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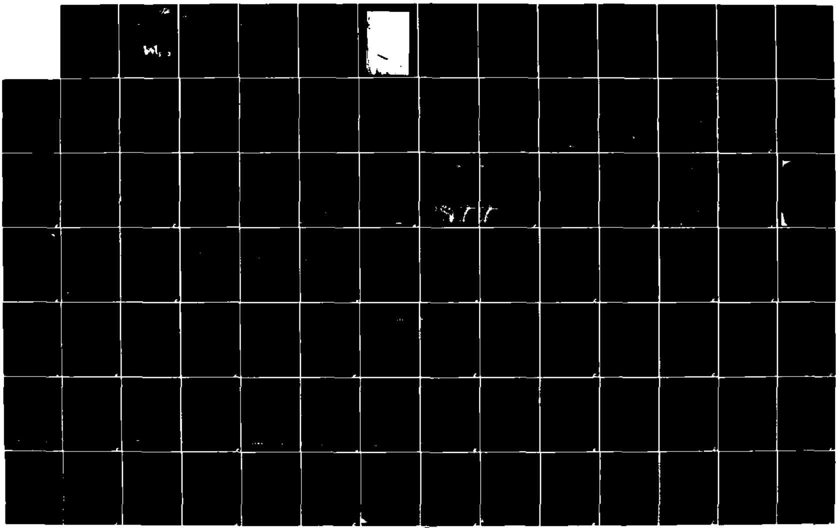

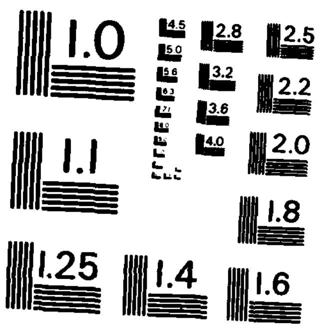

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CLARENCE J. BROWN RESERVOIR

GREATER MIAMI RIVER BASIN

OHIO

EMBANKMENT CRITERIA AND PERFORMANCE REPORT

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U.S. ARMY ENGINEER DISTRICT, LOUISVILLE
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SUBJECT: Embankment Criteria and Performance Report C. J. Brown Reservoir, Ohio

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18. SUPPLEMENTARY NOTES

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

Site Geology
Construction Notes
Foundation-Abutment Treatment
Slope Stability
Diversion-Closure
Compaction Test Results
Shear Test Data
Seepage Control
Operational Notes
Instrumentation

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

The embankment criteria and performance report provides a summary record of significant design data, design assumptions, design computations, specification requirements, construction equipment, construction procedures, construction experience, field control and record control test data and embankment performance as monitored by instrumentation during construction and during initial lake filling.

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C. J. BROWN RESERVOIR
GREATER MIAMI RIVER BASIN
OHIO

EMBANKMENT CRITERIA
AND
PERFORMANCE REPORT

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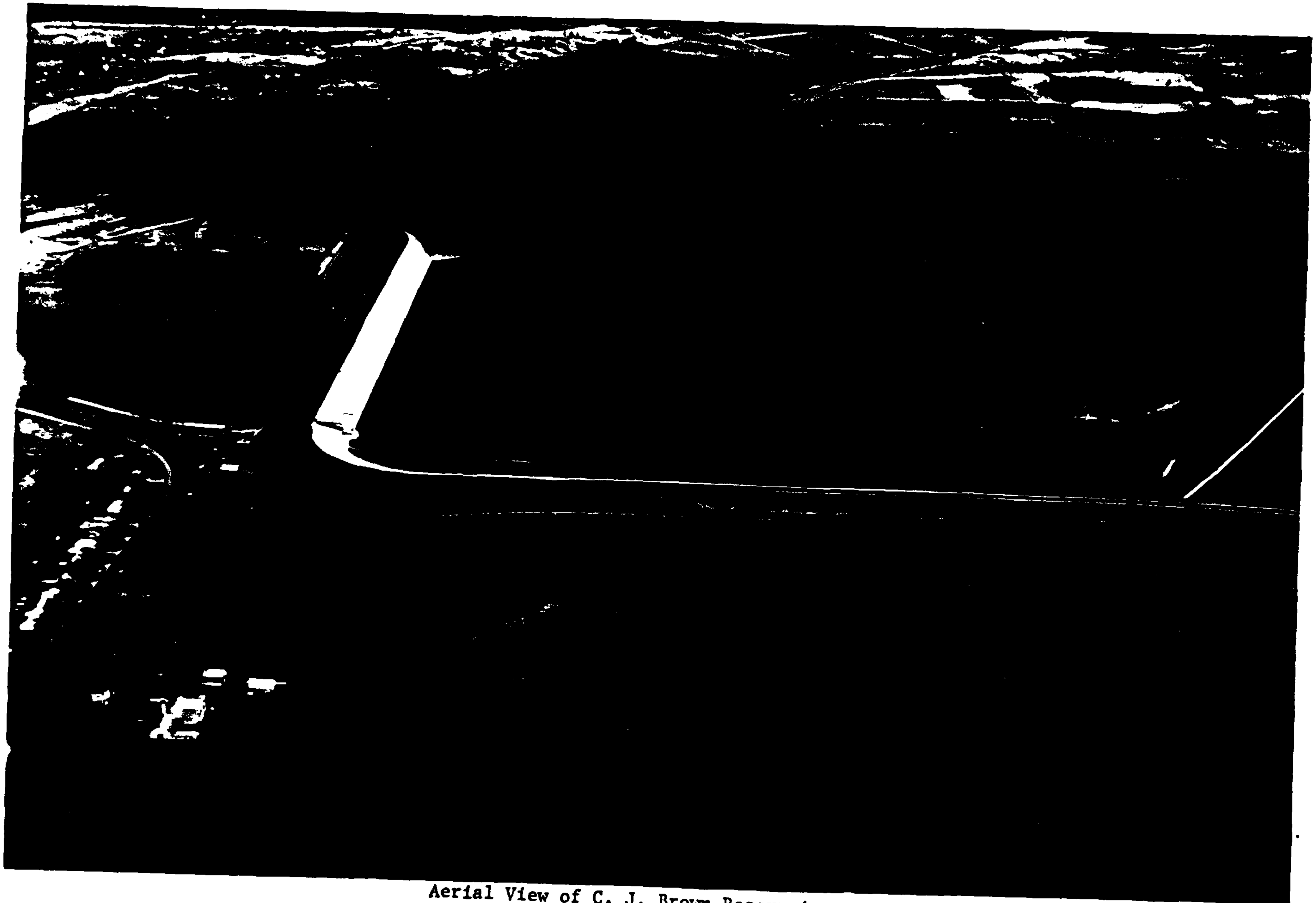

Aerial View of C. J. Brown Reservoir

C. J. BROWN RESERVOIR
BUCK CREEK, OHIO
EMBANKMENT CRITERIA AND PERFORMANCE REPORT

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C. J. BROWN RESERVOIR
BUCK CREEK, OHIO
EMBANKMENT CRITERIA AND PERFORMANCE REPORT

PERTINENT DATA

1. Authority for Project. Flood Control Act approved 23 October 1962 (Public Law 87-874, 87th Congress).

2. Purpose of Project. To furnish flood protection for the city of Springfield, Ohio, and reduce flood stages at all points downstream in the Mad River Basin. A secondary purpose of the project is to provide a pool for water supply, water quality, recreation, fish and wildlife, and related activities.

3. Location of Project. The dam is located on Buck Creek in the Mad River Basin near Springfield, Ohio, 7.3 miles above the mouth of Buck Creek.

4. Drainage Area. Dam Site - 82 square miles.

5. Lake.

Item	Elevation (feet msl)	Area (acres)	Storage (acre-feet)
Minimum pool	995	1,010	10,000
Water quality	995 - 1000	-	20,800
Seasonal pool	1009 - 1012	2,120	6,100
Flood pool	1009 - 1023	2,720	32,900

6. Dam.

a. Embankment.

Type	Earth fill
Top elevation	1040
Maximum height, feet	72
Length, feet	6,330
Top width	30

b. Spillway.

Type	Open cut through glacial till on right abutment ridge with concrete ogee chutes at end
Crest elevation	1023
Bottom width, feet	310
Entrance grade	0.5%
Protection for spillway cut	Sheet pile cutoff and riprap protection adjacent to control structure

c. Outlet Works.

Type	Circular
Diameter, feet	11
Control gates, number	2 service, 2 emergency
Size, feet	5 x 11, 5 x 11 (emergency)
Bypass gates, number, size	1 - 18-inch diameter 1 - 24-inch diameter

7. Land Acquisition.

Fee area, acres	4,127

8. Relocations.

a. New York Central Railroad, miles	5.5
b. Buck Creek Lane, miles	1.6
c. Power lines, miles	8.5
d. Telephone lines, miles	2.4
e. Pipeline, miles	1.4

9. Public Access

Number of sites	2

10. Reservoir Clearing

Area, acres	20

11. Hydroelectric Power — None

C. J. BROWN RESERVOIR
BUCK CREEK, OHIO
EMBANKMENT CRITERIA AND PERFORMANCE REPORT

1. General.

a. Authority. Authority for preparation of the Embankment Criteria and Performance Report for C. J. Brown Reservoir is contained in ER 1110-2-1901 dated 1 Aug 72.

b. Project Purpose. To furnish flood protection for the city of Springfield, Ohio, and reduce flood stages at all points downstream in the Mad River Basin. A secondary purpose of the project is to provide a pool for water supply, water quality, recreation, fish and wildlife, and related activities.

c. Project Location. The dam is located on Buck Creek in the Mad River Basin near Springfield, Ohio, 7.3 miles above the mouth of Buck Creek.

d. History of Construction. The outlet works was constructed under a separate contract, DACW27-67-C-0020. The contract was awarded on 7 September 1966, and completed on 16 July 1968. The contract DACW27-71-C-0054, Construction of Dam and Spillway and Relocation of Roads and Railroads, Clarence J. Brown Reservoir, Mad River Basin, Ohio, was awarded on 13 October 1970 to the Holloway Construction Company of Wixom, Michigan, and the notice to proceed was received on 26 October 1970.

Work began with some survey work on 5 November 1970 and clearing started on 24 November 1970. Excavation for railroad relocations was begun in December 1970, but stripping at the damsite did not begin until 28 April 1971.

The following is a compilation of significant starting dates:

02 Nov 1970 - Day 1 of the contract

28 Apr 1971 - Started stripping operations at damsite

10 May 1971 - Excavating in spillway - place in stage 2 Cofferdam.

19 May 1971 - Excavating core trench in stage 1. (Station 40+00 to 48+00)

26 May 1971 - Start pumping dewatering equipment in core trench

28 May 1971 - Compacting impervious fill in core trench, stage 1. (Station 36+50 to 39+00)

05 Jun 1971 - Placing chimney drain downstream of impervious core

07 Jun 1971 - Placing random fill

08 Jul 1971 - Opened up last section of cut-off trench in East-West leg of dam

28 Aug 1971 - Started constructing diversion cofferdam

30 Aug 1971 - Diverted stream through outlet works

02 Sep 1971 - Artesian flow started in core trench at Station 24+10

20 Sep 1971 - Artesian flow under control

14 Mar 1972 - Drilling dewatering well for stage 3 cut-off trench

05 Jun 1972 - Building stage 3 cofferdam

17 Aug 1972 - Opened up supplemental borrow area along spillway

24 Aug 1972 - Start borrow in upstream borrow area

19 Sep 1972 - Place a 2' thick impervious blanket between the core and the impervious layer on the upstream side of the dam at original ground between Stations 2+00 and 8+00

02 Nov 1972 - First periodic inspection in compliance with ER 1110-2-100

20 Nov 1972 - Start drilling relief wells

07 Jan 1973 - Relief wells complete

22 May 1973 - Topped out dam

16 Nov 1973 - Job accepted as being physically complete

2. Geology. a. Project Area. Before the great ice sheets of Pleistocene time invaded Ohio, drainage was quite different from that of today. The master stream of the pre-Pleistocene drainage system, the Teays River, had its headwaters in the Piedmont area of southeastern United States and flowed northwest through central Ohio, crossing the northeastern corner of Clark County. The dam site is located in the floor of the Teays Valley which is elevation 500+. Plate 2 shows the present and preglacial drainage in central Clark County. The Teays Valley is now buried by 475 to 600 feet of glacial drift. The two major types of glacial deposits in the area are clay till and sand and gravel. All drift exposed at the surface in Clark County was deposited during the Wisconsin stage; however, there are some Illinois deposits buried beneath the Wisconsin tills, sand and gravels. The Wisconsin glacier was split by highlands in the vicinity of Bellefontaine, Logan County, into two lakes, whose southward advance was concentrated along two main valleys, the Scioto Valley in central Ohio, and Miami Valley in western Ohio. From these principal routes the ice lakes spread outward and invaded Clark County from two directions, the Scioto lake from the east and the Miami lake from the northwest, approaching each other in the area south of Springfield. The area east of Springfield is composed of a series of end and ground moraines separated by outwash deposits. The end moraines consist of till with continuous and discontinuous lenses of sand and gravel. The outwash deposits consist primarily of sand and gravel; however, discontinuous ridges of clay till do occur within the sand and gravel.

When the Miami and Scioto lobes stood with their fronts some distance apart in eastern Clark County, floods of meltwater built a flat-topped plain 20 miles long and as much as 2 miles wide. The alignment of the outwash plain runs from New Moorefield and southwest in the present North Fork of the Little Miami River. The easternmost end moraine of the Miami lobe is on the west of the outwash plain and the westernmost advance of the Scioto lobe is on the east of the outwash plain. The right abutment of the dam and the spillway are located in the eastern Miami lobe end moraine. The left abutment of the dam and conduit tie into the western portion of the outwash plain. When the valleys became free of ice, they were drainage courses for meltwater which deposited pervious sand and gravel, called valley-train deposits. Valley-train deposits vary from less than 1/2 mile to 1 mile wide in the Buck Creek flood plain. These deposits are 20-25 feet thick at the dam site. (See Plate 3, for alluvial and glacial deposits of a portion of Clark County.) Topography in the project area varies from hummocky ridges in the right abutment end moraine to flat-topped outwash-plains which form the left abutment. Drainage is primarily internal. There are numerous springs which are forced to the surface by impervious layers of clay. There are 100 feet of relief in the area. Plate 4 shows a generalized geologic section of the dam site area, looking upstream.

b. Damsite. The right abutment is composed of horizons of clay, sand, gravels, and compact glacial till in descending order as shown on the geologic profile, Plates 10 and 11. The till is very compact with lenses of sand and gravel and is specifically classified as sandy gravelly clay. The abutment is relatively impervious up to elevation 980, top of till. The top of till continues to rise toward the spillway where it reaches an elevation of 1025, as shown on the geologic profile of the spillway, Plate 12. At the abutment there are 15 to 25 feet of pervious sand and gravel overlying the till.

The valley section of the dam is founded on valley train deposits. There are 20 feet of pervious sand and gravel overlying impervious clay till in the bottom with the exception at the toe of the left abutment where there are 25 feet of sand and gravel. This was the old channel prior to the deposition of the valley train sand and gravel.

The conduit and stilling basin were notched into the gently sloping left abutment and were founded directly on glacial till. Impervious backfill was used to cover the conduit in the area of the impervious core and random backfill was used to cover the conduit in the area of both the upstream and downstream random fill outer shells. Backfill was placed a minimum depth of 4 feet over the top of conduit for its entire length. The left abutment is composed of pervious sand and gravel, overlying impervious till. Plans and sections for the outlet works and stilling basin are shown on Plates 4A and 4B, respectively.

3. Foundation and Abutment Treatment. Excavation was accomplished mainly with rubber-tired scrapers with some localized excavation performed by backhoes and other similar equipment. For the most part, excavation was carried directly to grade with the equipment.

The cut-off trench for the dam was excavated one foot into the glacial till where it was encountered. Prior to placing the first lift of impervious material, the foundation surface was scaritied lightly with a disc or the teeth on the bucket of a front-end loader. The first lift of material was then placed on the foundation and construction proceeded in a normal manner. In the foundation under the random zones of the embankment, the ground surface was disked up and then compacted by twelve passes of the roller.

On the right abutment of the dam the impervious till was not encountered at the anticipated founding elevation at the core trench between Stations 0+80 and 1+80. The material in the abutment was composed of interbedded layers of sand and gravel. Three borings were taken along the centerline and shows a large sand and gravel lens lying between elevations 978 and 1000 downstation of Station 1+80. It is not known if this layer is continuous; however, a sand and gravel layer was day-lighted upstream of the dam where a haul road cut into the abutment. An impervious blanket two feet thick was placed over all exposed sands and gravels in the haul road cut upstream from the abutment of the dam. Furthermore, to preclude seepage through the upstream random zone of the dam into the underlying sand and gravel layers upstream of the dam, a 2-foot thick impervious blanket was placed from the impervious core upstream to the 2- to 4-foot thick impervious layer at ground level upstream from the dam. This blanket was placed between Stations 2+00 and 8+00.

4. Embankment.

a. General. The general plan is shown on Plate 5 and boring locations are shown on Plates 7-11. Typical embankment sections are presented on Plate 6. The right abutment and flood plain sections were designed using a central impervious core with random shells. The embankment on the left abutment was designed as a homogeneous impervious section with an upstream clay blanket. An inclined drain was provided between the impervious central core and the downstream random zone. The inclined drain was not required since the embankment is founded on pervious sand and gravel.

Embankment material was supplied by required excavation in the cut-off trench and the spillway supplemented by additional material alongside of the spillway and a borrow area just upstream of the dam in the pool area.

Impervious material for the core trench came from the spillway and auxiliary borrow area. The granular material for the pervious drain came from the spillway and in very few cases were there any problems in holding the amount of fines down (0-5% passing the #200 sieve).

The distribution of density tests performed on the embankment materials are shown on Plates 29 through 52. A summary of field compaction control test data and design placement requirements is shown on Plate 53. The laboratory compaction proctor curves are shown on Plate 54.

Contract requirements specified were:

	Impervious	Random	Pervious
Lift thickness	8" max.	12" max.	12" max.
Moisture (from optimum)	$\pm 2\%$	$\pm 2\%$	N/A
Type of Roller	Tamping	Rubber-Tired	Rubber-Tired
Number of Passes	6	4	4
Density	95% comp @ opt.	95% comp @ opt	95% comp @ opt

The Contractor used ten (10) 631 caterpillar scrapers to haul the material and compacted the impervious fill with a self-propelled sheepsfoot.

roller (Ferguson SP-112) and the random and pervious with a 50-ton pneumatic tired roller (BROS-ROLL-O-PACTOR 460). The following table lists the pertinent statistics for these rollers:

<u>FERGUSON SP 112 TAMPER</u>

<u>Type</u>	Self-propelled sheepsfoot
<u>Size</u>	2 drum - 5' diameter, 5' long
<u>Tamping Feet</u>	Base area - 7.06 in^2 Shape - round Length - 9-1/2" Feet/drum - 120 Feet/row - 4 feet/row/drum Rows - 30 rows/drum
<u>Weight</u>	Drums empty - 27,630# As used - 36,300# (diesel spec G.85)
<u>Foot Pressure</u>	648 psi (diesel filled) (8 feet in contact)
<u>Cleaners</u>	Spring actuated Reversible Front & rear
<u>Specified Speed</u>	3.5 mph max.

<u>BROS-ROLL-O-PACTOR 460</u>

<u>4-Tires 18.00 x 25 40 ply</u>

<u>Width</u>	7'-10" from outer edge to outer edge of tires
<u>Weight</u>	96,000 # with wet sand (18,460# ship weight) Tire pressure min 70 psi, max 150 psi
<u>Contact Pressure</u>	Variable
<u>Speed</u>	5 mph max. (specified) 3.5 mph (actual)

There were no problems achieving density and no additional rolling was necessary. Some problem was encountered in controlling the moisture in granular material in the random sections. The water would drain out of the material during compaction. As the material was usually wet coming from the borrow areas, it was rolled wet and the desired density was achieved.

b. Shear Strength. Laboratory tests were completed at the Ohio River Division Laboratories, Cincinnati, Ohio. Samples were subjected to visual classification with verifications by mechanical analysis and Atterberg Limits, natural moisture content, Q, R, and S shear tests, and consolidation tests. Shear test summaries are presented on Plates 13 through 16. The adopted shear strengths are given below and were all based on tests except the "S" strength value for the foundation sand and gravel which was assumed.

TABLE 1

ADOPTED DESIGN DATA

Material	Moist Wt. PCF	Sat. Wt. PCF	Sub. Wt. PCF	Type Test	Tan Ø	'C' TSF
				Q	0.00	0.70
Embankment	135.9	138.9	76.4	R	0.37	0.27
Impervious				S	0.60	0.00
Embankment Random	125.0	127.5	65.0	S	0.60	0.00
Foundation Sand & Gravel	---	---	--	S	0.60	0.00

c. Stability Analyses. The stability manual used was EM 1110-2-1902, dated 27 December 1960. The factors of safety for the embankment stability were determined by Slope Analysis Program 41-G-25-003 on the GE-225 computer by the Waterways Experiment Station. The minimum safety factor obtained for each condition, as compared to manual computations performed by the Fort Worth District (shown on Plates 17 through 20), is as follows:

TABLE 2

FACTORS OF SAFETY

Condition	Safety Factor Computer	Safety Factor Manual	Required Safety Factor
Post Condition	1.846	1.82	1.3
Rapid Drawdown			
From maximum pool	1.072	1.17	1.0
From spillway crest	---	1.26	1.2
Partial Pool @ El 1000	1.582	1.64	1.5
Steady seepage			
'R' Strengths	1.658	1.71	---
'S' Strengths	1.591	1.66	---
Average	1.642	1.68	1.5

There were no record control tests. The changes in design would not change the computed factors of safety significantly. Therefore, it is not deemed necessary to recalculate the factors of safety.

d. Seepage Control. Dewatering was required to some extent in all portions of the work. In general, the dewatering systems were overlying the glacial till. The one exception to this was the artesian well encountered in the core trench at Station 24+10.

The embankment was constructed in three stages over two construction seasons. The extent and type of dewatering system installed for each stage is decribed in the following paragraphs. All pumps used in the dewatering system were electric submersible, 3 and 4 inches in diameter.

In stage 1 (the outlet works to the eastern edge of the dam), the natural ground elevations of the stage were high and the bottom of the cut-off trench was generally above the natural ground water elevation except for low spots and the area between Stations 53+00 and 55+00 where there was a channel in the till and positive cut-off was not achieved. The wells installed in this area of the cut-off trench were 24-inch perforated pipe surrounded by a gravel pack. They functioned as sumps for water entering the sides of the trench. Essentially, ground water was not a problem through this stage.

In stage 2, the dam extended across the valley floor where the dam has the maximum fill height and the cut-off trench the deepest. A series of wells were installed on both sides of the cut-off trench. Generally, these wells were on 100-foot centers and from 29 to 80 feet deep. The water that came into the trench between the main dewatering wells was intercepted by ditches on both sides of the cut-off trench and then pumped out by submersible pumps placed in 24-inch diameter perforated pipes. The trenches on both sides of the impervious core were back-filled with sand to permit water flowing into the trenches to reach the pumps.

In stage 3 of the dam, between Stations 8+00 and 15+00, the dewatering system was almost identical to that used for stage 2. The contractor drilled 24-inch diameter wells outside of the cut-off trench which handled most of the water. The remaining water than ran into the trench was intercepted in ditches at the toe of the slope and diverted to pumps placed as needed. The stretch of cut-off trench between Stations 1+70 and 8+00 did not have much water. The contractor drilled a 24-inch diameter well on each side of the trench and supplemented this with a small pump on the upstream side.

Seepage through the sand and gravel-filled channel between Stations 53+00 and 55+00 was anticipated and therefore three relief wells were installed. The wells were located as follows:

Relief Well No.	Location	Bottom of Well
1	124.2' rt. Sta. 53+25	967.7
2	125.2' rt. Sta. 54+00	967.6
3	124.6' rt. Sta. 54+75	975.2

5. Diversion and Closure. The dam was divided into three stages. Stage 1, from the outlet works upstream to the eastern edge of the dam, had a high enough elevation that construction cofferdams were not necessary. This section was started in April 1971. Stage 2, across the valley bottom, required a cofferdam from the wing walls of the outlet works to the existing railroad embankment at approximately Station 12+60. The top elevation was 980 and it had a crest width of 10 feet with 3 on 1 side slopes. Stage 3 had to be left open at this time to prevent stream flows exceeding the capacity of the outlet works from overtopping into stage 2 excavation. The diversion cofferdam was begun 23 August 1971 and the diversion occurred on 30 August 1971. Stage 3 cofferdam was built 5-7 June 1972 and all flows then went through the outlet works.

6. Instrumentation.

a. General. Instrumentation consists of piezometers, observation wells, and movement markers. The locations of the instrumentation are shown on Plate 21.

b. Piezometers. A total of fourteen piezometers were installed to monitor the pore pressures. The piezometers are all open-system piezometers with six in the embankment and eight in the foundation.

c. Observation Wells. Seepage was anticipated through the left abutment. Therefore, nine observation wells were installed prior to construction to monitor this seepage downstream of the dam.

d. Movement Markers. Twelve movement markers were installed at 200-foot intervals along a line 15 feet downstream of the dam centerline.

e. Instrumentation Evaluation.

(1) Piezometer - Foundation piezometers located upstream of the impervious core reflect the reservoirpool. Embankment piezometers located within the impervious core show a significant head loss and indicate the predicted seepage line. Downstream peizometers show the effectiveness of the impervious core as the embankment piezometers are dry and the foundations piezometers have very low readings. Piezometer plots are shown on Plates 23 through 25.

(2) Observation Wells - All of the wellpoints are located in the vicinity of the left abutment and react with the pool. Wellpoints 403 and 405 follow the pool closely and indicate reservoir seepage through the abutment. The remaining wellpoints downstream of the dam indicate a head loss, but read very near the ground surface.

(3) Relief Wells - The three relief wells located along the downstream toe of the dam from Station 53+25 to 54+75 react with the reservoir pool. No significant flood storage has occurred to date, therefore, the relief wells have not experienced discharge conditions. The plots of the relief wells are presented on Plate 26.

(4) Movement Monuments - Cumulative horizontal and vertical displacement measurements are taken from movement monuments 1-12 along the downstream crest of the dam from Stations 8+00 and 30+00. Horizontal displacement was measured on 1 July 1976 and 18 November 1976 with vertical displacement measured on 29 June 1976 and 17 November 1976. A plot of the cumulative horizontal displacement indicates a trend of movement in the downstream direction and shows no change from the first readings taken on 2 October 1975. The plot of the cumulative vertical

movement shows minor settlement still occurring along the maximum embankment section from the conduit and toward the right abutment. The plot of the movement monuments are shown on Plates 27 and 28.

7. Construction Notes. On 1 September the contractor was excavating the cut-off trench in Stage 2 of the embankment foundation area. About noon on this day a small stream of water was noticed running from the bottom (elev. 955) of the left slope of the trench at Station 24+12. The flow steadily and rapidly increased and by late afternoon was completely out of control and far in excess of what the available pumping capacity would handle.

The contractor initially tried to build a sandbag dike around the flow, but the head of the water was far higher than could be reached by sandbags. A 12-inch diameter pipe was driven into the hole to elevation 915. The pipe was pumped which allowed an 8' x 8' x 6' excavation around the casing to be plugged with concrete. A 5-foot to 6-foot thick blanket of sand was then placed over the concrete plug around the well casing while grout was pumped under the concrete plug to shut off minor leakage. On 20 September, a hard rain set in and the contractor was directed to fill the area of the cut-off trench with about 10 feet of fill and close off the valve at the top of the well.

Several weeks later, when areas on both sides were cleaned up and partially filled and the contractor had good access, the area downstream of the artesian well was reexcavated and properly backfilled with impervious and filter material. The impervious core and filter were warped somewhat downstream from their plan location to keep at least 10 feet of material around the artesian well. The fill operation continued in a normal manner and a culvert pipe brought up around the casing to enable the valve on the well to be reached for grouting in the future. The casing was grouted in 1 August 1972 and took about 2-1/2 cubic yards of grout.

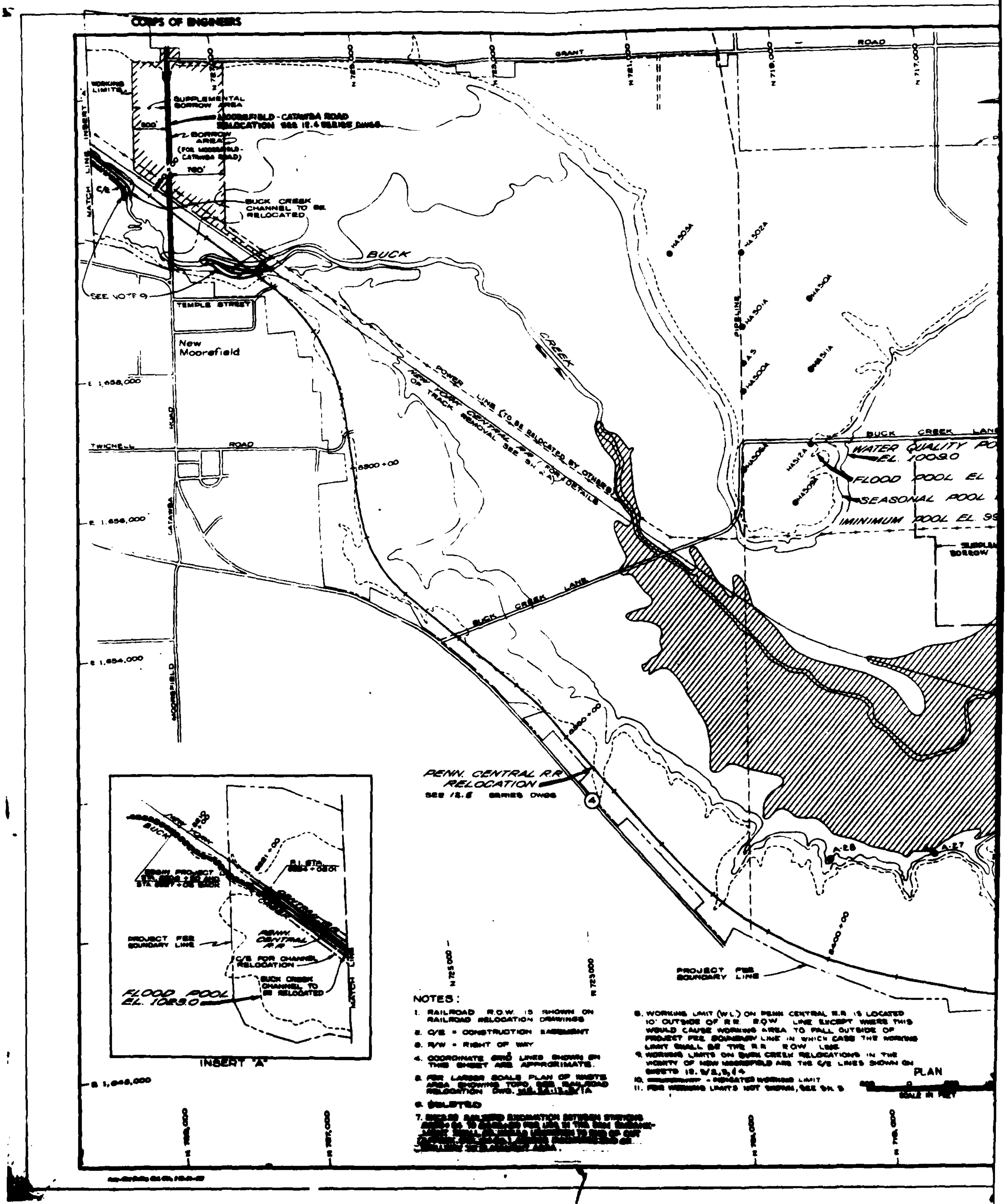
The contract documents showed a manhole located 130 feet right of dam Station 22+60 and required that this manhole and perforated pipe leading downstream be filled with lean concrete. An inspection after the manhole was dewatered revealed that, in addition, the pipe extended upstream from the manhole some 42 feet. A hole was augered about 45 feet upstream from the manhole to determine if the pipe went any further upstream. The auger did not reveal any indication of pipe at this point so the 42-foot section was filled with grout as was the manhole and section of pipe downstream of the manhole and underneath the dam foundation.

Three (3) relief wells were required to be installed at 75 feet center to center between Stations 51+00 and 52+50. This was to pick up any leakage which might occur through a sand and gravel-filled channel in the foundation which was shown to exist at the above stations. During construction of the cut-off trench, impervious material was encountered between Stations 51+00 and 52+50 and the channel was encountered between Stations 53+00 and 55+00, so it was deemed necessary to move the relief wells about 200 feet east of their planned location. Relief well No. 1 was located at Station 53+25, 124.2 feet right location. Relief well No. 2 was located at Station 54+00, 125.2 feet right of the centerline, and relief well No. 3 was located at Station 54+75, 124.6 feet right of the centerline.

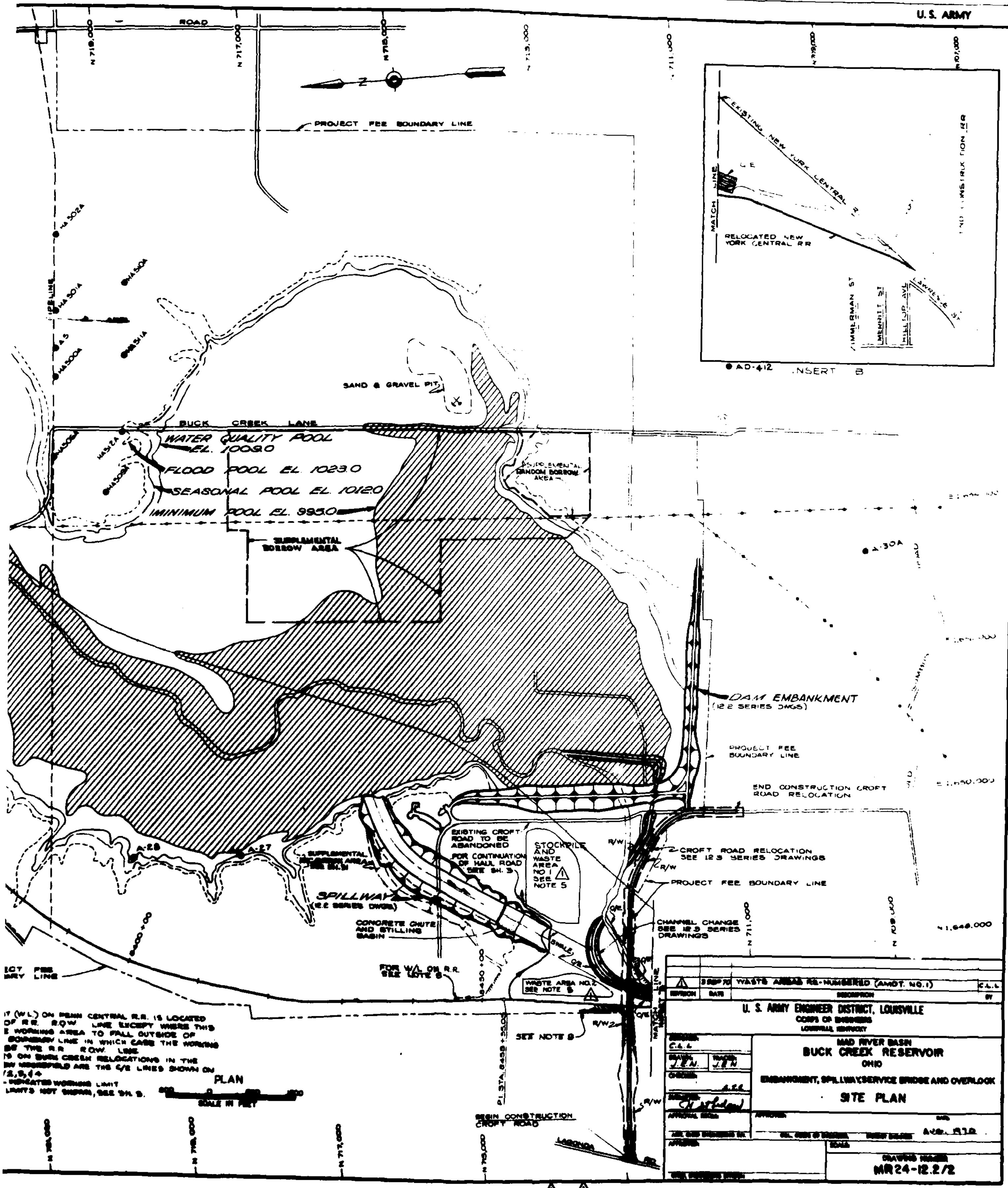
QUANTITIES

EXCAVATION	
Stripping	
Dam	85,185 CY
Spillway	33,401 CY
Supplemental Spillway Borrow	6,925 CY
Auxiliary Borrow Area	45,395 CY
TOTAL	170,906 CY
Unclassified and Borrow	
Core Trench	249,931 CY
Outlet Channel	19,369 CY
Inlet Channel	11,951 CY
Ditch	6,206 CY
Supplemtal Spillway Borrow	241,554 CY
Auxiliary Borrow Area	329,707 CY
Spillway	1,832,625 CY
TOTAL	2,691,343 CY
FILL	2,122,802 CY
Compacted**	

**Quantities for separate zones of the embankment were not differentiated in the contract. However, the impervious zone was 12 feet wide at top elevation 1038.5 transitioning down to 20 feet wide at the bottom of the cut-off trench (min. elev. 941). The pervious chimney drain filled the cut-off trench downstream until it was 18 feet wide, then stepped back to 8 feet wide up to the spillway crest elevation of 1023. With exceptions for riprap and bedding on the upstream face of the dam and topsoil on the downstream face, the rest of the fill was essentially random material.



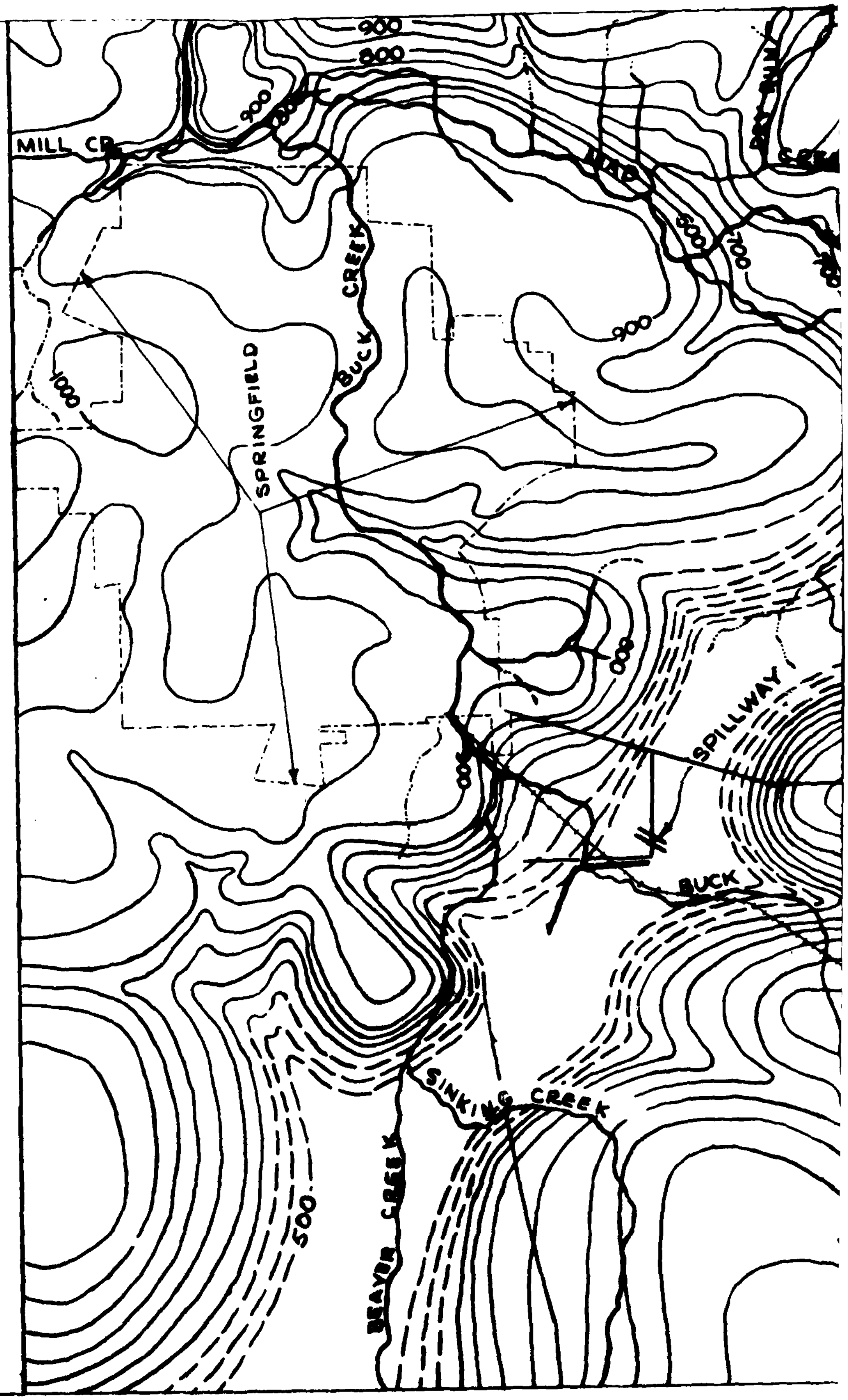
CORPS OF ENGINEERS
GRANT ROAD
WORKING LIMITS
SUPPLEMENTAL BORROW AREA
MOOREFIELD - CATAWBA ROAD RELOCATION SEE 12.4 SERIES DWGS.
BORROW AREA (FOR MOOREFIELD - CATAWBA ROAD)
MATCH LINE INSERT 'A'
BUCK CREEK CHANNEL TO BE RELOCATED
BUCK CREEK
SEE NOTE 9
TEMPLE STREET
New Moorefield
POWER LINE (TO BE RELOCATED BY OTHERS)
NEW YORK CENTRAL R.R. OF TRACK REMOVAL SEE SH. FOR DETAILS
TWICHELL ROAD
CATAWBA ROAD
MOOREFIELD
BUCK CREEK LANE
PIPELINE
WATER QUALITY POOL EL. 1002.0
FLOOD POOL EL
SEASONAL POOL
MINIMUM POOL EL.
PENN. CENTRAL R.R. RELOCATION SEE 12.5 SERIES DWGS
PROJECT FEE BOUNDARY LINE
E 1,658,000
E 1,656,000
E 1,654,000
E 1,648,000
N 725,000
N 723,000
N 721,000
N 719,000
N 717,000
6300+00
6400+00
A-28
A-27
INSERT 'A'
PROJECT FEE BOUNDARY LINE
PENN. CENTRAL R.R.
C/E FOR CHANNEL RELOCATION
BUCK CREEK CHANNEL TO BE RELOCATED
FLOOD POOL EL. 1023.0
MATCH LINE
NOTES:
1. RAILROAD R.O.W. IS SHOWN ON RAILROAD RELOCATION DRAWINGS
2. C/E = CONSTRUCTION EASEMENT
3. R/W = RIGHT OF WAY
4. COORDINATE GRID LINES SHOWN ON THIS SHEET ARE APPROXIMATE.
5. FOR LARGER SCALE PLAN OF WASTE AREA SHOWING TOPO SEE RAILROAD RELOCATION DWG.
6. DELETED
8. WORKING LIMIT (W.L.) ON PENN CENTRAL R.R. IS LOCATED 10' OUTSIDE OF R.R. R.O.W. LINE EXCEPT WHERE THIS WOULD CAUSE WORKING AREA TO FALL OUTSIDE OF PROJECT FEE BOUNDARY LINE IN WHICH CASE THE WORKING LIMIT SHALL BE THE R.R. ROW LINE.
9. WORKING LIMITS ON BUCK CREEK RELOCATIONS IN THE VICINITY OF NEW MOOREFIELD ARE THE C/E LINES SHOWN ON SHEETS
10. - INDICATED WORKING LIMIT
11. FOR WORKING LIMITS NOT SHOWN, SEE SH. 3
PLAN
SCALE IN FEET

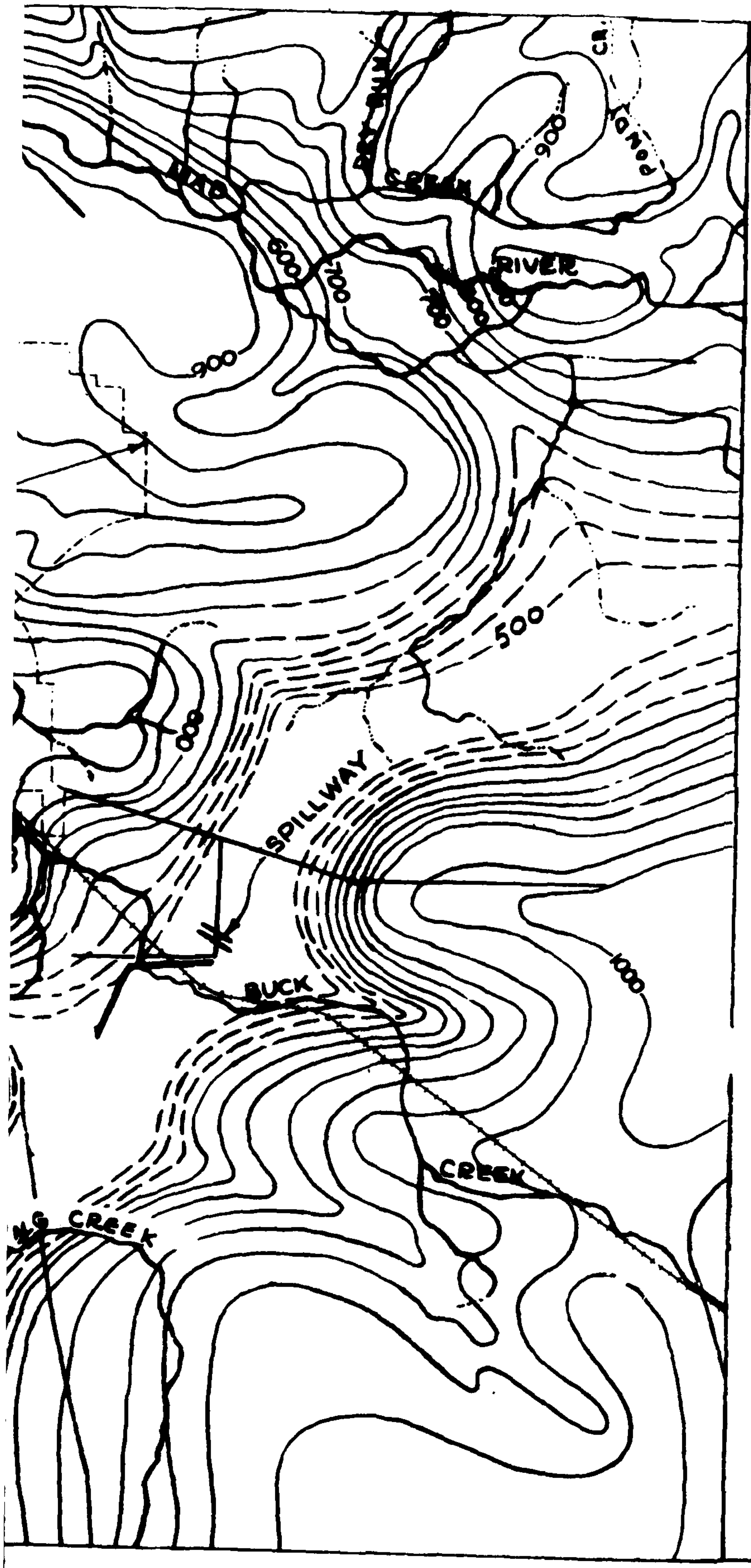


U.S. ARMY
ROAD
PROJECT FEE BOUNDARY LINE
EXISTING NEW YORK CENTRAL R.R.
RELOCATED NEW YORK CENTRAL R.R.
MATCH LINE
INSERT B
SAND & GRAVEL PIT
BUCK CREEK LANE
WATER QUALITY POOL EL. 1009.0
FLOOD POOL EL. 1023.0
SEASONAL POOL EL. 1012.0
MINIMUM POOL EL. 995.0
SUPPLEMENTAL RANDOM BORROW AREA
SUPPLEMENTAL BORROW AREA
DAM EMBANKMENT (12.2 SERIES DWGS)
PROJECT FEE BOUNDARY LINE
END CONSTRUCTION CROFT ROAD RELOCATION
EXISTING CROFT ROAD TO BE ABANDONED
FOR CONTINUATION OF HAUL ROAD SEE SH. 3
STOCKPILE AND WASTE AREA NO. 1 SEE NOTE 5
CROFT ROAD RELOCATION SEE 12.3 SERIES DRAWINGS
SPILLWAY (12.2 SERIES DWGS)
CONCRETE CHUTE AND STILLING BASIN
CHANNEL CHANGE SEE 12.5 SERIES DRAWINGS
FOR W/L ON R.R. SEE NOTE 8
WASTE AREA NO. 2 SEE NOTE 5
SEE NOTE 8
BEGIN CONSTRUCTION CROFT ROAD
PLAN
SCALE IN FEET
WASTE AREAS RE-NUMBERED (AMDT. NO. 1)
U. S. ARMY ENGINEER DISTRICT, LOUISVILLE
CORPS OF ENGINEERS
LOUISVILLE, KENTUCKY
MAD RIVER BASIN
BUCK CREEK RESERVOIR
OHIO
EMBANKMENT, SPILLWAY, SERVICE BRIDGE AND OVERLOOK
SITE PLAN
AUG. 1970
MR24-12.2/2

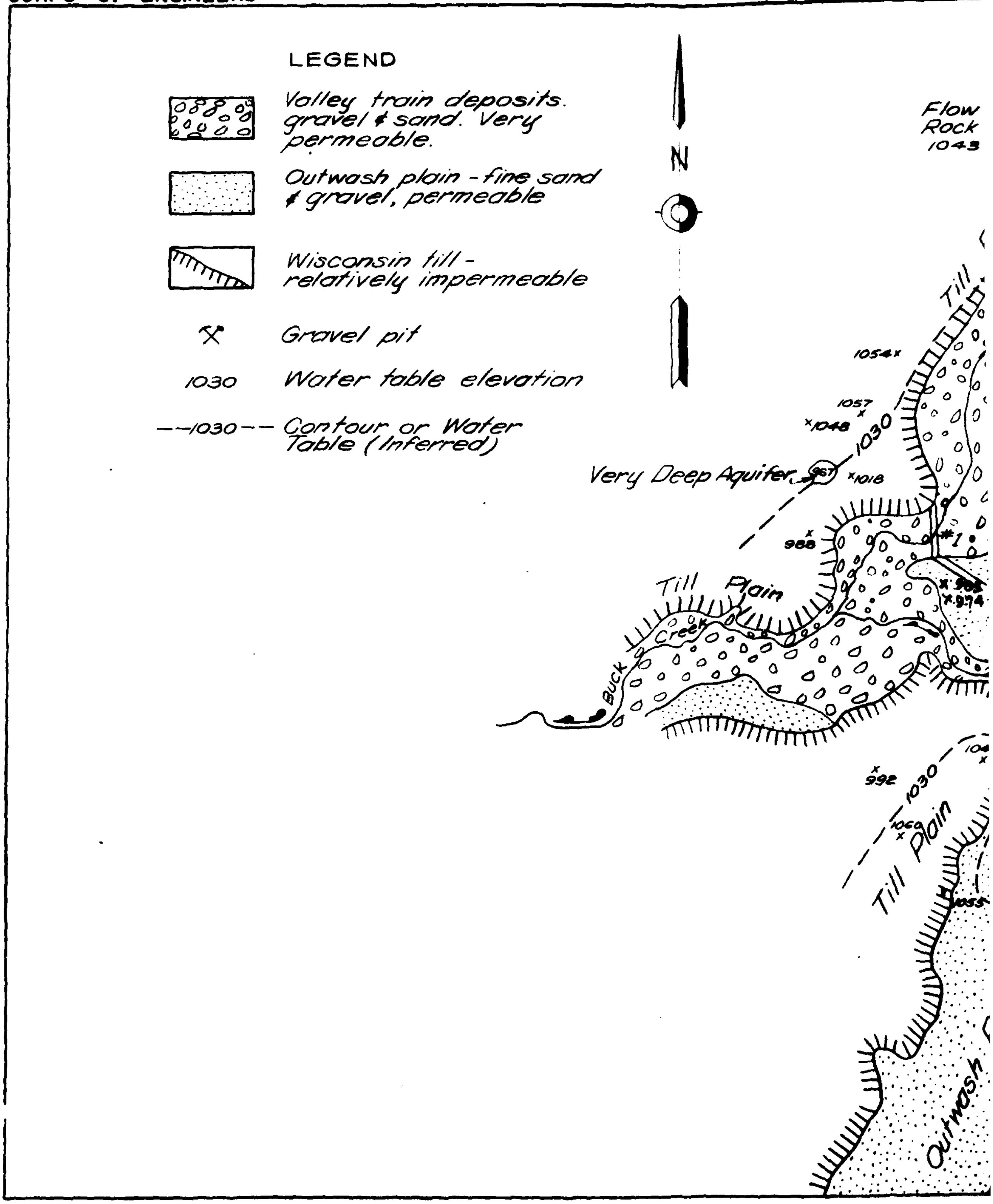
PLATE 1

CORPS OF ENGINEERS

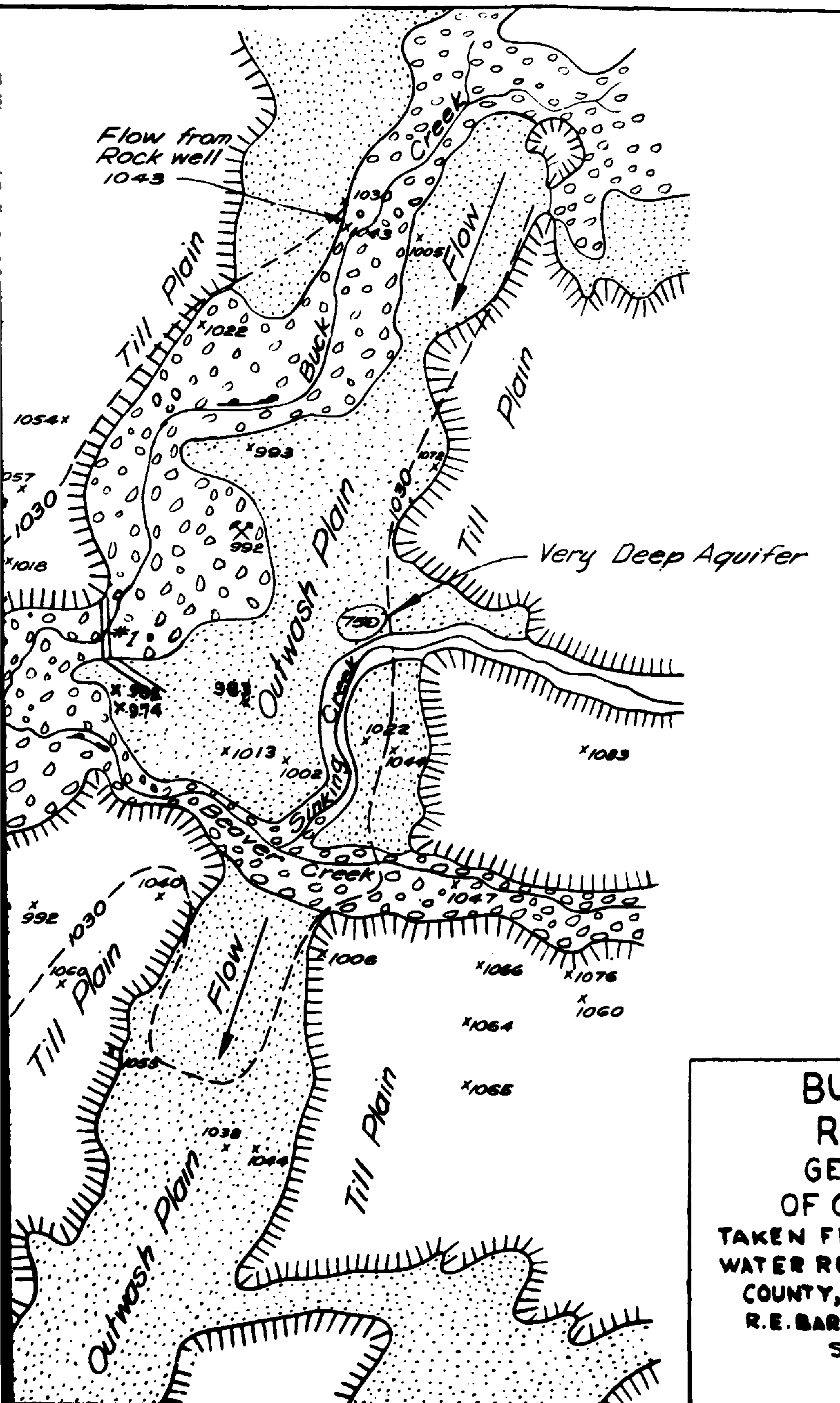




BUCK CREEK
RESERVOIR
PRESENT & PRE-GLACIAL
DRAINAGE WITH TOP OF
BEDROCK CONTOURS
CONTOUR INTERVAL = 50FT.
SCALE: 1" = 1MILE


