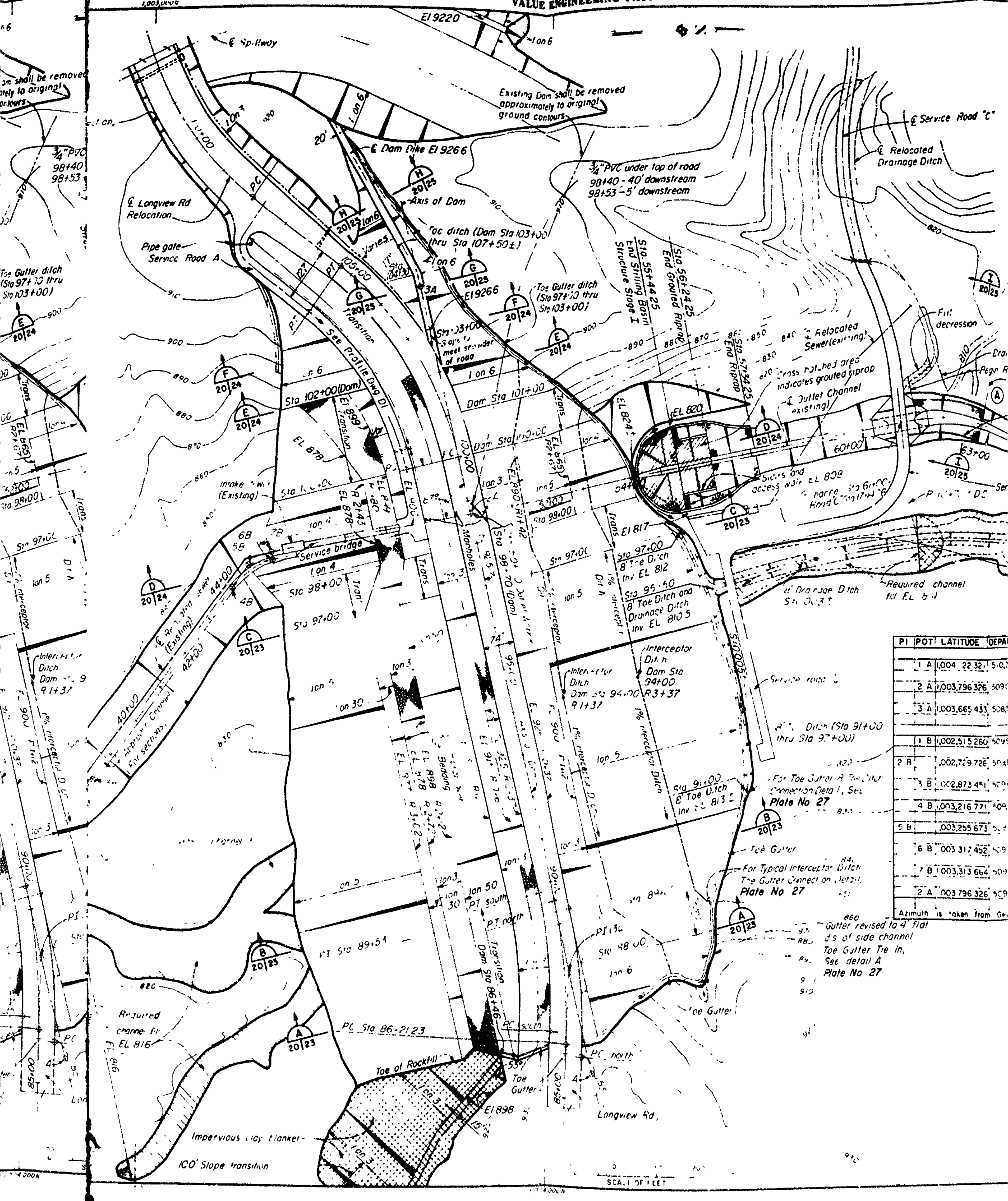
Revisions			
Symbol	Descriptions	Date	Approved

U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

Designed by R.G.D.	LITTLE BLUE RIVER, MISSOURI LONGVIEW LAKE EMBANKMENT CRITERIA AND PERFORMANCE REPORT DIVERSION AND CLOSURE: PLANS AND SECTIONS
Drawn by S.L.M.	
Checked by R.G.D/W.B.E	Scale AS SHOWN
Submitted by R.C.D	File No. RBL-3-1419

PLATE NO. 19

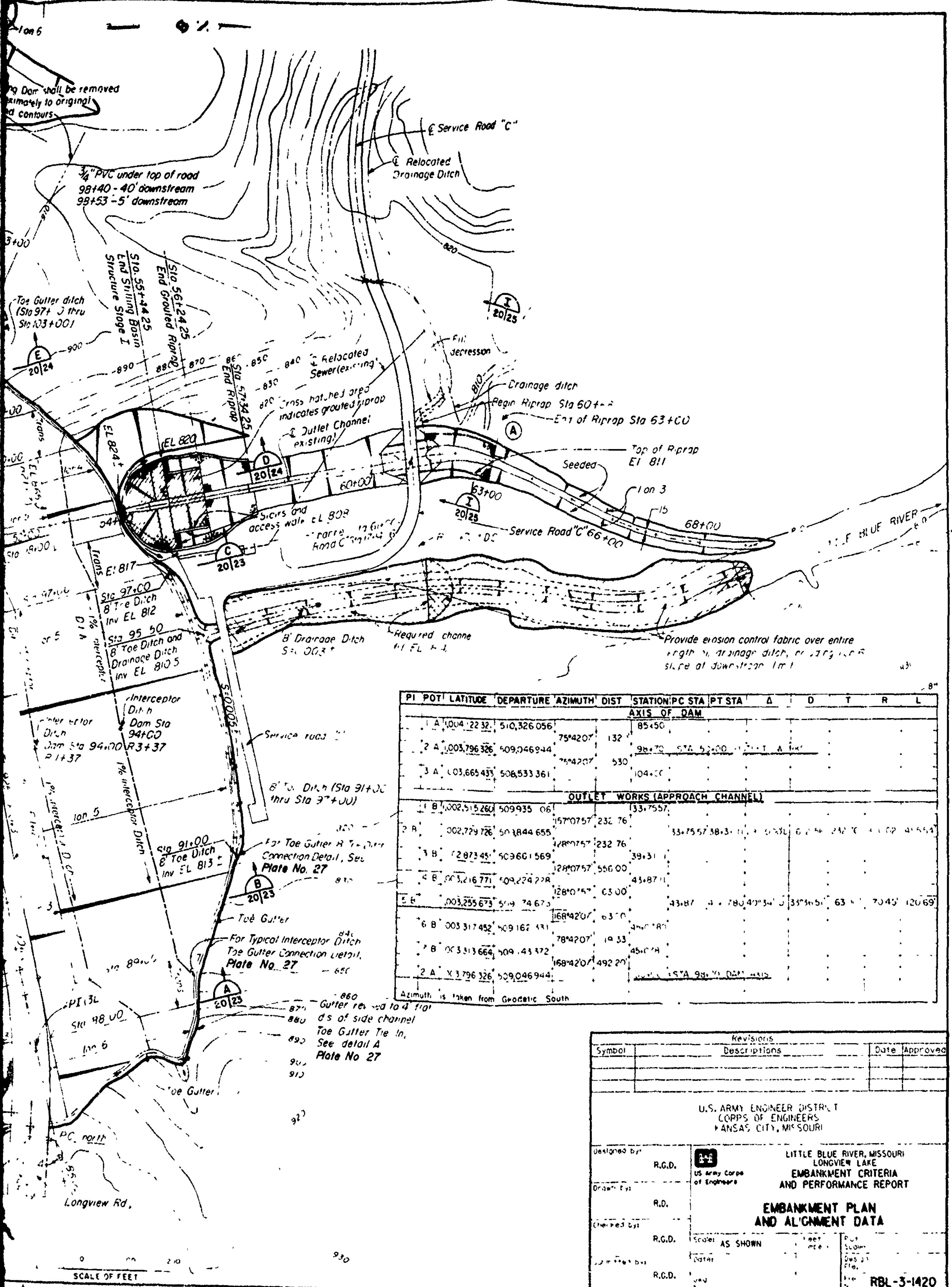

El 9220
℄ Spillway
See typical section
Existing Dam sh approximately to ground contours
℄ Dam Dike El 9266
Axis of Dam
℄ Longview Rd Relocation
Pipe gate
Service Road A
Toe ditch (Dam Sta 103+00 thru Sta 107+50±)
105+00
Transition
See Profile Dwg D1
El 9266
Sta 102+00(Dam)
El 899
Dam Sta 101+00
EL 878
Intake Tower (Existing)
Service bridge
Sta 98+00
Sta 97+00
Manholes
Sta 98+70 (Dam)
℄ Relocated sewer (Existing)
44+00
42+00
40+00
Approach Channel (For sections,
38+00
36+00
34+00
℄ Sewer
1 on 30
1 on 25
Diversion Dike - El 8230 Side slope 1 on 2
Channel fill EL 816
Required channel fill EL 816
PT Sta 89+53
PC Sta 86+2?23
Dam Sta 86+46
Toe of Rockfill
Toe Gutter
El 898
Impervious clay blanket
100' Slope transition
900
890
880
870
860
850
840
830
820
910
1 on 6
1 on 4
1 on 3
1 on 5
1 on 50
PT south
PT north



PI	POT	LATITUDE	DEPA
	1 A	1,004 22.32	5.0
	2 A	1,003,796 376	509
	3 A	1,003,665 433	508
	1 B	1,002,515 260	509
2 B		1,002,729 726	50
	3 B	002,873 481	509
	4 B	003,216 771	509
5 B		003,255 673	5
	6 B	003 317 452	509
	7 B	1003,313 664	509
	2 A	003 796 326	509

Azimuth is taken from Ge

LUE ENGINEERING PAYS



PI	POT	LATITUDE	DEPARTURE	AZIMUTH	DIST	STATION	PC STA	PT STA	Δ	D	T	R	L
AXIS OF DAM													
1	A	1,004 122 32	510,326 056			85+50							
				75°42'07"	132								
2	A	1,003,796 326	509,046 944			98+70 STA 52+00 [illegible]							
				75°42'07"	530								
3	A	1,003,665 433	508,533 361			104+00							
OUTLET WORKS (APPROACH CHANNEL)													
1	B	1,002,515 260	509935 06			33+75.57							
				157°07'57"	232 76								
2	B	1,002,729 726	509,844 655				33+75.57	38+3[illegible]	[illegible]	[illegible]	232 [illegible]	[illegible]	[illegible]
				128°07'57"	232 76								
3	B	[illegible]2 873 45	509,661 569			39+31							
				128°07'57"	556 00								
4	B	1,003,216 771	509,224 228			43+87							
				128°07'57"	63 00								
5	B	1,003,255 673	509 [illegible]74 67[illegible]				43+87	[illegible]780	40°34'[illegible]	33°56'5[illegible]	63 [illegible]	70 45	120 69
				168°42'07"	63 00								
6	B	1,003 317 452	509 162 [illegible]			45+0[illegible]80							
				78°42'07"	19 33								
7	B	1,003 313 664	509 143 372			45+0[illegible]							
				168°42'07"	492 20								
2	A	1,003 796 326	509,046 944			[illegible] STA 98+70 DAM AXIS							

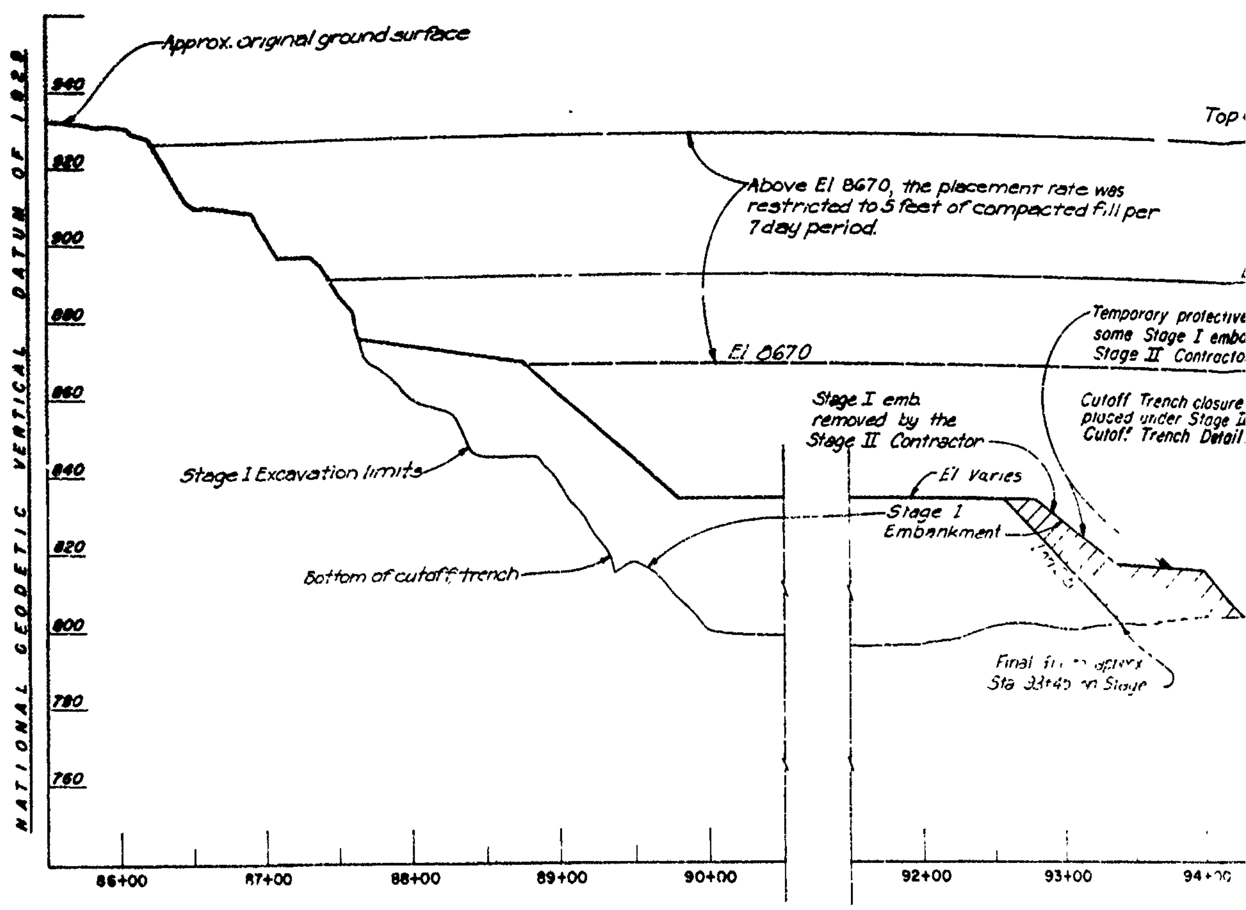
Azimuth is taken from Geodetic South

Revisions			
Symbol	Descriptions	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

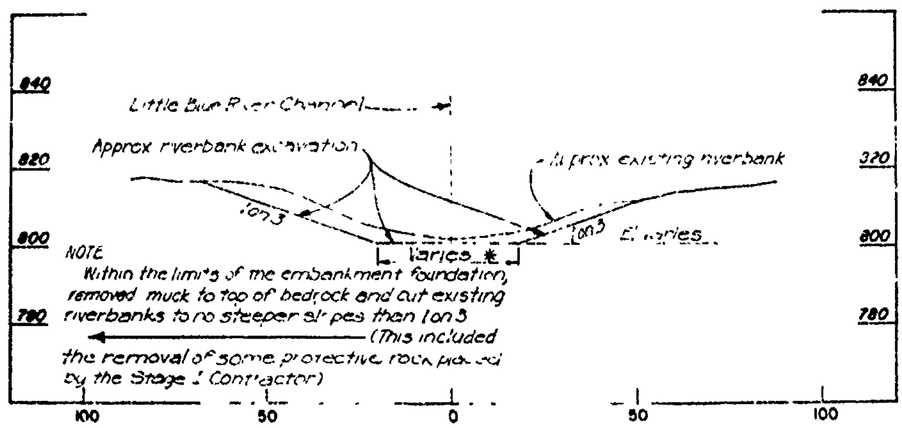
Designed by: R.G.D.	US Army Corps of Engineers — LITTLE BLUE RIVER, MISSOURI LONGVIEW LAKE EMBANKMENT CRITERIA AND PERFORMANCE REPORT
Drawn by: R.D.	**EMBANKMENT PLAN AND ALIGNMENT DATA**
Checked by: R.G.D.	Scale: AS SHOWN
Submitted by: R.G.D.	RBL-3-1420

PLATE NO. 20

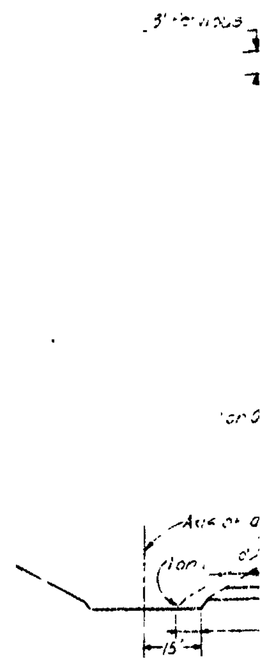


PROFILE ALONG DAM

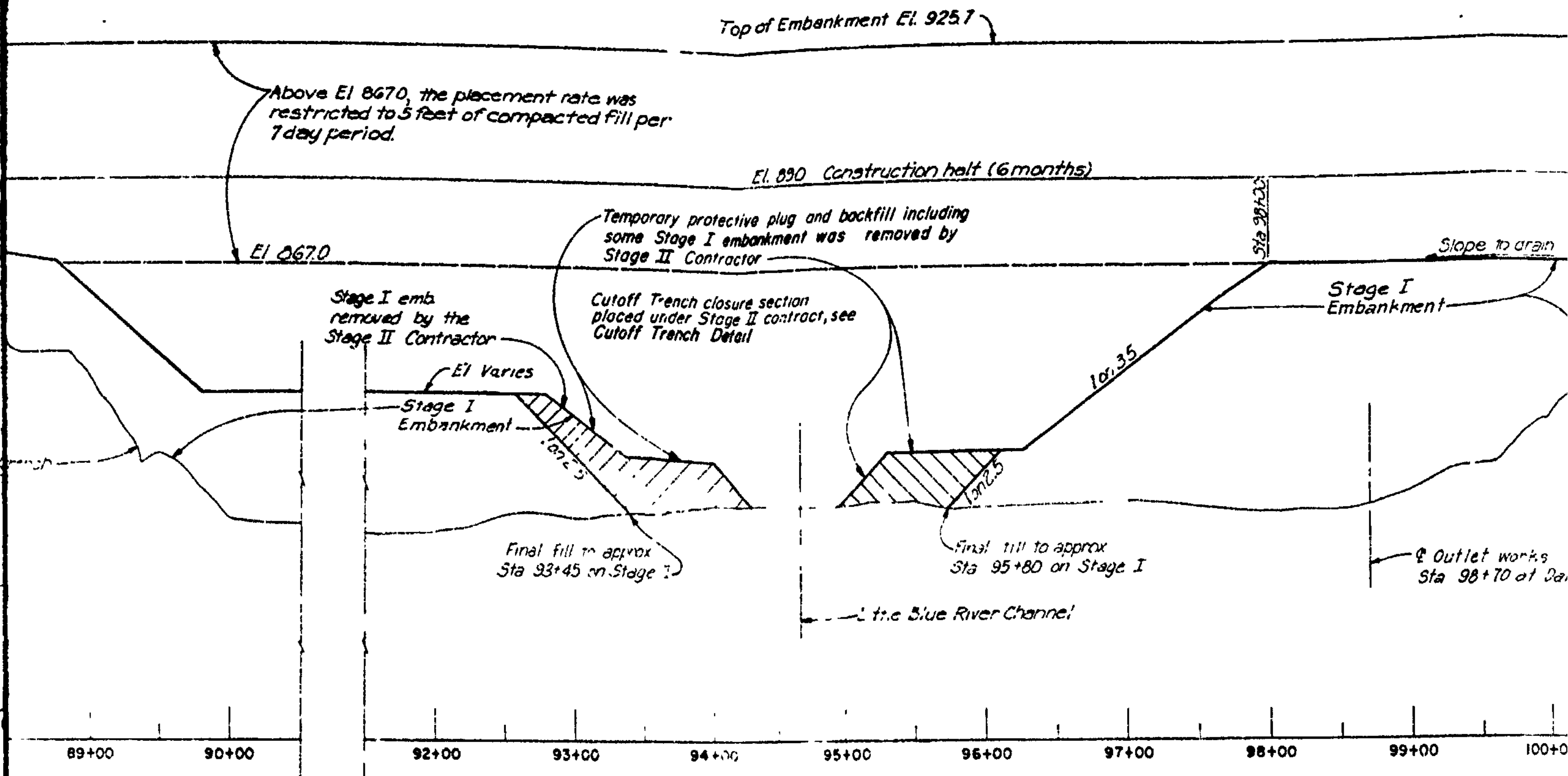
LOOKIN



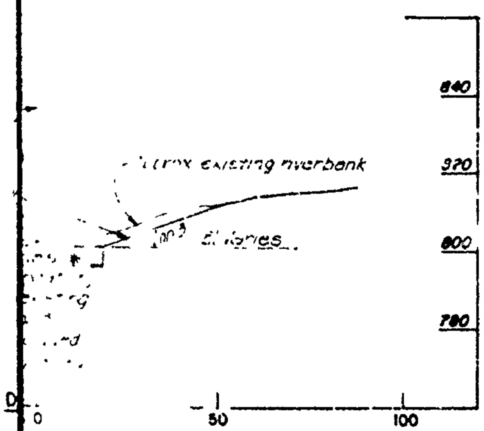
TYPICAL SECTION
RIVERBANK EXCAVATION INCLUDING ABANDONED RIVER CHANNEL AND EXISTING CHANNEL



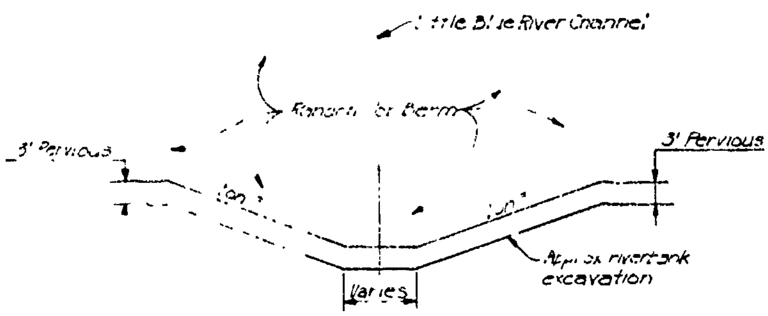
PERVIOUS
AND R



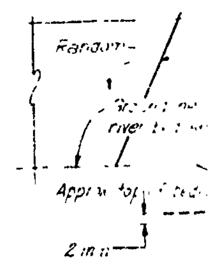
PROFILE ALONG DAM AXIS AND CUTOFF TRENCH
LOOKING UPSTREAM

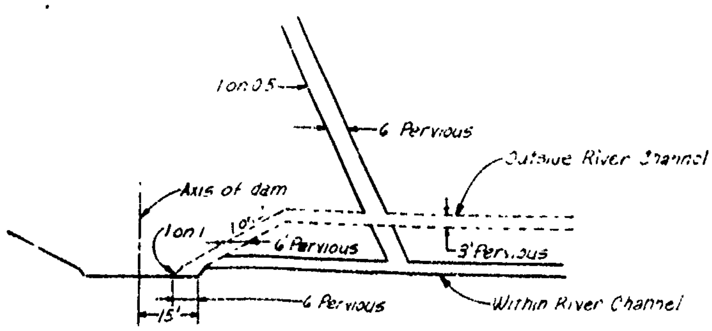


L SECTION
N INCLUDING ABANDONED
ND EXISTING CHANNEL

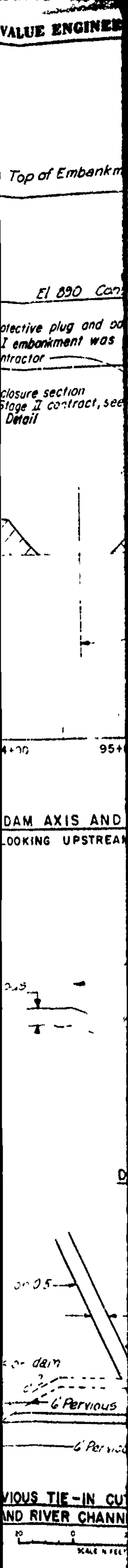


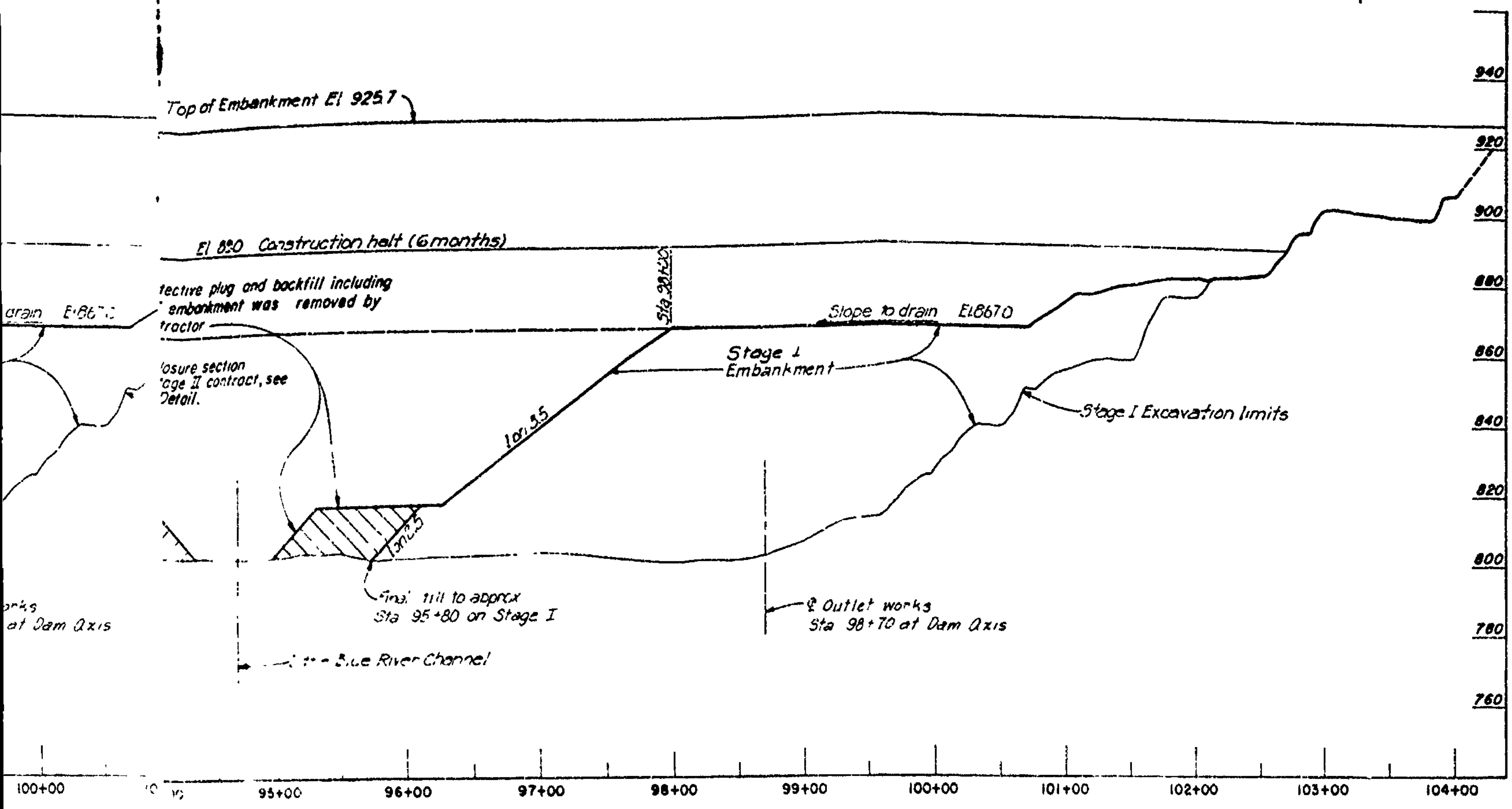
TYPICAL SECTION
RIVER CHANNEL BACKFILL
DOWNSTREAM OF CUTOFF TRENCH
Not to Scale





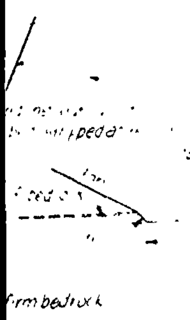
PERVIOUS TIE-IN CUTOFF TRENCH
AND RIVER CHANNEL DETAIL
20 0 20 40
SCALE IN FEET





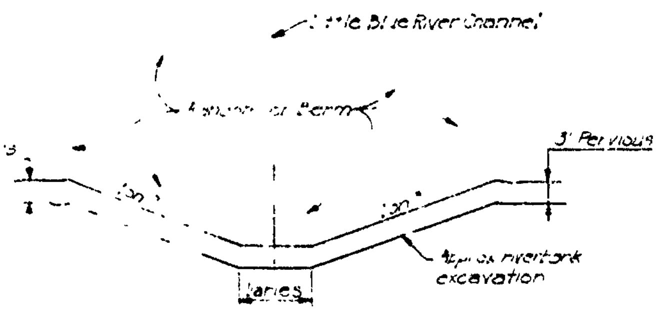
AM AXIS AND CUTOFF TRENCH

OKING UPSTREAM



CUTOFF TRENC

STA.93+45± TO

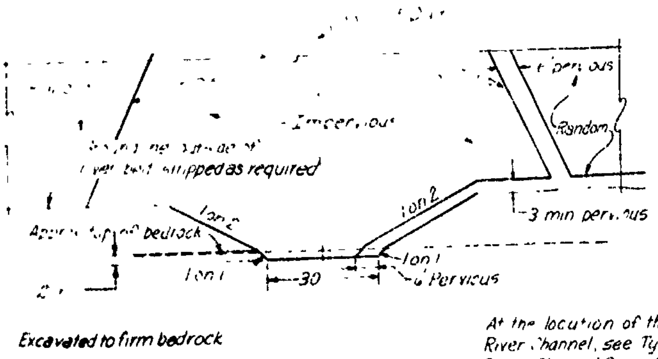


TYPICAL SECTION

RIVER CHANNEL BACKFILL

DOWNSTREAM OF CUTOFF TRENCH

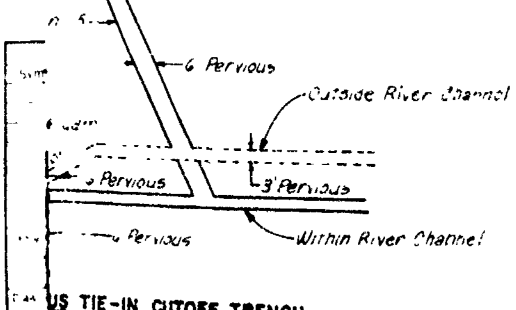
Not to Scale



At the location of the Little Blue River Channel, see Typical Section River Channel Backfill and Pervious Tie In Cutoff Trench and River Channel Detail.

CUTOFF TRENCH DETAIL

STA.93+45± TO STA.94+80±



US TIE-IN CUTOFF TRENCH

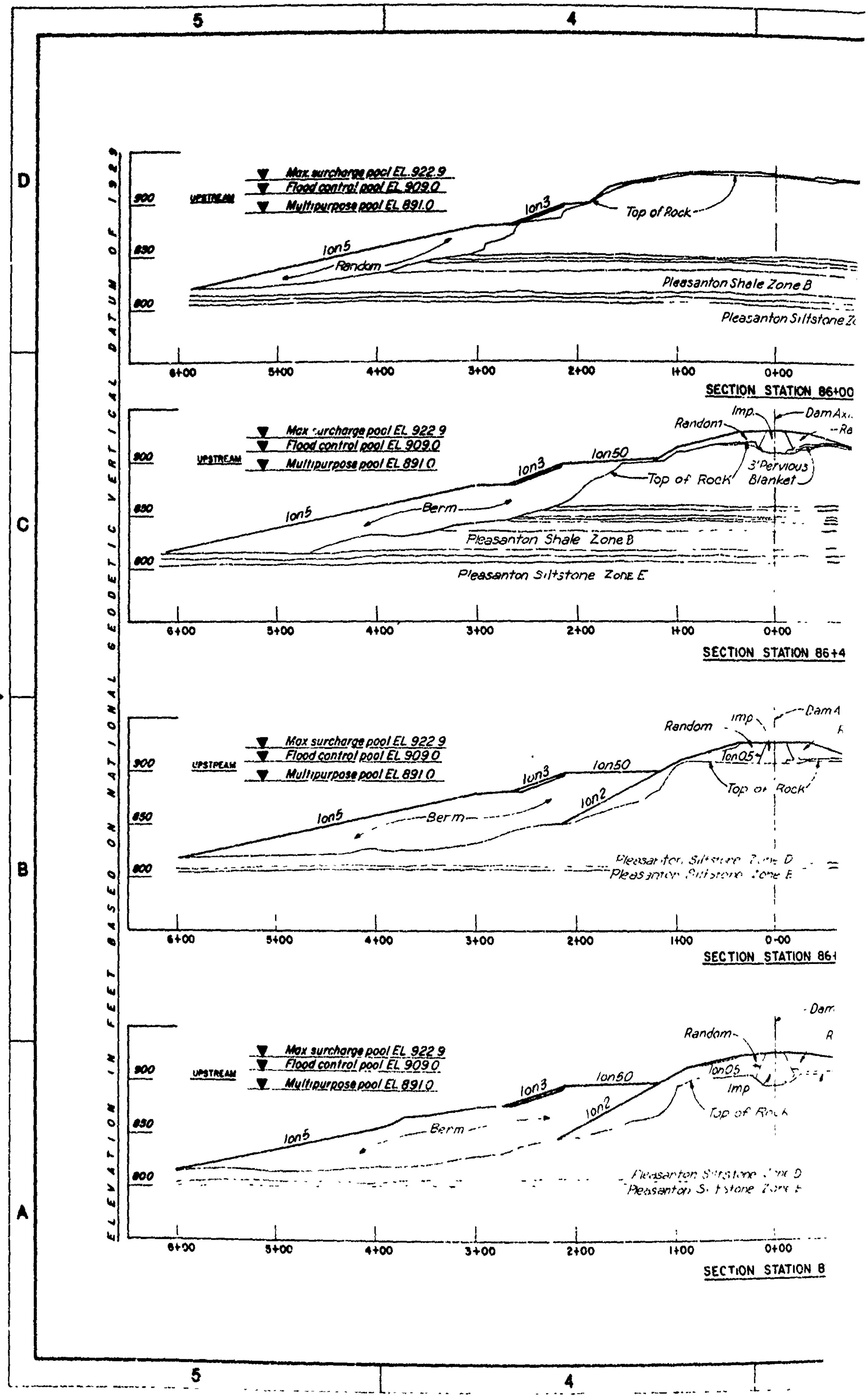
RIVER CHANNEL DETAIL

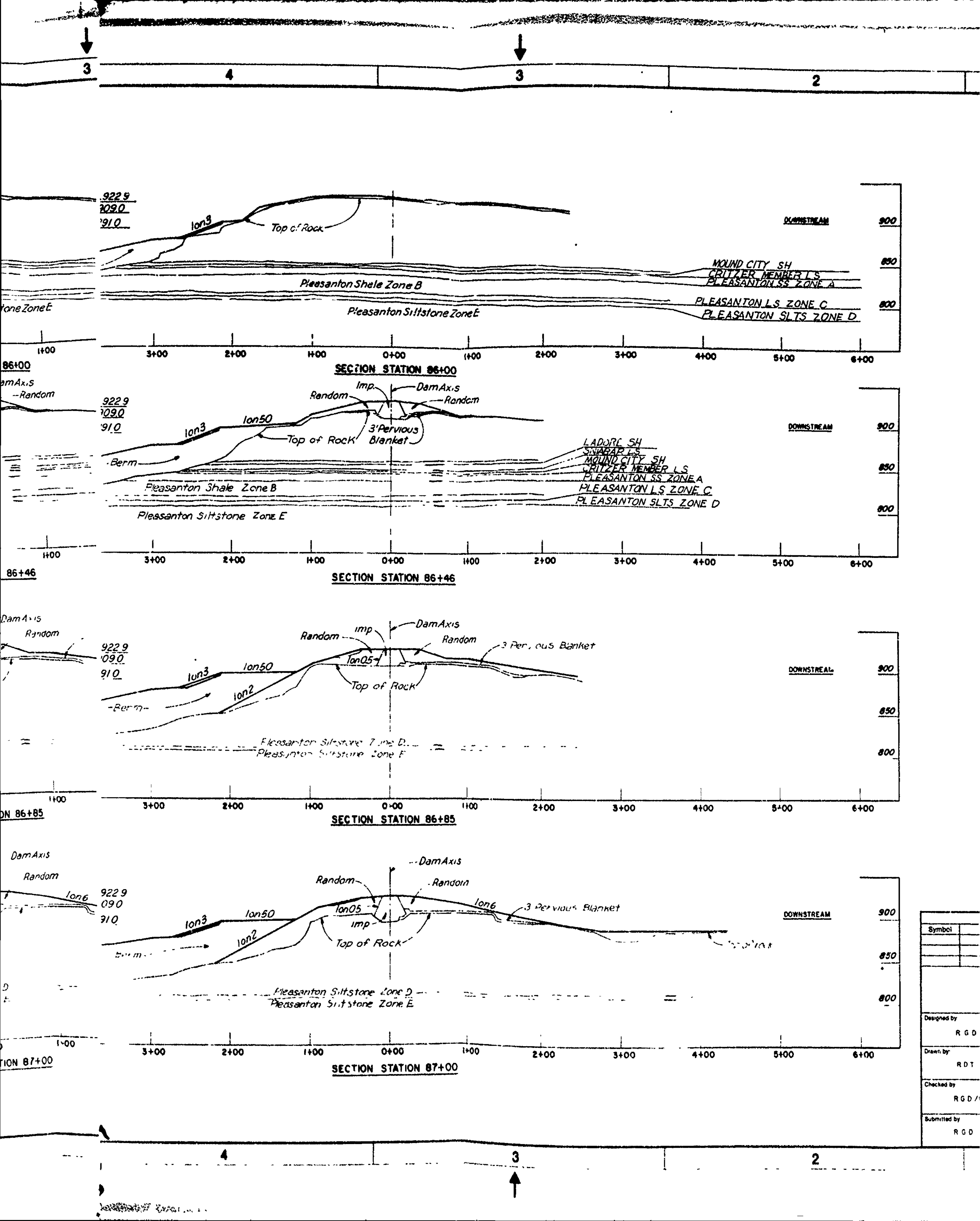
Revisions			
Symbol	Descriptions	Date	Approved

U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

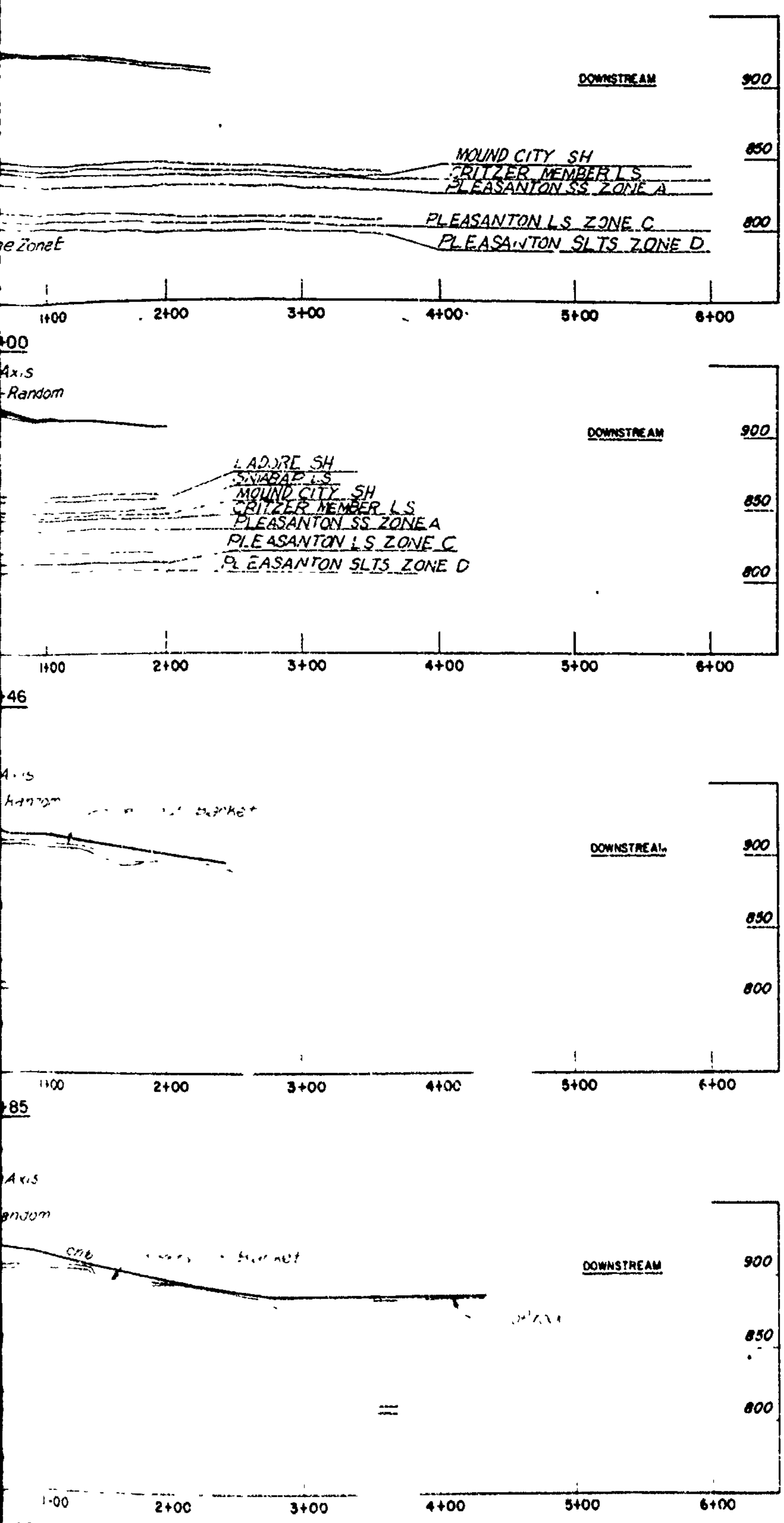
Designed by RGD	LITTLE BLUE RIVER, MISSOURI LONGVIEW LAKE EMBANKMENT CRITERIA AND PERFORMANCE REPORT
Drawn by SLM	DAM AXIS PROFILE AND MISC. SECTIONS & DETAILS
Checked by RGD/WBE	Scale AS SHOWN
Submitted by RGD	File No RBL-3-1421

PLATE NO. 21


ELEVATION IN FEET BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929
UPSTREAM
Max surcharge pool EL 922.9
Flood control pool EL 909.0
Multipurpose pool EL 891.0
Ion5
Random
Ion3
Top of Rock
Pleasanton Shale Zone B
Pleasanton Siltstone Zone E
SECTION STATION 86+00
Berm
Ion50
Imp
Dam Axis
3' Pervious Blanket
Ion2
Ion05
Pleasanton Siltstone Zone D
SECTION STATION 86+4
SECTION STATION 86+
SECTION STATION 8
900
850
800
6+00
5+00
4+00
3+00
2+00
1+00
0+00
5
4
D
C
B
A



3
4
3
2
922.9
909.0
910
Ion3
Top of Rock
DOWNSTREAM
900
850
800
MOUND CITY SH
CRITZER MEMBER LS
PLEASANTON SS ZONE A
Pleasanton Shale Zone B
PLEASANTON LS ZONE C
PLEASANTON SLTS ZONE D
Pleasanton Siltstone Zone E
3+00
2+00
1+00
0+00
1+00
2+00
3+00
4+00
5+00
6+00
SECTION STATION 86+00
Imp
Dam Axis
Random
Random
Ion50
3' Pervious Blanket
Top of Rock
Berm
LADORE SH
SNIABAR LS
MOUND CITY SH
CRITZER MEMBER LS
PLEASANTON SS ZONE A
PLEASANTON LS ZONE C
PLEASANTON SLTS ZONE D
Pleasanton Shale Zone B
Pleasanton Siltstone Zone E
SECTION STATION 86+46
Dam Axis
Imp
Random
Random
Ion05
Ion2
Berm
Top of Rock
Pleasanton Siltstone Zone D
Pleasanton Siltstone Zone E
SECTION STATION 86+85
Dam Axis
Random
Random
Ion6
Ion05
Imp
Ion2
3 Pervious Blanket
Top of Rock
Pleasanton Siltstone Zone D
Pleasanton Siltstone Zone E
SECTION STATION 87+00
Symbol
Designed by
RGD
Drawn by
RDT
Checked by
RGD
Submitted by
RGD



Revisions			
Symbol	Descriptions	Date	Approved

U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

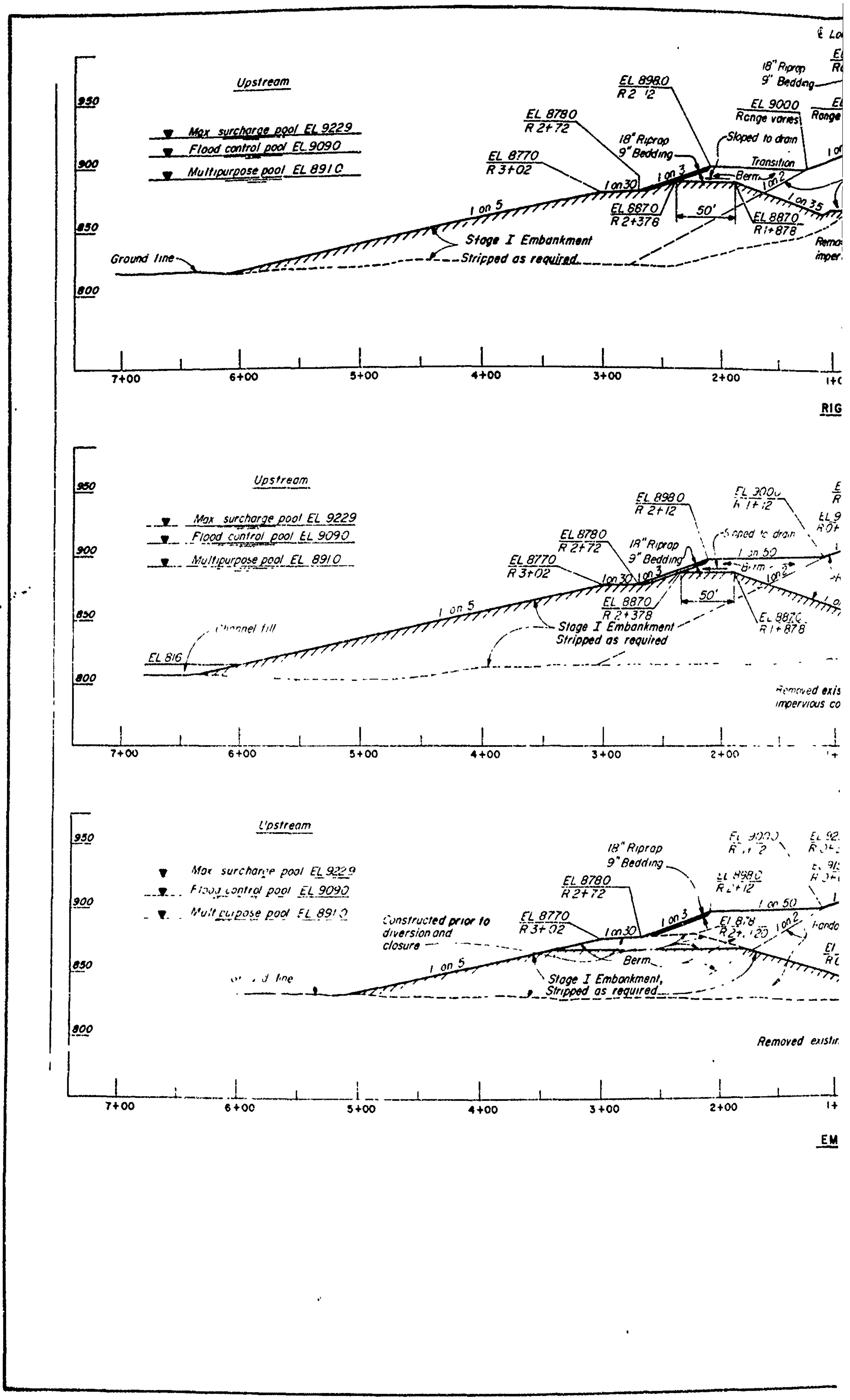
Designed by: R G D
Drawn by: R D T
Checked by: R G D / W L E
Submitted by: R G D

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA
AND PERFORMANCE REPORT

TYPICAL EMBANKMENT SECTIONS

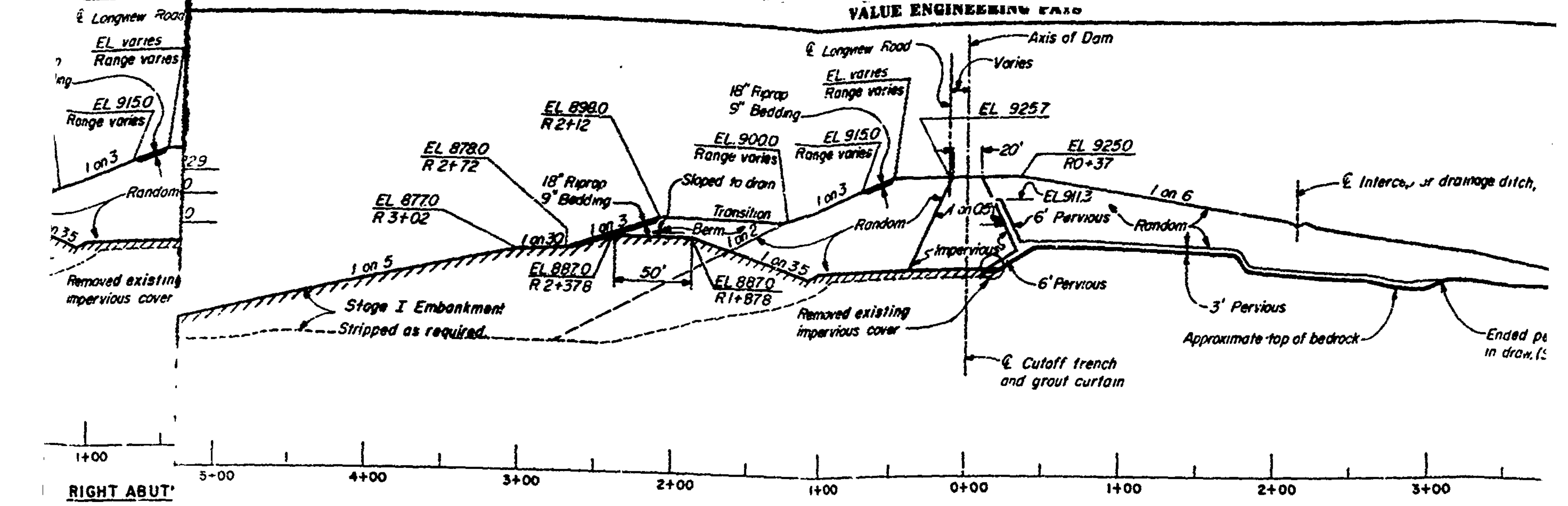
Scale: AS SHOWN
Date:
Sheet number: 1 of 4
Dwg No: RBL-3-1422

PLATE NO 22

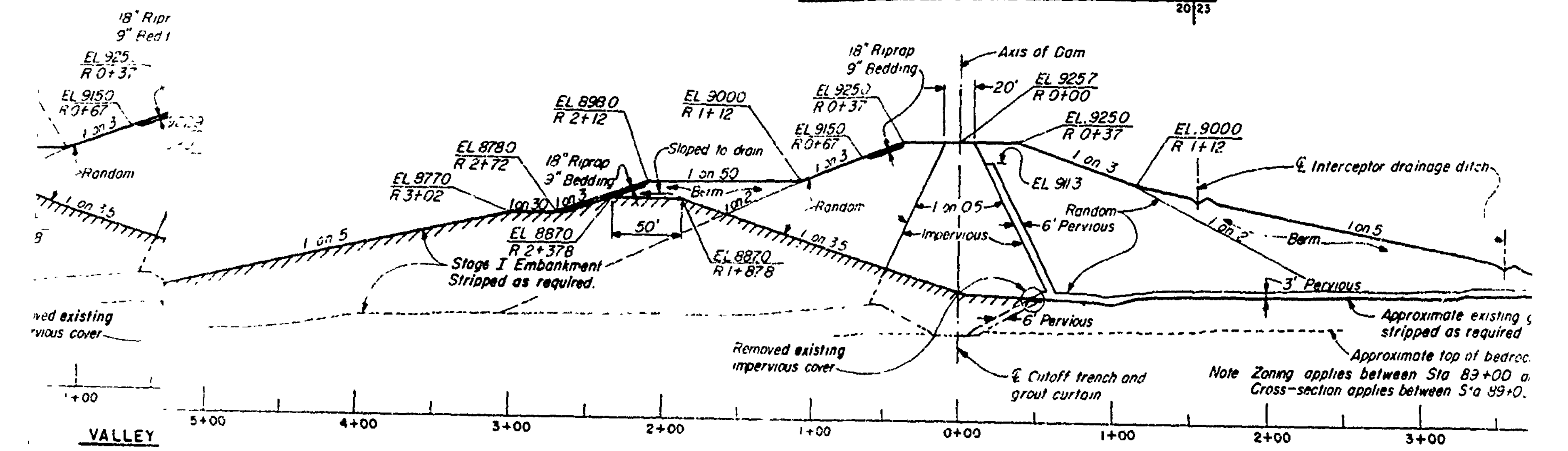


Upstream
Max surcharge pool EL 922.9
Flood control pool EL 909.0
Multipurpose pool EL 891.0
EL 898.0
R 2+12
EL 878.0
R 2+72
EL 877.0
R 3+02
18" Riprap
9" Bedding
EL 900.0
Range varies
Sloped to drain
Transition
Berm
1 on 30
1 on 3
1 on 2
1 on 3.5
1 on 5
EL 887.0
R 2+37.8
EL 887.0
R 1+87.8
50'
Stage I Embankment
Stripped as required
Ground line
950
900
850
800
7+00
6+00
5+00
4+00
3+00
2+00
RIG
Upstream
Max surcharge pool EL 922.9
Flood control pool EL 909.0
Multipurpose pool EL 891.0
EL 898.0
R 2+12
EL 878.0
R 2+72
EL 877.0
R 3+02
18" Riprap
9" Bedding
Sloped to drain
1 on 50
Berm
1 on 30
1 on 3
1 on 2
1 on 5
EL 887.0
R 2+37.8
50'
Channel fill
EL 816
Stage I Embankment
Stripped as required
Removed exis
impervious co
950
900
850
800
7+00
6+00
5+00
4+00
3+00
2+00
Upstream
Max surcharge pool EL 922.9
Flood control pool EL 909.0
Multipurpose pool EL 891.0
18" Riprap
9" Bedding
EL 878.0
R 2+72
EL 877.0
R 3+02
Constructed prior to
diversion and
closure
1 on 30
1 on 3
1 on 50
1 on 2
1 on 5
Berm
Stage I Embankment,
Stripped as required
Removed existin
950
900
850
800
7+00
6+00
5+00
4+00
3+00
2+00
EM

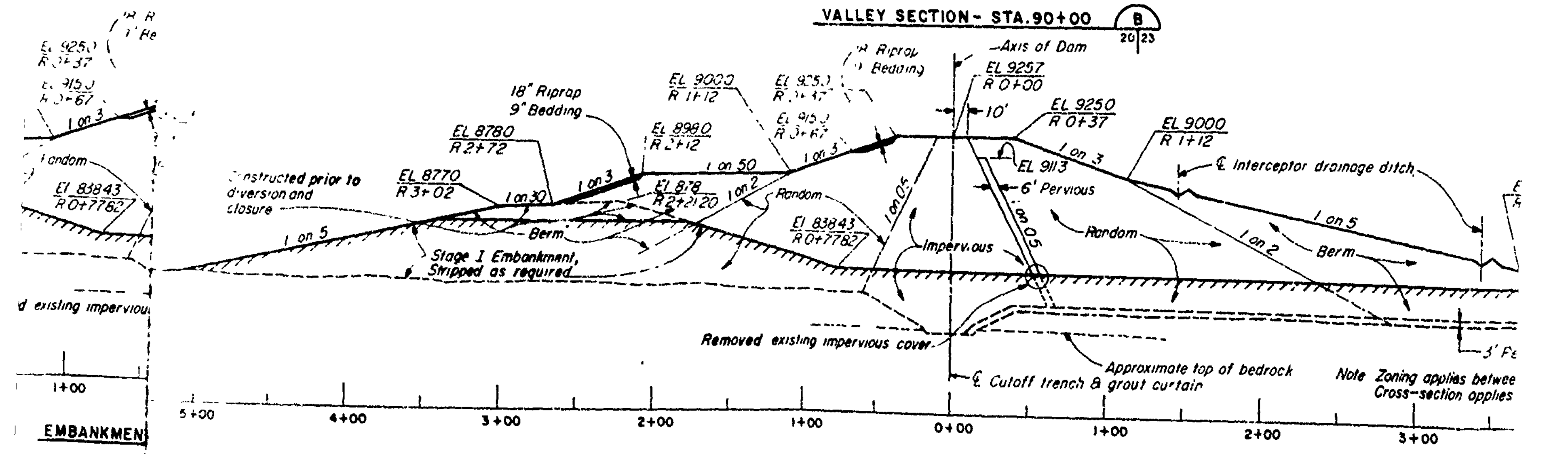
VALUE ENGINEERING [illegible]



RIGHT ABUTMENT SECTION - STA. 88+00 (A, 20/23)



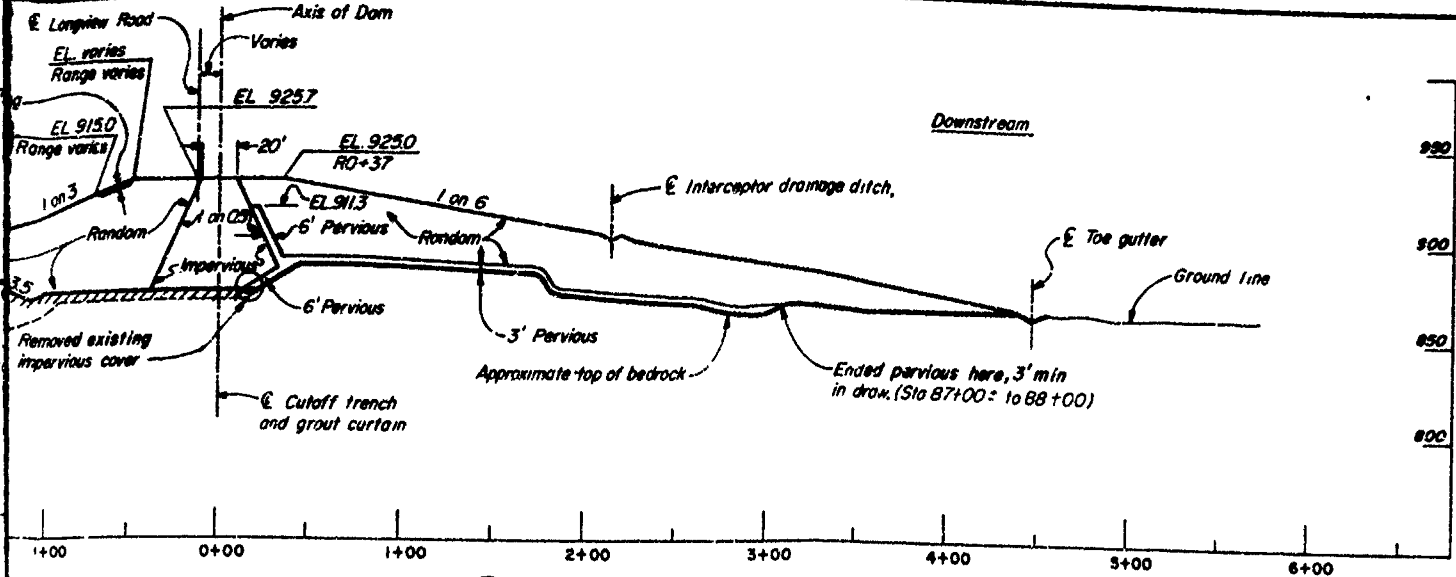
VALLEY SECTION - STA. 90+00 (B, 20/23)



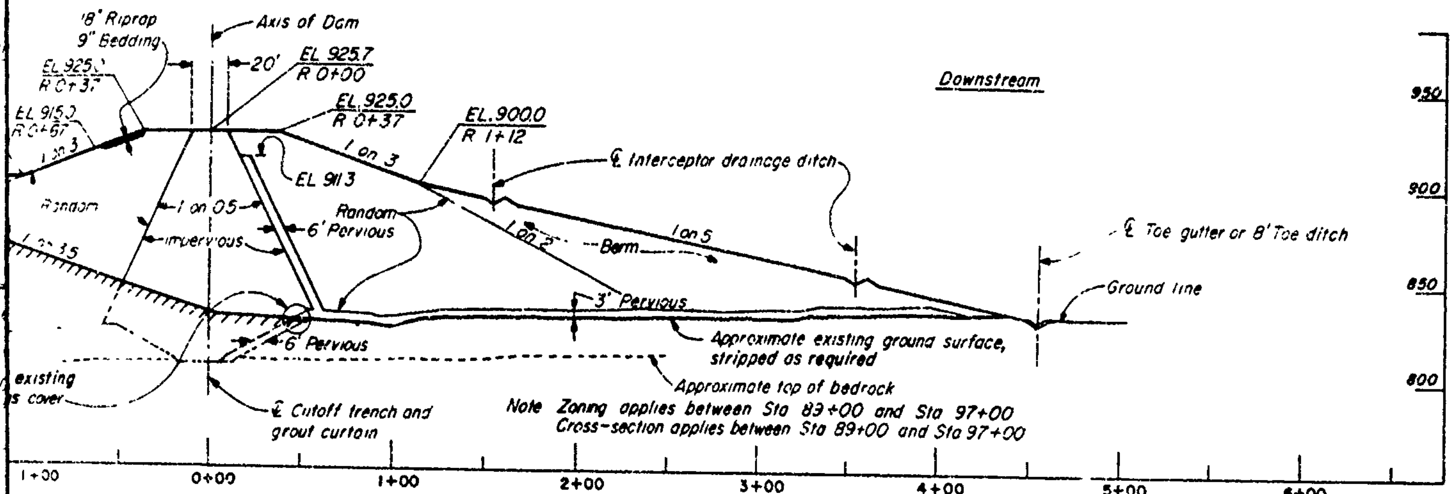
EMBANKMENT SECTION - STA. 97+00 (C, 20/23)

Notes 1 Hatched area represents approx. Stage I embankment

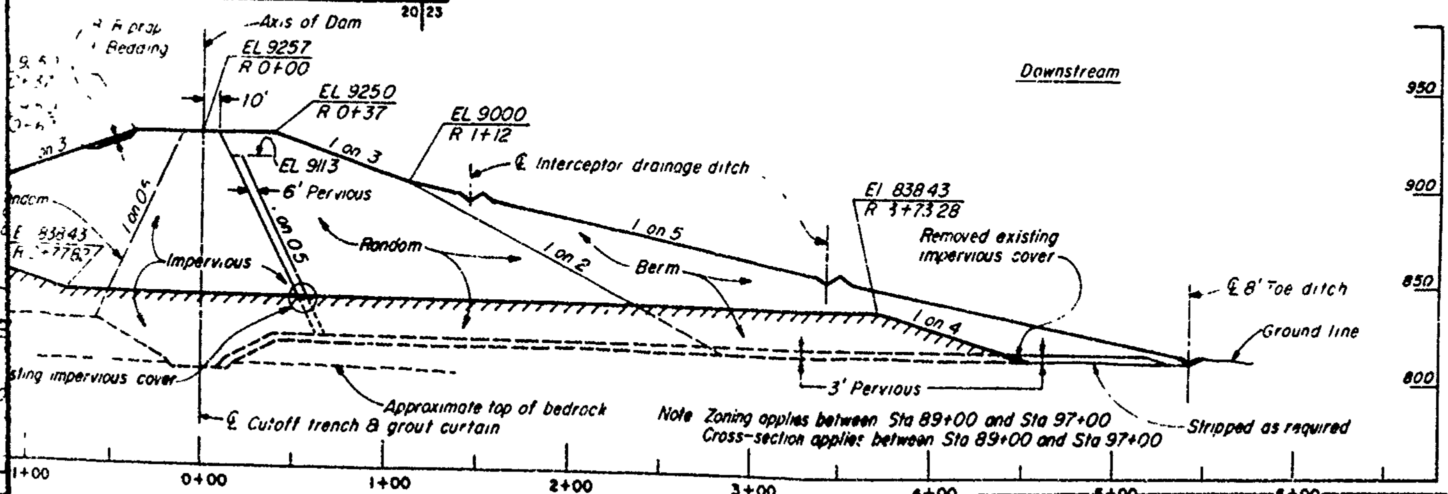
2 Top. oiled and seeded all upstream embankment s… El 898 and all downstream embankment slopes … areas having slope protection as shown on plan sections



RIGHT ABUTMENT SECTION - STA. 88+00 (A, 20|23)



VALLEY SECTION - STA. 90+00 (B, 20|23)



EMBANKMENT SECTION - STA. 97+00 (C, 20|23)

Notes. 1 Hatched area represents approx Stage I embankment

2 Topsoiled and seeded all upstream embankment slopes above El 898 and all downstream embankment slopes except areas having slope protection as shown on plan and sections

Symbol	Descriptions	Date	Approved

Revisions

U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

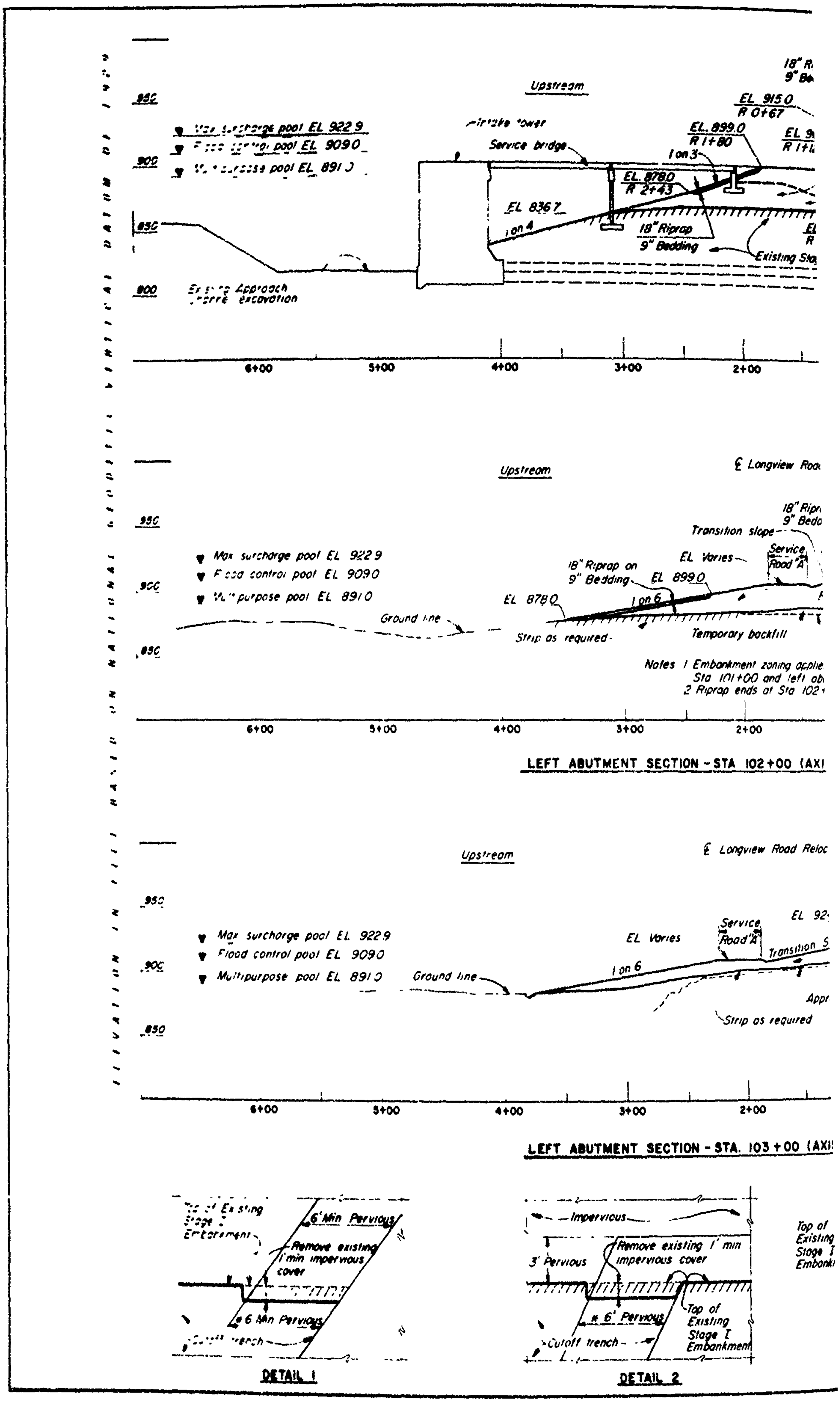
Designed by: R G D
Drawn by: S.E.S
Checked by: R G D / W B L
Submitted by:

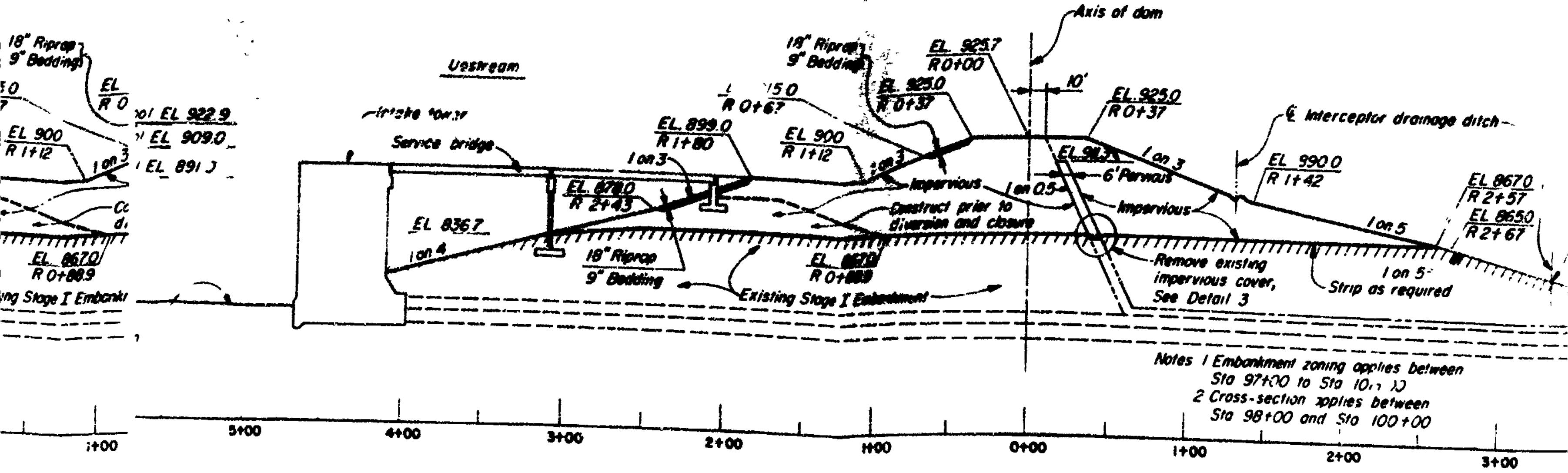
LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA
AND PERFORMANCE REPORT

TYPICAL EMBANKMENT SECTIONS

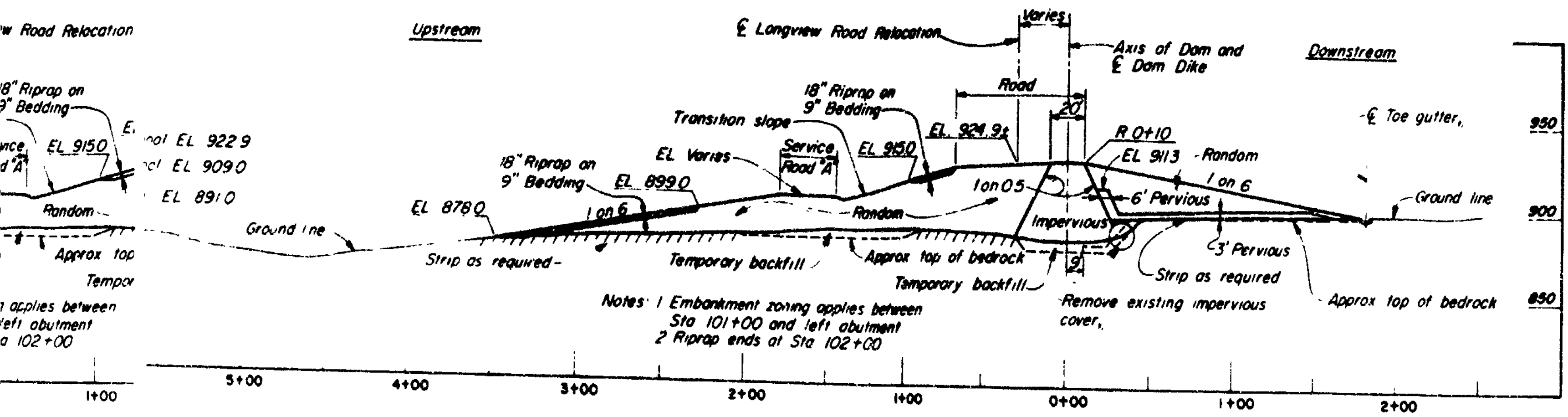
Scale: AS SHOWN
Sheet number:
Date:
Dwg No: 2 of 4
File No: RBL-3-1423

PLATE NO. 23

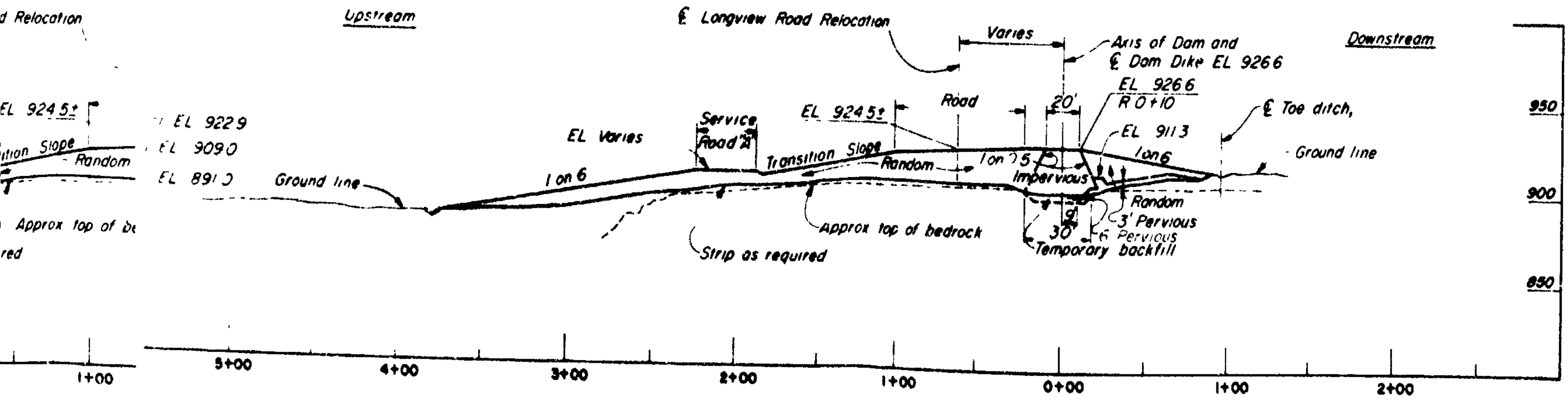

Upstream
EL 915.0
R 0+67
EL 899.0
R 1+80
Service bridge
1 on 3
EL 878.0
R 2+43
EL 836.7
1 on 4
18" Riprap
9" Bedding
Existing Approach channel excavation
950
900
850
800
6+00
5+00
4+00
3+00
2+00
Upstream
℄ Longview Road
18" Riprap
9" Bedding
Transition slope
Service Road "A"
Max surcharge pool EL 922.9
Multipurpose pool EL 891.0
EL Varies
18" Riprap on
9" Bedding
EL 899.0
1 on 6
EL 878.0
Ground line
Strip as required
Temporary backfill
Notes 1 Embankment zoning applie
Sta 101+00 and left ab
2 Riprap ends at Sta 102
LEFT ABUTMENT SECTION - STA 102+00 (AXI
Upstream
℄ Longview Road Reloc
Service Road "A"
Max surcharge pool EL 922.9
Flood control pool EL 909.0
Multipurpose pool EL 891.0
EL Varies
1 on 6
Ground line
Transition
Strip as required
LEFT ABUTMENT SECTION - STA. 103+00 (AXI
6' Min Pervious
Remove existing 1' min impervious cover
6 Min Pervious
DETAIL 1
Impervious
Remove existing 1' min impervious cover
3' Pervious
6' Pervious
Top of Existing Stage I Embankment
Cutoff trench
DETAIL 2



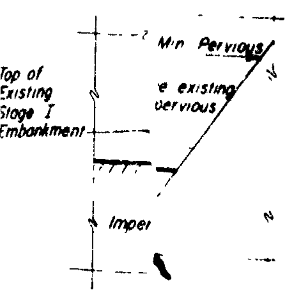
CONDUIT SECTION - STA. 98+70 (D 20|24)

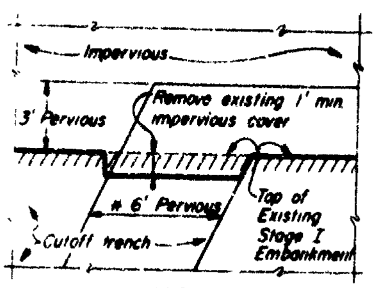


LEFT ABUTMENT SECTION - STA. 102+00 (AXIS OF DAM) (E 20|24)

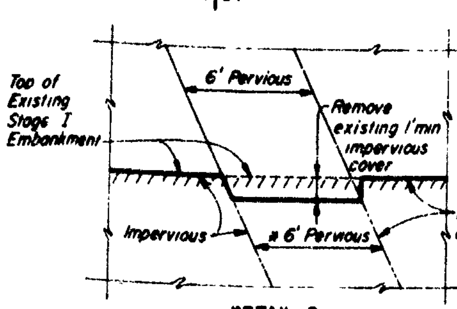


LEFT ABUTMENT SECTION - STA. 103+00 (AXIS OF DAM) (F 20|24)





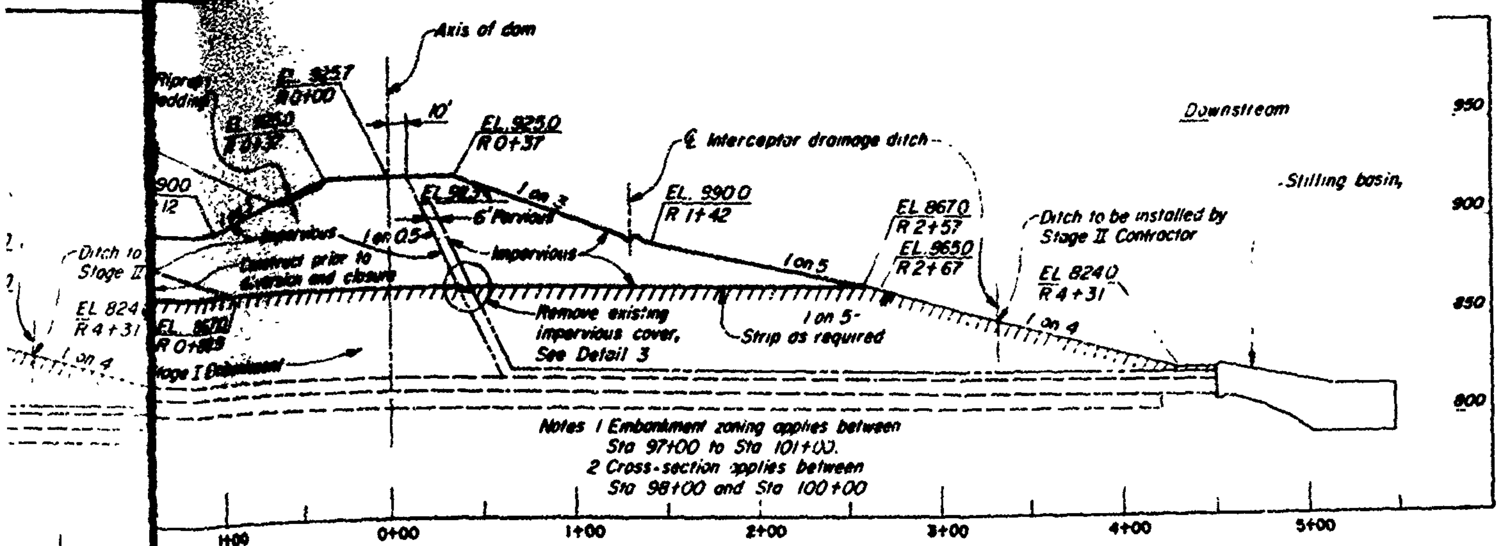
DETAIL 2



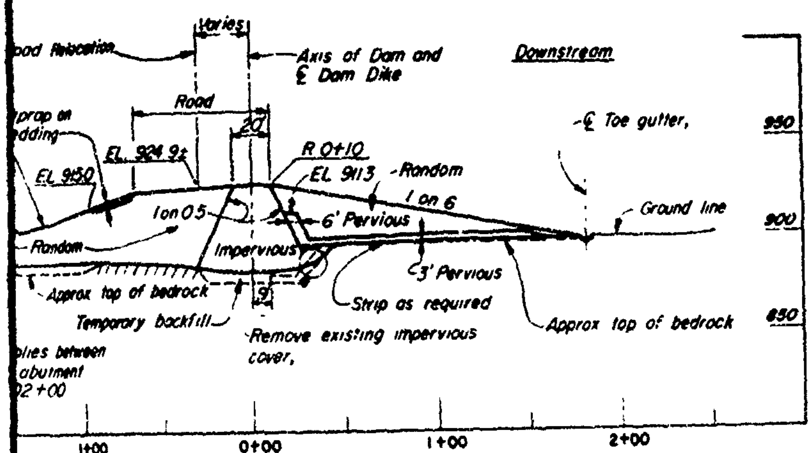
DETAIL 3

The tie-in location for the pervious fill ... from that shown on the drawings The ... Contractor will transition from the actu... of the tie-in to the plan location in 50...

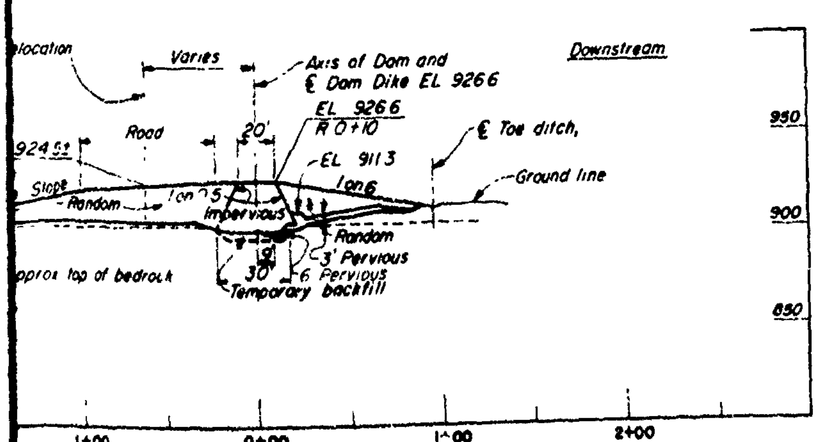
Notes.
1 Hatched area represents approx Sta... embankment See Dwg Nos B12 and ... existing condition
2 Topsoil and seed all upstream embank... slopes above EL 898 (EL 891 between ... to left abutment) except areas with slope... and all downstream embankment slopes



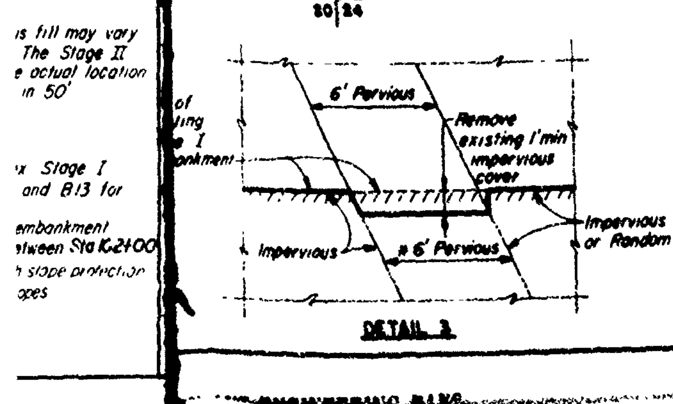
CONDUIT SECTION - STA. 98+70 (D / 20 | 24)



(AXIS OF DAM) (E / 20 | 24)



(AXIS OF DAM) (F / 20 | 24)



DETAIL 3

\# The tie-in location for the pervious fill may vary from that shown on the drawings. The Stage II Contractor will transition from the actual location of the tie-in to the plan location in 50'.

Notes

1. Hatched area represents approx Stage I embankment. See Dwg Nos B12 and B13 for existing condition.
2. Topsoil and seed all upstream embankment slopes above EL 898 (EL 891 between Sta 102+00 to left abutment) except areas with slope protection and all downstream embankment slopes.

Symbol	Descriptions	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

Designed by: R.G.D.
Drawn by: S.E.S.
Checked by: R.G.D.
Submitted by: R.G.D.

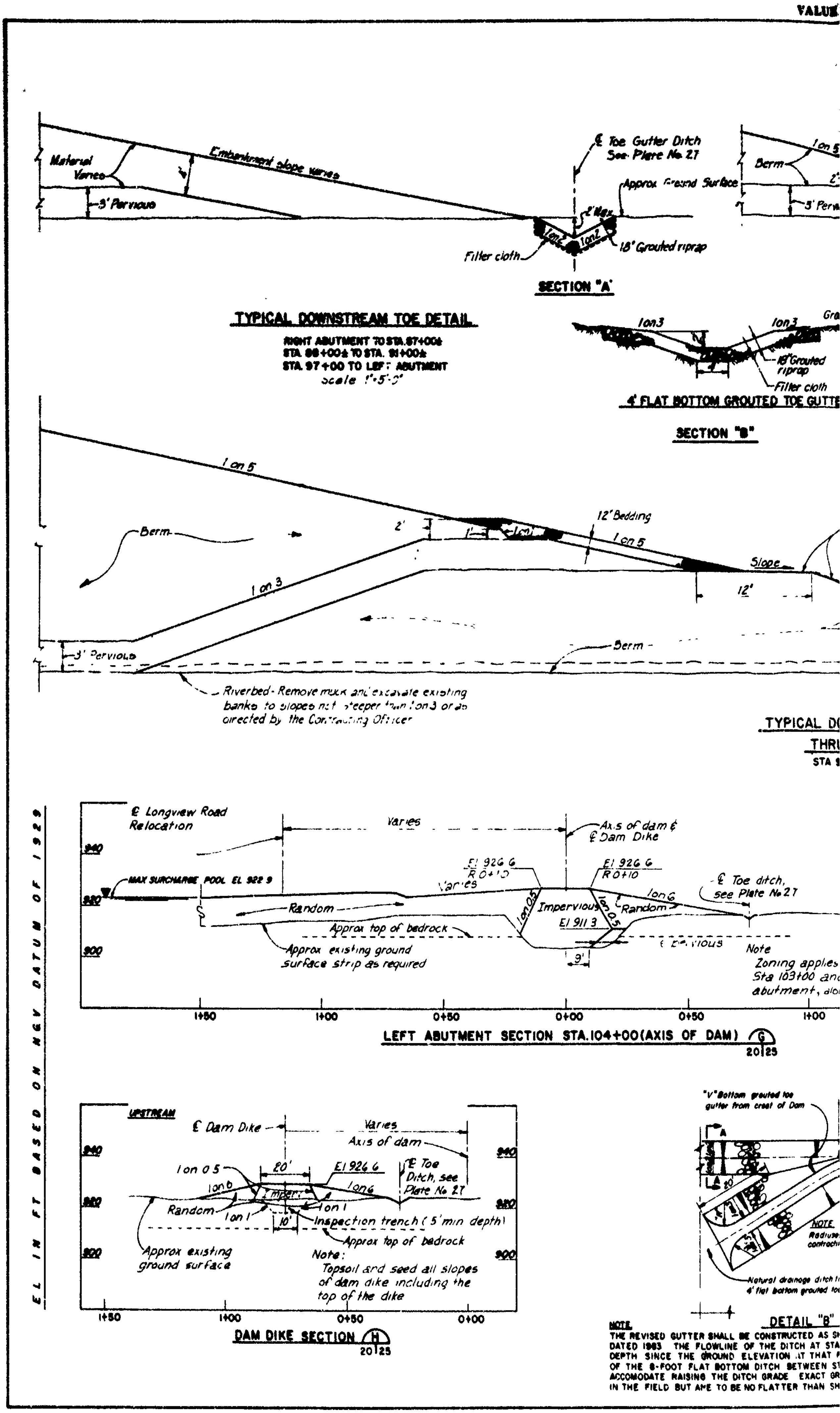
US Army Corps of Engineers

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA AND PERFORMANCE REPORT

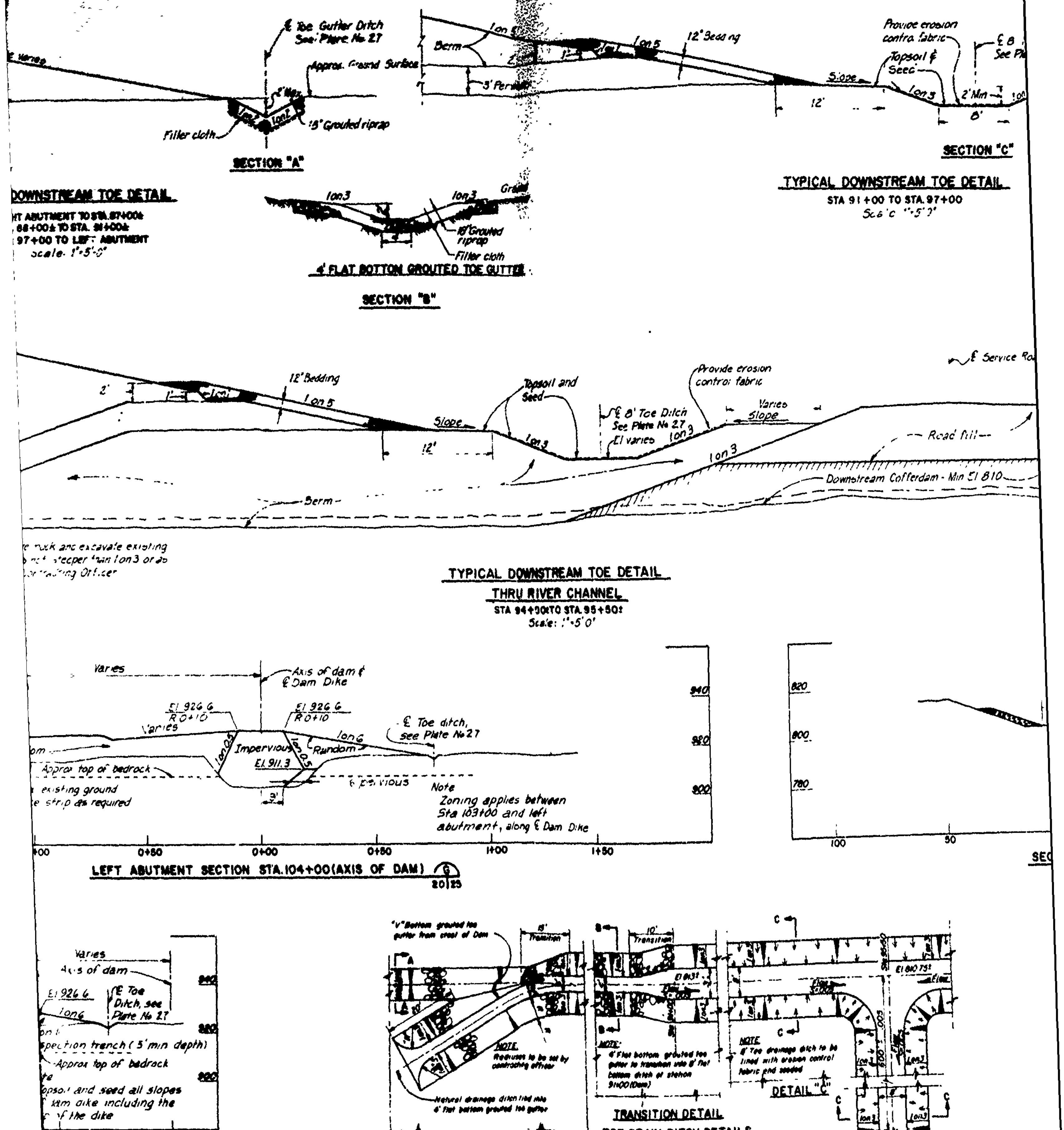
TYPICAL EMBANKMENT SECTIONS

Scale: AS SHOWN
Sheet numbers: 3 OF 4
File No.: RBL-3-1424

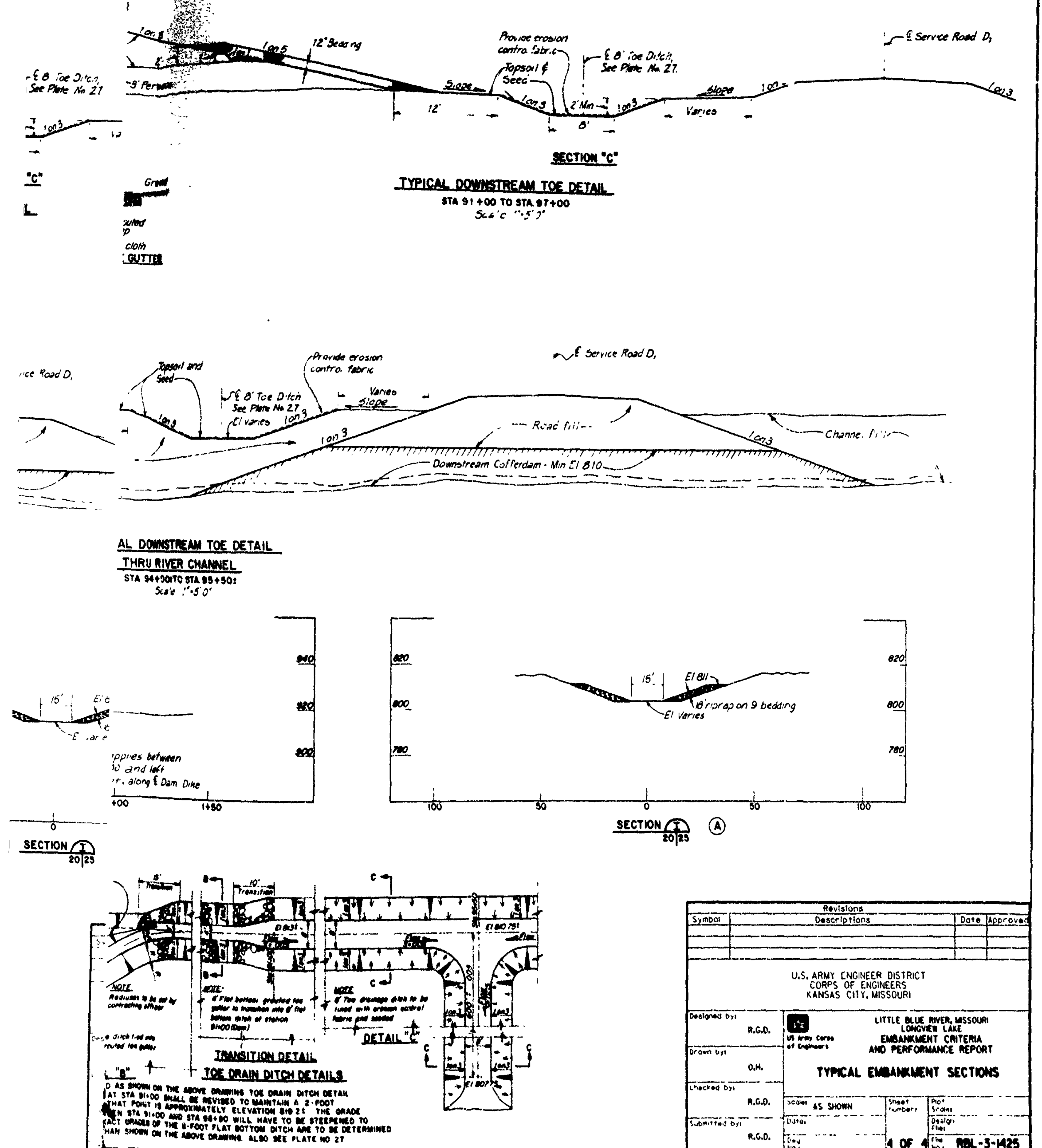
PLATE NO. 24



Material Varies
Embankment slope varies
3' Pervious
℄ Toe Gutter Ditch See Plate No. 27
Approx Ground Surface
2' Max
1 on 2
1 on 2
18" Grouted riprap
Filter cloth
SECTION "A"
Berm
1 on 5
3' Pervious
TYPICAL DOWNSTREAM TOE DETAIL
RIGHT ABUTMENT TO STA. 87+00±
STA. 88+00± TO STA. 91+00±
STA. 97+00 TO LEFT ABUTMENT
1 on 3
1 on 3
18" Grouted riprap
Filter cloth
4' FLAT BOTTOM GROUTED TOE GUTTE
SECTION "B"
1 on 5
12" Bedding
1 on 5
2'
Berm
Slope
12'
1 on 3
3' Pervious
Berm
Riverbed - Remove muck and excavate existing banks to slopes not steeper than 1 on 3 or as directed by the Contracting Officer
TYPICAL D
THRU
EL IN FT BASED ON NGV DATUM OF 1929
℄ Longview Road Relocation
Varies
Axis of dam ℄
℄ Dam Dike
MAX SURCHARGE POOL EL 922.9
El 926.6
R 0+10
Varies
El 926.6
R 0+10
1 on 6
℄ Toe ditch, see Plate No. 27
Random
Impervious
Random
1 on 0.5
1 on 0.5
El 911.3
Approx top of bedrock
Approx existing ground surface strip as required
9'
Note
Zoning applies
Sta 103+00 an
abutment, alo
940
920
900
1+50
1+00
0+50
0+00
0+50
1+00
LEFT ABUTMENT SECTION STA.104+00(AXIS OF DAM)
G
20|25
UPSTREAM
℄ Dam Dike
Varies
Axis of dam
1 on 0.5
20'
El 926.6
℄ Toe Ditch, see Plate No. 27
1 on 6
1 on 6
Imperv
1 on 1
Random
1 on 1
10'
Inspection trench (5' min depth)
Approx top of bedrock
Approx existing ground surface
Note:
Topsoil and seed all slopes of dam dike including the top of the dike
940
920
900
1+50
1+00
0+50
0+00
DAM DIKE SECTION
H
20|25
"V" Bottom grouted toe gutter from crest of Dam
Natural drainage ditch
4' flat bottom grouted toe
DETAIL "B"
NOTE
THE REVISED GUTTER SHALL BE CONSTRUCTED AS SH
DATED 1983. THE FLOWLINE OF THE DITCH AT STA
DEPTH SINCE THE GROUND ELEVATION AT THAT P
OF THE 8-FOOT FLAT BOTTOM DITCH BETWEEN ST
ACCOMODATE RAISING THE DITCH GRADE. EXACT GR
IN THE FIELD BUT ARE TO BE NO FLATTER THAN SH



NOTE
THE REVISED GUTTER SHALL BE CONSTRUCTED AS SHOWN ON THE ABOVE DRAWING TOE DRAIN DITCH DETAIL DATED 1983. THE FLOWLINE OF THE DITCH AT ST' 91+00 SHALL BE REVISED TO MAINTAIN A 2-FOOT DEPTH SINCE THE GROUND ELEVATION AT THAT POINT IS APPROXIMATELY ELEVATION 819.2± THE GRADE OF THE 8-FOOT FLAT BOTTOM DITCH BETWEEN STA 91+00 AND STA 95+50 WILL HAVE TO BE STEEPENED TO ACCOMODATE RAISING THE DITCH GRADE. EXACT GRADES OF THE 8-FOOT FLAT BOTTOM DITCH ARE TO BE DETERMINED IN THE FIELD BUT ARE TO BE NO FLATTER THAN SHOWN ON THE ABOVE DRAWING. ALSO SEE PLATE NO 27



Revisions			
Symbol	Descriptions	Date	Approved

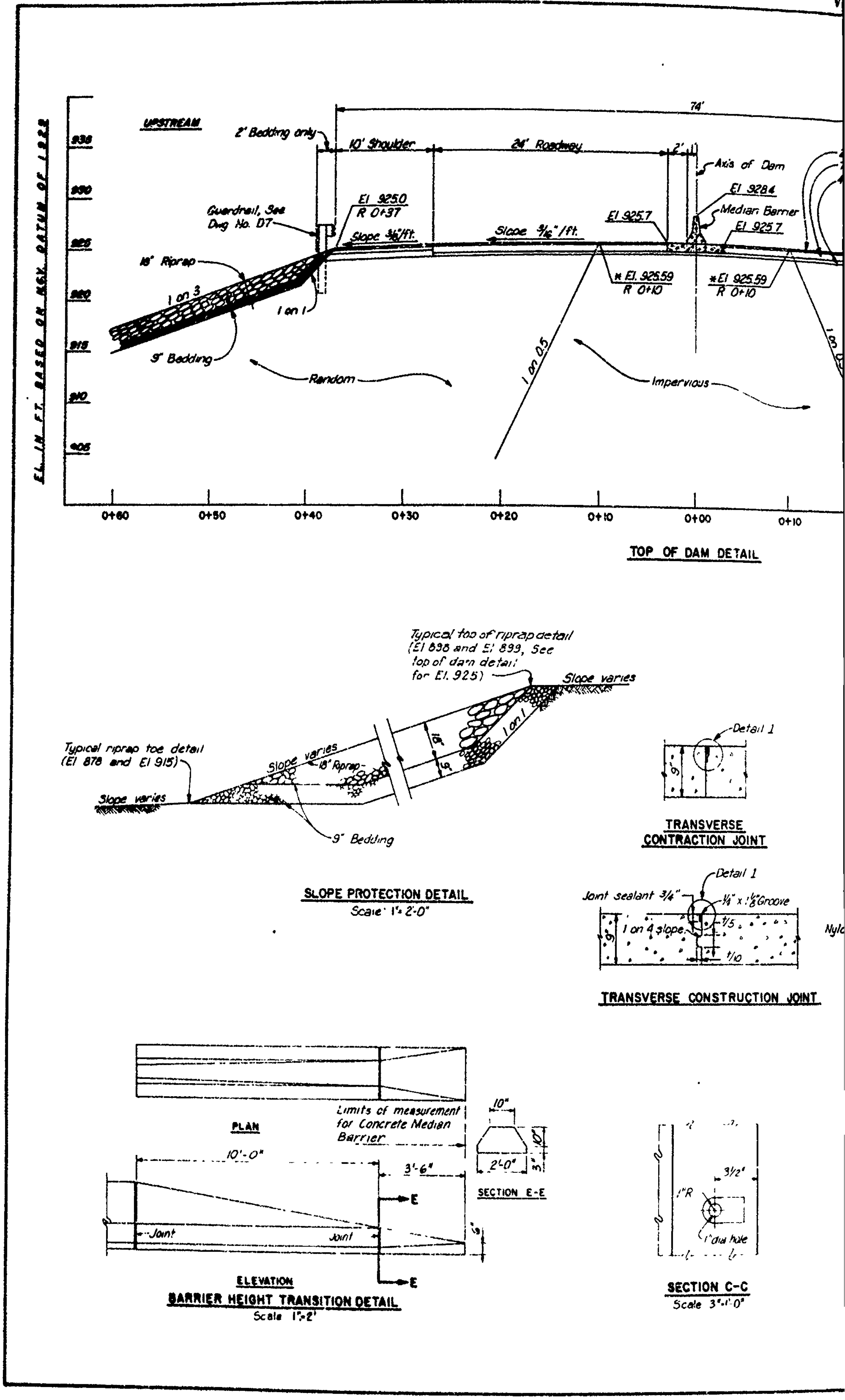
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

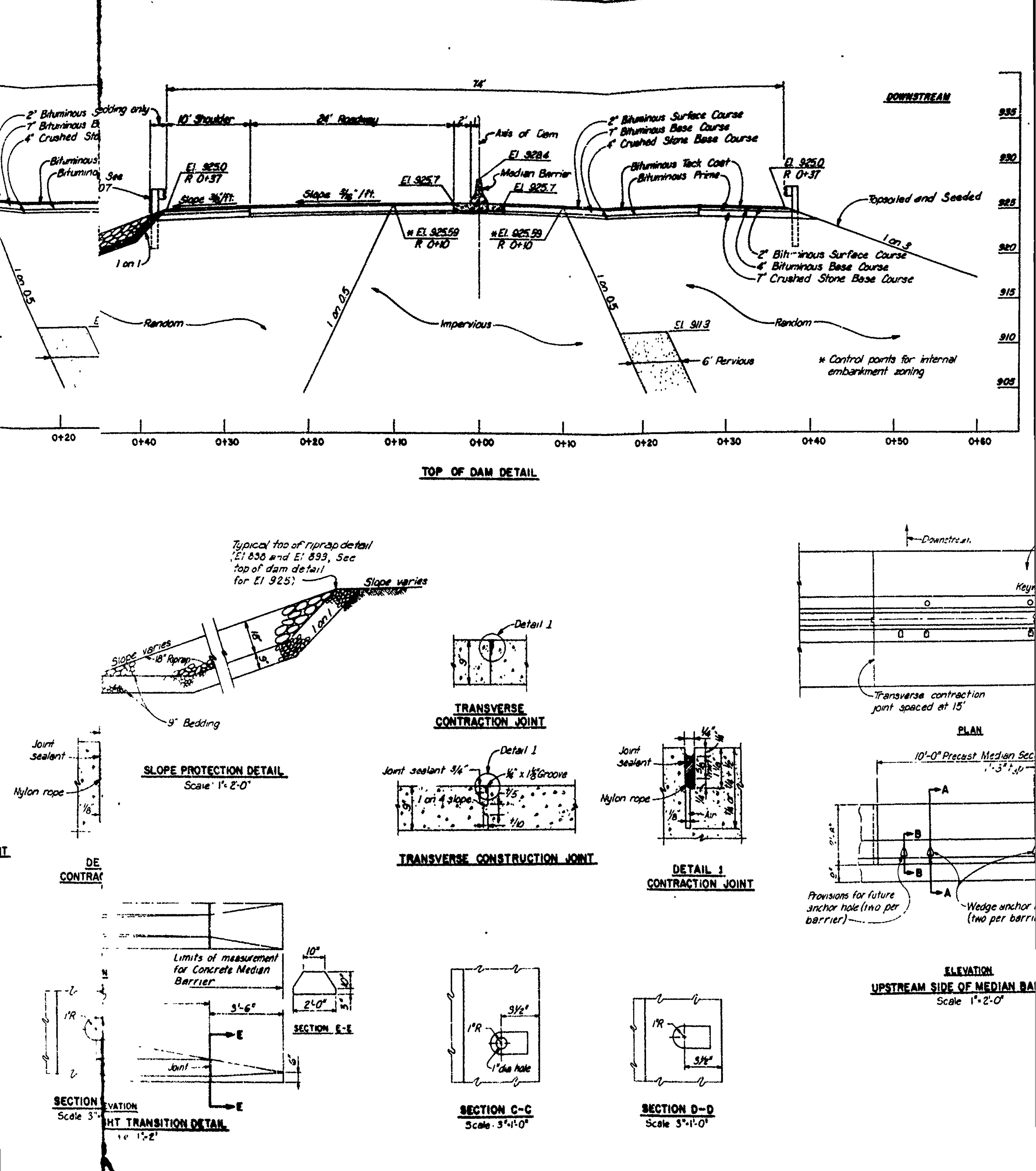
LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA
AND PERFORMANCE REPORT

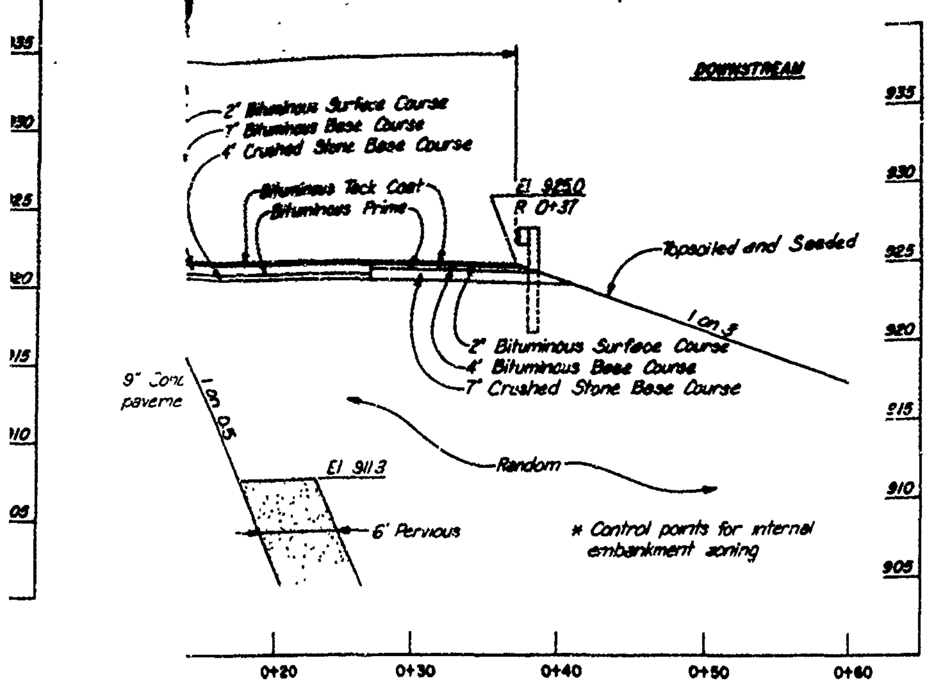
TYPICAL EMBANKMENT SECTIONS

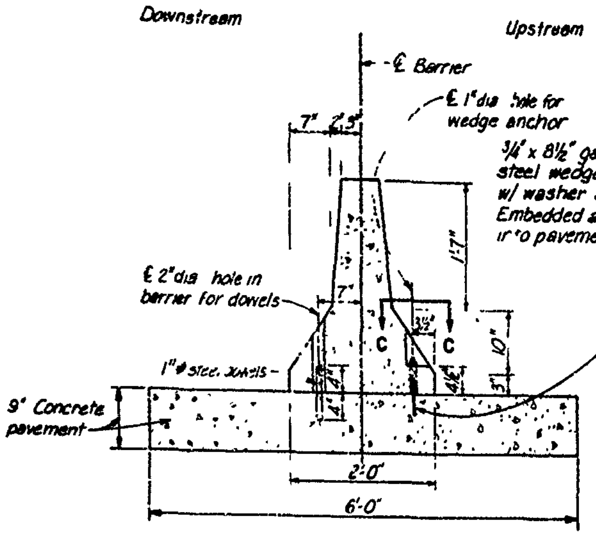
Designed by: R.G.D.
Drawn by: O.H.
Checked by: R.G.D.
Submitted by: R.G.D.
Scale: AS SHOWN
Sheet number: 4 OF 4
File No.: RBL-3-1425

PLATE NO. 25

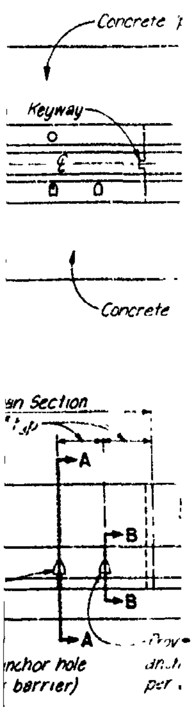

EL. IN FT. BASED ON MSL DATUM OF 1929
UPSTREAM
2' Bedding only
74'
10' Shoulder
24' Roadway
2'
Axis of Dam
El 928.4
Median Barrier
El 925.7
El 925.7
El 925.0
R 0+37
Guardrail, See Dwg No. D7
Slope 3/8"/ft.
Slope 3/16"/ft.
18" Riprap
1 on 3
1 on 1
9" Bedding
Random
* El. 925.59
R 0+10
* El 925.59
R 0+10
1 on 0.5
Impervious
930
925
920
915
910
905
0+60
0+50
0+40
0+30
0+20
0+10
0+00
0+10
TOP OF DAM DETAIL
Typical top of riprap detail (El 898 and El 899, See top of dam detail for El. 925)
Slope varies
1 on 1
Typical riprap toe detail (El 878 and El 915)
Slope varies
18" Riprap
18"
9"
Slope varies
9" Bedding
SLOPE PROTECTION DETAIL
Scale: 1"= 2'-0"
Detail 1
9"
TRANSVERSE CONTRACTION JOINT
Detail 1
Joint sealant 3/4"
1/4" x 1 1/8" Groove
1 on 4 slope
t/5
t/10
TRANSVERSE CONSTRUCTION JOINT
PLAN
Limits of measurement for Concrete Median Barrier
10'-0"
3'-6"
E
E
Joint
Joint
ELEVATION
BARRIER HEIGHT TRANSITION DETAIL
Scale 1"=2'
10"
2'-0"
3'
SECTION E-E
3 1/2"
1"R
1" dia hole
SECTION C-C
Scale 3"=1'-0"

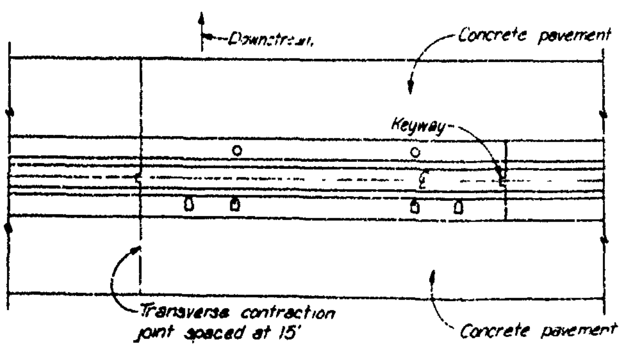

74'
DOWNSTREAM
2" Bituminous
7" Bituminous
4" Crushed Sto
Seeding only
10' Shoulder
24' Roadway
2'
Axis of Dam
2" Bituminous Surface Course
7" Bituminous Base Course
4" Crushed Stone Base Course
Bituminous
Bituminous
See
07
El 925.0
R 0+37
Slope 3/4"/ft.
Slope 5/16"/ft.
El 925.7
El 928.4
Median Barrier
El 925.7
Bituminous Tack Coat
Bituminous Prime
El 925.0
R 0+37
Topsoiled and Seeded
1 on 1
* El 925.59
R 0+10
* El 925.59
R 0+10
1 on 3
2" Bituminous Surface Course
4" Bituminous Base Course
7" Crushed Stone Base Course
1 on 0.5
1 on 0.5
1 on 0.5
Random
Impervious
Random
El 911.3
6' Pervious
* Control points for internal embankment zoning
935
930
925
920
915
910
905
0+20
0+40
0+30
0+20
0+10
0+00
0+10
0+20
0+30
0+40
0+50
0+60
TOP OF DAM DETAIL
Typical top of riprap detail (El 898 and El 893, See top of dam detail for El 925)
Slope varies
Slope varies
18" Riprap
1 on 1
9" Bedding
SLOPE PROTECTION DETAIL
Scale 1"=2'-0"
Detail 1
TRANSVERSE CONTRACTION JOINT
Downstream
Transverse contraction joint spaced at 15'
PLAN
Joint sealant
Nylon rope
DE
CONTRAC
Detail 1
Joint sealant 3/4"
1/4" x 1 1/8" Groove
1 on 4 slope
TRANSVERSE CONSTRUCTION JOINT
Joint sealant
Nylon rope
Air
DETAIL 1
CONTRACTION JOINT
10'-0" Precast Median Sec
A
B
B
A
Provisions for future anchor hole (two per barrier)
Wedge anchor (two per barri
ELEVATION
UPSTREAM SIDE OF MEDIAN BA
Scale 1"=2'-0"
Limits of measurement for Concrete Median Barrier
10"
2'-0"
SECTION E-E
3'-6"
E
E
Joint
1"R
SECTION
Scale 3"
ELEVATION
HT TRANSITION DETAIL
3 1/2"
1"R
1" dia hole
SECTION C-C
Scale 3"=1'-0"
1"R
3 1/2"
SECTION D-D
Scale 3"=1'-0"



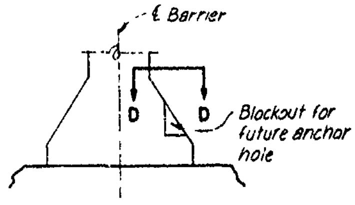


SECTION A-A
Scale 1" = 1'-0"

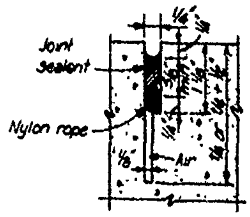




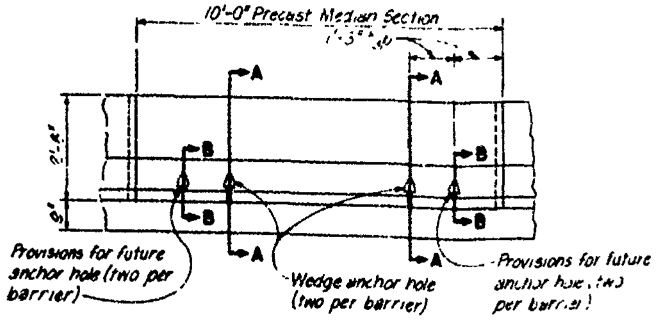
PLAN



SECTION B-B
Scale 1" = 2'-0"

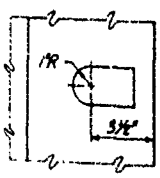


DETAIL 3
CONTRACTION JOINT



ELEVATION
UPSTREAM SIDE OF MEDIAN BARRIER
Scale 1" = 2'-0"

AN BARRIER



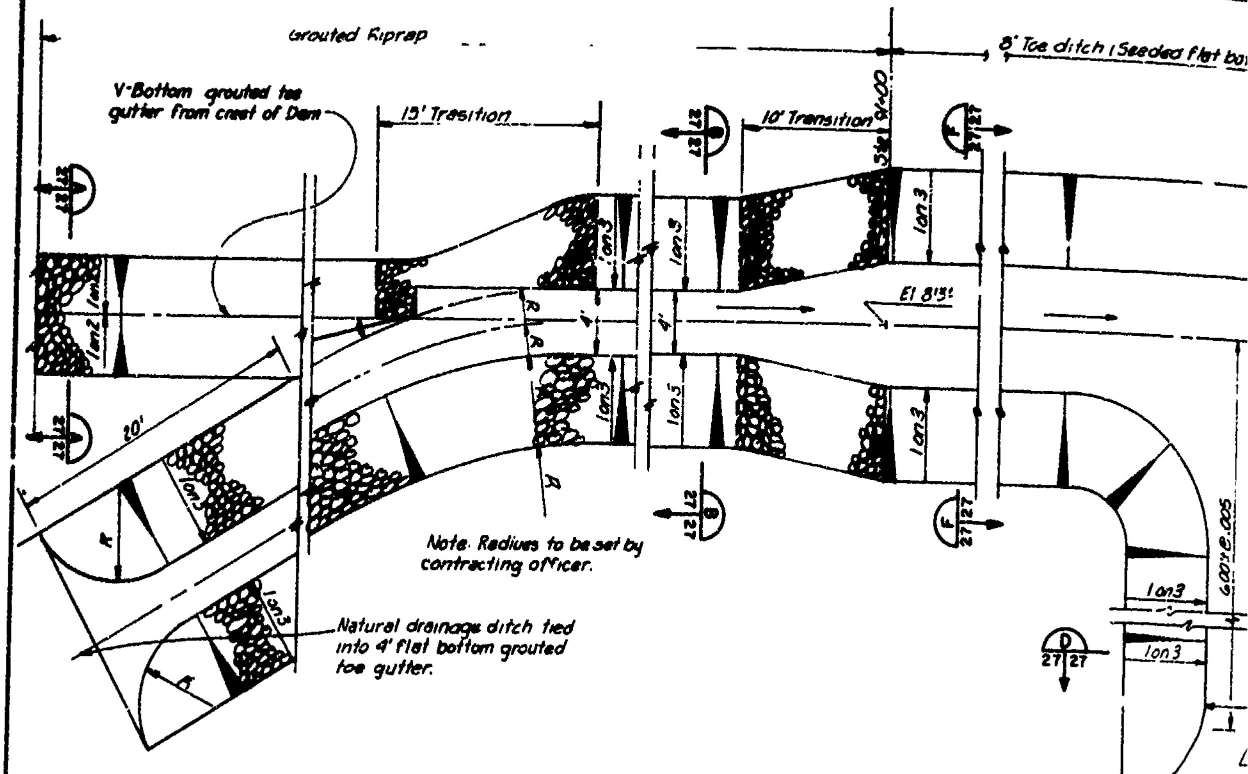
SECTION D-D
Scale 3" = 1'-0"

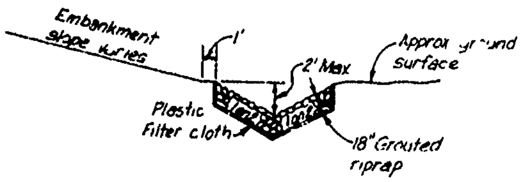
NOTES
1. Provided reinforcing as required for handling and to meet Missouri Highway and Transportation Commission Concrete Median Barrier Drawing 617.00P
2. For keyway and other details not shown, see Drawing 617.00P, Concrete Median Barrier, Missouri Highway Transportation Commission
3. Anchors for transition sections similar to those shown for other barrier precast sections.

Revisions			
Symbol	Descriptions	Date	Approved

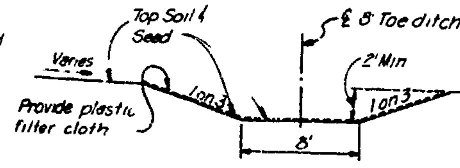
U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

Designed by R G D	LITTLE BLUE RIVER, MISSOURI LONGVIEW LAKE EMBANKMENT CRITERIA AND PERFORMANCE REPORT
Drawn by S E S	TOP OF DAM AND SLOPE PROTECTION DETAILS
Checked by R.G.D / W.B.E	Scale AS SHOWN · Sheet number
Submitted by R G D	Date · Dwg No · File No RBL-3-1426

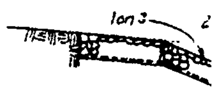




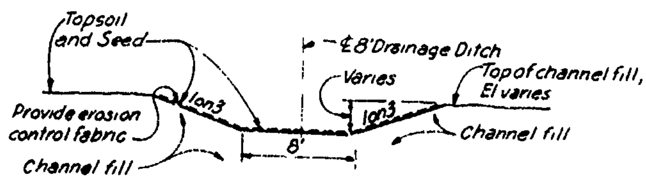
TOE GUTTER DITCH SECTION A 27|27
Scale 1"=5'-0"
FROM RIGHT ABUTMENT THRU STA 90+85 AND STA 99+10



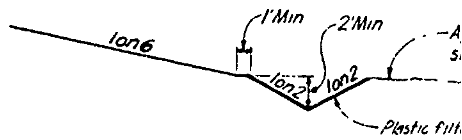
8' TOE DITCH SECTION F 27|27
Scale 1"=5'0"
STA 91+00 THRU STA 9?+00



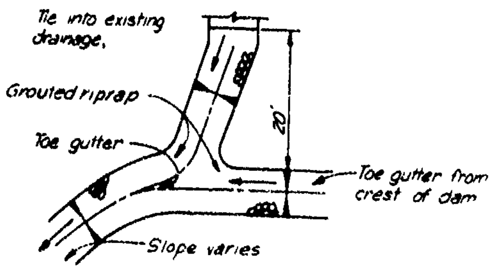
4' FLA



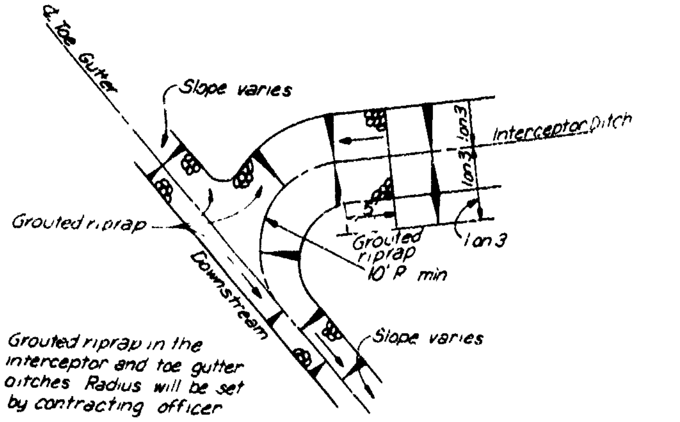
8' DRAINAGE DITCH SECTION D 27|27
DOWNSTREAM OF SERVICE ROAD D
Scale 1"=5'0"



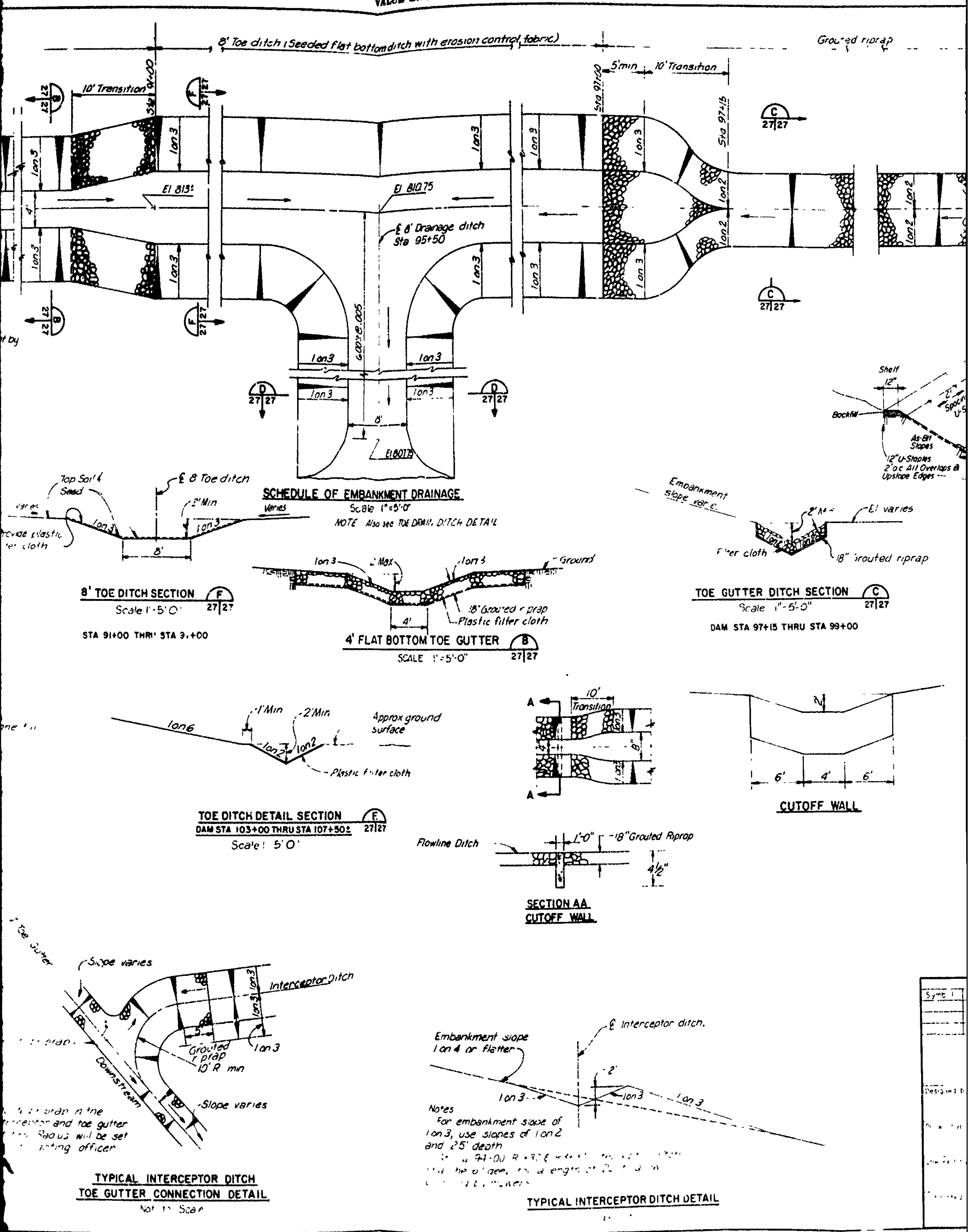
TOE DITCH DETAIL SECTION E
DAM STA 103+00 THRU STA 107+50±
Scale 1"=5'0"



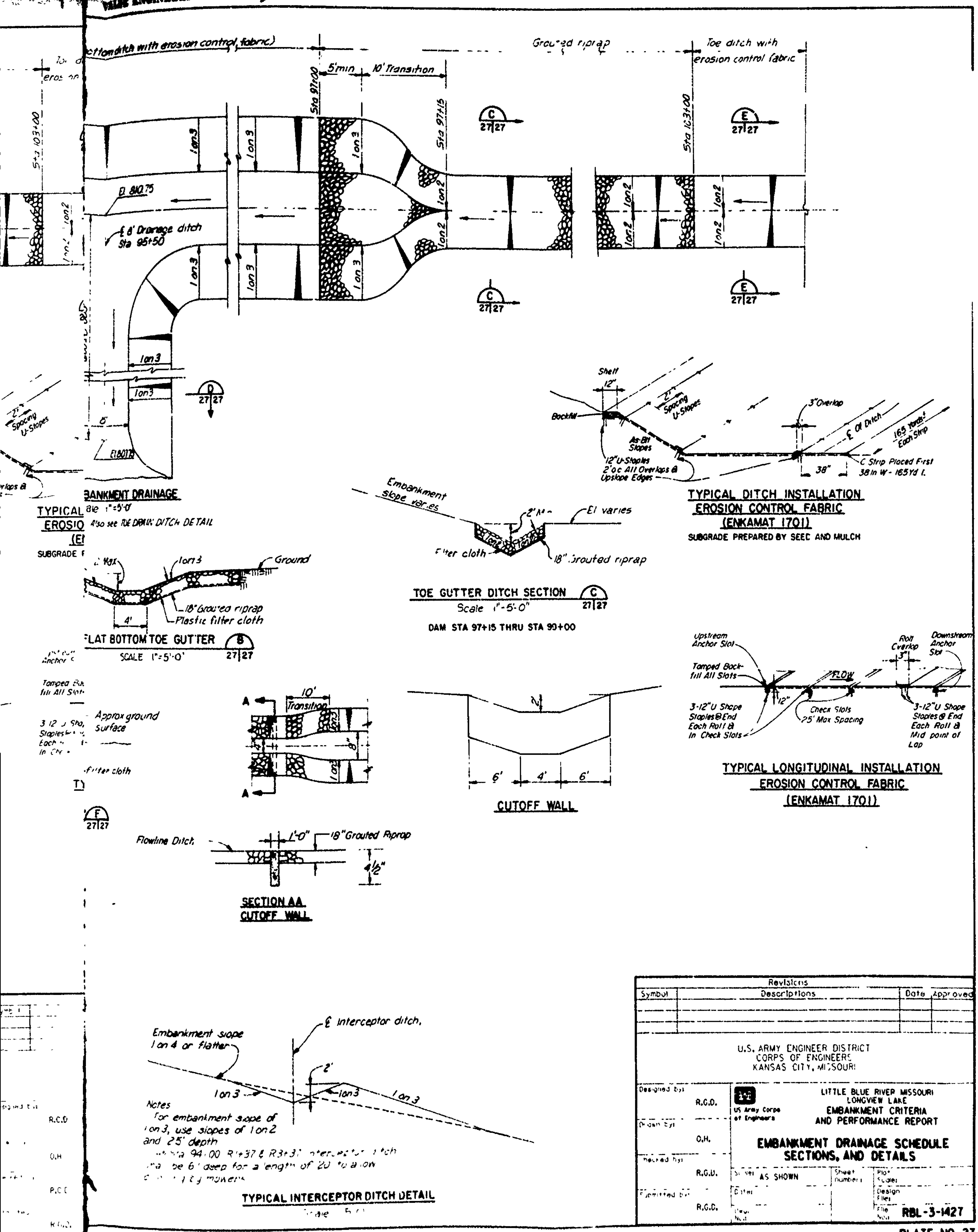
DETAIL A
TOE GUTTER TIE IN DETAIL RIGHT ABUTMENT
Not to Scale



TYPICAL INTERCEPTOR DITCH
TOE GUTTER CONNECTION DETAIL
Not to Scale



8' Toe ditch (Seeded flat bottom ditch with erosion control fabric)
Grouted riprap
10' Transition
5' min
10' Transition
Sta 91+00
Sta 97+15
El 813±
El 810.75
℄ 8' Drainage ditch Sta 95+50
1 on 3
1 on 2
.005±.006
El 801.75
SCHEDULE OF EMBANKMENT DRAINAGE
Scale 1"=5'-0"
NOTE Also see TOE DRAIN DITCH DETAIL
Shelf
Backfill
As-Bit Slopes
12" U-Staples 2' o.c. All Overlaps & Upslope Edges
Top Soil & Seed
℄ 8' Toe ditch
2' Min
Varies
8' TOE DITCH SECTION
Scale 1"-5'-0"
STA 91+00 THRU STA 9 +00
Ground
18" Grouted riprap
Plastic filter cloth
4' FLAT BOTTOM TOE GUTTER
SCALE 1"=5'-0"
Embankment slope varies
El varies
Filter cloth
18" Grouted riprap
TOE GUTTER DITCH SECTION
Scale 1"-5'-0"
DAM STA 97+15 THRU STA 99+00
1 on 6
1' Min
2' Min
Approx ground surface
Plastic filter cloth
TOE DITCH DETAIL SECTION
DAM STA 103+00 THRU STA 107+50±
Scale 1"-5'-0"
10' Transition
8"
CUTOFF WALL
6'
4'
6'
Flowline Ditch
1'-0"
18" Grouted Riprap
4½"
SECTION AA CUTOFF WALL
Slope varies
Interceptor Ditch
Grouted riprap
10' R min
Downstream
Slope varies
TYPICAL INTERCEPTOR DITCH TOE GUTTER CONNECTION DETAIL
Not to Scale
℄ Interceptor ditch.
Embankment slope 1 on 4 or flatter
2'
1 on 3
Notes
For embankment slope of 1 on 3, use slopes of 1 on 2 and 2.5' depth
TYPICAL INTERCEPTOR DITCH DETAIL

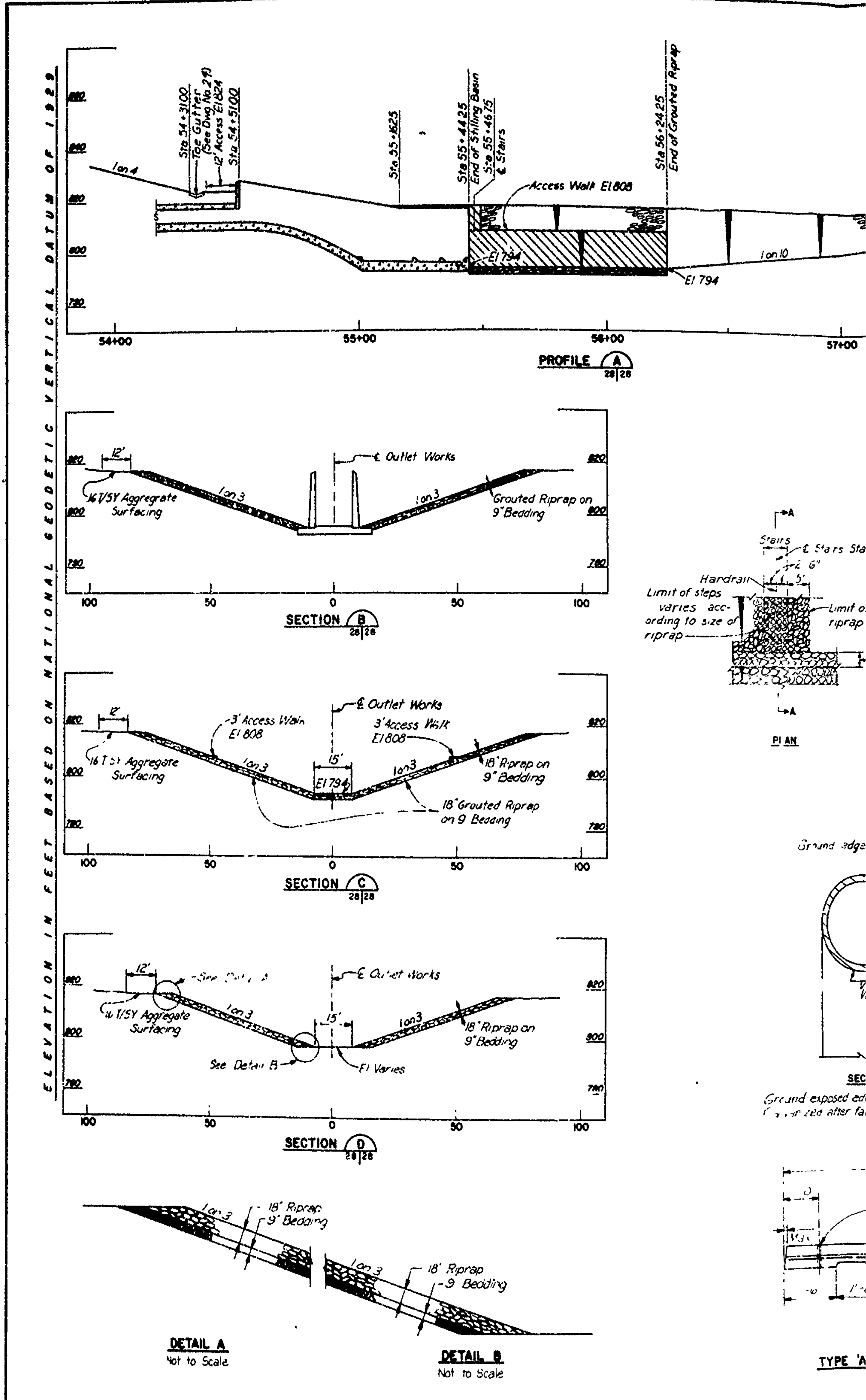


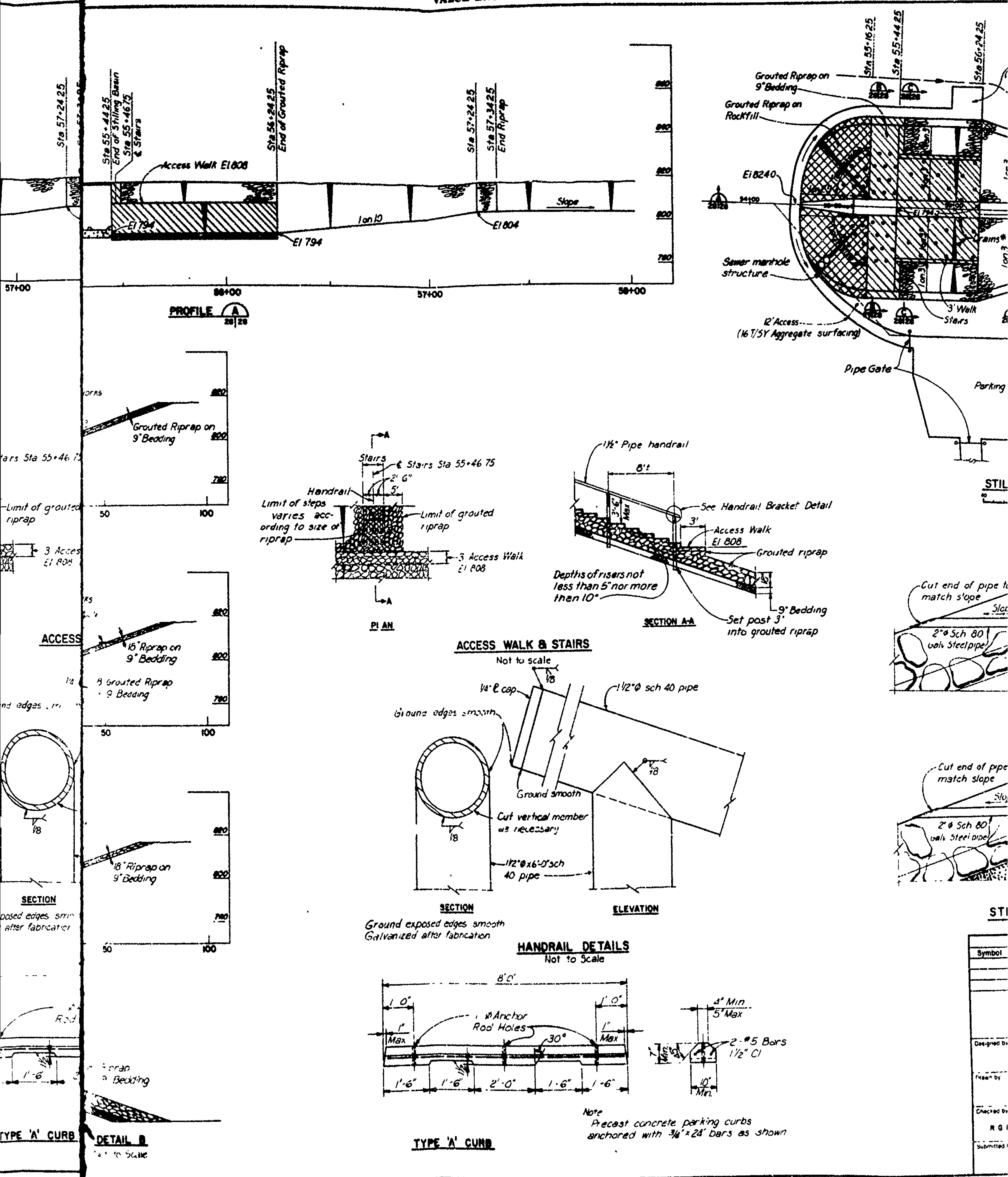
Symbol	Revisions Descriptions	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

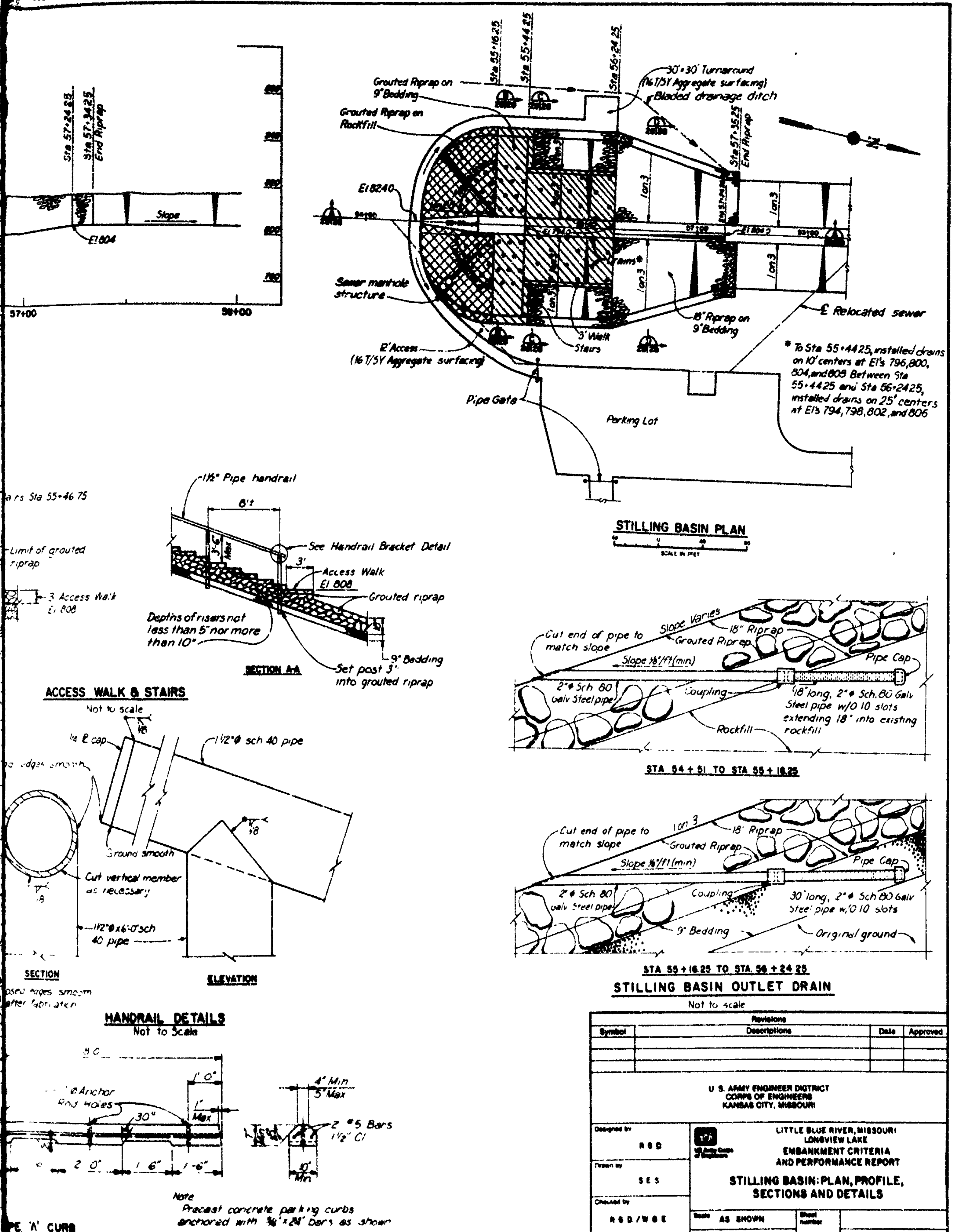
Designed by: R.G.D.	US Army Corps of Engineers	LITTLE BLUE RIVER MISSOURI LONGVIEW LAKE EMBANKMENT CRITERIA AND PERFORMANCE REPORT
Drawn by: O.H.		**EMBANKMENT DRAINAGE SCHEDULE SECTIONS, AND DETAILS**
Checked by: R.G.D.	Scale: AS SHOWN	
Submitted by: R.G.D.		File No.: RBL-3-1427

PLATE NO. 27


VA
ELEVATION IN FEET BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929
Sta 54+31.00
Toe Gutter
(See Dwg No 24)
12' Access El 824
Sta 54+51.00
Sta 55+16.25
Sta 55+44.25
End of Stilling Basin
Sta 55+46.75
℄ Stairs
Sta 56+24.25
End of Grouted Riprap
1 on 4
Access Walk El 808
El 794
1 on 10
El 794
54+00
55+00
56+00
57+00
PROFILE A
28|28
12'
℄ Outlet Works
16 T/SY Aggregate Surfacing
1 on 3
1 on 3
Grouted Riprap on 9" Bedding
SECTION B
28|28
℄ Outlet Works
3' Access Walk El 808
3' Access Walk El 808
1 on 3
1 on 3
15'
El 794
18" Riprap on 9" Bedding
18" Grouted Riprap on 9 Bedding
SECTION C
28|28
℄ Outlet Works
See Detail A
16 T/SY Aggregate Surfacing
1 on 3
1 on 3
15'
18" Riprap on 9" Bedding
See Detail B
El Varies
SECTION D
28|28
1 on 3
18" Riprap
9" Bedding
1 on 3
18" Riprap
9 Bedding
DETAIL A
Not to Scale
DETAIL B
Not to Scale
Stairs
℄ Stairs Sta
Handrail
Limit of steps varies according to size of riprap
Limit of riprap
PLAN
SEC
TYPE 'A



Sta 57+24.25
Sta 55+44.25 End of Stilling Basin
Sta 55+46.75 ℄ Stairs
Sta 56+24.25 End of Grouted Riprap
Sta 57+24.25
Sta 57+34.25 End Riprap
Access Walk El 808
El 794
El 794
1 on 10
El 804
Slope
57+00
56+00
57+00
58+00
PROFILE A
Grouted Riprap on 9" Bedding
Grouted Riprap on Rockfill
El 824.0
Sewer manhole structure
12' Access (16 T/SY Aggregate surfacing)
3' Walk Stairs
Pipe Gate
Parking
Sta 55+16.25
Sta 55+44.25
Sta 56+24.25
Grouted Riprap on 9" Bedding
15" Riprap on 9" Bedding
18" Riprap on 9" Bedding
SECTION
Stairs
℄ Stairs Sta 55+46 75
Handrail
Limit of steps varies according to size of riprap
Limit of grouted riprap
3 Access Walk El 808
PLAN
1½" Pipe handrail
See Handrail Bracket Detail
Access Walk El 808
Grouted riprap
9" Bedding
Set post 3' into grouted riprap
Depths of risers not less than 5" nor more than 10"
SECTION A-A
ACCESS WALK & STAIRS
Not to scale
¼" ℄ cap
1½"Φ sch 40 pipe
Ground edges smooth
Ground smooth
Cut vertical member as necessary
1½"Φ x 6'-0" sch 40 pipe
SECTION
ELEVATION
Ground exposed edges smooth
Galvanized after fabrication
HANDRAIL DETAILS
Not to Scale
Cut end of pipe to match slope
2"Φ Sch 80 Galv Steel pipe
8'-0"
1'-0"
1'-0"
Anchor Rod Holes
30°
1" Max
1'-6"
1'-6"
2'-0"
1'-6"
1'-6"
4" Min
5" Max
2-#5 Bars 1½" Cl
10" Min.
Note
Precast concrete parking curbs anchored with ¾" x 24" bars as shown
TYPE 'A' CURB
DETAIL B
Not to Scale
Symbol
Designed by
Drawn by
Checked by
Submitted by



Symbol	Descriptions	Date	Approved

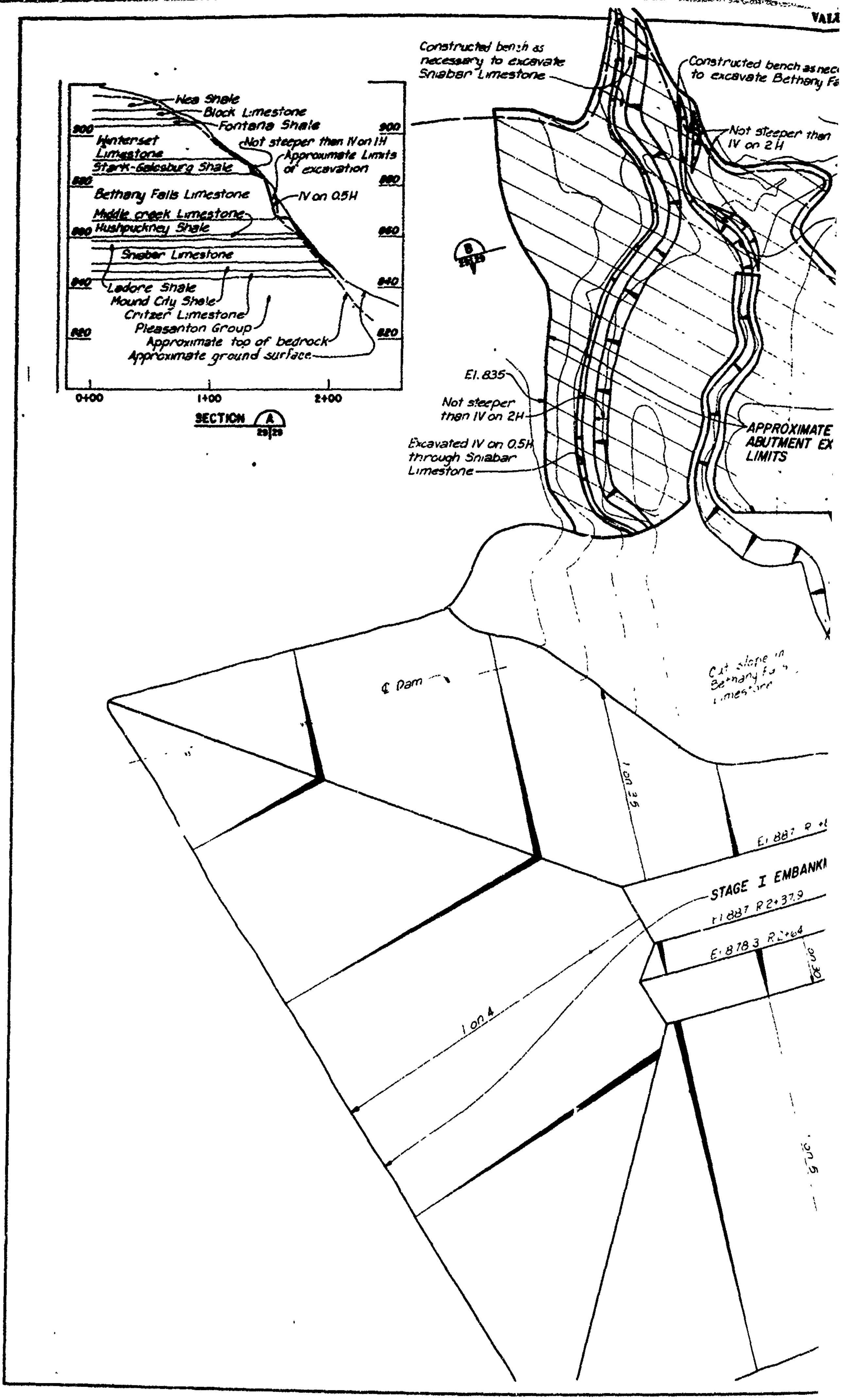
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA
AND PERFORMANCE REPORT

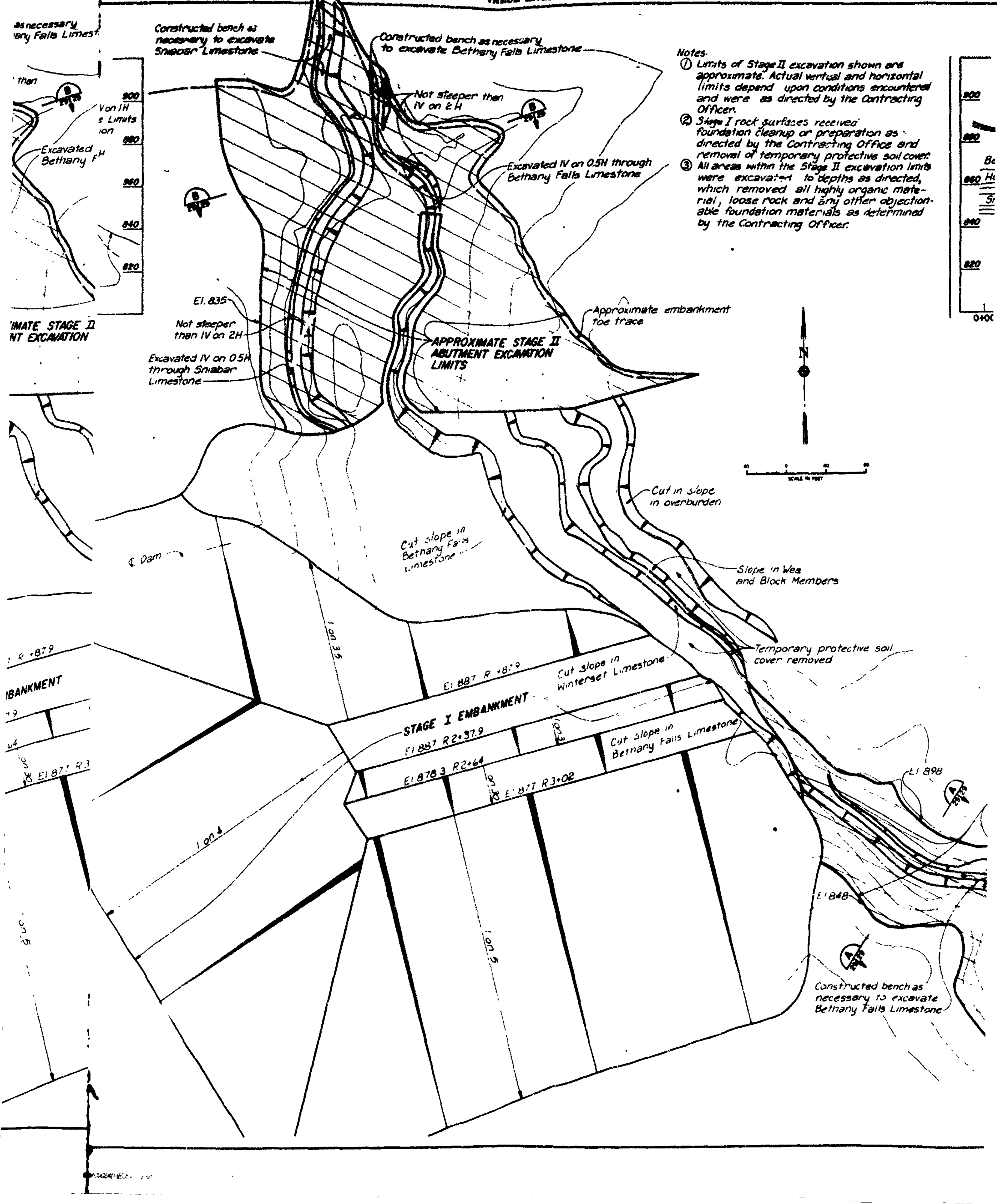
STILLING BASIN: PLAN, PROFILE, SECTIONS AND DETAILS

Designed by	RGD
Drawn by	SES
Checked by	RGD/WBE
Submitted by	RGD
Scale	AS SHOWN
File No	RBL-3-1428

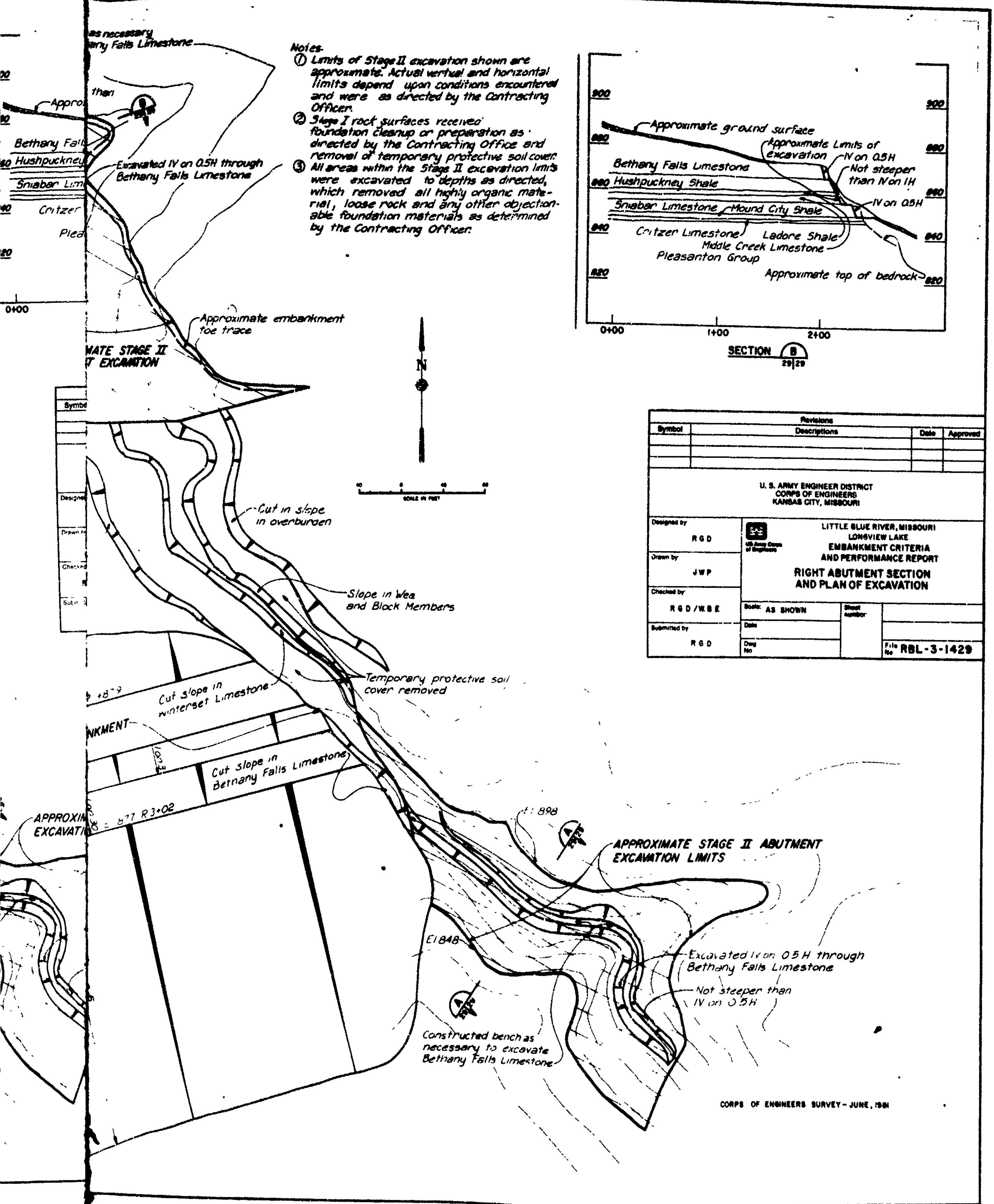
PLATE NO. 28

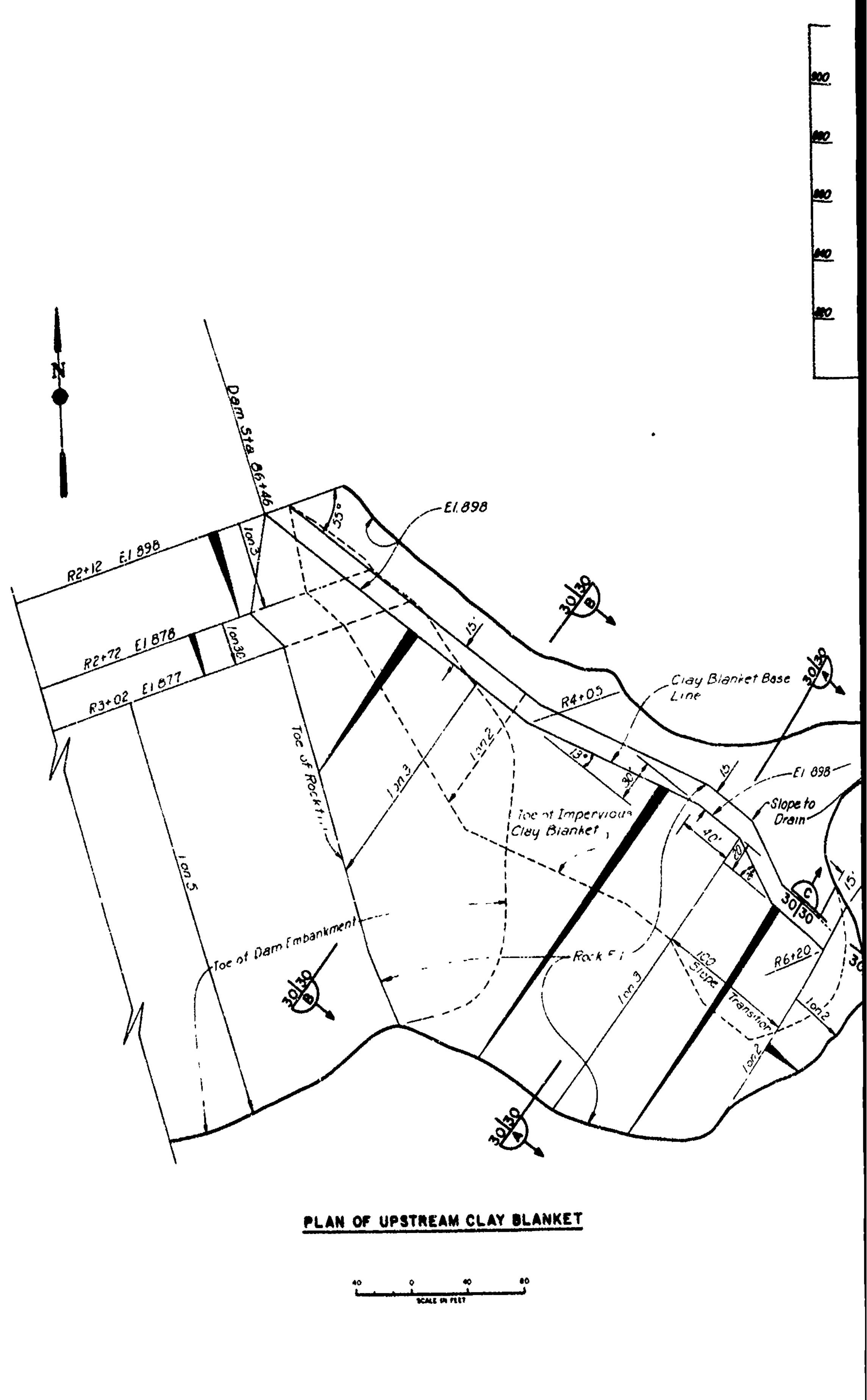


Nes Shale
Block Limestone
Fontana Shale
Winterset Limestone
Stark-Galesburg Shale
Bethany Falls Limestone
Middle creek Limestone
Hushpuckney Shale
Sniabar Limestone
Ladore Shale
Mound City Shale
Critzer Limestone
Pleasanton Group
Approximate top of bedrock
Approximate ground surface
Not steeper than IV on 1H
Approximate Limits of excavation
IV on 0.5H
900
880
860
840
820
0+00
1+00
2+00
SECTION A 29|29
Constructed bench as necessary to excavate Sniabar Limestone
Constructed bench as nec to excavate Bethany Fa
Not steeper than IV on 2H
El. 835
Not steeper than IV on 2H
Excavated IV on 0.5H through Sniabar Limestone
APPROXIMATE ABUTMENT EX LIMITS
℄ Dam
1 on 3.5
1 on 4
STAGE I EMBANKI
El 887 R2+37.9
El 878.3 R2+64
1 on 5



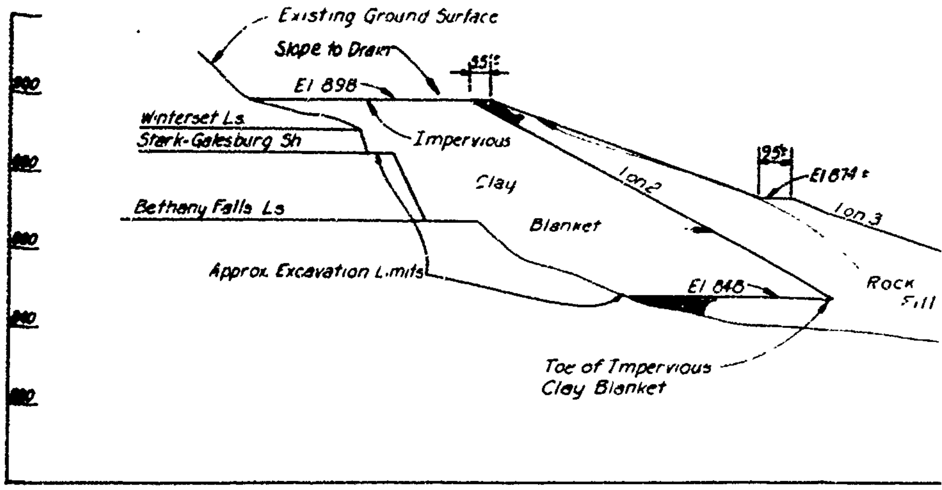
Constructed bench as necessary to excavate Sniabar Limestone
Constructed bench as necessary to excavate Bethany Falls Limestone
Not steeper than IV on 2H
Notes.
① Limits of Stage II excavation shown are approximate. Actual vertical and horizontal limits depend upon conditions encountered and were as directed by the Contracting Officer.
② Stage I rock surfaces received foundation cleanup or preparation as directed by the Contracting Office and removal of temporary protective soil cover.
③ All areas within the Stage II excavation limits were excavated to depths as directed, which removed all highly organic material, loose rock and any other objectionable foundation materials as determined by the Contracting Officer.
Excavated IV on 0.5H through Bethany Falls Limestone
Excavated Bethany F
El. 835
Not steeper than IV on 2H
Excavated IV on 0.5H through Sniabar Limestone
APPROXIMATE STAGE II ABUTMENT EXCAVATION LIMITS
Approximate embankment toe trace
N
Cut in slope in overburden
Cut slope in Bethany Falls Limestone
℄ Dam
Slope in Wea and Block Members
Temporary protective soil cover removed
Cut slope in Winterset Limestone
STAGE I EMBANKMENT
El 887 R +8.79
El 887 R2+37.9
El 878.3 R2+64
El 877 R3+02
Cut slope in Bethany Falls Limestone
1 on 3.5
1 on 4
1 on .5
1 on 5
El 898
El 848
Constructed bench as necessary to excavate Bethany Falls Limestone
900
880
860
840
820
APPROXIMATE STAGE II ABUTMENT EXCAVATION
STAGE I EMBANKMENT


Notes
① Limits of Stage II excavation shown are approximate. Actual vertical and horizontal limits depend upon conditions encountered and were as directed by the Contracting Officer.
② Stage I rock surfaces received foundation cleanup or preparation as directed by the Contracting Office and removal of temporary protective soil cover.
③ All areas within the Stage II excavation limits were excavated to depths as directed, which removed all highly organic material, loose rock and any other objectionable foundation materials as determined by the Contracting Officer.
900
880
860
840
820
Approximate ground surface
Approximate Limits of excavation
IV on 0.5H
Not steeper than IV on IH
IV on 0.5H
Bethany Falls Limestone
Hushpuckney Shale
Sniabar Limestone
Mound City Shale
Critzer Limestone
Ladore Shale
Middle Creek Limestone
Pleasanton Group
Approximate top of bedrock
0+00
1+00
2+00
SECTION B 29|29
Revisions
Symbol
Descriptions
Date
Approved
U. S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI
Designed by
RGD
Drawn by
JWP
Checked by
RGD/WBE
Submitted by
RGD
LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA
AND PERFORMANCE REPORT
RIGHT ABUTMENT SECTION
AND PLAN OF EXCAVATION
Scale AS SHOWN
Date
Dwg No
Sheet number
File No RBL-3-1429
as necessary
Bethany Falls Limestone
Bethany Falls
Hushpuckney
Sniabar Lim
Critzer
Plea
Excavated IV on 0.5H through Bethany Falls Limestone
Approximate embankment toe trace
APPROXIMATE STAGE II ABUTMENT EXCAVATION
N
SCALE IN FEET
Cut in slope in overburden
Slope in Wea and Block Members
Temporary protective soil cover removed
Cut slope in Winterset Limestone
EMBANKMENT
Cut slope in Bethany Falls Limestone
R3+02
El 898
APPROXIMATE STAGE II ABUTMENT EXCAVATION LIMITS
El 848
Excavated IV on 0.5H through Bethany Falls Limestone
Not steeper than IV on 0.5H
Constructed bench as necessary to excavate Bethany Falls Limestone
CORPS OF ENGINEERS SURVEY - JUNE, 1981

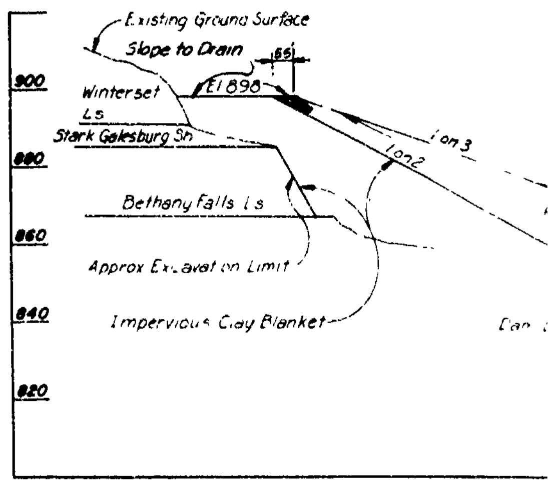


PLAN OF UPSTREAM CLAY BLANKET

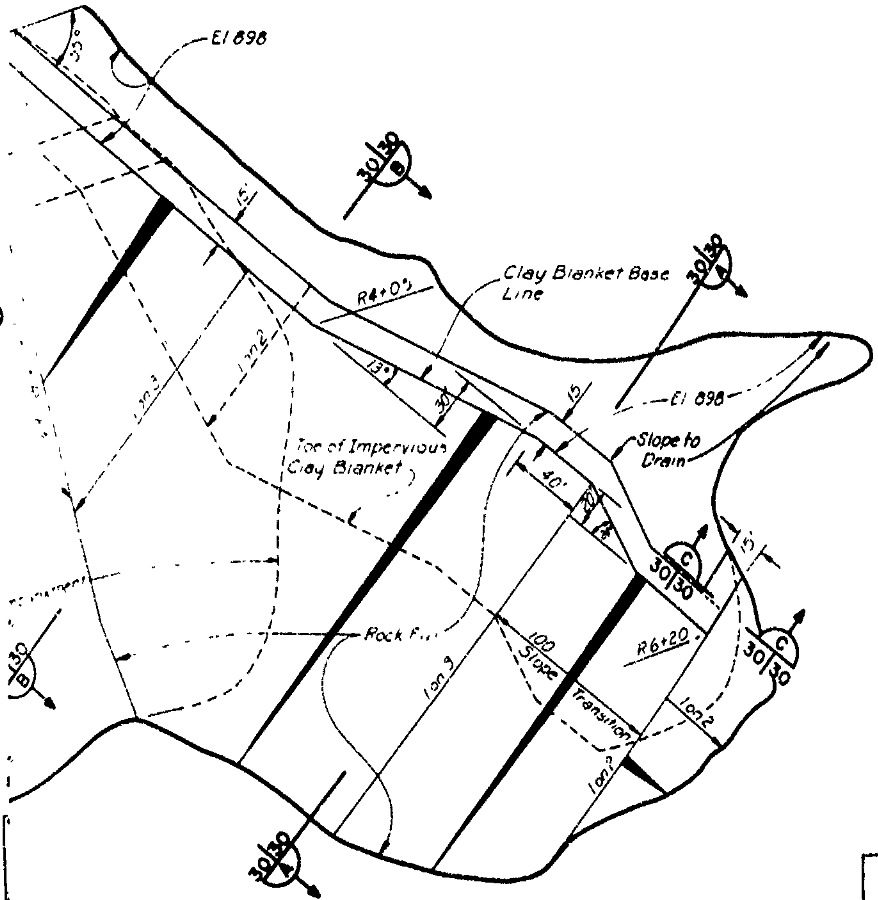
SCALE IN FEET



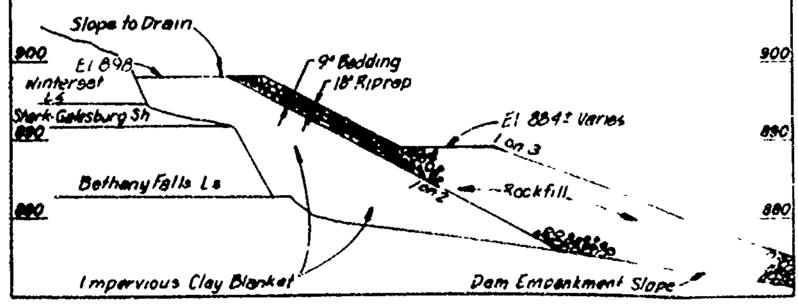
UPSTREAM CLAY BLANKET SECTION A 30|3



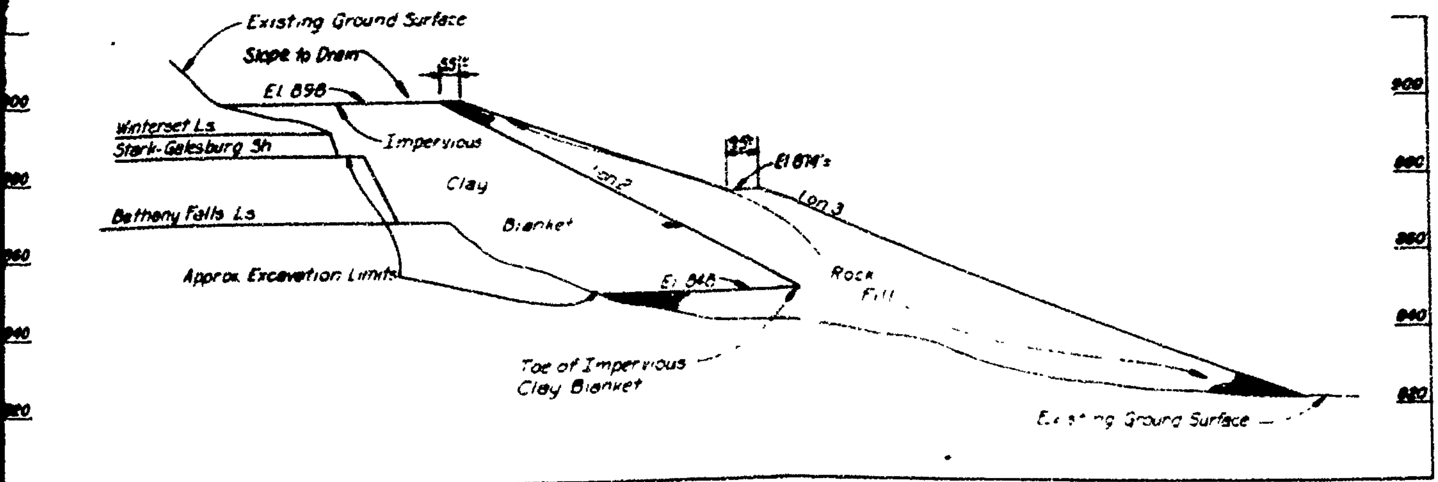
UPSTREAM CLAY BLA



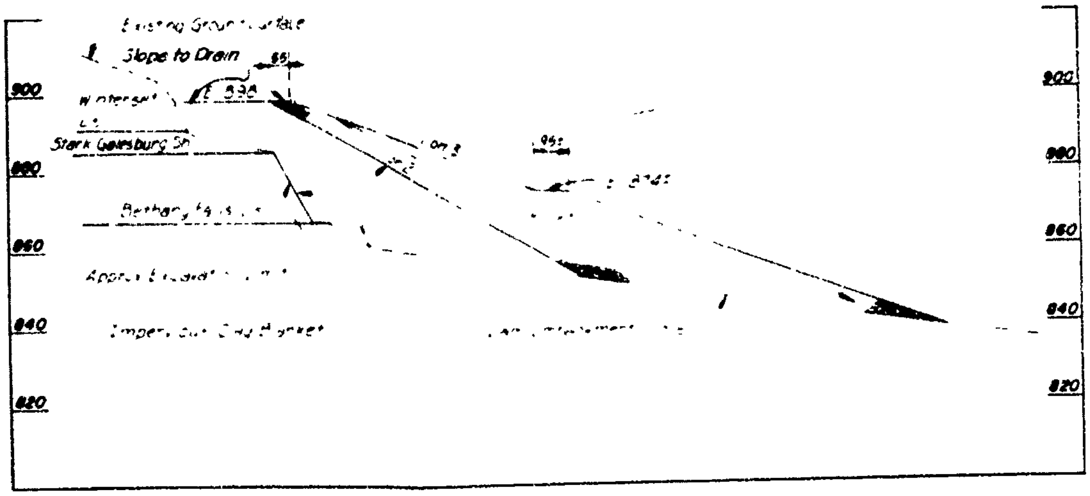
PLAN OF UPSTREAM CLAY BLANKET



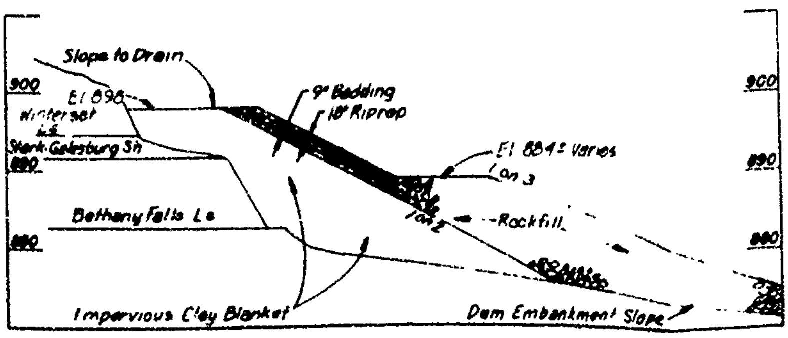
UPSTREAM CLAY BLANKET SECTION C 30|30



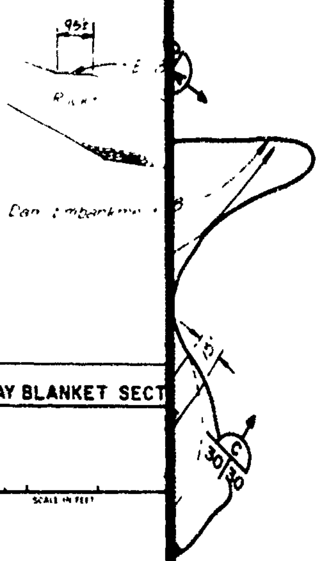
UPSTREAM CLAY BLANKET SECTION A 30|30



UPSTREAM CLAY BLANKET SECTION B 30|30



UPSTREAM CLAY BLANKET SECTION C 30|30



Symbol	Descriptions	Date	Approved
	Revisions		

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

US Army Corps of Engineers

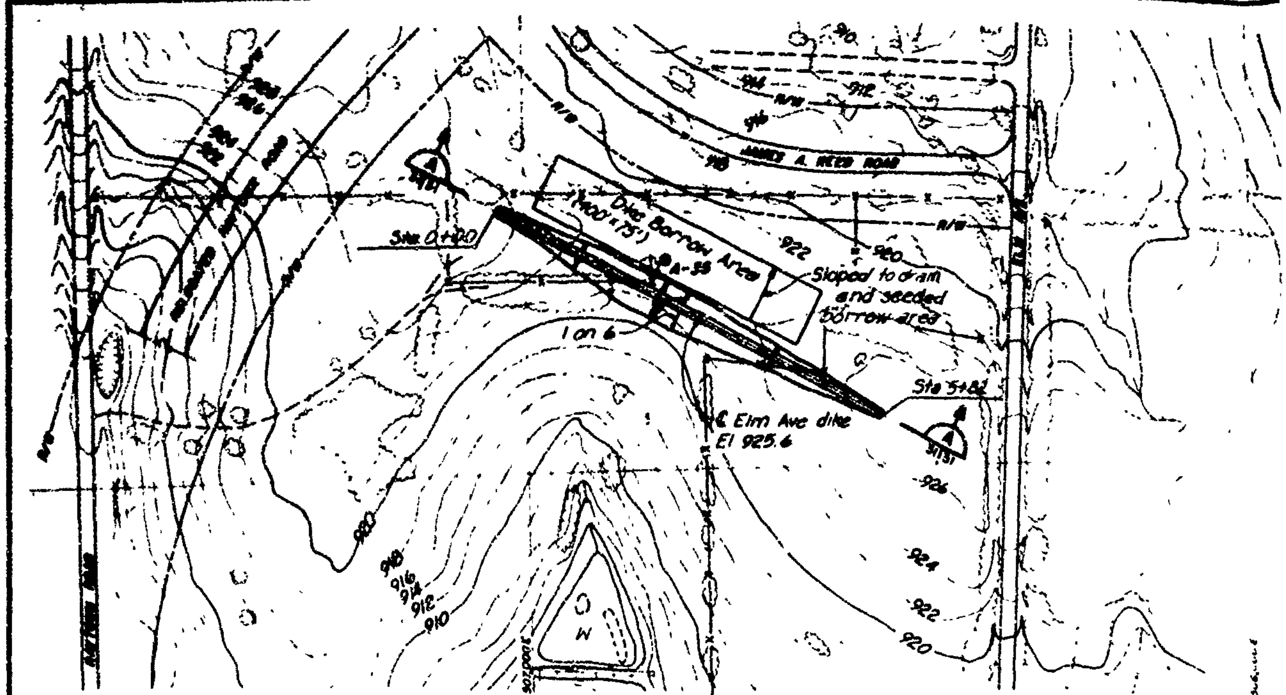
LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA
AND PERFORMANCE REPORT
RIGHT ABUTMENT
UPSTREAM IMPERVIOUS
CLAY BLANKET PLAN AND SECTIONS

Designed by: R.G.D.
Drawn by: J.W.T.
Checked by: R.G.D.
Submitted by: R.G.D.