LEGEND
Valley train deposits. gravel ¢ sand. Very permeable.
Outwash plain - fine sand ¢ gravel, permeable
Wisconsin till - relatively impermeable
Gravel pit
1030 Water table elevation
--1030-- Contour or Water Table (Inferred)
N
Flow
Rock
1043
Till
1054
1057
1048
1030
Very Deep Aquifer
967
1018
988
#1
Till Plain
Buck Creek
992
1030
1069
Till Plain
1055
Outwash

U. S. ARMY

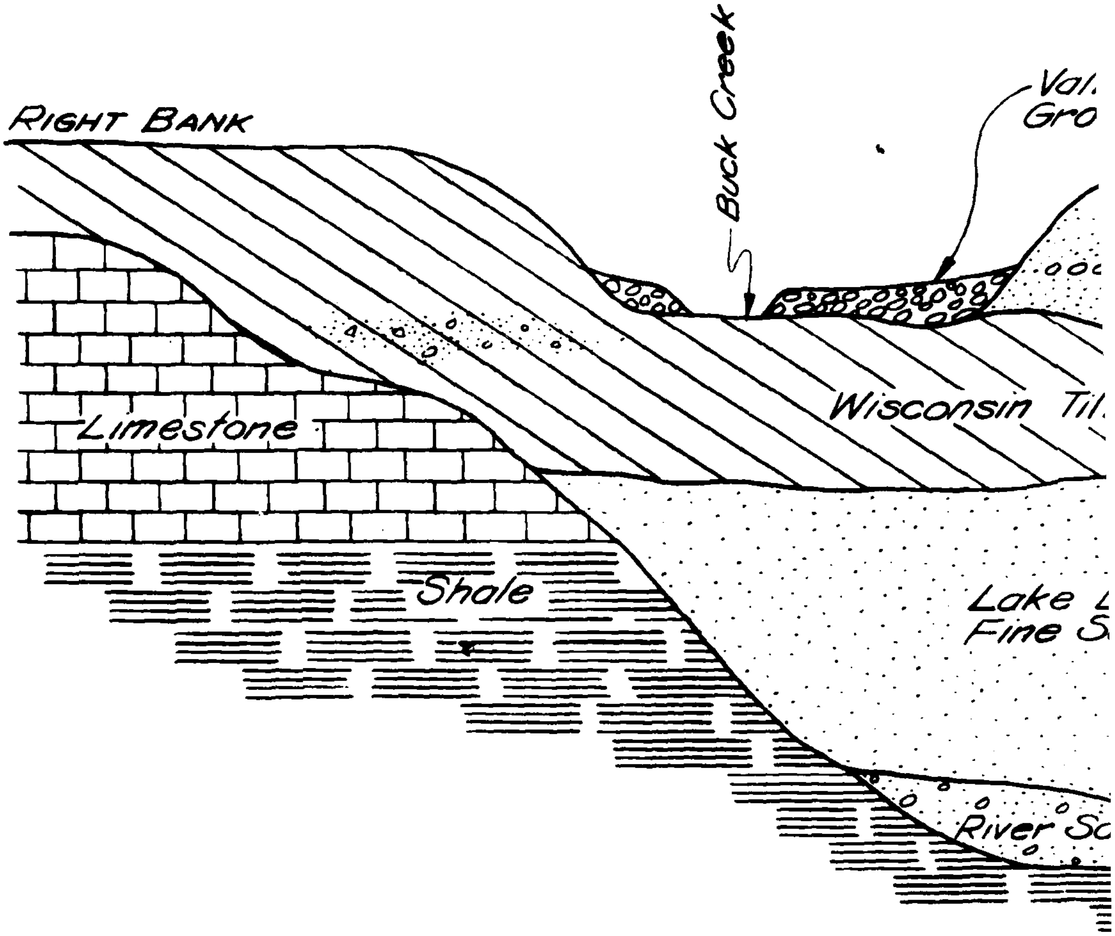


BUCK CREEK
RESERVOIR
GEOLOGIC MAP
OF GLACIAL SOILS

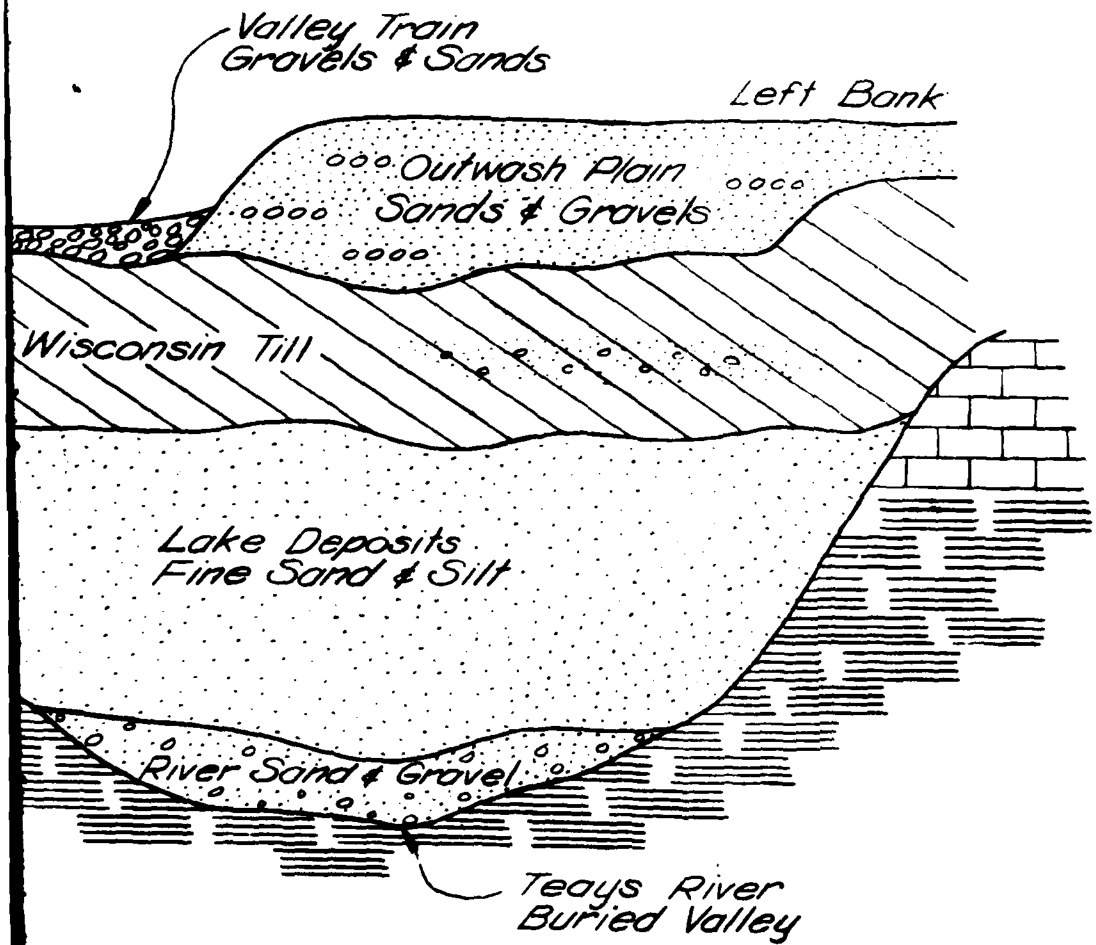
TAKEN FROM: BULLETIN 22 "THE WATER RESOURSES OF CLARK COUNTY, OHIO" AS REVISED BY R.E. BARNETT & S.S. PHILBRICK

SCALE: 1" = 1 MILE

PLATE 3


RIGHT BANK
Buck Creek
Val.
Gro
Wisconsin Til.
Limestone
Shale
Lake L
Fine S
River Sa

U. S. ARMY

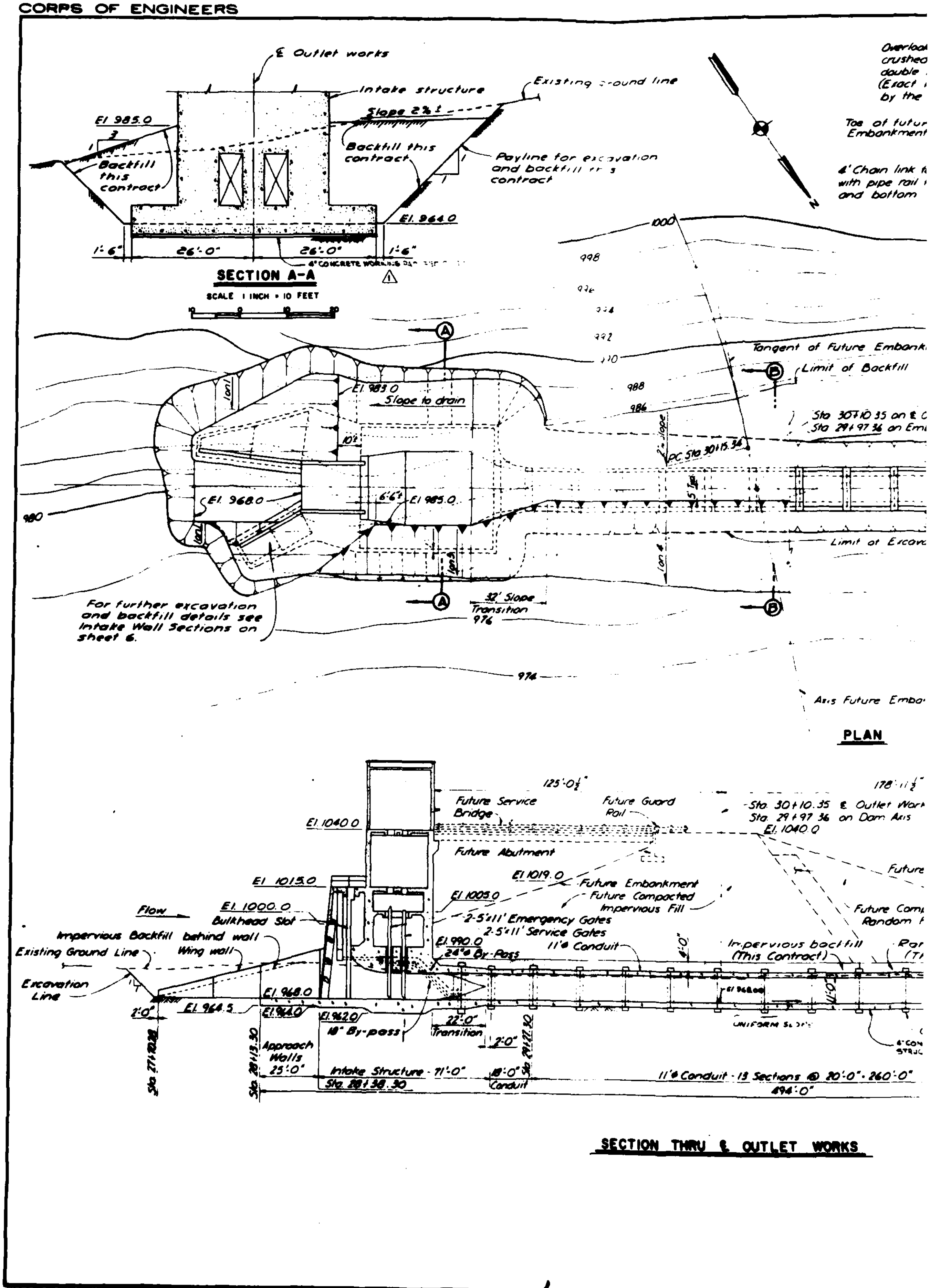


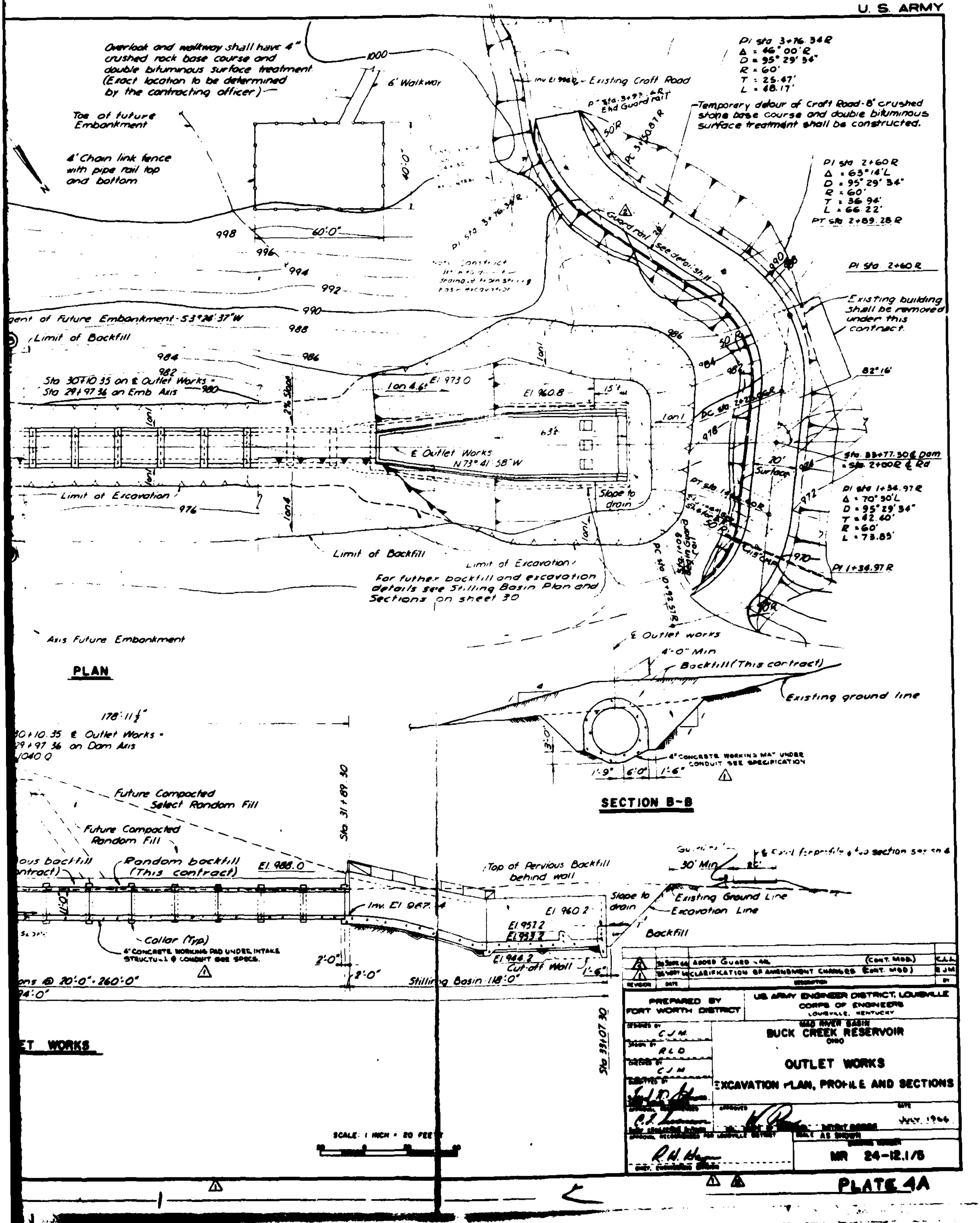
BUCK CREEK
RESERVOIR
GENERALIZED
GEOLOGIC PROFILE

SCALE: NONE

PLATE 4

CORPS OF ENGINEERS





△		ADDED GUARD RAIL (CONT. MOD.)	C.L.L.
△		CLARIFICATION OF AMENDMENT CHANGES (CONT. MOD.)	R.J.M.
REVISION	DATE	DESCRIPTION	BY

PREPARED BY FORT WORTH DISTRICT

US ARMY ENGINEER DISTRICT, LOUISVILLE
CORPS OF ENGINEERS
LOUISVILLE, KENTUCKY

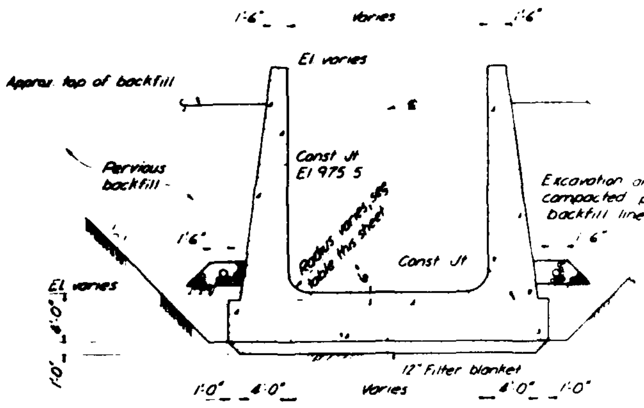
DESIGNED BY: C.J.M.
DRAWN BY: R.L.D.
CHECKED BY: C.J.M.

MAD RIVER BASIN
BUCK CREEK RESERVOIR
OHIO

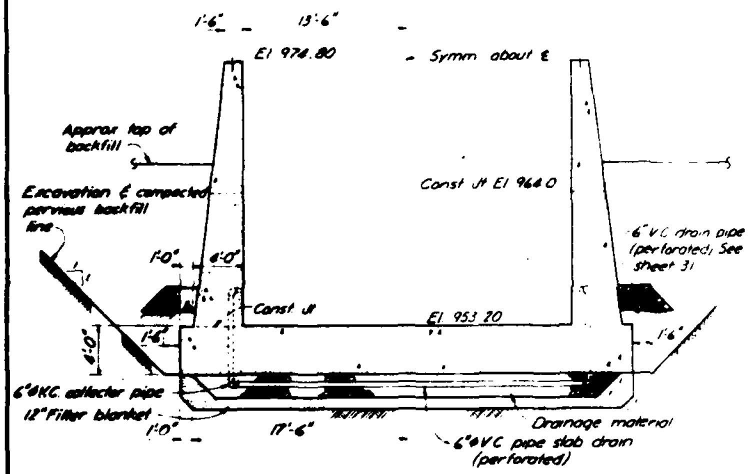
OUTLET WORKS
EXCAVATION PLAN, PROFILE AND SECTIONS

DATE: JULY, 1966
SCALE: AS SHOWN
DRAWING NUMBER: MR 24-12.1/5

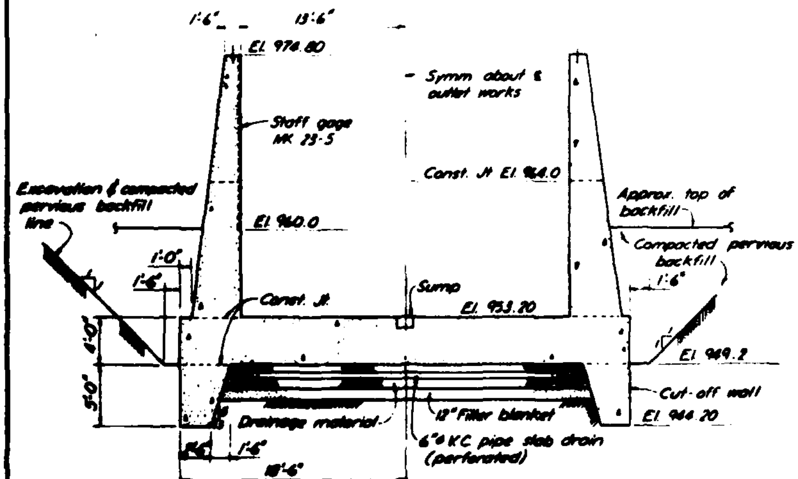
PLATE 4A



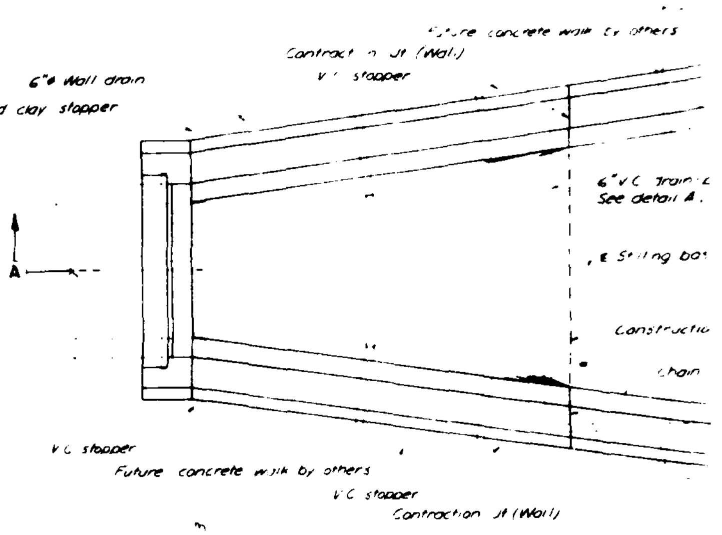
SECTION B-B

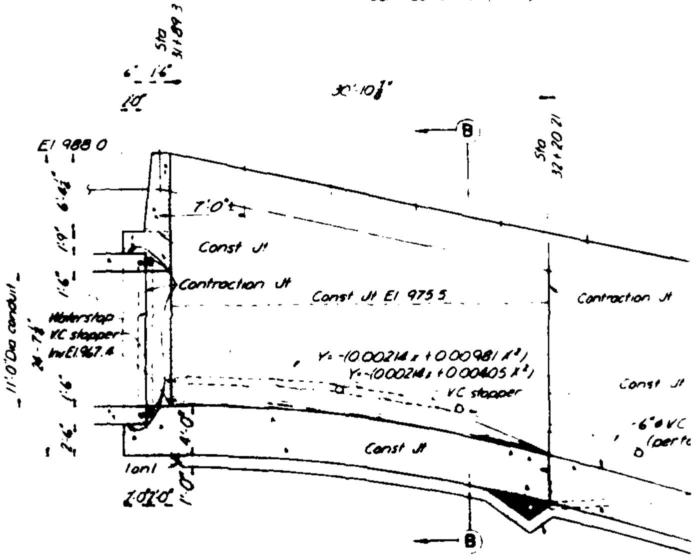


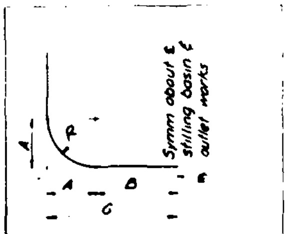
SECTION C-C



SECTION D-D



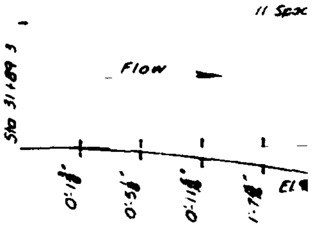




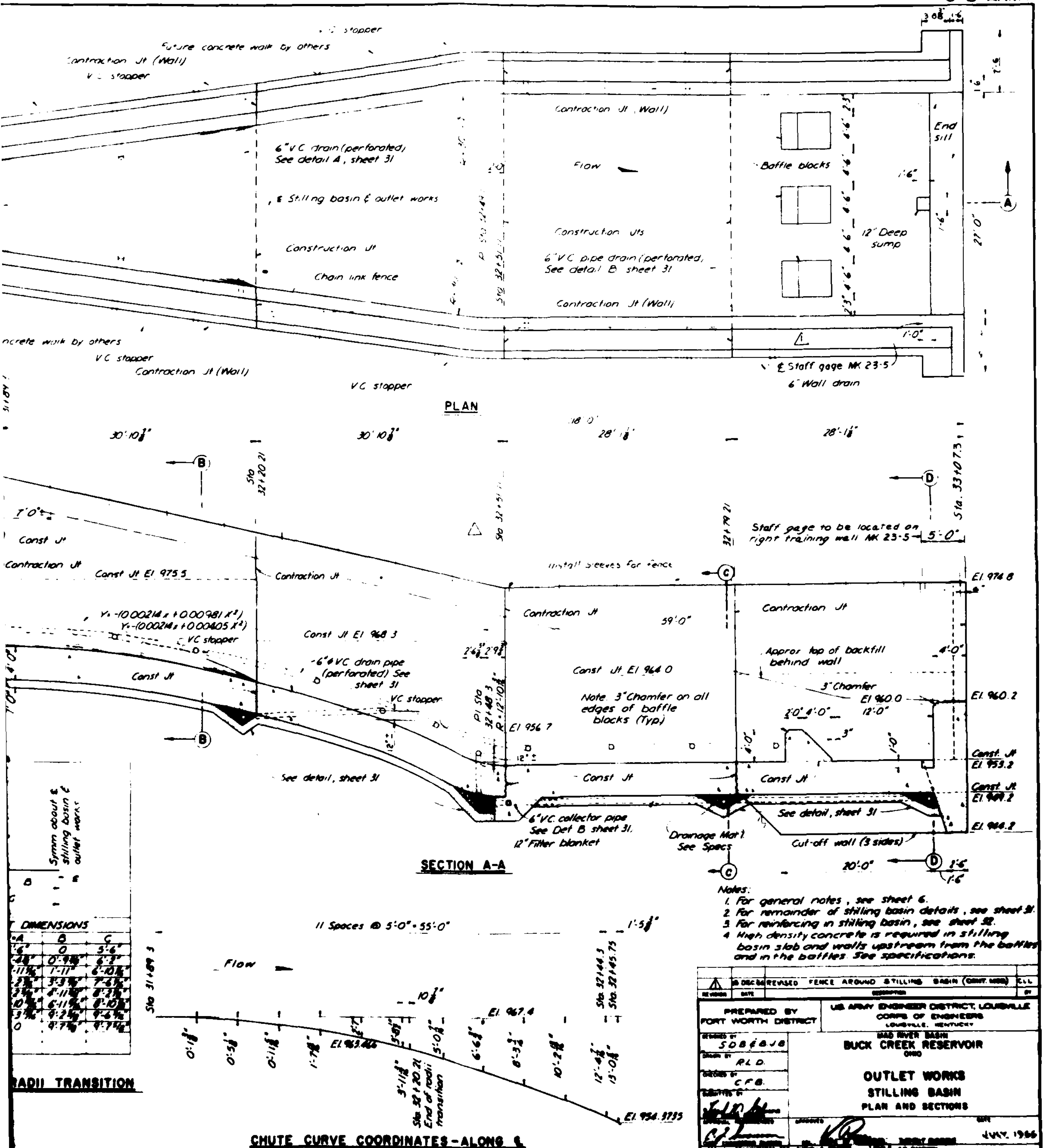
FILLET DIMENSIONS

Station	R=A	B	C
31+89.3	5'-6"	0	5'-6"
31+94.3	5'-4[illegible]"	0'-9[illegible]"	6'-2"
31+99.3	4'-11[illegible]"	1'-11"	6'-10[illegible]"
32+04.3	4'-2[illegible]"	3'-3[illegible]"	7'-6[illegible]"
32+09.3	3'-2[illegible]"	4'-11[illegible]"	8'-2[illegible]"
32+14.3	1'-10[illegible]"	6'-11[illegible]"	8'-10[illegible]"
32+19.3	0'-3[illegible]"	9'-2[illegible]"	9'-6[illegible]"
32+20.71	0	9'-7[illegible]"	9'-7[illegible]"

SECTION RADII TRANSITION



CHUTE CURVE



Notes:
1. For general notes, see sheet 6.
2. For remainder of stilling basin details, see sheet 31.
3. For reinforcing in stilling basin, see sheet 32.
4. High density concrete is required in stilling basin slab and walls upstream from the baffles and in the baffles. See specifications.

REVISED FENCE AROUND STILLING BASIN (CONT. MOD)

PREPARED BY FORT WORTH DISTRICT

US ARMY ENGINEER DISTRICT, LOUISVILLE
CORPS OF ENGINEERS
LOUISVILLE, KENTUCKY

MAD RIVER BASIN
BUCK CREEK RESERVOIR
OHIO

OUTLET WORKS
STILLING BASIN
PLAN AND SECTIONS

Designed by S.D.B. & B.J.B.
Drawn by R.L.D.
Checked by C.F.B.

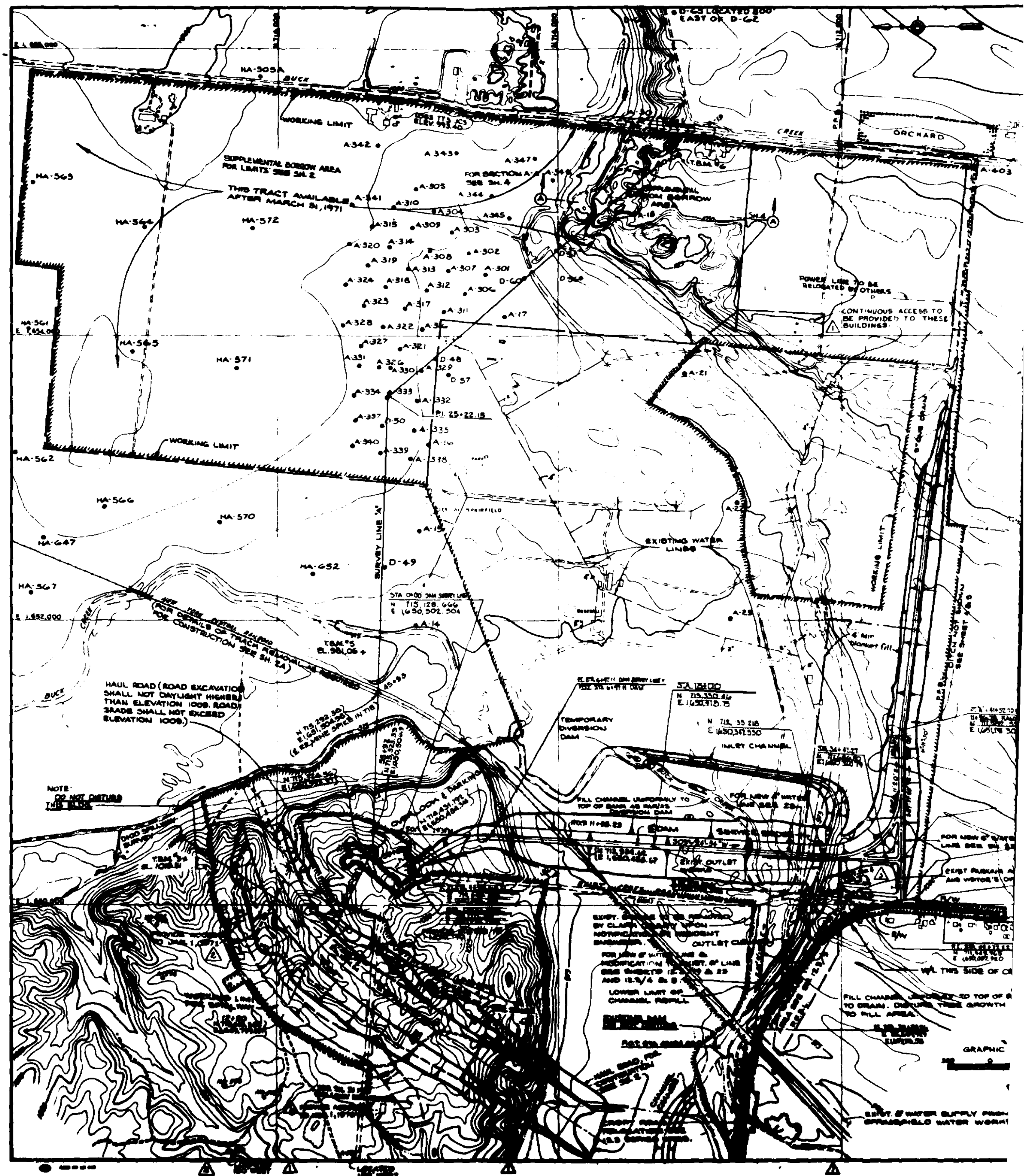
JULY, 1966

MR 24-12.1/30

PLATE 4B

RECORD DRAWING-"AS BUILT"

CORPS OF ENGINEERS



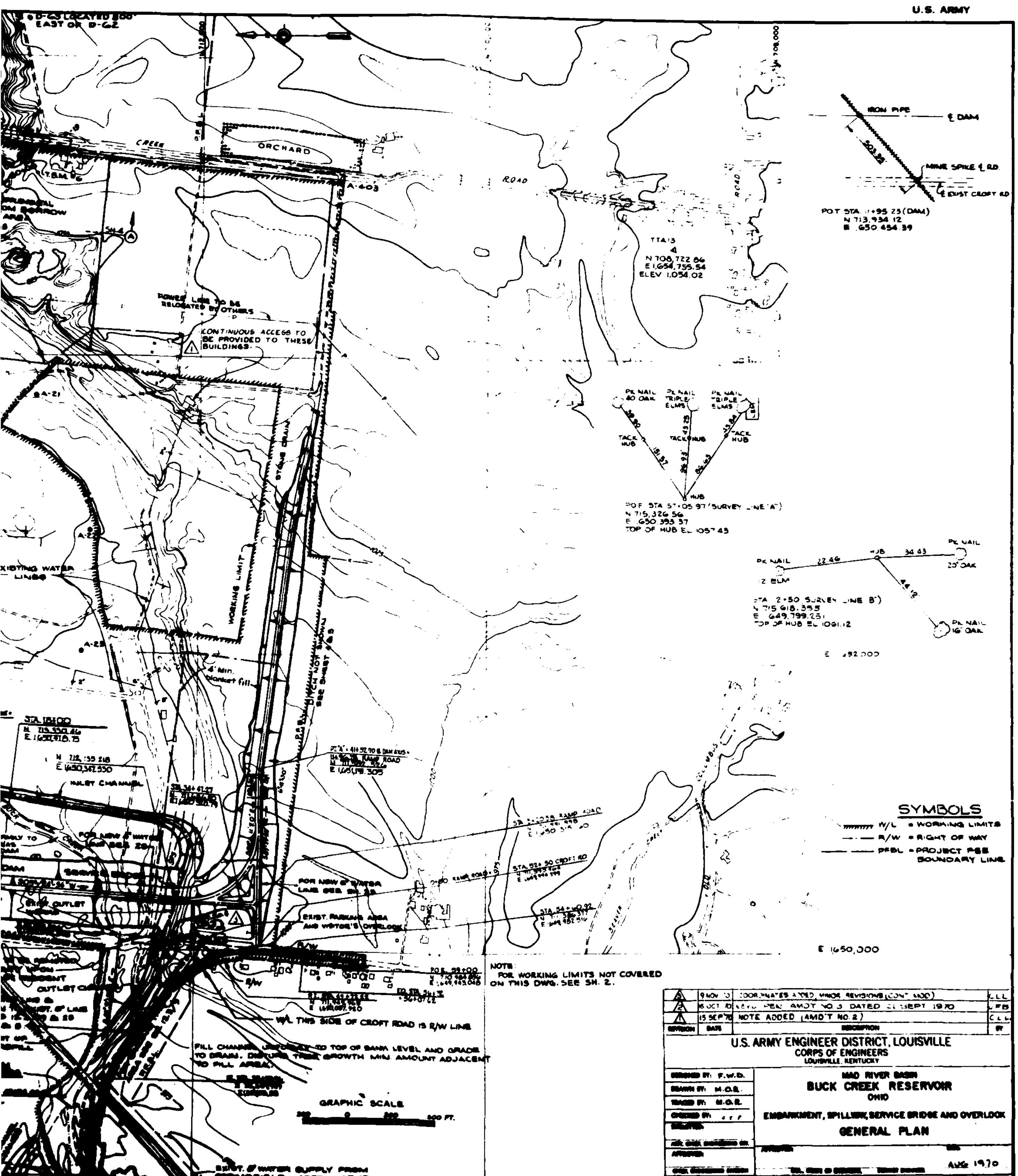
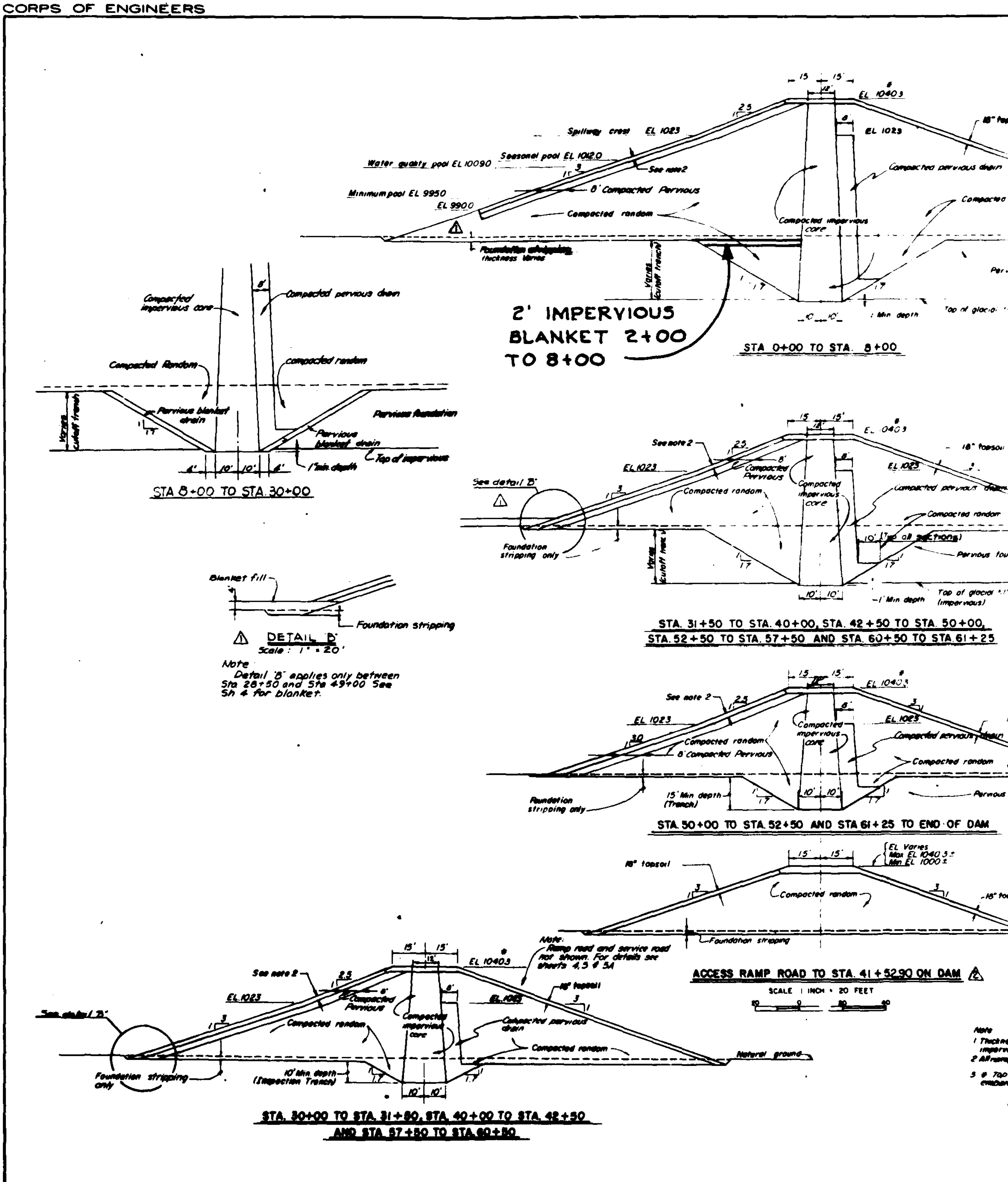
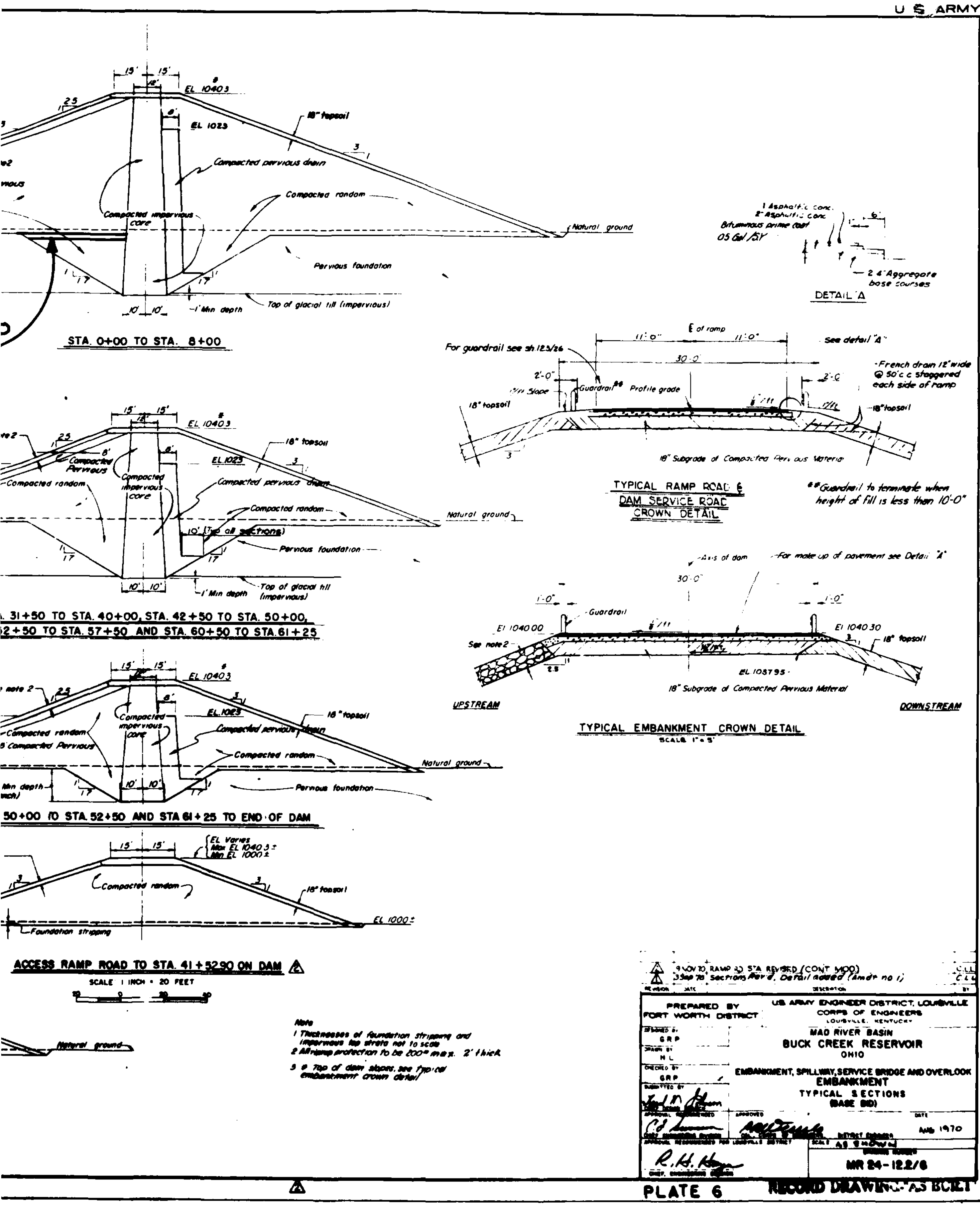


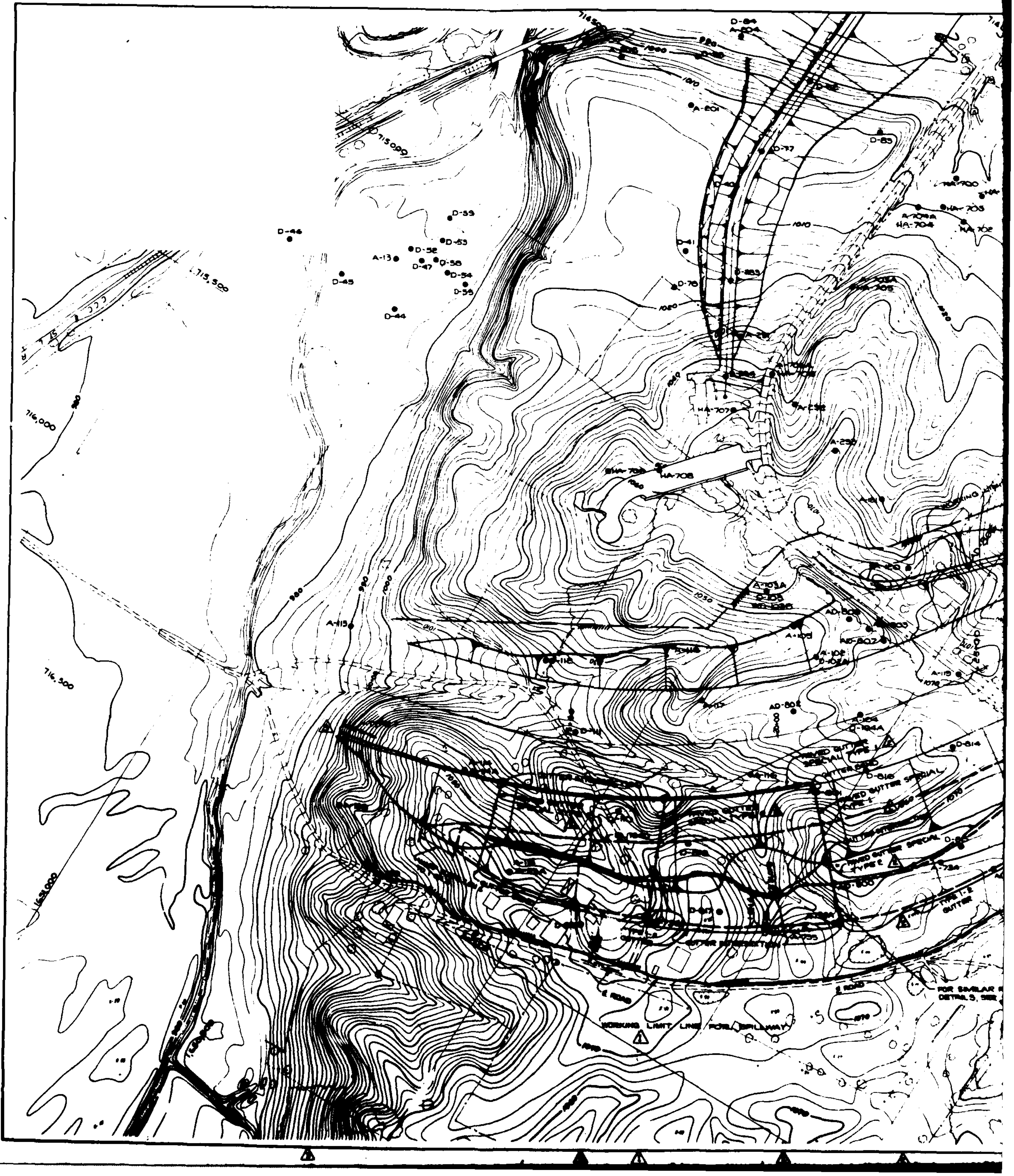
PLATE 5 RECORD DRAWING-"AS BUILT"

CORPS OF ENGINEERS

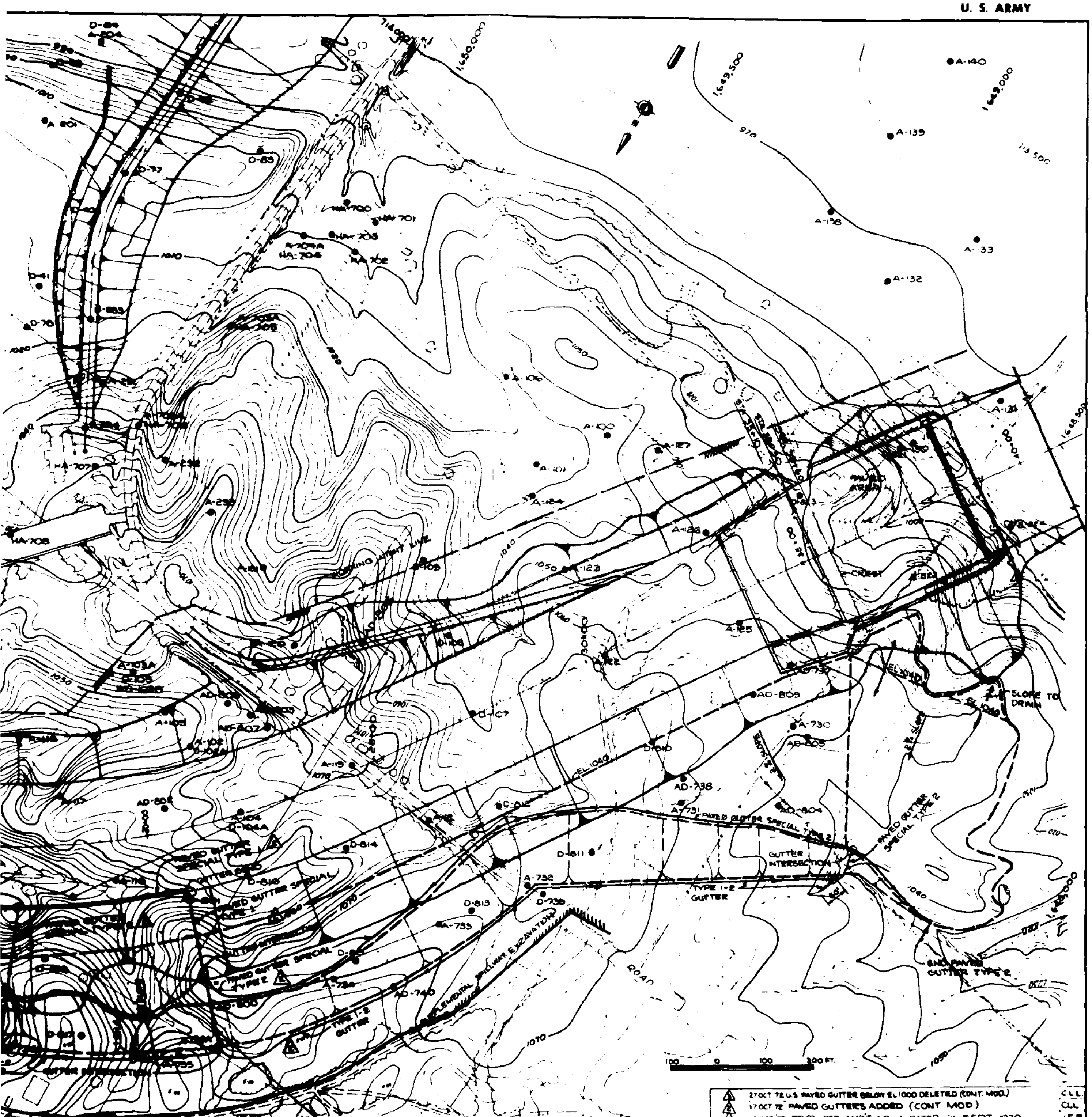



U S ARMY
15' 15' 18' EL 1040.3
EL 1025
18" topsoil
Compacted pervious drain
Compacted random
Compacted impervious core
Natural ground
Pervious foundation
10' 10' 1' Min depth
Top of glacial till (impervious)
STA. 0+00 TO STA. 8+00
1 Asphaltic conc.
2" Asphaltic conc.
Bituminous prime coat 0.5 Gal/SY
2-4" Aggregate base courses
DETAIL "A"
℄ of ramp
11'-0" 11'-0" 30'-0"
For guardrail see sh 123/26
See detail "A"
French drain 12" wide @ 50' c.c. staggered each side of ramp
2'-0" 2'-0"
Guardrail
Profile grade
18" topsoil
18" Subgrade of Compacted Pervious Material
TYPICAL RAMP ROAD & DAM SERVICE ROAD CROWN DETAIL
** Guardrail to terminate when height of fill is less than 10'-0"
10' (Typ all sections)
STA. 31+50 TO STA. 40+00, STA. 42+50 TO STA. 50+00, STA. 52+50 TO STA. 57+50 AND STA. 60+50 TO STA. 61+25
Axis of dam
For make up of pavement see Detail "A"
1'-0" 1'-0"
El 1040.00
El 1040.30
See note 2
EL 1037.95
UPSTREAM
DOWNSTREAM
TYPICAL EMBANKMENT CROWN DETAIL
SCALE 1" = 5'
STA. 50+00 TO STA. 52+50 AND STA. 61+25 TO END OF DAM
EL Varies Max EL 1040.3± Min EL 1000±
Foundation stripping
EL 1000±
ACCESS RAMP ROAD TO STA. 41+52.90 ON DAM
SCALE 1 INCH = 20 FEET
Note
1 Thicknesses of foundation stripping and impervious top strata not to scale
2 All riprap protection to be 200# max. 2' thick
3 # Top of dam slopes, see typical embankment crown detail
RAMP RD STA REVISED (CONT MOD)
See Sections Rev'd, Detail added (Amdt no 1)
PREPARED BY FORT WORTH DISTRICT
US ARMY ENGINEER DISTRICT, LOUISVILLE CORPS OF ENGINEERS LOUISVILLE, KENTUCKY
MAD RIVER BASIN
BUCK CREEK RESERVOIR
OHIO
EMBANKMENT, SPILLWAY, SERVICE BRIDGE AND OVERLOOK
EMBANKMENT
TYPICAL SECTIONS
(BASE BID)
Aug 1970
AS SHOWN
MR 24-122/6
PLATE 6
RECORD DRAWING "AS BUILT"

CORPS OF ENGINEERS



U. S. ARMY



FOR SIMILAR PAVED GUTTER DETAILS, SEE SH MR 24-12.5/33

NOTES:
1. FOR TYPE 1-2 GUTTER SEE DWG. MR 24-12.5/26. LOCATE GUTTER TO ALLOW 5' MIN. WIDE SHOULDER BETWEEN DAYLIGHT LINE OF SPILLWAY SLOPE AND EDGE OF SODDING. SEE SHEET 146 FOR DETAIL.
2. GUTTER BENDS, INTERSECTIONS AND SPECIAL TYPE 1 AND 2 GUTTERS SHALL BE SIMILAR TO DWG. MR 24-12.5/33.