Scale: AS SHOWN

File No. RBL-3-1430

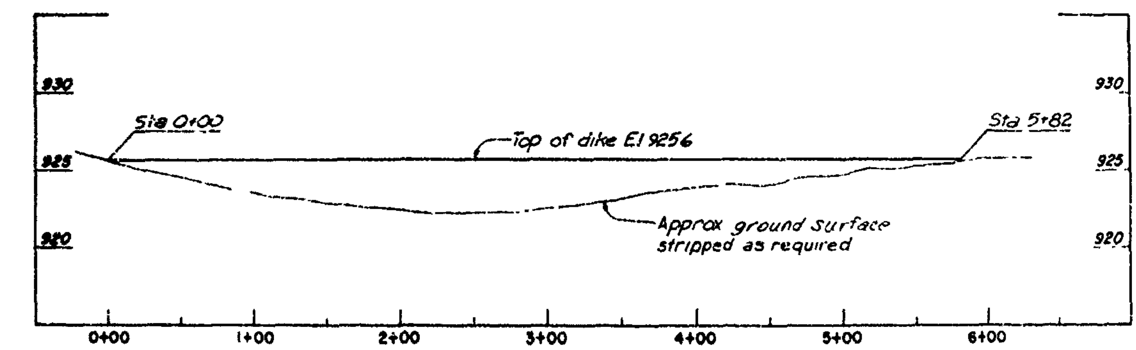
PLATE NO. 30



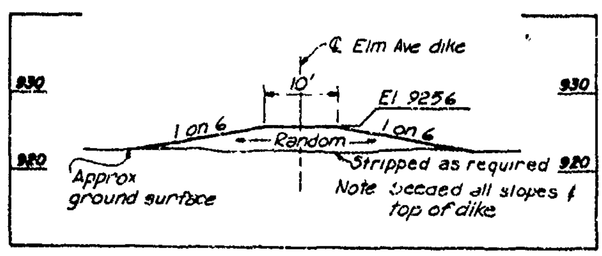
ELM AVE. DIKE PLAN

SCALE IN FEET

ELEVATION IN FEET BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929



PROFILE ALONG ℄ ELM AVE. DIKE (A 31|31)

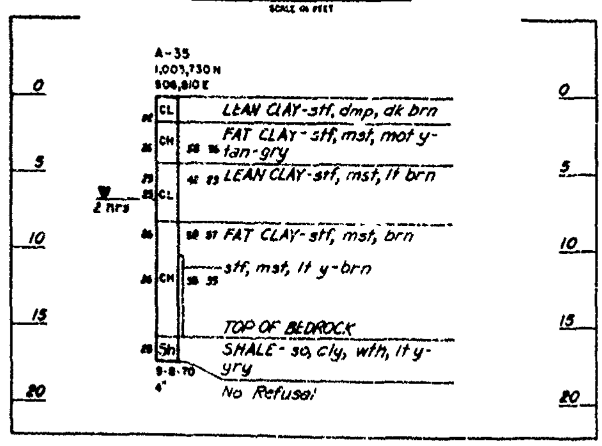


ELM AVE. DIKE-TYPICAL SECTION

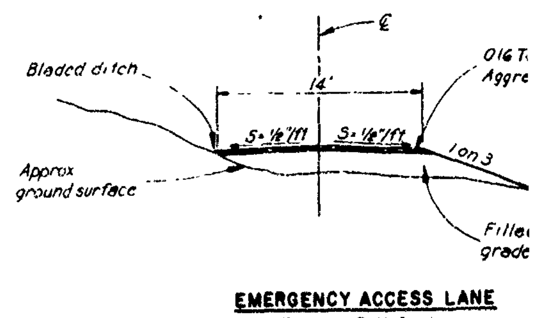
SCALE IN FEET

ELM AVE. DIKE ALINEMENT DATA				
POT STATION	LATITUDE	DEPARTURE	AZIMUTH	DIST
0+00 BEGIN DIKE	1,003,663793	507,035 036		
			116° 02' 20"	582 00
5+82 END DIKE	1,003,937 374	506,521 346		

DEPTH IN FEET



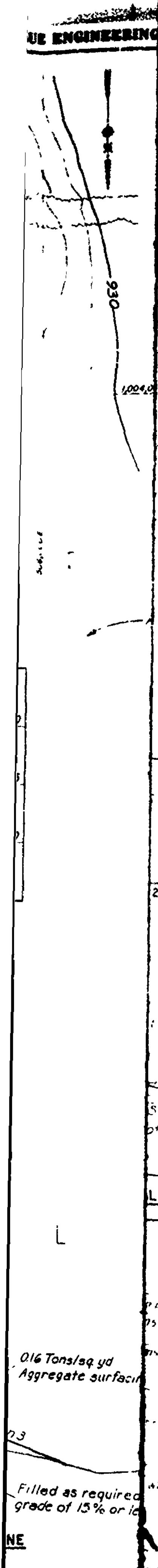
ELM DIKE BORROW AREA-LOG OF BORING

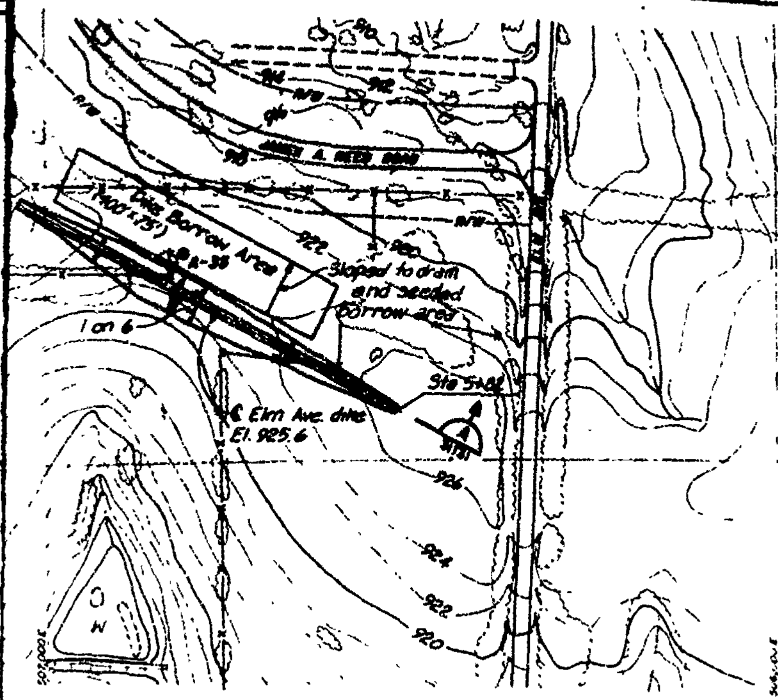


EMERGENCY ACCESS LANE

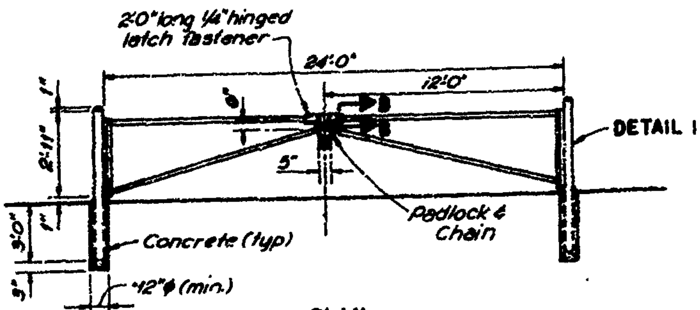
Typical Fill Section

Scale 1"=5'





ELM AVE. DIKE PLAN



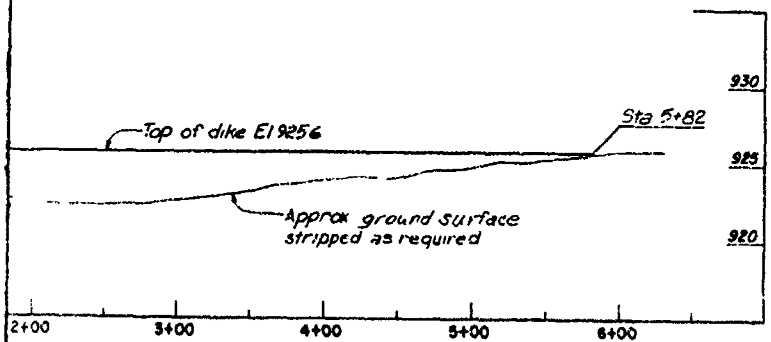
PLAN

PIPE GATE

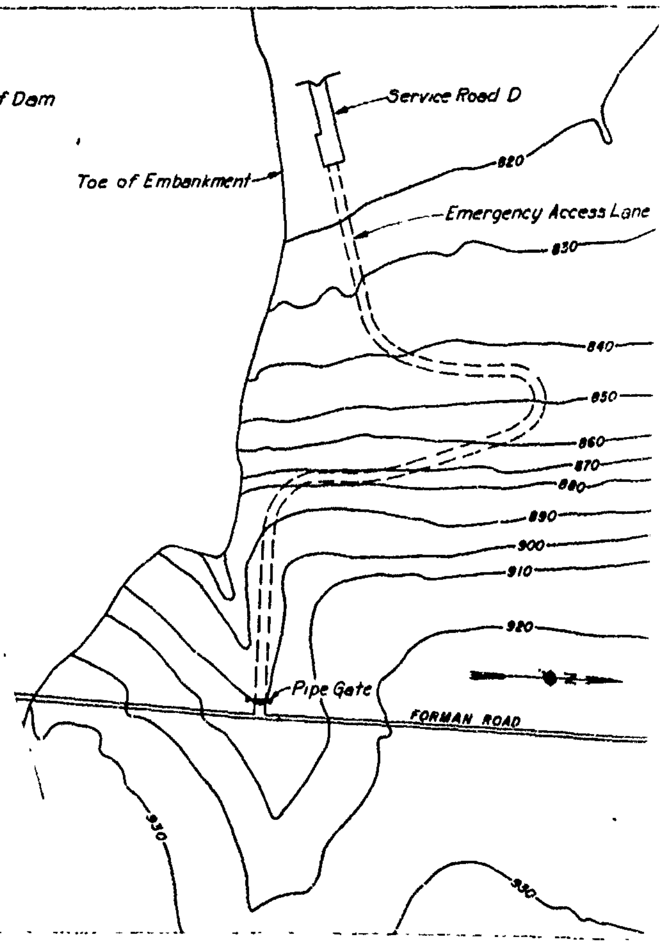
PIPE GATE DETAILS

Not to Scale

Axis of Dam

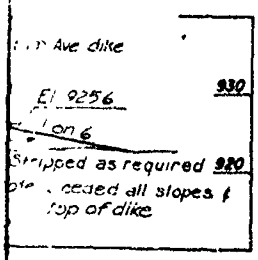


PROFILE ALONG ℄ ELM AVE. DIKE



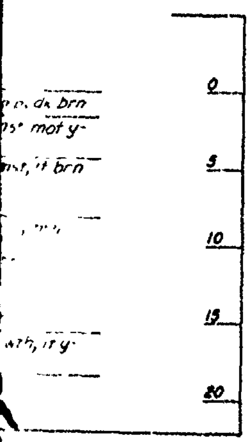
EMERGENCY ACCESS LANE PLAN

Scale 1"=100'

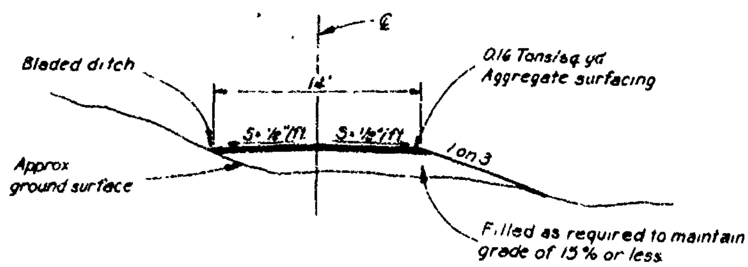


L SECTION

ELM AVE. DIKE ALINEMENT DATA				
POT STATION	LATITUDE	DEPARTURE	AZIMUTH	DIST
0+00 BEGIN DIKE	1,003,863 793	807,036 038		
			118° 02' 20"	582 00
5+82 END DIKE	1,003,937 374	806,521 346		



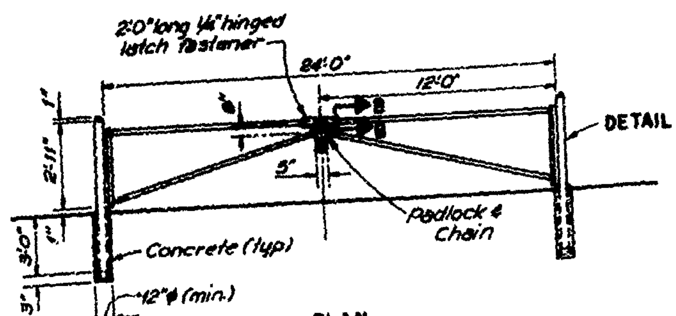
LOG OF BORING



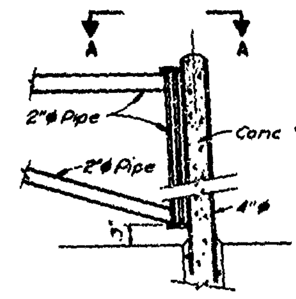
EMERGENCY ACCESS LANE

Typical Fill Section

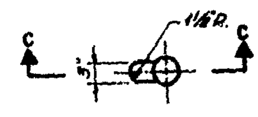
Scale 1"=5'



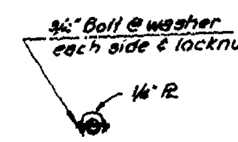
PLAN
PIPE GATE



DETAIL I



SECTION A



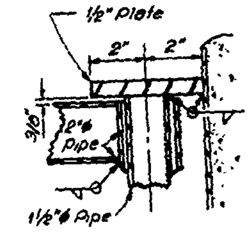
SECTION B

PIPE GATE DETAILS

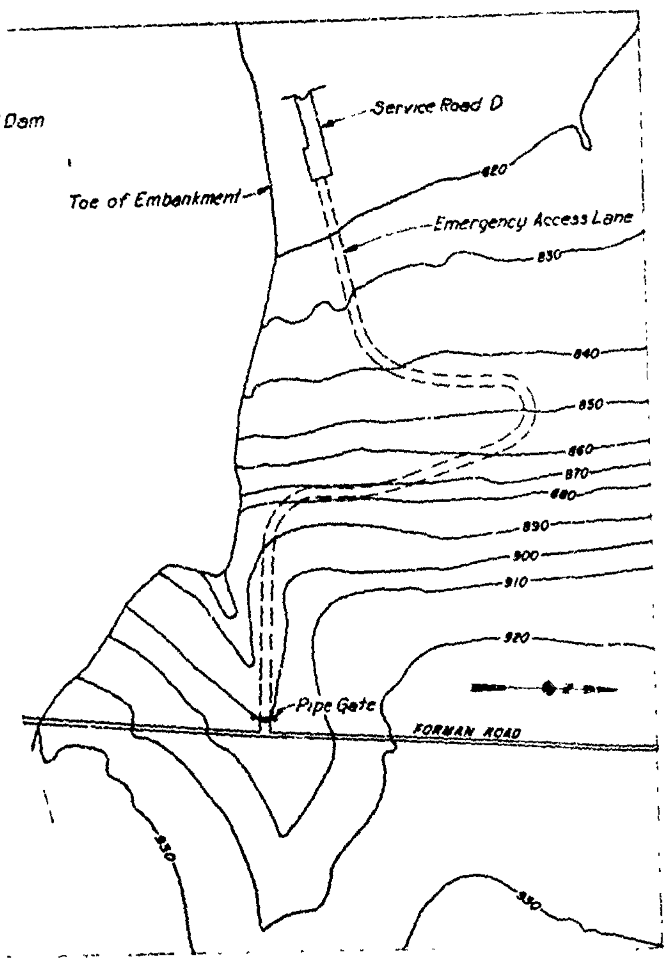
Not to Scale

NOTES:

1. All pipe Schedule 40 Steel
2. Pipe Gate completely welded at all joints and watertight.
3. Painted with one coat red lead primer and two coats yellow exterior enamel.



SECTION C
(Typical @ Top & Bottom)



EMERGENCY ACCESS LANE PLAN

Scale 1"=100'

2.6 Tons/sq yd
Aggregate surfacing

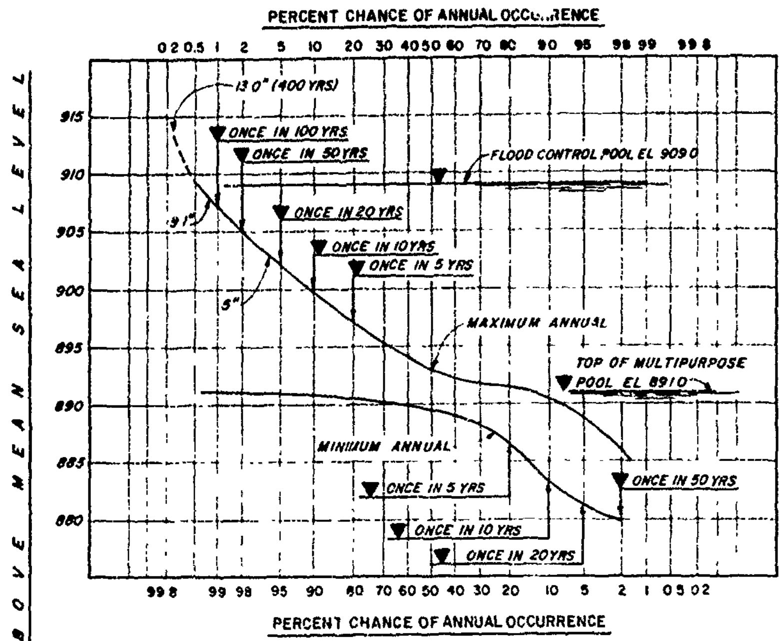
...ed as required to maintain
...e of 15% or less

Symbol	Revisions Descriptions	Date	Approved

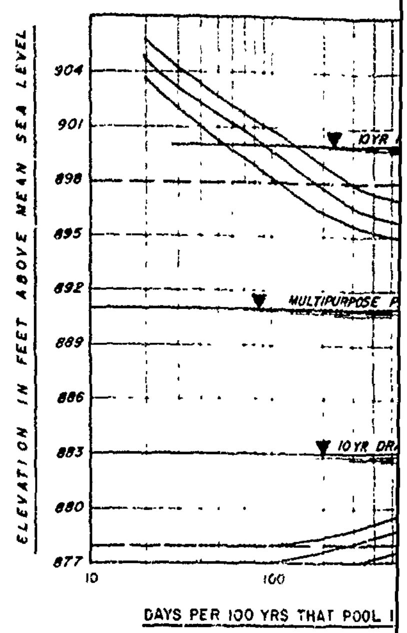
U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

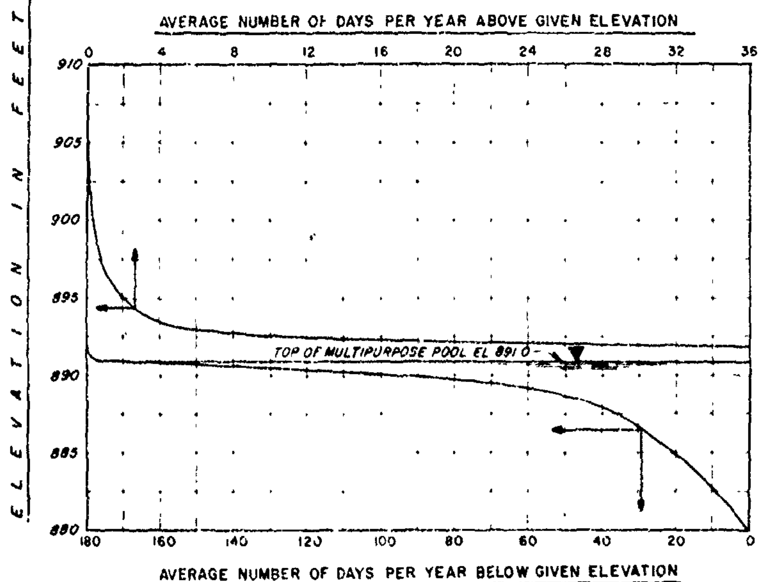
Designed by R G D	LITTLE BLUE RIVER, MISSOURI LONGVIEW LAKE EMBANKMENT CRITERIA AND PERFORMANCE REPORT
Drawn by J.W.P.	ELM AVENUE DIKE, ACCESS LANE AND PIPE GATE DETAILS
Checked by R.B.D./W.B.E.	Scale AS SHOWN
Submitted by R G D.	Date / Dwg No. / File No RBL-3-1431

PLATE NO. 31



POOL ELEVATION - EXCEEDANCE FREQUENCY CURVE





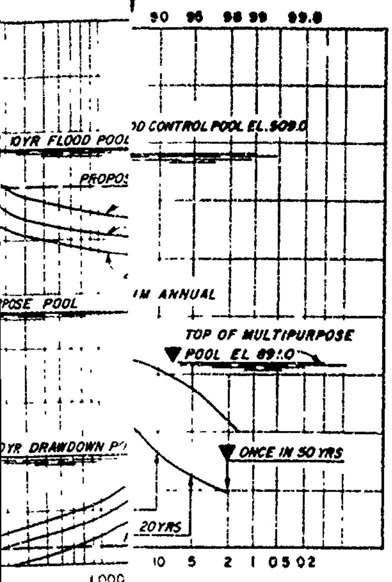
POOL ELEVATION - DURATION CURVE

WIND VELOCITY - FREQ

DIRECTION	FREQUENCY YRS	TOPEKA, KS MPH	C
SSE	100	[illegible]	[illegible]
S	[illegible]	[illegible]	[illegible]
SSW	[illegible]	[illegible]	[illegible]
SW	[illegible]	[illegible]	[illegible]
SSE	[illegible]	[illegible]	[illegible]
S	[illegible]	[illegible]	[illegible]
SSW	[illegible]	[illegible]	[illegible]
SW	[illegible]	[illegible]	[illegible]
SSE	[illegible]	[illegible]	[illegible]
S	[illegible]	[illegible]	[illegible]
SSW	[illegible]	[illegible]	[illegible]
SW	10	[illegible]	[illegible]

Notes
Average [illegible] wind
Data from First [illegible]
at airport [illegible]

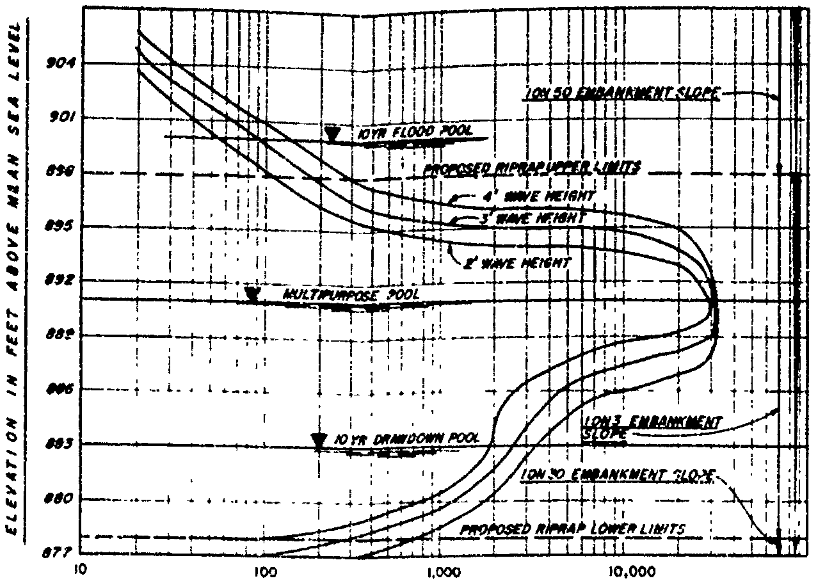
CURRENCE



CURRENCE

POOL IS WITHIN

REQUENCY CURVE



DAYS PER 100 YRS THAT POOL IS WITHIN ONE WAVE HEIGHT OF EACH ELEV

RIPRAP ST

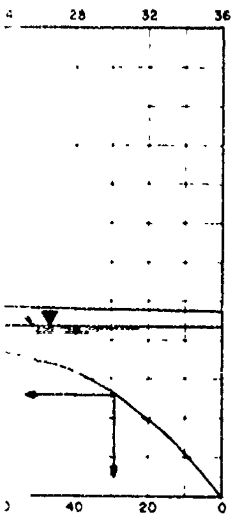
LOCATION			FETCH		DESIGN WIND		DESIGN (MIL
STA	ELEV	SLOPE	LENGTH	DIRECT	DURATION (MIN)	SPEED (MPH)	LENGTH
89+30	920	1 on 3	14	SW			
95+30	920	1 on 3	12	SW	[illegible]	[illegible]	4
101+90	920	1 on 3	8	SW			
89+90	891	1 on 3	66	SW			
95+30	891	1 on 3	67	[illegible]			
101+97	891	1 on 3	46	[illegible]	[illegible]	[illegible]9	[illegible]
98+20	891	1 on 3	67	[illegible]			

Note
1 Fetch length in mile
2 A [illegible] was utilized [illegible] upper 10' of dam [illegible] Riprap Design [illegible] Missouri River [illegible]

GIVEN ELEVATION

FREQUENCY

KS	COLUMBIA, MO MPH
	34
	42
	43
	54
	33
	[illegible]
	[illegible]
	[illegible]

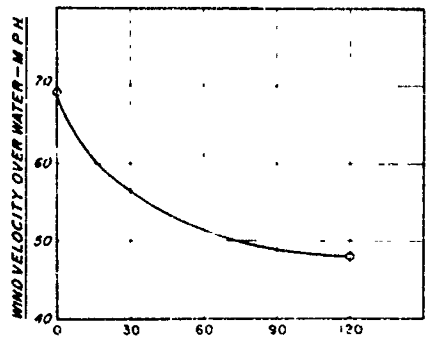


GIVEN ELEVATION

CURVE

WIND VELOCITY-FREQUENCY CHART				
DIRECTION	FREQUENCY YRS	TOPEKA, KS MPH	COLUMBIA, MO MPH	KANSAS CITY, MO MPH
SSE	100	49	34	31
S	100	56	42	38
SSW	100	[illegible]5	43	41
SW	100	5[illegible]	54	40
SSE	50	4[illegible]	33	29
S	50	[illegible]	[illegible]	36
SSW	5[illegible]	[illegible]	[illegible]	39
SW	5[illegible]	4[illegible]	[illegible]	37
SSE	[illegible]	42	[illegible]	[illegible]
S	[illegible]	46	[illegible]	31
SSW	[illegible]	45	[illegible]	34
SW	[illegible]	4[illegible]	[illegible]	32

Notes
Average [illegible] wind
Data from [illegible] Weather Bureau recording station at airport nearest [illegible]



WIND VELOCITY DURATION CURVE

Note
Wind velocity computed [illegible] converted to over water velocities by [illegible]

CRITICAL WIND VEL

RIPRAP	
WIND VELOCITY MPH	WIND
48	
49	
[illegible]	
53	
54	
56	
59 **	
63	
RIPRAP	
39	
49	
[illegible]	
[illegible]	
5[illegible]	
56 **	
59	
63	

Symbol

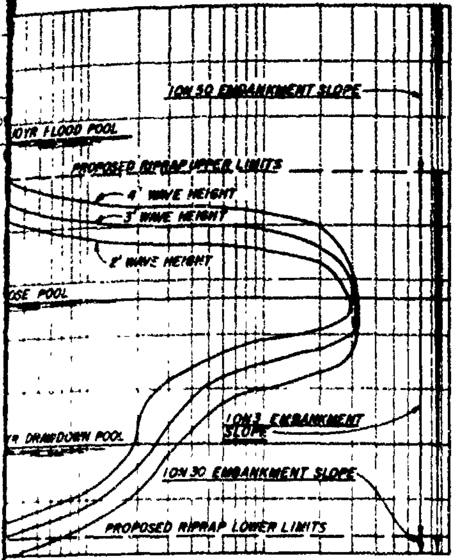
Designed by

Drawn by

Checked by

AP STUDY

DESIGN FETCH (MILES)	
LENGTH	DIRECT
4	



...OL IS WITHIN ONE WAVE HEIGHT OF EACH ELEV

RIPRAP STUDY

(SPECIFIC GRAVITY = 2.6)

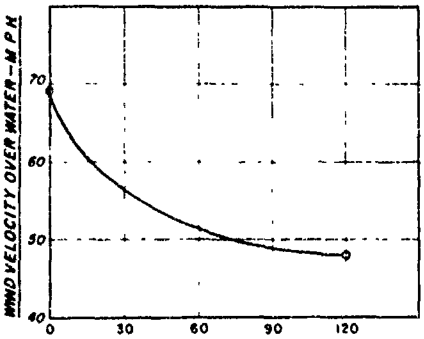
LOCATION			FETCH		DESIGN WIND		DESIGN FETCH (MILES)		DESIGN WAVE		RIPRAP			
STA	ELEV	SLOPE	LENGTH	DIRECT	DURATION (MIN)	SPEED (MPH)	LENGTH	DIRECT	H_S	H_D	We	We PROPOSED	THICK	S F
89+30	920	1on3	1.4	SW	30	56	1.4	SW	2.9	4.1	117	100	18"	See note
95+30	920	1on3	1.2	SW										
101+90	920	1on3	.8	SW										
89+90	891	1on3	.66	SW	20	59	0.7	SW	2.2	3.1	51	100	18"	1.3
95+30	891	1on3	.67	SW										
101+90	891	1on3	.46	S										
98+20	891	1on3	.67	SW										

Note
1 Fetch length in miles.
2 A reduced thickness of riprap was utilized for the upper 10' of dam in accordance with "Criteria for Riprap Design in Missouri River Division June 19..."

D VELOCITY – ...REQUENCY CHART

RIPRAP AT EL... WIND DURA... MIN	...S COLUMBIA, MO MPH	KANSAS CITY, MO MPH
	34	31
	42	38
	43	41
		40
		29
		36
		39
		37
RIPRAP AT EL...		25
		3
		34
		32

... recording station



WIND VELOCITY DURATION CURVE

Note
Wind velocity computed from ETL 1110-2-22 (29 Nov 16) converted to over water velocities by ratio of 1 to 1.13

CRITICAL WIND VELOCITY – DURATION CHART

WIND VELOCITY M P H	WIND DURATION MIN	FORECAST HS – HT
RIPRAP AT ELEV 891		
48	120	1.8 (Fetch limited)
49	90	1.8 (Fetch limited)
51	60	1.8 (Fetch limited)
53	50	2.0 (Fetch limited)
54	40	2.0 (Fetch limited)
56	30	2.1 (Fetch limited)
59 **	20	2.2 (Fetch limited)
63	10	2.0 (Duration limit)
RIPRAP AT ELEV 920		
48	120	2.6 (Fetch limited)
49	90	2.6 (Fetch limited)
51	60	2.6 (Fetch limited)
53	50	2.8 (Fetch limited)
54	40	2.8 (Fetch limited)
56 **	30	2.9 (Fetch limited)
59	20	2.4 (Duration limit)
63	10	2.2 (Duration limit)

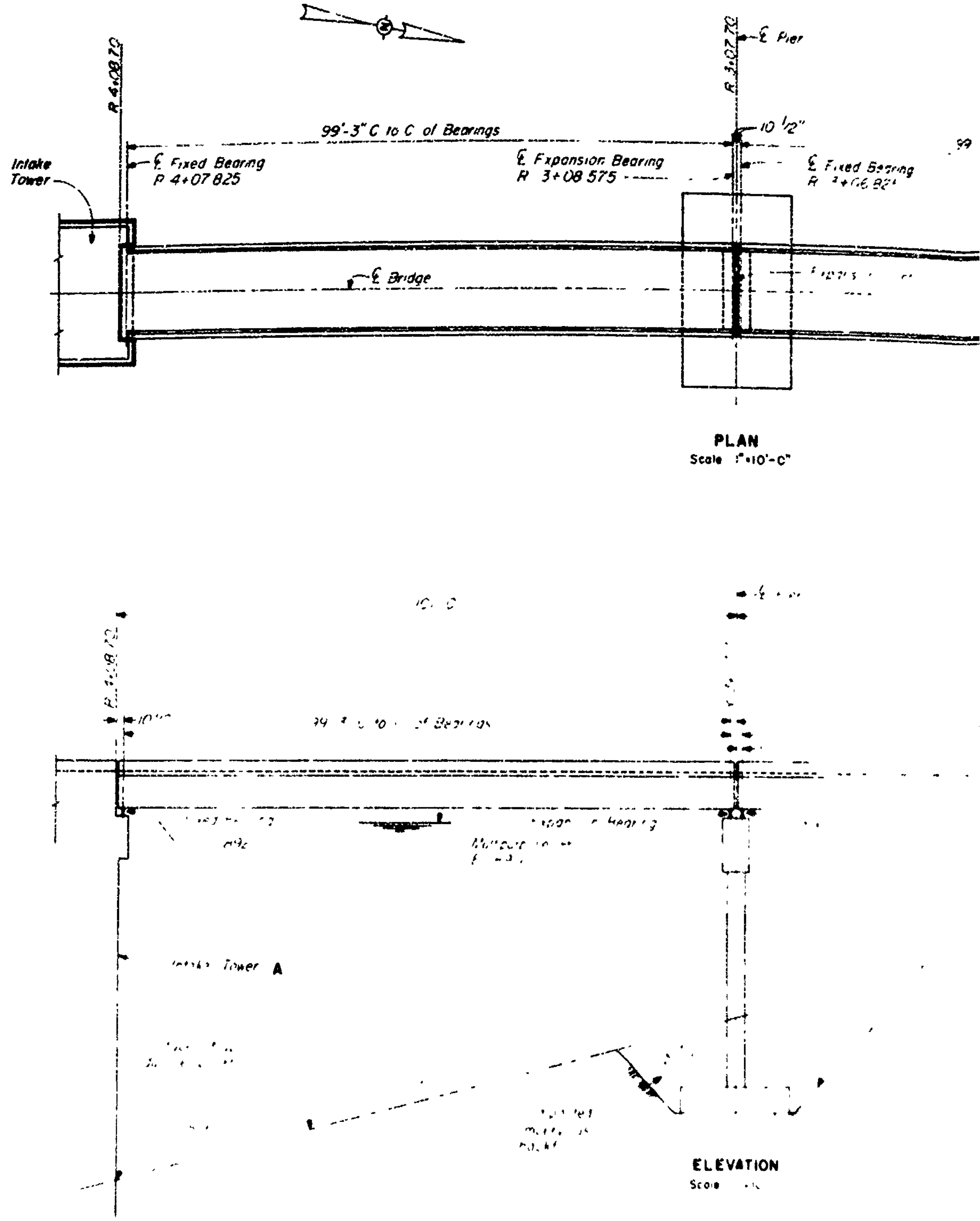
** Indicates critical wind velocity and duration

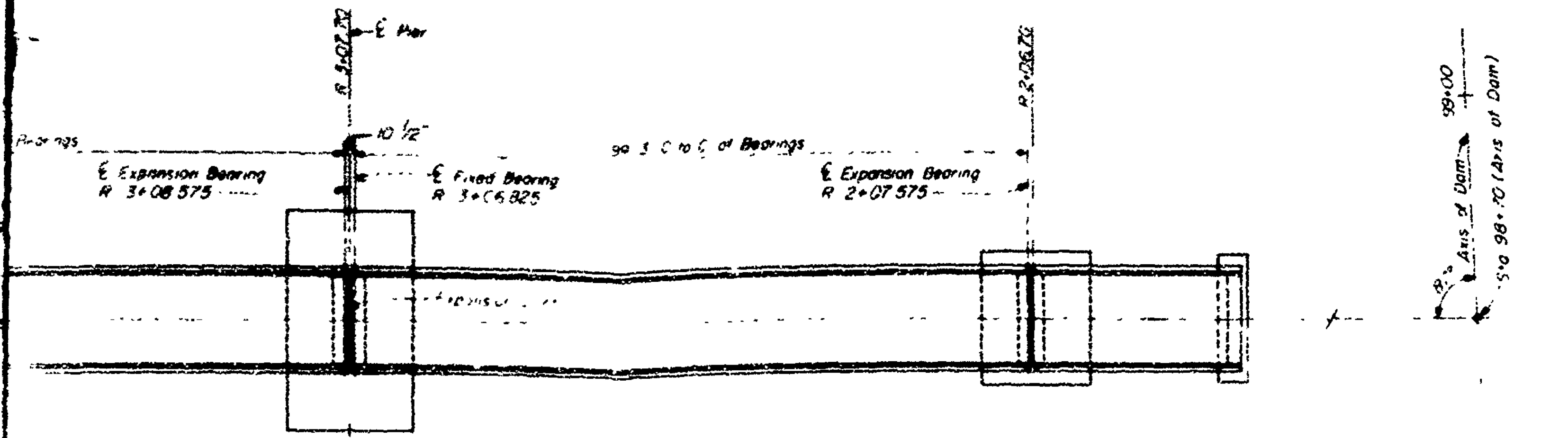
Revisions			
Symbol	Descriptions	Date	Approved

U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

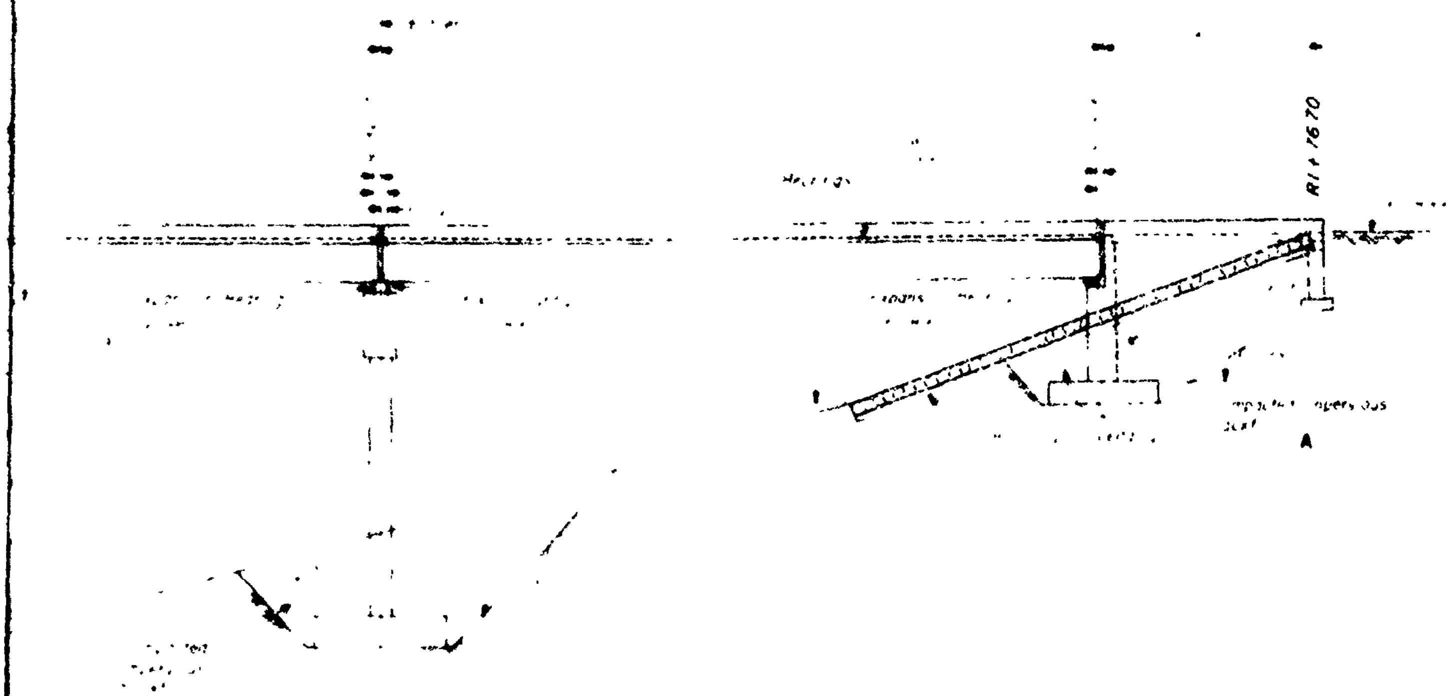
Designed by R G D	LITTLE BLUE RIVER, MISSOURI LONGVIEW LAKE EMBANKMENT CRITERIA AND PERFORMANCE REPORT
Drawn by J E B	SLOPE PROTECTION STUDY
Checked by R G D / W B E	Scale AS SHOWN · Sheet number
Submitted by R G D	Date · Dwg No · File No RBL-3-1432

PLATE NO. 32


R 4+08.70
R 3+07.70
Pier
99'-3" C to C of Bearings
10 1/2"
Intake Tower
Fixed Bearing
P 4+07 825
Expansion Bearing
R 3+08 575
Fixed Bearing
Bridge
PLAN
Scale 1"=10'-0"
Intake Tower A
ELEVATION

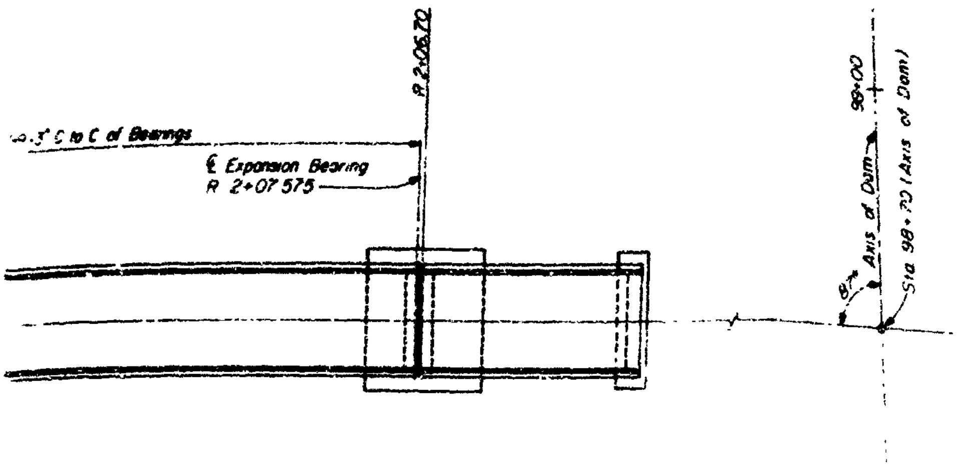


PLAN
Scale 1"=10'-0"

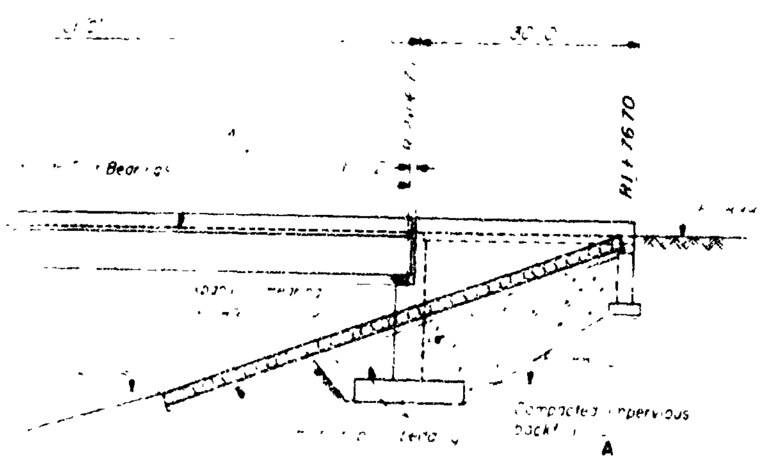


ELEVATION
Scale

GENE



GENERAL NC



GENERAL NOTES – BRIDGE

1. Design specification AASHTO 1977 Edition
   Live loads H 5-44 at normal stresses
2. Mobile crane weighing 35 tons carrying 9.0 kips,
   Live load at overstress without impact
3. All exposed concrete chamfered 3/4"
   unless otherwise noted
4. Construction joints, marked "CJ", have
   reinforcement continuous thru joints
5. All reinforcement splices lapped
   30 bar diameters, unless otherwise noted
6. Bridge stations are measured along centerline
   of Outlet Works with starting point at Intake Tower
   R 4+08.70 = Outlet Works Sta 45+91.30

Symbol	Revisions Descriptions	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

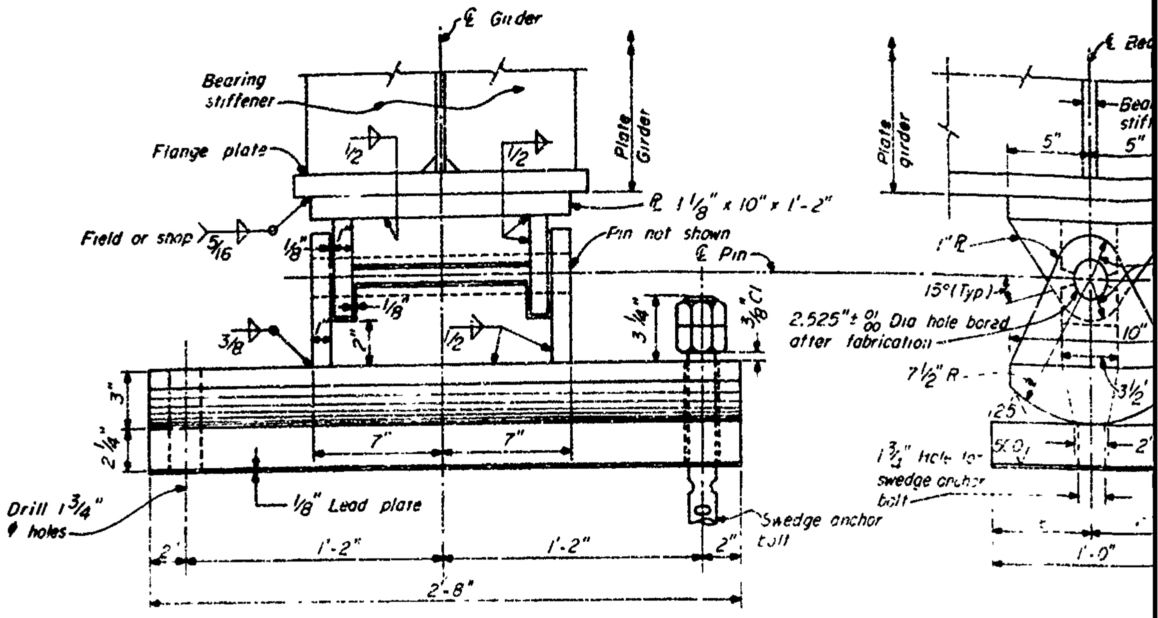
US Army Corps of Engineers

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA
AND PERFORMANCE REPORT

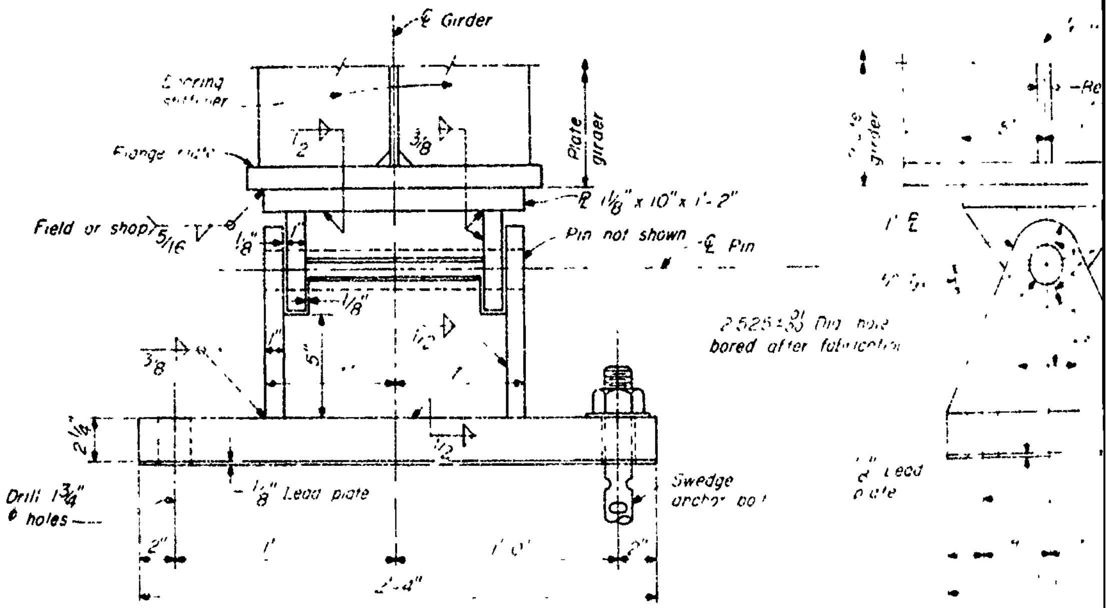
SERVICE BRIDGE
PLAN AND ELEVATION

Designed by: R G D	Scale: AS SHOWN	Sheet number	
Drawn by: P R L	Date		
Checked by: R G D / W B E	Dwg No	File No RBL-3-1433	
Submitted by: R G D			

PLATE NO 33



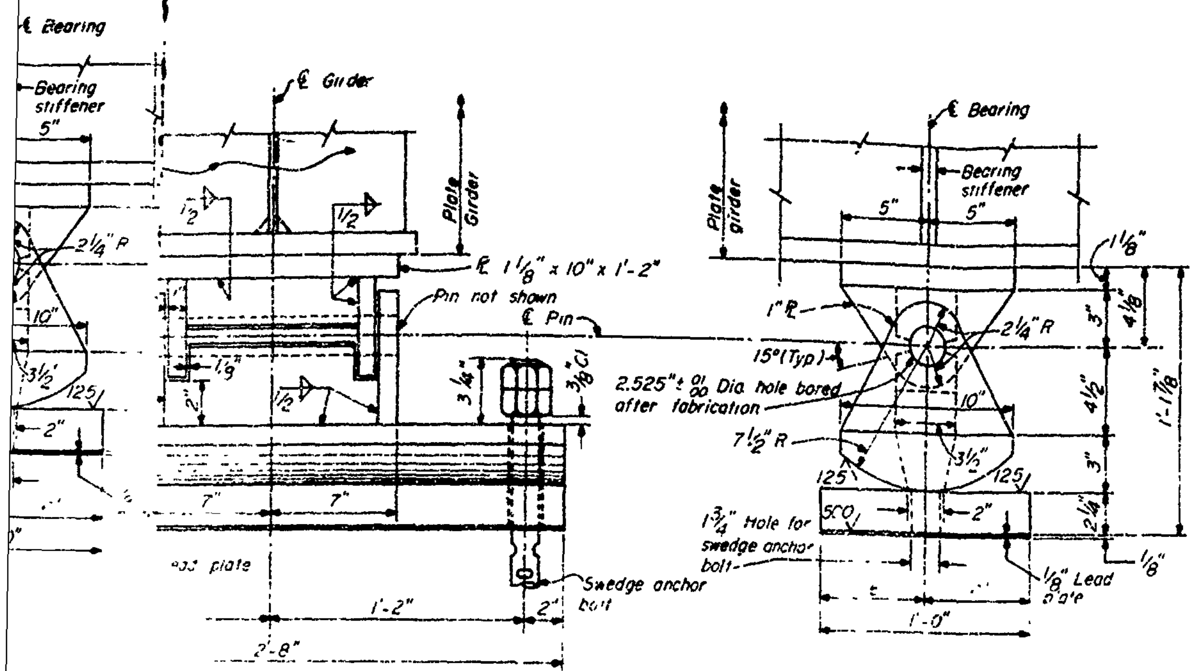
EXPANSION BEARING DETAIL.
Scale: 3" = 1'-0"



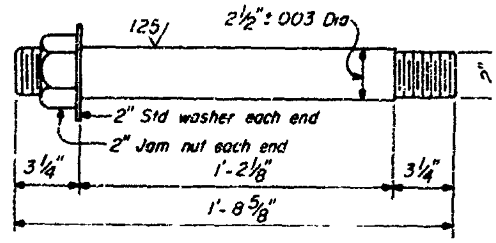
FIXED BEARING DETAIL
Scale: 3" = 1'-0"

ROCKER AND EXPANSION ℞ SETTING			
	INTAKE TOWER	PIER AND/OR ABUTMENT	
Temperature at time of setting			℄ Bearing
0°F	½"	3½"	-½"
50°F	½"	3"	0
100°F	½"	2½"	+½"

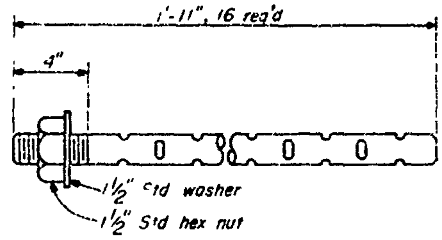
NOTE:
Axis of rocker is vertical at 50° F
For temperatures other than those shown, use straight line interpolation to determine proper position



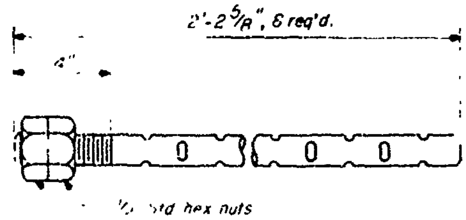
EXPANSION BEARING DETAIL
Scale 3" = 1'-0"



PIN
Not to Scale

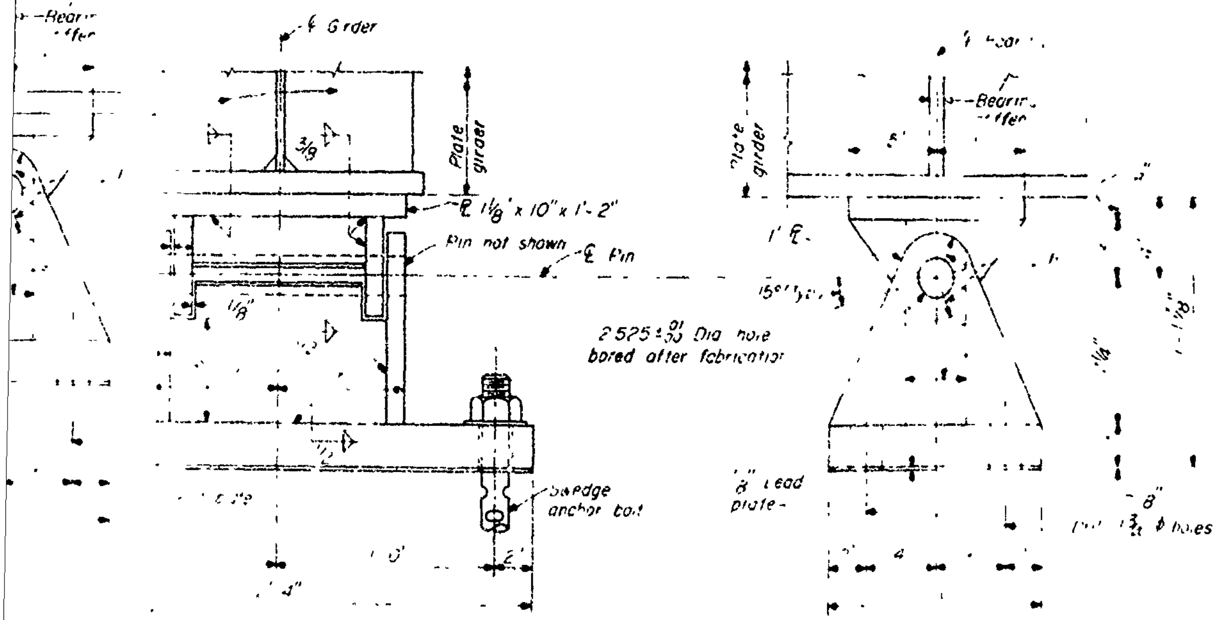


FIXED BEARING

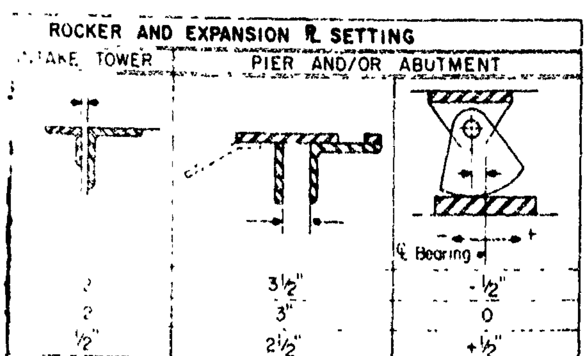


EXPANSION BEARING

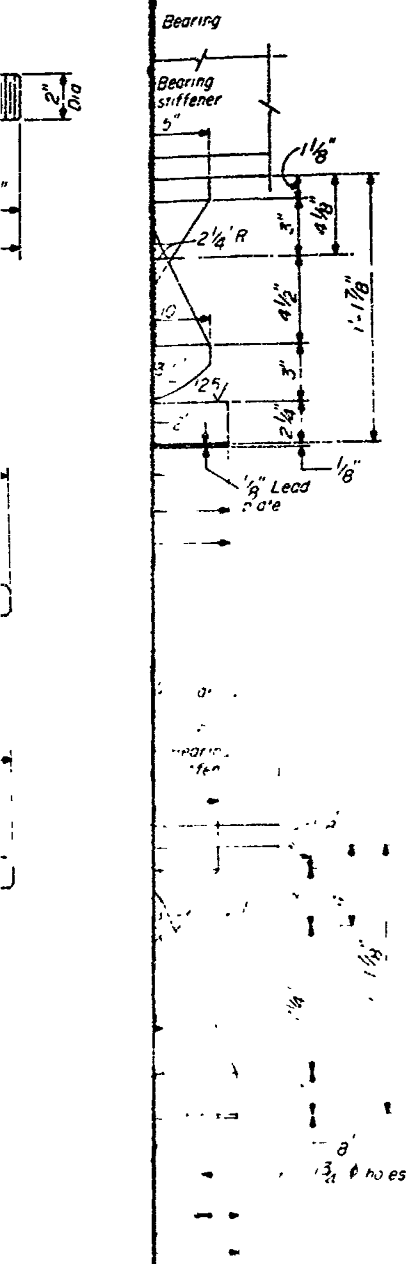
SWEDGE ANCHOR BOLTS
Not to Scale

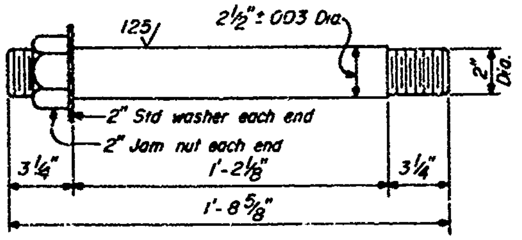


FIXED BEARING DETAIL
Scale 3" = 1'-0"

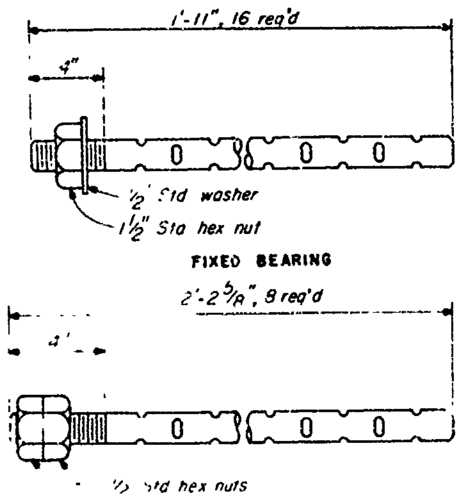


... s vertical at 50° F
... other than those
... ight line interpolation
... per position





PIN
Not to Scale



SWEDGE ANCHOR BOLTS
Not to Scale

NOTES

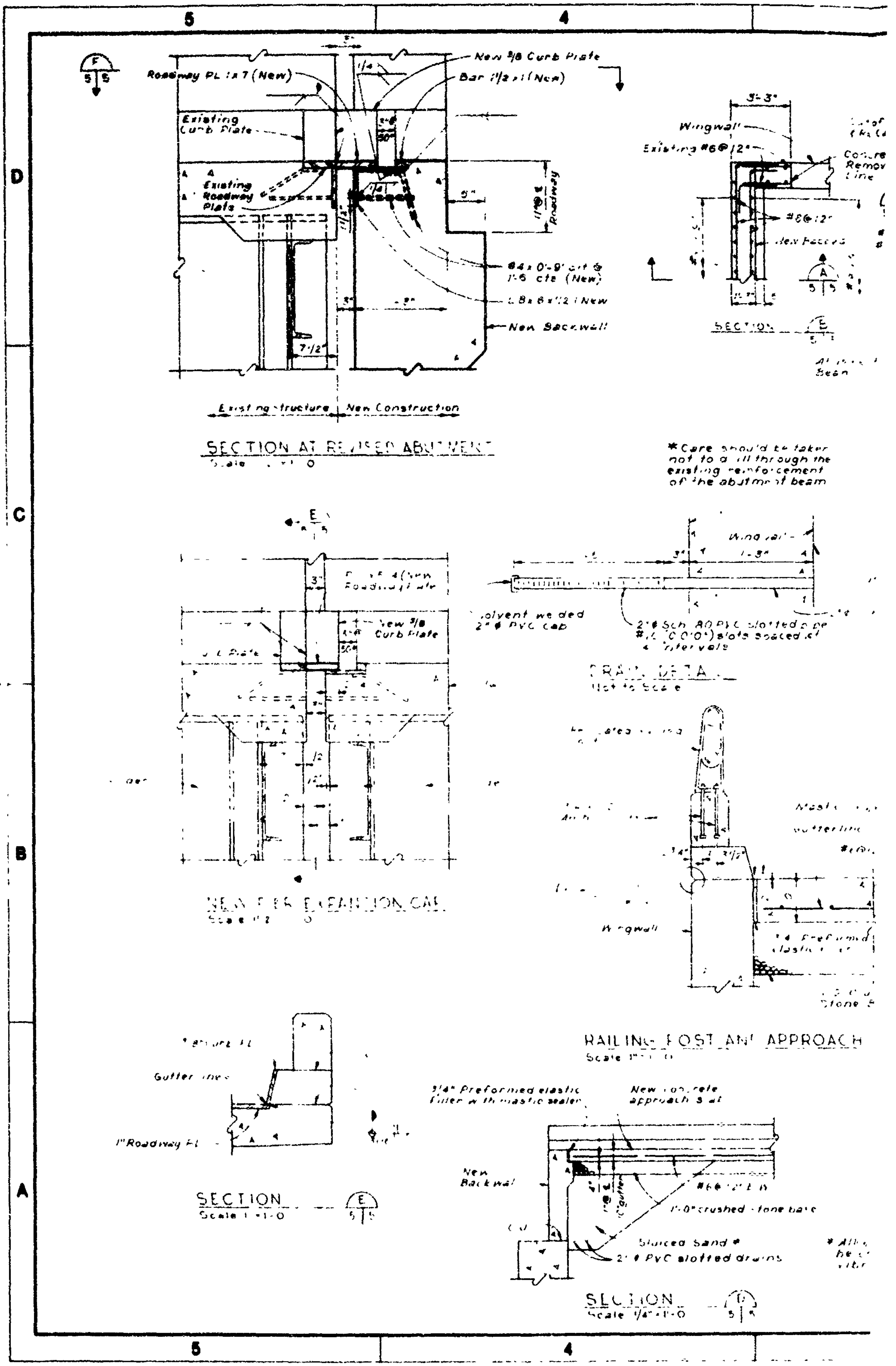
1. Shoes fabricated from structural steel plates. Where machined surfaces were required, sufficient stock was allowed to provide the dimensions as shown. Shoes were stress relieved by heat treating after welding.
2. Nuts for the anchor bolts on fixed bearings were tightened and the threads punched to lock nuts. Expansion bearings had the nuts tightened against each other.
3. Bolts may be deformed cold or heated to make swedge anchor bolts.
4. Anchor bolts for bearings are 1½" swedge bolts and extend 18" into concrete.
5. Used a Non-Ferrous, Non-Shrinking grout.

Revisions			
Symbol	Descriptions	Date	Approved

U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

Designed by RGD	US Army Corps of Engineers — LITTLE BLUE RIVER, MISSOURI LONGVIEW LAKE EMBANKMENT CRITERIA AND PERFORMANCE REPORT
Drawn by PRC	SERVICE BRIDGE MISCELLANEOUS DETAILS
Checked by RGD/WBE	Scale AS SHOWN; Sheet number
Submitted by RGD	Date; Dwg No; File No RBL-3-1434

PLATE NO. 34



SECTION AT REVISED ABUTMENT

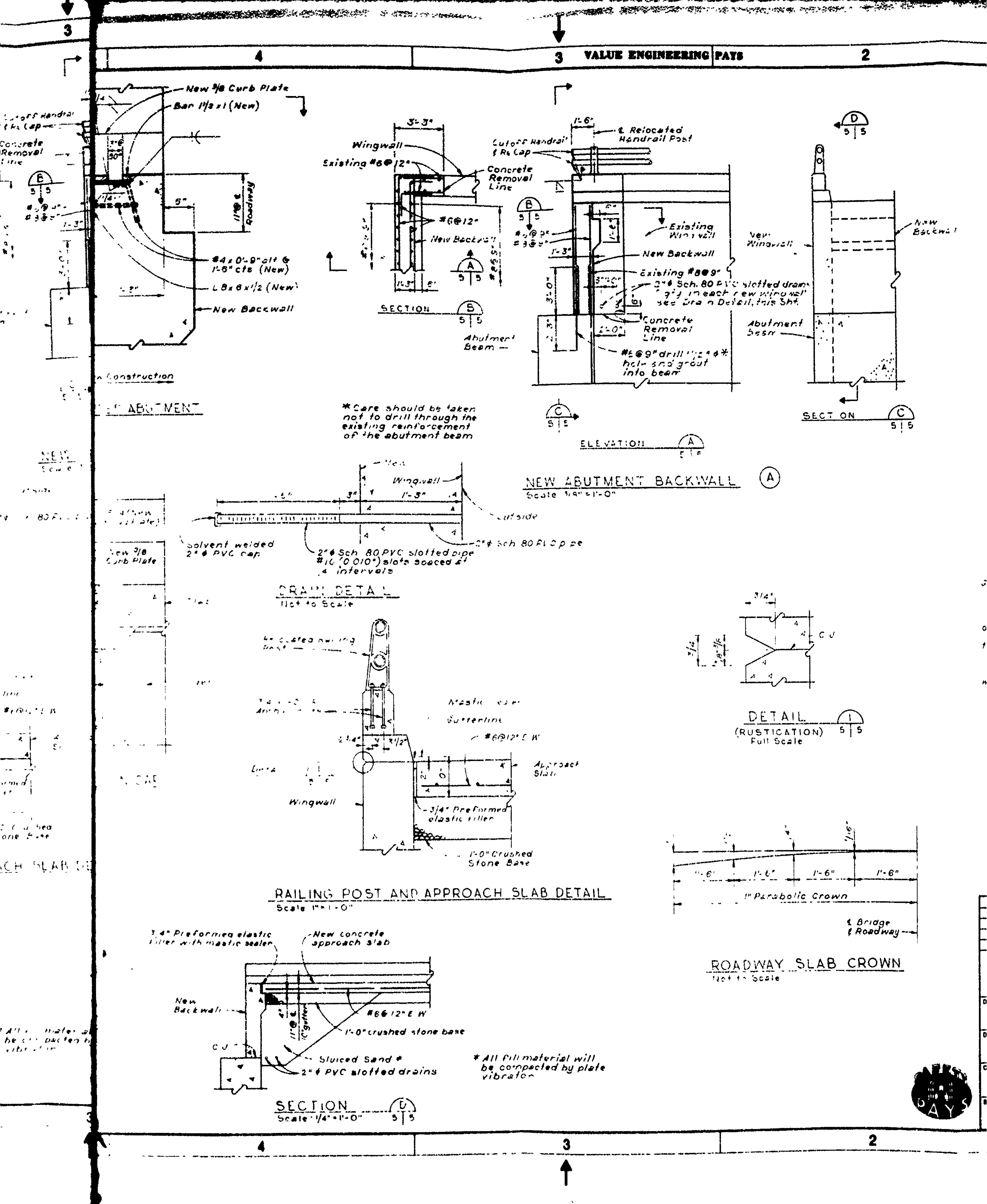
SECTION E 5|5
Scale 1"=1'-0"

NEW PIER EXPANSION CAP

DRAIN DETAIL
Not to Scale

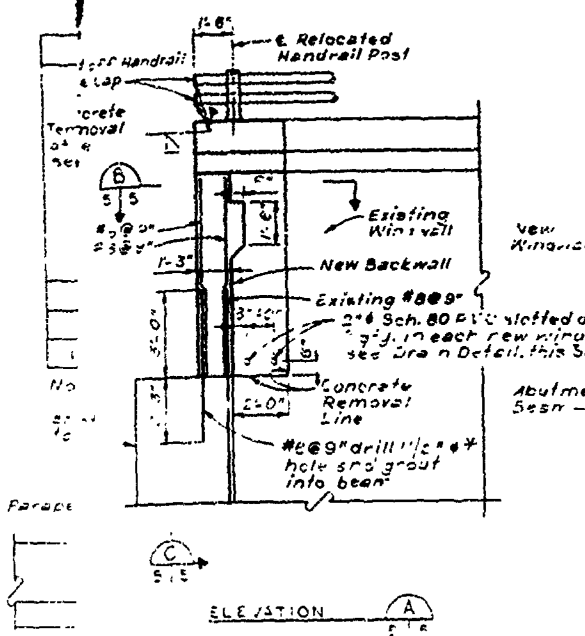
RAILING POST AND APPROACH

SECTION
Scale 1/4"=1'-0"

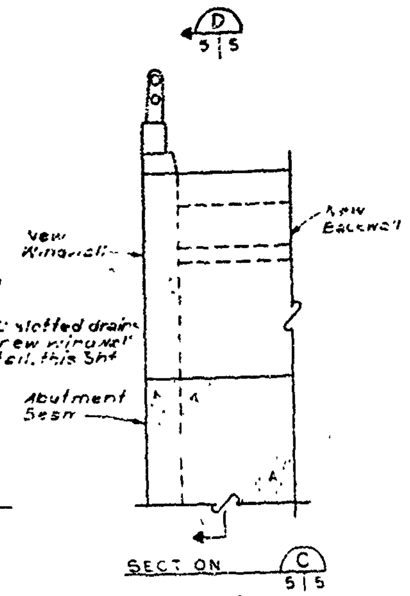


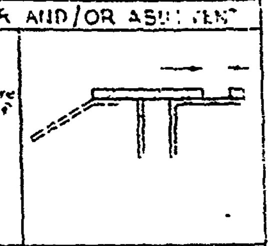
VALUE ENGINEERING PAYS
New 3/8 Curb Plate
Bar 1 1/2 x 1 (New)
#4 x 0'-9" alt @ 1'-6" cts (New)
L 8 x 6 x 1/2 (New)
New Backwall
Wingwall
Existing #6@12"
Concrete Removal Line
#6@12"
New Backwall
SECTION B 5|5
Abutment Beam
* Care should be taken not to drill through the existing reinforcement of the abutment beam
Cutoff Handrail & Rs Cap
℄ Relocated Handrail Post
Existing Wingwall
New Backwall
Existing #8@9"
2"ø Sch. 80 PVC slotted drain 1 @ in each new wingwall see Drain Detail, this Sht.
Concrete Removal Line
#6@9" drill 1"ø* hole and grout into beam
ELEVATION A 5|5
New Wingwall
New Backwall
Abutment Beam
SECTION C 5|5
NEW ABUTMENT BACKWALL
Scale 3/8"=1'-0"
A
Wingwall
Outside
Solvent welded 2"ø PVC cap
2"ø Sch. 80 PVC slotted pipe #10 (0.010") slots spaced 1/4" intervals
2"ø Sch 80 PVC pipe
DRAIN DETAIL
Not to Scale
Relocated Railing Post
Mastic Sealer
Gutterline
#6@12" E.W.
Approach Slab
Wingwall
3/4" Preformed elastic filler
1'-0" Crushed Stone Base
RAILING POST AND APPROACH SLAB DETAIL
Scale 1"=1'-0"
C.J.
DETAIL 1 5|5
(RUSTICATION)
Full Scale
1" Parabolic Crown
℄ Bridge ℄ Roadway
ROADWAY SLAB CROWN
Not to Scale
3/4" Preformed elastic filler with mastic sealer
New concrete approach slab
New Backwall
#6@12" E.W.
1'-0" crushed stone base
Sluiced Sand *
2"ø PVC slotted drains
C.J.
* All fill material will be compacted by plate vibrator
SECTION D 5|5
Scale 1/4"=1'-0"

3 VALUE ENGINEERING PAYS | 2 | 1

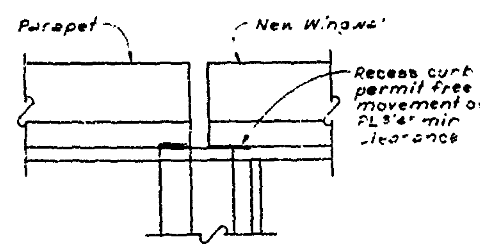


NEW ABUTMENT BACKWALL (A)
Scale ⅜"=1'-0"



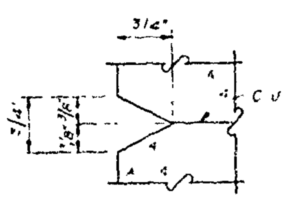
PIER AND/OR ABUTMENT	
Temperature at time of setting	
0°F	3½"
50°F	3"
100°F	2½"

Note: For temperatures other than those shown, use straight line interpolation to determine proper dimension.

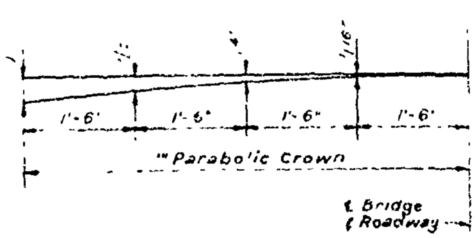


SECTION F 5|5
Scale 1"=1'-0"

GENERAL NOTES
1. Concrete f'c = 3,000 psi
2. Reinforcing steel fs = 24,000 psi
3. Structural steel fs = 20,000 psi
4. Clear distance of reinforcement shall be 2" unless otherwise noted
5. Top of backwall and expansion devices to conform to the crown of the roadway slab
6. CRES = Corrosion resisting steel
7. C.J. = Construction Joint
8. Curb and roadway plates will be preheated before welding.
9. All exposed concrete shall be chamfered ¾"



DETAIL (RUSTICATION) 5|5
Full Scale



ROADWAY SLAB CROWN
Not to Scale

SLAB DETAIL

RECORD DRAWING
JANUARY 1990
CONTRACT NO. DACW41-89-C-0131

Symbol	Revisions Descriptions	Date	Approved
(A)	Change size of rebar	6-21-89	
	Revised for "As Built" conditions	3-13-90	

U. S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

Designed by: RCL
Drawn by: PWM
Checked by: R.C.L.
Submitted by: T.D.W.

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA
AND PERFORMANCE REPORT

SERVICE BRIDGE ALTERATION

Scale: AS SHOWN
Date: MAY 1989
File No. RBL-3-1701

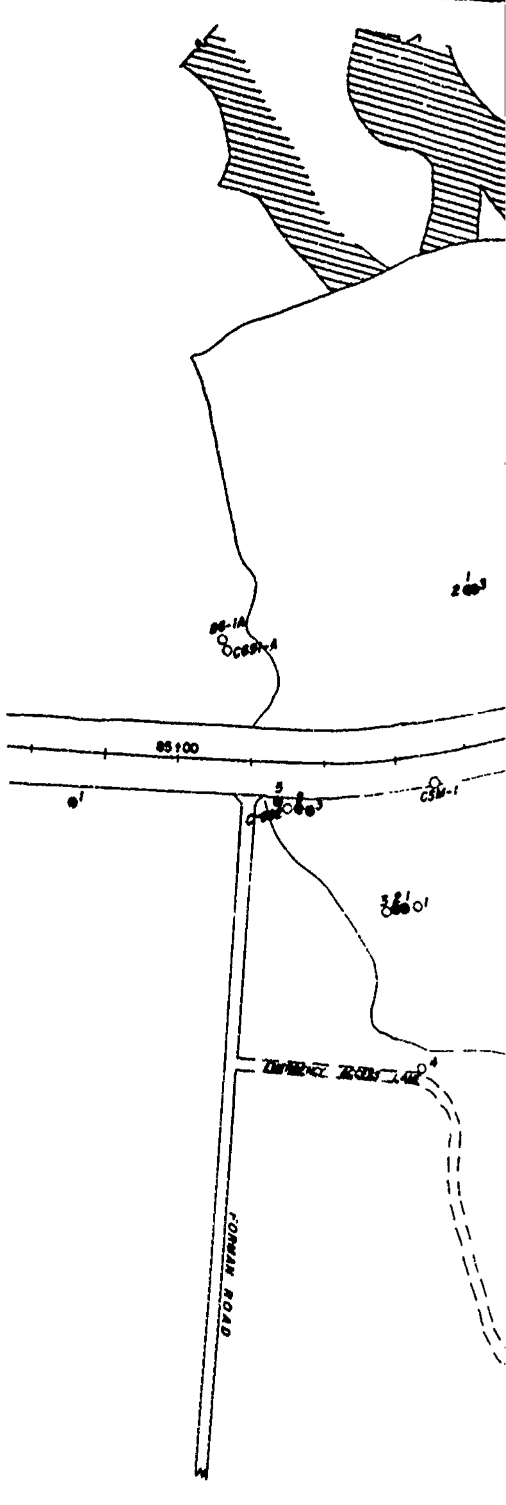
PLATE NO. 34A

3 | 2

5 | 4

OBSERVATION DEVICE SCHEDULE

DEVICE	STATION	RANGE	TOP ELEVATION	TIP ELEVATION	MATERIAL	INSTALLATION DETAIL
PPF 86-1	85+60	0+60D	937.4	863.8	FDN.SHALE	1
PPF 86-1A	86+49	[illegible]	929.3	783.3	[illegible]	1
PPF 87	96+19	2+00D	888.7	[illegible]	FDN.CL	1
PPF 87-2	86+70	0+58D	936.3	[illegible]	FDN SANDSTONE	1
PPF 87-3	86+85	0+61D	936.3	786.3	FDN SILTSTONE	1
PPF 87-4	87+10	3+01D	891.4	783.4	FDN ROCK STRATA	7a
PPF 87-5	86+48	8+49D	927.3	859.3	FDN ROCK STRATA	7a
PPF 88-1	87+99	1+92D	988.0	837.4	FDN ROCK STRATA	7a
PPF 88-2	87+86	1+43D	902.9	887.4	FDN.ROCK STRATA	7a
PZE 88-3	87+77	1+43D	903.4	879.9	SAND DRAIN	1
PZF 229	91+60	8+80U	919.1	805.5	FDN.GC	1
PPE 89-1	89+50	1+99U	903.1	834.9	EMB.CL	1
PPE 89-2	89+45	1+99U	903.1	861.8	EMB.CH	1
PPE 89-3	89+38	1+99U	902.9	814.0	EMB.CL	1
PZE 89-5	89+13	1+43D	888.0	845.5	SAND DRAIN	1
PZE 90-2	90+81	2+08D	889.6	829.9	SAND DRAIN	1
PPE 92-1	92+00	1+00D	908.3	823.6	EMB.CL	1
PPE 92-2	92+00	1+11D	904.9	823.3	EMB.CL	2
PPE 93-1	93+00	3+80U	——	818.9	EMB.CH	3
PPF 93-2	93+00	0+60U	921.3	811.4	FDN.CH	1
PPF 93-3A	93+00	1+40U	——	775.0	FDN.SILTSTONE	3
PPE 93-4	93+00	0+40U	924.6	815.5	EMB.CH	1
PPE 93-4A	93+00	2+30U	897.2	819.4	EMB.CH	1
PPE 93-5A	93+00	0+10U	——	812.0	EMB.CL	3
PPE 93-6A	93+00	0+30U	——	830.0	EMB.CH	3
PPF 93-8	93+00	0+55D	923.3	785.0	FDN SILTSTONE	1
PZF 93-9	93+00	1+05D	900.4	864.9	FDN GC	1
PZF 93-10A	93+00	3+00D	867.2	805.9	FDN CLAYEY SAND AND GRAVEL	1
PZF 93-11	93+00	5+62D	820.4	803.7	FDN CLAYEY GRAVEL AND SAND	1
PPE 93-12	93+00	1+10D	——	830.0	EMB.CH	3
PPE 96-1	96+00	[illegible]	——	820.0	EMB.CH	3
PPE 95-1	96+70	1+00D	907.2	826.4	EMB.CL	1
PZE 95-2	96+70	3+00D	866.6	796.3	SAND DRAIN	1
PPE 97-1	97+00	3+25U	——	820.2	EMB CL SEWER BACKFILL	3
PPP 97-2	97+00	2+10U	——	830.6	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	——	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	——	[illegible]	FDN.SHALE	3
PZF 97-10	97+00	1+20D	899.2	802.8	FDN.GC	1
PZE 97-11	97+00	1+80D	890.9	826.4	SAND DRAIN	1
PPE 97-13	97+32	1+98U	901.8	839.7	EMB.CL	1
PPE 97-14	97+36	1+96U	902.2	830.0	EMB.CL	1
PPE 97-15	97+35	2+02U	——	829.1	EMB.CL	5
PPE 97-16	97+00	0+80U	916.8	840.0	EMB.CL	1
PPE 97-17	97+00	0+75D	——	838.0	EMB.CL	3
PPE 98-1	97+80	1+00D	——	829.4	EMB.CL	3
PPE 98-2	98+40	1+70U	——	830.0	EMB.CL	3
PPP 99-1	98+40	2+02U	——	800.0	FDN.SHALE	3
PPE 99-2	98+60	0+80U	913.6	811.8	EMB.CL	1
PPF 99-3	98+60	0+40U	923.6	789.7	FDN SHALE AND SILTSTONE	[illegible]
PPF 99-4	98+60	0+40C	924.6	771.3	FDN SHALE AND SILTSTONE	[illegible]
PPE 99-5	98+60	0+60U	——	818.0	EMB CL	3
PPE 99-6	99+08	2+50U	——	822.5	EMB.CL	3
PPE 99-7	98+60	0+70U	916.8	809.5	EMB CL FDN SHALE CONTACT	1
PPE 99-8	98+45	0+80U	——	836.7	EMB.CL	5
PPE 99-10	99+00	1+50D	891.8	823.1	EMB CL	1
PPE 99-11	98+44	0+85U	——	827.4	EMB.CL	6
PPE 99-12	98+40	℄	——	839.0	EMB.CL	5
PPE 99-13	98+40	2+05U	896.9	828.2	EMB CL	1
PPE 99-14	99+10	0+40U	——	826.4	EMB.CL	3
PPE 99-17	98+50	1+00D	——	830.8	EMB CL	3
PPE 99-18	98+53	0+05D	——	801.5	EMB CH FDN SANDSTONE CONTACT	6
PPF-CG91A	85+68	1+30U	929.7	803.1	FDN.ROCK STRATA	6
PPF-CG92	86+90	0+60D	926.7	799.6	FDN.ROCK STRATA	8
PPF-CG93	103+00	1+30U	914.0	[illegible]	FDN ROCK STRATA	8
PPF CG94	103+00	1+50D	913.2	847.1	FDN ROCK STRATA	8
M-1	88+64	8+51D	839.4	811.6	FDN OVERBURDEN	7b
M-2	87+33	13+30D	865.2	850.3	FDN OVERBURDEN	7b
M-3	89+31	13+03D	832.9	808.0	FDN OVERBURDEN	7b
M-4	91+59	12+49D	826.9	808.8	FDN.OVERBURDEN	7b
M-5	91+64	14+17D	827.9	[illegible]	FDN OVERBURDEN	7b



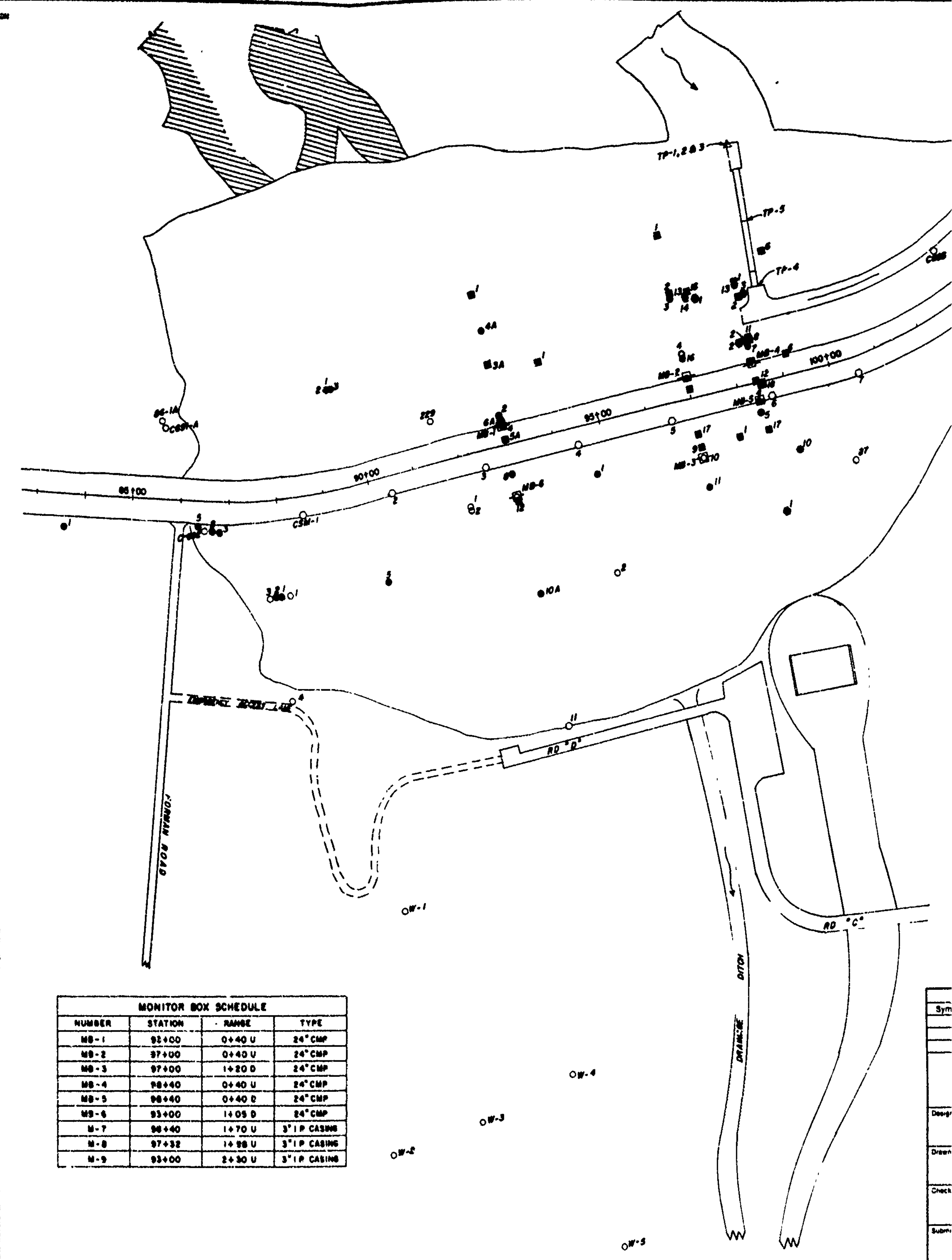
MONITOR BOX SCHEDULE			
NUMBER	STATION	RANGE	TYPE
MB-1	93+00	0+40 U	24" CMP
MB-2	97+00	0+40 U	24" CMP
MB-3	97+00	1+20 D	24" CMP
MB-4	98+40	0+40 U	24" CMP
MB-5	98+40	0+40 D	24" CMP
MB-6	93+00	1+05 D	24" CMP
M-7	98+40	1+70 U	3" I P CASING
M-8	97+32	1+98 U	3" I P CASING
M-9	93+00	2+30 U	3" I P CASING

5 | 4

4	3	2

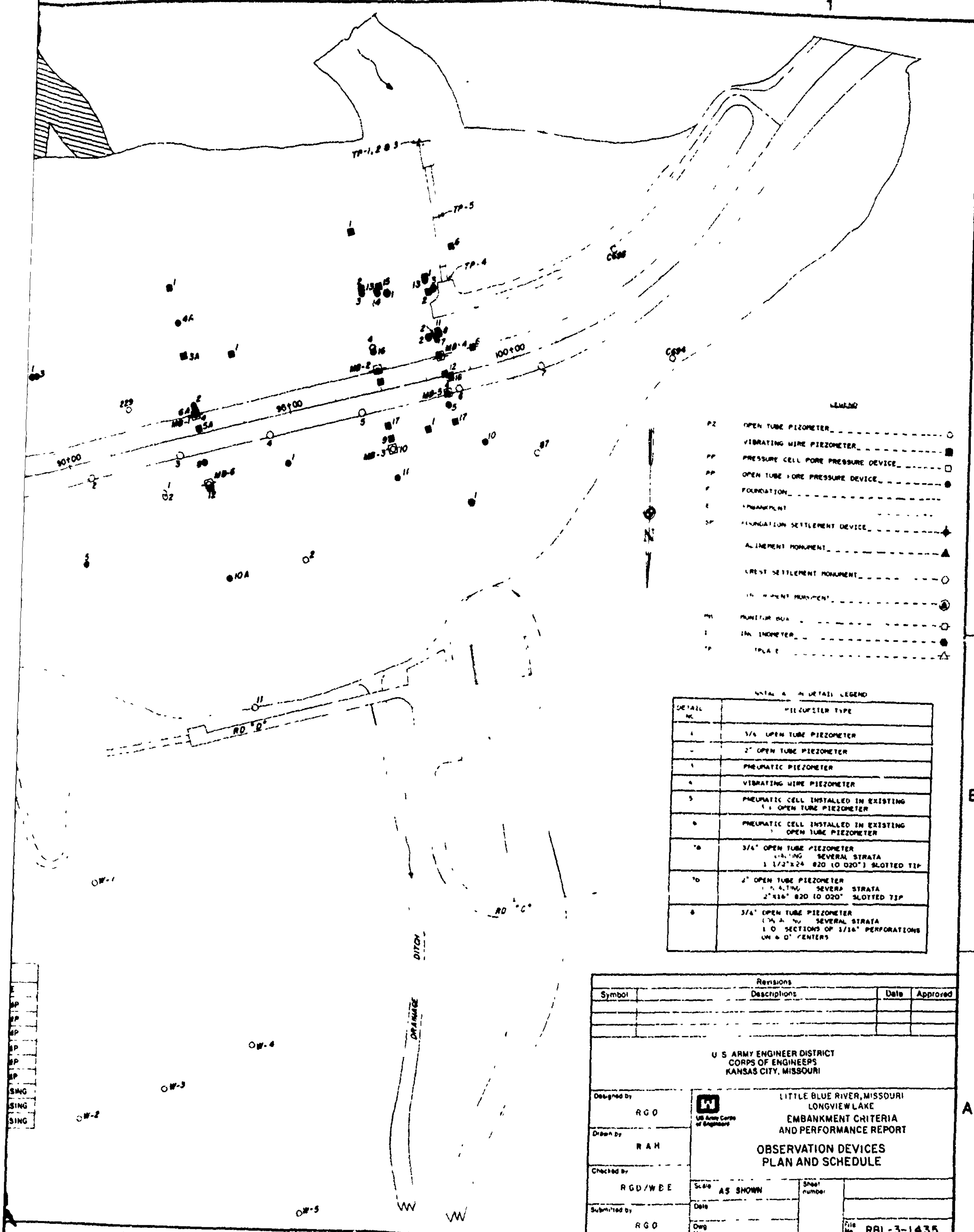
MATERIAL	INSTALLATION DETAIL
FDN. SHALE	1
[illegible]	1
FDN. CL	1
FDN SANDSTONE	1
FDN SILTSTONE	1
FDN ROCK STRATA	7a
FDN ROCK STRATA	7a
FDN ROCK STRATA	7a
FDN. ROCK STRATA	7a
SAND DRAIN	1
FDN GC	1
EMB. CL	1
EMB. CH	1
EMB. CL	1
SAND DRAIN	1
SAND DRAIN	1
EMB. CL	1
EMB. CL	2
EMB CH	3
FDN. CH	1
FDN SILTSTONE	3
EMB. CH	1
EMB CH	1
EMB CL	3
EMB. CH	3
FDN SILTSTONE	1
FDN GC	1
FDN CLAYEY SAND AND GRAVEL	1
FDN CLAYEY GRAVEL AND SAND	1
EMB CH	3
EMB. CH	3
EMB CL	1
SAND DRAIN	1
EMB CL SEWER BACKFILL	3
[illegible]	
[illegible]	[illegible]
[illegible]	
[illegible]	[illegible]
FDN SHALE	3
FDN GC	1
SAND DRAIN	1
EMB CL	1
EMB CL	1
EMB. CL	3
EMB CL	1
EMB CL	3
EMB CL	3
EMB CL	3
FDN SHALE	3
EMB CL	1
FDN SHALE AND SILTSTONE	[illegible]
FDN SHALE AND SILTSTONE	[illegible]
EMB CL	3
EMB. CL	3
EMB CL FDN SHALE CONTACT	1
EMB CL	5
EMB CL	1
EMB. CL	6
EMB CL	5
EMB CL	1
EMB CL	3
EMB CL	3
EMB CL FDN SANDSTONE CONTACT	4
FDN ROCK STRATA	6
FDN ROCK STRATA	6
FDN ROCK STRATA	6
FDN ROCK STRATA	6
FDN OVERBURDEN	7b
FDN OVERBURDEN	7b
FDN OVERBURDEN	7b
FDN OVERBURDEN	7b
FDN OVERBURDEN	7b

TYPE
CMP
CMP
CMP
CMP
CMP
CMP
CASING
CASING
CASING



MONITOR BOX SCHEDULE			
NUMBER	STATION	RANGE	TYPE
MB-1	93+00	0+40 U	24" CMP
MB-2	97+00	0+40 U	24" CMP
MB-3	97+00	1+20 D	24" CMP
MB-4	98+40	0+40 U	24" CMP
MB-5	98+40	0+40 D	24" CMP
MB-6	93+00	1+05 D	24" CMP
M-7	98+40	1+70 U	3" I P CASING
M-8	97+32	1+98 U	3" I P CASING
M-9	93+00	2+30 U	3" I P CASING

4	3	2



LEGEND

PZ	OPEN TUBE PIZOMETER	○
	VIBRATING WIRE PIEZOMETER	■
PP	PRESSURE CELL PORE PRESSURE DEVICE	□
PP	OPEN TUBE PORE PRESSURE DEVICE	●
F	FOUNDATION	
E	EMBANKMENT	
SP	FOUNDATION SETTLEMENT DEVICE	◆
	ALINEMENT MONUMENT	▲
	CREST SETTLEMENT MONUMENT	○
	... MENT MONUMENT	◬
MB	MONITOR BOX	○
I	INCLINOMETER	●
TP	...PLATE	△

... DETAIL LEGEND

DETAIL NO.	PIEZOMETER TYPE
1	3/4" OPEN TUBE PIEZOMETER
2	2" OPEN TUBE PIEZOMETER
3	PNEUMATIC PIEZOMETER
4	VIBRATING WIRE PIEZOMETER
5	PNEUMATIC CELL INSTALLED IN EXISTING ... OPEN TUBE PIEZOMETER
6	PNEUMATIC CELL INSTALLED IN EXISTING ... OPEN TUBE PIEZOMETER
7a	3/4" OPEN TUBE PIEZOMETER ...ING SEVERAL STRATA 1 1/2"x24 #20 (0.020") SLOTTED TIP
7b	2" OPEN TUBE PIEZOMETER ...ING SEVERAL STRATA 2"x16" #20 (0.020") SLOTTED TIP
8	3/4" OPEN TUBE PIEZOMETER ...ING SEVERAL STRATA 1.0 SECTIONS OF 1/16" PERFORATIONS ON 6.0' CENTERS

Revisions

Symbol	Descriptions	Date	Approved

U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

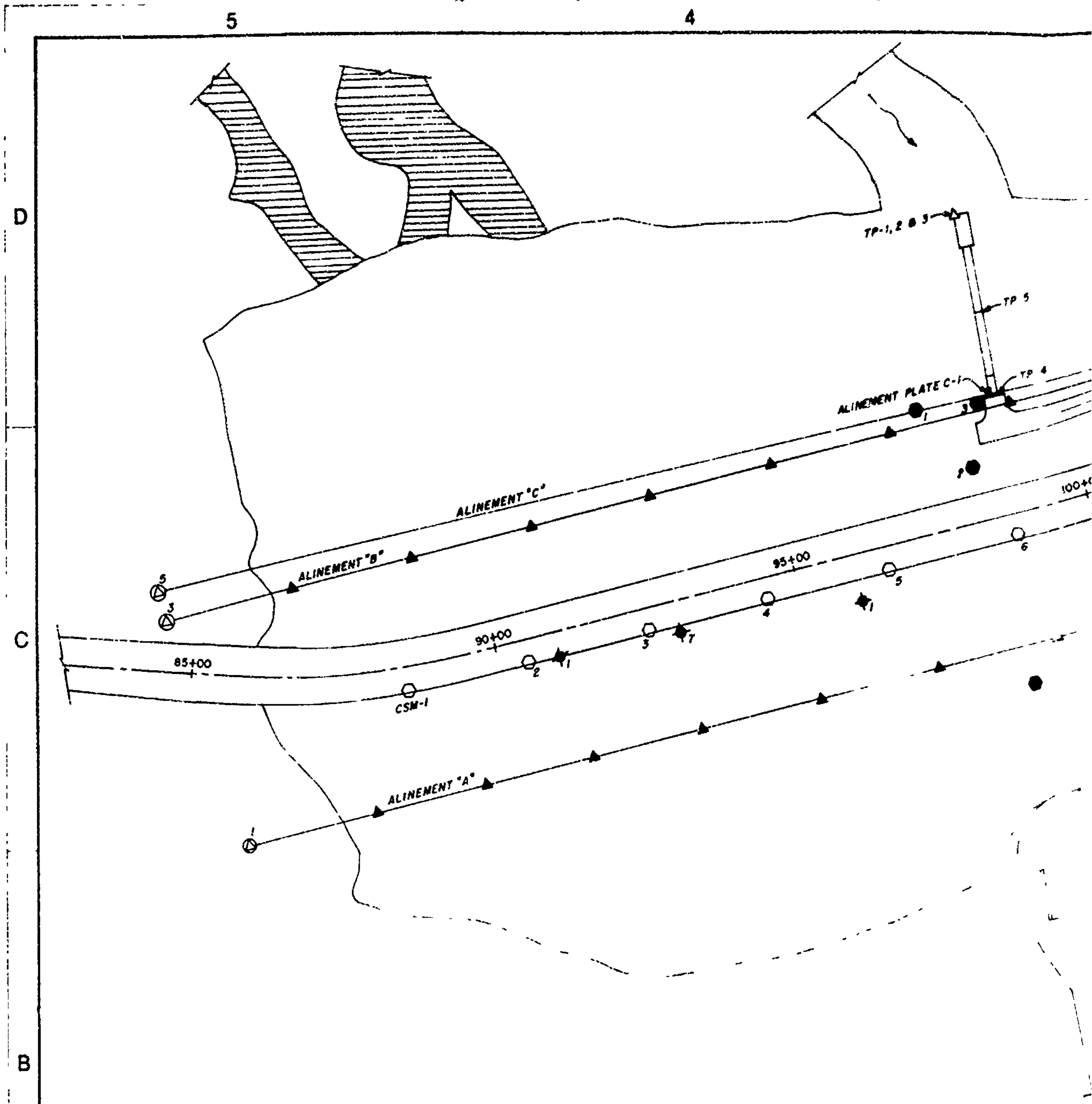
US Army Corps of Engineers

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA
AND PERFORMANCE REPORT

OBSERVATION DEVICES
PLAN AND SCHEDULE

Designed by: R G O
Drawn by: R A H
Checked by: R G D / W B E
Submitted by: R G O
Scale: AS SHOWN
Date:
Sheet number:
Dwg No:
File No: RBL-3-1435

PLATE NO 35



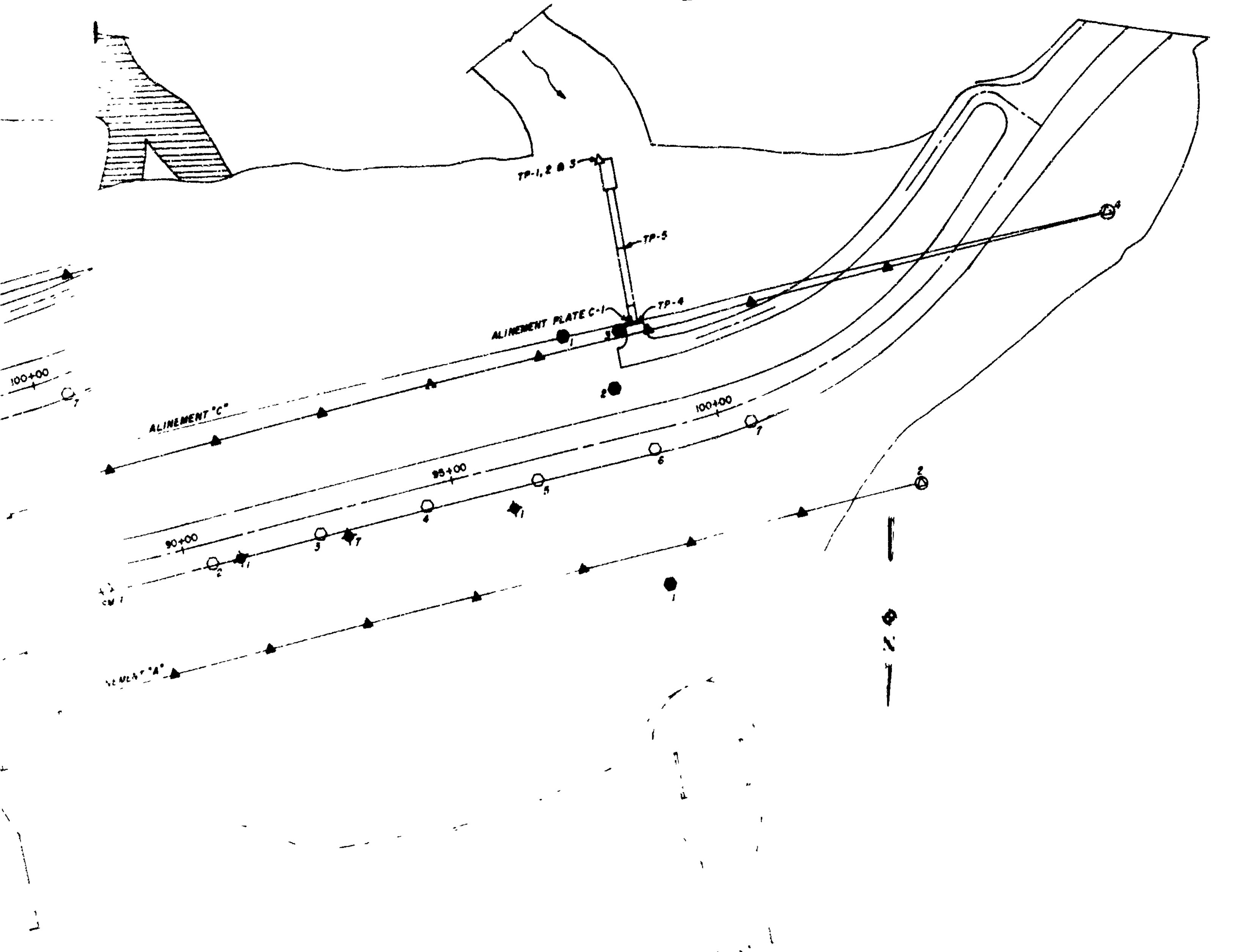
LEGEND

PZ PRESSURE CELL PIEZOMETER
PZ OPEN TUBE PIEZOMETER
PZ VIBRATING WIRE PIEZOMETER
PP PRESSURE CELL PORE PRESSURE DEVICE
PP OPEN TUBE PORE PRESSURE DEVICE
F FOUNDATION
E EMBANKMENT
SP FOUNDATION SETTLEMENT DEVICE
ALINEMENT MONUMENT
CREST SETTLEMENT MONUMENT
INSTRUMENT MONUMENT
MB MONITOR BOX
I INCLINOMETER
TP TILTPLATE

A

TILTPLATE SCHEDULE		
NUMBER	POSITION	LOCATION
TP-1	HORIZONTAL	S E CORNER TOP TOWER DECK
TP-2	VERTICAL	S E COR TOP TOWER [illegible]
TP-3	VERTICAL	S E COR. TOP TOWER [illegible] AST
TP-4	VERTICAL	U/S FACE TOWER [illegible] ABUT
TP 5	VERTICAL	D/S FACE TOWER [illegible] PIER,

5 4

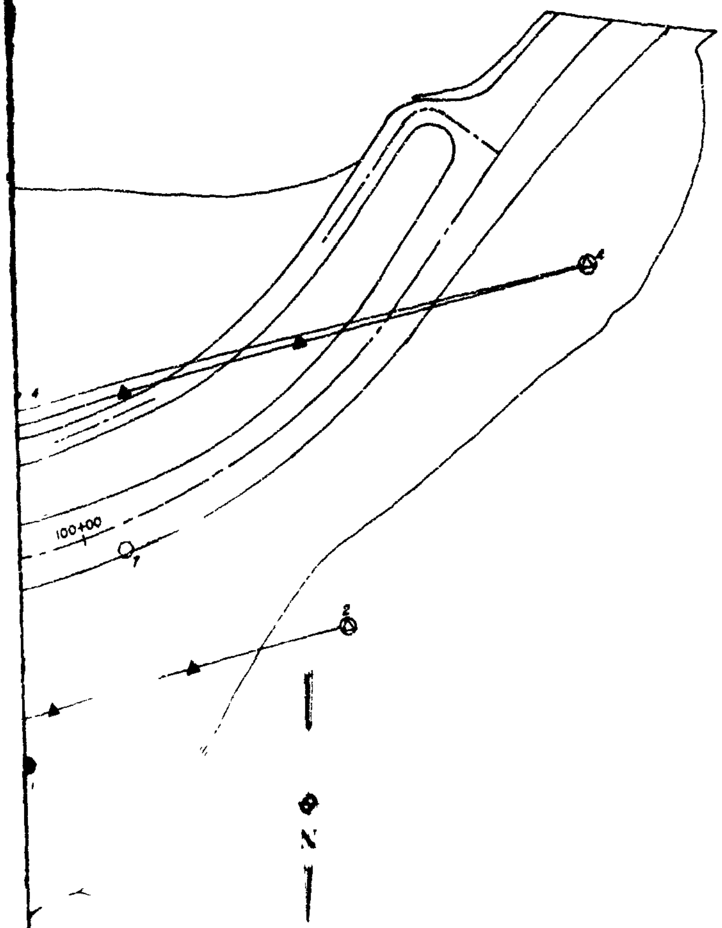


SCHEDULE OF FOUNDATION SETTLEMENT DEVICES		
NO	STATION	RANGE
SPPF-91-1	91+00	0+40 D
SPPF-93-7	93+00	0+50 D
SPPF-96-1	96+10	0+75 D

INCLINOMETER SCHEDULE		
NUMBER	STATION	RANGE
I 99-1	98+40	2+57 D
I 99-2	98+25	0+85 U
I 99-3	98+50	1+80 U
I 97-1	97+49	1+89 U

TILTPLATE SCHEDULE		
NUMBER	POSITION	LOCATION
TP-1	HORIZONTAL	S E CORNER TOP TOWER DECK
TP-2	VERTICAL	S E COR TOP TOWER DECK, S GUARDRAIL
TP-3	VERTICAL	S E COR TOP TOWER DECK AST GUARDRAIL
TP-4	VERTICAL	U/S FACE TOWER BRIDGE ABUT EL 890 5
TP 5	VERTICAL	FACE TOWER BRIDGE PIER, EL 866 5

CREST SETTLEMENT MONUMENT SCHEDULE		
NUMBER	STATION	RANGE
CSM-1	88+50	0+36 D
CSM 2	90+50	0+36 D
CSM-3	92+50	0+36 D
CSM-4	94+50	0+36 D
CSM-5	96+50	0+36 D
CSM-6	98+70	0+36 D
CSM-7	100+50	0+36 D



SCHEDULE OF ALINEMENT

		NUMBER	STATION	RANGE
INSTRUMENT MONUMENTS	LINE A	1	86+00	2+00 D.S.
	LINE A	2	102+50	2+00 D.S.
	LINE B	3	84+90	1+70 U.S.
	LINE B	4	107+80	1+70 U.S.
	LINE C	5	84+40	1+90 U.S.
ALINEMENT MONUMENTS	LINE A	A-1	87+50	2+00 D.S.
	LINE A	A-2	89+39	2+00 D.S.
	LINE A	A-3	91+07	2+00 D.S.
	LINE A	A-4	93+00	2+00 D.S.
	LINE A	A-5	95+00	2+00 D.S.
	LINE A	A-6	97+00	2+00 D.S.
	LINE A	A-7	99+00	2+00 D.S.
	LINE A	A-8	101+00	2+00 D.S.
	LINE B	B-1	87+00	1+70 U.S.
	LINE B	B-2	89+00	1+70 U.S.
	LINE B	B-3	91+00	1+70 U.S.
	LINE B	B-4	93+00	1+70 U.S.
	LINE B	B-5	95+00	1+70 U.S.
	LINE B	B-6	97+00	1+70 U.S.
	LINE B	B-7	99+00	1+70 U.S.
	LINE B	B-8	101+00	1+70 U.S.
	LINE B	B-9	103+50	1+70 U.S.
ALINEMENT PLATE	LINE C	C-1	98+66	1+77 U.S.
	PLATE IS TOP OF EAST CONC BRIDGE PARAPET, AT IT'S NORTH END, OVER THE ABUTMENT			

SCHEDULE OF FOUNDATION SETTLEMENT DEVICES

NO	STATION	RANGE
SPPF-91-1	91+00	0+40 D
SPPF-93-7	93+00	0+50 D
SPPF-96-1	96+10	0+75 D

INCLINOMETER SCHEDULE

NUMBER	STATION	RANGE
I 99-1	98+40	2+57 D
I 99-2	98+25	0+85 U
I 99-3	98+50	1+80 U
I 97 1	97+49	1+89 U

CREST SETTLEMENT MONUMENT SCHEDULE

NUMBER	STATION	RANGE
CSM-1	88+50	0+36 D
CSM-2	90+80	0+36 D
CSM-3	92+80	0+36 D
CSM-4	94+80	0+36 D
CSM-5	96+50	0+36 D
CSM-6	98+70	0+36 D
CSM-7	100+80	0+36 D

Symbol	Revisions Descriptions	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY MISSOURI

US Army Corps of Engineers

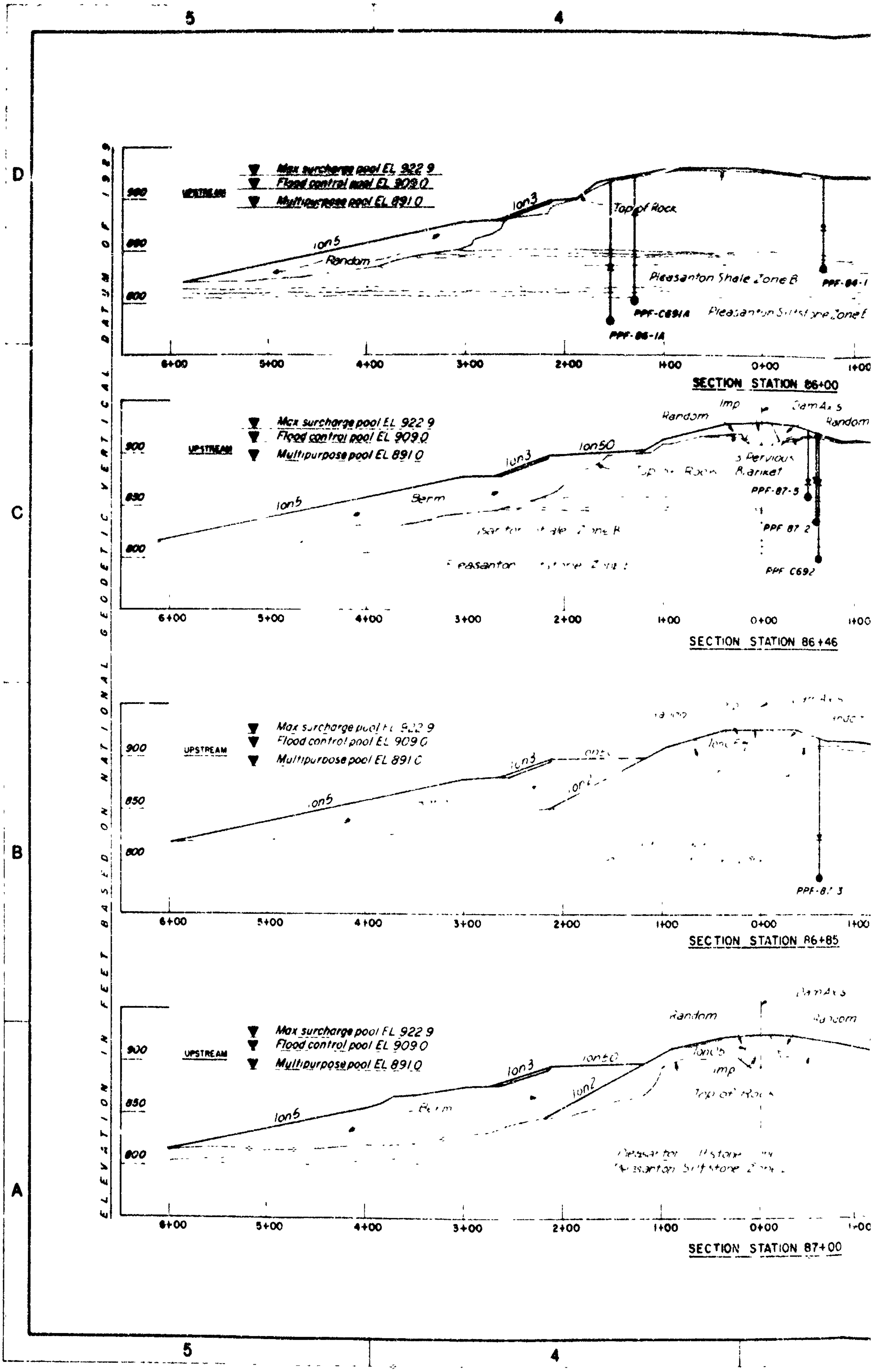
LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA
AND PERFORMANCE REPORT

OBSERVATION DEVICES
PLAN AND SCHEDULE

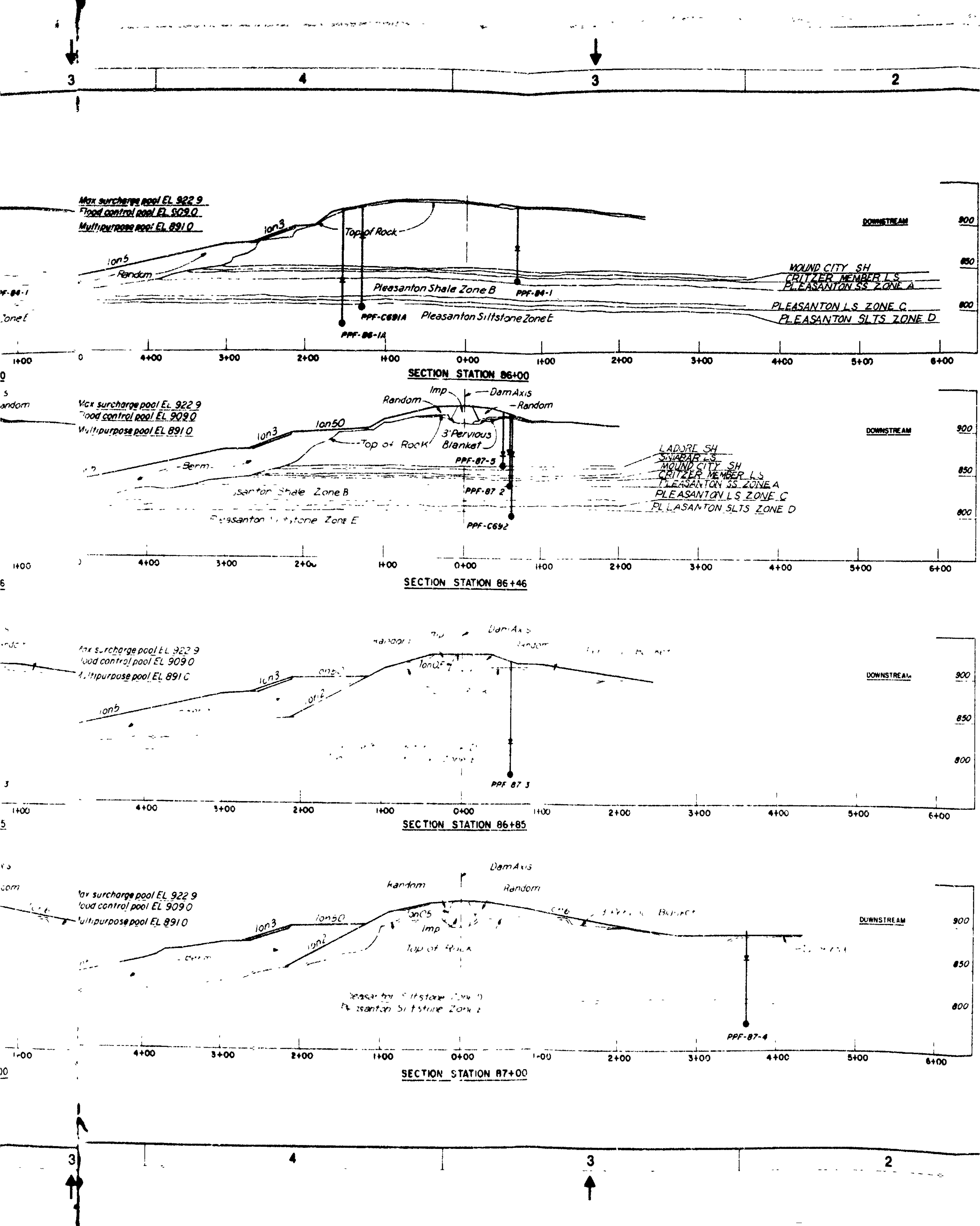
Designed: RGT
Drawn By: PST
Checked: WBE/R
Scale: AS SHOWN
WBE

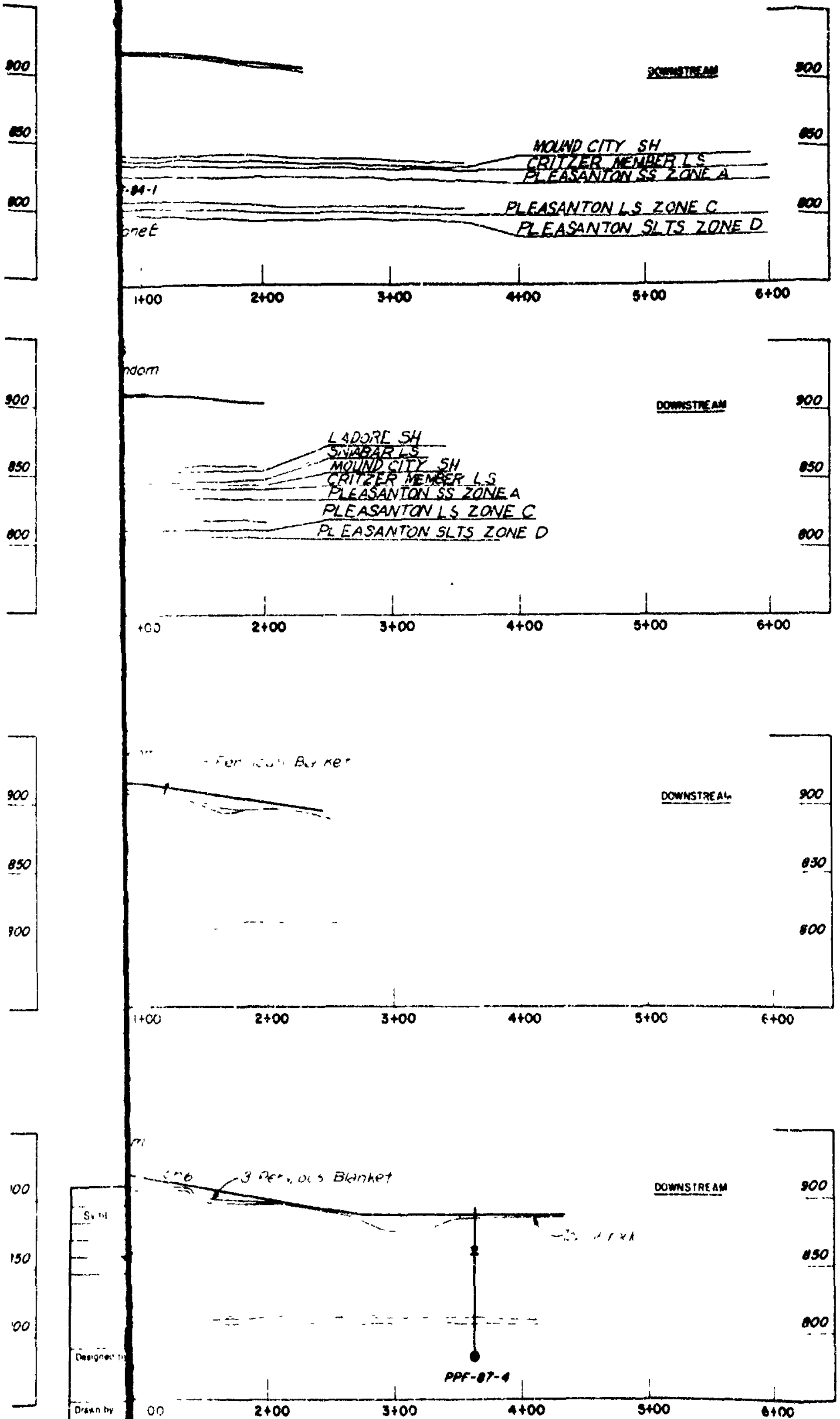
2 of 2 File No. RBL-3-1436

PLATE NO 36



ELEVATION IN FEET BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929
Max surcharge pool EL 922 9
Flood control pool EL 909 0
Multipurpose pool EL 891 0
UPSTREAM
Zon5
Zon3
Random
Top of Rock
Pleasanton Shale Zone B
PPF-C891A
PPF-86-1A
6+00
5+00
4+00
3+00
2+00
1+00
0+00
1+00
SECTION STATION 86+00
Zon50
Berm
Imp
Dam Axis
Pervious Blanket
PPF-87-5
PPF 87 2
PPF C692
SECTION STATION 86+46
UPSTREAM
PPF-8? 3
SECTION STATION 86+85
Zon2
SECTION STATION 87+00


3
4
3
2
Max surcharge pool EL 922 9
Flood control pool EL 909.0
Multipurpose pool EL 891 0
Ion3
Ion5
Random
Top of Rock
Pleasanton Shale Zone B
Pleasanton Siltstone Zone E
PPF-84-1
PPF-C691A
PPF-86-1A
DOWNSTREAM
MOUND CITY SH
CRITZER MEMBER LS
PLEASANTON SS ZONE A
PLEASANTON LS ZONE C
PLEASANTON SLTS ZONE D
900
850
800
4+00
3+00
2+00
1+00
0+00
1+00
2+00
3+00
4+00
5+00
6+00
SECTION STATION 86+00
Imp
Dam Axis
Random
Ion50
3' Pervious Blanket
Top of Rock
Berm
PPF-87-5
PPF-87 2
PPF-C692
LADORE SH
SNIABAR LS
MOUND CITY SH
CRITZER MEMBER LS
PLEASANTON SS ZONE A
PLEASANTON LS ZONE C
PLEASANTON SLTS ZONE D
SECTION STATION 86+46
Dam Axis
Random
Ion3
Ion5
PPF 87 3
SECTION STATION 86+85
Dam Axis
Random
Random
Ion3
Ion50
Imp
Top of Rock
Pleasanton Siltstone Zone E
PPF-87-4
SECTION STATION 87+00
3
4
3
2



LEGEND

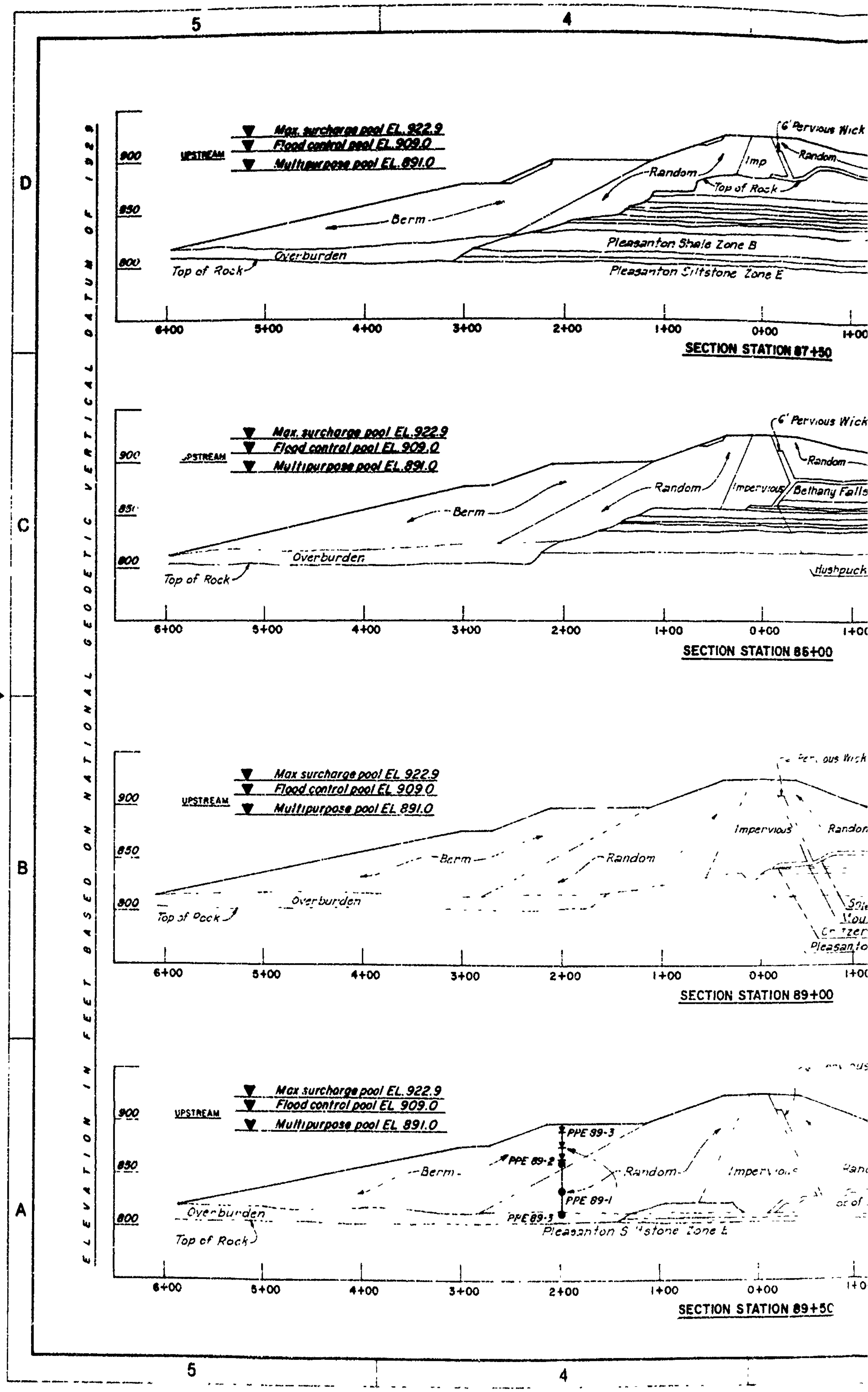
PZ	OPEN TUBE PIEZOMETER	○
PP	PRESSURE CELL PORE PRESSURE DEVICE	■
PP	OPEN TUBE PORE PRESSURE DEVICE	●
F	FOUNDATION	
E	EMBANKMENT	
SP	FOUNDATION SETTLEMENT DEVICE	◆
	ALINEMENT MONUMENT	▲
	CREST SETTLEMENT MONUMENT	○
	INSTRUMENT MONUMENT	
MB	MONITOR BOX	
TM	TILT METER	●
	PIEZOMETER WATER LEVEL AT MULTIPURPOSE POOL	
	OPEN TUBE PIEZOMETER (7-13-89)	
	PNEUMATIC PIEZOMETER (4-24-90)	

Revisions			
Symbol	Descriptions	Date	Approved

U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

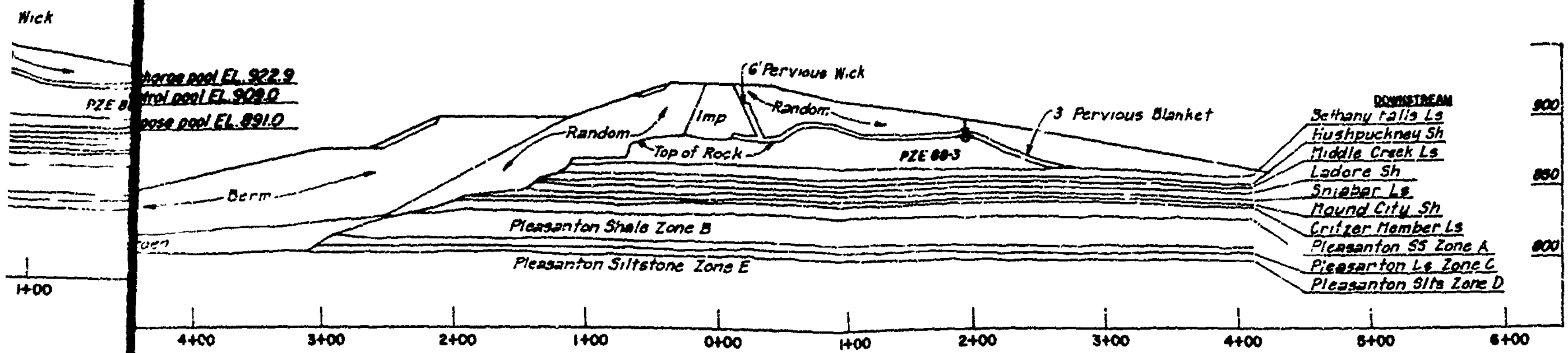
Designed by: R G D	LITTLE BLUE RIVER, MISSOURI LONGVIEW LAKE EMBANKMENT CRITERIA AND PERFORMANCE REPORT
Drawn by: R D T	INSTRUMENTATION CROSS SECTIONS
Checked by: R G D / W B E	Scale: AS SHOWN
Submitted by: R G D	Dwg No: 1 of 5 — File No: RBL-3-1437

PLATE NO. 37

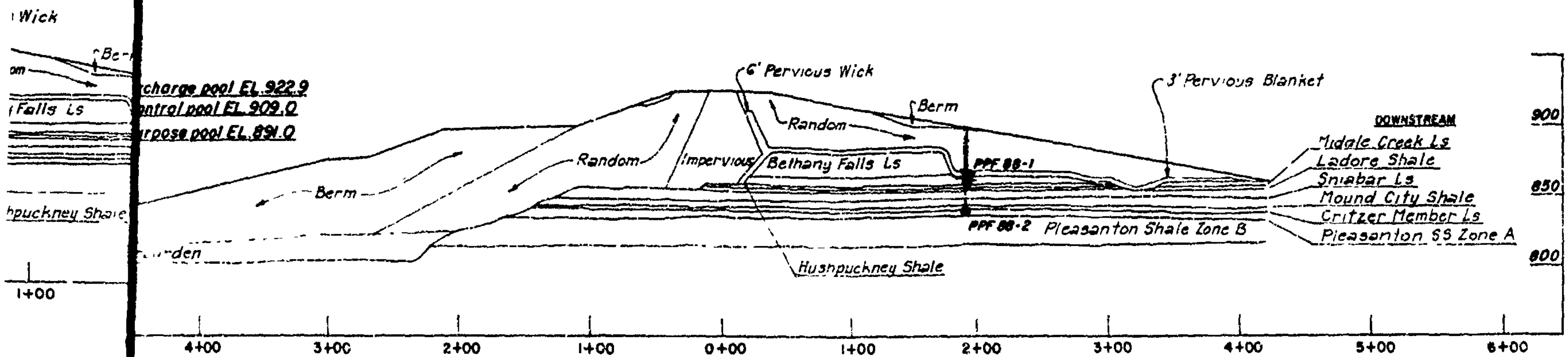


5
4
D
C
B
A
ELEVATION IN FEET BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929
UPSTREAM
Max. surcharge pool EL. 922.9
Flood control pool EL. 909.0
Multipurpose pool EL. 891.0
6' Pervious Wick
Random
Imp
Top of Rock
Berm
Overburden
Pleasanton Shale Zone B
Pleasanton Siltstone Zone E
900
850
800
6+00
5+00
4+00
3+00
2+00
1+00
0+00
1+00
SECTION STATION 87+50
Impervious
Bethany Falls
SECTION STATION 88+00
SECTION STATION 89+00
PPE 89-3
PPE 89-2
PPE 89-1
SECTION STATION 89+50

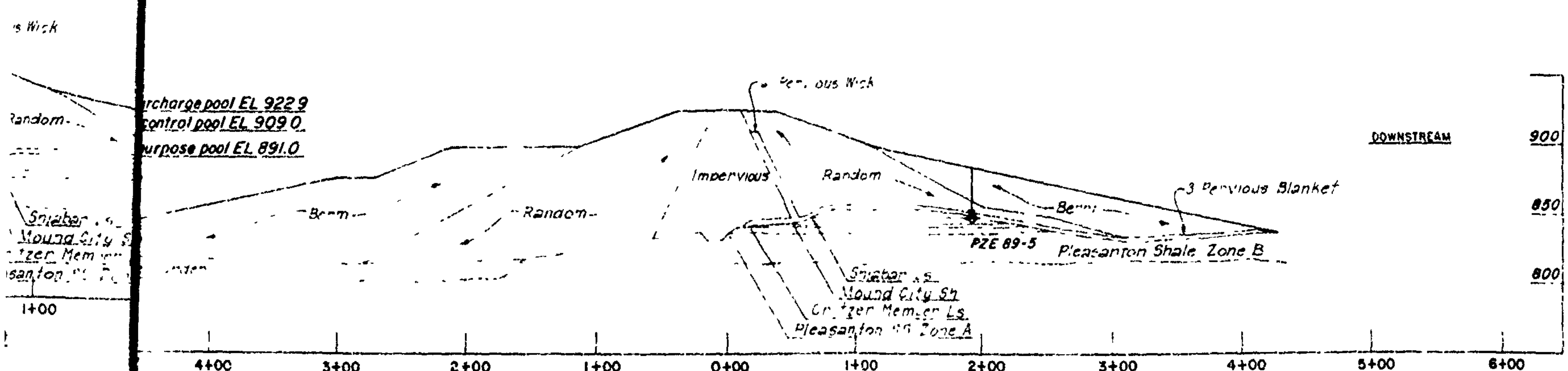
4 3 2



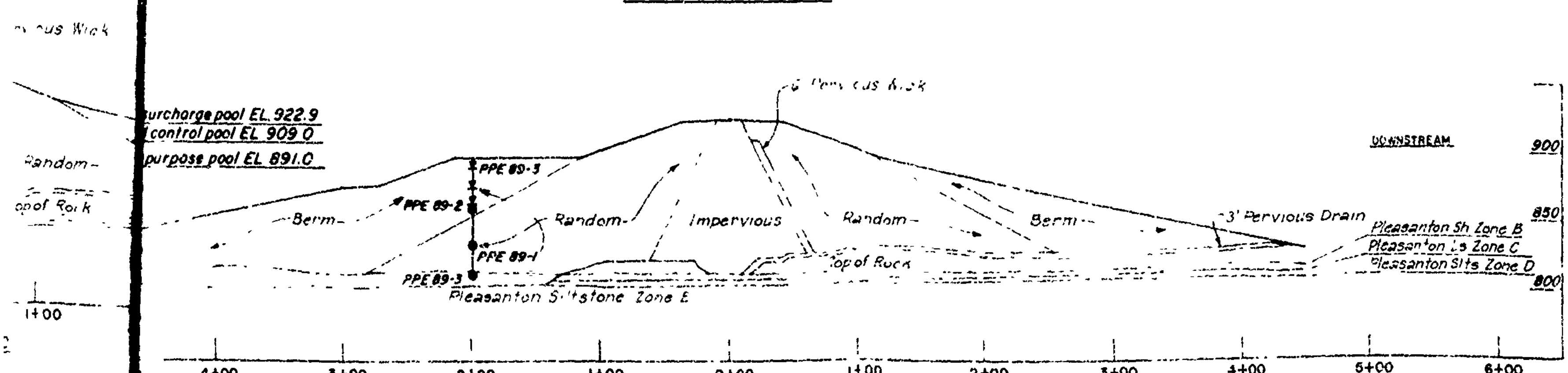
SECTION STATION 87+50



SECTION STATION 88+00

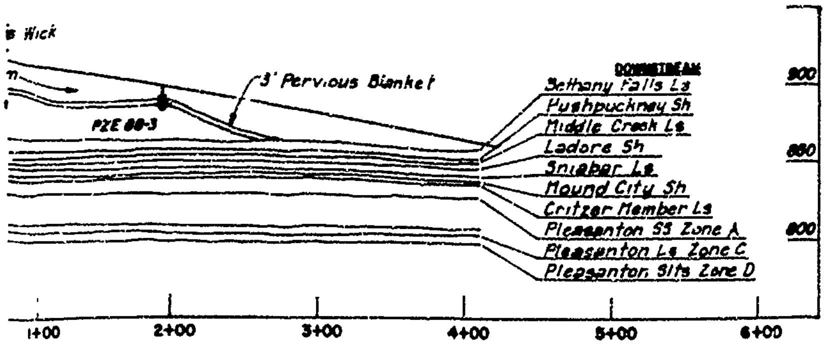


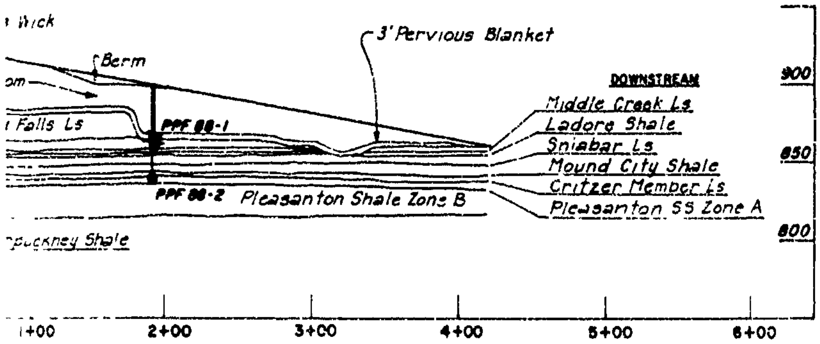
SECTION STATION 89+00

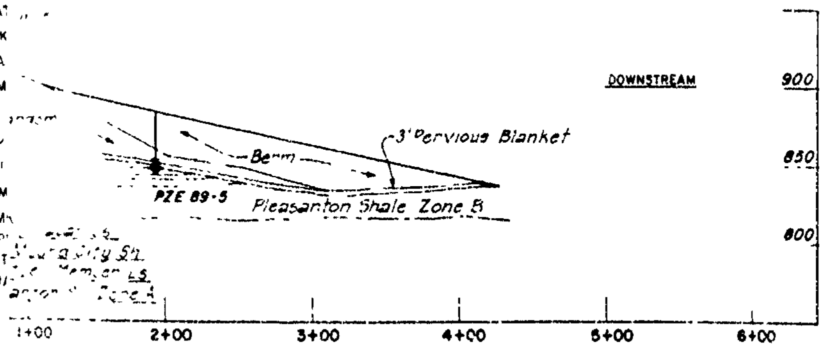


SECTION STATION 89+50

4 3 2

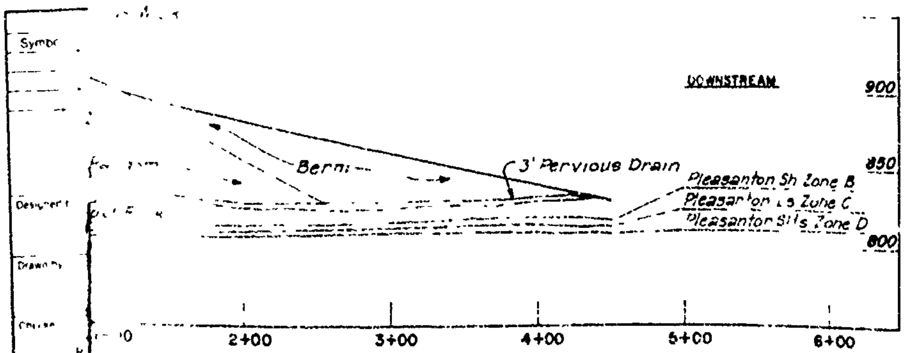






LEGEND

PZ	OPEN TUBE PIEZOMETER	○
PP	PRESSURE CELL PORE PRESSURE DEVICE	■
PP	OPEN TUBE PORE PRESSURE DEVICE	◆
F	FOUNDATION	
E	EMBANKMENT	
SP	FOUNDATION SETTLEMENT DEVICE	●
	ALIGNMENT MONUMENT	▲
	CREST SETTLEMENT MONUMENT	○ #4
	INSTRUMENT MONUMENT	Ⓐ
MB	MONITOR BOX	⊟
TM	TILT METER	●
	PIEZOMETER WATER LEVEL AT MULTIPURPOSE POOL	
	OPEN TUBE PIEZOMETER (7-13-89)	
	PNEUMATIC PIEZOMETER (4-24-90)	