REVISION	DATE	DESCRIPTION	BY
3	27 OCT 72	U.S. PAVED GUTTER BELOW EL 1000 DELETED (CONT. MOD.)	CLL
2	17 OCT 72	PAVED GUTTERS ADDED (CONT MOD)	CLL
1	16 OCT 70	REVD PER AMD'T NO. 3 DATED 21 SEPT 1970	JFB

U S ARMY ENGINEER DISTRICT, LOUISVILLE
CORPS OF ENGINEERS
LOUISVILLE, KENTUCKY

MAD RIVER BASIN
BUCK CREEK RESERVOIR
OHIO

EMBANKMENT, SPILLWAY, SERVICE BRIDGE AND OVERLOOK

BORING LAYOUT I

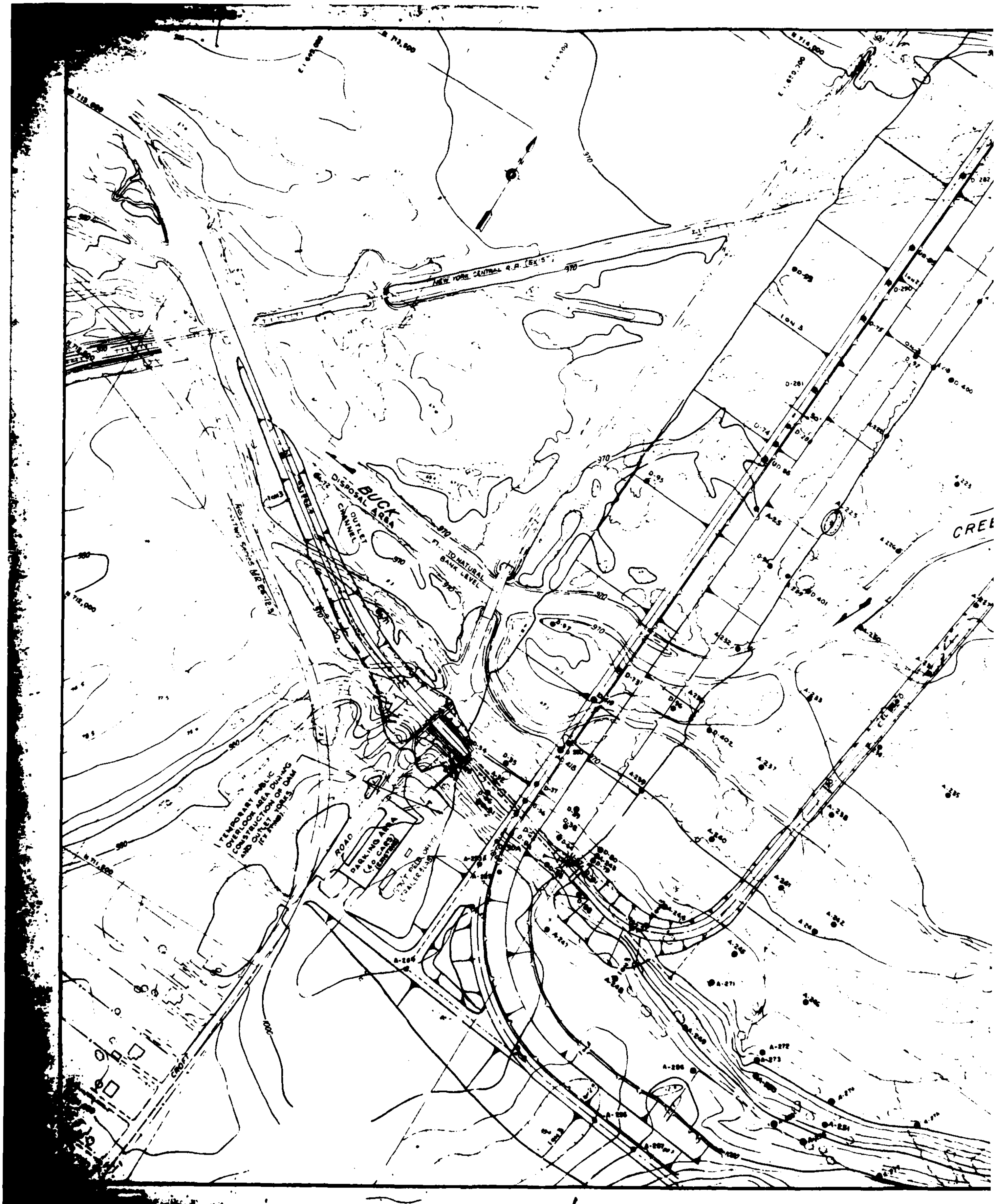
DESIGNED
DRAWN
TRACED K.L.H.
CHECKED
SUBMITTED
SCALE 1" = 100'
DATE Aug. 1970
DRAWING NUMBER
MR 24-12.2/31

PLATE 7

RECORD DRAWING "AS BUILT"

1

2


NEW YORK CENTRAL R.R. (EX'ST)
BUCK
DISPOSAL AREA
OUTLET CHANNEL
TO NATURAL BANK LEVEL
CREE
ROAD
PARKING AREA
TEMPORARY PUBLIC OVERLOOK AREA DURING CONSTRUCTION OF DAM AND OUTLET WORKS
CROFT

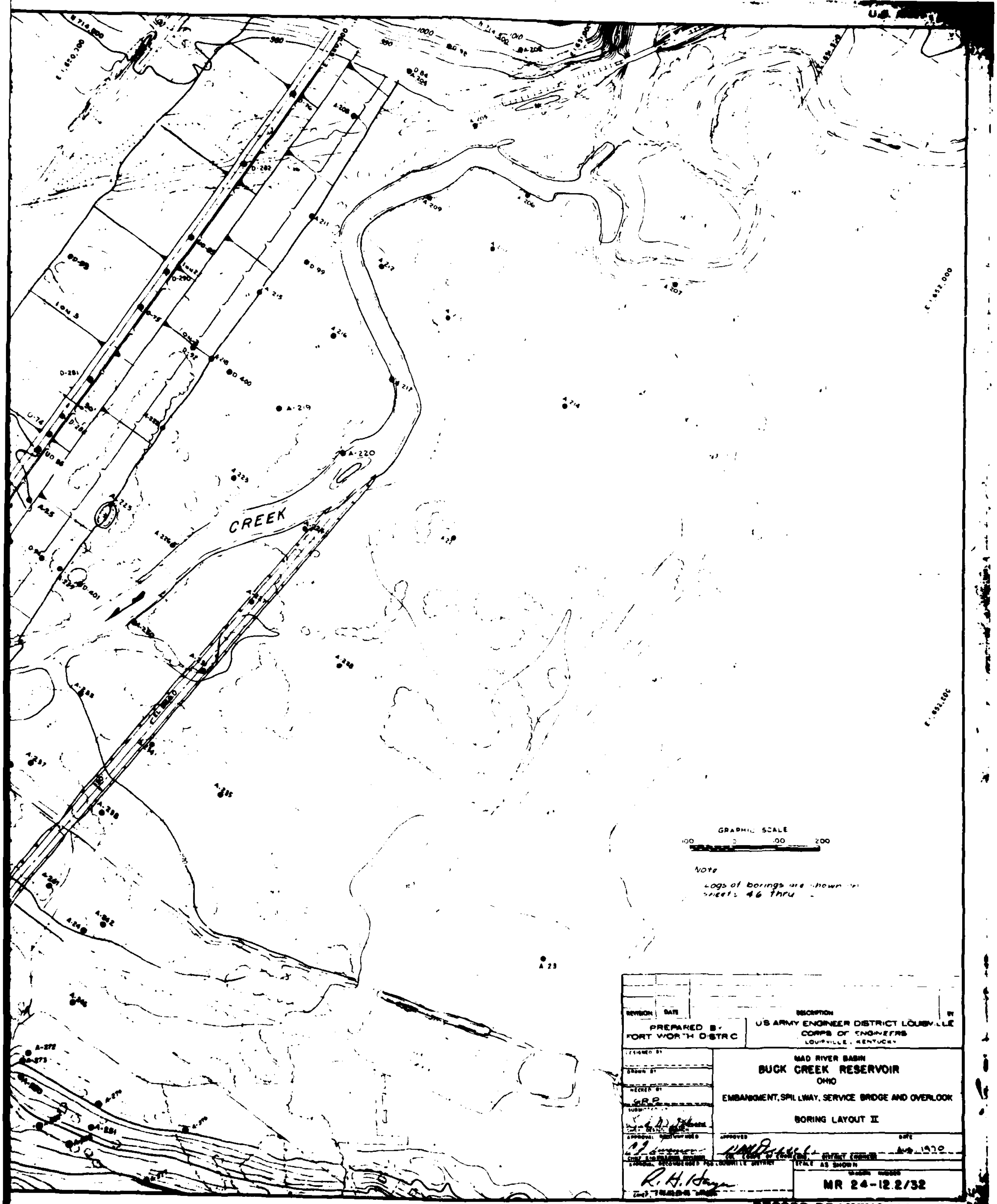
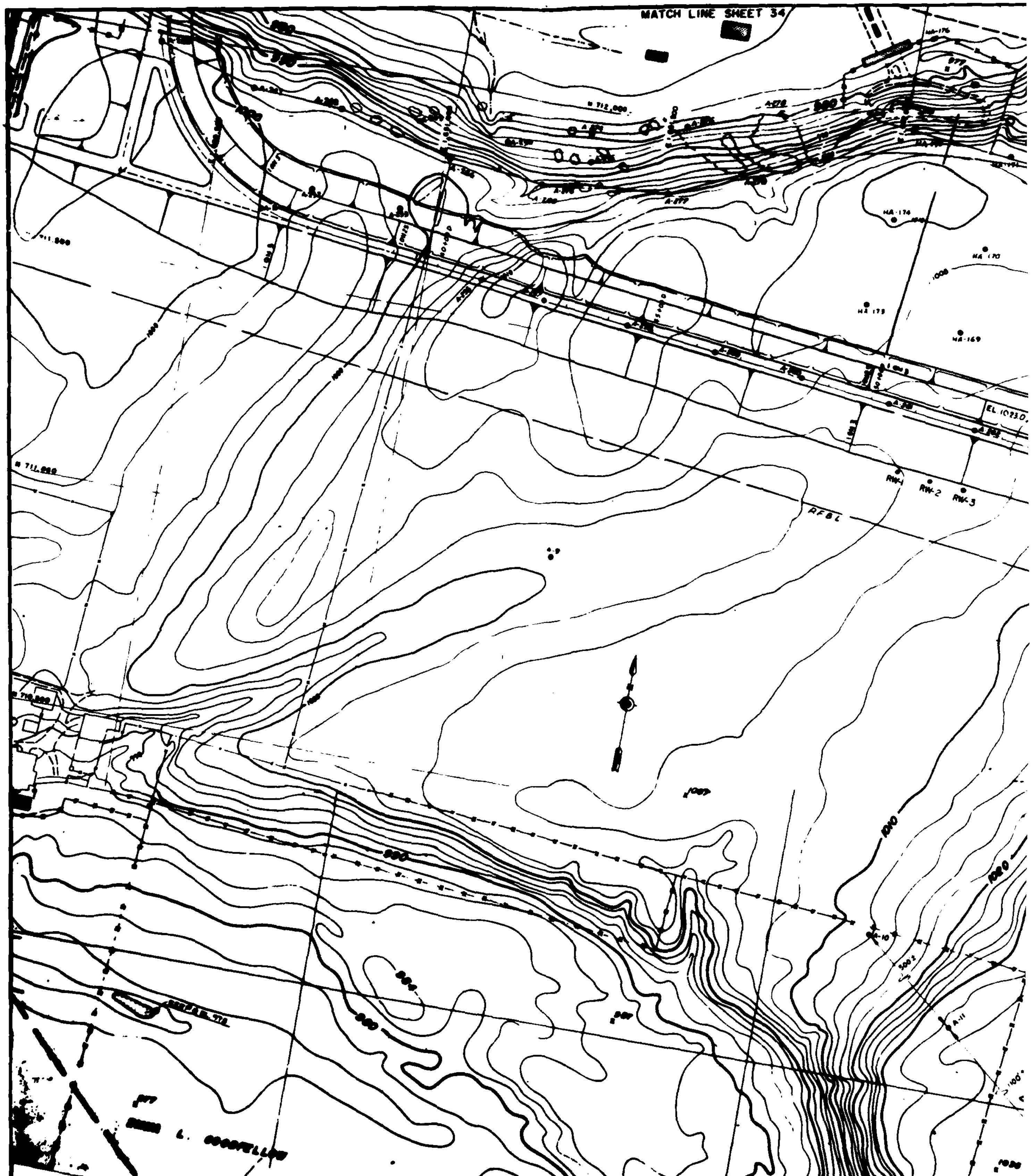


PLATE 8

RECORD DRAWING-"AS BUILT"

2


MATCH LINE SHEET 34
N 712,000
RW-1
RW-2
RW-3
RFBL
EL 1023.0
HA-174
HA-175
HA-169
1010
1020
990
980
L. GOODFELLOW

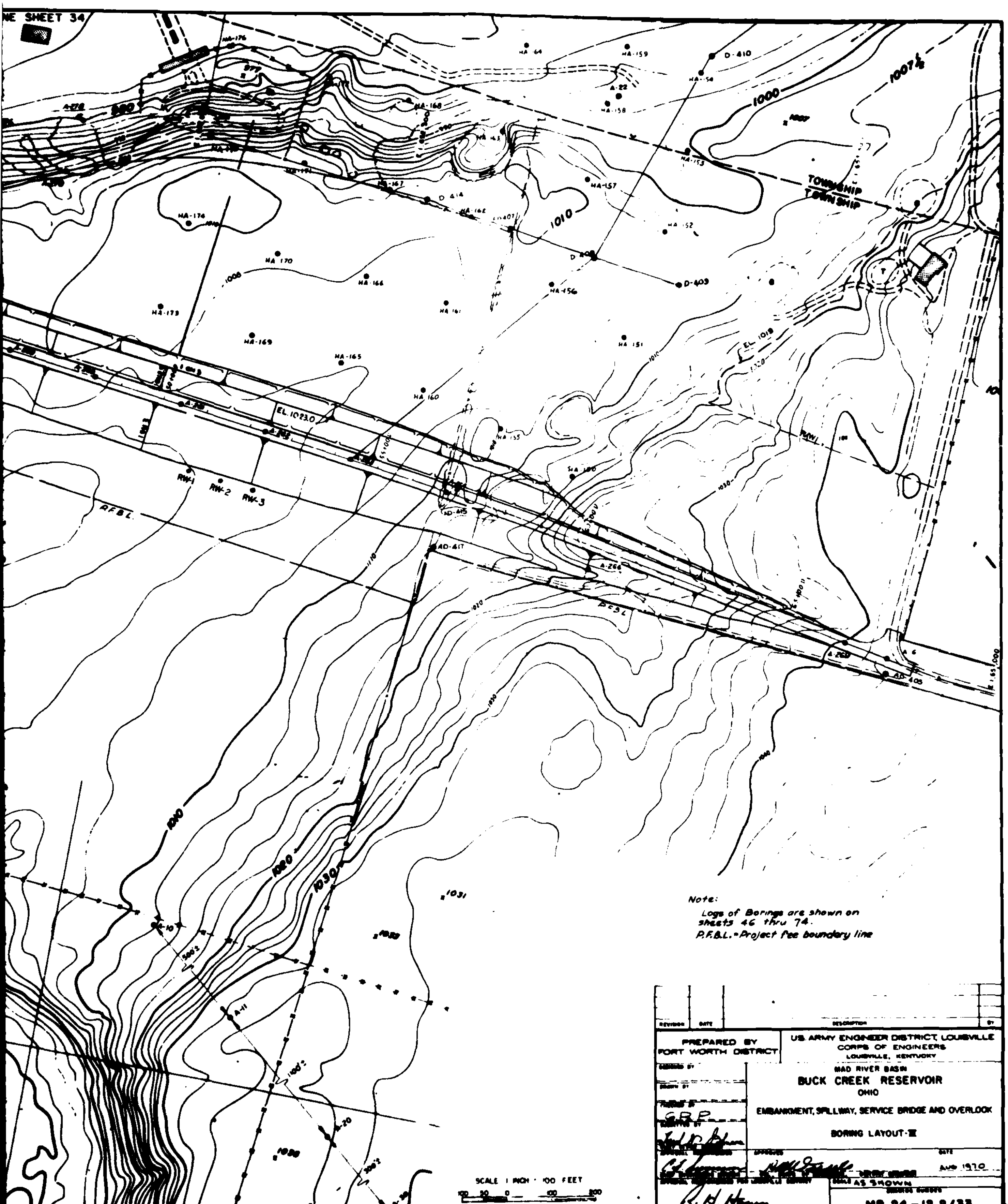
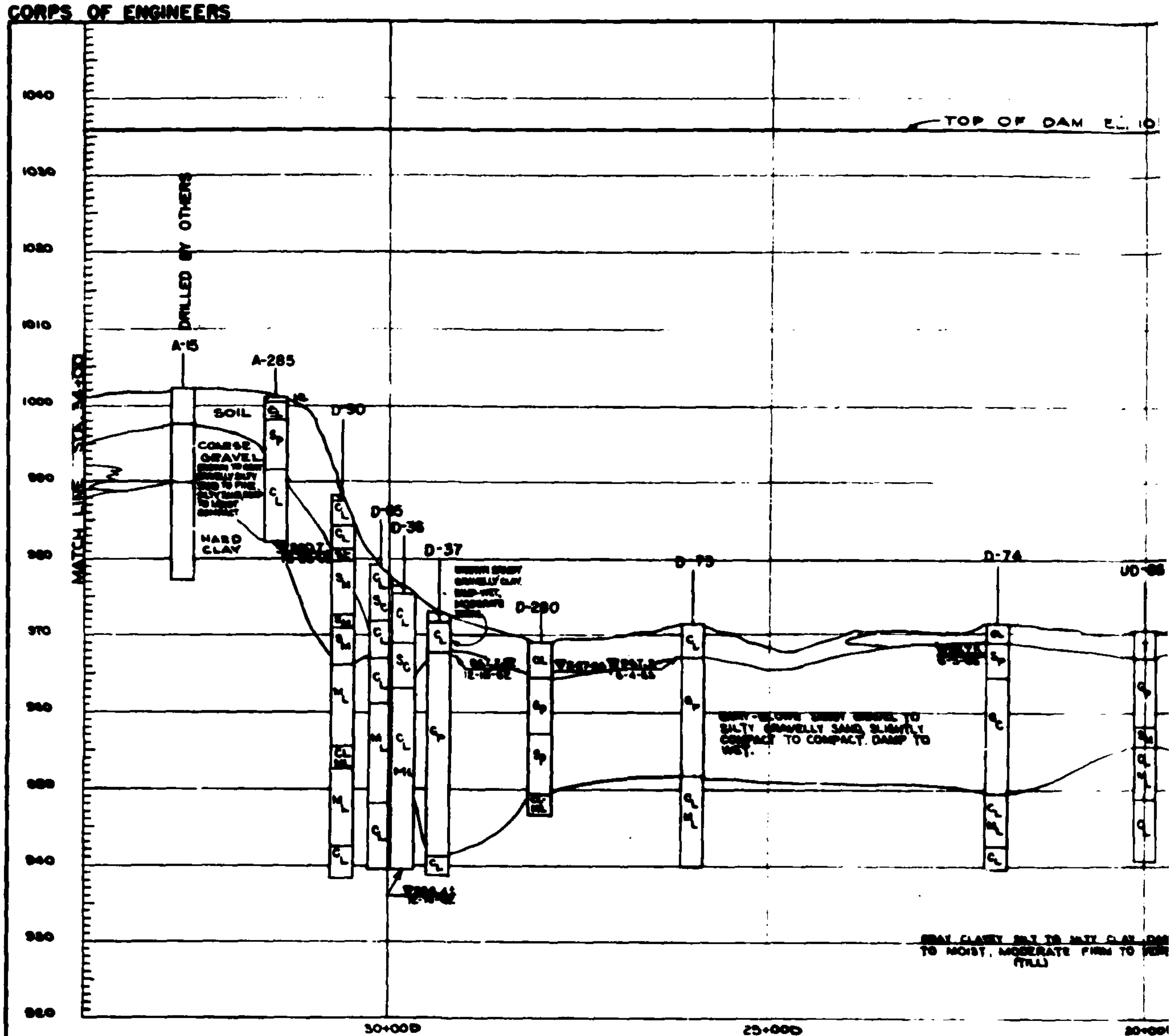


PLATE 9 RECORD DRAWING-"AS BUILT

1

2

CORPS OF ENGINEERS



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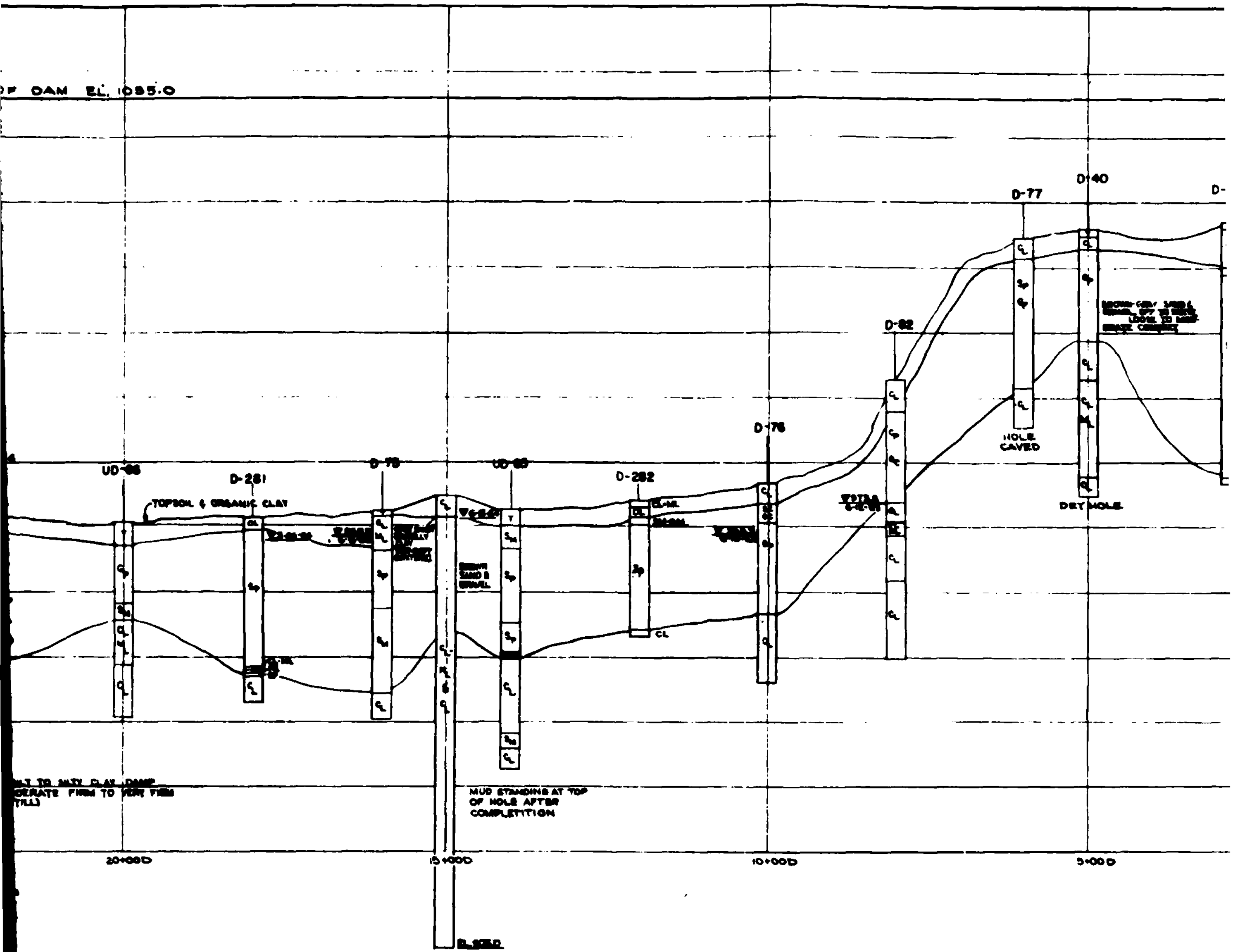
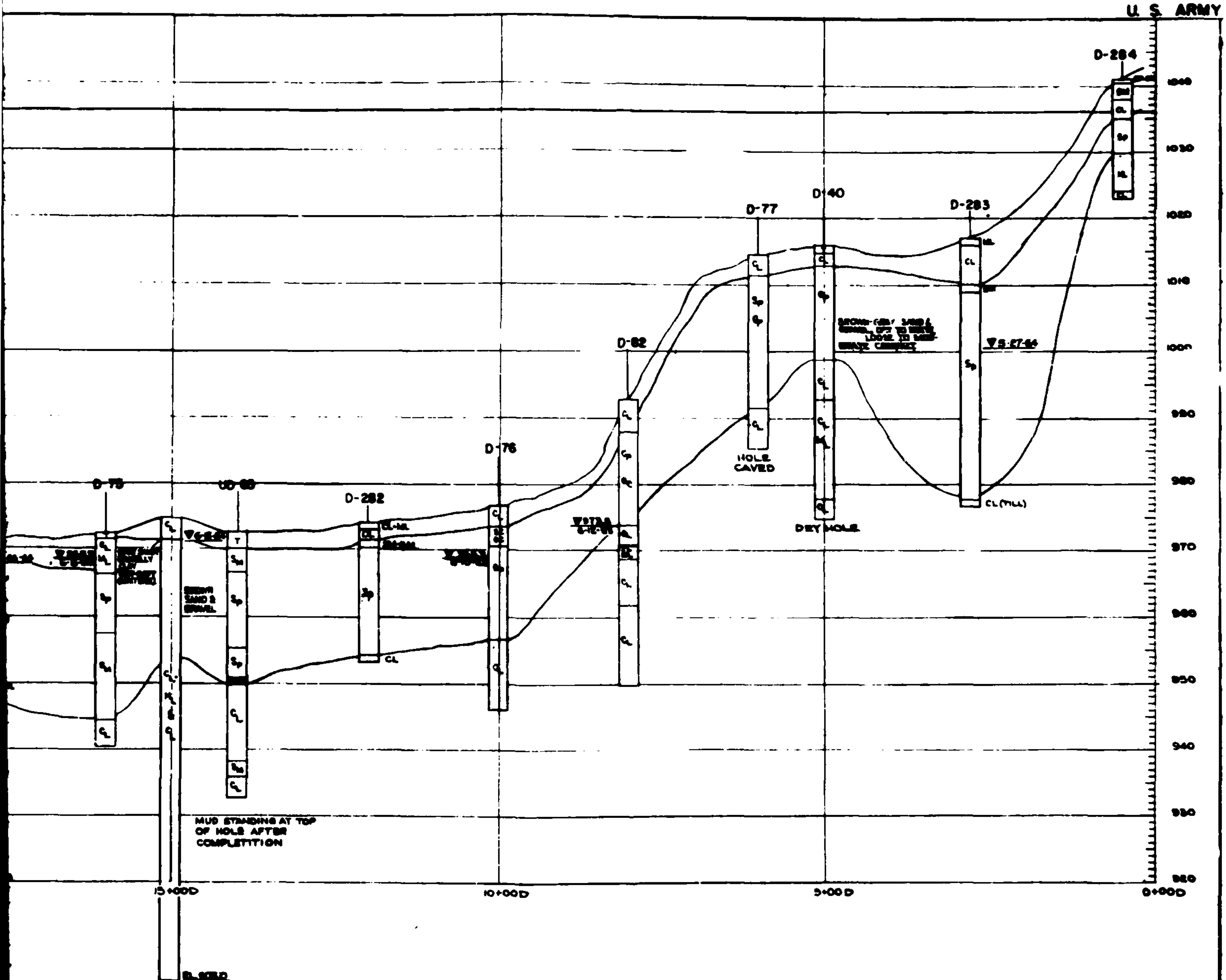

DAM EL. 1035.0
UD-66
D-281
D-79
D-282
D-76
D-82
D-77
D-40
TOPSOIL & ORGANIC CLAY
HOLE CAVED
DRY HOLE
MUD STANDING AT TOP OF HOLE AFTER COMPLETITION
20+00
15+00
10+00
5+00

PLATE

1

2



MAD RIVER BASIN

BUCK CREEK RESERVOIR

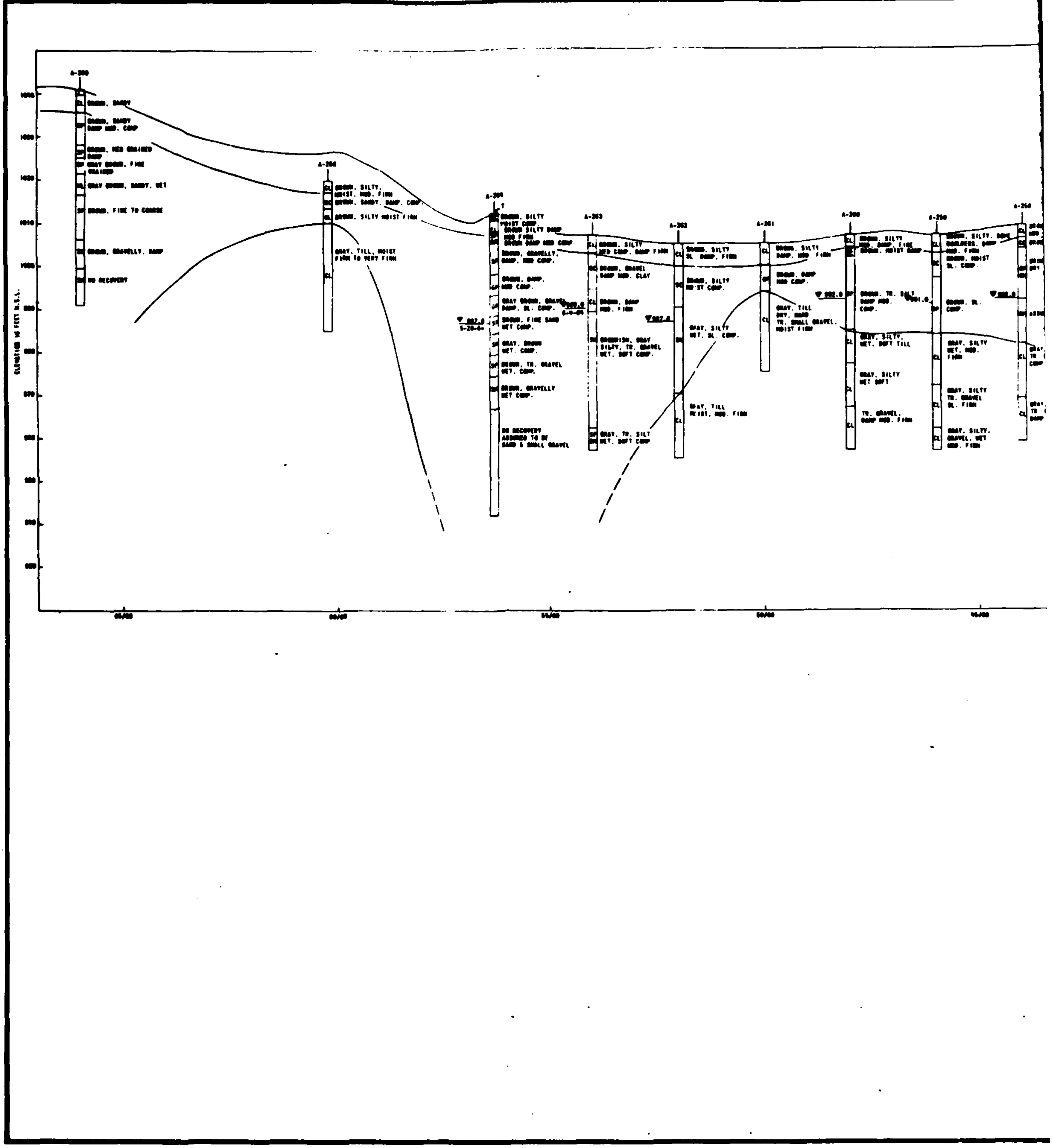
OHIO

GEOLOGIC PROFILE OF DAM

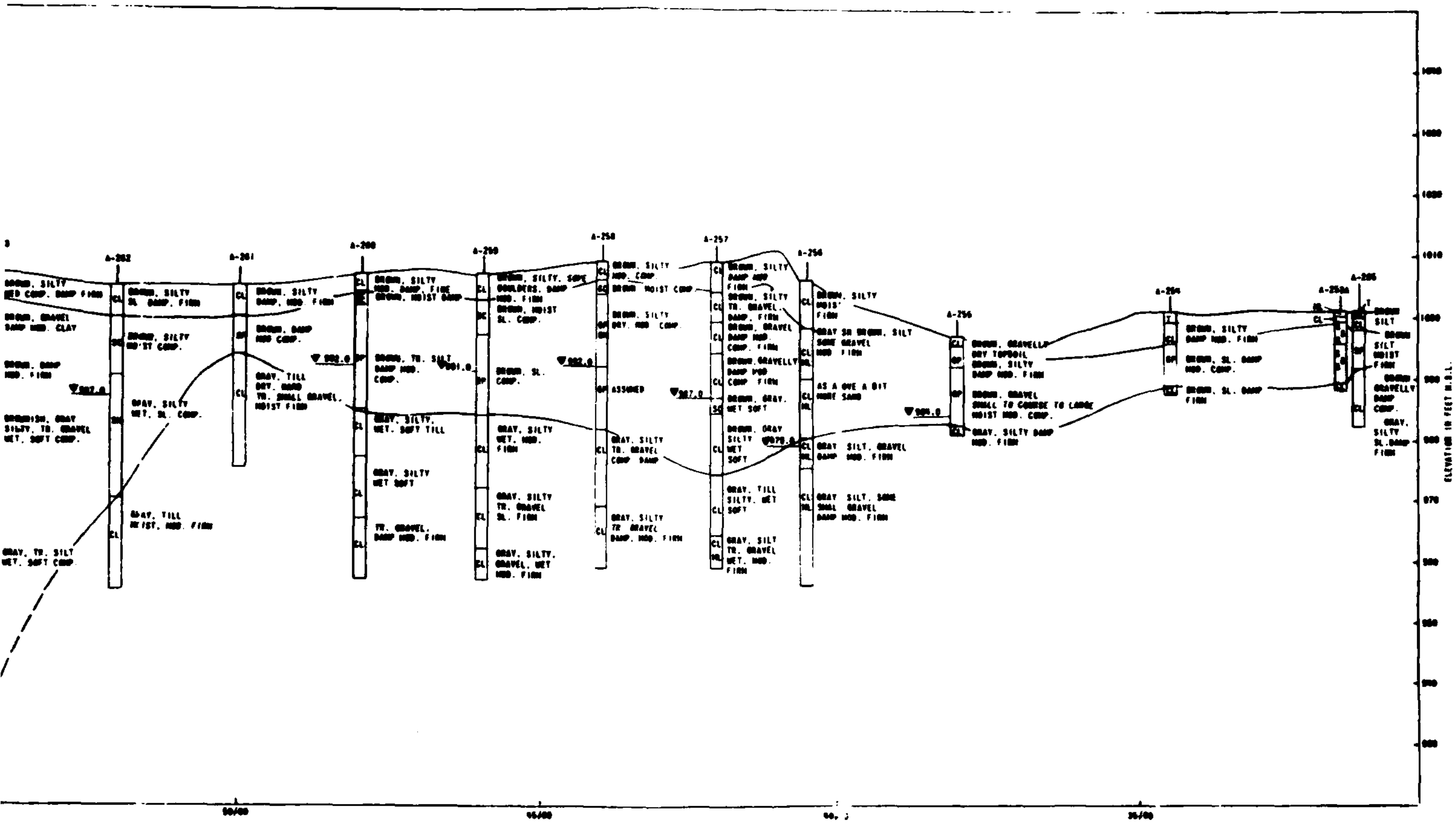
SHEET 1

PLATE 10

CORPS OF ENGINEERS



U.S. ARMY



MAD RIVER BASIN, OHIO
BUCK CREEK RESERVOIR
BUCK CREEK, OHIO

GEOLOGICAL PROFILE OF DAM

SHEET NO. 2

SCALE AS SHOWN

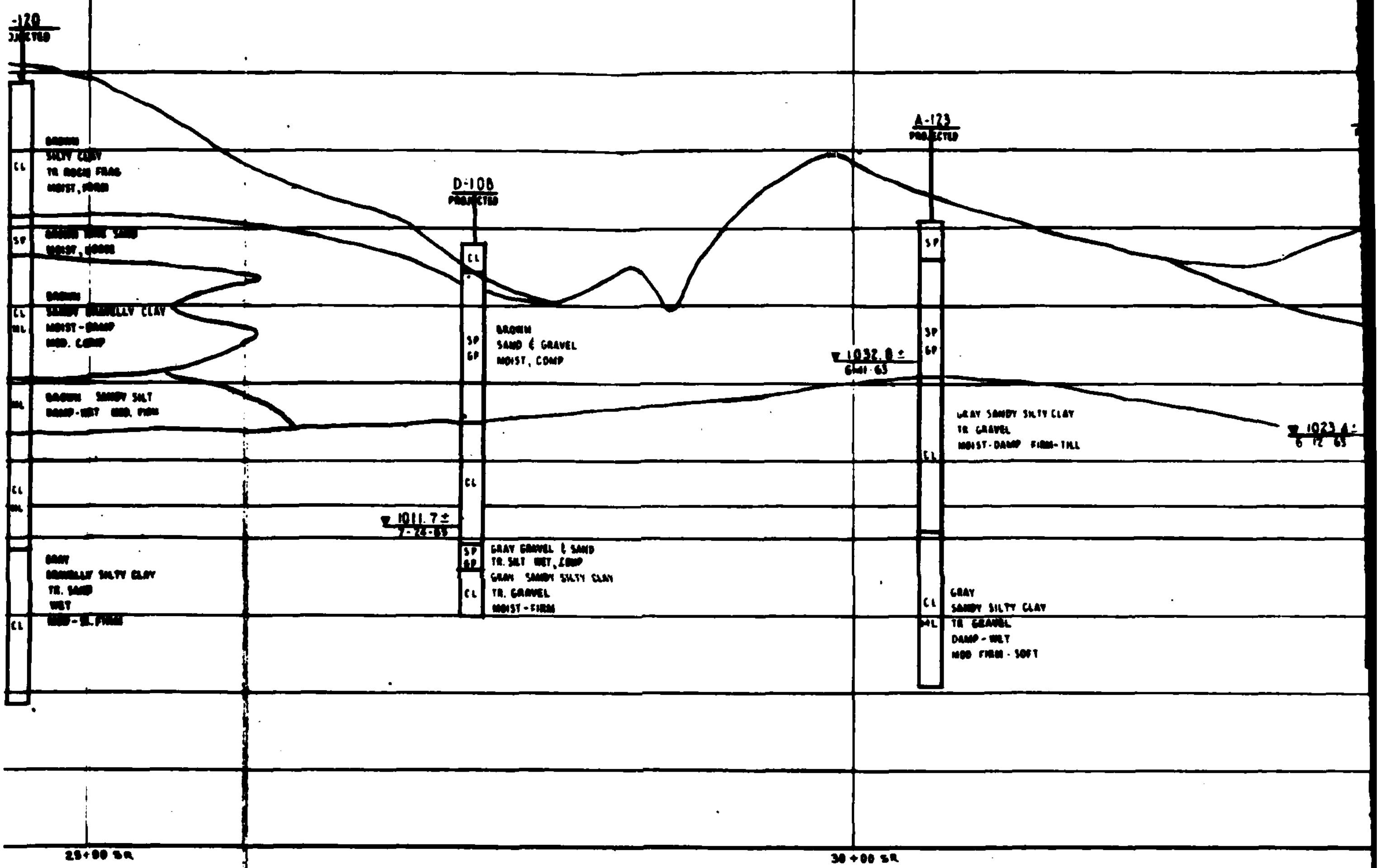
U.S. ARMY ENGINEER DISTRICT, FORT WORTH — NOV. 1964

TO ACCOMPANY DESIGN MEMORANDUM NUMBER 5
EMBANKMENT, SPILLWAY, AND OUTLET WORKS

FILE.

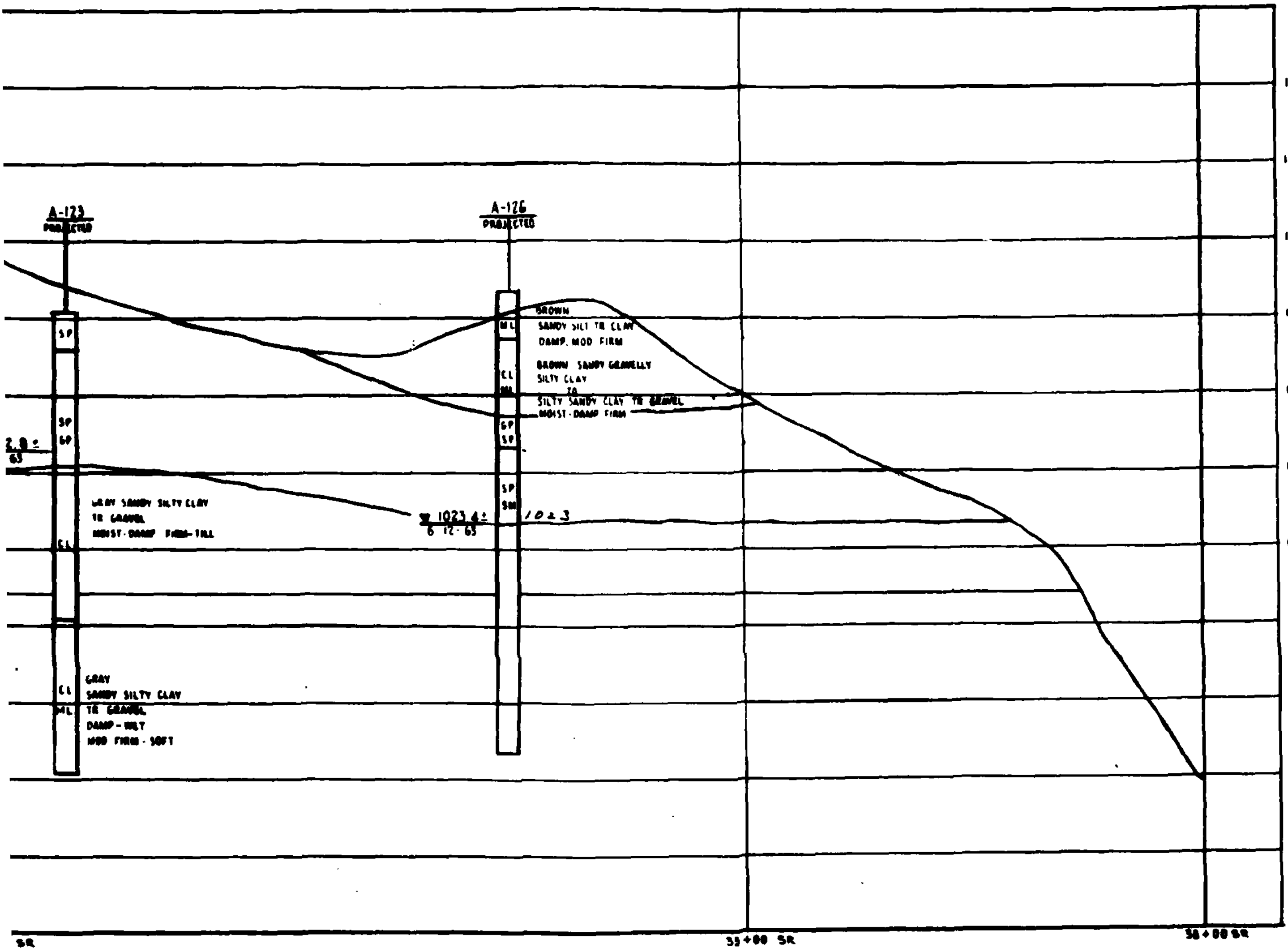
PLATE 11

2



D-108
PROJECTED
A-123
PROJECTED
BROWN
SILTY CLAY
TR ROCK FRAG
MOIST, FIRM
BROWN
SANDY GRAVELLY CLAY
MOIST-DAMP
MOD. COMP
BROWN SANDY SILT
DAMP-WET MOD. FIRM
GRAY
GRAVELLY SILTY CLAY
TR. SAND
WET
BROWN
SAND & GRAVEL
MOIST, COMP
1011.7 ±
7-24-65
GRAY GRAVEL & SAND
TR. SILT WET, COMP
GRAY SANDY SILTY CLAY
TR. GRAVEL
MOIST-FIRM
1052.8 ±
GRAY SANDY SILTY CLAY
TR. GRAVEL
MOIST-DAMP FIRM-TILL
1023.4 ±
GRAY
SANDY SILTY CLAY
TR. GRAVEL
DAMP-WET
MOD FIRM-SOFT
CL
SP
GP
ML
29+00 SR
30+00 SR

U. S. ARMY



MAD RIVER BASIN

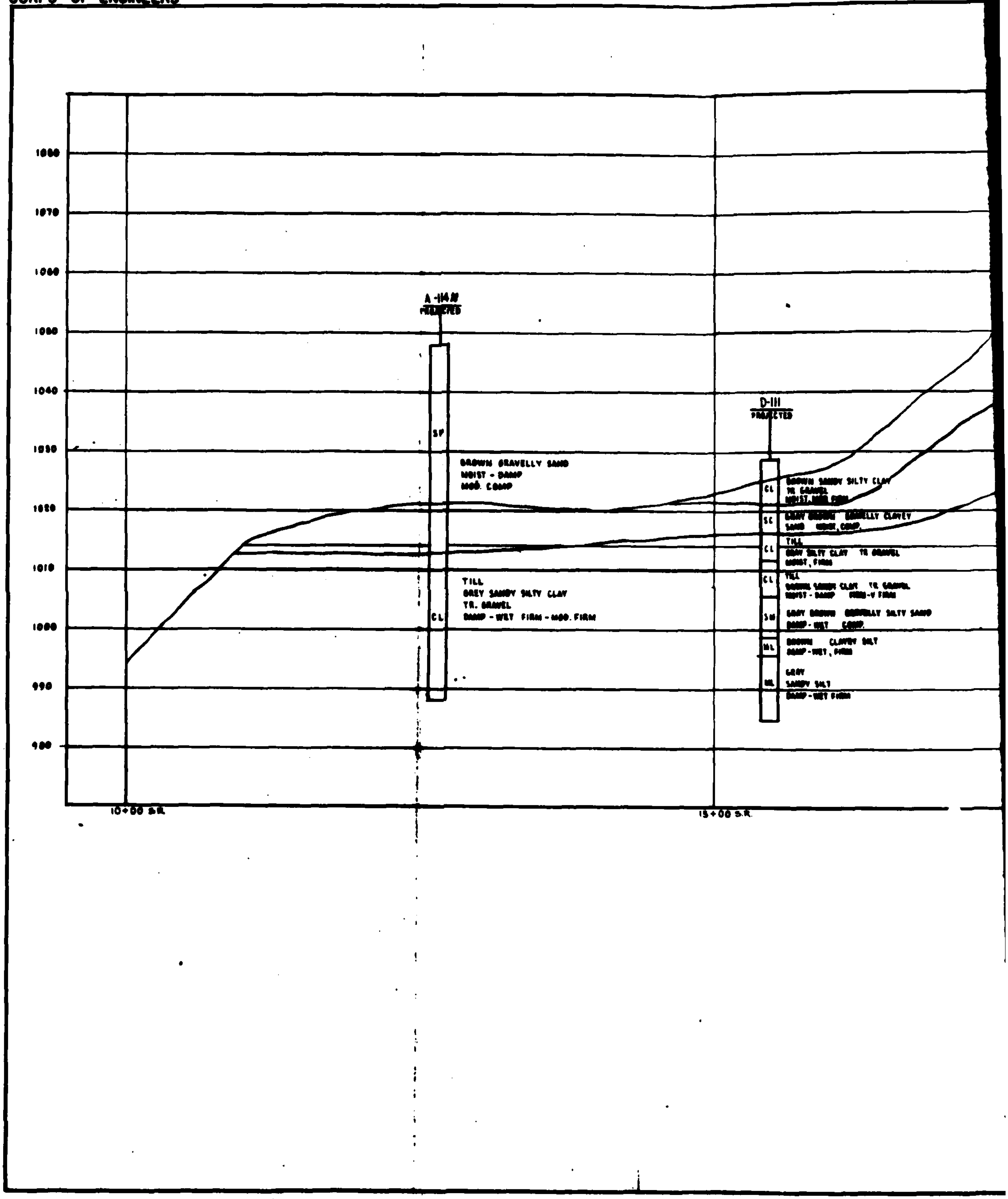
BUCK CREEK RESERVOIR

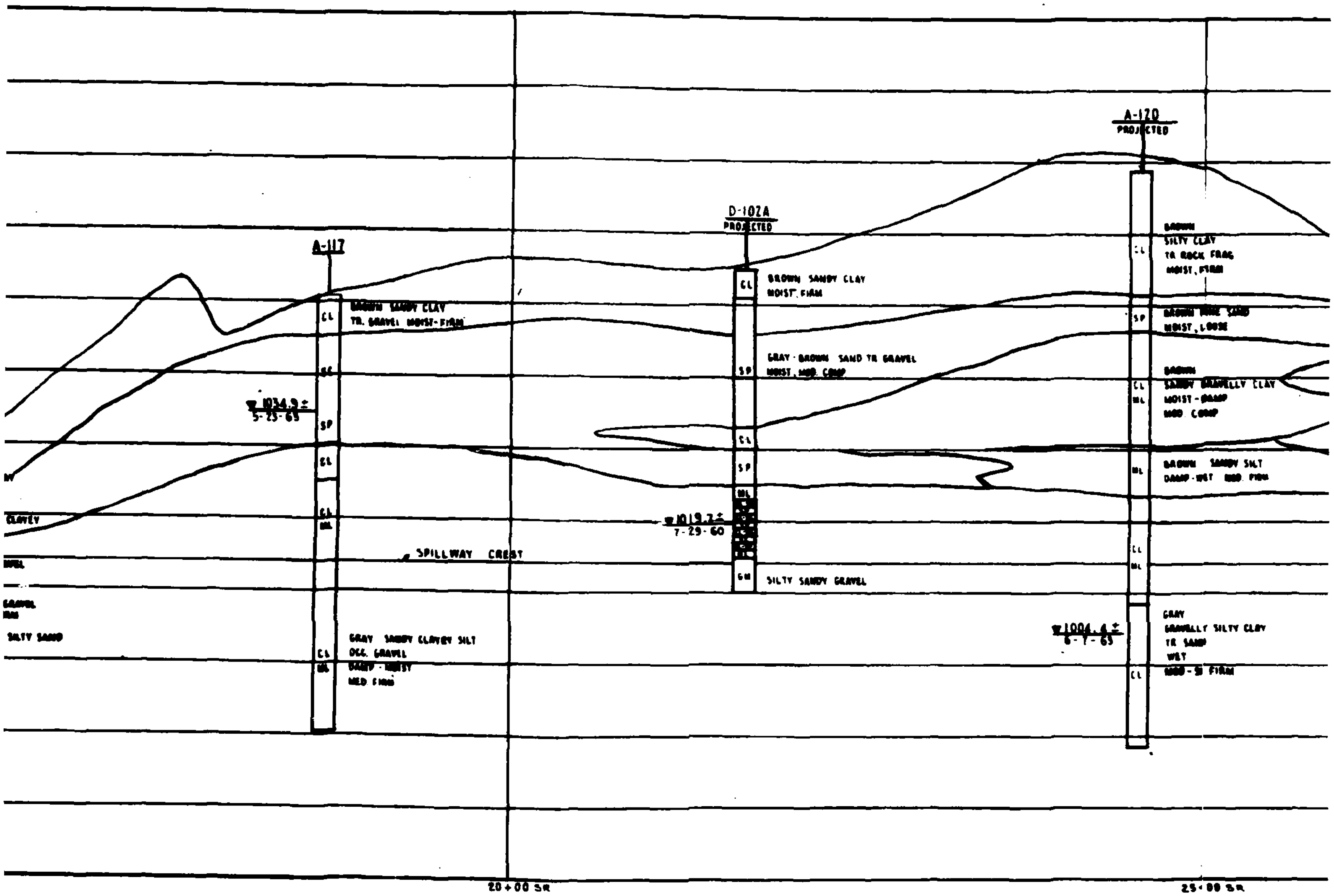
OHIO

GEOLOGIC PROFILE OF SPILLWAY

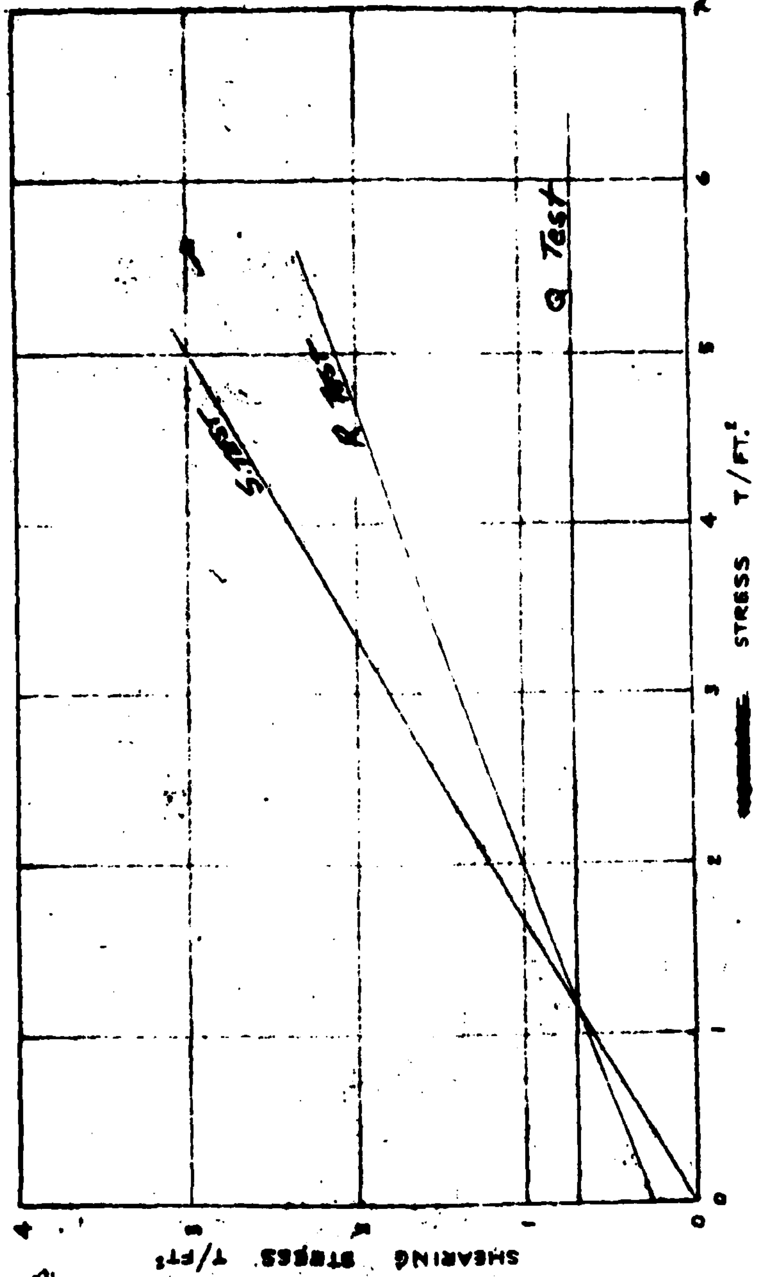
PLATE 12

CORPS OF ENGINEERS




A-117
D-102A
PROJECTED
A-120
PROJECTED
BROWN SANDY CLAY
TR. GRAVEL MOIST-FIRM
1034.9±
5-25-65
SPILLWAY CREST
GRAY SANDY CLAYEY SILT
OCC. GRAVEL
DAMP-MOIST
MED FIRM
BROWN SANDY CLAY
MOIST, FIRM
GRAY-BROWN SAND TR GRAVEL
MOIST, MED. COMP
1019.7±
7-29-60
SILTY SANDY GRAVEL
BROWN
SILTY CLAY
TR ROCK FRAG
MOIST, FIRM
BROWN FINE SAND
MOIST, LOOSE
BROWN
SANDY GRAVELLY CLAY
MOIST-DAMP
MED COMP
BROWN SANDY SILT
DAMP-WET MED. FIRM
1004.4±
6-7-65
GRAY
GRAVELLY SILTY CLAY
TR SAND
WET
20+00 SR
25+00 SR

1 1 2 12-A



Adopted Values

Emb. Mtl.