Revisions			
Symbol	Descriptions	Date	Approved

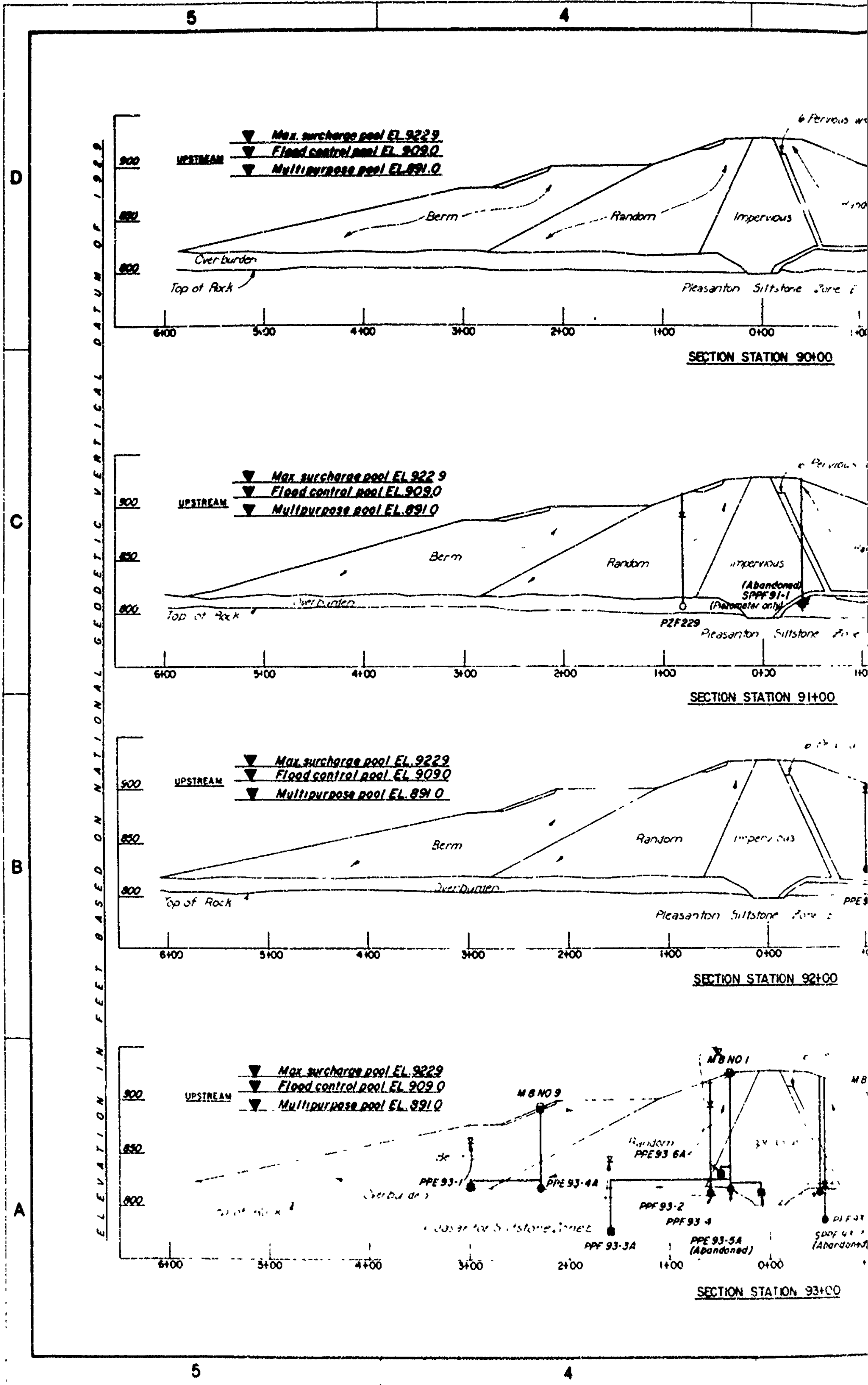
U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

US Army Corps of Engineers

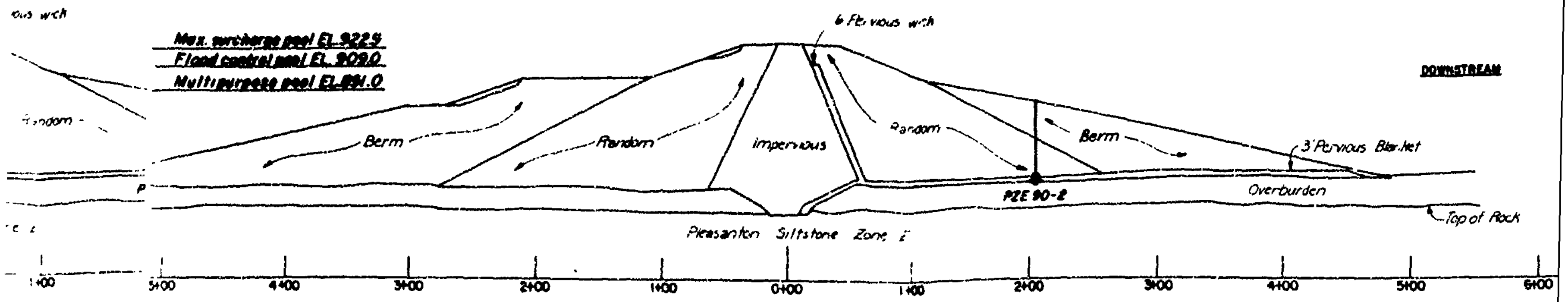
LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA
AND PERFORMANCE REPORT

INSTRUMENTATION CROSS SECTIONS

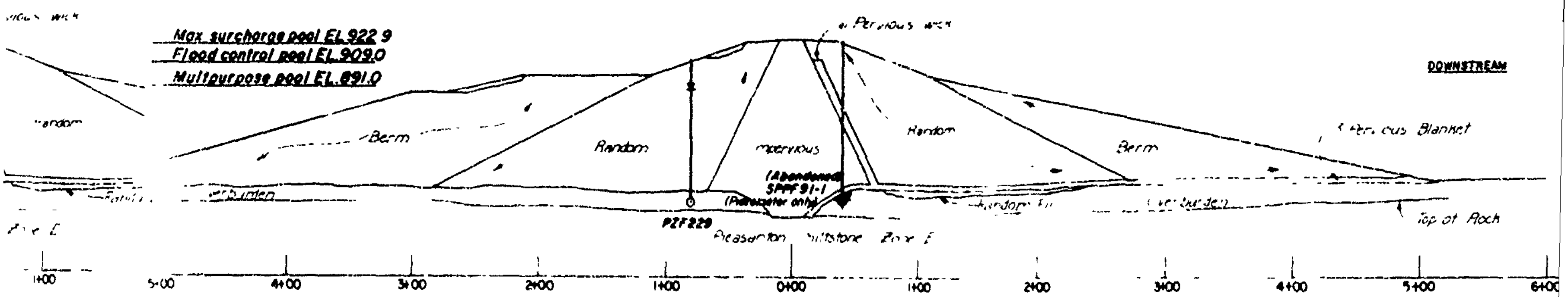
Designed by	R G D
Drawn by	P S T
Checked by	R G D / W B E
Submitted by	R G D
Scale	AS SHOWN
Sheet number	2 OF 5
File No.	RBL-3-1438



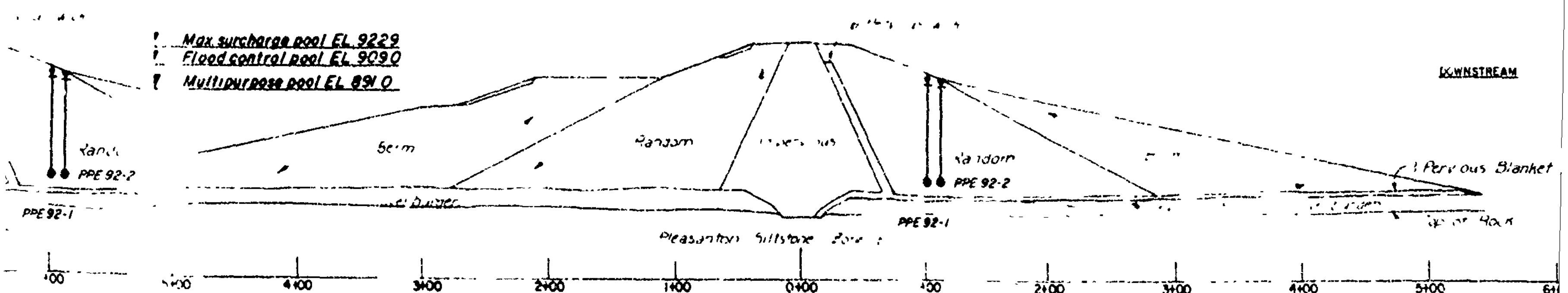
5
4
D
C
B
A
ELEVATION IN FEET BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929
UPSTREAM
Max. surcharge pool EL.922.9
Flood control pool EL.909.0
Multipurpose pool EL.891.0
900
850
800
Berm
Random
Impervious
Overburden
Top of Rock
Pleasanton Siltstone Zone E
6+00
5+00
4+00
3+00
2+00
1+00
0+00
SECTION STATION 90+00
(Abandoned)
SPPF 91-1
(Piezometer only)
PZF 229
SECTION STATION 91+00
SECTION STATION 92+00
M B NO 9
M B NO 1
PPE 93-1
PPE 93-4A
PPE 93 6A
PPF 93-2
PPF 93 4
PPF 93-3A
PPE 93-5A
(Abandoned)
SECTION STATION 93+00



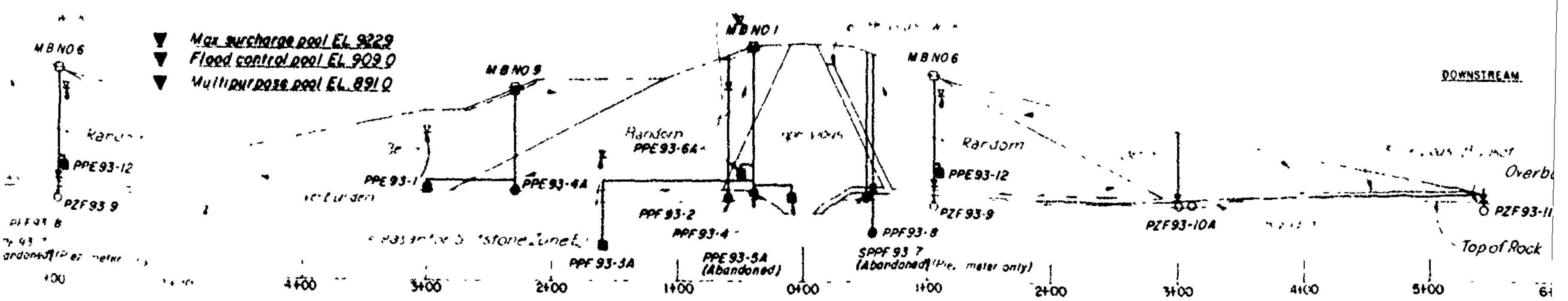
SECTION STATION 90+00



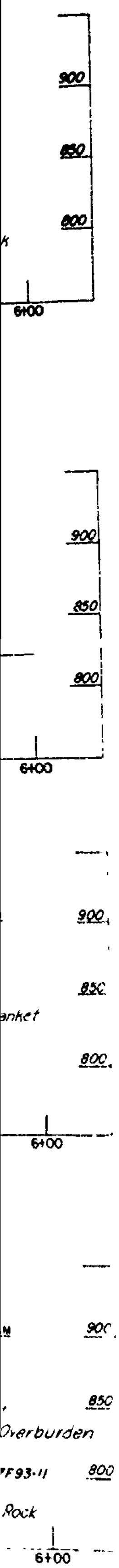
SECTION STATION 91+00

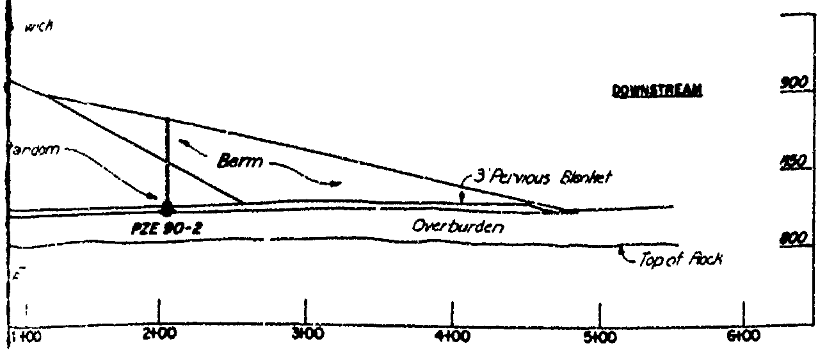


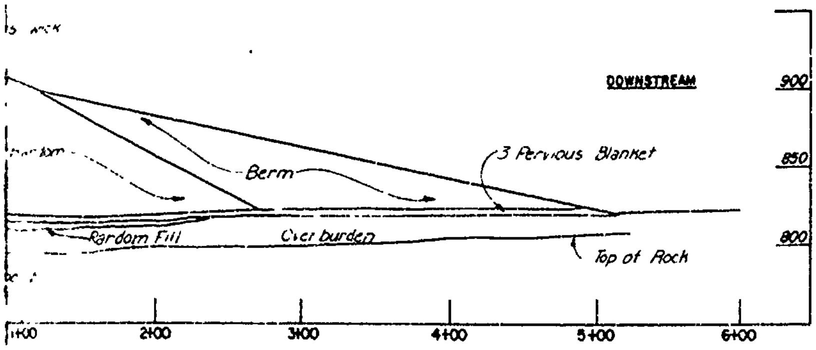
SECTION STATION 92+00

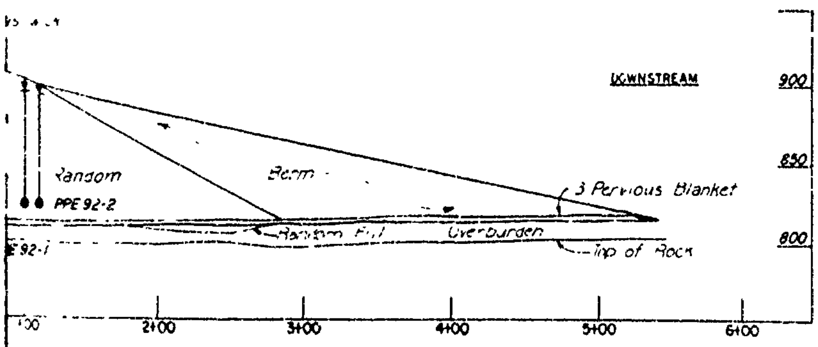


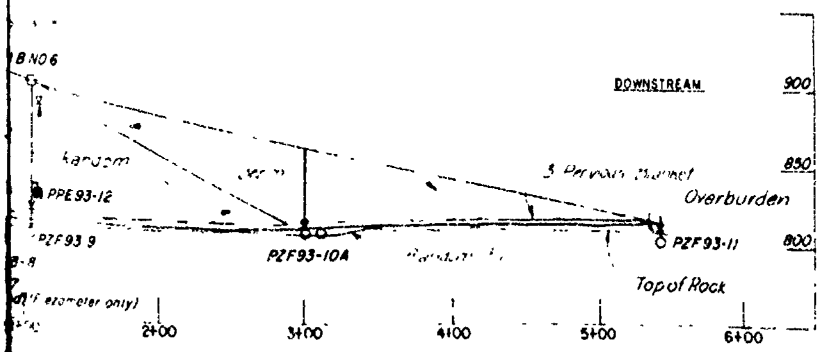
SECTION STATION 93+00











LEGEND

PZ	OPEN TUBE PIEZOMETER	⊙
PP	PRESSURE CELL PORE PRESSURE DEVICE	■
PP	OPEN TUBE PORE PRESSURE DEVICE	●
F	FOUNDATION	
E	EMBANKMENT	
SP	FOUNDATION SETTLEMENT DEVICE	◆
	ALINEMENT MONUMENT	▲
	CREST SETTLEMENT MONUMENT	●
	INSTRUMENT MONUMENT	Ⓐ
MB	MONITOR BOX	
TM	TILT METER	●
	PIEZOMETER WATER LEVEL AT MULTIPURPOSE POOL	
	OPEN TUBE PIEZOMETER (7-13-89)	
	PNEUMATIC PIEZOMETER (4-24-90)	

Revisions			
Symbol	Descriptions	Date	Approved

U. S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

Designed by: RGD
Drawn by: SEY
Checked by: RGD/WBE
Submitted by: RGD

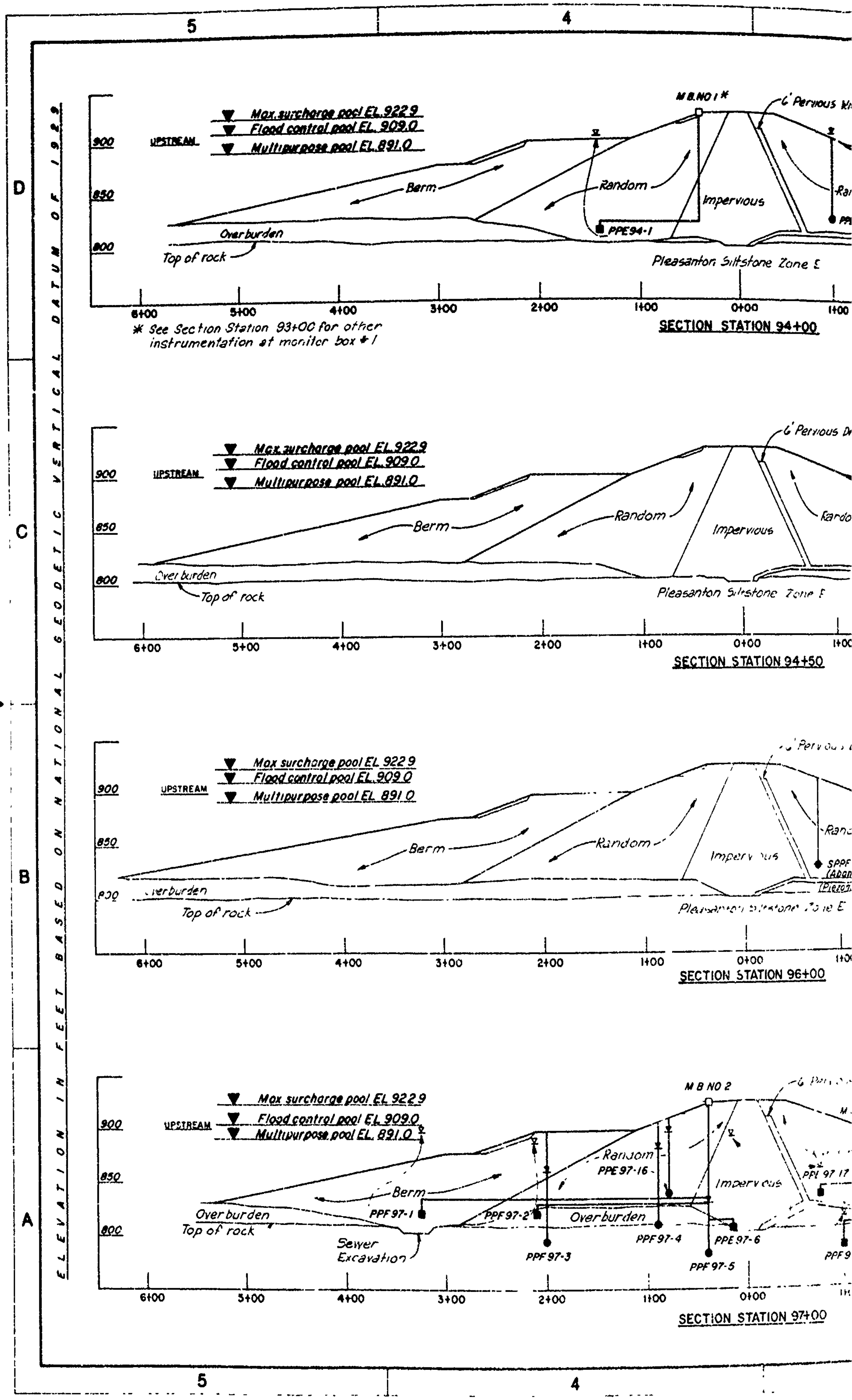
US Army Corps of Engineers

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA
AND PERFORMANCE REPORT

INSTRUMENTATION CROSS SECTIONS

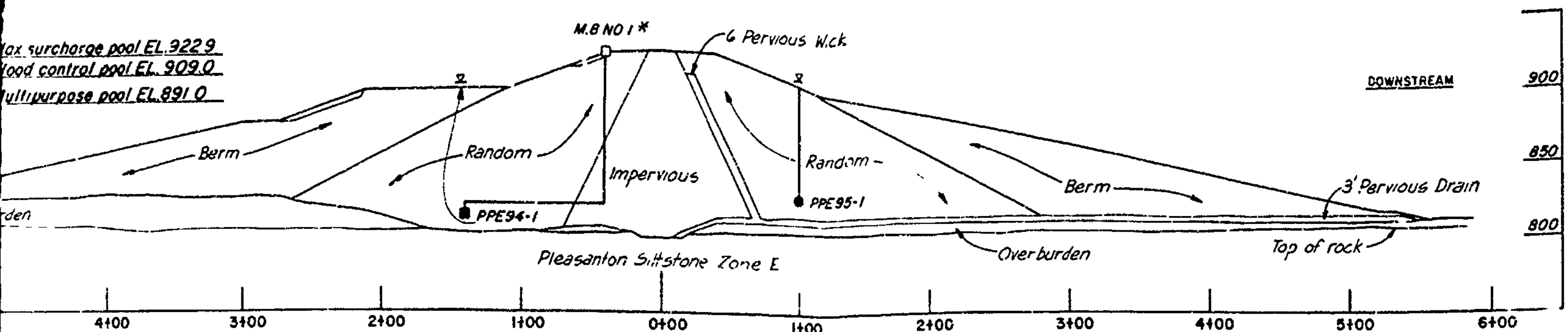
Scale: AS SHOWN
Date:
Dwg No.
Sheet number 3 OF 5
RBL-3-1439

PLATE NO. 39

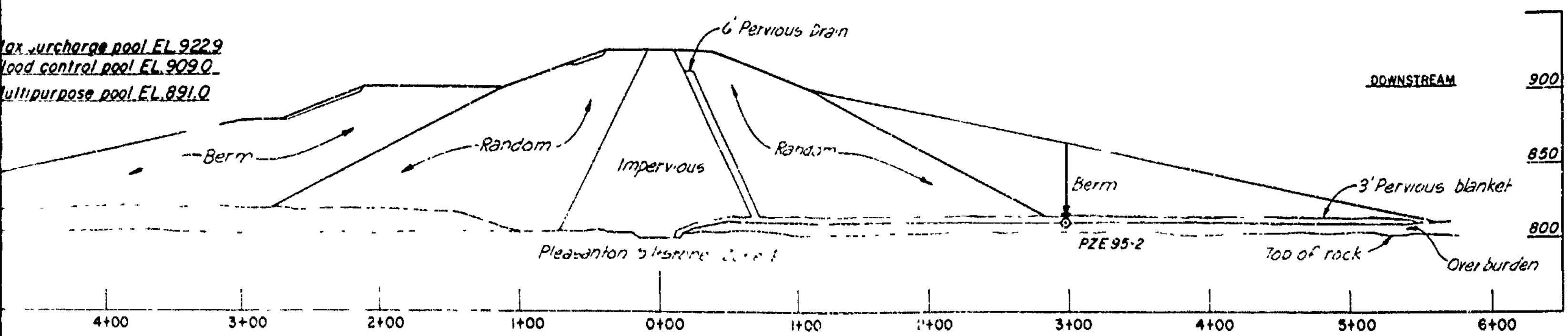


ELEVATION IN FEET BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929
Max surcharge pool EL 922.9
Flood control pool EL 909.0
Multipurpose pool EL 891.0
UPSTREAM
Berm
Random
Impervious
Overburden
Top of rock
Pleasanton Siltstone Zone E
M.B.NO 1*
PPE94-1
6+00
5+00
4+00
3+00
2+00
1+00
0+00
* See Section Station 93+00 for other instrumentation at monitor box #1
SECTION STATION 94+00
SECTION STATION 94+50
SECTION STATION 96+00
M B NO 2
PPE 97-16
PPF 97-1
PPF 97-2
PPF 97-3
PPF 97-4
PPF 97-5
PPE 97-6
Sewer Excavation
SECTION STATION 97+00
900
850
800
D
C
B
A
5
4

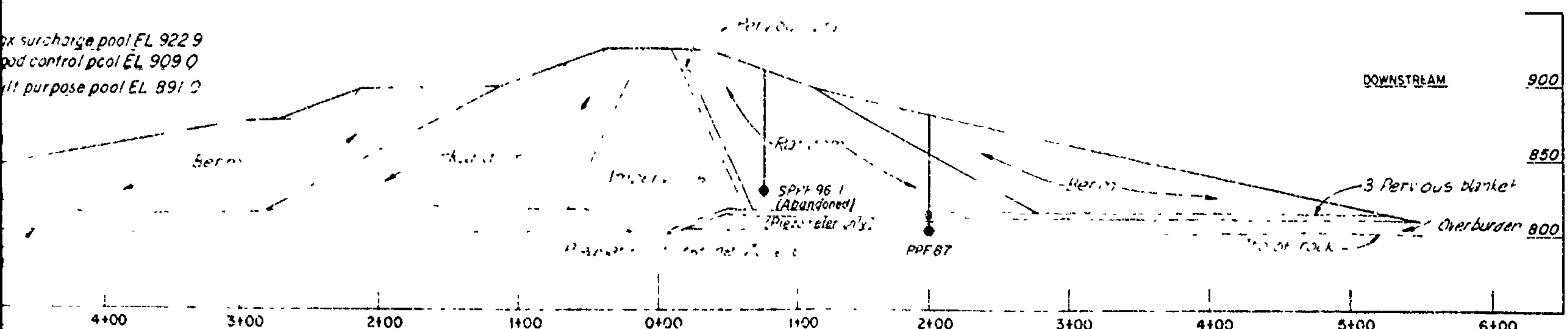
4 3 2



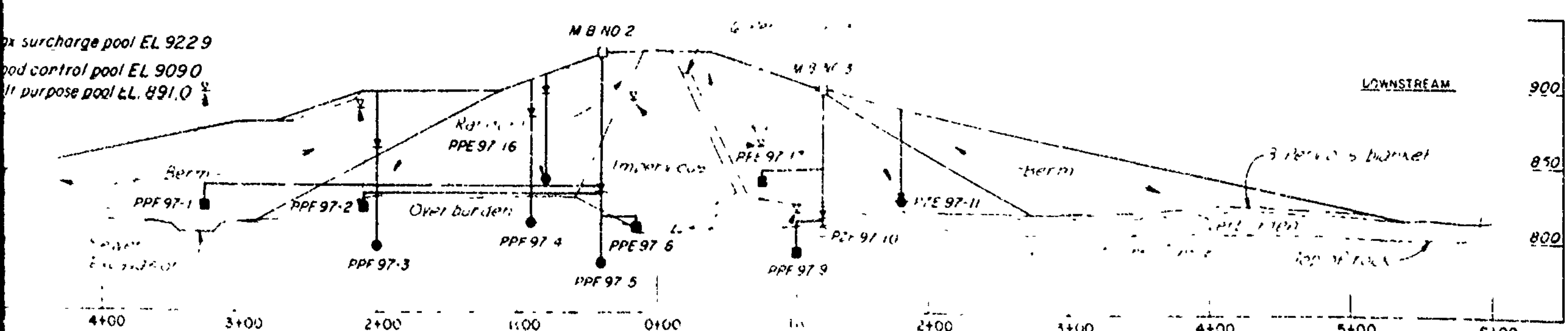
SECTION STATION 94+00



SECTION STATION 94+50

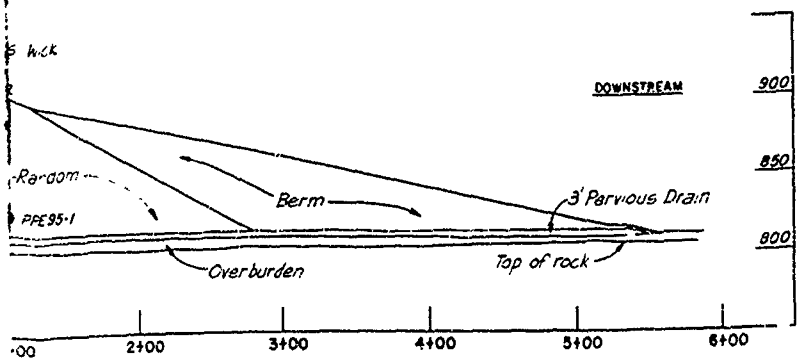


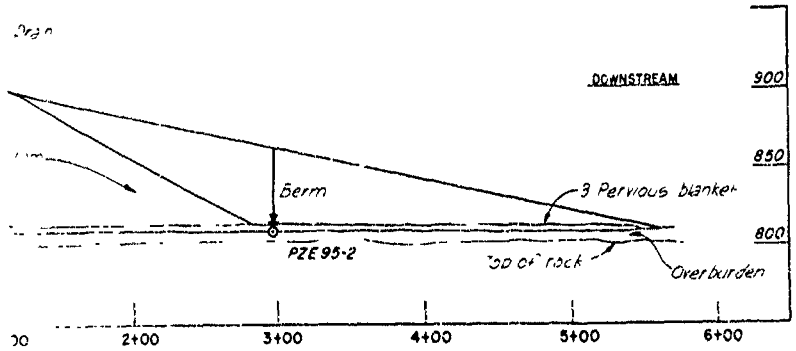
SECTION STATION 96+00

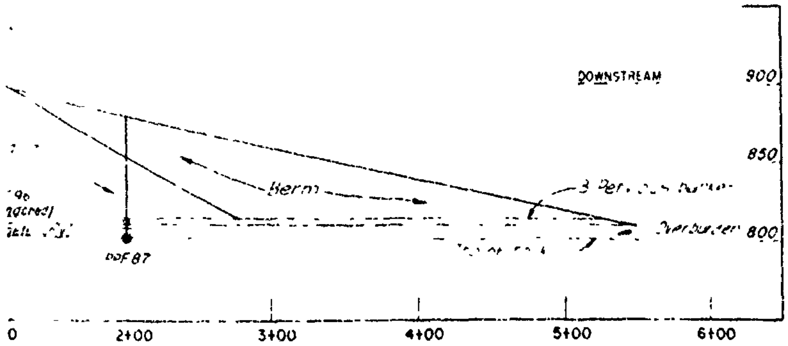


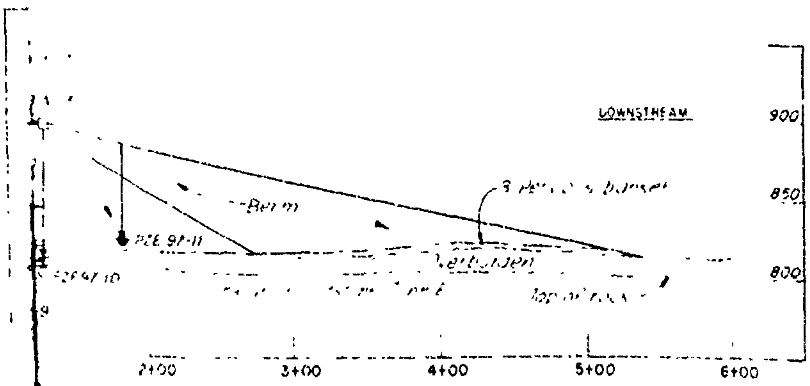
SECTION STATION 97+00

4 3 2









LEGEND

PZ	OPEN TUBE PIEZOMETER	○
PP	PRESSURE CELL PORE PRESSURE DEVICE	■
PP	OPEN TUBE PORE PRESSURE DEVICE	●
F	FOUNDATION	
E	EMBANKMENT	
SP	FOUNDATION SETTLEMENT DEVICE	◆
	ALINEMENT MONUMENT	▲
	CREST SETTLEMENT MONUMENT	○#4
	INSTRUMENT MONUMENT	(▲)
MB	MONITOR BOX	
TM	TILT METER	●
	PIEZOMETER WATER LEVEL AT MULTIPURPOSE POOL	
	OPEN TUBE PIEZOMETER (7-13-89)	
	PNEUMATIC PIEZOMETER (4-24-90)	

Revisions			
Symbol	Descriptions	Date	Approved

U. S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

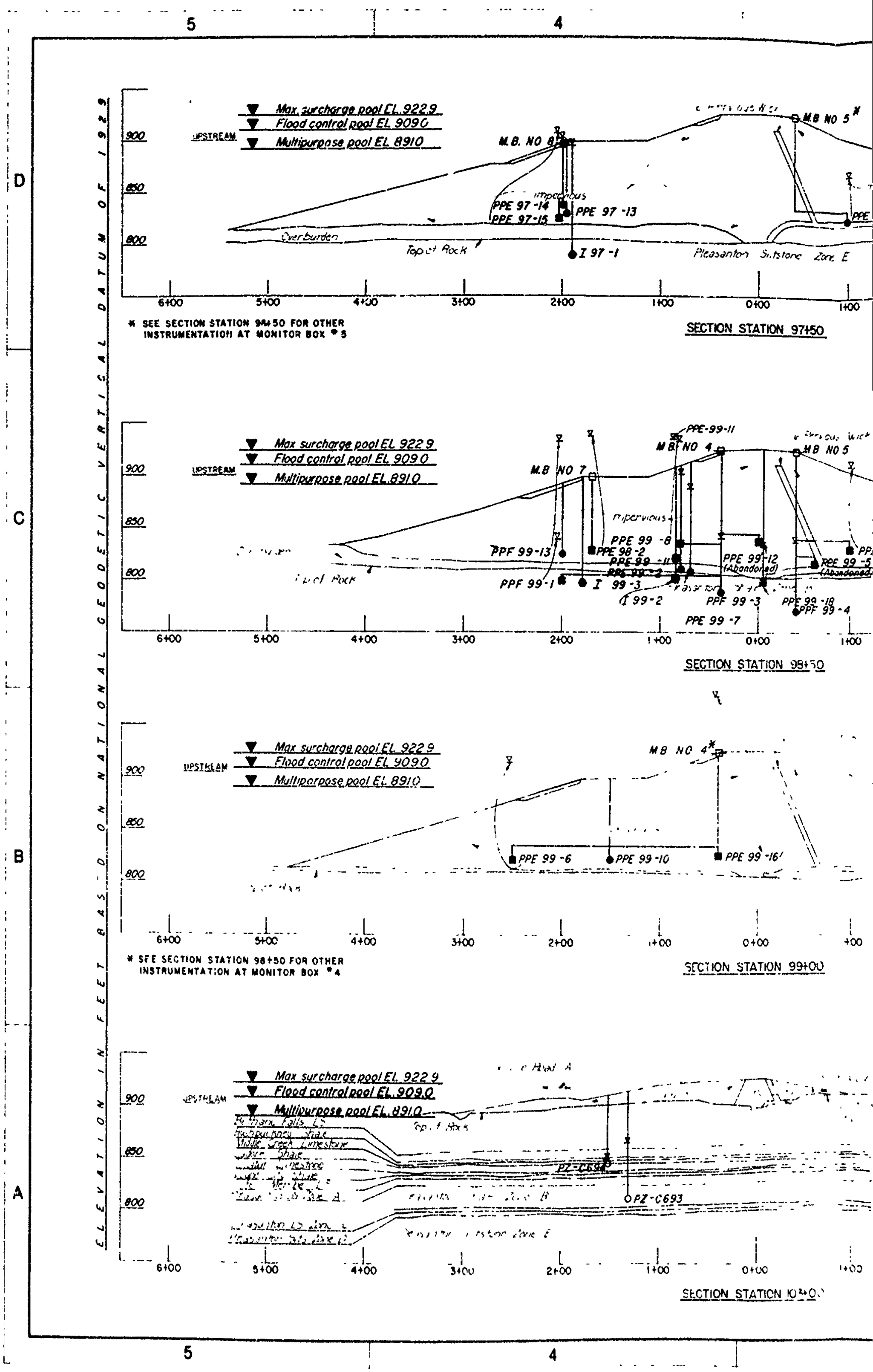
US Army Corps of Engineers

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA
AND PERFORMANCE REPORT

INSTRUMENTATION CROSS SECTIONS

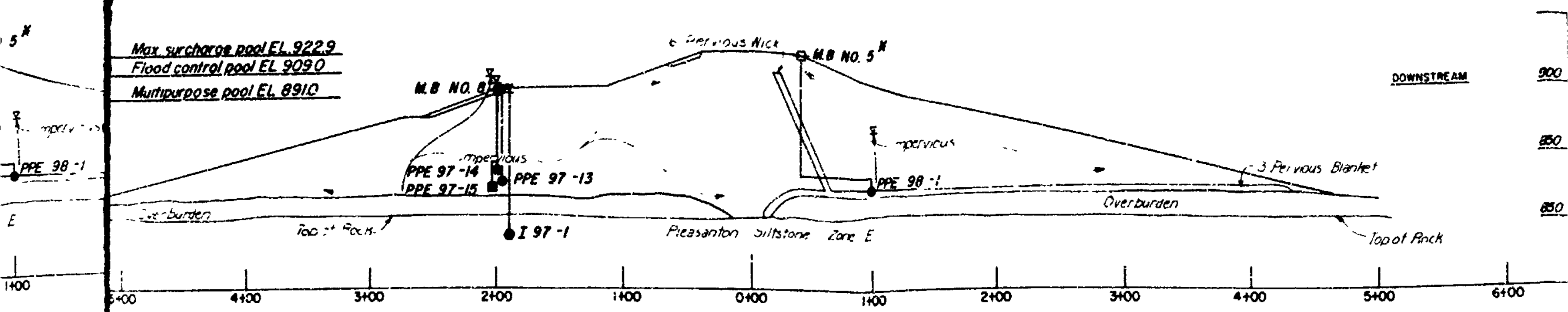
Designed by: R G D
Drawn by: P S T
Checked by: R G D / W B E
Submitted by: R G D
Scale: AS SHOWN
Sheet number: 4 of 5
RBL-3-1440

PLATE NO 40



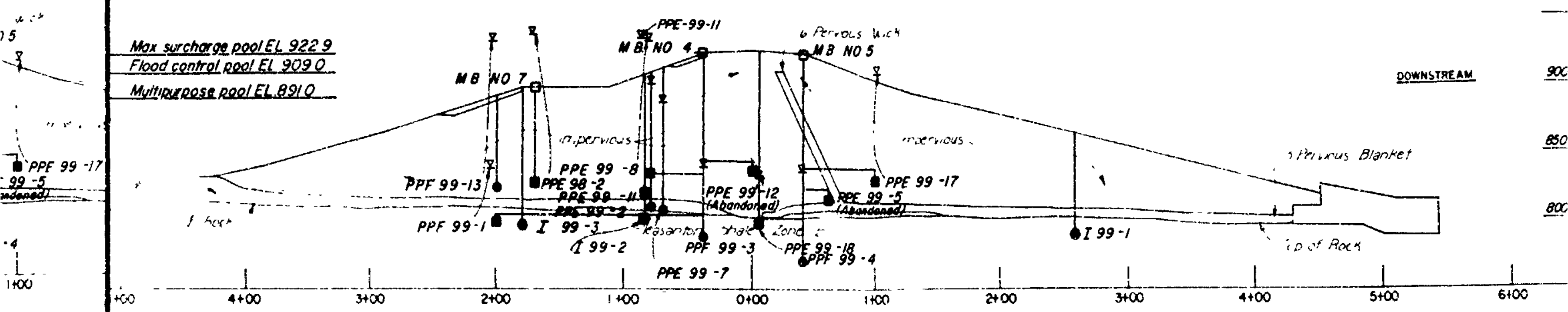
5
4
D
C
B
A
ELEVATION IN FEET BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929
Max surcharge pool EL 922.9
Flood control pool EL 909.0
Multipurpose pool EL 891.0
UPSTREAM
900
850
800
M.B. NO 6
M.B NO 5
PPE 97-14
PPE 97-15
PPE 97-13
I 97-1
Overburden
Top of Rock
Pleasanton Siltstone Zone E
6+00
5+00
4+00
3+00
2+00
1+00
0+00
* SEE SECTION STATION 98+50 FOR OTHER INSTRUMENTATION AT MONITOR BOX #5
SECTION STATION 97+50
PPE-99-11
M.B NO 4
M.B NO 5
M.B NO 7
PPF 99-13
PPE 98-2
PPE 99-8
PPE 99-11
PPF 99-1
I 99-3
I 99-2
PPE 99-12 (Abandoned)
PPE 99-5 (Abandoned)
PPF 99-3
PPF 99-18
PPF 99-4
PPE 99-7
SECTION STATION 98+50
M.B NO 4*
PPE 99-6
PPE 99-10
PPE 99-16
* SEE SECTION STATION 98+50 FOR OTHER INSTRUMENTATION AT MONITOR BOX #4
SECTION STATION 99+00
PZ-C694
PZ-C693
Top of Rock
SECTION STATION 100+00

4 3 2

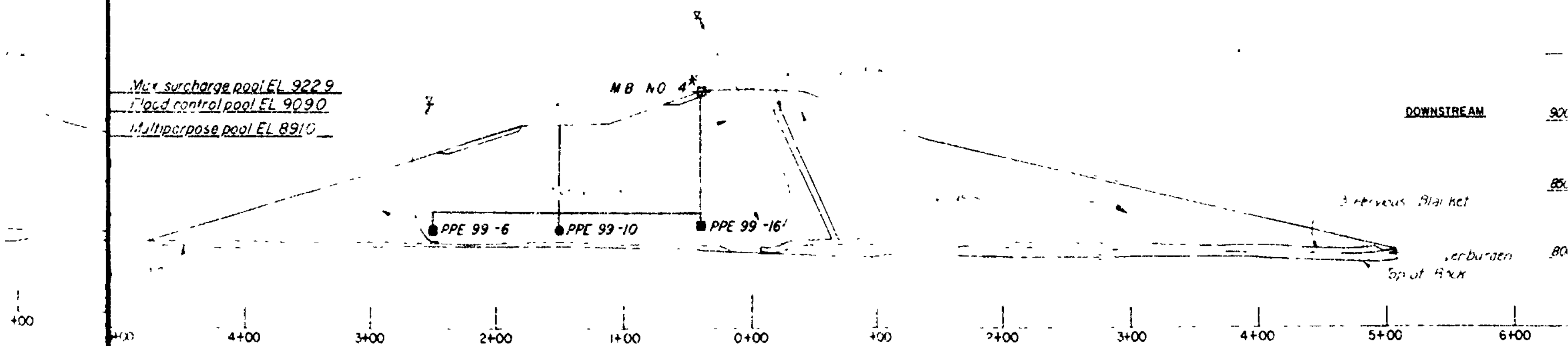


9+50 FOR OTHER
MONITOR BOX *5

SECTION STATION 97+50

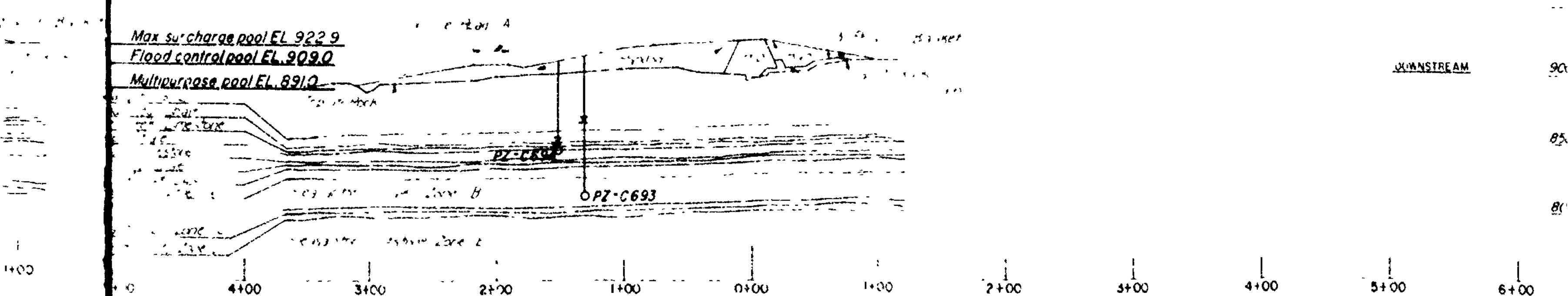


SECTION STATION 98+50



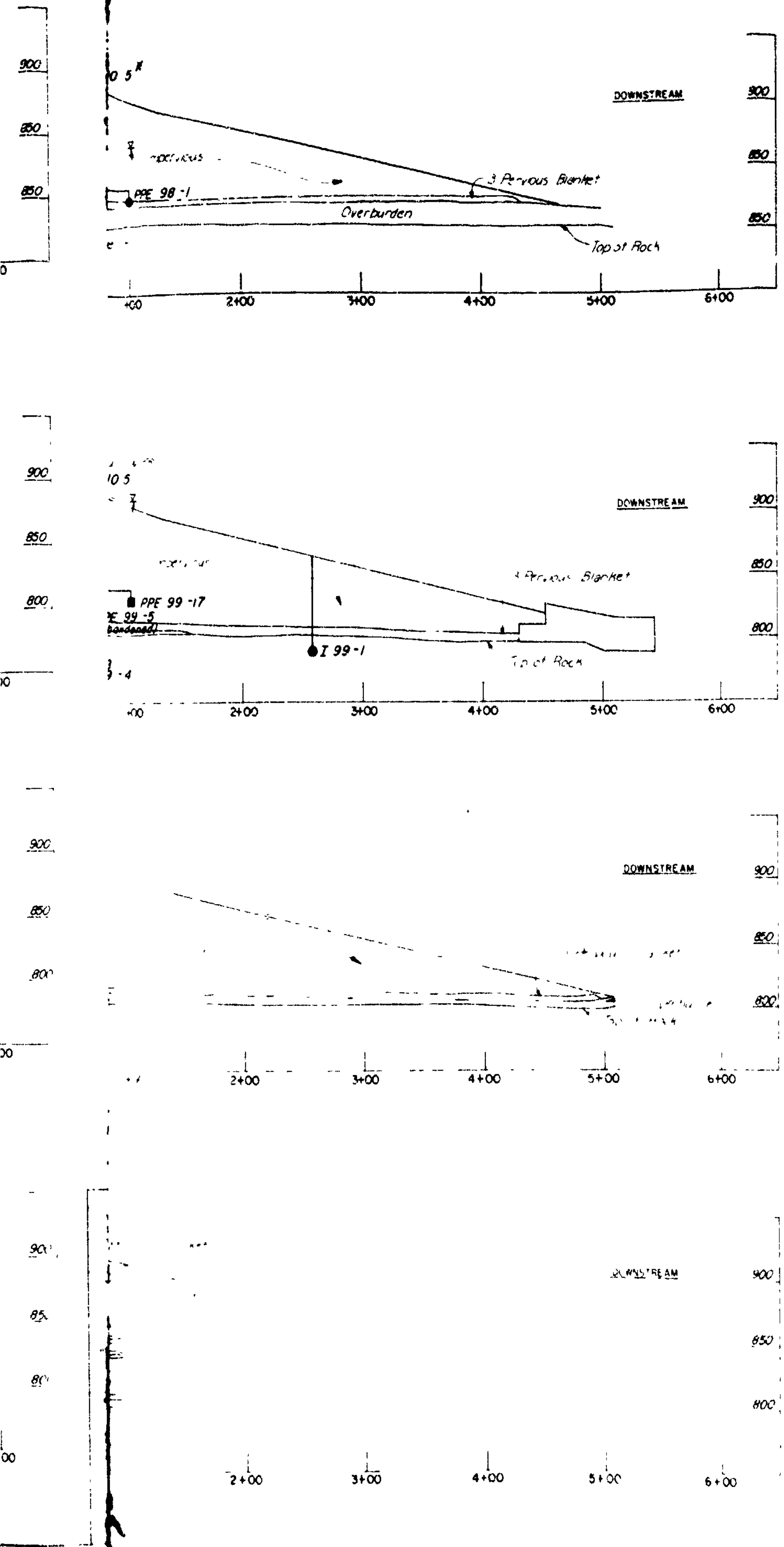
8+50 OR OTHER
MONITOR BOX *4

SECTION STATION 99+00



SECTION STATION 103+00

4 3 2



LEGEND

PZ	OPEN TUBE PIEZOMETER	○
	VIBRATING WIRE PIEZOMETER	⊞
PP	PRESSURE CELL PORE PRESSURE DEVICE	■
PP	OPEN TUBE PORE PRESSURE DEVICE	✦
F	FOUNDATION	
E	EMBANKMENT	
SP	FOUNDATION SETTLEMENT DEVICE	●
	ALIGNMENT MONUMENT	▲
	CREST SETTLEMENT MONUMENT	○ #4
	INSTRUMENT MONUMENT	Ⓐ
MB	MONITOR BOX	⊖
TM	TILT METER	●
	PIEZOMETER WATER LEVEL AT MULTIPURPOSE POOL	
	OPEN TUBE PIEZOMETER	7-13-89
	PNEUMATIC PIEZOMETER	4-24-90

Symbol	Revisions Descriptions	Date	Approved

U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY MISSOURI

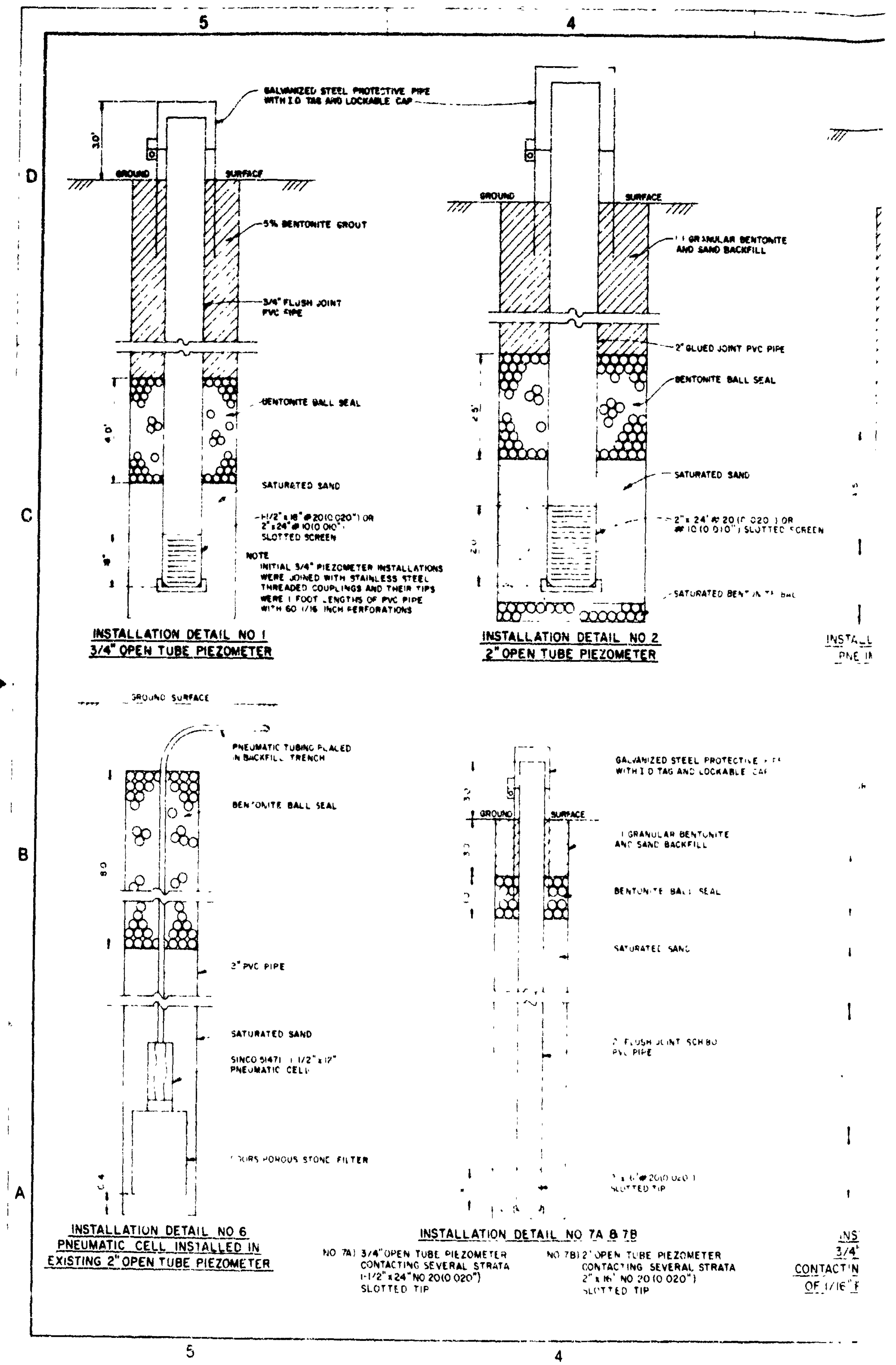
Designed by: R G D
Drawn by: SEY
Checked by: R G D / W B E
Submitted by: R G D

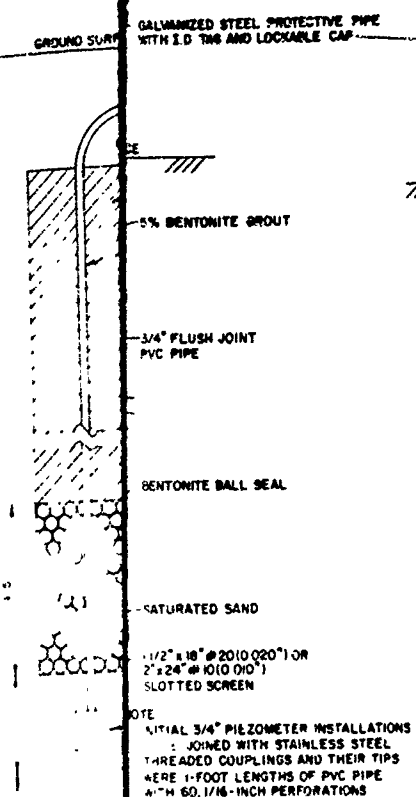
US Army Corps of Engineers

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA
AND PERFORMANCE REPORT

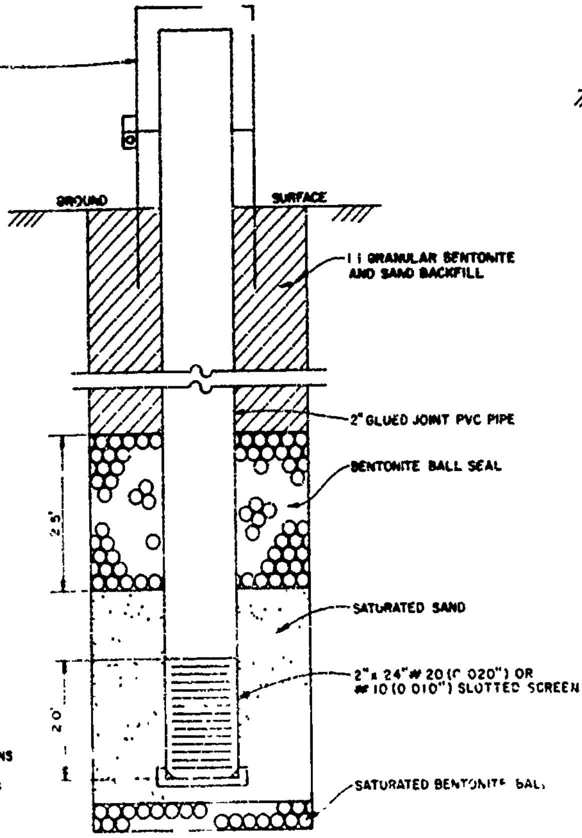
INSTRUMENTATION CROSS SECTIONS

Scale: AS SHOWN
Date:
Sheet number: 5 of 5
Dwg No: RBL-3-1441

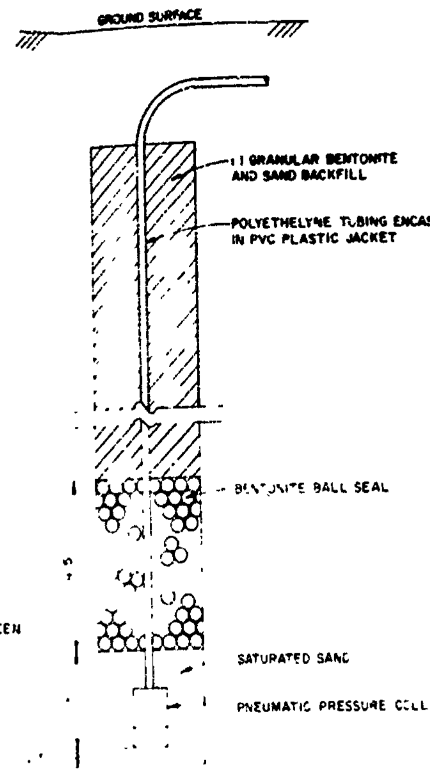

5
4
D
C
B
A
GALVANIZED STEEL PROTECTIVE PIPE WITH I.D. TAG AND LOCKABLE CAP
3.0'
GROUND
SURFACE
5% BENTONITE GROUT
3/4" FLUSH JOINT PVC PIPE
BENTONITE BALL SEAL
4.0'
SATURATED SAND
1-1/2" x 18" # 20 (0.020") OR 2" x 24" # 10 (0.010") SLOTTED SCREEN
NOTE
INITIAL 3/4" PIEZOMETER INSTALLATIONS WERE JOINED WITH STAINLESS STEEL THREADED COUPLINGS AND THEIR TIPS WERE 1 FOOT LENGTHS OF PVC PIPE WITH 60 1/16 INCH PERFORATIONS
INSTALLATION DETAIL NO 1
3/4" OPEN TUBE PIEZOMETER
1:1 GRANULAR BENTONITE AND SAND BACKFILL
2" GLUED JOINT PVC PIPE
BENTONITE BALL SEAL
SATURATED SAND
2" x 24" # 20 (0.020") OR # 10 (0.010") SLOTTED SCREEN
SATURATED BENTONITE BALL
INSTALLATION DETAIL NO 2
2" OPEN TUBE PIEZOMETER
GROUND SURFACE
PNEUMATIC TUBING PLACED IN BACKFILL TRENCH
BENTONITE BALL SEAL
8.0
2" PVC PIPE
SATURATED SAND
SINCO 51471 1 1/2" x 12" PNEUMATIC CELL
POROUS STONE FILTER
INSTALLATION DETAIL NO 6
PNEUMATIC CELL INSTALLED IN EXISTING 2" OPEN TUBE PIEZOMETER
GALVANIZED STEEL PROTECTIVE PIPE WITH I.D. TAG AND LOCKABLE CAP
GROUND
SURFACE
1:1 GRANULAR BENTONITE AND SAND BACKFILL
BENTONITE BALL SEAL
SATURATED SAND
2" FLUSH JOINT SCH 80 PVC PIPE
SLOTTED TIP
INSTALLATION DETAIL NO 7A & 7B
NO 7A) 3/4" OPEN TUBE PIEZOMETER CONTACTING SEVERAL STRATA 1-1/2" x 24" NO 20 (0.020") SLOTTED TIP
NO 7B) 2" OPEN TUBE PIEZOMETER CONTACTING SEVERAL STRATA 2" x 16" NO 20 (0.020") SLOTTED TIP
INSTALL
PNE
INS
3/4"
CONTACTIN
OF 1/16"
5
4



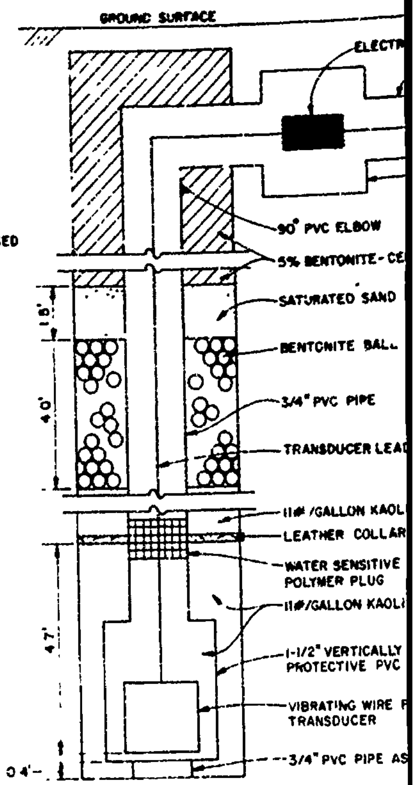
INSTALLATION DE... PNEUMATIC PIEZO...



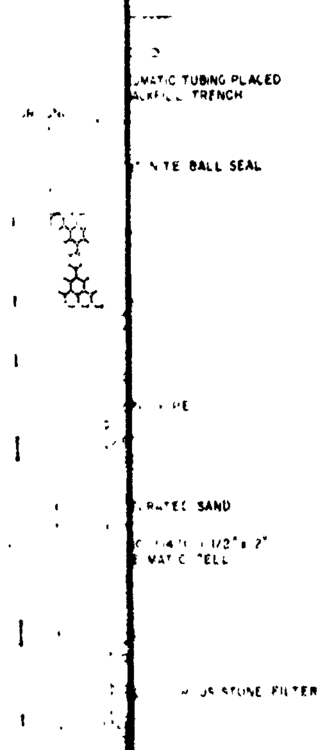
INSTALLATION DETAIL NO. 2
2" OPEN TUBE PIEZOMETER



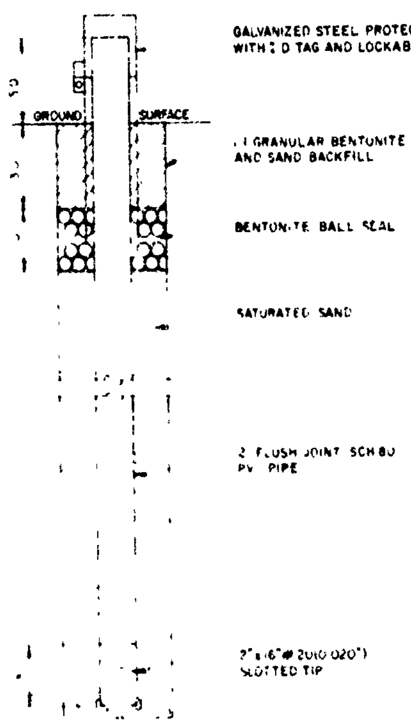
INSTALLATION DETAIL NO. 3
PNEUMATIC PIEZOMETER



INSTALLATION DETAIL NO. 4
VIBRATING WIRE PIEZOMETER



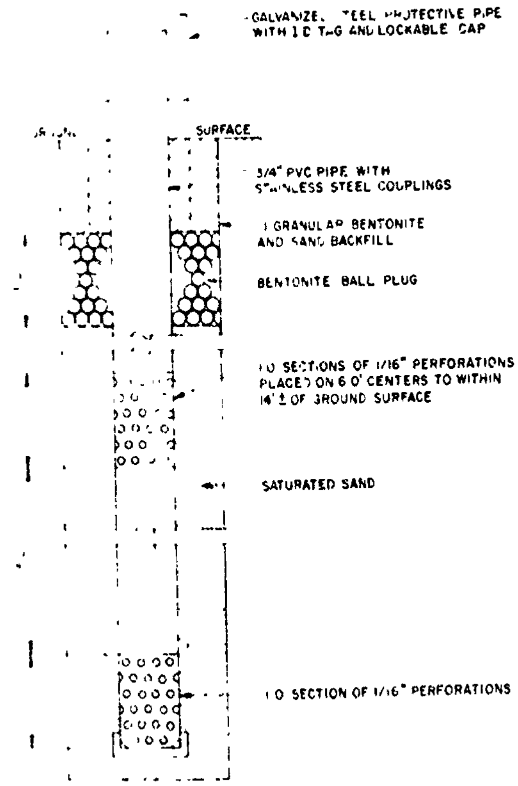
INSTALLATIO...
3/4" OPEN TU...
CONTACTING SEVERA...
1/16" PERFORAT...



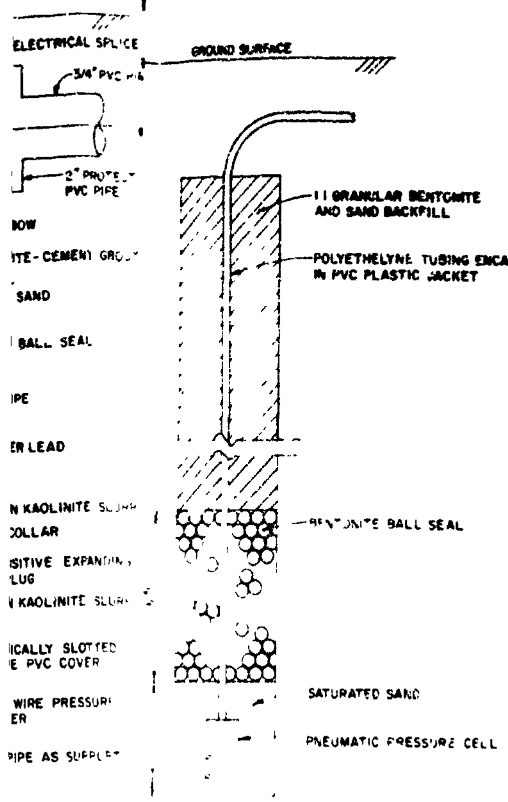
INSTALLATION DETAIL NO 7A & 7B

NO 7A) 3/4" OPEN TUBE PIEZOMETER CONTACTING SEVERAL STRATA 1-1/2" x 24" NO 20(0.020") SLOTTED TIP

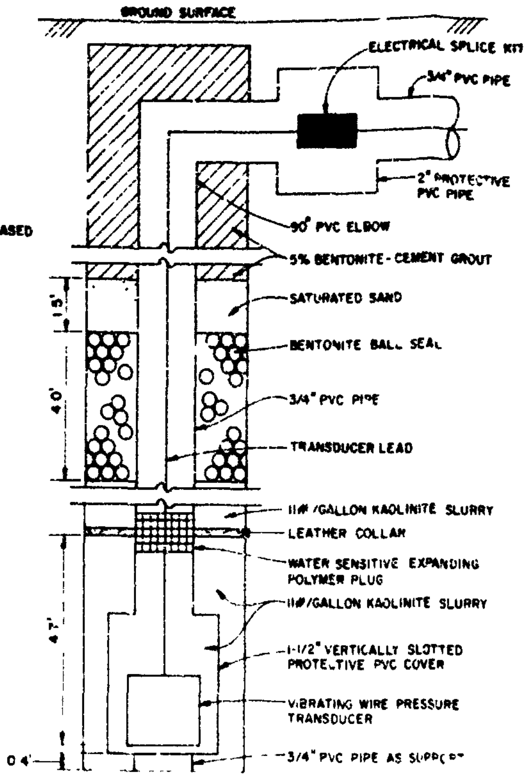
NO 7B) 2" OPEN TUBE PIEZOMETER CONTACTING SEVERAL STRATA 2" x 16" NO 20 (0.020") SLOTTED TIP



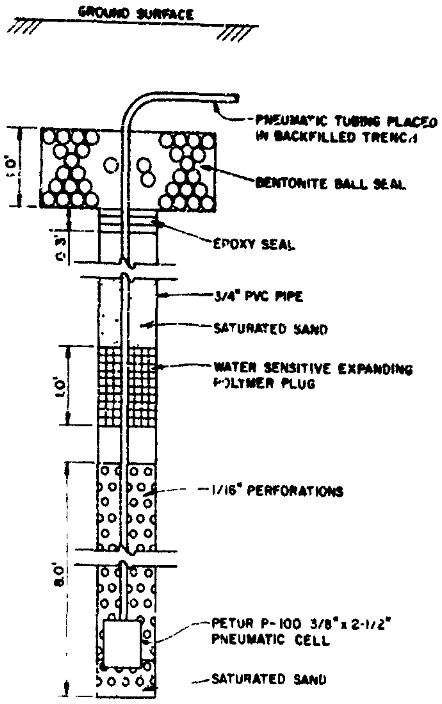
INSTALLATION DETAIL NO 8
3/4" OPEN TUBE PIEZOMETER
CONTACTING SEVERAL STRATA 1.0' SECTIONS
OF 1/16" PERFORATIONS ON 6.0' CENTERS



…LATION DETAIL NO 3
…MATIC PIEZOMETER

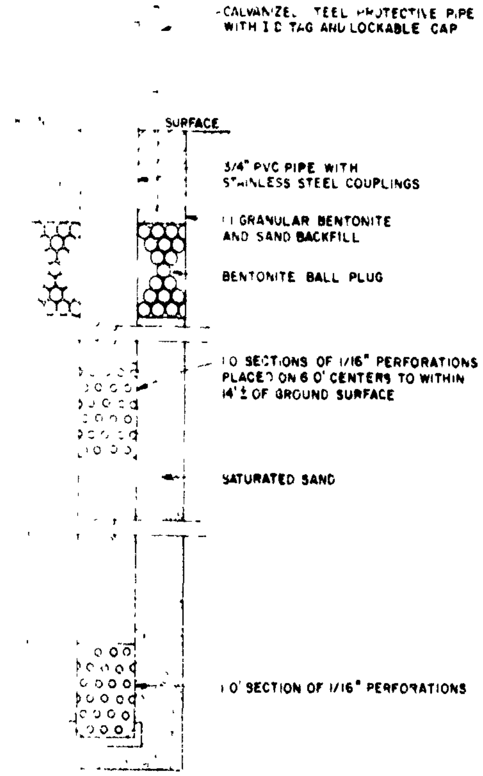


INSTALLATION DETAIL NO 4
VIBRATING WIRE PIEZOMETER



INSTALLATION DETAIL NO. 5
PNEUMATIC CELL INSTALLED IN
EXISTING 3/4" OPEN TUBE PIEZOMETER

DETAIL NO	PIEZOMETER TYPE
1	3/4" OPEN TUBE PIEZOMETER
2	2" OPEN TUBE PIEZOMETER
3	PNEUMATIC PIEZOMETER
4	VIBRATING WIRE PIEZOMETER
5	PNEUMATIC CELL INSTALLED IN EXISTING 3/4" OPEN TUBE PIEZOMETER
6	PNEUMATIC CELL INSTALLED IN EXISTING 2" OPEN TUBE PIEZOMETER
7A	3/4" OPEN TUBE PIEZOMETER CONTACTING SEVERAL STRATA 1-1/2" x 24" #20(0.020") SLOTTED TIP
7B	2" OPEN TUBE PIEZOMETER CONTACTING SEVERAL STRATA 2" x 16" #20(0.020") SLOTTED TIP
8	3/4" OPEN TUBE PIEZOMETER CONTACTING SEVERAL STRATA 1.0' SECTIONS OF 1/16" PERFORATIONS ON 6.0' CENTERS



…TALLATION DETAIL NO 8
…" OPEN TUBE PIEZOMETER
… SEVERAL STRATA 1.0' SECTIONS
…ERFORATIONS ON 6.0' CENTERS

Symbol	Revisions Descriptions	Date	Approved

U. S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

US Army Corps of Engineers

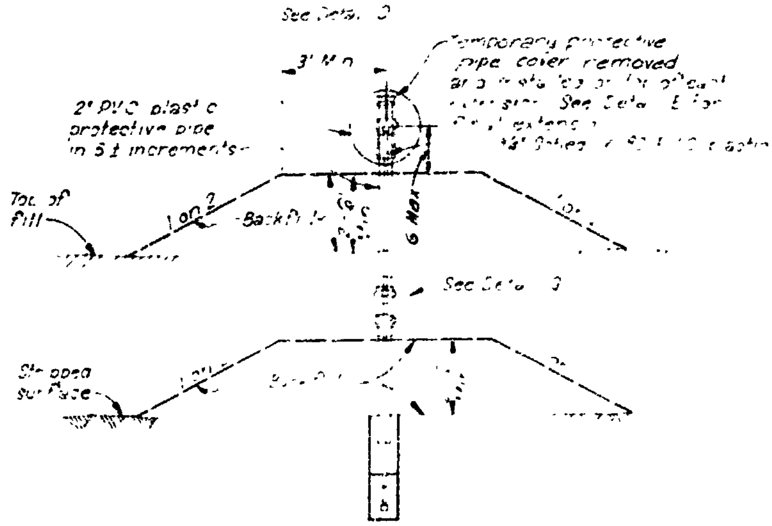
LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA
AND PERFORMANCE REPORT

INSTRUMENTATION INSTALLATION DETAILS

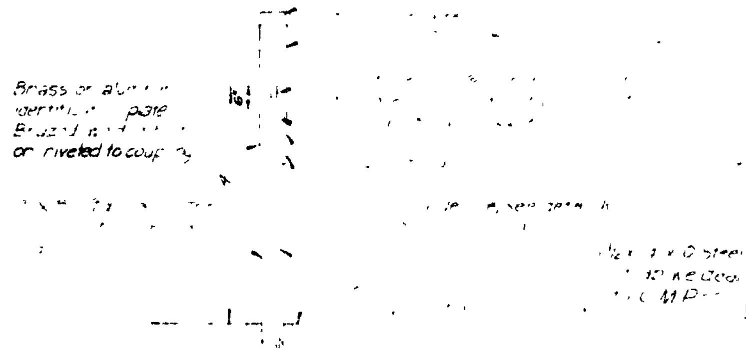
R.C.D.
J.H.
R.G.D. W.B.E.
NO SCALE
R.C.D.

1 of 2 RBL-3-1442

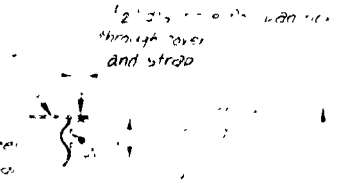
PLATE NO 42



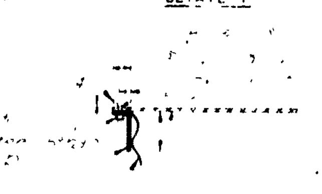
OPEN TUBE PIEZOMETER
INSTALLATION AND EXTENSION
DETAIL-A



FINAL POSITION OF PIEZOMETERS
AND SETTLEMENT DEVICES
DETAIL-E

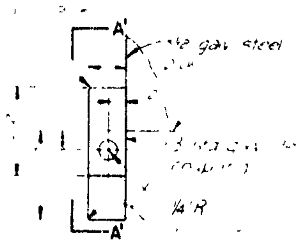


DETAIL-Y

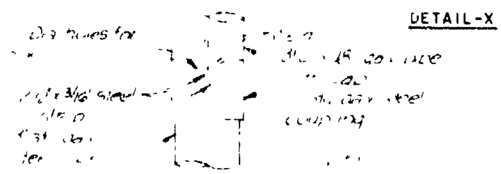


DETAIL-X

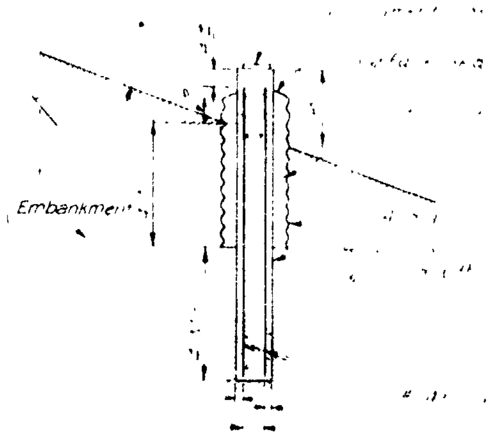
MONITOR BO
DETAIL-F



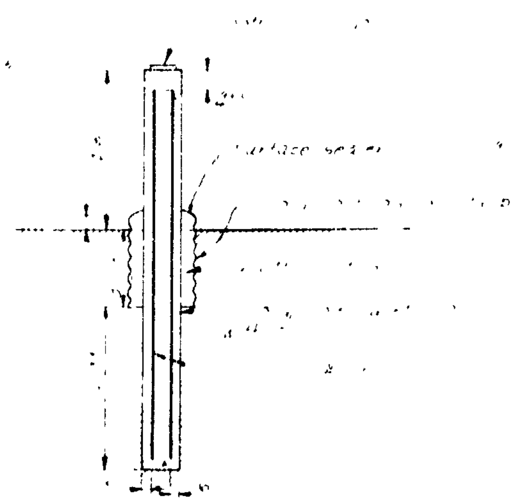
LOCKING DEVICE
DETAIL K



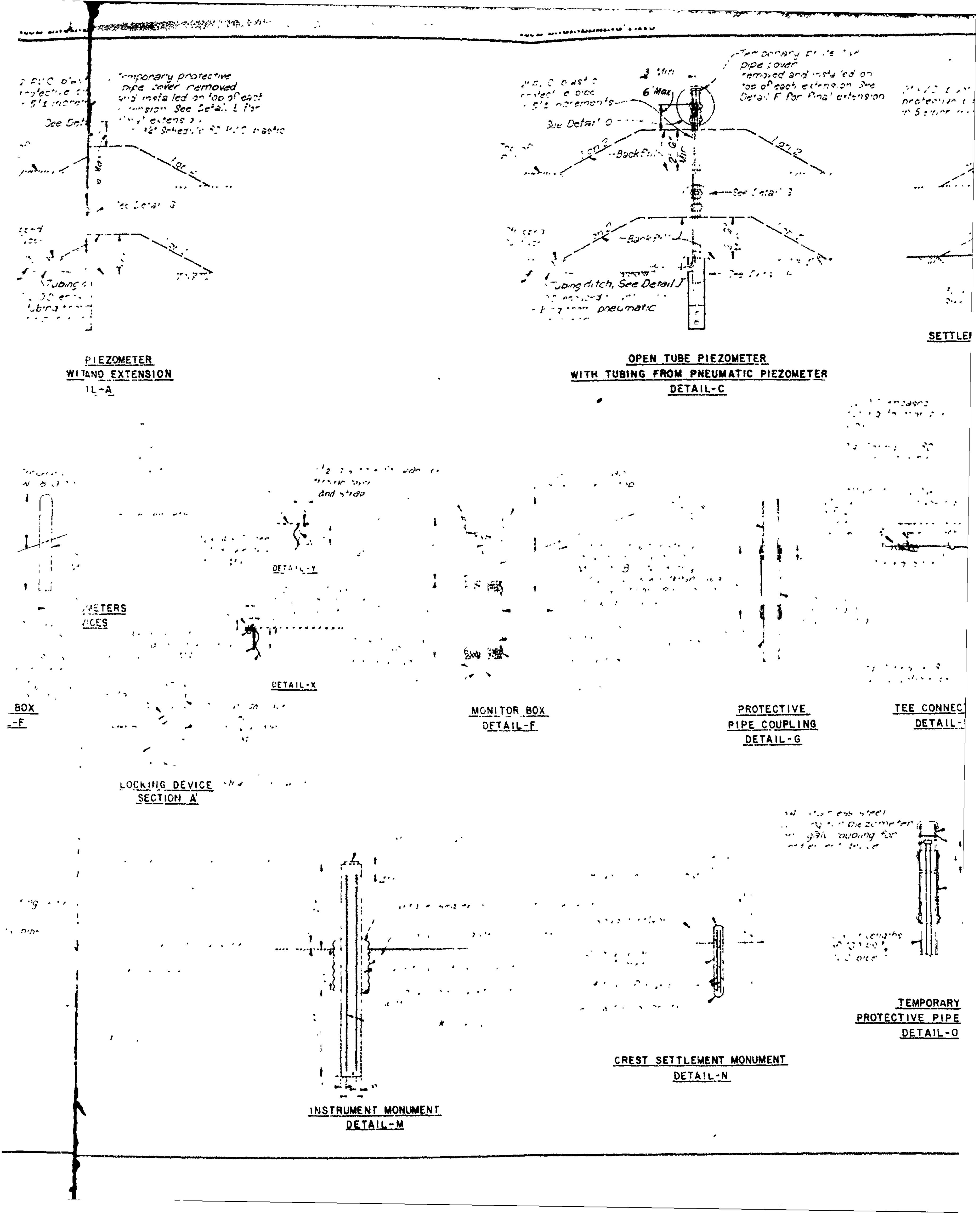
LOCKING DEVICE
SECTION A'



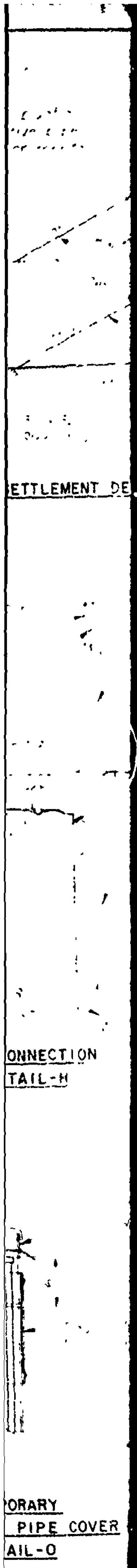
ALINEMENT MONUMENTS
DETAIL-L



INSTRUMENT MONUMENT
DETAIL-M



See Detail B
6' Max
See Detail O
Back Fill
Tubing ditch, See Detail J
pneumatic
PIEZOMETER
OPEN TUBE PIEZOMETER
WITH TUBING FROM PNEUMATIC PIEZOMETER
DETAIL-C
DETAIL-Y
DETAIL-X
BOX
MONITOR BOX
DETAIL-E
PROTECTIVE
PIPE COUPLING
DETAIL-G
LOCKING DEVICE
SECTION A'
INSTRUMENT MONUMENT
DETAIL-M
CREST SETTLEMENT MONUMENT
DETAIL-N
TEMPORARY
PROTECTIVE PIPE
DETAIL-O

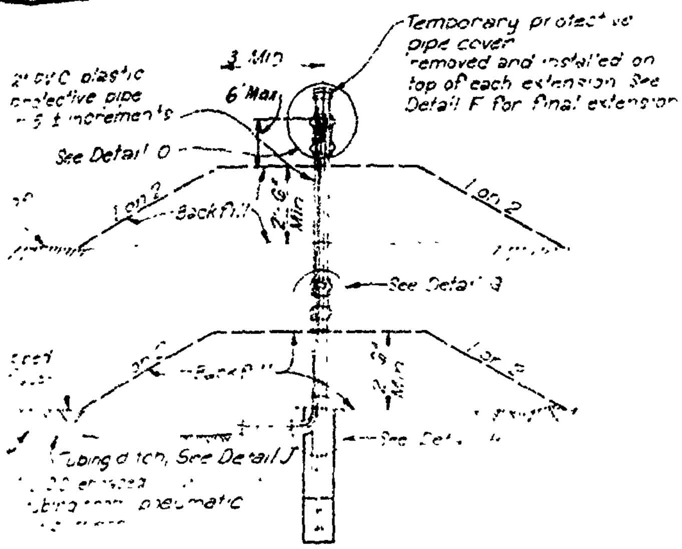


ETTLEMENT DE

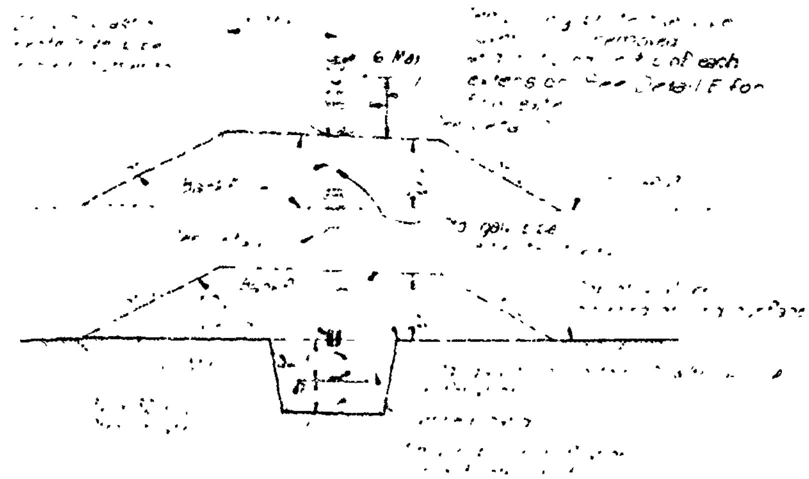
ONNECTION
TAIL-H

R BOX
IL-F

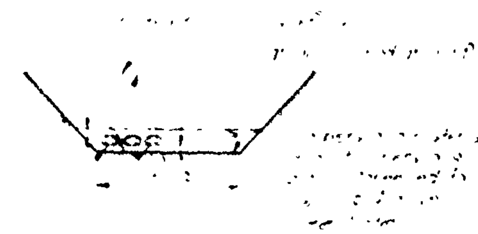
ORARY
PIPE COVER
AIL-O



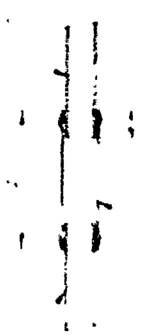
OPEN TUBE PIEZOMETER
WITH TUBING FROM PNEUMATIC PIEZOMETER
DETAIL-C



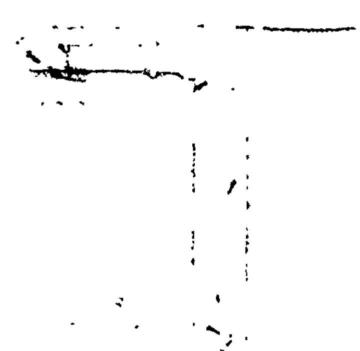
SETTLEMENT DEVICE INSTALLATION AND EXTENSION
DETAIL-D



TUBING DITCH
DETAIL-J

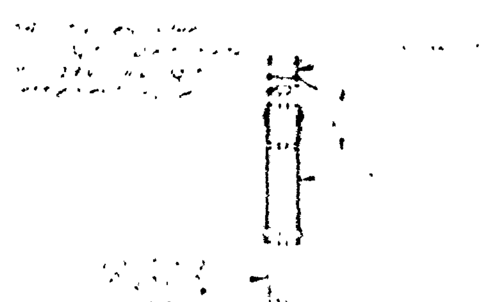


PROTECTIVE
PIPE COUPLING
DETAIL-G

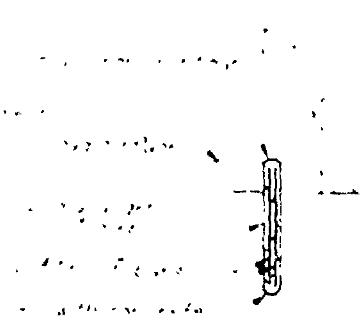


TEE CONNECTION
DETAIL-H

with 50% sand
bore holes, bentonite
have 3
tubing ditch located in pervious zone,
at all times



TEMPORARY
PROTECTIVE PIPE COVER
DETAIL-O



CREST SETTLEMENT MONUMENT
DETAIL-N

Symbol	Revisions Description	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

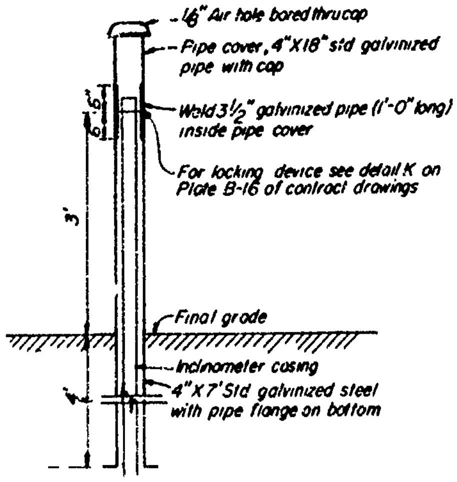
LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA
AND PERFORMANCE REPORT

EMBANKMENT OBSERVATION DEVICES,
INSTALLATION DETAILS

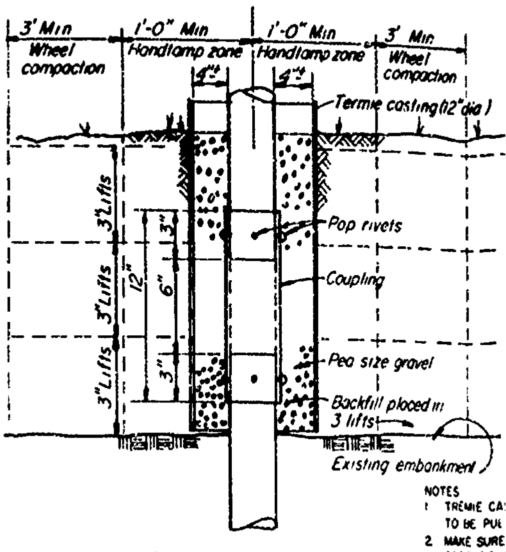
SHOWN

2 of 2 RBL-3-1443

PLATE NO 43



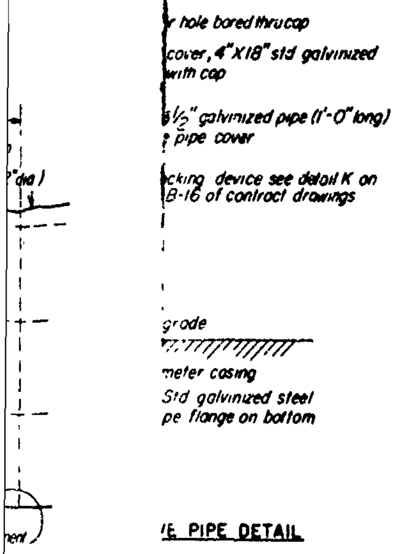
INCLINOMETER PROTECTIVE PIPE DETAIL



INCLINOMETER EXTENSION

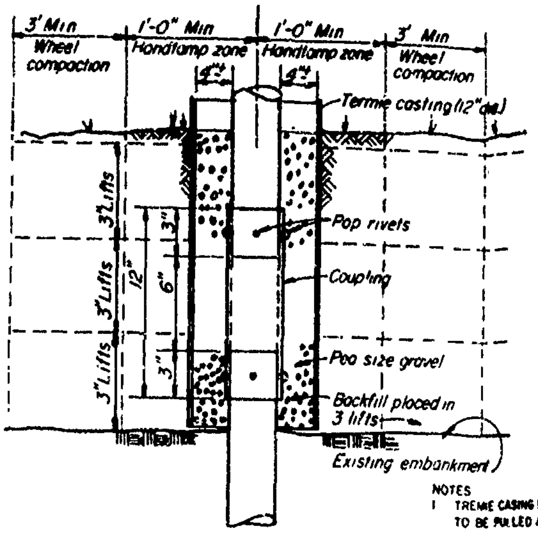
NOTES
1 TREMIE CA
TO BE PUL
2 MAKE SURE
GROOVES I
3 TREMIE PE
CASING, IN
4 POP RIVET
TO STANDA

3 4 3 2



'E PIPE DETAIL

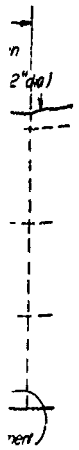
S
TREMIE CASING (12" DIA PLA
D BE PULLED AS EXTENSI
AKE SURE THAT THE FOUR
ROOVES IN UPPER AND LO
REMIE PEA SIZE GRAVEL
ASING, IN AN OUTER PROT
OP RIVET UPPER AND LOWE
O STANDARD COUPLING IN



INCLINOMETER EXTENSION

NOTES
1. TREMIE CASING (12" DIA PLASTIC PIPE [SCHEDULE 40]) TO BE PULLED AS EXTENSION PROGRESSES
2. MAKE SURE THAT THE FOUR INTERNAL LONGITUDINAL GROOVES IN UPPER AND LOWER CASING MATCH UP
3. TREMIE PEA SIZE GRAVEL AROUND INCLINOMETER CASING, IN AN OUTER PROTECTIVE PIPE
4. POP RIVET UPPER AND LOWER INCLINOMETER CASING TO STANDARD COUPLING IN FOUR PLACES

4 3 2



S
REME CASING (12" DIA PLASTIC PIPE (SCHEDULE 40))
D BE PULLED AS EXTENSION PROGRESSES
AKE SURE THAT THE FOUR INTERNAL LONGITUDINAL
ROOVES IN UPPER AND LOWER CASING MATCH UP
REME PEA SIZE GRAVEL AROUND INCLINOMETER
ASING, IN AN OUTER PROTECTIVE PIPE
P RIVET UPPER AND LOWER INCLINOMETER CASING
STANDARD COUPLING IN FOUR PLACES

Revisions			
Symbol	Descriptions	Date	Approved

U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

Designed by: R A
Drawn by: J D
Checked by: R A S
Submitted by:

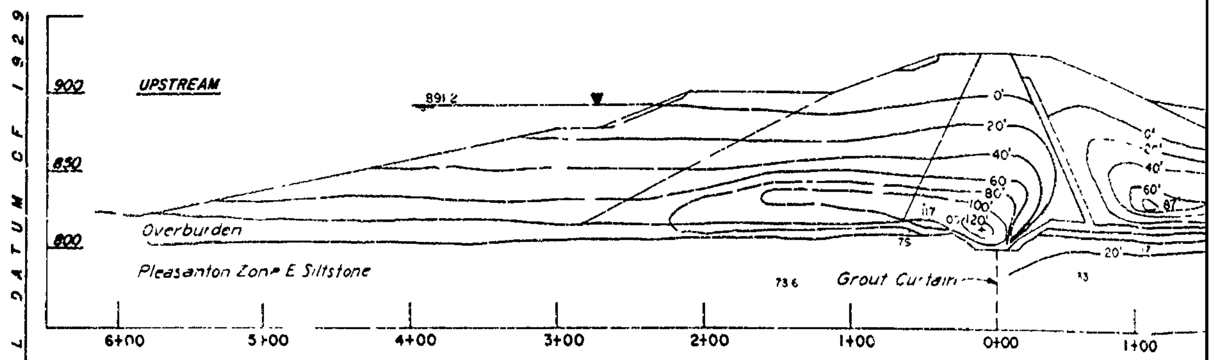
US Army Corps of Engineers

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA AND PERFORMANCE REPORT

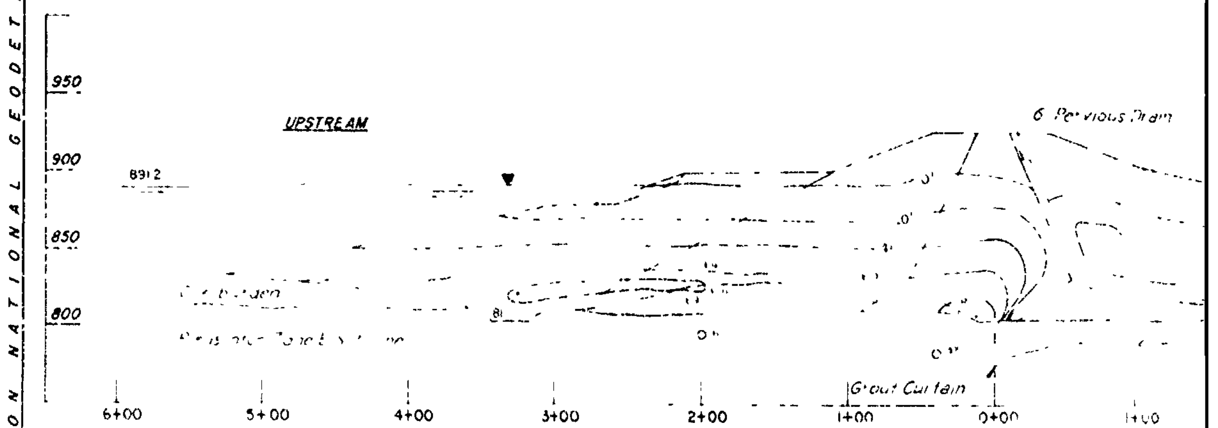
INCLINOMETER DETAILS

Scale: AS SHOWN
Date: JUNE 1985
Dwg No.
Sheet number

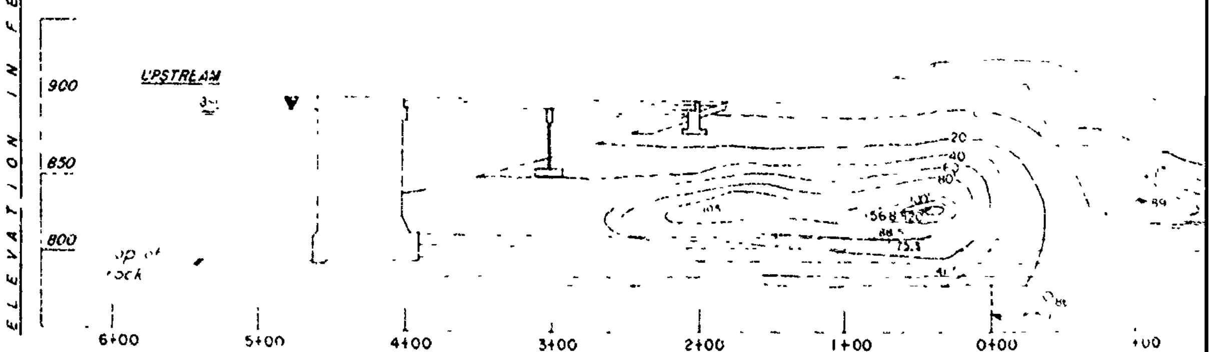
RBL-3-1696



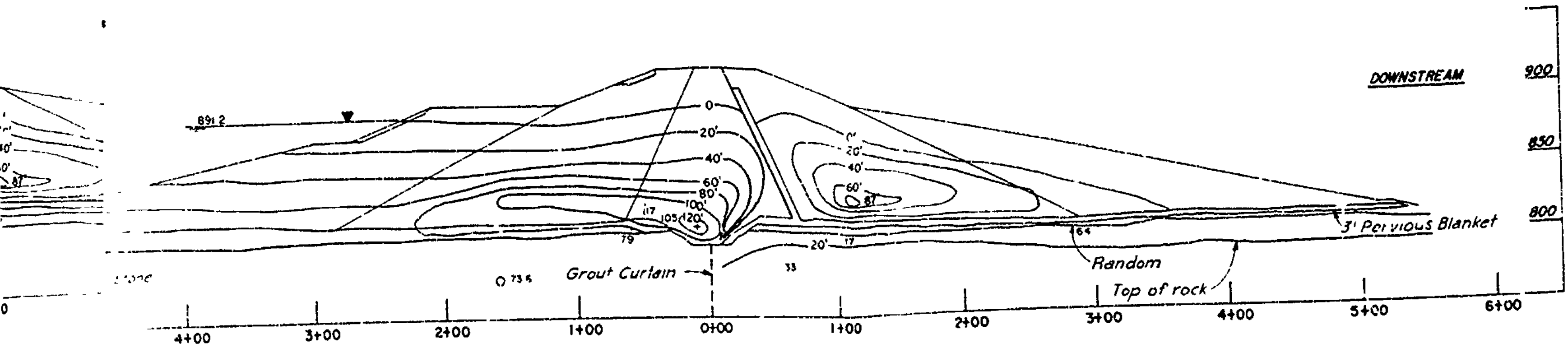
SECTION STATION 93+00



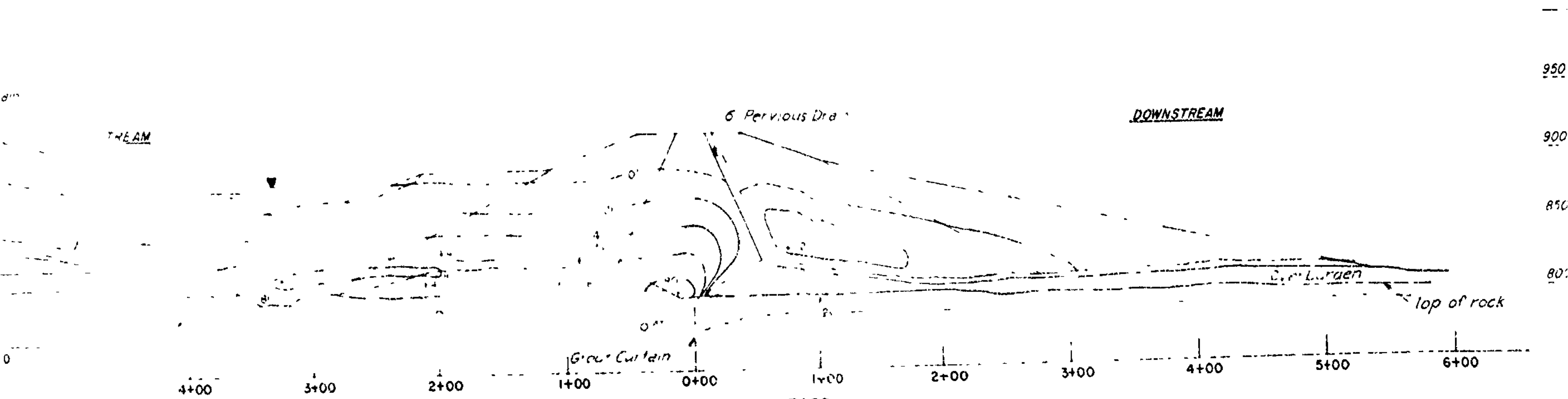
EMBANKMENT SECTION STA 97+00



CONDUIT SECTION STA 98+70



SECTION STATION 93+00



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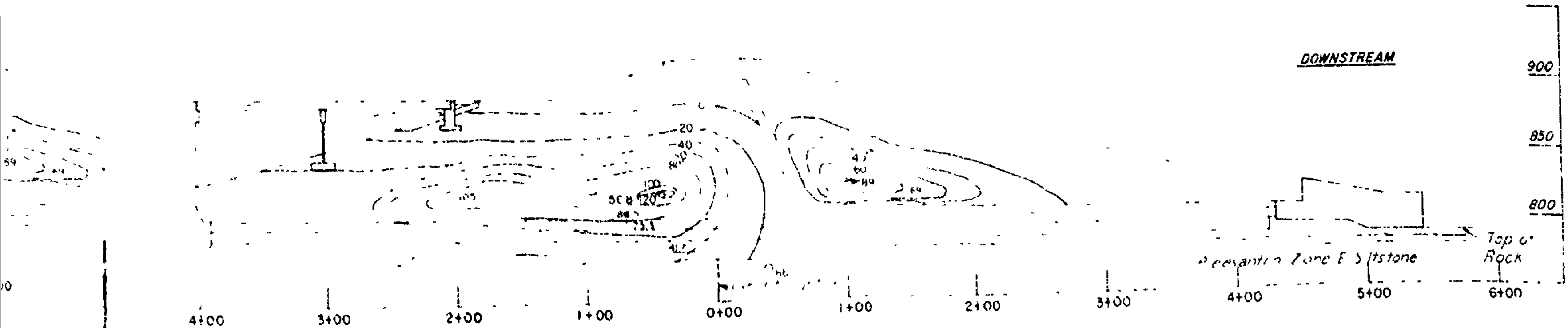
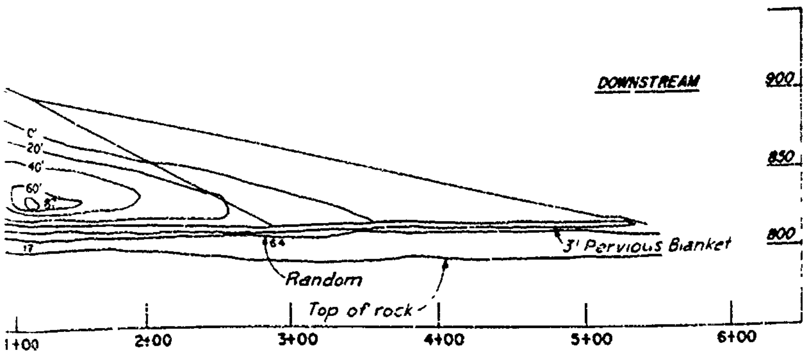
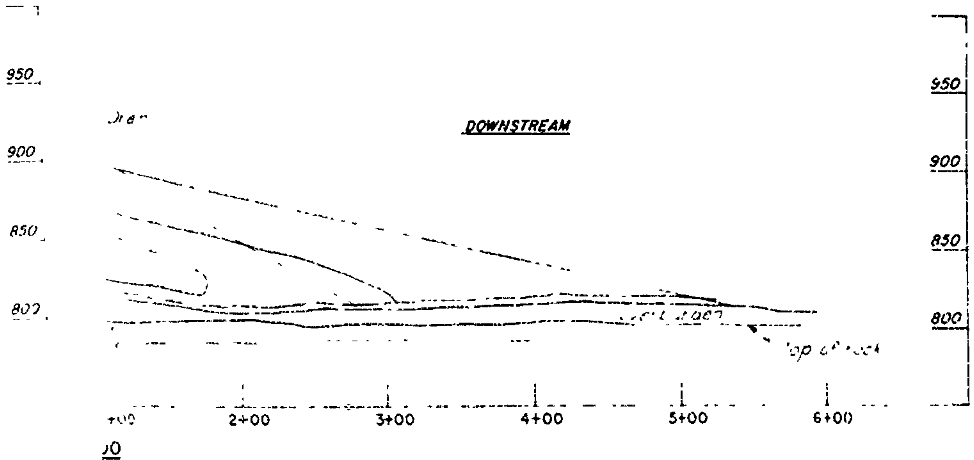
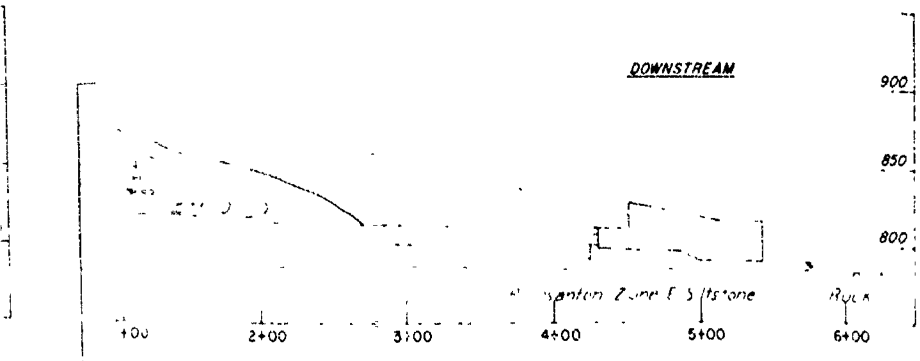


CONDUIT SECTION STA 98+70





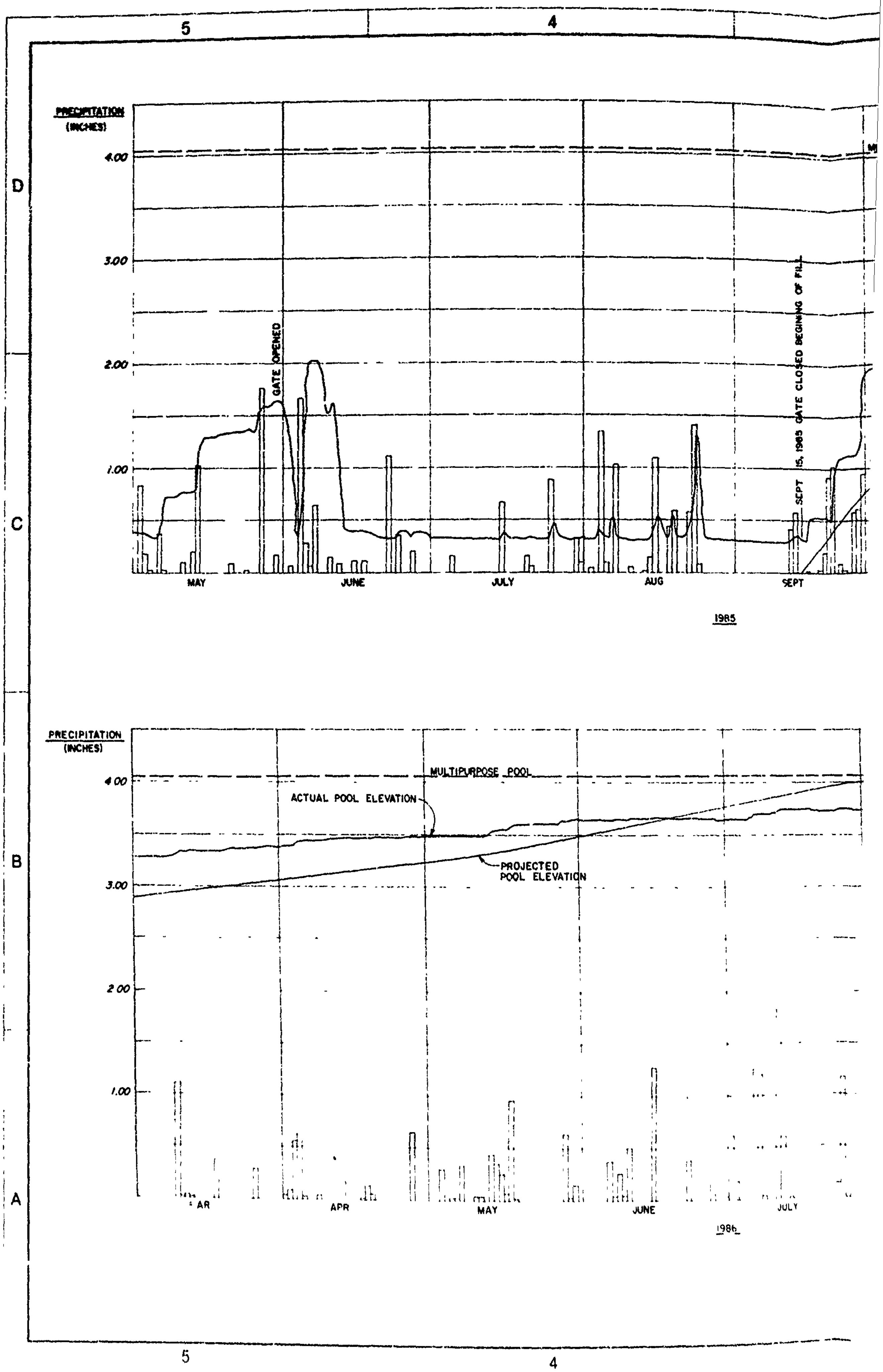


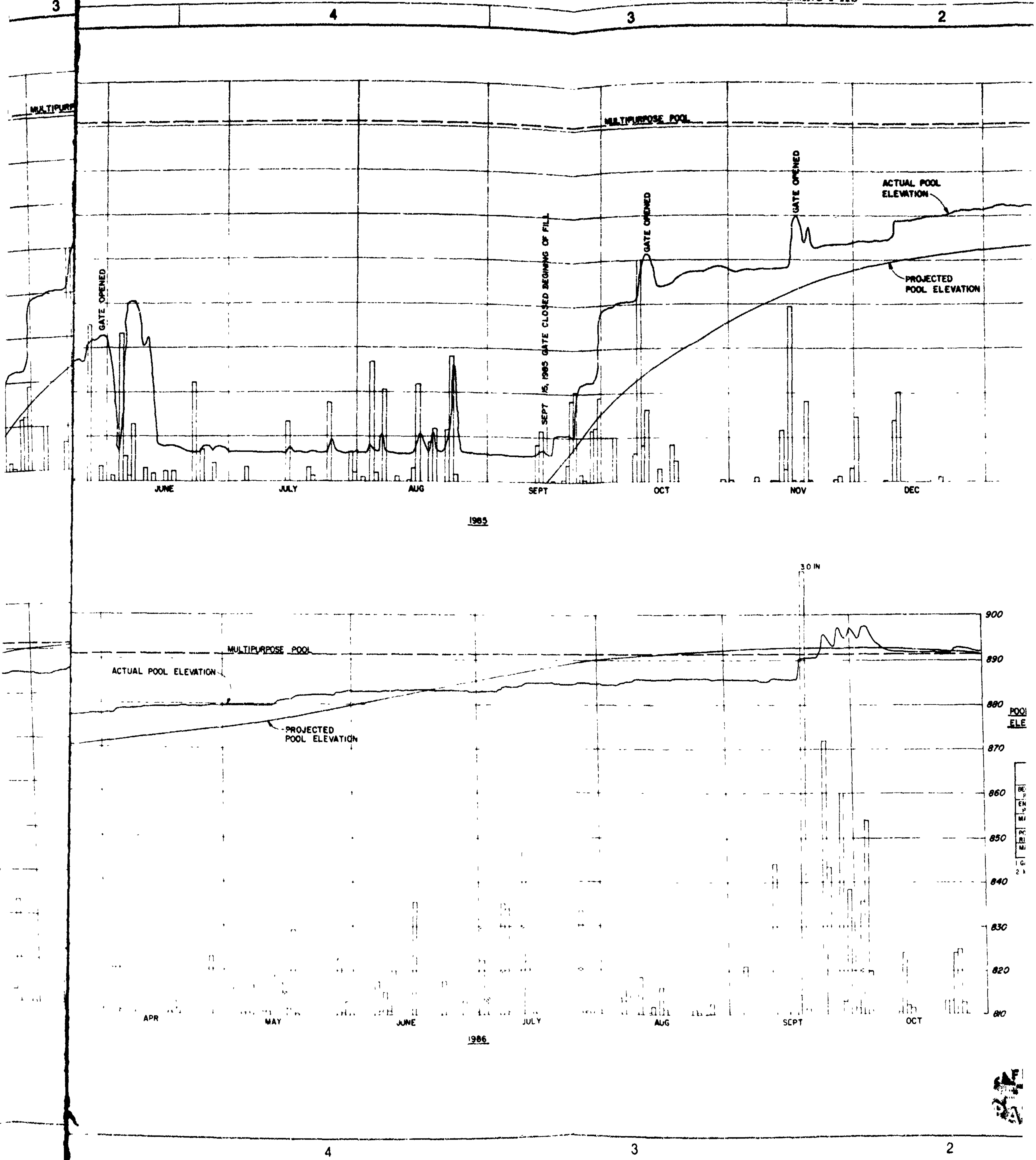
Symbol	Revisions Descriptions	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

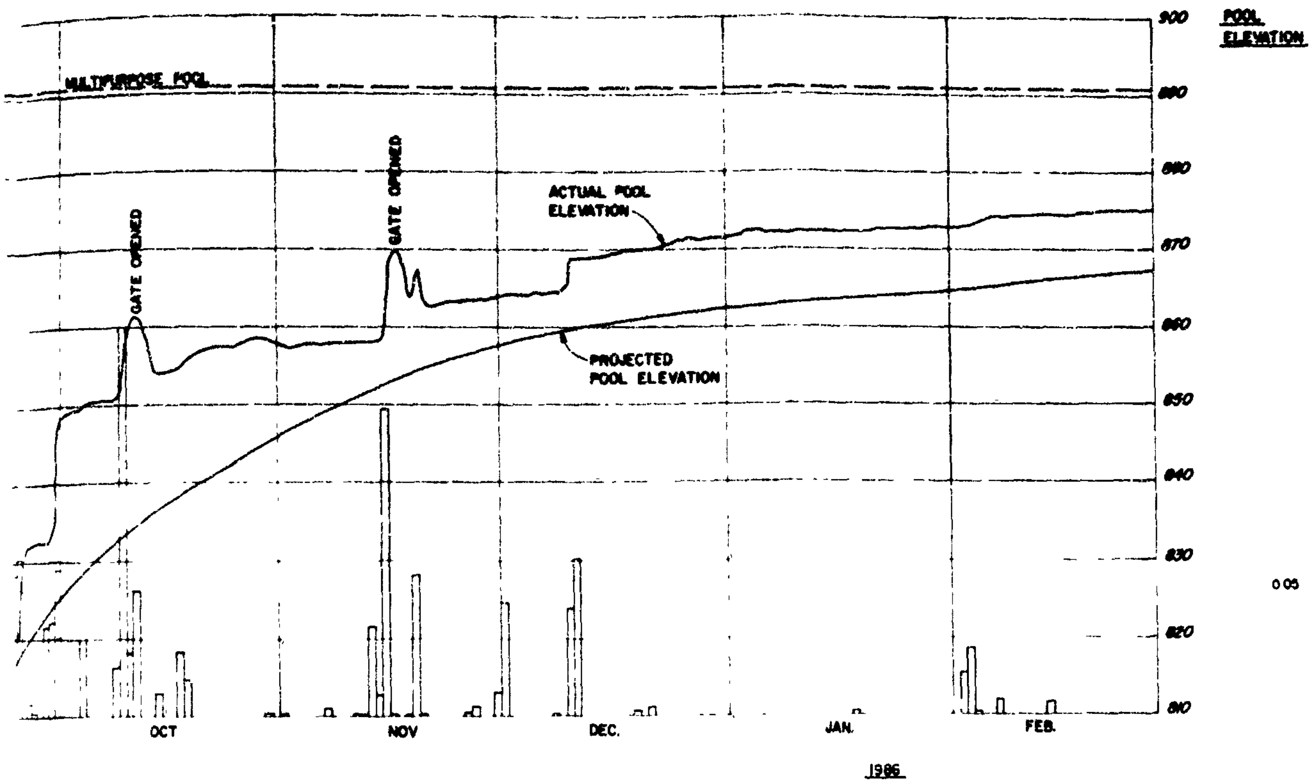
Designed by: RDG	LITTLE BLUE RIVER, MISSOURI LONGVIEW LAKE EMBANKMENT CRITERIA AND PERFORMANCE REPORT
Drawn by: PST	PORE PRESSURE CONTOURS (JANUARY 1987) POOL EL. 891.2
Reviewed by: RDG/WBE	Scale: AS SHOWN
Submitted by: RDG	File No.: RBL-3-1444

PLATE NO.44

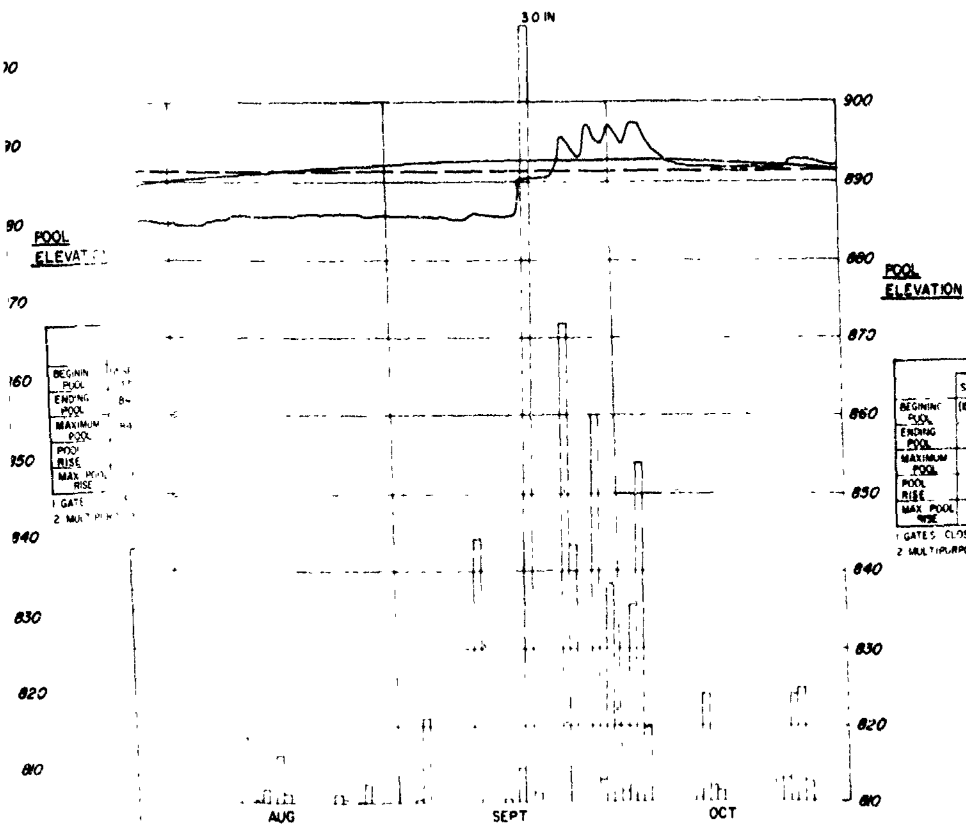

5
4
D
C
B
A
PRECIPITATION (INCHES)
4.00
3.00
2.00
1.00
GATE OPENED
SEPT 15, 1985 GATE CLOSED BEGINING OF FILL
MAY
JUNE
JULY
AUG
SEPT
1985
PRECIPITATION (INCHES)
MULTIPURPOSE POOL
ACTUAL POOL ELEVATION
PROJECTED POOL ELEVATION
4.00
3.00
2.00
1.00
APR
MAY
JUNE
JULY
1986
5
4


4
3
2
MULTIPURPOSE POOL
GATE OPENED
GATE OPENED
GATE OPENED
SEPT 15, 1985 GATE CLOSED BEGINING OF FILL
ACTUAL POOL ELEVATION
PROJECTED POOL ELEVATION
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
1985
3.0 IN
900
890
880
870
860
850
840
830
820
810
MULTIPURPOSE POOL
ACTUAL POOL ELEVATION
PROJECTED POOL ELEVATION
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
1986
4
3
2

VALUE ENGINEERING PAYS



NOTE:
THE PROJECTED POOL ELEVATION SHOWN ON THIS PLATE WAS COMPUTED USING AVERAGE MONTHLY INFLOW AND MINIMUM RELEASES. INFLOW IS BASED ON A 16 YEAR-PERIOD OF RECORD OF LITTLE BLUE RIVER FLOWS AT LONGVIEW ROAD IN KANSAS CITY, MO (LATER BELOW LONGVIEW DAMSITE) PUBLISCD BY U.S. GEOLOGICAL SURVEY



	1985				1986								
	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT
BEGINING POOL	(15SEPT) 816.7	849.4	857.9	864.3	872.0	873.2	875.3	877.3	879.4	882.3	882.7	884.4	885.2
ENDING POOL	844.4	857.9	864.3	872.0	873.2	875.3	877.3	879.4	882.3	882.7	884.4	885.2	895.2
MAXIMUM POOL	849.4	861.7	870.0	872.0	873.2	875.3	877.3	879.4	882.3	883.0	884.5	885.3	897.0
POOL RISE	32.7	8.5	6.4	7.7	1.2'	2.1	2.0	2.1	2.9'	0.4	1.7'	0.8'	10.0'
MAX POOL RISE	32.7	12.3'	12.1	7.7	1.2	2.1	2.0	2.1	2.9	0.7	1.8	0.9'	11.8

1 GATES CLOSED 15 SEPT 1985
2 MULTIPURPOSE POOL REACHED 22 SEPT 1986

Symbol	Revisions Descriptions	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

Designed by: W B E
Drawn by: M A W
Checked by: W B E / R G D
Submitted by: F C W

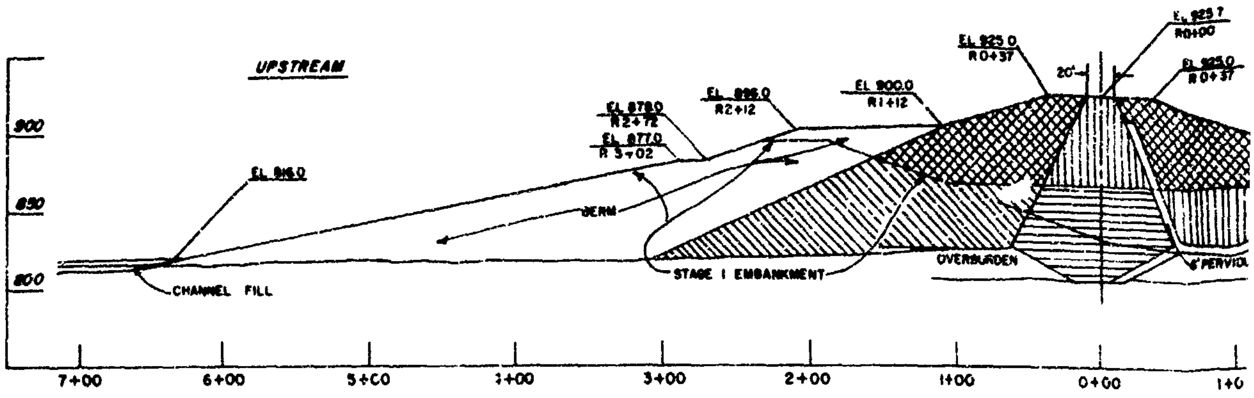
US Army Corps of Engineers

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA AND PERFORMANCE REPORT

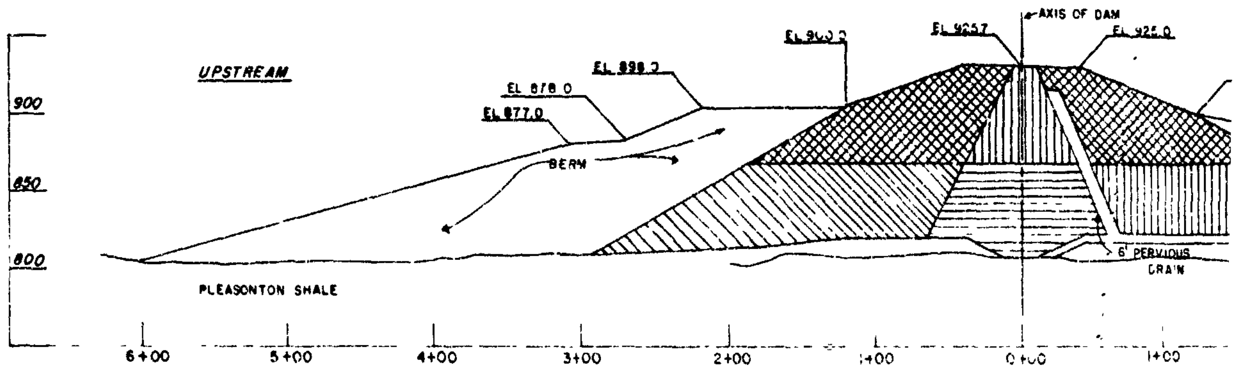
PRECIPITATION AND LAKE FILLING RATE

AS SHOWN

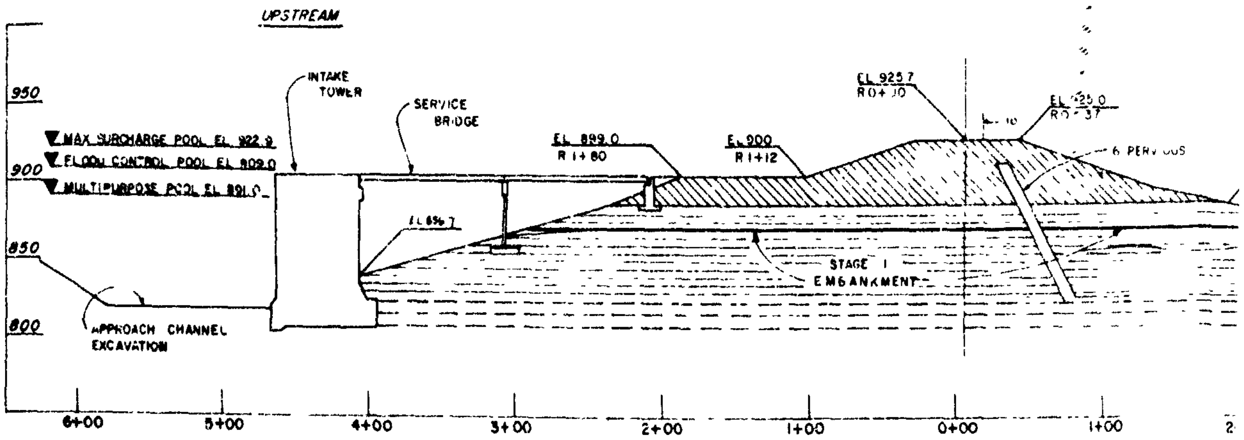
File No. RBL-3-1445



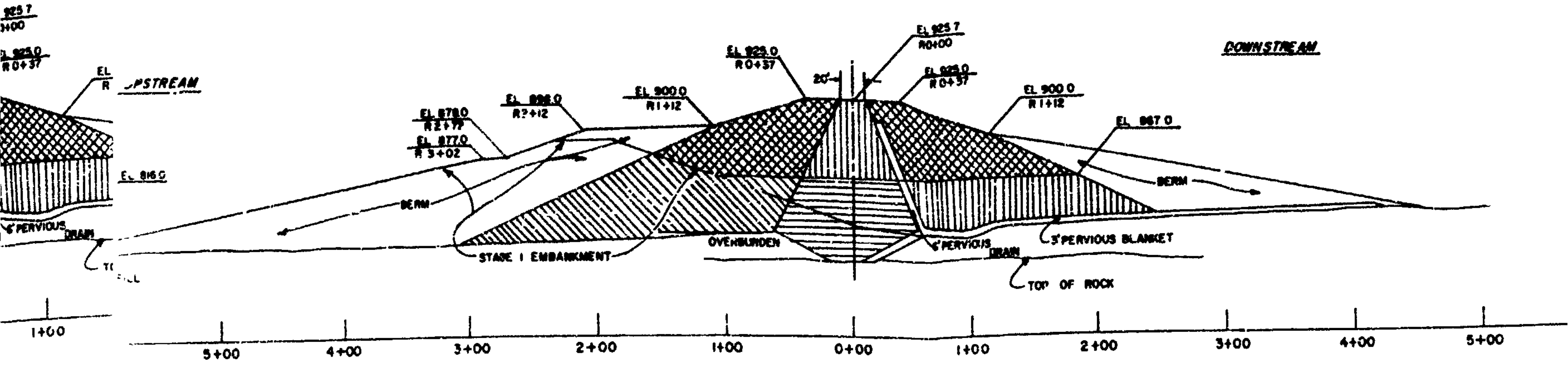
VALLEY SECTION – STA 90+00



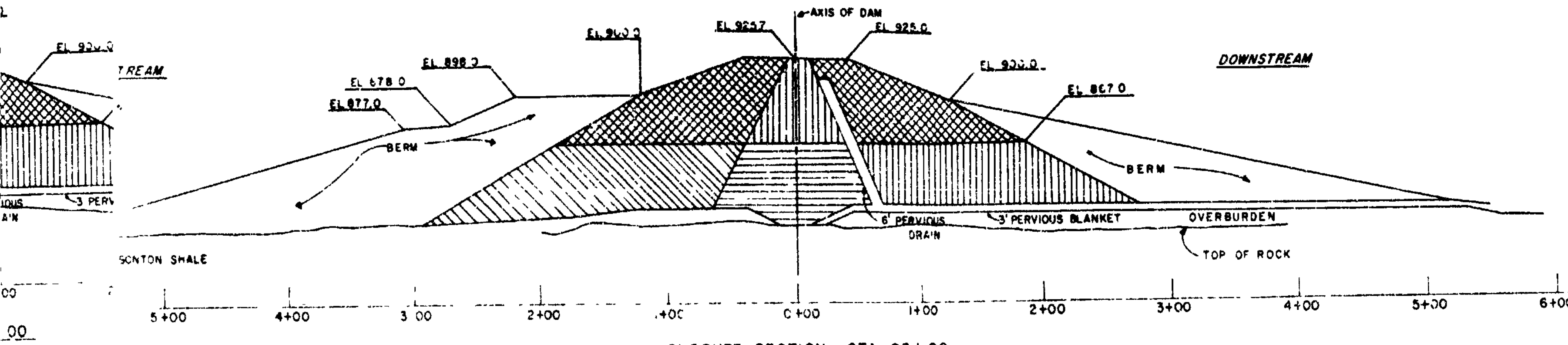
CLOSURE SECTION – STA 93+00



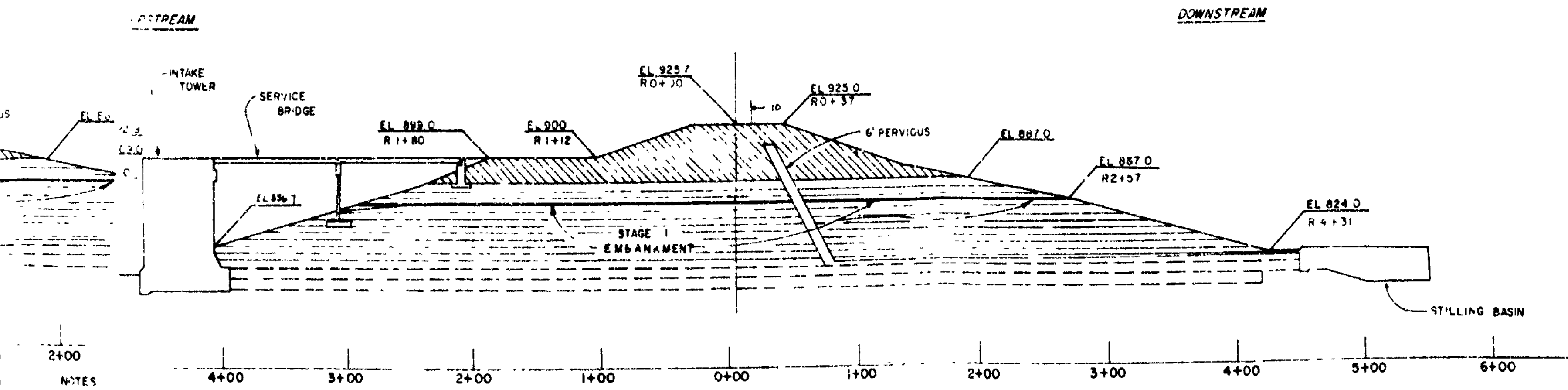
CONDUIT SECTION – STA 98+70



VALLEY SECTION – STA 90+00

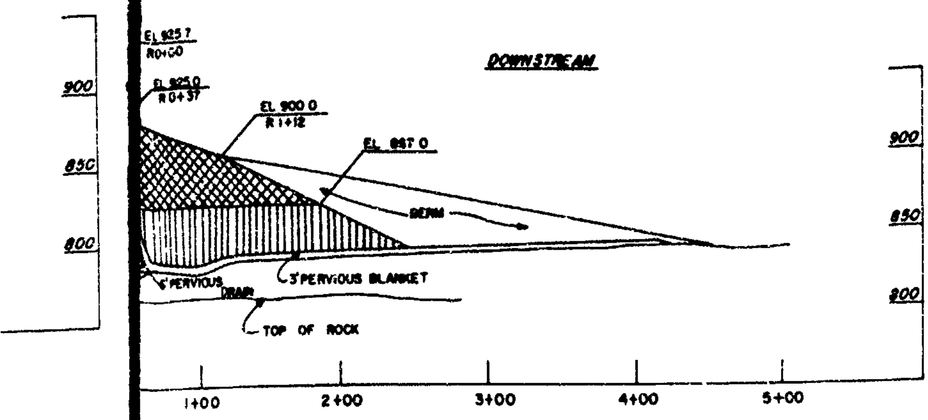


CLOSURE SECTION – STA 93+00

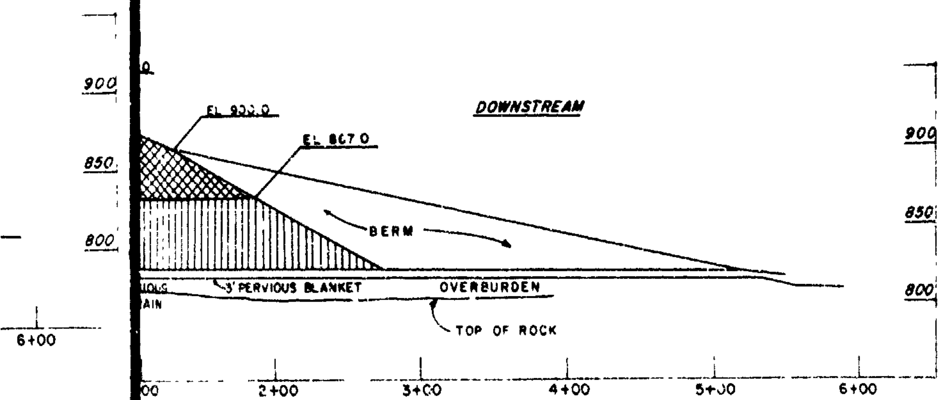


CONDUIT SECTION – STA 98+70

NOTES
1. EMBANKMENT ZONING APPLIES BETWEEN STA 97+00 AND STA 101+00
2. CROSS-SECTION APPLIES BETWEEN STA 98+00 AND STA 100+00



90+00



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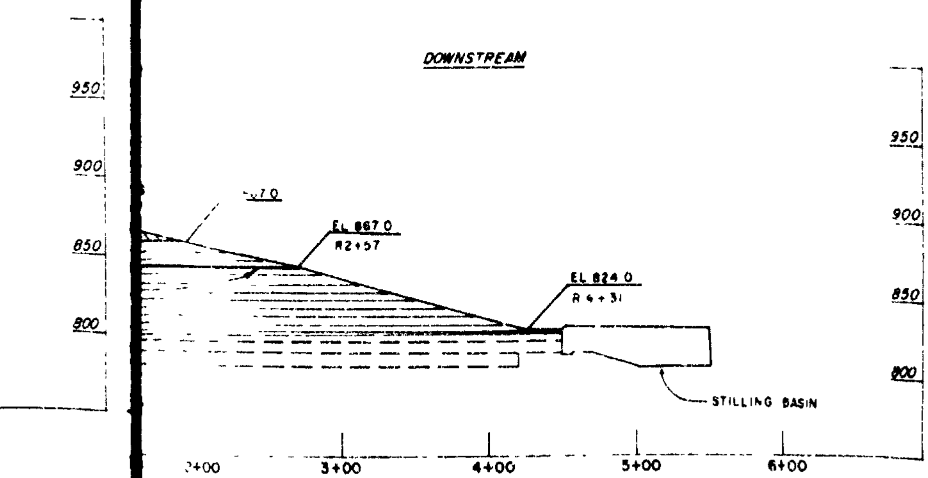


NOTES 1. EMBANKMENT ZONING APPLIES BETWEEN STA 97+00 AND STA 101+00

2. CROSS-SECTION APPLIES BETWEEN STA 98+00 AND STA 100+00

SYMBOL	ALLOWABLE LIQUID LIMIT	ZONE
	55	– IMPERVIOUS, BELOW 867.0, INCLUDING CUTOFF TRENCH – IMPERVIOUS BETWEEN STA 97+00 AND STA 101+00 - BELOW EL 867.0 – RIVERBANK EXCAVATION BACKFILL – IMPERVIOUS, FINISH STAGE I – NO CUTOFF TRENCH
	60	– IMPERVIOUS, CUTOFF TRENCH ABOVE EL 867.0 – IMPERVIOUS, INSPECTION TRENCH – IMPERVIOUS, BETWEEN STA 97+00 AND STA 101+00 - ABOVE EL 867.0 RANDOM, BELOW EL 867 UPSTREAM OF DAM AXIS
	65	– IMPERVIOUS, ABOVE EL 867.0, EXCLUDING CUTOFF TRENCH, INSPECTION TRENCH, & BETWEEN STA 97+00 & STA 101+00 – IMPERVIOUS, CLAY BLANKET – RT ABUTMENT – RANDOM, BELOW EL 867.0 DOWNSTREAM OF DAM AXIS
	70	– RANDOM, ABOVE EL 867.0

Symbol	Revisions Descriptions	Date	Approval

U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY MISSOURI

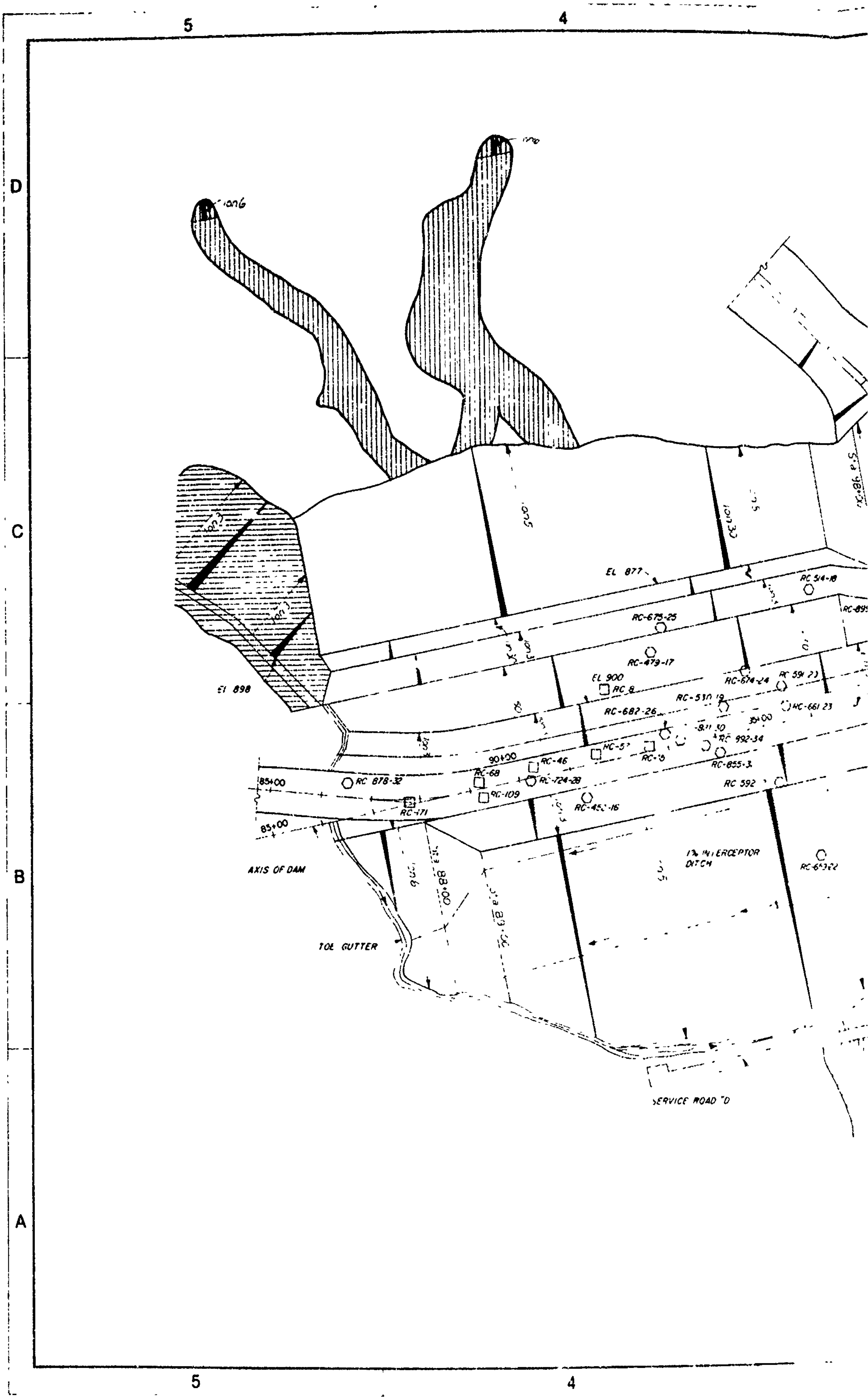
Designed by W B E
Drawn by M A W
Checked by W B E / R G D
Submitted by F C W

US Army Corps of Engineers

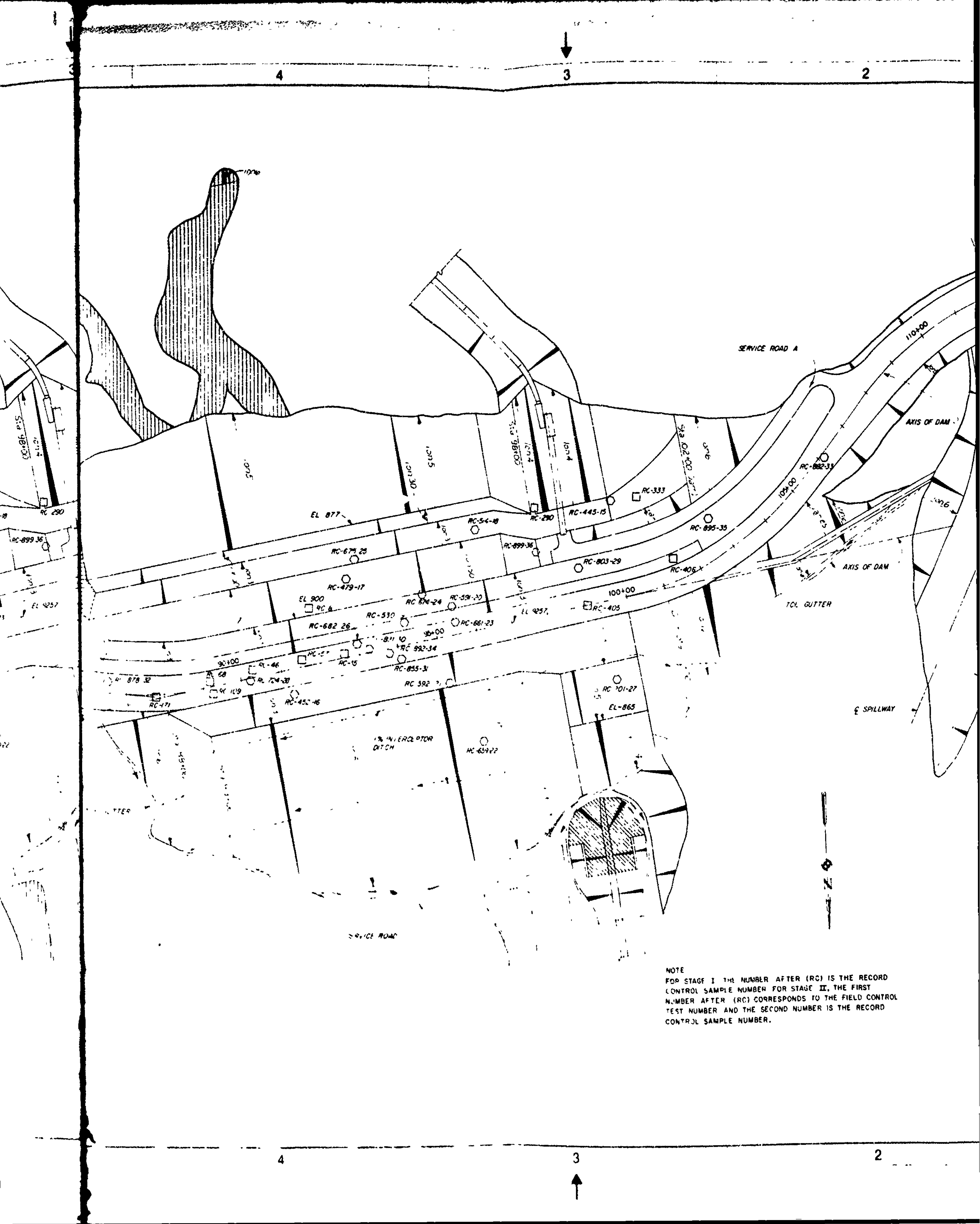
LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA
AND PERFORMANCE REPORT

LIQUID LIMIT ZONE
CROSS SECTIONS

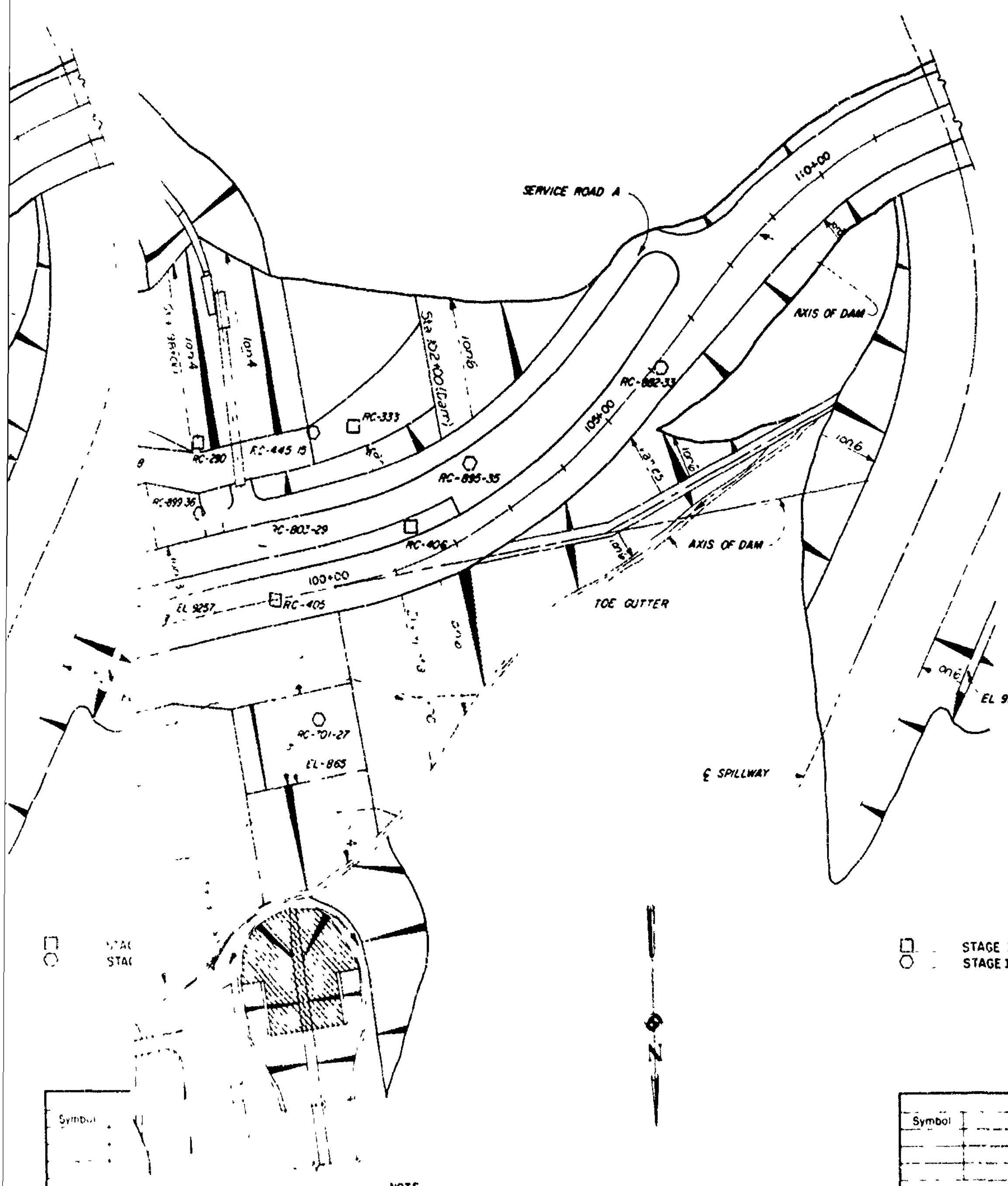
Scale AS SHOWN
Sheet number
Date
Dwg No
File No RBL-3-1446



D
C
B
A
EL 877
EL 900
EL 898
RC 514-18
RC-675-25
RC-479-17
RC 8
RC-682-26
RC 878-32
RC 592
RC-724-28
RC-109
RC-68
RC-46
85+00
90+00
AXIS OF DAM
TOE GUTTER
1% INTERCEPTOR DITCH
SERVICE ROAD "D



NOTE
FOR STAGE I THE NUMBER AFTER (RC) IS THE RECORD CONTROL SAMPLE NUMBER FOR STAGE II, THE FIRST NUMBER AFTER (RC) CORRESPONDS TO THE FIELD CONTROL TEST NUMBER AND THE SECOND NUMBER IS THE RECORD CONTROL SAMPLE NUMBER.



LEGEND

□ STAGE I RECORD CONTROL SAMPLE LOCATION
○ STAGE II RECORD CONTROL SAMPLE LOCATION

NOTE
FOR STAGE I, THE NUMBER AFTER (RC) IS THE RECORD CONTROL SAMPLE NUMBER. FOR STAGE II, THE FIRST NUMBER AFTER (RC) CORRESPONDS TO THE FIELD CONTROL TEST NUMBER AND THE SECOND NUMBER IS THE RECORD CONTROL SAMPLE NUMBER.

Symbol	Revisions Descriptions	Date	Approved

U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

Designed by: R G D
Drawn by: S E Y
Checked by: R G D - W B E
Submitted by: P G D

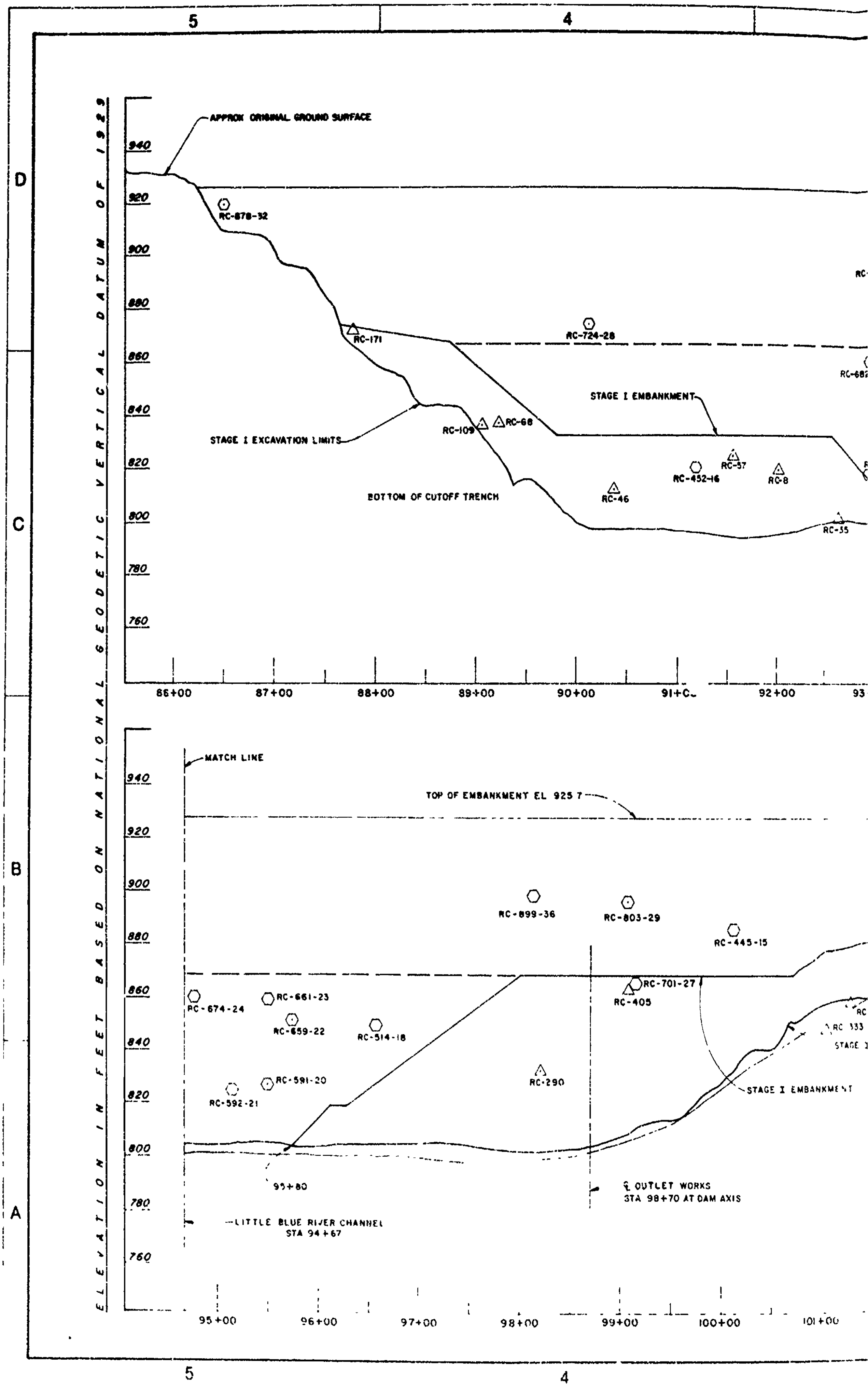
US Army Corps of Engineers

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA
AND PERFORMANCE REPORT

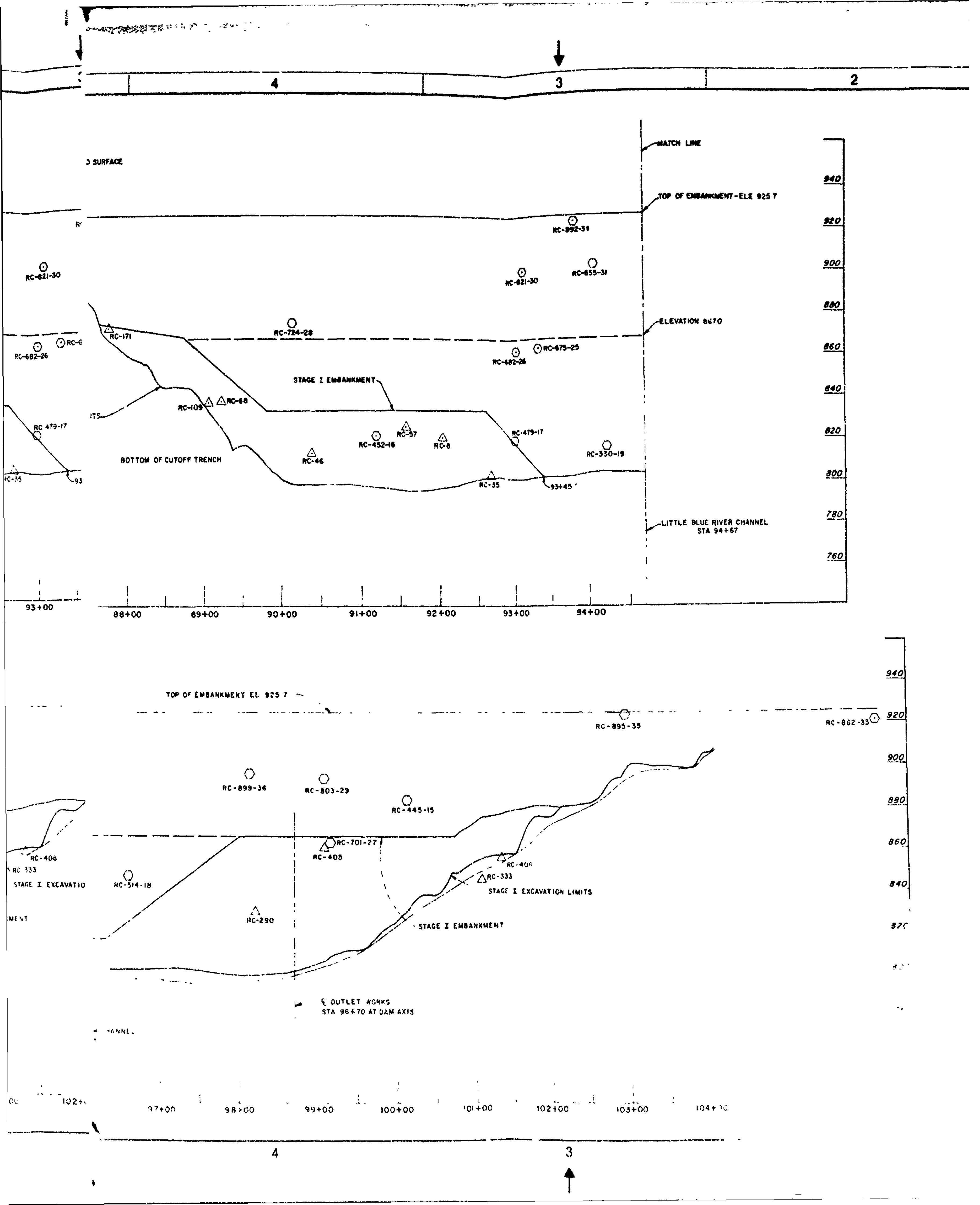
PLAN OF RECORD CONTROL SAMPLE LOCATIONS

Scale: AS SHOWN
Sheet Number:
Date:
Dwg No: RBL-3-1447

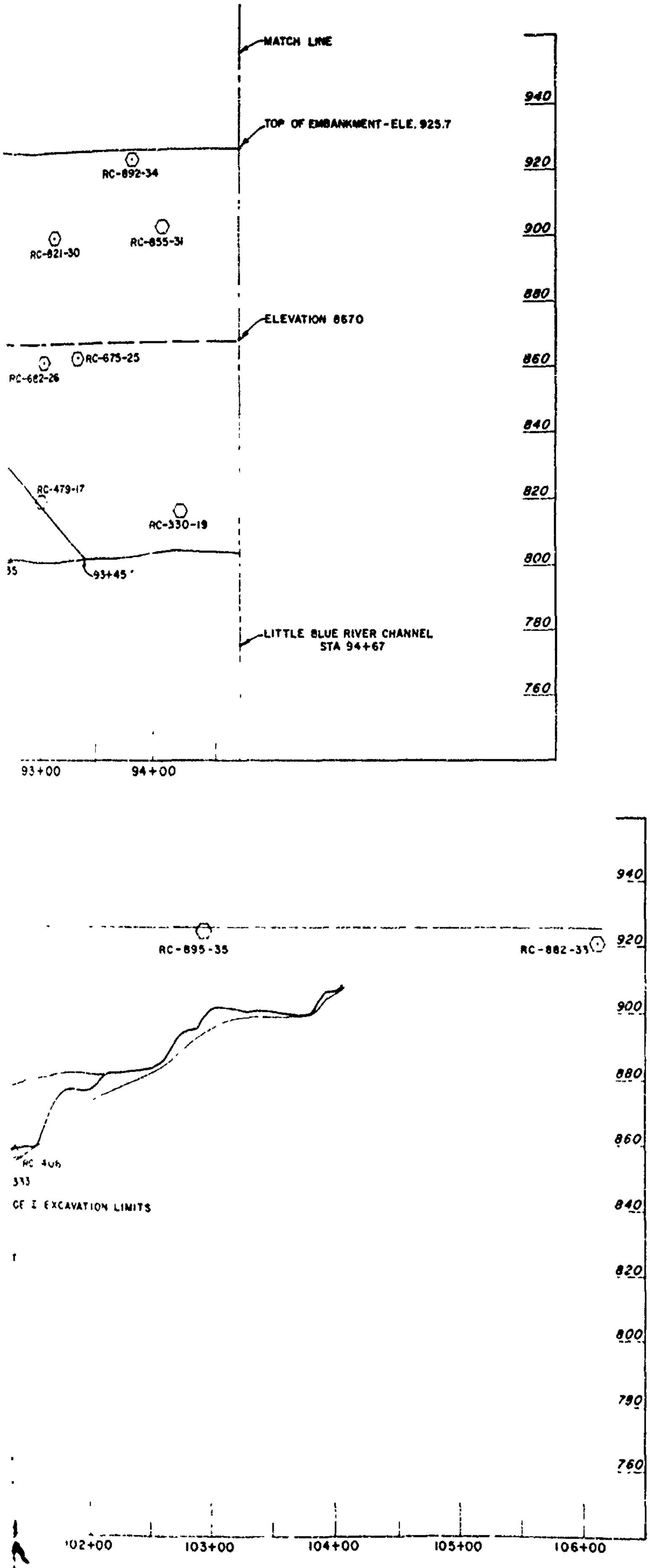
PLATE NO. 47



5
4
D
C
B
A
ELEVATION IN FEET BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929
APPROX ORIGINAL GROUND SURFACE
RC-878-32
RC-171
RC-724-28
STAGE I EMBANKMENT
STAGE I EXCAVATION LIMITS
RC-109
RC-68
RC-452-16
RC-57
RC-8
RC-46
BOTTOM OF CUTOFF TRENCH
RC-35
940
920
900
880
860
840
820
800
780
760
86+00
87+00
88+00
89+00
90+00
92+00
MATCH LINE
TOP OF EMBANKMENT EL 925 7
RC-899-36
RC-803-29
RC-445-15
RC-701-27
RC-405
RC-674-24
RC-661-23
RC-659-22
RC-514-18
RC-290
RC-591-20
RC-592-21
STAGE I EMBANKMENT
95+80
℄ OUTLET WORKS
STA 98+70 AT DAM AXIS
LITTLE BLUE RIVER CHANNEL
STA 94+67
95+00
96+00
97+00
98+00
99+00
100+00
101+00



MATCH LINE
TOP OF EMBANKMENT-ELE 925 7
ELEVATION 867.0
STAGE I EMBANKMENT
BOTTOM OF CUTOFF TRENCH
LITTLE BLUE RIVER CHANNEL STA 94+67
RC-892-34
RC-621-30
RC-655-31
RC-724-28
RC-171
RC-682-26
RC-675-25
RC-109
RC-68
RC-57
RC-452-16
RC-8
RC-46
RC-479-17
RC-330-19
RC-35
93+45
88+00
89+00
90+00
91+00
92+00
93+00
94+00
940
920
900
880
860
840
820
800
780
760
TOP OF EMBANKMENT EL 925 7
RC-895-35
RC-862-33
RC-899-36
RC-803-29
RC-445-15
RC-701-27
RC-405
RC-406
RC-333
RC-514-18
RC-290
STAGE I EXCAVATION LIMITS
STAGE I EMBANKMENT
℄ OUTLET WORKS STA 98+70 AT DAM AXIS
98+00
99+00
100+00
101+00
102+00
103+00
4
3
2



LEGEND

△ - STAGE I RECORD CONTROL SAMPLE LOCATION

⬡ - STAGE II RECORD CONTROL SAMPLE LOCATION

Symbol	Descriptions	Date	Approved

U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY MISSOURI

Designed by: W B E
Drawn by: E G M
Checked by: W B E / R G D
Submitted by: F C W

US Army Corps of Engineers

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA
AND PERFORMANCE REPORT

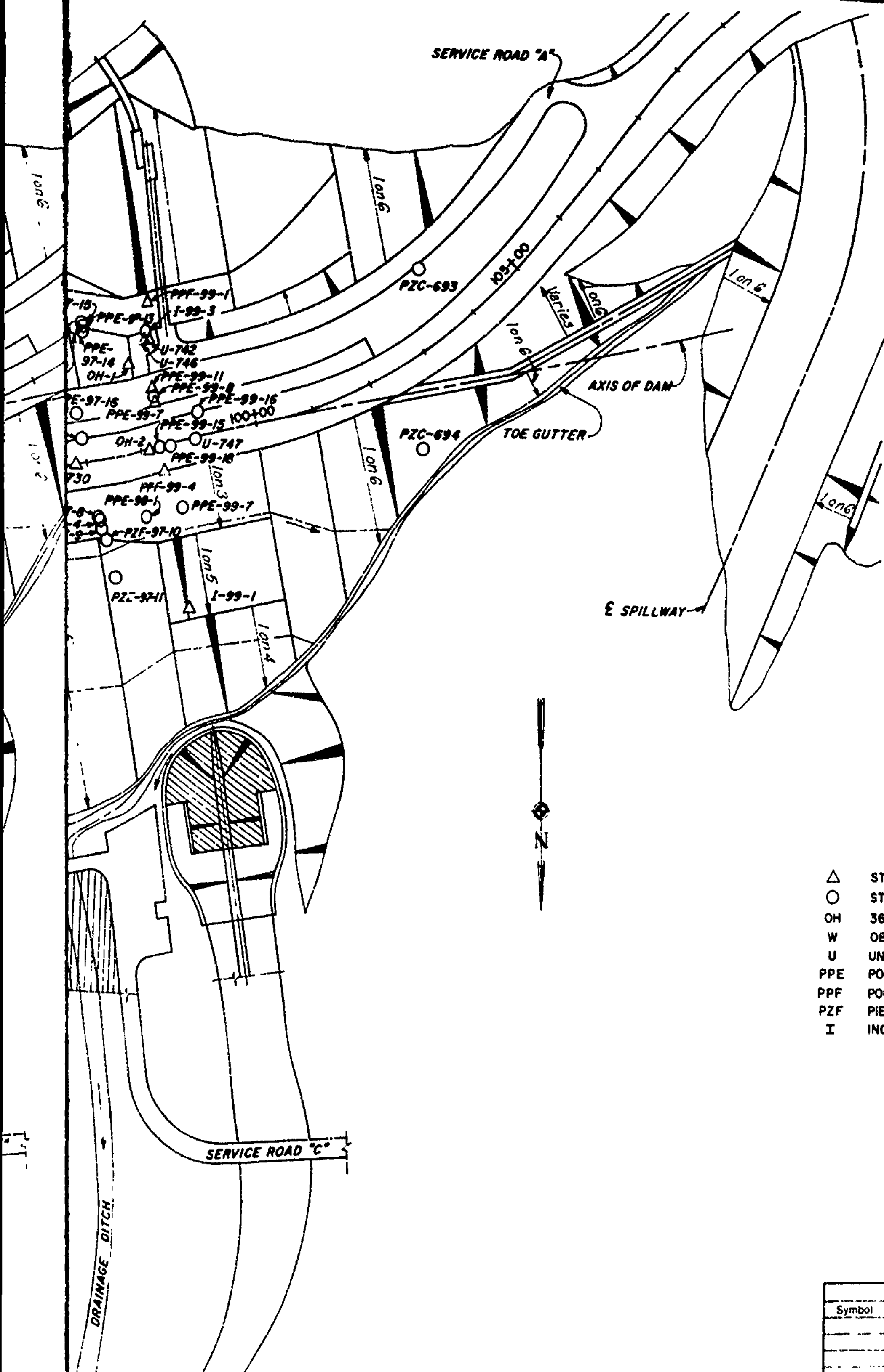
PROFILE OF RECORD CONTROL
SAMPLE LOCATIONS

Scale: AS SHOWN

File No: RBL-3-1448

PLATE NO 48

5
4
3
D
C
B
A
1 on 2
1 on 3
1 on 5
1 on 30
1 on 3
1 on 50
1 on 6
1 on 4
EL. 877
EL. 900
PPE-97-1
PPE-93-1
PPE-93-4A
PPF-93-3A
PPE-94-1
PPE-97-15
PPF-97-2
PPE-97-3
PPE-97-12
PPE-97-13
PPE-97-14
OH-1
PPF-99-1
I-99-3
U-742
U-746
PPE-99-11
PPE-99-16
PPE-97-16
PPE-99-7
PPE-99-15
PPE-99-18
100+00
PPF-97-5
OH-2
U-747
U-594
U-740
U-595
PPF-86-1A
PZ-C691A
PPF-93-2
U-731
PPE-93-4
U-741
95+00
U-730
PPF-99-4
PPE-98-1
PPE-93-6A
PPE-93-5A
U-744
PPF-97-8
PZF-97-4
PZF-97-9
PZF-97-10
85+00
90+00
U-745
U-732
PPF-93-8
PPE-93-1
PPE-92-1
PPE-92-7
PZF-93-9
PPE-93-12
PZE-97-11
I-99-1
PPF-84-1
PPF-87-5
PZC-692
AXIS OF DAM
PPF-87-2
PPF-87-3
PPF-88-3
PPF-88-2
PPF-88-1
TOE GUTTER
PPF-87-4
PZE-89-1
PZE-90-2
1% INTERCEPTOR DITCH
PPF-93-10A
PZE-95-2
PZF-93-11
SERVICE ROAD "D"
SERVICE ROAD "C"
DRAINAGE DITCH
W-1
W-4
W-3
W-2
W-5



LEGEND

△	STAGE I BORING LOCATION
○	STAGE II BORING LOCATION
OH	36" DIA. DRILLED HOLE
W	OBSERVATION WELL
U	UNDISTURBED BORING
PPE	PORE PRESSURE DEVICE IN EMBANKMENT
PPF	PORE PRESSURE DEVICE IN FOUNDATION
PZF	PIEZOMETER IN FOUNDATION
I	INCLINOMETER

NOTE:
THE MAJORITY OF THESE BORINGS WERE FOR INSTRUMENTATION. SAMPLES WERE TAKEN TO SUPPLEMENT THE RECORD CONTROL TESTING

Revisions			
Symbol	Descriptions	Date	Approved

U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

Designed by: W B E
Drawn by: R A C
Checked by: W B E / R G D
Submitted by: F C W

US Army Corps of Engineers

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA
AND PERFORMANCE REPORT

PLAN OF BORING SAMPLE LOCATIONS

Scale: AS SHOWN
Date:
Dwg No:
Sheet number:
File No: RBL-3-1449

PLATE NO. 49

LIQUID LIMIT – 55 IMPERVIOUS ZONE
STAGE I

SAMPLE	STATION	RANGE	ELEV.	SAMPLE NO.	SAMPLE DEPTH
RC-35	92+65	0+06 U/S	805 5		
RC-46	90+35	0+15 U/S	817.0		
RC-57	91+56	0+15 U/S	827.0		
RC-68	89+20	0+10 U/S	836 5		
RC-100	89+20	0+30 D/S	835.0		
RC-122	44+50	0+15 U/S	815.0		
RC-171	37+75	0+06 U/S	873 0		
RC-197	51+25	0+16 U/S	811.0		
RC-290	98+20	2+80 U/S	832 0		
RC-333	101+05	2+20 U/S	847 5		
RC-405	98+05	℄	864.0		
RC-406	101+32	0+55 U/S	857.5		
OH-1	98+00	1+43 U/S	853.0	1	17.0
			846 0	3	24.0
			836 0	4	34 0
			830.5	6	39.5
OH-2	98+12	℄	847 8	1	19 2
			839.6	3	27.4
			837.1	4	29.9
			833 3	5	33.7
			829 3	6	37 7
			825 1	8	41.9
U-595	88+85	1+18 U/S	864 0	WAX 1	3 0
			855.5	5	11 5
PPF-99-1	98+51	2+20 U/S	822 7	1	3 0
			816 7	4	9 0
			815 2	5	10 5
I-99-1	98+36	2+56 U/S	857 5	4	9 5
			840 0	7	17 0
			824 0	12	27 0
			814 0	19	43 0
			805 5	22	53 0
				26	61 5
PPE-99-7	98+40	0+70 U/S	863	1	3 5
			855	5	11.5
			837	11	29 5
			829	14	37 5
			821.5	18	45 0
			810 5	23	56 0
PPE-99-11	98+35	0+88 U/S		20	
			839 2	14	28 0
			827 7	20	39 5
PPF-99-4	98+38	0+40 D/S	823 0	1	

LIQUID LIMIT – 55 IMPERVIOUS ZONE
STAGE II

SAMPLE	STATION	RANGE	ELEV.
RC-530-19	94+25	0+50 U/S	815.0
RC-591-20	95+50	0+65 U/S	828 0
RC-661-23	95+50	0+30 U/S	857 0
RC-682-26	93+00	0+25 U/S	862.0
RC-701-27	99+30	1+85 U/S	865.0

LIQUID LIMIT – 60 RANDOM ZONE
STAGE I

SAMPLE	STATION	RANGE	ELEV
RC-8	92+00	1+30 U/S	821 7

LIQUID LIMIT — 60 IMPERVIOUS ZONE STAGE II					
SAMPLE	STATION	RANGE	ELEV	SAMPLE NO	SAMPLE DEPTH
RC-898-36	96+00	1+50 U/S	896 0		
RC-808-29	99+00	0+90 D/S	891.0		
U-746	96+40	1+70 U/S	828-827 5	4	70 6-71 1
			826 3-825 8	5	72.3-72.8
U-747	99+00	℄	921 0-920 5	2	34-39

LIQUID LIMIT — 65 RANDOM ZONE STAGE II					
SAMPLE	STATION	RANGE	ELEV	SAMPLE NO.	SAMPLE DEPTH
RC-659-22	95+70	2+60 D/S	849.0		
RC-582-21	95+10	1+10 U/S	825.5		
RC-452-16	91+20	0+60 D/S	822 0		
PPE-92-1	92+00	1+00 D/S	841.7		58.3
PPE-95-1	94+70	1+00 D/S	862 2	8	18 8-19 3
			852 0	12	28 8-29 3
PPE-93-12	93+00	1+15 D/S	835 7	3	54-59

LIQUID LIMIT — 60 RANDOM ZONE STAGE II					
SAMPLE	STATION	RANGE	ELEV	SAMPLE NO	SAMPLE DEPTH
RC-479-17	93+00	1+80 U/S	818.0		
RC-674-24	94+75	1+10 U/S	861 5		
PPE-94-1	94+00	1+40 U/S	842 5-842 0	3	5.5-5 9
			836 5-836 1	6	11 5-11 9
			823 5-823 0	13	24 5-25 0

LIQUID LIMIT — 70 RANDOM ZONE STAGE II					
SAMPLE	STATION	RANGE	ELEV.	SAMPLE NO	SAMPLE DEPTH
RC-855-31	94+00	0+30 D/S	909 0		
RC-8[illegible]	86+50	0+22 U/S	919 5		
RC [illegible]	102+90	0+90 U/S	924 0		
PPE-92-1	92+00	1+00 D/S	898 7	1	1 3-1 8
			893 7	3	6.3-6.8
			861 2	16	38 8-39 3
PPE-95-1	94+70	1+00 D/S	880 5	1	0-0.5
			869 7	5	11 3-11 8
U-744	94+00	0+30 U/S	917 4-916 9	3	6 4-6.9
			913 3-912 8	5	10 5-11 0
			903 7-903.2	7	20.1-20 6

LIQUID LIMIT — 65 IMPERVIOUS ZONE STAGE II					
SAMPLE	STATION	RANGE	ELEV	SAMPLE NO	SAMPLE DEPTH
RC-445-15	100+10	2+30 U/S	886 0		
RC-724-28	90+20	0+05 D/S	874 0		
RC-821-30	93+20	0+10 D/S	900 0		
RC-882-35*	106+15	0+08 D/S	921 0		
RC-892-34	93+75	0+10 D/S	923 5		
U-745	91+00	℄	918 0-917 5	3	6 4-6 9
			908 0-907 5	7	16 4-16 9

* INSPECTION TRENCH

BERM ZONE — NO SPECIFIED LIQUID LIMIT STAGE II					
SAMPLE	STATION	RANGE	ELEV	SAMPLE NO	SAMPLE DEPTH
RC-675-25	93+30	2+20 U/S	864 0		
RC-514-18	96+56	2+35 U/S	853.5		
PPF-93-10A	93+00	3+00 D/S	825.4-824 9	2	2 0-2 5
U-594	89+60	2+80 U/S	884	1	3.0
			873	6	13.0
SACK ** COMPOSITE SAMPLE FROM SPENCER SEEP AREA					

Revisions			
Symbol	Descriptions	Date	Approved

U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

US Army Corps of Engineers

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA
AND PERFORMANCE REPORT

RECORD CONTROL SAMPLE SCHEDULE

Designed by	RDG
Drawn by	PST
Checked by	RDG/WBE
Submitted by	RDG
Scale	AS SHOWN
Date	
Dwg No	
Sheet number	1 of 1
File No	RBL-3-1450

PLATE NO 50

5 | 4 | 3

D

C

B

A

SAMPLE	DEPTH (FT)	NO. OF GRADATION TESTS	TRIAXIAL 'Q' TEST	TRIAXIAL 'R' TEST	TRIAXIAL 'R̄' TEST	DIRECT SHEAR 'S' TEST	DENSITY TEST	COMPACTION TEST	PERMEABILITY TEST
STAGE I; LIQUID LIMIT — 55 IMPERVIOUS ZONE									
RC-35		2	X	X		X		X	
RC-46		2	X	X		X		X	
RC-57		2	X	X		X		X	
RC-68		2	X	X		X		X	
RC-109		2	X	X		X		X	
RC-122		2	X	X		X		X	
RC-171		2	X	X		X		X	
RC-197		2	X	X		X		X	
RC-290		2	X	X		X		X	
RC-333		2	X	X		X		X	
RC-405		3	X	X		X		X	
RC-406		1	X	X		X		X	
OH-1	17 0			X	X		X		
	24 0		X	X	X		X		
	34 0			X	X		X		
	39 5		X	X	X		X		
OH-2	19 2		X	X	X		X		
	274	1		X	X		X		X
	299			X	X		X		
	33 7			X	X		X		X
	37 7		X	X	X		X		
	41 9		X	X	X		X		
I-99-1	9 5					X			
	17 0	1	X						
	27 0	1				X			
	43 0	1	X	X	X				
	53 0	1				X			
	61 5		X	X	X				
PPF-99-1	3 0	1				X			
	9 0	1				X			
	10 5	1				X			
PPF-99-4		1				X			
PPE-99-7	3 5					X			
	11 5					X			
	29 5	1				X			
	37 5		X	X	X				
	45 0					X			
	56 0			X	X				
PPE-99-11	28	1					X		
	39 5	2					X		
U-595	30	1		X	X				
	11 5	1		X	X				

SAMPLE	DEPTH (FT)	NO. OF GRADATION TESTS	TRIAXIAL 'Q' TEST	TRIAXIAL 'R' T	TRIAXIA	D
STAGE II, LIQUID LIMIT — 55 IMPERVICUS ZO						
RC-530-19		3	X	X	X	
RC-581-20		1	X	X	X	
RC-661-23		2				X
RC-682-26		2	X			X
RC-701-27		2				X
STAGE I, LIQUID LIMIT — 60 RANDOM ZON						
RC-8		2	X	X		X
STAGE II; LIQUID LIMIT — 60 IMPERVIOUS Z						
RC-803-29		2	X	X	X	
RC-899-36		1				
U-746	70.8-71.1	1	X	X	X	
	72 3-72.8	1	X	X	X	
U-747	34- 39	1	X	X	X	
STAGE II, LIQUID LIMIT — 60 RANDOM Z						
RC-479-17		2	X	X	X	
RC-674-24		2	X	X	X	
PPE-94-1	5 5-5 9	1	X	X	X	
	11 5-11 9	1	X	X	X	
	24 5-25 0	1	X	X	X	
STAGE II, LIQUID LIMIT — 65 IMPERVIOUS						
RC-445-15		1	X	X	X	X
RC-724-28		2	X	X	X	
RC-821-30		2	X	X	X	
RC-882-33		2	X	X	X	
RC-892-34		1				
U-745	6 4- 6 9	2	X	X	X	
	16 4-16 9	1	X			

5 | 4 | 3

SAMPLE	DEPTH (FT)	NO OF GRADATION TESTS	TRIAXIAL 'Q' TEST	TRIAXIAL 'R' TEST	TRIAXIAL 'R̄' TEST	DIRECT SHEAR 'S' TEST	DENSITY TEST	COMPACTION TEST
STAGE II; LIQUID LIMIT — 55 IMPERVIOUS ZONE								
RC-530-19		3	X	X	X		X	X
RC-591-20		1	X	X	X		X	X
RC-661-23		2				X	X	X
RC-682-26		2	X			X	X	X
RC-701-27		2				X	X	X
STAGE I, LIQUID LIMIT — 60 RANDOM ZONE								
RC-6		2	X	X		X		X
STAGE II, LIQUID LIMIT — 60 IMPERVIOUS ZONE								
RC-803-29		2	X	X	X		X	X
RC-899-36		1						X
U-746	70.6-71.1	1	X	X	X		X	X
	72 3-72 8	1	X	X	X		X	X
U-747	34- 39	1	X	X	X			
STAGE II, LIQUID LIMIT — 60 RANDOM ZONE								
RC-479-17		2	X	X	X		X	X
RC-674-24		2	X	X	X		X	X
PPE-94-1	5 5-5 9	1	X	X	X		X	
	11 5-11 9	1	X	X	X			
	24 5-25 0	1	X	X	X			
STAGE II, LIQUID LIMIT — 65 IMPERVIOUS ZONE								
RC-445-15		1	X	X	X	X	X	X
RC-724-28		2	X	X	X		X	X
RC-921-30		2	X	X	X		X	X
RC-882-33		2	X	"	X		X	X
RC-892-34		1						X
U-745	6 4- 6 9	2	X	X	X			
	16 4-16 9	1	X					

SAMPLE	DEPTH (FT)	NO. OF GRADATION TESTS	TRIAXIAL 'Q' TEST	TRIAXIAL 'R' TEST	TRIAXIAL 'R̄' TEST	DIRECT SHEAR 'S' TEST	DENSITY TEST	COMPACTION TEST
STAGE II, LIQUID LIMIT — 65 RANDOM ZONE								
RC-452-16		1	X	X	X	X	X	X
RC-592-21		2	X	X	X		X	X
RC-659-22		2	X	X	X		X	X
PPE-93-12	5 4-5 9	1	X	X	X		X	
PPE-95-1	18.8-19.3	1				X		
	28.8-29.3	1	X	X	X			
STAGE II; LIQUID LIMIT — 70 RANDOM ZONE								
RC-855-31		2	X	X	X		X	X
RC-878-32		2	X	X	X		X	X
RC-896-33		1						X
PPE-92-1	1.3- 1.8	1	X	X	X			
	6.3- 6 8	1	X	X	X			
	13.8-15.0	1				X		
	38.8-39 3	1	X	X	X			
PPE-95-1	0 0-0 5	1	X	X	X			
	11 3- 11 8	1	X	X	X			
U-744	6 4-6 9	1	X	X	X			
	10 5-11 0	1	X	X	X			
	20 1-20 6	1	X	X	X			
STAGE II; BERM ZONE (UNSPECIFIED LIQUID LIMIT)								
RC-514-18		2	X	X	X		X	X
RC-675-25		2	X	X	X		X	X
PPF-93-10A		1	X					
U-594	3 0	-		X	X			
	13 0	-	X	X	X			
SACK # 1		1	X	X	X			X

Revisions			
Symbol	Descriptions	Date	Approved

U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY MISSOURI

Designed by: RDG
Drawn by: PST
Checked by: RDG / WBE
Submitted by: RDG

US Army Corps of Engineers

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA AND PERFORMANCE REPORT

LABORATORY SOILS TESTING LOG

Scale: AS SHOWN
Date:
Dwg No. 49
Sheet number: 1 of 1
RBL-3-1451

D

DATA ON RECORD CONTROL SAMPLES

STAGE I LIQUID LIMIT — 55 IMPERVIOUS ZONE

HOLE NO	SAMPLE DEPTH	CLASSIFICATION SYM	CLASSIFICATION L.L.	CLASSIFICATION P.L	CLASSIFICATION P.I.	DRY DENSITY MAX.	DRY DENSITY INITIAL RANGE	WATER CONTENT OPT	WATER CONTENT INITIAL RANGE	WATER CONTENT PERCENT SATURATION	"Q" TEST TAN ø	"Q" TEST C T.S.F	"R̄" TAN Ø
RC - 35		CH	65	22	43	97 2	96 8 - 97 1	23 5	26 6 - 27 4	97 - 99	0 052	1 08	
RC - 46		CL	40	18	22	105.2	106.4 - 107 5	16 5	19 9 - 20 2	97 - 98	0 096	1.00	
RC - 57		CL	48	16	32	105 0	107 6 - 108 3	17 8	18 5 - 18 6	88 - 89			
RC - 68		CH	50	20	30	97.4	98 5 - 98 7	21 2	24 0 - 24 1	91 - 92	0 070	1 25	
RC-109		CL	46	18	28	103 0	107 3 - 107.8	19 0	18 9 - 19 1	90	0 016	2 15	
RC-122		CL	44	18	26	102.2	106 5 - 107 5	18 7	20 2 - 20 7	95	0	1 35	
RC-171		CL	46	19	27	103 8	99 3 - 101 0	18 8	24 8 - 25 9	100	0 035	1 25	
RC-197		CH	57	17	40	99 7	93 1 - 93 3	21 3	29 3 - 29 5	100	0 123	0 55	
RC-290		CL	43	20	23	105.3	104 6 - 104 9	18 7	21 6 - 21 9	99-100	0 044	1 70	
RC-333		CL	45	25	20	101 6	97 5 - 97 8	20 3	25 7 - 25 9	100	0 121	0 75	
RC-405		CH	56	22	34	95 6	99 0 - 100 7	24 3	23 6	92-96	0 155	1 23	
RC-406		CH	56	20	36	97 7	105 7 - 106.1	22 2	20 6 - 20 8	94-95	0 070	2 38	
OH-1	17 0	CH	53	16	37		104 8 - 105 7		21 6 - 22 0	100			0 521
	24 0	CL	43	15	28		107 2 - 108 1		20 1 - 20 4	98-100	0 035	1 35	0 61
	34 0	CL	41	16	25		99 5 - 103 6		21 5 - 23 8	92-95			0 53
	39.5	CL	40	16	24		102 8 - 104 4		20 5 - 22 2	93-97	0 070	0 40	0 53
OH 2	19 2	CL	48	16	32		105.7 - 107 9		18 9 - 19 7	92-98	0 167	1 15	0 46
	27 4	CL	36	18	18		106 6 - 107 3		18 3 - 18 7				0 58
	29 9	CL	39	18	21		106 9 - 107 8		19 4 - 20 1	93 - 97			0 57
	33 7	CL	41	16	25		110 2 - 110 9		18 8 - 19 0	100			0 57
	37 7	CL	32	16	16		113 0 - 115 0		16 4 - 17 1	98-99	0 456	1 45	0 68
	41 9	CL	43	16	27		102 0 - 102 3		22 7 - 23 0	98-100	0 437	0 75	0 57
U-595	3 0	CH	53	17	36		100 8 - 101 8		23 1 - 23 4	94- 95			0 48
	11.5	CL	45	17	28		108.6		17 5	86			—
PPF-99-1	3 0						91 2 - 94 5		26 0 - 27 1	89-97			
	9 0						100 8 - 105 4		19 8 - 21 3	90-94			
	10 5						102 4 - 104 4		21 7	94-99			
I-99-1	9 5						102 3 - 105 1		21 3 - 21 9	93-98	0 035	1 50	
	17 0	CL	46	17	29		101 1 - 103 9		22 3 - 24 0	97-98			
	27 0						103 2 - 107 8		18 5 - 21 0	90-93			
	43 0	CL	41	15	25		106 5 - 107 4		19 8 - 20 4	95-99	0 100	0 75	0 60
	53 0						103 9 - 104 3		23 8 - 23 9	100			
	61.5	CL	41	14	27		102 4 - 110 3		18 2 - 23 1	96-100	0 315	0 40	0 48
PPF-99-4							99 1 - 103 4		21 5 - 22 0	92 96			0 4
PPE-99-7	3 5						100 0 - 100 7		22 1 - 22 5	89-90			
	11 5						100 0 - 101 6		23 3 - 24 2	92-99			
	29 5						106 4 - 108 7		18 9 - 19 1	89-96			
	37 5	CL	33	17	16		104 9 - 107 3		20 3 - 21 4	95-96			0 5
	45 0						104 7 - 105 0		21 8	97-98			
	56 0	CL	48	17	31		104 2 - 105 4		19 8 - 21 0	96-98			

C

B

NOTE: EXCEPT FOR THE "R̄" TEST, ALL SHEAR STRENGTH PARAMETERS PROVIDED ON THE SUMMARY TABLE ABOVE WERE DERIVED FROM A BEST FIT TANGENT 1 TH
THE "R̄" TEST-EFFECTIVE STRESS STRENGTH PARAMETERS WERE DERIVED FROM THE POINTS PLOTTED AS DESIGNATED BY THE CORRESPONDING MOHR'S DIAGRAM

* SUSPECT TEST

A

3 | 2 | 1

NE

RECORD CONTROL SAMPLES

LIQUID LIMIT — 55 IMPERVIOUS ZONE

"R" T... TAN Ø	...TER CONTENT INITIAL RANGE	PERCENT SATURATION	"Q" TEST TAN Ø	"Q" TEST C T.S.F.	"R̄" TEST TAN Ø	"R̄" TEST C T.S.F.	"R" TEST TAN Ø	"R" TEST C T.S.F.	"S" TEST DIRECT SHEAR TAN Ø	"S" TEST DIRECT SHEAR C T.S.F.
	26 6 - 27 4	97 - 99	0 052	1 08			0 213	0 50	0 436	0
	19 9 - 20 2	97 - 98	0.096	1 00			0.306	0 70	0.597	0
	18 5 - 18 6	88 - 89					0 268	1 25	0 615	0
	24 0 - 24 1	91 - 92	0 070	1 25			0 194	0 58	0 538	0
	18 9 - 19 1	90	0 016	2 15			0 374	0 55	0 592	0
	20 2 - 20 7	95	0	1 35			0 202	1 23	0 634	0
	24 8 - 25 9	100	0 035	1 25			0 259	0 30	0 634	0
	29 3 - 29 5	100	0 123	0 55			0 277	0 01	0 580	0
	21 6 - 21 9	99-100	0 044	1 70			0 296	0 30	0 630	0
	25 7 - 25 9	100	0 121	0 75			0 287	0 53	0 610	0
	23 6	92 - 96	0 155	1 23			0 144	1 13	0 534	0
0 521	20 5 - 20 8	94 - 95	0 070	2 38			0.268	0.75	0 584	0
0 613	21 6 - 22 0	100			0 521	0 19	0 335	0 25		
0 532	20 1 - 20 4	98 - 100	0 035	1 35	0 613	0 *	0 364	0 23		
0 532	21 5 - 23 8	92 - 95			0 532	0 #	0 287	0 08		
0 462	20 5 - 22 2	93 - 97	0 070	0 40	0 532	0 14	0 296	0 25		
0 589	18 9 - 19 7	92 - 98	0 167	1 15	0 462	0.42	0 224	0 88		
0 573	18 3 - 18 7				0 589	0	0 321	2 00		
0 577	19 4 - 20 1	93 - 97			0 573	0	0 317	0 25		
0 68'	18 8 - 19 0	100			0 577	0 08	0 335	0 45		
0 577	16 4 - 17 1	93 - 99	0 456	1 45	0 687	0 30 *	0 781	0		
0 488	22 7 - 23 0	98 - 100	0 437	0 75	0 577	0 23	0 279	0 25		
	23 1 - 23 4	94 - 95			0 488	0 20	0 274	0 45		
	17 5	86			—	—	—	—		
	26 0 - 27 1	89 - 97							0 600	0
	19 8 - 21 3	90 - 94							0 542	0
	21 7	94 - 99							0 433	0
	21 3 - 21 9	93 - 98	0 035	1 50					0 490	0 27
	22 3 - 24 0	97 - 98							0 490	0
0 60	18 5 - 21 0	90 - 93							0 521	0
	19 8 - 20 4	95 - 99	0 100	0 75	0 601	0 10	0 402	0 50		
0 488	23 8 - 23 9	100							0 568	0
0 414	18 2 - 23 1	96 - 100	0 315	0 40	0 488	0 51	0 374	0 98		
	21 5 - 22 0	92 - 96			0 414	0 20			0 590	0
	22 1 - 22 5	89 - 90							0 538	0
	23 3 - 24 2	92 - 99							0 477	0
0 532	18 9 - 19 1	89 - 96							0 618	0
	20 3 - 21 4	95 - 96			0 532	0 32	0 414	0 50		
	21 8	97 - 98							0 534	0
	19 8 - 21 0	96 - 98			0 398	0 60	0 185	1 00		

1 THE M... DIAGRAM

...OVE WERE DERIVED FROM A BEST FIT TANGENT TO THE MOHR'S CIRCLES FOR EACH SAMPLE TESTED.
...S DESIGNATED BY THE CORRESPONDING MOHR'S DIAGRAM.

Symbol	Revisions Descriptions	Date	Approved

U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY MISSOURI

US Army Corps of Engineers

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA AND PERFORMANCE REPORT

TEST DATA SUMMARIES
LIQUID LIMIT-55 IMPERVIOUS ZONE
STAGE I

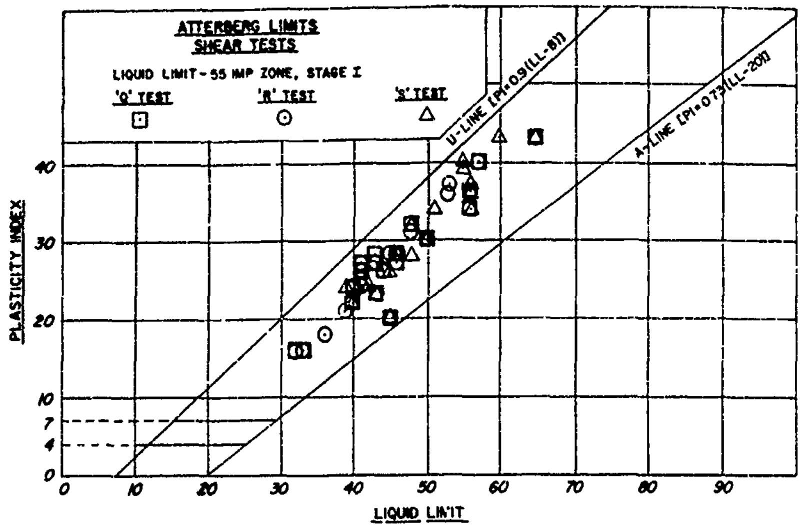
Designed by: RDG
Drawn by: PST
Checked by: RDG / WBE
Submitted by: RDG
Scale: AS SHOWN
Date:
Sheet number: 1 of 1
Dwg No:
File no: KBL-3-1452

3 | 2 | 1

D C B A

5 4 3

D



LIQUID LIMIT - 55
IMPERVIOUS ZONE
STAGE I

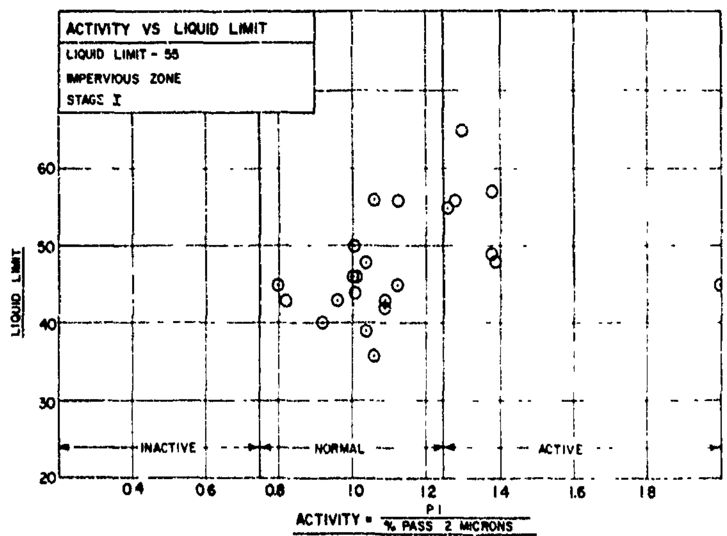
SAMPLE
OH-2

DIFFERENTIAL HEAD
HORIZONTAL SPECIME

MAT

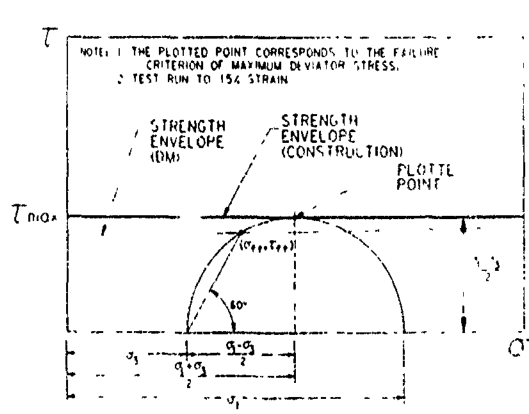
BERM
HILLSIDE BO
VALLEY BOR
FOUNDATION
SHALE - PE
SHALE - RE

C

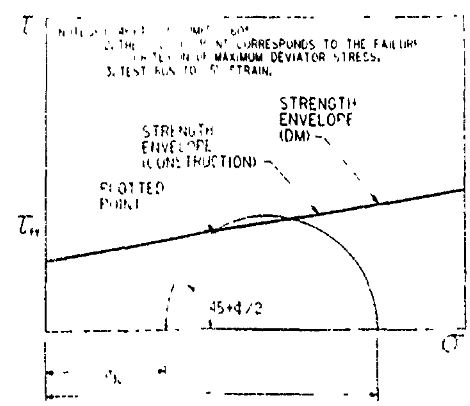


LIQU
GRAD

B



"Q"
MOHR'S DIAGRAM



TOTAL STRESS "R"
MOHR'S DIAGRAM

A

5 4 3

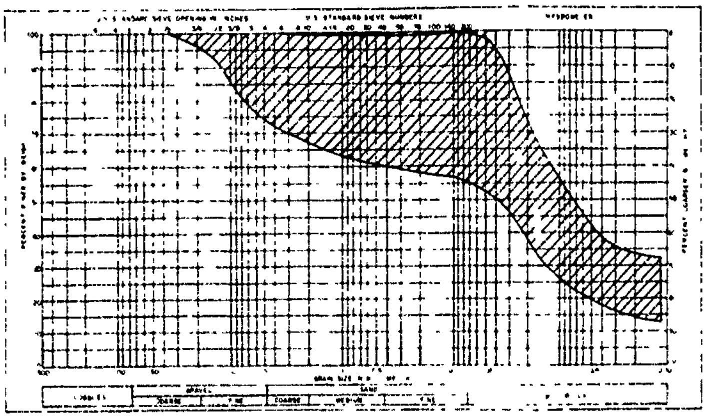
CONSTANT HEAD PERMEABILITY TEST SUMMARY

LIQUID LIMIT-55 IMPERVIOUS ZONE STAGE I						INITIAL SPECIMEN CONDITIONS				FINAL SPECIMEN CONDITIONS			
SAMPLE	DEPTH (FT)	LL	PL	PI	SPECIFIC GRAVITY	WATER CONTENT (%)	VOID RATIO	SAT (%)	DRY DENSITY (LBS/FT³)	WATER CONTENT (%)	VOID RATIO	DRY DENSITY (LBS/FT³)	AVERAGE PERMEABILITY CM/S
OH-2	22.0	41	14	27	2 64	20 6	0.58	94	104 2	21.4	0.49	110 5	$1\,9 \times 10^{-7}$
	37 5	28	19	9	2.62	16.2	0 42	100	115.1	16.0	0 40	117.0	$2\,2 \times 10^{-8}$
	37 5	28	19	9	2 62	19 0	0 49	100	109 9	17 8	0 42	115 5	$2\,6 \times 10^{-8}$

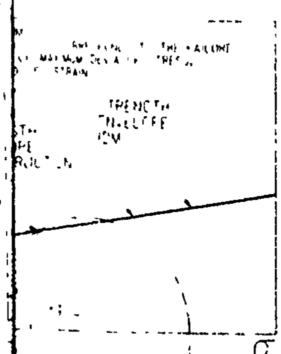
DIFFERENTIAL HEAD = 3 PSI
HORIZONTAL SPECIMEN ALIGNMENT

PHYSICAL SOIL CONSTANTS

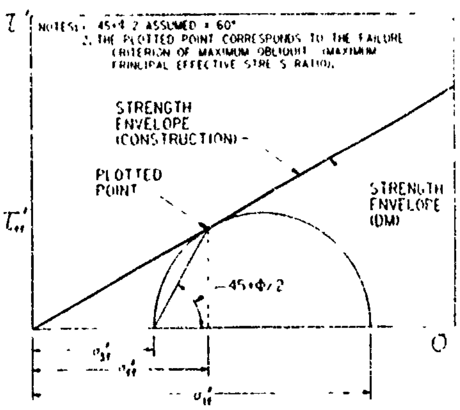
MATERIAL	UNIT WEIGHT P.C.F.		DESIGN SHEAR STRENGTHS Q			R			S		
	SAT.	MOIST	C(T.S.F)	Ø	TAN Ø	C(T.S.F)	Ø	TAN Ø	C(T.S.F)	Ø	TAN Ø
BERM	115	110	0.45	0.00	0.00	0.10	11.3	0.20	0.00	16.7	0.30
HILLSIDE BORROW	125	115	0.90	0.00	0.00	0.20	11.3	0.20	0.00	19.8	0.36
VALLEY BORROW	125	115	0.90	0.00	0.00	0.20	11.3	0.20	0.00	26.6	0.50
FOUNDATION OVERBURDEN	115	110	0.60	0.00	0.00	0.20	11.3	0.20	0.00	26.6	0.50
SHALE - PEAK	140	140	-	-	-	-	-	-	0.00	31.0	0.60
SHALE - RESIDUAL	140	140	-	-	-	-	-		0.00	16.7	0.30



LIQUID LIMIT - 55 IMPERVIOUS ZONE STAGE I
GRADATION LIMITS FOR RECORD CONTROL SAMPLES TESTED.



AL STRESS "R"
HR'S DIAGRAM



EFFECTIVE STRESS
MOHR'S DIAGRAM

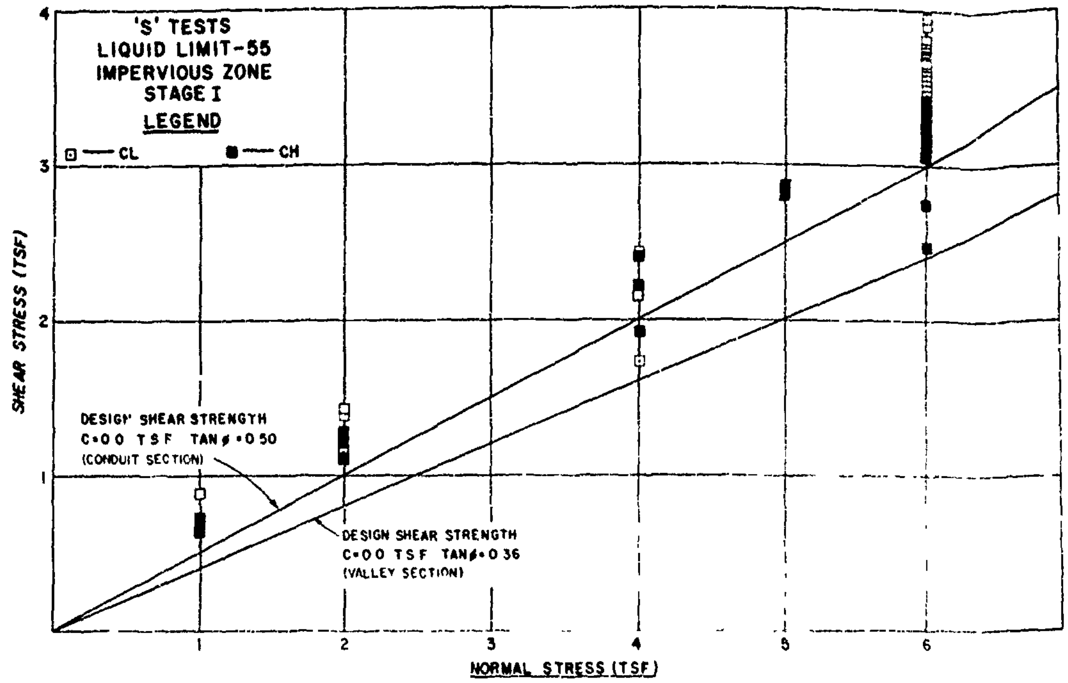
Revisions			
Symbol	Descriptions	Date	Approved

U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY MISSOURI

Designed by: W B E	US Army Corps of Engineers — LITTLE BLUE RIVER, MISSOURI LONGVIEW LAKE EMBANKMENT CRITERIA AND PERFORMANCE REPORT
Drawn by: E D P	TEST DATA SUMMARIES LIQUID LIMIT-55 IMPERVIOUS ZONE STAGE I
Checked by: W.B.E./R.G.D.	Scale: AS SHOWN — Sheet number:
Submitted by: F.C.W.	Date: — Dwg No: — File No: RBL-3-1453

5 4 3

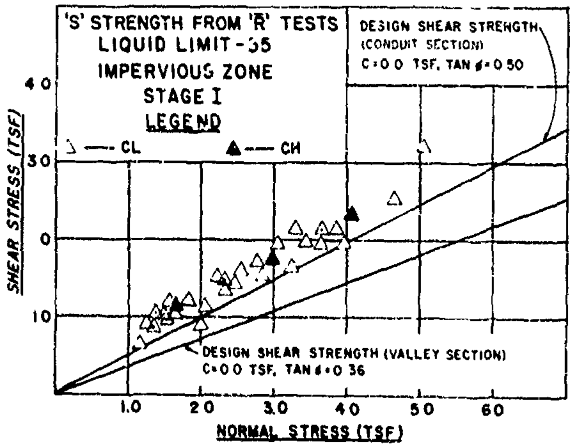
D



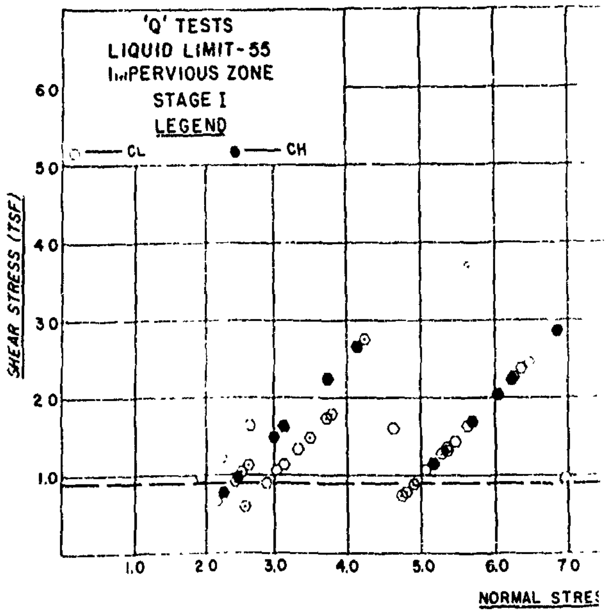
'S' TESTS
LIQUID LIMIT-55
IMPERVIOUS ZONE
STAGE I
LEGEND
CL
CH
SHEAR STRESS (TSF)
DESIGN SHEAR STRENGTH
C=0.0 TSF TAN φ =0.50
(CONDUIT SECTION)
DESIGN SHEAR STRENGTH
C=0.0 TSF TAN φ =0.36
(VALLEY SECTION)
NORMAL STRESS (TSF)

C

B



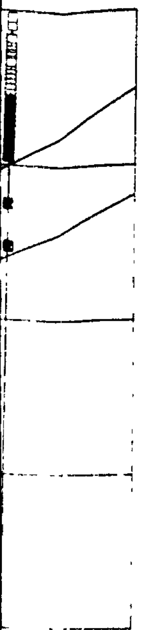
'S' STRENGTH FROM 'R' TESTS
LIQUID LIMIT-55
IMPERVIOUS ZONE
STAGE I
LEGEND
CL
CH
DESIGN SHEAR STRENGTH
(CONDUIT SECTION)
C=0.0 TSF, TAN φ =0.50
DESIGN SHEAR STRENGTH (VALLEY SECTION)
C=0.0 TSF, TAN φ =0.36
SHEAR STRESS (TSF)
NORMAL STRESS (TSF)

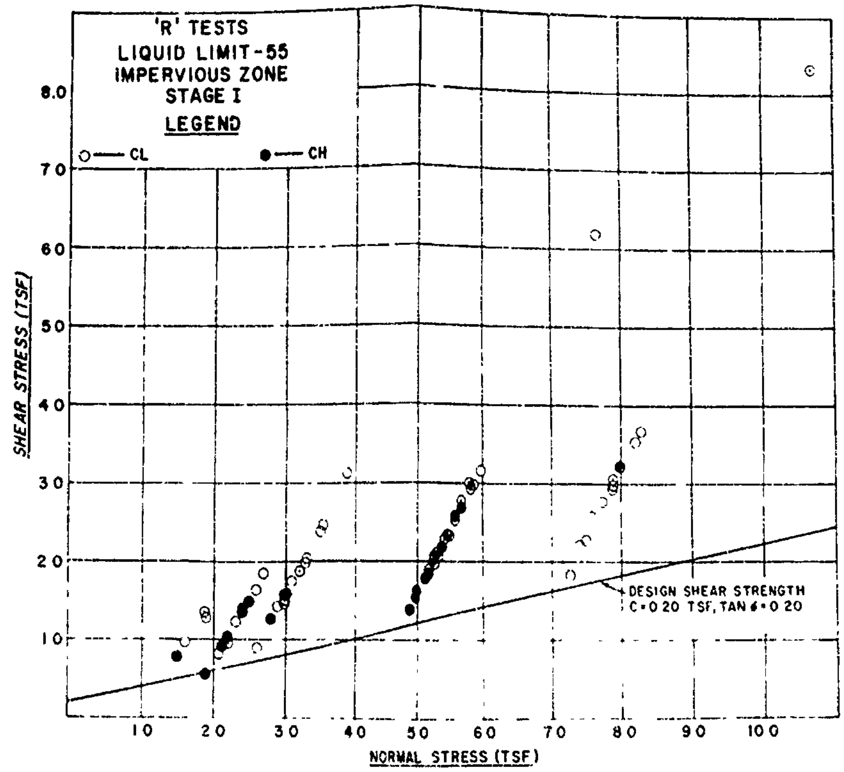


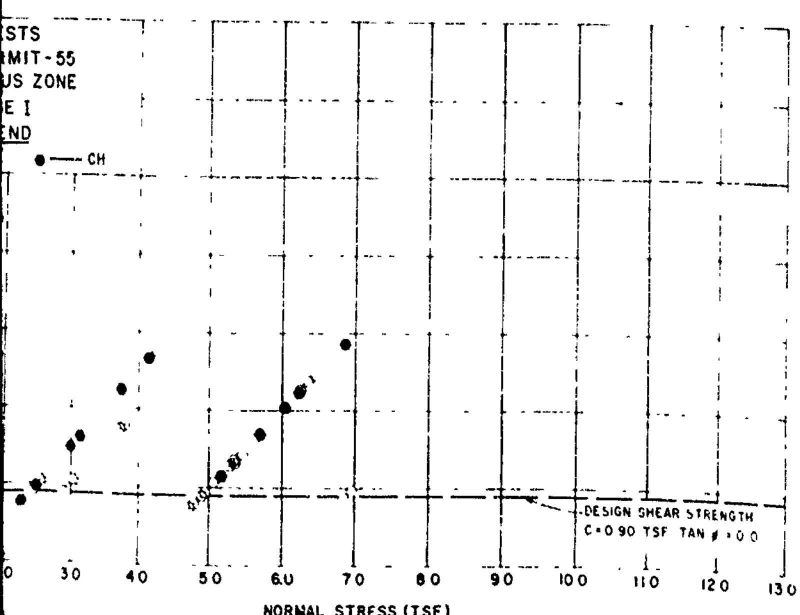
'Q' TESTS
LIQUID LIMIT-55
IMPERVIOUS ZONE
STAGE I
LEGEND
CL
CH
SHEAR STRESS (TSF)
NORMAL STRES

A

5 4 3







Symbol	Revisions Descriptions	Date	Approved

U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY MISSOURI

Designed by RDG

Drawn by MAW

Checked by RDG / WSE

Submitted by RDG

US Army Corps of Engineers

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA AND
PERFORMANCE REPORT

SHEAR TEST SUMMARIES
LIQUID LIMIT-55 IMPERVIOUS ZONE
STAGE I

Scale AS SHOWN

Date

Dwg No

Sheet number

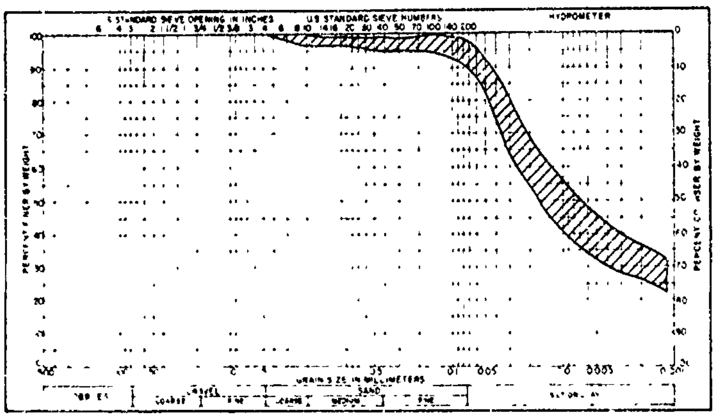
File No RBL-3-1454

PLATE NO 54

DATA ON RECORD CONTROL SAMPLES
STAGE II LIQUID LIMIT –55 IMPERVIOUS ZONE

HOLE NO.	SAMPLE DEPTH	CLASSIFICATION SYM.	L.L.	P.L.	P.I.	DRY DENSITY MAX.	DRY DENSITY INITIAL RANGE	WATER CONTENT OPT.	WATER CONTENT INITIAL RANGE	PERCENT SATURATION	"Q" TEST TAN Ø	"Q" TEST C T.S.F.	"R" TEST TAN Ø	"R" TEST C T.S.F.
RC-530-19		CL	48	16	32	100 6	103.0 – 104 8	20 6	20.7 – 21.9	94-96	0.087	1.05	0.532	0.19
RC-591-20		CH	55	15	40	98 3	102.5 – 103.8	22 1	22 6 – 23 0	100	0.018	0.85	0.404	0 21
RC-661-23		CL	46	16	30	98 1		22 7						
RC-682-26		CL	44	16	28	100.5	101 1 – 106 4	19 8	18 6 – 19.0	77-87	0 298	1.15		
RC-701-27		CH	51	18	33	98 3		22.5						

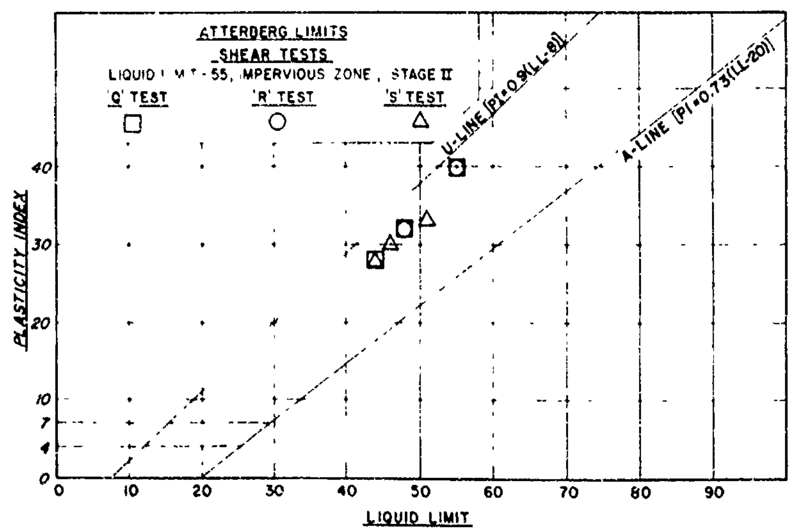
NOTE: EXCEPT FOR THE "R" TEST, ALL SHEAR STRENGTH PARAMETERS PROVIDED ON THE SUMMARY TABLE ABOVE WERE DERIVED FROM A BEST FIT TANGENT TO THE MOHR'S CIRCLES THE "R" TEST-EFFECTIVE STRESS STRENGTH PARAMETERS WERE DERIVED FROM THE POINTS PLOTTED AS DESIGNATED BY THE CORRESPONDING MOHR'S DIAGRAM.

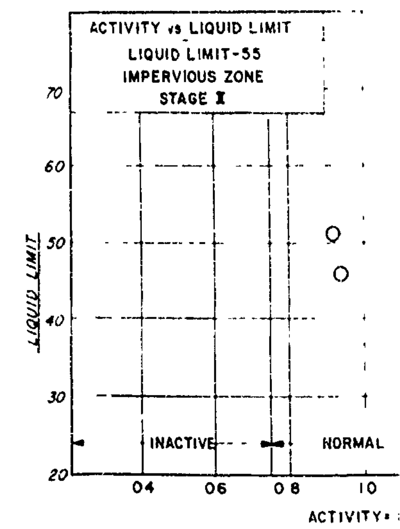


LIQUID LIMIT - 55 IMPERVIOUS ZONE STAGE II
GRADATION LIMITS FOR RECORD CONTROL SAMPLES TESTED.

PHYSICAL SOIL

MATERIAL	UNIT WEIGHT P.C.F. SAT.	UNIT WEIGHT P.C.F. MOIST	C (T.S.F.)	Q Ø
BERM	115	110	0 45	0.00
HILLSIDE BORROW	125	115	0.90	0.00
VALLEY BORROW	125	115	0.90	[illegible]
FOUNDATION OVERBURDEN	115	110	0.60	[illegible]
SHALE PEAK	140	140		
SHALE - RESIDUAL	140	140	-	



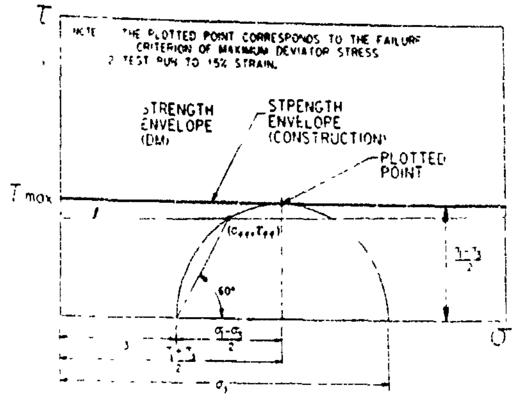


SAMPLES

ERVIOUS ZONE

T	PERCENT SATURATION	"Q" TEST TAN Ø	"Q" TEST C T.S.F	"R" TEST TAN Ø	"R" TEST C T.S.F	"R" TEST TAN Ø	"R" TEST C T.S.F	"S" TEST DIRECT SHEAR TAN Ø	"S" TEST DIRECT SHEAR C T.S.F
	94-96	0.087	1 05	0 532	0.19	0 298	0.28	0 477	0
	100	0 018	0 85	0 404	0 21	0 222	0 55		
								0.563	0
	77-87	0 298	1 15					0.601	0
								0 514	0

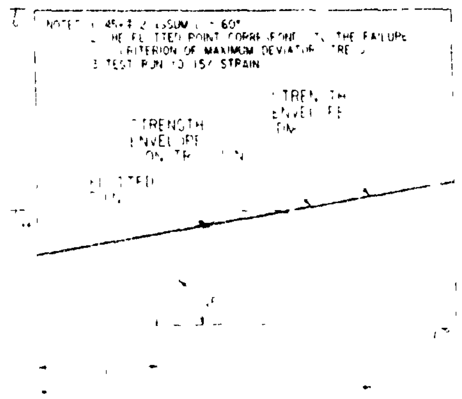
VED FROM A BEST FIT TANGENT TO THE MOHR'S CIRCLES FOR EACH SAMPLE TESTED.
CIRCLES F BY THE CORRESPONDING MOHR'S DIAGRAM.



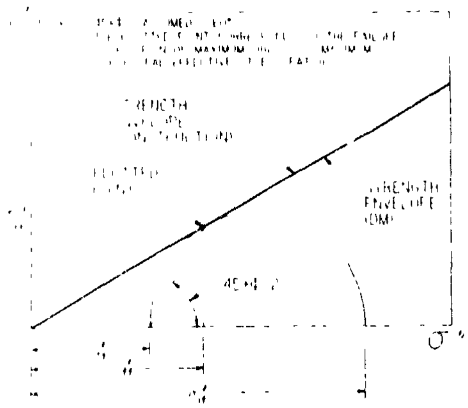
"Q"
MOHR'S DIAGRAM

PHYSICAL SOIL CONSTANTS

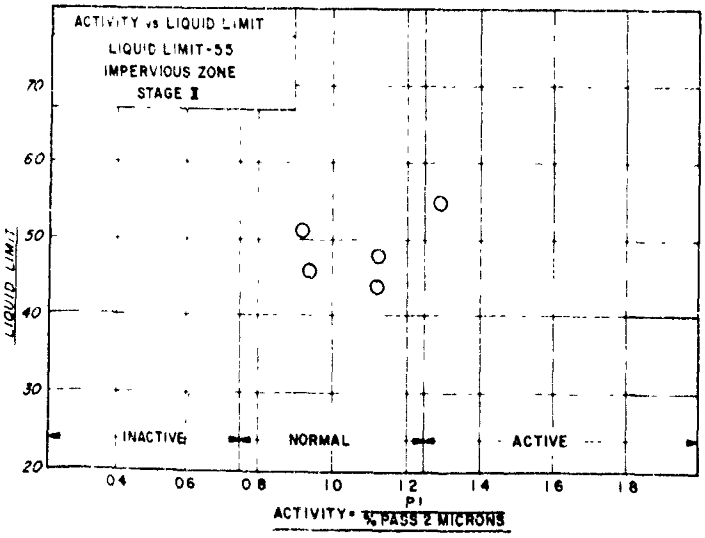
MATERIAL	UNIT WEIGHT P.C.F. SAT.	UNIT WEIGHT P.C.F. MOIST	Q C(T.S.F)	Q Ø	Q TAN Ø	R C(T.S.F)	R Ø	R TAN Ø	S C(T.S.F)	S Ø	S TAN Ø
TABERM	115	10	0.45	0.00	0.00	0.10	11.3	0 20	0.00	16.7	0.30
HILLSIDE BORROW	[illegible]	115	0 90	0.00	0 00	0 20	11.3	0 20	0.00	19 8	0 36
VALLEY BORROW	[illegible]	5	0 90	0 00	0 00	0 20	11.3	0.20	0.00	26 6	0.50
FOUNDATION OVERBURDEN	115	[illegible]	0.60	0.00	0.00	0.20	11.3	0.20	0.00	26.6	0.50
SHALE PEAK	140	140	-	-		-			0.00	31.0	0.60
SHALE - RESIDUAL	140	10	-	-		-	-	-	0.00	16.7	0.30



TOTAL STRESS "R"
MOHR'S DIAGRAM



EFFECTIVE STRESS
MOHR'S DIAGRAM



ACTIVITY = PI / % PASS 2 MICRONS

Symbol	Revisions Descriptions	Date	Approved

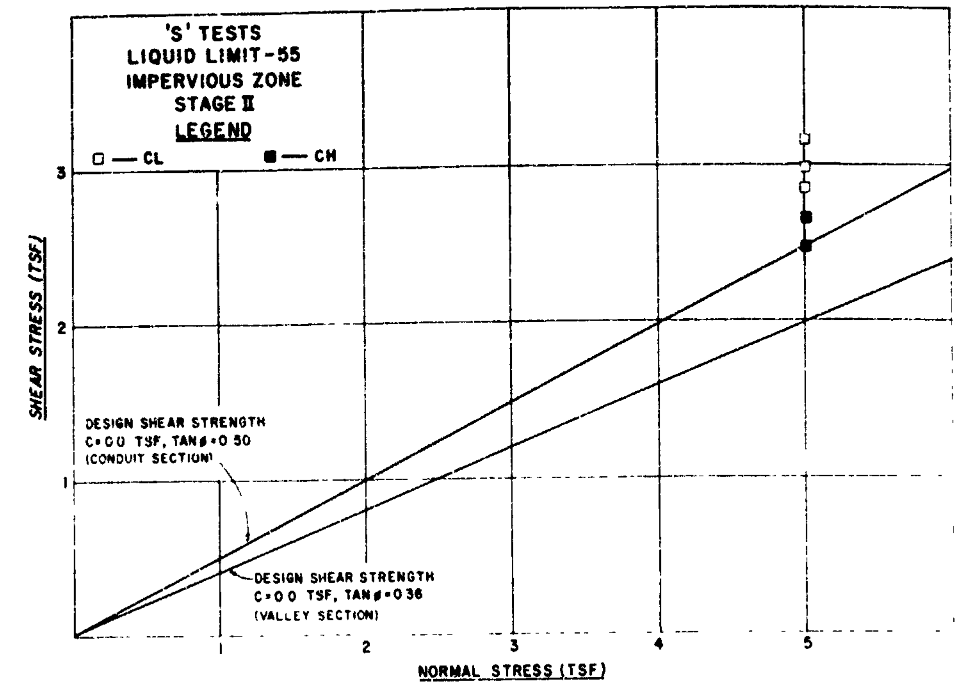
U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY MISSOURI

US Army Corps of Engineers

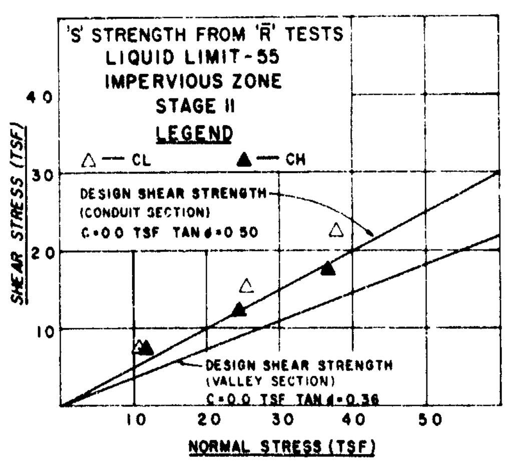
LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA AND PERFORMANCE REPORT
TEST DATA SUMMARIES
LIQUID LIMIT-55 IMPERVIOUS
STAGE II

Designed by: RDG
Drawn by: RAC
Checked by: RDG/WBE
Submitted by: RDG

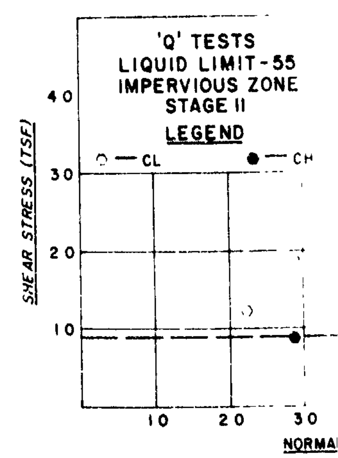
Scale: AS SHOWN
Date:
Dwg No.: 1 of 1
Sheet number:
File No. RBL-3-1455



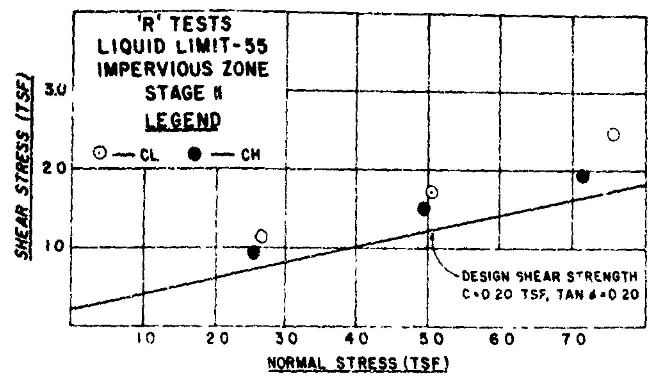
'S' TESTS
LIQUID LIMIT-55
IMPERVIOUS ZONE
STAGE II
LEGEND
□ — CL
■ — CH
DESIGN SHEAR STRENGTH
C=0.0 TSF, TANφ=0.50
(CONDUIT SECTION)
DESIGN SHEAR STRENGTH
C=0.0 TSF, TANφ=0.36
(VALLEY SECTION)
SHEAR STRESS (TSF)
NORMAL STRESS (TSF)

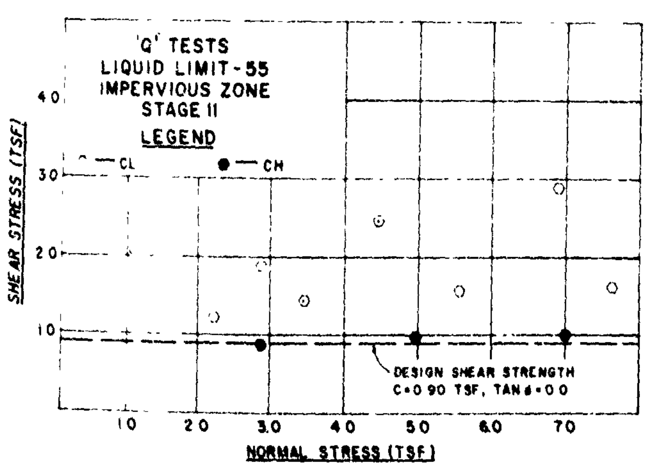


'S' STRENGTH FROM 'R̄' TESTS
LIQUID LIMIT-55
IMPERVIOUS ZONE
STAGE II
LEGEND
△ — CL
▲ — CH
DESIGN SHEAR STRENGTH
(CONDUIT SECTION)
C=0.0 TSF TANφ=0.50
DESIGN SHEAR STRENGTH
(VALLEY SECTION)
C=0.0 TSF TANφ=0.36
SHEAR STRESS (TSF)
NORMAL STRESS (TSF)



'Q' TESTS
LIQUID LIMIT-55
IMPERVIOUS ZONE
STAGE II
LEGEND
○ — CL
● — CH
SHEAR STRESS (TSF)





Symbol	Revisions Descriptions	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

US Army Corps of Engineers

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA AND
PERFORMANCE REPORT
SHEAR TEST SUMMARIES
LIQUID LIMIT-55 IMPERVIOUS ZONE
STAGE II

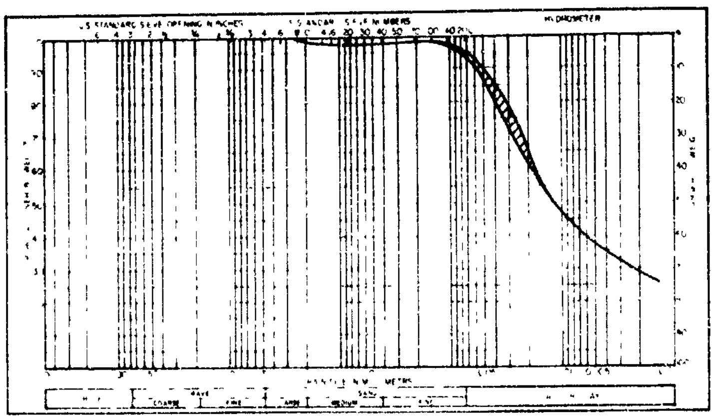
Designed by: W.B.E.
Drawn by: M.A.W.
Checked by: W.B.E./R.G.D.
Submitted by: F.C.W.
Scale: AS SHOWN
Date:
Dwg No.:
Sheet number:
File No.: RBL-3-1456

PLATE NO. 56

DATA ON RECORD CONTROL SAMPLES
STAGE I LIQUID LIMIT – 60 RANDOM ZONE

HOLE	SAMPLE	CLASSIFICATION				DRY DENSITY		WATER CONTENT			
NO	DEPTH	SYM.	L.L.	P.L.	PI	MAX	INITIAL RANGE	OPT	INITIAL RANGE	PER CENT SATURATION	TA Ø
RC-8		CH	51	15	36	100 8	99 8 – 103 7	20 4	22.3 – 24 6	98	0 0

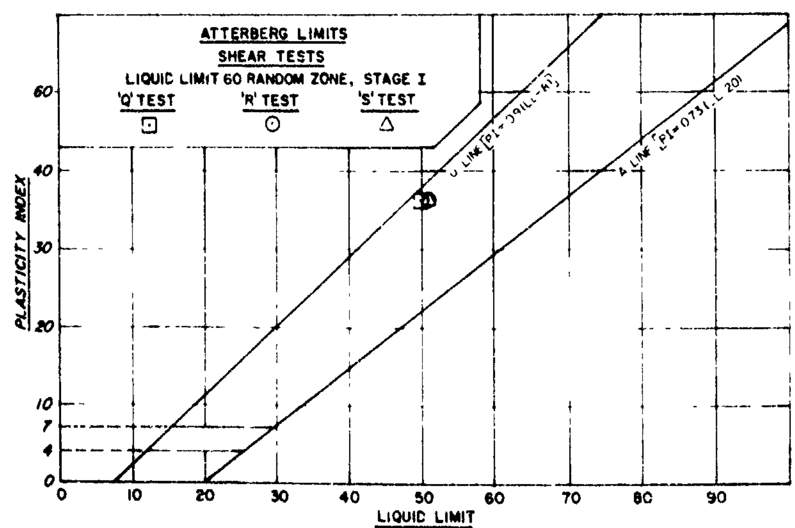
NOTE: ALL "Q" AND "R" SHEAR STRENGTH PARAMETERS PROVIDED ON THE SUMMARY TABLE ABOVE WERE DERIVED FROM A BEST FIT LINE TANGENT TO THE MOHR'S CIRCLES FOR EACH SAMPLE.

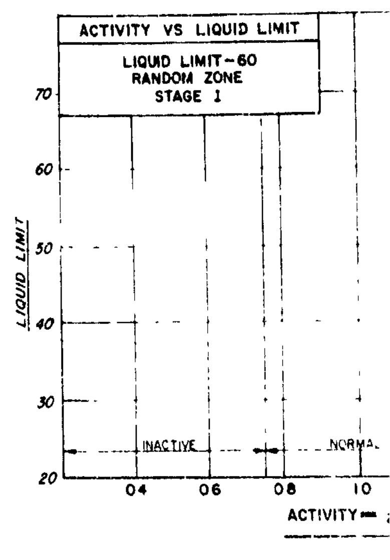


LIQUID LIMIT - 60 RANDOM ZONE STAGE I
GRADATION LIMITS FOR RECORD CONTROL SAMPLES TESTED.

PHYSICAL SOIL C

MATERIAL	UNIT WEIGHT P.C.F. SAT.	MOIST	Q C(T.S.F.)	Ø
BERM	115	110	0.45	0.00
HILLSIDE BORROW	125	115	0.90	[illegible].00
VALLEY BORROW	125	115	0.90	0.00
FOUNDATION OVERBURDEN	115	110	0.60	0.00
SHALE - PEAK	140	140	-	-
SHALE RESIDUAL	140	140	-	-





DATA ON RECORD CONTROL SAMPLES

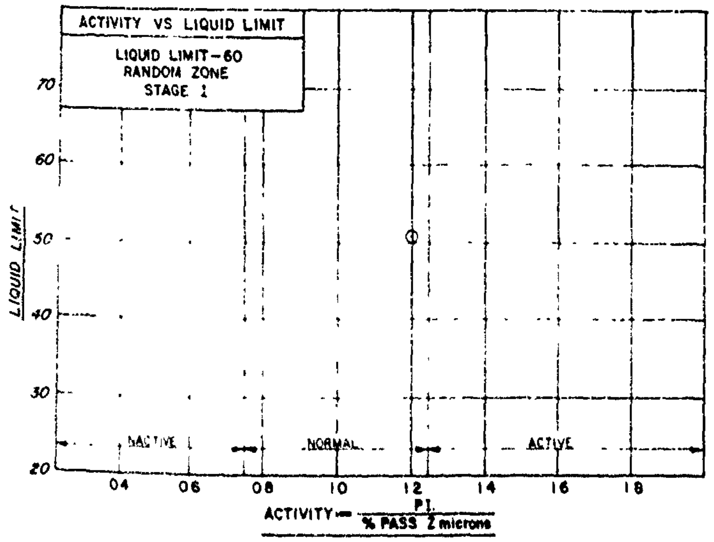
STAGE I LIQUID LIMIT – 60 RANDOM ZONE

...SITY	WATER CONTENT			"Q" TEST		"R̄" TEST		"R" TEST		"S" TEST DIRECT SHEAR	
...AL RANGE	OPT.	INITIAL RANGE	PER CENT SATURATION	TAN Ø	C T.S.F.	TAN Ø	C T.S.F.	TAN Ø	C T.S.F.	TAN Ø	C T.S.F.
...8 – 103.7	20.4	22.3 — 24.6	98	0.009	1.20			0.105	1.00	0.477	0

...ERS PROVIDED ON THE SUMMARY TABLE ABOVE WERE
... TO THE MOHR'S CIRCLES FOR EACH SAMPLE.

PHYSICAL SOIL CONSTANTS

MATERIAL	UNIT WEIGHT P.C.F.		DESIGN SHEAR STRENGTHS Q			R			S		
	SAT.	MOIST	C(T.S.F.)	Ø	TAN Ø	C(T.S.F.)	Ø	TAN Ø	C(T.S.F.)	Ø	TAN Ø
BERM	115	110	0.45	0.00	0.00	0.10	11.3	0.20	0.00	16.7	0.30
HILLSIDE BORROW	125	115	0.90	0.00	0.00	0.20	11.3	0.20	0.00	19.8	0.36
VALLEY BORROW	125	115	0.90	0.00	0.00	0.20	11.3	0.20	0.00	26.6	0.50
FOUNDATION OVERBURDEN	115	110	0.60	0.00	0.00	0.20	11.3	0.20	0.00	26.6	0.50
SHALE - PEAK	140	140	-	-	-	-	-	-	0.00	31.0	0.60
SHALE - RESIDUAL	140	140	-	-	-	-	-		0.00	16.7	0.30

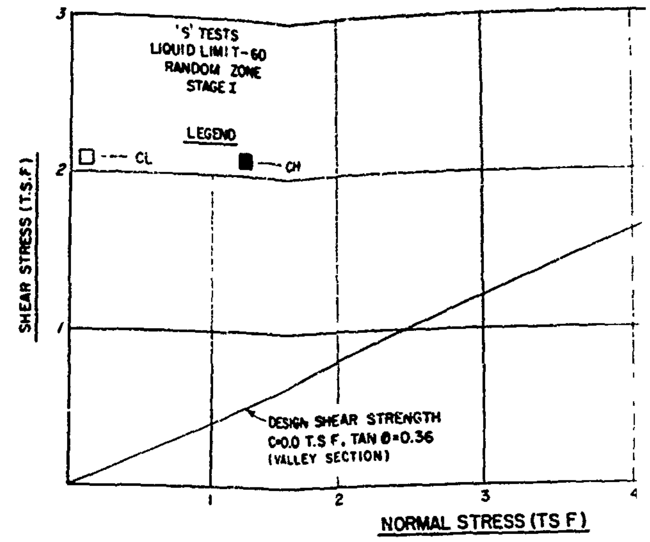


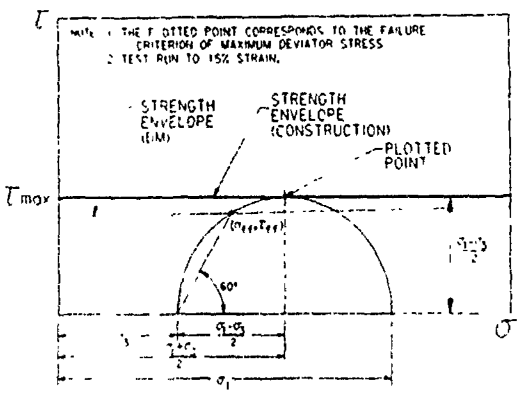
Symbol	Revisions Descriptions	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

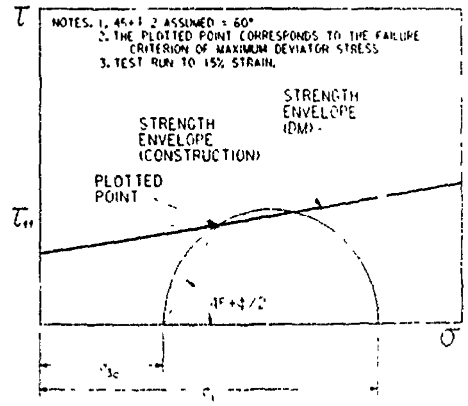
Designed by: W B E	LITTLE BLUE RIVER, MISSOURI LONGVIEW LAKE EMBANKMENT CRITERIA AND PERFORMANCE REPORT TESTS DATA SUMMARIES LIQUID LIMIT – 60 RANDOM ZONE STAGE I
Drawn by: R A C	
Checked by: R G D / W B E	Scale: AS SHOWN
Submitted by: F C W	Date:
	Dwg No.: File No. RBL-3-1457

PLATE NO. 57

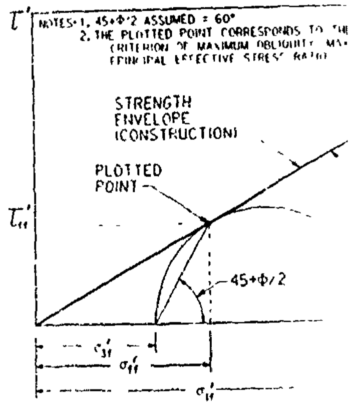




"Q"
MOHR'S DIAGRAM

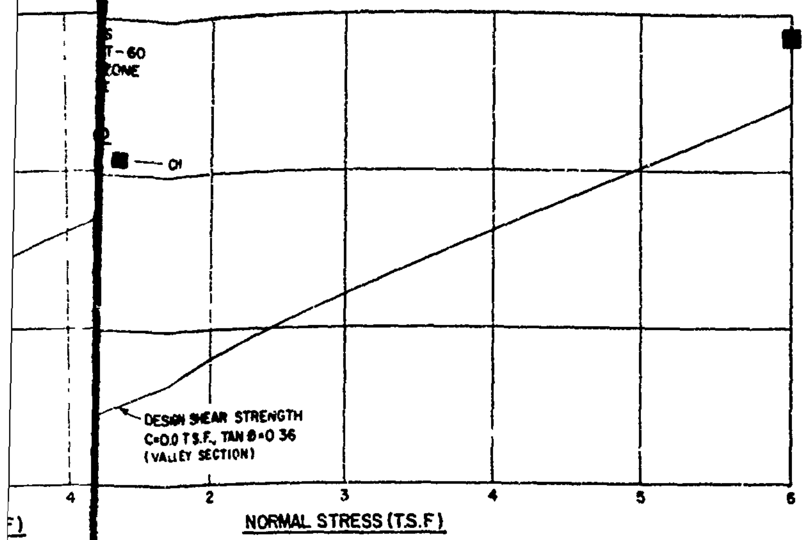


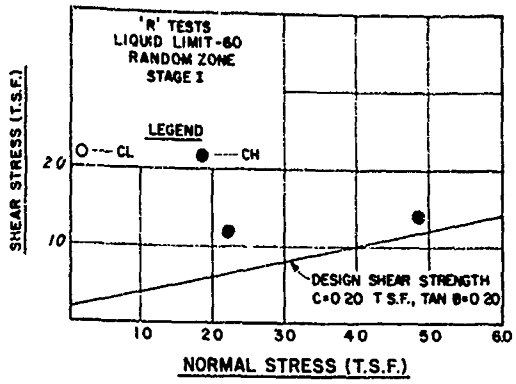
TOTAL STRESS "R"
MOHR'S DIAGRAM



EFFECTIVE STRE
MOHR'S DIAGRA

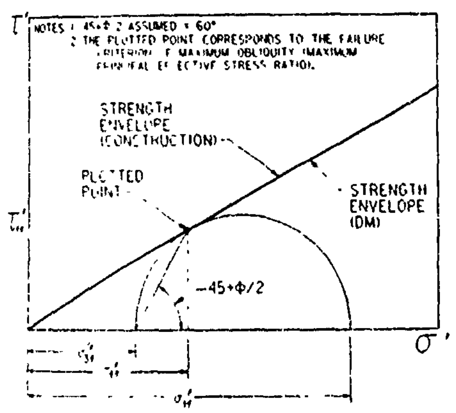
3 2 1



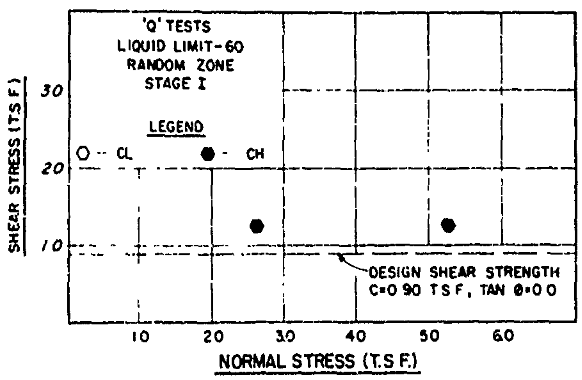


D

C



EFFECTIVE STRESS
MOHR'S DIAGRAM



B

Symbol	Revisions Descriptions	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

Designed by RDG	US Army Corps of Engineers — LITTLE BLUE RIVER, MISSOURI LONGVIEW LAKE EMBANKMENT CRITERIA AND PERFORMANCE REPORT SHEAR TEST DATA SUMMARIES **LIQUID LIMIT-60 RANDOM ZONE STAGE I**
Drawn by SEY	
Checked by RDG/WBE	Scale AS SHOWN — Sheet number
Submitted by RDG	Date — Dwg No — File No RBL-3-1458

A

3 2 1 PLATE NO. 58

5	4	3

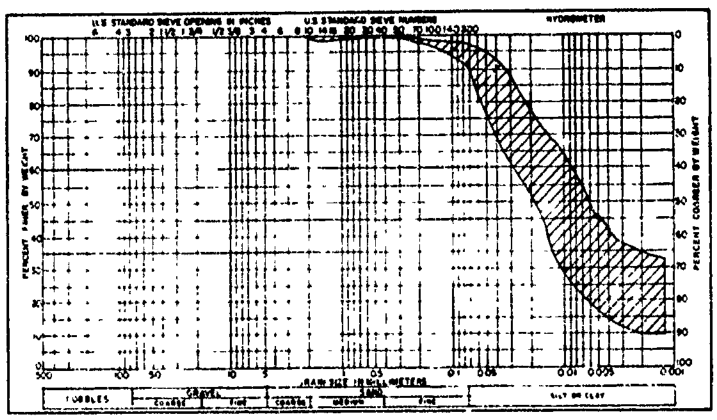
D

DATA ON RECORD CONTROL SAMPLES
STAGE II LIQUID LIMIT — 60 IMPERVIOUS ZONE

HOLE NO.	SAMPLE DEPTH	CLASSIFICATION				DRY DENSITY		WATER CONTENT		
		SYN.	L.L.	P.L.	P.I.	MAX.	INITIAL RANGE	OPT.	INITIAL RANGE	PER CENT SATURATION
RC-803-29		CH	53	24	29	98 0	101.3 — 103 6	23 2	22 9 — 24.4	100
U-746	70.6-71.1	CL	43	18	25		105.5 — 106.3		20.8 — 21.4	97–98
	72.3-72.8	CL	45	20	25		101.1 — 101.4		23.2 — 23.5	97
U-747	3.4—3.9	CH	67	16	51		103 5 — 105.2		21.3 — 22.3	93–95

NOTE: EXCEPT FOR THE 'R' TEST, ALL SHEAR STRENGTH PARAMETERS PROVIDED ON THE SUMMARY TABLE ABOVE WERE DERIVED FROM A BES
THE 'R' TEST-EFFECTIVE STRESS STRENGTH PARAMETERS WERE DERIVED FROM THE POINTS PLOTTED AS DESIGNATED BY THE CORRESF

C

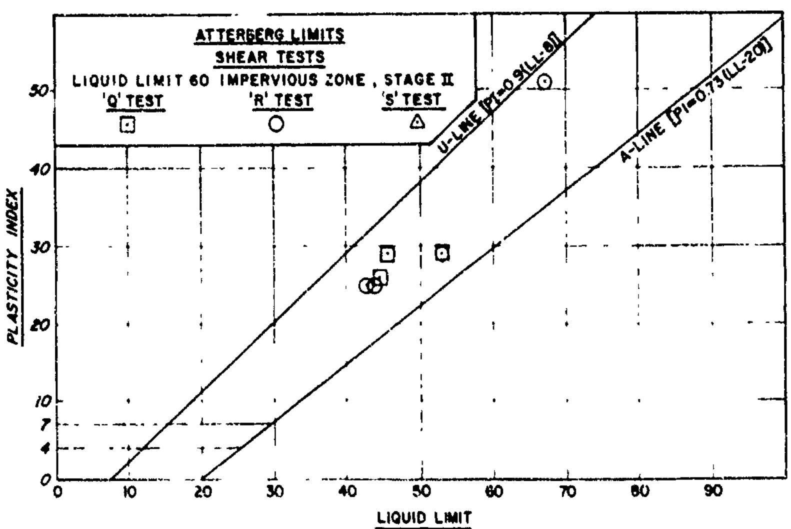


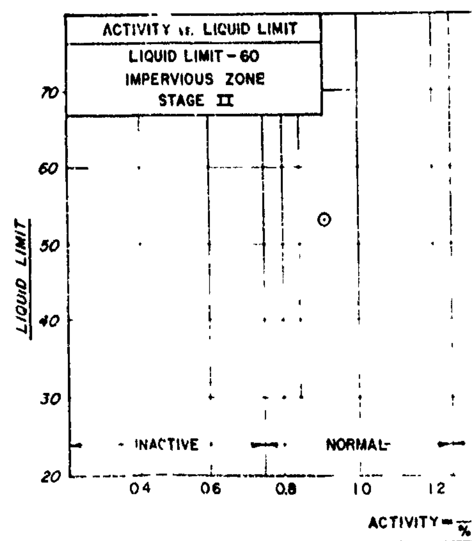
LIQUID LIMIT - 60 IMPERVIOUS ZONE STAGE II
GRADATION LIMITS FOR RECORD CONTROL SAMPLES TESTED.

PHYSICAL SOIL C

MATERIAL	UNIT WEIGHT P.C.F.		Q	
	SAT.	MOIST	C(T.S.F)	Ø
BERM	115	110	0.45	0 00
HILLSIDE BORROW	125	115	0.90	0.0
VALLEY BORROW	125	115	0.90	0 0
FOUNDATION OVERBURDEN	115	110	0.60	0 00
SHALE - PEAK	140	140	-	-
SHALE - RESIDUAL	140	140	-	-

B





A

5	4	3

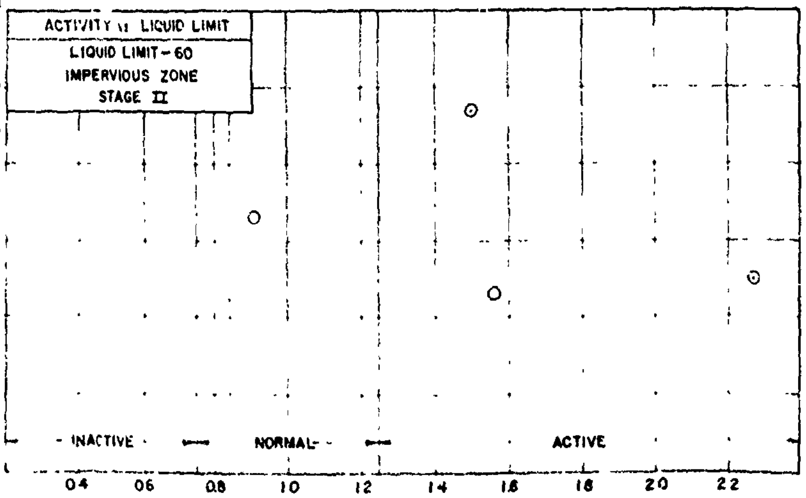
DATA ON RECORD CONTROL SAMPLES
STAGE II LIQUID LIMIT - 60 IMPERVIOUS ZONE

DENSITY	WATER CONTENT			"Q" TEST		"R̄" TEST		"R" TEST		"S" TEST DIRECT SHEAR	
...AL RANGE	OPT.	INITIAL RANGE	PERCENT SATURATION	TAN Ø	C T.S.F.	TAN Ø	C T.S.F.	TAN Ø	C T.S.F.	TAN Ø	C T.S.F.
... — 103.6	23.2	22.9 — 24.4	100	0.141	1.50	0.456	0.21	0.325	0.55		
... — 106.3		20.8 — 21.4	97–98	0.35 0.35	1.25 1.30	0.287	1.75	0.577	0.39		
... — 101.4		23.2 — 23.5	97	0 0	0.58 0.55	0.344	0.50	0.577	0.20		
... — 105.2		21.3 — 22.3	93–96	0.110	1.10	0.287	0.38	0.240	0.65		

...ON THE SUMMARY TABLE ABOVE WERE DERIVED FROM A BEST FIT TANGENT TO THE MOHR'S CIRCLES FOR EACH SAMPLE TESTED.
...FROM THE POINTS PLOTTED AS DESIGNATED BY THE CORRESPONDING MOHR'S DIAGRAM.

PHYSICAL SOIL CONSTANTS

MATERIAL	UNIT WEIGHT P.C.F.		DESIGN SHEAR STRENGTHS Q			R			S		
	SAT.	MOIST	C(T.S.F.)	Ø	TAN Ø	C(T.S.F.)	Ø	TAN Ø	C(T.S.F.)	Ø	TAN Ø
BERM	115	110	0.45	0.00	0.00	0.10	11.3	0.20	0.00	16.7	0.30
HILLSIDE BORROW	125	115	0.90	0.00	0.00	0.20	11.3	0.20	0.00	19.8	0.36
VALLEY BORROW	125	115	0.90	0.00	0.00	0.20	11.3	0.20	0.00	26.6	0.50
FOUNDATION OVERBURDEN	115	110	0.60	0.00	0.00	0.20	11.3	0.20	0.00	26.6	0.50
SHALE - PEAK	140	140	-	-	-	-	-	-	0.00	31.0	0.60
SHALE - RESIDUAL	140	140	-	-	-	-	-	-	0.00	16.7	0.30



ACTIVITY = $\frac{PI}{\%\ PASS\ 2\ MICRONS}$

Symbol	Revisions Descriptions	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY MISSOURI

Designed by: WBE
Drawn by: EGM
Checked by: RGD/WBE
Submitted by: FCW

US Army Corps of Engineers

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA AND PERFORMANCE REPORT

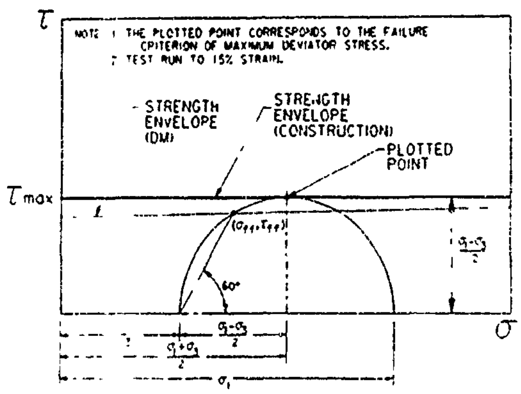
TEST DATA SUMMARIES
LIQUID LIMIT-60 IMPERVIOUS ZONE
STAGE II

Scale: AS SHOWN
Sheet number
Date
Dwg. No.

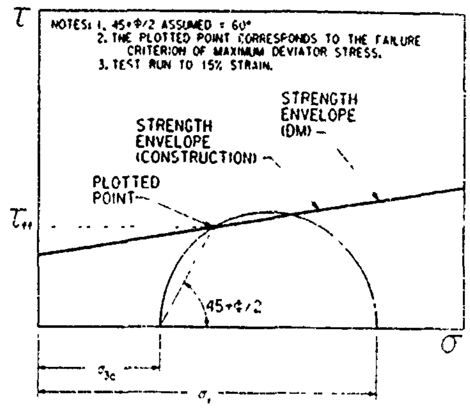
RBL-3-1459

5 4 3

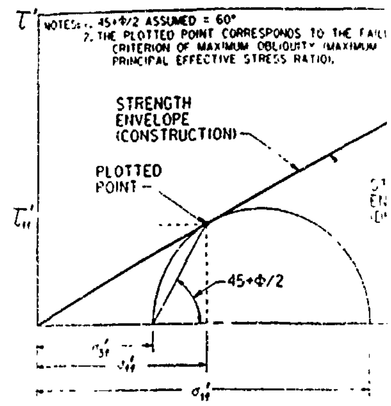
D



"Q"
MOHR'S DIAGRAM



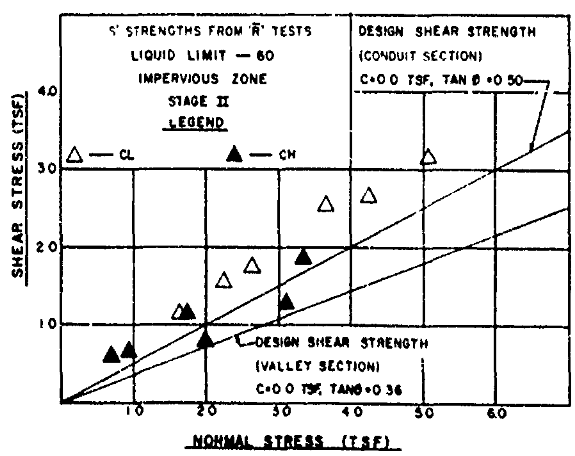
TOTAL STRESS "R"
MOHR'S DIAGRAM

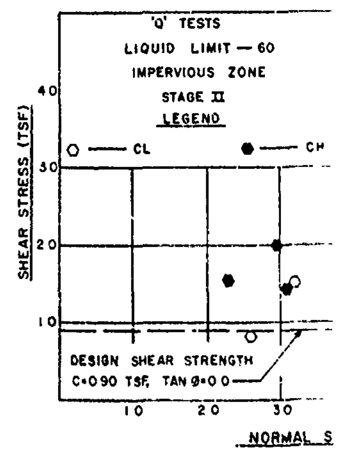


EFFECTIVE STRESS
MOHR'S DIAGRAM

C

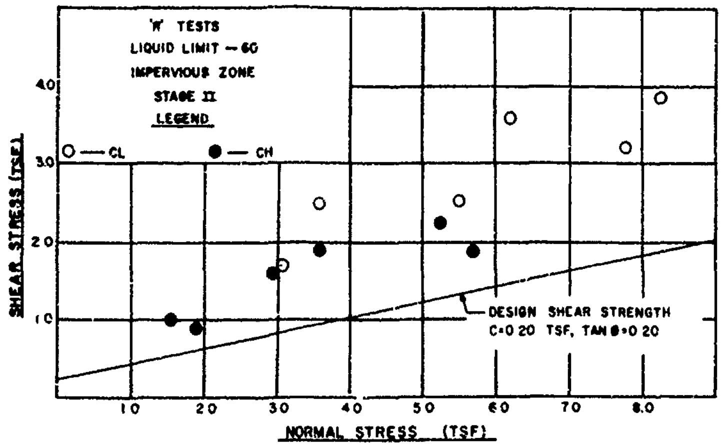
B

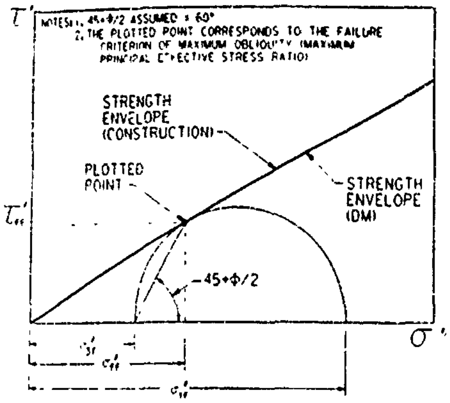




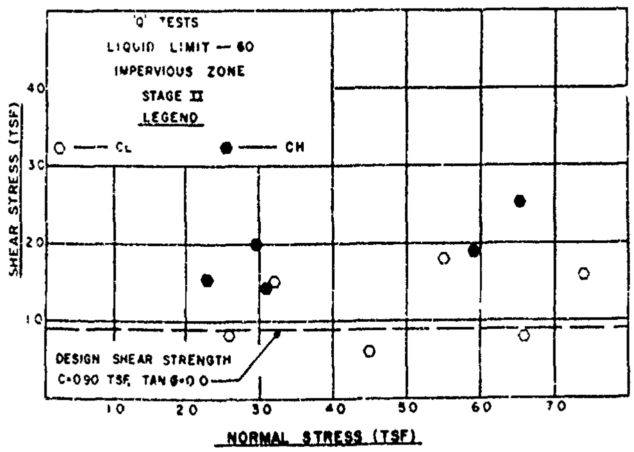
A

5 4 3





EFFECTIVE STRESS
MOHR'S DIAGRAM



Revisions			
Symbol	Descriptions	Date	Approved

U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

Designed by: W B E
Drawn by: J G S
Checked by: R G D / W B E
Submitted by: F C W

US Army Corps of Engineers

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA AND PERFORMANCE REPORT

SHEAR TEST SUMMARIES
LIQUID LIMIT-60 IMPERVIOUS ZONE
STAGE II

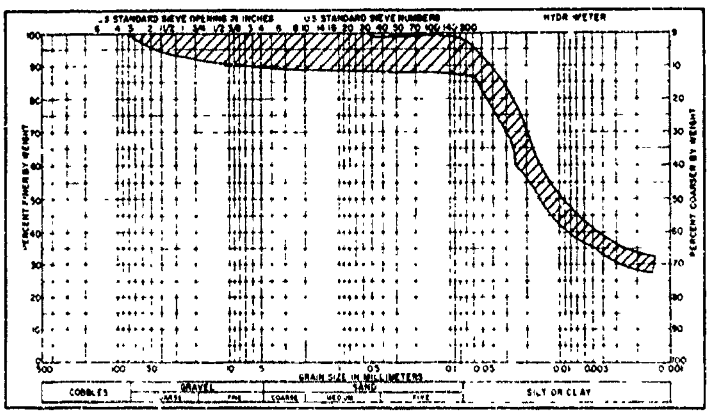
Scale: AS SHOWN
Date:
Dwg No:
Sheet number:
File No. RBL-3-1460

PLATE NO. 60

DATA ON RECORD CONTROL SAMPLES
STAGE II LIQUID LIMIT – 60 RANDOM ZONE

HOLE NO.	SAMPLE DEPTH	CLASSIFICATION SYM.	CLASSIFICATION L L.	CLASSIFICATION P.L.	CLASSIFICATION P.I.	DRY DENSITY MAX	DRY DENSITY INITIAL RANGE	WATER CONTENT OPT	WATER CONTENT INITIAL RANGE	WATER CONTENT PERCENT SATURATION	"Q… TAN ø
RC-479-17		CH	52	18	34	978	103 4-104 5	227	22 2-22.8	100	005…
RC-674-24		CH	52	15	41	98.0	98 4-99 7	228	24 6-25.1	96-97	003…
PPE-94-1	5 5-5.9	CH	53	17	36		99 6-102 4		22 9-24 6	96	0.02…
	11.5-11.9	CL	49	16	33		106 5-108 0		20.4-21.3	100	0 00…
	24.5-25.0	CL	38	14	24		1076-110 6		19.4-20 8	96-100	0 04…

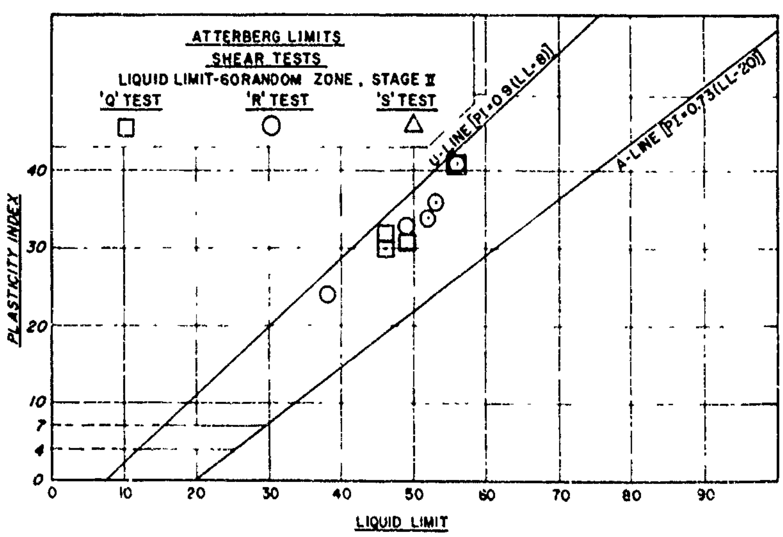
NOTE: EXCEPT FOR THE "R" TEST, ALL SHEAR STRENGTH PARAMETERS PROVIDED ON THE SUMMARY TABLE ABOVE WERE DERIVED FROM A BEST F…
THE "R" TEST-EFFECTIVE STRESS STRENGTH PARAMETERS WERE DERIVED FROM THE POINTS PLOTTED AS DESIGNATED BY THE CORRESPON…

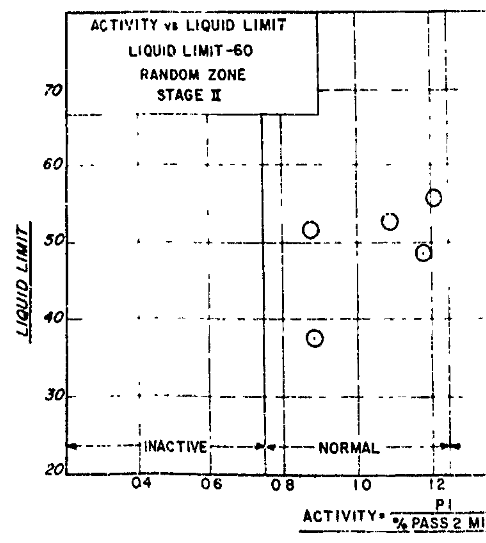


LIQUID LIMIT - 60 RANDOM ZONE STAGE II
GRADATION LIMITS FOR RECORD CONTROL SAMPLES TESTED.

PHYSICAL SOIL CONSTAN…

MATERIAL	UNIT WEIGHT P.C.F. SAT.	UNIT WEIGHT P.C.F. MOIST	C(T.S.F)	Q ø	DESIGN… TAN ø	C(T.S…
BERM	115	110	0.45	0.00	0.00	0.1…
HILLSIDE BORROW	125	115	0.90	0.00	0.00	0.2…
VALLEY BORROW	125	115	0.90	0.00	0.00	0…
FOUNDATION OVERBURDEN	115	110	0.60	0.00	0.00	0…
SHALE PEAK	140	140		-		
SHALE - RESIDUAL	140	140	-		-	-





DATA ON RECORD CONTROL SAMPLES

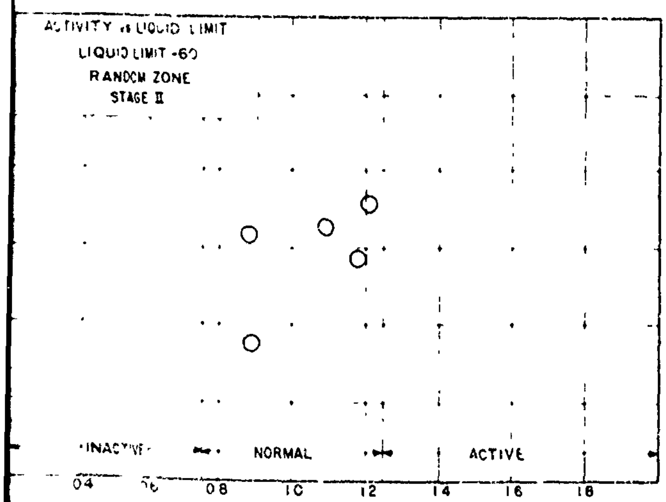
TAGE II LIQUID LIMIT-60 RANDOM ZONE

SITY	WATER CONTENT			"Q" TEST		"R" TEST		"R" TEST		"S" TEST DIRECT SHEAR	
L RANGE	OPT	INITIAL RANGE	PERCENT SATURATION	TAN Ø	C TSF	TAN Ø	C TSF	TAN Ø	C TSF	TAN Ø	C T.S.F
104 5	227	22 2-22 8	100	0052	1 00	0 456	0.20	0222	0 50		
99 7	228	24 6-25 1	96-97	0035	1 05	0 456	0 07	0240	0.20		
102 4		22 9-24 6	96	0 026	1 05	0.414	0 20	0096	1 25		
108 0		20 4-21.3	100	0 009	1 18	0 466	0 28	0259	0 73		
110 6		19 4-20 8	98-100	0.044	0 78	0.577	0	0335	0		

N THE SUMMARY TABLE ABOVE WERE DERIVED FROM A BEST FIT TANGENT TO THE MOHR'S CIRCLES FOR EACH SAMPLE TESTED.
OM THE POINTS PLOTTED AS DESIGNATED BY THE CORRESPONDING MOHR'S DIAGRAM.

PHYSICAL SOIL CONSTANTS

ATERIAL	UNIT WEIGHT P.C.F. SAT.	MOIST	Q C(T.S.F)	Q Ø	Q TAN Ø	R C(T.S.F)	R Ø	R TAN Ø	S C(T.S.F)	S Ø	S TAN Ø
	15	9	0.45	0.00	0.00	0.10	11.3	0.20	0.00	16.7	0.30
BORROW	125	15	0.90	0.00	0.00	0.20	11.3	0.20	0.00	19.8	0.36
ROW	125	15	0.90	0.00	0.00	0.20	11.3	0.20	0.00	26.6	0.50
ON OVERBURDEN	15	[illegible]	0.60	0.00	0.00	0.20	11.3	0.20	0.00	26.6	0.50
AK	40	40				-	-		0.00	31.0	0.60
OUA	40	40				-			0.00	16.7	0.30



ACTIVITY = $\frac{PI}{\%\ PASS\ 2\ MICRONS}$

Symbol	Revisions Descriptions	Date	Approved

U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY MISSOURI

US Army Corps of Engineers

Designed: W B E
Drawn: R A C
Checked: R G D / W B E
Submitted: F C W

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA AND PERFORMANCE REPORT

TEST DATA SUMMARIES
LIQUID LIMIT-60 RANDOM ZONE
STAGE II

Scale: AS SHOWN

RBL-3-1461

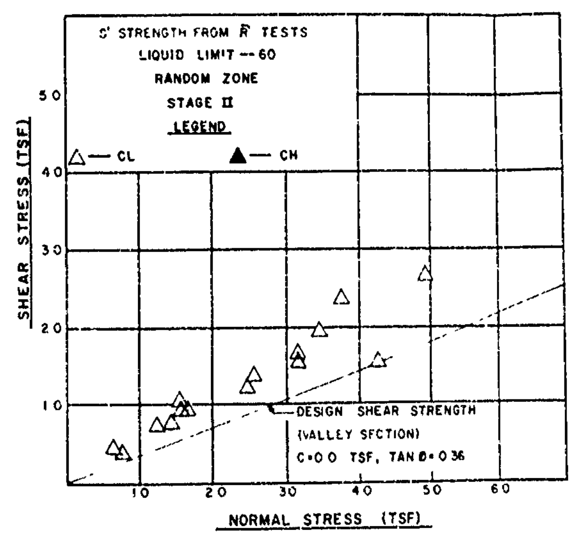
5 4 3

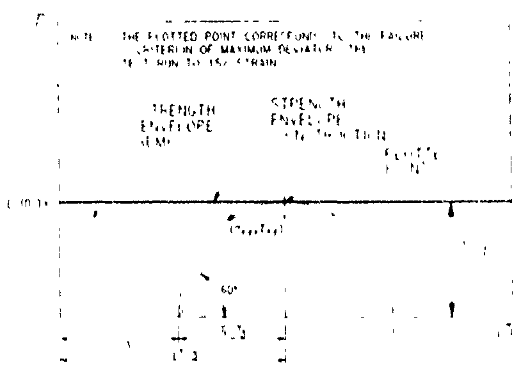
D

C

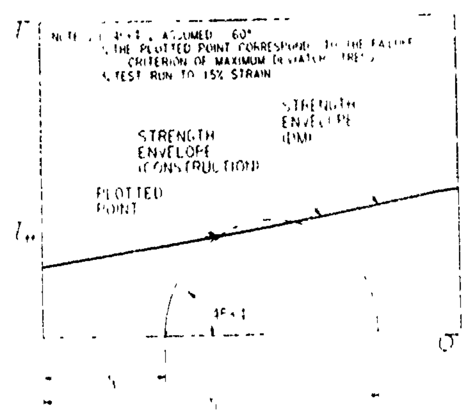
B

A

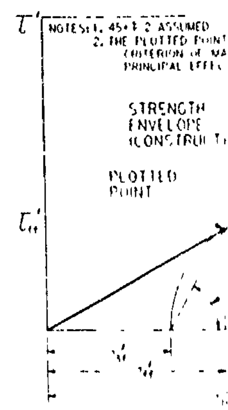




"Q"
MOHR'S DIAGRAM



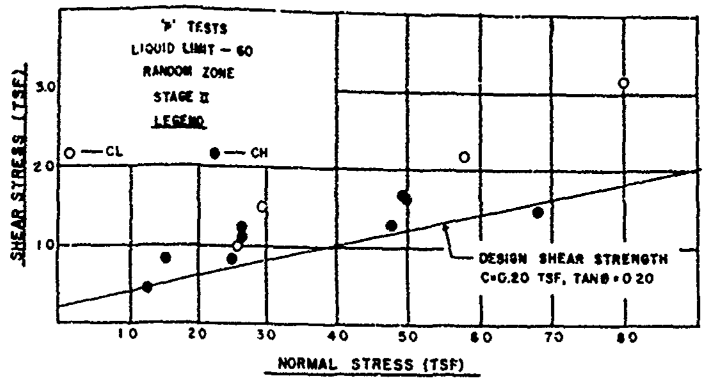
TOTAL STRESS "R"
MOHR'S DIAGRAM

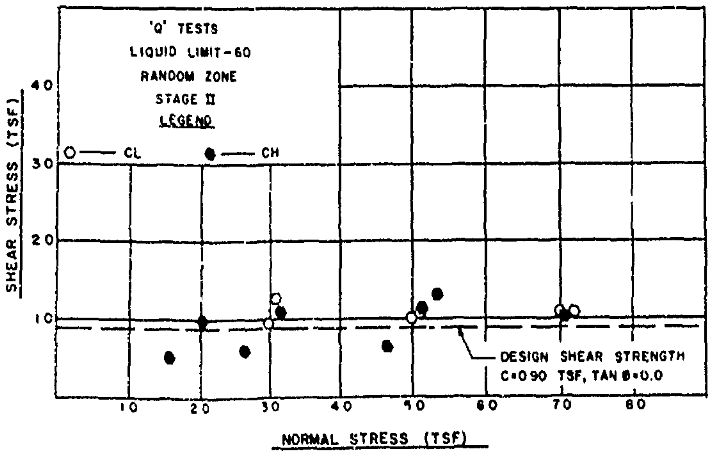


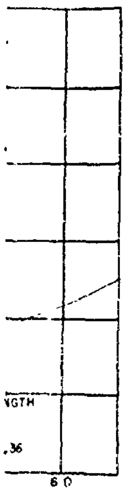
EFFE
MOH

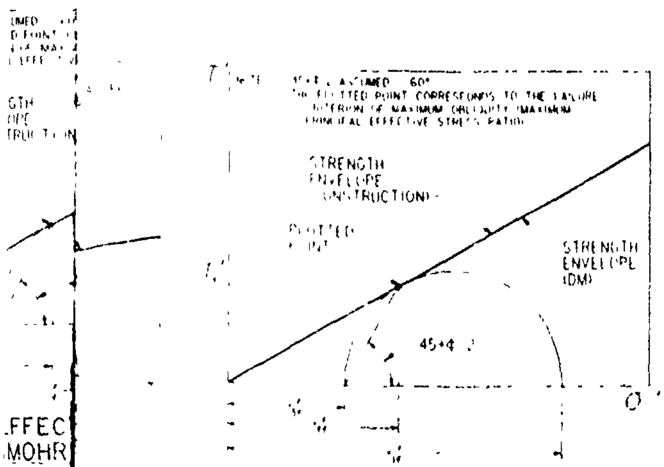
5 4 3

3 2 1









EFFECTIVE STRESS
MOHR'S DIAGRAM

Revisions			
Symbol	Descriptions	Date	Approved

U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

Designed by WBE
Drawn by MAW
Checked by RGW/WBE
Submitted by FCW

US Army Corps of Engineers

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA AND
PERFORMANCE REPORT
SHEAR TEST SUMMARIES
LIQUID LIMIT-60 RANDOM ZONE
STAGE II

Scale AS SHOWN

File No RBL-3-1462

3 2 1

PLATE NO 62

A B C D

5 4 3

D

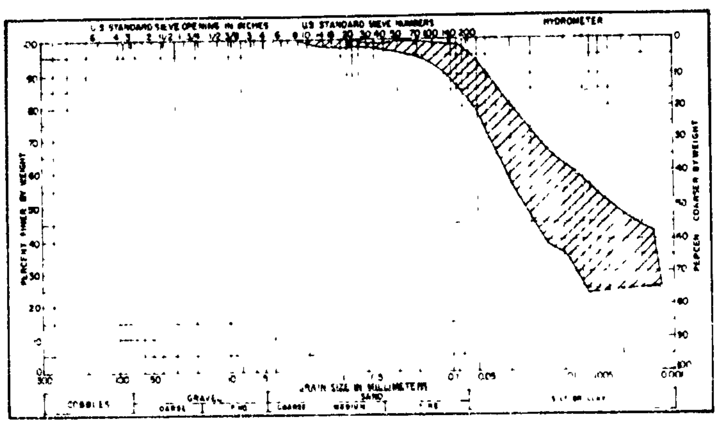
DATA ON RECORD CONTROL SAMPLES

STAGE II LIQUID LIMIT — 65 IMPERVIOUS ZO

HOLE NO	SAMPLE DEPTH	CLASSIFICATION				DRY DENSITY		WATER CONTENT		
		SYN	L L	P L	P I.	MAX	INITIAL RANGE	OPT	INITIAL RANGE	PER CENT SATURATION
RC-445-15		CL	41	18	23	99 2	104.3 — 106 1	22.7	20.9 — 21.8	96
RC-724-28		CH	55	17	38	97 7	98.8 — 100 1	20 7	23 6 — 24 1	95–96
RC-821-30		CH	56	25	31	97 3	101.2 — 102 4	23 3	24.4 — 24.9	96–97
RO-882-33		CL	49	16	33	102.4	104 5 — 105 5	19 7	21 2 — 21 8	94–99
U-745	64–69	CH	64	16	48		99 4 — 104 2		22.8 — 23 3	92–100
	16.4–16.9	CL	49	18	31		102 1 — 104 1		22.3 — 23 5	96–99

NOTE: EXCEPT FOR THE 'R' TEST, ALL SHEAR STRENGTH PARAMETERS PROVIDED ON THE SUMMARY TABLE ABOVE WERE DERIVED FROM A
THE 'R' TEST-EFFECTIVE STRESS STRENGTH PARAMETERS WERE DERIVED FROM THE POINTS PLOTTED AS DESIGNATED BY THE CORR

C

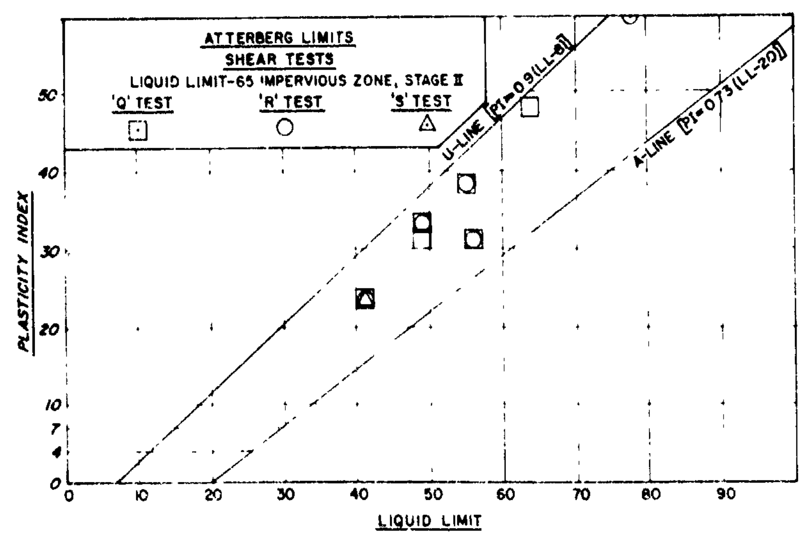


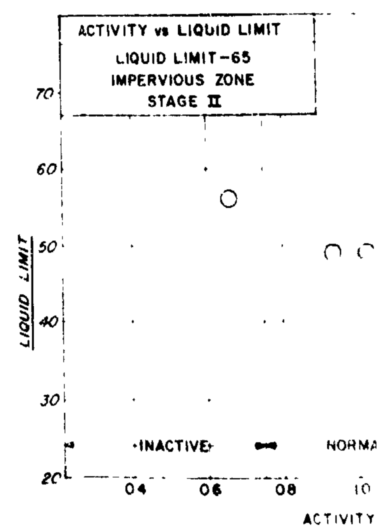
LIQUID LIMIT - 65 IMPERVIOUS ZONE STAGE II
CRADATION LIMITS FOR RECORD CONTROL SAMPLES TESTED.

PHYSICAL SOIL

MATERIAL	UNIT WEIGHT P.C.F. SAT.	MOIST	C(T.S.F.)	Ø
BERM	115	110	0.45	0.00
HILLSIDE BORROW	125	115	0.90	0.00
VALLEY BORROW	125	115	0.90	0.00
FOUNDATION OVERBURDEN	115	110	0.60	0.00
SHALE PEAK	140	140	-	
SHALE - RESIDUAL	140	140	-	

B





A

5 4 3

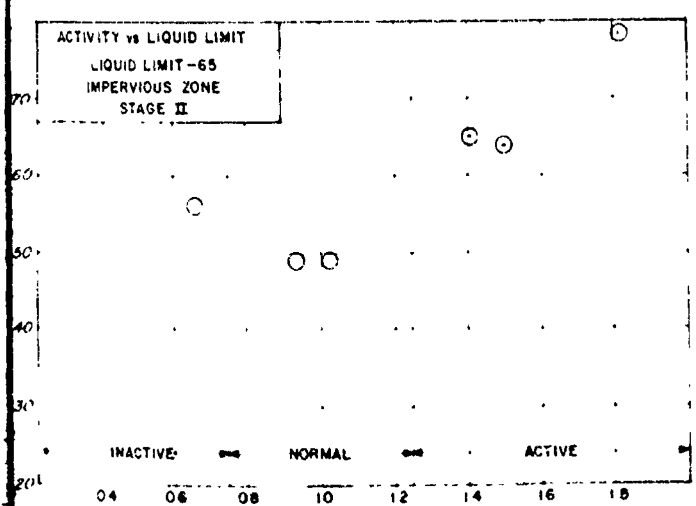
DATA ON RECORD CONTROL SAMPLES
II LIQUID LIMIT — 65 IMPERVIOUS ZONE

	WATER CONTENT			"Q" TEST		"R" TEST		"R" TEST		"S" TEST DIRECT SHEAR	
ANGE	OPT.	INITIAL RANGE	PER CENT SATURATION	TAN ø	C TSF	TAN ø	C TSF	TAN ø	C TSF	TAN ø	C TSF
06 1	22.7	209 — 21 8	96	0065	148	0.404	0.13	0.246	0.28	0505	0
00 1	207	236 — 241	95-96	0059	1.00	0 521	0 14	0 268	0.53		
02 4	233	244 — 249	96-97	0.045	1.13	0.379	0 17	0.213	0 30		
06 5	19 7	21 2 — 21 8	94-99	0040	1.50	0.344	0 21	0.216	0 53		
04 2		22.8 — 23.3	92—100	0.052	148	0.240	058	0.194	0 65		
04 1		22.3 — 23 5	94-99	0 070	0.75						

...E SUMMARY TABLE ABOVE WERE DERIVED FROM A BEST FIT TANGENT TO THE MOHR'S CIRCLES FOR EACH SAMPLE TESTED.
...THE POINTS PLOTTED AS DESIGNATED BY THE CORRESPONDING MOHR'S DIAGRAM.

PHYSICAL SOIL CONSTANTS

MATERIAL	UNIT WEIGHT P.C.F. SAT.	UNIT WEIGHT P.C.F. MOIST	DESIGN SHEAR STRENGTHS Q C(T.S.F.)	Q ø	Q TAN ø	R C(T.S.F.)	R ø	R TAN ø	S C(T.S.F.)	S ø	S TAN ø
	115	110	0.45	0.00	0.00	0.10	11.3	0.20	0.00	16.7	0.30
...E BORROW	125	115	0.90	0.00	0.00	0.20	11.3	0.20	0.00	19.8	0.36
... BORROW	125	115	0.90	0.00	0.00	0.20	11.3	0.20	0.00	26.6	0.50
...ION OVERBURDEN	115	110	0.60	0.00	0.00	0.20	11.3	0.20	0.00	26.6	0.50
... PEAK	140	140		-	-	-	-	-	0.00	31.0	0.60
... RESIDUAL	140	140	-	-	-	-	-	-	0.00	16.7	0.30



ACTIVITY = $\frac{PI}{\%\ PASS\ 2\ MICRONS}$

Symbol	Revisions Descriptions	Date	Approved

U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY MISSOURI

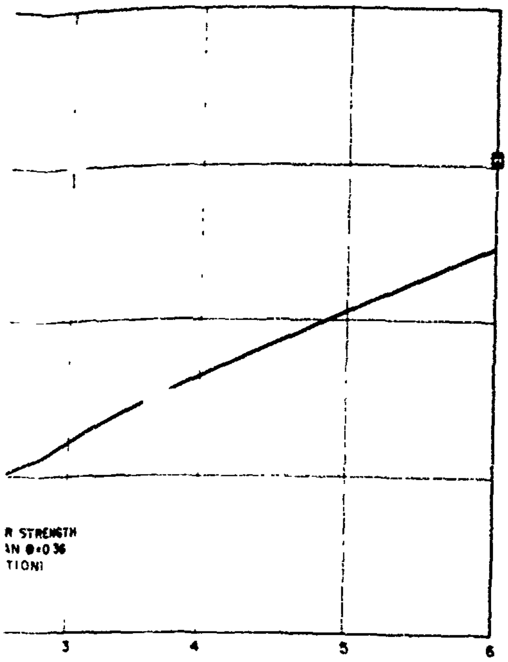
US Army Corps of Engineers

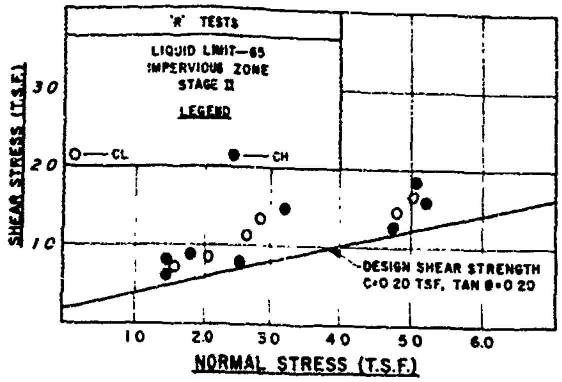
LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA AND
PERFORMANCE REPORT

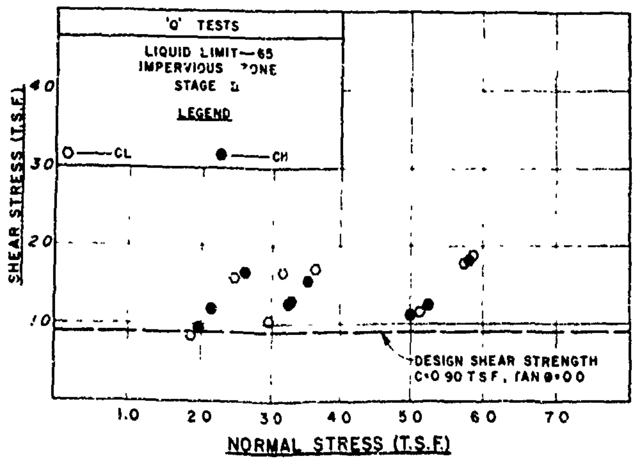
TEST DATA SUMMARIES
LIQUID LIMIT-65 IMPERVIOUS ZONE
STAGE II

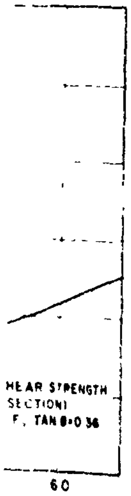
W B E
E G M
R C D / W B E
AS SHOWN
F L W

RBL-3-1463









Revisions			
Symbol	Descriptions	Date	Approved

U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

Designed by: WBE
Drawn by: JGS
Checked by: RGD/WBE
Submitted by: FCW

US Army Corps of Engineers

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA AND
PERFORMANCE REPORT

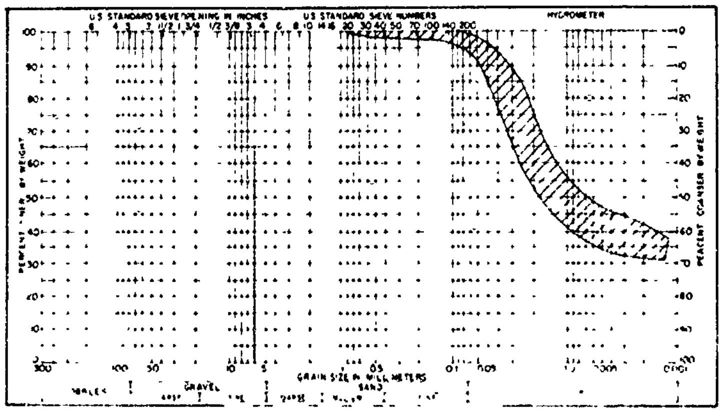
SHEAR TEST SUMMARIES
LIQUID LIMIT-65 IMPERVIOUS ZONE
STAGE II

Scale: AS SHOWN
Sheet number:
Date:
Dwg No:
File No. RBL-3-1464

DATA ON RECORD CONTROL SAMPLES
STAGE II LIQUID LIMIT-65 RANDOM ZONE

HOLE NO.	SAMPLE DEPTH	CLASSIFICATION SYN	L L.	PL	P.I.	DRY DENSITY MAX	INITIAL RANGE	WATER CONTENT OPT	INITIAL RANGE	PER CENT SATURATION	FA ø
RC-659-22		CH	57	16	41	99.7	1039 – 1056	20 8	19.5 – 20.5	84–90	0 2
RC-592-21		CH	62	16	46	97 5	101 0 – 101 6	22.6	240 – 244	99	0 0
RC-452-16		CH	54	16	38	100.2	1053 – 1065	21 6	21 2 – 21 9	98	0 0
[illegible]-92-1	58 3										
PPE-95-1	18.8–19 3	CH	78	20	58		1032 – 1046		20.7 – 20 8	89–92	
	28.8-29.3	CH	65	18	47		1041 – 105.0		22.2 – 22.5	100	0
PPE-93-12	5.4–5.9	CH	55	21	34		1075 – 1094		18 4 – 19 3	93–94	0 0

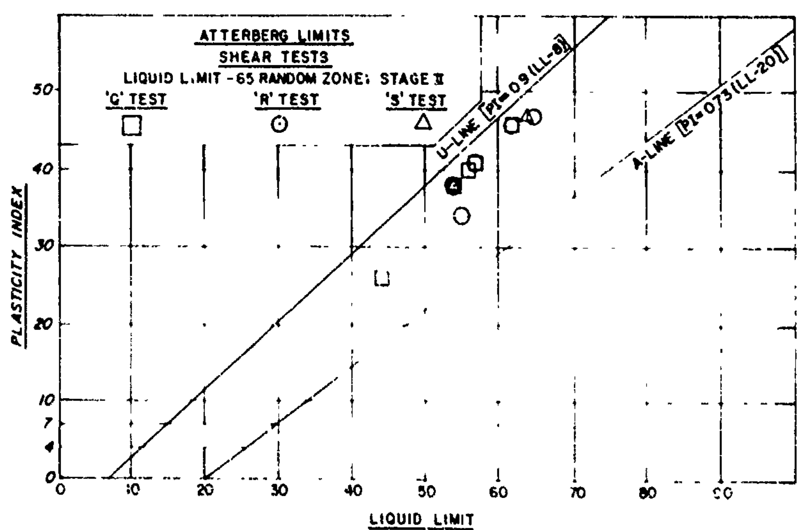
NOTE: EXCEPT FOR THE "R" TEST, ALL SHEAR STRENGTH PARAMETERS PROVIDED ON THE SUMMARY TABLE ABOVE WERE DERIVED FROM A BEST F
THE "R" TEST-EFFECTIVE STRESS STRENGTH PARAMETERS WERE DERIVED FROM THE POINTS PLOTTED AS DESIGNATED BY THE CORRESPON

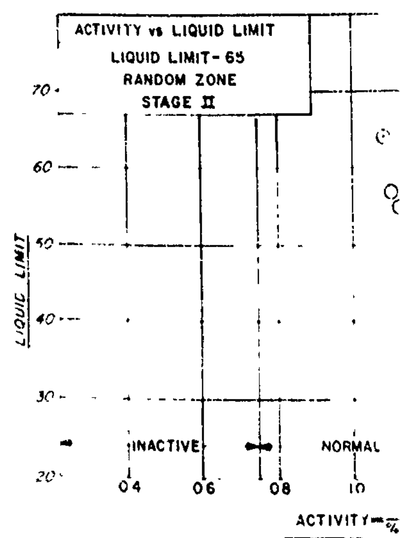


LIQUID LIMIT - 65 RANDOM ZONE STAGE II
CRADATION LIMITS FOR RECORD CONTROL SAMPLES TESTED.

PHYSICAL SOIL CONSTANT

MATERIAL	UNIT WEIGHT P.C.F. SAT.	MOIST	C(T.S.F)	0 ø	DESIGN S TAN ø	C(T.S.
BERM	115	110	0.45	0.00	0.00	0.10
HILLSIDE BORROW	125	115	0.90	0.00	0.00	0.20
VALLEY BORROW	125	115	0.90	0.00	0.00	0.20
FOUNDATION OVERBURDEN	115	110	0.60	0.00	0.00	0.[illegible]
SHALE - PEAK	140	140	-	-	-	-
SHALE - RESIDUAL	140	140	-	-		





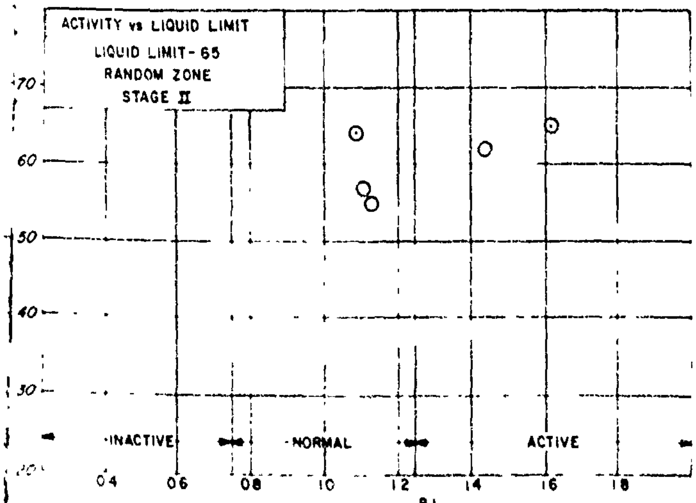
DATA ON RECORD CONTROL SAMPLES
LIQUID LIMIT-65 RANDOM ZONE

OPT	INITIAL RANGE	PER CENT SATURATION	"Q" TEST TAN ø	"Q" TEST C T.S.F.	"R̄" TEST TAN ø	"R̄" TEST C T.S.F	"R" TEST TAN ø	"R" TEST C T.S.F	"S" TEST DIRECT SHEAR TAN ø	"S" TEST DIRECT SHEAR C T.S.F
20.8	19.5 – 20.5	84–90	0.240	1.50	0.456	0.13	0.277	0.25		
22.6	24.0 – 24.4	99	0.017	1.30	0.466	0.23	0.249	0.53		
21.6	21.2 – 21.9	98	0.096	1.23	0.445	0.11	0.249	0.73	0.507	0
	20.7 – 20.8	89–92							0.477	0
	22.2 – 22.5	100	0	1.50	0.204	0.75	0.488	0.42		
	18.4 – 19.3	93–94	0.035	2.25	0.384	0.09	0.313	0.10		

... SUMMARY TABLE ABOVE WERE DERIVED FROM A BEST FIT TANGENT TO THE MOHR'S CIRCLES FOR EACH SAMPLE TESTED. ... POINTS PLOTTED AS DESIGNATED BY THE CORRESPONDING MOHR'S DIAGRAM.

PHYSICAL SOIL CONSTANTS

	UNIT WEIGHT P.C.F. SAT.	UNIT WEIGHT P.C.F. MOIST	DESIGN SHEAR STRENGTHS Q C(T.S.F.)	Q ø	Q TAN ø	R C(T.S.F.)	R ø	R TAN ø	S C(T.S.F.)	S ø	S TAN ø
	115	110	0.45	0.00	0.00	0.10	11.3	0.20	0.00	16.7	0.30
	125	115	0.90	0.00	0.00	0.20	11.3	0.20	0.00	19.8	0.36
	125	115	0.90	0.00	0.00	0.20	11.3	0.20	0.00	26.6	0.50
...RBURDEN	115	110	0.60	0.00	0.00	0.20	11.3	0.20	0.00	26.6	0.50
	140	140	-	-		-	-	-	0.00	31.0	0.60
	140	140	-	-	-	-	-	-	0.00	16.7	0.30



ACTIVITY = $\frac{\text{PI}}{\text{\% PASS 2 MICRONS}}$

Revisions Symbol	Descriptions	Date	Approved

U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

Designed by: W B E
Drawn by: E G M
Checked by: R.G.D./W.B.E.
Submitted by: F.C.W.

US Army Corps of Engineers

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA AND PERFORMANCE REPORT
TEST DATA SUMMARIES
LIQUID LIMIT-65 RANDOM ZONE
STAGE II

Scale: AS SHOWN
Date:
Dwg No:
Sheet number:
File No: RBL-3-1465

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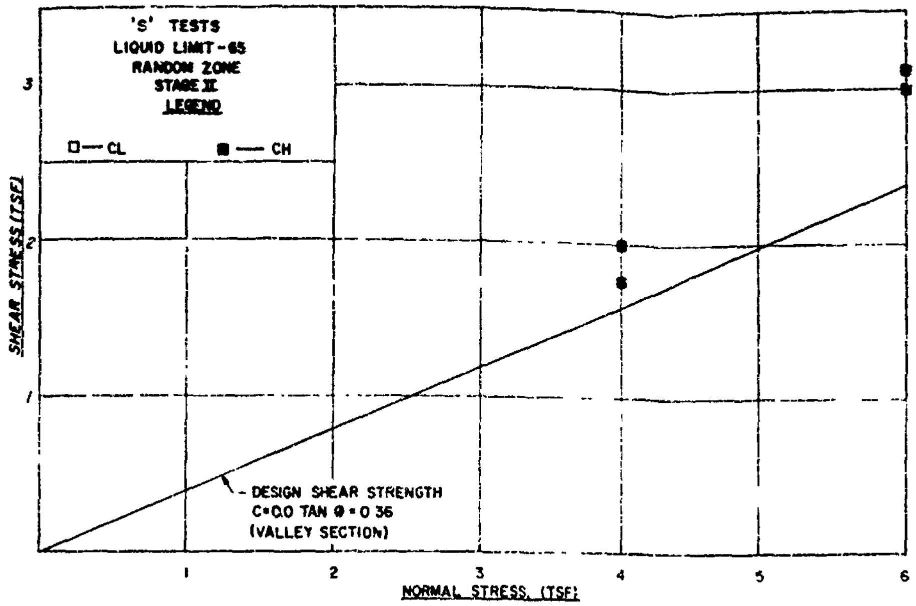

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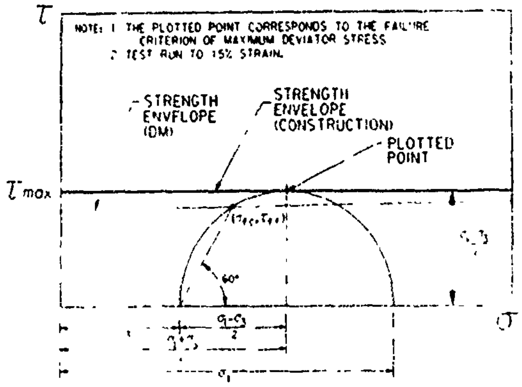
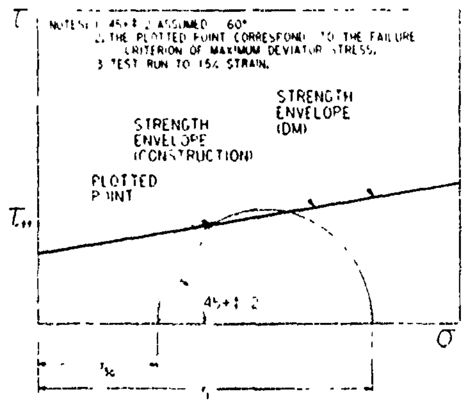
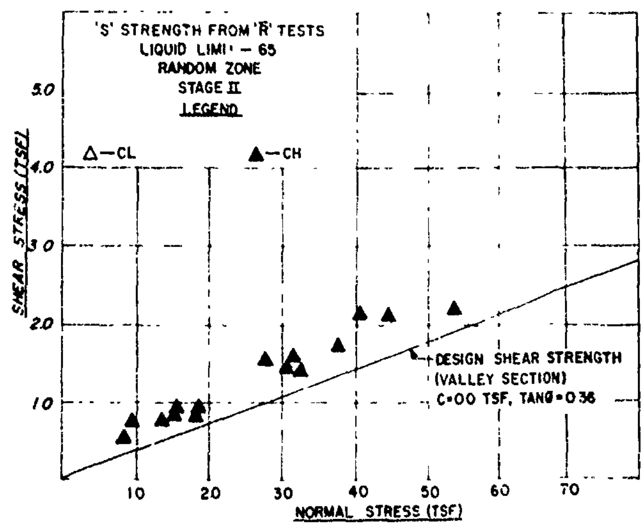


"Q"
MOHR'S DIAGRAM

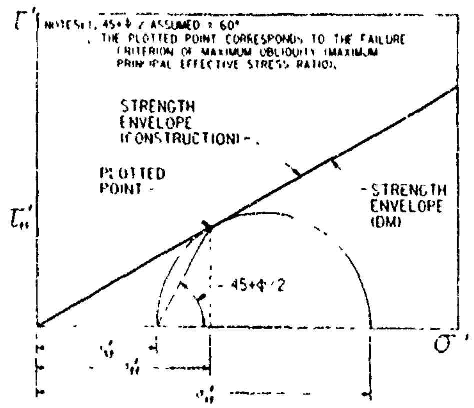
B





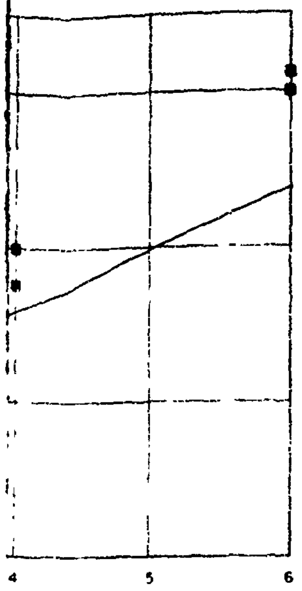
TOTAL STRESS "R"
MOHR'S DIAGRAM

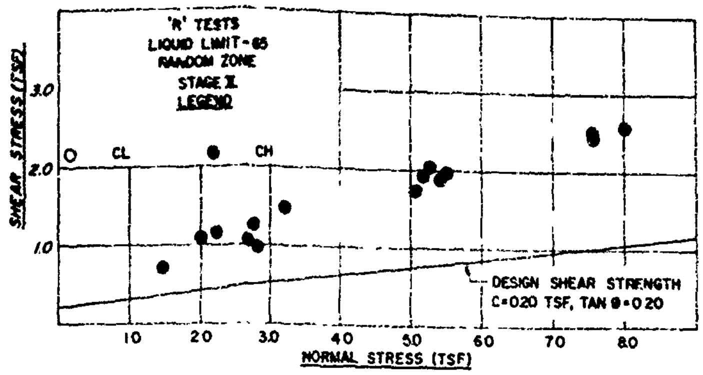
A

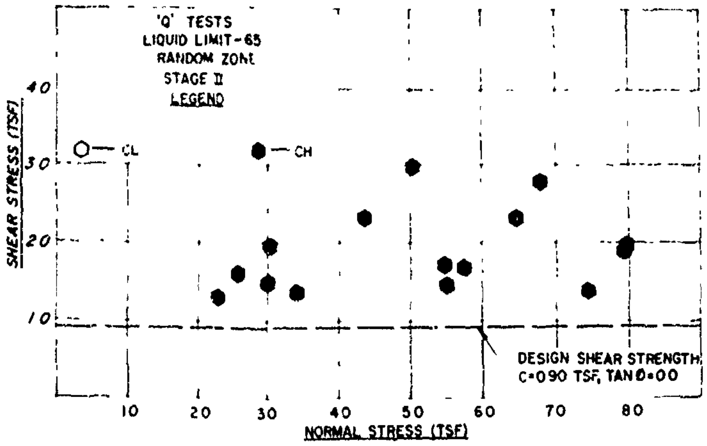


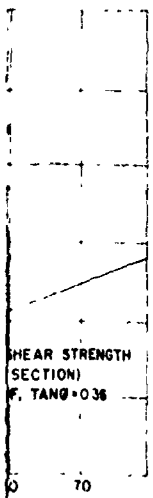
EFFECTIVE STRESS
MOHR'S DIAGRAM

5 4 3









Symbol	Revisions Descriptions	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

US Army Corps of Engineers

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA AND PERFORMANCE REPORT

SHEAR TEST SUMMARIES
LIQUID LIMIT-65 RANDOM ZONE
STAGE II

Designed by: WBE
Drawn by: JGS
Checked by: RGD/WBE
Submitted by: FCW
Scale: AS SHOWN
Dwg No.: RBL-3-1466

PLATE NO. 66

5 4 3

D

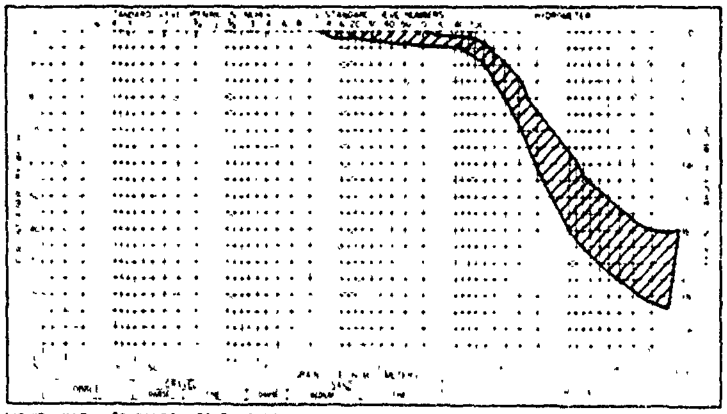
DATA ON RECORD CONTROL SAMPLES

STAGE II LIQUID LIMIT-70 RANDOM ZONE

HOLE NO.	SAMPLE DEPTH	CLASSIFICATION				DRY DENSITY		WATER CONTENT			'Q' TEST		'R̄' TEST		'R' TEST	
		SYM.	L.L.	P.L.	P.I.	MAX.	INITIAL RANGE	OPT.	INITIAL RANGE	(%) SATURAT.	TAN Ø	C T.S.F.	TAN Ø	C T.S.F.	TAN Ø	C T.S.F.
RC-856-31		CH	62	19	43	95.6	99.8-103.2	24.8	23.4-25.9	100	0.105	1.80	0.306	0.15	0.249	0.25
RC-878-32		CH	59	19	40	97.7	99.6-102.2	23.7	22.4-24.4	89-100	0.059	0.98	0.268	0.13	0.187	0.25
PPE-92-1	1.3-1.8	CH	66	19	47		93.5-101.3		24.3-25.5	98	0	1.75	0.259	0.55	0.374	0.26
	6.3-6.8	CH	72	20	52		100.9-102.2		22.9-23.2	93-96	0.144	1.38	0.217	0.51	0.394	0.31
	13.8-15.0						101.2-104.7		21.6-23.6	96						
	38.8-39.3	CH	78	22	56		98.[illegible]-99.5		25.4-25.6	98-99	0.061	1.03	0.306	0.50	0.394	0.41
PPE-95-1	0.0-0.5	CH	57	19	38		99.1-100.2		25.1-25.8	97-98	0.096	0.55	0.466	0.13	0.364	0.13
	8.3-8.8						91.8-95.4		28.5-31.2	100	0.158	1.05	0.185	0.25	0.222	0.25
U-744	6.4-6.9	CH	77	19	58		93.4-96.7		28.4-29.2	99-100	0.013	1.48	0.216	0.34	0.149	0.45
	10.5-11.0	CH	70	16	54		103.7-106.9		20.9-22.3		0	1.50	0.257	0.40	0.154	0.60
	20.1-20.6	CH	83	19	64		99.8-100.6		23.7-24.2		0	1.10	0.325	0.21	0.173	0.30

NOTE: EXCEPT FOR THE 'R̄' TEST, ALL SHEAR STRENGTH PARAMETERS PROVIDED ON THE SUMMARY TABLE ABOVE WERE DERIVED FROM A BEST FIT TANGENT TO THE MOHR'S CIRCLES FOR EACH SAMPLE TES
THE 'R̄' TEST-EFFECTIVE STRESS STRENGTH PARAMETERS WERE DERIVED FROM THE POINTS PLOTTED AS DESIGNATED BY THE CORRESPONDING MOHR'S DIAGRAM.

C

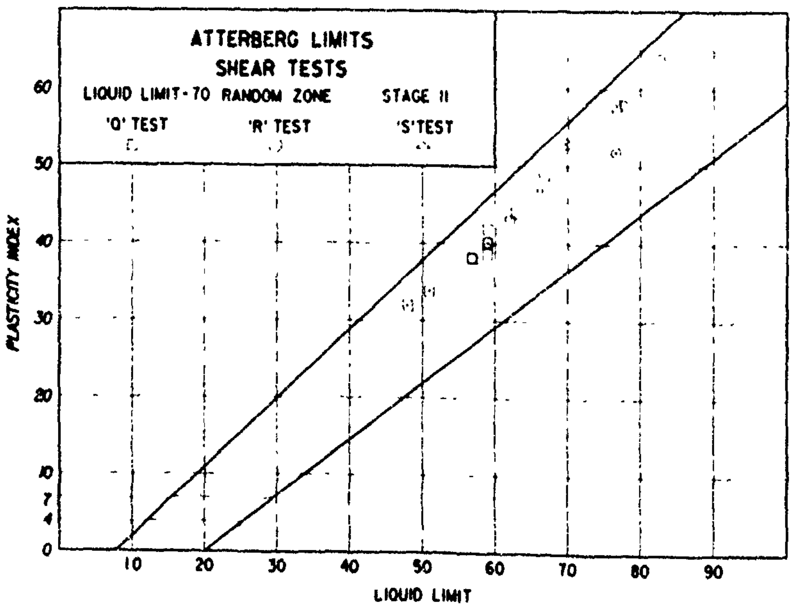


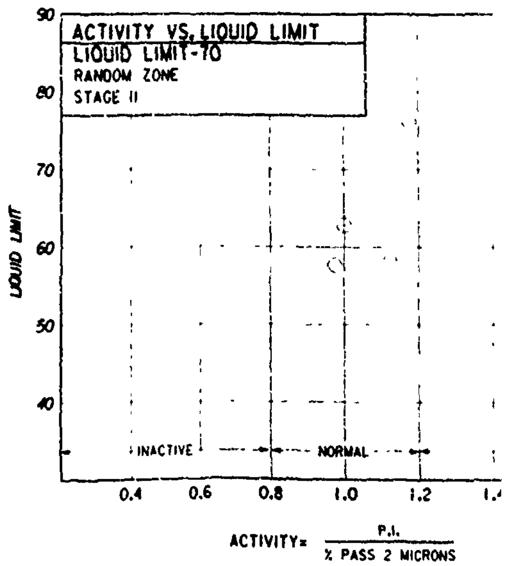
LIQUID LIMIT - 70 RANDOM ZONE STAGE II
GRADATION LIMITS FOR RECORD CONTROL SAMPLES TESTED.