Q-Test
Tan ϕ=0
C=.70 T/FT²

R-Test
Tan ϕ=.37
'C'=.27 T/FT²

S-Test
Tan ϕ=.60
C=0

EMBANKMENT SOIL SUMMARY

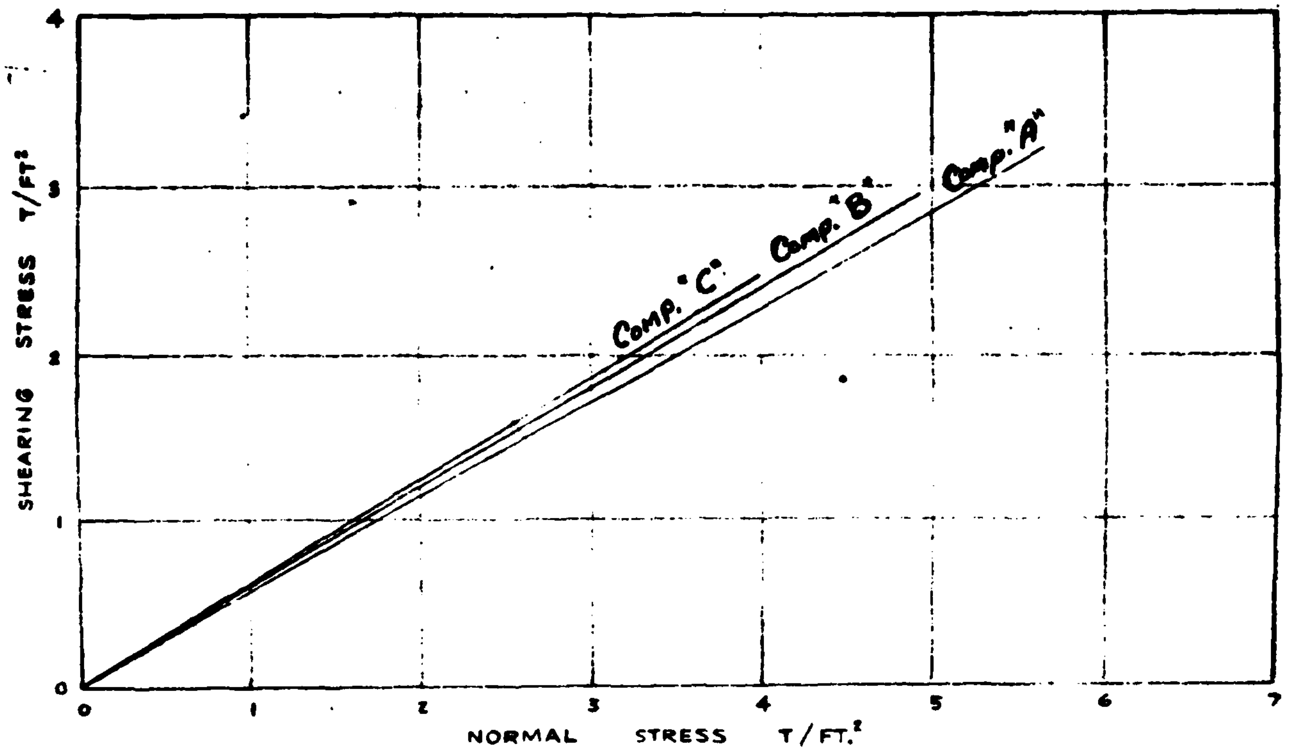
HOLE NO.	SAMPLE NO.	CLASS.	LL	PL	TAN ϕ	C T/FT²	SATURATION

BUCK CREEK RESERVOIR, OHIO

BY Rhm DATE 9/5/63 SUBJECT BUCK CREEK RESERVOIR SHEET NO. 2E OF 4E
CHKD BY DATE SHEAR TEST SUMMARY JOB NO.

AVERAGE VALUE
TAN ϕ = .604
"C" = 0

ADOPTED VALUE
TAN ϕ = .60
"C" = 0



HOLE NO.	SAMPLE NO.	CLASS.	LL %	PL %	TAN ϕ	C T/FT²	~~SATURATION~~ HOLE NUMBERS
Comp. "A"		CL	26.6	14.7	0.575	0.00	A-113, 117, 123
Comp. "B"	(Till)	CL-ML	19.7	12.6	0.607	0.00	A-119, 120, 121
Comp. "C"		CL-ML	24.1	17.1	0.630	0.00	A-337

S - TEST

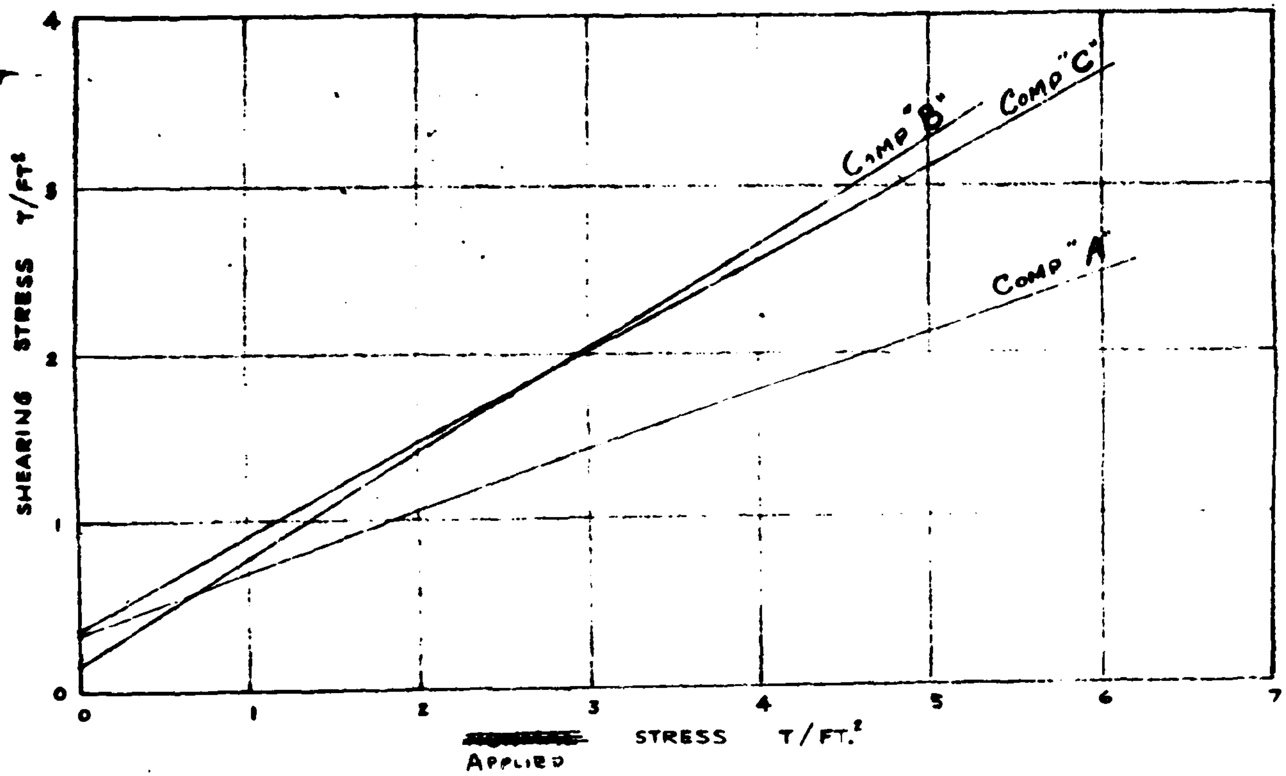
BUCK CREEK RESERVOIR, OHIO

PLATE 14

BY ___ DATE 9/5/63 SUBJECT ___
CHK'D BY ___ DATE ___ SHEAR TEST ___

Average Value
Tan φ = .515
"C" = .27 T/FT²

Adopted Value
Tan φ = .37
"C" = .27 T/FT²



HOLE NO.	SAMPLE NO.	CLASS.	LL %	PL %	TAN φ	C T/FT²	SATURATION		
Comp. "A"		CL	26.6	14.7	0.365	0.32	100.0	95.8	97.8
Comp. "B"	(Till)	CL-ML	19.7	12.6	0.630	0.15	95.9	99.0	94.2
Comp. "C"		CL-ML	24.1	17.1	0.551	0.34	88.5	84.1	82.5

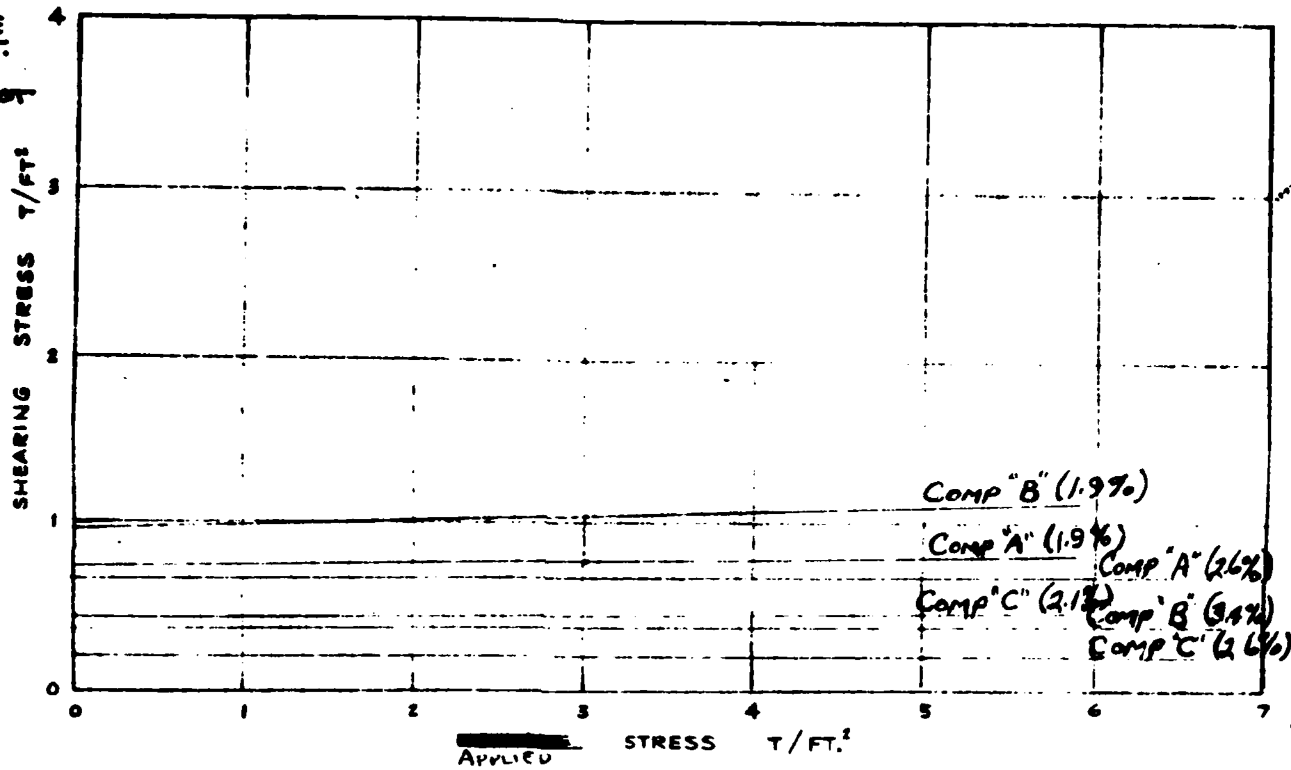
BUCK CREEK RESERVOIR, OHIO

PLATE 15

BY ... DATE 9/5/63 SUBJECT BUCK CREEK RESERVOIR SHEET NO 4E OF 4E
CHK'D BY ... DATE ... SHEAR TEST SUMMARY JOB NO

AVERAGE VALUE

RESULTS DO NOT AVG. SEE PLATE 84



HOLE NO.	SAMPLE NO.	CLASS.	LL %	PL %	TAN ϕ	C T/FT²	SATURATION
Comp "A"		CL	26.6	14.7	0.000	0.66	2.6 % WET OF OPTIMUM
					0.015	0.72	1.9 % WET OF OPTIMUM
Comp "B"	(T.11)	CL-ML	19.7	12.6	0.000	0.36	3.4 % WET OF OPTIMUM
					0.033	0.96	1.9 % WET OF OPTIMUM
Comp. C.		CL-ML	24.1	17.1	0.000	0.20	2.6 % WET OF OPTIMUM
					0.000	0.43	2.1 % WET OF OPTIMUM

EMBANKMENT SOIL

Q - TEST

BUCK CREEK RESERVOIR, OHIO

PLATE 16

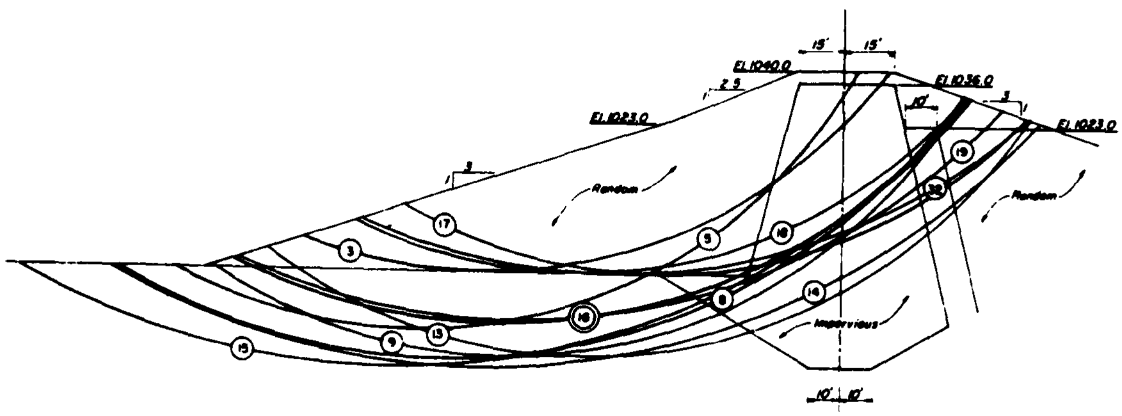
CORPS OF ENGINEERS

CIRCLE	SAFETY FACTORS	
	COMPUTED	REQUIRED
3	2 071	1 300
5	2 168	"
8	2.019	"
9	2 020	"
13	2 483	"
14	2.261	"
15	2 001	"
● 16	1 846	"
17	2 617	"
18	2 104	"
19	1 947	"
32	2 426	"

Summary of safety factors determined by W.E.S. computer program

POST CONSTRUCTION CONDITION

● Critical safety factor



Impervio

Random (

POST CONSTRUCTION CONDITION

	Seg.	Area sq.ft	Unit wt. k.c.f	Force kips	Tan ϕ	N Tan ϕ kips	Arc length ft.	C k.s.f.	C kips	ΣN Tan ϕ + C kips
[illegible]	A	168	0.125	21	0.60	13				
	B	532	0.125	66	0.00					
	C	1418	0.1380	192	0.00					
	D	404	0.125	51	0.60	31				
	E	547	0.125	68	0.00					
	F	32	0.0784	2	0.00					
	G	3810	0.125	476	0.60					
	H	24	0.0784	2	0.60					
	I	1468	0.065	95	0.60	344				
						388	76	1.4	106	494
[illegible]	I act	1140	0.125	143						
	II	984	0.1380	129						
	III	24	0.0784	2						
	III act	-32	0.065	-2						
			ΣT =	272						

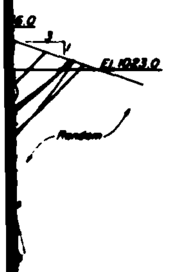
Safety factor $\frac{\Sigma N \tan\phi + C}{\Sigma T} = \frac{494}{272} =$ [illegible]

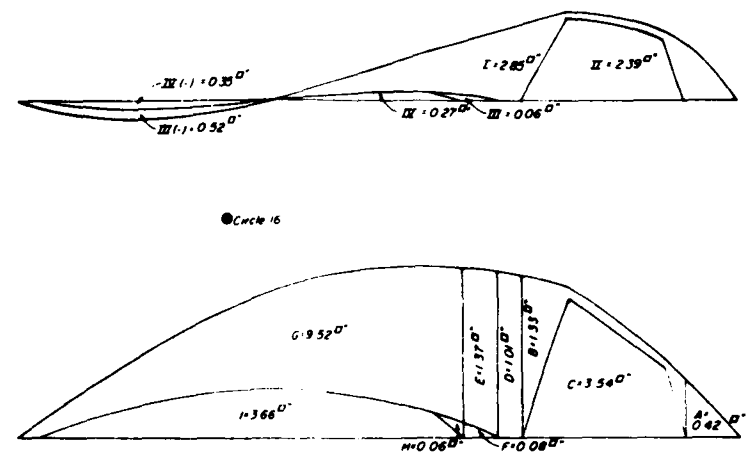
W.E.S. computer safety factor = 1.846

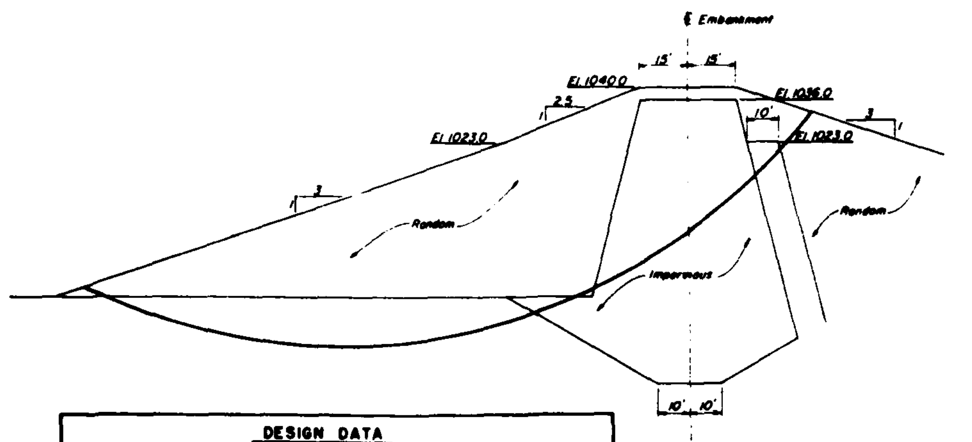
U S ARMY

factors determined by W.E.S. ...uter program
...UCTION CONDITION
...FETY FACTORS

	REQUIRED
	1.300
	"
	"
	"
	"
	"
	"
	"
	"
	"
	"







DESIGN DATA

UNIT WEIGHT		SHEAR STRENGTHS Q	R	S
Impervious (Emb. and Cutoff)				
γ_{moist}	= 136.9 p.c.f.	tan. ϕ = 0	tan. ϕ = 0.37	tan. ϕ = 0.60
γ_{sat}	= 136.9 p.c.f.	c = 0.7 t.s.f.	c = 0.27 t.s.f.	c = 0
γ_{buoy}	= 76.4 p.c.f.	"	"	"
Random (Shells and Foundation)				
γ_{moist}	= 125.0 p.c.f.	tan. ϕ = 0.60	tan. ϕ = 0.60	tan. ϕ = 0.60
γ_{sat}	= 127.8 p.c.f.	c = 0	c = 0	c = 0
γ_{buoy}	= 68.0 p.c.f.	"	"	"

NOTE:
The difference in safety factors between analyses performed by the Waterways Experiment Station computer program and graphical analyses performed in the Fort Worth District is believed to be the result of small errors accumulated in the manual computations.

REVISION	DATE	DESCRIPTION	BY

PREPARED BY FORT WORTH DISTRICT

US ARMY ENGINEER DISTRICT, LOUISVILLE
CORPS OF ENGINEERS
LOUISVILLE, KENTUCKY

MAD RIVER BASIN, OHIO
BUCK CREEK RESERVOIR
BUCK CREEK, OHIO
STABILITY ANALYSIS
CIRCULAR ARC METHOD
POST CONSTRUCTION CONDITION
UPSTREAM
DESIGN RESUME

DESIGNED BY: S.R.P.
DRAWN BY: F.D.M.
CHECKED BY:
SUBMITTED BY:
APPROVAL RECOMMENDED
APPROVED
DATE
SCALE
CHIEF, ENGINEERING DIVISION

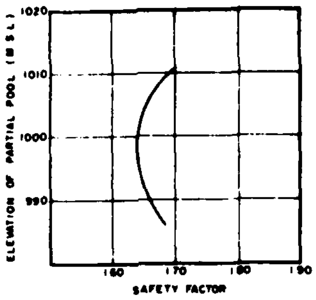
PLATE 17

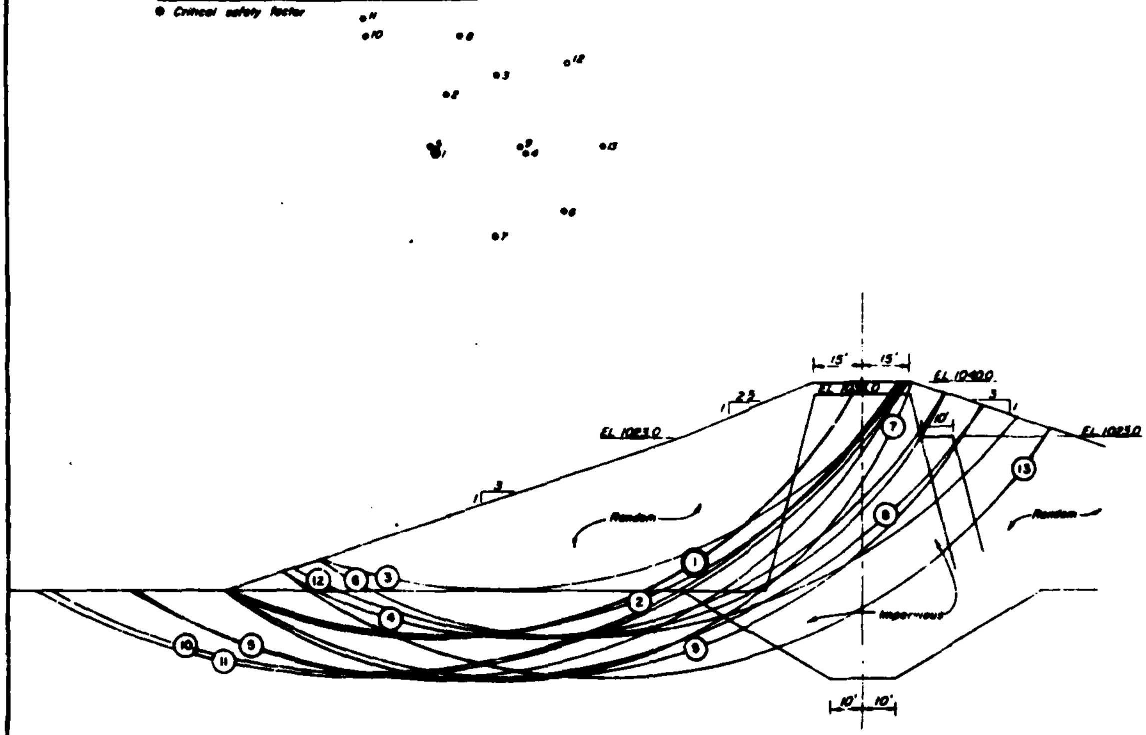
2

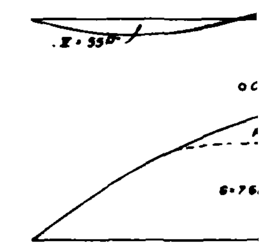
CORPS OF ENGINEERS

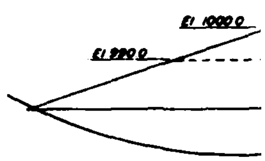
Summary of safety factors determined by WES computer program			
CRITICAL POOL CONDITION			
CIRCLE	COMPUTED SAFETY FACTOR	POOL ELEVATION	REQUIRED SAFETY FACTOR
● 1	1.582	999.0	1.500
2	1.599	1001.0	1.500
3	1.616	1008.0	1.500
4	1.634	1002.0	1.500
5	1.639	994.0	1.500
6	1.654	1003.0	1.500
7	1.662	987.0	1.500
8	1.693	996.0	1.500
9	1.703	998.0	1.500
10	1.708	992.0	1.500
11	1.712	998.0	1.500
12	1.868	1003.0	1.500
13	2.118	1000.0	1.500

● Critical safety factor









UNIT WEIGHT

Impervious (Emb & cutoff)
γ_{moist} = 135.9 pcf
γ_{sat} = 138.9 pcf
γ_{buoy} = 76.4 pcf
Random (Shells & ...)
γ_{moist} = 125.0 pcf
γ_{sat} = 127.5 pcf
γ_{buoy} = 65.0 pcf

	Seg.	Area sq ft	Unit wt k.c.f	Force kips	Tan φ	N tan φ kips	Arc length ft	C k.s.f	C kips	N tan. φ + C
PARTIAL POOL CONDITION — POOL EL 999.0										
NORMAL FORCES	A	12	.125	1	.60	1				
	B	100	.125	13	.37	[illegible]				
	C	100	.1389	14	.37	10				
	D+E+F	2444	.125	305	.60	[illegible]				
	G	3048	.065	198	.60	302				
						313	32	.54	17	330
TANGENTIAL FORCES	1+3+4	1340	.125	168						
	2	140	.1389	19						
	5 (Buoy)	184	.065	12						
				199						

Safety factor $= \frac{\Sigma N \tan \phi + C}{\Sigma T} = \frac{330}{199} = 1.66$

W.E.S computer safety factor = 1.582

	Seg.	Area sq ft	Unit wt k.c.f	Force kips	Tan φ	N tan φ kips	Arc length ft	C k.s.f	C kips	N tan. φ + C
PARTIAL POOL CONDITION — POOL EL [illegible]										
	A	12	.125	1	.60	1				
	B	100	.125	13	.37	[illegible]				
	C	100	.1389	14	.37	10				
	D+E	1476	.125	184	.60	110				
	F+G	4016	.065	261	.60	157				
						278	32	.54	17	295
	1+3	1032	.125	129						
	2	140	.1389	19						
	4+5 (Buoy)	492	.065	32						
				180						

Safety factor $= \frac{\Sigma N \tan \phi + C}{\Sigma T} = \frac{295}{180} = 1.64$

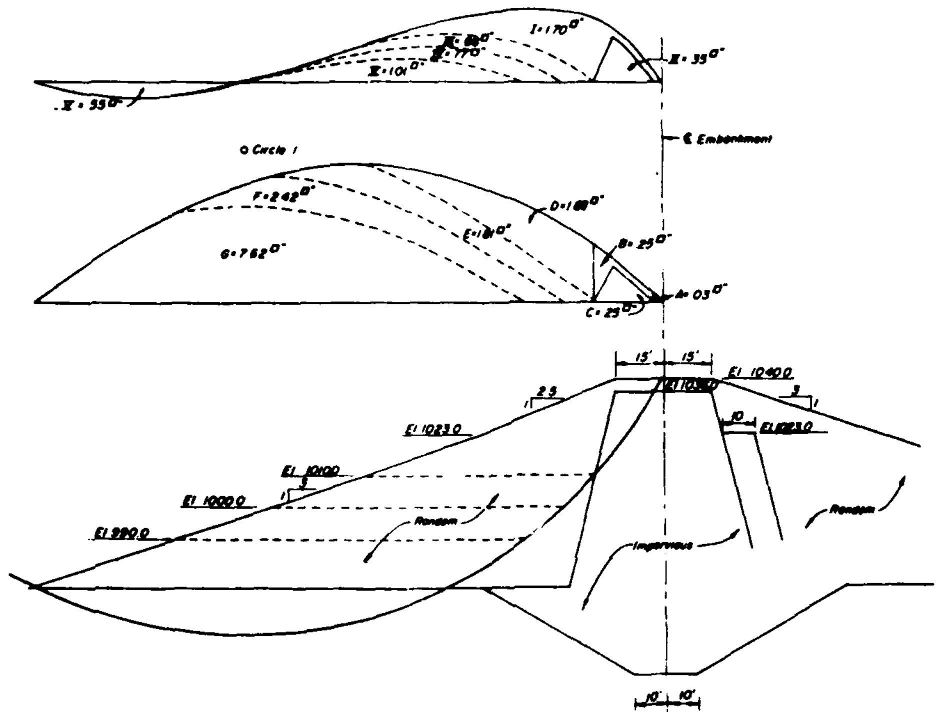
W.E.S. computer safety factor = 1.582

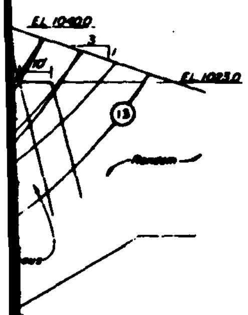
Seg.	Area sq ft
A	12
B	100
C	100
D	782
E+F+G	4740
1	660
2	140
3+4+5 (Buoy)	944

Safety factor = ...

W.E.S. computer safety ...

U. S. ARMY





DESIGN DATA

UNIT WEIGHT	SHEAR STRENGTHS Q	R	S
Impervious (Emb & cutoff)			
γ_{moist} = 135.9 pcf	tan ϕ = 0, c = 0.7 tsf	tan ϕ = 0.37, c = 0.27 tsf	tan ϕ = 0.60, c = 0
γ_{sat} = 138.9 pcf			
γ_{buoy} = 76.4 pcf			
Random (Shells & fdn.)			
γ_{moist} = 125.0 pcf	tan ϕ = 0.60, c = 0	tan ϕ = 0.60, c = 0	tan ϕ = 0.60, c = 0
γ_{sat} = 127.5 pcf			
γ_{buoy} = 68.0 pcf			

NOTE

The difference in safety factors between analyses performed by the Waterways Experiment Station computer program and graphical analyses performed in the Fort Worth District is believed to be the result of small errors accumulated in the manual computations.

...TIAL POOL CONDITION

POOL EL [illegible]

Tan ϕ	N tan ϕ kips	Arc length ft	C k.s.f	C kips	N tan ϕ + C
60	1				
37	1				
37	10				
60	110				
60	157				
	279	32	94	17	296

...296 = 1.64
...180
...1.982

PARTIAL POOL CONDITION

POOL EL 1010.0

	Seg	Area sq ft	Unit wt k.c.f	Force kips	Tan ϕ	N tan ϕ kips	Arc length ft	C k.s.f	C kips	N tan ϕ + C
	A	12	125	1	60	1				
	B	100	125	13	37	1				
	C	100	1389	14	37	10				
	D	752	125	94	60	1				
	E+F+G	4740	068	308	60	241				
						252	32	94	17	269
	1	680	125	85						
	2	140	1389	19						
	3+4+5 (sub)	844	068	55						
				159						

Safety factor = $\frac{\Sigma N \tan \phi + C}{\Sigma T} = \frac{269}{159}$ = 1.69

W.E.S. computer safety factor = 1.582

REVISION	DATE	DESCRIPTION	BY

PREPARED BY FORT WORTH DISTRICT	U.S. ARMY ENGINEER DISTRICT, LOUISVILLE CORPS OF ENGINEERS LOUISVILLE, KENTUCKY

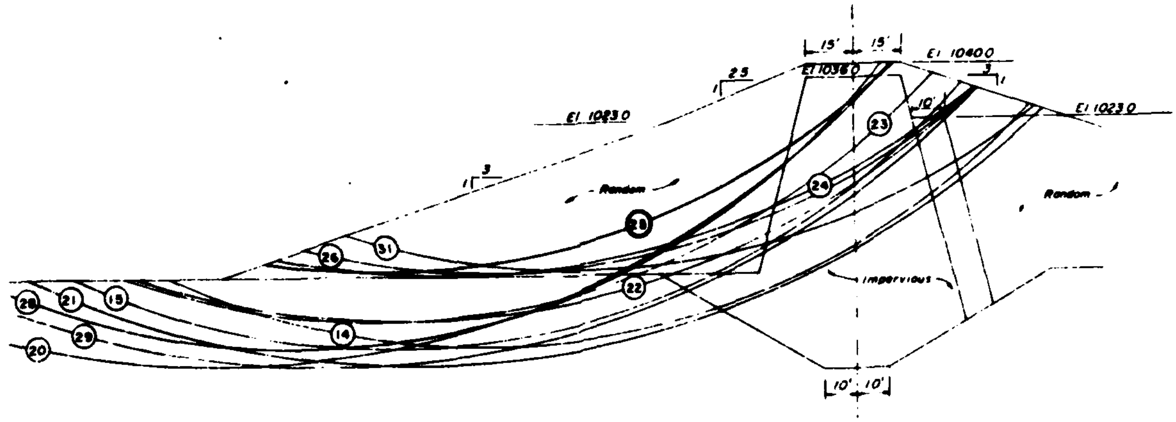
DESIGNED BY A.R.P.	MAD RIVER BASIN, OHIO
DRAWN BY L.B.R.	BUCK CREEK RESERVOIR
CHECKED BY	BUCK CREEK, OHIO
SUBMITTED BY	STABILITY ANALYSIS CIRCULAR ARC METHOD CRITICAL POOL CONDITION UPSTREAM DESIGN RESUME

PLATE 18

2

Summary of safety factors determined by W.E.S. computer program				
RAPID DRAWDOWN CONDITION				
CIRCLE	SAFETY FACTORS			
	[illegible]		[illegible]	
	COMPUTED	REQUIRED	COMPUTED	REQUIRED
14	1.499	1.000	1.594	1.200
15	1.318	"	1.400	"
20	1.498	"	1.589	"
21	1.520	"	1.606	"
22	1.264	"	1.377	"
23	1.187	"	1.292	"
24	1.251	"	–	"
● 25	1.072	"	–	"
26	1.267	"	–	"
28	1.364	"	1.454	"
29	1.408	"	1.497	"
31	1.593	"	–	"

● Critical safety factor



RAPID DRAWDOWN CONDITION										
EL. [illegible] – EL. [illegible]										
	Seg.	Area sq ft	Unit wt k.c.f.	Force kips	Tan. ϕ	N Tan ϕ kips	Arc length ft	C k.s.f.	C kips	ΣN Tan ϕ + C kips
NORMAL FORCES	A	12	0.125	2	0.60	1				
	B	86	0.125	11	0.37					
	C	26	0.1380	3	0.37					
	D + E	232	0.0784	18	0.37					
	F + G	60	0.065	4	0.37	13				
	H	12	0.125	2	0.60					
	I + J	3670	0.065	239	0.60	144				
						158	38	0.54	20	178
TANGENTIAL FORCES	I	84	0.125	11						
	II	20	0.1380	3						
	III + IV	172	0.1380	24						
	V + VI	812	0.1275	104						
	V net	160	0.065	10						
			ΣT =	152						

Safety factor $\frac{\Sigma N \tan\phi + C}{\Sigma T} = \frac{178}{152} = 1.17$

W.E.S. computer safety factor = 1.072

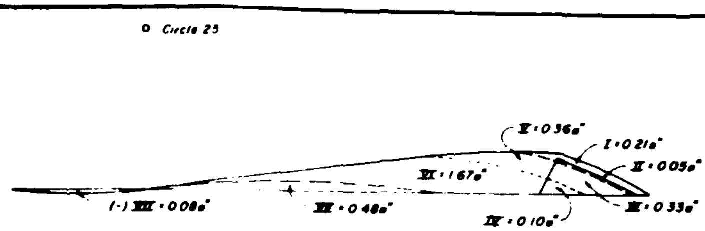
∴ 1.17 > Required S.F. of 1.0

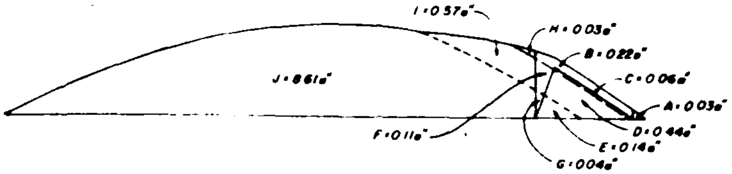
RAPID DRAWDOWN CONDITION										
EL. [illegible] – EL. 995.0										
	Seg.	Area sq ft	Unit wt. k.c.f.	Force kips	Tan. ϕ	N Tan ϕ kips	Arc length ft	C k.s.f.	C kips	ΣN Tan ϕ + C kips
NORMAL FORCES	A	12	0.125	2	0.60	1				
	B + F	132	0.125	16	0.37					
	C + D	200	0.1380	27	0.37					
	E	56	0.0784	4	0.37					
	G	16	0.065	1	0.37	18				
	H + I	240	0.125	30	0.60					
	J	3444	0.065	224	0.60	152				
						171	38	0.54	20	191
TANGENTIAL FORCES	I + II	226	0.125	29						
	II + III	152	0.1380	21						
	IV	40	0.1380	6						
	V	660	0.1275	85						
	VI net	160	0.065	10						
			ΣT =	191						

Safety factor $\frac{\Sigma N \tan\phi + C}{\Sigma T} = \frac{191}{151} = 1.26$

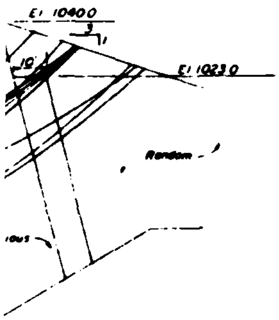
∴ 1.26 > Required S.F. of 1.20

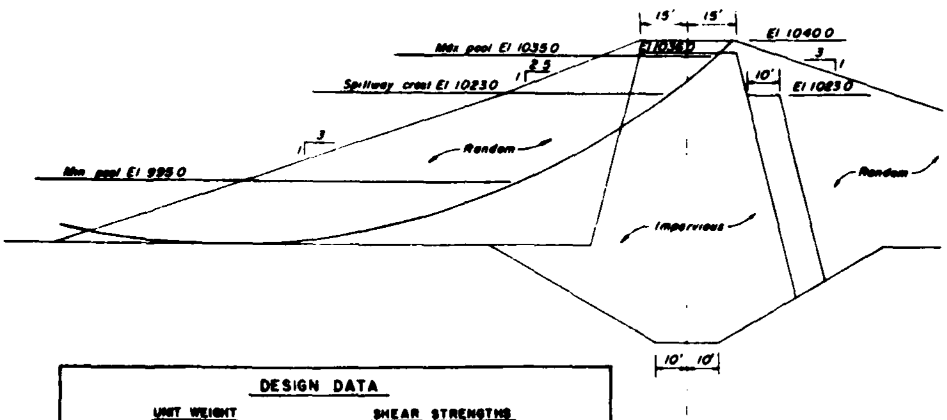
U S ARMY





formed by WES gram	
ONDITION	
ACTORS	
394	1 200
400	"
589	"
606	"
377	"
1 292	"
–	"
–	"
–	"
454	"
497	"
–	"





DESIGN DATA

UNIT WEIGHT		SHEAR STRENGTHS Q	R	S
Impervious (Emb. and Cutoff)				
γ_{moist}	= 135.9 pcf	tan ϕ = 0	tan ϕ = 0.37	tan ϕ = 0.60
γ_{sat}	= 138.9 pcf	c = 0.7 tsf	c = 0.27 tsf	c = 0
γ_{buoy}	= 76.4 pcf	"	"	"
Random (Shells and Foundation)				
γ_{moist}	= 125.0 pcf	tan ϕ = 0.60	tan ϕ = 0.60	tan ϕ = 0.60
γ_{sat}	= 127.8 pcf	c = 0	c = 0	c = 0
γ_{buoy}	= 65.0 pcf	"	"	"

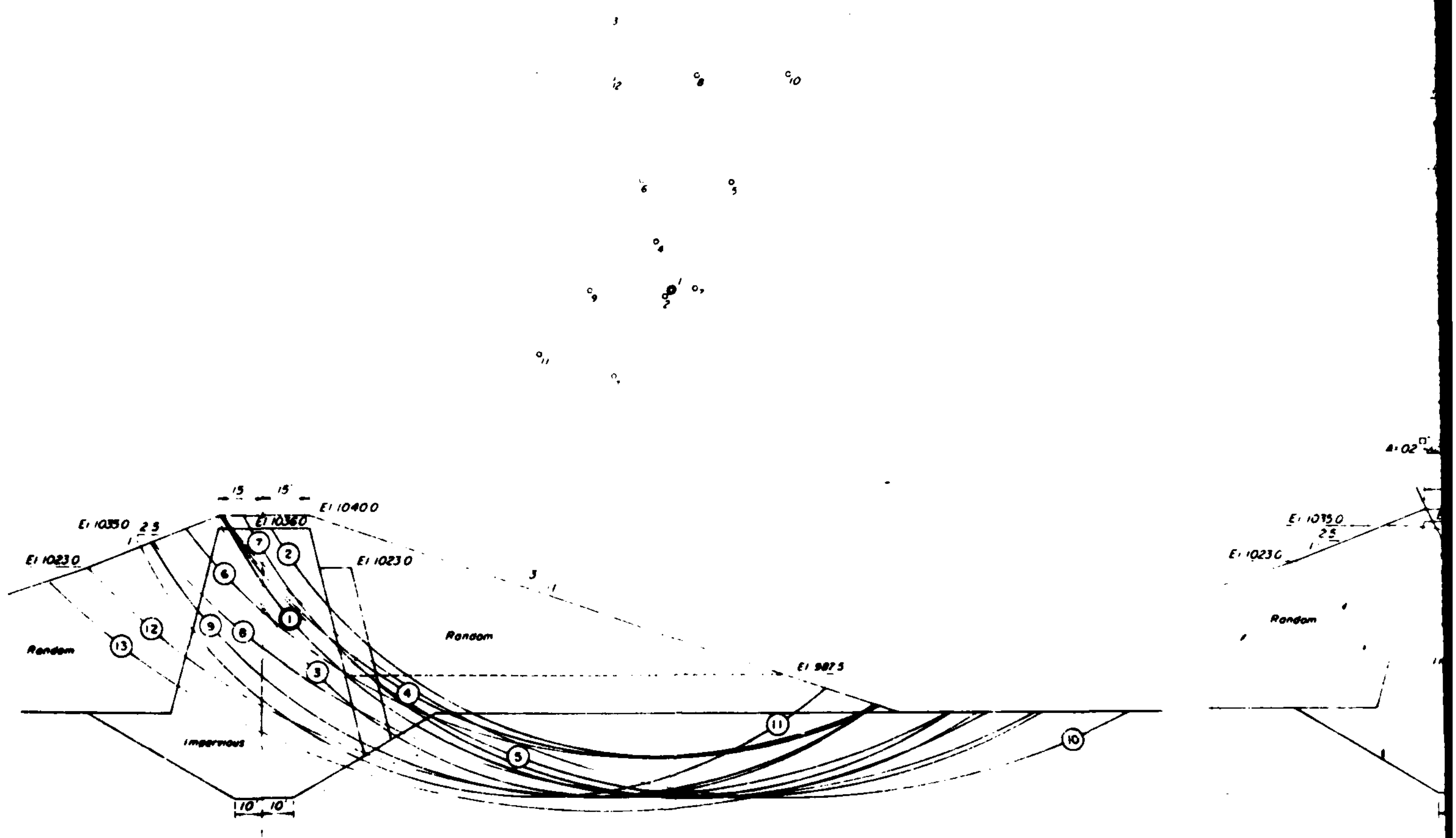
TION			
c tsf	C kips	... Σ tan ϕ+c kips	
38	0.94	20	191

NOTE

The difference in safety factors between analyses performed by the Waterways Experiment Station computer program and graphical analyses performed in the Fort Worth District is believed to be the result of small errors accumulated in the manual computations.

PREPARED BY FORT WORTH DISTRICT	U.S. ARMY ENGINEER DISTRICT, LOUISVILLE CORPS OF ENGINEERS LOUISVILLE, KENTUCKY
GRP / T&B	MAD RIVER BASIN, OHIO BUCK CREEK RESERVOIR BUCK CREEK, OHIO STABILITY ANALYSIS CIRCULAR ARC METHOD RAPID DRAWDOWN CONDITION UPSTREAM DESIGN RESUME

CORPS OF ENGINEERS



STEADY SEEPAGE CONDITION -"R" STRENGTH										
	SEG.	AREA SQ FT	UNIT WT KCF	FORCE KIPS	TAN ϕ	N TAN ϕ KIPS	ARC LENGTH FT	C KSF	C KIPS	N TAN ϕ + C
NORMAL FORCES	A	8	.125	1	.60	1				
	B	304	.125	38	.37					
	C	96	.1359	13	.37					
	D	424	.0764	32	.37	31				
	E	3196	.125	388	.60					
	F	5312	.065	345	.60	446				
						478	63	.54	34	512
TANGENTIAL FORCES	1 (NET)	1964	.125	196						
	2	120	.1359	16	Safety Factor = ΣN Tan ϕ + C / ΣT = 512/299 = 1.71					
	3	498	.1389	69	WES Computer Safety Factor = 1.658					
	4 (NET)	280	.066	18						
			ΣT = 299							

STEADY SEEPAGE CONDITION - "S" STRENGTH										
	SEG.	AREA SQ FT	UNIT WT KCF	FORCE KIPS	TAN ϕ	N TAN ϕ KIPS	ARC LENGTH FT	C KSF	C KIPS	N TAN ϕ + C
NORMAL FORCES	A	8	.125	1	.60					
	B	304	.125	38	.60					
	C	96	.1359	13	.60					
	D	424	.0764	32	.60					
	E	3196	.125	399	.60					
	F	5312	.065	345	.60	497				
						497	63	0	0	497
TANGENTIAL FORCES	1 (NET)	1964	.125	196						
	2	120	.1359	16	Safety Factor = ΣN Tan ϕ + C / ΣT = 497/299 = 1.66					
	3	498	.1389	69	WES Computer Safety Factor = 1.591					
	4 (NET)	280	.65	18						
			ΣT = 299			AVERAGE SAFETY FACTOR = 1.624				

NOTE

The difference in safety factors between analyses performed by the waterways experiment station computer program and graphical analyses performed in the Fort Worth District is believed to be the result of small errors accumulated in the manual computations.

Summary of safety factors determined by WES computer program					
STEADY STATE SEEPAGE CONDITION					
	CIRCLE	SAFETY FACTORS			
		"R" STRENGTH	"S" STRENGTH	AVERAGE S. FACTOR	REQUIRED S. FACTOR
	1	1.658	1.591	1.624	1.500
⊕	2	1.664	1.628	1.646	1.500
	3	1.695	1.617	1.656	1.500
	4	1.678	1.638	1.658	1.500
	5	1.702	1.647	1.674	1.500
	6	1.695	1.685	1.690	1.500
*	7	1.750	1.690	1.720	1.500
	8	1.724	1.730	1.727	1.500
	9	1.722	1.745	1.733	1.500
	10	1.764	1.713	1.738	1.500
	11	1.839	1.893	1.866	1.500
	12	1.992	1.971	1.931	1.500
	13	2.043	2.140	2.091	1.500

⊕ Acquired by graphical analysis

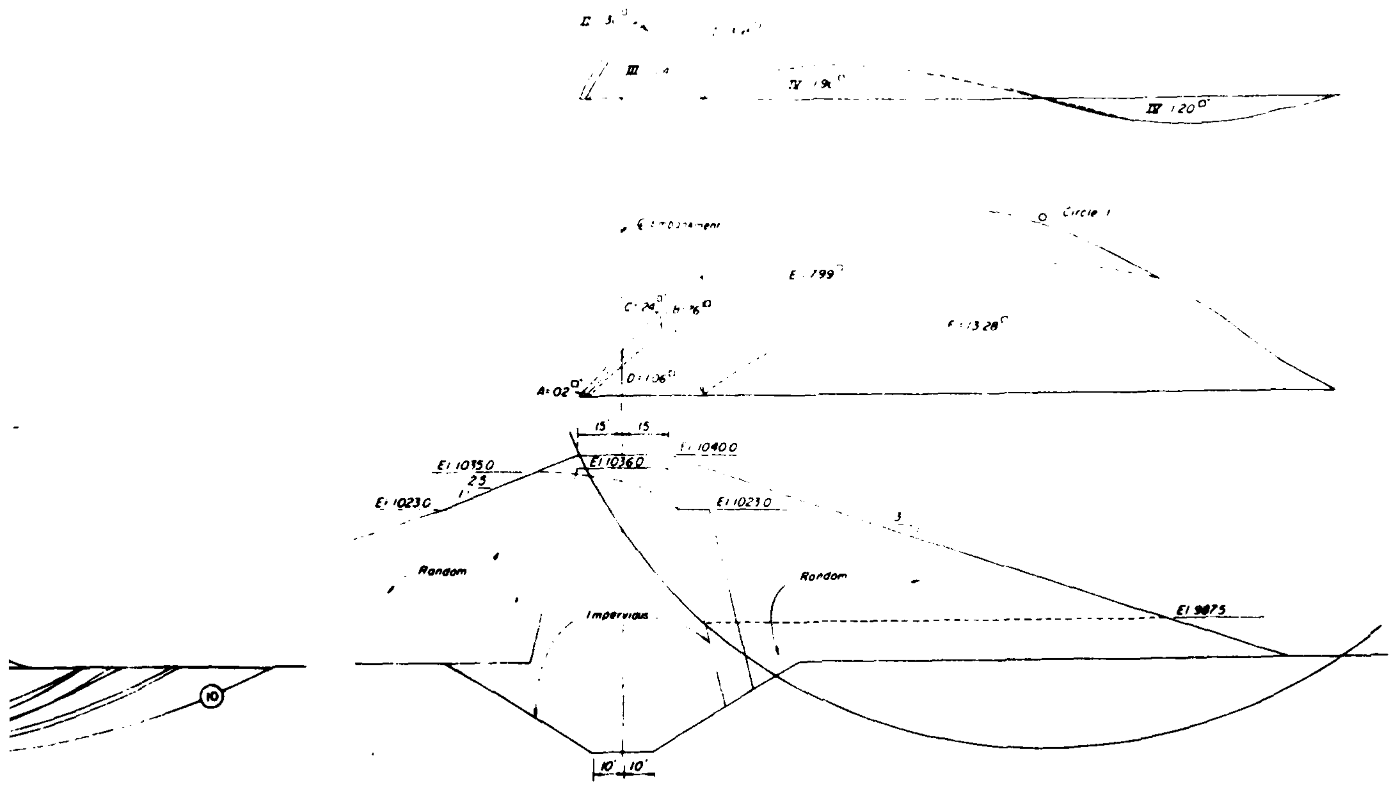
DESIGN

UNIT WEIGHT

Impervious (Emb & cutoff)
γ_{moist} = 135.3 pcf
γ_{sat} = 138.9 pcf
γ_{buoy} = 76.4 pcf

Random (Shells & fdn)
γ_{moist} = 125.0 pcf
γ_{sat} = 127.5 pcf
γ_{buoy} = 65.0 pcf

U S ARMY



...rs determined by W.E.S. ...ogram		
...PAGE CONDITION		
...ETY FACTORS		
...TH	AVERAGE S. FACTOR	REQUIRED S. FACTOR
	1.624	1.500
	1.646	1.500
	1.656	1.500
	[illegible]	1.500
	1.674	1.500
	1.690	1.500
	1.720	1.500
	1.727	1.500
	1.733	1.500
	1.736	1.500
	1.866	1.500
	1.931	1.500
	2.091	1.500

DESIGN DATA

UNIT WEIGHT	SHEAR STRENGTH Q	R	S
Impervious (Emb & cutoff)			
γ_{moist} = 135.3 pcf	tan ϕ = 0	tan ϕ = 0.37	tan ϕ = 0.60
γ_{sat} = 138.9 pcf	c = 0.7 tsf	c = 0.27 tsf	c = 0
γ_{buoy} = 76.4 pcf			
Random (Shells & fdn)			
γ_{moist} = 125.0 pcf	tan ϕ = 0.60	tan ϕ = 0.60	tan ϕ = 0.60
γ_{sat} = 127.5 pcf	c = 0	c = 0	c = 0
γ_{buoy} = 65.0 pcf			

PREPARED BY
FORT WORTH DISTRICT

US ARMY ENGINEER DISTRICT, LOUISVILLE
CORPS OF ENGINEERS
LOUISVILLE, KENTUCKY

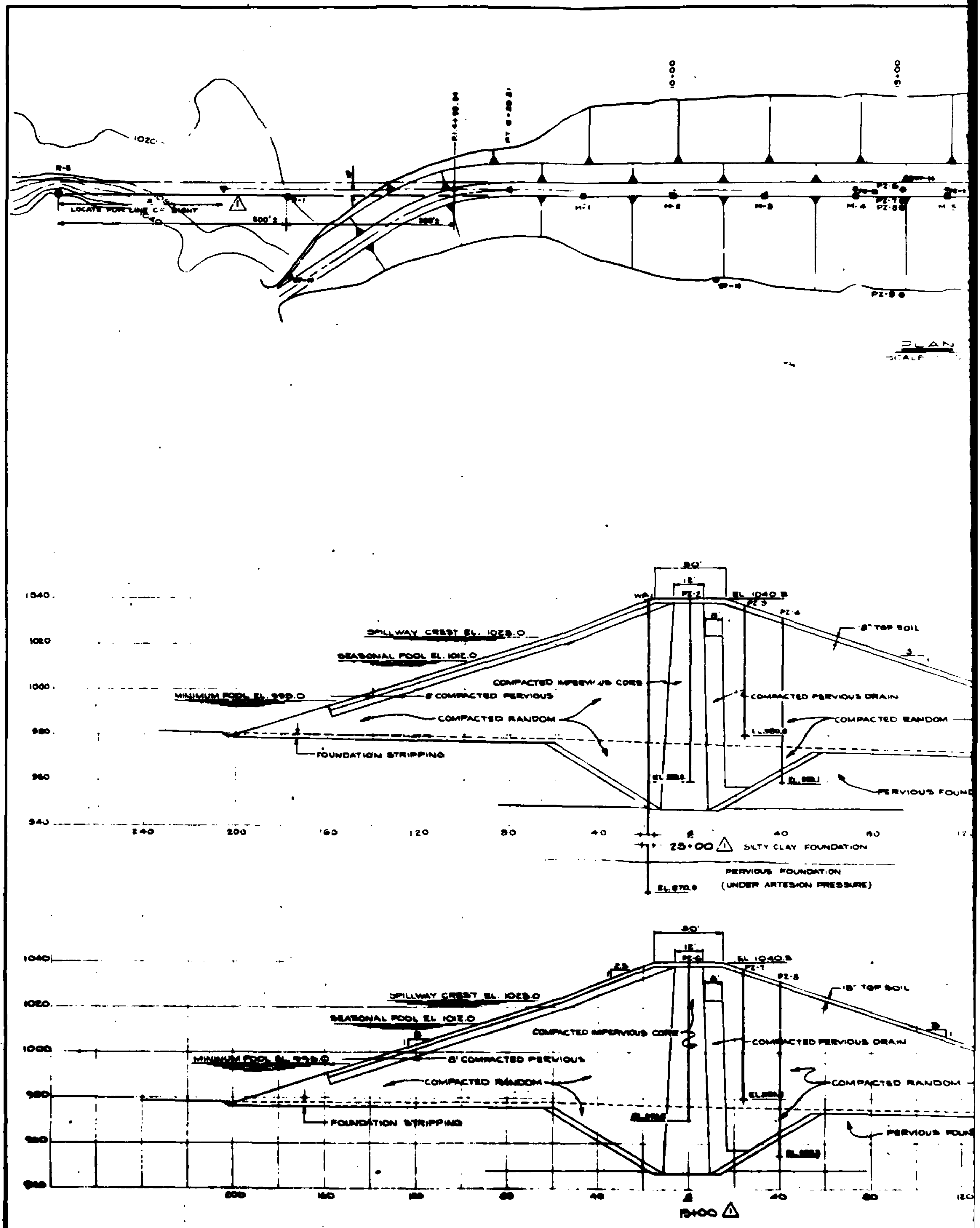
MAD RIVER BASIN, OHIO
BUCK CREEK RESERVOIR
BUCK CREEK, OHIO
STABILITY ANALYSIS
CIRCULAR ARC METHOD
STEADY SEEPAGE CONDITION
DOWNSTREAM
DESIGN RESUME

PLATE 20

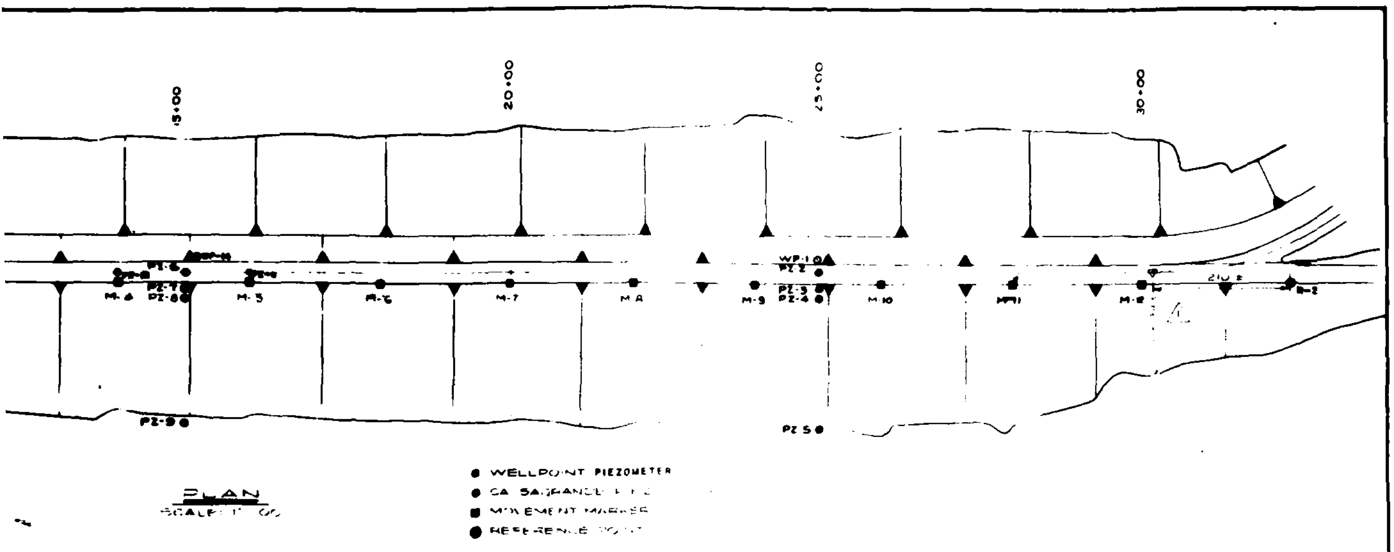
1

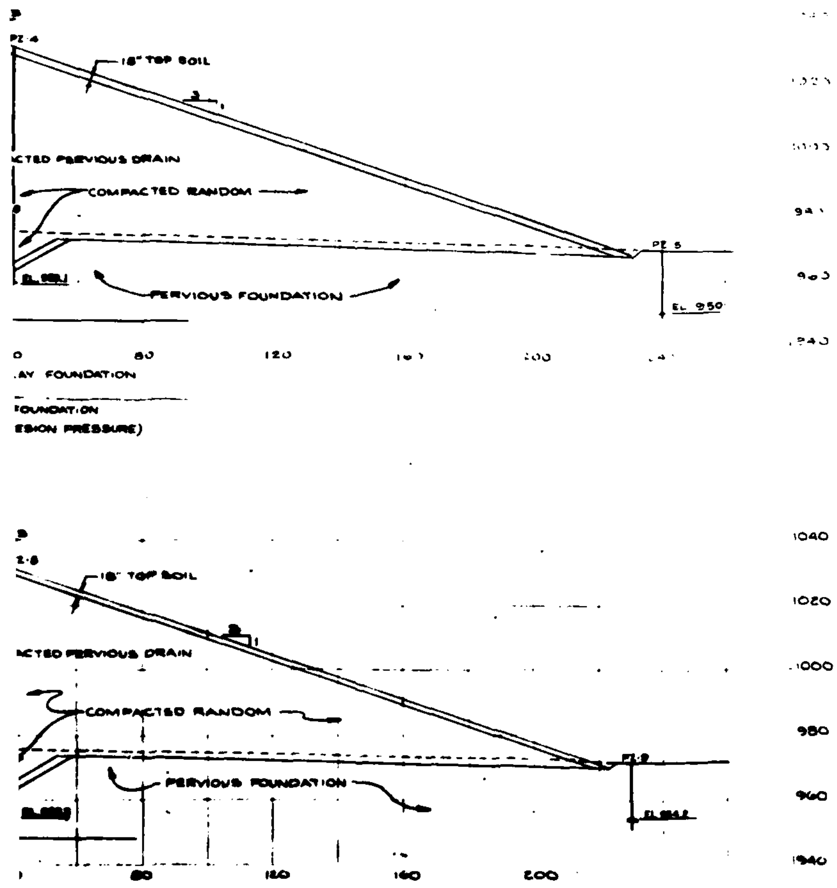
2

CORPS OF ENGINEERS



U. S. ARMY





[illegible]	L[illegible]T[illegible]	[illegible]	[illegible]	ELEV
WP-1	US STA 15+00	FDN (SP-SM)	1044.0	[illegible]
PZ 2	℄	"	EMB (CL)	1040.0	959.6
PZ-3	24' DS "	EMB (CL & SP)	1041.8	960.0
PZ-4	40' DS "	FDN (SP)	1035.1	959
PZ-5	240 DS	FDN (CL & ML)	977.9	957
PZ-6	℄ STA [illegible]	EMB (CL)	1039.9	970.6
PZ-7	24' DS	EMB (SP)	1041.9	960
PZ-8	40 DS	FDN (SP)	1034.4	956.3
PZ-9	230 DS	FDN (ML-CL)	974.9	954.2
WP-10	18' US STA 1+00	FDN (SP)	1044.6	990.6
PZ-1	℄ STA. 16+00	EMB (CL)	[illegible]9.7	962
PZ-2	℄ STA. 4+00	EMB (CL)	1040.	960.3
WP-3	190' DS STA. [illegible]	FDN (SP-GP)	968.0	952.
WP-4	18 US STA. 15+	FDN (S[illegible])	1042.2	870.7
WP-403	N 711,080; E 1,655,180	FDN (SP-ML)	1057.1	955.3
WP-406	N 711,180; E 1,653,760	— " — (ML-SM)	1042.7	942.7
WP-417	N 711,290; E 1,652,700	— " — (SP-GP)	1011.3	989.3
WP 901	N 710,370; E 1,651,760	— " — (GP)	1004.7	969.4
WP 902	N 710,290; E 1,651,100	— " — (CL)	987.6	967.
WP 903	N 709,995; E 1,650,560	— " — (ML)	978.6	958.6
WP 904	N 708,990; E 1,651,450	— " — (SC)	978.5	958.5
WP 905	N 707,900; E 1,652,410	— " — (CL)	978.8	958.8
WP 907	N 709,040; E 1,653,680	FDN (CL)	999.6	968.6

WELL	LOCAT[illegible]	SCREEN LOCATION	RISER ELEV	BOTTOM ELEV
[illegible]-1	15' DS STA 5+[illegible]	FDN [illegible]	[illegible]9.0	967.[illegible]
[illegible]-2	[illegible]TA [illegible]	F[illegible]	[illegible]9.9	[illegible]
[illegible]-3	35' DS STA 52+50	FDN SM	[illegible]	97[illegible]

REVISION	DATE	DESCRIPTION	BY
1	4 AUG 73	ADDED PZ TIP ELEV & MONUMENT ALIGNMENT CONTROL (CONT MOD)	[illegible]
	14 AUG 73	SHEET ADDED (CONT MOD)	[illegible]

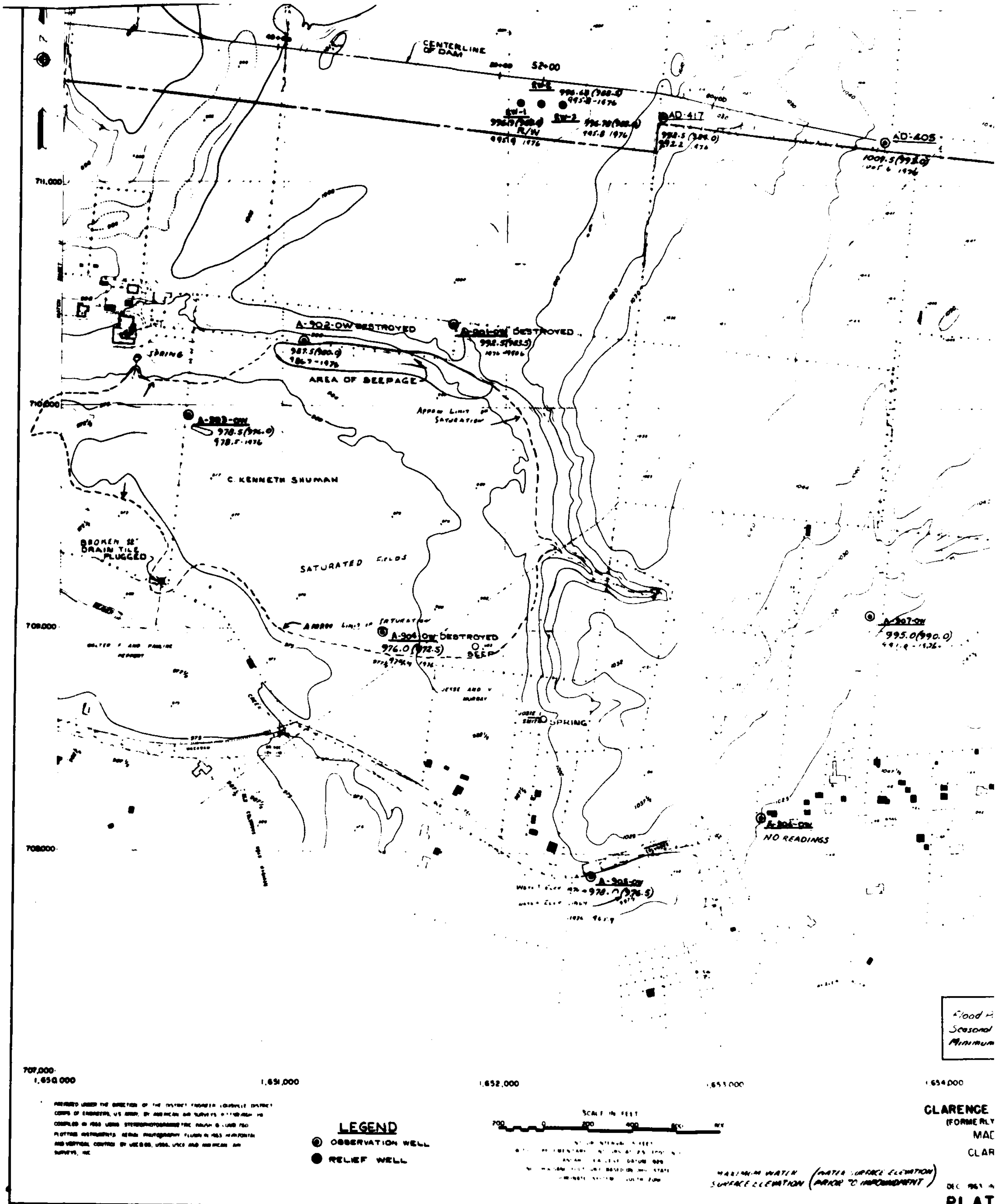
U. S. ARMY ENGINEER DISTRICT, LOUISVILLE
CORPS OF ENGINEERS
LOUISVILLE, KENTUCKY

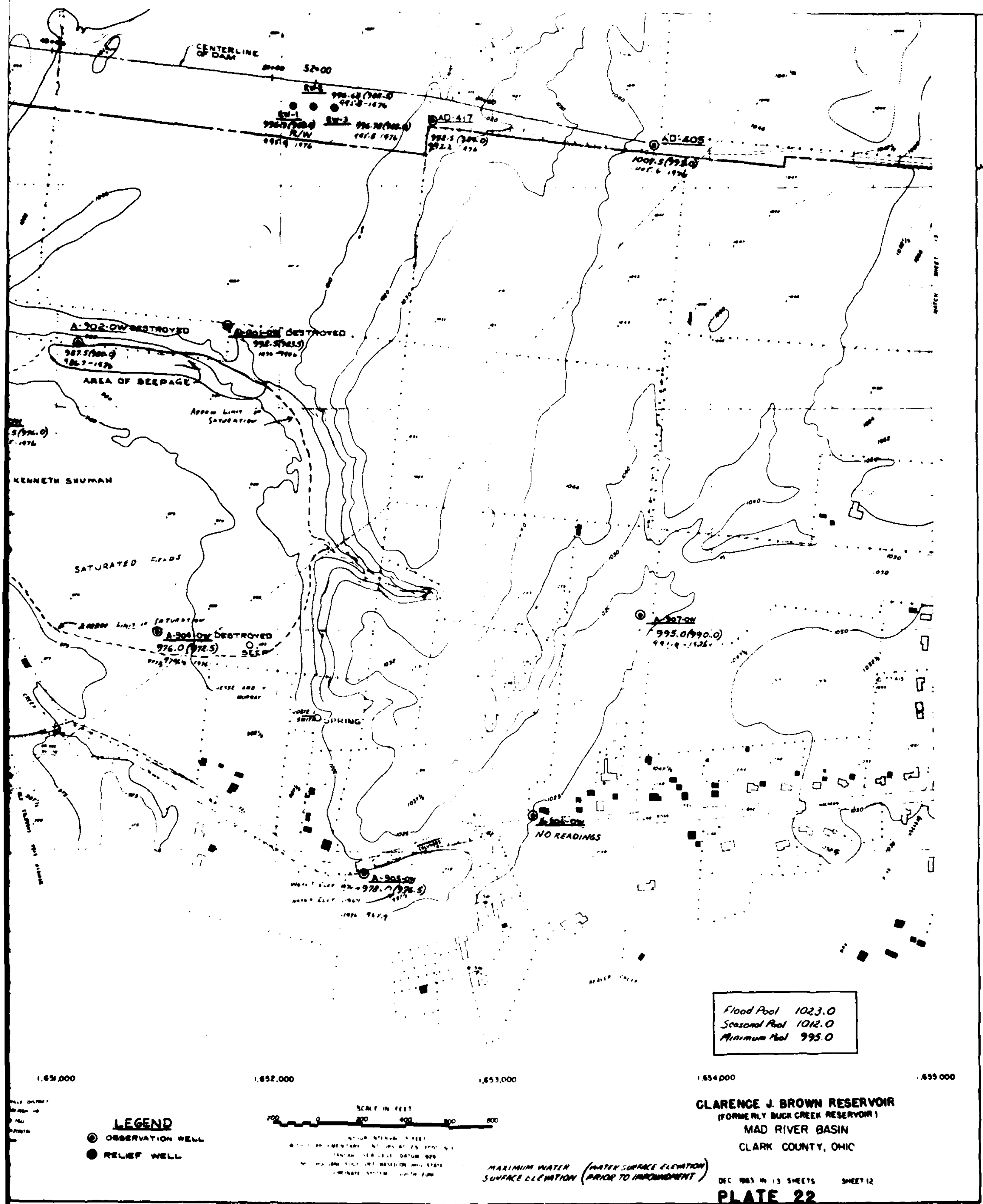
MAD RIVER BASIN
CLARENCE J. BROWN RESERVOIR
OHIO

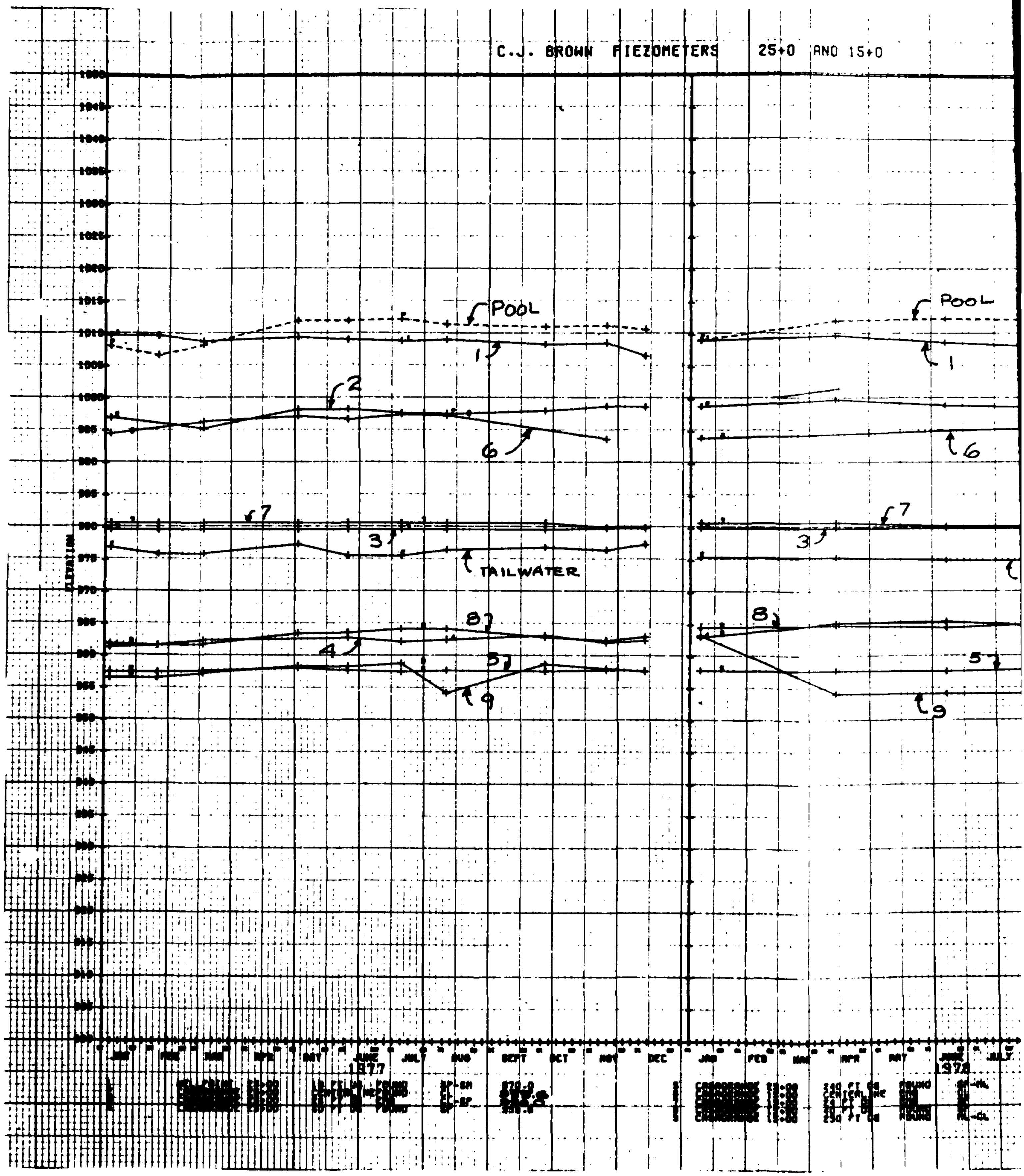
INSTRUMENTATION LOCATIONS & SECTIONS

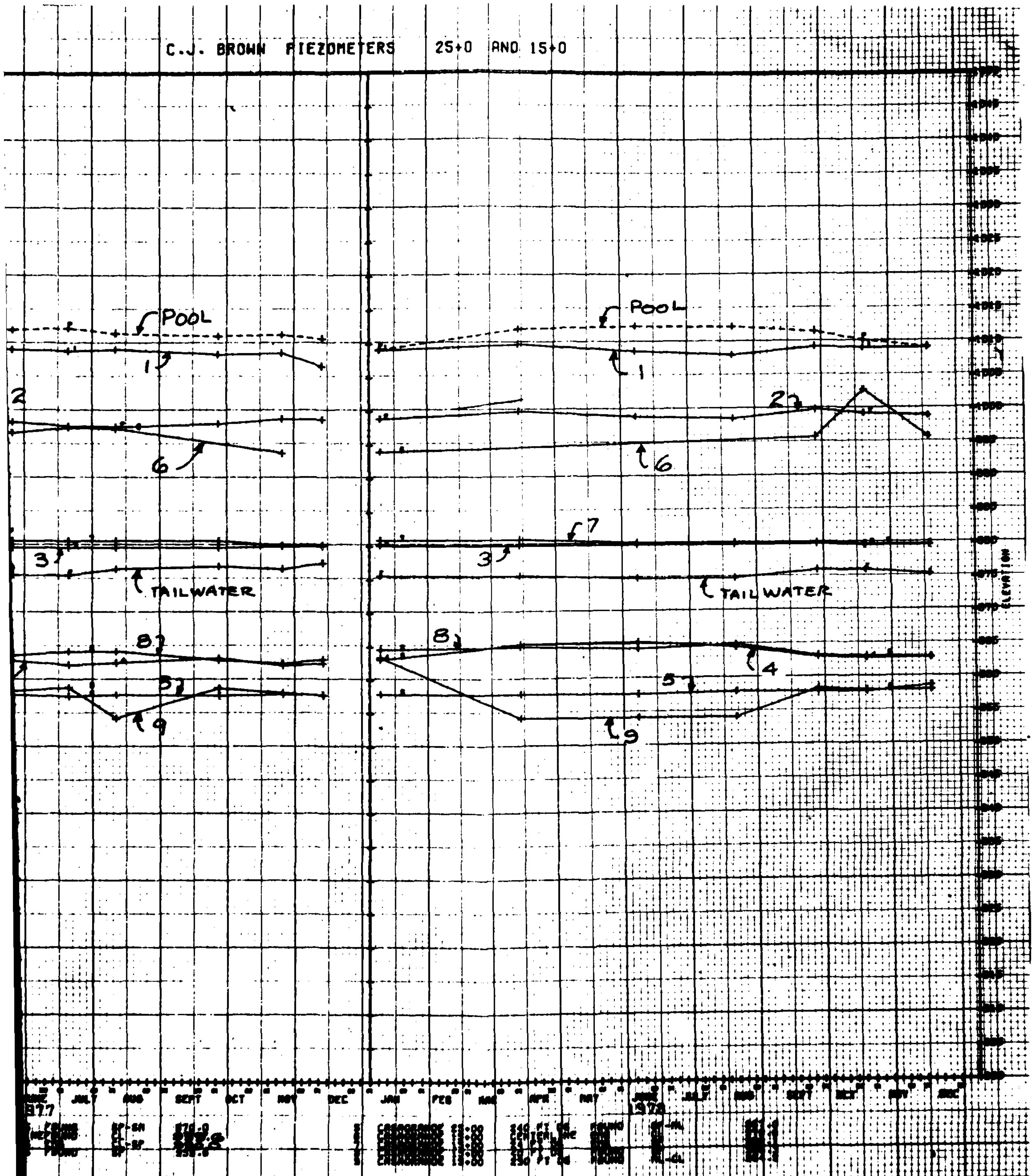
DESIGNED: GCC
DATE: JANUARY 30, 1977 A.D.
DRAWING NUMBER: MR 24-12.2/88

PLATE 21 RECORD DRAWING-"AS BUILT"


CENTERLINE OF DAM
52+00
AD-417
AD-405
1009.5(993.0)
A-902-OW DESTROYED
987.5(980.0)
A-901-OW DESTROYED
992.5(983.5)
SPRING
AREA OF SEEPAGE
Approx Limit of Saturation
A-903-OW
978.5(976.0)
978.5-1976
C. KENNETH SHUMAN
BROKEN 12" DRAIN TILE PLUGGED
SATURATED FIELDS
Approx Limit of Saturation
A-904-OW DESTROYED
976.0(972.5)
SEEP
SPRING
A-907-OW
995.0(990.0)
A-906-OW
NO READINGS
A-905-OW
978.0(976.5)
711,000
710,000
709,000
708,000
707,000
1,650,000
1,651,000
1,652,000
1,653,000
1,654,000
LEGEND
OBSERVATION WELL
RELIEF WELL
SCALE IN FEET
MAXIMUM WATER SURFACE ELEVATION
(WATER SURFACE ELEVATION PRIOR TO IMPOUNDMENT)
CLARENCE
(FORMERLY
MAD
CLAR
PLAT

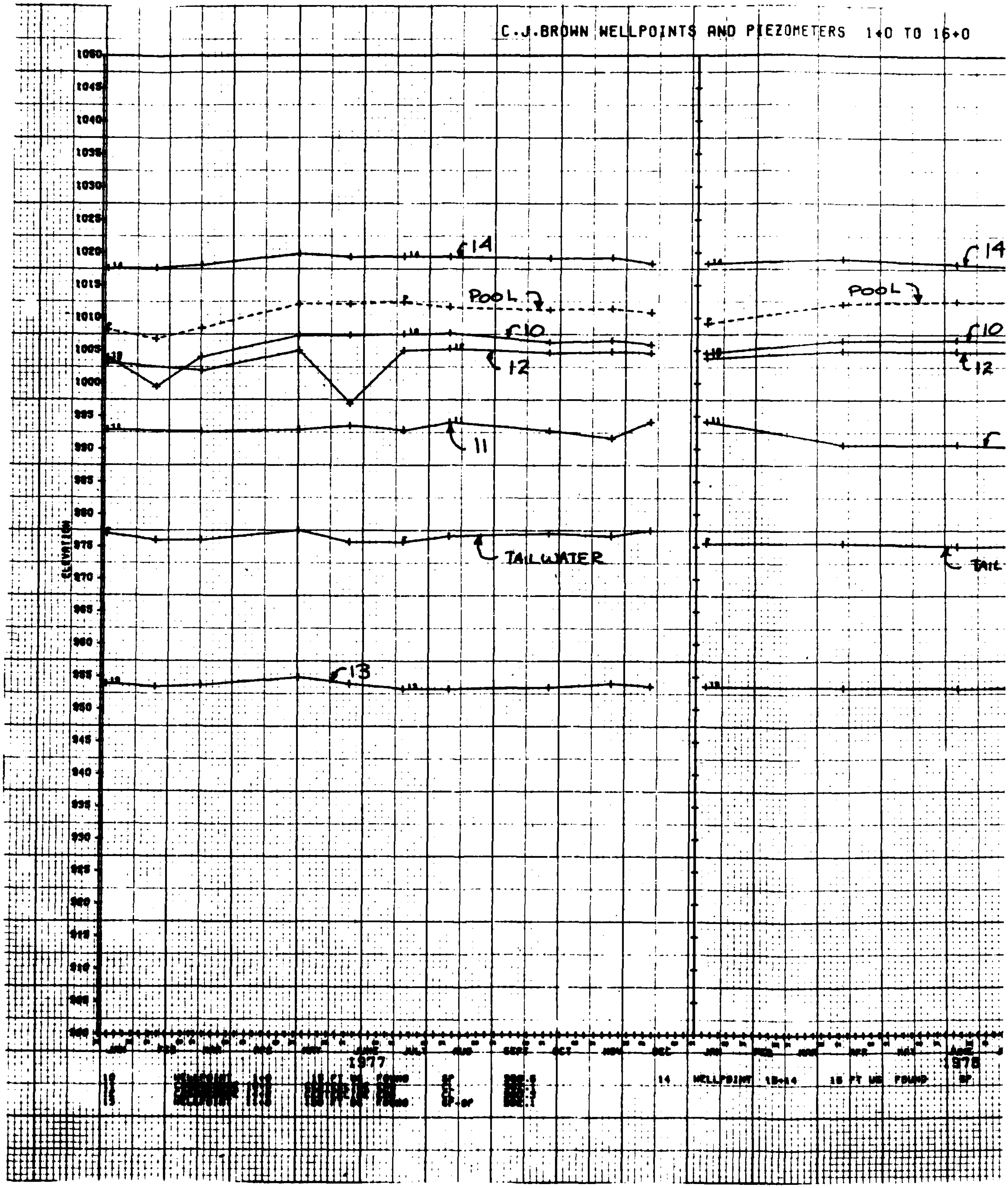

CENTERLINE OF DAM
52+00
AD-417
AD-405
A-902-OW DESTROYED
A-901-OW DESTROYED
AREA OF SEEPAGE
KENNETH SHUMAN
SATURATED FIELDS
A-904-OW DESTROYED
976.0 (972.5)
SPRING
A-907-OW
995.0 (990.0)
A-906-OW
NO READINGS
A-905-OW
Flood Pool 1023.0
Seasonal Pool 1012.0
Minimum Pool 995.0
1,651,000
1,652,000
1,653,000
1,654,000
1,655,000
LEGEND
OBSERVATION WELL
RELIEF WELL
SCALE IN FEET
MAXIMUM WATER SURFACE ELEVATION
(WATER SURFACE ELEVATION PRIOR TO IMPOUNDMENT)
CLARENCE J. BROWN RESERVOIR
(FORMERLY BUCK CREEK RESERVOIR)
MAD RIVER BASIN
CLARK COUNTY, OHIO
DEC 1983 IN 13 SHEETS SHEET 12
PLATE 22

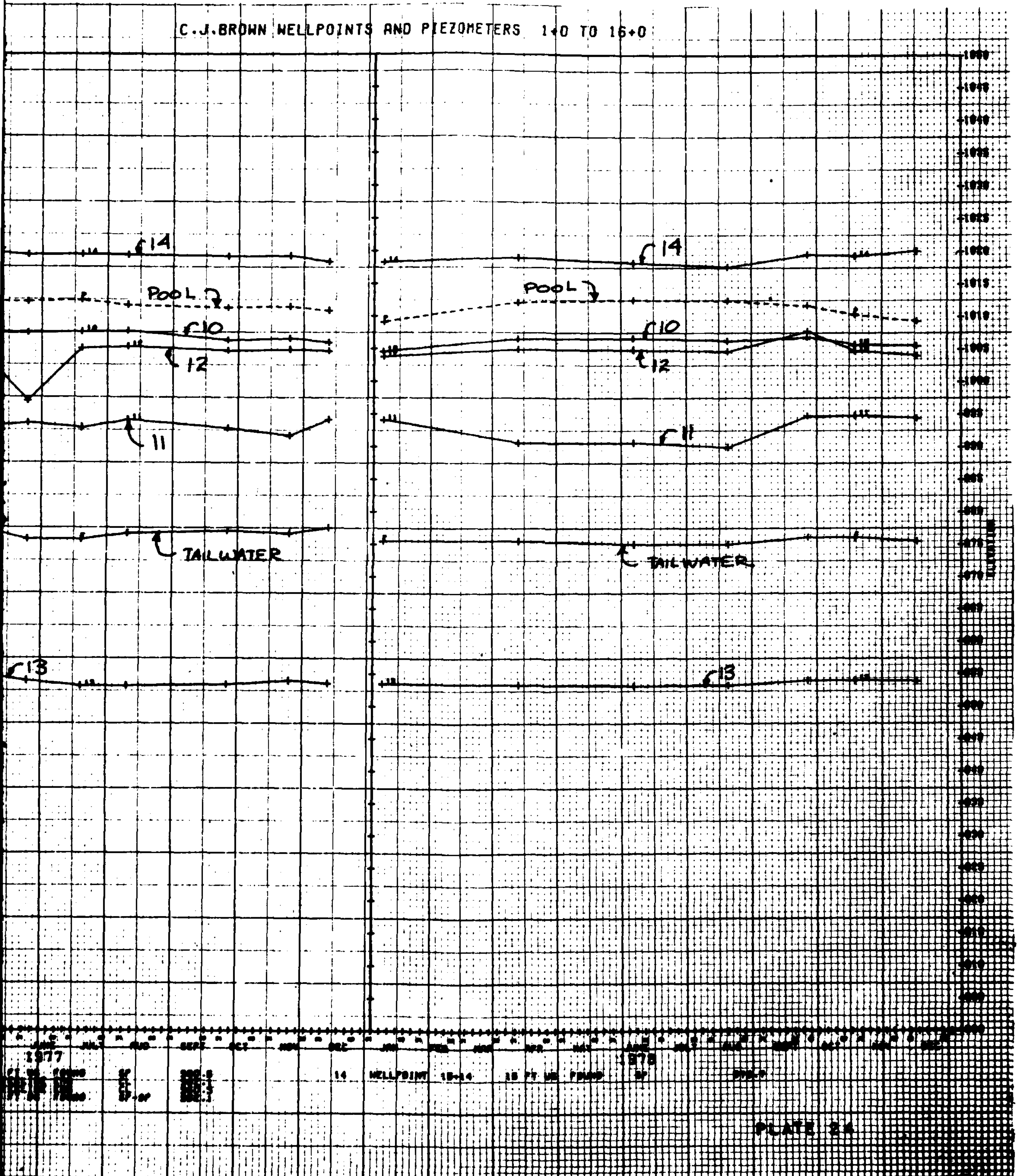

C.J. BROWN PIEZOMETERS 25+0 AND 15+0
POOL
TAILWATER
POOL
JAN
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
1977
1978

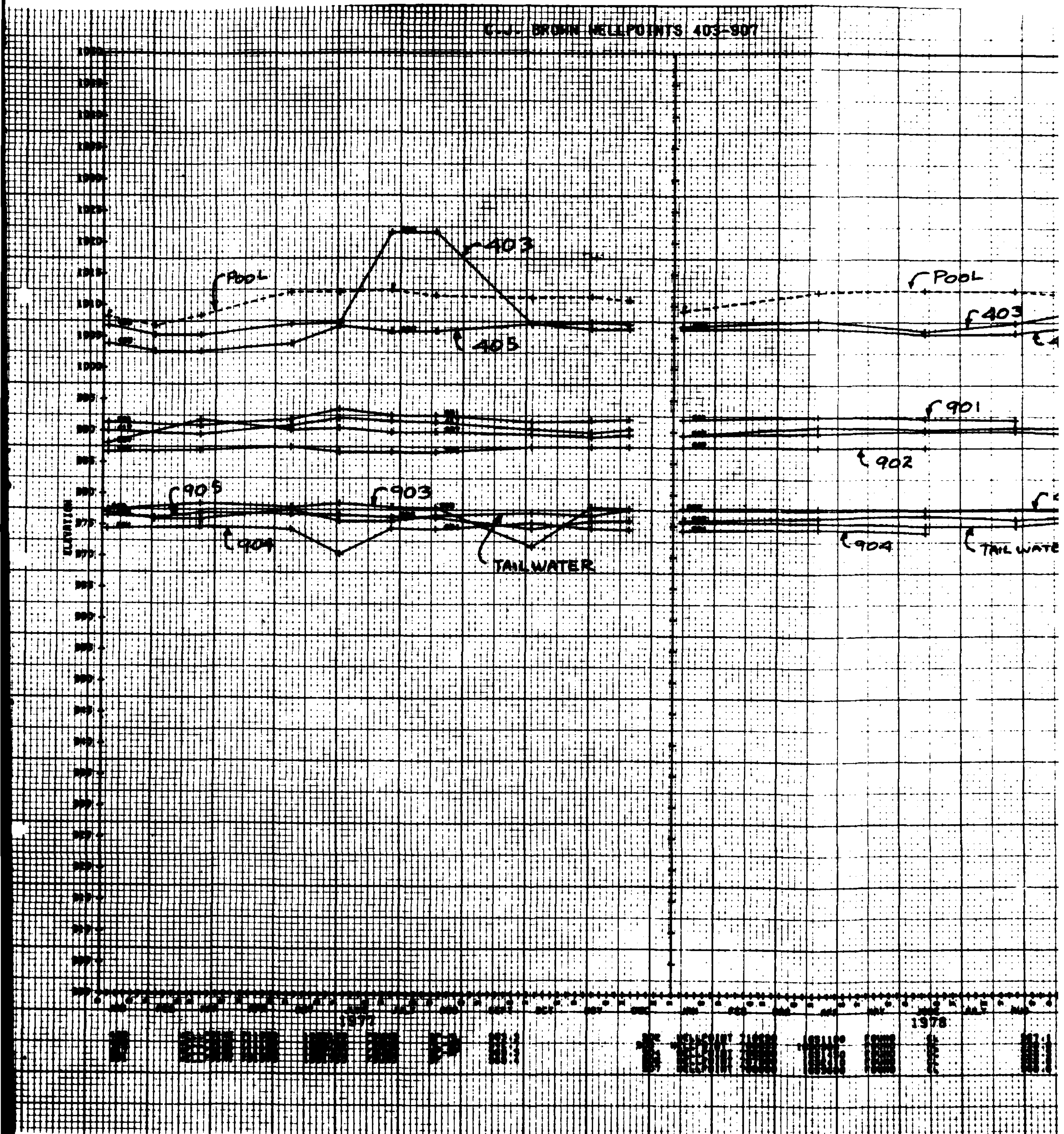


C.J. BROWN PIEZOMETERS 25+0 AND 15+0
POOL
POOL
TAILWATER
TAIL WATER
ELEVATION
JULY
AUG
SEPT
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
1977
1978

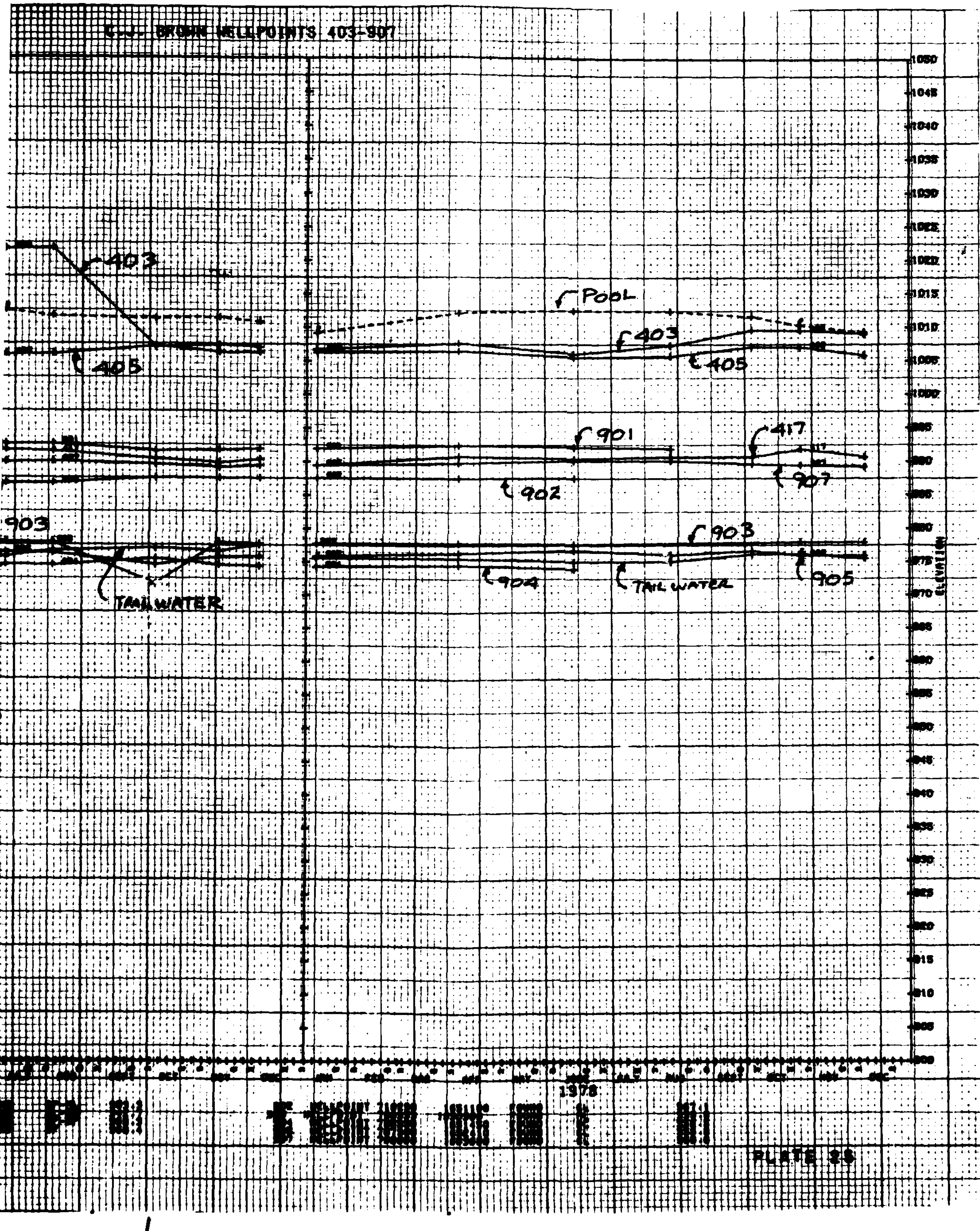
PLATE 23

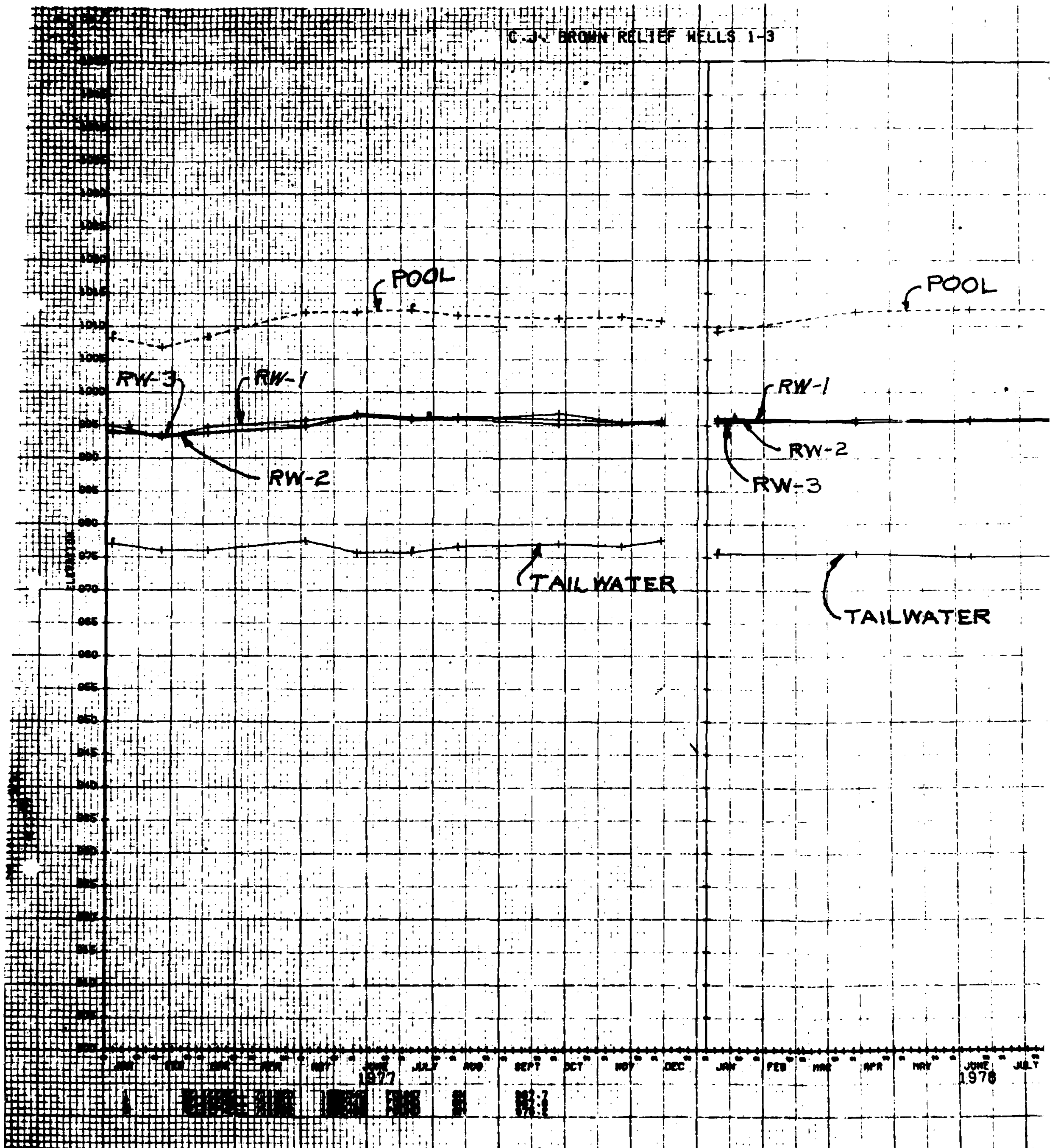

C.J.BROWN WELLPOINTS AND PIEZOMETERS 1+0 TO 16+0
ELEVATION
14
POOL
10
12
11
TAILWATER
13
1977
1978
14 WELLPOINT 15+14 15 FT WE FOUND SP
14
POOL
10
12
TAIL


C.J.BROWN WELLPOINTS AND PIEZOMETERS 1+0 TO 16+0
14
POOL
10
12
11
TAILWATER
13
1977
1978
14 WELLPOINT
PLATE 24



C.J. BROWN WELLPOINTS 403-907
ELEVATION
POOL
403
405
901
902
905
903
904
TAILWATER
1977
1978


C.J. BROWN WELLPOINTS 403-907
1050
1045
1040
1035
1030
1025
1020
1015
1010
1005
1000
403
405
POOL
901
417
902
907
903
904
905
TAILWATER
ELEVATION
1978
PLATE 28