PHYSICAL SOIL CONSTANTS

MATERIAL	UNIT WEIGHT P.C.F.		DESIGN SHEAR ST				
			Q				R
	SAT.	MOIST	C(T.S.F.)	Ø	TAN Ø	C(T.S.F.)	Ø
BERM	115	110	0.45	0.00	0.00	0.10	11.3
HILLSIDE BORROW	125	115	0.90	0.00	0.00	0.20	11.3
VALLEY BORROW	125	115	0.90	0.00	0.00	0.20	11.3
FOUNDATION OVERBURDEN	115	110	0.60	0.00	0.00	0.20	11.3
SHALE - PEAK	140	140	-	-	-	-	-
SHALE - RESIDUAL	140	140	-	-	-	-	-

B





ACTIVITY = $\frac{\text{P.I.}}{\text{\% PASS 2 MICRONS}}$

A

5 4 3

VALUE

VALUE ENGINEERING PAYS

3 2 1

D

"S" T
DIRECT
TAN θ

0.538

TESTE

F.	Q TEST TAN θ	Q TEST C T.S.F.	"R" TEST TAN θ	"R" TEST C T.S.F.	"S" TEST DIRECT SHEAR TAN θ	"S" TEST DIRECT SHEAR C T.S.F.
)	0.306	0.6	0.249	0.25		
8	0.268	0.3	0.187	0.25		
	0.299	0.95	0.374	0.26		
	0.277	0.5	0.384	0.3		
					0.538	0
	0.306	0.50	0.394	0.41		
	0.466	0.3	0.364	0.3		
	0.185	0.25	0.222	0.25		
	0.26	0.34	0.49	0.45		
	0.257	0.40	0.54	0.60		
	0.325	0.21	0.173	0.30		

TO THE MOHR'S CIRCLES FOR EACH SAMPLE TESTED.
DIAGRAM

C

R STRENGT

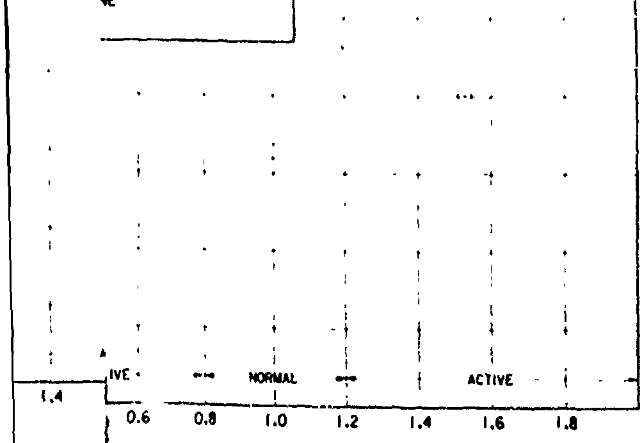
R θ	TAN θ
.3	0.2
.3	0.2
.3	0.
.3	0.2

PHYSICAL SOIL CONSTANTS

WEIGHT C.F. MOIST	DESIGN SHEAR STRENGTHS C(T.S.F)	Q θ	Q TAN θ	C(T.S.F)	R θ	R TAN θ	C(T.S.F)	S θ	S TAN θ
10	0.45	0.00	0.00	0.10	1.3	0.20	0.00	16.7	0.30
15	0.90	0.00	0.00	0.20	1.3	0.20	0.00	19.8	0.36
15	0.90	0.00	0.00	0.20	1.3	0.20	0.00	26.6	0.50
10	0.60	0.00	0.00	0.20	1.3	0.20	0.00	26.6	0.50
140							0.00	34.0	0.60
140							0.00	16.7	0.30

B

VS. LIQUID LIMIT
MIT-70
NE



ACTIVITY = $\frac{\text{P.I.}}{\text{\% PASS 2 MICRONS}}$

A

Symbol	Revisions Descriptions	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

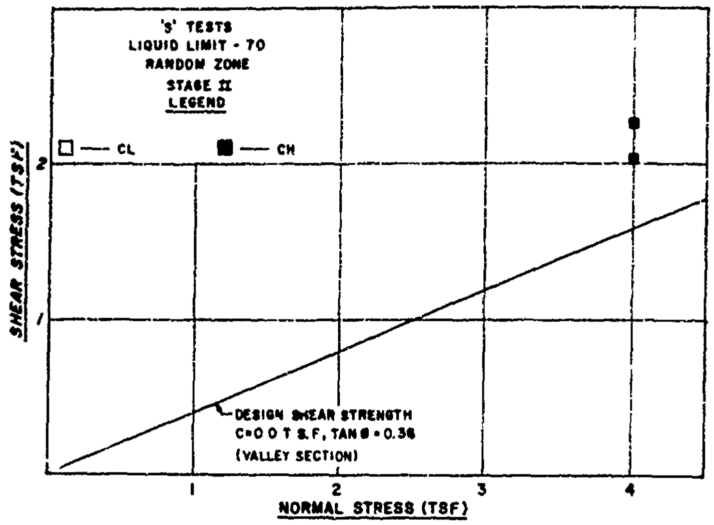
Designed by: R.C.D.	US Army Corps of Engineers — LITTLE BLUE RIVER, MISSOURI LONGVIEW LAKE EMBANKMENT CRITERIA AND PERFORMANCE REPORT **TEST DATA SUMMARIES LIQUID LIMIT-70 RANDOM ZONE STAGE II**
Drawn by: R.A.C.	
Checked by: A.L.P.	Scale: AS SHOWN; Sheet number; Plot Scale: 12 :1
Submitted by: R.G.D.	Date:; Design File: 100.623LVLRPT80; Dwg. No.:; File No.: RBL-3-1467

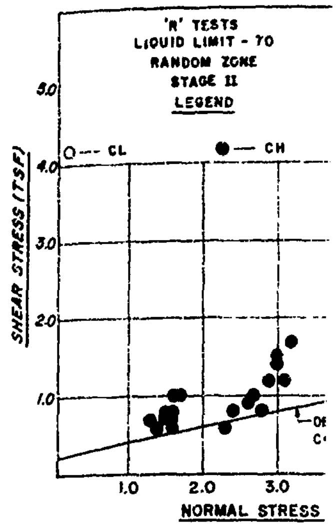
3 2 1

PLATE NO. 67

5 4 3

D





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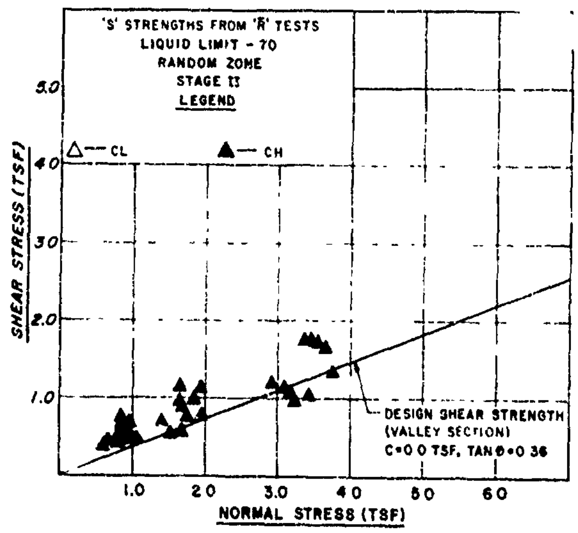

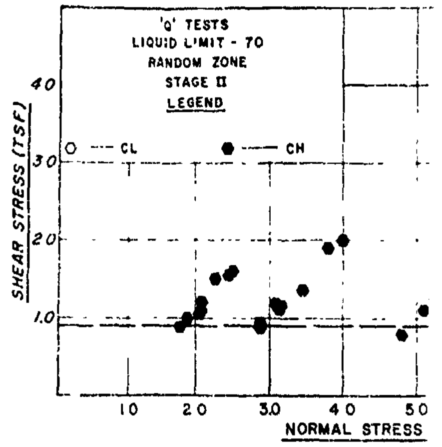

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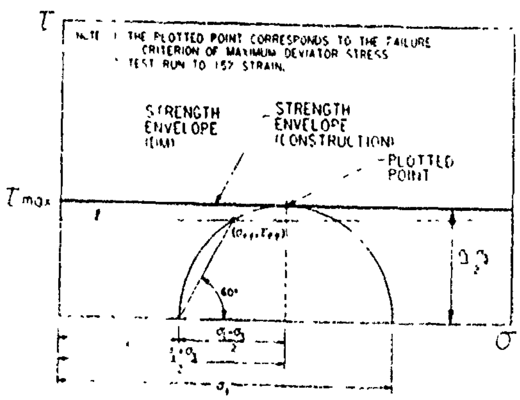
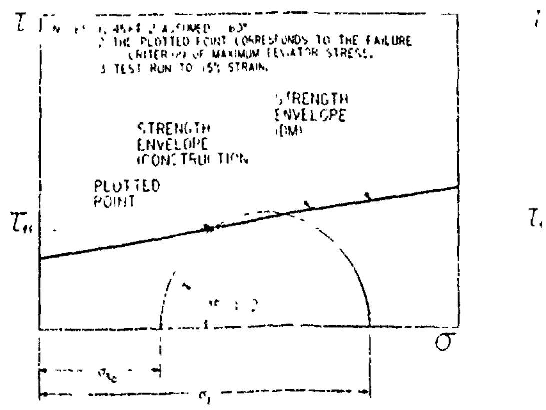


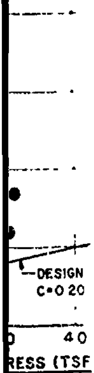
"Q"
MOHR'S DIAGRAM

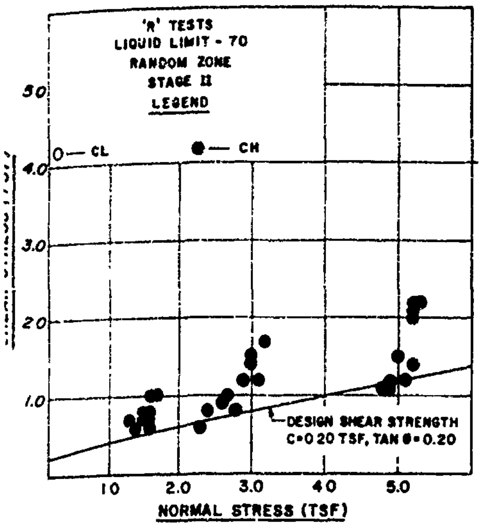


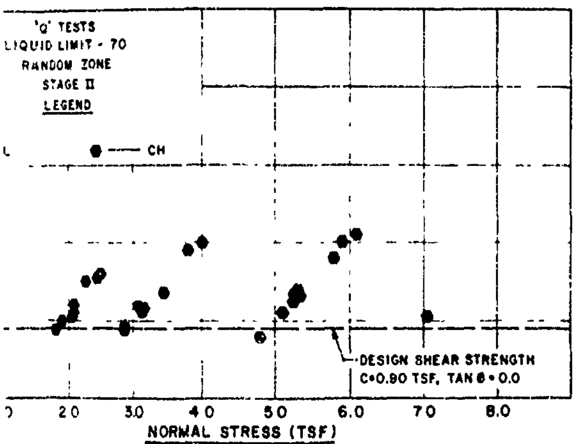
TOTAL STRESS "R"
MOHR'S DIAGRAM

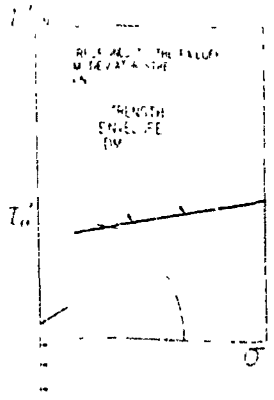
A

5 4 3

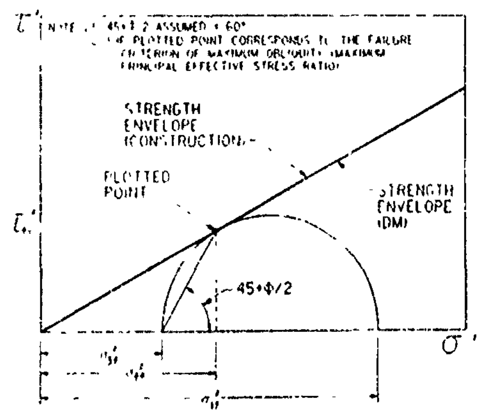








TRESS "R"
DIAGRAM



EFFECTIVE STRESS
MOHR'S DIAGRAM

Revisions			
Symbol	Descriptions	Date	Approved

U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

Designed by: W B E	LITTLE BLUE RIVER, MISSOURI LONGVIEW LAKE EMBANKMENT CRITERIA AND PERFORMANCE REPORT SHEAR TEST SUMMARIES LIQUID LIMIT-70 RANDOM ZONE STAGE II
Drawn by: E G M	
Checked by: W B E / R G D	Scale: AS SHOWN
Submitted by: F C W	File No.: RBL-3-1468

PLATE NO. 68

5 4 3

D

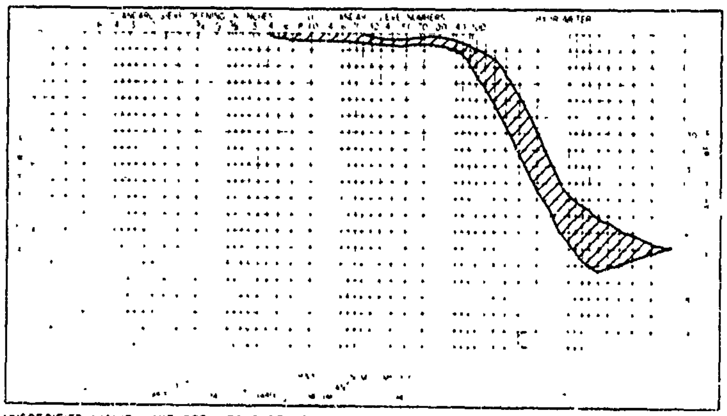
DATA ON RECORD CONTROL SAMPLES
STAGE II, UNSPECIFIED LIQUID LIMIT-BERM ZONE

HOLE NO	SAMPLE DEPTH	CLASSIFICATION				DRY DENSITY		WATER CONTENT			'Q' TEST		'R̄' TEST		'R' TEST		"S" TEST DIRECT
		SYM.	L.L.	P.L.	P.I.	MAX.	INITIAL RANGE	OPT.	INITIAL RANGE	(%) SATURAT.	TAN Ø	C T.S.F.	TAN Ø	C T.S.F.	TAN Ø	C T.S.F.	TAN Ø
RC-675-25		CH	58	15	43	99.9	95.0-103.4	21.8	21.1-21.7	75-90	0.259	0.75	0.404	0.20	0.203	0.35	
RC-514-18		CL	49	16	33	100.3	103.3-105.7	20.3	19.4-20.7	83-90	0.296	1.25	0.414	0.21	0.315	0.15	
PPF-93-10A	2.0-2.5	CL	38	16	22		96.2-96.8		26.7-27.5	95-100	0.052	1.38					
SACK 1✳		CL	47	18	29	96.8	91.6-92.1	21.7	24.1-24.7	80-81	0.013	0.53	0.556	0	0.277	0.08	
U-594	3.0	CH	56	16	40		97.5-101.5		22.6-26.1	92-96			0.384	0.07	0.249	0.23	
	13.0	CH	54	15	39		105.2-106.8		20.5-21.3	96-97	0.249	2.0	0.364	0.20	0.259	0.325	

NOTE: EXCEPT FOR THE 'R̄' TEST, ALL SHEAR STRENGTH PARAMETERS PROVIDED ON THE SUMMARY TABLE ABOVE WERE DERIVED FROM A BEST FIT TANGENT TO THE MOHR'S CIRCLES FOR EACH SAMPLE TESTED. THE 'R̄' TEST-EFFECTIVE STRESS STRENGTH PARAMETERS WERE DERIVED FROM THE POINTS PLOTTED AS DESIGNATED BY THE CORRESPONDING MOHR'S DIAGRAM.

✳ COMPOSITE SAMPLE FROM RIGHT ABUTMENT SEEP AREA

C



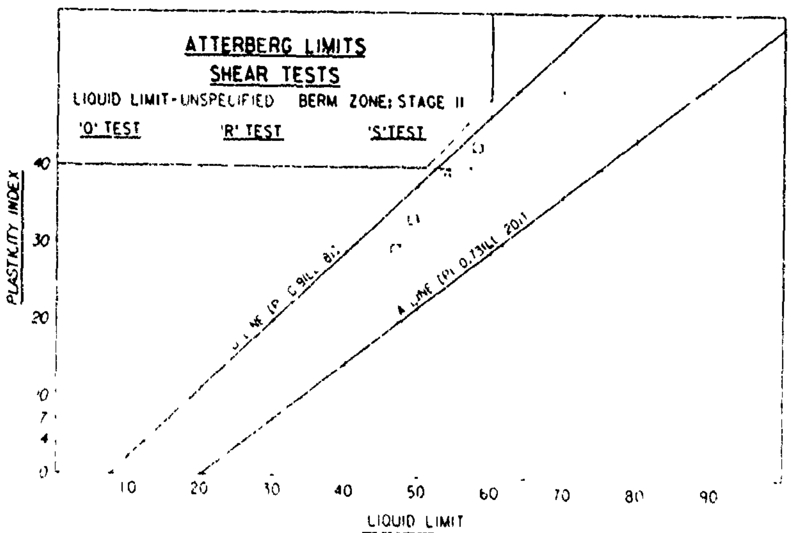
UNSPECIFIED LIQUID LIMIT BERM ZONE STAGE II
GRADATION LIMITS FOR RECORD CONTROL SAMPLES TESTED.

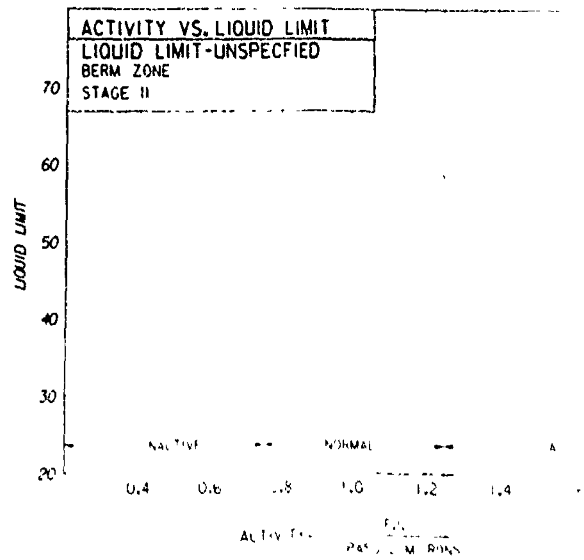
PHYSICAL SOIL CONSTANTS

MATERIAL	UNIT WEIGHT P.C.F.			Q	DESIGN SHEAR STR		R
	SAT.	MOIST	C(T.S.F)	Ø	TAN Ø	C(T.S.F)	Ø
BERM	115	110	0.45	0.00	0.00	0.10	11.3
HILLSIDE BORROW	125	115	0.90	0.00	0.00	0.20	11.3
VALLEY BORROW	125	115	0.90	0.00	0.00	0.20	11.3
FOUNDATION OVERBURDEN	115	110	0.60	0.00	0.00	0.20	11.
SHALE - PEAK	140	140	-	-	-		
SHALE - RESIDUAL	140	140	-	-	-	-	

B

A





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.F.	"R̄" TEST TAN Ø	"R̄" TEST C T.S.F.	"R" TEST TAN Ø	"R" TEST C T.S.F.	"S" TEST DIRECT SHEAR TAN Ø	"S" TEST DIRECT SHEAR C T.S.F.
75	0.404	0.20	0.203	0.35		
5	0.414	0.21	0.315	0.15		
8						
3	0.556	0	0.277	0.08		
	0.384	0.07	0.249	0.23		
)	0.364	0.20	0.259	0.325		

"S" TE
DIRECT
TAN Ø

TESTED.

T TO THE MOHR'S CIRCLES FOR EACH SAMPLE TESTED.
S DIAGRAM.

D

AR STR

PHYSICAL SOIL CONSTANTS

R Ø	UNIT WEIGHT P.C.F. SAT.	UNIT WEIGHT P.C.F. MOIST	C(T.S.F.)	DESIGN SHEAR STRENGTHS Q Ø	Q TAN Ø	Q C(T.S.F.)	R Ø	R TAN Ø	R C(T.S.F.)	S Ø	S TAN Ø
11.3	45	10	0.45	0.00	0.00	0.10	11.3	0.20	0.00	16.7	0.30
11.3	25	15	0.90	0.00	0.00	0.20	11.3	0.20	0.00	19.8	0.36
11.[illegible]	25	15	0.90	0.00	0.00	0.20	11.3	0.20	0.00	26.6	0.50
	[illegible]	10	0.60	0.00	0.00	0.20	11.3	0.20	0.00	26.6	0.50
	40	140		-	-	-	-	-	0.00	31.0	0.60
	4[illegible]	142		-		-	-		0.00	16.7	0.30

C

B

ID LIMIT
PECIFIED

.2 .4 .6 .8

A

EMBANKMENT CRITERIA
AND PERFORMANCE REPORT
TEST DATA SUMMARIES
UNSPECIFIED LIQUID LIMIT BERM ZONE
STAGE II

RBL [illegible] 469

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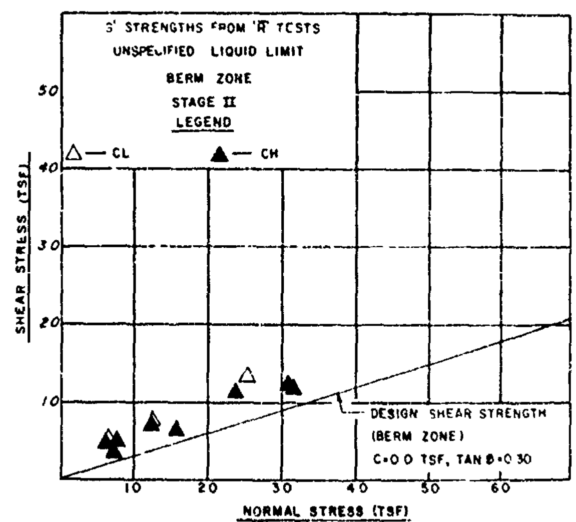
5 4 3

D

C

B



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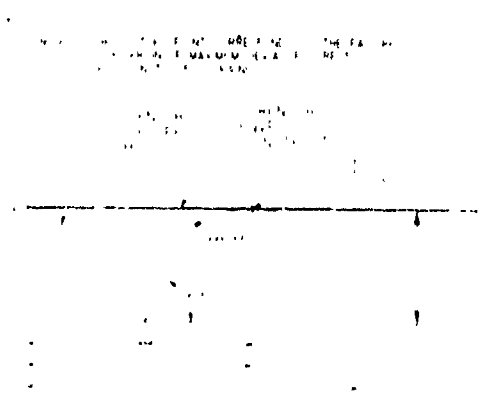
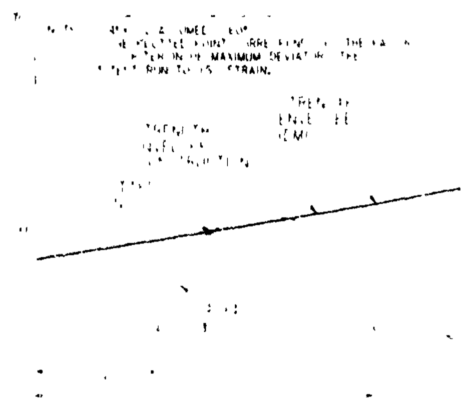
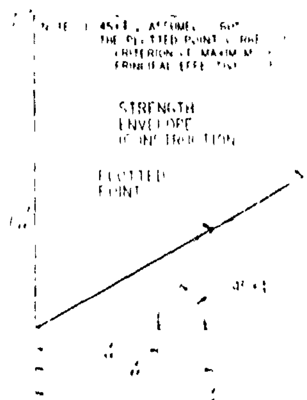


"Q"
MOHR'S DIAGRAM

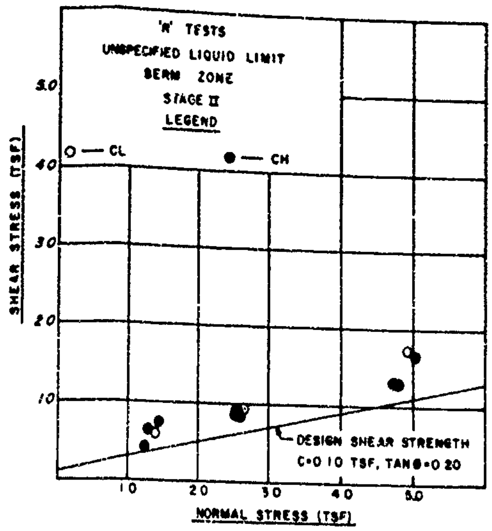


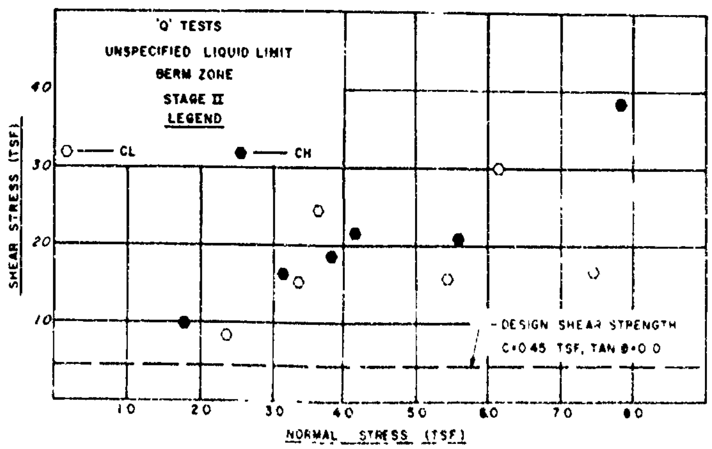
TOTAL STRESS "R"
MOHR'S DIAGRAM

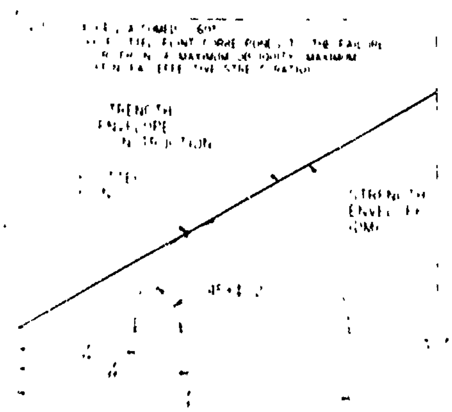


EFFECTIVE
MOHR'S DIA

5 4 3







EFFECTIVE STRESS
MOHR'S DIAGRAM

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

EMBANKMENT CRITERIA AND
PERFORMANCE REPORT

SHEAR TEST SUMMARIES
UNSPECIFIED LIQUID LIMIT BERM ZONE
STAGE II

AS SHOWN

RBL-3-1470

PLATE NO. 70

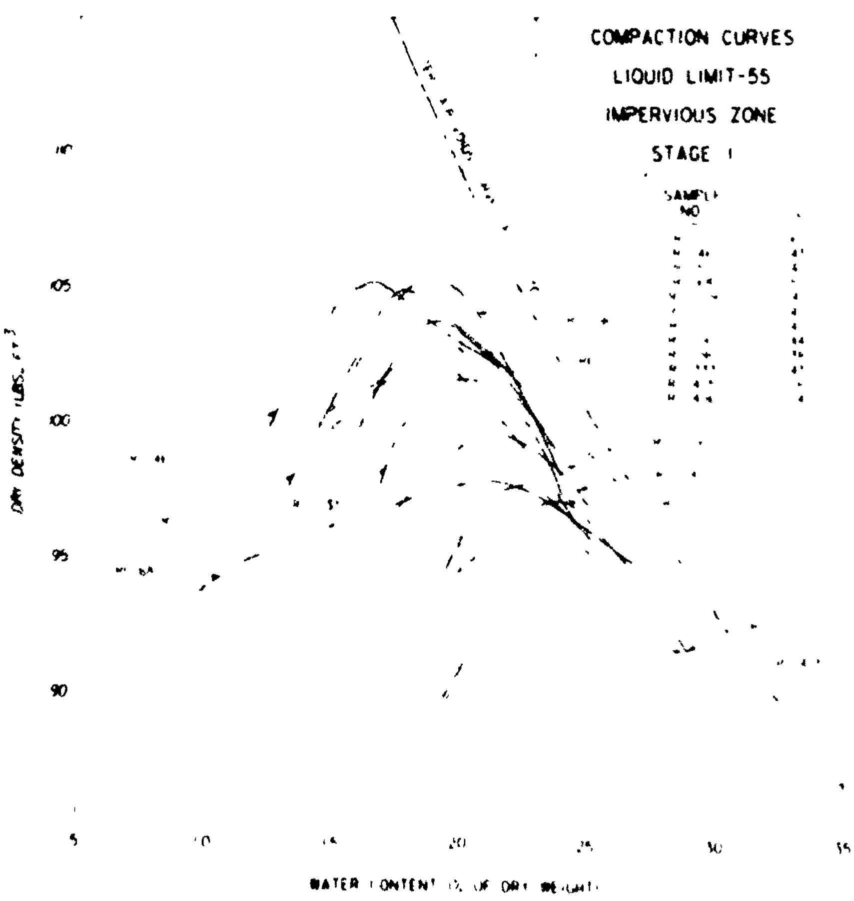
LIQUID LIMIT-55 IMPERVIOUS ZONE STAGE I

RECORD CONTROL SAMPLE				SOIL CLASSIFICATION DATA									STANDARD COMPACTION TEST				DENSITY		
				FIELD			M.R.D. LABORATORY						FIELD		M.R.D. LAB		SAND CONE DA[TA]		
							SHEAR TEST SPECIMEN			COMPACTION TEST SPECIMEN									
NUMBER	STATION	RANGE	ELEV.	LL	PI	CLASS	LL	PI	CLASS	LL	PI	CLASS	MAX. DRY DENSITY (P.C.F.)	OPT. MOIST. CONT. (%)	MAX. DRY DENSITY (P.C.F.)	OPT. MOIST. CONT. (%)	DRY DENSITY (P.C.F.)	COM-PACTION (%)	WATE[R] CONTE[NT] (%)
RC-35	92+65	0+06u/s	805.5			CH	65	43	CH	63	46	CH	96.2	23.1	97.2	23.5	96.6	99.4	[illegible]
RC 46	90+35	0+15u/s	817.0	42	[illegible]	CL	40	22	CL	43	27	CL	104.0	19.3	105.2	16.5	105.9	100.7	[illegible]
RC-5[illegible]	91+55	0+15u/s	827.0	4[illegible]	22	CL	44	32	CL	4[illegible]	27	CL	103.9	19.8	105.0	17.8	107.3	102.2	[illegible]
RC-68	89+20	0+10u/s	836.5	49		CL	50	30	CH	5[illegible]	34	CH	98.2	23.[illegible]	97.4	21.2	100.4	103.[illegible]	24
RC 109	89+20	0+30d/s	835.0	44		CL	46	28	CL	4[illegible]	[illegible]	CL	[illegible]	[illegible]	103.0	19.0	109.2	106.0	[illegible]
RC 122	44+50	0+15u/s	845.0	47		CL	44	26	[illegible]	4[illegible]	28		[illegible]	19.[illegible]	102.2	18.7	107.9	105.6	[illegible]
RC 171	87+75	[illegible]+06d/s	873.0	46		C[illegible]	46	2[illegible]	[illegible]	42	[illegible]	[illegible]	[illegible]	[illegible]	103.8	18.8	104.3	100.[illegible]	[illegible]
RC 197	5+25	0+46d/s	8[illegible].0	53		CH	57	40	CH	44	28	CL	[illegible]	[illegible]	99.[illegible]	21.9	100.5	100.8	[illegible]
RC 290	98+20	2+50u/s	83[illegible]	4[illegible]	[illegible]	[illegible]	43	23		38	18		[illegible]	[illegible]	105.3	18.7	102.3	97.2	[illegible]
RC 333	101+05	2+20u/s	847.5	46		CL	45	21	[illegible]	43	[illegible]	CL	[illegible]	[illegible]	10[illegible].6	20.3	91.9	90.[illegible]	
RC 405	99+05	0+00	864.[illegible]	60		CH	56	34	CH	58	4[illegible]	CH	[illegible]	[illegible]	95.6	24.3	98.0	102.5	
R[illegible] [illegible]06	101+32	0+55u/s	857.5	56		CH	56	36	CH	54	34	CH	[illegible]	[illegible]	9[illegible]	22.2	104.7	10[illegible]	

* UNDISTURBED DATA OBTAINED BY AVERAGING MOISTURE AND DENSITY VALUES OF ALL AVAILABLE SHEAR TEST SPECIMENS.

NOTES: 1. DRY DENSITIES AND WATER CONTENTS ARE COMPARED TO M.R.D. DATA TO OBTAIN PERCENT COMPACTION AND WATER CONTENT PERCENT + OPTIMUM.

THE RECORD CONTROL SAMPLES WITH A LIQUID LIMIT GREATER THAN 55 WERE LOCATED IN THE LOWER PORTION OF THE CUTOFF TRENCH.



LIQUID LIMIT-55 IMPERVIOUS ZONE STAGE I

MISSOURI RIVER

	DEPTH	WATER CONTENT (%)	[illegible]
**		[illegible]	[illegible]
	4		
	34	3.4	
**	[illegible]	[illegible]	[illegible]
	41.9		
PPE [illegible]	[illegible]	[illegible]	[illegible]
PPE [illegible]	[illegible]	[illegible]	[illegible]

3 2 1

D

WATER CONTENT (%)	OPT. MOIST. CONT. (%)	M.R.D. LAB MAX. DRY DENSITY (P.C.F.)	M.R.D. LAB OPT. MOIST. CONT. (%)	SAND CONE DATA DRY DENSITY (P.C.F.)	SAND CONE DATA COM-PACTION (%)	SAND CONE DATA WATER CONTENT (%)	SAND CONE DATA WATER CONTENT (+-%OPT)	*UNDISTURBED DATA DRY DENSITY (P.C.F.)	*UNDISTURBED DATA COM-PACTION (%)	*UNDISTURBED DATA WATER CONTENT (%)	*UNDISTURBED DATA WATER CONTENT (+-%OPT)
[illegible]	23.7	97.2	23.5	96.6	99.4	26.8	+3.3	96.6	99.4	27.4	+3.9
[illegible]	19.3	105.2	16.5	105.9	100.7	21.1	+4.6	107.0	101.7	20.3	+3.8
[illegible]	19.8	105.0	17.8	107.3	102.2	19.0	+1.2	107.7	102.6	19.2	+1.4
[illegible]	23.[illegible]	97.4	21.2	100.4	103.1	24.8	+3.6	99.6	102.3	23.6	+2.4
[illegible]	9.7	103.0	19.0	109.2	106.0	19.9	+0.9	107.7	104.6	19.2	+0.2
	[illegible]	102.2	18.7	107.9	105.6	20.5	+1.8	106.5	104.2	20.6	+1.9
	[illegible].3	103.8	18.8	104.3	100.5	21.9	+3.1	101.1	97.4	24.3	+5.5
	[illegible].5	99.7	21.3	100.5	100.8	23.8	+2.5	96.4	96.7	27.2	+5.9
	[illegible]	105.3	18.7	102.3	97.2	21.1	+2.4	104.4	99.1	21.9	+3.2
	[illegible]	10.6	20.3	94.9	90.5	22.8	+2.5	99.7	98.1	24.7	+4.4
	[illegible]	95.6	24.3	98.0	102.5	23.5	-0.8	99.9	104.5	23.0	[illegible]
	[illegible]	97.7	22.2	104.7	107.2	19.7	-2.5	106.9	109.4	20.4	[illegible].8

C

[illegible] LIMIT-55
[illegible]IOUS ZONE
[illegible]AGE I

MISSOURI RIVER DIVISION LABORATORY DATA

DEPTH	WATER CONTENT (%)	DRY DENSITY (LBS/FT3)	SATURATION* (%)	LL	PL	PI	SPECIFIC GRAVITY
[illegible]	[illegible]	105.0	100				
	22.[illegible]	97.6	85				
[illegible]	[illegible]	107.0	98				
[illegible]	[illegible]	100.6	96				
	[illegible]	101.6	94	42	20	22	
[illegible]	[illegible]	104.[illegible]	97				
	[illegible]	106.9	95				
[illegible]	[illegible]	[illegible]	95				
[illegible]	[illegible]	102.8	99				2.64
[illegible]	8.6	106.[illegible]	92				2.62
[illegible]	18.4	107.0	89				2.66
[illegible]	8.6	109.8	98				2.65
[illegible]	[illegible]	[illegible]	96				2.65
[illegible]	[illegible]	109.4	97				2.62
[illegible]	[illegible]	101.4	97				2.63
[illegible]	18.9	104.8	87				
[illegible]	19.[illegible]	104.8	88	42	17	25	
[illegible]	[illegible]	103.6	89				
[illegible]	19.[illegible]	105.7	90				
[illegible]	18.8	107.4	92	42	17	25	
[illegible]	20.5	103.0	93	43	18	25	2.60
[illegible]	20.6	96.9	79				
[illegible]	[illegible]	104.3	93				
[illegible]	19.9	104.2	93				
[illegible]	20.5	99.5	85				
[illegible]	20.8	100.0	89				
[illegible]	20.8	101.3	90	49	16	33	2.60

[illegible] ASSUMED SPECIFIC GRAVITY OF 2.65

[illegible] THE [illegible] OF A 36 INCH DIAMETER BUCKET AUGER HOLE.

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Symbol	Revisions Descriptions	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

US Army Corps of Engineers

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA
AND PERFORMANCE REPORT

LIQUID LIMIT-55 IMPERVIOUS ZONE
STAGE I DENSITY AND
COMPACTION TEST SUMMARIES

Designed by: R.G.D.
Drawn by: R.D.T.
Checked by: A.L.P.
Submitted by: R.G.D.

Scale: AS SHOWN

File No.: RBL-3-1471

3 2 1

PLATE NO. 71

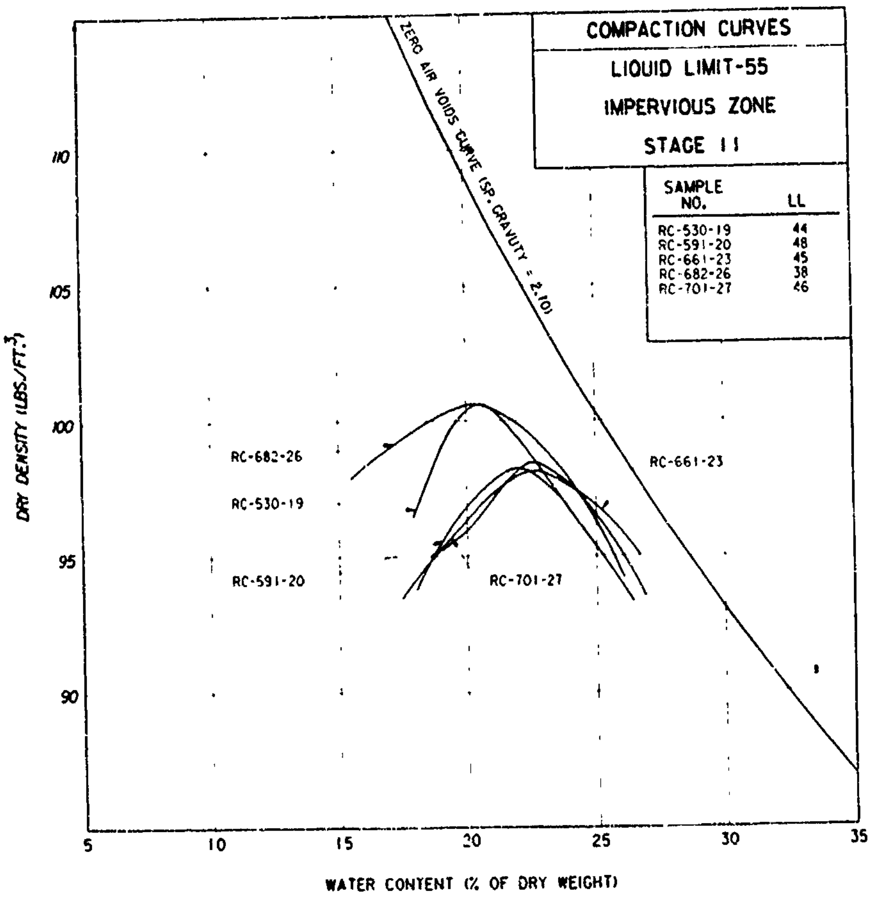
VALUE E

LIQUID LIMIT-55 IMPERVIOUS ZONE: STAGE II

RECORD CONTROL SAMPLE				SOIL CLASSIFICATION DATA										STANDARD COMPACTION TEST				DE…	
				FIELD			M.R.D. LABORATORY							FIELD		M.R.D. LAB		SAND CO…	
							SHEAR TEST SPECIMEN UNDISTURBED SAMPLE			COMPACTION TEST SPECIMEN SACK SAMPLE									
NUMBER	STATION	RANGE	ELEV.	LL	PI	CLASS	LL	PI	CLASS	LL	PI	CLASS	MAX. DRY DENSITY (P.C.F.)	OPT. MOIST. CONT. (%)	MAX. DRY DENSITY (P.C.F.)	OPT. MOIST. CONT. (%)	DRY DENSITY (P.C.F.)	COM-PACTION (%)
RC-530-19	94+25	0+50u/s	815.0	43	18	CL	48	32	CL	44	26	CL	104.0	22.0	100.6	20.6	102.9	102.3
RC-591-20	95+50	0+65u/s	828.0	49	27	CL	55	40	CH	48	31	CL	101.6	22.5	98.3	22.1	97.5	99.2
RC-661-23	95+50	0+30u/s	857.0	51	26	CH	46	30	CL	45	28	CL	100.5	22.2	98.1	22.7	99.2	[illegible]
RC-682-26	93+00	0+25u/s	862.0	45	26	CL	44	28	CL	38	23	CL	100.5	21.5	100.5	19.8	103.5	103.[illegible]
RC-701-27	99+30	1+85d/s	865.0	44	22	CL	51	33	CH	46	28	CL	98.0	22.5	98.5	22.5	99.4	100.9

* UNDISTURBED DATA OBTAINED BY AVERAGING MOISTURE AND DENSITY VALUES OF ALL AVAILABLE SHEAR TEST SPECIMENS.

NOTE: ALL DRY DENSITIES AND WATER CONTENTS ARE COMPARED TO M.R.D. DATA TO OBTAIN PERCENT COMPACTION AND WATER CONTENT PERCENT ± OPTIMUM.



THE COMPACTION CURVES ARE BASED ON MISSOURI RIVER DIVISION LABORATORY STANDARD COMPACTION TESTS.

DENSITY TEST S…

LIQUID LIMIT-55 IMPERVIOUS ZONE STAGE II		K.C.D. LAB SAND CONE			
SAMPLE	DEPTH	W (%)	DRY DENSITY (LBS/FT³)	L.L.	P.I.
RC-530-19		20.9	102.9	43	25
RC-591-20		24.5	97.5	49	22
RC-661-23		21.2	98.1	48	21
RC-682-26		17.7	98.6	45	19
RC-701-27		21.0	95.9	44	22

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ND CO

ANDARD COMPACTION TEST / DENSITY AND MOISTURE CONTENT

COM-ACTION (%)	FIELD . DRY SITY C.F.)	FIELD OPT. MOIST. CONT. (%)	M.R.D. LAB MAX. DRY DENSITY (P.C.F.)	M.R.D. LAB OPT. MOIST. CONT. (%)	SAND CONE DATA DRY DENSITY (P.C.F.)	SAND CONE DATA COM-PACTION (%)	SAND CONE DATA WATER CONTENT (%)	SAND CONE DATA WATER CONTENT (+-%OPT)	*UNDISTURBED DATA DRY DENSITY (P.C.F.)	*UNDISTURBED DATA COM-PACTION (%)	*UNDISTURBED DATA WATER CONTENT (%)	*UNDISTURBED DATA WATER CONTENT (+-%OPT)
102.3												
99.2	4.0	22.0	100.6	20.6	102.9	102.3	20.9	+0.5	100.0	99.4	20.7	+0.1
101	.6	22.5	98.3	22.1	97.5	99.2	24.5	+2.4	101.0	102.8	23.2	+1.1
103	0.5	22.2	98.1	22.7	99.2	101.1	23.4	-0.7	99.6	101.5	23.8	+1.1
100.9	0.5	21.5	100.5	19.8	103.5	103.0	19.6	-0.2	101.5	101.0	18.9	-0.9
	1.0	22.5	98.5	22.5	99.4	100.9	23.5	+1.0	98.1	99.6	23.4	+0.9

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DENSITY TEST SUMMARY

P.L.	MIT-55 JS ZONE	DEPTH	K.C.D. LAB SAND CONE W (%)	DRY DENSITY (LBS/FT^3)	L.L.	P.L.	P.I.	M.R.D. LAB RECORD CONTROL UNDISTURBED W (%)	DRY DENSITY (LBS/FT^3)	L.L.	P.L.	P.I.
25												
22	)		20.9	102.9	43	25	18	20.7	100.0	48	16	32
21	)		24.5	97.5	49	22	27	23.2	101.0	55	15	40
19	)		21.2	98.1	48	21	27	23.9	99.6	46	16	30
22			17.7	98.6	45	19	26	18.9	101.5	44	16	28
			21.0	95.9	44	22	22	23.4	98.1	51	18	33

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Symbol	Revisions Descriptions	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

Designed by: R.C.D.
Drawn by: R.D.T.
Checked by: A.L.P.
Submitted by: R.C.D.

US Army Corps of Engineers

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA
AND PERFORMANCE REPORT

LIQUID LIMIT-55 IMPERVIOUS ZONE STAGE II DENSITY AND COMPACTION TEST SUMMARIES

Scale: AS SHOWN
Date:
Dwg No:
Sheet numbers:
Plot Scale:
Design File:
File No.: RBL-3-1472

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3 2 1

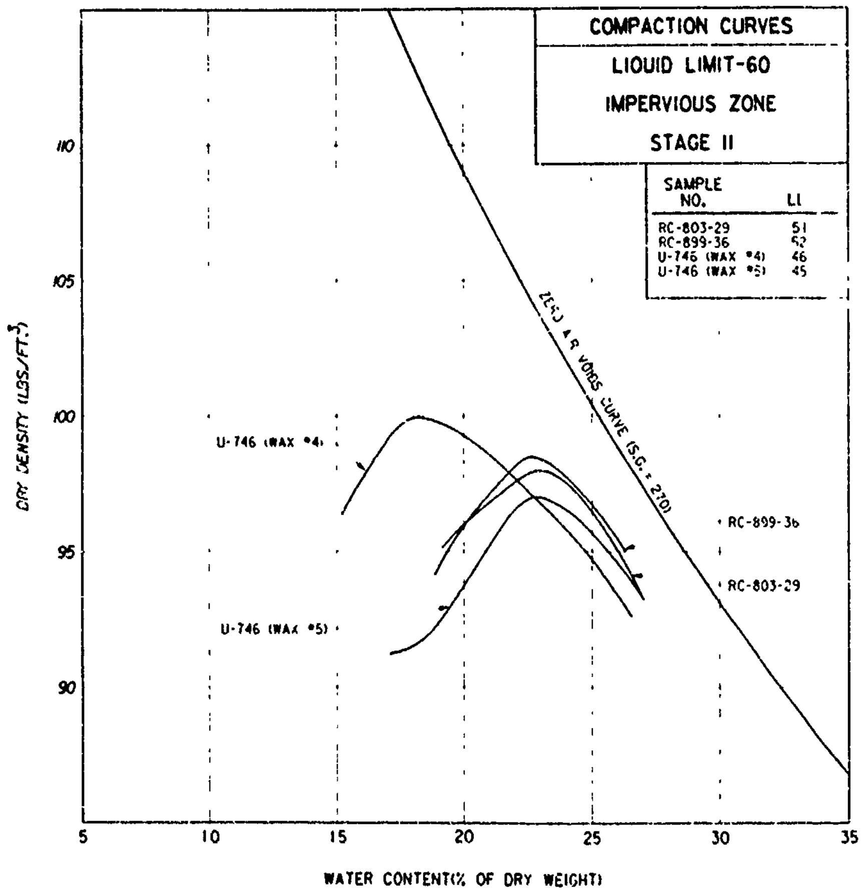
VALUE

LIQUID LIMIT-60 IMPERVIOUS ZONE; STAGE II																		
RECORD CONTROL SAMPLE				SOIL CLASSIFICATION DATA										STANDARD COMPACTION TEST				SAND
				FIELD			M.R.D. LABORATORY							FIELD		M.R.D. LAB		
							SHEAR TEST SPECIMEN (UNDISTURBED SAMPLE)			COMPACTION TEST SPECIMEN (SACK SAMPLE)								
NUMBER	STATION	RANGE	ELEV.	LL	PI	CLASS	LL	PI	CLASS	LL	PI	CLASS		MAX. DRY DENSITY (P.C.F.)	OPT. MOIST. CONT. (%)	MAX. DRY DENSITY (P.C.F.)	OPT. MOIST. CONT. (%)	DRY DENSITY (P.C.F.)
RC-803-29	99+00	0+90u/s	891.0	54	31	CH	53	29	CH	51	29	CH		98.9	23.3	98.0	23.2	96.1
RC-899-36	98+00	1+50u/s	898.0	64	43	CH				52	34	CH		99.3	24.2	98.5	22.7	104.5
U-746*4	98+40	1+70u/s	828.0				43	25	CL	46	29	CL				100.0**	18.3	
U-746-*5	98+40	1+70u/s	826.3				43	25	CL	45	26	CL				97.2**	22.2	

*UNDISTURBED DATA OBTAINED BY AVERAGING MOISTURE AND DENSITY VALUES OF ALL AVAILABLE SHEAR TEST SPECIMENS.

NOTE: ALL DRY DENSITIES AND WATER CONTENTS ARE COMPARED TO M.R.D. DATA TO OBTAIN PERCENT COMPACTION AND WATER CONTENT PERCENT ± OPTIMUM.

**HARVARD MINIATURE COMPACTION TEST



THE COMPACTION CURVES ARE BASED ON MISSOURI RIVER DIVISION LABORATORY STANDARD COMPACTION TESTS.

DENSITY				
LIQUID LIMIT-60 IMPERVIOUS ZONE STAGE II		K.C.D. LAB		
SAMPLE	DEPTH	W (%)	DRY DENSITY (LBS/FT³)	[illegible]
R[illegible]03 29		25.6	[illegible]	
U 746	70.6-71.[illegible]			
U 746	72.3-72.8			

VALUE ENGINEERING PAYS

ANDARD COMPACTION TEST				DENSITY AND MOISTURE CONTENT							
FIELD		M.R.D. LAB		SAND CONE DATA				*UNDISTURBED DATA			
K. DRY NSITY C.F.)	OPT. MOIST. CONT. (%)	MAX. DRY DENSITY (P.C.F.)	OPT. MOIST. CONT. (%)	DRY DENSITY (P.C.F.)	COM-PACTION (%)	WATER CONTENT (%)	WATER CONTENT (+-%OPT)	DRY DENSITY (P.C.F.)	COM-PACTION (%)	WATER CONTENT (%)	WATER CONTENT (+-%OPT)
98.9	23.3	98.0	23.2	96.1	98.1	25.6	+2.4	101.0	103.1	22.7	0.5
99.3	24.2	98.5	22.7	104.5	106.1	23.1	+0.4				
		100.0**	18.3					105.6	105.6	21.1	+2.8
		97.2**	22.2					99.0	101.9	25.6	+3.4

DENSITY TEST SUMMARY

UID LIMIT-60 ERVIOUS ZONE GE II		K.C.D. LAB					M.R.D. LAB				
MPLE	DEPTH	W (%)	DRY DENSITY (LBS/FT 3)	L.L.	P.L.	P.I.	W (%)	DRY DENSITY (LBS/FT 3)	L.L.	P.L.	P.I.
[illegible]	[illegible]	25.6	96	51	[illegible]	3	[illegible]	[illegible]	61	[illegible]	[illegible]
[illegible]	[illegible]						[illegible]	[illegible]			
[illegible]	[illegible]						23.3	[illegible]			

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

U.S. Army Corps of Engineers

R.G.D.
R.A.C.
A.L.P.
R.G.D.

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA
AND PERFORMANCE REPORT
LIQUID LIMIT-60 IMPERVIOUS ZONE
STAGE II DENSITY AND
COMPACTION TEST SUMMARIES

AS SHOWN

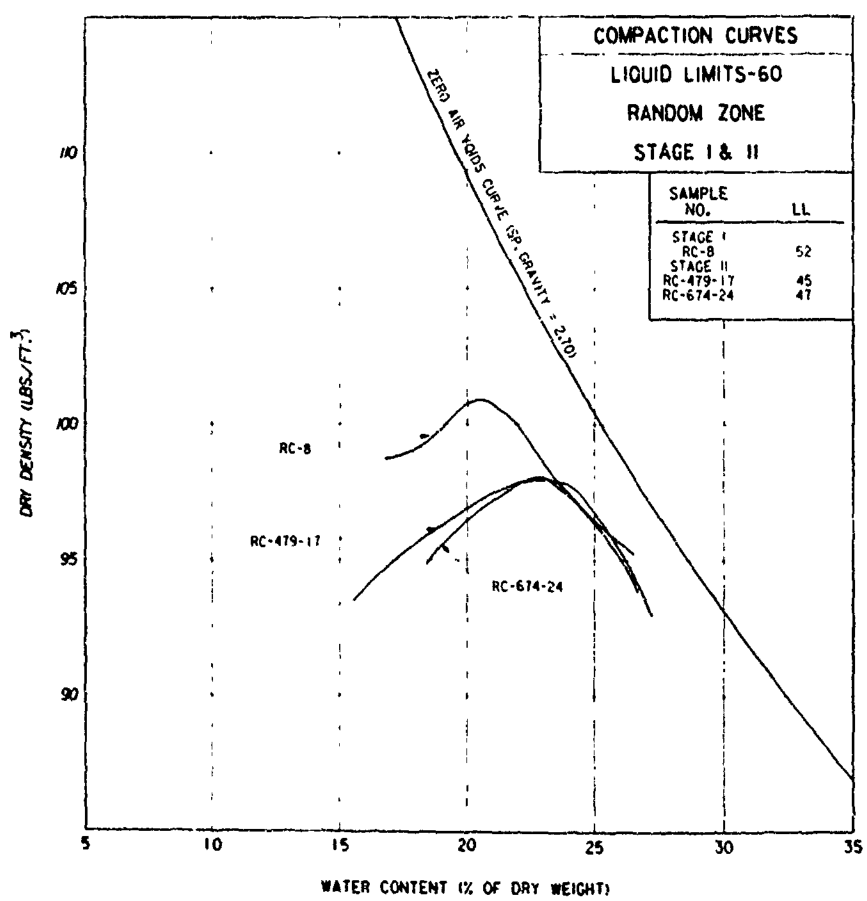
RBL-3-1473

VALUE

LIQUID LIMIT-60 RANDOM ZONE; STAGE I																	
RECORD CONTROL SAMPLE				SOIL CLASSIFICATION DATA									STANDARD COMPACTION TEST				SA
				FIELD			M.R.D. LABORATORY						FIELD		M.R.D. LAB		
							SHEAR TEST SPECIMEN			COMPACTION TEST SPECIMEN							
NUMBER	STATION	RANGE	ELEV.	LL	PI	CLASS	LL	PI	CLASS	LL	PI	CLASS	MAX. DRY DENSITY (P.C.F.)	OPT. MOIST. CONT. (%)	MAX. DRY DENSITY (P.C.F.)	OPT. MOIST. CONT. (%)	DRY DENSITY (P.C.F.)
RC-8	92+00	1+30u/s	821.7	50		CH	51	36	CH	52	35	CH	105.2	20.3	100.8	20.4	105.6
LIQUID LIMIT-60 RANDOM ZONE; STAGE II																	
RC-479-17	93+00	1+80u/s	818.0	55	32	CH	52	34	CH	45	29	CL	98.6	22.5	97.8	22.7	99.5
RC-674-24	94+75	1+10u/s	861.5	55	33	CH	56	41	CH	47	34	CL	100.8	21.0	98.0	22.8	102.4

* UNDISTURBED DATA OBTAINED BY AVERAGING MOISTURE AND DENSITY VALUES OF ALL AVAILABLE SHEAR TEST SPECIMENS.

NOTE: ALL DRY DENSITIES AND WATER CONTENTS ARE COMPARED TO M.R.D. DATA TO OBTAIN PERCENT COMPACTION AND WATER CONTENT PERCENT ± OPTIMUM.



THE COMPACTION CURVES ARE BASED ON MISSOURI RIVER DIVISION LABORATORY STANDARD COMPACTION TESTS.

LIQUID LIMIT-60 RANDOM ZONE STAGE II			
SAMPLE	ELEV.	W (%)	DRY DENSIT (LBS/F
RC-479-17	818.0	24.[illegible]	98.4
RC-674-24	861.5	20.6	97.[illegible]
*PPE-94-1	852.5		

ALUE

VALUE ENGINEERING PAYS

STANDARD COMPACTION TEST				DENSITY AND MOISTURE CONTENT							
FIELD		M.R.D. LAB		SAND CONE DATA				*UNDISTURBED DATA			
MAX. DRY DENSITY (P.C.F.)	OPT. MOIST. CONT. (%)	MAX. DRY DENSITY (P.C.F.)	OPT. MOIST. CONT. (%)	DRY DENSITY (P.C.F.)	COM-PACTION (%)	WATER CONTENT (%)	WATER CONTENT (+-%OPT)	DRY DENSITY (P.C.F.)	COM-PACTION (%)	WATER CONTENT (%)	WATER CONTENT (+-%OPT)
105.2	20.3	100.8	20.4	105.6	104.8	22.5	+2.1	100.6	99.8	24.3	+3.9
98.6	22.5	97.8	22.7	99.5	101.7	23.8	+1.1	104.4	106.8	22.3	-0.4
100.8	21.0	98.0	22.8	102.4	104.5	22.4	-0.4	98.6	100.6	24.3	+1.5

DENSITY TEST SUMMARY											
LIQUID LIMIT-60 RANDOM ZONE STAGE II		K.C.D. LAB					M.R.D. LAB				
SAMPLE	ELEV.	W (%)	DRY DENSITY (LBS/FT^3)	L.L.	P.L.	P.I.	W (%)	DRY DENSITY (LBS/FT^3)	L.L.	P.L.	P.I.
RC-479-17	818.0	24.0	98.4	53	22	31	22.3	104.4	52	18	34
RC-674-24	861.5	20.6	97.5	55	22	33	24.3	98.6	56	15	41
*PPE-94-1	852.5						23.7	99.4	53	17	36

Revisions			
Symbol	Descriptions	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

Designed by: R.G.D.
Drawn by: R.A.C.
Checked by: A.L.P.
Submitted by: R.G.D.

US Army Corps of Engineers

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA
AND PERFORMANCE REPORT

LIQUID LIMIT-60 RANDOM ZONE STAGES I AND II DENSITY AND COMPACTION TEST SUMMARIES

Scale: AS SHOWN
Sheet number:
Date:
Dwg No.:
Plot Scale:
Design File:
File No.: RBL-3-1474

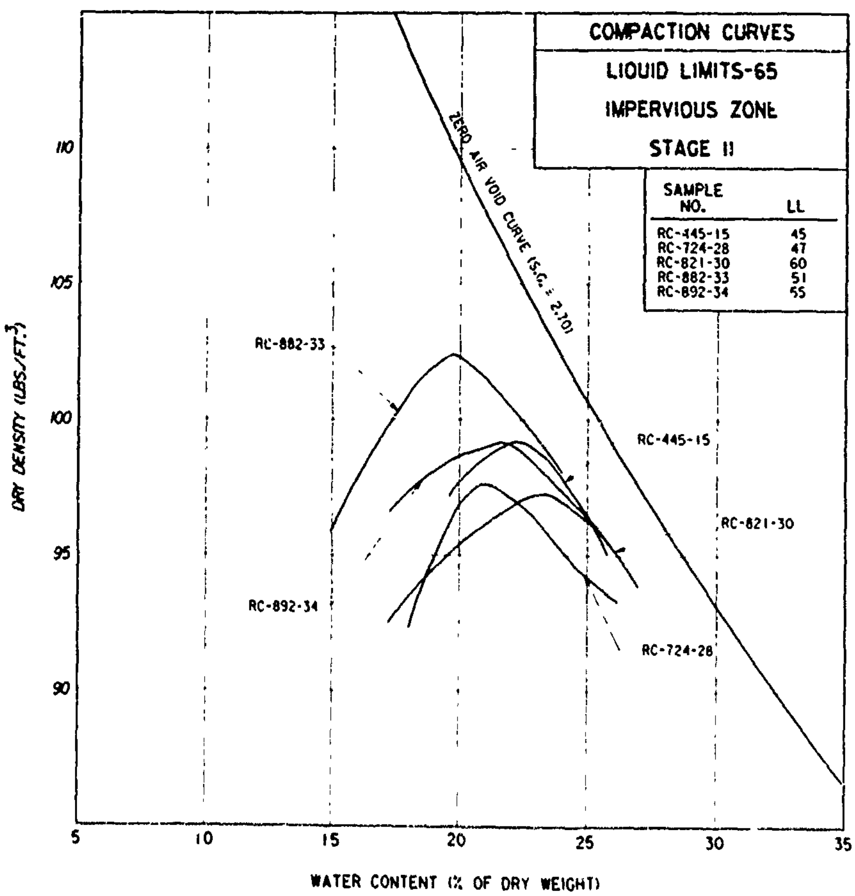
PLATE NO. 74

LIQUID LIMIT-65 IMPERVIOUS ZONE; STAGE II

RECORD CONTROL SAMPLE				SOIL CLASSIFICATION DATA									STANDARD COMPACTION TEST				SANC	
				FIELD			M.R.D. LABORATORY						FIELD		M.R.D. LAB			
							SHEAR TEST SPECIMEN (UNDISTURBED SAMPLE)			COMPACTION TEST SPECIMEN (SACK SAMPLE)								
NUMBER	STATION	RANGE	ELEV.	LL	PI	CLASS	LL	PI	CLASS	LL	PI	CLASS	MAX. DRY DENSITY (P.C.F.)	OPT. MOIST. CONT. (%)	MAX. DRY DENSITY (P.C.F.)	OPT. MOIST. CONT. (%)	DRY DENSITY (P.C.F.)	C(PAC(
RC-445-15	100+10	2+30u/s	886.0	49	27	CL	41	23	CL	45	28	CL	99.4	23.0	99.2	22.7	102.4	[illegible]
RC-724-28	90+20	0+05d/s	874.0	55	30	CH	55	38	CH	47	32	CL	97.5	24.2	97.7	20.7	97.4	[illegible]
RC-821-30	93+20	0+10d/s	900.0	56	34	CH	56	31	CH	60	43	CH	99.4	24.3	97.3	23.3	98.2	[illegible]
RC-882-33	106+15	0+08d/s	921.0	43	27	CL	49	33	CL	51	37	CH	102.2	23.0	102.4	19.7	98.1	[illegible]
RC-892-34	99+75	0+10d/s	923.5	53	34	CH				55	40	CH	103.0	22.3	99.2	21.5	103.8	[illegible]

* UNDISTURBED DATA OBTAINED BY AVERAGING MOISTURE AND DENSITY VALUES OF ALL AVAILABLE SHEAR TEST SPECIMENS.

NOTE: ALL DRY DENSITIES AND WATER CONTENTS ARE COMPARED TO M.R.D. DATA TO OBTAIN PERCENT COMPACTION AND WATER CONTENT PERCENT ± OPTIMUM.



THE COMPACTION CURVES ARE BASED ON MISSOURI RIVER DIVISION LABORATORY STANDARD COMPACTION TESTS.

DENSITY				
LIQUID LIMIT-65 IMPERVIOUS ZONE STAGE II		K.C.D. LAB		
SAMPLE	DEPTH	W (%)	DRY DENSITY (LBS/FT³)	L.L.
RC-445-15		22.6	102.4	49
RC-724-28		23.9	96.4	55
RC-821-30		24.7	98.2	56

STANDARD COMPACTION TEST				DENSITY AND MOISTURE CONTENT							
FIELD		M.R.D. LAB		SAND CONE DATA				*UNDISTURBED DATA			
MAX. DRY DENSITY (P.C.F.)	OPT. MOIST. CONT. (%)	MAX. DRY DENSITY (P.C.F.)	OPT. MOIST. CONT. (%)	DRY DENSITY (P.C.F.)	COM-PACTION (%)	WATER CONTENT (%)	WATER CONTENT (+-%OPT)	DRY DENSITY (P.C.F.)	COM-PACTION (%)	WATER CONTENT (%)	WATER CONTENT (+-%OPT)
99.4	23.0	99.2	22.7	102.4	103.2	22.6	-0.1	105.9	106.8	21.0	-1.7
97.5	24.2	97.7	20.7	97.4	99.7	25.2	+4.5	98.2	100.5	23.9	+3.2
99.4	24.3	97.3	23.3	98.2	100.9	24.7	+1.4	100.4	103.2	24.8	+1.5
102.2	23.0	102.4	19.7	98.1	95.8	22.4	+2.7	104.1	101.7	21.2	+1.5
103.0	22.3	99.2	21.5	103.8	104.6	20.3	-1.2				

DENSITY TEST SUMMARY

LIQUID LIMIT-65 IMPERVIOUS ZONE STAGE II		K.C.D. LAB					M.R.D. LAB				
SAMPLE	DEPTH	W (%)	DRY DENSITY (LBS/FT^3)	L.L.	P.L.	P.I.	W (%)	DRY DENSITY (LBS/FT^3)	L.L.	P.L.	P.I.
RC-445-15		22.6	102.4	49	27	22	21.0	105.9	41	18	23
RC-724-26		23.9	96.4	55	25	30	23.9	98.2	55	17	38
RC-821-30		24.7	98.2	56	22	34	24.8	100.4	56	25	31

Revisions

Symbol	Descriptions	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

US Army Corps of Engineers

Designed by: R.G.D.

Drawn by: R.A.L.

Checked by: A.L.P.

Submitted by: R.G.D.

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA
AND PERFORMANCE REPORT

LIQUID LIMIT-65 IMPERVIOUS ZONE STAGE II DENSITY AND COMPACTION TEST SUMMARIES

Scale: AS SHOWN

RBL-3-1475

PLATE NO. 75

D

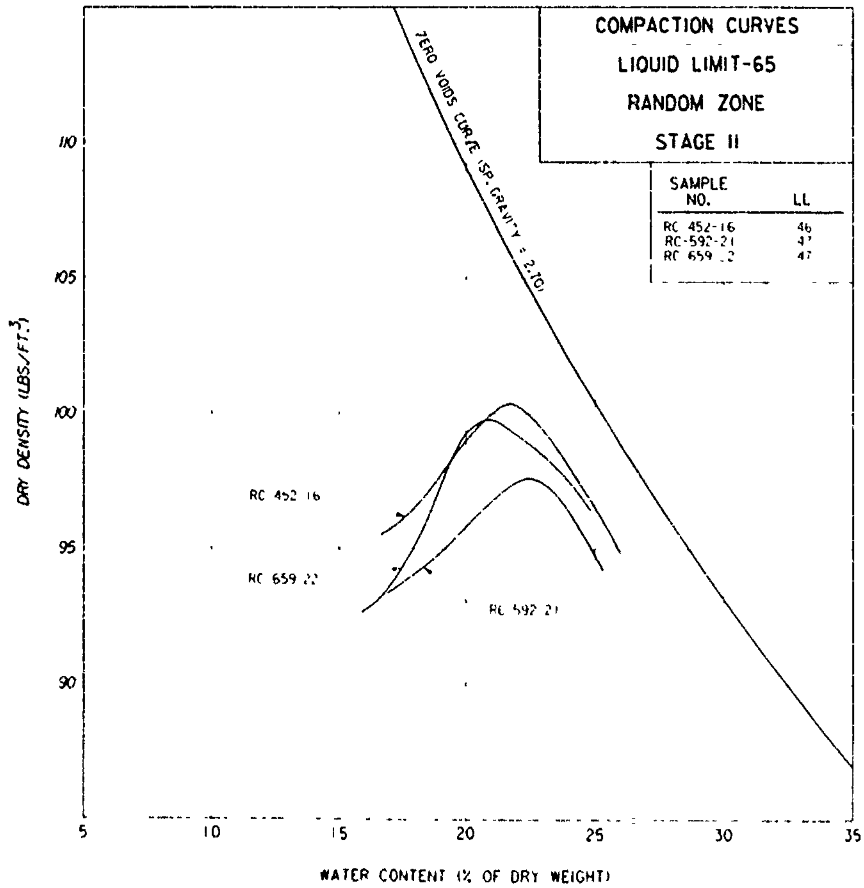
LIQUID LIMIT-65 RANDOM ZONE; STAGE II

RECORD CONTROL SAMPLE				SOIL CLASSIFICATION DATA									STANDARD COMPACTION TEST				
				FIELD			M.R.D. LABORATORY						FIELD		M.R.D. LAB		
							SHEAR TEST SPECIMEN			COMPACTION TEST SPECIMEN							
NUMBER	STATION	RANGE	ELEV.	LL	PI	CLASS	LL	PI	CLASS	LL	PI	CLASS	MAX. DRY DENSITY (P.C.F.)	OPT. MOIST. CONT. (%)	MAX. DRY DENSITY (P.C.F.)	OPT. MOIST. CONT. (%)	DR DEN. (P.C.F.)
RC-452-16	91+20	0+60d/s	822.0	53	29	CH	54	38	CH	46	31	[illegible]	100.4	24.1	100.2	21.6	[illegible]
RC-592-21	95+10	1+10d/s	825.5	54	33	CH	62	46	CH	47	33	[illegible]	101.0	22.8	97.5	22.6	[illegible]
RC-659-22	95+70	2+60d/s	849.0	50	32	CH	57	41	CH	47	31	CL	99.5	22.0	99.7	20.8	[illegible]

* UNDISTURBED DATA OBTAINED BY AVERAGING MOISTURE AND DENSITY VALUES OF ALL AVAILABLE SHEAR TEST SPECIMENS.

NOTE: ALL DRY DENSITIES AND WATER CONTENTS ARE COMPARED TO M.R.D. DATA TO OBTAIN PERCENT COMPACTION AND WATER CONTENT PERCENT ± OPTIMUM.

C



THE COMPACTION CURVES ARE BASED ON MISSOURI RIVER DIVISION LABORATORY STANDARD COMPACTION TESTS

DENSITY			
LIQUID LIMIT-65 RANDOM ZONE STAGE II		K.C.D. LAB	
SAMPLE	DEPTH	W (%)	DRY DENSITY (LBS/FT^3)
RC 452-16		23.6	97.6
RC 592-21		22.4	97.[illegible]
RC 659-22		19.2	96.3
*PFE 33-12	5.4 5.9		
*PFE 35-1	18.8 19.3		

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STANDARD COMPACTION TEST — DENSITY AND MOISTURE CONTENT

DRY DEN. (P.C.F.)	FIELD: MAX. DRY DENSITY (P.C.F.)	FIELD: OPT. MOIST. CONT. (%)	M.R.D. LAB: MAX. DRY DENSITY (P.C.F.)	M.R.D. LAB: OPT. MOIST. CONT. (%)	SAND CONE DATA: DRY DENSITY (P.C.F.)	SAND CONE DATA: COMPACTION (%)	SAND CONE DATA: WATER CONTENT (%)	SAND CONE DATA: WATER CONTENT (+-%OPT)	*UNDISTURBED DATA: DRY DENSITY (P.C.F.)	*UNDISTURBED DATA: COMPACTION (%)	*UNDISTURBED DATA: WATER CONTENT (%)	*UNDISTURBED DATA: WATER CONTENT (+-%OPT)
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	97.6	97.4	23.6	+2.0	104.9	[illegible]	[illegible]	
[illegible]	[illegible]	22.8	[illegible]	22.6	97.3	99.3	22.4	0.2	97.8	[illegible]	[illegible]	[illegible]
[illegible]	99.5	22.0	[illegible]	20.8	[illegible]	99.0	20.3	-0.5	99.9	[illegible]	[illegible]	[illegible]

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DENSITY TEST SUMMARY

LIQUID LIMIT-65 RANDOM ZONE STAGE II

SAMPLE	DEPTH	K.C.D. LAB: W (%)	K.C.D. LAB: DRY DENSITY (LBS/FT³)	K.C.D. LAB: L.L.	K.C.D. LAB: P.L.	K.C.D. LAB: P.I.	M.R.D. LAB: W (%)	M.R.D. LAB: DRY DENSITY (LBS/FT³)	M.R.D. LAB: L.L.	M.R.D. LAB: P.L.	M.R.D. LAB: P.I.
[illegible]		[illegible]	[illegible]	53	24	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		[illegible]	[illegible]				[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]						[illegible]	[illegible]			
[illegible]	[illegible]						[illegible]	[illegible]			

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U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

US Army Corps of Engineers

LITTLE BLUE RIVER MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA
AND PERFORMANCE REPORT

LIQUID LIMIT-65 RANDOM ZONE
STAGE II DENSITY AND
COMPACTION TEST SUMMARIES

R.G.D.
R.A.C.
A.L.P.
R.G.D.

Scale: AS SHOWN

File No. RBL-3-1476

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LIQUID LIMIT-70 RANDOM ZONE: STAGE II

RECORD CONTROL SAMPLE				SOIL CLASSIFICATION DATA									STANDARD COMPACTION TEST				
				FIELD			M.R.D. LABORATORY						FIELD		M.R.D. LAB		SAN
							SHEAR TEST SPECIMEN			COMPACTION TEST SPECIMEN							
NUMBER	STATION	RANGE	ELEV.	LL	PI	CLASS	LL	PI	CLASS	LL	PI	CLASS	MAX. DRY DENSITY (P.C.F.)	OPT. MOIST. CONT. (%)	MAX. DRY DENSITY (P.C.F.)	OPT. MOIST. CONT. (%)	DRY DENSITY (P.C.F.)
RC 855 31	94+00	0+30d s	909	65	41	CH	62	43	CH	62	46	CH	95.5	26.0	95.6	24.8	97.5
RC 878 32	86+5[illegible]	0+22u s	919 [illegible]	6[illegible]	40	CH	59	40	CH	60	44	CH	95.5	25.5	97.7	23.7	100.6
RC 895 35	102+90	0+900 s	[illegible]	5[illegible]	35	CH				49	[illegible]6	CL	102.6	20.6	98.7	22.5	109.0

* UNDISTURBED DATA OBTAINED BY AVERAGING MOISTURE AND DENSITY VALUES OF ALL AVAILABLE SHEAR TEST SPECIMENS

NOTE: ALL DRY DENSITIES AND WATER CONTENTS ARE COMPARED TO M.R.D. DATA TO OBTAIN PERCENT COMPACTION AND WATER CONTENT PERCENT + OPTIMUM

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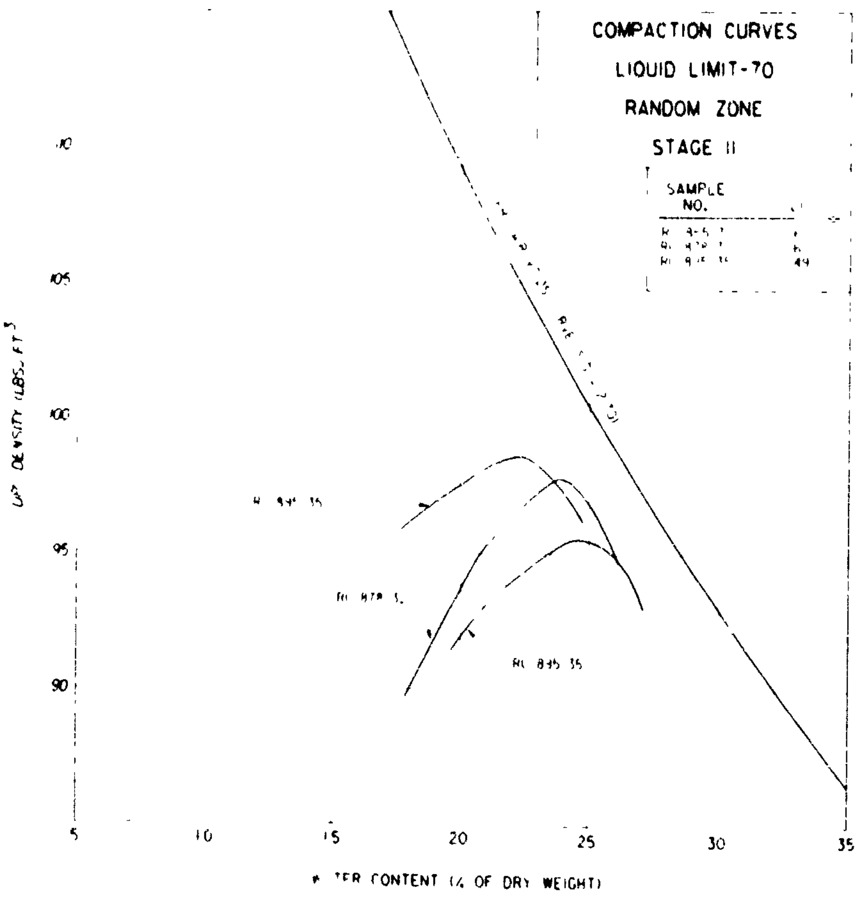

THE COMPACTION CURVES ARE BASED ON MISSOURI RIVER DIVISION LABORATORY STANDARD COMPACTION TEST

DENSI[illegible]			
LIQUID LIMIT-70 RANDOM ZONE STAGE II			
SAMPLE	DEPTH	W (%)	DRY DENSITY (LBS/FT³)
R[illegible] 855 31		24.9	9[illegible]
R[illegible] 878 32		24.0	10[illegible]
[illegible]PPE 32 [illegible]	13.8-14.3		
[illegible]PPE 35	0.0-0.5		

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...Y ...SITY ...F.)	...ANDARD COMPACTION TEST: FIELD ...X. DRY ...NSITY ...C.F.)	FIELD OPT. MOIST. CONT. (%)	M.R.D. LAB MAX. DRY DENSITY (P.C.F.)	M.R.D. LAB OPT. MOIST. CONT. (%)	DENSITY AND MOISTURE CONTENT: SAND CONE DATA DRY DENSITY (P.C.F.)	SAND CONE DATA COM-PACTION (%)	SAND CONE DATA WATER CONTENT (%)	SAND CONE DATA WATER CONTENT (+-%OPT)	*UNDISTURBED DATA DRY DENSITY (P.C.F.)	*UNDISTURBED DATA COM-PACTION (%)	*UNDISTURBED DATA WATER CONTENT (%)	*UNDISTURBED DATA WATER CONTENT (+-%OPT)
.5	...5.5	26.0	95.6	24.8	97.5	102.0	24.9	+0.[illegible]	104.0	108.8	22.5	-2.3
...6	...5.5	25.5	97.7	23.7	100.6	103.0	24.0	+0.3	100.7	103.1	24.4	+0.7
...0	...2.6	20.6	98.7	22.5	109.0	80.4	20.2	-2.3				

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DENSITY TEST SUMMARY

LIQUID LIMIT-70 RANDOM ZONE STAGE II: SAMPLE	DEPTH	K.C.D. LAB: W (%)	DRY DENSITY (LBS/FT^3)	L.L.	P.L.	P.I	M.R.D. LAB: (%)	DRY DENSITY (LBS/FT^3)	L.L.	P.L.	P.I.
[illegible]		24.9	97.5	65	24		[illegible]	104.0	6[illegible]	[illegible]	
[illegible]		24.[illegible]	100.6	61	[illegible]		24.4	[illegible]00.7	[illegible]	[illegible]	
[illegible]PFE 9[illegible]	3.9-4.3						24.4	98.0			
PFE 35	[illegible]0-0.5						25.3	97.2			

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Symbol	Revisions Descriptions	Date	Approved

U.S. ARMY ENGINEER DISTRICT
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R.A.C.
A.L.P.
R.G.D.

US Army Corps of Engineers

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA
AND PERFORMANCE REPORT

LIQUID LIMIT-70 RANDOM ZONE
STAGE II DENSITY AND
COMPACTION TEST SUMMARIES

AS SHOWN

RBL-3-1477

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LIQUID LIMIT-UNSPECIFIED BERM ZONE, STAGE II

RECORD CONTROL SAMPLE — SOIL CLASSIFICATION DATA — STANDARD COMPACTION TEST

RECORD CONTROL SAMPLE				SOIL CLASSIFICATION DATA: FIELD			M.R.D. LABORATORY: SHEAR TEST SPECIMEN			M.R.D. LABORATORY: COMPACTION TEST SPECIMEN			STANDARD COMPACTION TEST: FIELD		STANDARD COMPACTION TEST: M.R.D. LAB		SAND…
NUMBER	STATION	RANGE	ELEV.	LL	PI	CLASS	LL	PI	CLASS	LL	PI	CLASS	MAX. DRY DENSITY (P.C.F.)	OPT. MOIST. CONT. (%)	MAX. DRY DENSITY (P.C.F.)	OPT. MOIST. CONT. (%)	DRY DENSITY (P.C.F.)
RC 514 18	96+56	2+350 [illegible]	853.5	47	[illegible]	[illegible]	49	33	CL	43	[illegible]		[illegible]	[illegible]	100.3	[illegible]	[illegible]
RC 675 25	93+30	2+200 [illegible]	864.0	55	33	CH	58	43	CH	45	[illegible]		[illegible]	[illegible]	99.9	20.8	[illegible]
SACK #1	RIGHT	ABUT.	SEEP				47	29	CL	47	29				96.8	2[illegible]	

* UNDISTURBED DATA OBTAINED BY AVERAGING MOISTURE AND DENSITY VALUES OF ALL AVAILABLE SHEAR TEST SPECIMENS

NOTE: ALL DRY DENSITIES AND WATER CONTENTS ARE COMPARED TO M.R.D. DATA TO OBTAIN PERCENT COMPACTION AND WATER CONTENT PERCENT [illegible]

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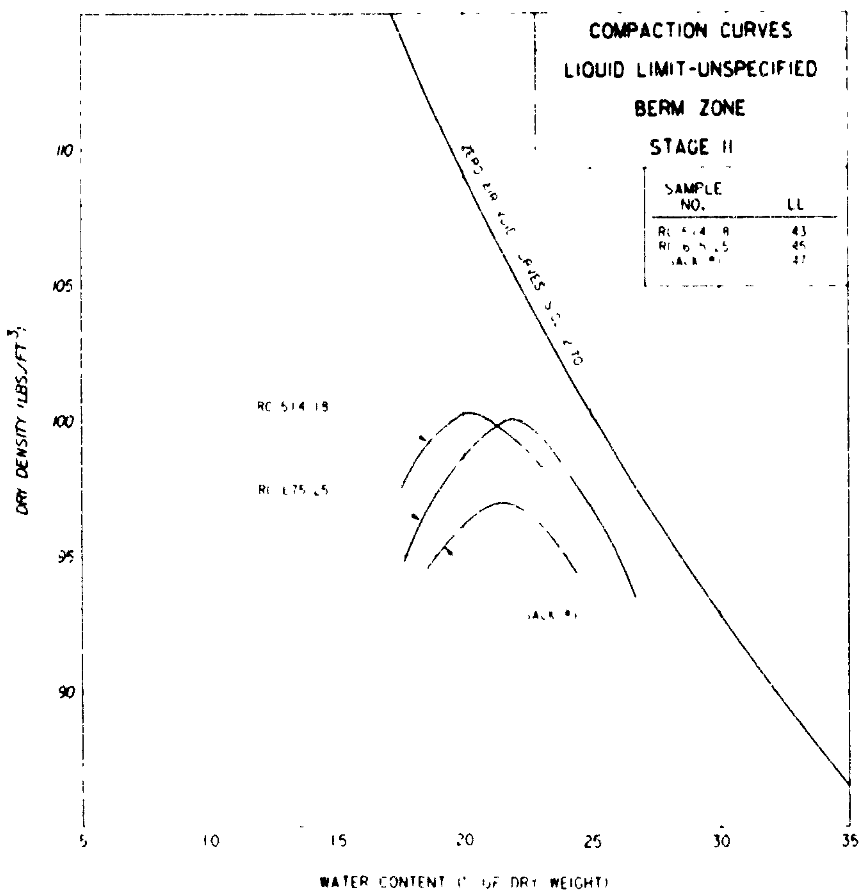

DENSITY TE…

LIQUID LIMIT-UNSPEC. BERM ZONE STAGE II		M.R.D. LAB	
SAMPLE	DEPTH	W (%)	DRY DENSITY (LBS/FT³)
[illegible]		[illegible]	[illegible]
[illegible]		20.8	96

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ANDARD COMPACTION TEST				DENSITY AND MOISTURE CONTENT							
FIELD		M.R.D. LAB		SAND CONE DATA				*UNDISTURBED DATA			
DRY DENSITY (P.C.F.)	OPT MOIST CONT. (%)	MAX. DRY DENSITY (P.C.F.)	OPT. MOIST. CONT. (%)	DRY DENSITY (P.C.F.)	COM-PACTION (%)	WATER CONTENT (%)	WATER CONTENT (+-%OPT)	DRY DENSITY (P.C.F.)	COM-PACTION (%)	WATER CONTENT (%)	WATER CONTENT (+-%OPT)
[illegible]	[illegible]	[illegible]	[illegible]	105.0	104.7	[illegible]	+0.8	104.7	104.4	19.3	1.0
[illegible]4	[illegible]	99.[illegible]	[illegible]8	98.0	98.[illegible]	22.7	+0.9	99.4	99.5	21.2	-0.6
		96.[illegible]	21.[illegible]								

C

DENSITY TEST SUMMARY										
UNSPEC. ZONE			K.C.D. LAB				M.R.D. LAB			
DEPTH	W	DRY DENSITY (LBS/FT³)	L.L.	P.L.	P.I.	W (%)	DRY DENSITY (LBS/FT³)	L.L.	P.L.	P.I.
		[illegible]	5[illegible]	[illegible]	30	19.3	104.7	49	16	33
		[illegible]	54	20	34	2	99.4	58	15	43

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LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA
AND PERFORMANCE REPORT

BERM ZONE (NO SPECIFIED LIQUID LIMIT)
STAGE II DENSITY AND
COMPACTION TEST SUMMARIES

AS SHOWN

RBL-3-1478

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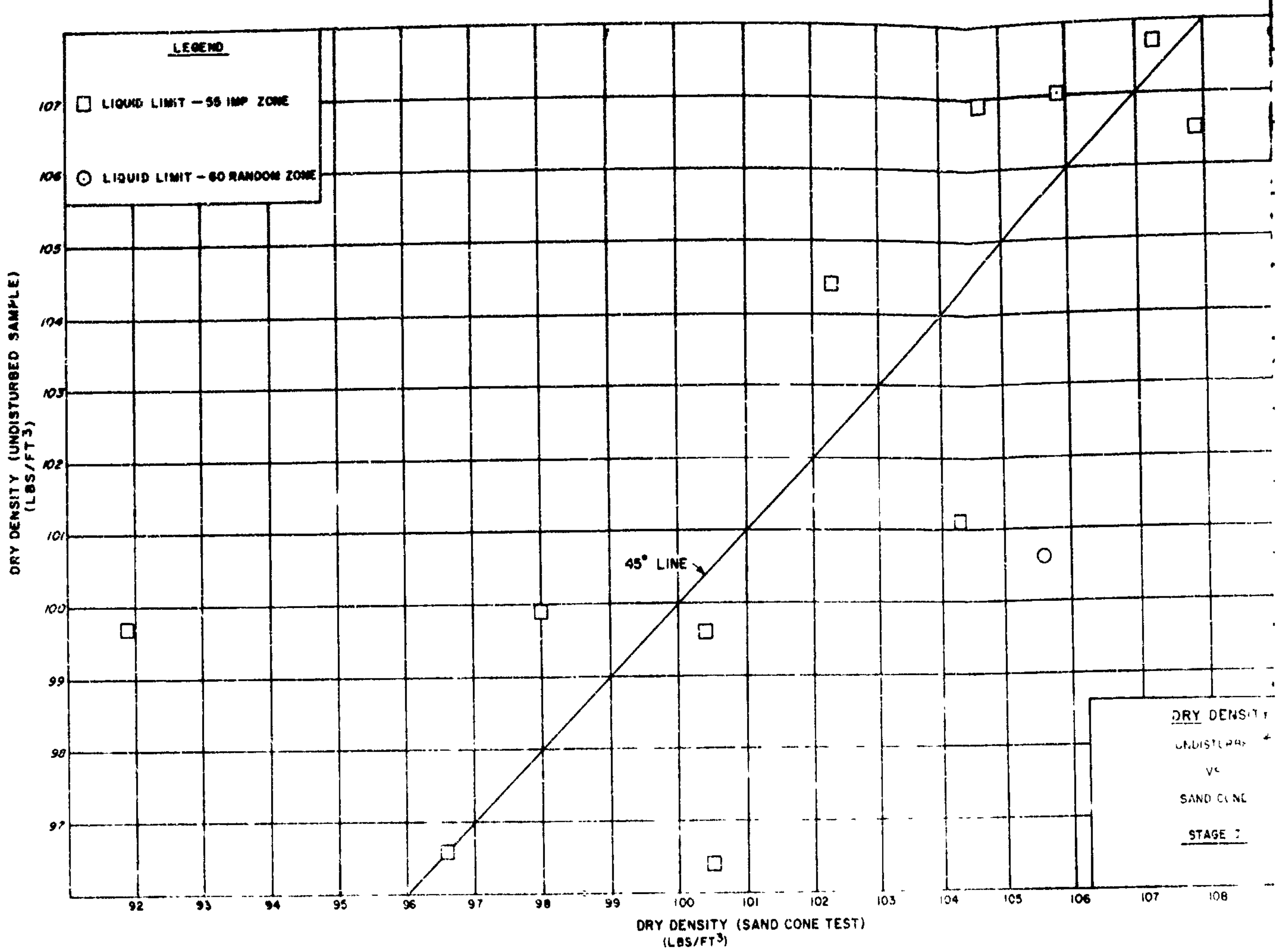
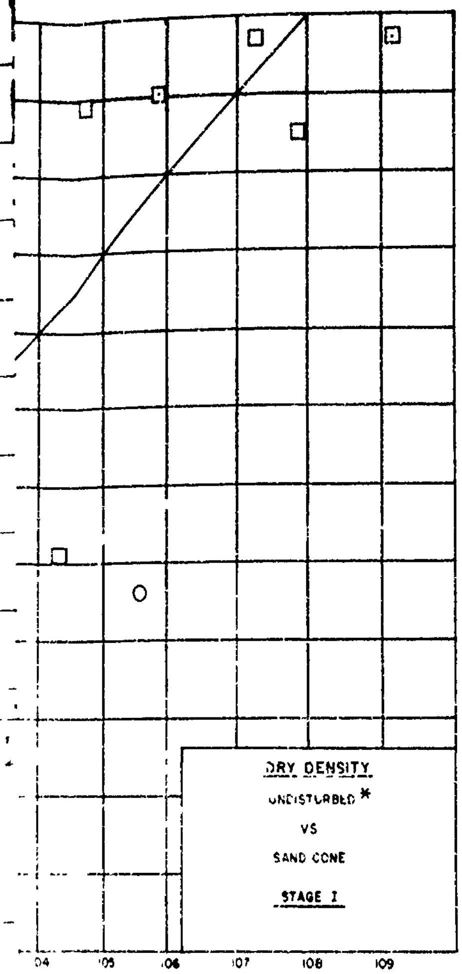
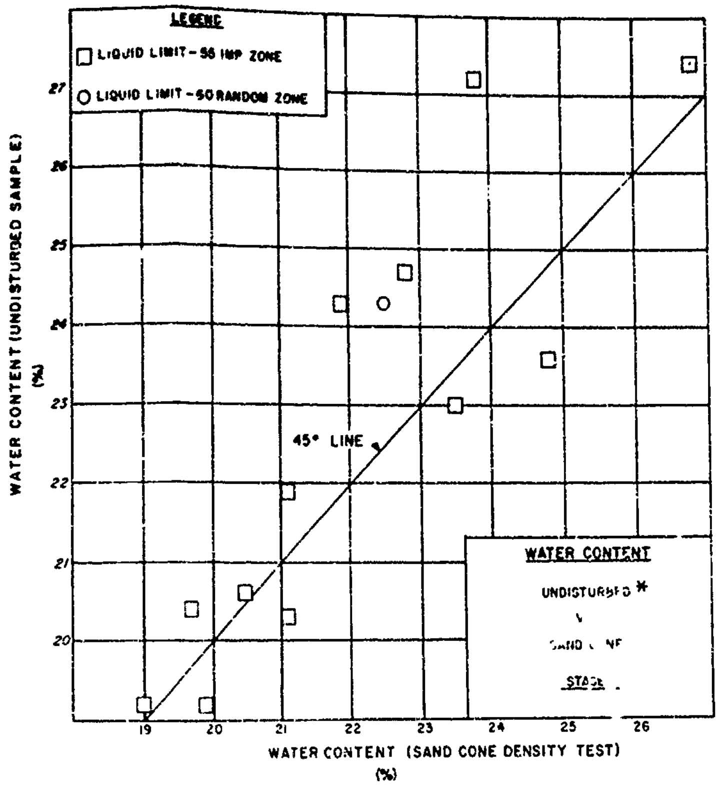
PLATE NO. 78



LEGEND
LIQUID LIMIT — 56 IMP ZONE
LIQUID LIMIT — 60 RANDOM ZONE
DRY DENSITY (UNDISTURBED SAMPLE) (LBS/FT3)
107
106
105
104
103
102
101
100
99
98
97
45° LINE
92
93
94
95
96
97
98
99
100
101
102
103
104
105
106
107
108
DRY DENSITY (SAND CONE TEST) (LBS/FT3)
DRY DENSITY
VS
SAND CONE
STAGE





*NOTE
THE UNDISTURBED DATA WAS OBTAINED BY AVERAGING MOISTURE AND DENSITY VALUES OF ALL AVAILABLE SHEAR TEST SPECIMENS FOR EACH RECORD CONTROL SAMPLE

Symbol	Revisions Descriptions	Date	Approved

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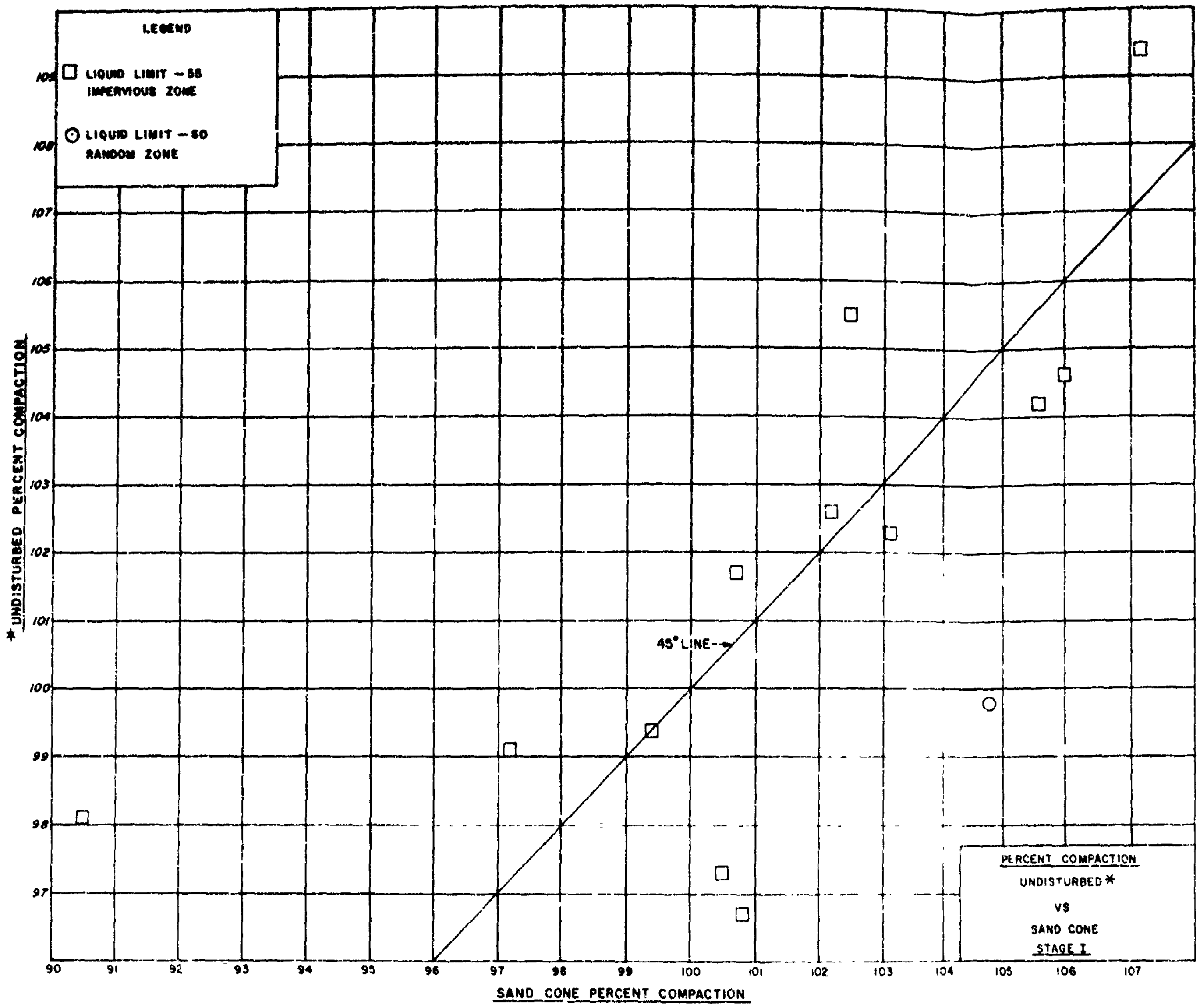
US Army Corps of Engineers

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA
AND PERFORMANCE REPORT

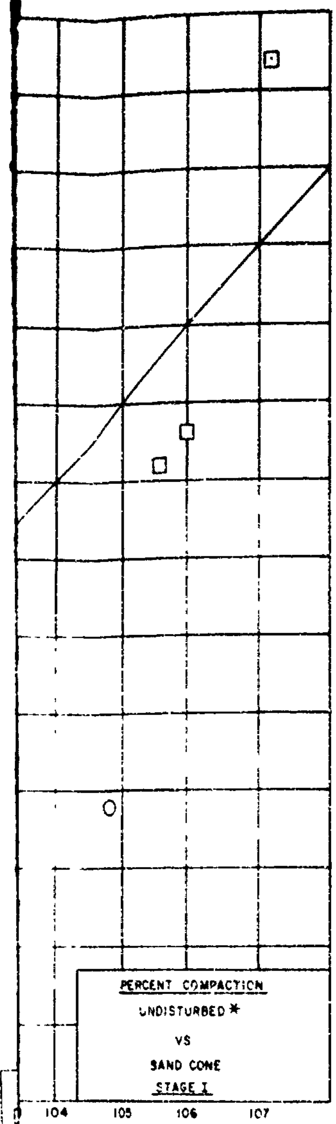
COMPACTION TEST SUMMARIES
STAGE I

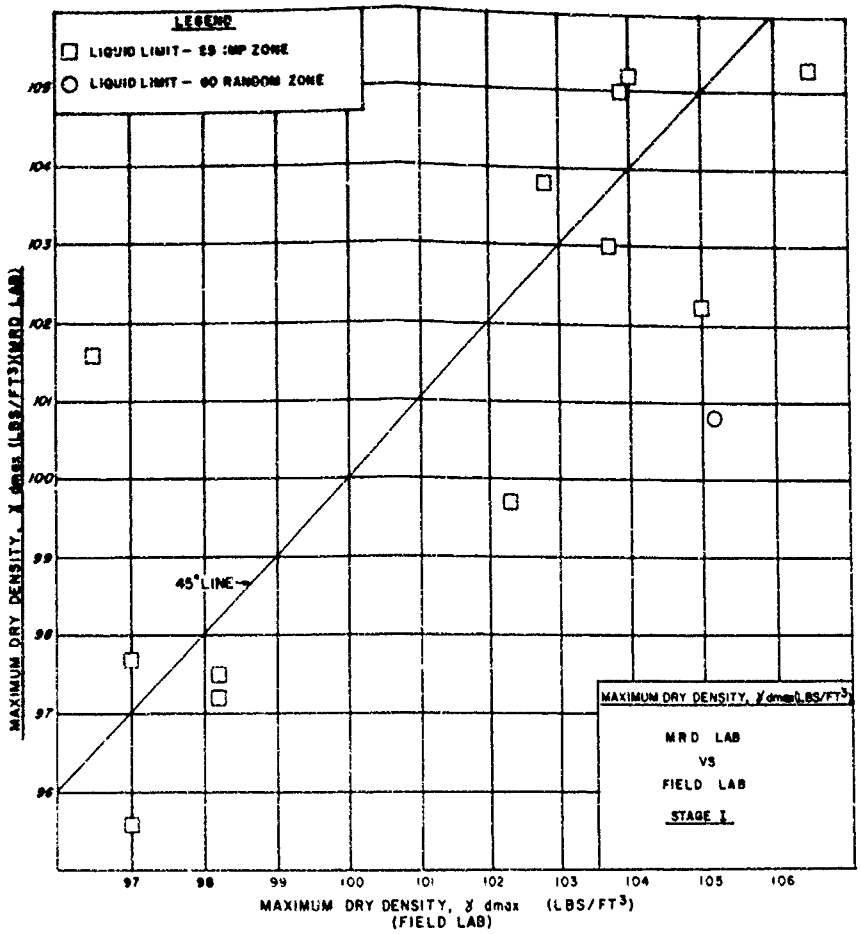
Designed by	W.B.E	Scale	
Drawn by	R A C	Date	
Checked by	W B E / R G D	Sheet Number	
Submitted by	F C W	Dwg No.	File No. RBL-3-1479

PLATE NO. 79

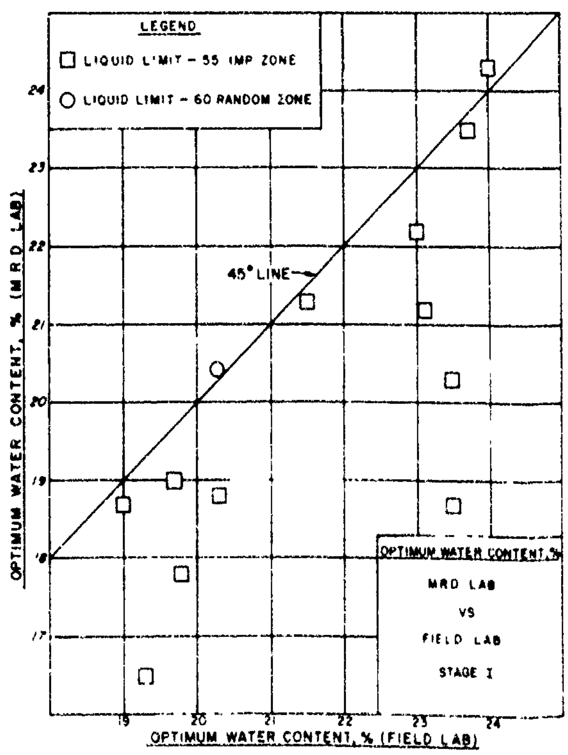


* NOTE
THE PERCENT COMPACTION WAS OBTAINED BY COMPARING THE DRY DENSITIES TO THE M.R.D. DATA. UNDISTURBED DATA WAS OBTAINED BY AVERAGING THE DENSITY VALUES OF ALL AVAILABLE SHEAR TEST SPECIMENS FOR EACH RECORD CONTROL SAMPLE





-CTION WAS OBTAINED BY COMPARING
TO THE MRD DATA UNDISTURBED
BY AVERAGING THE DENSITY VALUES
HEAR TEST SPECIMENS FOR EACH
MPLE



Symbol	Revisions Descriptions	Date	Approved

U.S. ARMY ENGINEER DISTRICT
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KANSAS CITY, MISSOURI

US Army Corps of Engineers

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA
AND PERFORMANCE REPORT

COMPACTION TEST SUMMARIES
STAGE I

Designed by	W B E
Drawn by	J G S
Checked by	W B E / R G D
Submitted by	F C W
Scale	AS SHOWN

RBL-3-1480

PLATE NO 80

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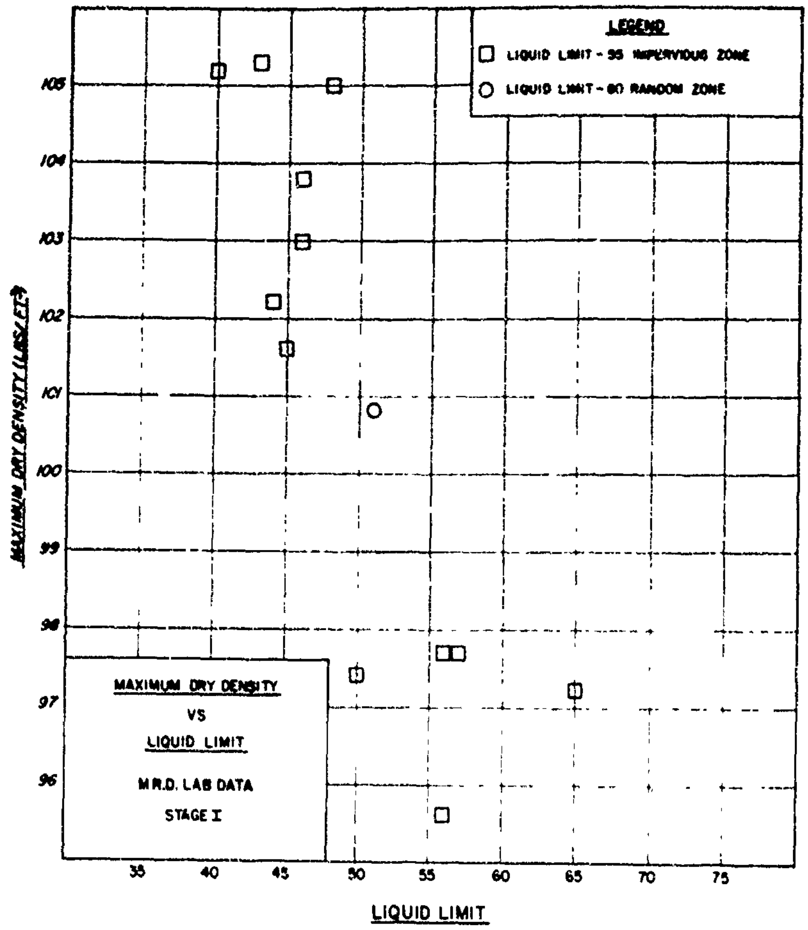
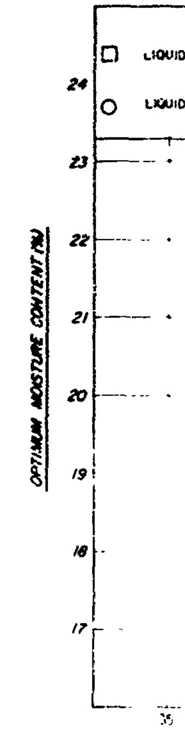


MAXIMUM DRY DENSITY
VS
LIQUID LIMIT
M.R.D. LAB DATA
STAGE I



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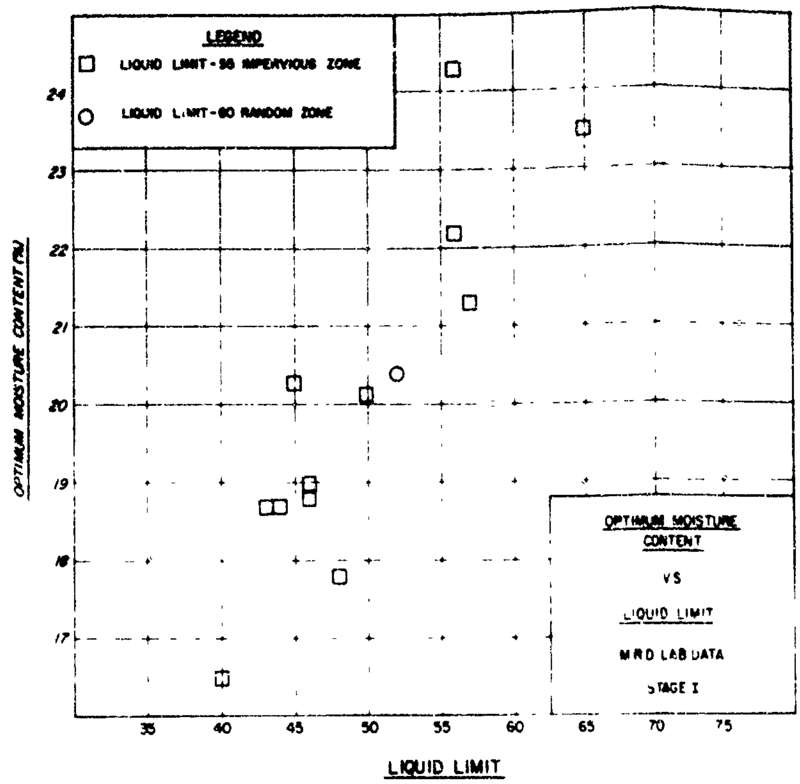


NOTE:
SOME OF THE IMPERVIOUS ZONE LIQUID LIMIT 55 RECORD CONTROL SAMPLES HAVE A LIQUID LIMIT GREATER THAN 55 THESE SAMPLES WERE LOCATED IN THE LOWER PORTION OF THE CUTOFF TRENCH

Symbol	Revisions Descriptions	Date	Approved

U. S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

Designed by: WBE
Drawn by: SEY
Checked by: RGD/WBE
Submitted by: FCW

US Army Corps of Engineers

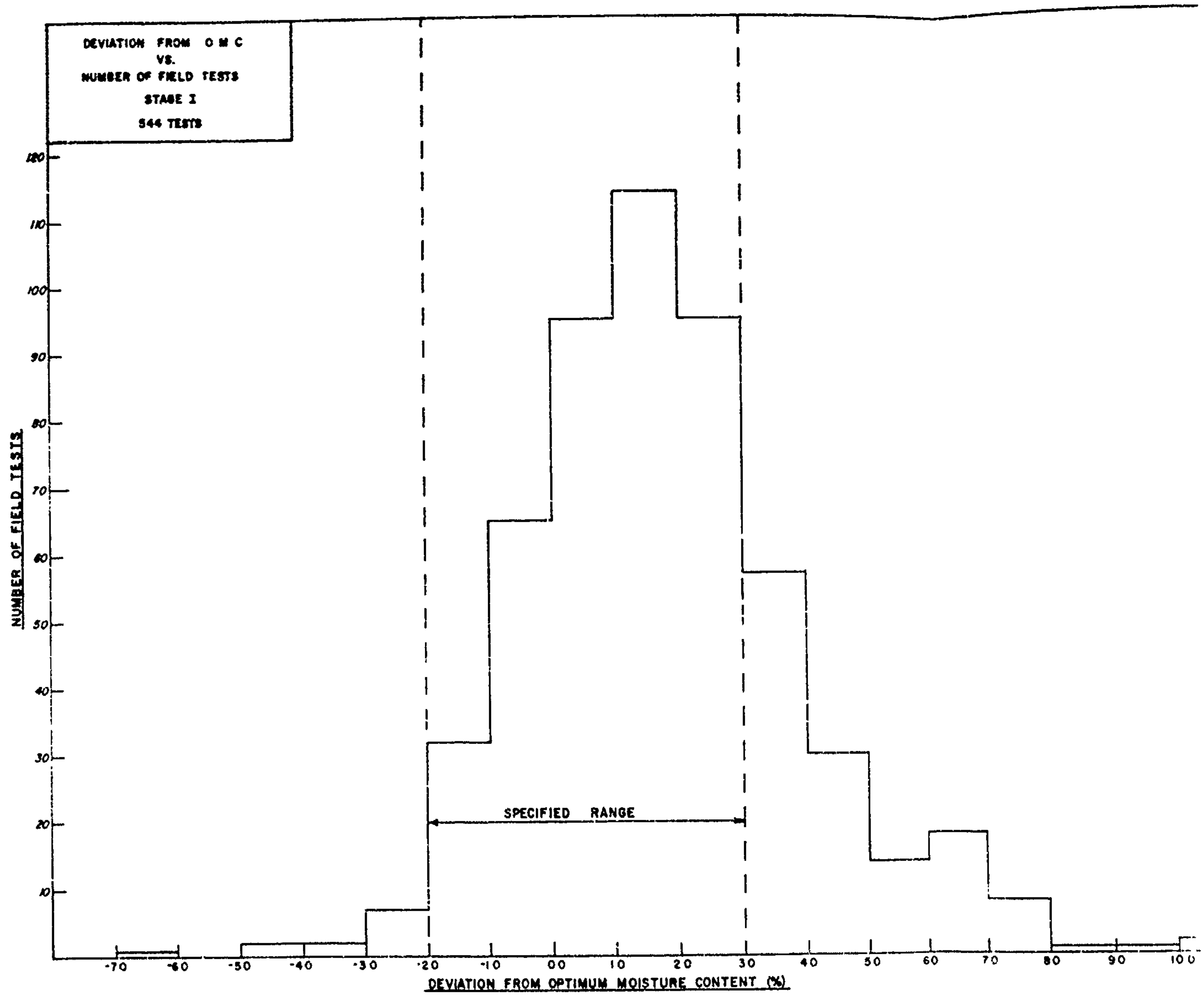
LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA
AND PERFORMANCE REPORT

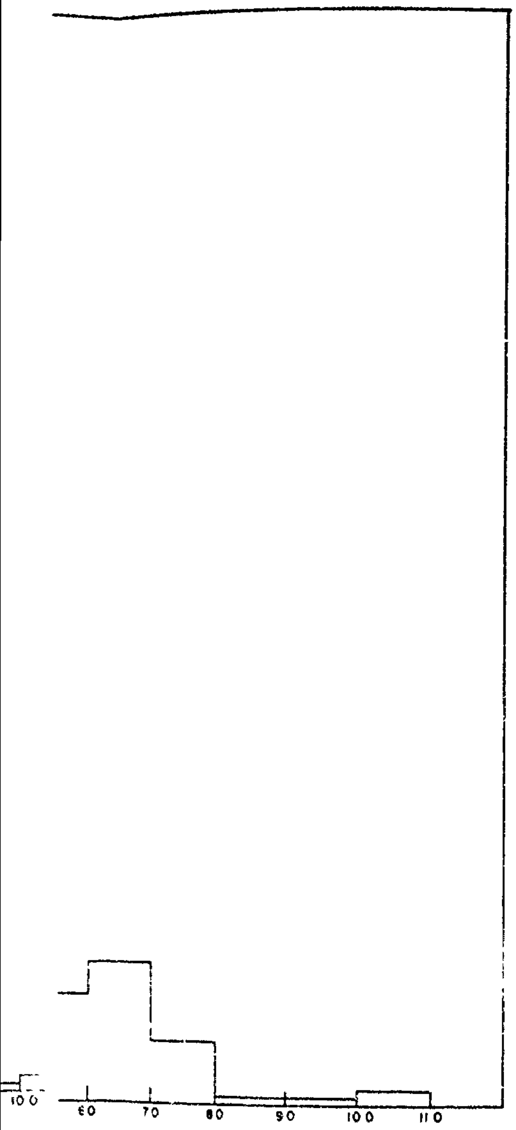
COMPACTION TEST SUMMARIES
STAGE I

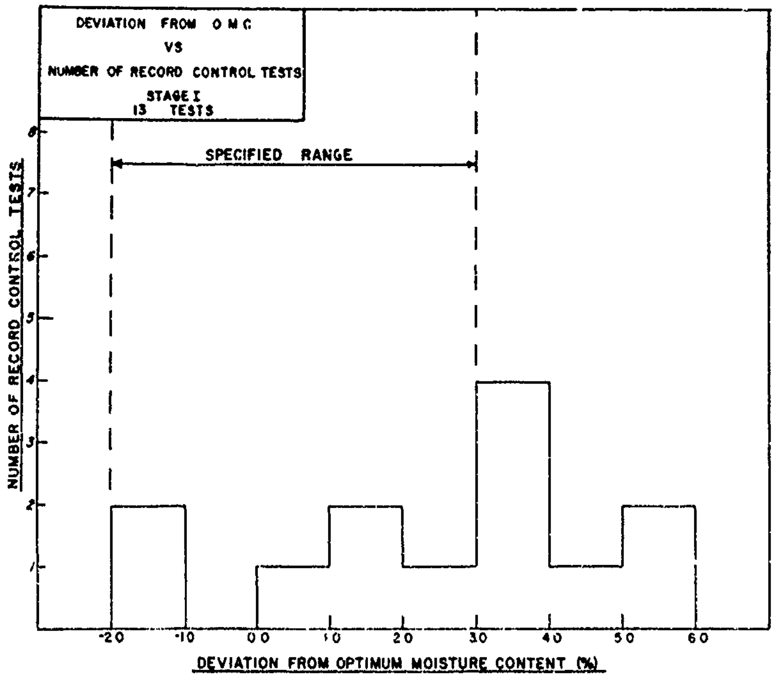
Scale: AS SHOWN

RBL-3-1481

PLATE NO. 81


DEVIATION FROM O M C
VS.
NUMBER OF FIELD TESTS
STAGE I
544 TESTS
NUMBER OF FIELD TESTS
SPECIFIED RANGE
DEVIATION FROM OPTIMUM MOISTURE CONTENT (%)
120
110
100
90
80
70
60
50
40
30
20
10
-70 -60 -50 -40 -30 -20 -10 00 10 20 30 40 50 60 70 80 90 100





NOTE:
THE REFERENCED OPTIMUM MOISTURE CONTENT WAS DETERMINED BY THE MISSOURI RIVER DIVISION LABORATORY STANDARD COMPACTION TEST

Revisions			
Symbol	Descriptions	Date	Approved

U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

US Army Corps of Engineers

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA
AND PERFORMANCE REPORT

COMPACTION TEST SUMMARIES
STAGE I

Designed by	W B E
Drawn by	M A W
Checked by	W B E / P G D
Submitted by	F C W
Scale	AS SHOWN
Date	
Dwg No.	
Sheet number	
File No.	RBL-3-1482

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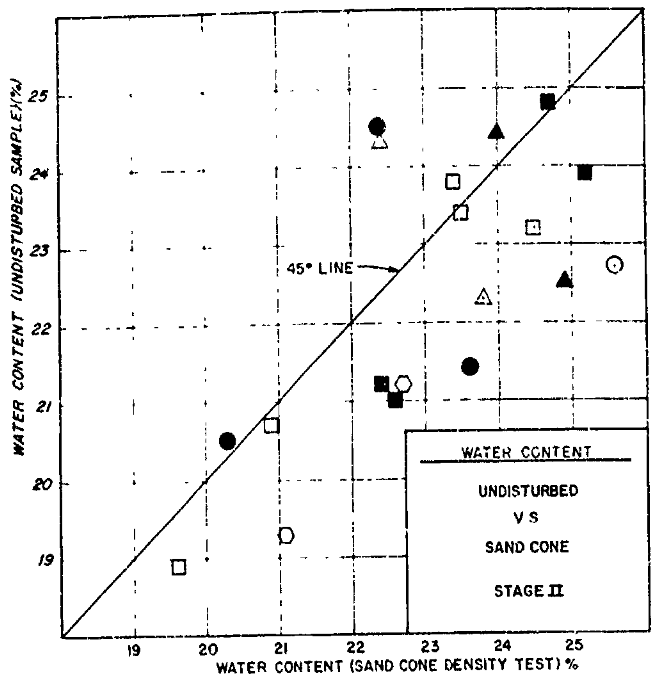
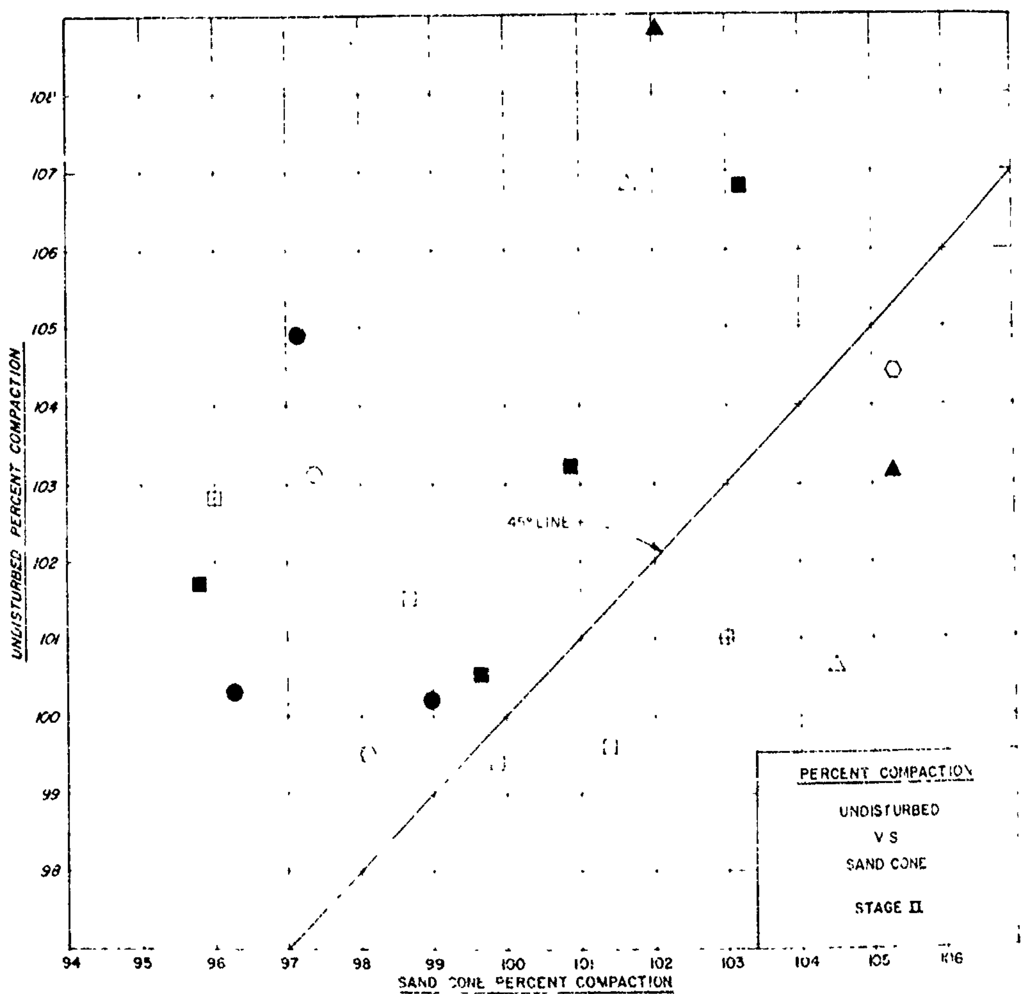


WATER CONTENT (UNDISTURBED SAMPLE)(%)
WATER CONTENT (SAND CONE DENSITY TEST) %
45° LINE
WATER CONTENT
UNDISTURBED
VS
SAND CONE
STAGE II

C



UNDISTURBED PERCENT COMPACTION
SAND CONE PERCENT COMPACTION
45° LINE
PERCENT COMPACTION
UNDISTURBED
VS
SAND CONE
STAGE II

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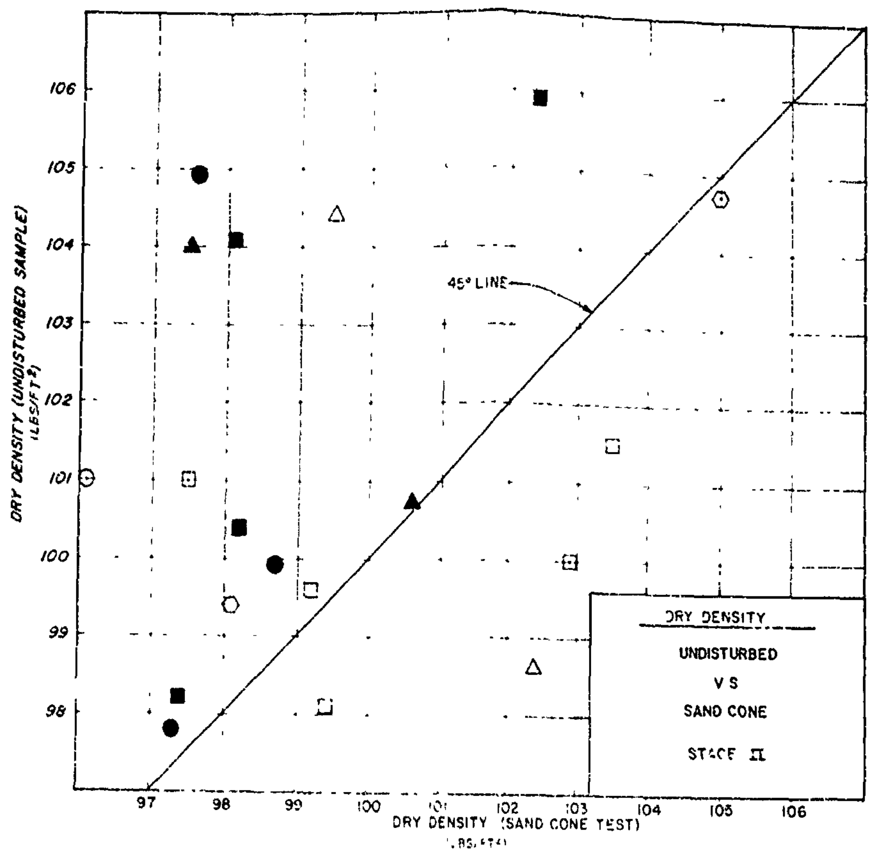

LEGEND – STAGE II

SYMBOL	SAMPLE	LOCATION
□	LIQUID LIMIT	— 55 IMP ZONE
○	LIQUID LIMIT	— 60 IMP ZONE
△	LIQUID LIMIT	— 60 RDM ZONE
■	LIQUID LIMIT	— 65 IMP ZONE
●	LIQUID LIMIT	— 65 RDM ZONE
▲	LIQUID LIMIT	— 70 RDM ZONE
⬡	BERM ZONE	— UNSPEC LIQUID LIMIT

NOTE
THE UNDISTURBED DATA WAS OBTAINED BY AVERAGING MOISTURE AND DENSITY VALUES OF ALL AVAILABLE SHEAR TEST SPECIMENS FOR EACH RECORD CONTROL SAMPLE

Symbol	Revisions Descriptions	Date	Approved

U. S. ARMY ENGINEER DISTRICT
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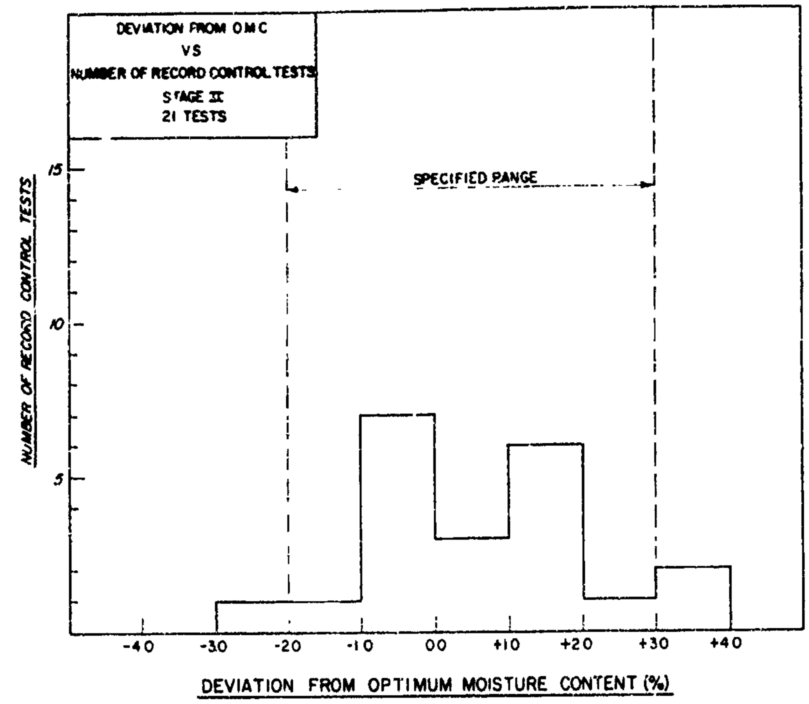
LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA
AND PERFORMANCE REPORT

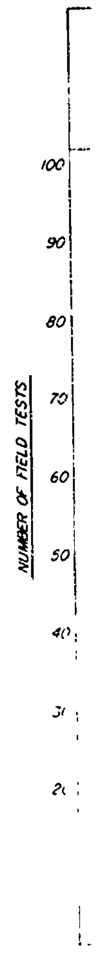
COMPACTION TEST DATA SUMMARY
STAGE II

W B E
E G M
R G D / W B E
E C W

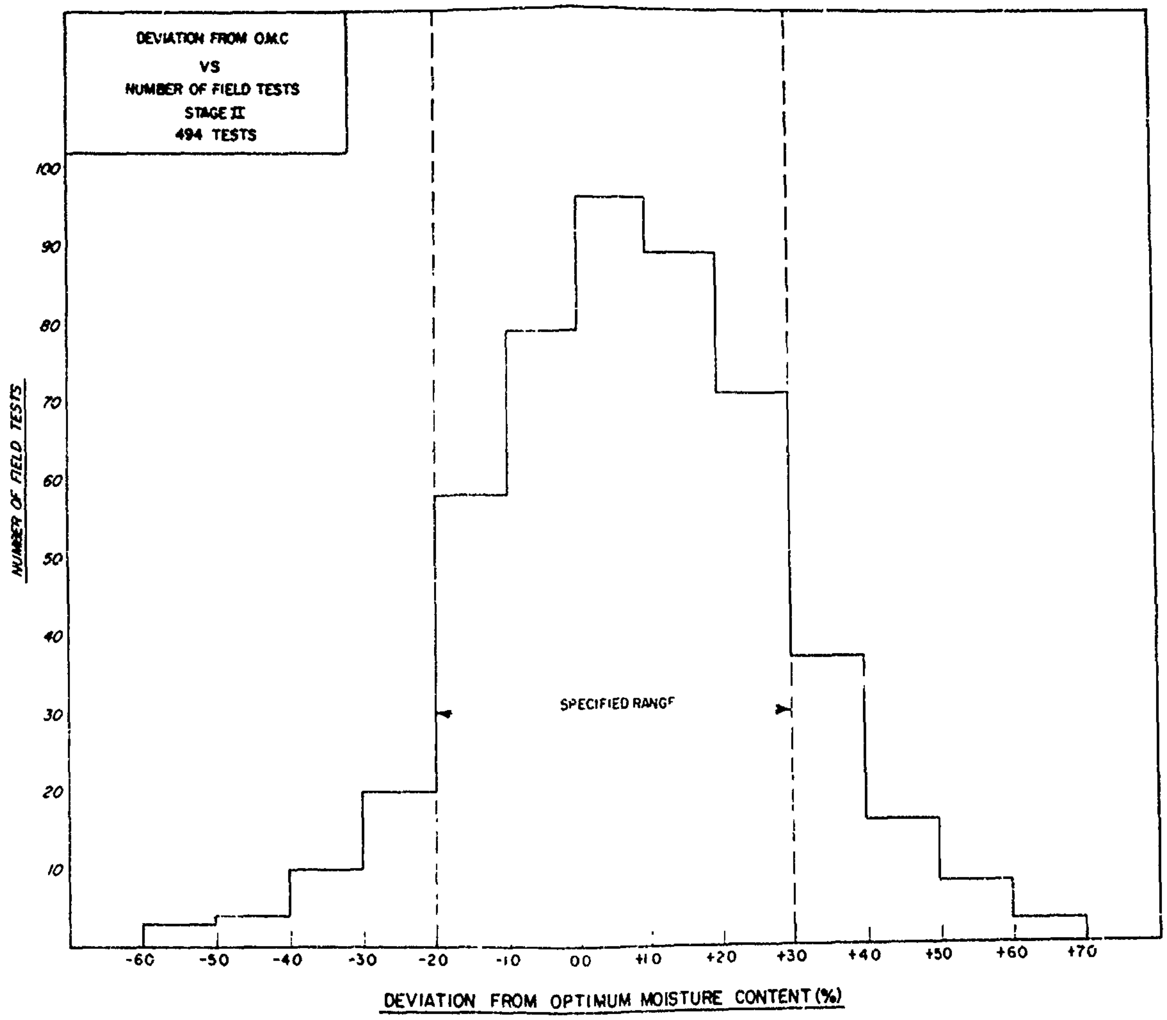
Scale AS SHOWN
Date
Dwg No.
Sheet Number
File No. RBL-3-1483

PLATE NO 83





NOTE
THE REFERENCE
BY MISSOURI RI



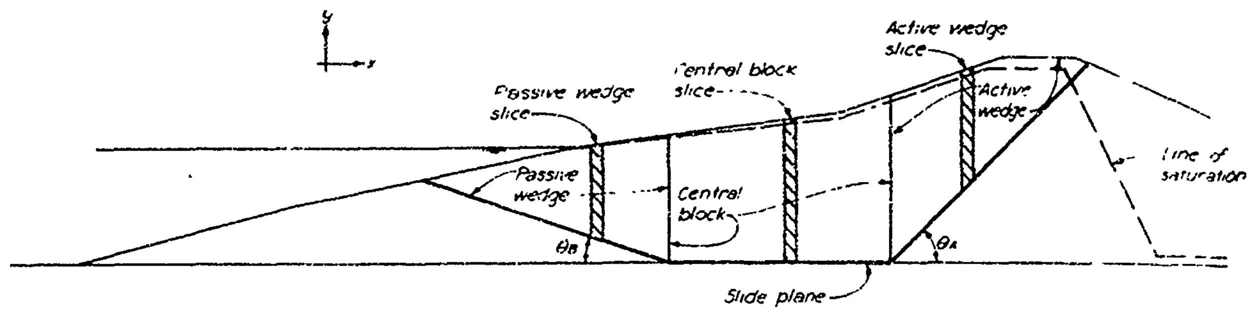
NOTE
THE REFERENCED OPTIMUM MOISTURE CONTENT WAS DETERMINED BY MISSOURI RIVER DIVISION LABORATORY STANDARD COMPACTION TEST

Symbol	Revisions Descriptions	Date	Approved

U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

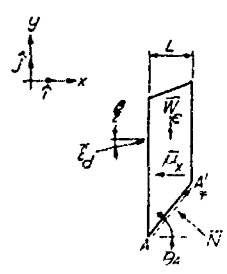
Designed by WBE	LITTLE BLUE RIVER, MISSOURI LONGVIEW LAKE EMBANKMENT CRITERIA AND PERFORMANCE REPORT
Drawn by SEY	COMPACTION TEST SUMMARIES STAGE II
Checked by WBE/RGD	Scale AS SHOWN
Submitted by FCW	Dwg No 3 of 3 — File No RBL-3-1485

PLATE NO 85



GENERALIZED CROSS-SECTION SHOWING A TYPICAL SLIDE PLANE

ACTIVE WEDGE ANALYSIS



$\vec{W}_e = -W_e \hat{j}$ ... (1a)

$\vec{H}_x = H_x \hat{i}$ ... (1b)

$\vec{N} = N(\sin\theta_A \hat{i} + \cos\theta_A \hat{j})$ ... (1c)

$\vec{T} = T(\cos\theta_A \hat{i} + \sin\theta_A \hat{j})$ ... (1d)

$\vec{T}_d = L_d(\cos\delta \hat{i} + \sin\delta \hat{j})$ ... (1e)

For the above freebody [illegible] the following condition must [illegible]:

$\Sigma F = 0$ ... (2)

But N can be represented as,

$N = \sigma_n A$

where,

A = area of [illegible]
$= L/\cos\theta_A$
σ_n = average [illegible] stress [illegible]

Therefore,

$N = \sigma_n L/\cos\theta_A$ ... (3)

Similarly, T can be represented as

$T = \tau A$

where A is defined as [illegible]

$\tau = \tau/FS$

with

FS = factor of safety against sliding
τ = average shear stress [illegible]

From Coulombs Law

$\tau = c + \sigma_n \tan\phi$

where c and $\tan\phi$ are [illegible] constants. Therefore,

$T = \left(\frac{c}{FS} + \sigma_n \frac{\tan\phi}{FS}\right)\frac{L}{\cos\theta_A}$ ... (4)

Substituting Equations (1a), (1b), (1c), (1d), (1e), 3 and 4 into Equation (2), and expressing in matrix form the condition that the algebraic summation of the coefficients of $\hat{i}$ and $\hat{j}$ equals zero gives

$\begin{Bmatrix} L_d \\ \sigma_n \end{Bmatrix} [A] = \begin{Bmatrix} k_1 \\ k_2 \end{Bmatrix}$ ... (5)

where

[illegible]

The solution to Equation (5) is

$\begin{Bmatrix} L_d \\ \sigma_n \end{Bmatrix} = [A]^{-1}\begin{Bmatrix} k_1 \\ k_2 \end{Bmatrix}$ ... (6)

where

[illegible]

... (7)

[illegible]

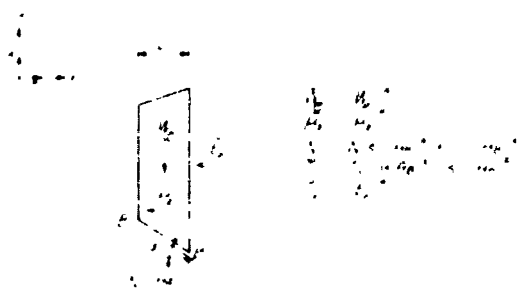
where

[illegible]

DEFINITION OF SYMBOLS USED IN DERIVATION OF STABILITY EQUATIONS

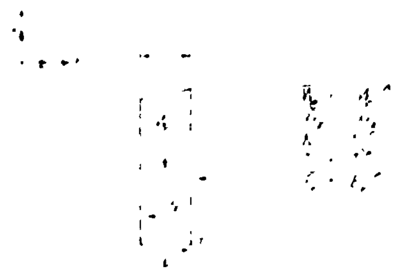
- $\hat{i}$ . . . unit vector in x direction
- $\hat{j}$ . . . unit vector in y direction
- $\bar{W}_e$ . . Effective weight vector
- $\bar{U}_h$ Net horizontal seepage force vector (equal to the vector summation of the horizontal components of all water forces [illegible])
- $\bar{N}$ Normal force vector acting perpendicular to slide plane
- $\bar{T}$ Tangential force vector acting tangentially to slide plane
- $\bar{E}_d$ Driving earth force vector contributed by active wedge [illegible]
- $\bar{E}_r$ Resisting earth force vector contributed by passive wedge [illegible] central block [illegible]
- L horizontal width [illegible]
- θ Slope of [illegible]

PASSIVE WEDGE ANALYSIS



[illegible]

CENTRAL BLOCK ANALYSIS



[illegible] contributed by [illegible] for the resisting force [illegible] form for a cen[illegible] plane (θ_B 0) the [illegible]

SYM	DESCRIPTION	DATE	APP'D
	REVISIONS		

LITTLE BLUE RIVER, MISSOURI

LONGVIEW LAKE

EMBANKMENT CRITERIA AND PERFORMANCE REPORT

DERIVATION OF STABILITY EQUATIONS

In 1 sheet | Sheet No. 1 | Scale as shown

CORPS OF ENGINEERS, KANSAS CITY DISTRICT — U.S. ARMY — JUNE 1978

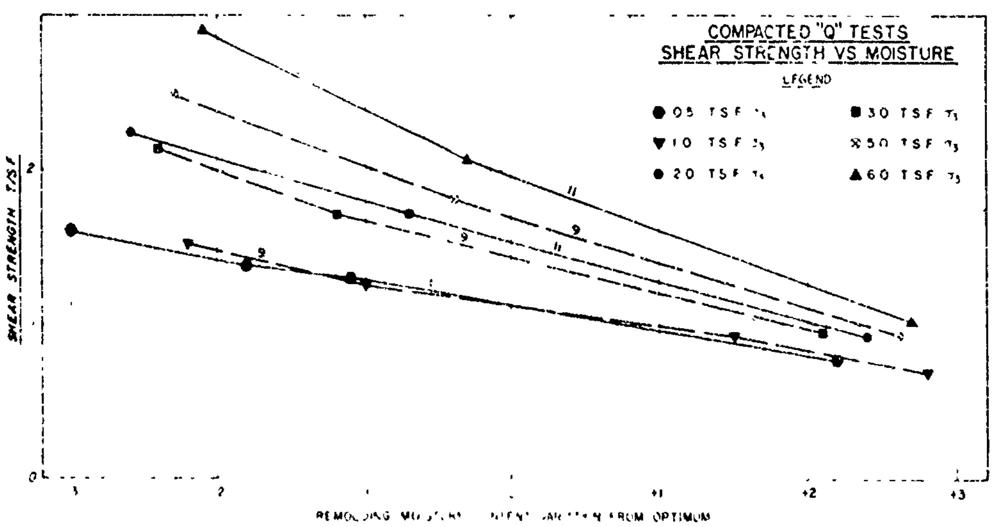
Submitted: [illegible] Recommended: [illegible] Approved: [illegible]

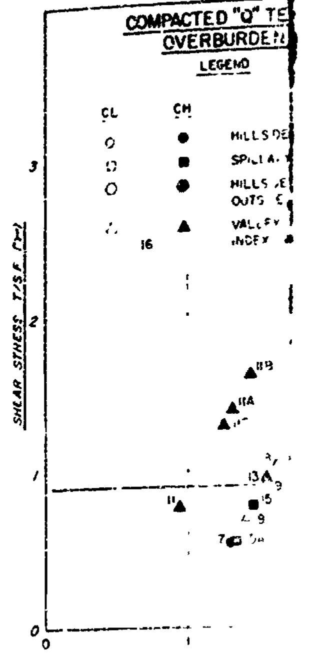
RBL-3-1564

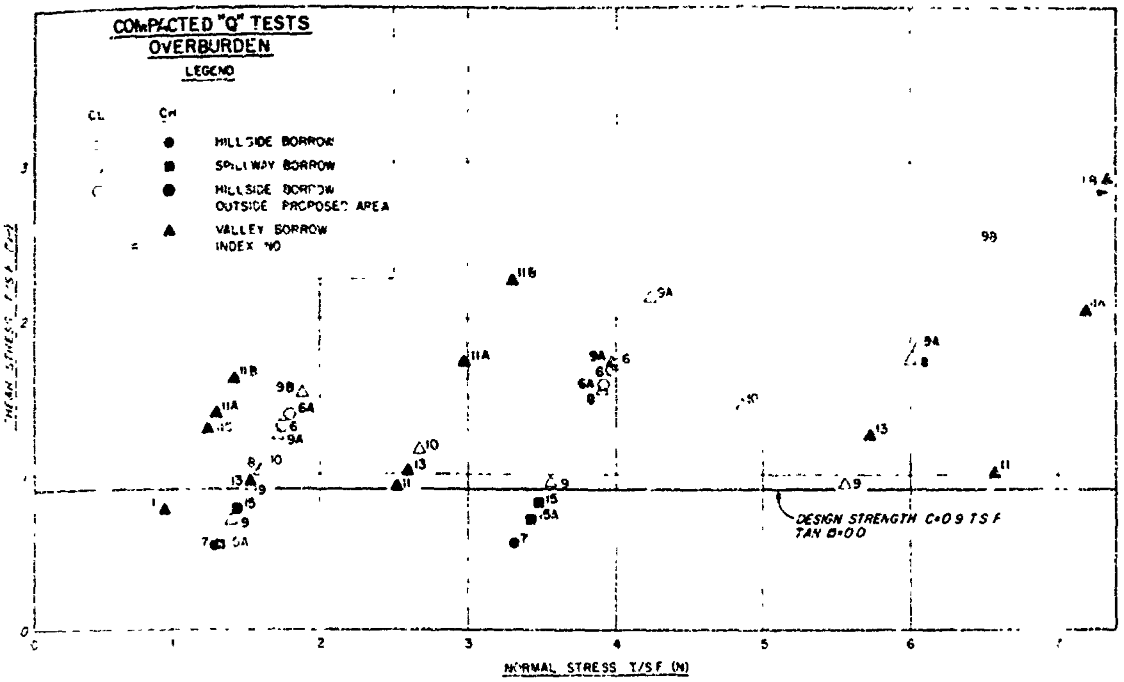
PLATE NO 8

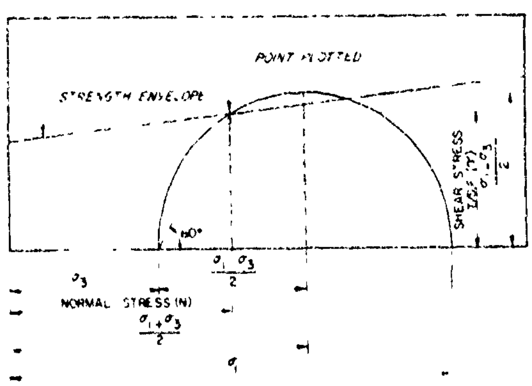
"Q" TEST DATA ON COMPOSITE SAMPLES														
INDEX	COMPOSITE	CLASSIFICATION				DRY DENSITY		WATER CONTENT		N	τ	C		
NUMBER	NUMBER	SYMBOL	LL	PL	PI	MAXIMUM	AT TEST	OPTIMUM	AT TEST	T S F	T S F	T S F	TAN Ø	LOCATION
6 *	6	CL	44 50	17	27 33	95.5	90.8 90.7 90.1	18.5	21.8 21.6 22.4	1.75 3.97 3.99	1.30 1.68 1.72	1.00	.18	HILLSIDE BORROW
6A *	6	CL	44 50	17	27 33	95.5	95.9 95.4	18.5	20.9 21.8	1.80 3.91	1.38 1.58	1.3	.08	HILLSIDE BORROW
7	7	CH	55 52	15 6	40 36	98.5	94.4 93.6	23.5	26.1 26.3	1.32 3.32	.54 .56	.50	.02	HILLSIDE BORROW
8	8	CL	45	15	30	103.5	99.0 98.6 98.1	19.5	22.2 22.6 22.2	1.59 3.89 6.00	1.02 1.54 1.73	.80	.16	DOWNSTREAM VALLEY
9	9	CL	43	17	26	101.5	97.4 96.9 96.7 96.7	21.0	22.5 23.1 23.6 23.8	1.53 3.55 5.54 1.40	.92 .95 .93 .69	.60	.06	VALLEY
9A	9	CL	43	17	26	101.5	97.7 97.3 96.7	21.0	20.0 19.8 20.6	1.72 3.99 6.04	1.25 1.71 1.80	1.00	.14	VALLEY
9B	9	CL	43	17	26	101.5	96.7 96.6 96.9	21.0	18.8 18.6 18.7	1.88 4.23 6.44	1.52 2.13 2.48	1.10	.23	VALLEY
10	10	CL	38	18	20	105.0	99.2 99.3 99.4	17.0	19.7 19.9 19.5	1.59 2.67 4.84	1.03 1.16 1.45	.85	.13	VALLEY
11	11	CH	51	16	35	103.5	99.5 98.8 98.8	19.5	21.7 21.9 22.2	.94 2.53 6.58	.77 .92 1.01	.08	.04	VALLEY
11A	11	CH	[illegible]	16	35	[illegible]	[illegible] 99.5 99.0	[illegible]	17.7 18.[illegible] [illegible]	1.30 2.98 7.19	1.39 1.71 2.06	1.3	.12	VALLEY
11B	11	CH	[illegible]	16	35	103.5	99.3 98.6 93.7	[illegible]	16.5 16.9 17.4	1.43 3.29 7.67	1.61 2.24 2.89	1.3	.21	VALLEY
11C	11	CH	[illegible]	16	35	103.5	99.3	19.5	18.3	1.24	1.29	1.4	.06	VALLEY
13	13	CH	50	17	33	103.5	98.5 98.4 98.5	19.5	22.5 22.5 22.5	1.54 2.59 5.72	.94 1.02 1.25	.92	.08	OUTLET WORKS
15	15	CH	55	16	39	102.0	93.8 92.9	20.0	23.0 23.4	1.44 3.47	.77 .81	.75	.03	SPILLWAY
15A	15	CH	55	16	39	102.0	82.4 82.5	20.0	23.5 23.2	1.3[illegible] 3.41	.54 .71	.75	.08	SPILLWAY

* COMPOSITE NO 6 TAKEN OUTSIDE THE PROPOSED BORROW AREA









MOHR'S DIAGRAM

SYM	DESCRIPTION	DATE	APP'D

REVISIONS

LITTLE BLUE RIVER, MISSOURI

LONGVIEW LAKE

EMBANKMENT CRITERIA AND PERFORMANCE REPORT

TEST DATA SUMMARY
COMPACTED EMBANKMENT MATERIAL
Q-TESTS AND ATTERBERG LIMIT TESTS

In 1 sheet — Sheet No. 1 — Scale as shown

CORPS OF ENGINEERS, KANSAS CITY DISTRICT — U.S. ARMY — JUNE 1978

Submitted / Recommended / Approved

COMPUTED BY G.L.G. — DRAWN BY J.P.M. — CHECKED BY R.G.D.