C.J. BROWN RELIEF WELLS 1-3
POOL
RW-3
RW-1
RW-2
TAILWATER
POOL
RW-1
RW-2
RW-3
TAILWATER
JAN
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUNE
JULY
1977
1978

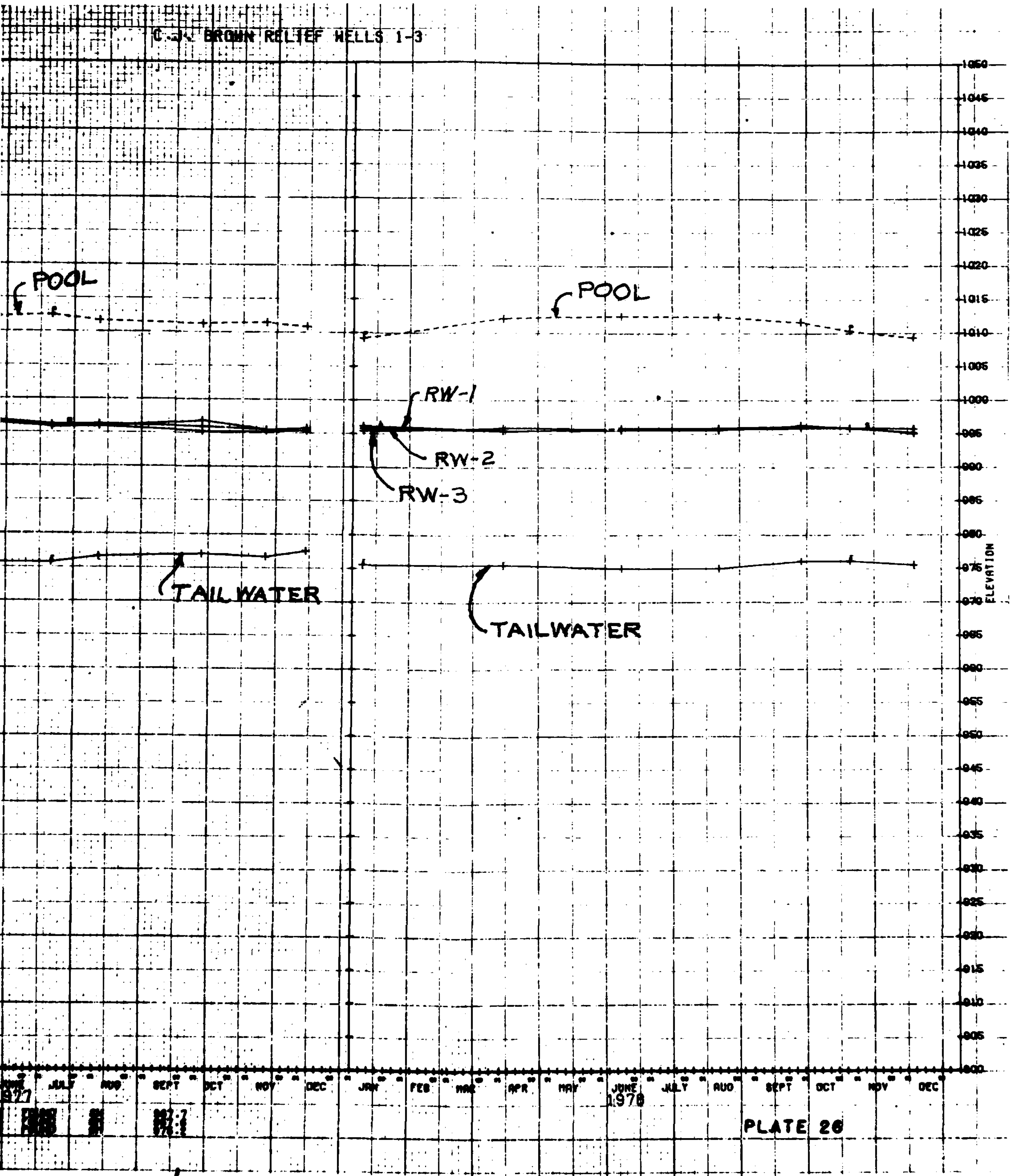
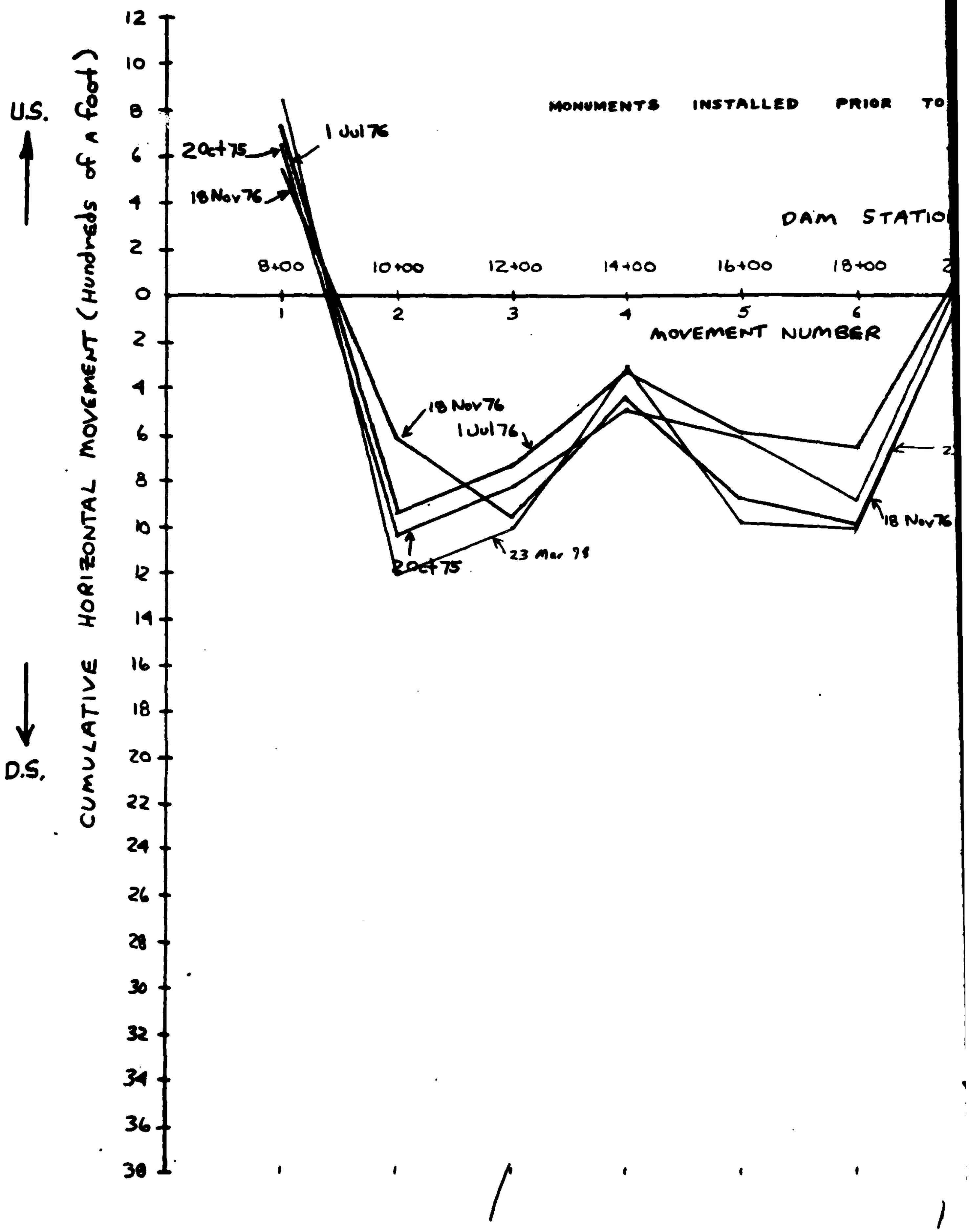
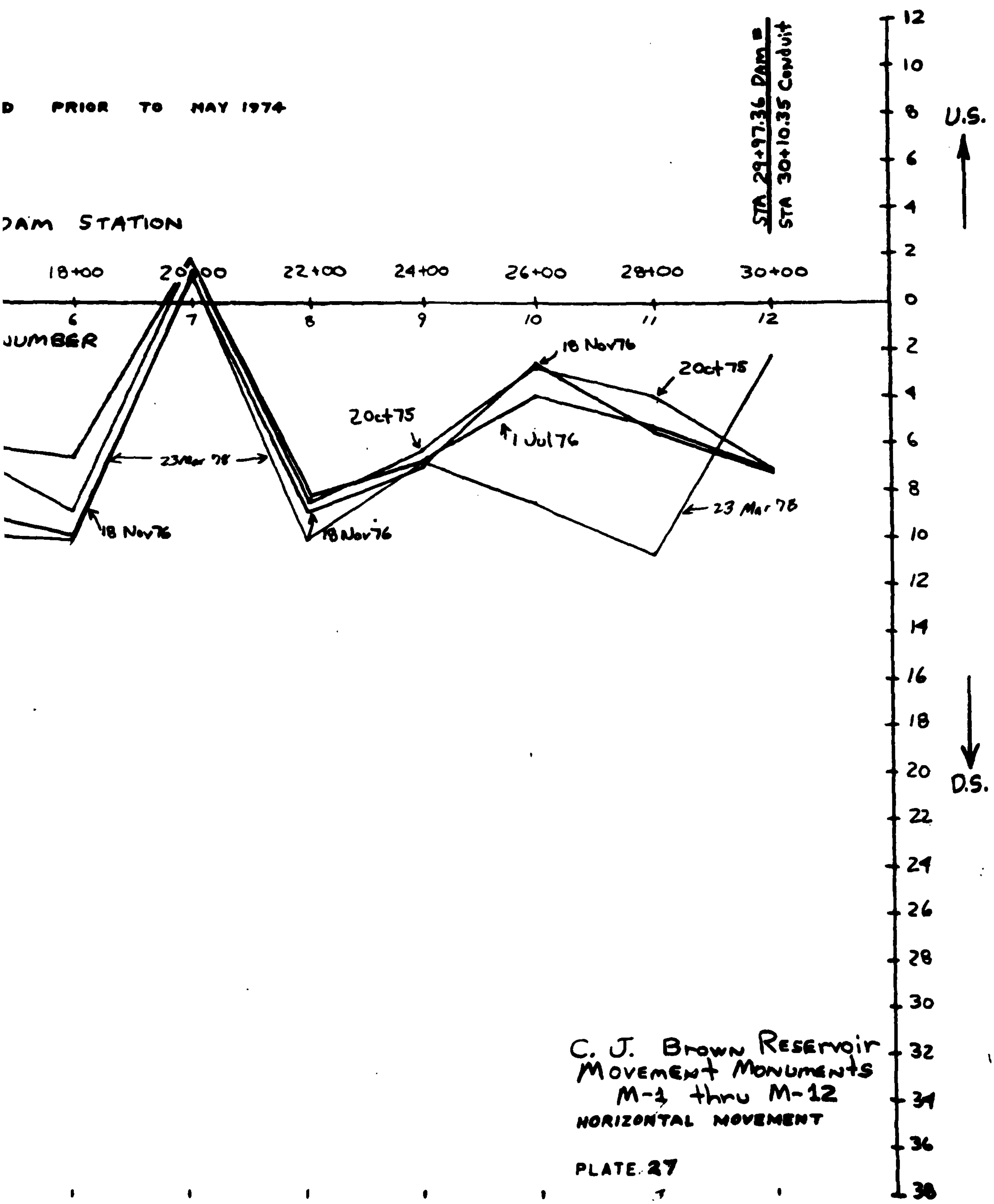

C.J. BROWN RELIEF WELLS 1-3
POOL
POOL
RW-1
RW-2
RW-3
TAILWATER
TAILWATER
ELEVATION
1050
1045
1040
1035
1030
1025
1020
1015
1010
1005
1000
JULY
AUG
SEPT
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUNE
1978
JULY
AUG
SEPT
OCT
NOV
DEC

PLATE 26

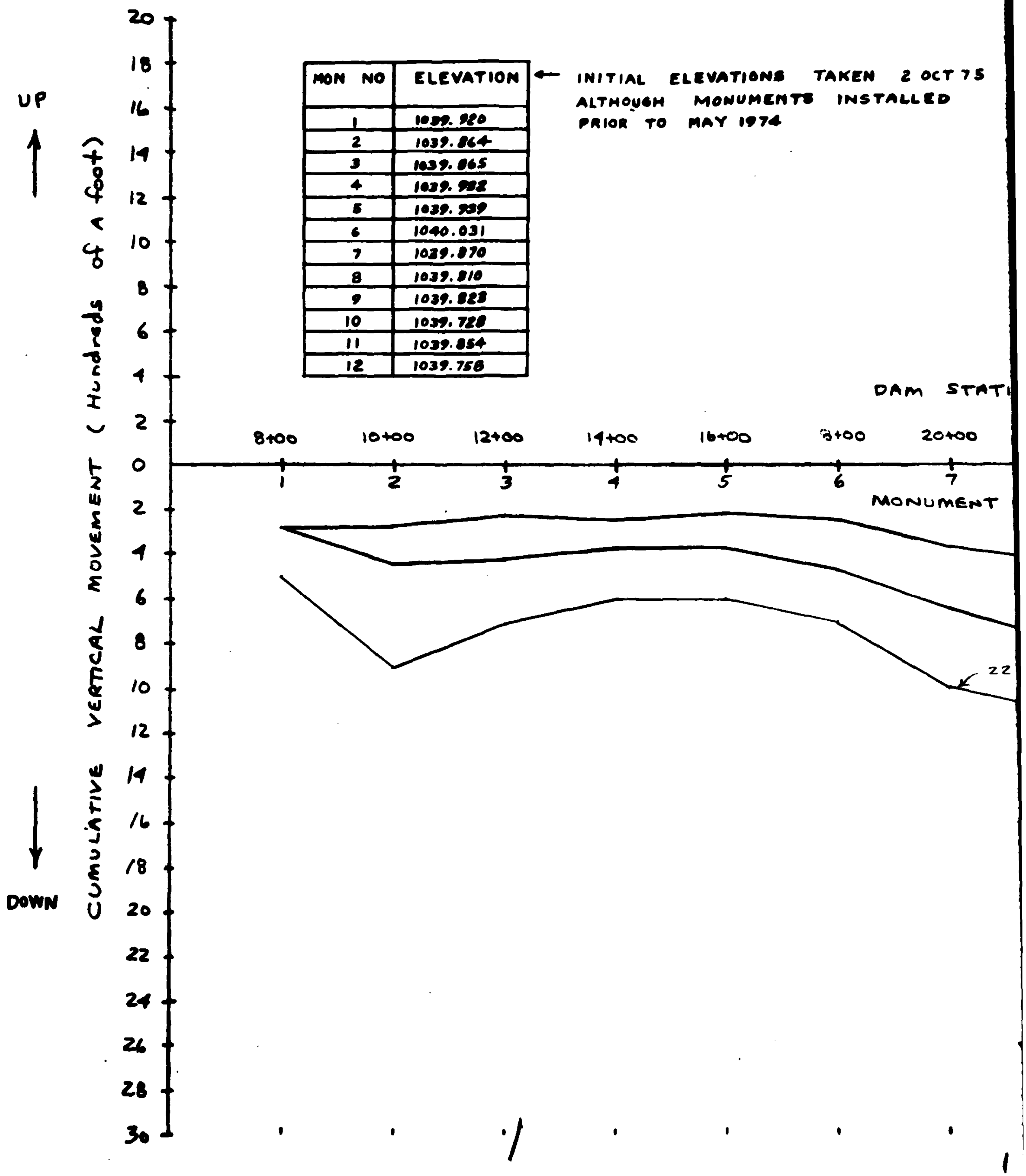


U.S.
D.S.
CUMULATIVE HORIZONTAL MOVEMENT (Hundreds of a foot)
12
10
8
6
4
2
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
MONUMENTS INSTALLED PRIOR TO
DAM STATIO
8+00
10+00
12+00
14+00
16+00
18+00
1
2
3
4
5
6
MOVEMENT NUMBER
2 Oct 75
1 Jul 76
18 Nov 76
18 Nov 76
1 Jul 76
2 Oct 75
23 Mar 78
18 Nov 76



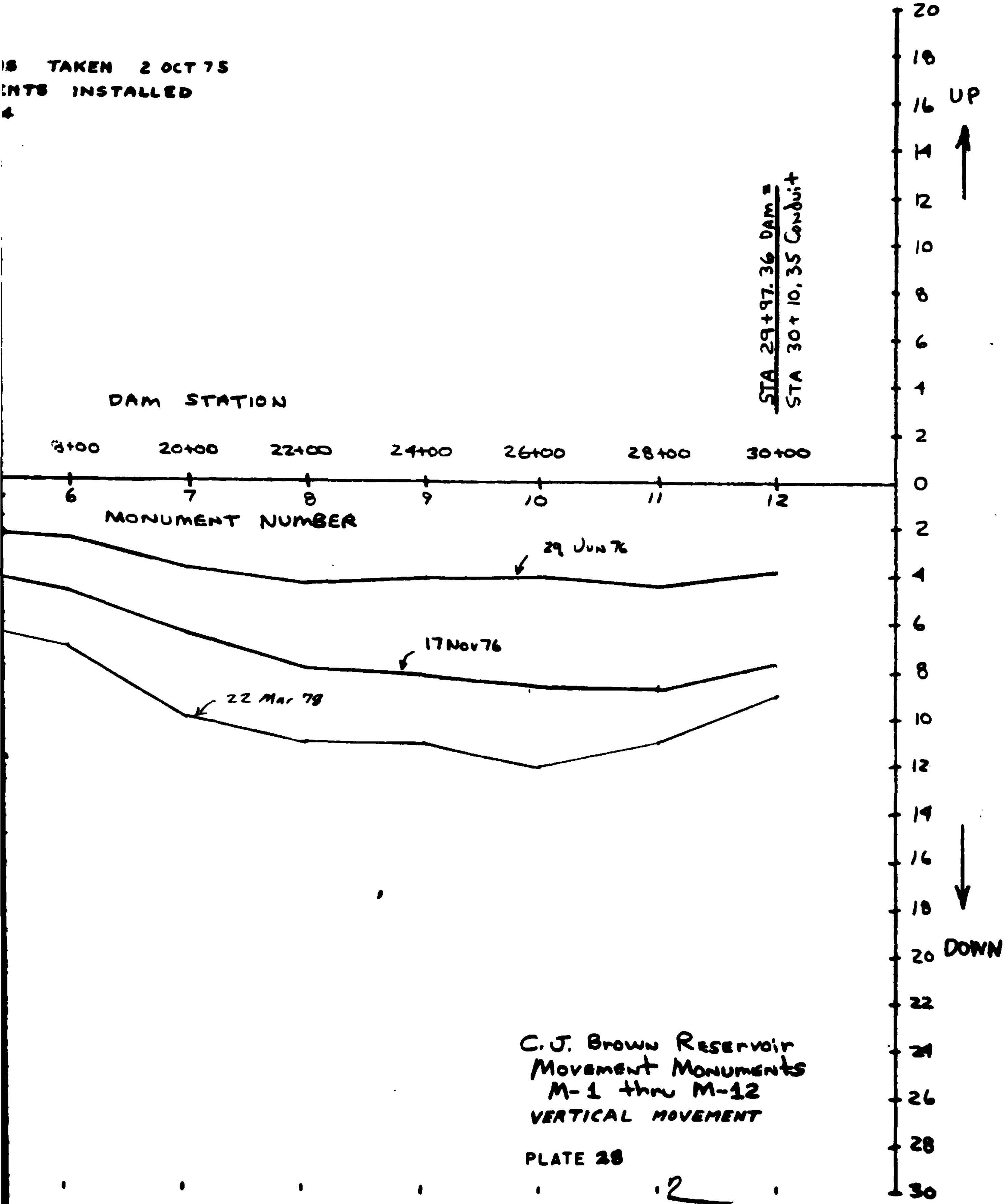
C. J. Brown Reservoir
Movement Monuments
M-1 thru M-12
HORIZONTAL MOVEMENT

PLATE 27



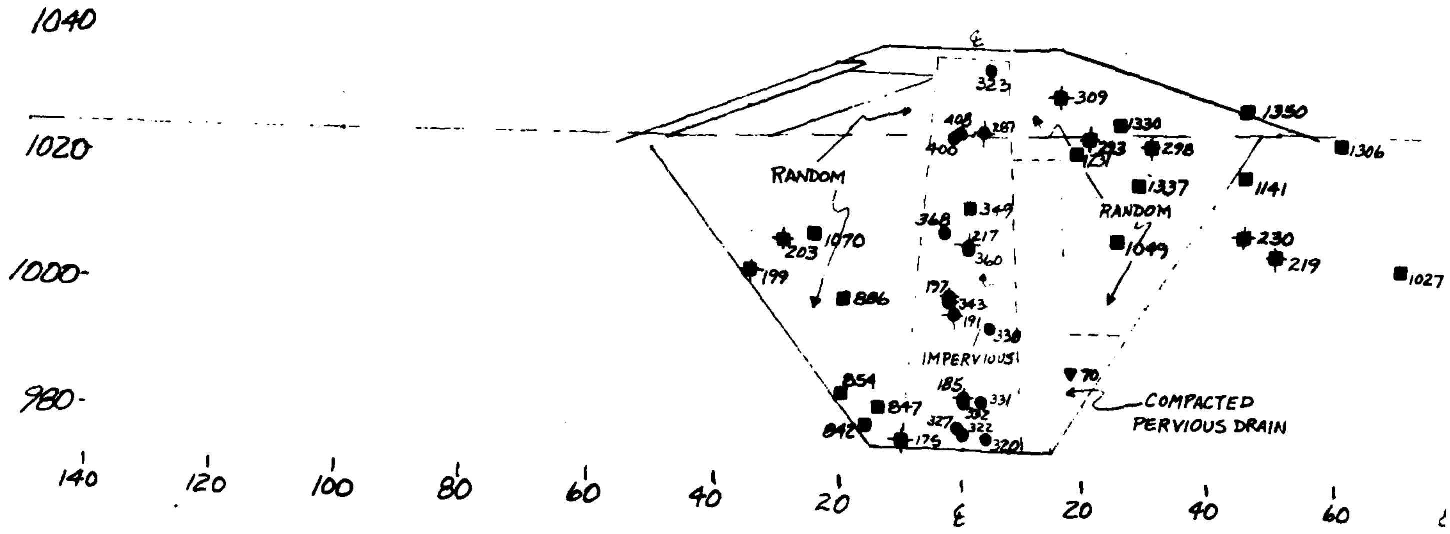
MON NO	ELEVATION
1	1039.920
2	1039.864
3	1039.865
4	1039.982
5	1039.939
6	1040.031
7	1039.870
8	1039.810
9	1039.823
10	1039.728
11	1039.854
12	1039.758

INITIAL ELEVATIONS TAKEN 2 OCT 75 ALTHOUGH MONUMENTS INSTALLED PRIOR TO MAY 1974

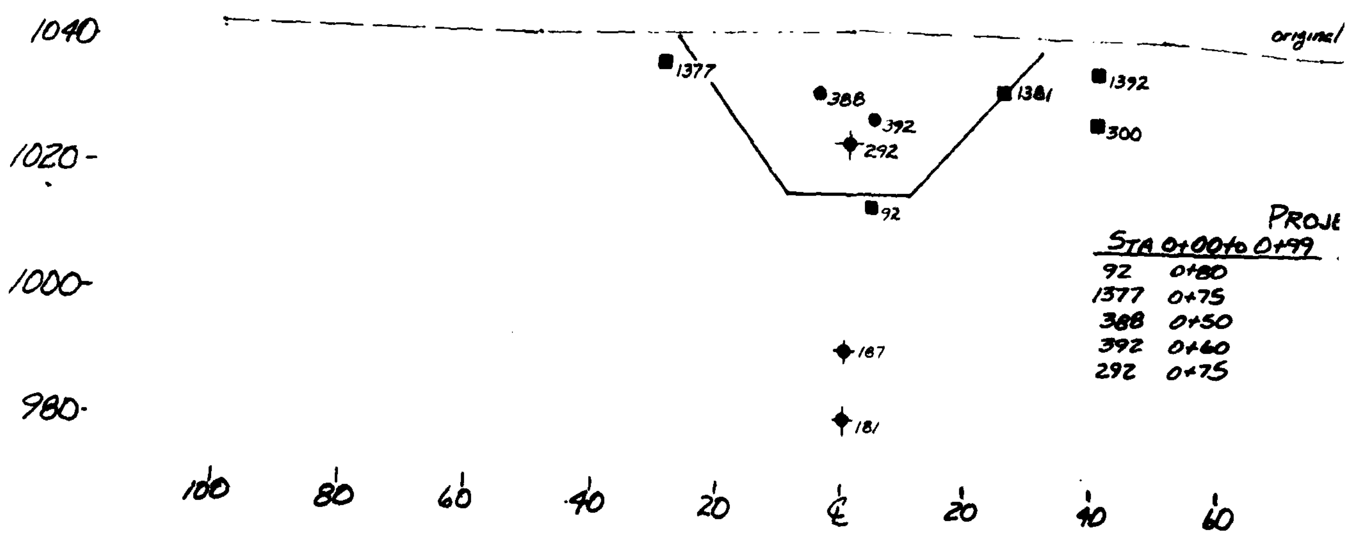


C.J. Brown Reservoir
Movement Monuments
M-1 thru M-12
VERTICAL MOVEMENT

PLATE 28



STA 2+00
(Tests 1+51 to 2+50)



PROJE

STA 0+00 to 0+99	
92	0+80
1377	0+75
388	0+50
392	0+60
292	0+75

STA 1+00
(Tests 0+00 to 1+50)

-1050

350

1306

-1030

41

30

219

1027

-1010

-990

IN

60 80 100

PROJECTIONS

STA 1+51 to 1+99	
185	1+75
203	1+75
298	1+75
287	1+75
323	1+60

STA 2+01 to 2+50			
349	2+50	70	2+25
320	2+25	1027	2+50
322	2+50	219	2+10
327	2+50	230	2+40
331	2+50	1070	2+50
332	2+50	141	2+5C
338	2+25	360	2+50
343	2+50	217	2+40
191	2+50	1231	2+10
197	2+10	293	2+10
175	2+50	1337	2+50
842	2+50	1350	2+50
847	2+50	309	2+15
854	2+50		
886	2+50		
199	2+25		

LEGEND
- ● IMPERVIOUS [CONTRACTOR]
- ✦ IMPERVIOUS [GOVERNMENT]
- ■ RANDOM [CONTRACTOR]
- ✦ RANDOM [GOVERNMENT]
- ▼ PERVIOUS [CONTRACTOR]
- ✦ PERVIOUS [GOVERNMENT]

-1050

original ground

PROJECTIONS

0+00 to 0+99	STA 1+01 to 1+50	
0+80	181	1+25
0+75	187	1+25
0+50	300	1+40
0+60	1381	1+25
0+75	1392	1+50

60

REVISION	DATE	DESCRIPTION	BY

U. S. ARMY ENGINEER DISTRICT, LOUISVILLE
CORPS OF ENGINEERS
LOUISVILLE, KENTUCKY

DESIGNED:
DRAWN: JAK
TRACED:
CHECKED:
SUBMITTED:

MAD RIVER BASIN
C.J. BROWN RESERVOIR
OHIO
FIELD CONTROL TEST LOCATIONS

SCALE: 0 20 40 60

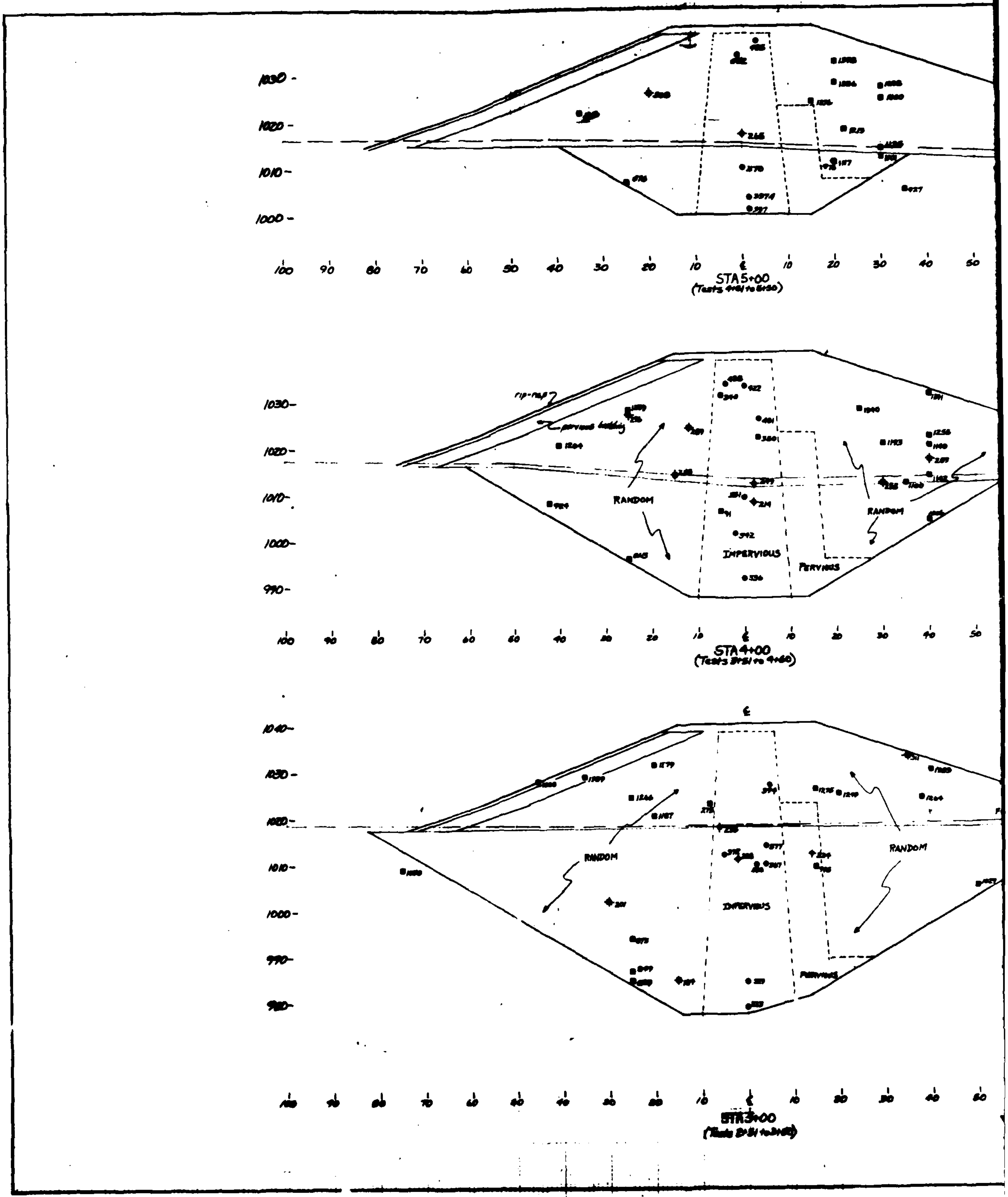
DATE: APR 1977

PLATE 29

DRAWING NUMBER
CJB ER/CT101

1

2


STA 5+00
STA 4+00
rip-rap
pervious bedding
RANDOM
IMPERVIOUS
PERVIOUS
STA 3+00

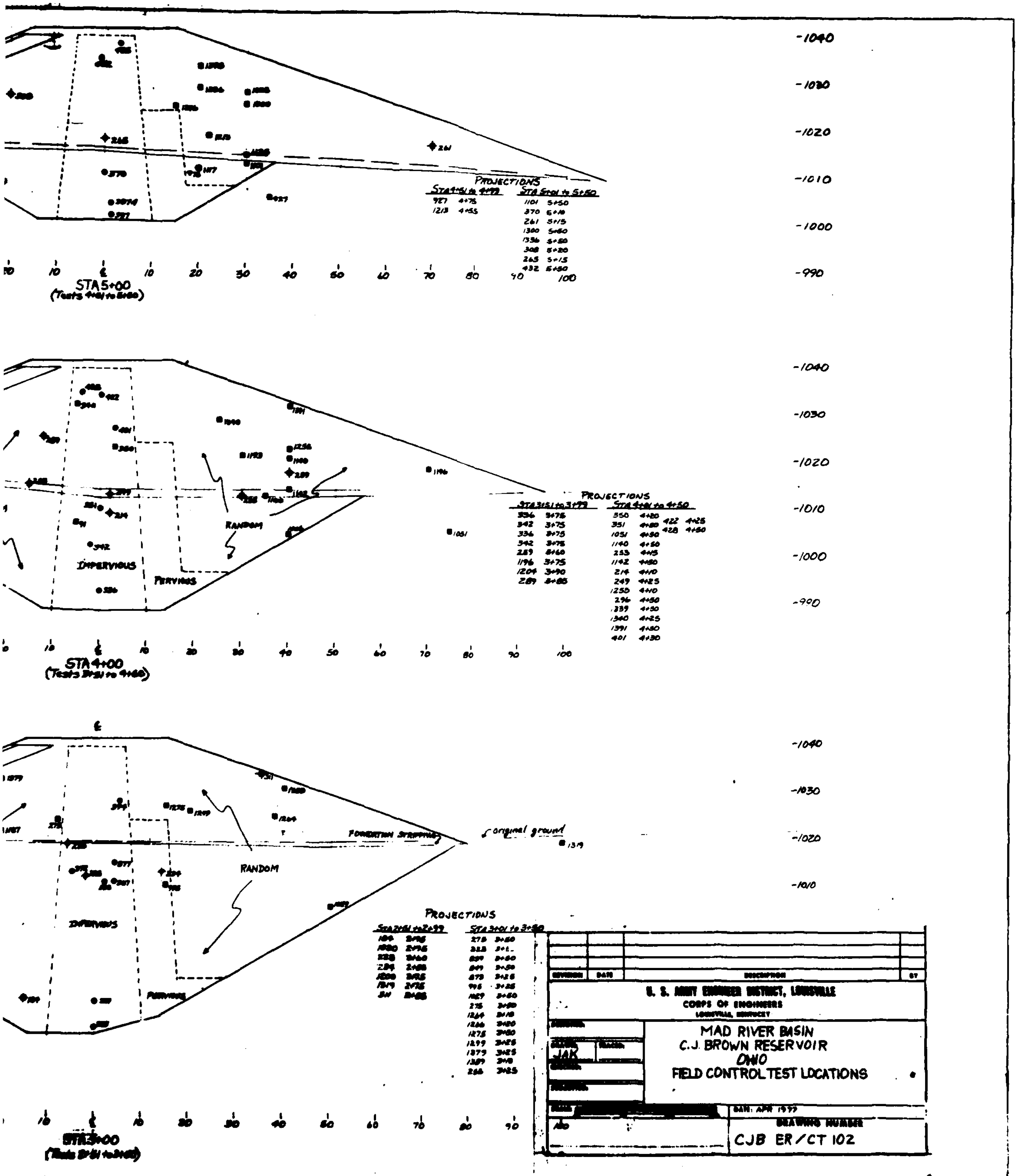
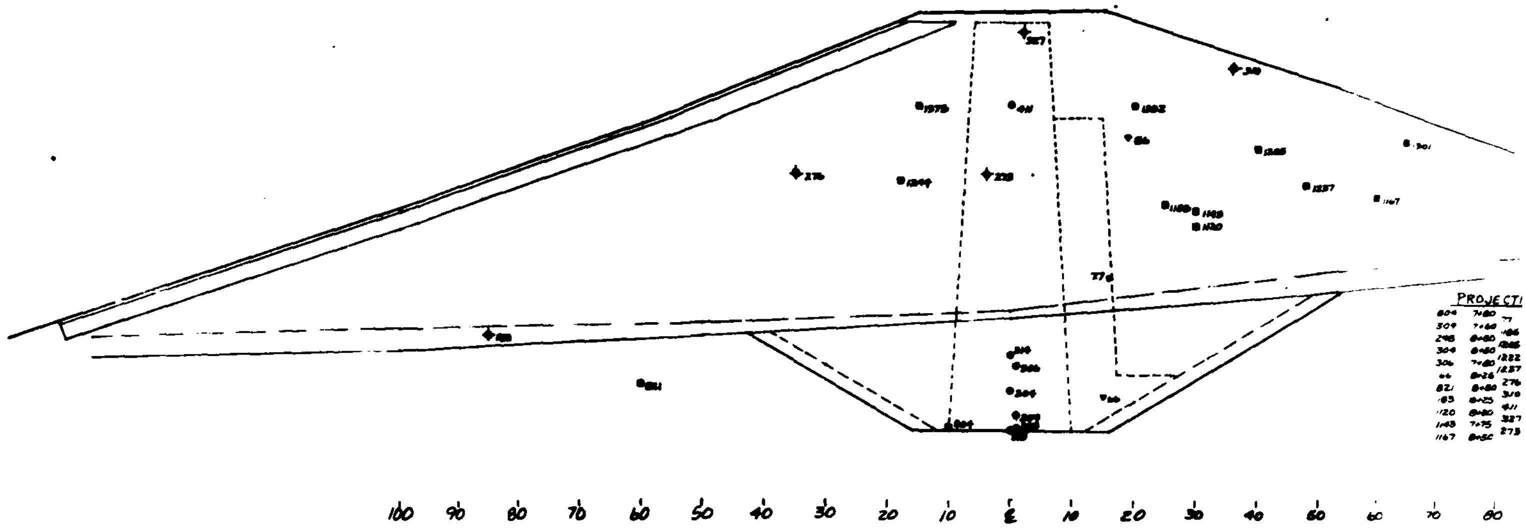
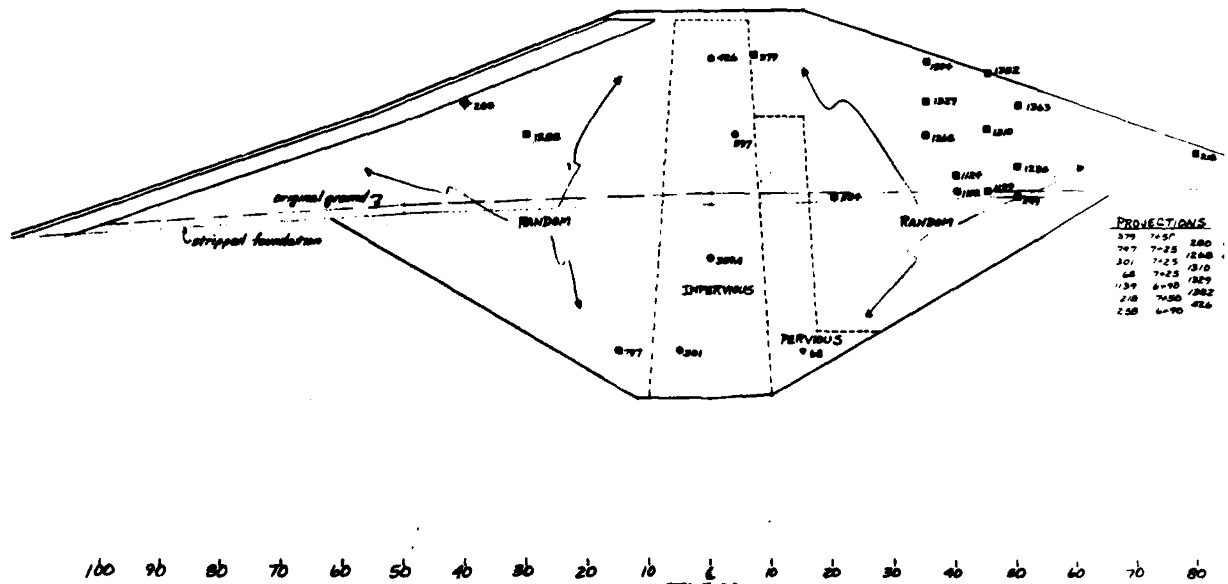

STA 5+00
(Tests 4+61 to 5+60)
STA 4+00
(Tests 3+51 to 4+60)
STA 3+00
PROJECTIONS
IMPERVIOUS
PERVIOUS
RANDOM
FOUNDATION STRIPPING
original ground
U. S. ARMY ENGINEER DISTRICT, LOUISVILLE
CORPS OF ENGINEERS
LOUISVILLE, KENTUCKY
MAD RIVER BASIN
C.J. BROWN RESERVOIR
OHIO
FIELD CONTROL TEST LOCATIONS
DATE: APR 1977
DRAWING NUMBER
CJB ER/CT 102

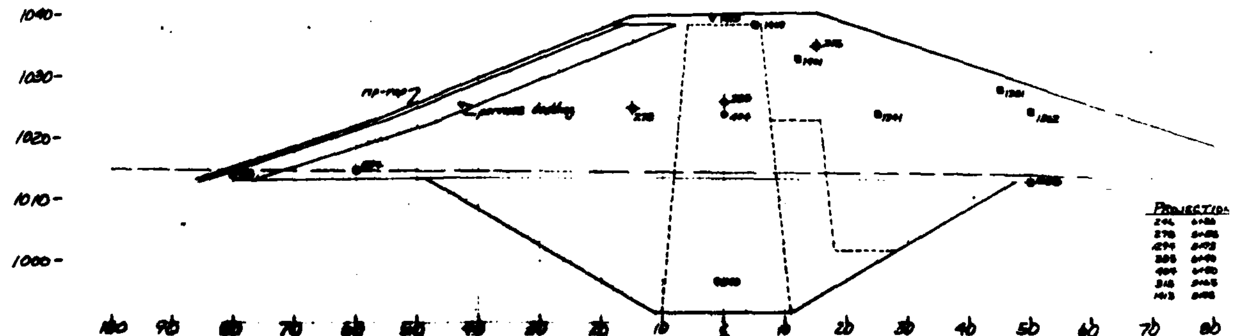
PLATE 30



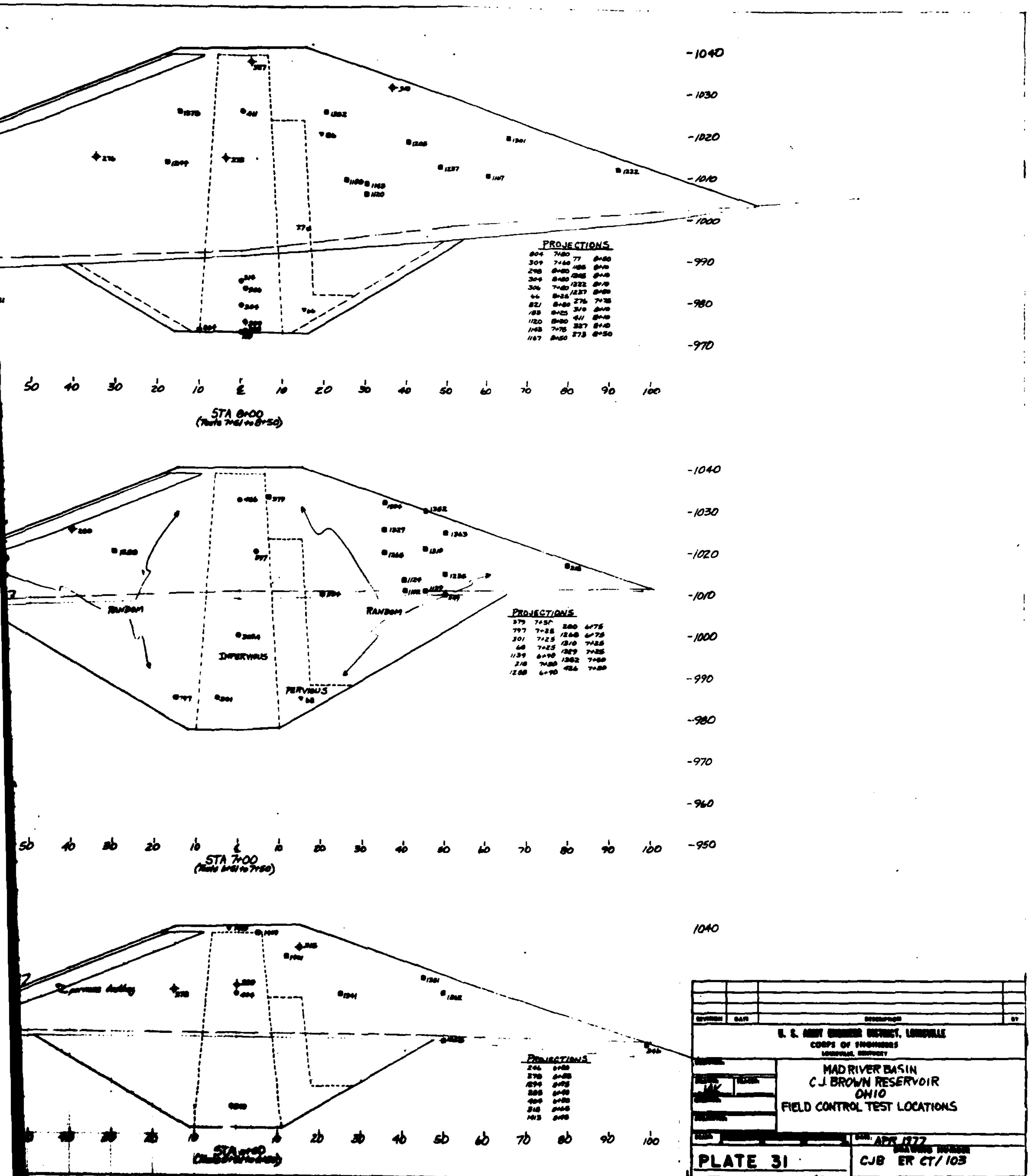
STA 8+00
(Tests 7+61 to 8+50)



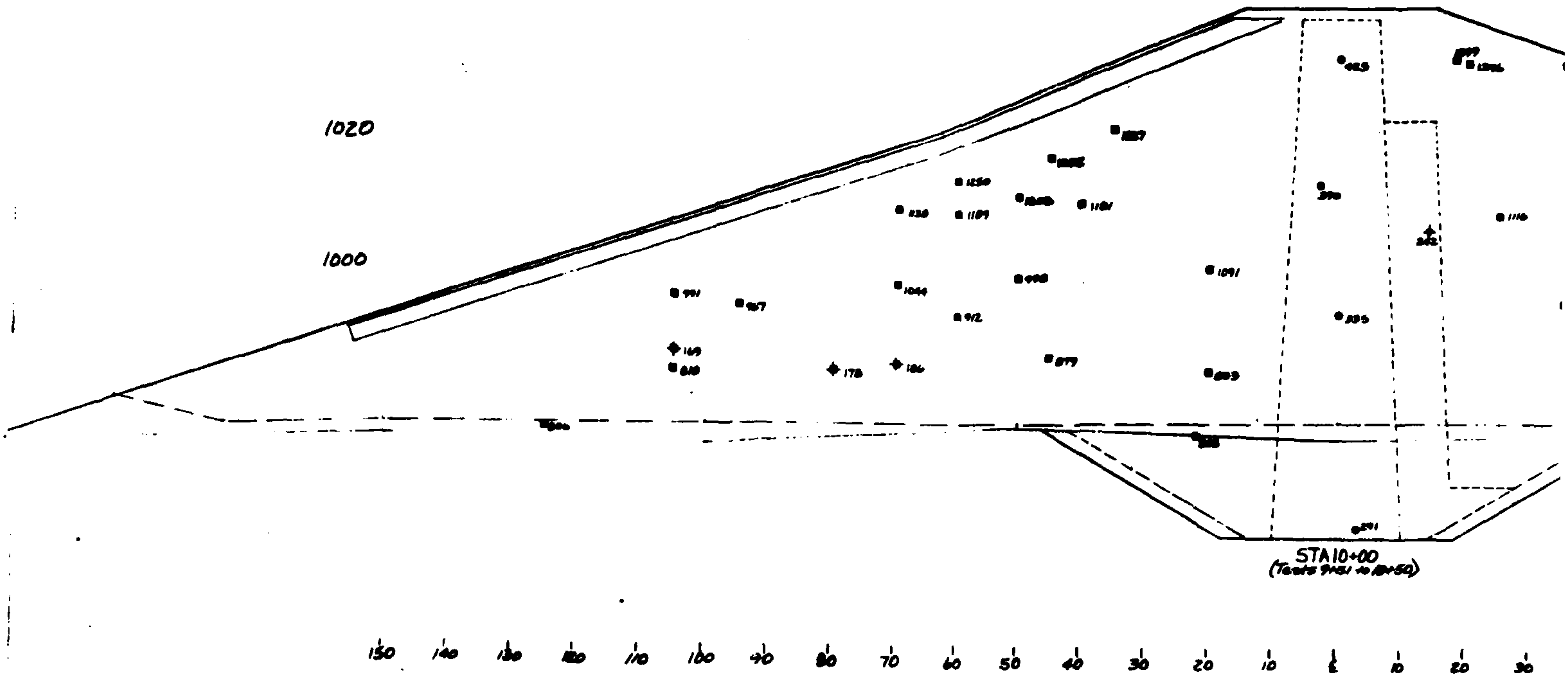
STA 7+00
(Tests 6+61 to 7+50)



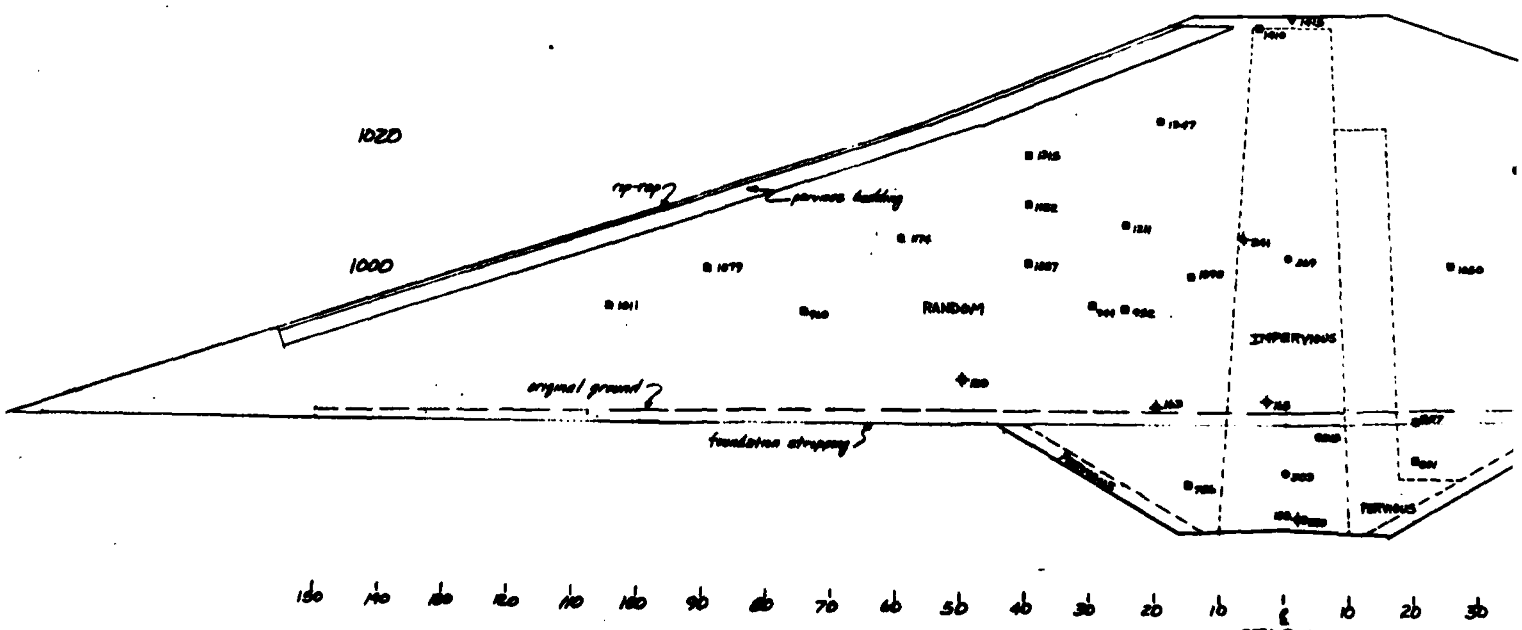
STA 6+00



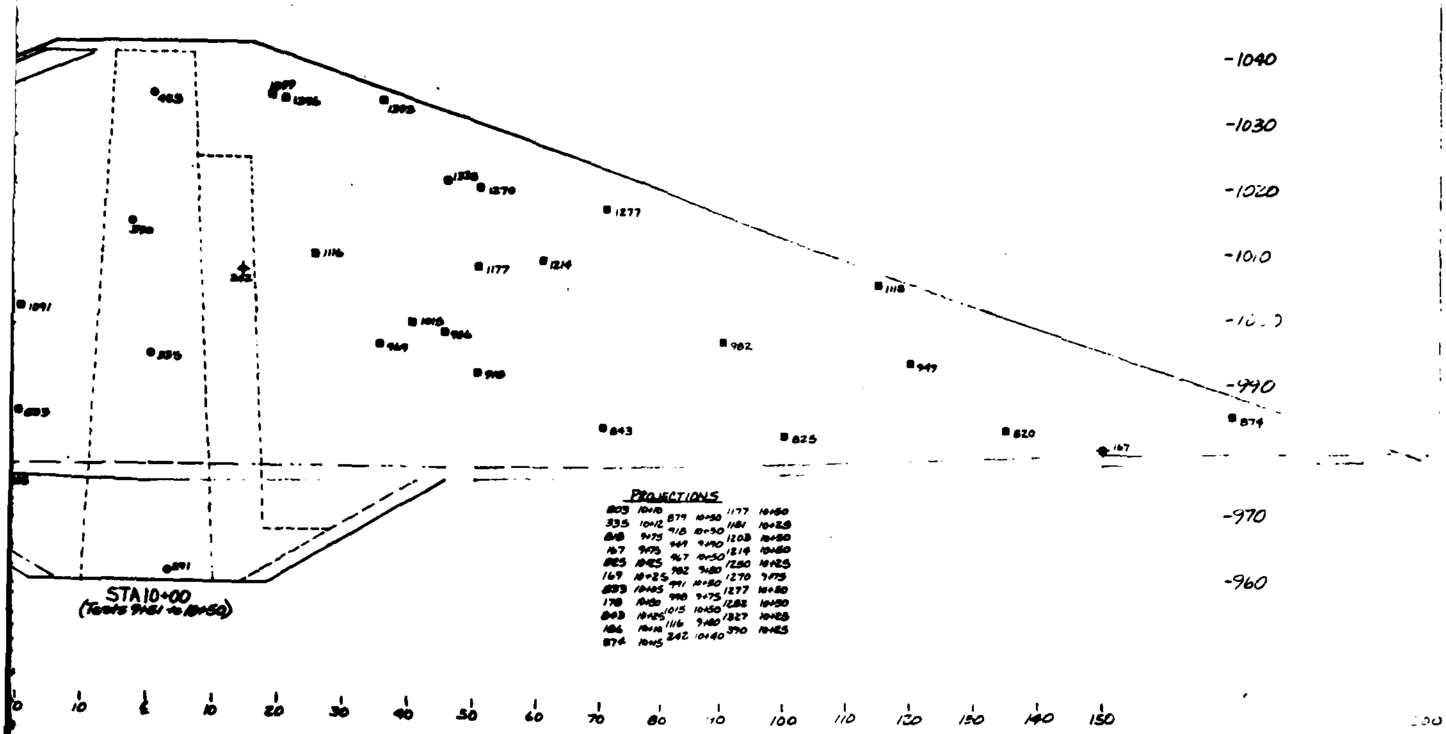
STA 8+00
PROJECTIONS
STA 7+00
RANDOM
IMPERVIOUS
PERVIOUS
PROJECTIONS
PROJECTIONS
U. S. ARMY ENGINEER DISTRICT, LOUISVILLE
CORPS OF ENGINEERS
MAD RIVER BASIN
C.J. BROWN RESERVOIR
OHIO
FIELD CONTROL TEST LOCATIONS
APR 1977
PLATE 31
CJB ER CT/103