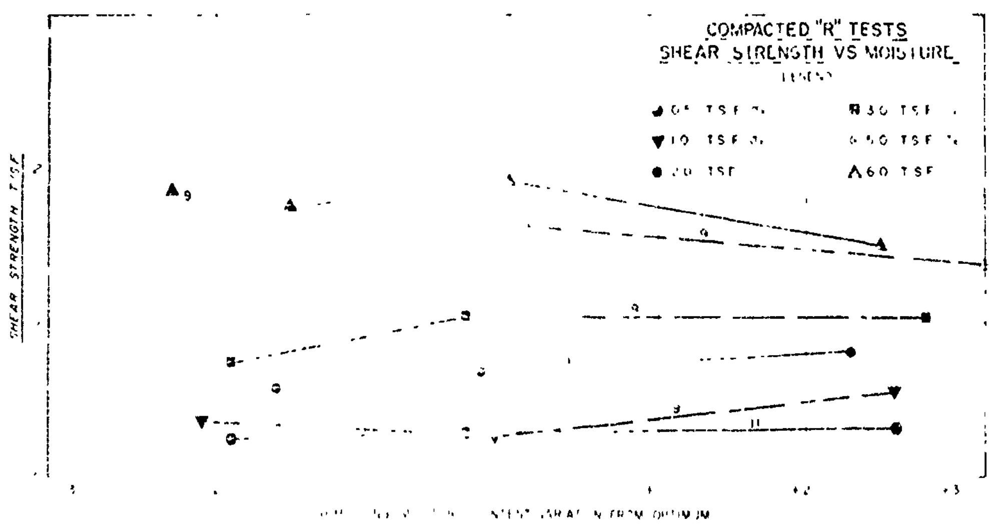
FILE NO. RBL-3-1686

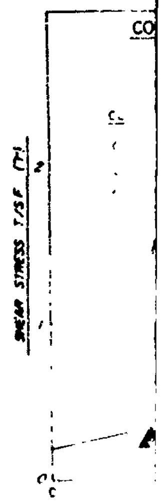
PLATE NO. 86A

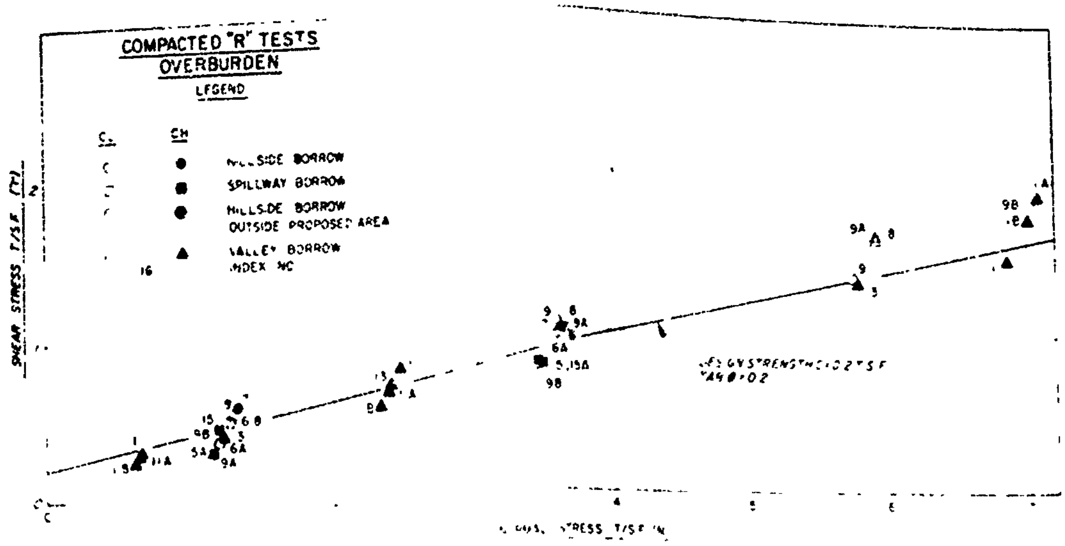
"R" TEST DATA ON COMPOSITE SAMPLES

INDEX NUMBER	COMPOSITE NUMBER	CLASSIFICATION SYMBOL	LL	PL	PI	DRY DENSITY MAXIMUM	DRY DENSITY AT TEST	WATER CONTENT OPTIMUM	WATER CONTENT AT TEST	N TSF	? TSF	C TSF	TAN Ø	LOCATION
6✱	6	CL	44	17	27	95 5	91 7 90 7	18 5	21 0 21 7	1 29 3 58	50 1 00	25	22	HILLSIDE BORROW
6A✱	6	CL	44	17	27	95 5	95 5 95.5	18 5	21 0 21 1	1 21 3 5 6	37 97	01	28	HILLSIDE BORROW
7	7	CH	55	15	40	98 5	93 7 93 7	25 5	26 3 26 2	1 34 3 59	58 1 02	30	20	HILLSIDE BORROW
8	8	CL	45	15	30	103 5	99 0 98 9 98 1	19 5	22 0 22 1 22 1	1 29 3 60 5 94	50 1 04 1 63	20	24	DOWNSTREAM VALLEY
9	9	CL	43	17	26	101 5	96 8 96 7 96 4	21 0	23 6 23 8 24.2	1 32 3 59 5 79	55 1 03 1 37	40	18	VALLEY
9A	9	CL	43	17	26	101 5	98 1 100 5 96 4	21 0	20 9 20 7 21 1	1.1 5 3 60 5 94	26 1 04 1 64	0 0	28	VALLEY
9B	9	CL	43	17	26	101 5	96 7 96 6 96 6	21 0	18 9 19 1 18 7	1 21 3 43 7 08	36 74 1 86	10	26	VALLEY
11	11	CH	51	16	35	103 5	98 9 98 9 99 0	19 5	22.1 21 8 22 0	68 2 47 6 87	31 81 1 50	20	20	VALLEY
11A	11	CH	51	16	35	103 5	99 1 98 6 99 6	19 5	19 2 19 3 19 5	67 2 39 7 10	29 68 1 91	20	25	VALLEY
11B	11	CH	51	16	35	103 5	98 5 98 1 97 9	19 5	17 6 17 9 18 0	64 2 33 7 02	25 57 1 76	10	24	VALLEY
13	13	CH	50	17	33	103 5	98 5 99 5 98 8	19 5	22 5 22 5 22 4	1 24 2 41 5 78	40 70 1 35	18	20	OUTLET WORKS
15	15	CH	55	16	39	102 0	93 1 93 4	20 0	23 2 23 4	1 22 3 46	38 80	19	19	SPILLWAY
15A	15	CH	55	16	39	102 0	81 7 82 1	20 0	24 4 23 7	1 17 3 46	29 80	05	22	SPILLWAY

✱ COMPOSITE NO 6 TAKEN OUTSIDE THE PROPOSED BORROW AREA

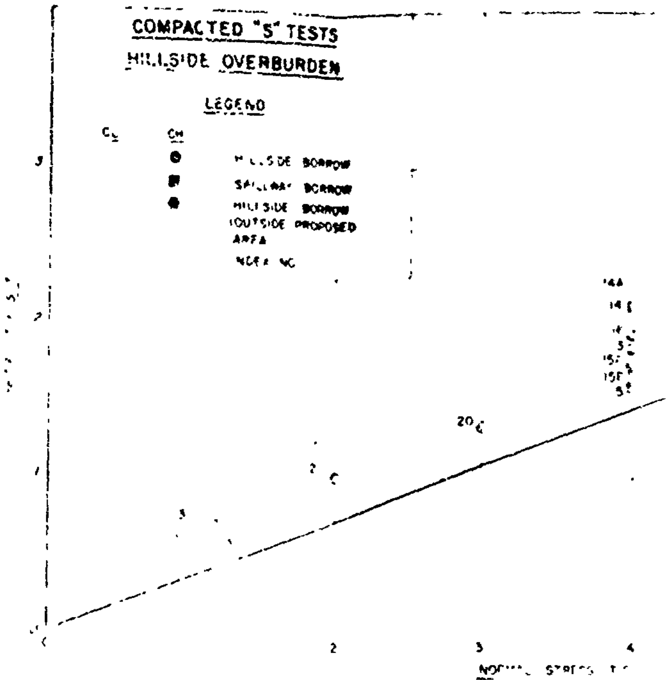


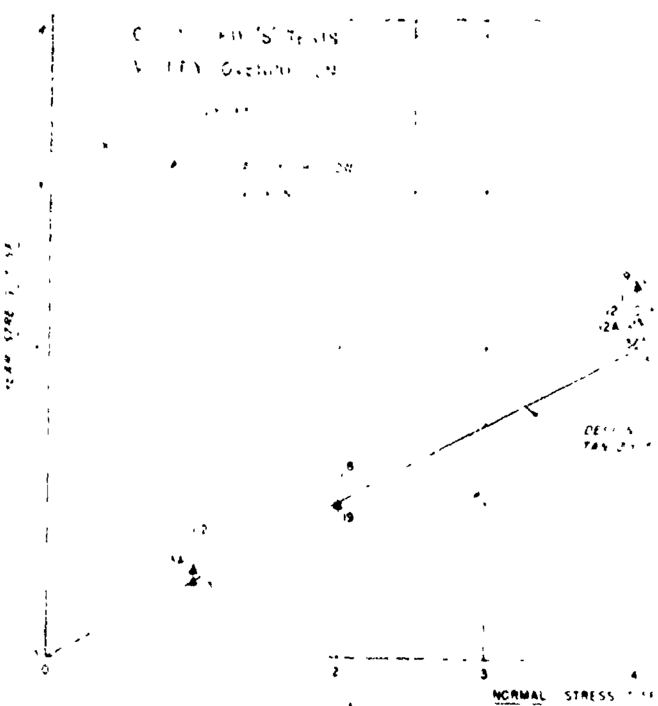


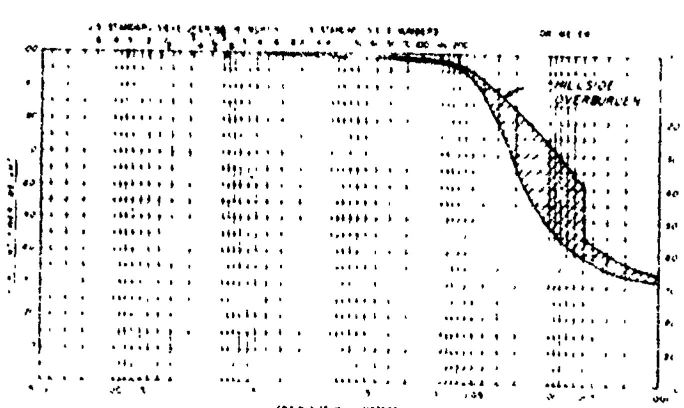


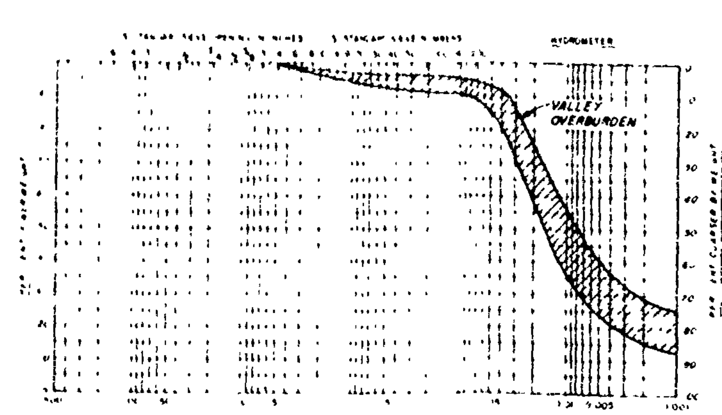
LONGVIEW LAKE

INDEX NO	COMPOSITE NO	CLASSIFICATION SYMBOL	LL	PL	PI	DRY DENSITY MAXIMUM	DRY DENSITY AT TEST	WATER CONTENT OPTIMUM	WATER CONTENT AT TEST	σ_3 T.S.F.	τ MAX T.S.F.	C T.S.F.	TAN ϕ	LOCATION
2	2	CL	37	21	16	106.5	100.5	17.0	21.0	1 4	0.79 2.38	0.05	.5	[illegible]
3KK	3	CH	67	21	46	101.0	96.5	21.0	23.4	1 4	0.59 1.54	0.32	.44	HILLSIDE
8	8	CH	50	22	28	103.5	98.5	19.5	22.5	4 4	2.[illegible] 2.40	0.0	.57	DOWNSTREAM VALLEY
9	9	CL	48	24	24	101.5	96.5	21.0	23.5	4 6	2.46 [illegible]	0.0	.62	[illegible]
10	10	CL	40	21	19	105.9	99.0	17.0	20.0	5 6	[illegible]	[illegible]	[illegible]	[illegible]
11	11	CL	46	2[illegible]	25	103.5	99.0	19.5	22.0	4 6	[illegible]	[illegible]	[illegible]	[illegible]
1[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	100.[illegible]	1[illegible]	[illegible]	4 6	[illegible]	[illegible]	[illegible]	[illegible]
12A	12	CL	47	21	2[illegible]	105.0	100.0	19.[illegible]	[illegible]0	4 6	[illegible]	[illegible]	[illegible]	
12B	12	CL	47	21	2[illegible]	[illegible]5.0	100.0	19.0	[illegible]	4 6	[illegible]	[illegible]	[illegible]	
12C	12	CL	41	16	25	[illegible]5.0	84.0 94.0	19.0	[illegible]	4 4	[illegible]	[illegible]	[illegible]	
13	13	CH	54	2[illegible]	3[illegible]	[illegible]	92.[illegible]	19.5	[illegible]	4 6	[illegible]		[illegible]	[illegible]
13[illegible]	13	CH	54	22	32	[illegible]3.5	96.5	[illegible]9.5	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
13[illegible]	13	CH	54	22	32	13[illegible]	96.5	19.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1[illegible]	[illegible]4	CH	53	[illegible]	[illegible]	[illegible]	98.0	19	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
14[illegible]	[illegible]4	[illegible]	[illegible]	[illegible]	[illegible]		82.[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]5	[illegible]5	CH	59	[illegible]	3[illegible]		[illegible]			[illegible]	[illegible]		[illegible]	

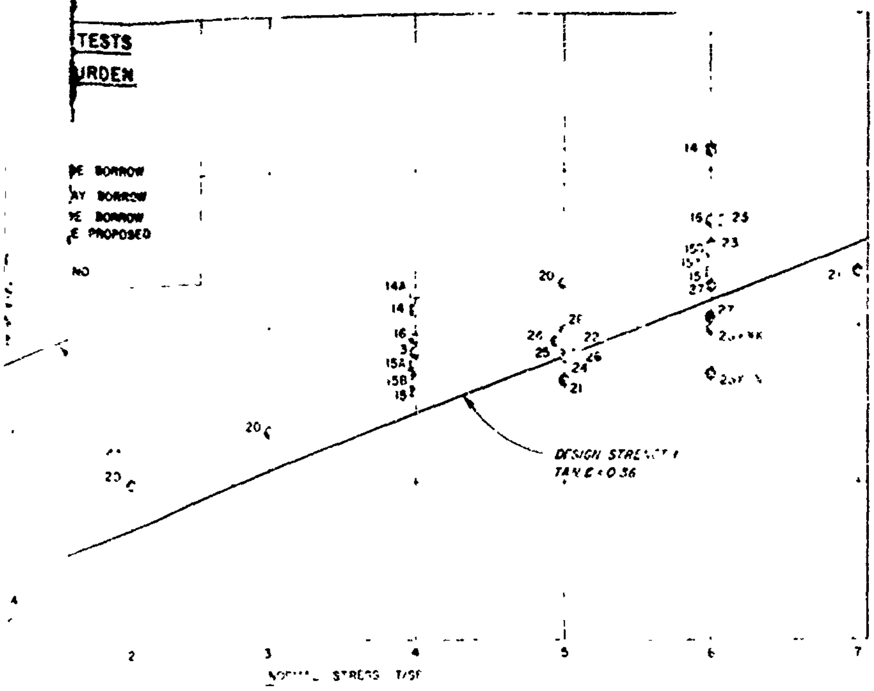


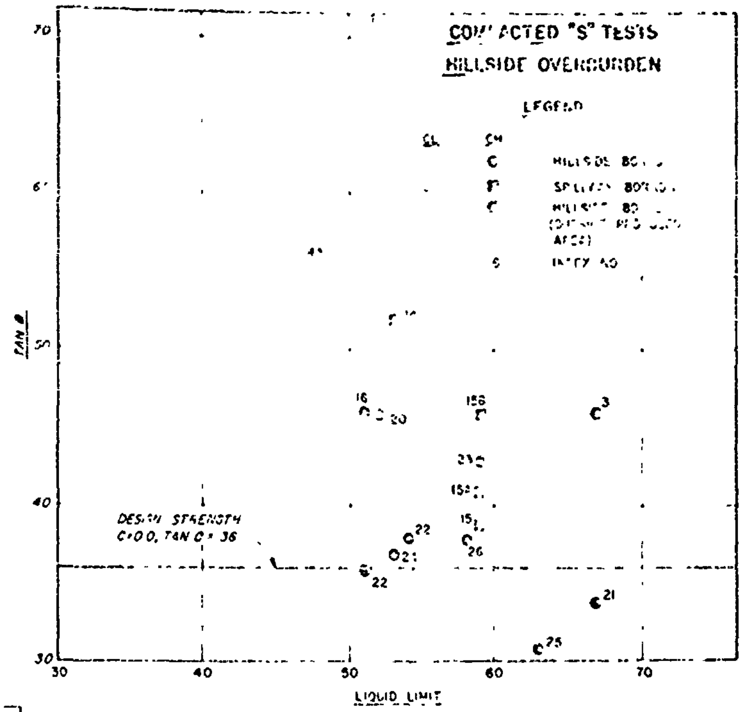


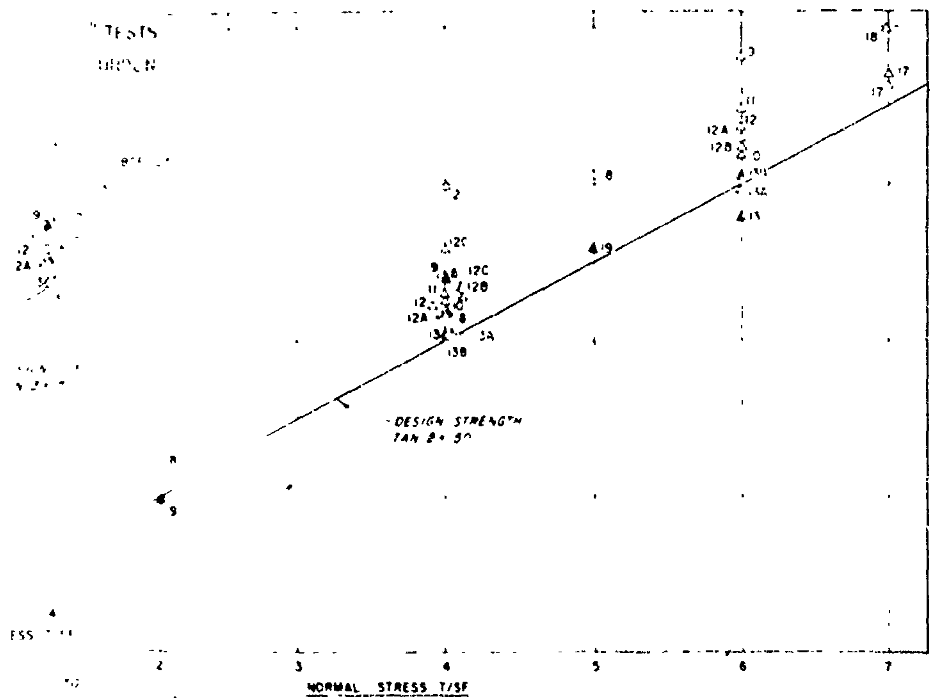


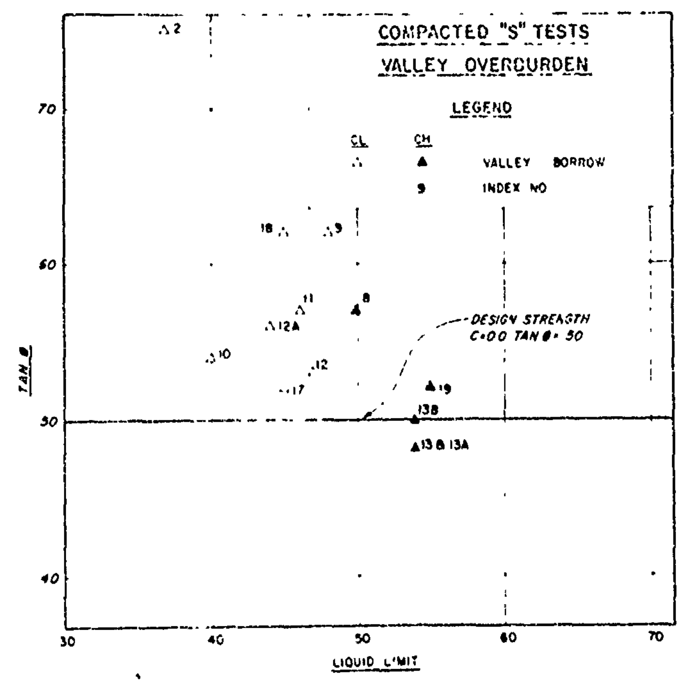


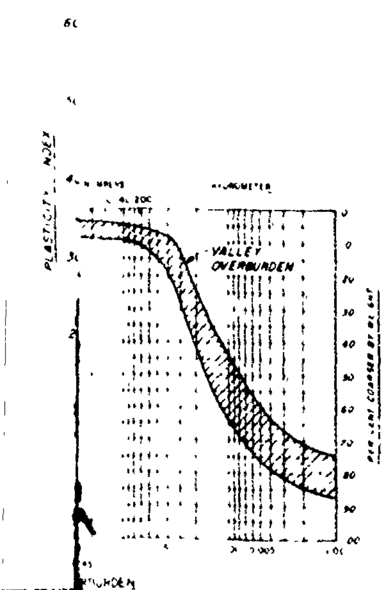
GRADATION VALLEY OVERBURDEN

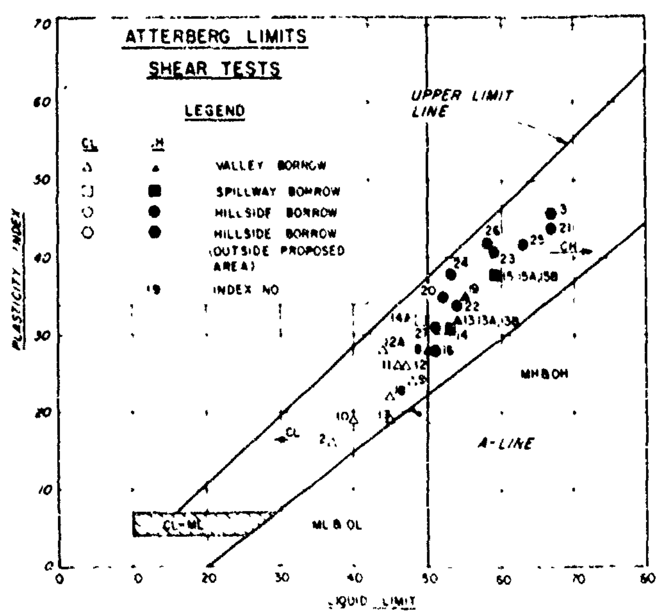












SYM	DESCRIPTION REVISIONS	DATE	APP'D

LITTLE BLUE RIVER, MISSOURI

LONGVIEW LAKE

EMBANKMENT CRITERIA AND PERFORMANCE REPORT

TEST DATA SUMMARY
COMPACTED EMBANKMENT MATERIAL
S-TESTS AND ATTERBERG LIMIT TESTS

In 1 sheet — Sheet No 1 — Scale as shown

CORPS OF ENGINEERS KANSAS CITY DISTRICT — U.S. ARMY JUNE 1978

Submitted — Recommended — Approved

RGD — PM — RGD

RBL-3-1688

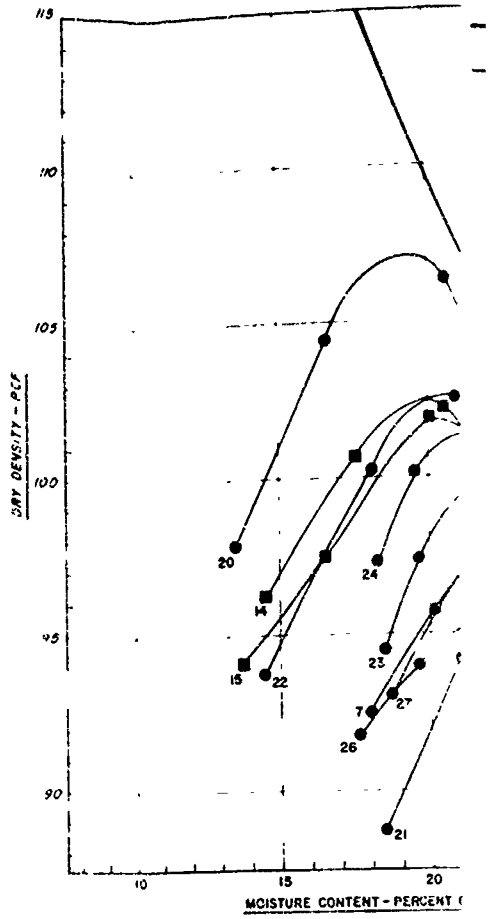
PLATE NO. 86C

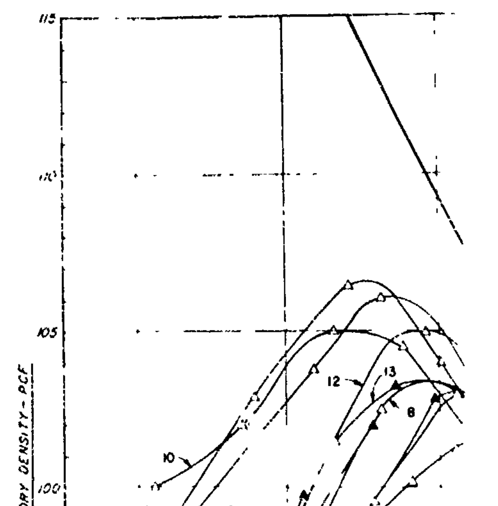
DATA ON COMPOSITE SAMPLES

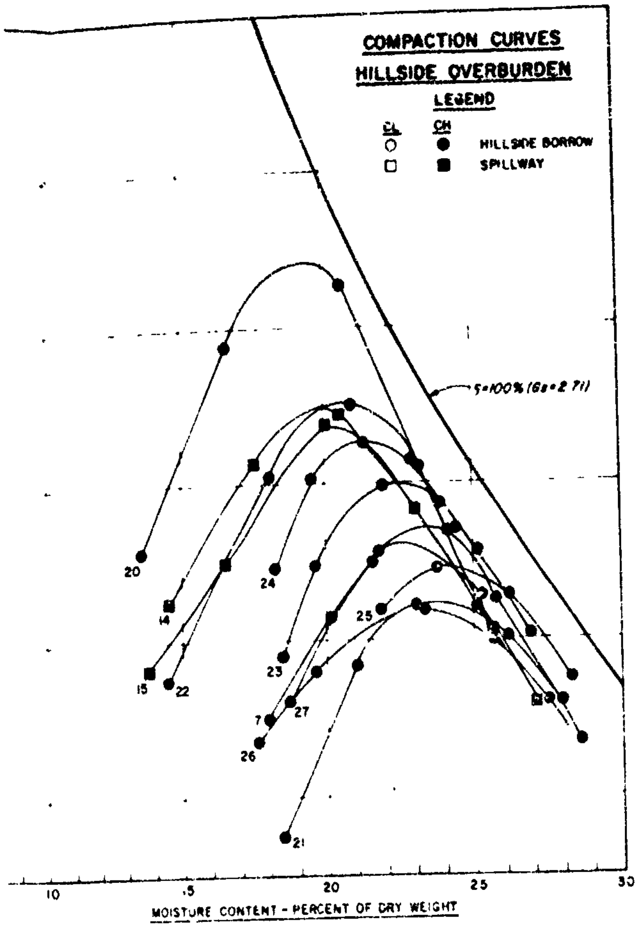
INDEX NUMBER	COMP NUMBER	HOLE NUMBER	SACK NUMBER	DEPTH	CLASSIFICATION SYMBOL	LL	PL	PI	MAXIMUM DRY DENSITY	OPTIMUM WATER CONTENT	LOCATION
2	2	A 33 A 34	1 & 2 2	10384375 60110	CL	37	21	16	106 5	17 0	VALLEY BORROW
3	3	A 74 A 75	1 1	0570 0575	CH	67	21	46	101 0	21 0	HILLSIDE BORROW
4	4	A 78 A 79	1 1 & 2	050 05080110	CH	55	24	31	102 0	19 5	HILLSIDE BORROW
4AN	4N	A 78 A 79	1 1 & 2	050 05080110	CH	55	24	31	112 0	16 0	HILLSIDE BORROW
5	5	A 68 A 69	1 1	30125 0667	CH	55	21	34	103 5	19 5	HILLSIDE BORROW
5AN	5N	A 68 A 69	1 1	30125 6667	CH	55	21	34	111 5	16 6	HILLSIDE BORROW
6	6	A 81 A 67	1 1	2082 25110	CL	44	17	27	95 5	18 5	HILLSIDE BORROW
7	7	A 72 A 88	1 1	0150 0120	CH	55	15	40	98 5	22 5	HILLSIDE BORROW
8	8	D 90 D 91	1 1	0250 0170	CH	50	22	28	103 5	19 5	DOWNSTREAM BORROW
9	9	D 84 D 85	1 1	0120 068	CL	48	24	24	101 5	21 0	VALLEY BORROW
10	10	A 62 A 63	1 1	055 050	CL	40	21	19	105 0	17 0	VALLEY BORROW
11	11	A 73 D 86	1 1	054 075	CL	46	20	26	103 5	19 5	VALLEY BORROW
12	12	A 57 AC 21	1 & 2 3 & 4	10200 160260	[illegible]	47	21	26	105 0	19 0	OUTLET WORKS
13	13	AC 30 AC 55	1 & 2 1	2080 1025	CH	54	22	32	103 5	19 5	OUTLET WORKS
14	14	AC 52 AC 53	1 1	10110 1070	CH	53	22	31	103 0	19 5	SPILLWAY
15	15	AC 52 AC 54	2 1	115150 1080	CH	59	21	38	102 0	20 0	SPILLWAY
16	16	A 65 A 66	1 1	17127 036	CH	51	23	28	102 0	20 0	HILLSIDE BORROW
17	17	D 171 D 172	1 2	4060 80110	CL	45	24	21	106 0	18 0	VALLEY BORROW
18	18	D 173 D 40A	1 1	2040 2040	CL	45	23	22	102 5	20 5	VALLEY BORROW
19	19	D 20A	1 & 2	2356460	CH	55	20	35	103 0	20 5	VALLEY
20	20	D 175 D 184	2 1	6080 2080	CH	52	17	35	107 0	19 0	HILLSIDE BORROW
21	21	D 176 D 17.	1 1	2040 2040	CH	67	23	44	96 0	23 5	HILLSIDE BORROW
22	[illegible]	D 190 D 19.	1 1	2040 4060	CH	54	20	34	102 5	20 5	HILLSIDE BORROW
23	23	D 131A D 184	2 1	4060 2040	CH	59	18	41	100 0	22 2	HILLSIDE BORROW
24	24	C 131A D 182	1 2	4060 86100	CH	53	15	38	107 0	21 2	HILLSIDE BORROW
25	25	D 88 A 135	2 2	120215 60110	CH	63	21	42	96 5	24 3	HILLSIDE BORROW
26	25	A 71 D 178	1 2	75100 100120	CH	58	16	42	96 0	23 3	HILLSIDE BORROW
27	27	D 186 D 18A D 176	1 2 2	2040 100120 80100	CH	51	20	[illegible]	98 5	22 8	HILLSIDE BORROW

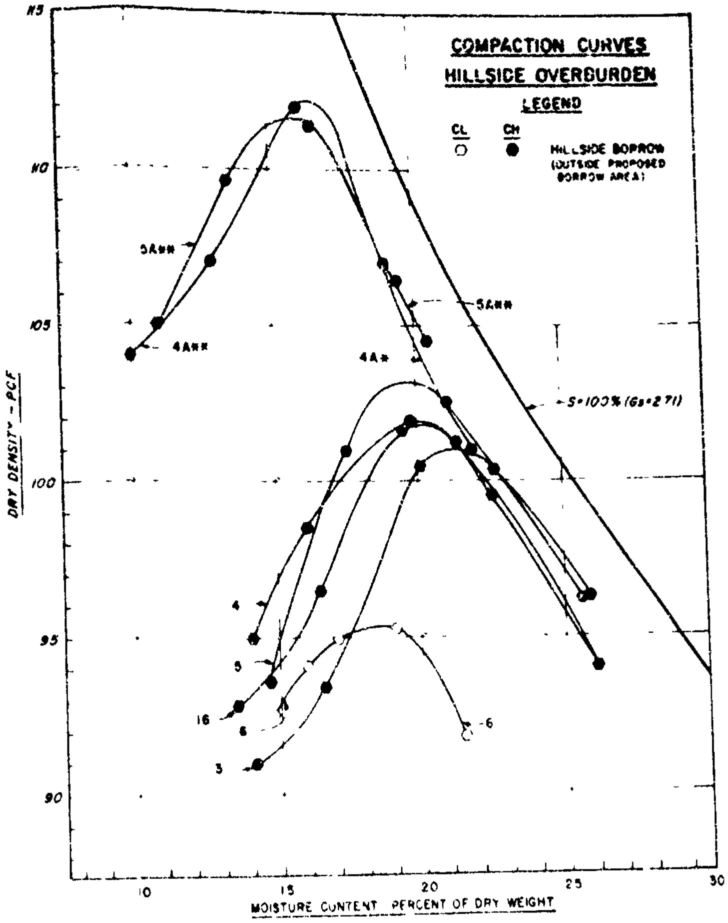
\# MODIFIED PROCTOR TEST

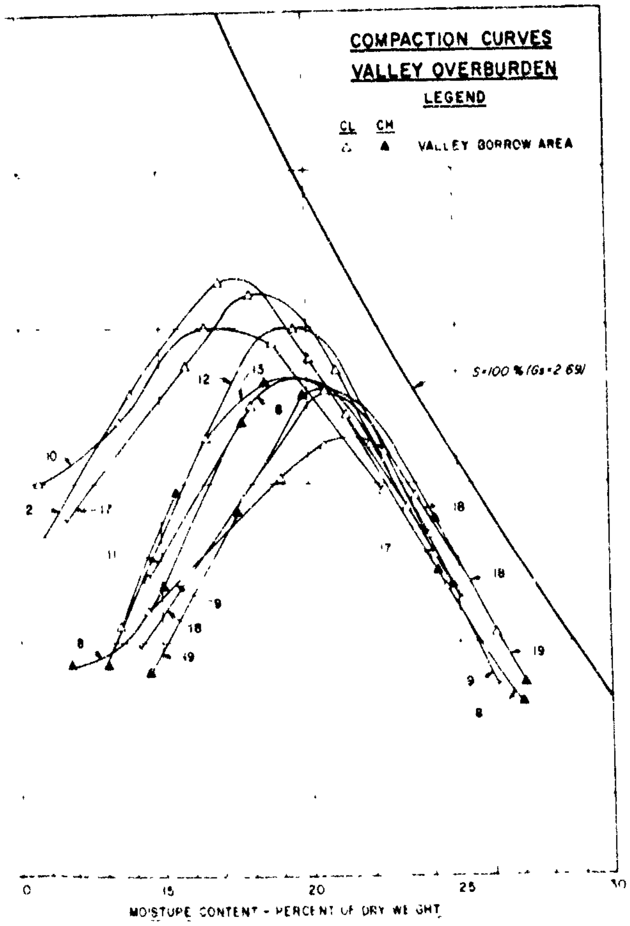
NOTE COMPOSITES N? 3 4 5 6 AND 16 ARE OUTSIDE THE PROPOSED BORROW AREA

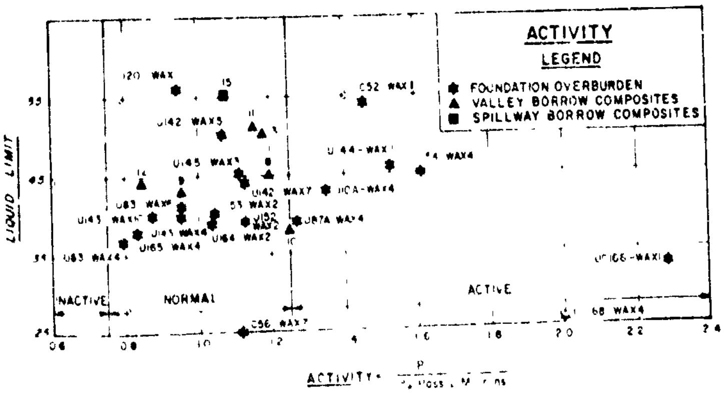












**NOTE ... posites 4A & 5A are from Mod ied ... Test

LITTLE BLUE RIVER MISSOURI

LONGVIEW LAKE

EMBANKMENT CRITERIA AND PERFORMANCE REPORT

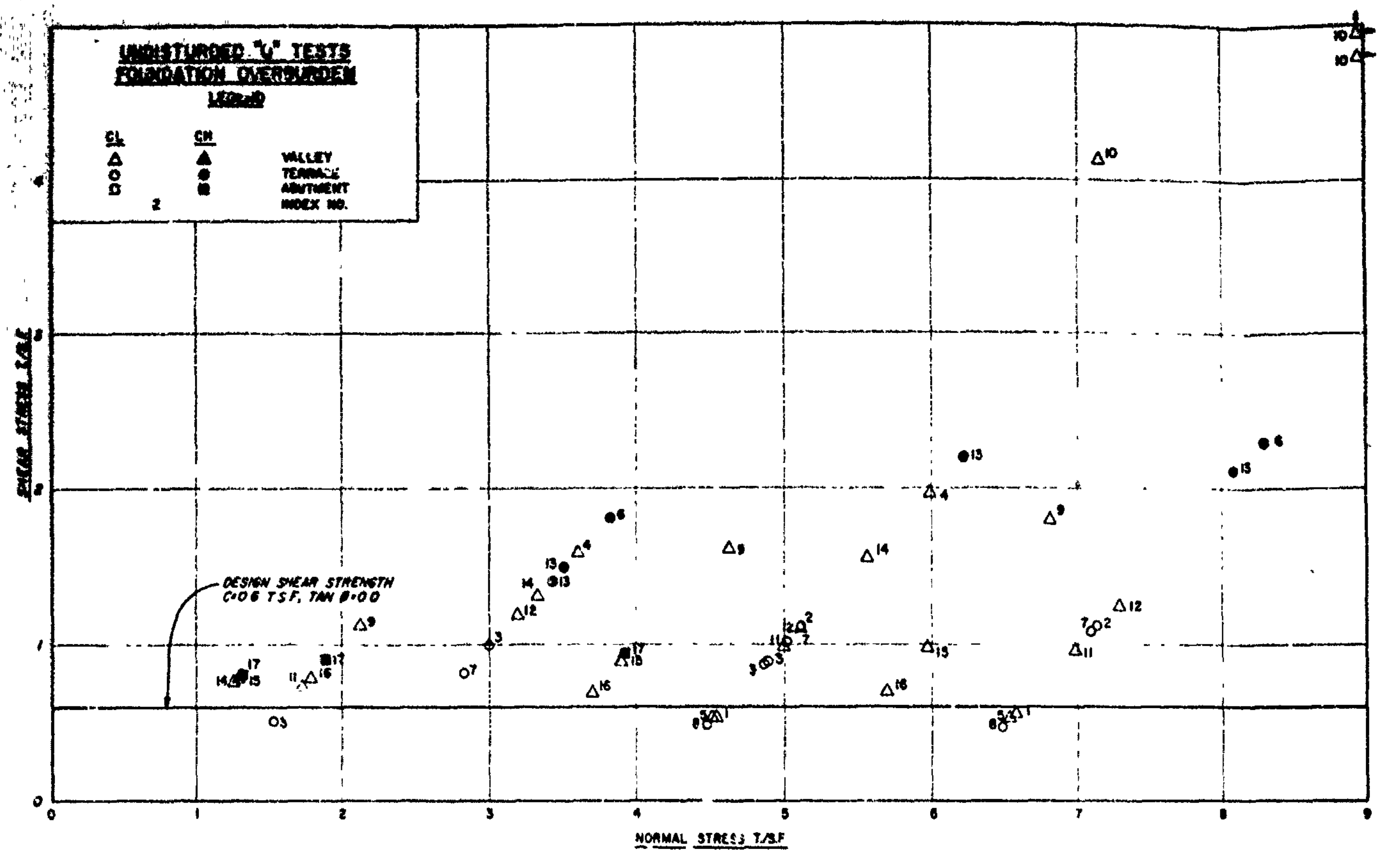
TEST DATA SUMMARY
COMPACTED EMBANKMENT
COMPACTION CURVES
GRADATIONS AND ACTIVITY DATA

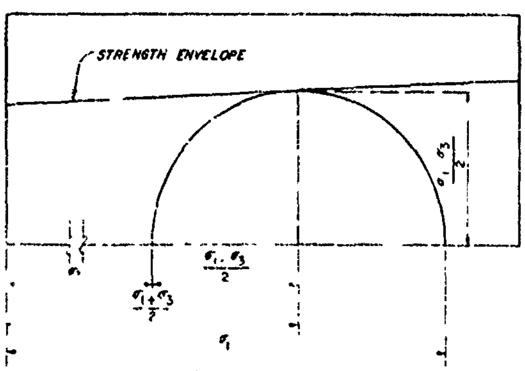
Scale as shown
U. S. ARMY
JUNE 1978

CORPS OF ENGINEERS
KANSAS CITY

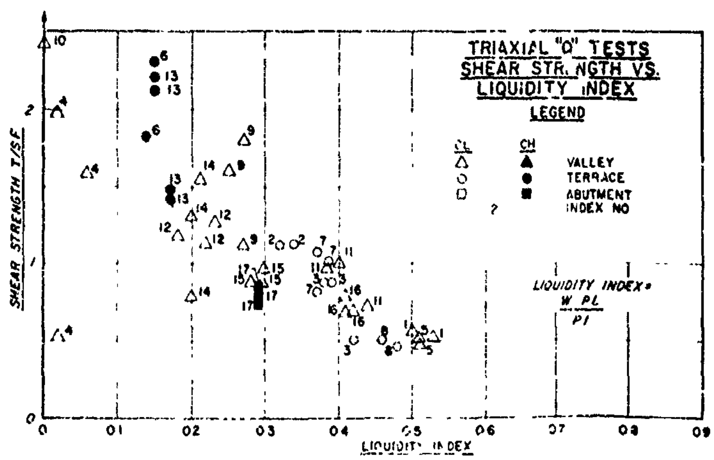
RBL-3-1689

PLATE NO. 86D

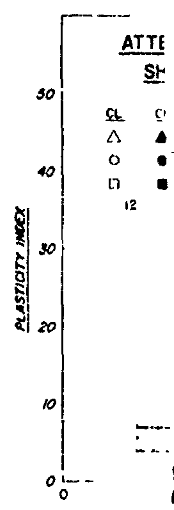


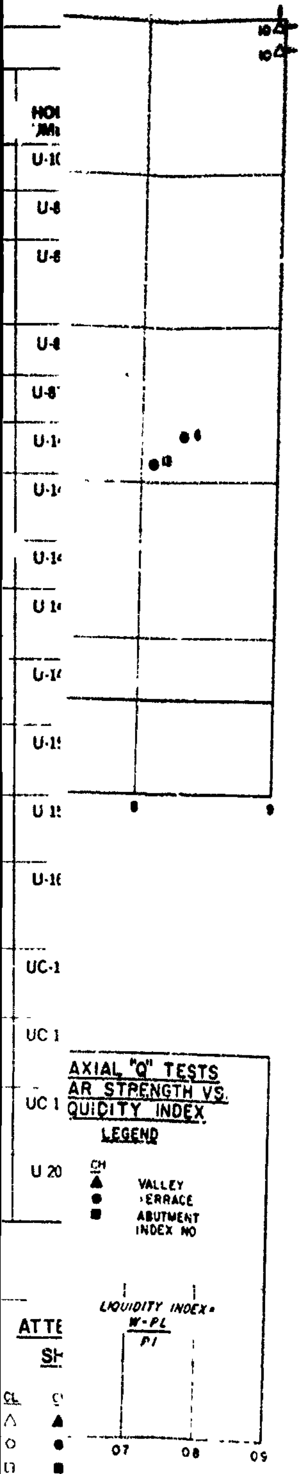


MOHR'S DIAGRAM



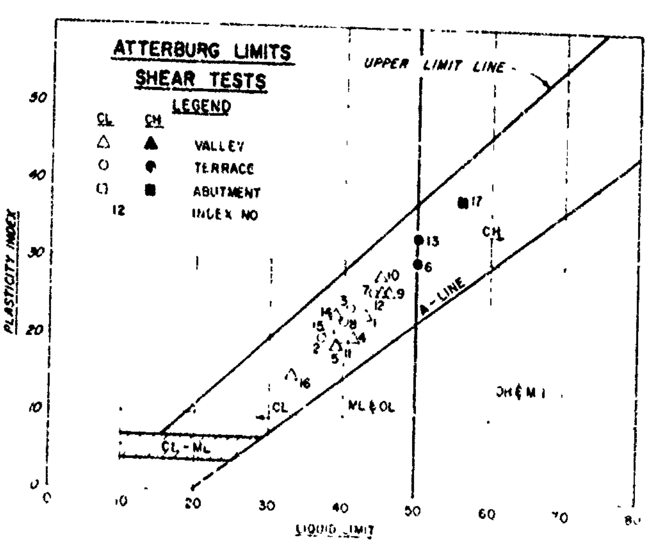
INDEX NUM.	HOL...
1	U-1(
2	U-8
3	U-8
4	U-8
5	U-8
6	U-1
7	U-1
8	U 1
9	U-1
10	U-1
11	U-1
12	U-1
13	U-1
14	UC-1
15	UC 1
16	UC 1
17	U 20





TRIAXIAL "Q" TEST DATA

INDEX NUMBER	HOLE NUMBER	SAMPLE NUMBER	DEPTH	CLASSIFICATION SYMBOL	L. L.	P. L.	P. I.	INITIAL CONDITIONS DRY DENSITY	WATER CONTENT	% SAT.	σ_3 T. S. F.	σ_1 T. S. F.	$\frac{(\sigma_1-\sigma_3)}{2}$ T. S. F.	$\frac{(\sigma_1+\sigma_3)}{2}$ T. S. F.	C T. S. F.	TAN θ	LOCATION
1	U-10A	WAX 4	7.0-7.9	CL	43	20	23	87.6 88.1	32.5 31.6	96 96	4 6	5.05 7.13	.53 .55	4.53 6.56	0.52	0.0	VALLEY
2	U-83	WAX 4	7.2-7.9	CL	37	17	20	98.6 98.7	23.4 23.7	90 91	4 6	6.24 8.27	1.12 1.13	5.12 7.13	1.00	.08	TERRACE
3	U-83	WAX 6	10.0-11.2	CL	41	17	24	94.4 94.6 94.6 92.9	26.4 26.3 27.1 26.0	93 92 96 80	2 4 1 4	3.98 5.77 2.04 5.74	.99 .88 .52 .87	2.99 4.88 1.52 4.87	0.4	.10	TERRACE
4	U-87	WAX 3	4.0-5.0	CL	41	21	20	81.8 83.4	22.2 21.4	58 54	2 4	5.18 7.94	1.59 1.97	3.59 5.97	1.0	.18	VALLEY
5	U-87A	WAX 4	7.5-7.8	CL	39	20	19	91.2 90.8	29.8 29.7	96 97	4 6	5.08 7.05	.54 .52	4.54 6.52	.52	0.0	VALLEY
6	U-142	WAX 5	7.1-8.0	CH	50	20	30	97.2 98.5	24.1 24.6	88 95	2 6	5.67 10.62	1.83 2.31	3.83 8.31	.95 (σ_3<6) 2.4 (σ_3>6)	.24 0.0	TERRACE
7	U-142	WAX 7	10.0-11.5	CL	44	18	26	93.9 93.3 94.5	28.1 27.7 27.7	96 98 96	4 6 2	6.02 8.19 3.66	1.01 1.09 .83	5.01 7.09 2.83	.6 (σ_3<6) 1.1 (σ_3>6)	.08 0.0	TERRACE
8	U-143	WAX 10	18.0-19.0	CL	40	18	22	96.2 95.9	28.1 28.5	100 100	4 6	5.05 6.96	.52 .48	4.52 6.48	.50	0.0	TERRACE
9	U-144	WAX 1	0.5-1.8	CL	46	20	26	88.6 88.9 89.0	26.9 26.6 27.1	83 84 84	1 3 5	3.22 6.21 8.60	1.11 1.60 1.80	2.11 4.61 6.80	0.8 (σ_3<6) 1.8 (σ_3>6)	.18 0.0	VALLEY
10	U-145	WAX 5	4.0-5.9	CL	45	17	28	93.5 95.2 93.2	16.3 16.1 16.4	56 57 63	3 5 7	11.29 14.60 18.18	4.14 4.80 5.59	7.14 9.80 12.59	2.4	.28	VALLEY
11	U-153	WAX 2	2.0-3.6	CL	40	20	20	89.6 89.6 91.6	28.7 28.0 27.7	90 86 91	1 4 6	2.45 6.00 7.92	.72 1.00 .96	1.72 5.00 6.96	.75	0.0	VALLEY
12	U-154	WAX 4	6.0-7.9	CL	45	19	26	90.8 87.7 88.1	24.7 24.9 23.7	73 73 72	4 6 2	6.24 8.56 4.36	1.12 1.28 1.18	5.12 7.28 3.18	1.2	0.0	VALLEY
13	U-163	WAX 3	4.0-5.9	CH	50	17	33	100.7 101.3 101.2 101.5	22.7 21.9 22.1 22.6	90 86 89 92	2 4 6 2	4.83 8.43 10.28 5.00	1.41 2.21 2.14 1.50	3.41 6.21 8.14 3.50	0.7 (σ_3<6) 2.1 (σ_3>6)	.24 0.0	TERRACE
14	UC-164	WAX 2	2.0-3.9	CL	39	16	23	97.4 97.0 96.9	20.6 20.6 20.9	77 76 77	.5 2 4	2.08 4.62 7.11	.79 1.31 1.55	1.29 3.31 5.55	0.5 (σ_3<3) 1.0 (σ_3>3)	.23 .10	VALLEY
15	UC-165	WAX 4	6.0-7.9	CL	38	17	21	100.6 101.0 101.1	22.8 23.4 23.4	94 97 97	1 3 5	2.75 4.77 6.93	.87 .88 .96	1.87 3.88 5.96	.85	.02	VALLEY
16	UC-166	WAX 3	4.0-5.7	CL	33	18	15	100.5 100.6 100.0	24.2 24.3 24.2	98 99 97	1 3 5	2.56 4.39 6.39	.78 .69 .69	1.78 3.69 5.69	.70	0.0	VALLEY
17	U 201	WAX 1	1.0-2.0	CH	56	18	38	96.6 96.9 96.7	26.2 26.2 26.1	97 98 97	.5 1 3	2.11 2.74 4.84	.80 .87 .92	1.30 1.87 3.92	.75	.05	ABUTMENT



SYM	DESCRIPTION	DATE	APP'D

REVISIONS

LITTLE BLUE RIVER, MISSOURI

LONGVIEW LAKE

EMBANKMENT CRITERIA AND PERFORMANCE REPORT

TEST DATA SUMMARY
UNDISTURBED FOUNDATION OVERBURDEN
Q-TESTS

In 1 sheet — Sheet No 1 — Scale as shown

CORPS OF ENGINEERS
KANSAS CITY DISTRICT

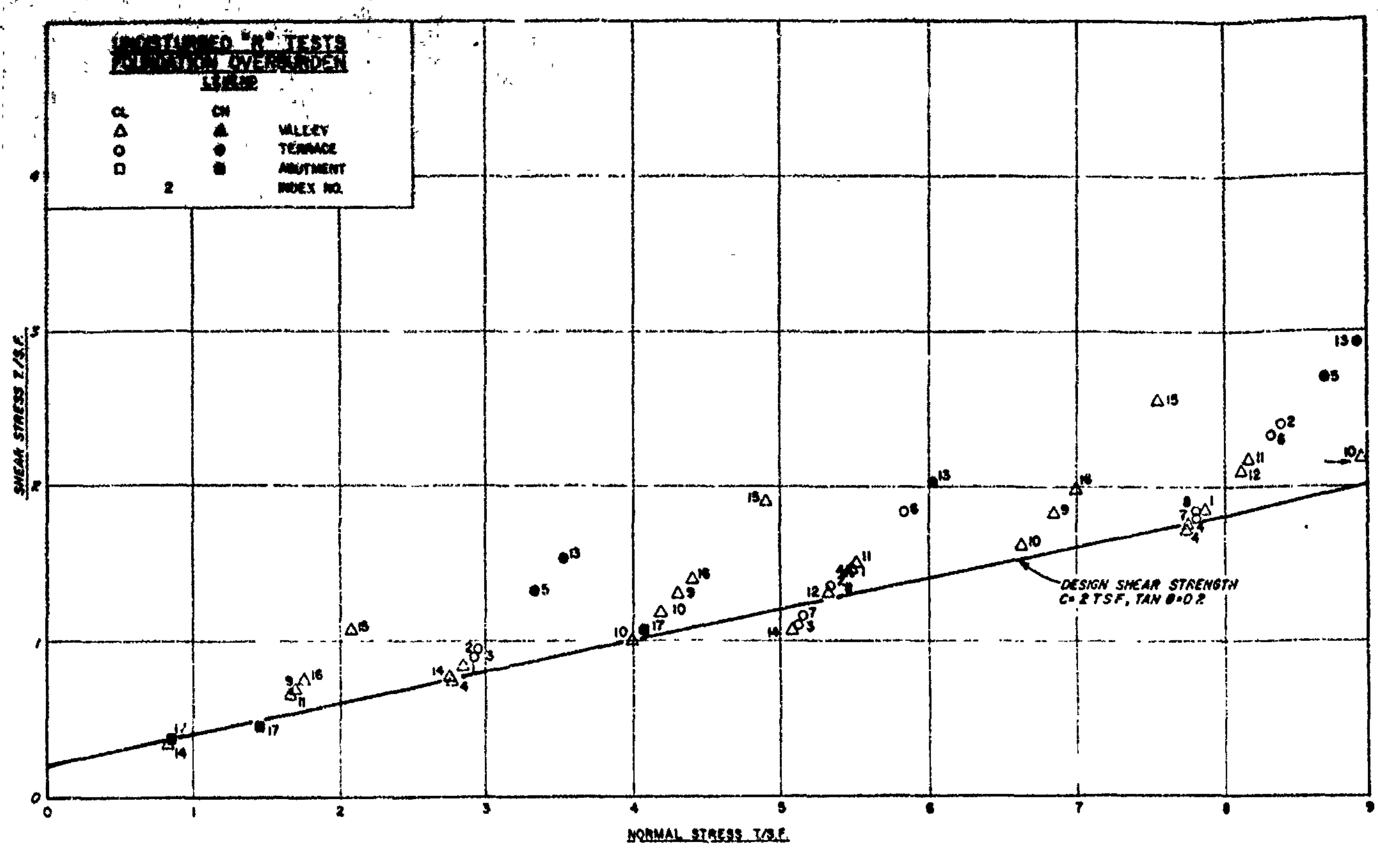
U S ARMY
JUNE 1978

Submitted — CHIEF, DAMS & FOUNDATIONS SECT
Recommended — CHIEF, FOUNDATIONS & MATLS BR
Approved — CHIEF, ENGINEERING DIVISION

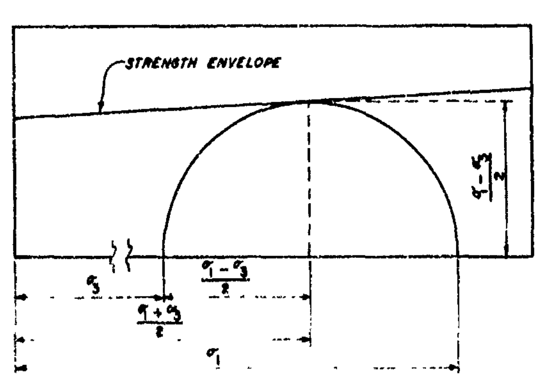
COMPILED BY G L G — DRAWN BY J P M — CHECKED BY R G D

FILE NO RBL-3-1690

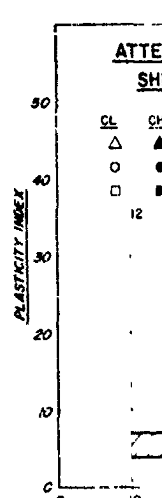
PLATE NO. 86E



INDEX NUMBER	HOLE NUMBER
1	U-10A
2	U-83
3	U-83
4	U-87
5	U-142
6	U-142
7	U-143
8	U-143
9	U-144
10	U-145
11	U-153
12	U-154
13	U-163
14	UC-164
15	UC-165
16	UC-166
17	U-201

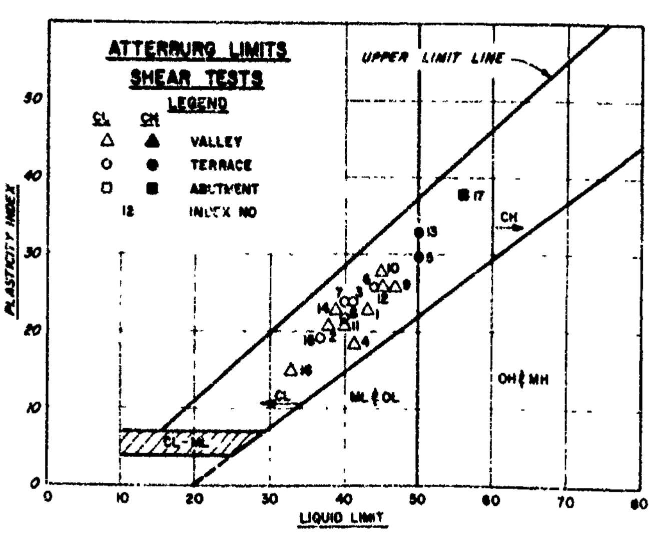


MOHR'S DIAGRAM



TRIAXIAL "R" TEST DATA

INDEX NUMBER	HOLE NUMBER	SAMPLE NUMBER	DEPTH	CLASSIFICATION SYMBOL	L.L.	P.L.	P.I.	INITIAL CONDITIONS DRY DENSITY	WATER CONTENT	% SAT.	σ_3 T.S.F.	σ_1 T.S.F.	$\frac{\sigma_1-\sigma_3}{2}$ T.S.F.	$\frac{\sigma_1+\sigma_3}{2}$ T.S.F.	C T.S.F.	TAN Ø	LOCATION
1	U-10A	WAX 4	7.0-7.9	CL	43	20	23	81.1 85.8 85.1	33.7 32.5 32.3	86 92 90	2 4 6	3.68 6.92 9.71	.84 1.46 1.86	2.84 5.46 7.86	0.25	.22	VALLEY
2	U-83	WAX 4	7.2-7.9	CL	37	17	20	96.7 90.4 98.9	23.6 23.6 23.8	91 92 92	4 6 2	6.68 10.79 3.90	1.34 2.40 .96	5.34 8.40 2.96	.20	.26	TERRACE
3	U-83	WAX 6	10.0-11.9	CL	41	17	24	94.5 95.2	28.2 26.9	93 97	2 4	3.82 6.25	.91 1.12	2.91 5.12	0.70	.33	TERRACE
4	U-87	WAX 3	4.0-5.9	CL	41	21	20	87.3 87.4 82.0 84.4	22.6 23.9 21.1 20.6	68 72 56 58	2 4 6 6	3.54 6.94 9.48 9.50	.77 1.47 1.74 1.75	2.77 5.47 7.74 7.75	.25	.21	VALLEY
5	U-142	WAX 6	7.1-8.0	CH	50	20	30	96.3 96.6	25.0 25.0	83 90	2 6	4.64 11.39	1.32 2.70	3.32 8.70	.50	.27	TERRACE
6	U-142	WAX 7	10.0-11.9	CL	44	18	26	93.2 93.2	27.8 27.5	93 93	4 6	7.67 10.67	1.84 2.34	5.84 8.34	1.00	.17	TERRACE
7	U-143	WAX 4	6.0-7.9	CL	40	16	24	97.2 97.7	24.7 24.7	92 93	4 6	6.29 9.55	1.14 1.78	5.14 7.78	0.0	.24	TERRACE
8	U-143	WAX 10	18.0-19.0	CL	40	18	22	94.1 94.0	28.1 28.8	96 98	4 6	6.68 9.66	1.34 1.83	5.34 7.83	.25	.21	TERRACE
9	U-144	SHELBY 1	0.5-1.8	CL	46	20	26	91.7 91.4 93.2	26.6 26.6 26.5	88 88 91	1 3 5	2.39 5.60 8.67	.70 1.30 1.84	1.70 4.30 6.84	.30	.20	VALLEY
10	U-145	SHELBY 3	4.0-5.9	CL	45	17	28	97.0 96.1 96.1 96.5	15.7 16.2 16.2 16.2	58 59 59 60	3 5 7 3	5.37 8.25 11.37 5.01	1.18 1.62 2.18 1.00	4.18 6.62 9.18 4.00	.20	.23	VALLEY
11	U-153	SHELBY 2	2.0-3.6	CL	40	20	20	87.1 87.2 87.5	28.2 28.7 28.3	84 85 85	1 4 6	2.33 7.03 10.34	.66 1.52 2.17	1.66 5.52 8.17	.30	.235	VALLEY
12	U-154	WAX 4	6.0-7.9	CL	45	19	26	88.4 90.8	27.7 27.1	83 86	4 6	6.63 10.23	1.32 2.12	5.32 8.12	0.0	.26	VALLEY
13	U-163	SHELBY 3	4.0-5.9	CH	50	17	33	102.2 102.3 102.5	21.8 21.8 22.4	90 90 93	2 4 6	5.08 8.05 11.84	1.54 2.02 2.92	3.54 6.02 8.92	.90	22	TERRACE
14	UC-164	WAX 2	2.0-3.9	CL	39	16	23	95.0 96.7 96.0	21.3 21.7 21.6	75 80 78	0.5 2 4	1.19 3.53 6.16	.34 .76 1.08	.84 2.76 5.08	.25	.17	VALLEY
15	UC-165	SHELBY 4	6.0-7.9	CL	38	17	21	101.5 101.2 101.6	23.4 23.4 23.3	98 98 98	1 3 5	3.17 6.76 10.09	1.08 1.88 2.54	2.08 4.88 7.54	.60	.38	VALLEY
16	UC-166	SHELBY 3	4.0-5.7	CL	33	18	15	99.9 100.8 101.2	24.5 24.7 24.6	98 100+ 100+	1 3 5	2.51 5.77 8.96	.76 1.38 1.98	1.76 4.38 6.98	40	.24	VALLEY
17	U-201	SAMPLE 1	1.0-2.0	CH	56	18	38	94.9 95.7 93.7	28.1 28.1 27.8	100 100+ 96	0.5 1 3	1.22 1.90 5.14	.36 45 1.07	.86 1.45 4.07	.20	22	ABUTMENT



SYM	DESCRIPTION	DATE	APP'D

REVISIONS

LITTLE BLUE RIVER, MISSOURI

LONGVIEW LAKE

EMBANKMENT CRITERIA AND PERFORMANCE REPORT

TEST DATA SUMMARY
UNDISTURBED FOUNDATION OVERBURDEN
R-TESTS

In 1 sheet — Sheet No 1 — Scale, as shown

CORPS OF ENGINEERS
KANSAS CITY DISTRICT

U S ARMY
JUNE 1978

Submitted — CHIEF, DAMS & FOUNDATIONS SECT
Recommended — CHIEF, FOUNDATIONS & MATLS BR
Approved — CHIEF, ENGINEERING DIVISION

COMPILED BY G L G — DRAWN BY O H — CHECKED BY R G D

FILE NO RBL-3-1691

PLATE NO 86E

SUMMARY UNDISTURBED "S" TEST DATA OVERBURDEN MATERIALS

INDEX NUMBER	HOLE NUMBER	SAMPLE NUMBER	DEPTH	CLASSIFICATION SYMBOL	L. L.	P. L.	P. I.	INITIAL CONDITIONS DRY DENSITY	WATER CONTENT	% SAT.	σ_3 T.S.F.	τ MAX. T.S.F.	τ RESIDUAL T.S.F.	C T.S.F.	TAN ϕ	LOCATION
1	UC-9	WAX 2	3 3-3 7	OH	51	30	21	80 5	34	85	6 6	3 8 3 9		0 0	0 60	VALLEY
2	UC 9	WAX 4	6 8-7 2	CL	50	23	27	91 5	30 5	98	6 6	4 03 3 76		0 0	0 65	VALLEY
3	U-9A	WAX 4	7 4 7 8	CL	42	21	21	91 5	27	89	2 2	1 02 1 3[illegible]		0 0	0 58	VALLEY
4	U-10A	WAX 4	6 5 6 8	CL	46	24	22	91 0	31 5	100	6	3 81 3 60		0 0	0 62	VALLEY
5	U-10B	WAX 3	4.9 5 3	CL	44	24	20	89 0	25 0	77	4	2.41 2 65		0 0	0 63	VALLEY
6	U 10B	WAX 5	8 5 9 0	CL	41	21	20	95 0	33 0	95	4	2 20 2 75		0 0	0 62	VALLEY
7	U 82	WAX 1	1 0 1 5	CL	44	27	7	91 5	28	93	6	4 24 3 84		0 0	0 67	VALLEY
8	U 82	WAX 5	8 8 9 1	CL	40	22	18	97 0	26	97	6	3 74 3 84		0 0	0 63	VALLEY
9	U 83	WAX 2	2 8 3 1	CL	34	23	11	90 5	14 5	90 5	4 6	2.70 3 81		0 6	[illegible]	TERRACE
10	U-83	WAX 2	2 8 3 1	CL	34	23	11	90 5	14 5	90 5	4 6		2 50 3 50	0 5	0 50	TERRACE
11	U 83	WAX 4	6 6 6 9	CL	42	22	20	94 5	24 0	84	4 6	2 59 3 57		0 5	0 53	TERRACE
12	U 83	WAX 6	10 0 11 9	CL	41	17	24	92 1 91 0 95 7	27 9 28 2 28 2	93 92 100	2 4 6	1 06 2 24 3 58		0 0	0 53	TERRACE
13	U 83	WAX 10	18 6 18 9	CL	38	23	15	96 0	27 5	98	4 6	2 39 3 62		0 0	0 60	TERRACE
14	U 87	WAX 1	1 0 1 3	CL	40	24	16	87 5	20 0	87 5	6	3 35 3 92		0 0	0 62	VALLEY
15	U 87	WAX 1	1 0 [illegible] 3	CL	40	24	16	87 5	20 0	87 5	6		3 40 3 60	0 0	[illegible]	VALLEY
16	U 87	WAX 3	4 0 5 9	CL	41	21	20	79 3 81 9 87 8	21 0 19 0 17 9	52 50 55	2 4 6	1 42 2 63 4 37		0 0	[illegible]	VALLEY
17*	U 87	WAX 3	4 0 5 9	CL	41	21	20	87 3 87 4	22 6 23 9	68 72	1 2 2	0 65 1 40		0 0	0 65	VALLEY
18	U 87	WAX 4	6 1 6 6	CL	46	22	24	90 0	27 5	90	6	3 57 3 74		0 0	0 61	VALLEY
19	U 87A	WAX 1	1 2 1 6	CL	46	24	22	92 0	28 0	92	5	3 04 3 28		0 0	0 63	VALLEY
20	U 87A	WAX 4	6 9 [illegible] 3	CL	46	24	22	85 0	31 0	85 5	6	3 60 3 93		0 0	0 63	VALLEY
21	U 142	WAX 3	5 3 5 9	CH	61	19	42	97 0	25 5	93	2 4 6 6	1 14 2 25 2 90 2 94		0 16	0 46	TERRACE
22	U 142	WAX 4	6 5 6 8	CH	57	24	33	95 5	26 0	93	2 4 6	[illegible] 10 2 29 3 09		0 22	0 49	TERRACE
23	U 142	WAX 5	8 0 8 9	CH	52	26	26	92 5	25 5	92 5	6	2 74 3 18		0 0	0 49	TERRACE
24	U 142	WAX 5	8 0 8 9	CH	52	26	26	92 5	25 5	92 5	6		2 40 3 05	0 0	0 46	TERRACE
25	U 142	WAX 9	15 4 15 9	CL	44	19	25	96 5	27 0	99	4 6	2 31 3 59		0 0	0 60	TERRACE
26	U 143	WAX 4	6 0 9 0	CL	40	16	24	96 2	24 6	89	6	3 36		0 0	0 56	TERRACE
27	U 143	WAX 4	6 0 7 9	CL	40	16	24	96 2 98 7	24 6 24 2	89 93	6		3 28 3 39	0 0	0 54	TERRACE
28*	U 143	WAX 4	6 0-7 9	CL	40	16	24	97 2 97 7	24 7 24 7	92 93	1 9 2 5	50 1 75		0 0	0 53	TERRACE
29	U 143	WAX 5	9 0 9 8	CL	42	18	24	95	27	93	2 6	1 34 3 53		0 25	0 55	TERRACE
30	U 143	WAX 9	17 0 17 5	CL	43	21	22	94	28 5	97	1 4 6	67 2 59 3 45		0 23	0 55	TERRACE
31	U 143	WAX 10	19 3 19 7	CL	44	[illegible]	27	86 5	31	87	6 6	3 45 4 04		0 0	0 625	TERRACE
32	U 143	WAX 12	22 2 22 7	CL	49	18	31	90 5	31 5	100	6 6	3 25 3 62		0 0	0 57	TERRACE
33*	U 144	WAX 1	0 5 1 8	CL	46	20	26	93 2	26 5	91	2 4	1 75		0 0	0 70	VALLEY

INDEX NUMBER
34
35
36*
37
38
39
40
41
42
43
44*
45
46*
47
48
49
50
51
52*

* NOTE

SUMMARY UNDISTURBED "S" TEST DATA OVERBURDEN MATERIALS

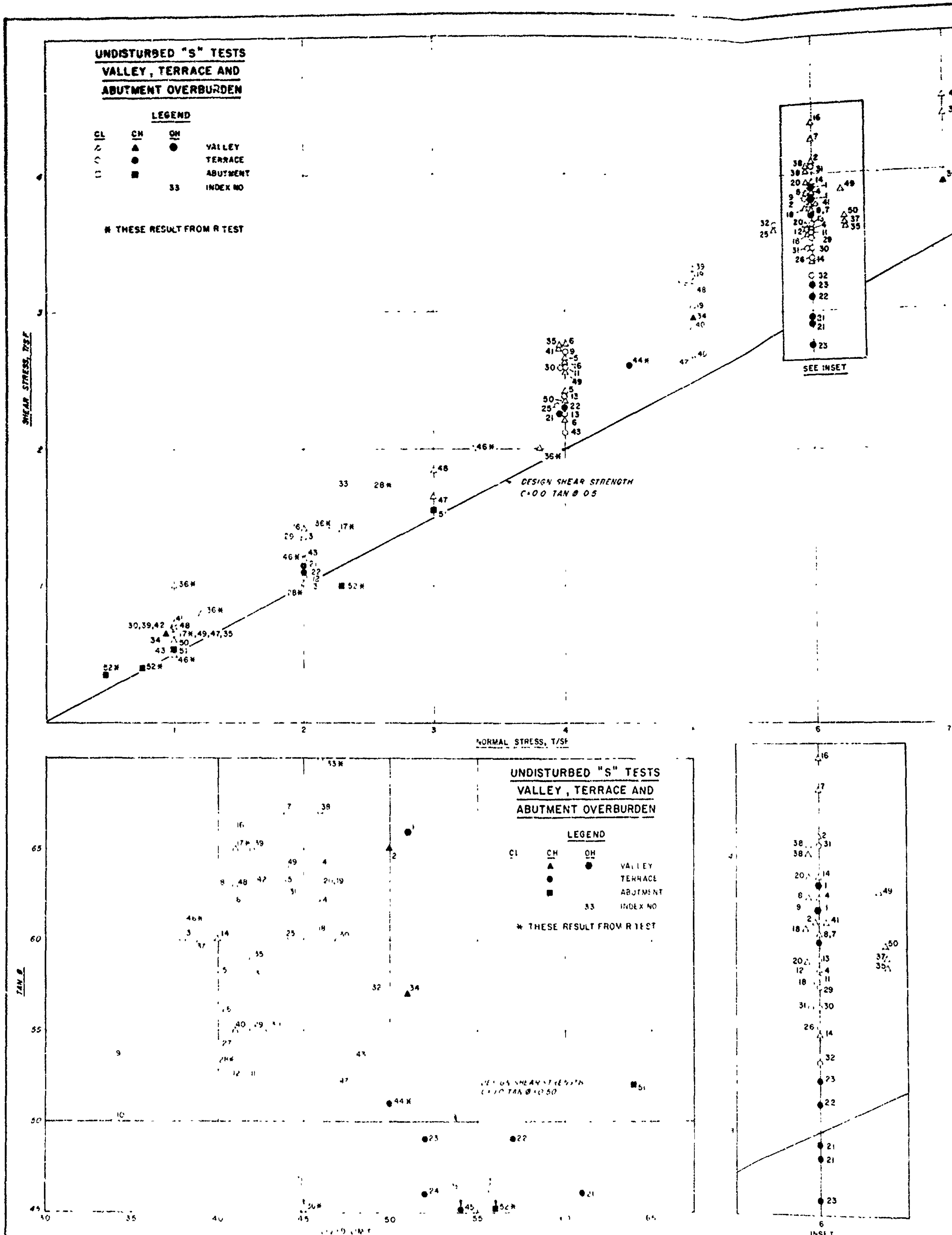
INDEX NUMBER	HOLE NUMBER	SAMPLE NUMBER	DEPTH	CLASSIFICATION SYMBOL	L.L.	P.L.	P.I.	INITIAL CONDITIONS DRY DENSITY	WATER CONTENT	% SAT.	σ_n T.S.F.	τ MAX T.S.F.	τ RESIDUAL T.S.F.	C T.S.F.	TAN θ	LOCATION
34	U 145	WAX 1	14 18	CH	51	21	30	93 5	26 0	80	1 5 7	0 85 2 95 3 90		0 0	0 57	VALLEY
35	U 145	WAX 2	30 35	CL	42	21	21	98	24	98	1 4 6	65 2 75 3 60		0 0	0 59	VALLEY
36*	U 145	WAX 3	40 59	CL	45	17	28	97 0 96 1 95 1 95 5	15 7 16 2 16 2 16 2	58 59 59 60	1 2 2 3 8 1 2	1 0 1 4 2 0 8		0 7	0 23	VALLEY
37	U 152	WAX 2	20-39	CL	39	22	17	88 2	27 6	84	6	3 62		0 0	0 60	VALLEY
38	U 152	WAX 4	63 68	CL	46	24	22	89 5	25	78	6 6	4 04 4 01		0 0	0 67	VALLEY
39	U 153	WAX 1	10-15	CL	42	24	18	92 5	27 5	93	1 5 7	0 68 3 35 4 43		0 0	0 65	VALLEY
40	U 154	WAX 2	20 25	CL	41	22	19	89 5	24 5	75 5	5 5	2 67 2 79		0 0	0 55	VALLEY
41	U 154	WAX 5	85 89	CL	46	25	21	84	35	95	1 4 6	72 2 76 3 76		0 0	0 64	VALLEY
42	U 155	WAX 1	15 18	CL	43	25	18	89 5	31	98	1 5 7	66 3 23 4 53		0 0	0 63	VALLEY
43	U 163	WAX 2	34 38	CL	48	22	26	101 5	22 5	92 5	1 2 4	0 53 1 23 2 14		0 0	0 54	TERRACE
44*	U 163	WAX 3	40 59	CH	50	17	33	102 5	22 4	93	4 5	2 6		0 0	0 51	TERRACE
45	U 163	WAX 4	72 76	CH	54	19	35	101 5	22 5	93	3 5		1 3 2 0	0 0	0 40	TERRACE
46*	UC 165	WAX 4	60 79	CL	38	17	21	101 5 101 2 101 6	23 4 23 4 23 3	98 98 98	1 2 3 3	5 1 2 2 0		0 0	0 61	VALLEY
47	UC 165	WAX 7	13 1 13 4	CL	47	22	25	97	26	96	1 3 5	66 1 64 2 67		0 0'	0 52	VALLEY
48	U 166	WAX 4	61 64	CL	41	19	22	93 5	29	99	1 3 5	69 1 83 3 15		0 0	0 63	VALLEY
49	UC 168	WAX 2	24 28	CL	44	28	16	84 5	29 5	83	1 4 6	65 2 55 3 86		0 0	0 64	VALLEY
50	UC 168	WAX 2	30 33	CL	47	27	20	85 5	27	77	1 4 6	0 60 2 35 3 65		0 0	0 60	VALLEY
51	U 200	WAX 1	15 17	CH	64	23	41	88 5	30	90	1 3	53 1 55		0 0	0 53	LT ABUTMENT
52*	U 201	WAX 1	10 20	CH	56	18	38	94 9 95 7 93 7	28 1 28 1 27 8	100 100 96	5 75 2 30	0 35 0 40 1 00		17	0 35	LT ABUTMENT

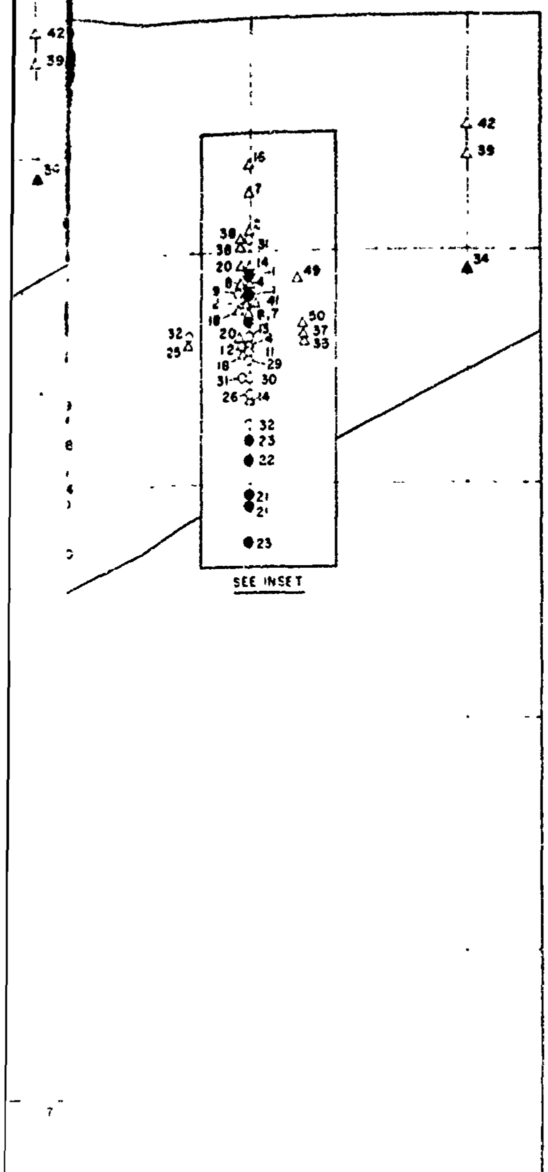
* NOTE From $\bar{R}$ Tests

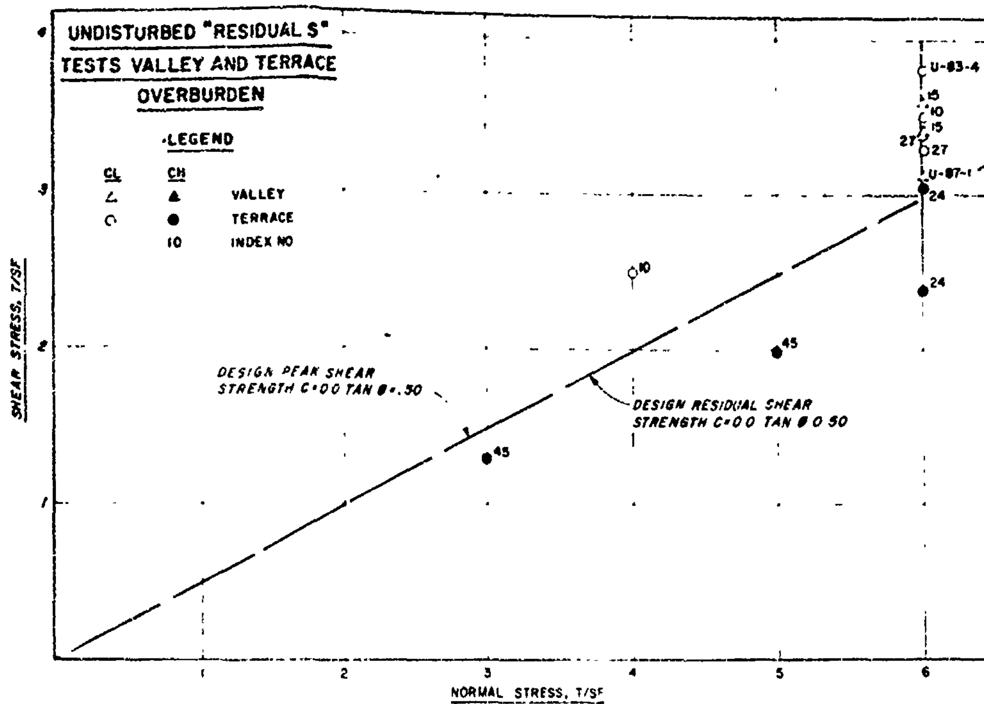
SYM DESCRIPTION DATE APP'D
REVISIONS

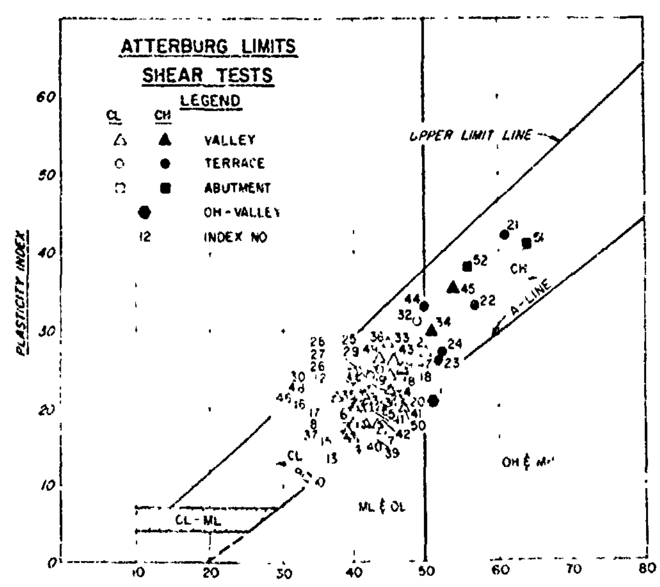
LITTLE BLUE RIVER MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA AND PERFORMANCE REPORT
TEST DATA SUMMARY
UNDISTURBED FOUNDATION OVERBURDEN
S-TESTS DATA

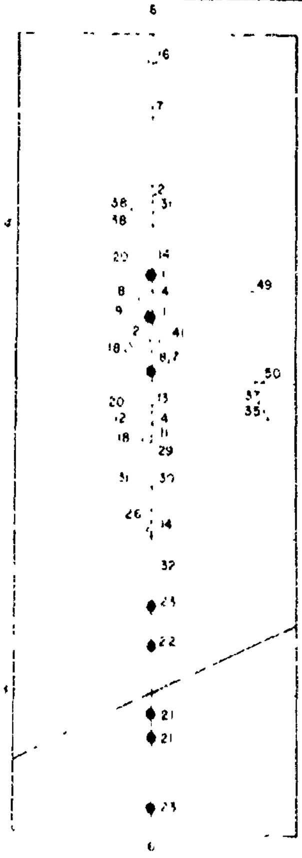
In sheet Sheet No. 1 Scale as shown
CORPS OF ENGINEERS U.S. ARMY
KANSAS CITY DISTRICT JUNE 1978


UNDISTURBED "S" TESTS
VALLEY, TERRACE AND
ABUTMENT OVERBURDEN
LEGEND
CL
CH
OH
VALLEY
TERRACE
ABUTMENT
33 INDEX NO
* THESE RESULT FROM R TEST
SHEAR STRESS, T/SF
NORMAL STRESS, T/SF
DESIGN SHEAR STRENGTH
C=0.0 TAN Ø 0.5
SEE INSET
TAN Ø
INSET









SYM | DESCRIPTION | DATE | APPD

REVISIONS

LITTLE BLUE RIVER MISSOURI

LONGVIEW LAKE

EMBANKMENT CRITERIA AND PERFORMANCE REPORT

TEST DATA SUMMARY

UNDISTURBED FOUNDATION OVERBURDEN

S-TESTS, PLOTS

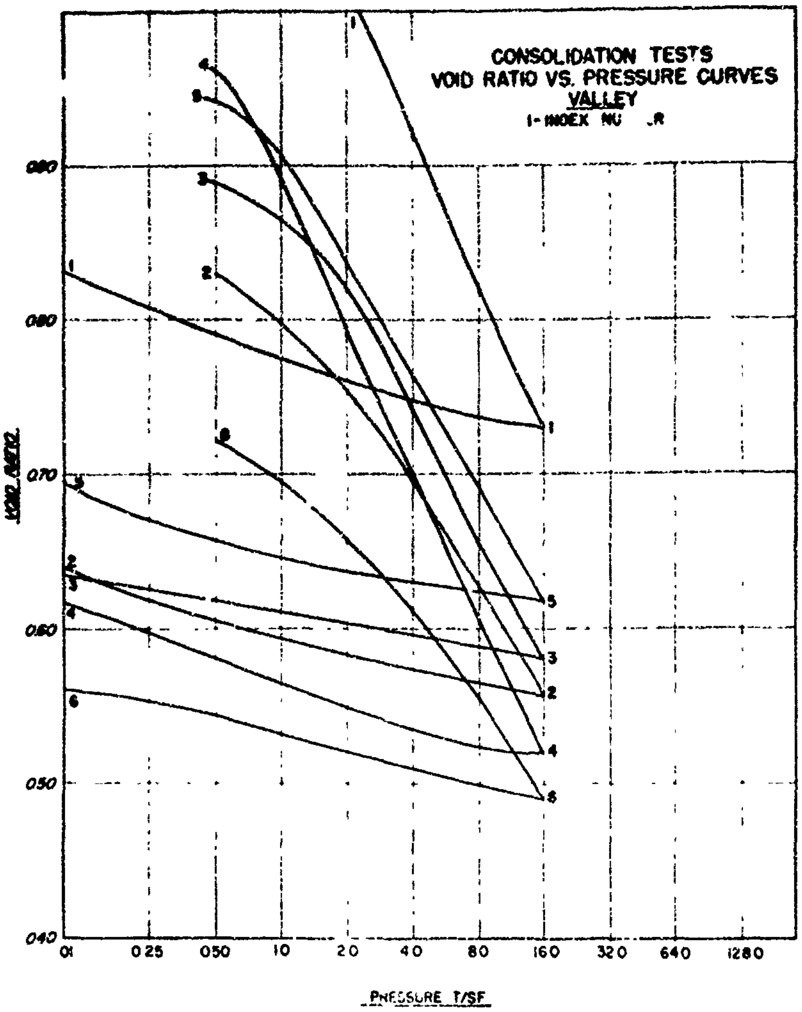
CORPS OF ENGINEERS
KANSAS CITY DISTRICT

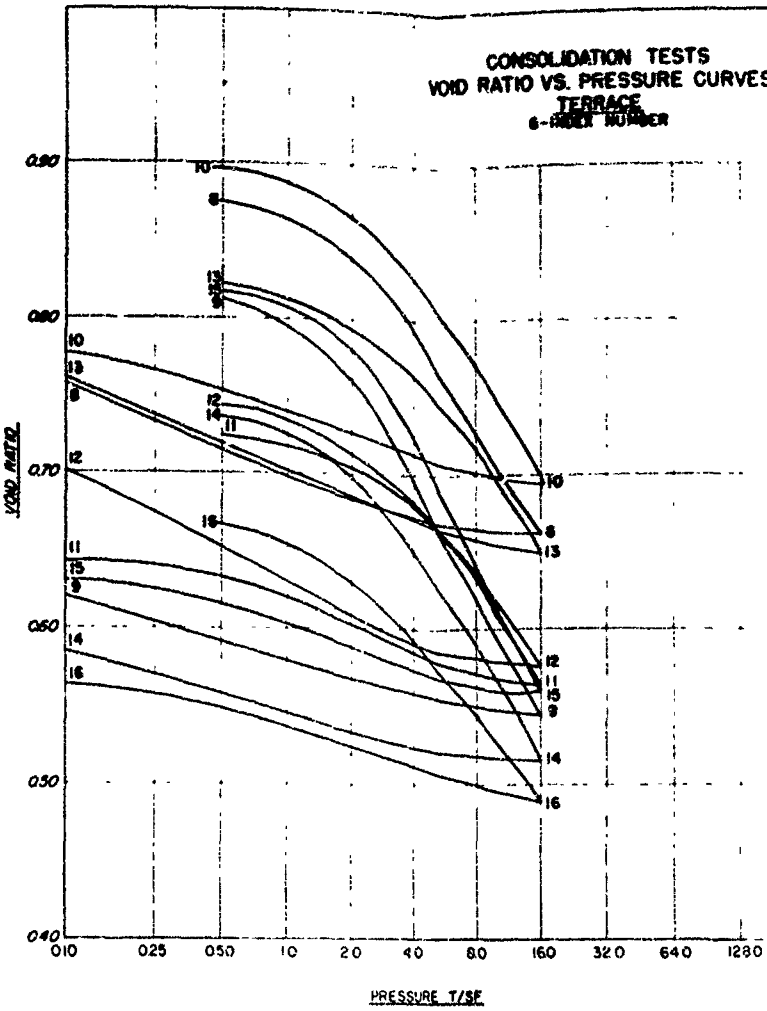
Sheet No. 1

Scale as shown

JUNE 1978

RBL-3-1693



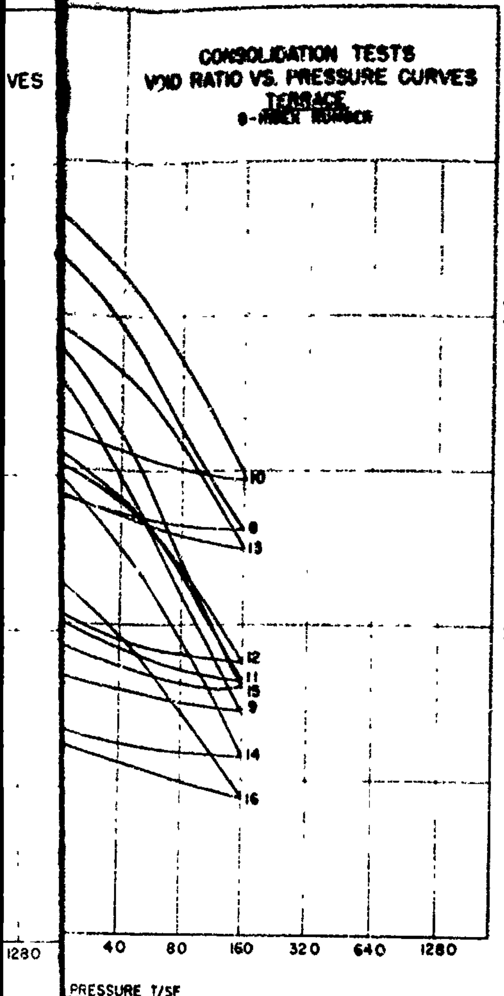


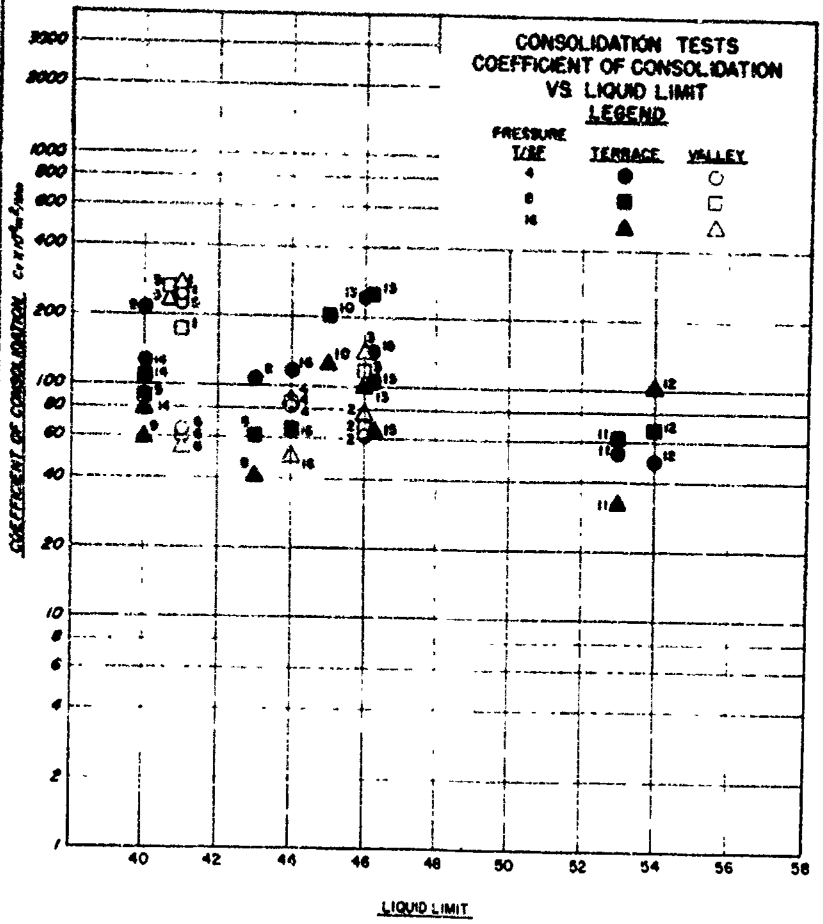
CONSOLIDATION TEST DATA
VALLEY (DAM AXIS STA 90+00 - 97+00)

INDEX NUMBER	HOLE NUMBER	BAX NUMBER	SAMPLE DEPTH	[illegible]	[illegible] T S F	[illegible] T S F	e_c	e_{16}	C	C_s	4 T S F	8 T S F	16 T S F
1	U 10A	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0 046	0 31	0 0245	0 0175	[illegible]
2	U 10A	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0 0061	0 0065	[illegible]
3	U [illegible]B	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0 27	—	[illegible]	[illegible]
4	[illegible]		[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	0 053	0 31	[illegible]	[illegible]	[illegible]
5	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

CONSOLIDATION TEST D[illegible]
TERRACE (DAM AXIS [illegible]

INDEX NUMBER	HOLE NUMBER	BAX NUMBER	SAMPLE DEPTH	L L	Po T S F	Pc T S F	e
8	U [illegible]	[illegible]	6 9 - 7 0	43	0 38	2 7	
9	U [illegible]	[illegible]	12 5 - 12 9	40	0 71	1 9	
10	[illegible]	[illegible]	17 2 - 17 4	45	0 98	2 8	[illegible]
11	[illegible]	[illegible]	6 3 - 6 5	53	0 39	5 9	[illegible]
12	[illegible]	[illegible]	7 8 - 9 0	54	0 48	5 7	[illegible]
13	[illegible]	[illegible]	15 1 - 15 4	46	0 92	4 5	[illegible]
14	[illegible]		9 2 - 9 4	40	0 56	2 7	[illegible]
15	[illegible]		19 0 - 19 3	46	1 19	2 7	[illegible]
16	[illegible]	[illegible]	[illegible] 3 2	44	0 19	2 6	[illegible]





CONSOLIDATION TEST DATA

TERRACE (DAM AXIS STA. 97+00 - 99+50)

[illegible]	WAX NUMBER	SAMPLE DEPTH	L L	Po T S F	Pc T S F	e_0	e_{16}	C_r	C_c	Cv in²/min 4 T S F	8 T S F	16 T S F
[illegible]	4	6.9 - 7.0	43	0.38	2.7	0.887	0.660	[illegible]	0.22	0.0107	0.0061	0.0042
[illegible]	7	12.5 - 12.9	40	0.71	1.9	[illegible]	0.544	[illegible]	0.25	0.0213	0.0089	0.0059
[illegible]	5	[illegible]	45	0.98	2.8	0.942	0.694	0.036	0.24	--	0.0204	0.0121
[illegible]	4	6.3 - 6.5	53	0.39	5.9	0.745	0.565	0.034	0.22	0.0054	0.0061	0.0032
[illegible]	5	[illegible] 8.0	54	0.48	[illegible]	[illegible]	0.576	0.060	0.21	0.0049	[illegible]	0.0102
[illegible]	2	[illegible] 5.4	46	0.97	4.5	0.845	[illegible]	[illegible]	0.24	0.0245	[illegible]	0.0102
[illegible]	5	[illegible] 3.4	43	0.56	2.2	0.749	[illegible]	0.033	0.25	[illegible]	0.0110	0.0090
[illegible]	1	[illegible] 2.9	46	1.19	2.2	0.841	0.560	0.032	[illegible]	0.0140	[illegible]	0.0064
[illegible]	2	[illegible]	44	0.19	2.6	[illegible]	0.493	0.032	0.17	[illegible]	[illegible]	0.0043

SYM

DESCRIPTION

REVISIONS

LITTLE BLUE RIVER MISSOURI

LONGVIEW LAKE

EMBANKMENT CRITERIA AND PERFORMANCE REPORT

TEST DATA SUMMARY

FOUNDATION OVERBURDEN

CONSOLIDATION TESTS

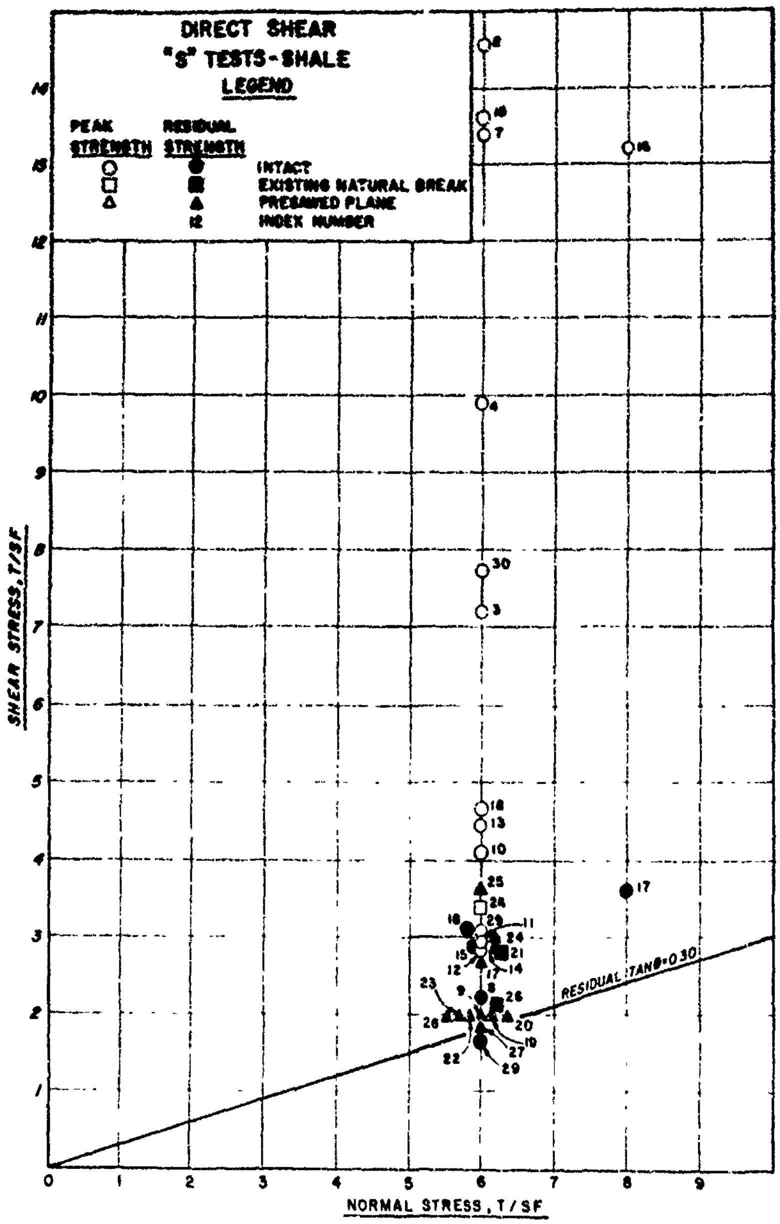
CORPS OF ENGINEERS

KANSAS CITY

W.W.B.

RBL-? 169-

PLATE NO. [illegible]



	DIRECT SHEAR "S" TESTS										
				INITIAL CONDITION			TEST RESULTS				
INDEX NUMBER	HOLE NUMBER	BOX NUMBER	SAMPLE DEPTH	DRY DENSITY	MOISTURE CONTENT	SATURATION	NORMAL STRESS T	MAX SHEAR STRESS (T SF)	PEAK TAN φ	RESIDUAL SHEAR STRESS (T SF)	RESID TAN
1	DC-32	1	22 6-23 6	132		77	6		3 67*		
2	DC-32	1	22 6-23 6	132		8[illegible]	6		1 67*		
3	DC-32	3	40 1-51 0	140	8	9[illegible]	6	7 22	1 2		
4	DC-32	3	40 1-51 0	140	8	9[illegible]	6	9 95	1 66		
5	DC-32	5	60 5-60 8	142		9[illegible]	6		1 6[illegible]*		
6	DC-32	5	60 0-60 8	142		94	6		1 6[illegible]*		
7	AC-46	13	31 7-33 5	136 2	[illegible]2	79	6	13 40	2 23		
8	AC-46	13	31 7-33 5	133 2	6 3	78	6	14 56	2 42	2 71	
9	AC-46	13	31 7-33 5	136 4	5 5	67	6			2 00	
10	C-52**	1	24 0-24 0	116 3	15 0	98	6	4 16	69		
11	C-52**	2	26 5-26 9	119 0	1[illegible] 0	77	6	2 96	49		
12	C-52**	11	58 2-60	124 6	9 6	76	6	2 85	46		
13	C-56	7	31 3-33 2	129 9	7 7	71	6	4 44	74		
14	C-61	2	38 6-39 5	138 8	5 7	64	6			2 08	
15	C-61	2	38 0-39 5	141 1	6 3	8[illegible]	6	13 6	2 27	2 93	
16	C-61	2	38 0-39 5	142 0	5 8	86	6	13 2	1 95	3 53	
17	C-61	9	46 4-47 9	132 1	6 7	65 6	6			2 79	
18	C-61A	2	33 4-34 7	141 0	3 6	48 1	6	4 64	78	3 12	
19	UC-164	9	19 3-19 6	132 0	9 5	92	6			2 0	
20	UC-164	9	19 3-19 6	132 0	9 5	92	6			2 1	
21	UC-164	10	20 5	134	9 5	100	6			2 04	
22	UC-164	10	20 7-21 0	134 5	9 5	99	6			2 1	
23	UC-164	10	20 7-21 0	134 5	9 5	99	6			2 0	
24	UC-165	1	17 7-19 5	119 9	12 0	83	6			2 [illegible]	
25	UC-165	1	17 7-19 5	151 2	2 6	55	6			1 67	
26	UC-165	3	20 8-22 4	150 4	2 6	4[illegible]	6	3 42	57	2 [illegible]	
27	DC 167	1	14 8	137 0	8	93	6			[illegible]	
28	DC 167	1	15 0	137 0	8	92	6			2 0	
29	UC-168	1	14 9	123	14	95	6	3 07	51	[illegible]	
30	UC-168	4	19 0-20 8	126 4	4 5	76	6	7 77	1 29		

* [illegible] LOS NANCAS [illegible] SHEAR MACHINE [illegible] OF 10 T SF
** [illegible] BAY AREA

RESIDUAL TAN Ø

DIRECT SHEAR 'S' TESTS

SATURATION	NORMAL STRESS	MAX SHEAR STRESS (T SF)	PEAK TAN Ø	RESIDUAL SHEAR STRESS (T SF)	RESIDUAL TAN Ø	TYPE OF SHEAR SURFACE	GEOLOGIC MEMBER
97	6		1.67*			INTACT	PLEASANTON SHALE
95	6		1.67*			INTACT	PLEASANTON SHALE
96	6	7.22	1.2			INTACT	PLEASANTON SHALE
91	6	9.95	1.66			INTACT	PLEASANTON SHALE AND SANDSTONE
94	6		1.67*			INTACT	PLEASANTON SHALE
94	6		1.67*			INTACT	PLEASANTON SHALE
79	6	13.40	2.23			INTACT	PLEASANTON SHALE
78	6	14.56	2.42	2.21	.31	INTACT	PLEASANTON SHALE
61	6			2.00	.33	PRESAWED	PLEASANTON SHALE
90	6	4.16	.69			INTACT	WEA SHALE
72	6	2.96	.49			INTACT	WEA SHALE
76	6	2.85	.48			INTACT	STARK GALESBURG SH
71	6	4.44	.74			INTACT	PLEASANTON SHALE
64	6			2.88	.48	PRESAWED	PLEASANTON SHALE
84	6	13.6	2.27	7.93	.49	INTACT	PLEASANTON SHALE
82	6	13.2	1.65	3.53	.45	INTACT	PLEASANTON SHALE
65.6	6			2.79	.47	PRESAWED	PLEASANTON SHALE
48.0	6	4.69	.78	3.12	.52	INTACT	PLEASANTON SHALE
92	6			2.0	.33	PRESAWED	PLEASANTON SHALE
92	6			2.1	.35	PRESAWED	PLEASANTON SHALE
100	6			2.80	.46	EXISTING BREAK	PLEASANTON SHALE
99	6			2.1	.35	PRESAWED	PLEASANTON SHALE
99	6			2.0	.33	PRESAWED	PLEASANTON SHALE
83	6			[illegible]	.49	PRESAWED	PLEASANTON SILTSTONE
53	6			3.62	.60	PRESAWED	PLEASANTON SILTSTONE
49	6	3.42	.57	[illegible]	.34	EXISTING BREAK	PLEASANTON SILTSTONE
93	6			[illegible]	.30	PRESAWED	PLEASANTON SILTSTONE
92	6			2.0	.33	PRESAWED	PLEASANTON SILTSTONE
99	6	3.0	.51	[illegible]	.28	INTACT	PLEASANTON SHALE
96	6	[illegible]	.29			INTACT	PLEASANTON SHALE

[illegible] OF 10 TSF

SYM | DESCRIPTION | DATE | APP'D

REVISIONS

LITTLE BLUE RIVER MISSOURI

LONGVIEW LAKE

EMBANKMENT CRITERIA AND PERFORMANCE REPORT

TEST DATA SUMMARY FOUNDATION SHALES

In 1 sheet | Sheet No 1 | Scale as shown

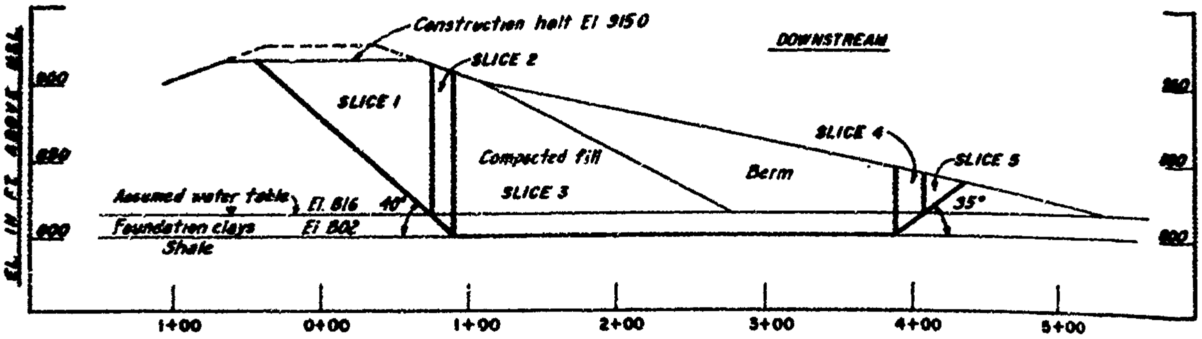
CORPS OF ENGINEERS KANSAS CITY DISTRICT

U. S. ARMY JUNE 1978

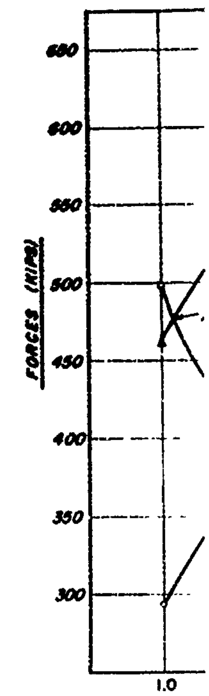
W W B | S. R | [illegible]

RBL-3-1695

PLATE NO. 86J

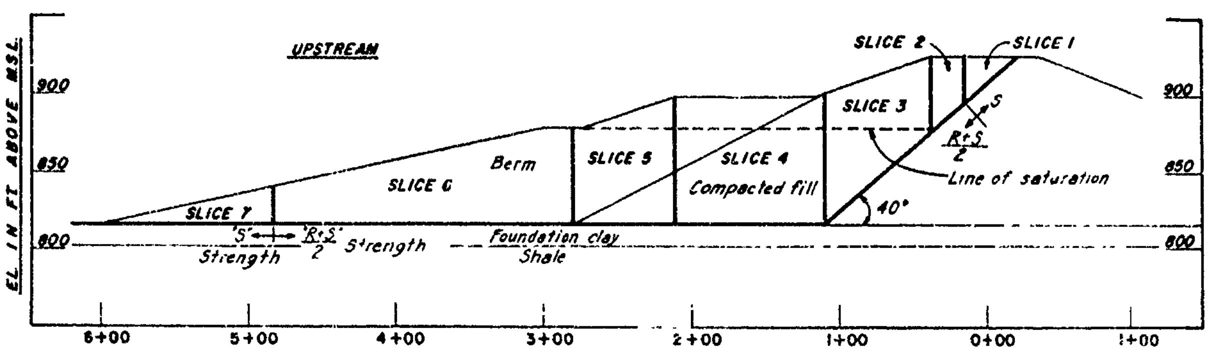


END OF CONSTRUCTION CASE EL.915.0

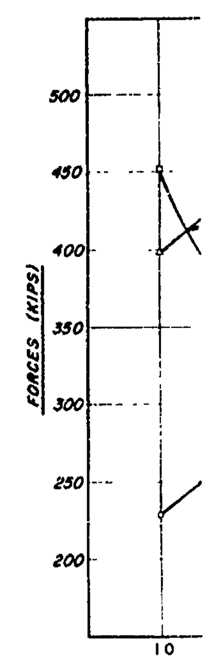


END OF

END OF CONSTRUCTION CASE EL.915.0												
SLICE	"Q" STRENGTH C(KIPS)	"Q" STRENGTH TAN Ø	L (FT)	W_{EFF} (KIPS)	W_{TOTAL} (KIPS)	TAN $\beta/2$	μ_H	F.S. / EARTH FORCES (KIPS)	1.0	1.34	1.50	2.0
1	1.80	0	118	682.1	682.1	.09	0	Driving	195.9	281.3	308.2	364.3
2	1.20	0	15	162.2	167.7	.09	0	Driving	98.1	105.4	107.6	112.4
3	1.20	0	300	2187.2	2408.1	0	0	Resisting	360.0	268.7	240.0	180.0
4	1.20	0	18	59.1	65.7	0	0	Resisting	73.6	65.4	62.8	57.5
5	.90	0	28	38.5	38.5	0	0	Resisting	64.5	55.0	52.0	45.7



PARTIAL POOL CASE

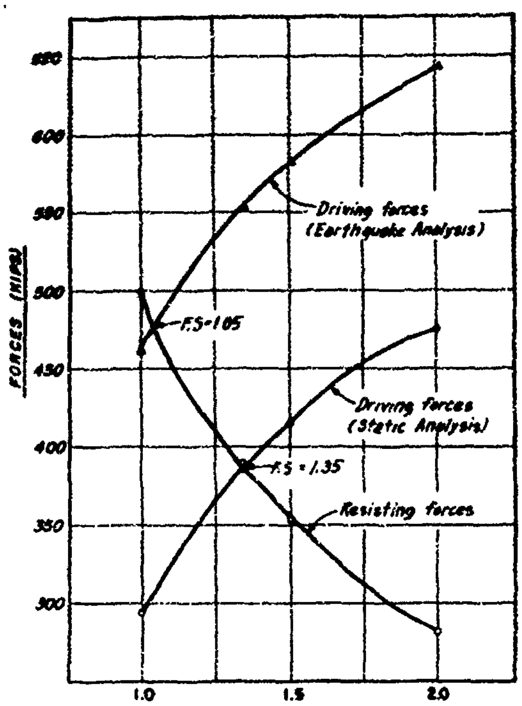


PARTIAL POOL CASE EL.878													
SLICE	"S" STRENGTH C (KIPS)	"S" STRENGTH TAN Ø	$\frac{R+S}{2}$ STRENGTH C (KIPS)	$\frac{R+S}{2}$ STRENGTH TAN Ø	L (FT)	W_{EFF} (KIPS)	W_{TOTAL} (KIPS)	TAN $\beta/2$	μ_H	F.S. / EARTH FORCES (KIPS)	1.0	1.53	2.0
1	0	36			56	60.7	60.7	09	0	Driving	21.7	29.3	33.1
2			20	28	225	101.6	101.6	09	0	Driving	38.3	50.9	57.0
3			20	28	72	4318	5738	09	0	Driving	1690	2201	2456
4			20	28	102	6200	1002.3	0	0	Resisting	1940	126.8	97.0
5			20	.28	68	2977	529.4	0	0	Resisting	98.2	64.2	49.1
6			.10	25	202	475.5	951.0	0	0	Resisting	139.2	91.0	69.6
7	0	30			117	73.9	147.8	0	0	Resisting	22.2	14.5	71.1

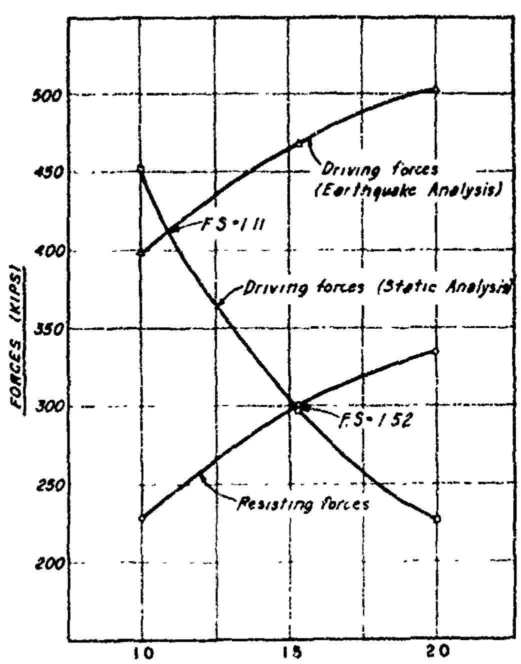
PARTIAL POOL CASE EL.878			
FACTOR OF SAFETY	1.0	1.53	2.0
Σ RESISTING FORCES (KIPS)	-453.5	-296.9	226.8
Σ DRIVING FORCES STATIC ANALYSIS (KIPS)	229.0	300.9	335.7
Σ DRIVING FORCES EARTHQUAKE ANALYSIS (KIPS)	397.7	469.6	504.4

Σ Driving forces (Earthquake Analysis) =
Σ Driving forces (static analysis)
+ Δ Driving forces
Where Δ Driving forces = ψ2 Wτ
= 0.05 × 3374.5 K
168.7 K

SUMMARY - PARTIAL POOL CASE			
TYPE OF ANALYSIS	HAND ANALYSIS FS	COMPUTER FS	REQUIRED FS
STATIC	1.52	1.53	1.50
EARTHQUAKE	1.11		1.00



END OF CONSTRUCTION CASE EL.915.0



PARTIAL POOL EL.878

SUMMARY- END OF CONSTRUCTION CASE			
TYPE OF ANALYSIS	HAND ANALYSIS F.S.	COMPUTER F.S.	REQUIRED F.S.
STATIC	1.35	1.34	1.30
EARTHQUAKE	1.05	—	1.00

END OF CONSTRUCTION CASE EL.915.0				
FACTOR OF SAFETY	1.0	1.34	1.5	2.0
Σ RESISTING FORCES (KIPS)	498.1	389.1	354.8	283.2
Σ DRIVING FORCES STATIC ANALYSIS (KIPS)	294.0	386.0	415.8	476.7
Σ DRIVING FORCES EARTHQUAKE ANALYSIS (KIPS)	462.1	554.1	583.9	644.8

Σ Driving forces (Earthquake Analysis) = Σ Driving forces (static analysis) + Δ Driving forces

Where Δ Driving forces = $\varphi \Sigma W_F$
= 0.05 × 3362.1
= 168.1 (Kips)

PHYSICAL SOIL CONSTANTS								
MATERIAL	UNIT WEIGHT P.C.F.		DESIGN SHEAR STRENGTHS					
			Q		R		S	
	SAT.	DRAINED	C (KIPS)	TAN Ø	C (KIPS)	TAN Ø	C (KIPS)	TAN Ø
BERM	115	110	90	0.0	20	20	0.0	.30
COMPACTED FILL (HILLSIDE BORROW)	125	115	1.80	0.0	.40	.20	0.0	.36
FOUNDATION CLAY	115	110	1.20	0.0	.40	.20	0.0	.50
SHALE - PEAK	140	140	--	--	-	-	0.0	0.6

SYM	DESCRIPTION	DATE	APP'D

REVISIONS

LITTLE BLUE RIVER, MISSOURI

LONGVIEW LAKE

EMBANKMENT CRITERIA AND PERFORMANCE REPORT

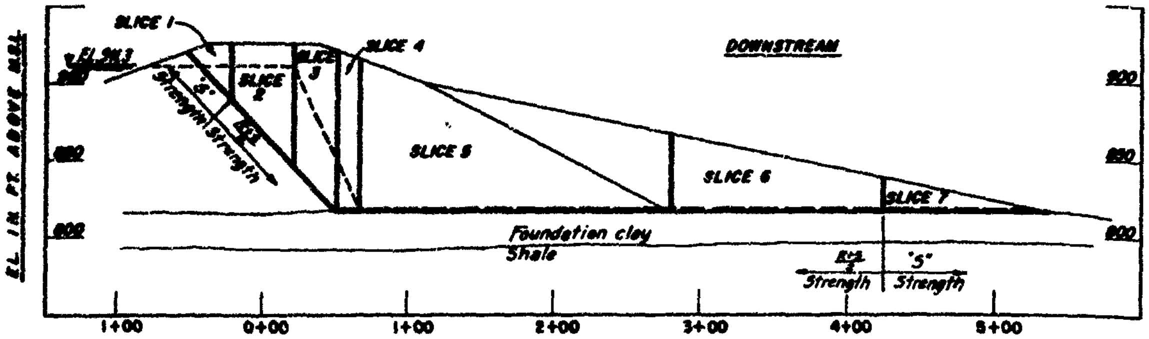
TYPICAL STABILITY ANALYSIS
END OF CONSTRUCTION AND PARTIAL POOL CASE

In 1 sheet — Sheet No 1

CORPS OF ENGINEERS
KANSAS CITY DISTRICT

Submitted — Recommended — Approved

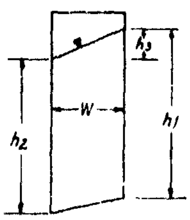
RGD — AP — RGD



STEADY SEEPAGE SPILLWAY CREST EL. 911.3

STEADY SEEPAGE CASE AT SPILLWAY CREST EL. 911.3													
SLICE	"S" STRENGHT		$\frac{R+S}{2}$ STRENGTH		L (FT)	W_{EFF} (KIPS)	W_{TOTAL} (KIPS)	TAN $\theta/2$	μ_h	F.S / EARTH FORCES (KIPS)	1.0	1.5	2.0
	C (KIPS)	TAN ϕ	C (KIPS)	TAN ϕ									
1	0	36			300	54.6	69.4	.09	0	Driving	24.7	31.7	35.7
2			.20	.28	42.5	177.9	286.4	.09	0	Driving	82.6	105.9	118.7
3			.20	.28	30.0	236.8	329.4	.09	185.3	Driving	294.2	321.0	335.9
4			20	.28	17	182.2	201.6	0	38.1	Resisting	16.3	-1.8	-10.9
5			20	.28	212	1728.1	1748.1	0	0	Resisting	526.3	350.8	263.1
6			.10	25	72	565.8	577.2	0	0	Resisting	155.9	103.9	77.9
7	0	.30			107	131.7	139.8	0	0	Resisting	39.5	26.3	19.8
8													

Sample calculation for μ_h (Seepage Force)



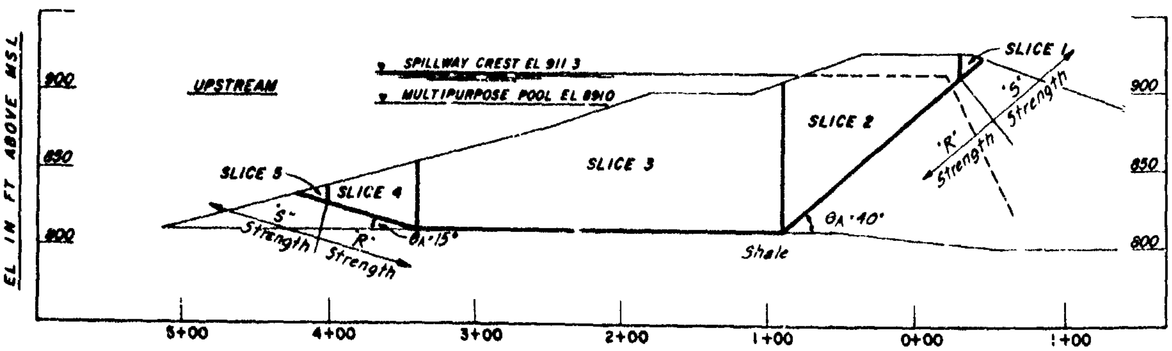
$\mu_H = \gamma_W A i$

Where γ_W = unit wt of water

$A = (w)\dfrac{(h_1 + h_2)}{2}$

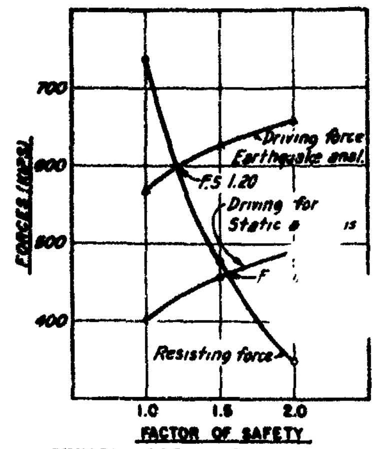
i = hydraulic gradient

$i = h_3/w$



RAPID DRAWDOWN FROM SPILLWAY CREST EL. 911.3

RAPID DRAWDOWN FROM SPILLWAY CREST EL 911.3														
SLICE	"S" STRENGTH		"R" STRENGTH		L (FT)	W_{EFF} (KIPS)	TAN θ_A	TAN($\theta/2$)	μ_h	FS / EARTH FORCES (KIPS)	1.0	1.21	1.50	2.0
	C (KIPS)	TAN ϕ	C (KIPS)	TAN ϕ										
1	0	.50			15	14.3	.84	.09	0	Driving	3.4	4.4	5.5	6.7
2			.40	.20	119	458.9	.84	.09	29.3	Driving	231.3	262.3	292.0	324.4
3			.40	.20	250	1164.8	0	0	88.4	Resisting	-244.6	-186.8	-133.6	-78.1
4			.40	.20	62	108.7	.27	0	0	Resisting	82.1	-72.5	-63.9	-55.0
5	0	.50			22	8.1	.27	0	0	Resisting	-7.2	6.2	-5.4	4.5



STEADY SEEPAGE SPILLWAY CREST

SUMMARY-STEADY SEEPAGE SPILLWAY CREST			
TYPE OF ANALYSIS	HAND ANAL. F.S.	COMP. F.S.	REQ'D F.S.
STATIC	1.53	1.53	1.50
EARTHQUAKE	1.20	—	1.0

STEADY SEEPAGE AT SPILLWAY CREST			
FACTOR OF SAFETY	1.0	1.5	2.0
Σ RESISTING FORCES (KIPS)	738.0	479.2	349.9
Σ DRIVING FORCES STATIC ANALYSIS (KIPS)	401.5	458.6	490.3
Σ DRIVING FORCES EARTHQUAKE ANALYSIS (KIPS)	569.1	626.2	657.9

Driving forces (Earthquakes Analysis) =
Σ Driving forces (Static analysis)
+ Δ Driving forces

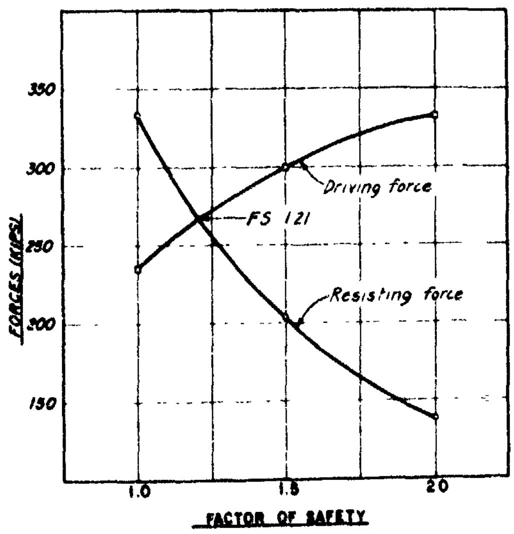
Where Δ Driving forces = ΨΣ Total weight
= .05 × 3351.9 K
= 167.6 (Kips)

SUMMARY-RAPID DRAWDOWN FROM SPILLWAY CREST			
TYPE OF ANALYSIS	HAND ANAL. F.S.	COMPUTER F.S.	REQUIRED F.S.
STATIC	1.21	1.21	1.20

PHYSICAL SOIL CONSTANTS								
MATERIAL	UNIT WEIGHT PCF		DESIGN SHEAR STRENGTHS					
			Q		R		S	
	SAT	DRAINED	C (KIPS)	TAN ϕ	C (KIPS)	TAN ϕ	C (KIPS)	TAN ϕ
BERM	115.0	110.0	.90	0	.20	.20	0	.30
COMPACTED FILL	125.0	115.0	1.80	0	.40	.20	0	.36
FDN. CLAY	115.0	110.0	1.20	0	.40	.20	0	.50
SHALE	140.0	140.0	—	—	—	—	0	0.6

RAPID DRAWDOWN FROM SPILLWAY CREST EL.911.3				
FACTOR OF SAFETY	1.0	1.21	1.50	2.0
Σ RESISTING FORCES	-333.9	-265.5	-202.9	-137.6
Σ DRIVING FORCES	234.7	266.7	297.5	331.1

NOTES.
1. Tan (θ/2) for active wedge is assumed to be one half the average slope of the outer embankment.
2. Tan (θ/2) for central block and passive wedge is assumed to be zero.
3. Seepage force equation is from book entitled "Soil Mechanics, T.H. Wu" Section 3.12.
4. Ψ = seismic coefficient.



RAPID DRAWDOWN FROM SPILLWAY CREST EL.911.3

SYM	DESCRIPTION	DATE	APP'D
	REVISIONS		

LITTLE BLUE RIVER, MISSOURI

LONGVIEW LAKE

EMBANKMENT CRITERIA AND PERFORMANCE REPORT

TYPICAL STABILITY ANALYSIS
RAPID DRAWDOWN AND STEADY SEEPAGE

In 1 sheet — Sheet No. 1 — Scale as shown

CORPS OF ENGINEERS
KANSAS CITY DISTRICT

U S ARMY
JUNE 1978

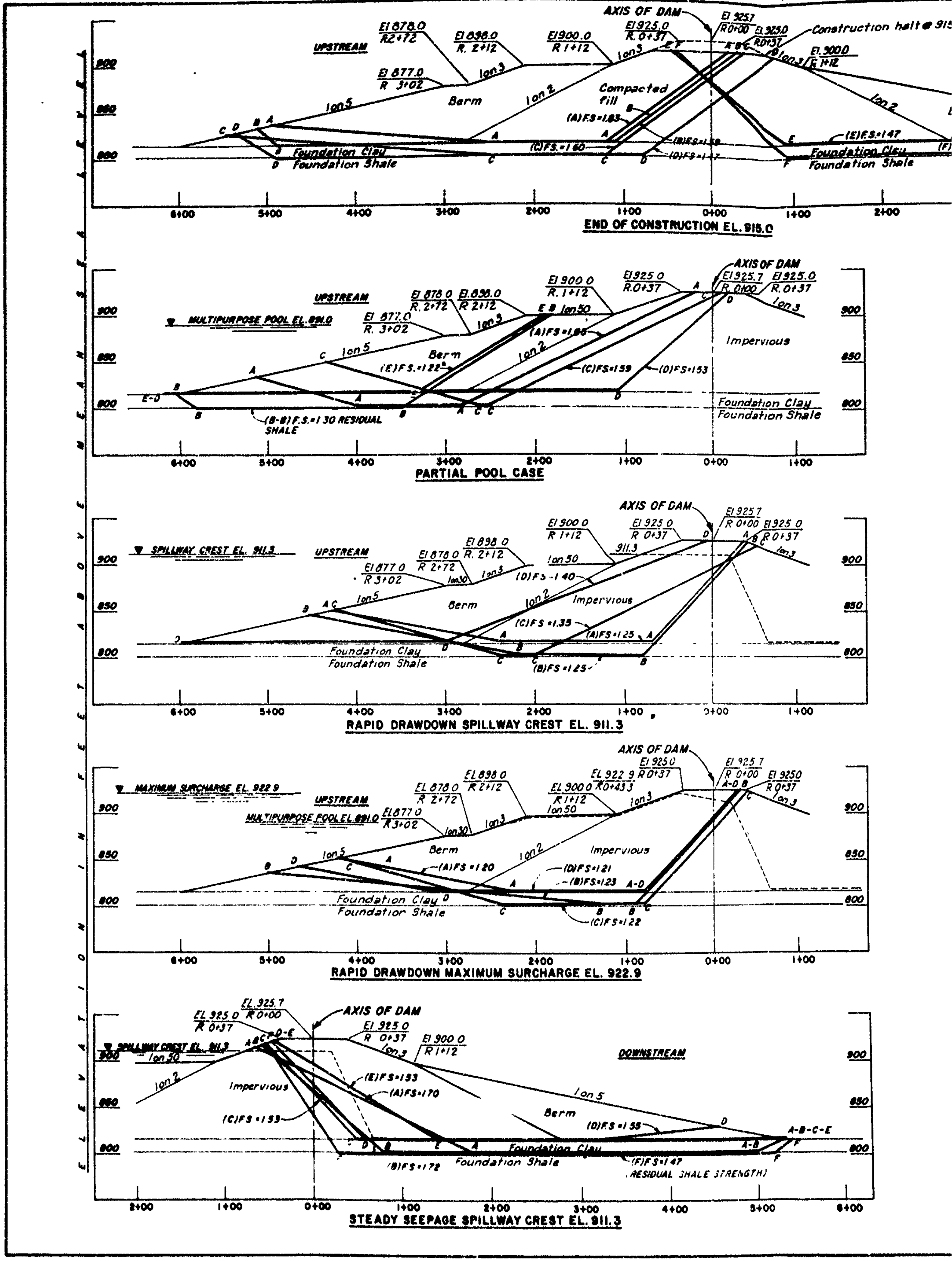
Submitted — Recommended — Approved

CHIEF FOUNDATIONS & MATLS BR — CHIEF ENGINEERING DIVISION

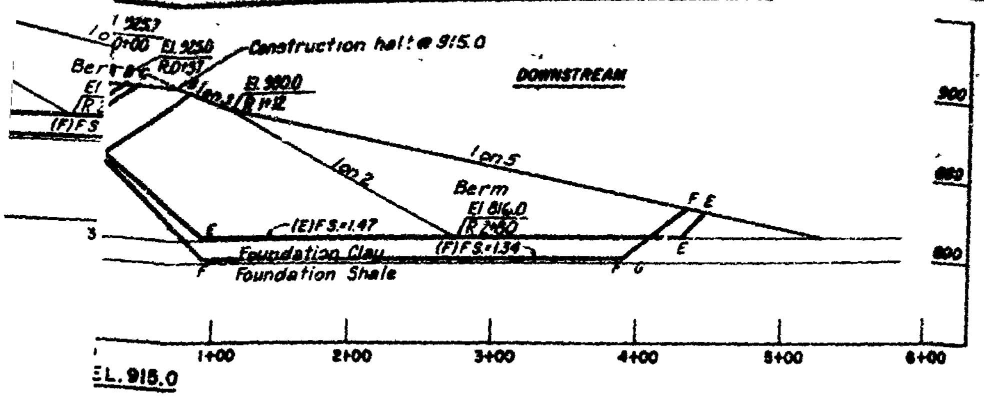
COMPILED BY WWB — TRACED BY JW — CHECKED BY RGD

FILE NO. RBL-3 1566

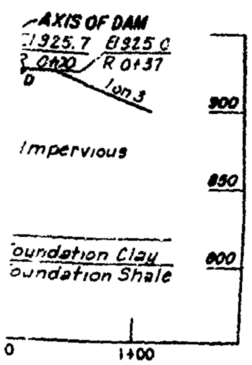
PLATE NO 88



AXIS OF DAM
UPSTREAM
Construction halt
Compacted fill
Berm
Foundation Clay
Foundation Shale
END OF CONSTRUCTION EL. 915.0
MULTIPURPOSE POOL EL. 891.0
Impervious
(B-B) F.S. = 1.30 RESIDUAL SHALE
PARTIAL POOL CASE
SPILLWAY CREST EL. 911.3
RAPID DRAWDOWN SPILLWAY CREST EL. 911.3
MAXIMUM SURCHARGE EL. 922.9
RAPID DRAWDOWN MAXIMUM SURCHARGE EL. 922.9
DOWNSTREAM
(F) FS = 1.47 (RESIDUAL SHALE STRENGTH)
STEADY SEEPAGE SPILLWAY CREST EL. 911.3
ELEVATION IN FEET ABOVE MSL



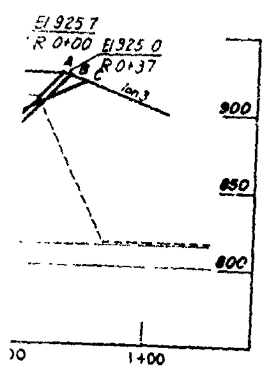
END OF CONSTRUCTION CASE			
SURFACE	FAILURE PLANE EL.	ELEVATION	F.S.
A	816	U/S	1.83
D	802	U/S	1.47
E	816	D/S	1.47
F	802	D/S	1.34



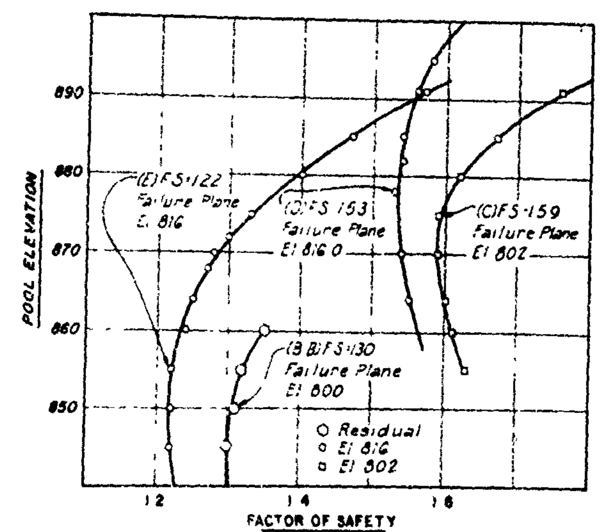
PHYSICAL SOIL CONSTANTS								
MATERIAL	UNIT WEIGHT PCF		DESIGN SHEAR STRENGTH					
			"Q"		"R"		"S"	
	SAT	DRAINED	C(KIPS)	TAN θ	C(KIPS)	TAN θ	C(KIPS)	TAN θ
BERM	115	110	0.90	0.0	0.20	0.20	0.0	0.30
COMPACTED FILL (HILLSIDE BORROW)	125	115	1.80	0.0	0.40	0.20	0.0	0.36
COMPACTED FILL (VALLEY BORROW)	125	115	1.80	0.0	0.40	0.20	0.0	0.50
FOUNDATION CLAY	115	110	1.20	0.0	0.40	0.20	0.0	0.50
SHALE (PEAK)	140	140	—	—	—	—	0.0	0.60
SHALE (RESIDUAL)	140	140	—	—	—	—	—	0.30

NOTE ALL SAFETY FACTORS COMPUTED UTILIZING HILLSIDE BORROW MATERIAL

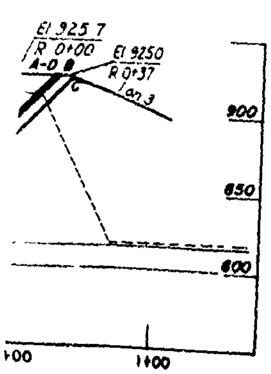
STABILITY STUDIES USING RESIDUAL STRENGTHS FOR FOUNDATION SHALES		
SURFACE	CASE	FS
B-B	Partial pool	1.30
F-F	Steady seepage	1.47



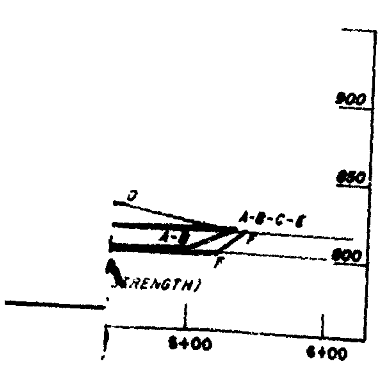
RAPID DRAWDOWN FROM SPILLWAY CREST PEAK STRENGTHS			
SURFACE	FAILURE PLANE EL.	POOL LEVELS	FS
A	816	911.3/891	1.25
B	802	911.3/891	1.25
C	802	911.3/891	1.35
D	816	911.3/891	1.40



PARTIAL POOL CASE



RAPID DRAWDOWN FROM MAXIMUM SURCHARGE PEAK STRENGTHS			
SURFACE	FAILURE PLANE EL.	POOL LEVELS	FS
A	816	922.9/891	1.20
B	802	922.9/891	1.23
C	802	922.9/891	1.22
D	816	922.9/891	1.21



STEADY SEEPAGE SPILLWAY CREST EL. 911.3 PEAK STRENGTHS			
SURFACE	FAILURE PLANE EL.	POOL LEVELS	FS
A	802	911.3/891	1.70
B	802	911.3/891	1.72
C	816	911.3/891	1.53
D	816	911.3/891	1.55
E	816	911.3/891	1.53

SYM	DESCRIPTION	DATE	APP'D

REVISIONS

LITTLE BLUE RIVER, MISSOURI

LONGVIEW LAKE

EMBANKMENT CRITERIA AND PERFORMANCE REPORT

EMBANKMENT STABILITY ANALYSIS SUMMARY
VALLEY SECTION

In 1 sheet — Sheet No. 1 — Scale: as shown

CORPS OF ENGINEERS
KANSAS CITY DISTRICT

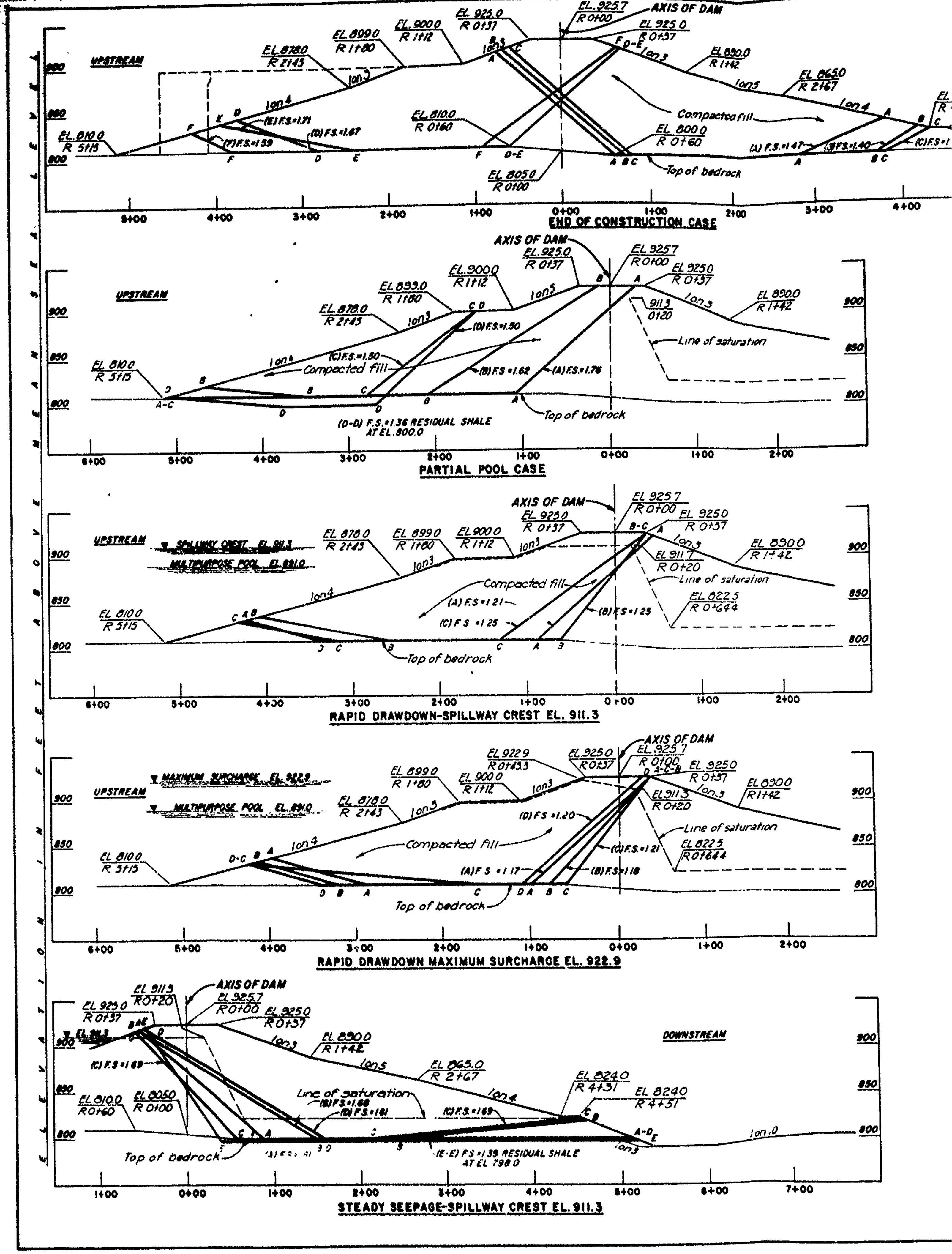
U.S. ARMY
JUNE 1978

Submitted: CHIEF, DAMS & FOUNDATIONS SECT. — Recommended: CHIEF, FOUNDATIONS & MATLS BR. — Approved: CHIEF, ENGINEERING DIVISION

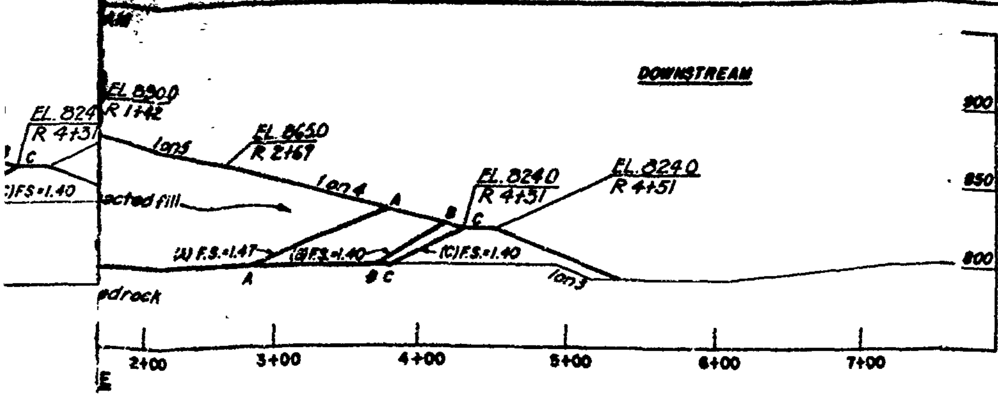
COMPILED BY R C B — DRAWN BY J E B — CHECKED BY R G D

FILE NO. RBL-3-1567

PLATE NO 89

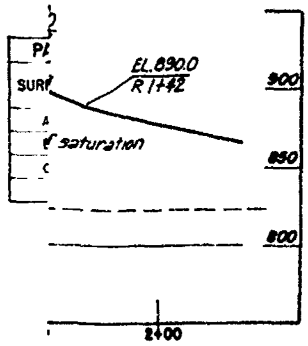


UPSTREAM
AXIS OF DAM
EL 925.7
R 0+00
EL 925.0
R 0+37
EL 900.0
R 1+12
EL 899.0
R 1+80
EL 878.0
R 2+43
EL 810.0
R 5+15
EL 890.0
R 1+42
EL 865.0
R 2+67
EL 810.0
R 0+60
EL 800.0
R 0+60
EL 805.0
R 0+00
Compacted fill
Top of bedrock
(E) F.S.=1.71
(D) F.S.=1.67
(F) F.S.=1.59
(A) F.S.=1.47
(B) F.S.=1.40
END OF CONSTRUCTION CASE
(D) F.S.=1.50
(C) F.S.=1.50
(B) F.S.=1.62
(A) F.S.=1.76
(D-D) F.S.=1.36 RESIDUAL SHALE AT EL.800.0
911.3
0+20
Line of saturation
PARTIAL POOL CASE
SPILLWAY CREST EL. 911.3
MULTIPURPOSE POOL EL. 891.0
EL 911.7
R 0+20
EL 822.5
R 0+64.4
(A) F.S.=1.21
(C) F.S.=1.25
(B) F.S.=1.25
RAPID DRAWDOWN-SPILLWAY CREST EL. 911.3
MAXIMUM SURCHARGE EL. 922.9
MULTIPURPOSE POOL EL. 891.0
EL 922.9
R 0+43.3
EL 911.3
R 0+20
EL 822.5
R 0+64.4
(D) F.S.=1.20
(C) F.S.=1.21
(A) F.S.=1.17
(B) F.S.=1.18
RAPID DRAWDOWN MAXIMUM SURCHARGE EL. 922.9
DOWNSTREAM
EL 911.3
R 0+20
EL 824.0
R 4+31
EL 824.0
R 4+51
(C) F.S.=1.69
(B) F.S.=1.68
(D) F.S.=1.81
(E-E) F.S.=1.39 RESIDUAL SHALE AT EL 798.0
STEADY SEEPAGE-SPILLWAY CREST EL. 911.3



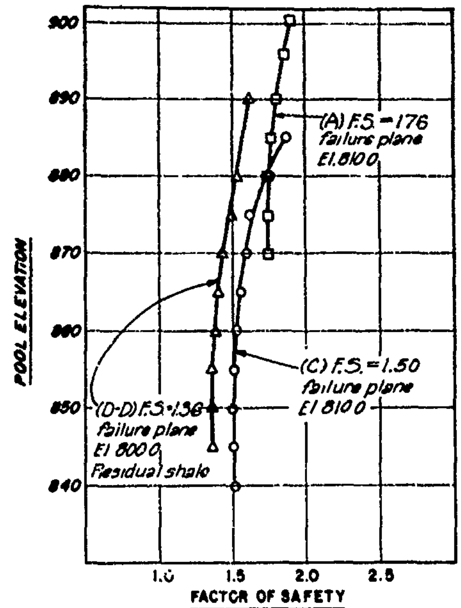
END OF CONSTRUCTION CASE

SURFACE	FAILURE PLANE EL.	LOCATION	F.S.
A	800	D/S	1.47
B	800	D/S	1.40
D	810	U/S	1.67
F	810	U/S	1.59

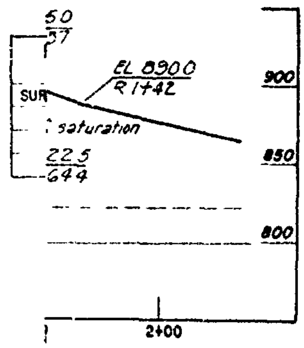


PARTIAL POOL CASE PEAK STRENGTH

SURFACE	FAILURE PLANE EL	CRITICAL POOL EL.	F.S.
A	810	880.0	1.76
B	810	875.0	1.62
C	810	845.0	1.50



PARTIAL POOL CASE

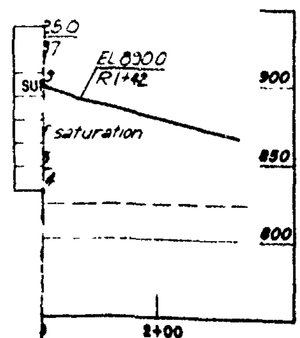


RAPID DRAWDOWN FROM SPILLWAY CREST – PEAK STRENGTH

SURFACE	FAILURE PLANE EL	POOL LEVELS	F.S.
A	810	911.3/891	1.21
B	810	911.3/891	1.25
C	810	911.3/891	1.25

PHYSICAL SOIL CONSTANTS

MATERIAL	UNIT WEIGHT PCF		DESIGN SHEAR STRENGTH					
			"Q"		"R"		"S"	
	SAT	DRAINED	C(KIPS)	TAN Ø	C(KIPS)	TAN Ø	C(KIPS)	TAN Ø
COMPACTED FILL (VALLEY BORROW)	125.0	115.0	1.80	0.0	.40	.20	0.0	.50
SHALE (PEAK)	140.0	140.0	2.00	2.0	2.00	2.00	2.00	2.00
SHALE (RESIDUAL)	140.0	140.0	0.00	0.0	0.0	0.0	0.0	0.30

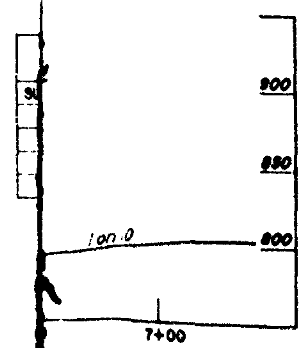


RAPID DRAWDOWN MAXIMUM SURCHARGE EL. 922.9

SURFACE	FAILURE PLANE EL	POOL LEVELS	FS
A	810	922.9/891	1.17
B	810	922.9/891	1.18
C	810	922.9/891	1.21
D	810	922.9/891	1.20

STABILITY STUDIES USING RESIDUAL STRENGTH, FOR FOUNDATION SHALES

SURFACE	CASE	F S
D-D	Partial Pool	1.36
E-E	Steady Seepage	1.39



STEADY SEEPAGE AT SPILLWAY CREST EL. 911.3

SURFACE	FAILURE PLANE EL	FS
A	800	1.61
B	800	1.68
C	800	1.69
D	800	1.61

SYM	DESCRIPTION	DATE	APP'D
	REVISIONS		

LITTLE BLUE RIVER, MISSOURI

LONGVIEW LAKE

EMBANKMENT CRITERIA AND PERFORMANCE REPORT

EMBANKMENT STABILITY ANALYSIS SUMMARY CONDUIT SECTION

In 1 sheet — Sheet No. 1 — Scale: as shown

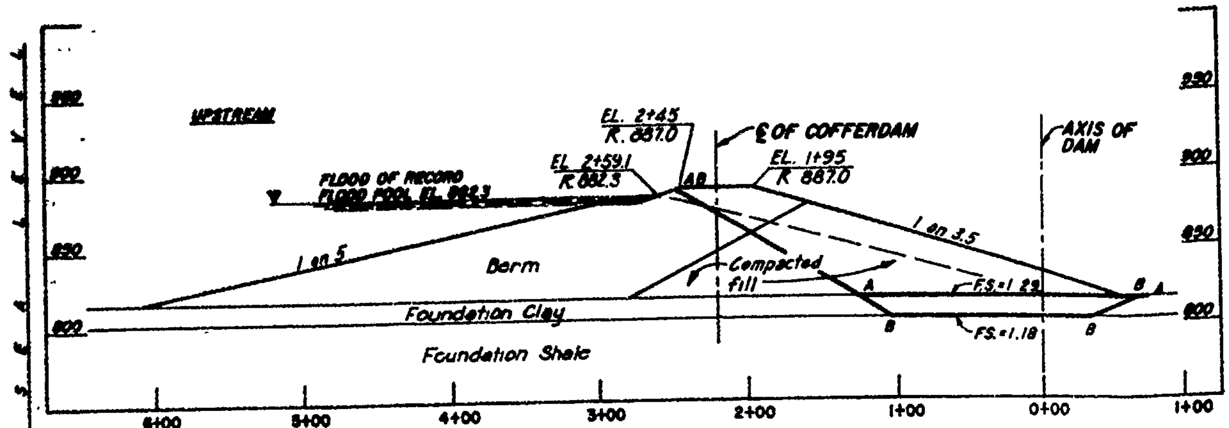
CORPS OF ENGINEERS, KANSAS CITY DISTRICT — U. S. ARMY, JUNE 1978

Submitted: CHIEF, DAMS & FOUNDATIONS SECT. — Recommended: CHIEF, FOUNDATIONS & MAT'LS. BR. — Approved: CHIEF, ENGINEERING DIVISION

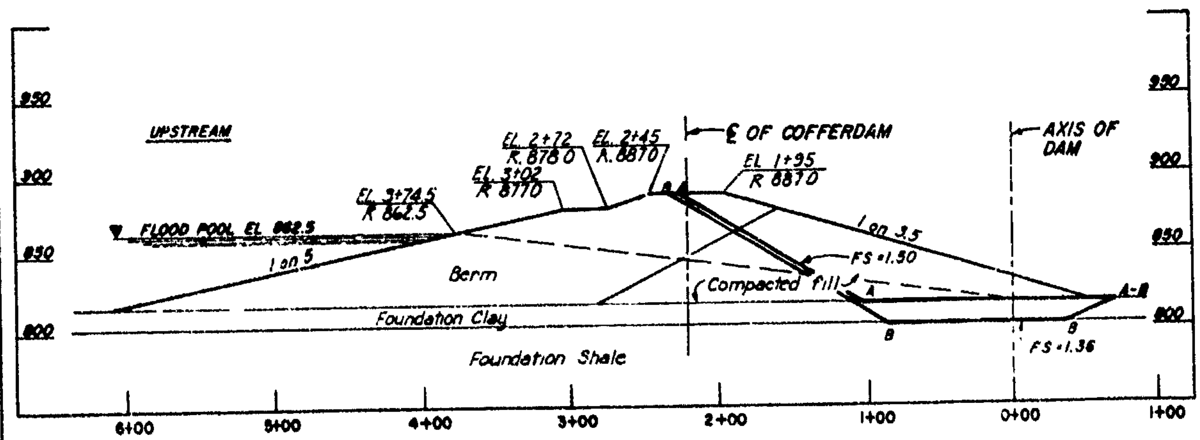
COMPILED BY B.A.B. — DRAWN BY J.P.M. — CHECKED BY R.G.D. — FILE NO. RBL-3-1566

PLATE NO 90

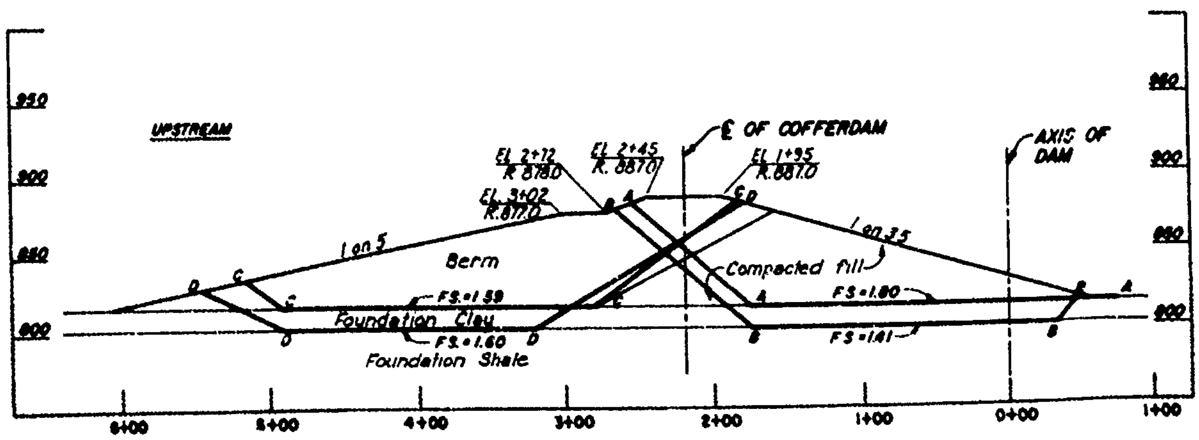
ELEVATION IN FEET ABOVE MEAN SEA LEVEL



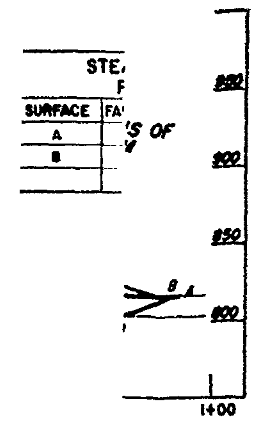
STEADY SEEPAGE POOL EL. 882.3



STEADY SEEPAGE POOL EL. 862.5

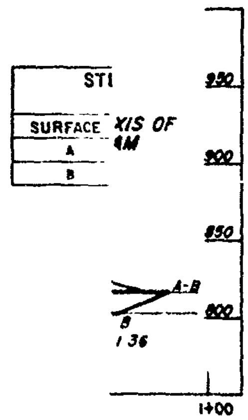


END OF CONSTRUCTION EL. 887.0



STEADY SEEPAGE CASE POOL EL. 882.3		
SURFACE	FAILURE PLANE EL.	F.S.
A	816	129
B	802	1.18

PHYSICAL SOIL CONSTANTS								
MATERIAL	UNIT WEIGHT PCF		DESIGN SHEAR STRENGTH					
			"Q"		"R"		"S"	
	SAT.	DRAINED	C(KSF)	TAN Ø	C(KSF)	TAN Ø	C(KSF)	TAN Ø
BERM	115	110	0.90	0	020	020	0 0	030
COMPACTED FILL	125	115	1.80	0	040	020	.3	036
FOUNDATION CLAY	115	110	120	0	040	020	0	050
SHALE	140	140	—	—	—	—	0 0	060

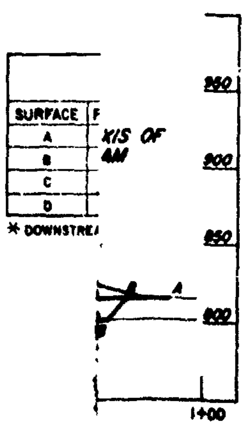


STEADY SEEPAGE CASE POOL EL. 862.5		
SURFACE	FAILURE PLANE EL.	F.S
A	816	1 50
B	802	1 36

Notes

1. Elevation 882.3 is the maximum lake elevation for the all season flood of record routed through the outlet works

2. Elevation 862.5 is maximum elevation for the third flood of record for the period 1 Aug - 28 Feb routed through outlet works



END OF CONSTRUCTION POOL EL. 887.0			
SURFACE	FAILURE PLANE EL.	LOCATION	F.S.
A	816	D/S *	1 80
B	802	D/S *	1 41
C	816	U/S	1 59
D	802	U/S	1 60

* DOWNSTREAM ℄ OF COFFERDAM

SYM	DESCRIPTION	DATE	APP'D.

REVISIONS

LITTLE BLUE RIVER, MISSOURI

LONGVIEW LAKE

EMBANKMENT CRITERIA AND PERFORMANCE REPORT

EMBANKMENT STABILITY ANALYSIS SUMMARY COFFERDAM

In 1 sheet — Sheet No. 1 — Scale: as shown

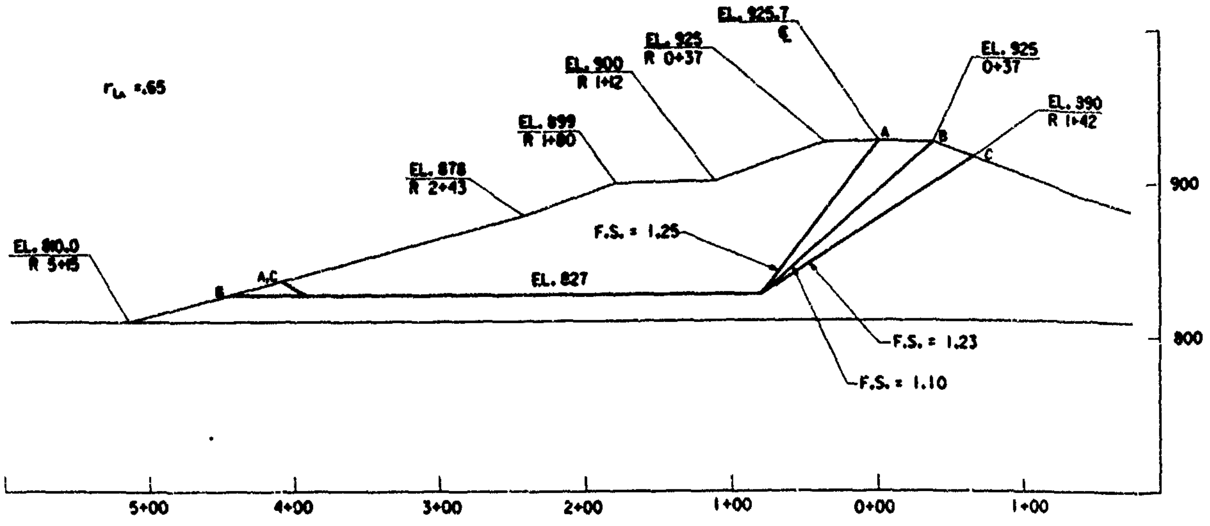
CORPS OF ENGINEERS KANSAS CITY DISTRICT — U. S. ARMY JUNE 1979

Submitted: CHIEF, DAMS & FOUNDATIONS SECT. — Recommended: CHIEF, FOUNDATIONS & MAT'LS BR. — Approved: CHIEF, ENGINEERING DIVISION

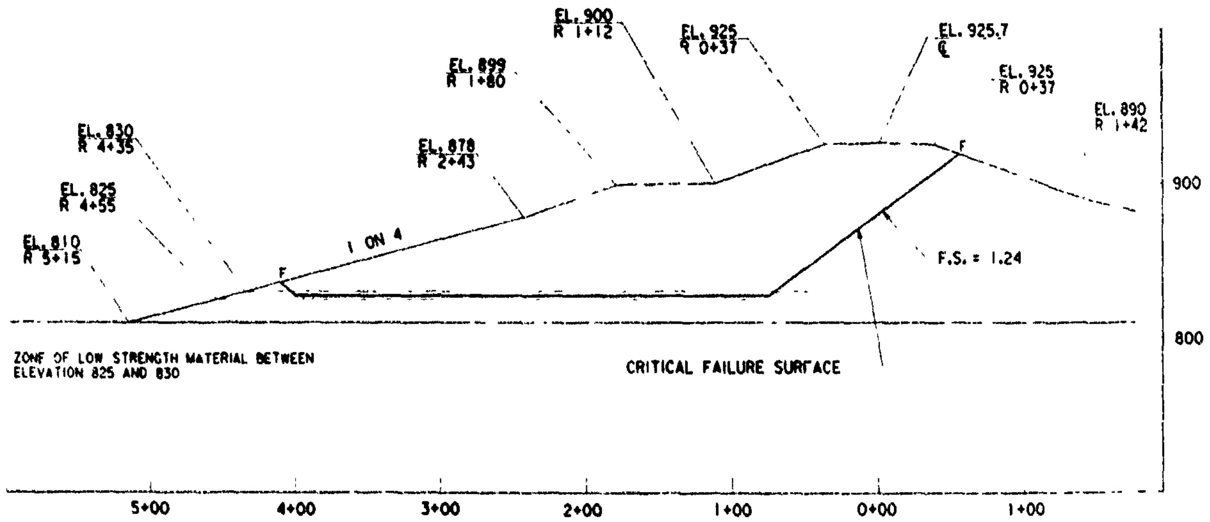
COMPUTED BY B A B — DRAWN BY J P M — CHECKED BY B G D

FILE NO. RBL-3-1569

PLATE NO. 91



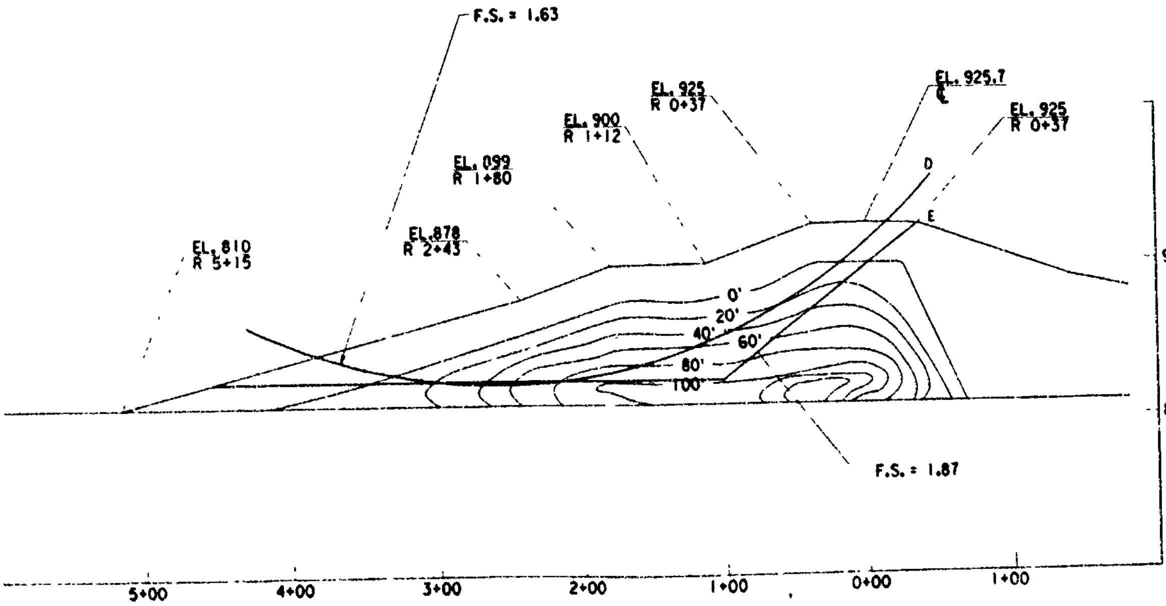
LONGVIEW CONDUIT SECTION - UPSTREAM
EFFECTIVE STRESS ANALYSIS



LONGVIEW STABILITY - U/S CONDUIT SECTION
TOTAL STRESS ANALYSIS

END OF CONSTRUCTION CASE			
SURFACE	FAILURE PLANE EL.	LOCATION	F.S.
A	827	U/S	1.25
B	827	U/S	1.10
C	827	U/S	1.23
D	CIRC. FAILURE SURF.	U/S	1.63
E	827	U/S	1.87
F	827	U/S	1.24

PHYSICAL SOIL CONSTANTS								
MATERIAL	UNIT WEIGHT PCF		DESIGN SHEAR STRENGTH					
			"Q"		"R"		"S"	
	SAT.	DRAINED	C(KIPS)	TAN Ø	C(KIPS)	TAN Ø	C(KIPS)	TAN Ø
EMBANKMENT	125.0	115.0	1.80	0.0	.40	.20	0.2	.50
ZONE OF LOW STRENGTH MTRL.	125.0	115.0	1.00	0.0				
SHALE (PEAK)	140.0	140.0	2.0	2.0	2.0	2.00	2.0	2.0



LONGVIEW CONDUIT SECTION - UPSTREAM
EFFECTIVE STRESS ANALYSIS WITH PORE PRESSURE CONTOURS

Revisions			
Symbol	Descriptions	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

US Army Corps of Engineers

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA AND PERFORMANCE REPORT
STAGE II EMBANKMENT STABILITY ANALYSIS SUMMARY
CONDUIT SECTION

Designed by: D.A.K.
Drawn by: L.M.P.
Checked by: L.L.L.
Submitted by: R.G.D.

Scale: 1" = 50'
Date: X
Dwg. No.:
Sheet number:
Plot Scale: S=50
Design File: [100,55]LOSTAB
File No.: RBL-3-1486

PLATE NO. 92

VAL[illegible]

MATERIAL	STAGE	MAJOR SOURCE	MATERIAL DESCRIPTION	CLASS.	ZONE USAGE	PLACEMENT REQUIREMENTS: EQUIPMENT	MAXIMUM UNCOMPACTED LIFT THICKNESS (INCHES)	NUMBER OF PASSES	DENSITY	MOISTURE
IMPERVIOUS *	I	REQUIRED EXCAVATION AND BORROW	CLAYS WITH LL < [illegible] AND LESS THAN [illegible] GRAVEL DOWNSTREAM OF DAM AXIS	CL CH	IMPERVIOUS ZONE AND SPECIAL BACKFILL IN IMPERVIOUS AND RANDOM ZONES	TAMPING ROLLER	8	6	95% OF MAXIMUM DRY DENSITY AT OPTIMUM MOISTURE CONTENT	+3% TO -2% OF OPTIMUM MOISTURE CONTENT
IMPERVIOUS *	II	REQUIRED EXCAVATION BORROW AND STOCKPILE	CLAY WITH <[illegible] GRAVEL UPSTREAM OF DAM AXIS. BELOW EL. [illegible] LL<[illegible] BELOW EL. [illegible] BETWEEN 97+00 AND 101+00 LL<[illegible] ABOVE EL. [illegible] BETWEEN 97+00 AND 101+00 LL<[illegible] CUTOFF AND INSPECTION TRENCH LL<[illegible] ABOVE EL. [illegible] EXCLUDING CUTOFF AND INSPECTION TRENCH AND BETWEEN 97+00 AND 101+00 LL<[illegible]	CL CH	IMPERVIOUS ZONE AND SPECIAL BACKFILL IN IMPERVIOUS AND RANDOM ZONES	TAMPING ROLLER	8	6	95% OF MAXIMUM DRY DENSITY AT OPTIMUM MOISTURE CONTENT	+3% TO -2% OF OPTIMUM MOISTURE CONTENT
RANDOM *	I	REQUIRED EXCAVATION AND BORROW	OVERBURDEN MATERIAL EXCEPT [illegible] OR SHALE WITH LIQUID LIMIT LESS THAN 60	VARIES	RANDOM ZONE	TAMPING ROLLER PNEUMATIC ROLLER	8 12	6 3	95% OF MAXIMUM DRY DENSITY AT OPTIMUM MOISTURE CONTENT	+3% TO -2% OF OPTIMUM MOISTURE CONTENT
RANDOM *	II	REQUIRED EXCAVATION AND BORROW	SAME AS ABOVE UPSTREAM BELOW [illegible] LL<[illegible] DOWNSTREAM BELOW [illegible] LL<[illegible] ABOVE [illegible] LL<[illegible] SPILLWAY AND ELM AVE. [illegible] LL NOT SPECIFIED (CL OR CH).	VARIES	RANDOM ZONE AND SPILLWAY DIKE	TAMPING ROLLER PNEUMATIC ROLLER	8 12	6 3	95% OF MAXIMUM DRY DENSITY AT OPTIMUM MOISTURE CONTENT	+3% TO -2% OF OPTIMUM MOISTURE CONTENT
BERM	I	REQUIRED EXCAVATION AND BORROW	MATERIAL INCLUDING SHALE [illegible] IN EXCESS OF THE REQUIREMENTS OF OTHER ZONES. OUTER 5' NORMAL TO THE SLOPE IS FAT CLAY.	VARIES OUTER 5' IS CH	BERM ZONE	PNEUMATIC ROLLER TAMPING ROLLER	24 8	2 2	NONE SPECIFIED	CONTROLLED TO ALLOW UNASSISTED MOVEMENT OF COMPACTION EQUIPMENT
BERM	II	REQUIRED EXCAVATION AND BORROW	SAME AS ABOVE OUTER 5' NORMAL TO THE SLOPE IS FAT CLAY (CH).	VARIES	BERM ZONE	TAMPING ROLLER PNEUMATIC ROLLER	8 12	4 2	NONE SPECIFIED	-4% OF OMC-WET OF OPTIMUM CONTROLLED TO ALLOW UNASSISTED MOVEMENT OF COMPACTION EQUIPMENT
DIVERSION DIKE AND DOWNSTREAM COFFERDAM	I	REQUIRED EXCAVATION AND BORROW	MATERIAL NOT SUITABLE FOR PLACEMENT ELSEWHERE	VARIES	DIVERSION DIKE AND DOWNSTREAM COFFERDAM	TRAFFIC COMPACTED	24	EVEN ROUTING	NONE SPECIFIED	CONTROLLED TO ALLOW UNASSISTED MOVEMENT OF COMPACTION EQUIPMENT
CHANNEL FILL, DIVERSION DIKE	II	REQUIRED EXCAVATION AND BORROW	MATERIAL NOT SUITABLE FOR PLACEMENT ELSEWHERE CHANNEL FILL INCLUDES MATERIAL FROM ROCK EXCAVATION COVERED WITH AT LEAST 2' OF OTHER MATL.	VAI ES	CHANNEL FILL AND DIVERSION DIKE	TRAFFIC COMPACTED	24	EVEN ROUTING	NONE SPECIFIED	-4% OF OMC-WET OF OPTIMUM CONTROLLED TO ALLOW UNASSISTED MOVEMENT OF COMPACTION EQUIPMENT
DOWNSTREAM COFFERDAM	II	REQUIRED EXCAVATION AND BORROW	MATERIAL NOT SUITABLE FOR PLACEMENT ELSEWHERE	VARIES	DOWNSTREAM COFFERDAM	TAMPING ROLLER PNEUMATIC ROLLER	8 12	6 3	NONE SPECIFIED	-4% OF OMC-WET OF OPTIMUM CONTROLLED TO ALLOW UNASSISTED MOVEMENT OF COMPACTION EQUIPMENT
IMPERVIOUS CLAY BLANKET	II	REQUIRED EXCAVATION BORROW AND STOCKPILE	CLAY WITH < [illegible] GRAVEL AND LIQUID LIMIT LESS THAN 60	CL CH	RIGHT ABUTMENT CLAY BLANKET	TAMPING ROLLER PNEUMATIC ROLLER	8 12	6 3	95% OF MAXIMUM DRY DENSITY AT OPTIMUM MOISTURE CONTENT	+3% TO -2% OF OPTIMUM MOISTURE CONTENT
SPECIAL BACKFILL	I AND II	REQUIRED EXCAVATION BORROW OR OFFSITE SOURCES	IMPERVIOUS IN IMPERVIOUS ZONE RANDOM IN RANDOM ZONE PERVIOUS IN PERVIOUS ZONE	VARIES	ADJACENT TO STRUCTURES,OBSERVATION DEVICES,AND ROCK SURFACES AND TO FILL IRREGULARITIES	POWER TAMPER (IMPERVIOUS AND RANDOM) VIBRATORY PLATE (PERVIOUS)	3	AS REQUIRED AS REQUIRED	95% MAXIMUM DRY DENSITY 80% RELATIVE DENSITY **	MOISTU[illegible] SPECIF[illegible] TO THE BACKF[illegible]
TOPSOIL	I AND II	REQUIRED EXCAVATION, BORROW STRIPPING, OR STOCKPILE	MATERIAL CONTAINING ORGANIC MATTER NOT SUITABLE FOR PLACEMENT ELSEWHERE	VARIES	AREAS TO BE TOPSOILED AND SEEDED	TRAFFIC COMPACTED	12	EVEN ROUTING	FIRM WELL-PACKED CONDITION	CONTROLLED TO ALLOW UNASSISTED MOVEMENT OF EQUIPMENT
PERVIOUS	I	OFFSITE SOURCES MISSOURI OR KANSAS RIVERS	CLEAN,DURABLE,NATURAL SAND [illegible]	SP	PERVIOUS BLANKET, PERVIOUS DICK AND SPECIAL BACKFILL IN PERVIOUS ZONES.	PLATE VIBRATORY COMPACTOR VIBRATORY ROLLER	4 12	AS REQUIRED 3	80% RELATIVE DENSITY **	SATURATED
PERVIOUS	II	OFFSITE SOURCES MISSOURI OR KANSAS RIVERS	CLEAN,DURABLE,NATURAL SAND [illegible]	SP	PERVIOUS BLANKET, PERVIOUS DICK AND SPECIAL BACKFILL IN PERVIOUS ZONES.	PLATE VIBRATORY COMPACTOR VIBRATORY ROLLER	6 12	AS REQUIRED 3	70% RELATIVE DENSITY	SATURATED
ROCK FILL	I	REQUIRED EXCAVATION	BETTER QUALITY LIMESTONE WITH LESS THAN 10% FRIABLE PARTICLES INCLUDING SHALE, [illegible] MAXIMUM 0 - 15% LESS THAN 2 INCHES.	[illegible]	ROCK FILL ZONE OVER AND UNDER CLAY BLANKET	......	36	NONE	NONE	NONE
ROCK FILL	II	REQUIRED EXCAVATION AND STOCKPILE	BETTER QUALITY LIMESTONE WITH LESS THAN 10% FRIABLE PARTICLES INCLUDING SHALE, [illegible] MAXIMUM 0 - 15% LESS THAN 2 INCHES.	[illegible]	ROCK FILL ZONE OVER CLAY BLANKET	....	36	NONE	NONE	NONE
BEDDING	I	REQUIRED EXCAVATION	[illegible]	[illegible]	BEDDING FOR RIPRAP SLOPE PROTECTION	.....	12	NONE	NONE	NONE
BEDDING (9-INCH)	II	OFFSITE COMMERCIAL QUARRY	SOUND,DURABLE LIMESTONE WITH [illegible]	[illegible]	BEDDING FOR RIPRAP SLOPE PROTECTION	.....	FULL LAYER THICKNESS		.....	NONE
BEDDING (12-INCH)	II	OFFSITE COMMERCIAL QUARRY	SOUND,DURABLE LIMESTONE WITH NO DELETERIOUS SUBSTANCES. (GRADATION SAME AS ABOVE)	[illegible]	BEDDING FOR RIPRAP SLOPE PROTECTION	...	FULL LAYER THICKNESS		....	NONE
RIPRAP	II	OFFSITE COMMERCIAL QUARRY	SOUND,DURABLE LIMESTONE WITH LESS THAN 10% DELETERIOUS SUBSTANCES. [illegible]	[illegible]	SLOPE PROTECTION	CLAM,DRAGLINE, ROCK BLANKET OR ORANGE PEEL	FULL LAYER THICKNESS	NONE	NONE	NONE

3 2 1

...UMBER OF ...ASSES	DENSITY	MOISTURE	MOISTURE-DENSITY PER EM-1110-2-1906	FIELD DENSITY DETERMINATION	RECORD CONTROL SAMPLES
	...QUIREMENTS		DENSITY CONTROL		
6	[illegible]	+3% TO -2% OF OPTIMUM MOISTURE CONTENT	ONE FAMILY OF CURVES FOR EACH MATERIAL OR COMBINATION OF MATERIALS USED	AS DIRECTED BY CONTRACTING OFFICER	ONE SACK AND ONE 6" DIA X 6" LONG UNDISTURBED SAMPLE EVERY 30,000 CY
6	[illegible]	+3% TO -2% OF OPTIMUM MOISTURE CONTENT	ONE FAMILY OF CURVES FOR EACH MATERIAL OR COMBINATION OF MATERIALS USED	AS DIRECTED BY CONTRACTING OFFICER	ONE SACK AND ONE 6" DIA X 6" LONG UNDISTURBED SAMPLE EVERY 30,000 CY
6 / 3	[illegible]	+3% TO -2% OF OPTIMUM MOISTURE CONTENT	ONE FAMILY OF CURVES FOR EACH MATERIAL OR COMBINATION OF MATERIALS USED	AS DIRECTED BY CONTRACTING OFFICER	ONE SACK AND ONE 6" DIA X 6" LONG UNDISTURBED SAMPLE EVERY 30,000 CY
6 / 3	[illegible]	+3% TO -2% OF OPTIMUM MOISTURE CONTENT	ONE FAMILY OF CURVES FOR EACH MATERIAL OR COMBINATION OF MATERIALS USED	AS DIRECTED BY CONTRACTING OFFICER	ONE SACK AND ONE 6" DIA X 6" LONG UNDISTURBED SAMPLE EVERY 30,000 CY
2 / 2	NONE SPECIFIED	CONTROLLED TO ALLOW UNASSISTED MOVEMENT OF COMPACTION EQUIPMENT	ONE FAMILY OF CURVES FOR EACH MATERIAL OR COMBINATION OF MATERIALS USED	AS DIRECTED BY CONTRACTING OFFICER	ONE SACK AND ONE 6" DIA X 6" LONG UNDISTURBED SAMPLE EVERY 75,000 CY
2	NONE SPECIFIED	-4% OF BUCKET OF OPTIMUM CONTROLLED TO ALLOW UNASSISTED MOVEMENT OF COMPACTION EQUIPMENT	ONE FAMILY OF CURVES FOR EACH MATERIAL OR COMBINATION OF MATERIALS USED	AS DIRECTED BY CONTRACTING OFFICER	ONE SACK AND ONE 6" DIA X 6" LONG UNDISTURBED SAMPLE EVERY 75,000 CY
EVEN ROUTING	NONE SPECIFIED	CONTROLLED TO ALLOW UNASSISTED MOVEMENT OF COMPACTION EQUIPMENT	ONE FAMILY OF CURVES FOR EACH MATERIAL OR COMBINATION OF MATERIALS USED	AS DIRECTED BY CONTRACTING OFFICER	NONE
EVEN ROUTING	NONE SPECIFIED	-4% OF BUCKET OF OPTIMUM CONTROLLED TO ALLOW UNASSISTED MOVEMENT OF COMPACTION EQUIPMENT	ONE FAMILY OF CURVES FOR EACH MATERIAL OR COMBINATION OF MATERIALS USED	AS DIRECTED BY CONTRACTING OFFICER	AS DIRECTED BY CONTRACTING OFFICER
6 / 3	NONE SPECIFIED	-4% OF BUCKET OF OPTIMUM CONTROLLED TO ALLOW UNASSISTED MOVEMENT OF COMPACTION EQUIPMENT	ONE FAMILY OF CURVES FOR EACH MATERIAL OR COMBINATION OF MATERIALS USED	AS DIRECTED BY CONTRACTING OFFICER	AS DIRECTED BY CONTRACTING OFFICER
6 / 3	[illegible]	+3% TO -2% OF OPTIMUM MOISTURE CONTENT	ONE FAMILY OF CURVES FOR EACH MATERIAL OR COMBINATION OF MATERIALS USED	AS DIRECTED BY CONTRACTING OFFICER	AS DIRECTED BY CONTRACTING OFFICER
AS REQUIRED	[illegible] DRY DENSITY	MOISTURE, MOISTURE-DENSITY, AND FIELD DENSITY SPECIFICATIONS AND PROCEDURES CORRESPOND TO THE EMBANKMENT ZONE IN WHICH THE BACKFILL IS PLACED			AS DIRECTED BY CONTRACTING OFFICER
AS REQUIRED	[illegible] RELATIVE DENSITY **				
EVEN ROUTING	[illegible] CONDITION	CONTROLLED TO ALLOW UNASSISTED MOVEMENT OF EQUIPMENT	NONE	NONE	NONE
AS REQUIRED / 3	[illegible] RELATIVE DENSITY **	SATURATED	NONE	AS DIRECTED BY CONTRACTING OFFICER	FIELD CONTROL TESTS SERVE AS RECORD CONTROL TESTS
AS REQUIRED / 3	[illegible] RELATIVE DENSITY	SATURATED	NONE	AS DIRECTED BY CONTRACTING OFFICER	FIELD CONTROL TESTS SERVE AS RECORD CONTROL TESTS
NONE	NONE	NONE	NONE	NONE	NONE
NONE	NONE	NONE	NONE	NONE	NONE
NONE	NONE	NONE	NONE	NONE	NONE
	----	NONE	NONE	4 GRADATIONS	FIELD CONTROL TESTS SERVE AS RECORD CONTROL TESTS
	----	NONE	NONE	4 GRADATIONS	FIELD CONTROL TESTS SERVE AS RECORD CONTROL TESTS
NONE	NONE	NONE	NONE	2 IN PLACE GRADATION AND ELONGATION TESTS 12' X 12' X 15 TONS. 2 TRUCKLOAD GRADATION AND ELONGATION TESTS	FIELD CONTROL TESTS SERVE AS RECORD CONTROL TESTS

MATERIAL	STAGE I (YD^3)	STAGE II (YD^3)	TOTAL (YD^3)
PERVIOUS	30,307	74,197	104,504
IMPERVIOUS	[illegible]	518,062	[illegible]
RANDOM	215,452	699,361	914,813
BERM	344,467	621,504	965,971

* WHEN PLACED OVER A ROCK FOUNDATION, THE LIFT THICKNESS WAS 6 INCHES AND COMPACTION WAS ACHIEVED WITH TWO PASSES OF A RUBBER-TIRED ROLLER UNTIL THE FILL REACHED 18 INCHES THICKNESS OVER THE ROCK FOUNDATION. IF THE RUBBER-TIRED ROLLER CAUSED BREAKAGE OF SHALE FOUNDATION, THE BALLAST WAS LESSENED OR OTHER ROLLERS WERE USED AS APPROVED BY THE CONTRACTING OFFICER.

** 80% RELATIVE DENSITY WAS NOT ACHIEVABLE AND THE SPECIFIED DENSITY WAS REDUCED TO 70% RELATIVE DENSITY.

Revisions			
Symbol	Descriptions	Date	Approved

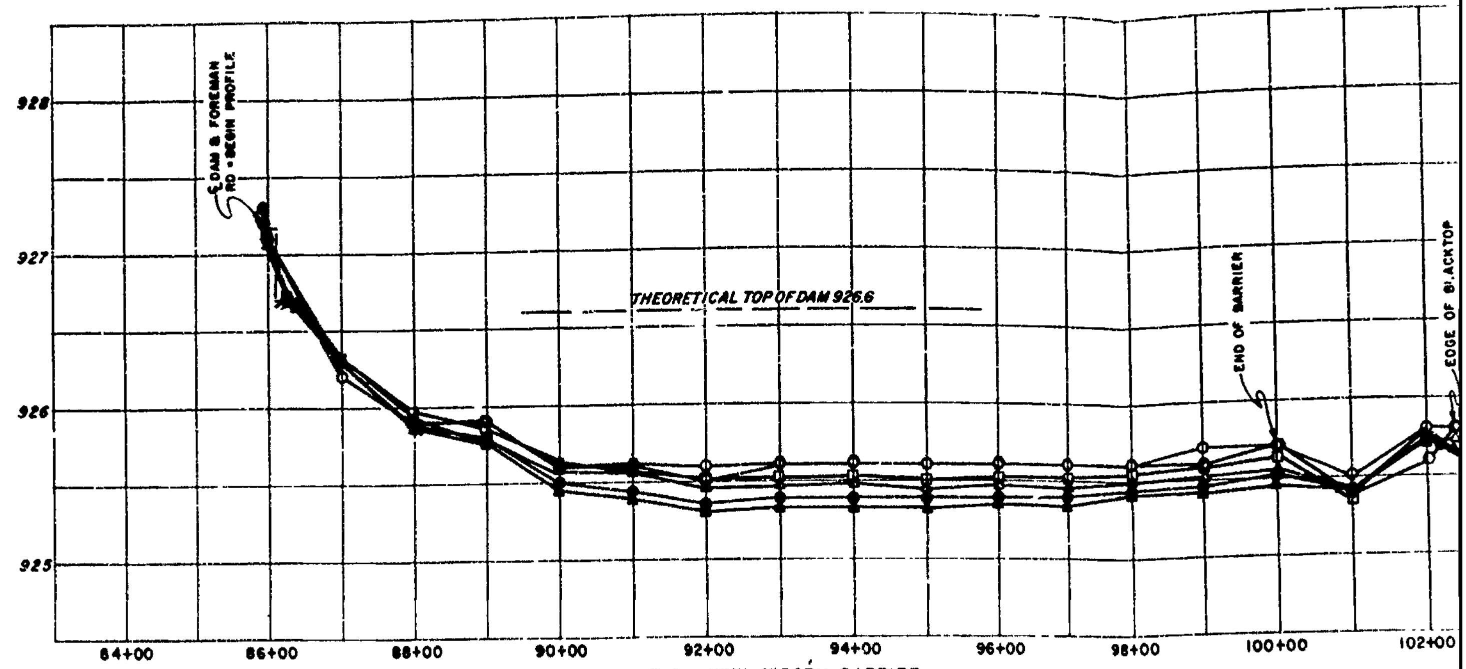
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

Designed by: R.G.D.	US Army Corps of Engineers — LITTLE BLUE RIVER, MISSOURI LONGVIEW LAKE EMBANKMENT CRITERIA AND PERFORMANCE REPORT
Drawn by: R.A.A.	EMBANKMENT MATERIAL PLACEMENT REQUIREMENTS AND QUANTITIES
Checked by: L.L.L.	Scale: NO SCALE; Sheet number:; Plot Scale: .0833
Submitted by: X	Date: X; Design File: 100,553.ONGEMB; Dwg. No.:; File No.: RBL-3-1487

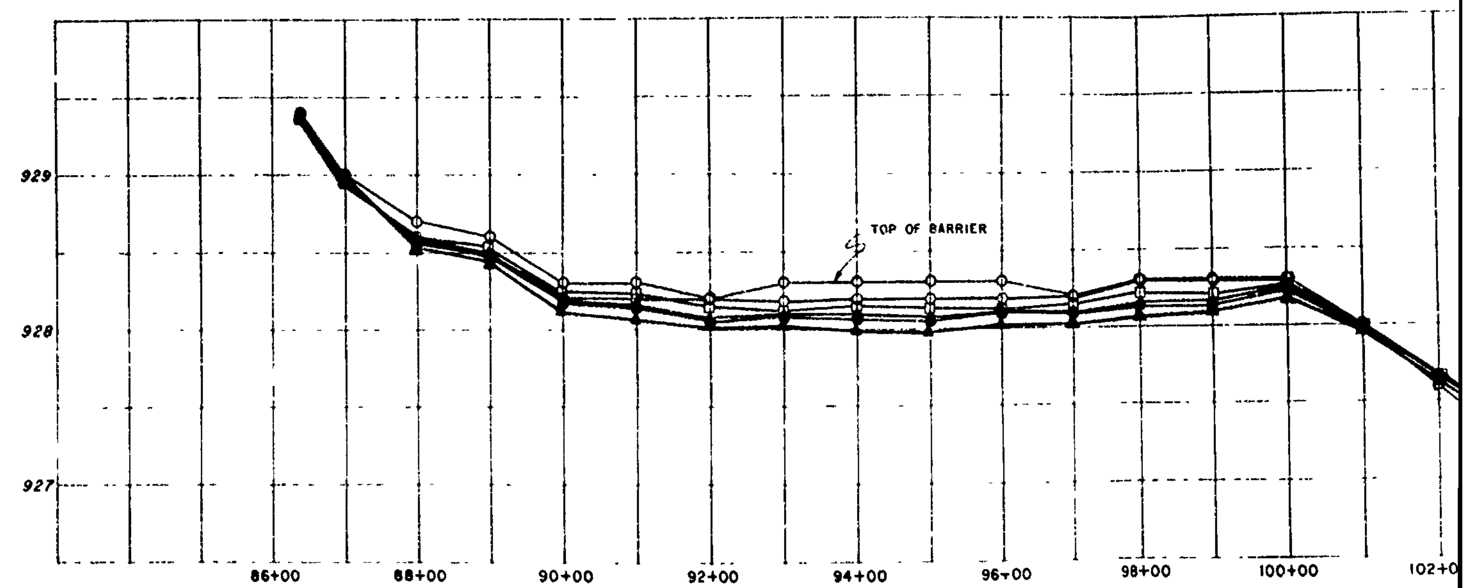
D C B A

3 2 1

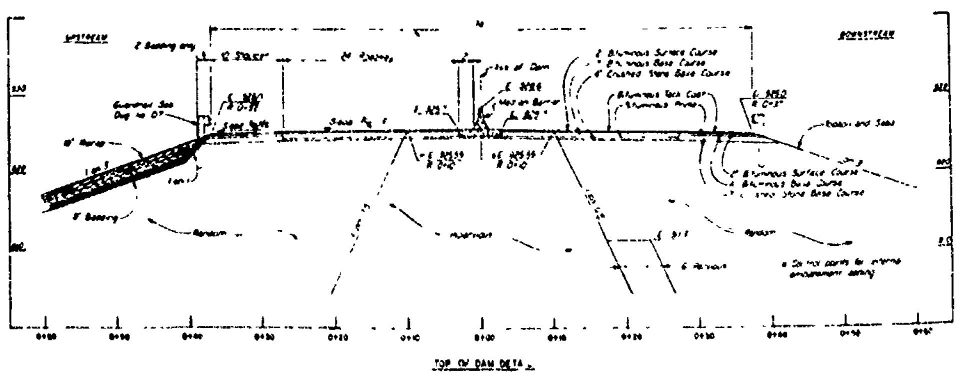
ELEVATION IN FEET BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929



TOP OF DAM PROFILE ADJACENT TO NEW JERSEY BARRIER
DOWNSTREAM EDGE

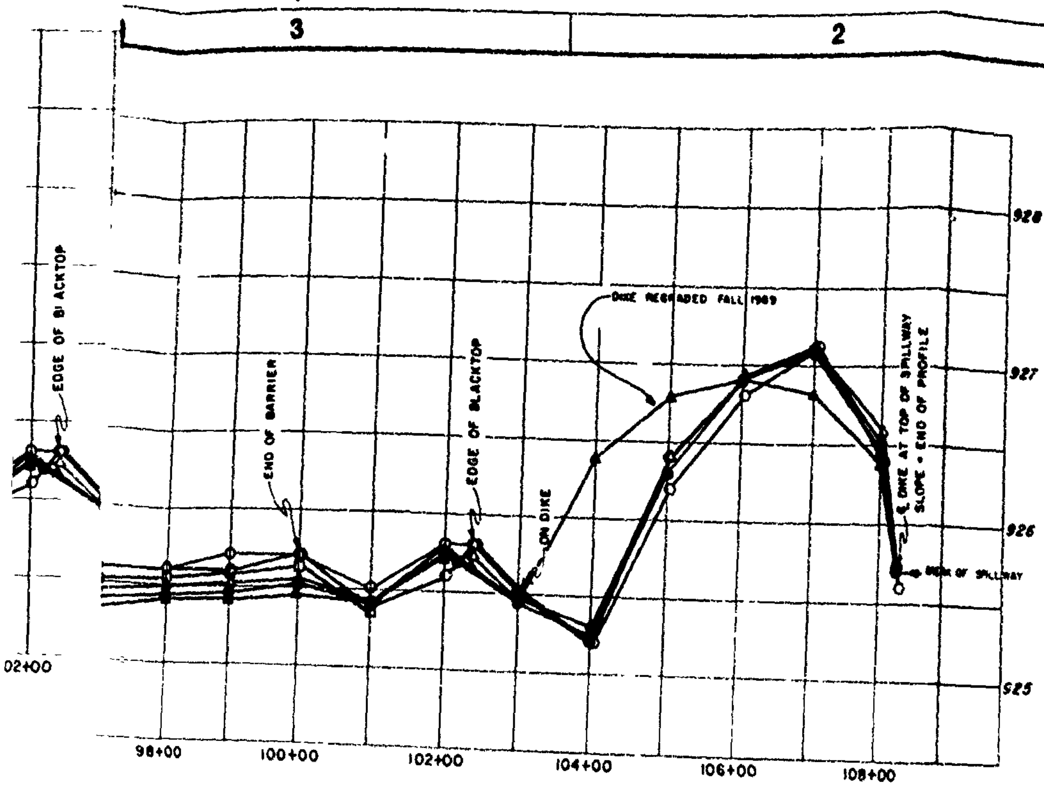


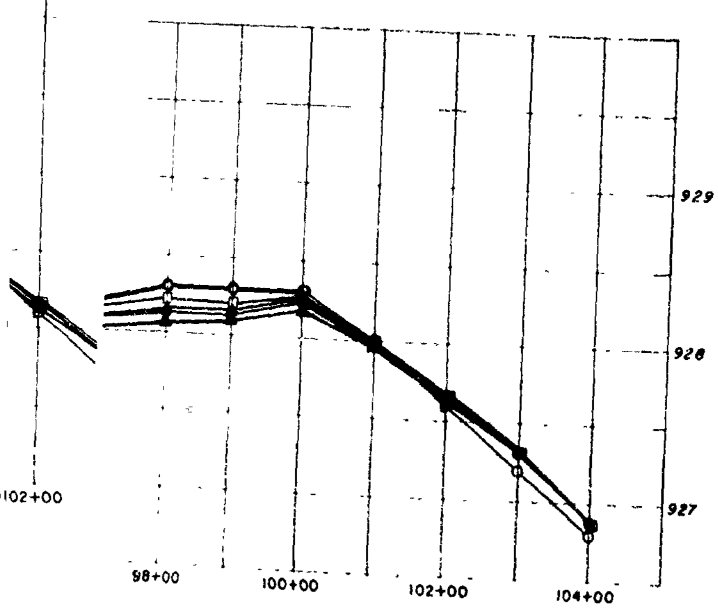
PROFILE TOP OF NEW JERSEY BARRIER

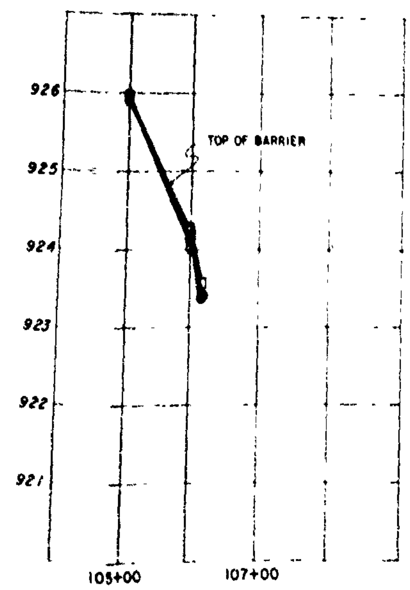


TOP OF DAM DETAIL

LE
INITIAL PROFILE BN







TOP OF NEW JERSEY BARRIER (CONT)

LEGEND

ILE 8 NOV '85
5 MAR '87
4 JUN '87
13 MAR '88
12 JAN '89
23 APR '90

LEGEND

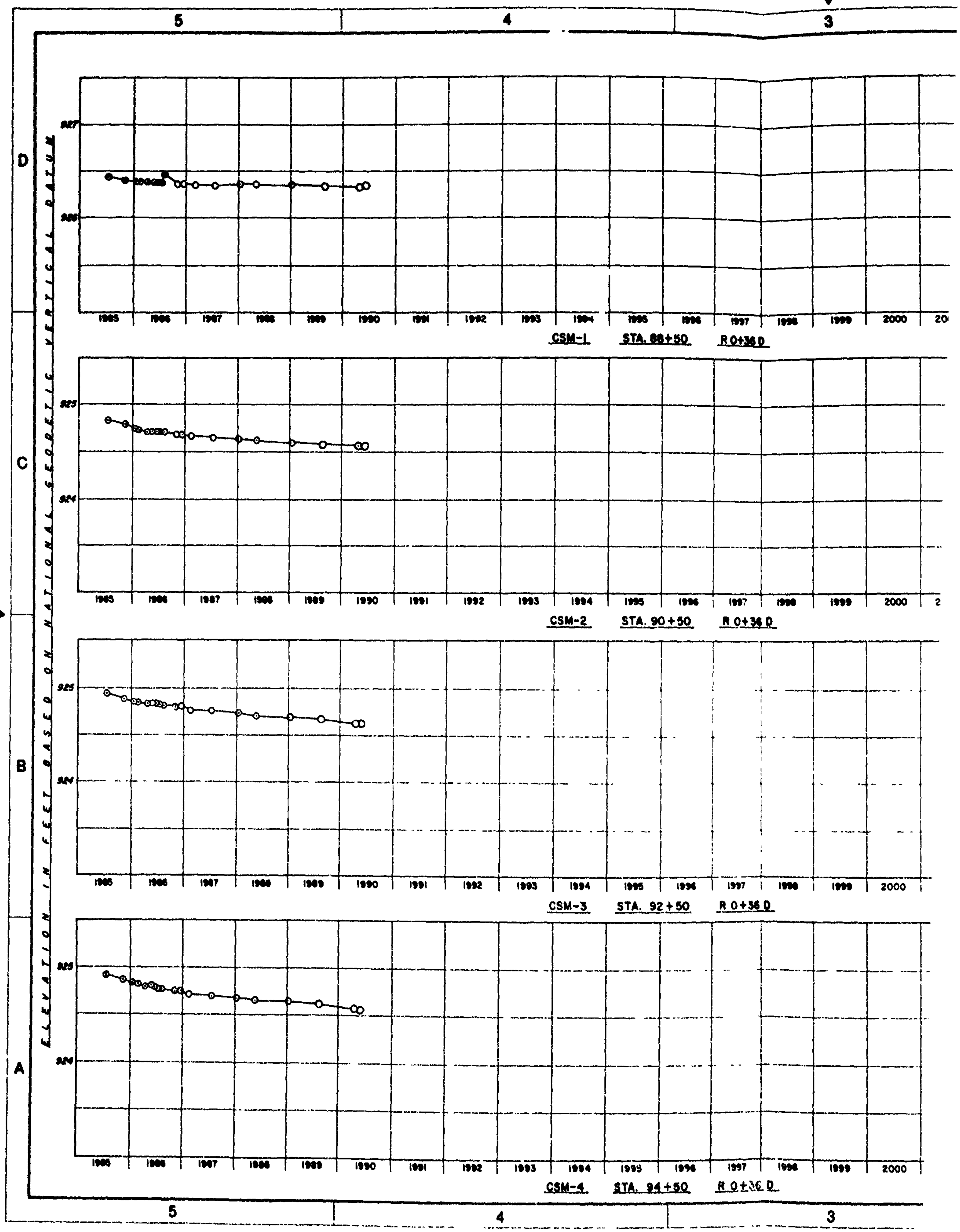
INITIAL PROFILE 8 NOV '85 ---------- ○
5 MAR '87 ---------- ○
4 JUN '87 ---------- □
13 MAR '88 ---------- △
12 JAN '89 ---------- ●
23 APR '90 ---------- ▲

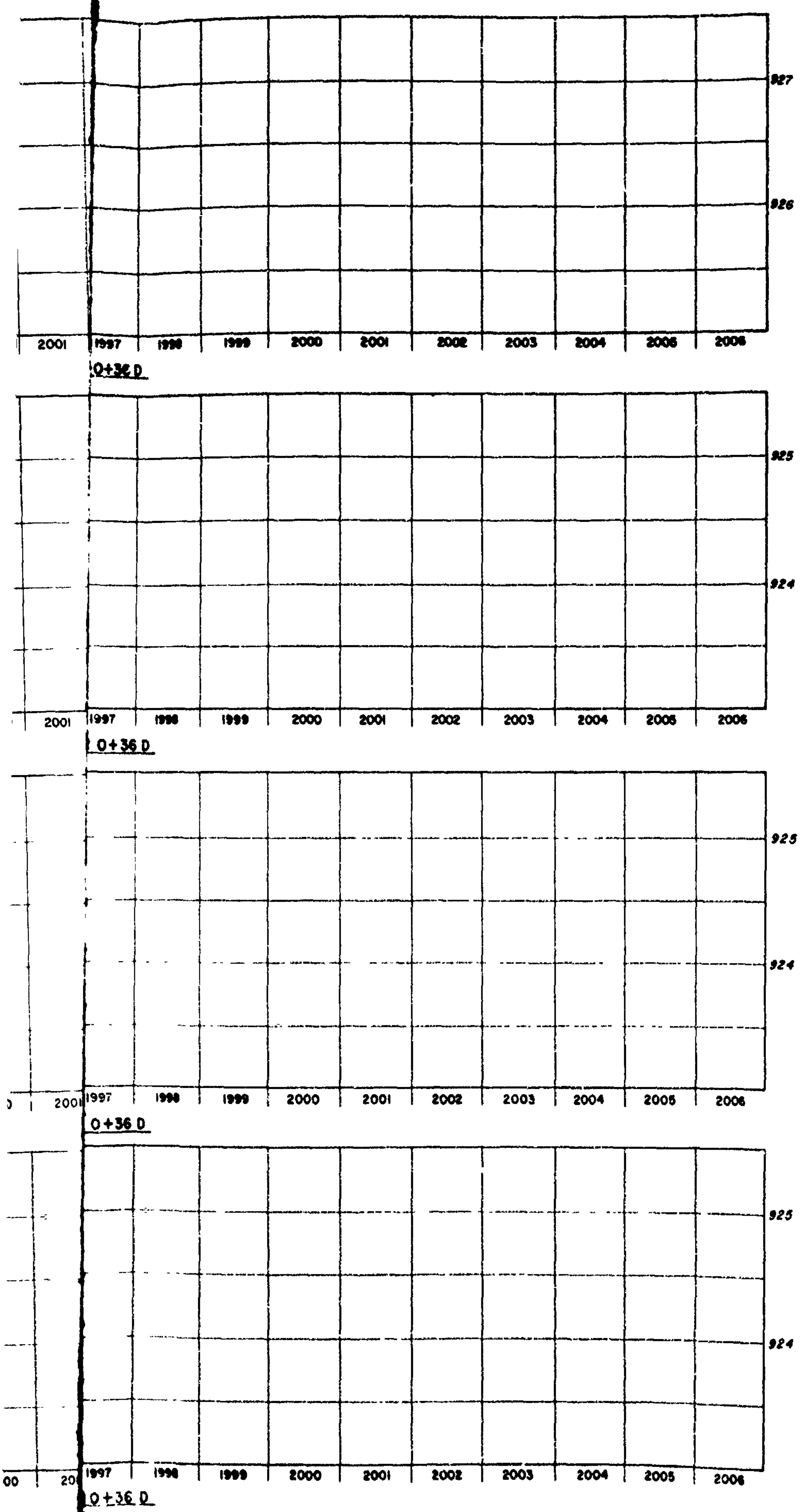
Revisions			
Symbol	Descriptions	Date	Approved
	Revised March 1990		

U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

Designed by RGO	LITTLE BLUE RIVER, MISSOURI LONGVIEW LAKE EMBANKMENT CRITERIA AND PERFORMANCE REPORT		
Drawn by VAB	TOP OF DAM PROFILE PLOTS		
Checked by RLA	Scale AS SHOWN	Sheet number	
Submitted by WBE	Date DECEMBER 1986		
	Dwg No		File No RBL-3-1570

PLATE NO. 94


5
4
3
D
C
B
A
ELEVATION IN FEET BASED ON NATIONAL GEODETIC VERTICAL DATUM
927
926
925
924
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
CSM-1 STA. 88+50 R 0+36 D
CSM-2 STA. 90+50 R 0+36 D
CSM-3 STA. 92+50 R 0+36 D
CSM-4 STA. 94+50 R 0+36 D



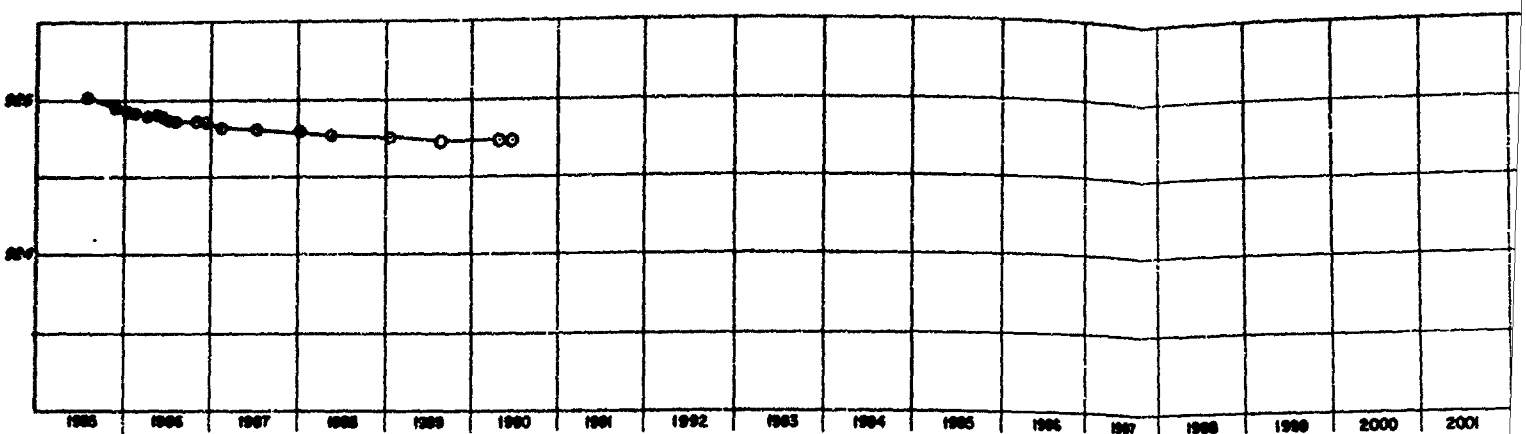
Revisions			
Symbol	Descriptions	Date	Approved
	Revised March 1990		

U. S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

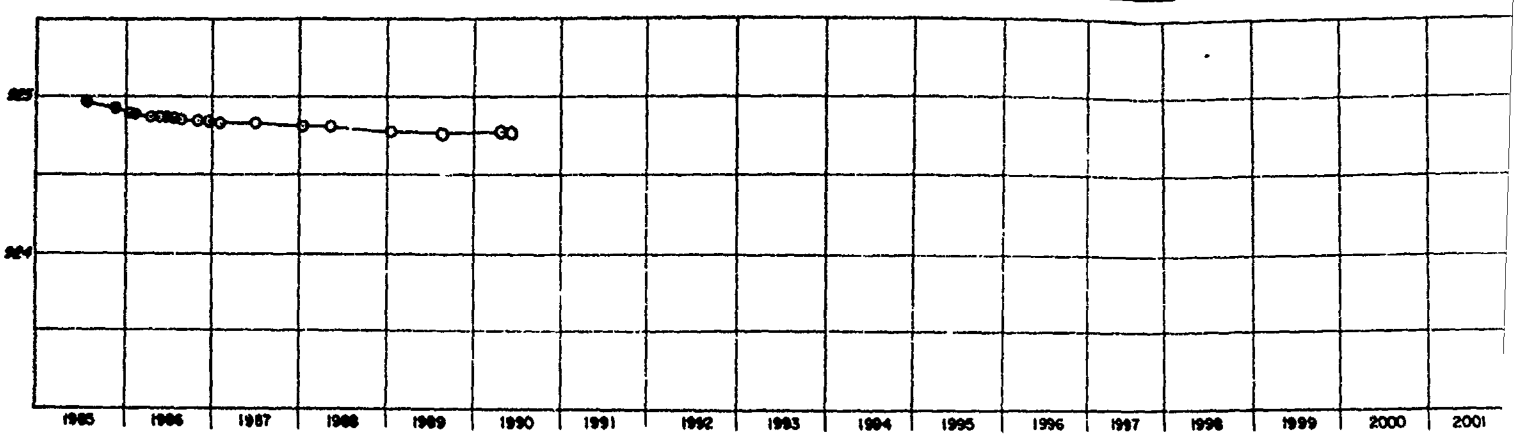
Designed by: RGD	US Army Corps of Engineers — LITTLE BLUE RIVER, MISSOURI LONGVIEW LAKE EMBANKMENT CRITERIA AND PERFORMANCE REPORT
Drawn by: EGM	CREST SETTLEMENT MONUMENT PLOTS
Checked by: RLA	Scale: AS SHOWN — Sheet number:
Submitted by: WBE	Date: DECEMBER 1986 — Dwg No: 1 OF 2 — File No: RBL-3-1571

PLATE NO. 95

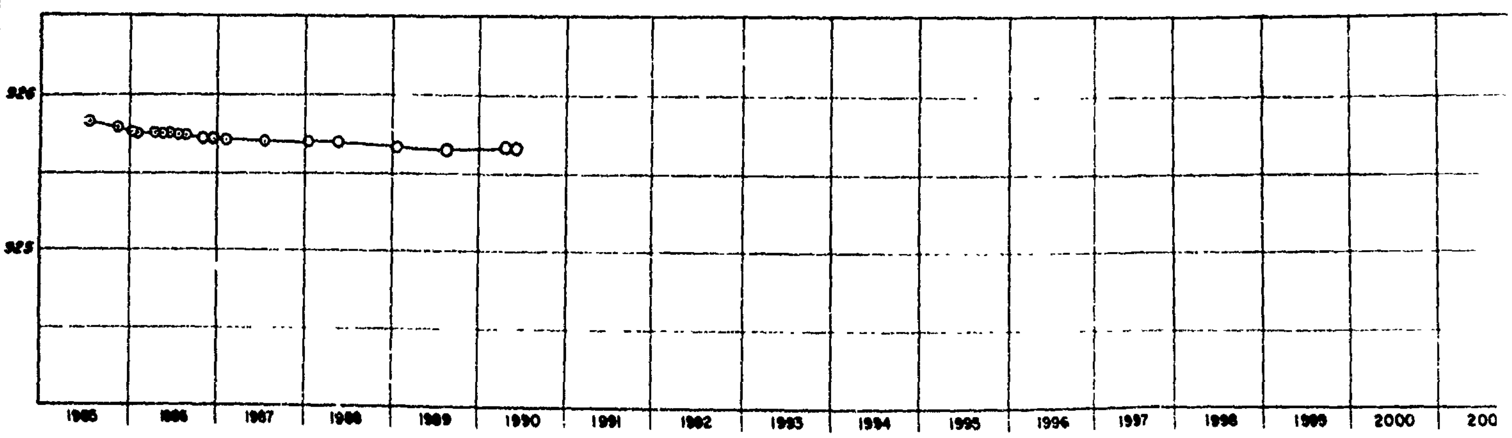
ELEVATION IN FEET BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929



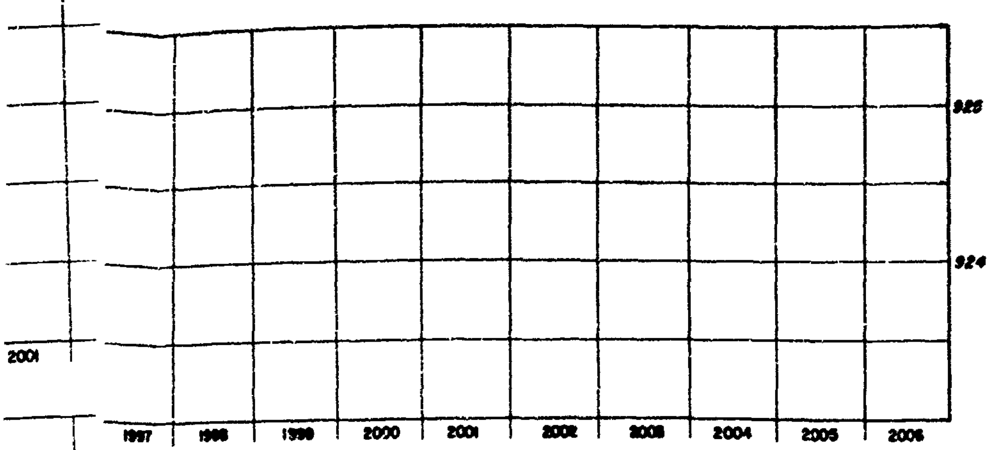
CSM-5 STA. 98+50 0+36 D



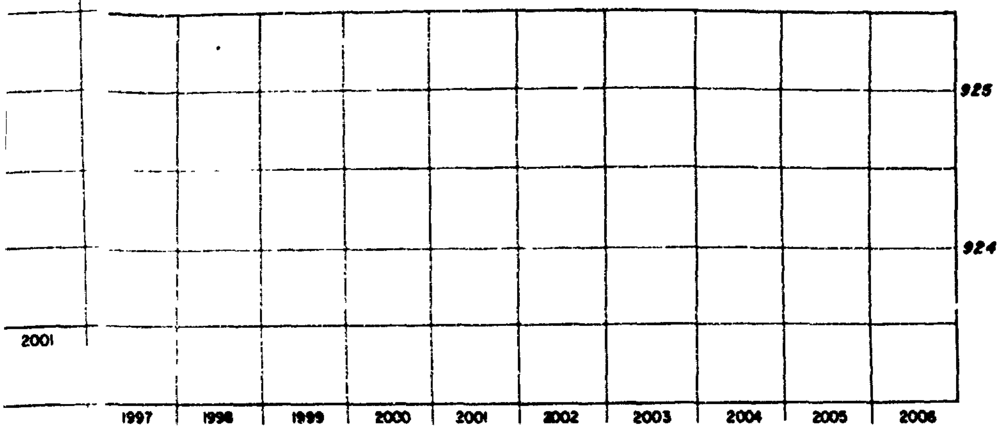
CSM-6 STA. 98+70 0+36 D



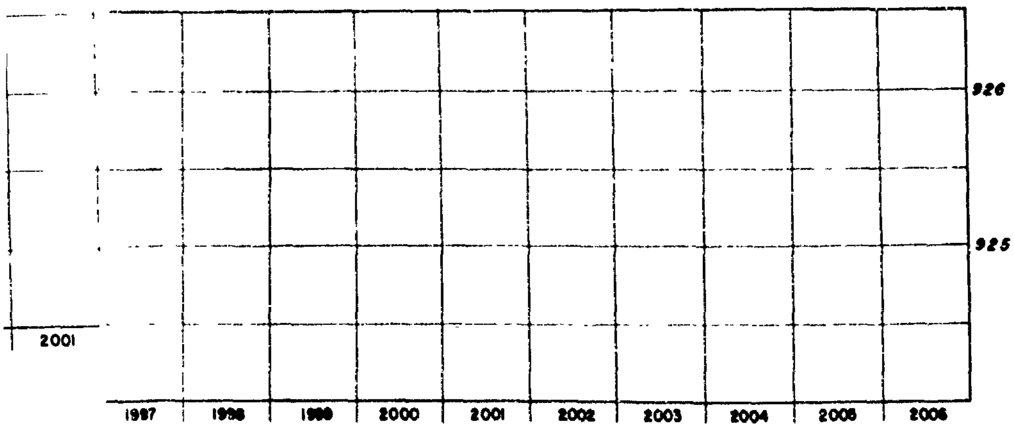
CSM-7 STA. 100+50 0+36 D



0+36 D



0+36 D



0+36 D

Revisions			
Symbol	Descriptions	Date	Approved
	Revised March 1990		

U. S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

Designed by: RGD
Drawn by: JGS
Checked by: RLA
Submitted by: WBE

US Army Corps of Engineers

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA AND PERFORMANCE REPORT

CREST SETTLEMENT MONUMENT PLOTS

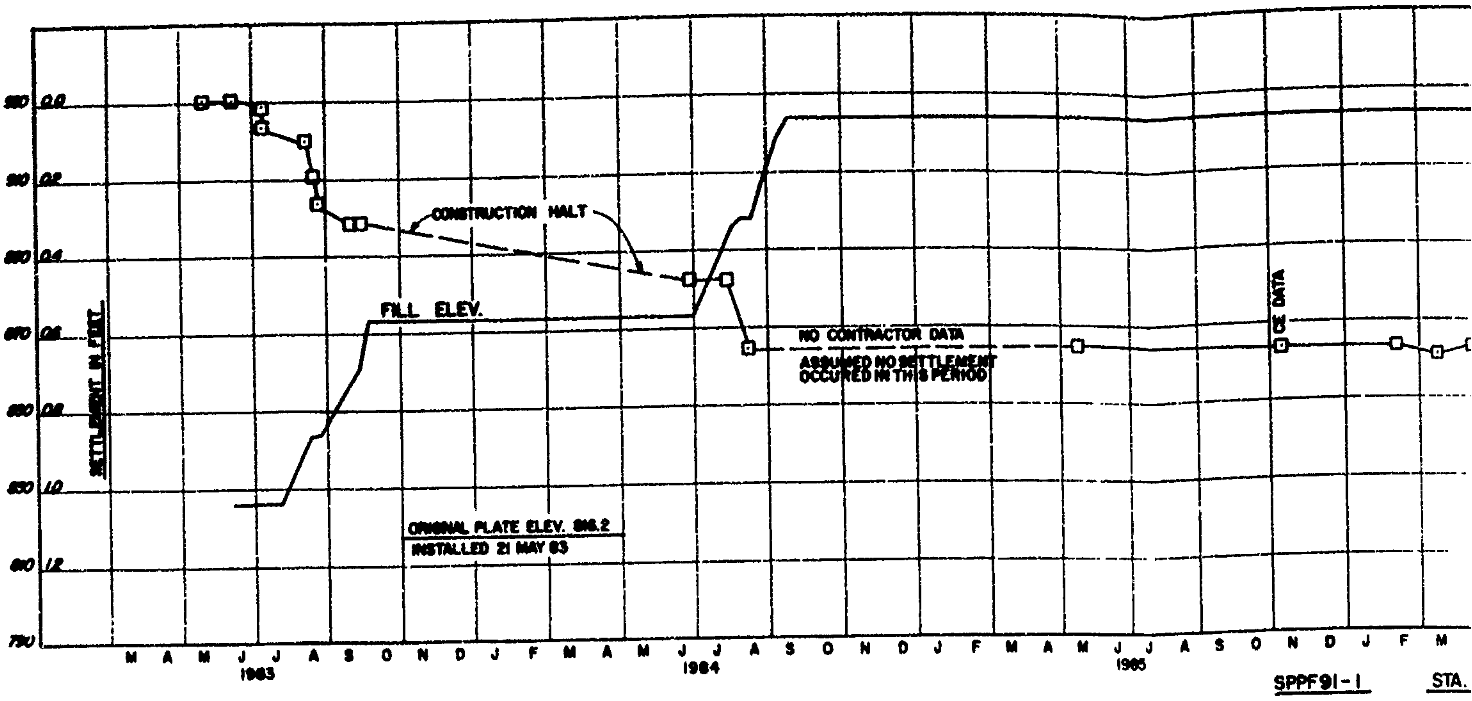
Scale: AS SHOWN
Date: DECEMBER 1986
Dwg No: 2 OF 2
Sheet number:
File No: RBL-3-1572

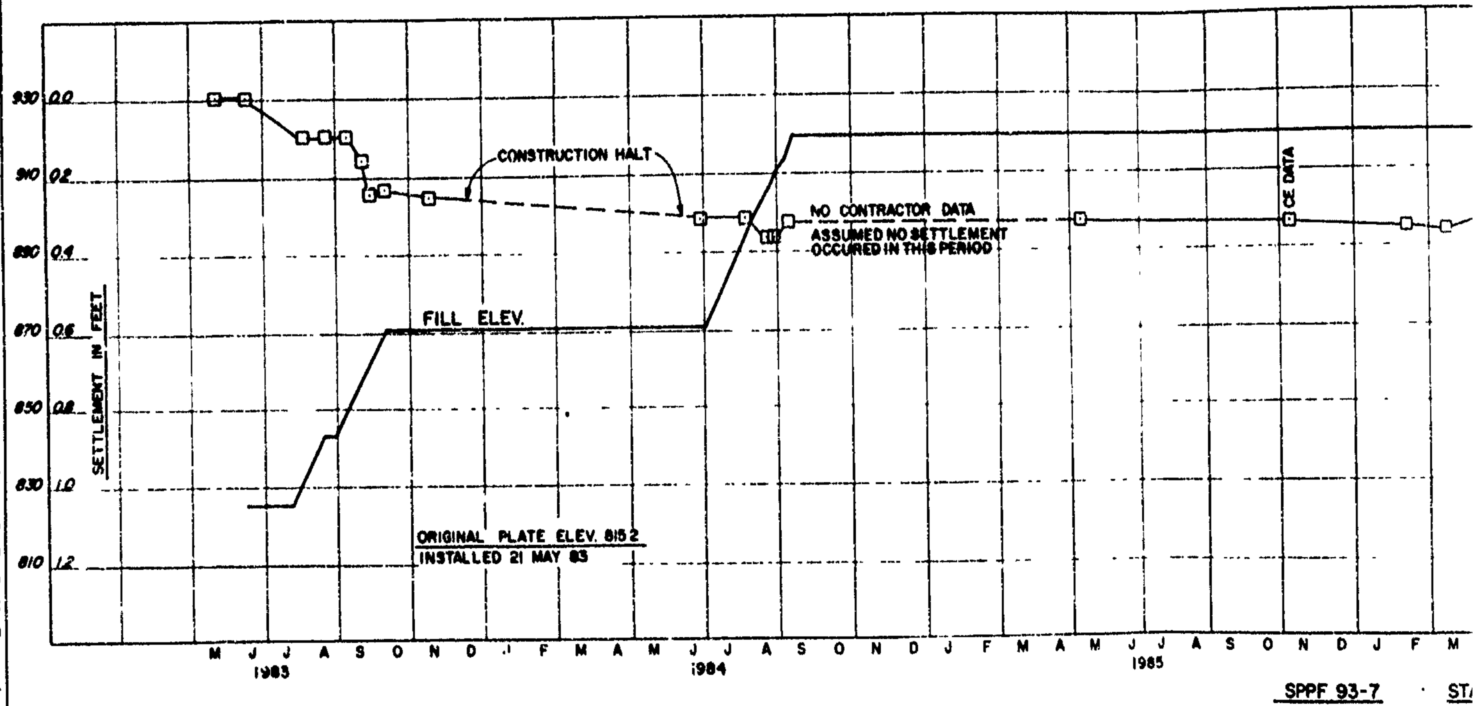
PLATE NO. 96

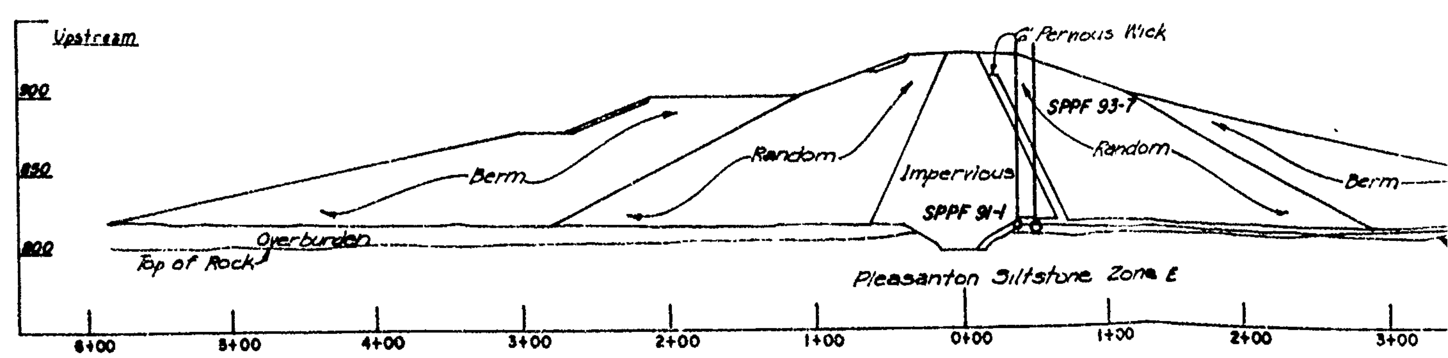
5 4 3

D C B A

ELEVATION IN FEET BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929

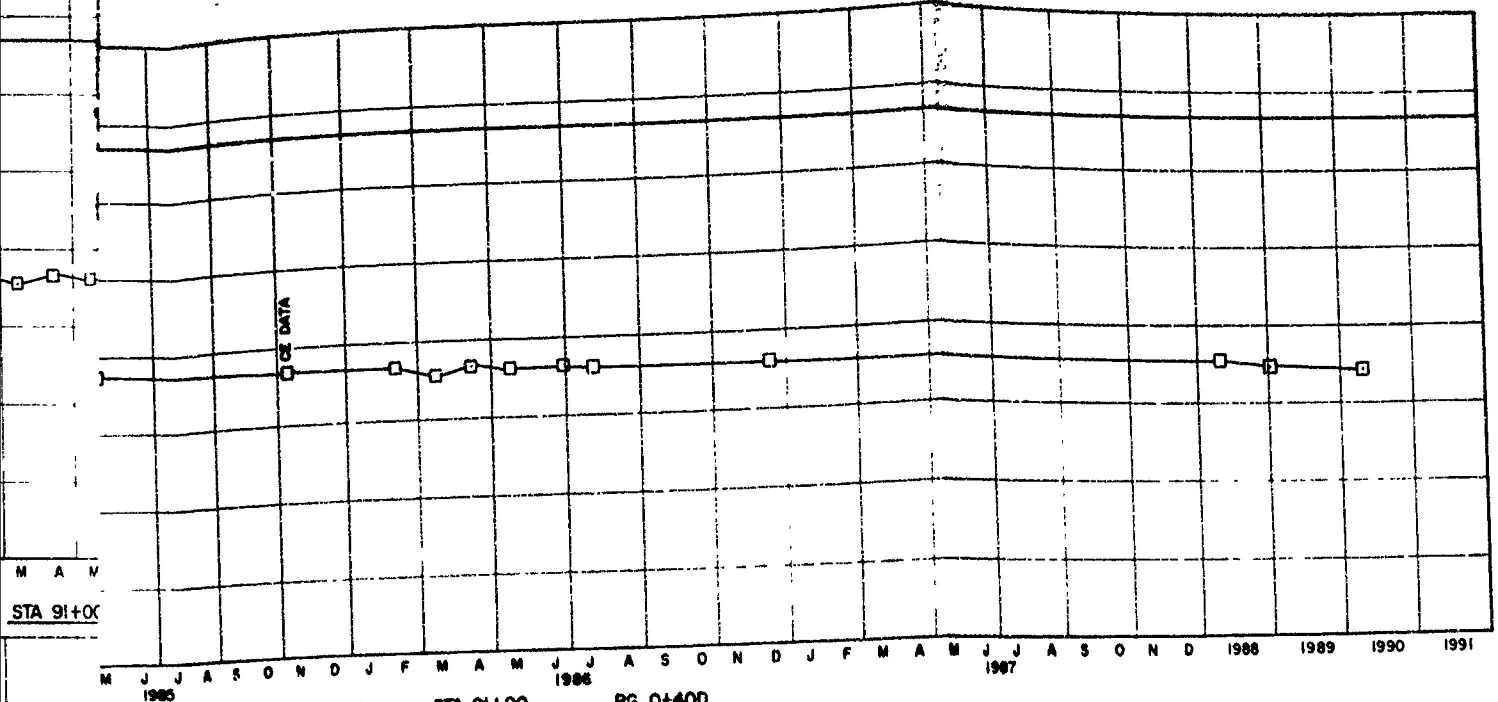




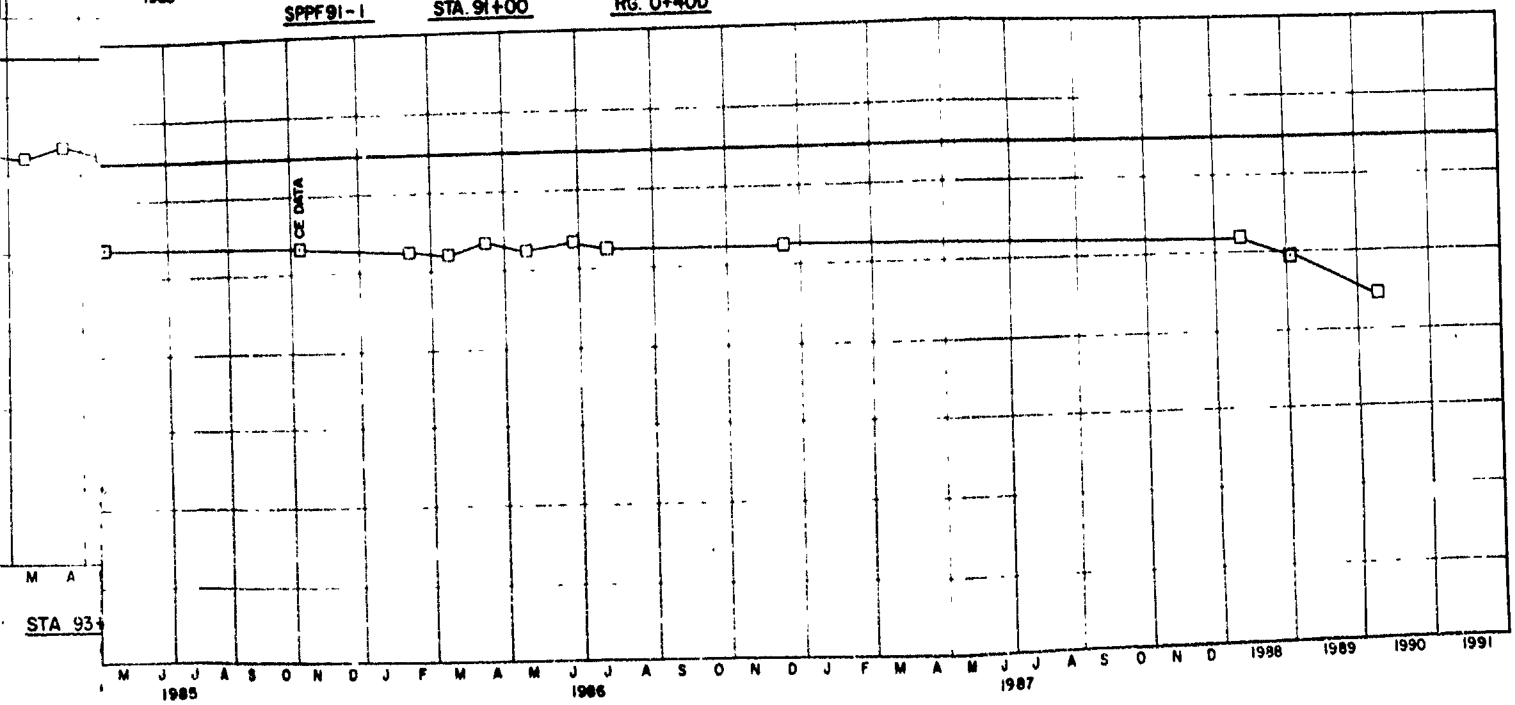


5 4 3

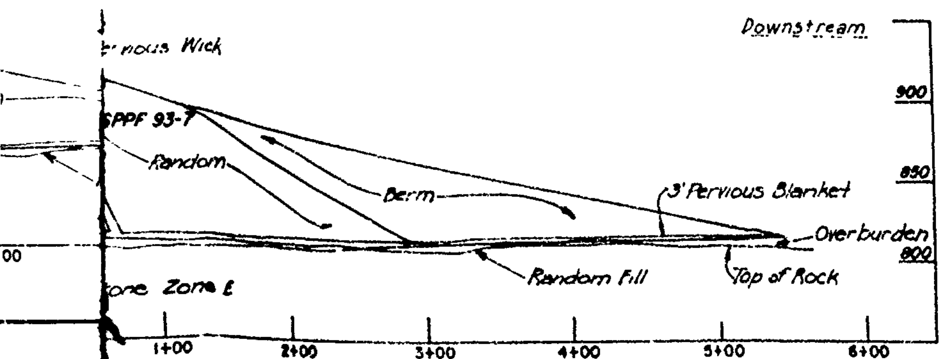
3 2 1



SPPF91-1 STA. 91+00 RG. 0+400



SPPF 93-7 STA. 93+00 RG. 0+500



Revisions			
Symbol	Descriptions	Date	Approved
	Revised March 1990		

U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA AND
PERFORMANCE REPORT

SETTLEMENT PLATE DATA PLOTS
SPPF 91-1 AND SPPF 93-7

Designed by: RGD
Drawn by: SEY
Checked by: RLA
Submitted by: WBE
Scale: AS SHOWN
Date: DECEMBER 1986
Sheet number:
Dwg. No.
File No. RBL-3-1573

PLATE NO. 97

3 2 1

5 4 3

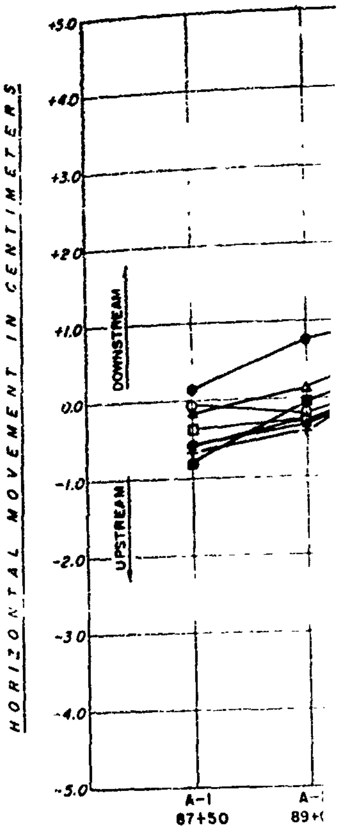
D

LEGEND

ORIGINAL MEANED SURVEY — —
3 SEPT 87 — ○
7 JAN. 88 — □
13 APR 88 — ○
11 JAN 89 — △
9 AUG. 89 — ●
23 APR. 90 — ▲
17 MAY 90 — ■
1 JUN 90 — +

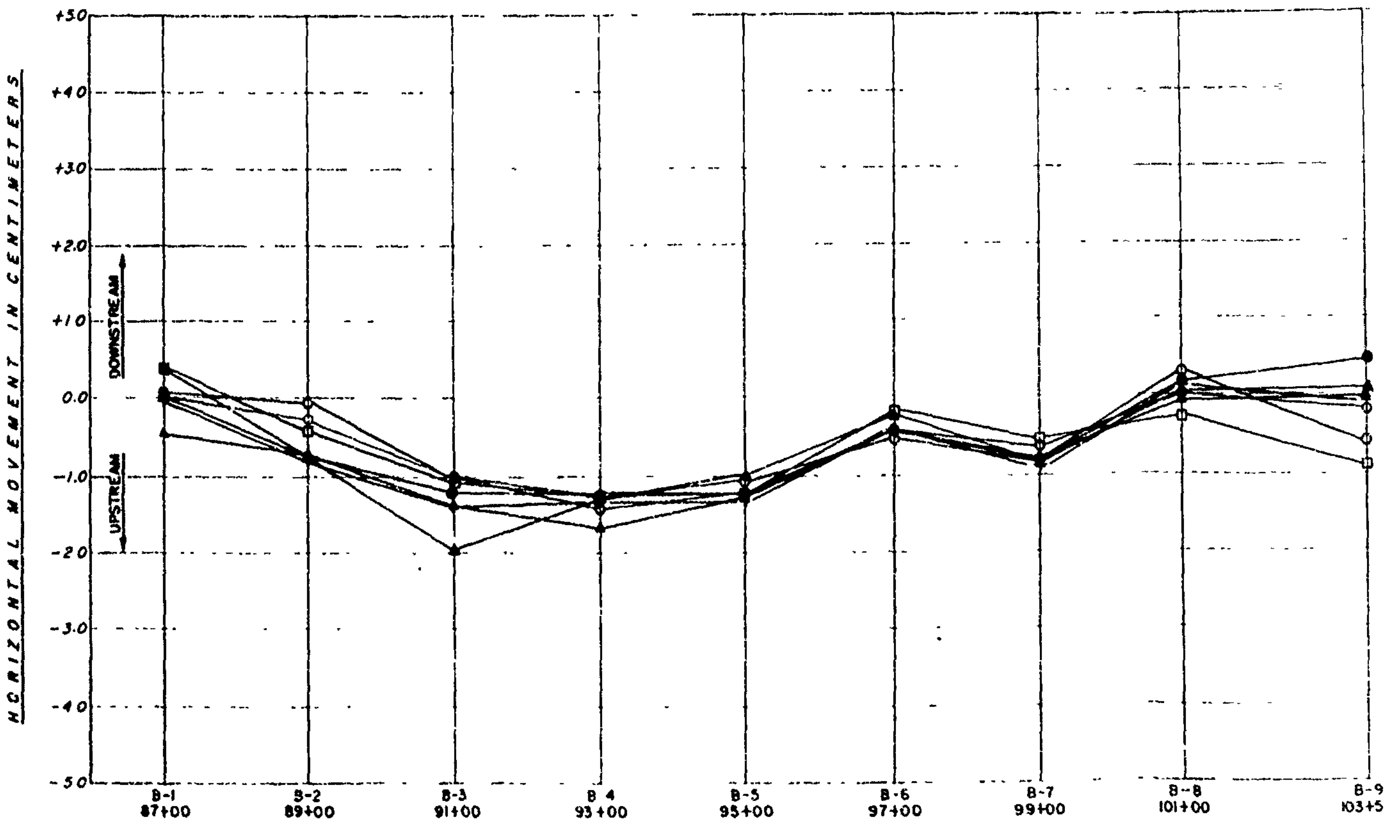
ORIGINAL MEANED SURVEY DATES

LINE "A"	LINE "B"
[illegible] JULY 1985	30 AUG 1985
30 AUG 1985	30 SEPT 1985[3]
30 SEPT 1985[1]	30 SEPT 1985[4]



C

B

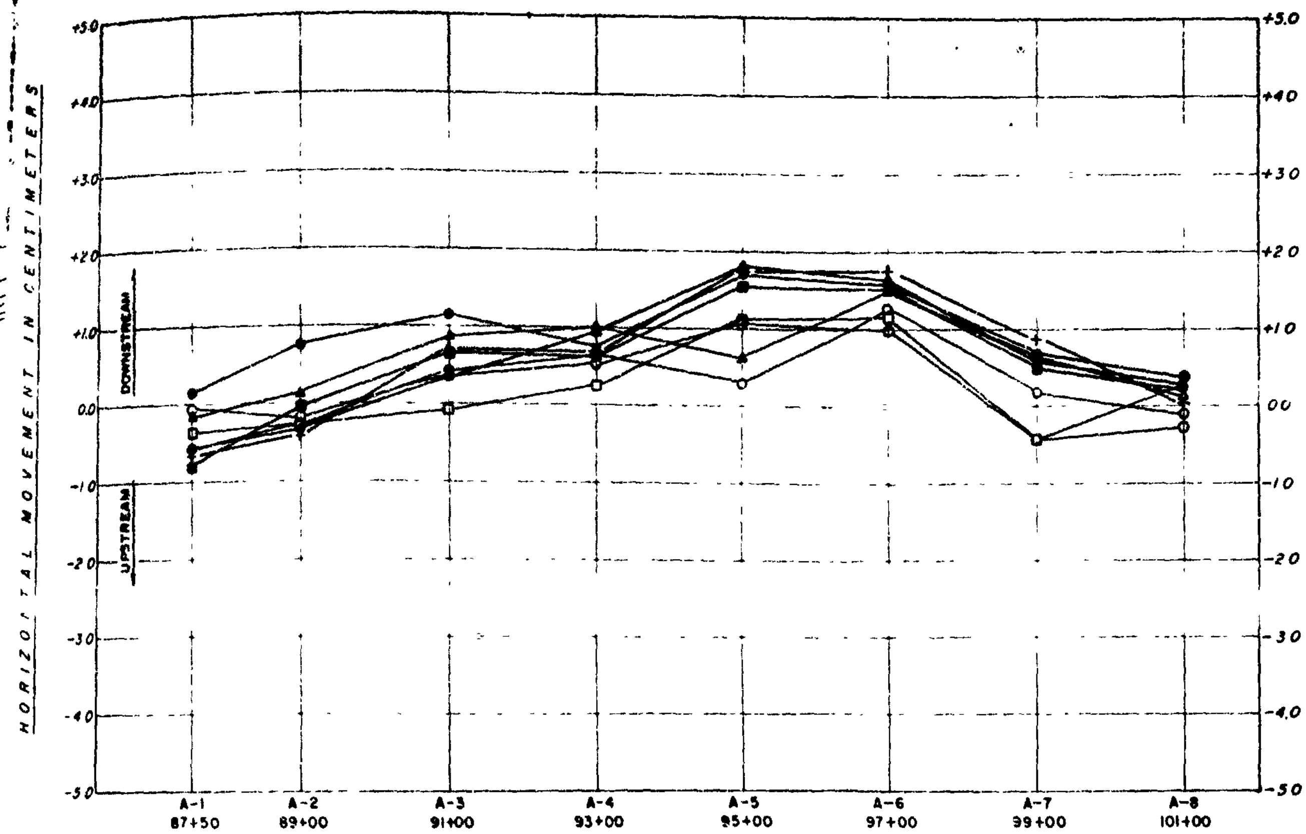


A

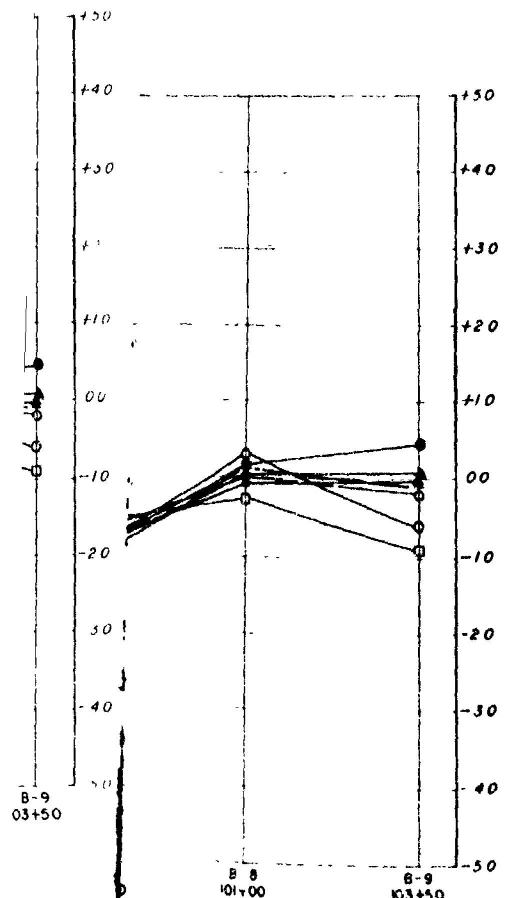
ALIGNMENT LINE "B" MONUMENTS

RANGE 1+70 UPSTREAM

5



ALIGNMENT LINE "A" MONUMENTS
RANGE 2+00 DOWNSTREAM



Symbol	Descriptions	Date	Approved
	Revised March 1990		

U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

US Army Corps of Engineers

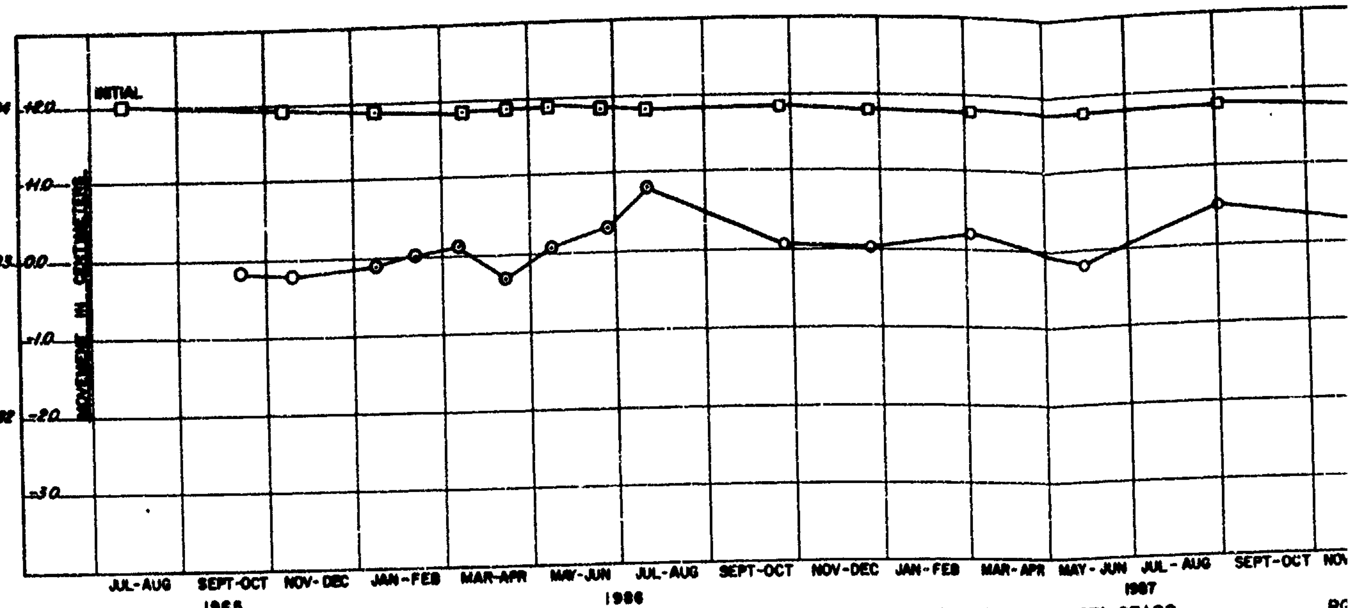
LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA AND PERFORMANCE REPORT

ALIGNMENT MONUMENT HORIZONTAL PROFILE
ORIGINAL SURVEY BASE LINES
LINES "A" AND "B" SUMMARY

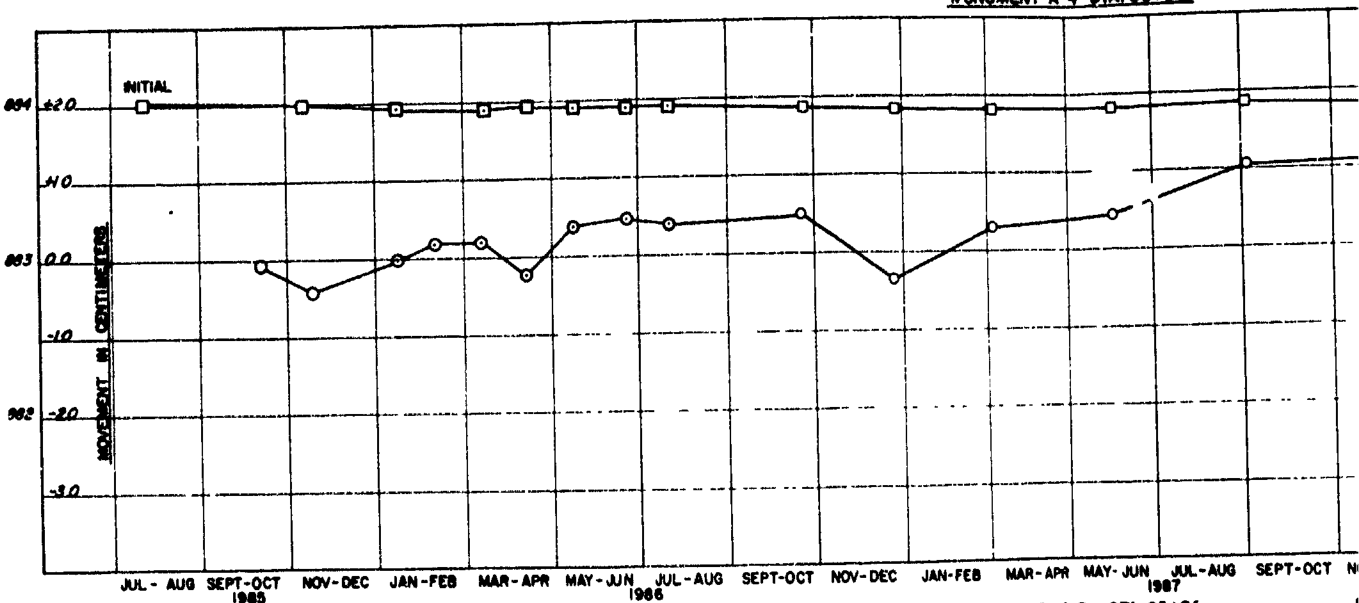
Designed by	RGD
Drawn by	RDT
Checked by	RLA
Submitted by	WBE
Scale	AS SHOWN
Date	
Dwg No	4 of 4
Sheet number	
File No	RBL-3-1574

PLATE NO. 98

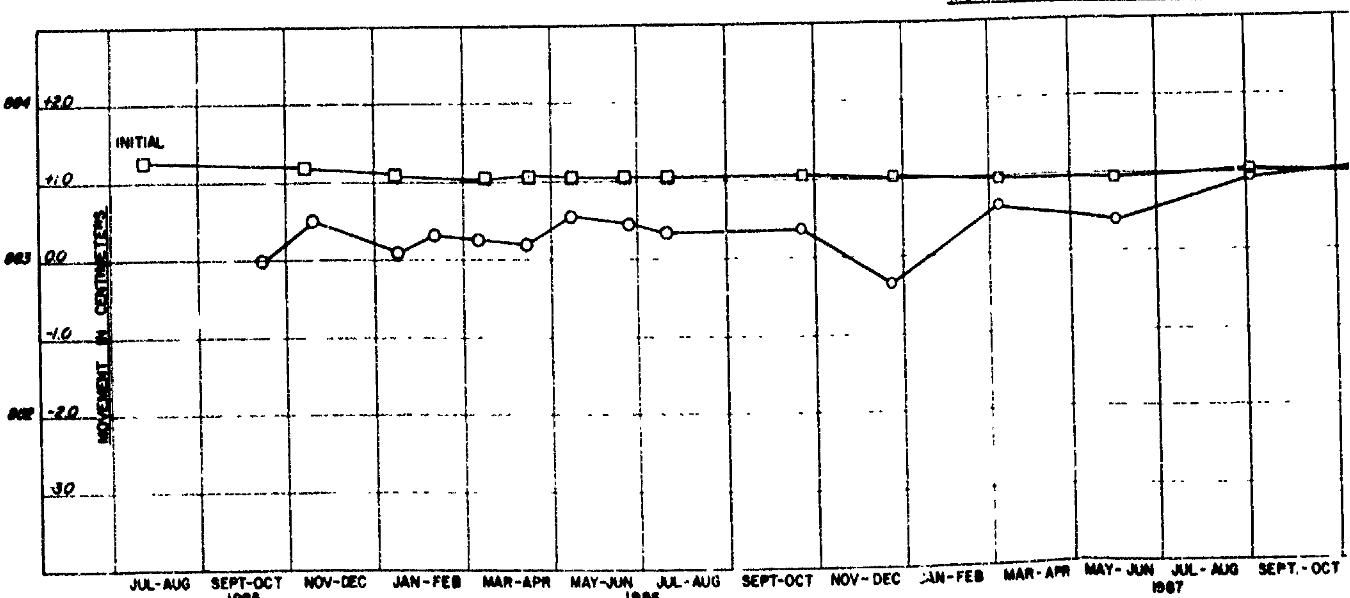
ELEVATION IN FEET BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929



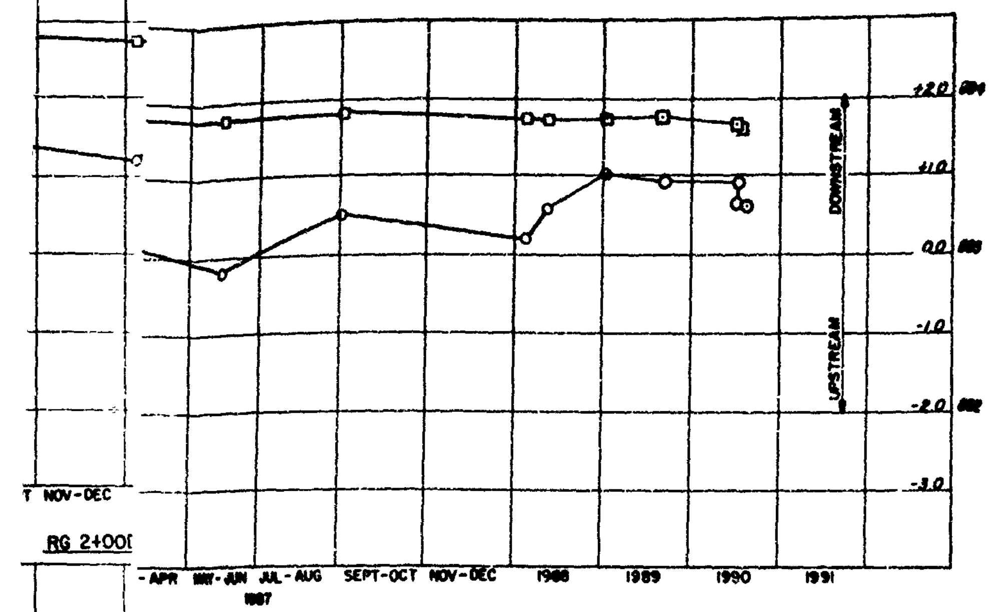
MONUMENT A-4 STA. 93+00



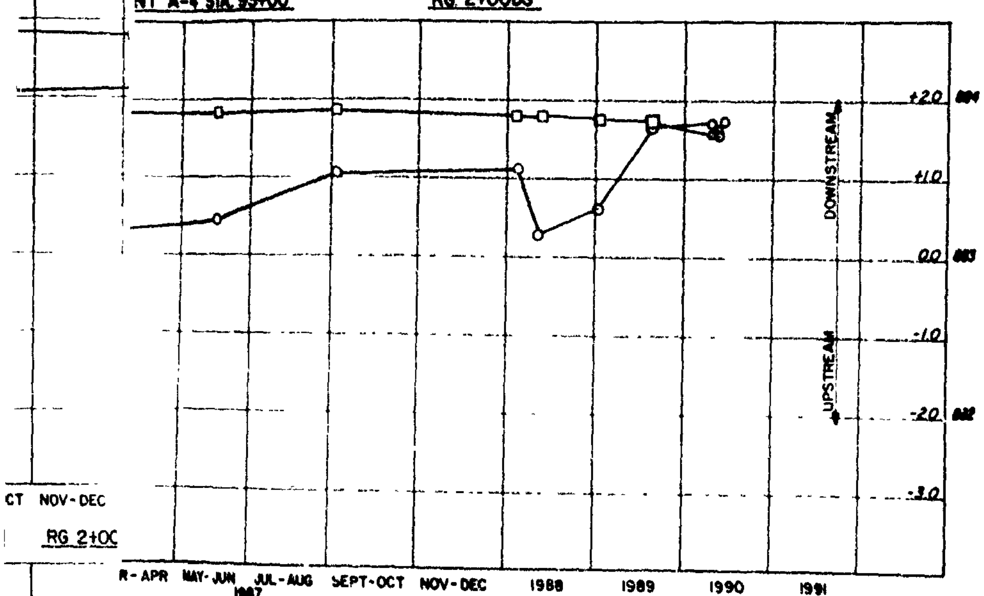
MONUMENT A-5 STA. 95+00



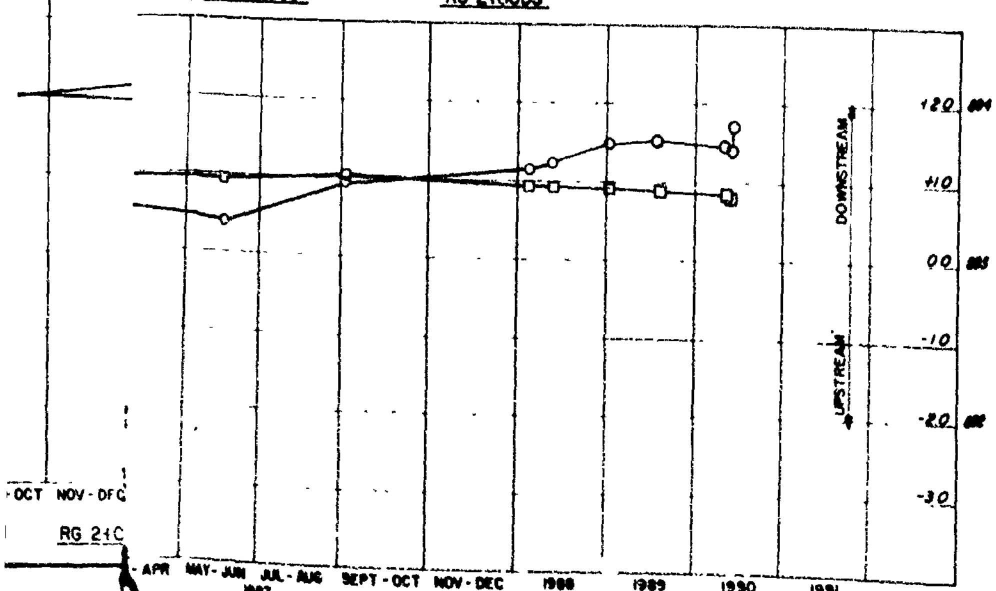
MONUMENT A-6 STA. 97+00



NT A-4 STA 93+00 RG 2+00DS



NT A-5 STA 95+00 RG 2+00DS



NT A-6 STA 97+00 RG 2+00DS

LEGEND

VERTICAL MOVEMENT ------ □

HORIZONTAL MOVEMENT ----- ○

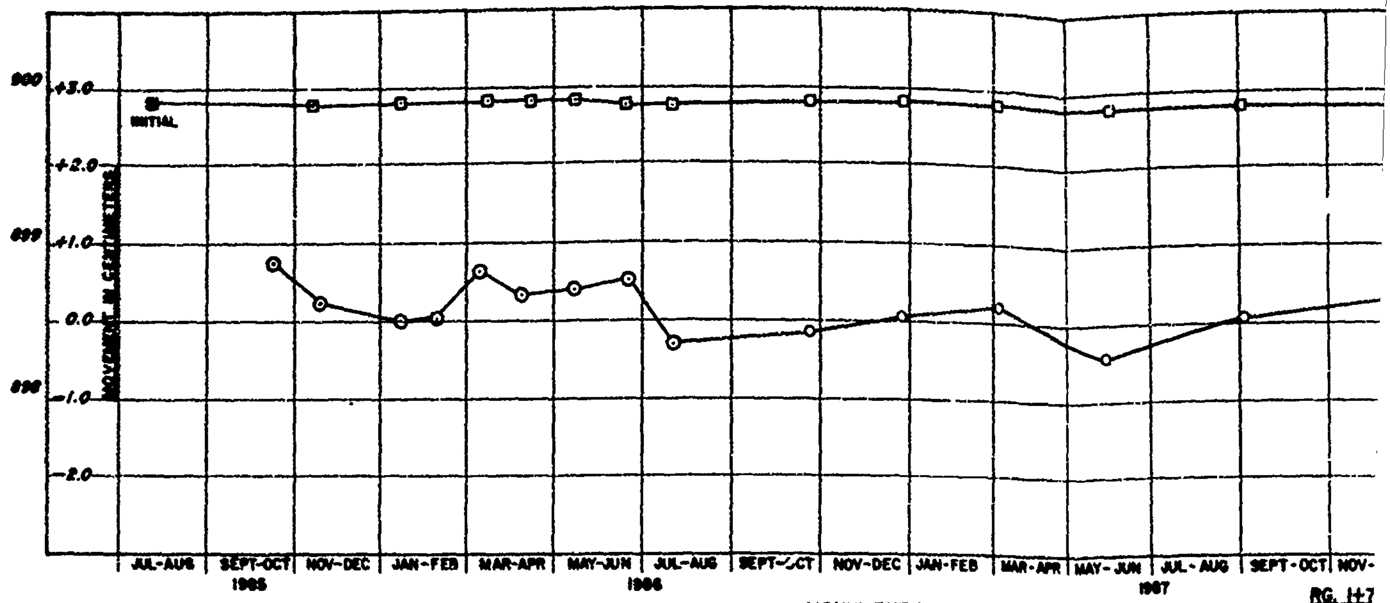
Revisions			
Symbol	Descriptions	Date	Approved
	Revised March 1990		

U. S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

Designed by: RGD	LITTLE BLUE RIVER, MISSOURI LONGVIEW LAKE EMBANKMENT CRITERIA AND PERFORMANCE REPORT
Drawn by: SEY	ALIGNMENT MONUMENTS HORIZONTAL AND VERTICAL DATA PLOTS MONUMENTS A-4, A-5 AND A-6.
Checked by: RLA	Scale: AS SHOWN — Sheet number
Submitted by: WBE	Date: DECEMBER 1986 — Dwg No — File No RBL-3-1575

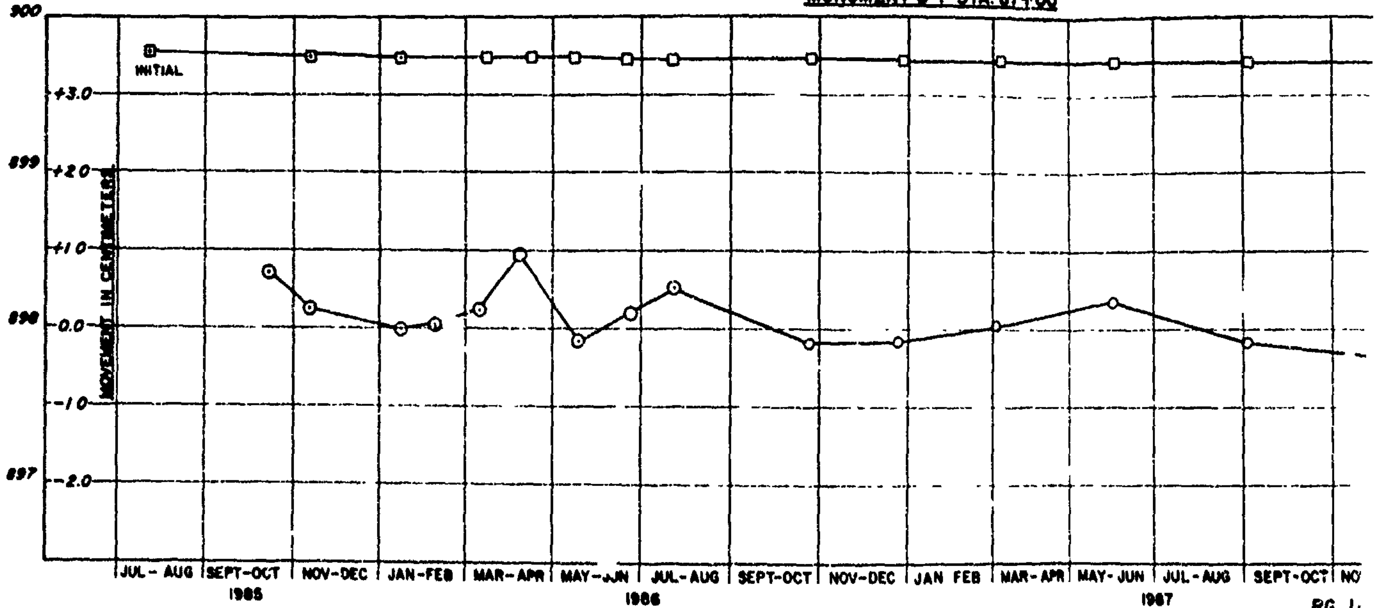
PLATE NO. 99

ELEVATION IN FEET BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929



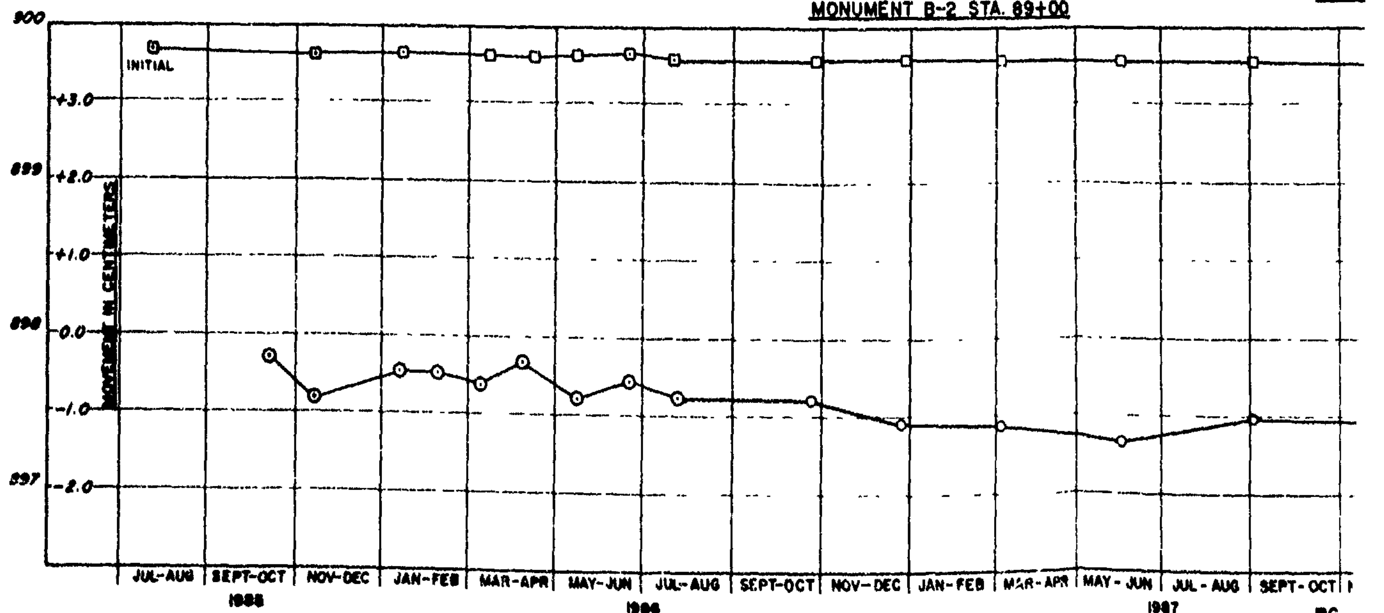
MONUMENT B-1 STA. 87+00

RG. I+7



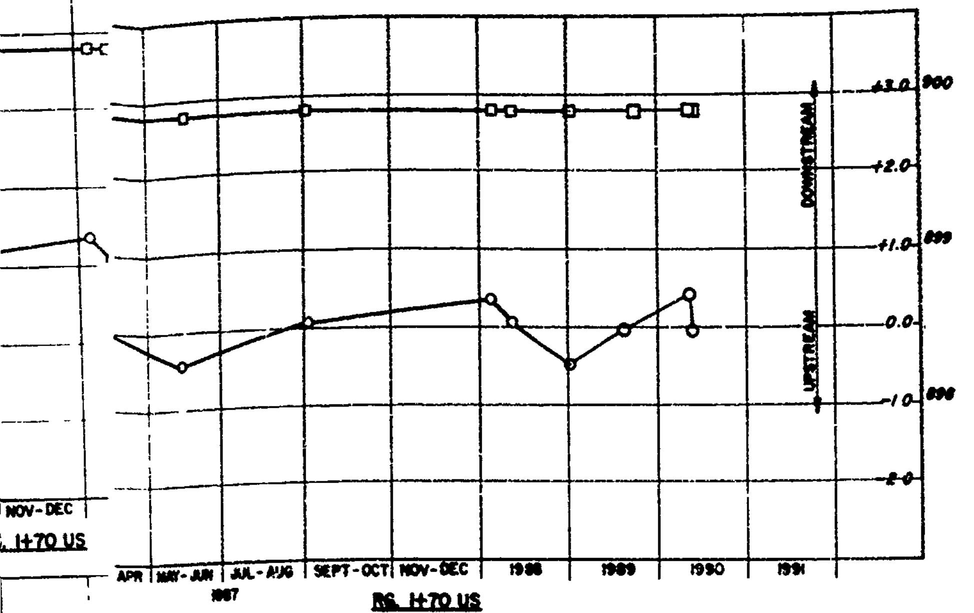
MONUMENT B-2 STA. 89+00

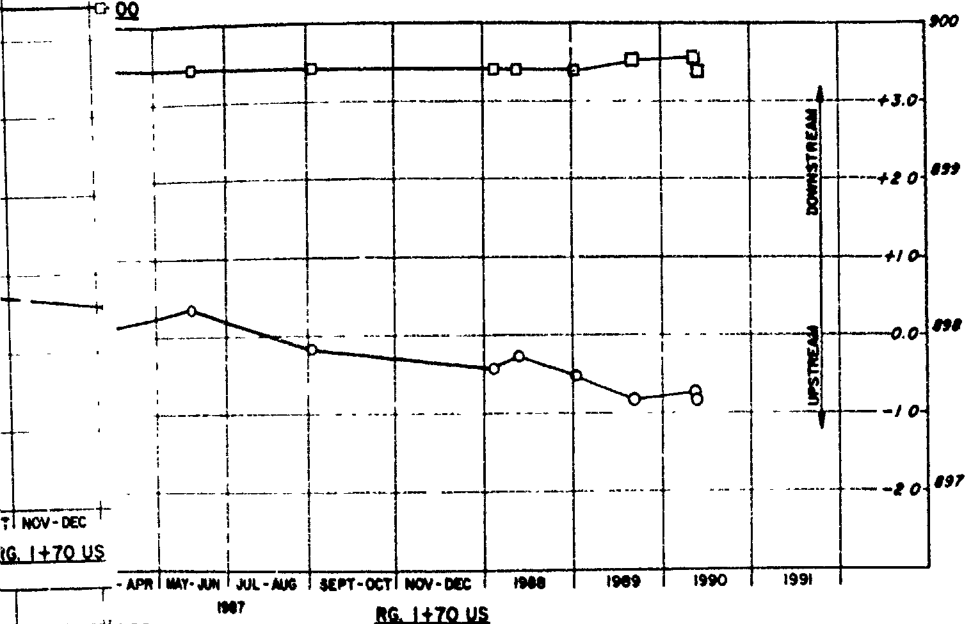
RG. I-

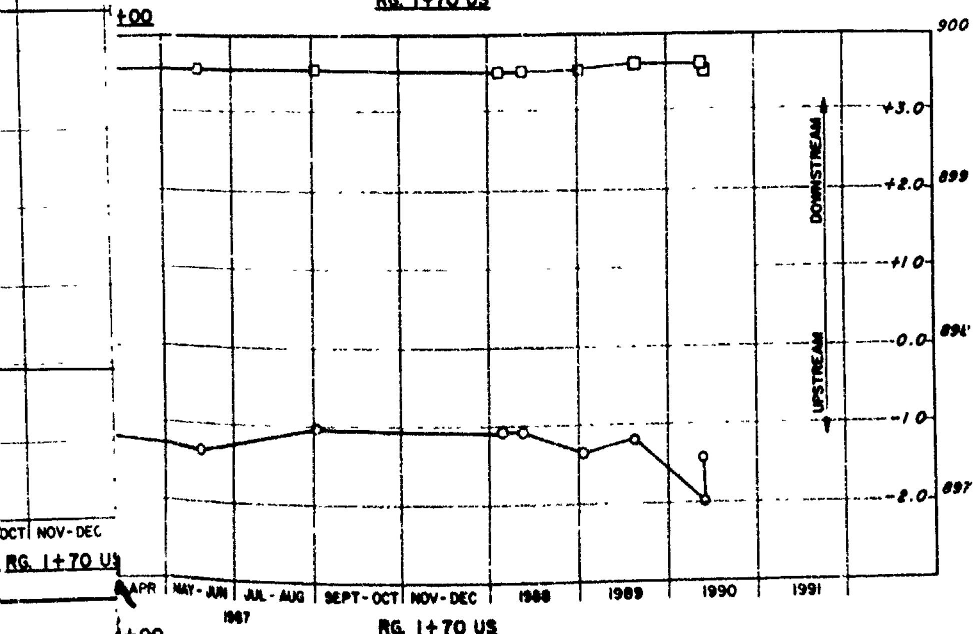


MONUMENT B-3 STA. 91+00

RG.







LEGEND

VERTICAL MOVEMENT ———— □

HORIZONTAL MOVEMENT ———— ○

Revisions			
Symbol	Descriptions	Date	Approved
	Revised March 1990		

U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

Designed by: R G D

Drawn by: E D P

Checked by: R L A

Submitted by: W B E

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA AND PERFORMANCE REPORT
ALIGNMENT MONUMENTS
HORIZONTAL AND VERTICAL DATA PLOTS
MONUMENTS B-1, B-2 AND B-3

Scale: AS SHOWN

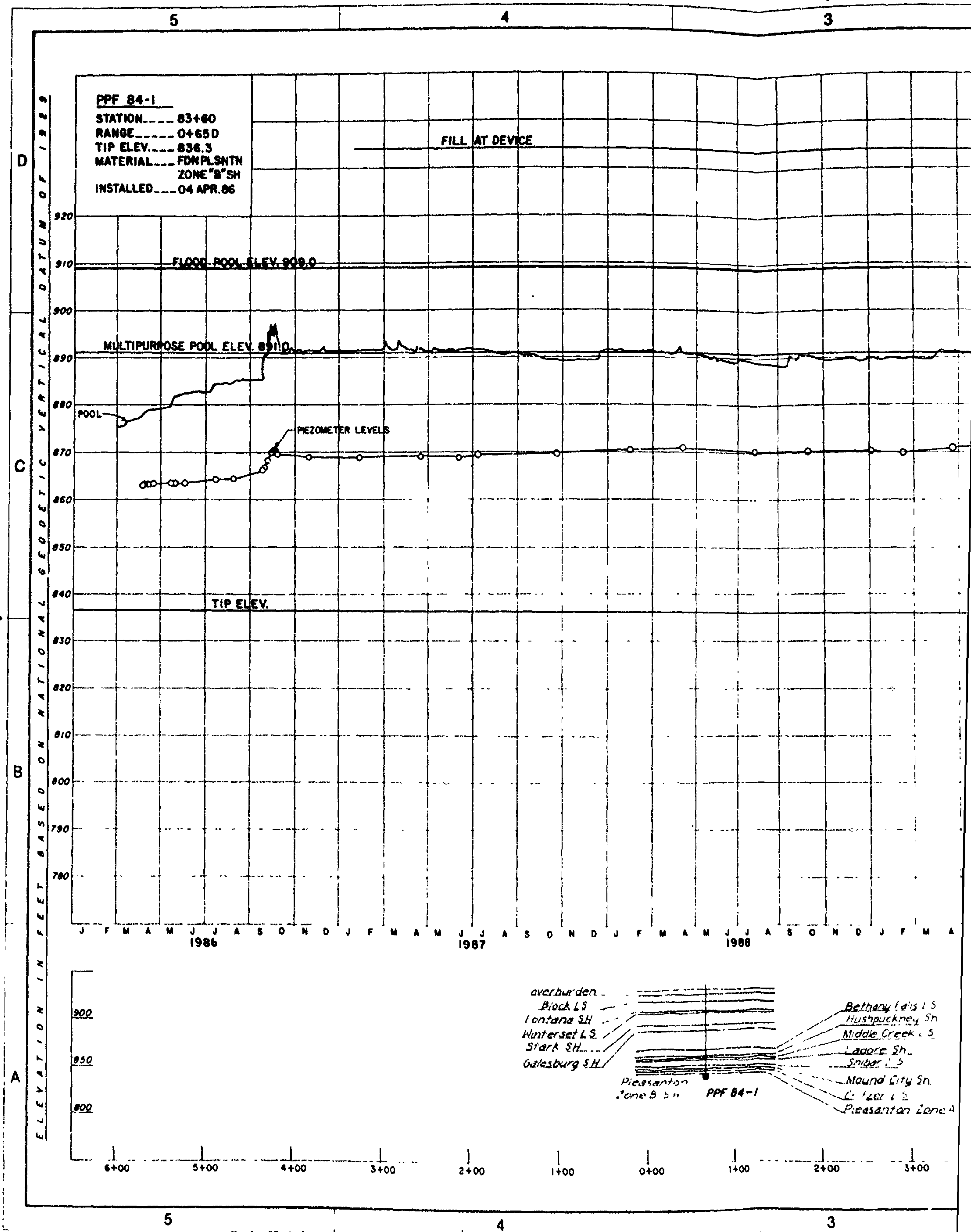
Date: DECEMBER 1986

Dwg No

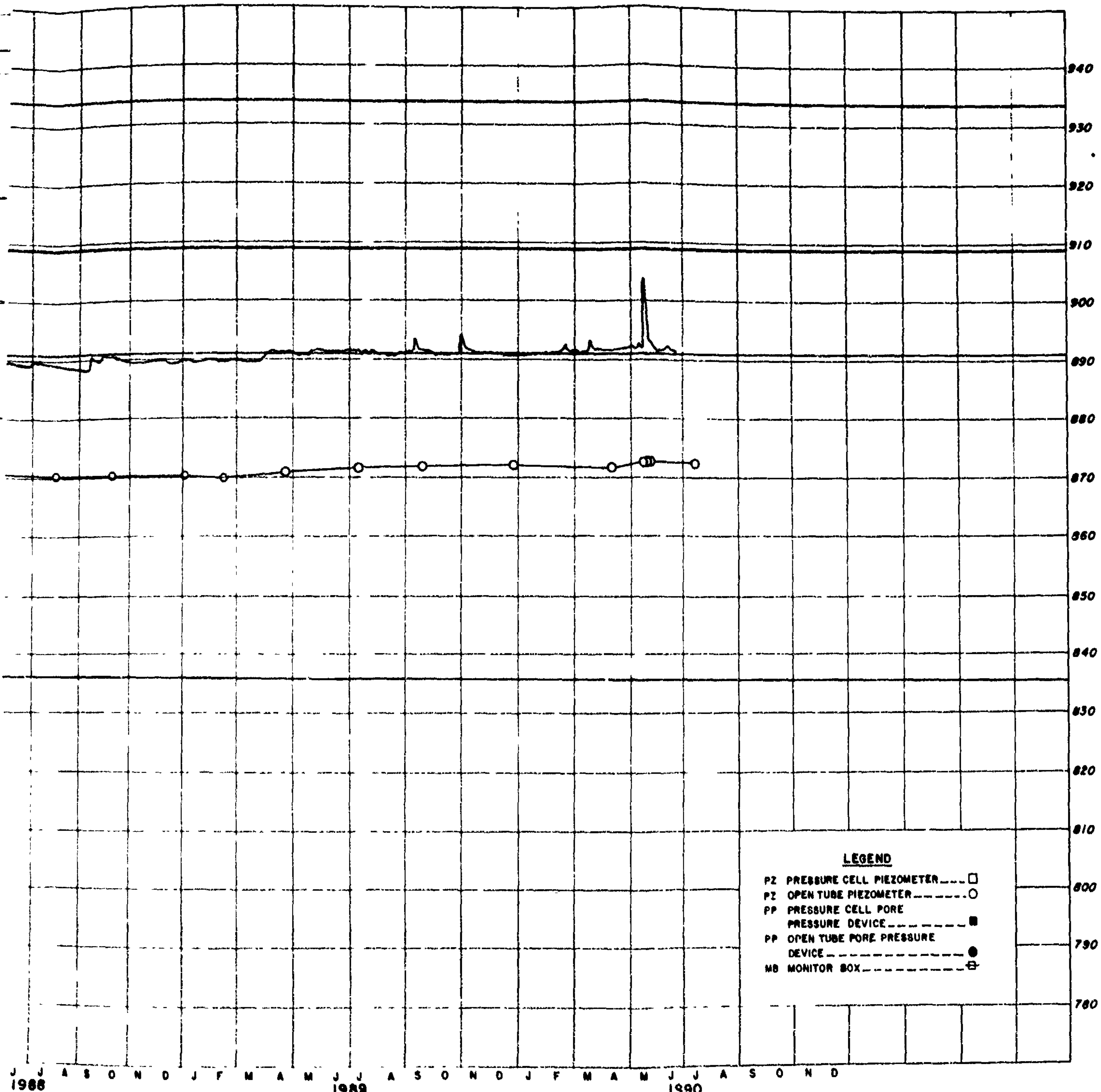
Sheet number

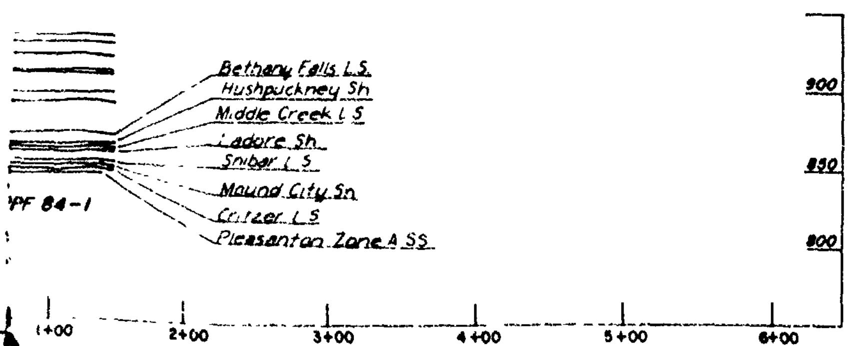
File No. RBL-3-1576

PLATE NO. 100



PPF 84-1
STATION.... 83+60
RANGE...... 0+65D
TIP ELEV..... 836.3
MATERIAL.... FDNPLSNTN ZONE"B"SH
INSTALLED.... 04 APR.86
FILL AT DEVICE
FLOOD POOL ELEV. 909.0
MULTIPURPOSE POOL ELEV. 891.0
POOL
PIEZOMETER LEVELS
TIP ELEV.
ELEVATION IN FEET BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929
920
910
900
890
880
870
860
850
840
830
820
810
800
790
780
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A
1986
1987
1988
900
850
800
overburden
Block LS
Fontana SH
Winterset LS
Stark SH
Galesburg SH
Pleasanton Zone B Sh
PPF 84-1
Bethany Falls LS
Hushpuckney Sh
Middle Creek LS
Ladore Sh
Sniboa LS
Mound City Sh
Pleasanton Zone A
6+00
5+00
4+00
3+00
2+00
1+00
0+00
1+00
2+00
3+00
5
4
3
D
C
B
A





Symbol	Revisions Descriptions	Date	Approved
	Revised March 1990		

U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

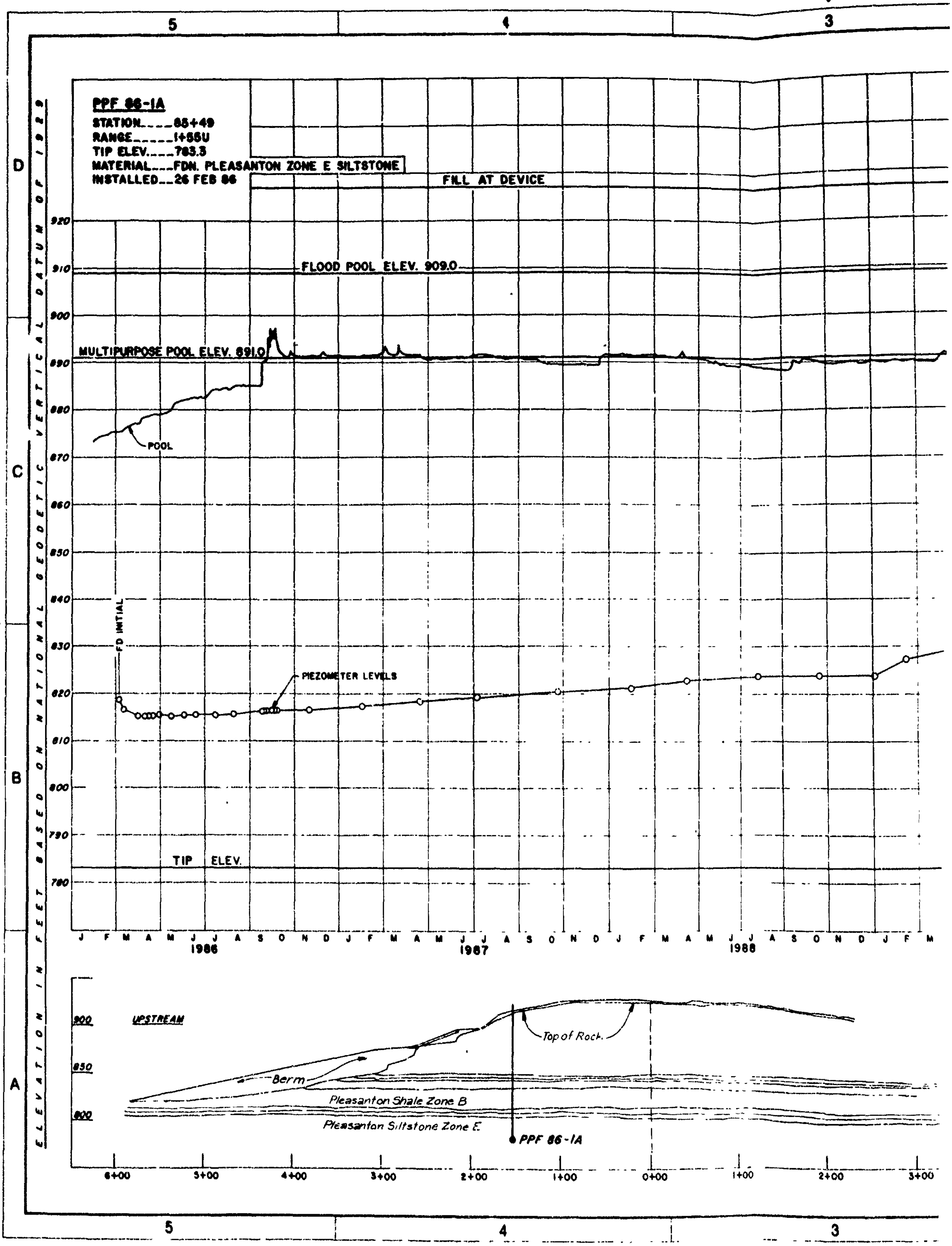
US Army Corps of Engineers

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA AND PERFORMANCE REPORT

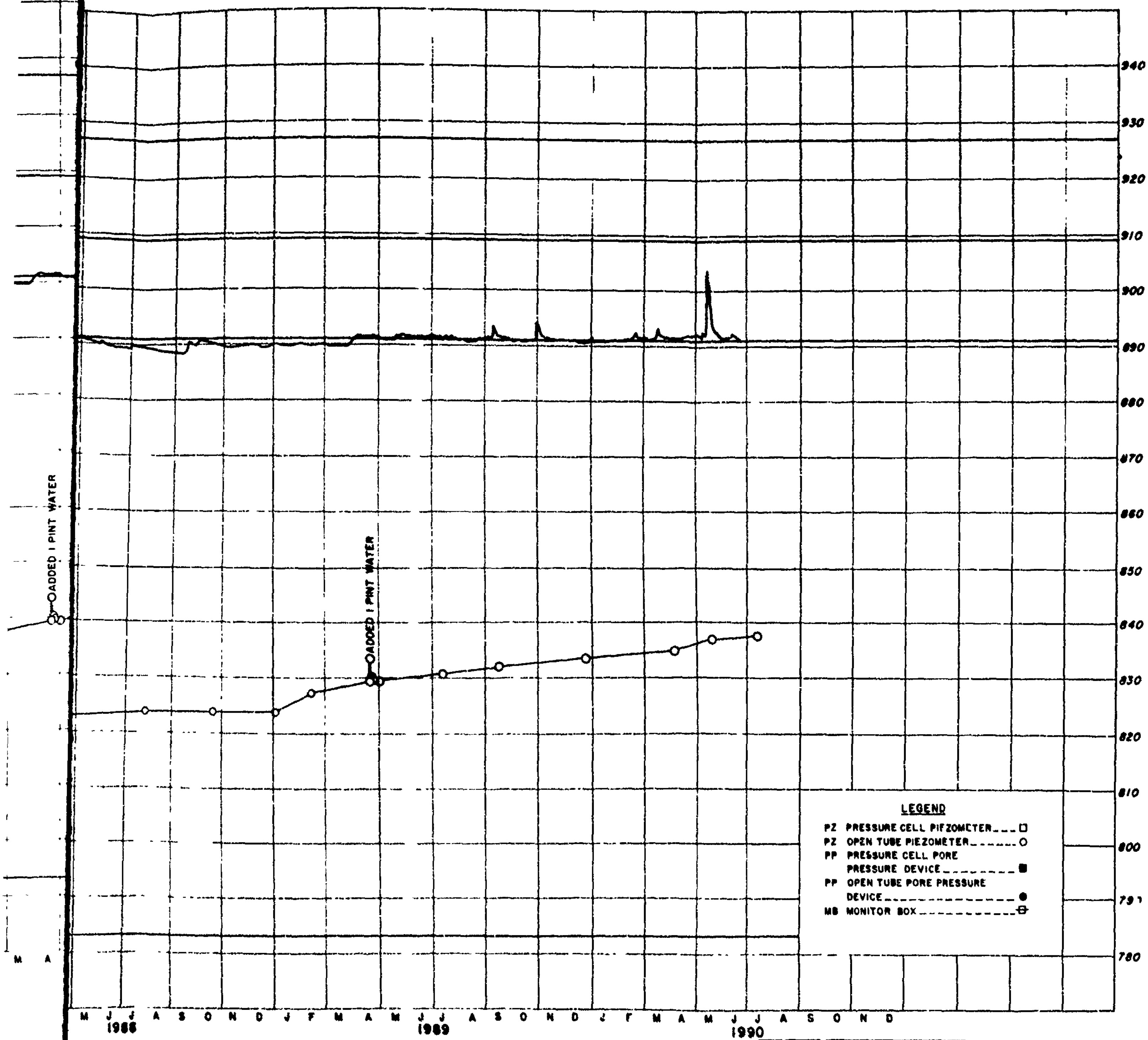
PIEZOMETER PLOTS
OPEN TUBE PZ
PPF 84-1

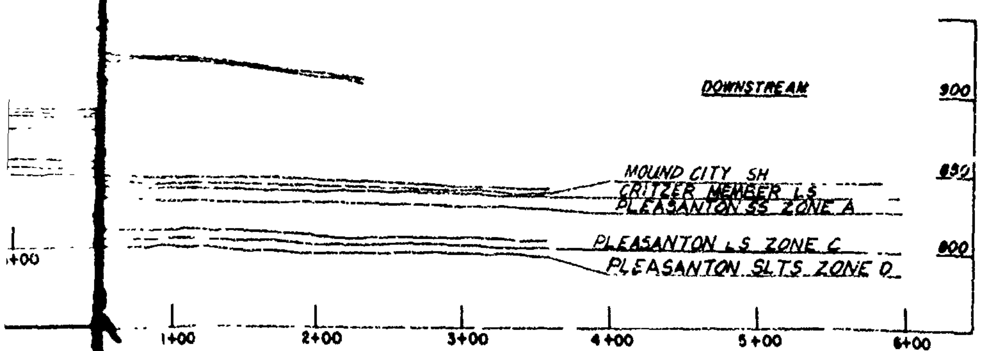
Designed by	RGD
Drawn by	PST
Checked by	RLA
Submitted by	WBE
Scale	AS SHOWN
Date	DECEMBER 1986
Dwg No	
Sheet number	
File No	RBL-3-1577

PLATE NO. 101



PPF 86-1A
STATION.....85+49
RANGE......1+55U
TIP ELEV.....783.3
MATERIAL....FDN. PLEASANTON ZONE E SILTSTONE
INSTALLED...26 FEB 86
FILL AT DEVICE
FLOOD POOL ELEV. 909.0
MULTIPURPOSE POOL ELEV. 891.0
POOL
FD INITIAL
PIEZOMETER LEVELS
TIP ELEV.
ELEVATION IN FEET BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929
920
910
900
890
880
870
860
850
840
830
820
810
800
790
780
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M
1986
1987
1988
UPSTREAM
900
850
800
Top of Rock
Berm
Pleasanton Shale Zone B
Pleasanton Siltstone Zone E
PPF 86-1A
6+00
5+00
4+00
3+00
2+00
1+00
0+00
1+00
2+00
3+00
5
4
3
D
C
B
A





Revisions			
Symbol	Descriptions	Date	Approved
	Revied March 1990		

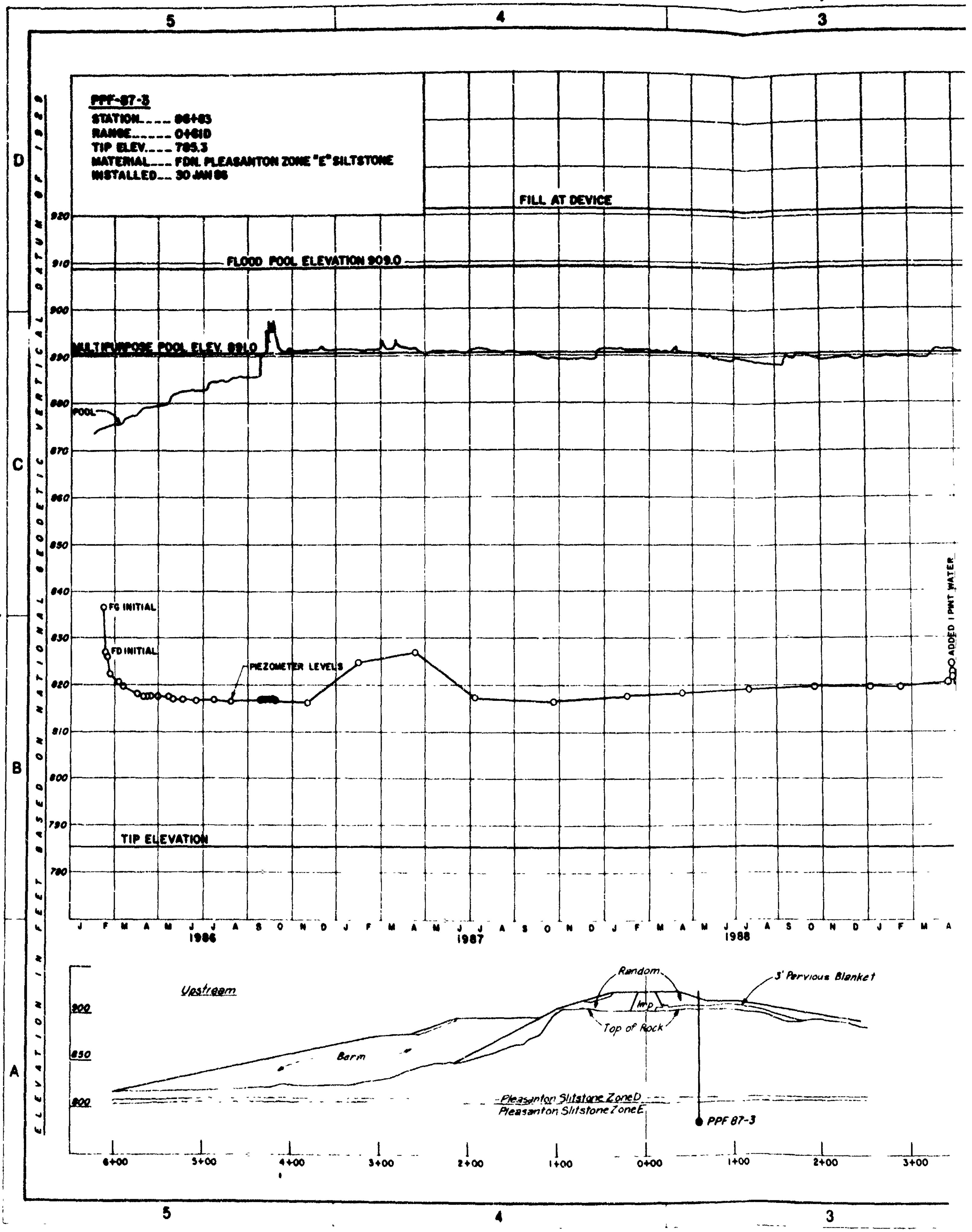
U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA AND PERFORMANCE REPORT

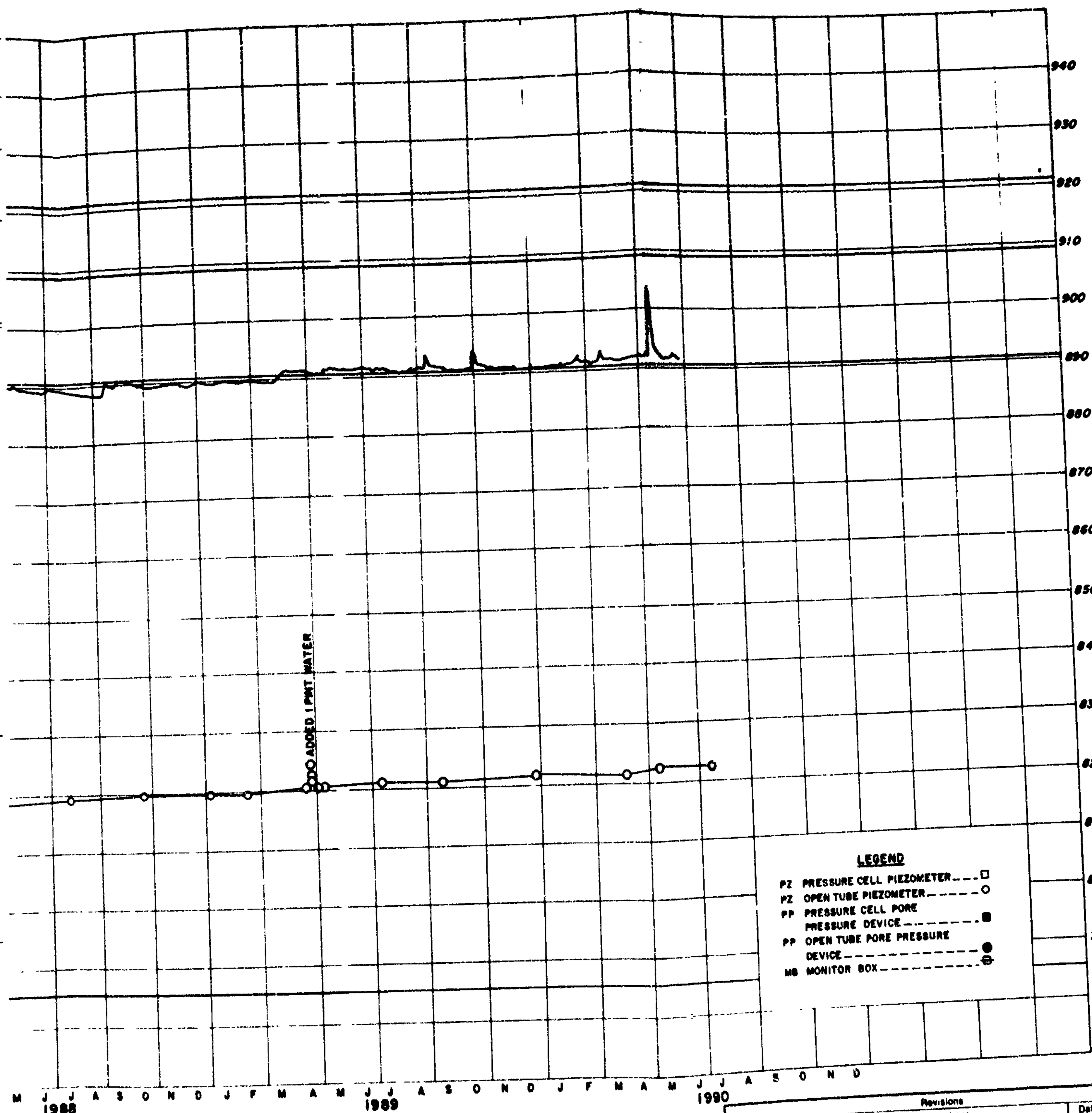
PIEZOMETER PLOTS
OPEN TUBE PZ
PPF 86-1A

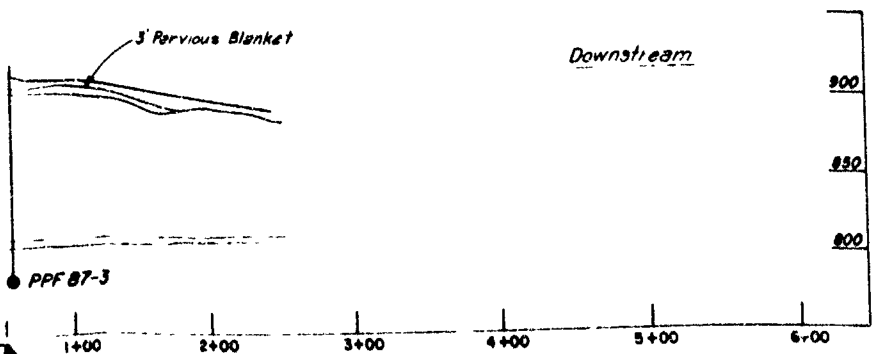
Designed by	K. C. D.
Drawn by	PST
Checked by	RLA
Submitted by	WBE
Scale	AS SHOWN
Date	DECEMBER 1986
File No	RBL-3-1578

PLATE NO. 102



PPF-87-3
STATION...... 86+83
RANGE....... 0+61D
TIP ELEV..... 785.3
MATERIAL.... FDN. PLEASANTON ZONE "E" SILTSTONE
INSTALLED... 30 JAN 86
FILL AT DEVICE
FLOOD POOL ELEVATION 909.0
MULTIPURPOSE POOL ELEV. 891.0
POOL
FG INITIAL
FD INITIAL
PIEZOMETER LEVELS
ADDED 1 PINT WATER
TIP ELEVATION
ELEVATION IN FEET BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929
1986
1987
1988
Upstream
Random
3' Pervious Blanket
Imp
Top of Rock
Berm
Pleasanton Siltstone Zone D
Pleasanton Siltstone Zone E
PPF 87-3





Symbol	Revisions Descriptions	Date	Approved
	Revised March 1990		

U. S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

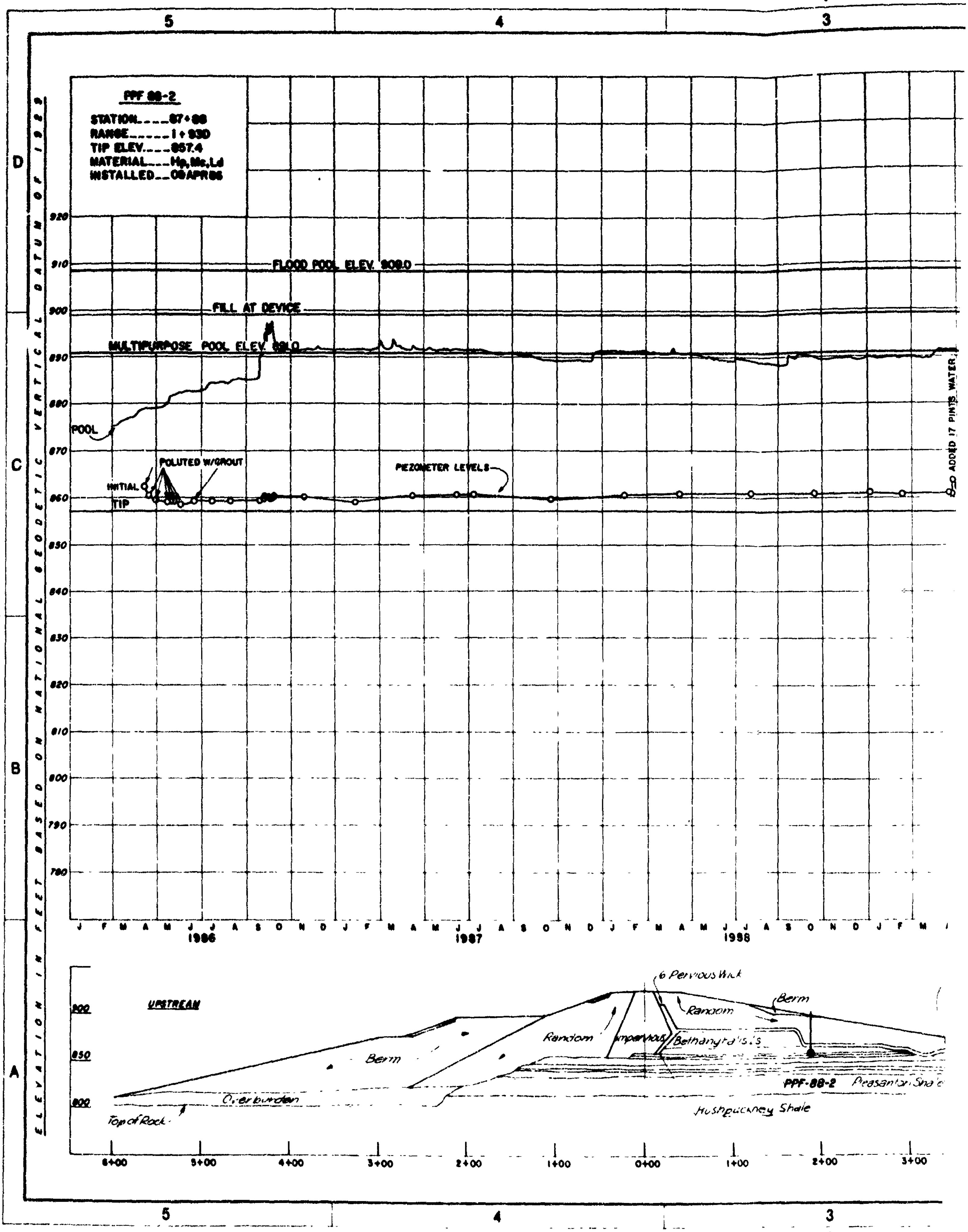
US Army Corps of Engineers

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA AND PERFORMANCE REPORT

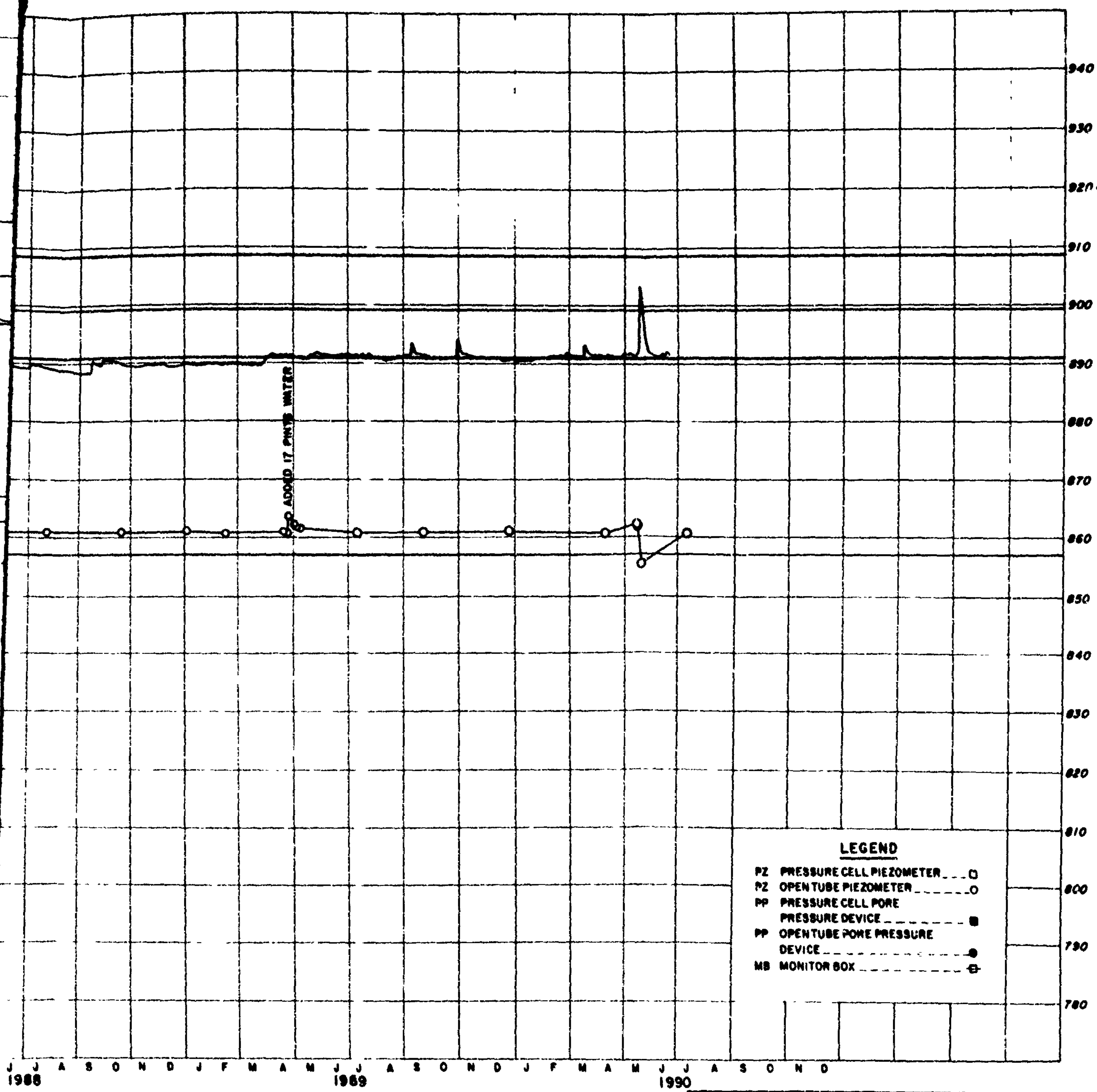
PIEZOMETER PLOTS
OPEN TUBE PZ
PPF 87-3

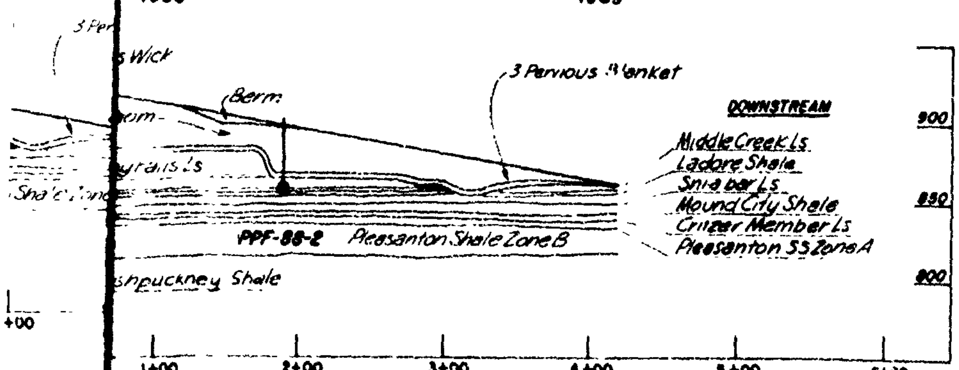
Designed by: NGD
Drawn by: PST
Checked by: RLA
Submitted by: WBE
Scale: AS SHOWN
Date: DECEMBER 1986
Sheet number:
Dwg. No.:
File No. RBL-3-1579

PLATE NO. 103



PPF 88-2
STATION.....87+88
RANGE.......1+930
TIP ELEV.....857.4
MATERIAL....Hp,Ms,Ld
INSTALLED...08APR86
ELEVATION IN FEET BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929
FLOOD POOL ELEV. 909.0
FILL AT DEVICE
MULTIPURPOSE POOL ELEV. 891.0
POOL
POLUTED W/GROUT
INITIAL
TIP
PIEZOMETER LEVELS
ADDED 17 PINTS WATER
1986
1987
1988
UPSTREAM
6 Pervious Wick
Berm
Random
Impervious
Bethany Falls LS
PPF-88-2
Pleasanton Shale
Overburden
Top of Rock
Hushpuckney Shale





Symbol	Revisions Descriptions	Date	Approved
	Revised March 1990		

U. S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA AND PERFORMANCE REPORT

PIEZOMETER PLOTS
OPEN TUBE PZ
PPF-88-2

Designed by: RGD
Drawn by: FDN
Checked by: RLA
Submitted by: WSE

Scale: AS SHOWN
Date: DECEMBER 1986
File No.: RBL-3-1580

PLATE NO. 104

VALUE

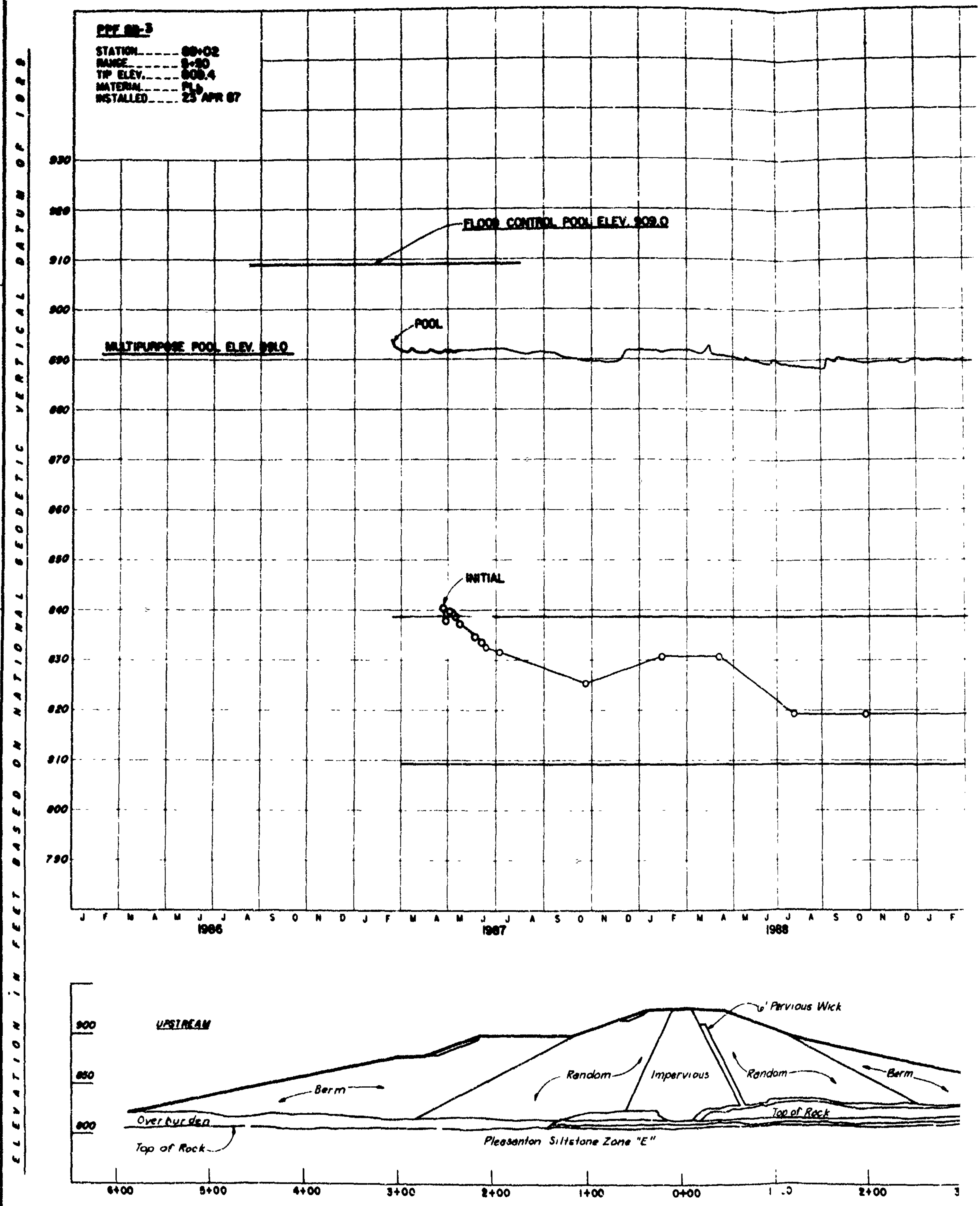
5 4 3

D

C

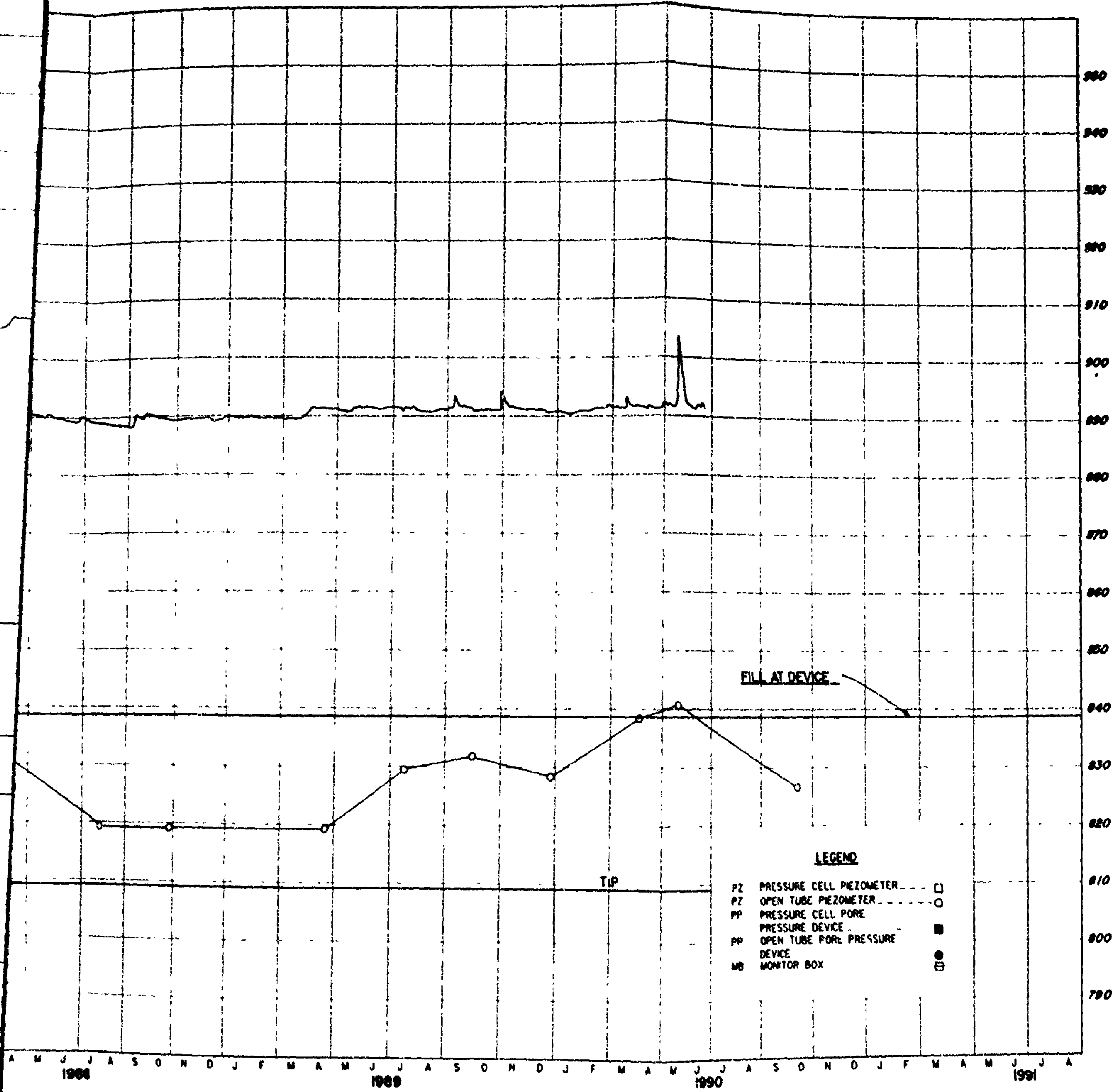
B

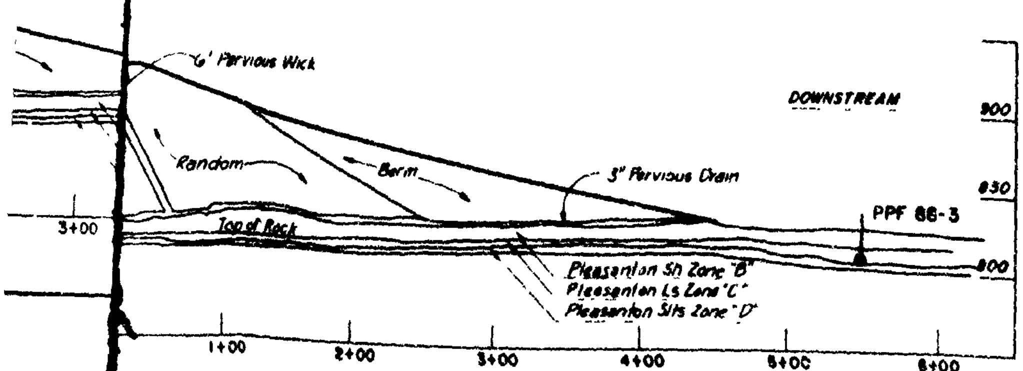
A



5 4 3

VALUE ENGINEERING PAYS





Revisions			
Symbol	Descriptions	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

Designed by: JPM
Drawn by: LJD
Checked by: RLA
Submitted by: JPM

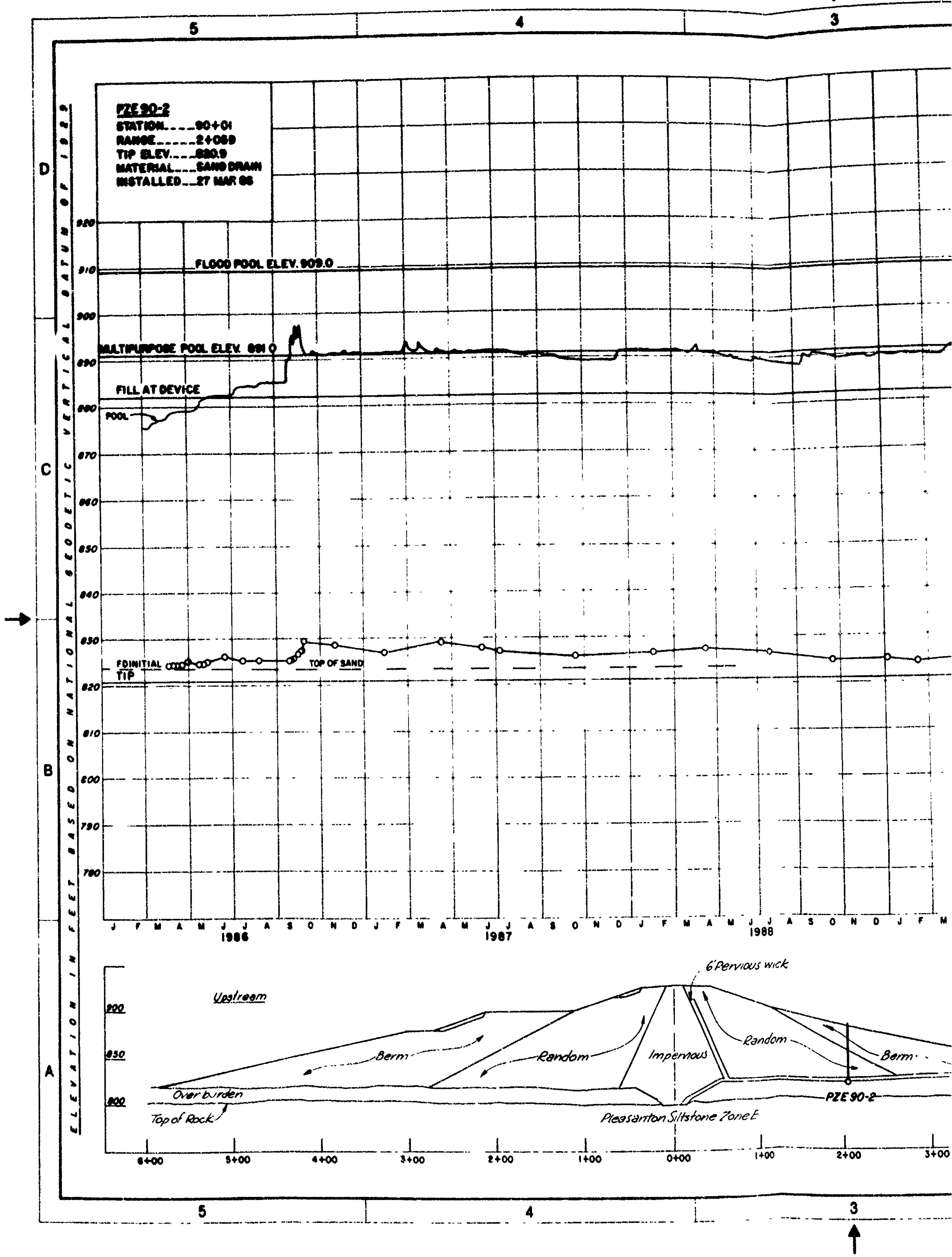
US Army Corps of Engineers

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA AND PERFORMANCE REPORT

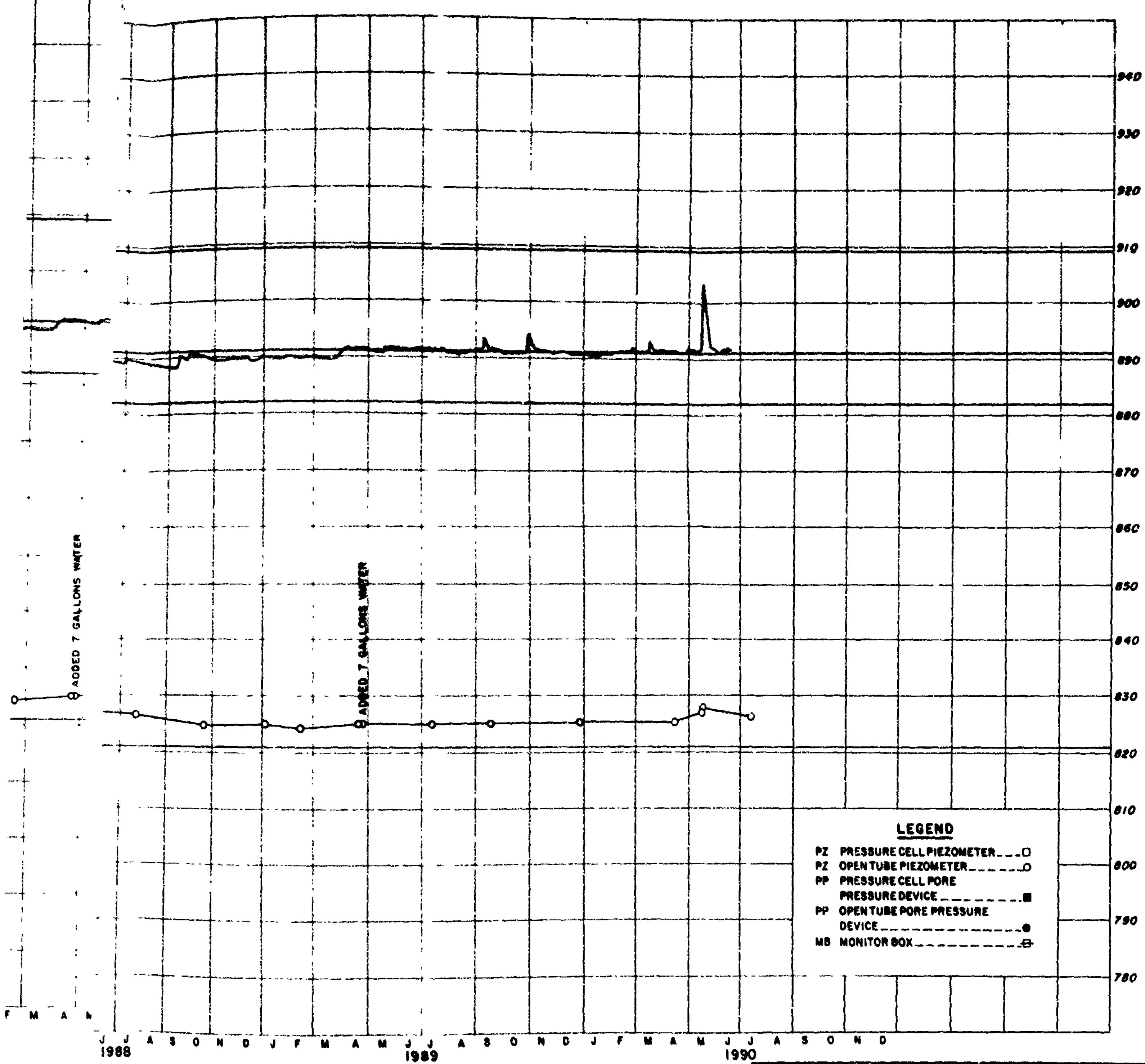
PIEZOMETER PLOTS
OPEN TUBE PZ
PPF 88-3

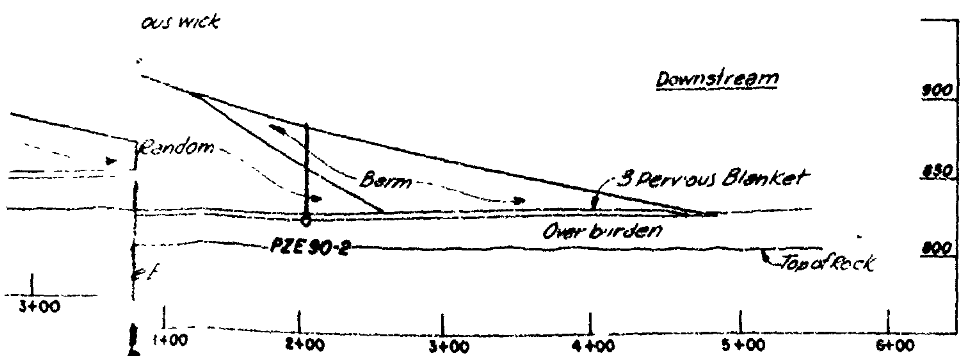
Scale: AS SHOWN
Date: AUGUST 1987
Dwg No.:
Sheet number:
Plot Scale: 12.1
Design File: [100,65]PROFILE
File No. RBL-3-1581

PLATE NO. 105



PZE 90-2
STATION.....90+01
RANGE.......2+05D
TIP ELEV.....820.9
MATERIAL.....SAND DRAIN
INSTALLED...27 MAR 86
ELEVATION IN FEET BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929
FLOOD POOL ELEV. 909.0
MULTIPURPOSE POOL ELEV. 891.0
FILL AT DEVICE
POOL
INITIAL
TIP
TOP OF SAND
1986
1987
1988
Upstream
6' Pervious wick
Berm
Random
Impervious
Random
Berm
Overburden
Top of Rock
Pleasanton Siltstone Zone E
PZE 90-2
6+00
5+00
4+00
3+00
2+00
1+00
0+00
1+00
2+00
3+00



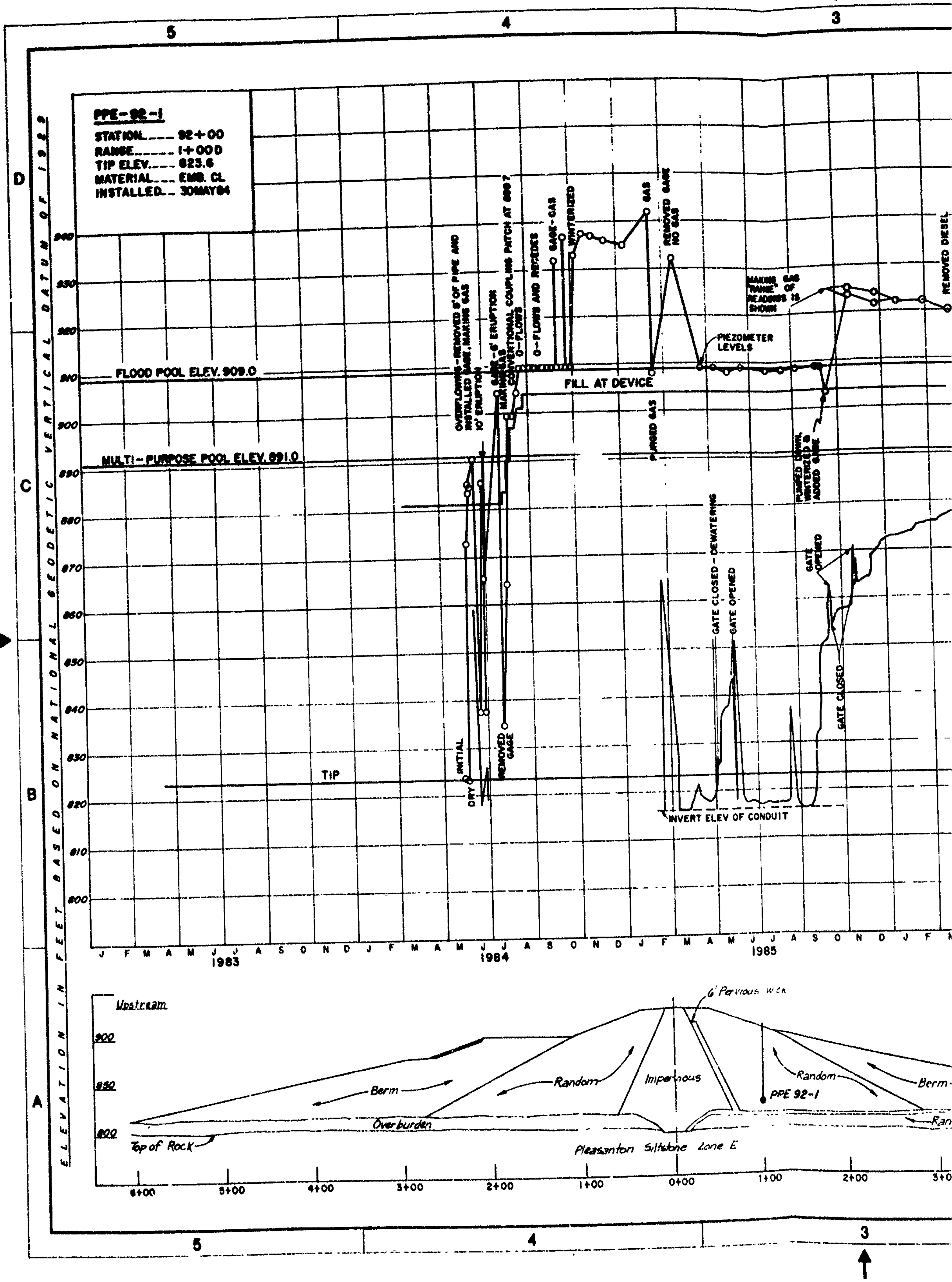


Revisions			
Symbol	Descriptions	Date	Approved
	Revised March 1990		

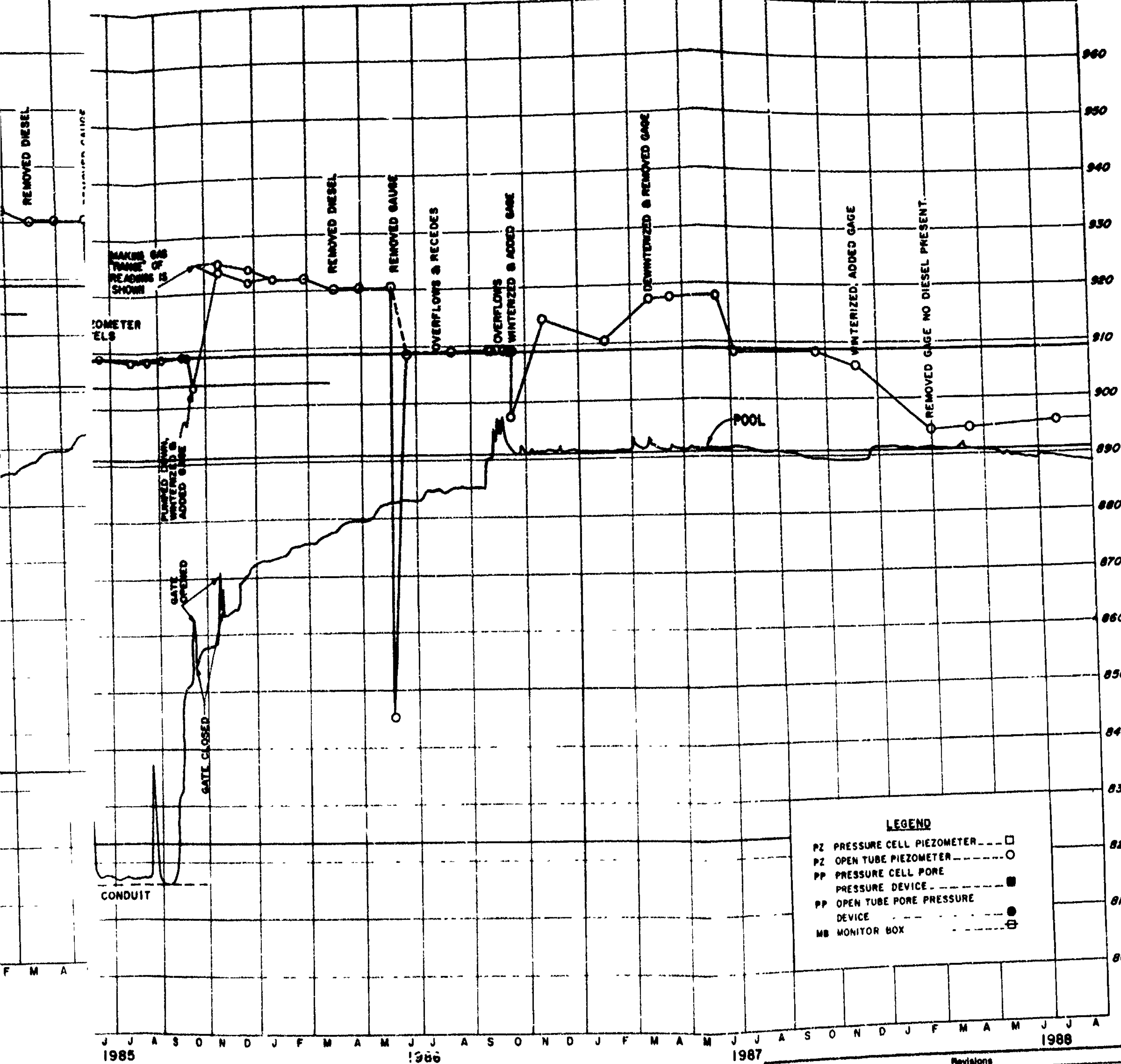
U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

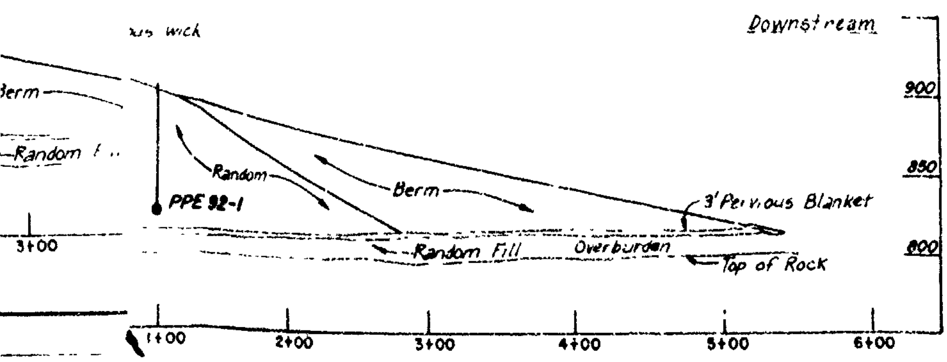
Designed by: RGD	LITTLE BLUE RIVER, MISSOURI LONGVIEW LAKE EMBANKMENT CRITERIA AND PERFORMANCE REPORT
Drawn by: PFL	PIEZOMETER PLOTS OPEN TUBE PZ PZE 90-2
Checked by: RLA	Scale: AS SHOWN
Submitted by: WBE	Date: DECEMBER 1988
Dwg No	File No. RBL-3-1582