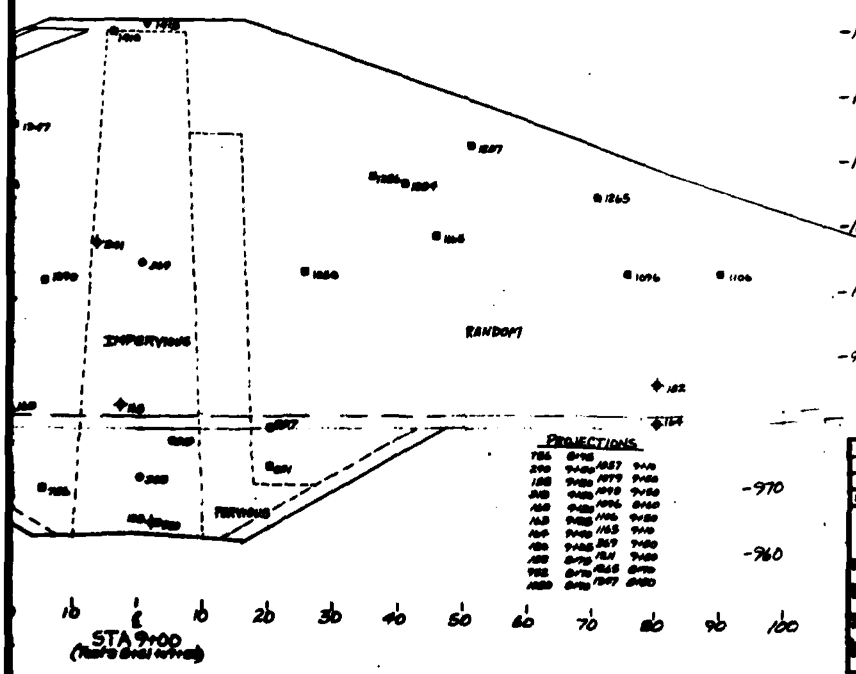


STA 10+00



STA 9+00





U. S. ARMY ENGINEER DISTRICT, LOUISVILLE
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MAD RIVER BASIN
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FIELD CONTROL TEST LOCATIONS

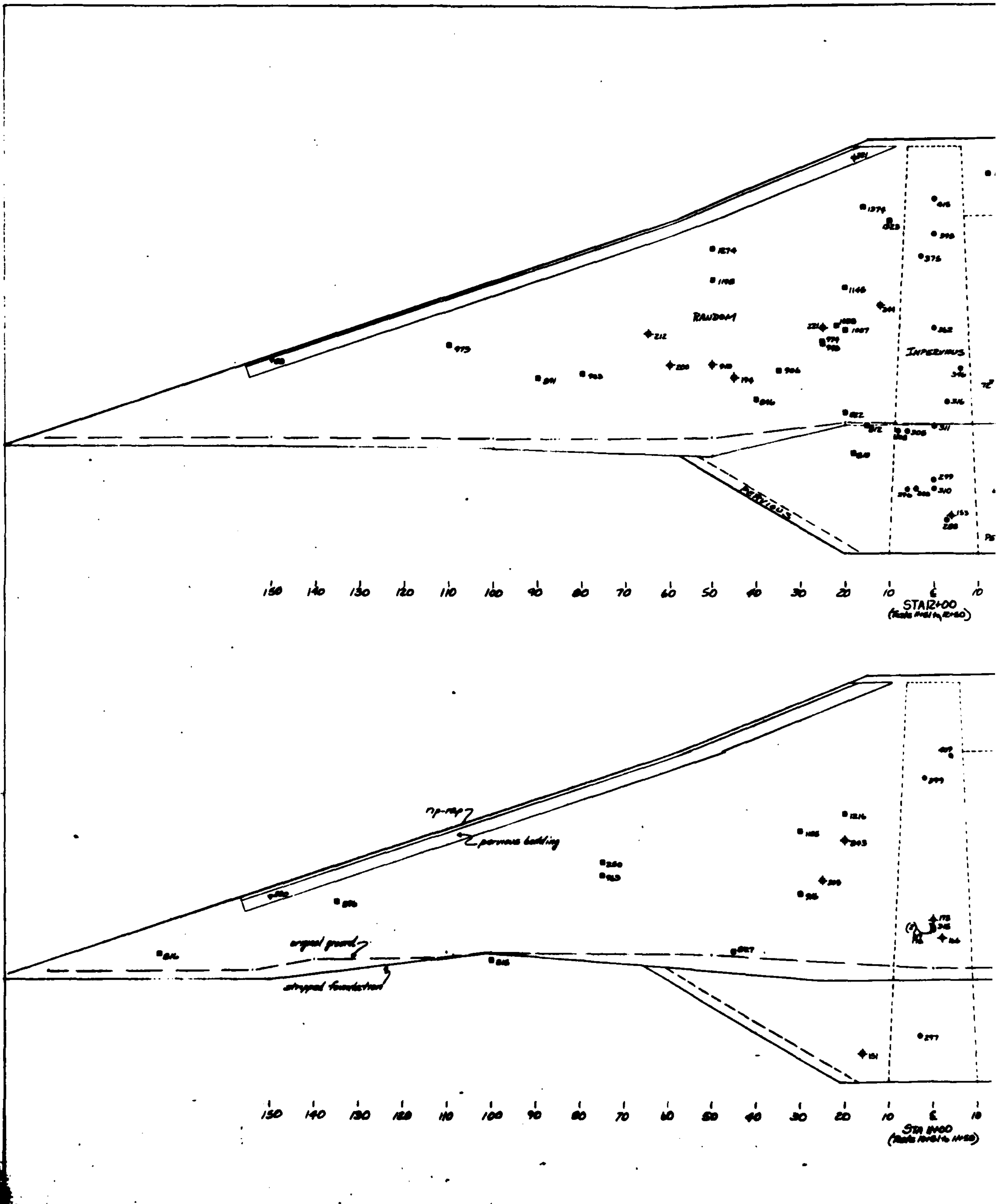
JAK

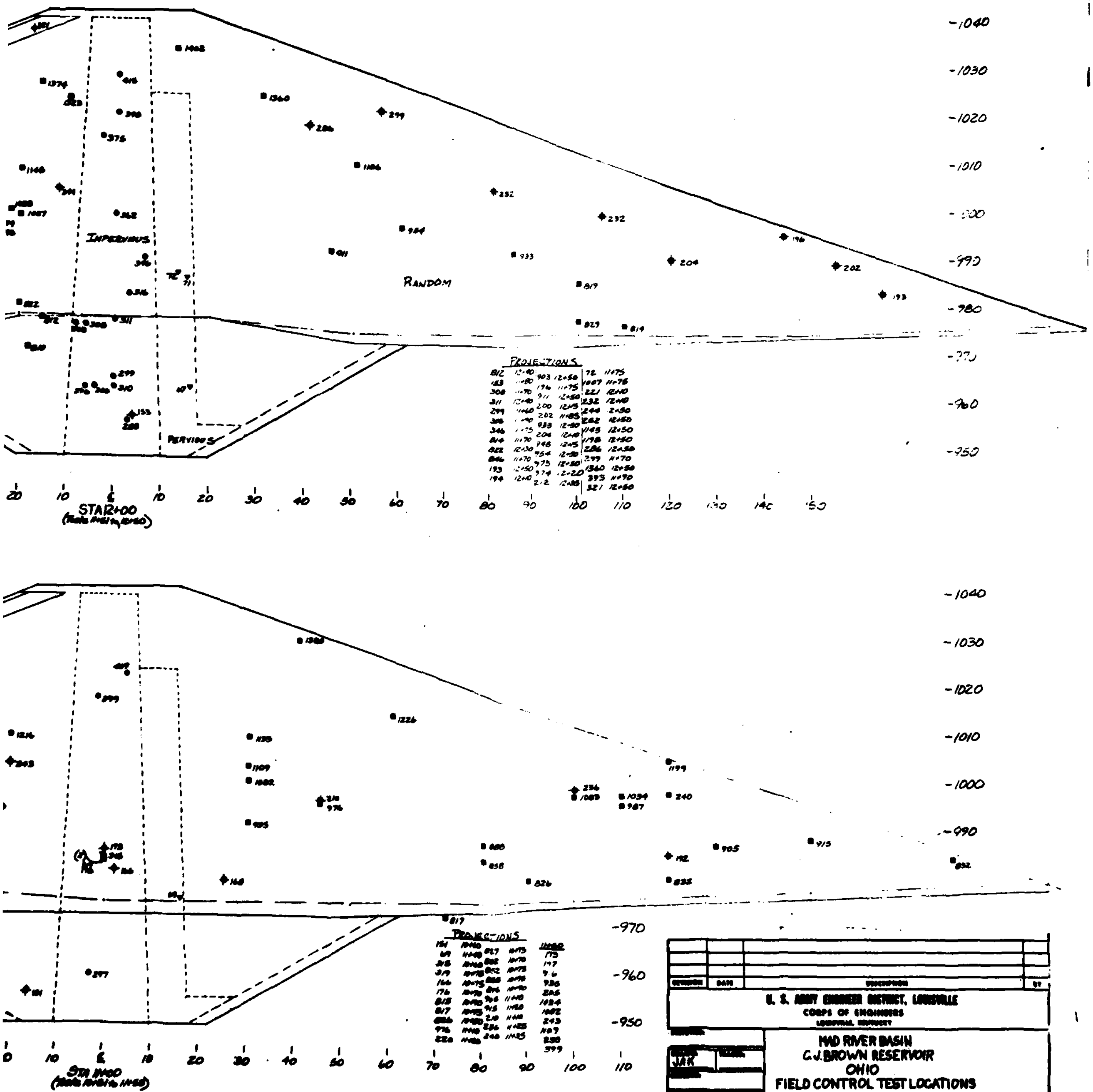
APR 1977

PLATE 32

CJB ER/CT 104

2


RANDOM
IMPERVIOUS
PERVIOUS
150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ℄ 10
STA 12+00
rip-rap
pervious bedding
original ground
stripped foundation
130 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ℄ 10
STA 14+00



U. S. ARMY ENGINEER DISTRICT, LOUISVILLE
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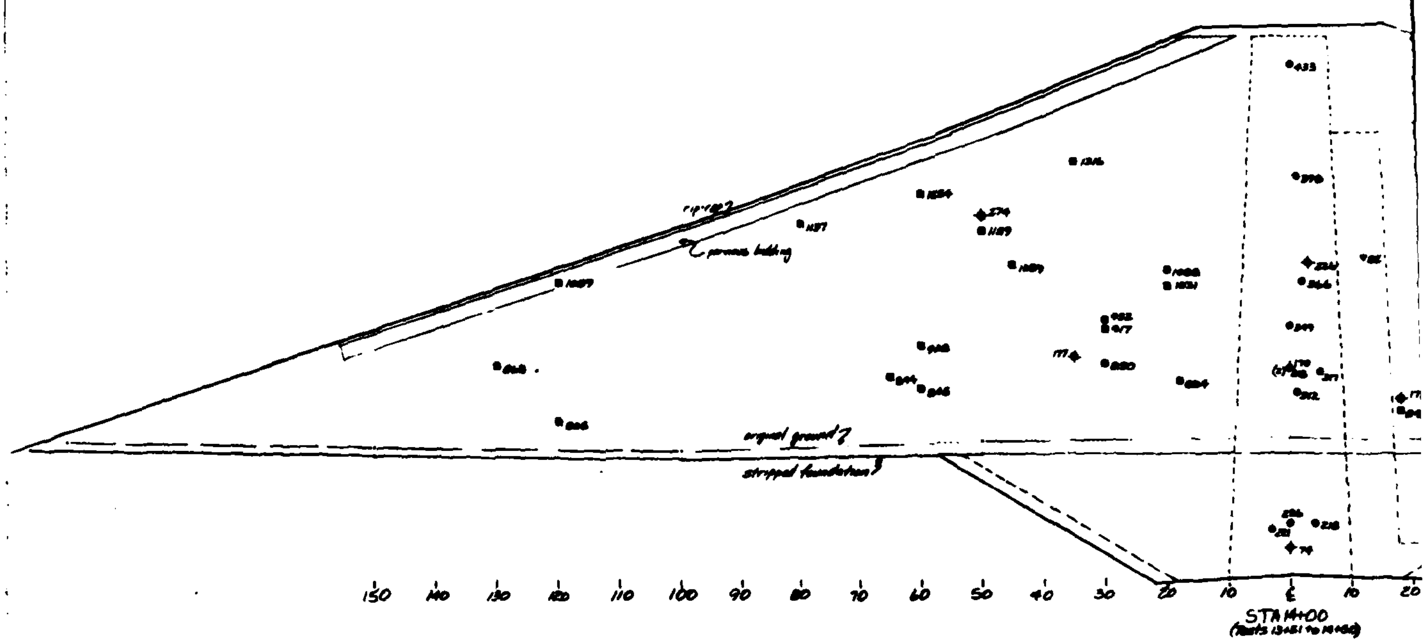
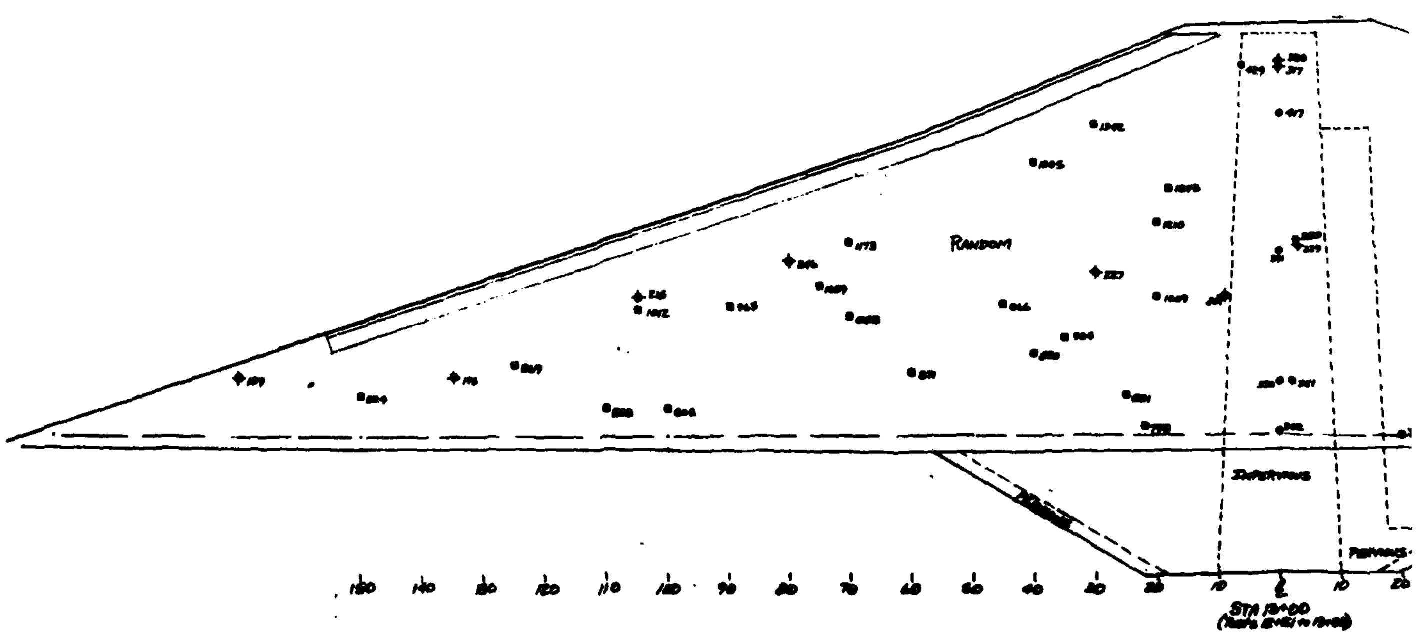
PLATE 33

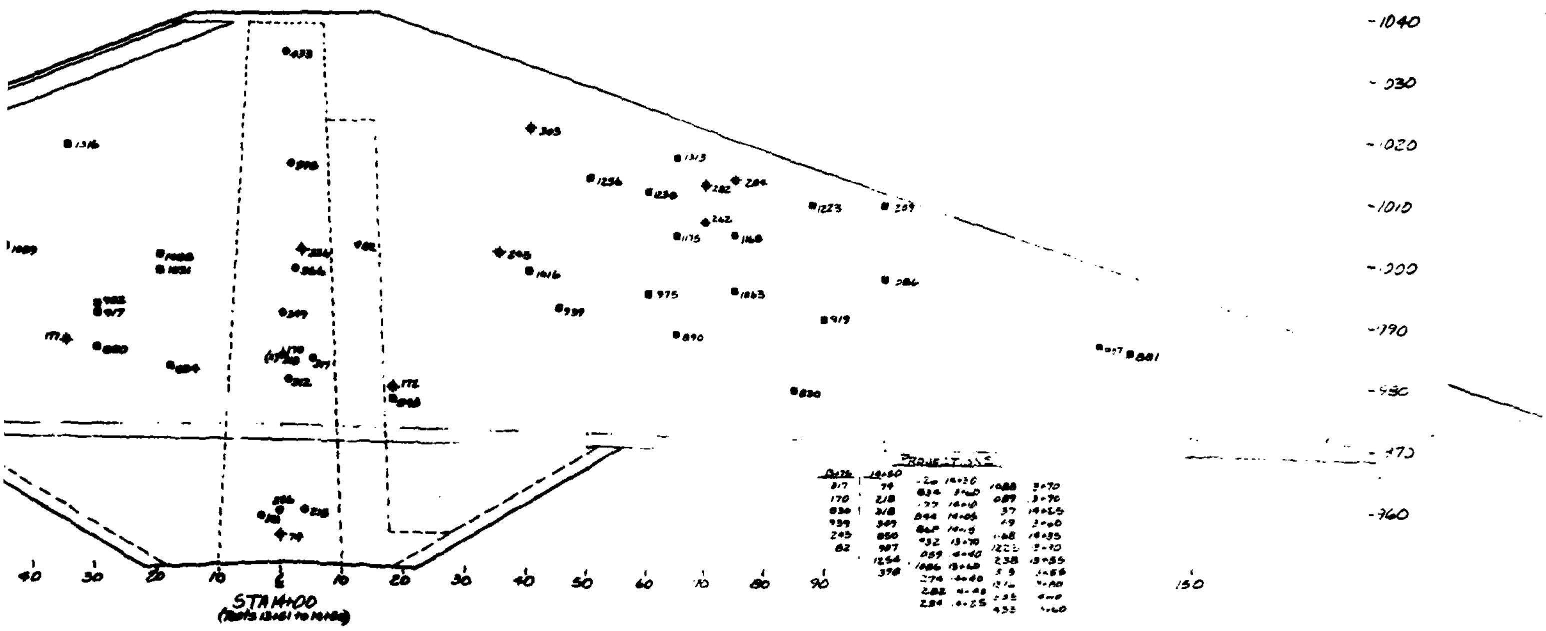
CJB ER/CT 105

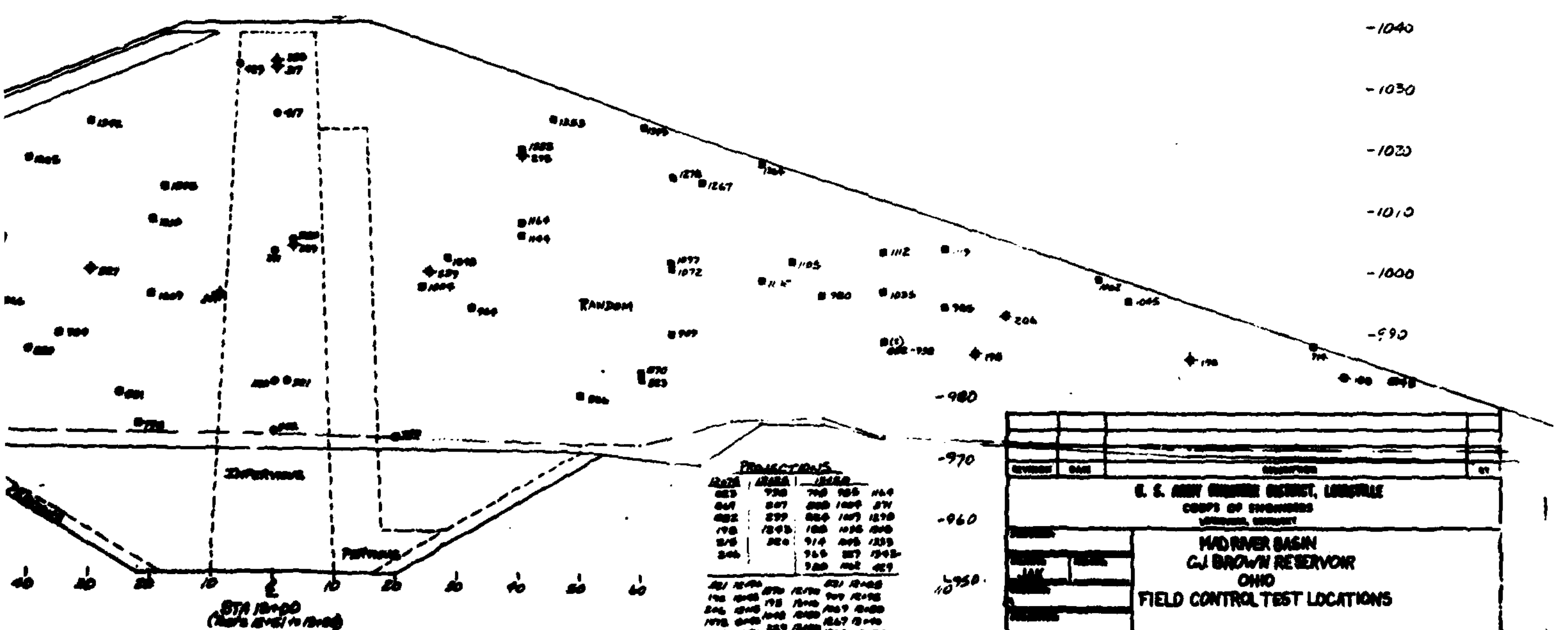
2


riprap
porous bedding
original ground
stripped foundation
150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ℄ 10 20
STA 14+00


RANDOM
IMPERVIOUS
PERVIOUS
130 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ℄ 10 20
STA 13+00

/





U. S. ARMY ENGINEER DISTRICT, LOUISVILLE
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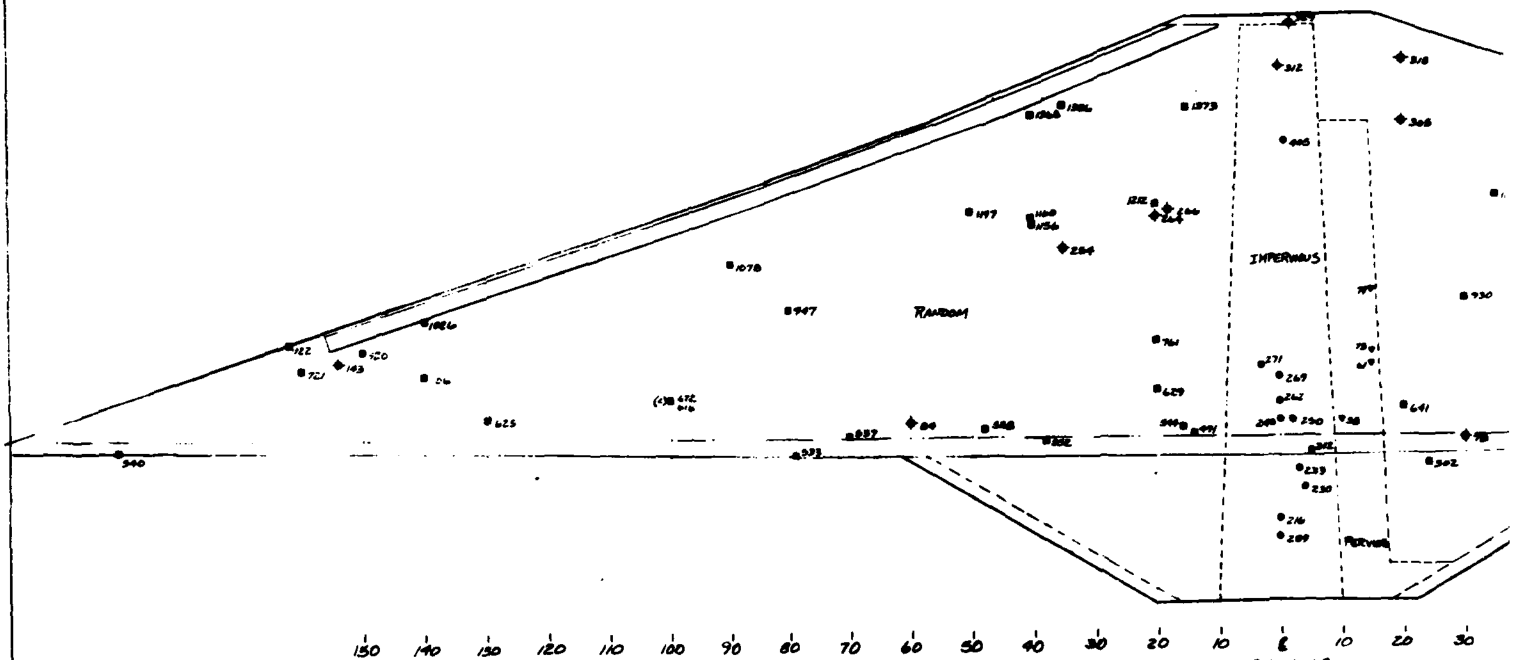
FIELD CONTROL TEST LOCATIONS

JAK

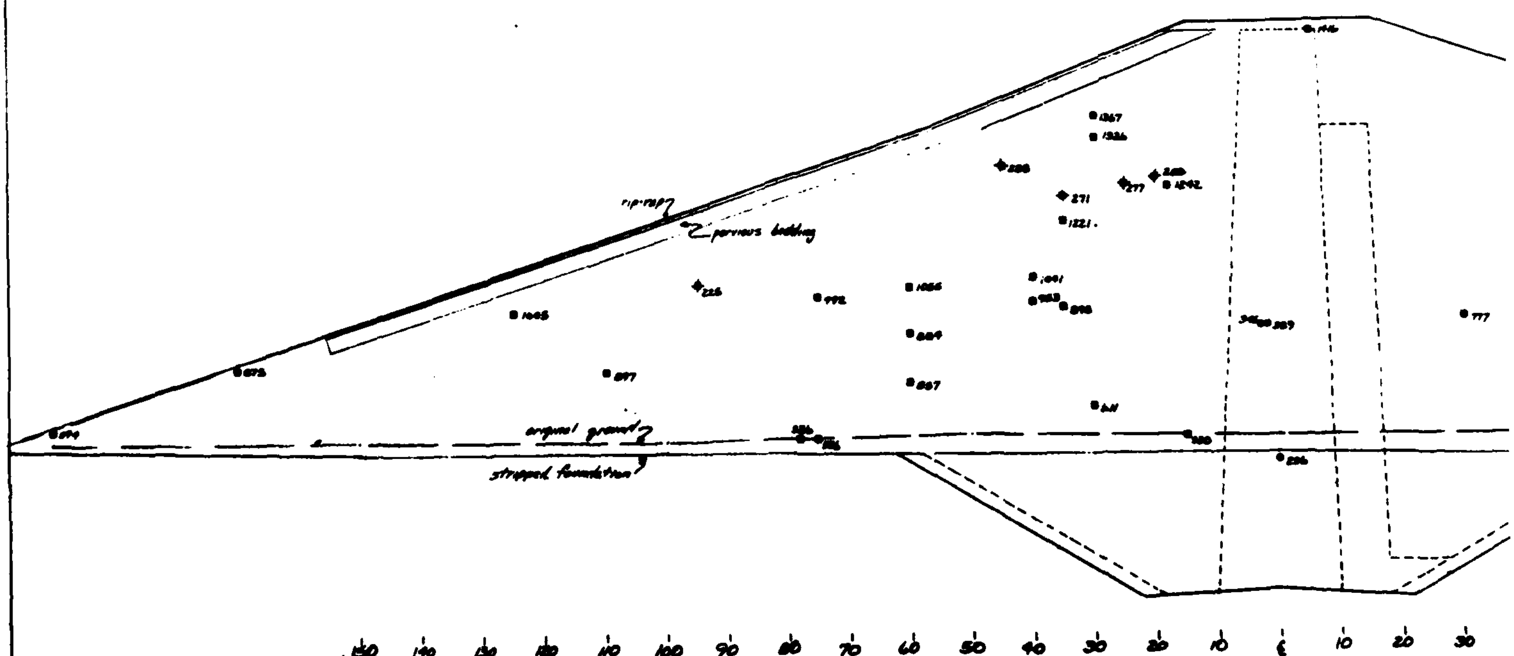
PLATE 34

CJB ER/CT 106

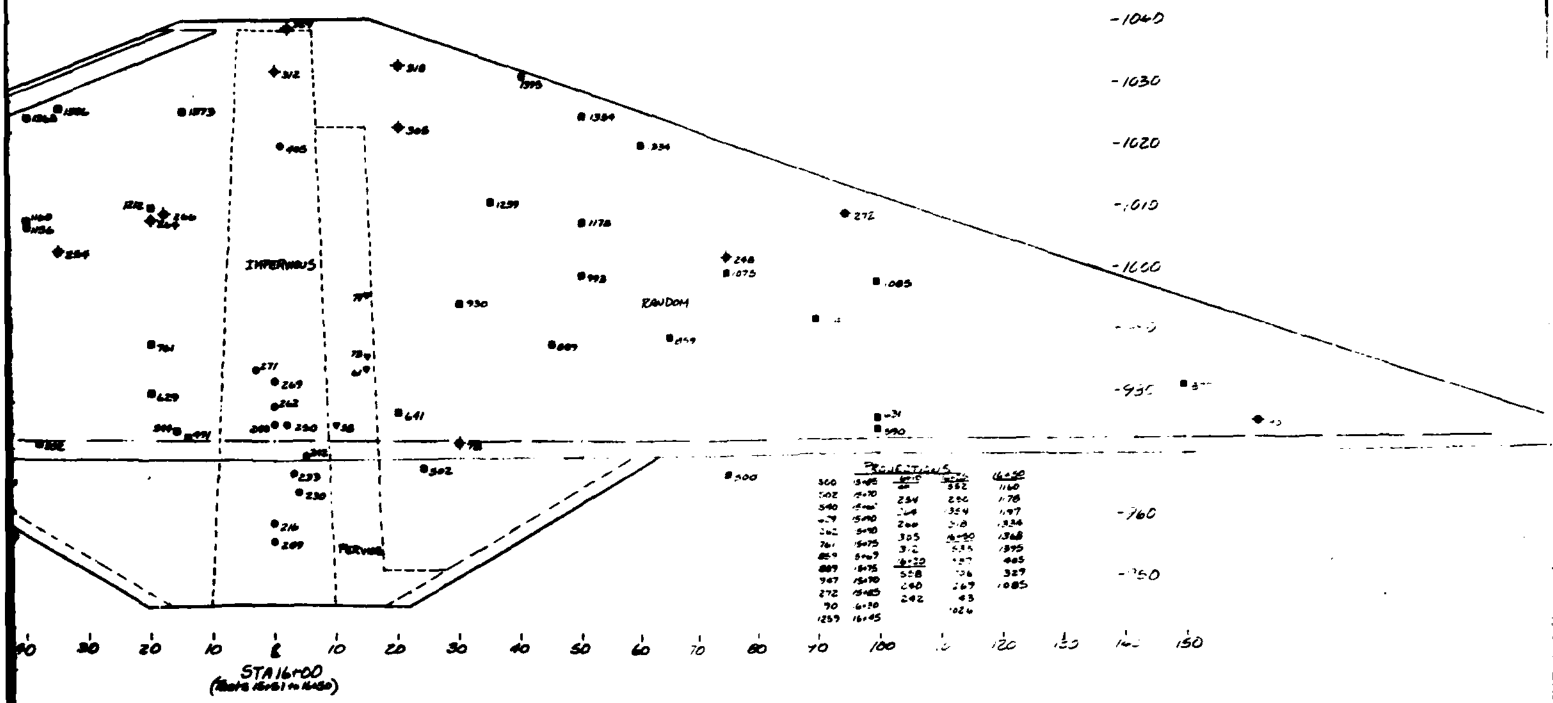
2

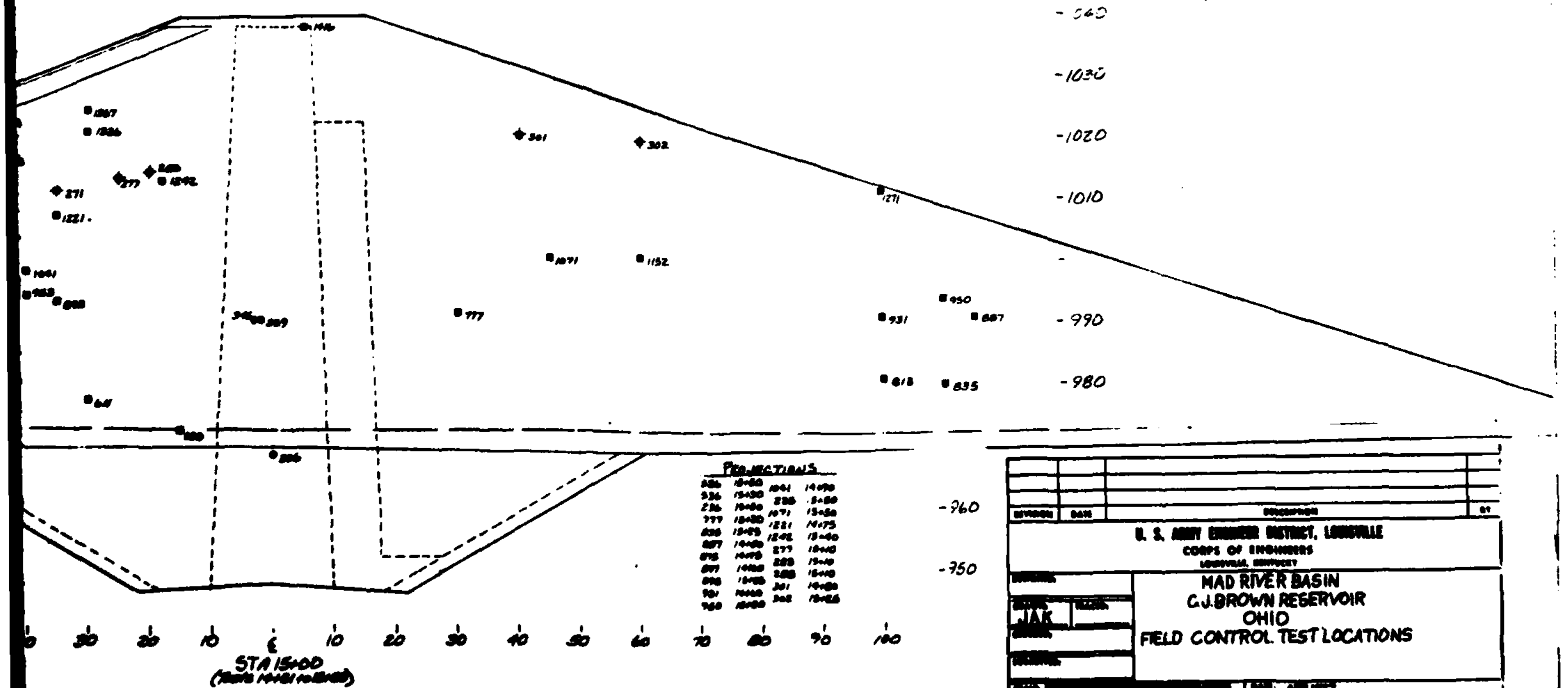


STA 16+00
(Tests 15+51 to 16+50)



STA 15+00





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FIELD CONTROL TEST LOCATIONS

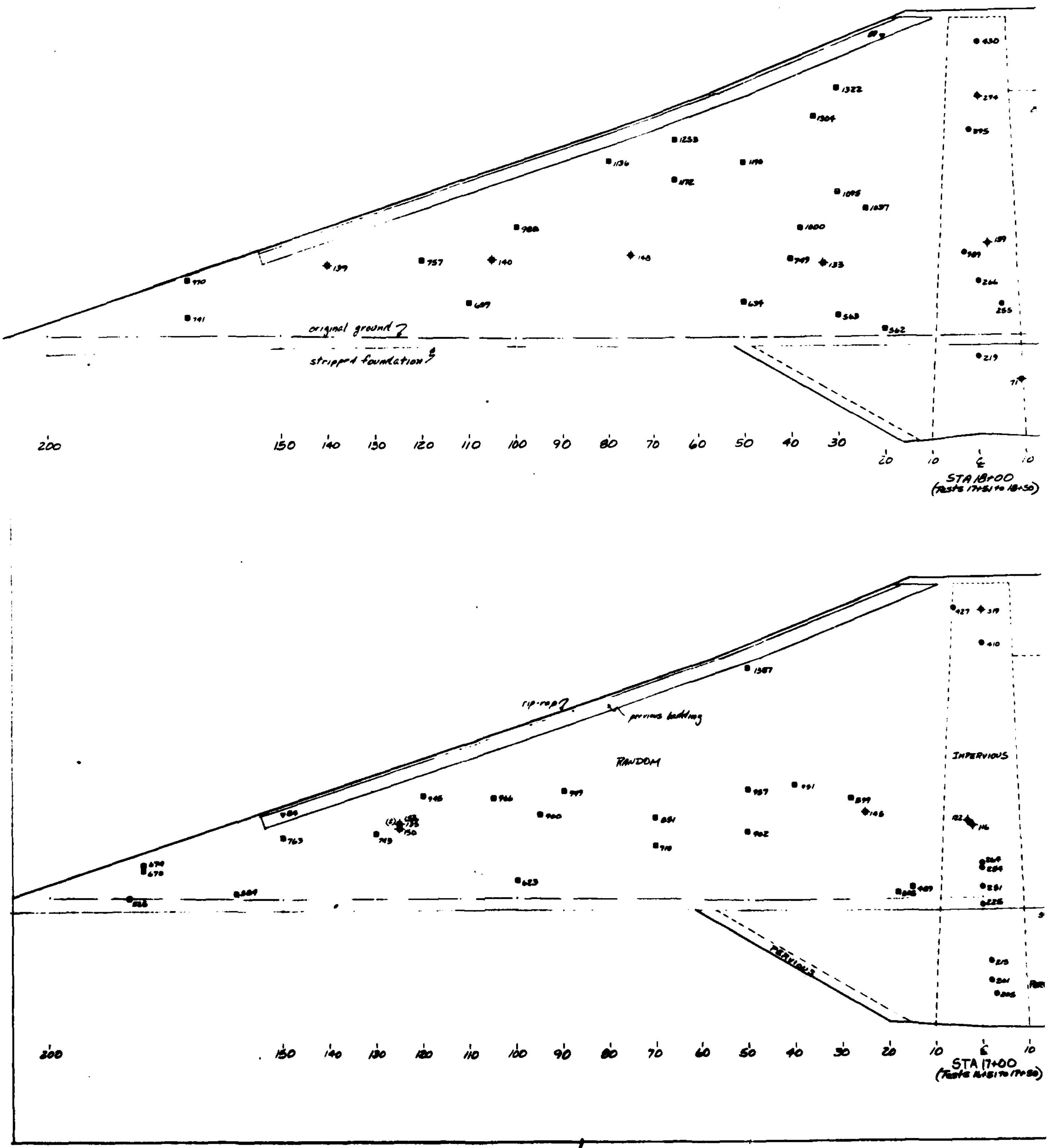
JAK

PLATE 35

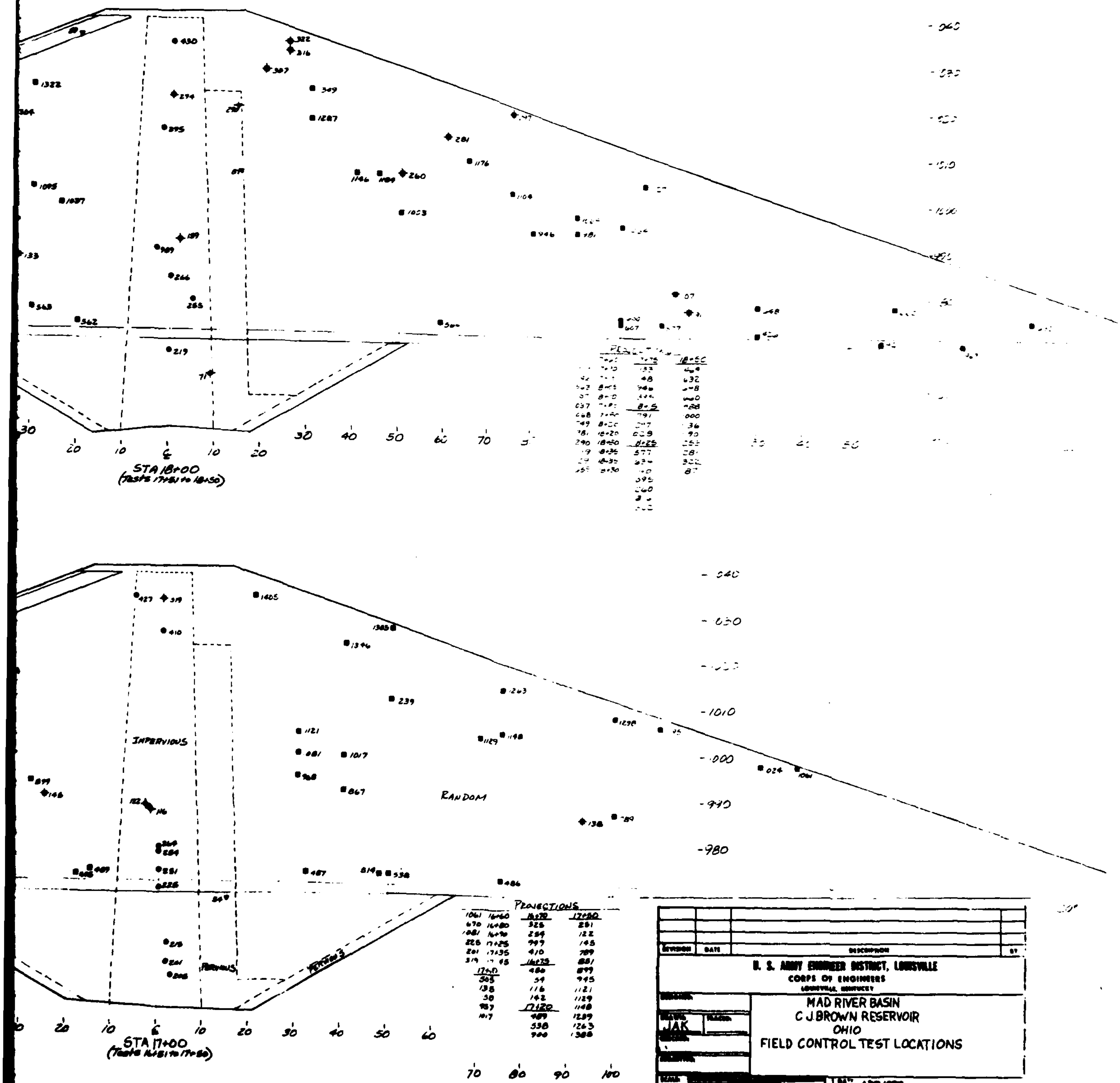
CJB ER/CT 107

2

1



original ground
stripped foundation
200
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
℄
10
STA 18+00
(Tests 17+51 to 18+50)
rip-rap
pervious bedding
RANDOM
IMPERVIOUS
PERVIOUS
200
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
℄
10
STA 17+00
(Tests 16+51 to 17+50)



U. S. ARMY ENGINEER DISTRICT, LOUISVILLE
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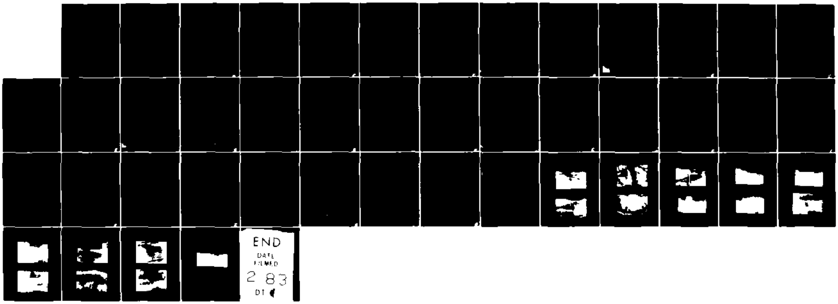
DRAWING NUMBER
CJB ER/CT 108

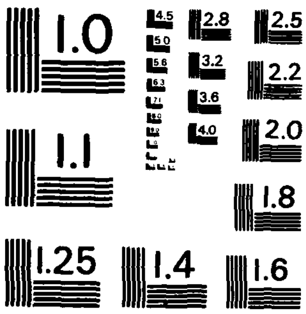
1

2

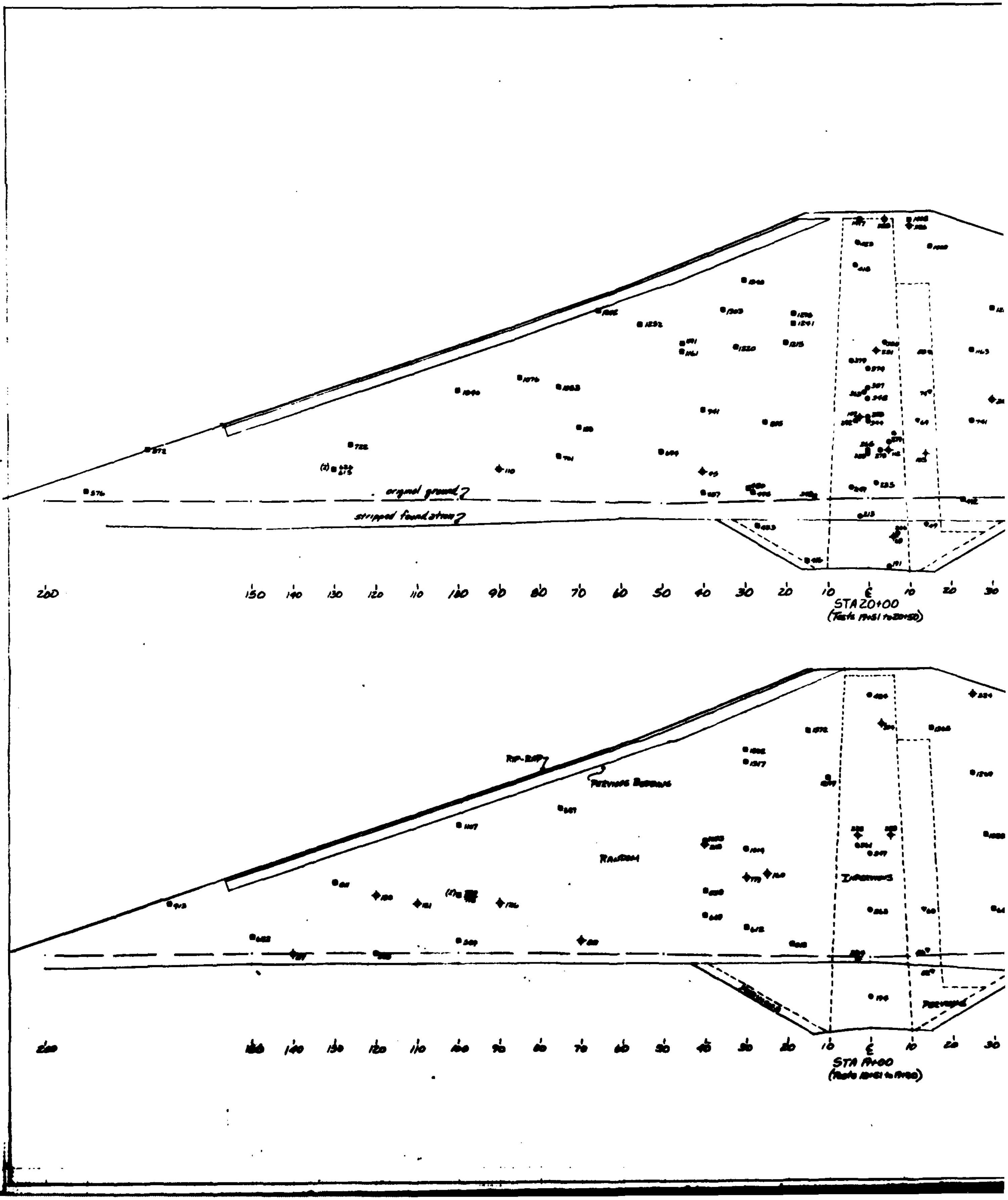
AD-A122 682 CLARENCE J BROWN RESERVOIR GREATER MIAMI RIVER BASIN OHIO EMBANKMENT CRITERIA AND PERFORMANCE REPORT(U) ARMY ENGINEER DISTRICT LOUISVILLE KY SEP 82 2/2