PLATE NO. 106



PPE-92-1
STATION..... 92+00
RANGE....... 1+00D
TIP ELEV..... 823.6
MATERIAL.... EMB. CL
INSTALLED... 30MAY84
ELEVATION IN FEET BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929
FLOOD POOL ELEV. 909.0
MULTI-PURPOSE POOL ELEV. 891.0
TIP
FILL AT DEVICE
INITIAL
DRY
REMOVED GAGE
OVERFLOWING-REMOVED 5' OF PIPE AND INSTALLED GAGE, MAKING GAS
10' ERUPTION
GAGE-6' ERUPTION
MAKING GAS
CONVENTIONAL COUPLING PATCH AT 899.7
0-FLOWS
0-FLOWS AND RECEDES
GAGE-GAS
WINTERIZED
GAS
REMOVED GAGE NO GAS
PURGED GAS
PIEZOMETER LEVELS
MAKING GAS "RANGE" OF READINGS IS SHOWN
REMOVED DIESEL
PUMPED DOWN, WINTERIZED & ADDED GAGE
GATE CLOSED-DEWATERING
GATE OPENED
GATE OPENED
GATE CLOSED
INVERT ELEV OF CONDUIT
1983
1984
1985
Upstream
6' Pervious w ck
Berm
Random
Impervious
Random
Berm
PPE 92-1
Overburden
Top of Rock
Pleasanton Siltstone Zone E
6+00
5+00
4+00
3+00
2+00
1+00
0+00
1+00
2+00





Symbol	Revisions Descriptions	Date	Approved

U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

US Army Corps of Engineers

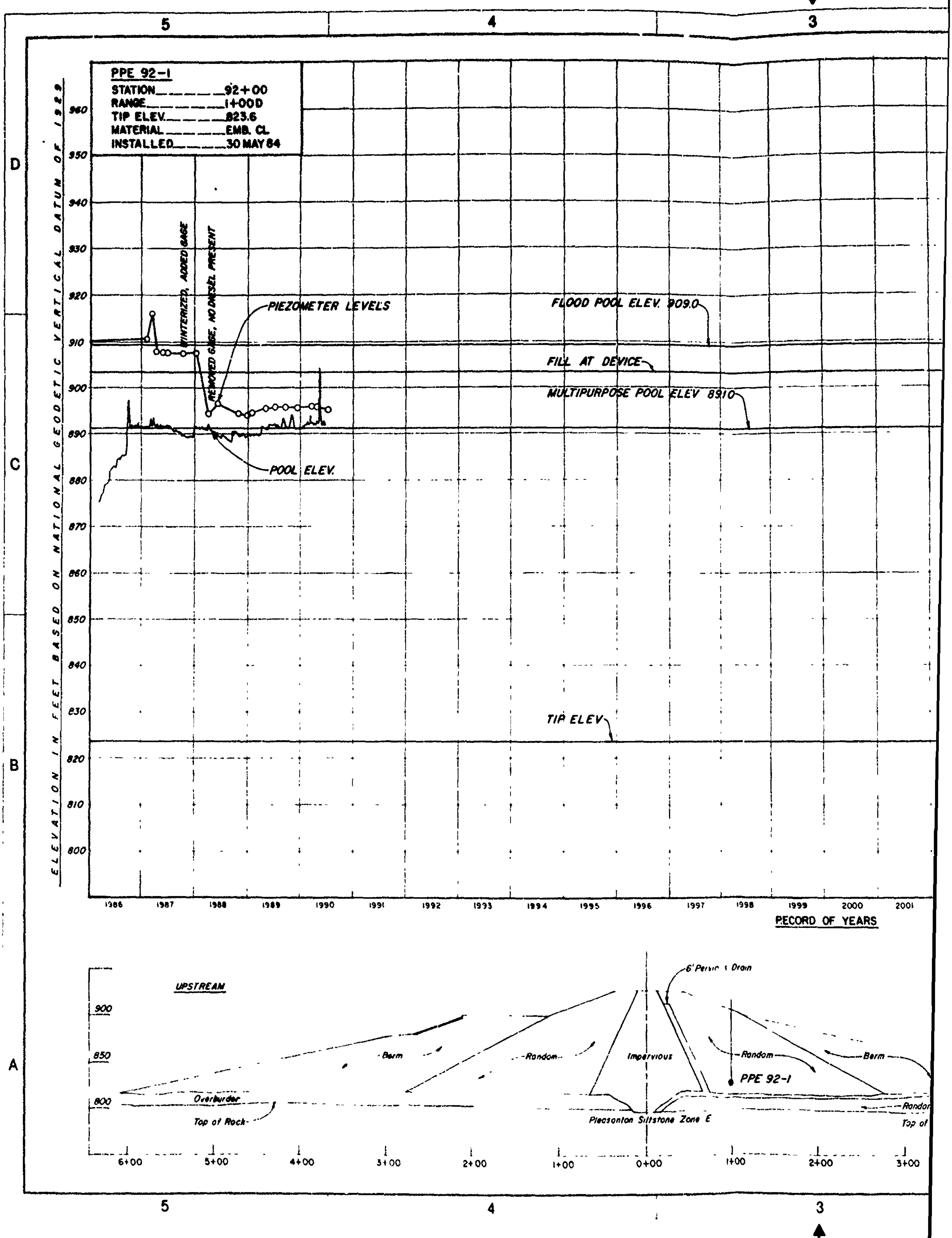
LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA AND PERFORMANCE REPORT

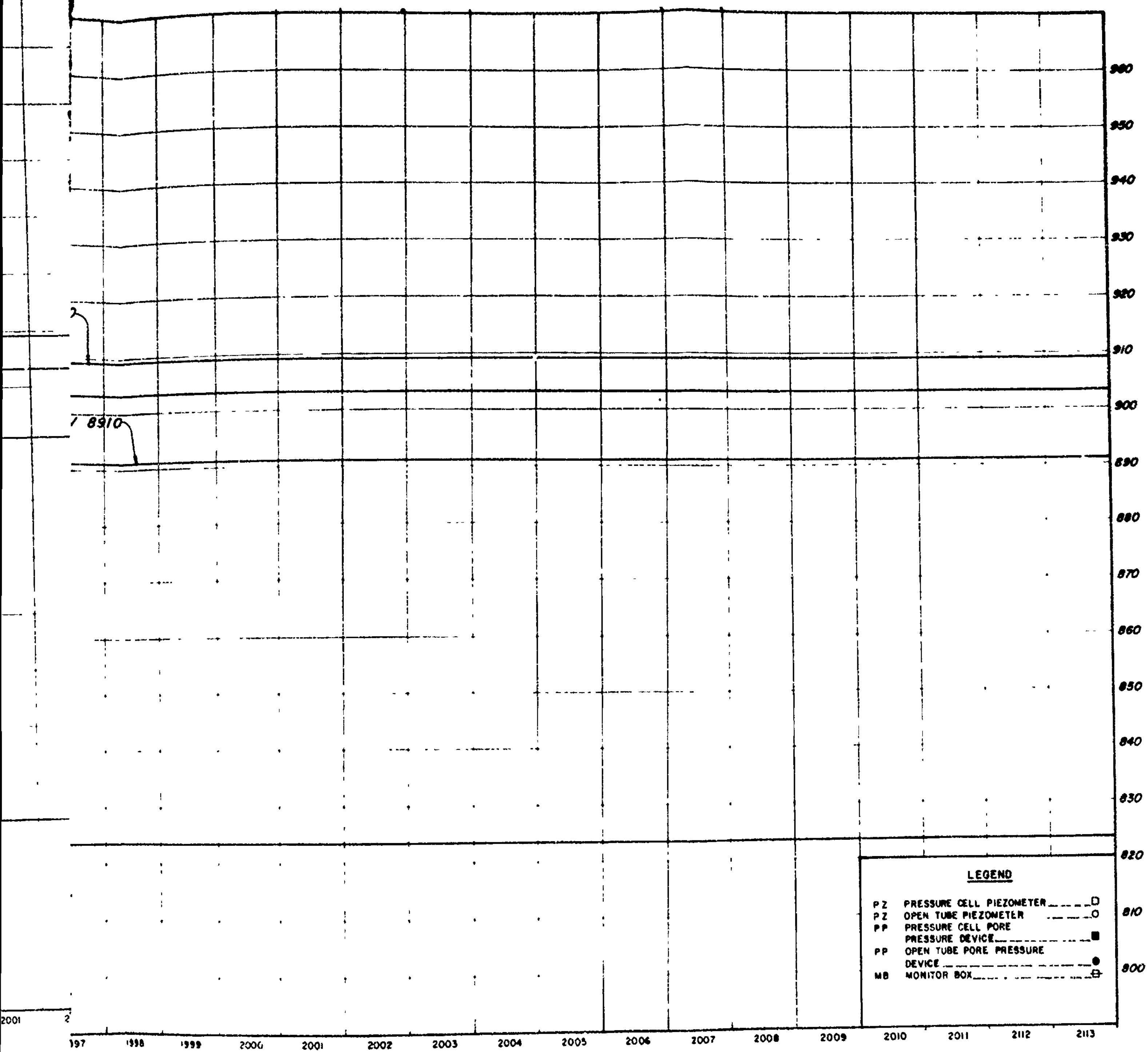
PIEZOMETER PLOTS
OPEN TUBE PZ
PPE 92-1

Designed by RGD
Drawn by MJK
Checked by RLA
Submitted by WBE

Scale AS SHOWN
Date DECEMBER 1986
Dwg No 1 OF 2
Sheet number
File No RBL-3-1583

PLATE NO. 107

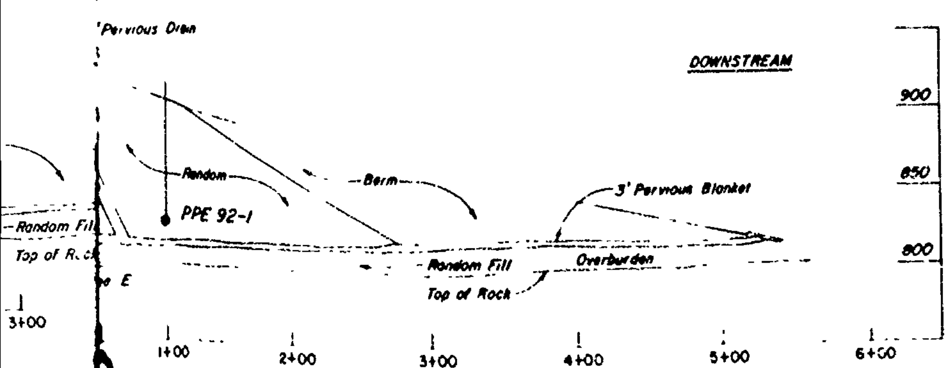

5
4
3
PPE 92-1
STATION 92+00
RANGE 1+00D
TIP ELEV. 823.6
MATERIAL EMB. CL.
INSTALLED 30 MAY 84
D
C
B
A
ELEVATION IN FEET BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929
960
950
940
930
920
910
900
890
880
870
860
850
840
830
820
810
800
WINTERIZED, ADDED GAGE
REMOVED GAGE, NO DIESEL PRESENT
PIEZOMETER LEVELS
FLOOD POOL ELEV. 909.0
FILL AT DEVICE
MULTIPURPOSE POOL ELEV 891.0
POOL ELEV.
TIP ELEV.
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
RECORD OF YEARS
UPSTREAM
6' Pervious Drain
900
850
800
Berm
Random
Impervious
Random
Berm
PPE 92-1
Overburden
Top of Rock
Pleasanton Siltstone Zone E
Random
Top of
6+00
5+00
4+00
3+00
2+00
1+00
0+00
1+00
2+00
3+00
5
4
3



LEGEND

PZ	PRESSURE CELL PIEZOMETER	□
PZ	OPEN TUBE PIEZOMETER	○
PP	PRESSURE CELL PORE PRESSURE DEVICE	■
PP	OPEN TUBE PORE PRESSURE DEVICE	●
MB	MONITOR BOX	⊖

PECORD OF YEARS



Symbol	Revisions Descriptions	Date	Approved
	Revised March 1990		

U. S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

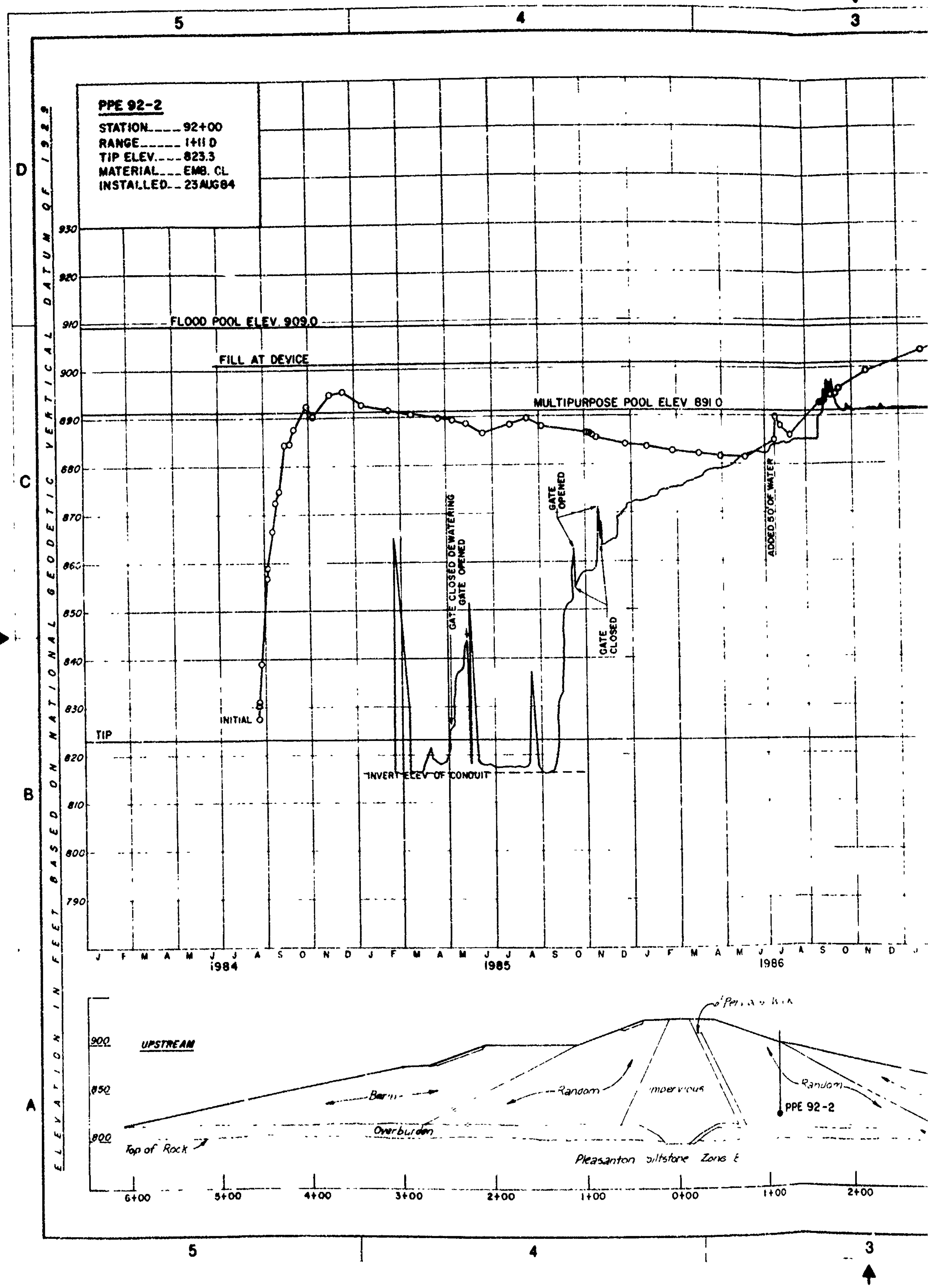
US Army Corps of Engineers

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA AND PERFORMANCE REPORT

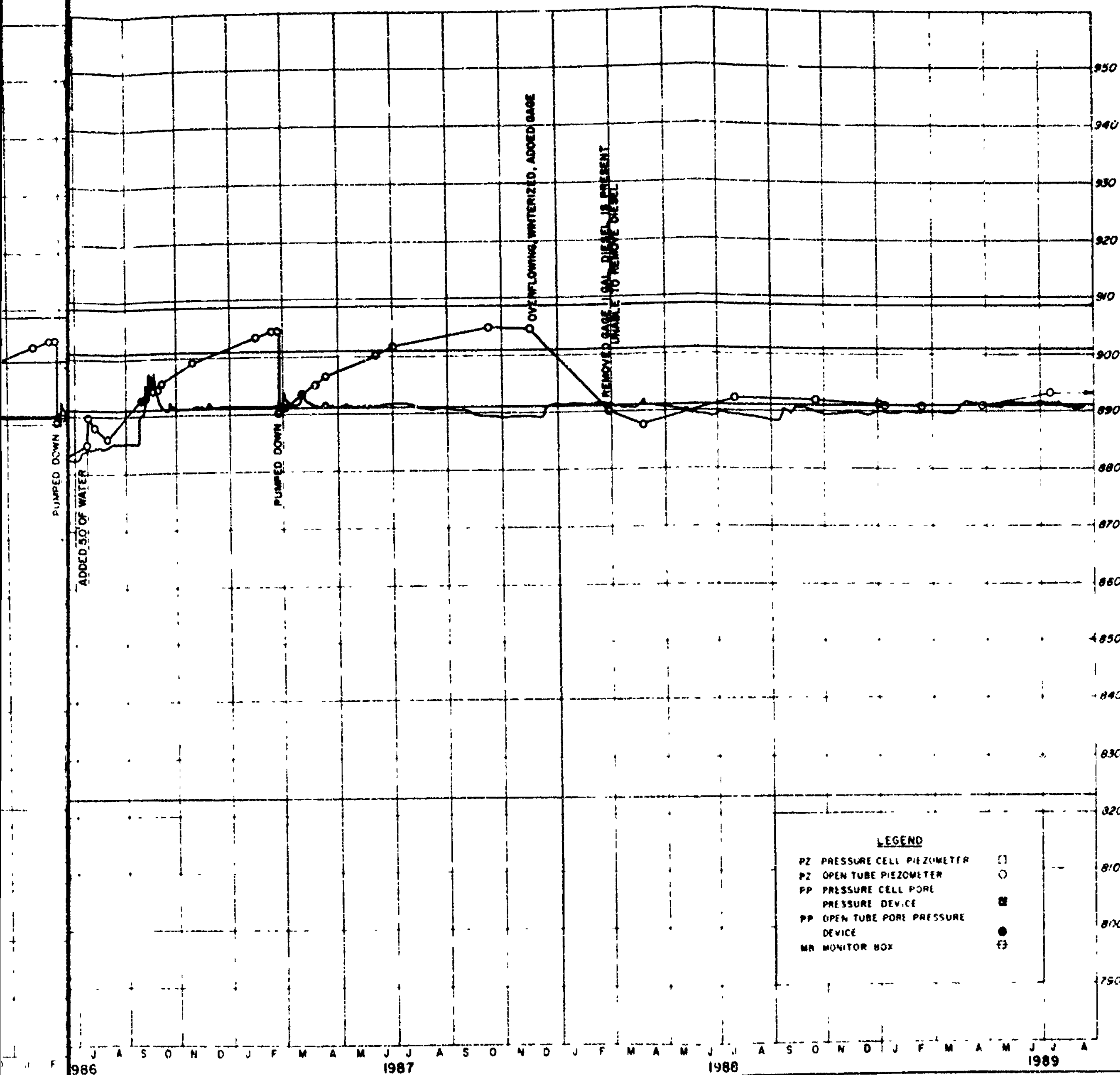
PIEZOMETER PLOTS
OPEN TUBE PZ
PPE 92-1

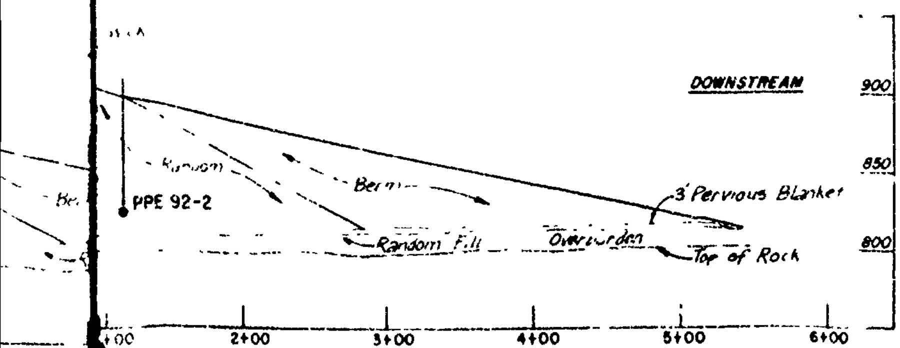
Designed by	RGD
Drawn by	ERW
Checked by	WBE
Submitted by	WBE
Scale	AS SHOWN
Date	DECEMBER 1986
Dwg Nr	2 of 2
Sheet number	
File No	RBL-3-1584

PLATE NO 108



PPE 92-2
STATION____92+00
RANGE______1+11 D
TIP ELEV.___823.3
MATERIAL___EMB. CL
INSTALLED__23AUG84
ELEVATION IN FEET BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929
FLOOD POOL ELEV. 909.0
FILL AT DEVICE
MULTIPURPOSE POOL ELEV 891.0
GATE CLOSED DEWATERING
GATE OPENED
GATE OPENED
GATE CLOSED
ADDED 50' OF WATER
INITIAL
TIP
INVERT ELEV OF CONDUIT
1984
1985
1986
UPSTREAM
Berm
Random
Impervious
Random
Overburden
Top of Rock
PPE 92-2
Pleasanton Siltstone Zone E
6+00
5+00
4+00
3+00
2+00
1+00
0+00
1+00
2+00





Symbol	Revisions Descriptions	Date	Approved
	Revised March 1990		

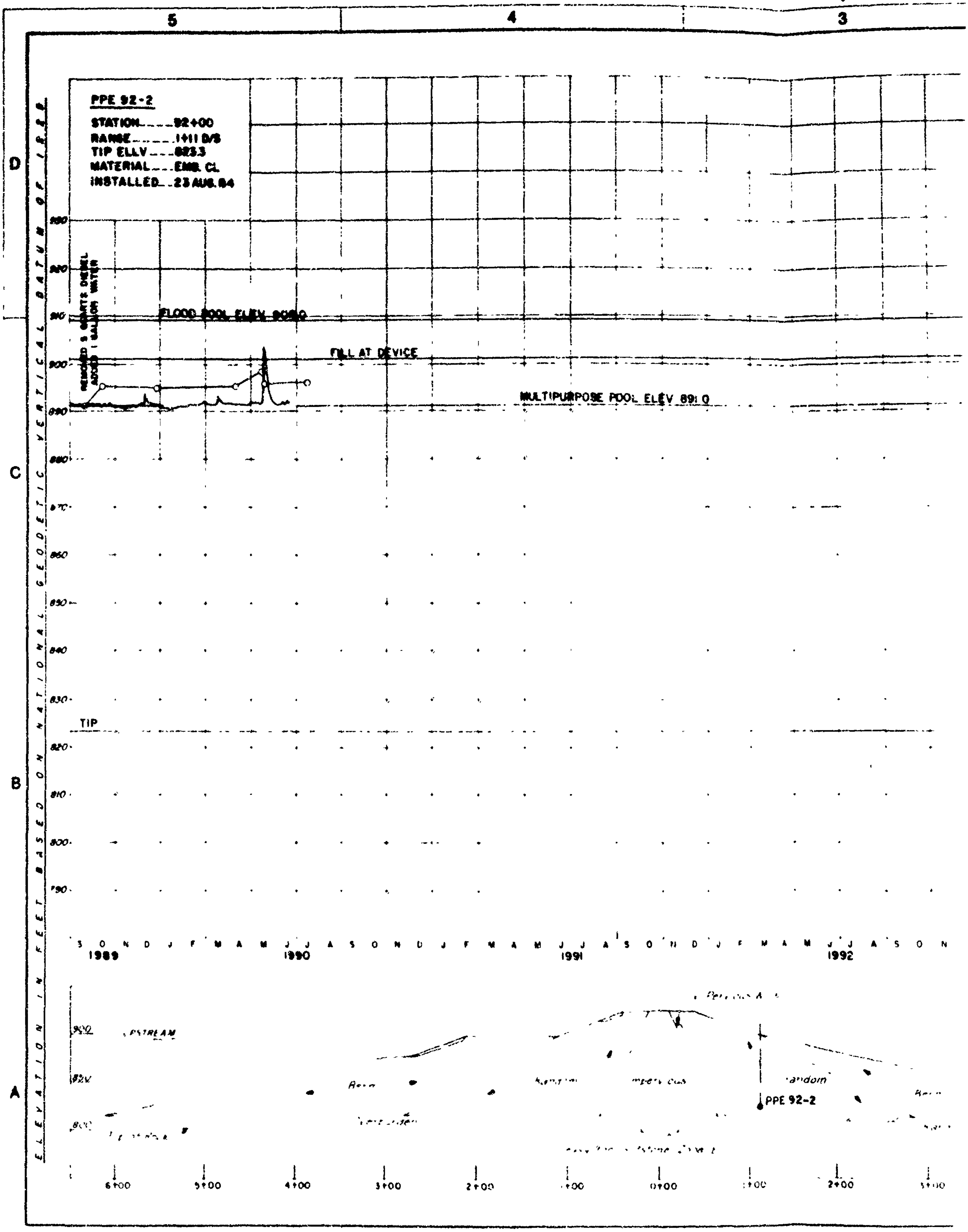
U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA AND PERFORMANCE REPORT

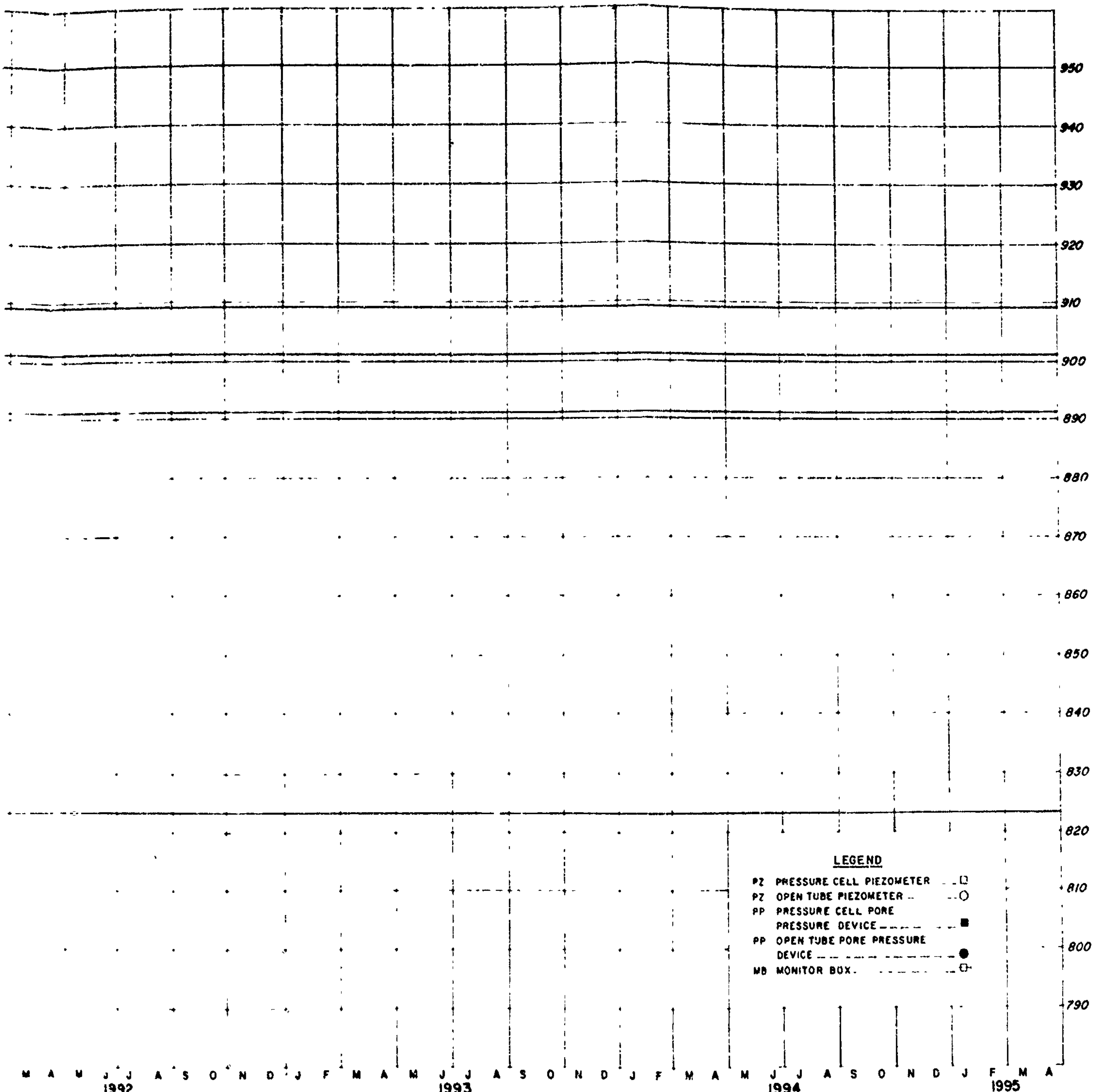
PIEZOMETER PLOT
2" OPEN TUBE PVC
PPE 92-2

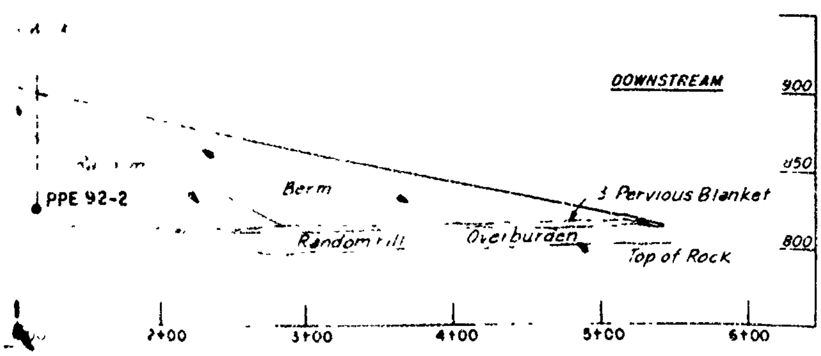
Designed by	RGD
Drawn by	DHL
Checked by	RLA
Submitted by	WBE
Scale	AS SHOWN
Date	DECEMBER 1986
Dwg No	1 of 2
File No	RF _-3-1585

PLATE NO 109



PPE 92-2
STATION.....92+00
RANGE.......1+11 D/S
TIP ELLV....823.3
MATERIAL....EMB. CL
INSTALLED...23 AUG. 84
FLOOD POOL ELEV 909.0
FILL AT DEVICE
MULTIPURPOSE POOL ELEV 891.0
TIP
ELEVATION IN FEET BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929
1989
1990
1991
1992
PPE 92-2
6+00
5+00
4+00
3+00
2+00
0+00
2+00
3+00





Symbol	Revisions Descriptions	Date	Approved
	Revised March 1990		

U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY MISSOURI

Designed by RGD
Drawn by DHL
Checked by RLA
Submitted by WBE

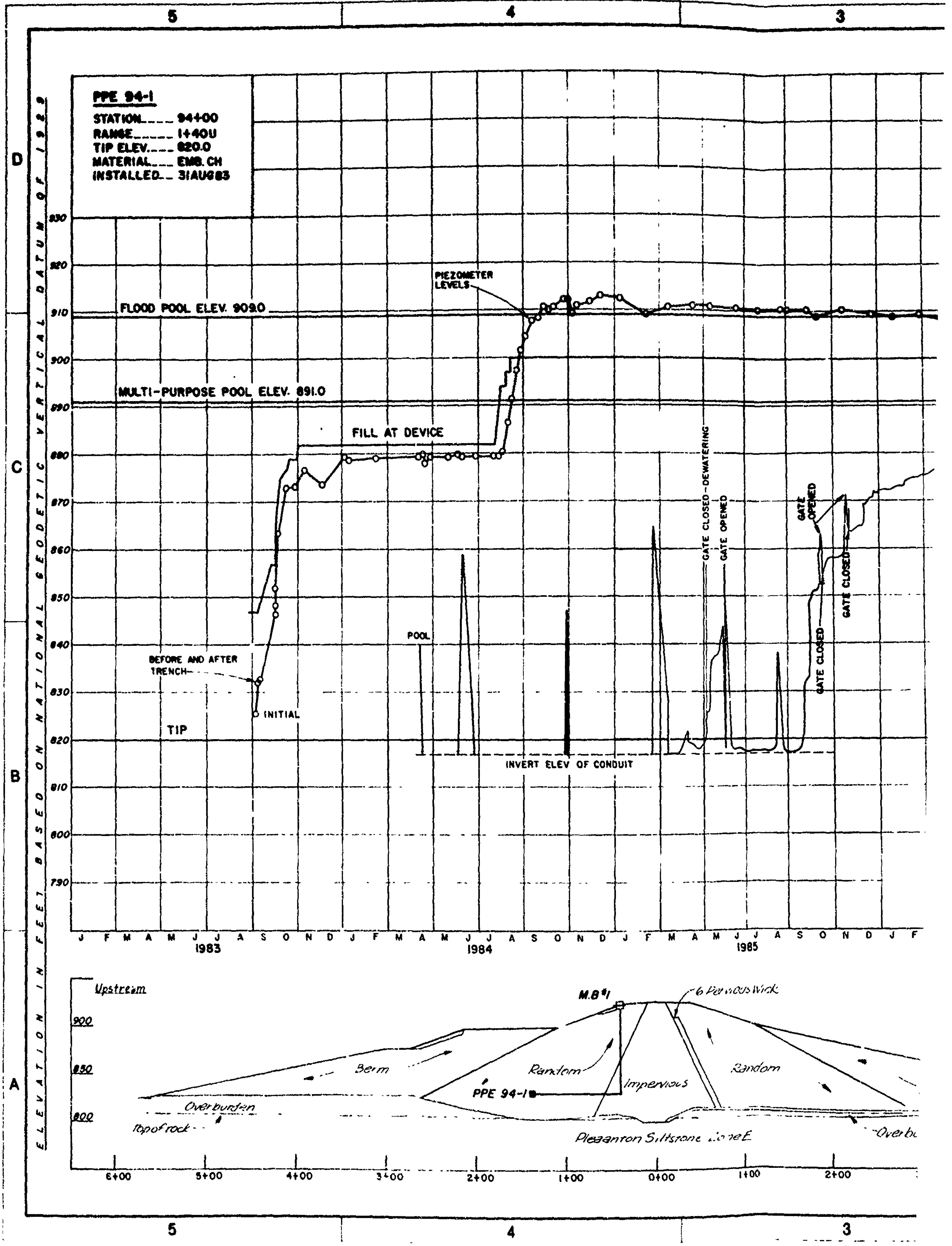
US Army Corps of Engineers

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA AND PERFORMANCE REPORT

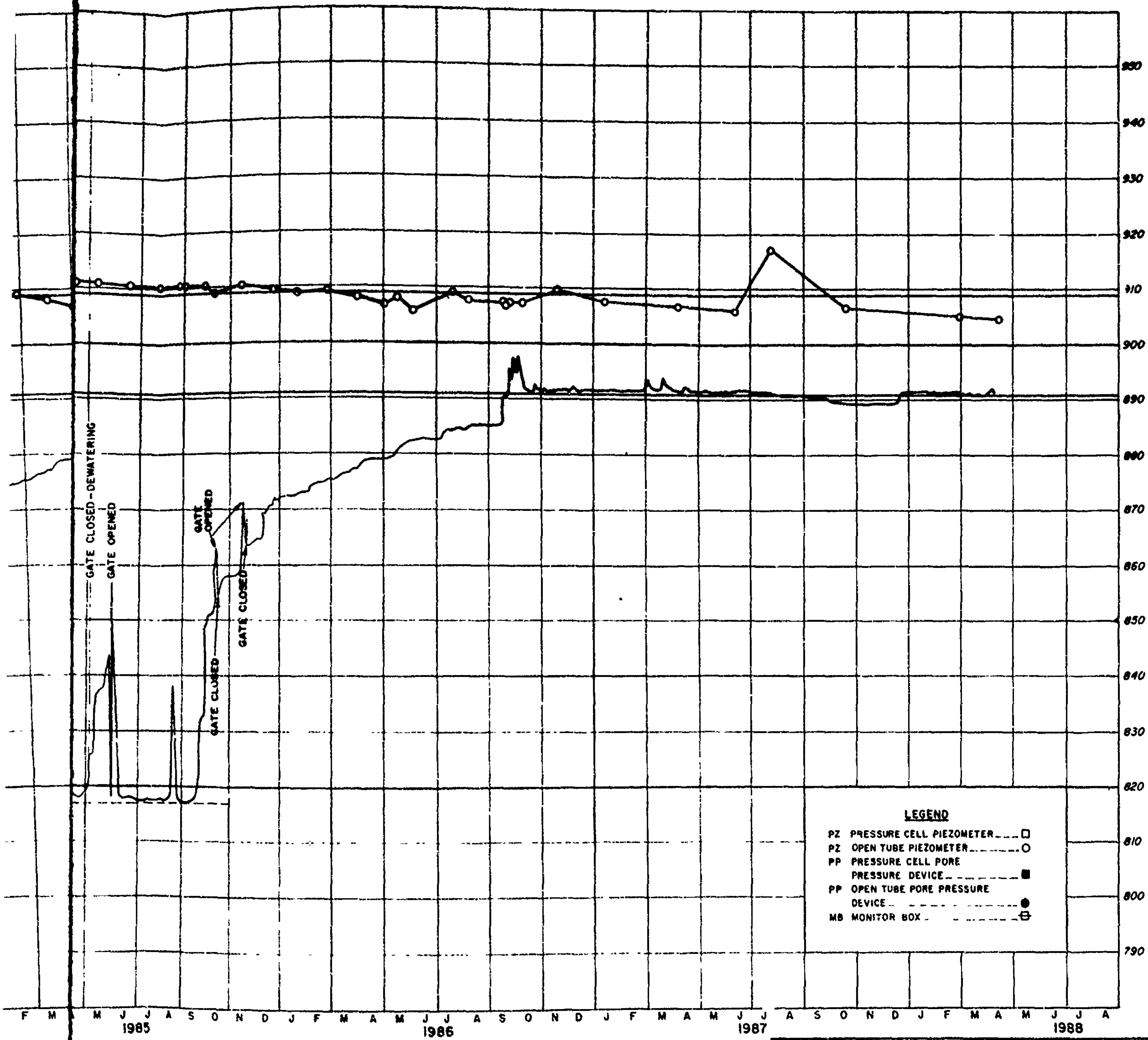
PIEZOMETER PLOT
2" OPEN TUBE PVC
PPE 92-2

Scale AS SHOWN
Date DECEMBER 1986
Dwg No 2 of 2
Sheet number
File No RBL-3-1586

PLATE NO 110

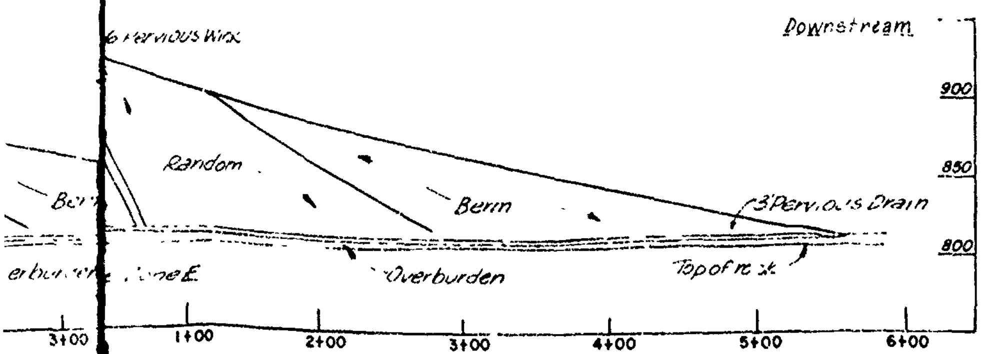


PPE 94-1
STATION.... 94+00
RANGE...... 1+40U
TIP ELEV.... 820.0
MATERIAL.... EMB. CH
INSTALLED... 31AUG83
ELEVATION IN FEET BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929
FLOOD POOL ELEV. 909.0
MULTI-PURPOSE POOL ELEV. 891.0
PIEZOMETER LEVELS
FILL AT DEVICE
BEFORE AND AFTER TRENCH
INITIAL
TIP
POOL
INVERT ELEV OF CONDUIT
GATE CLOSED-DEWATERING
GATE OPENED
GATE OPENED
GATE CLOSED
GATE CLOSED
1983
1984
1985
Upstream
M.B.#1
6 Pervious Wick
Berm
Random
Impervious
Random
PPE 94-1
Overburden
Top of rock
Pleasanton Siltstone Zone E
Overbu



LEGEND

PZ PRESSURE CELL PIEZOMETER .... □
PZ OPEN TUBE PIEZOMETER .... ○
PP PRESSURE CELL PORE PRESSURE DEVICE .... ■
PP OPEN TUBE PORE PRESSURE DEVICE .... ●
MB MONITOR BOX .... ⊖



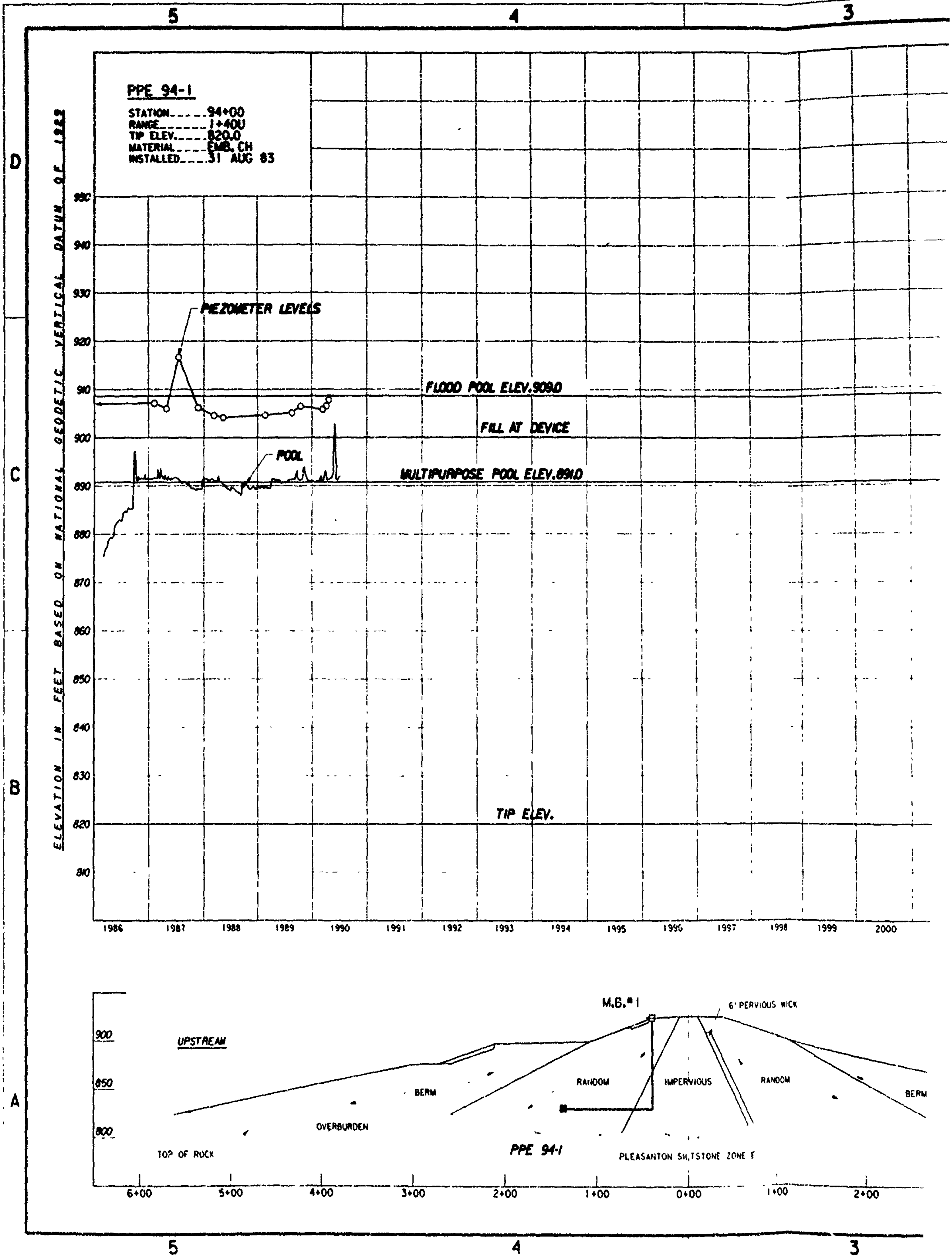
Revisions			
Symbol	Descriptions	Date	Approved

U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

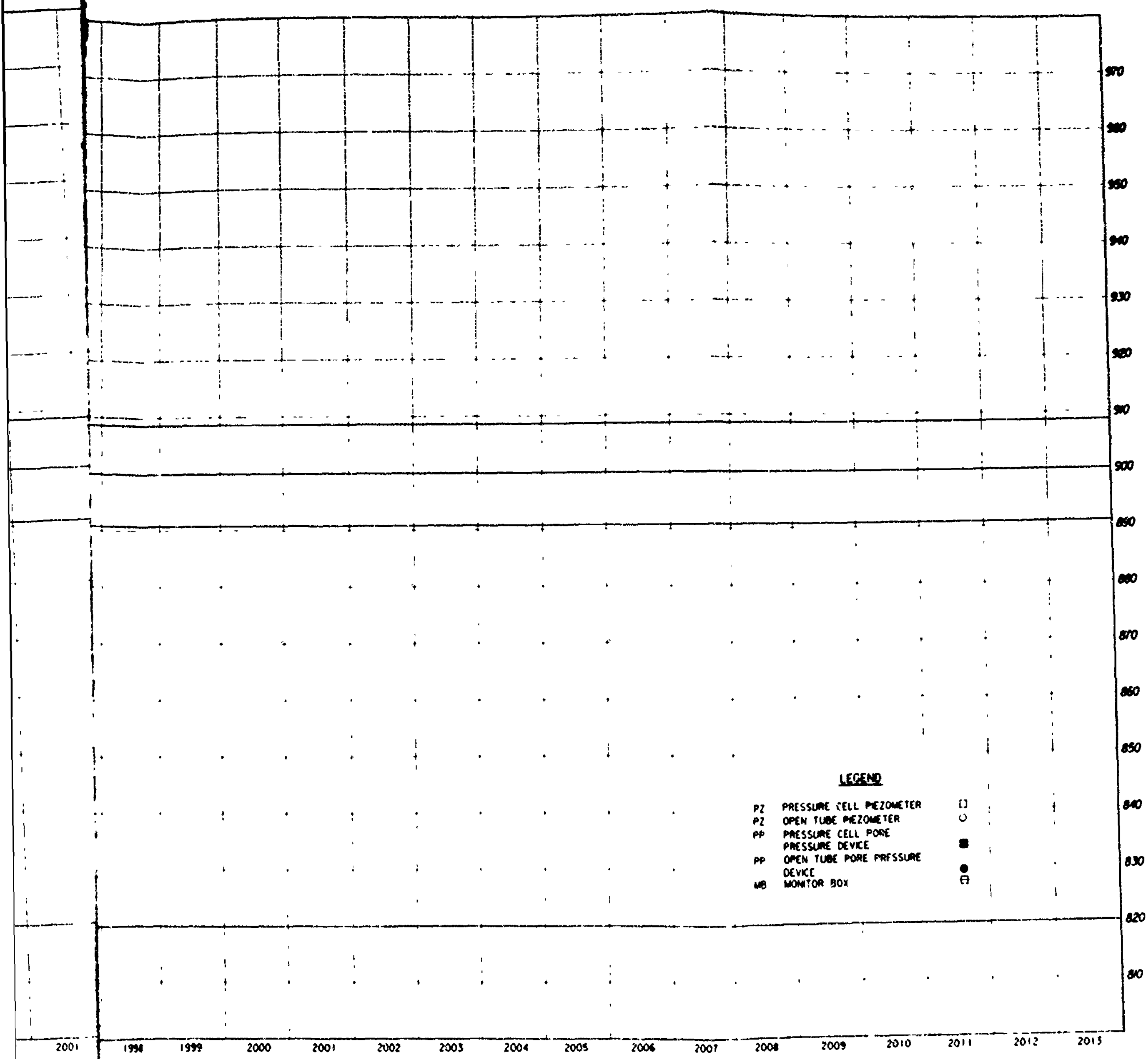
Designed by RGD	LITTLE BLUE RIVER, MISSOURI LONGVIEW LAKE EMBANKMENT CRITERIA AND PERFORMANCE REPORT
Drawn by PFL	PIEZOMETER PLOTS PNEUMATIC PZ PPE 94-1
Checked by RLA	Scale AS SHOWN · Sheet number
Submitted by WBE	Date DECEMBER 1986 · Dwg No 1 OF 2 · File No RBL-3-1587

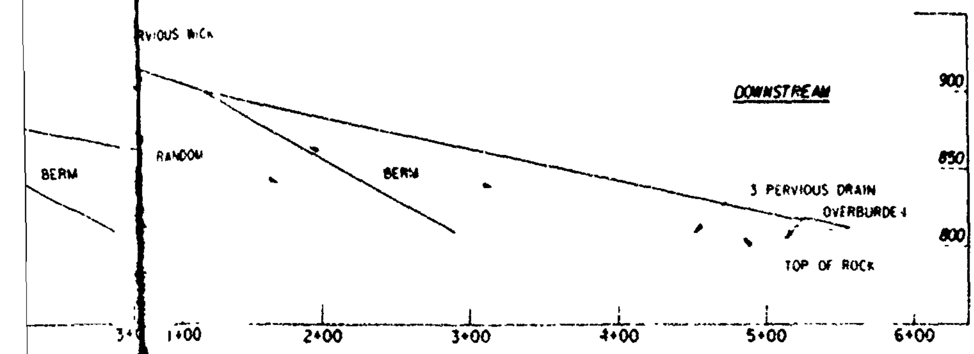
PLATE NO. III

VAL



PPE 94-1
STATION.....94+00
RANGE.......1+40U
TIP ELEV.....820.0
MATERIAL....EMB. CH
INSTALLED....31 AUG 83
ELEVATION IN FEET BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929
PIEZOMETER LEVELS
FLOOD POOL ELEV.909.0
FILL AT DEVICE
POOL
MULTIPURPOSE POOL ELEV.891.0
TIP ELEV.
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1997
1998
1999
2000
M.B.#1
6' PERVIOUS WICK
UPSTREAM
BERM
RANDOM
IMPERVIOUS
RANDOM
BERM
OVERBURDEN
TOP OF ROCK
PPE 94-1
PLEASANTON SILTSTONE ZONE E
6+00
5+00
4+00
3+00
2+00
1+00
0+00
1+00
2+00





Symbol	Revisions Descriptions	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

Designed by: R.G.D.
Drawn by: J.W.P.
Checked by: W.B.E.
Submitted by: W.B.F.

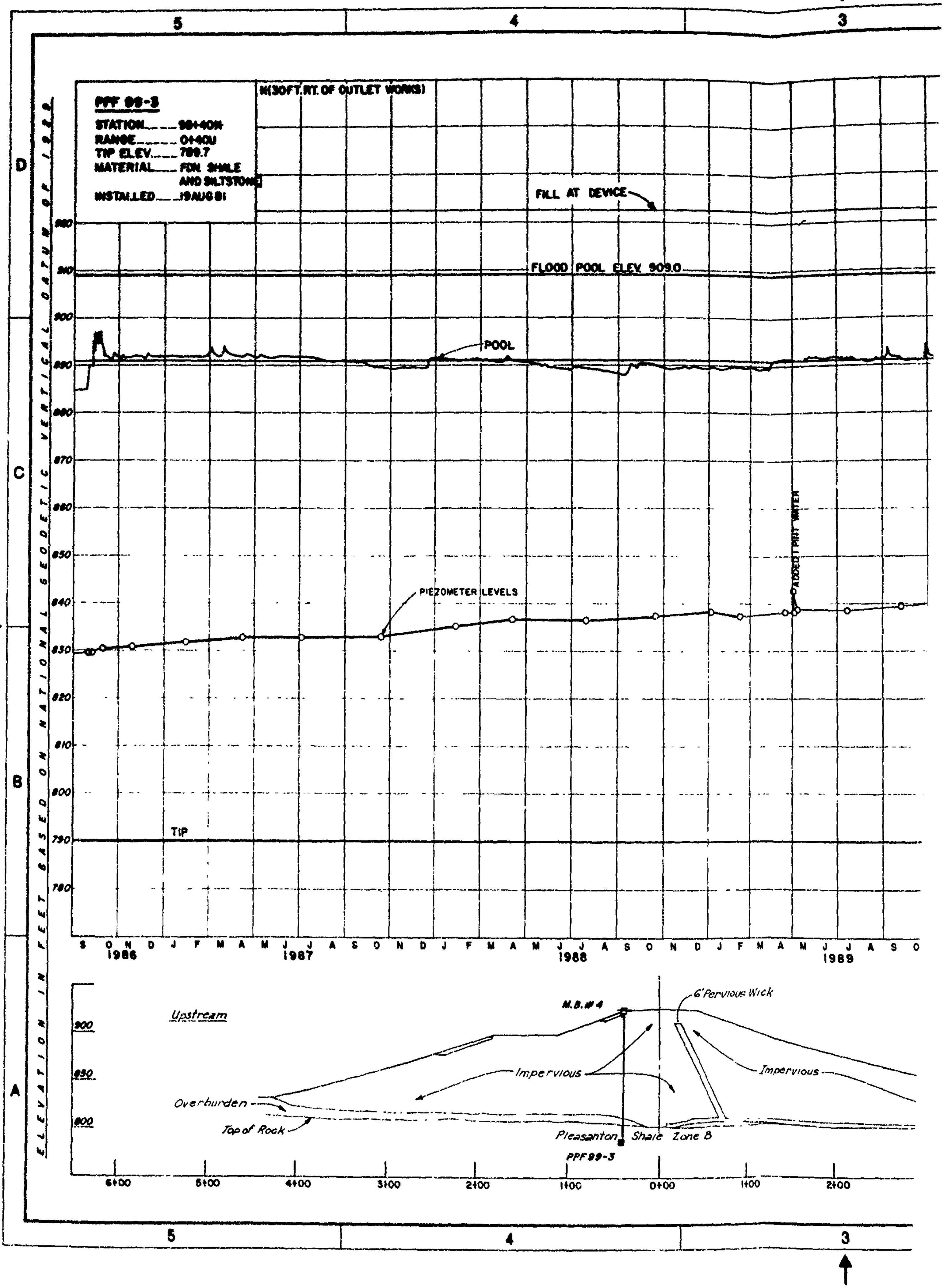
LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA AND PERFORMANCE REPORT

PIEZOMETER PLOTS
PNEUMATIC PZ
PPE 94-1

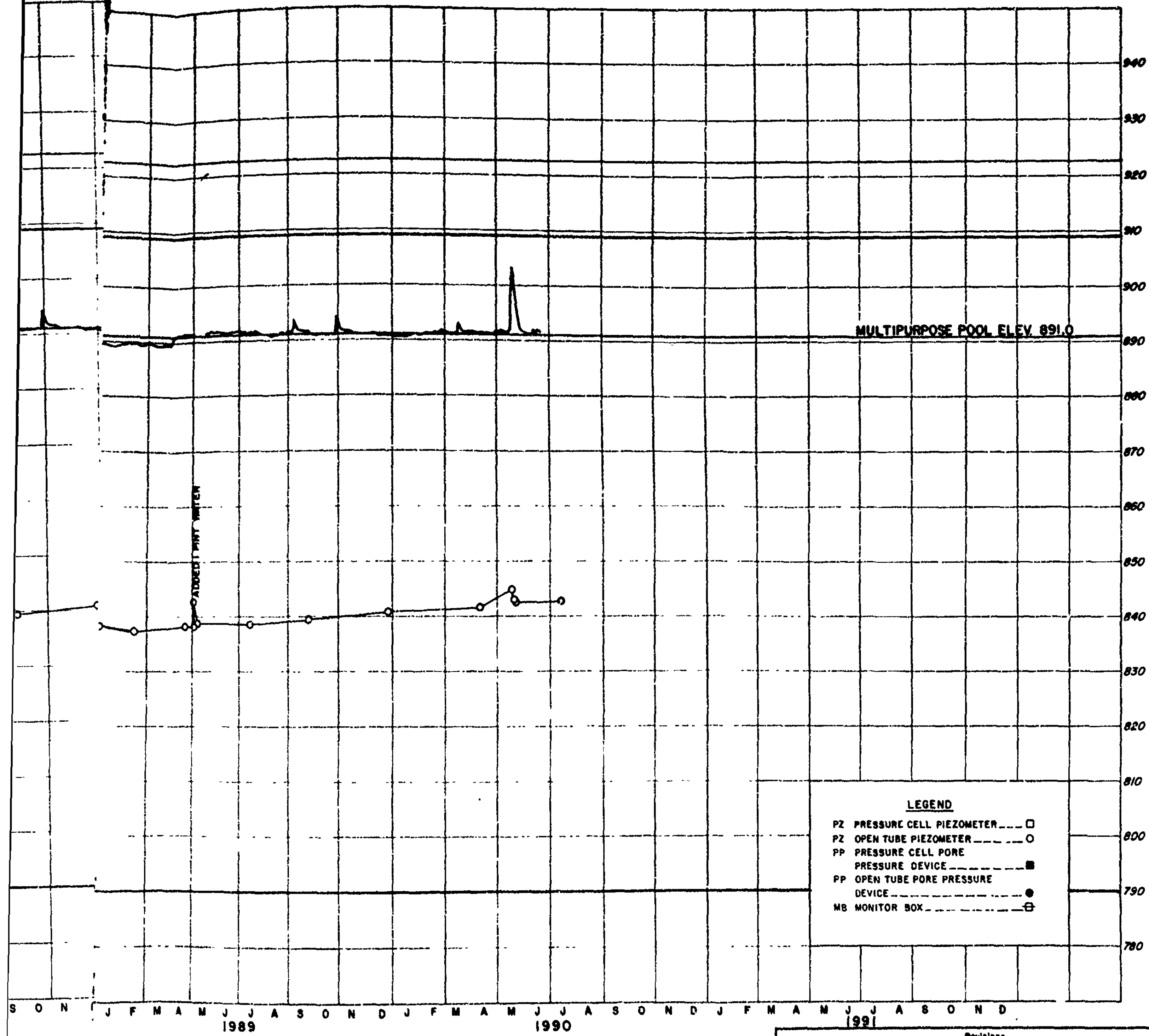
AS SHOWN

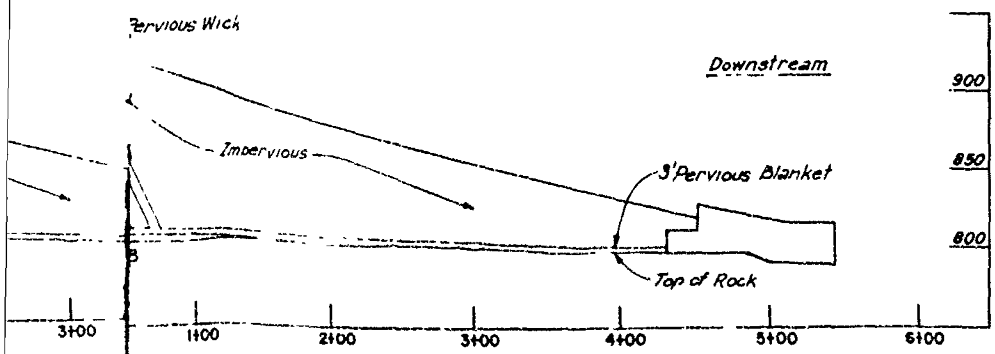
JULY 1990

RBL-3-1588



5
4
3
D
C
B
A
PPF 99-3
STATION......98+40N
RANGE......0+40U
TIP ELEV......789.7
MATERIAL......FDN. SHALE AND SILTSTONE
INSTALLED......19AUG81
(30FT. RT. OF OUTLET WORKS)
FILL AT DEVICE
FLOOD POOL ELEV. 909.0
POOL
PIEZOMETER LEVELS
ADDED PURE WATER
TIP
ELEVATION IN FEET BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929
920
910
900
890
880
870
860
850
840
830
820
810
800
790
780
S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O
1986
1987
1988
1989
Upstream
M.B. # 4
6' Pervious Wick
Impervious
Impervious
Overburden
Top of Rock
Pleasanton Shale Zone B
PPF 99-3
900
850
800
6+00
5+00
4+00
3+00
2+00
1+00
0+00
1+00
2+00
5
4
3





Revisions			
Symbol	Descriptions	Date	Approved
	Revised March 1990		

U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

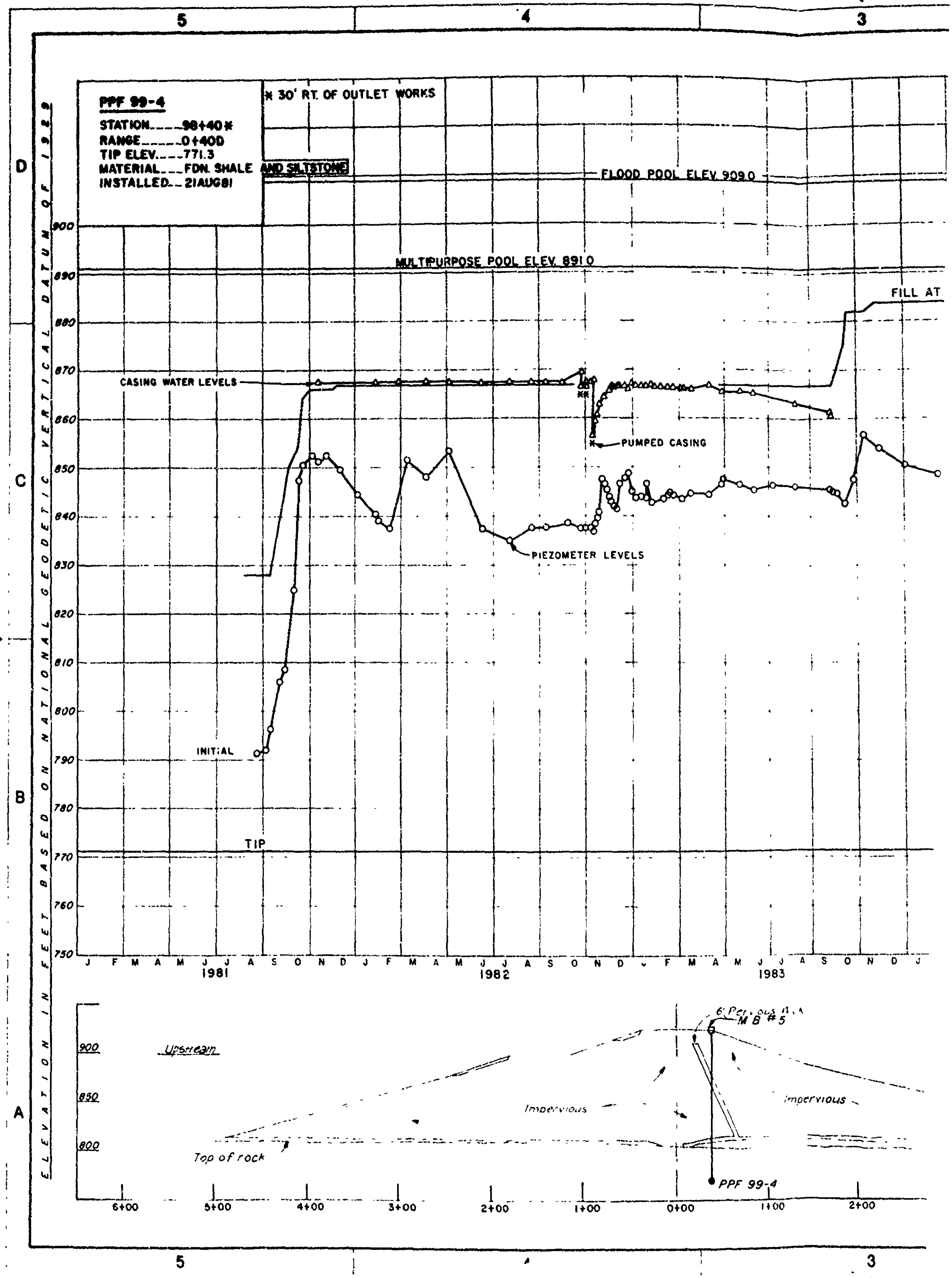
LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA AND PERFORMANCE REPORT

PIEZOMETER PLOTS
OPEN TUBE PZ
PPF 99-3

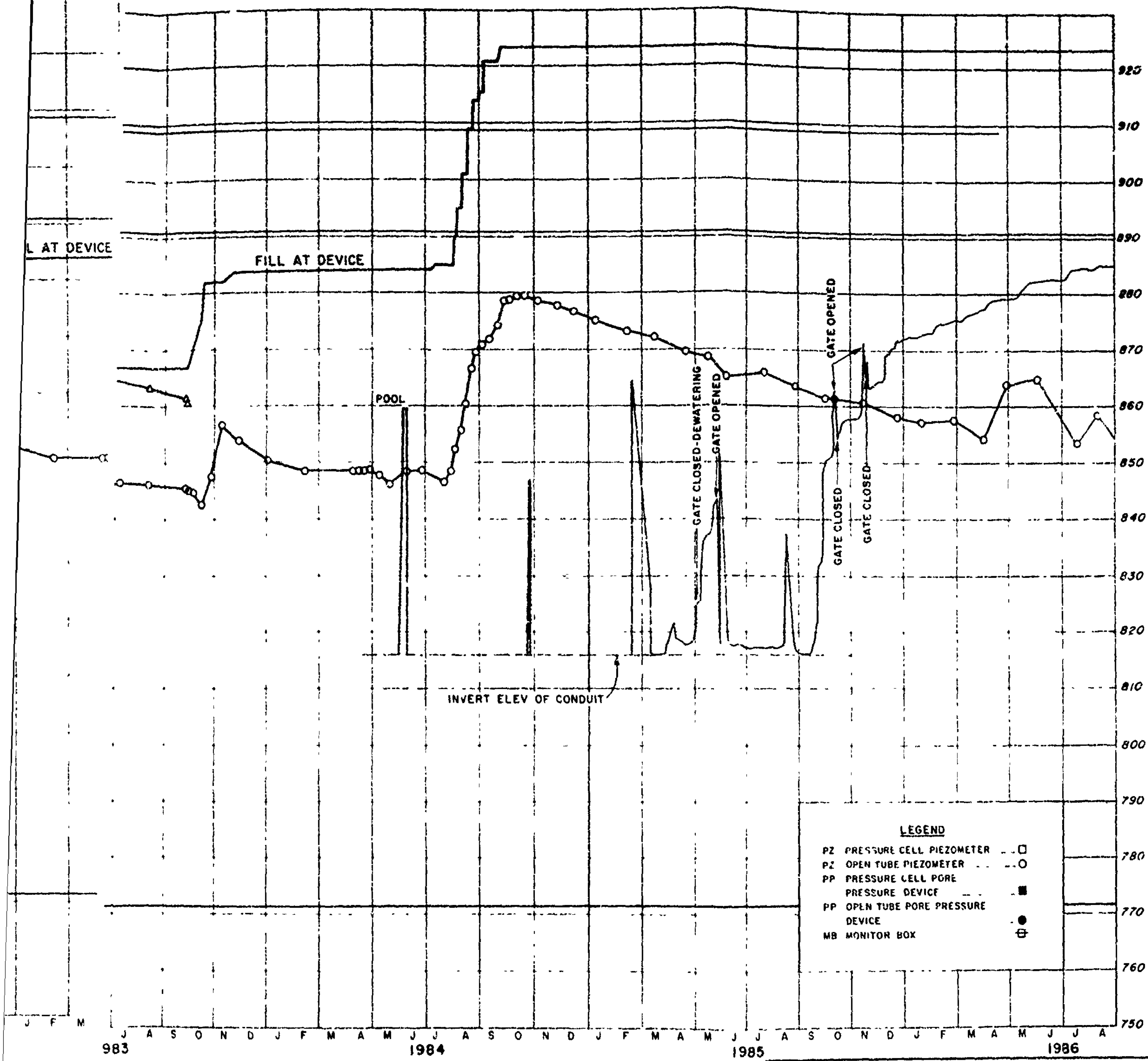
Designed by: RGD
Drawn by: RDT
Checked by: RLA
Submitted by: WBE

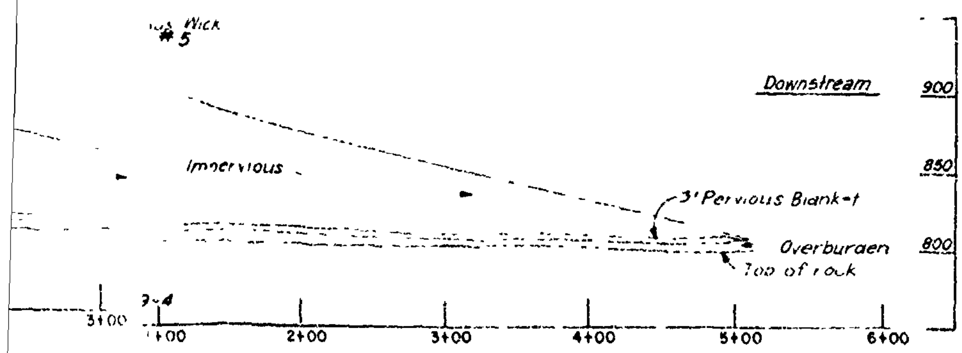
Scale: AS SHOWN
Date: DECEMBER 1988
Dwg No: 2 of 2
Sheet number:
File No: RBL-3-1589

PLATE NO. 113



PPF 99-4
STATION.....98+40*
RANGE.....0+40D
TIP ELEV.....771.3
MATERIAL....FDN. SHALE AND SILTSTONE
INSTALLED...21AUG81
* 30' RT. OF OUTLET WORKS
FLOOD POOL ELEV. 909.0
MULTIPURPOSE POOL ELEV. 891.0
FILL AT
CASING WATER LEVELS
PUMPED CASING
PIEZOMETER LEVELS
INITIAL
TIP
ELEVATION IN FEET BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929
1981
1982
1983
Upstream
Impervious
Impervious
Top of rock
MB #5
PPF 99-4





Symbol	Revisions Descriptions	Date	Approved

U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY MISSOURI

US Army Corps of Engineers

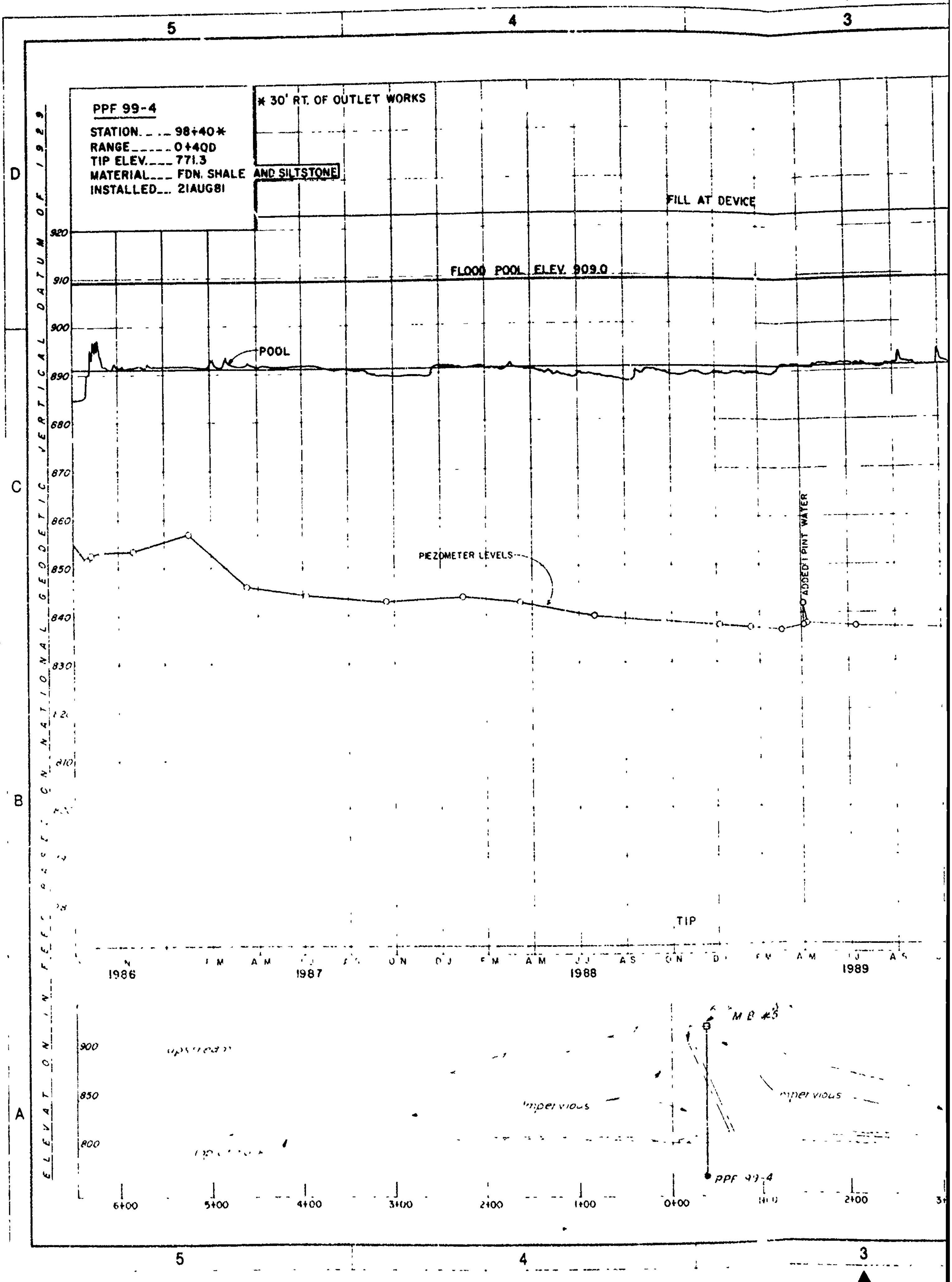
LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA AND PERFORMANCE REPORT

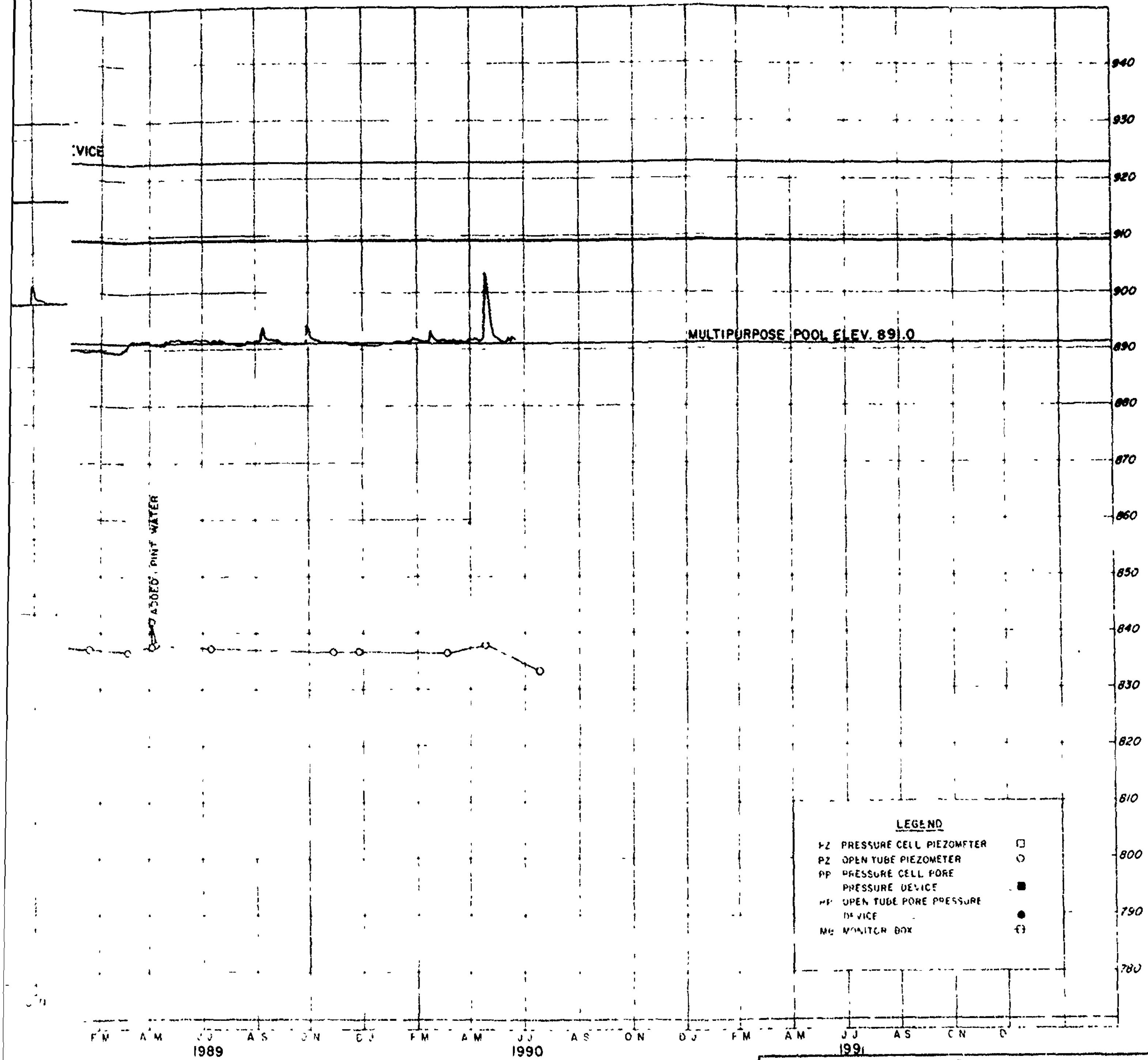
PIEZOMETER PLOTS
OPEN TUBE PZ
PPF 99-4

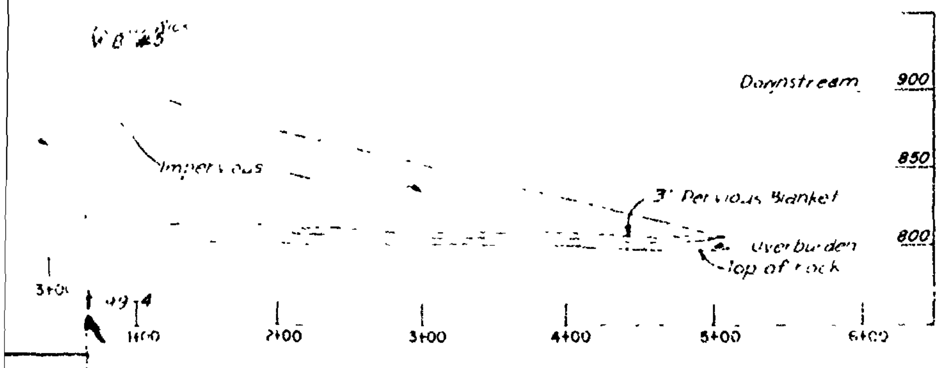
Designed by RGD
Drawn by EER
Checked by RLA
Submitted by WBE

Scale AS SHOWN
Date DECEMBER 1986
Dwg No 1 of 2
Sheet number
File No RBL-3-1590

PLATE NO. 114


PPF 99-4
STATION.... 98+40*
RANGE...... 0+40D
TIP ELEV.... 771.3
MATERIAL.... FDN. SHALE AND SILTSTONE
INSTALLED.... 21AUG81
* 30' RT. OF OUTLET WORKS
FILL AT DEVICE
FLOOD POOL ELEV. 909.0
POOL
PIEZOMETER LEVELS
ADDED 1 PINT WATER
TIP
ELEVATION IN FEET ON NATIONAL GEODETIC VERTICAL DATUM OF 1929
1986
1987
1988
1989
impervious
PPF 99-4
6+00
5+00
4+00
3+00
2+00
1+00
0+00
2+00





Symbol	Revisions Descriptions	Date	Approved
	Revised March 1990		

U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

Designed by: RGD
Drawn by: ECR
Checked by: RLA
Submitted by: WHE

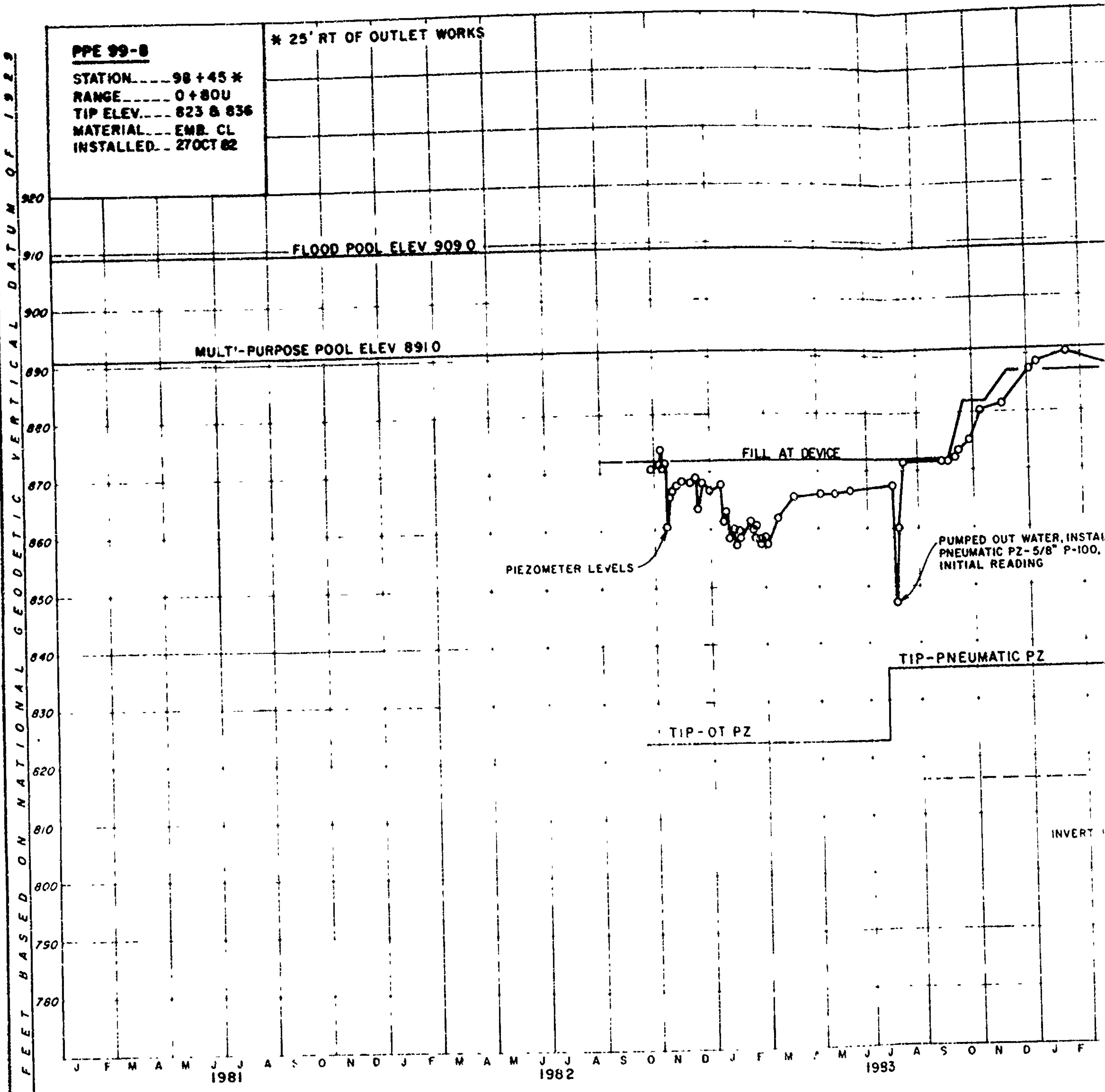
US Army Corps of Engineers

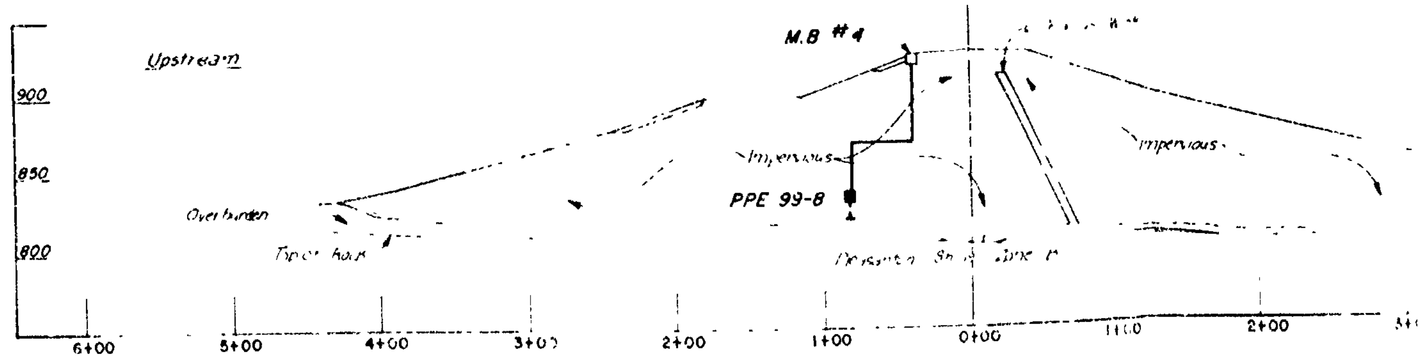
LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA AND PERFORMANCE REPORT

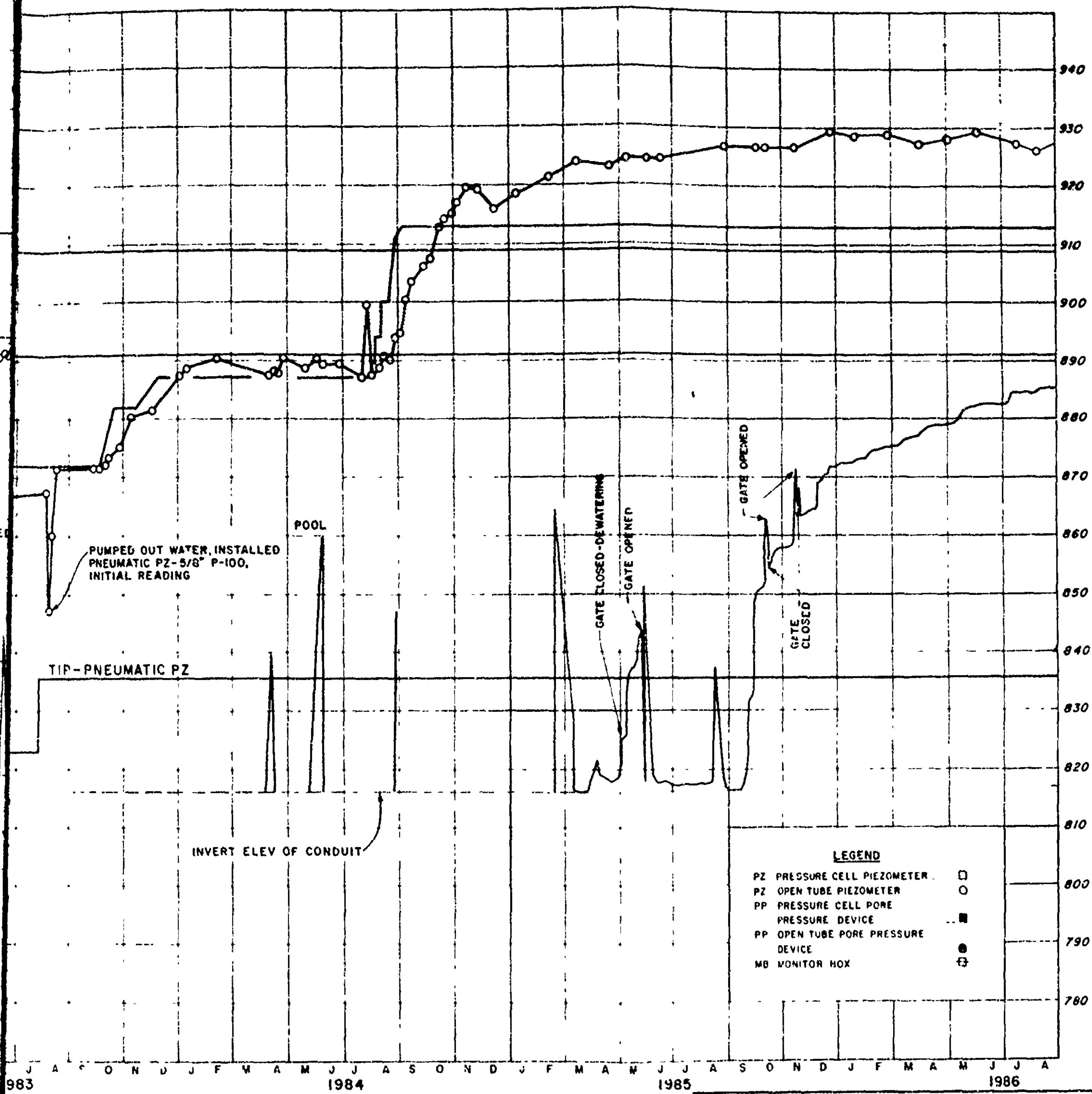
PIEZOMETER PLOTS
OPEN TUBE PZ
PPF 99-4

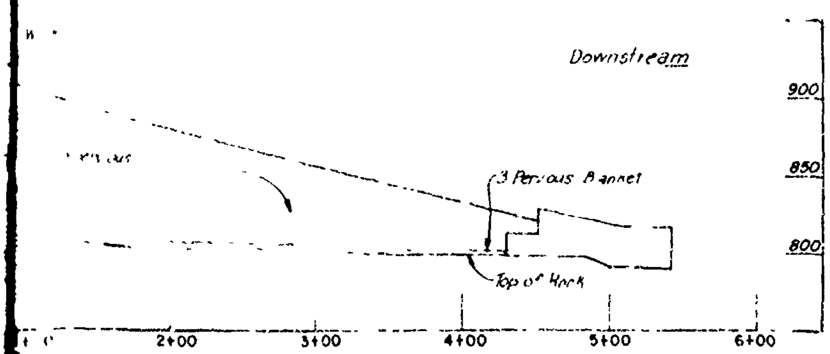
Scale: AS SHOWN
Date: DECEMBER 1986
Dwg No: 2 of 2
Sheet number:
File No: RBI-3-1680

PLATE NO.115


PPE 99-8
STATION.....98 + 45 *
RANGE......0 + 80U
TIP ELEV.....823 & 836
MATERIAL....EMB. CL
INSTALLED...27OCT 82
* 25' RT OF OUTLET WORKS
ELEVATION IN FEET BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929
FLOOD POOL ELEV 909.0
MULTI-PURPOSE POOL ELEV 891.0
FILL AT DEVICE
PIEZOMETER LEVELS
PUMPED OUT WATER, INSTAL
PNEUMATIC PZ-5/8" P-100,
INITIAL READING
TIP-PNEUMATIC PZ
TIP-OT PZ
INVERT
1981
1982
1983


M.B #4
Upstream
Impervious
Impervious
PPE 99-8
Overburden
6+00
5+00
4+00
3+00
2+00
1+00
0+00
2+00





Symbol	Descriptions	Date	Approved

U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

Designed by: RGD
Drawn by: EER
Checked by: RLA
Submitted by: WBE

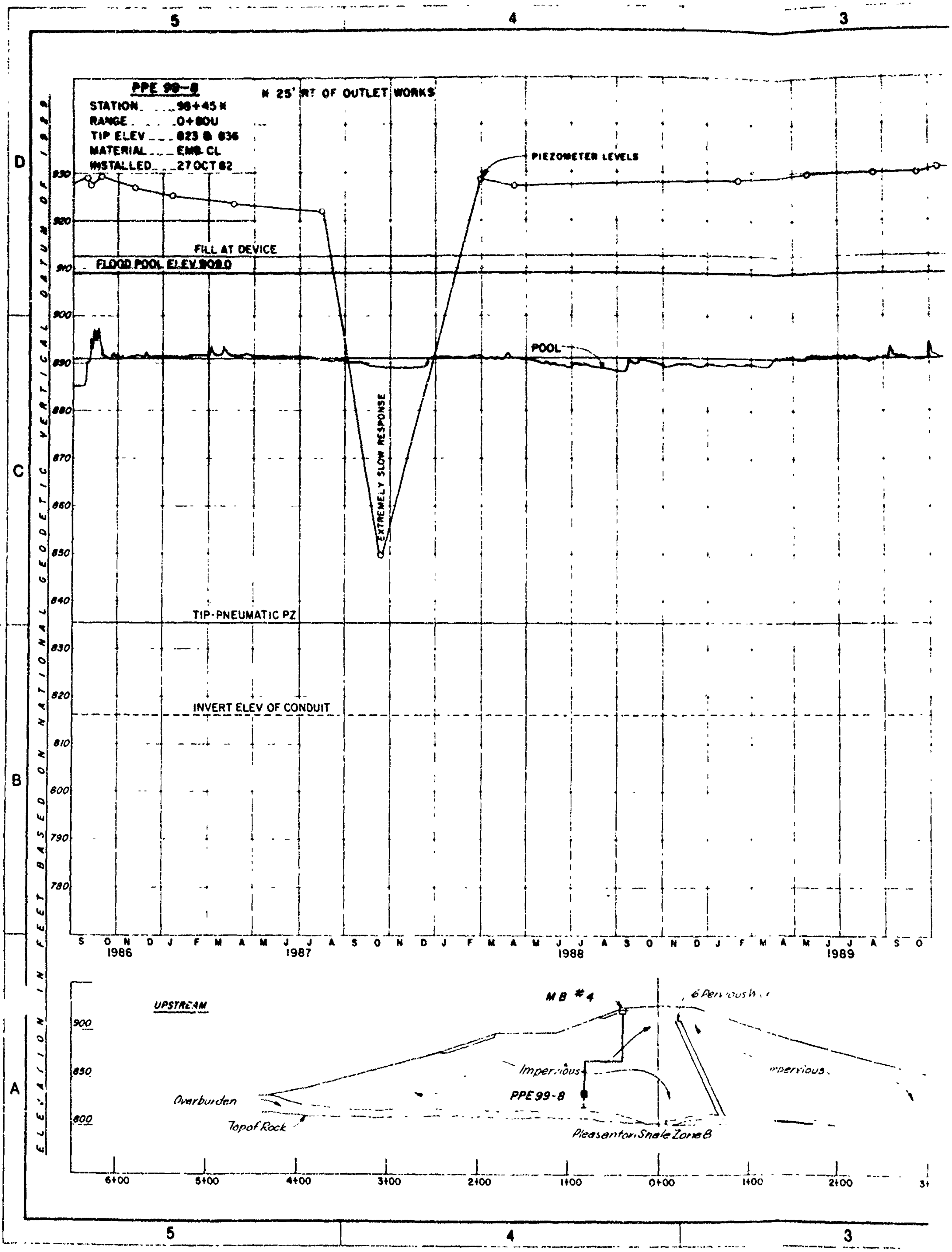
US Army Corps of Engineers

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA AND PERFORMANCE REPORT

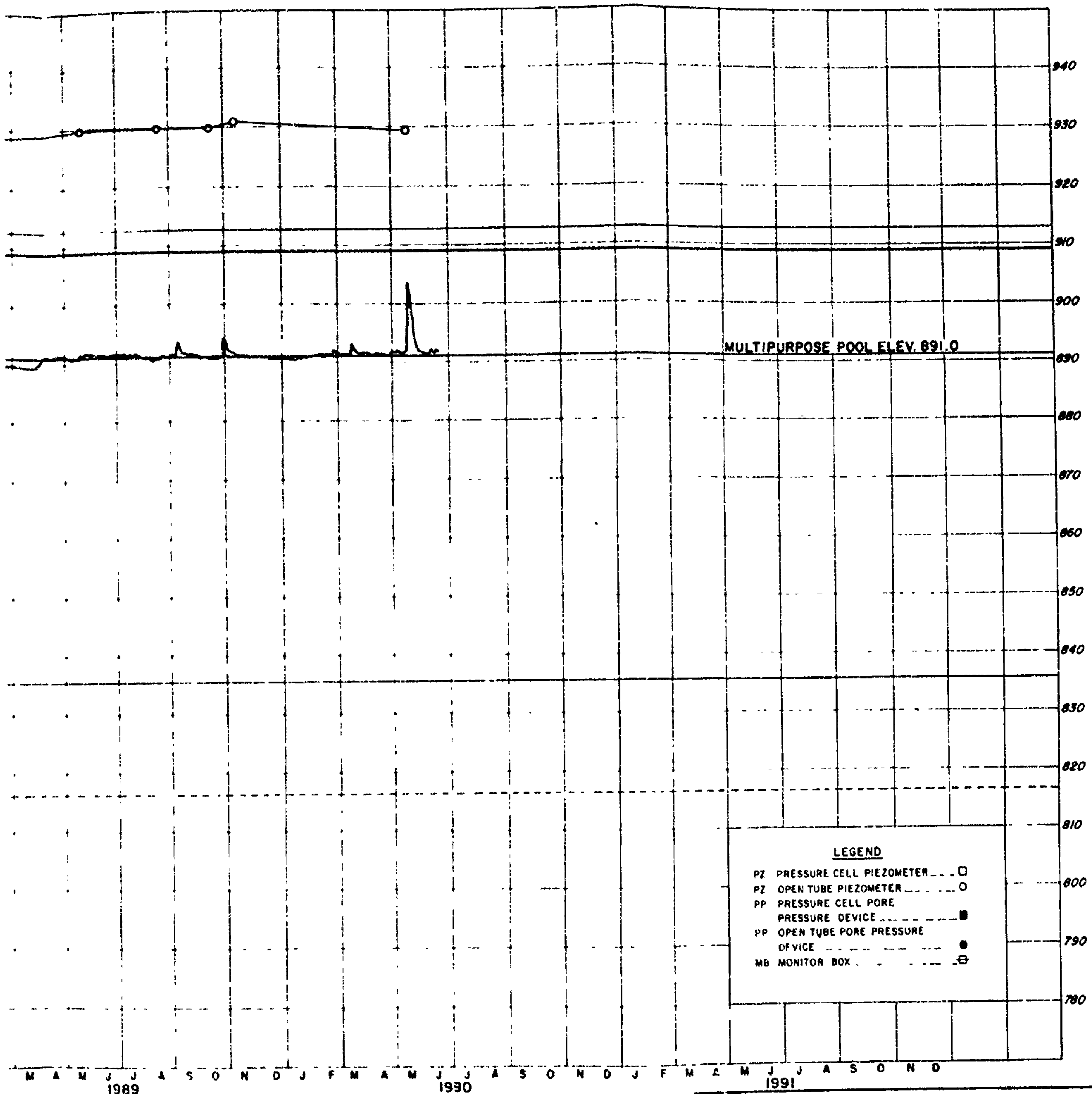
PIEZOMETER PLOTS
PNEUMATIC PZ
PPE 99-8

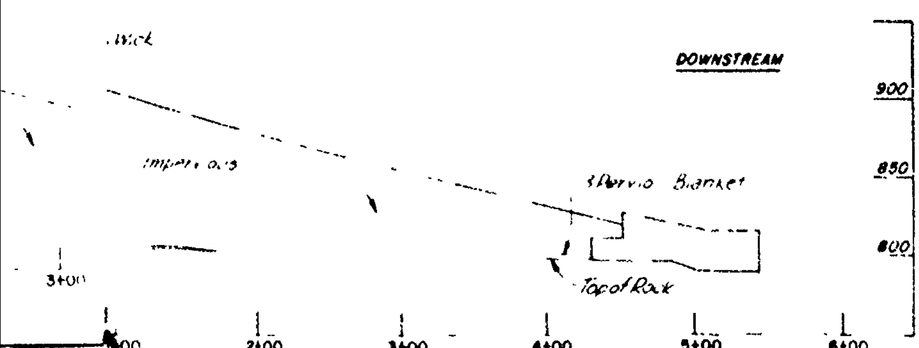
Scale: AS SHOWN
Date: DECEMBER 1986
Dwg No: 1 of 2
Sheet number:
File No: RBL-3-1681

PLATE NO. 116



PPE 99-8
STATION ... 98+45 N
RANGE ... 0+80U
TIP ELEV ... 823 @ 836
MATERIAL ... EMB. CL
INSTALLED ... 27 OCT 82
N 25' RT OF OUTLET WORKS
PIEZOMETER LEVELS
FILL AT DEVICE
FLOOD POOL ELEV 909.0
POOL
EXTREMELY SLOW RESPONSE
TIP-PNEUMATIC PZ
INVERT ELEV OF CONDUIT
ELEVATION IN FEET BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929
930
920
910
900
890
880
870
860
850
840
830
820
810
800
790
780
S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O
1986
1987
1988
1989
UPSTREAM
MB #4
Impervious
Pervious
PPE 99-8
Overburden
Top of Rock
Pleasanton Shale Zone B
900
850
800
6+00
5+00
4+00
3+00
2+00
1+00
0+00
1+00
2+00
5
4
3
D
C
B
A



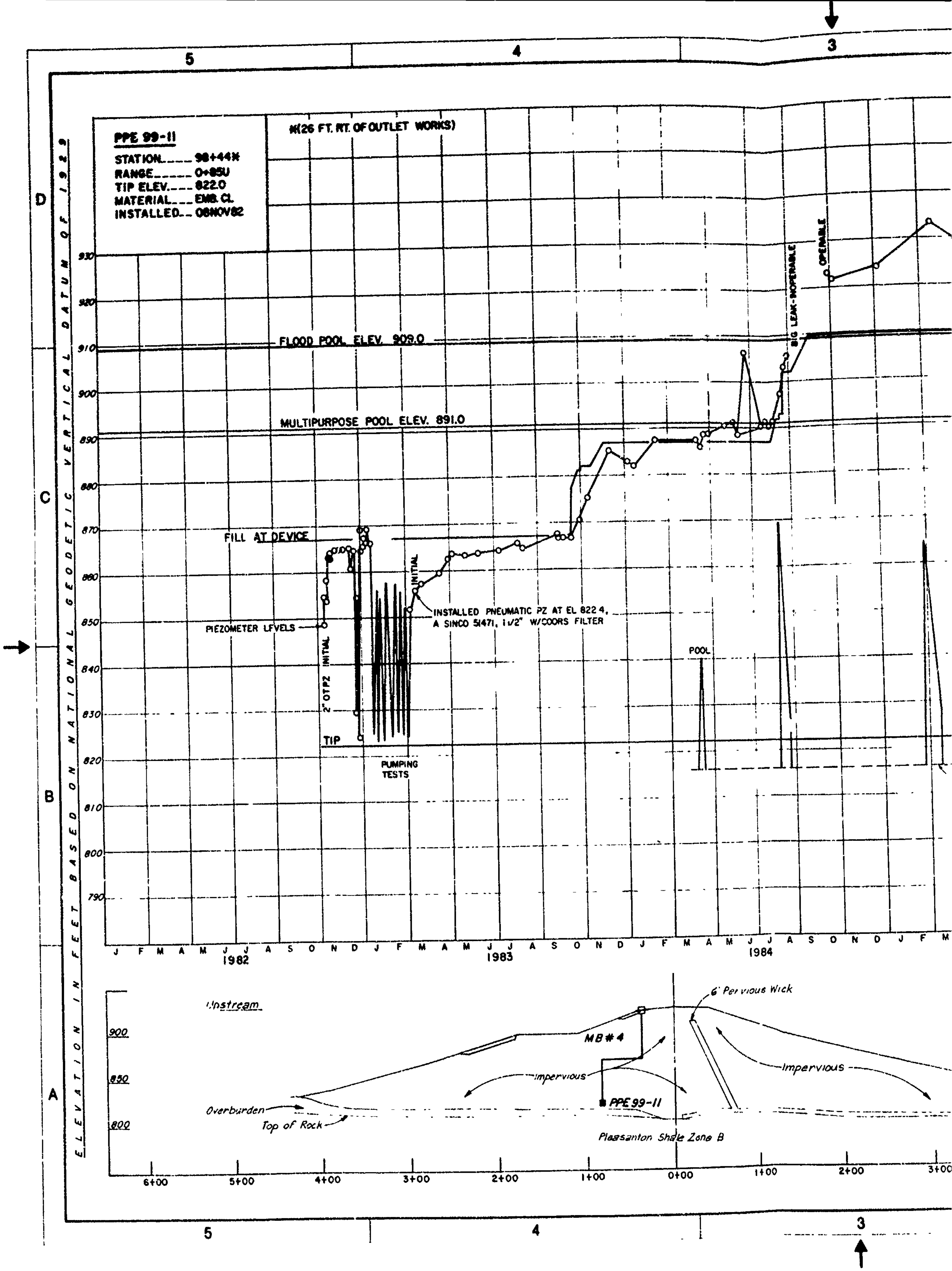


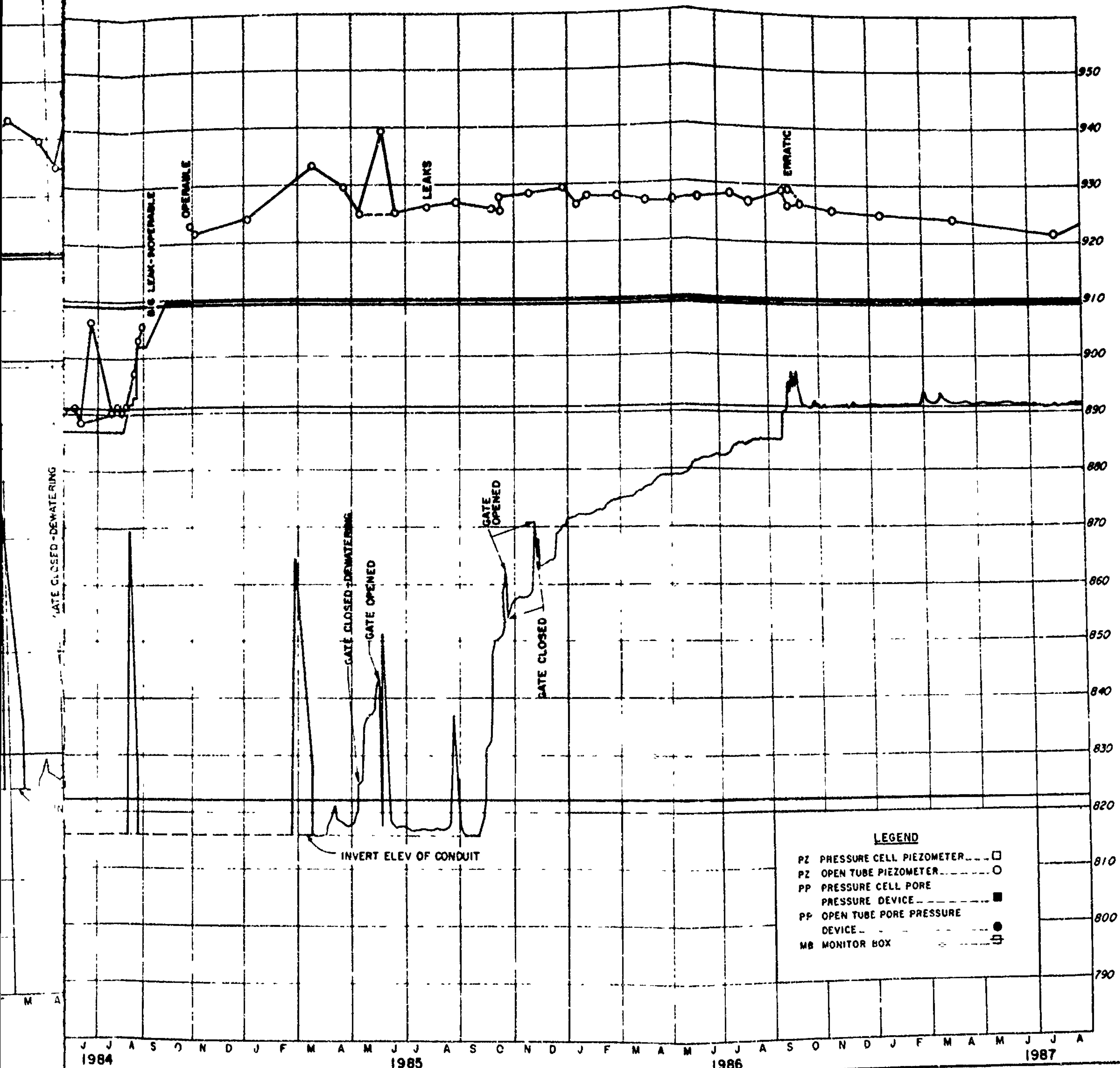
Revisions			
Symbol	Descriptions	Date	Approved
	Revised March 1990		

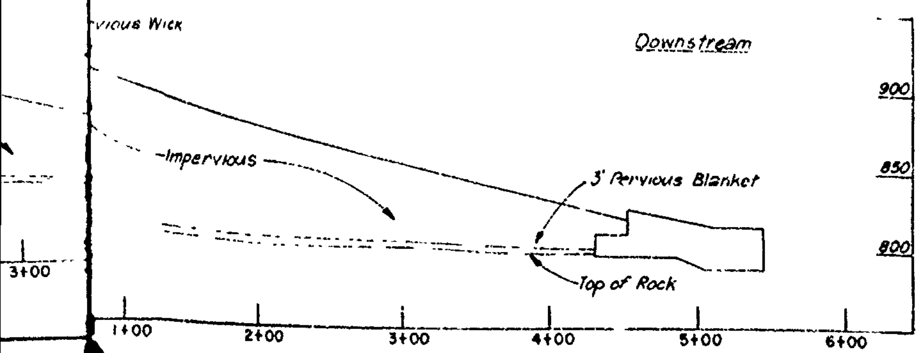
U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

Designed by: RGD	LITTLE BLUE RIVER, MISSOURI LONGVIEW LAKE EMBANKMENT CRITERIA AND PERFORMANCE REPORT PIEZOMETER PLOTS PNEUMATIC PZ PPE 99-8
Drawn by: EER	
Checked by: RLA	Scale: AS SHOWN
Submitted by: WBL	Date: DECEMBER 1986
	Dwg No: 2 of 2 — File No: RBL-3-1682

PLATE NO. 117


PPE 99-11
STATION.....98+44*
RANGE......0+85U
TIP ELEV.....822.0
MATERIAL....EMB. CL
INSTALLED...08NOV82
*(26 FT. RT. OF OUTLET WORKS)
ELEVATION IN FEET BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929
FLOOD POOL ELEV. 909.0
MULTIPURPOSE POOL ELEV. 891.0
FILL AT DEVICE
PIEZOMETER LEVELS
2" OTPZ INITIAL
INITIAL
INSTALLED PNEUMATIC PZ AT EL 822.4, A SINCO 51471, 1/2" W/COORS FILTER
PUMPING TESTS
TIP
POOL
BIG LEAK-INOPERABLE
OPERABLE
1982
1983
1984
Upstream
6' Pervious Wick
MB#4
Impervious
PPE 99-11
Overburden
Top of Rock
Pleasanton Shale Zone B
6+00
5+00
4+00
3+00
2+00
1+00
0+00
1+00
2+00
3+00





Symbol	Revisions Descriptions	Date	Approved

U S ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

Designed by RGD
Drawn by SEY
Checked by RLA
Submitted by WBE

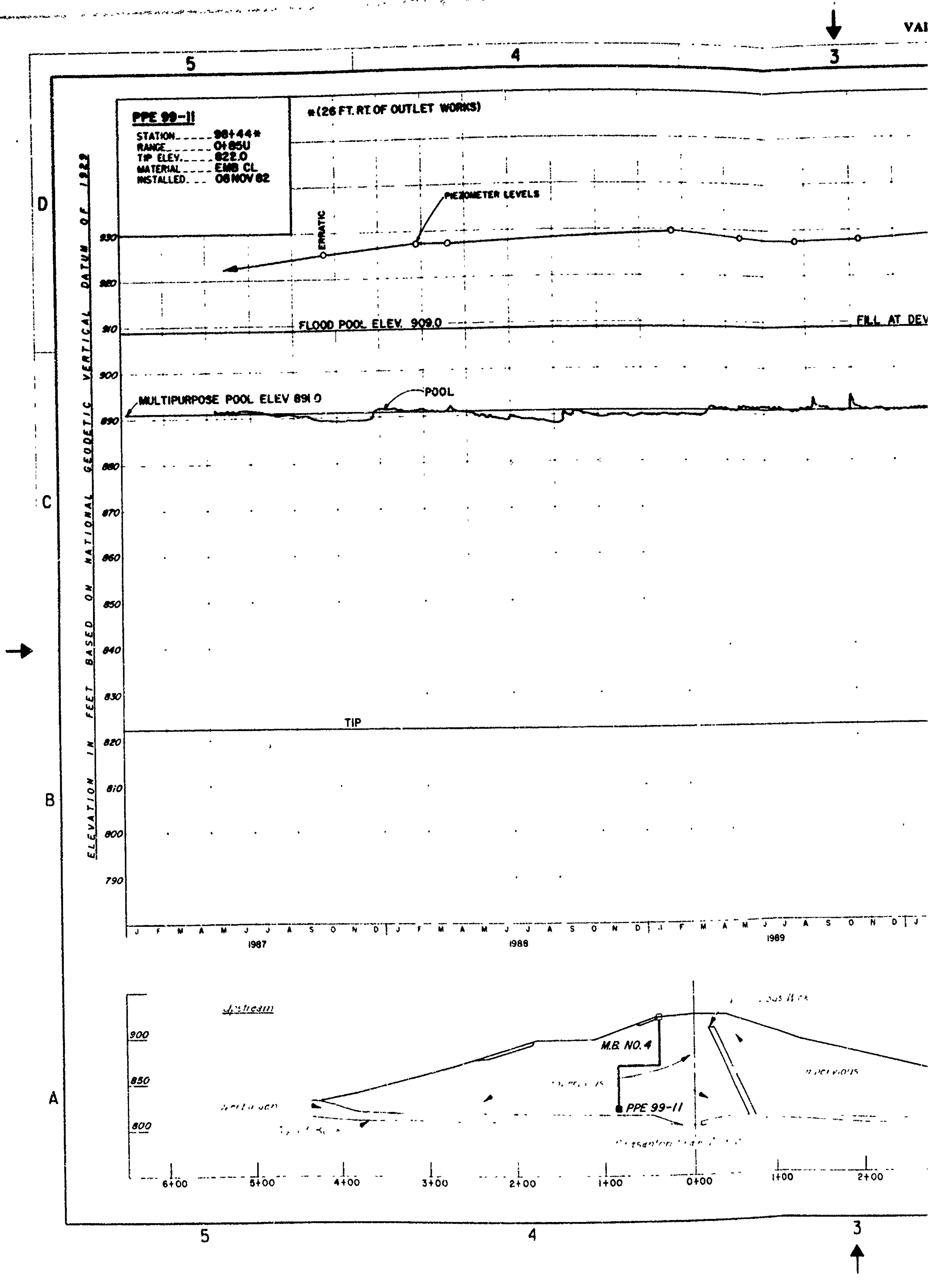
US Army Corps of Engineers

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA AND PERFORMANCE REPORT

PIEZOMETER PLOTS
PNEUMATIC PZ
PPE99-II

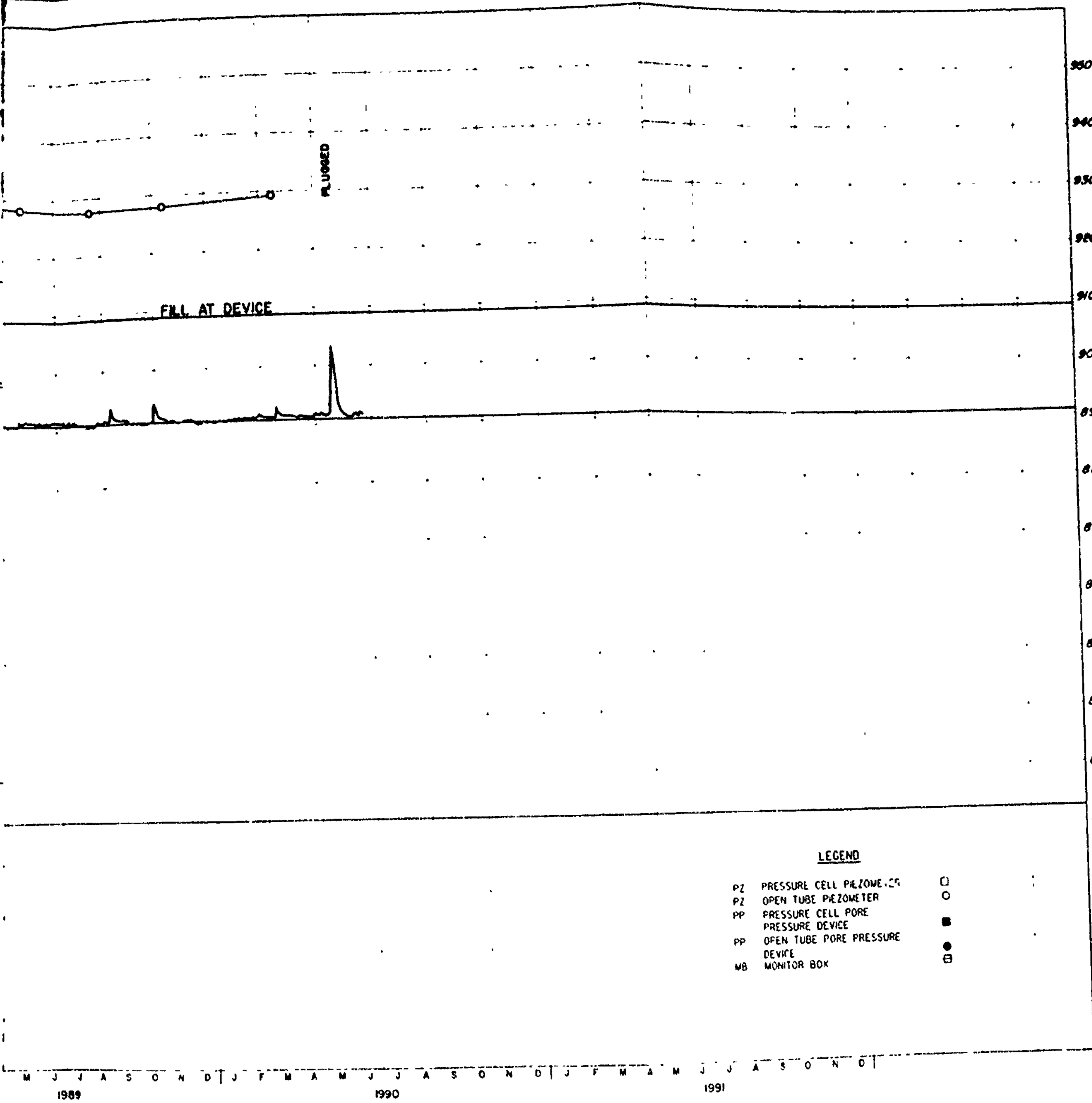
Scale AS SHOWN
Date DECEMBER 1986
Dwg No 1 OF 2
Sheet number
File No RBL-3-1683

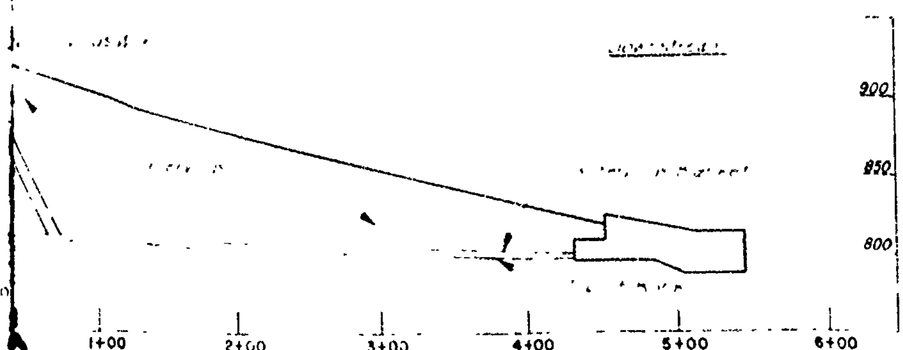
PLATE NO. 118



PPE 99-11
STATION ..... 98+44*
RANGE ..... 0+85U
TIP ELEV. 822.0
MATERIAL ..... EMB CL
INSTALLED ..... 08 NOV 82
*(26 FT. RT. OF OUTLET WORKS)
PIEZOMETER LEVELS
ERRATIC
FLOOD POOL ELEV. 909.0
FILL AT DEV
MULTIPURPOSE POOL ELEV 891.0
POOL
TIP
ELEVATION IN FEET BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929
930
920
910
900
890
880
870
860
850
840
830
820
810
800
790
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J
1987
1988
1989
M.B. NO. 4
PPE 99-11
900
850
800
6+00
5+00
4+00
3+00
2+00
1+00
0+00
1+00
2+00
5
4
3
D
C
B
A
VAL

VALUE ENGINEERING PAYS





Revisions Descriptions	Date	Approved
Revised March 1990		

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA AND PERFORMANCE REPORT

PIEZOMETER PLOTS
PNEUMATIC PZ
PPE 99-11

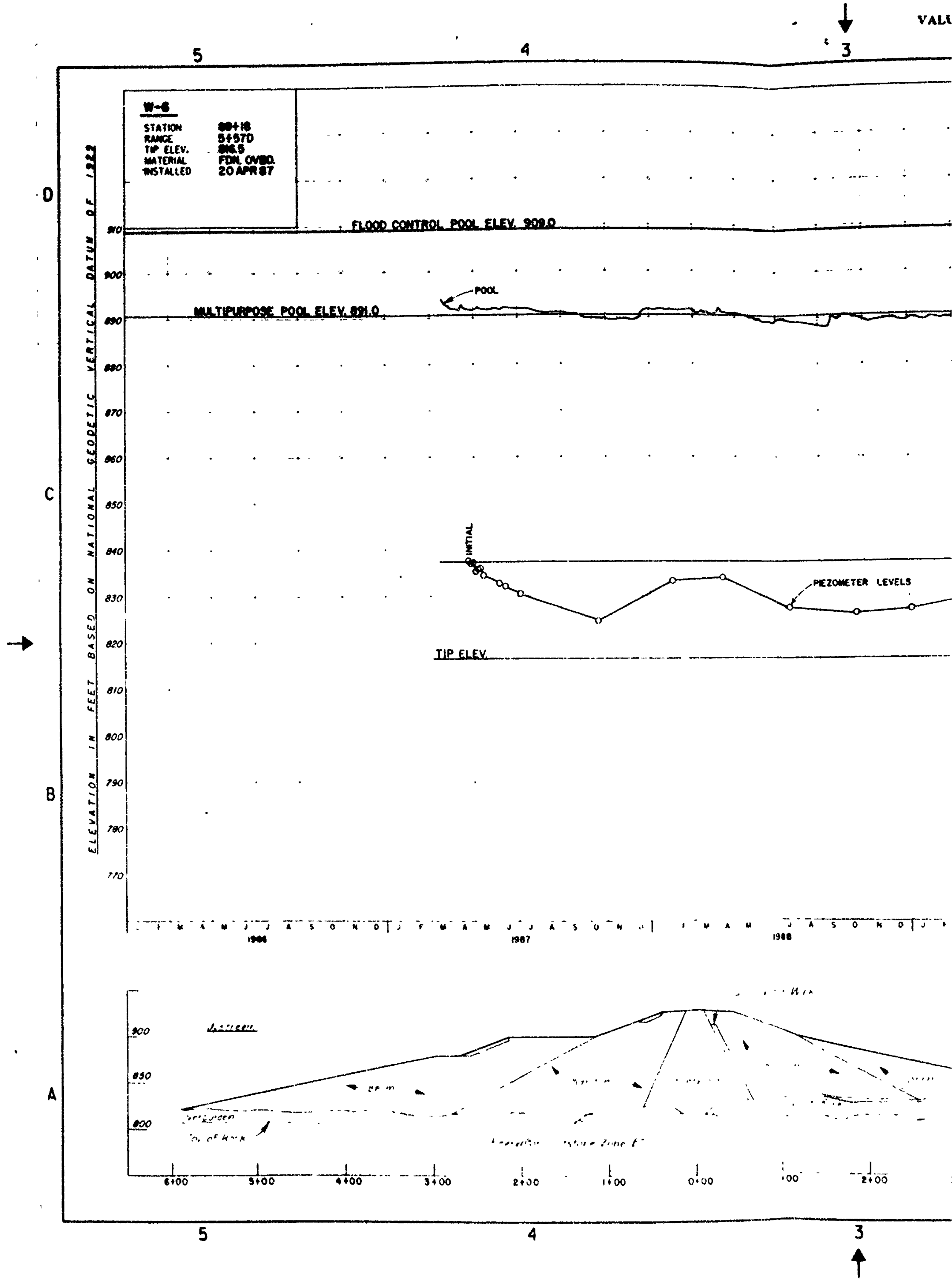
AS SHOWN

DECEMBER 1986

(100,65)PROFILE

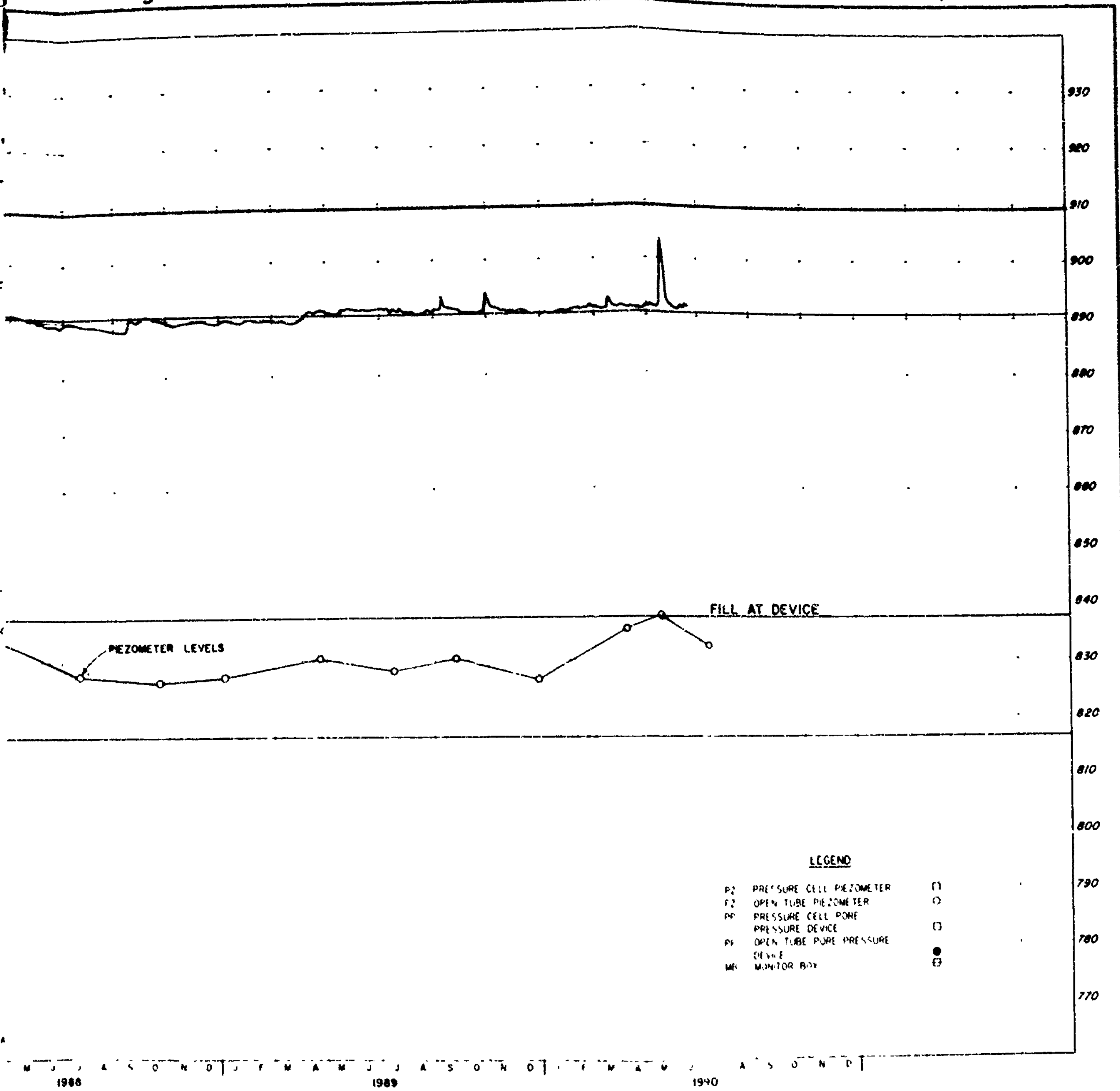
RBL-3-1684

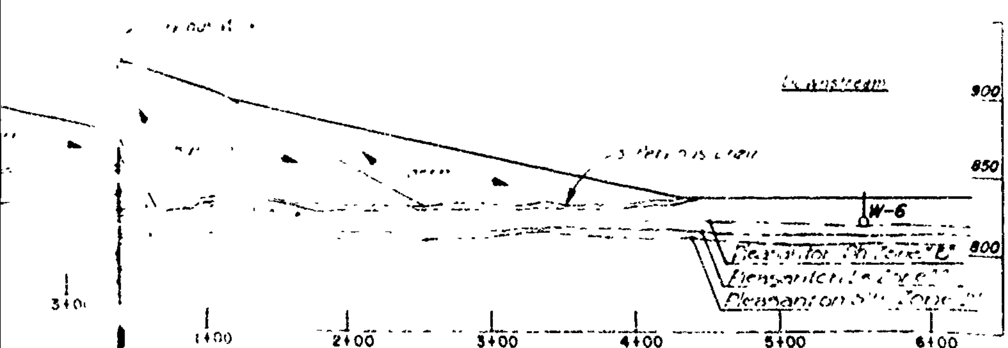
PLATE NO. 119



VALU
W-6
STATION
RANGE 5+570
TIP ELEV.
MATERIAL
INSTALLED 20 APR 87
FLOOD CONTROL POOL ELEV. 909.0
POOL
MULTIPURPOSE POOL ELEV. 891.0
INITIAL
PIEZOMETER LEVELS
TIP ELEV.
ELEVATION IN FEET BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929
910
900
890
880
870
860
850
840
830
820
810
800
790
780
770
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J
1986
1987
1988
900
850
800
6+00
5+00
4+00
3+00
2+00
1+00
0+00
1+00
2+00

VALUE ENGINEERING PAYS





Revised March 1990

Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

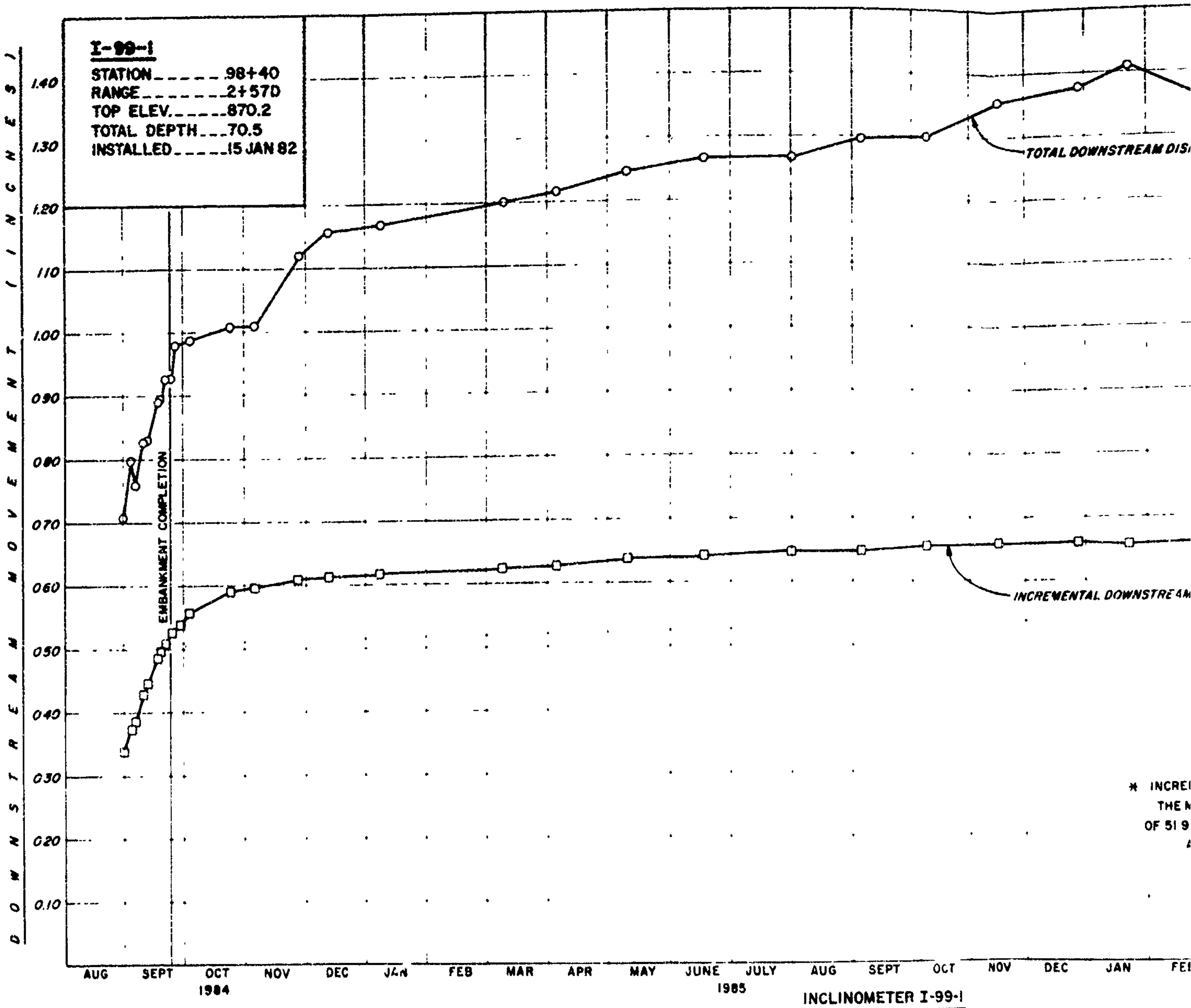
US Army Corps of Engineers

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA AND PERFORMANCE REPORT

PIEZOMETER PLOTS
OPEN TUBE PZ
W-6

PM
RDT
RCA
JFM

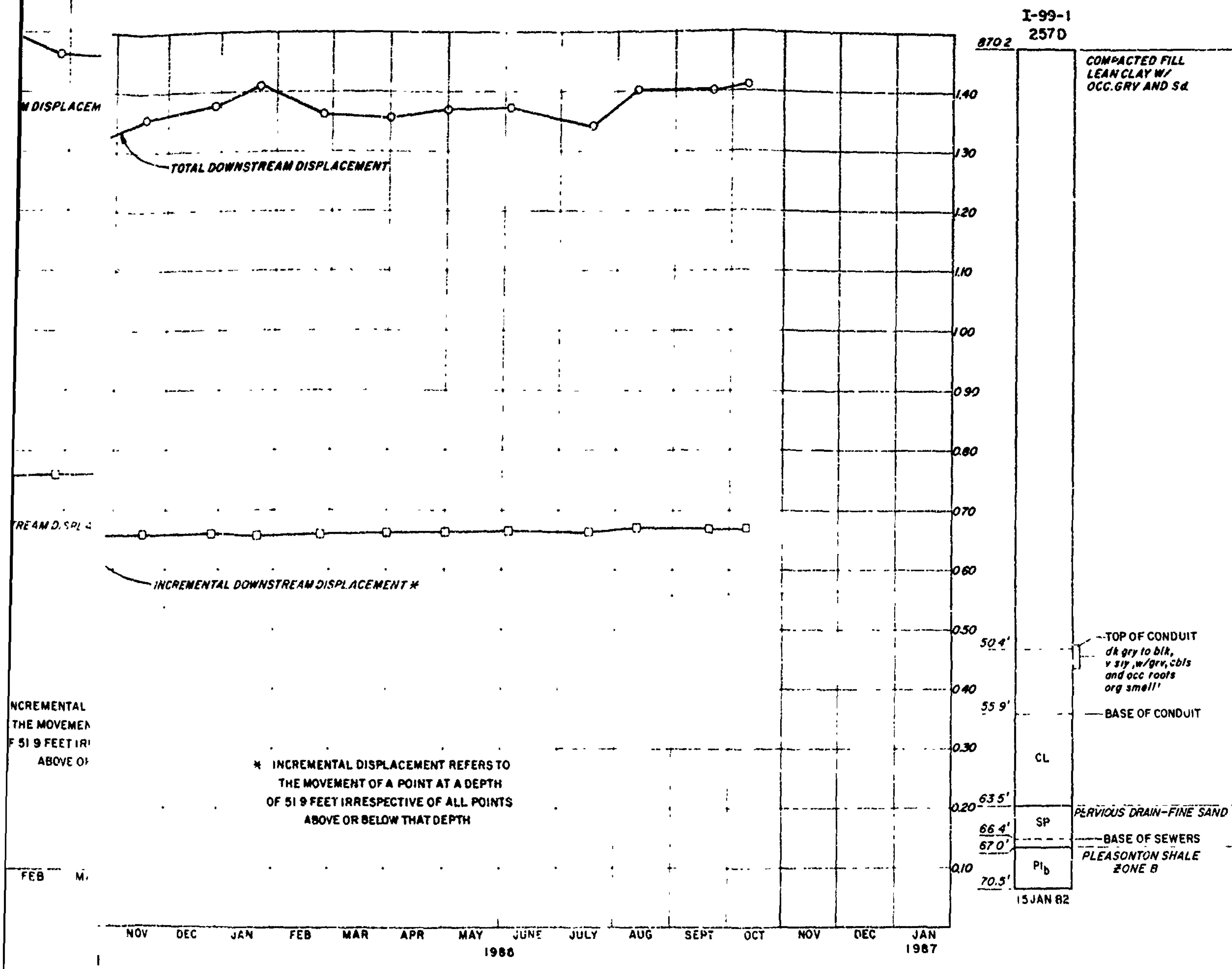
Scale: AS SHOWN
Date: DECEMBER 1986
Plot Scale: 12:1
Design File: [100,65]PROFILE
File No.: RBL-3-1685



INCLINOMETER I-99-1

ND INCREMENTAL DOWNSTREAM DISPLACEMENT VS. TIME

DEPTH: 51.9 FT. ELEVATION: 818.3



SPLACEMENT VS. TIME

1:818.3

Symbol	Revisions Descriptions	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

US Army Corps of Engineers

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA
AND PERFORMANCE REPORT

INCLINOMETER DISPLACEMENTS
I-99-1

Designed by: RGD
Drawn by: DEJ
Checked by: RLA
Submitted by: WBE

Scale: AS SHOWN
Date: DECEMBER 1986
Sheet number:
Dwg No:
File No: RBL-3-1697

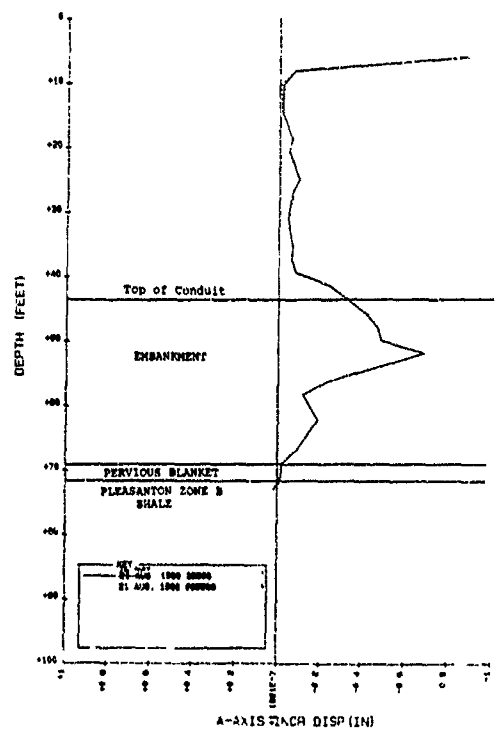
PLATE NO. 121

VALUE

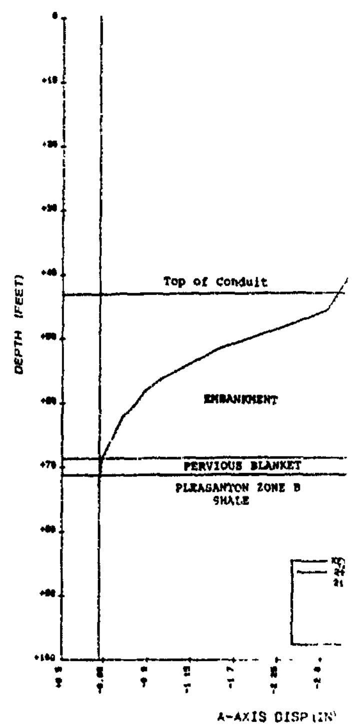
5 4 3

D

LONGVIEW LAKE I-99-1 R2+57D



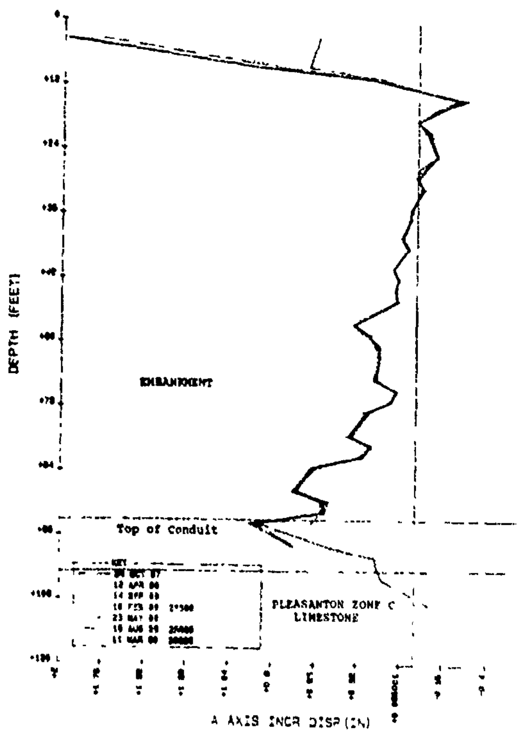
LONGVIEW LAKE I-99-1 R2+57D



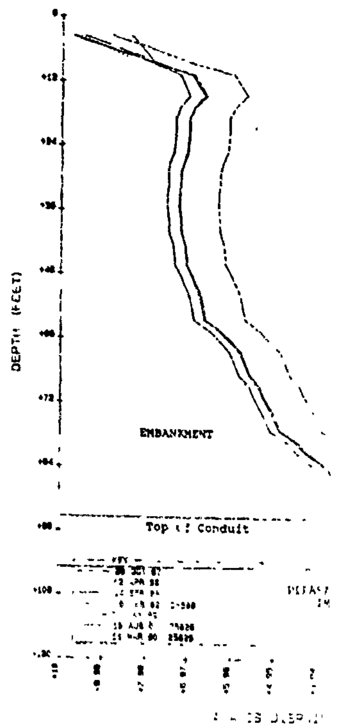
C

B

LONGVIEW LAKE I-99-2 R0+85U



LONGVIEW LAKE I-99-2 R0+85U

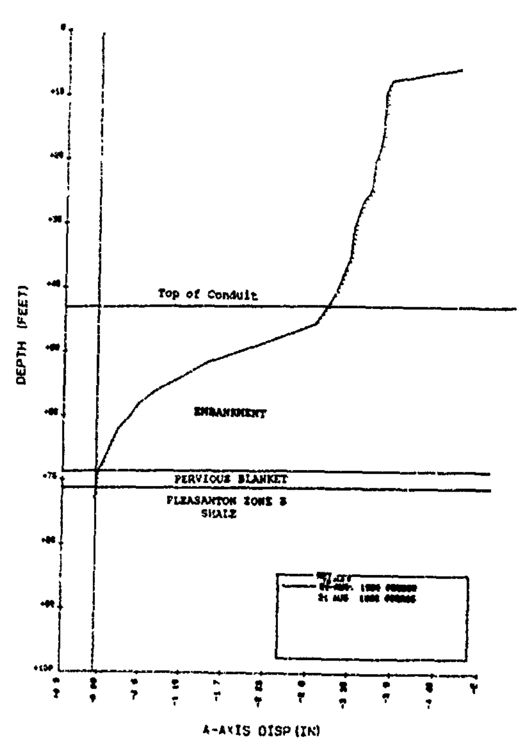


A

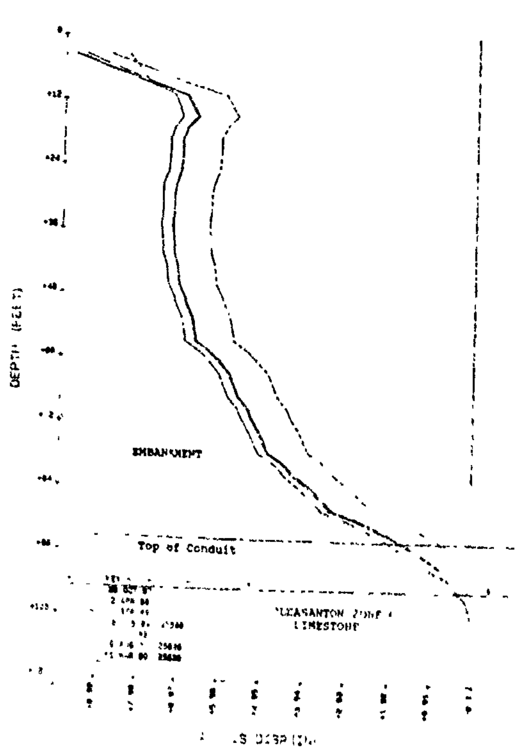
5 4 3

VALUE ENGINEERING PAYS

LONGVIEW LAKE I-99-1 R2+57D



LONGVIEW LAKE I-99-2 R0+85U



Revisions			
Symbol	Descriptions	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

US Army Corps of Engineers

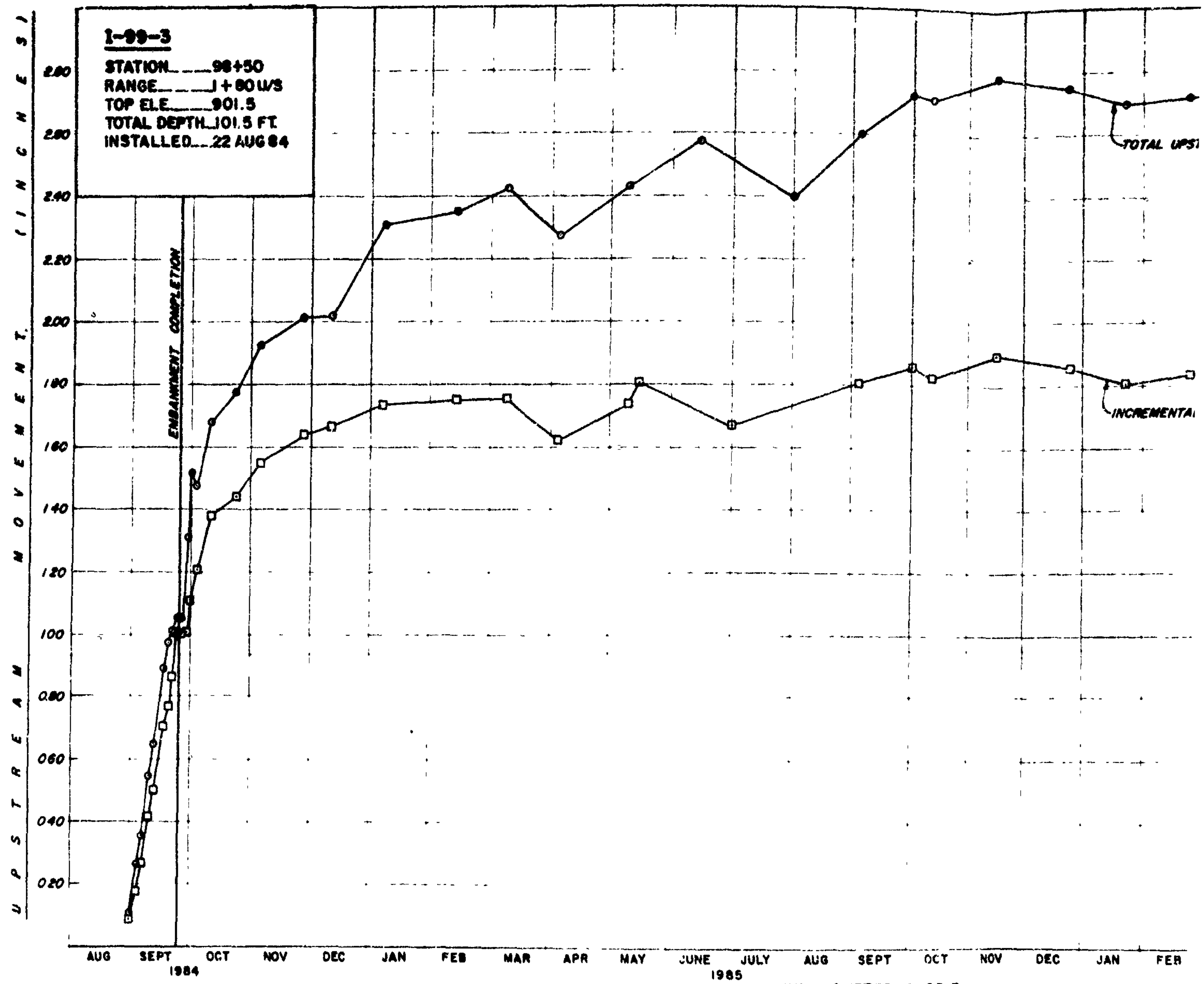
LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA
AND PERFORMANCE REPORT

INCLINOMETER DATA PLOTS
I-99-I AND I-99-2

Designed by:	WBE
Drawn by:	KDS
Checked by:	LLL
Submitted by:	RDG
Scale:	AS SHOWN
Date:	JANUARY 1991
Sheet number:	
Plot Scale:	
Design File:	
Dwg. No.:	
File No.:	RBL-3-1698

PLATE NO. 122

5	4	3

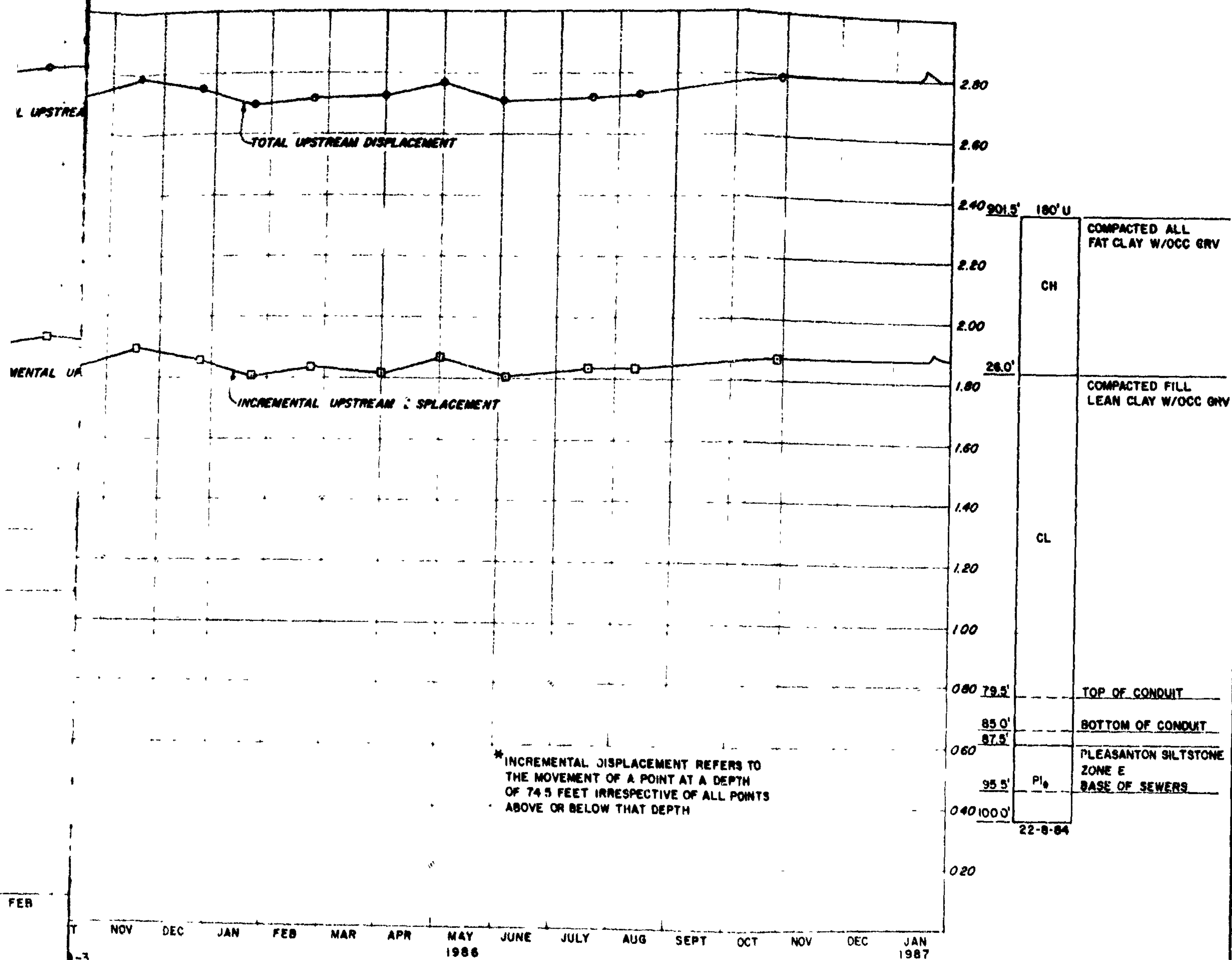


INCLINOMETER I-99-3

TOTAL AND INCREMENTAL UPSTREAM DISPLACEMENT VS TIME

DEPTH 74.5' ELEVATION 827.0

5	4	3



-3

PLACEMENT VS. TIME

827.0

Symbol	Descriptions	Date	Approved

Revisions

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

US Army Corps of Engineers

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA
AND PERFORMANCE REPORT

INCLINOMETER DISPLACEMENTS
I-99-3

Designed by: R G O
Drawn by: F J M
Checked by: R L A
Submitted by: W B F

Scale: AS SHOWN
Date: DECEMBER 1986

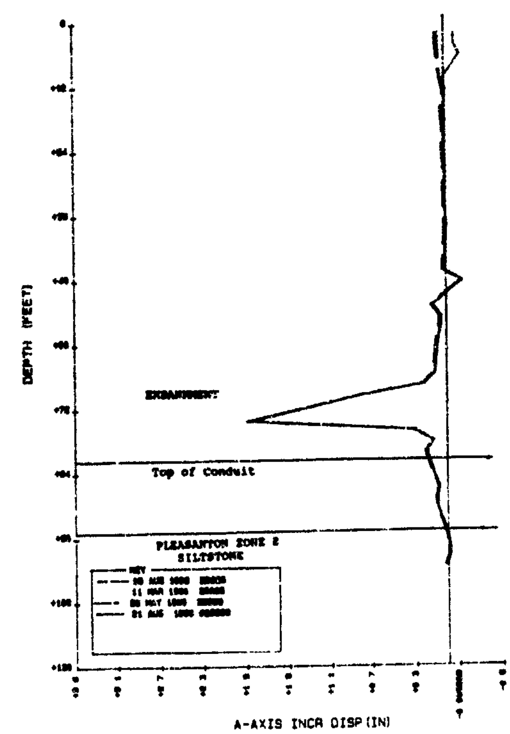
RBL-3-1699

PLATE NO. 123

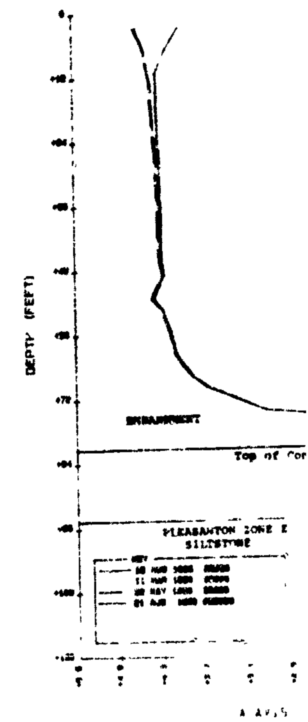
VALUE

5 4 3

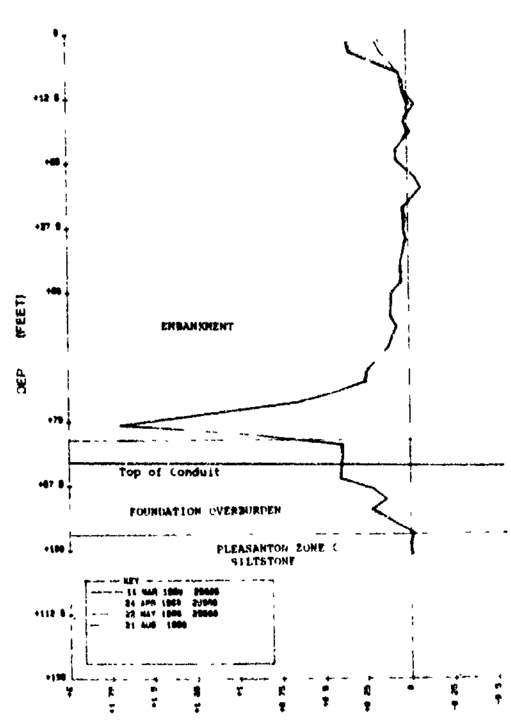
LONGVIEW LAKE I-96-3 R1+80 U/S



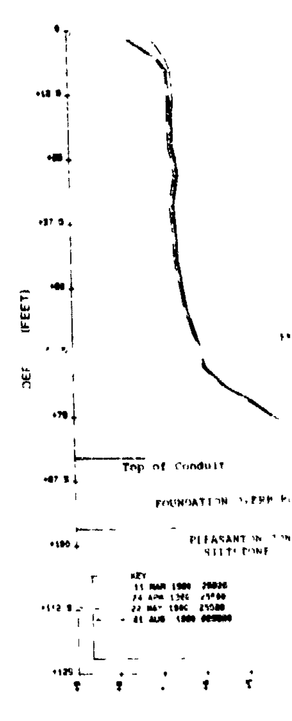
LONGVIEW LAKE I-96-3 R1+80 U/S



LONGVIEW LAKE I-97 1 R1+89 U/S



LONGVIEW LAKE I 97 1 R1+89



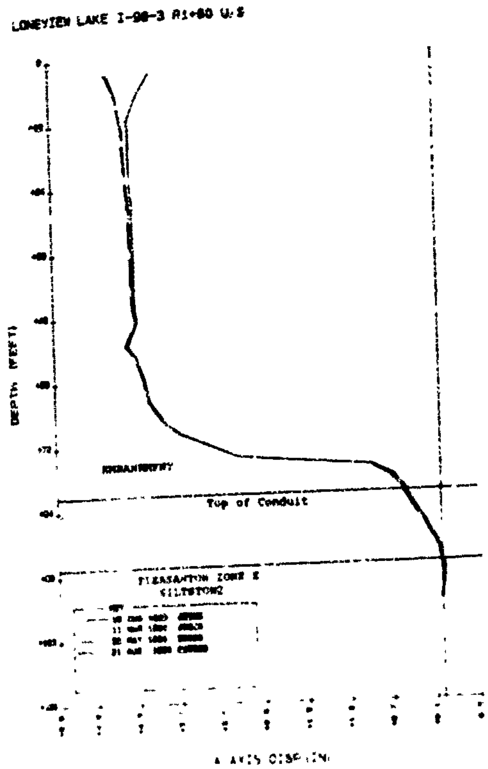
D

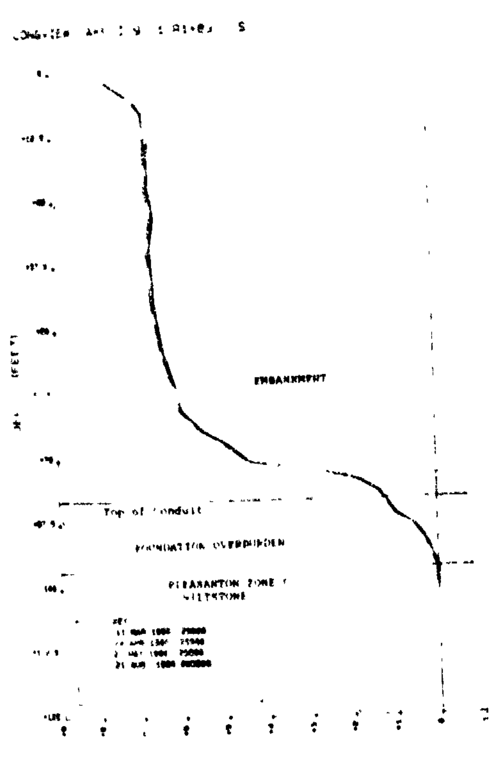
C

B

A

5 4 3





Symbol	Revisions Descriptions	Date	Approved

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI

US Army Corps of Engineers

LITTLE BLUE RIVER, MISSOURI
LONGVIEW LAKE
EMBANKMENT CRITERIA
AND PERFORMANCE REPORT

INCLINOMETER DATA PLOTS
I-99-3 AND I-97-1

Designed by: WBE
Drawn by: KDS
Checked by: LLS
Submitted by: RDL

Scale: AS SHOWN
Date: JANUARY 1991

RBL-3-1700