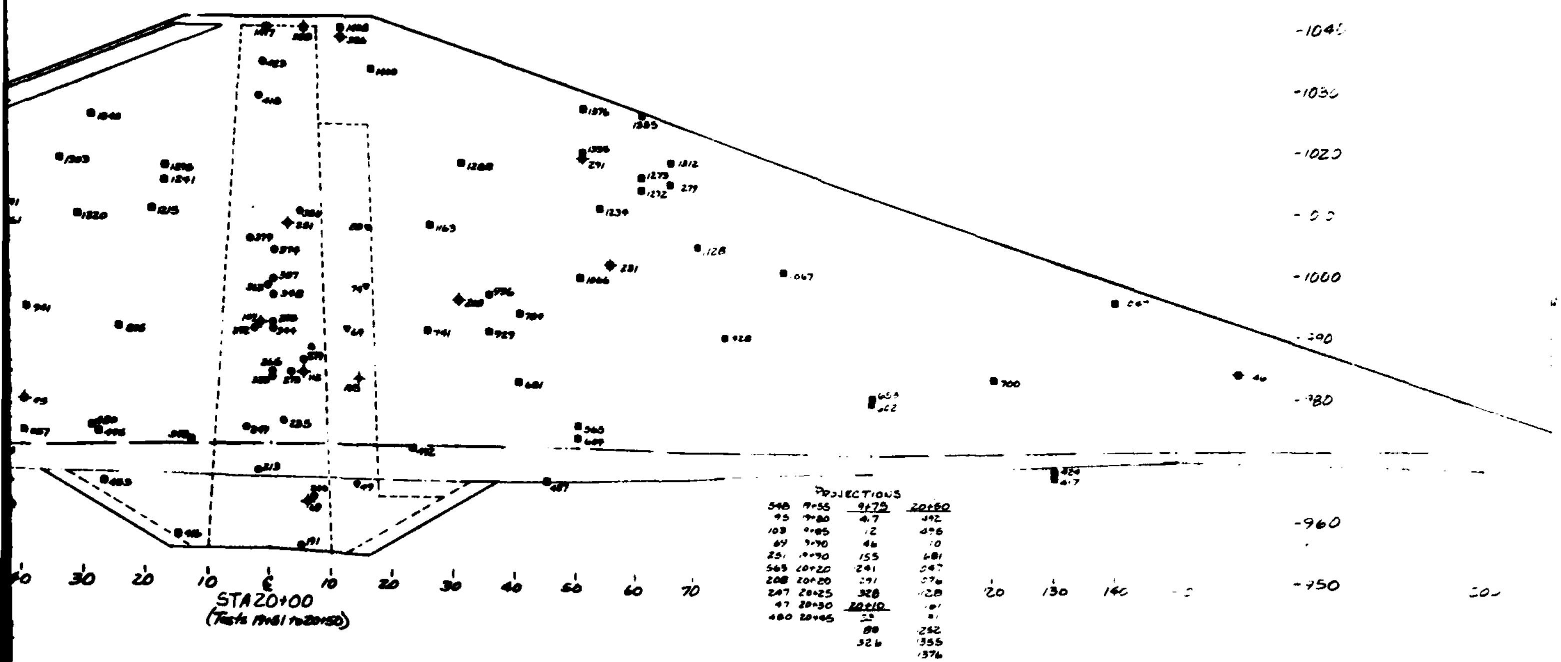
UNCLASSIFIED F/G 13/13 NL

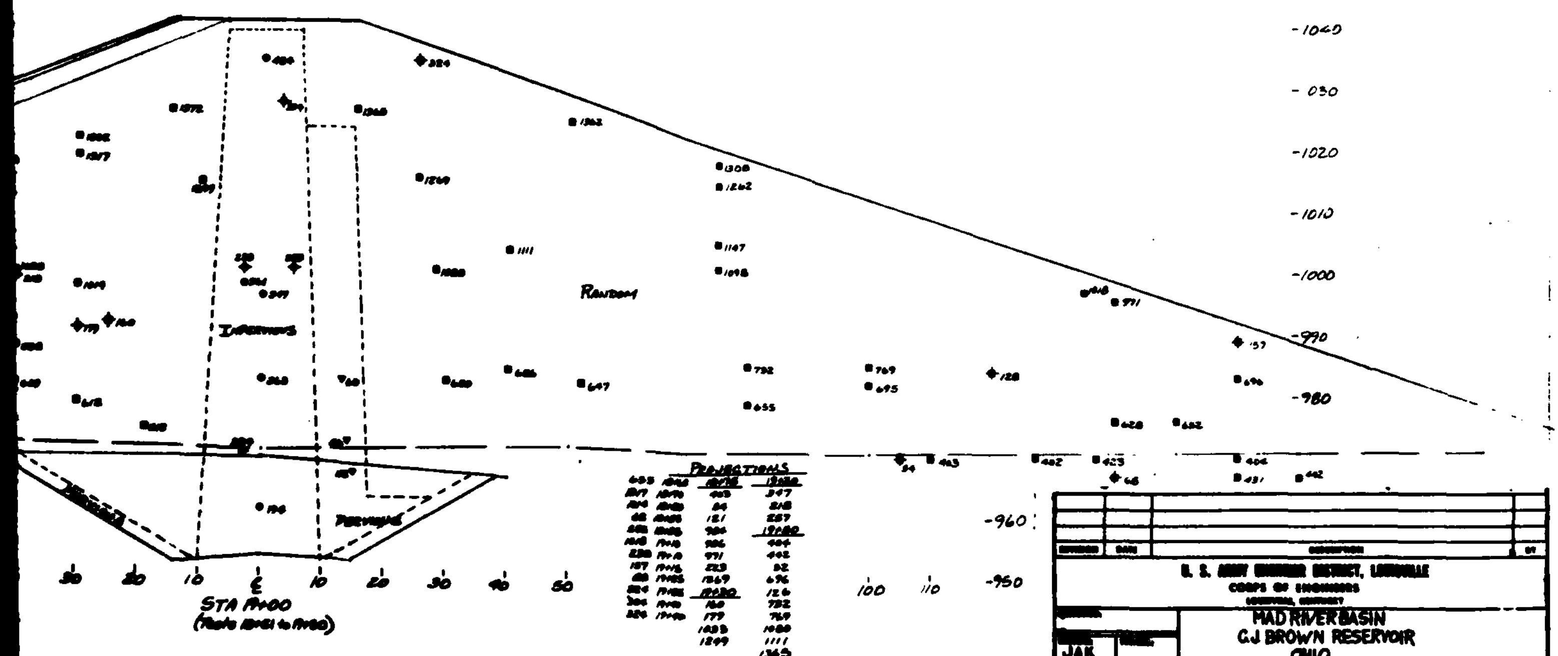




MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A


original ground
stripped foundation
STA 20+00
RIP-RAP
RANDOM
IMPERVIOUS
200
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
10
20
30





CORPS OF ENGINEERS

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PLATE 37

DRAWING NUMBER
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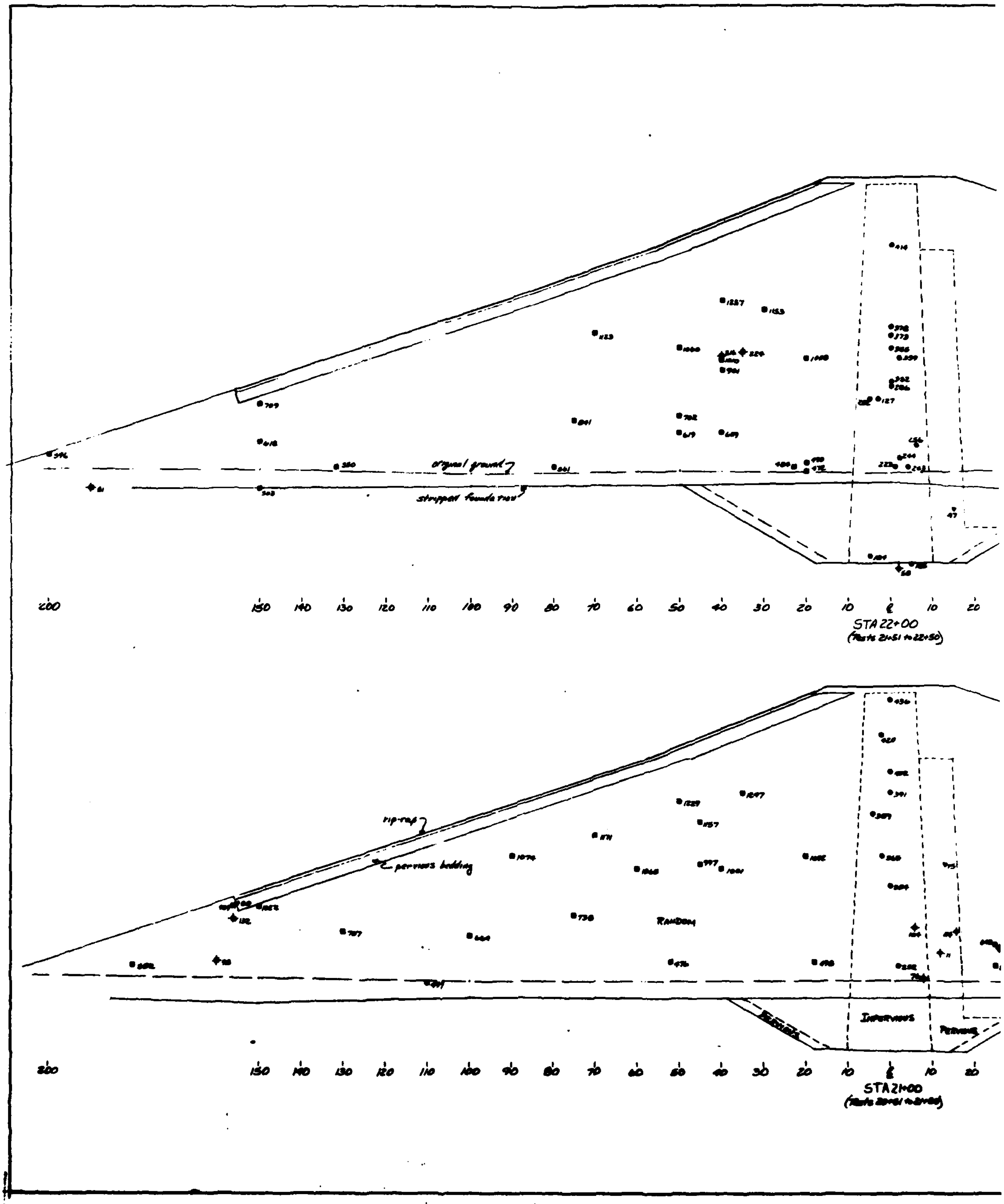
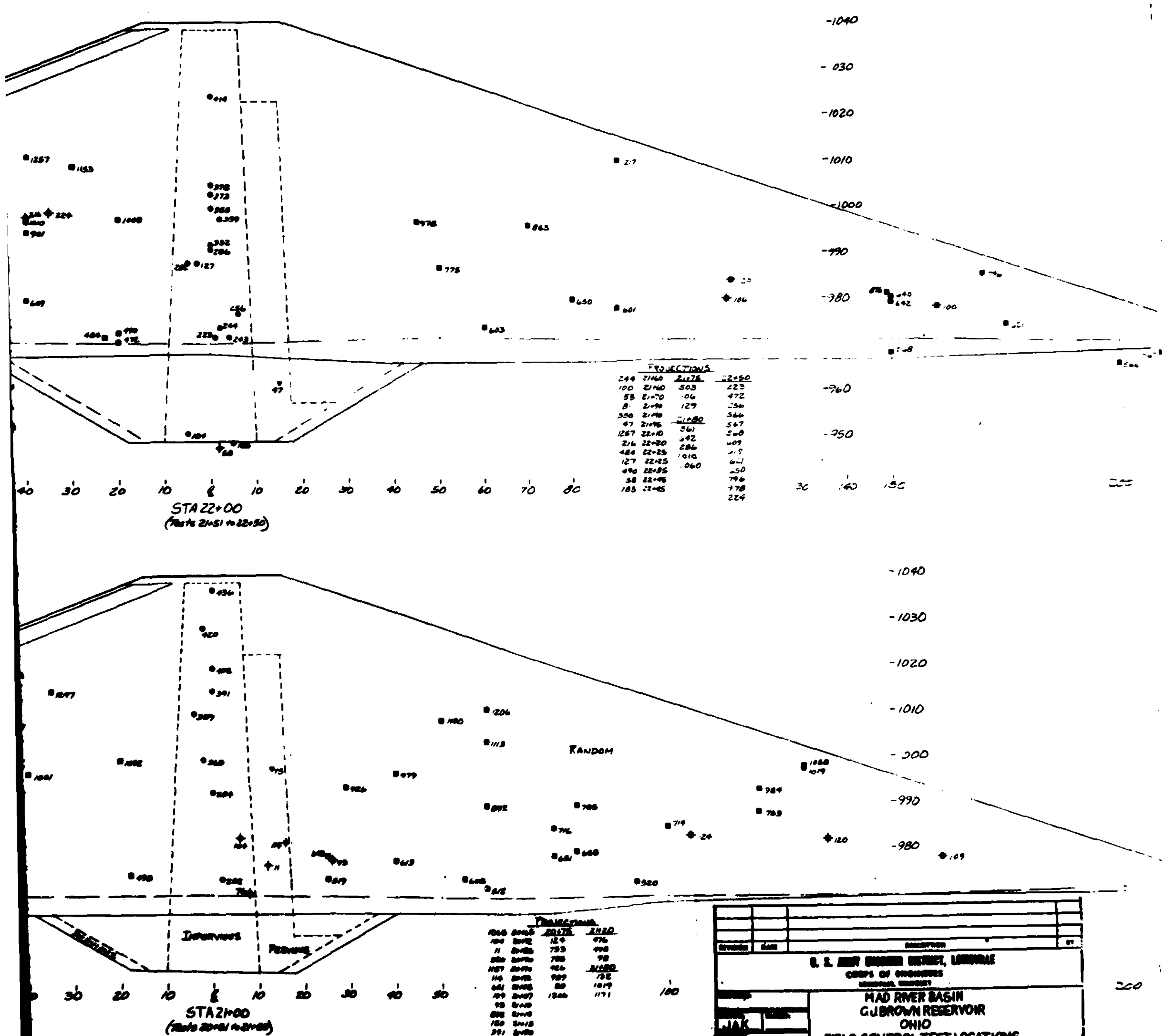

original ground
stripped foundation
STA 22+00
(Tests 21+51 to 22+50)
rip-rap
pervious bedding
RANDOM
IMPERVIOUS
PERVIOUS
STA 21+00
(Tests 20+51 to 21+50)



MAD RIVER BASIN
C J BROWN RESERVOIR
OHIO
FIELD CONTROL TEST LOCATIONS

JAK

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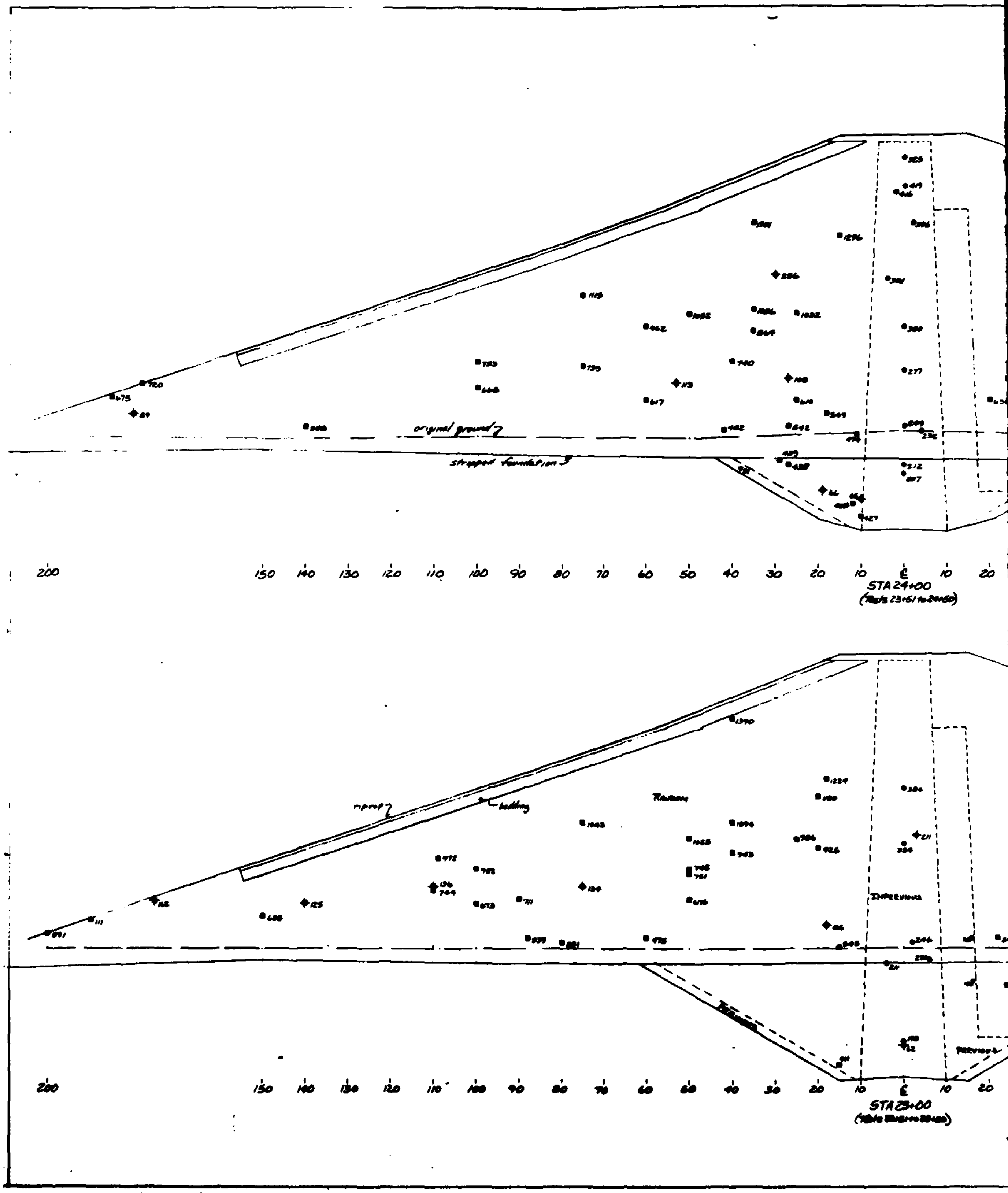
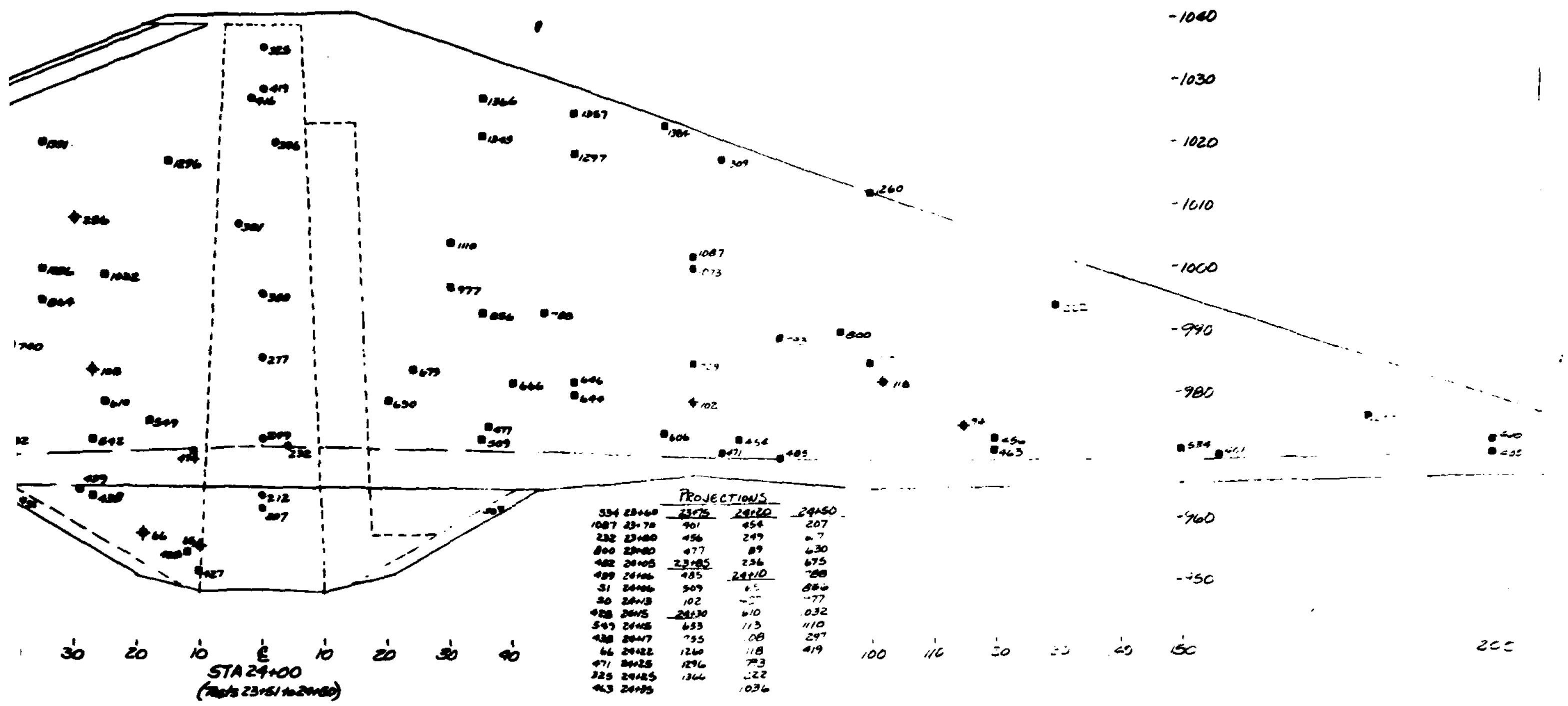
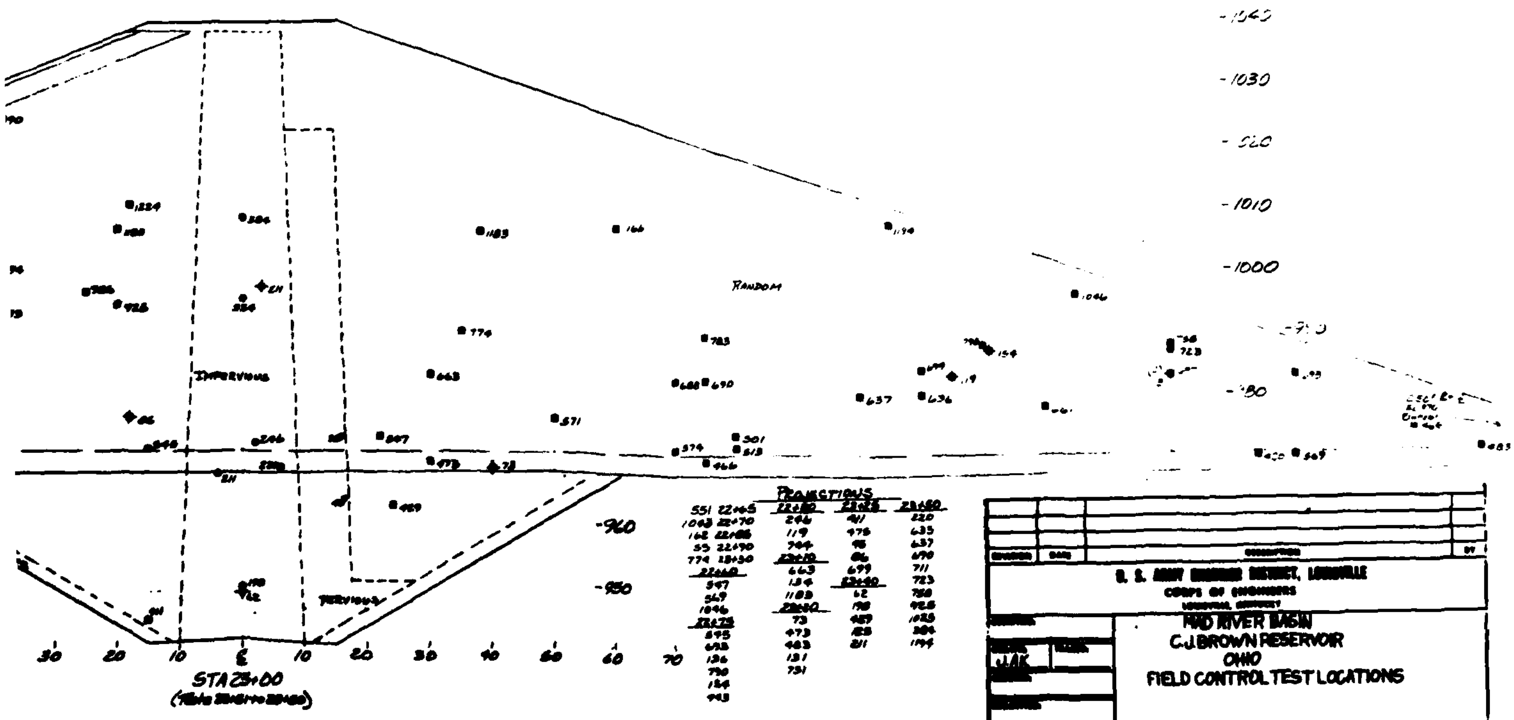
PLATE 38

CJB ER/CT 110



original ground
stripped foundation
STA 24+00
riprap
bedding
Random
Impervious
Pervious
STA 23+00





U. S. ARMY ENGINEER DISTRICT, LOUISVILLE
CORPS OF ENGINEERS
LOUISVILLE, KENTUCKY

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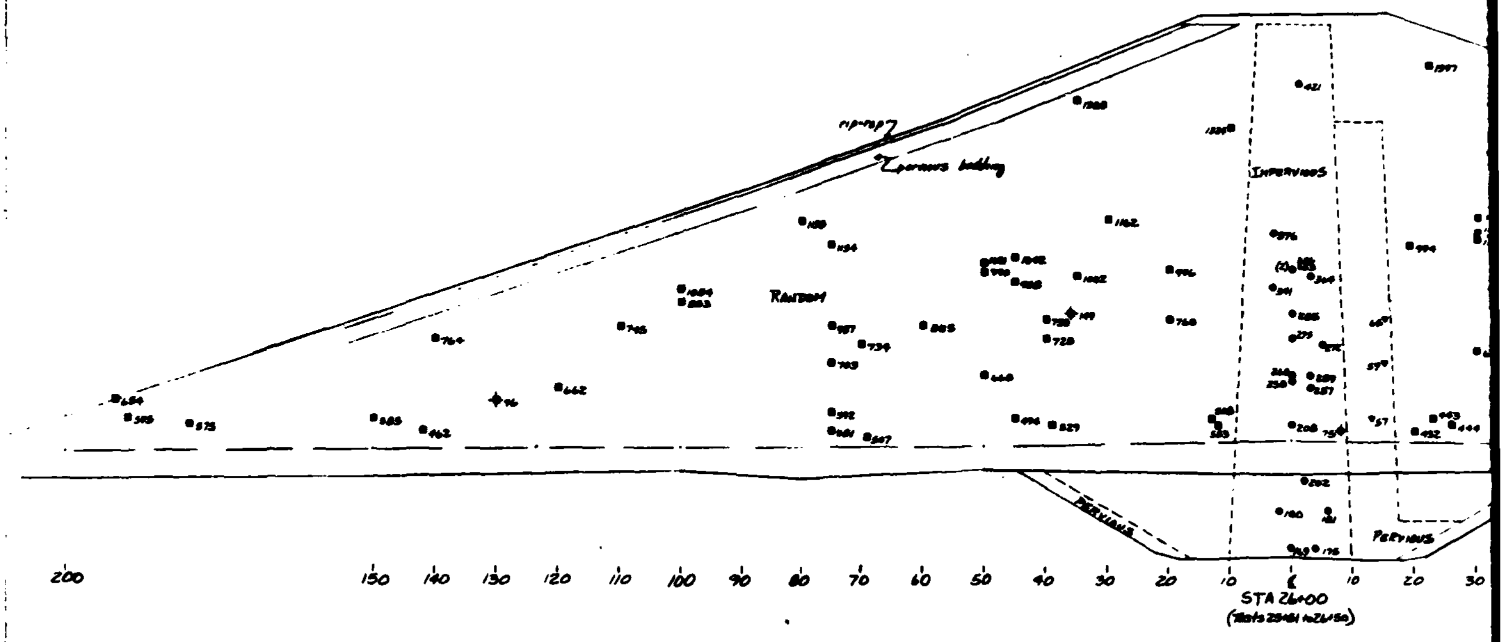
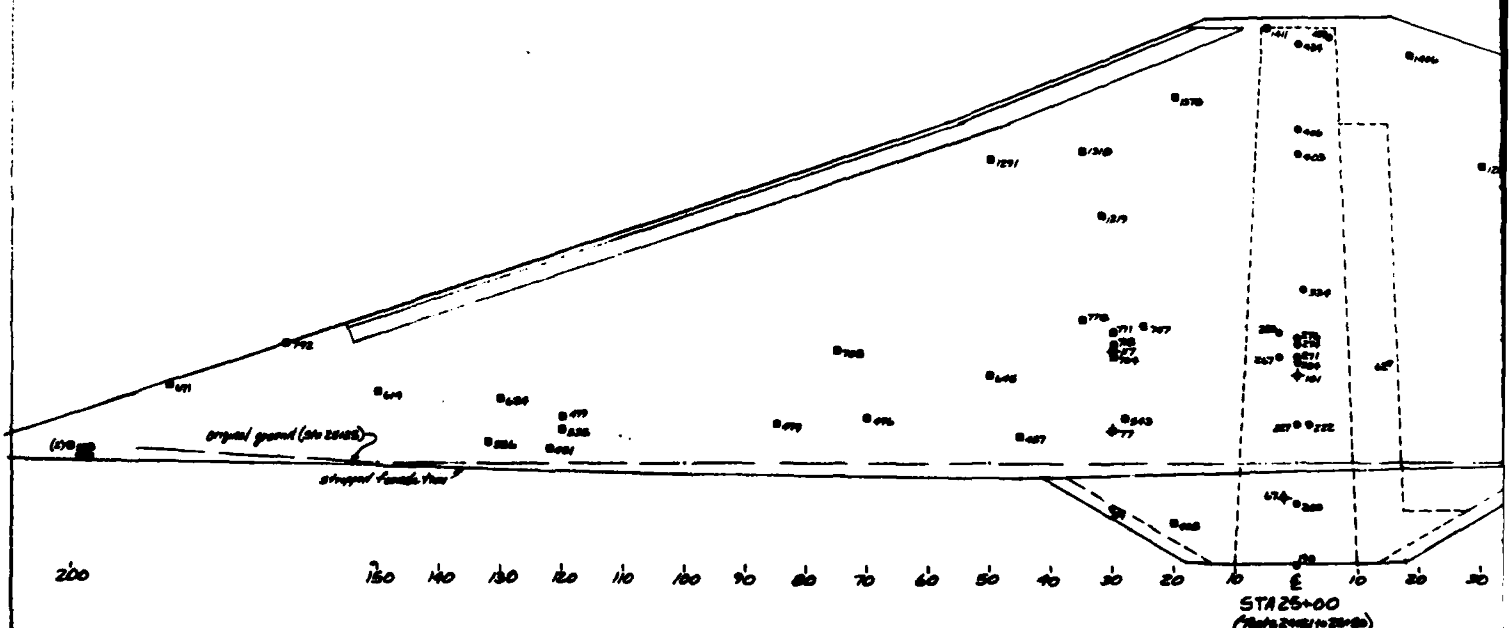
DATE APR 1977

PLATE 39

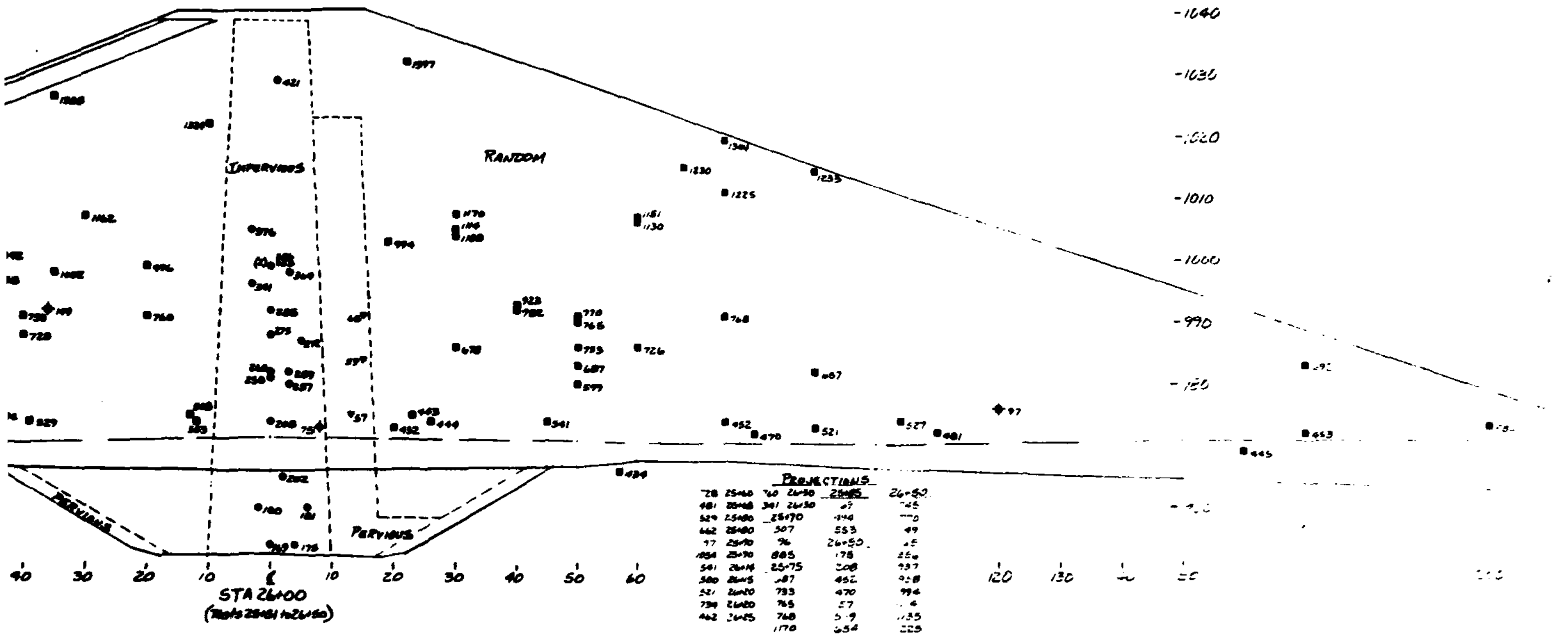
CJB ER/CT III

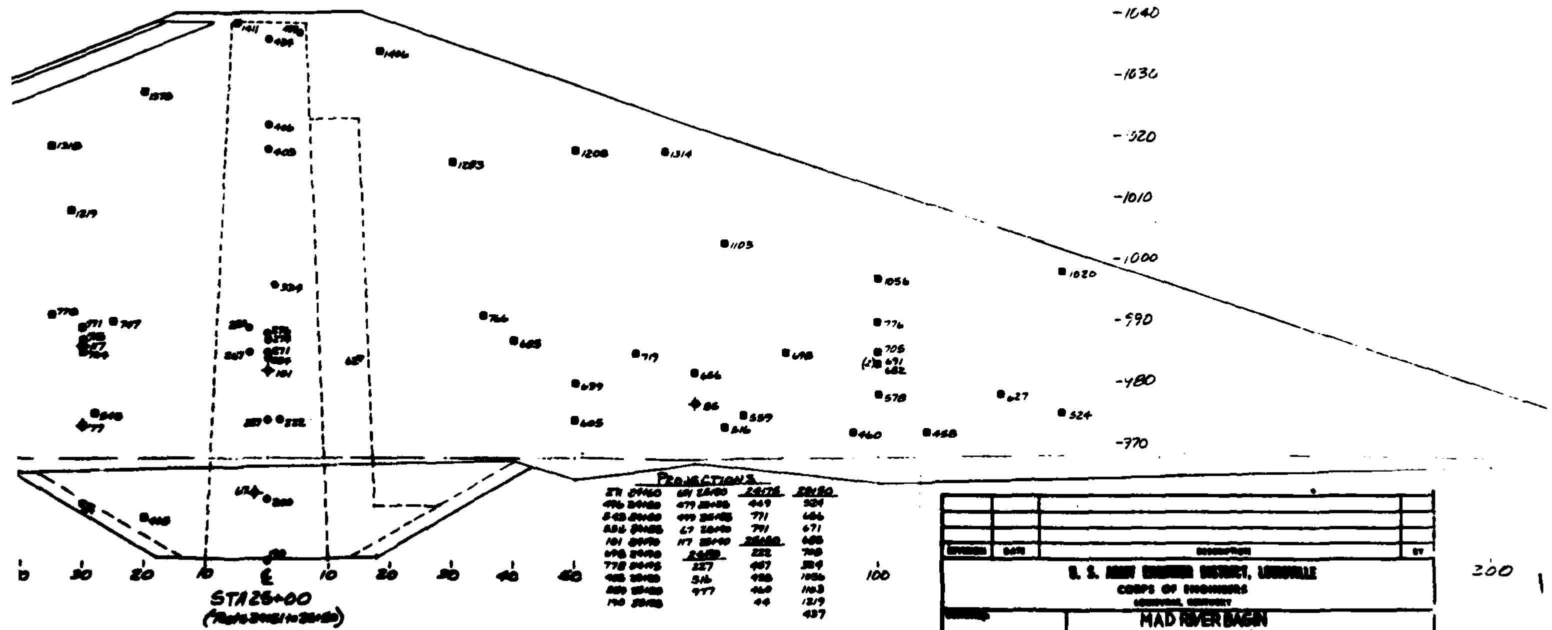


rip-rap
pervious bedding
IMPERVIOUS
RANDOM
PERVIOUS
PERVIOUS
200
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
℄
10
20
30
STA 26+00



original ground
stripped foundation
200
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
℄
10
20
30
STA 25+00





U. S. ARMY ENGINEER DISTRICT, LOUISVILLE
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FIELD CONTROL TEST LOCATIONS

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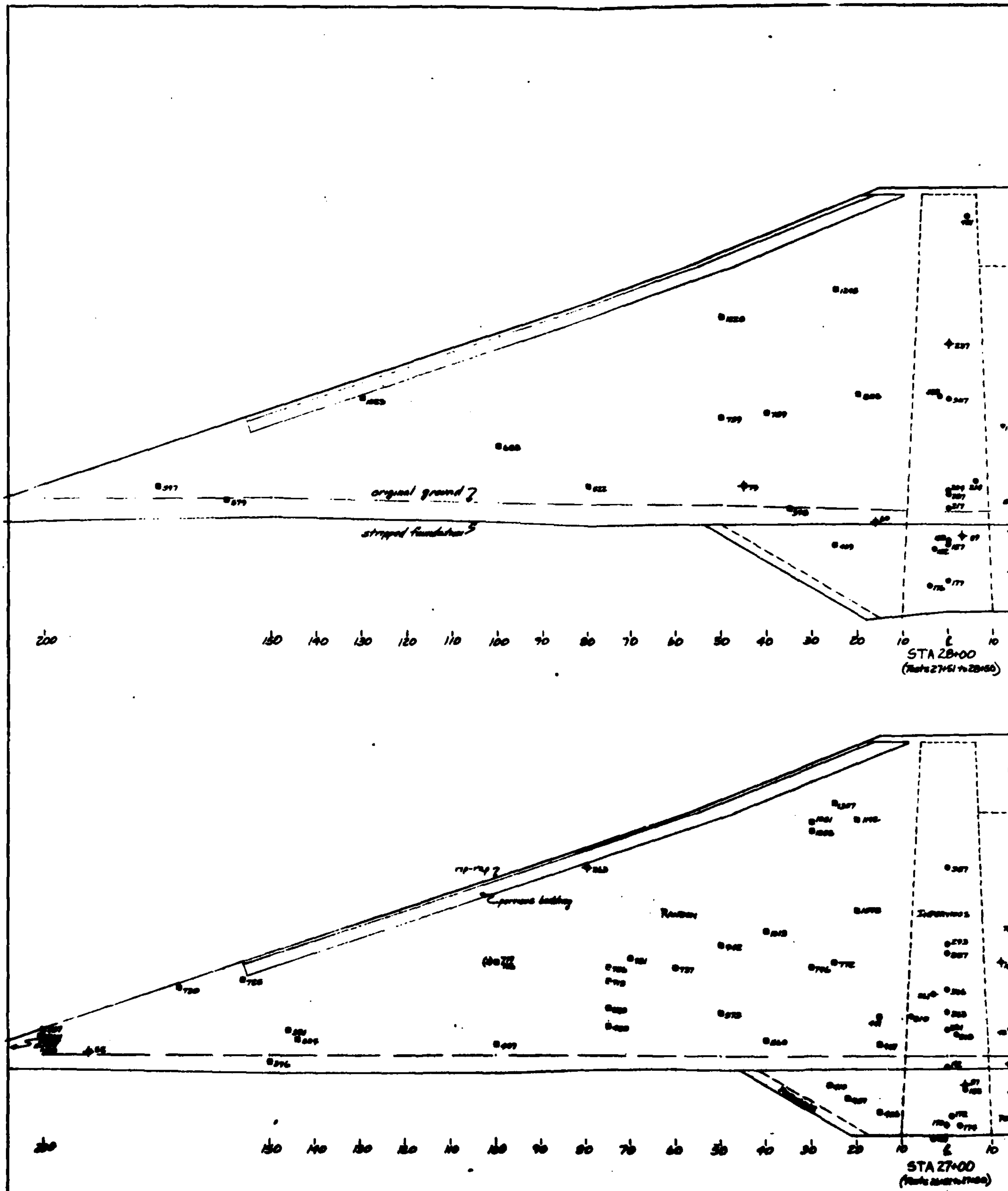
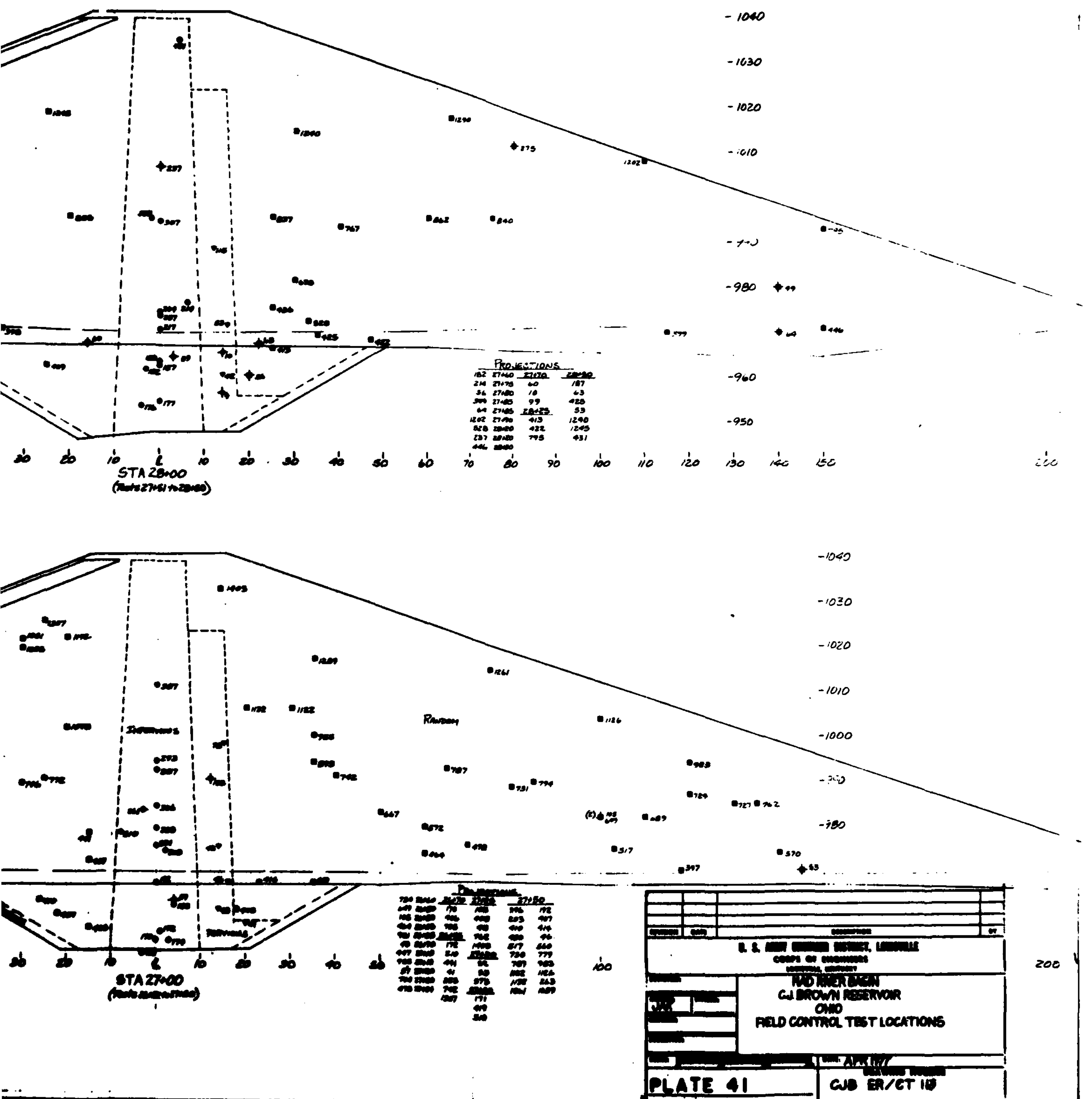
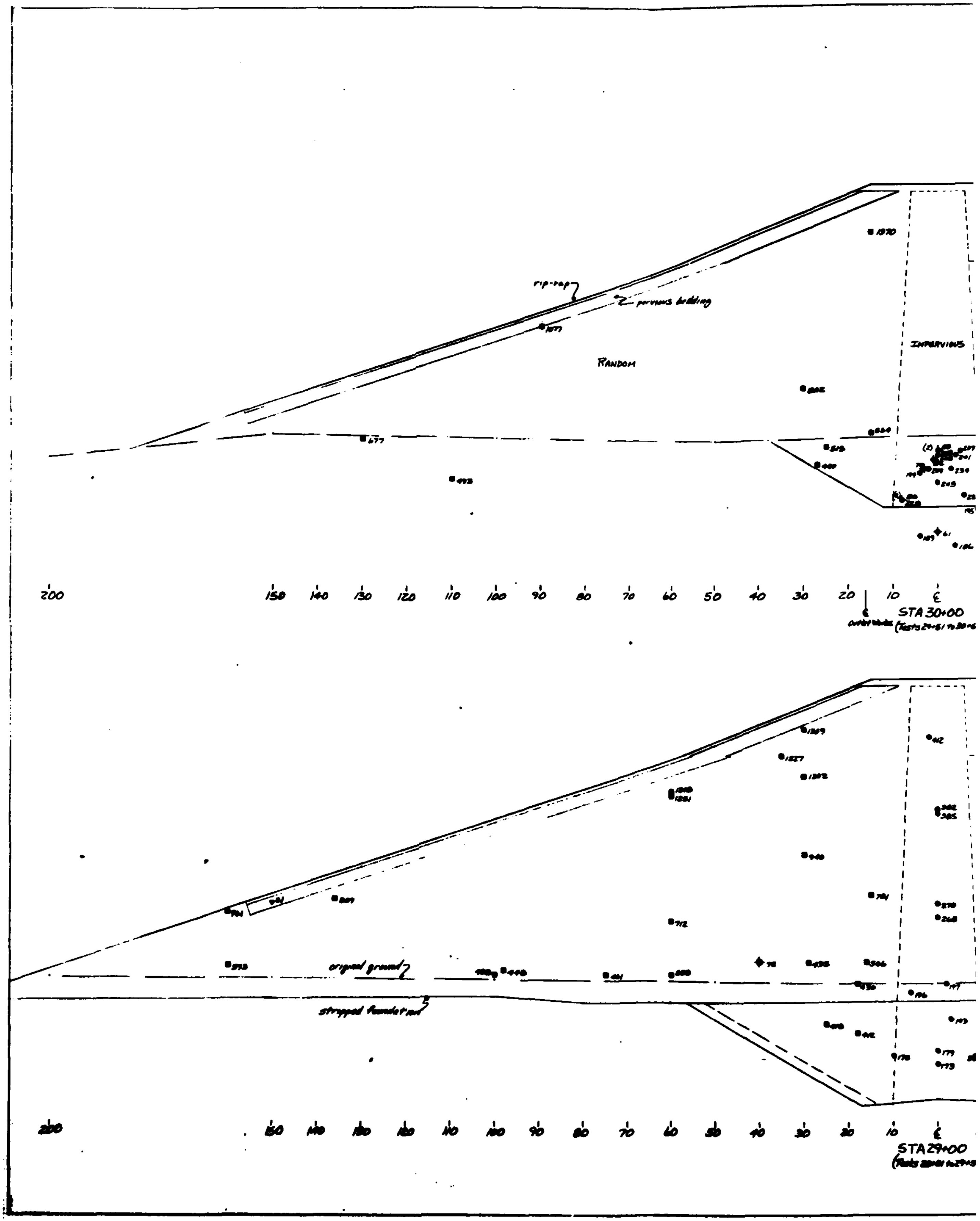
PLATE 40

CJB ER/CT112

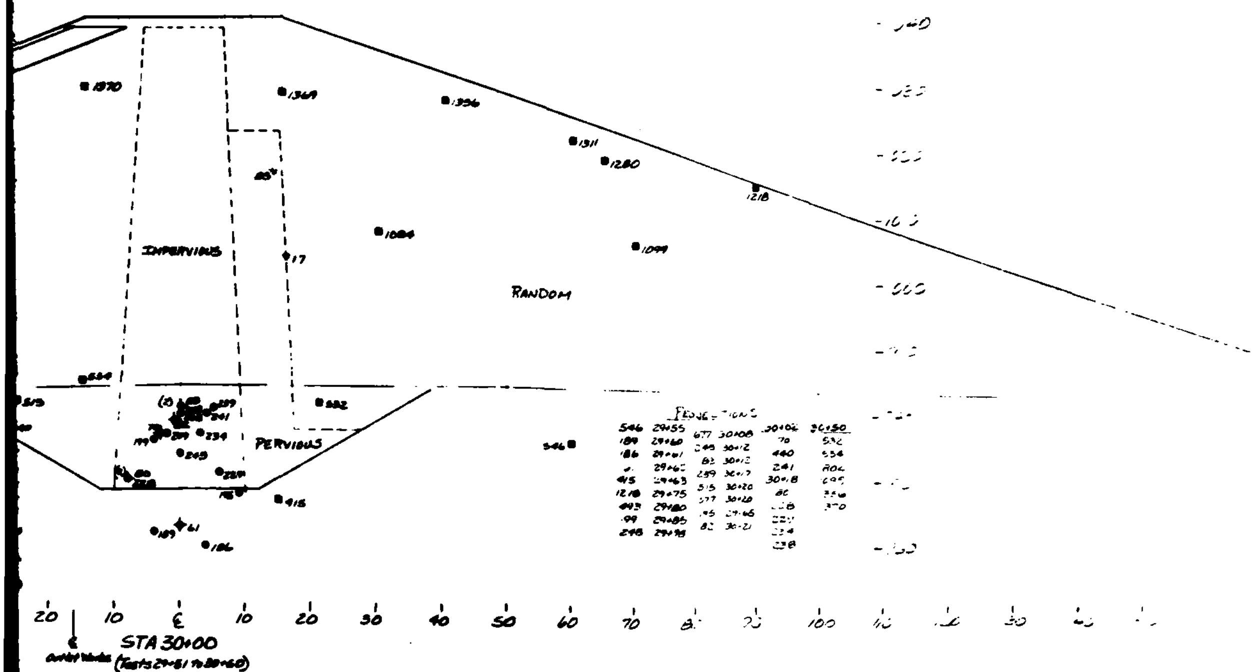

original ground
stripped foundation
200 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ℄ 10
STA 28+00
rip-rap
pervious bedding
200 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ℄ 10
STA 27+00

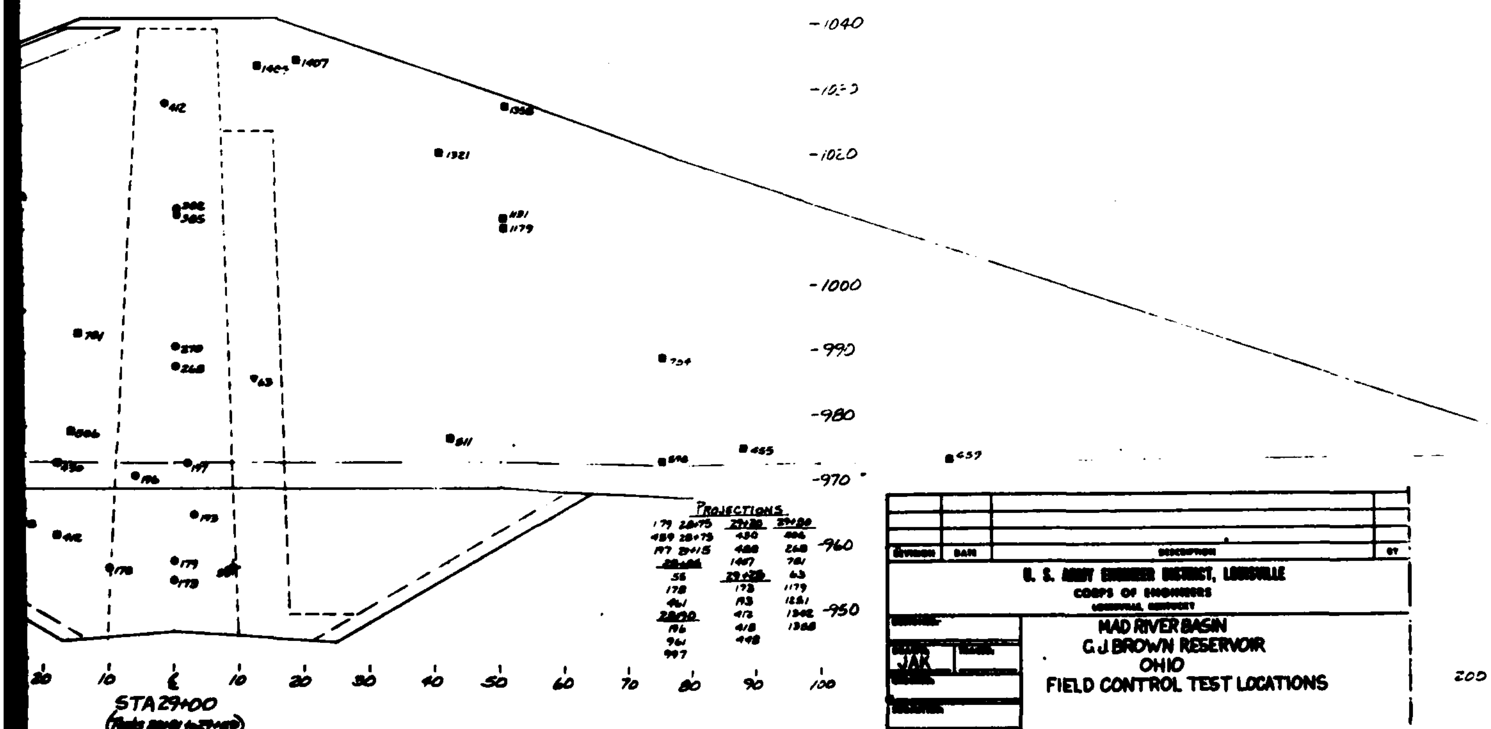


STA 28+00
STA 27+00
PROJECTIONS
RANDOM
MAD RIVER BASIN
C.J. BROWN RESERVOIR
OHIO
FIELD CONTROL TEST LOCATIONS
PLATE 41
CJB ER/CT 119



rip-rap
pervious bedding
RANDOM
IMPERVIOUS
200
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
℄
STA 30+00
original ground
stripped foundation
STA 29+00





U. S. ARMY ENGINEER DISTRICT, LOUISVILLE
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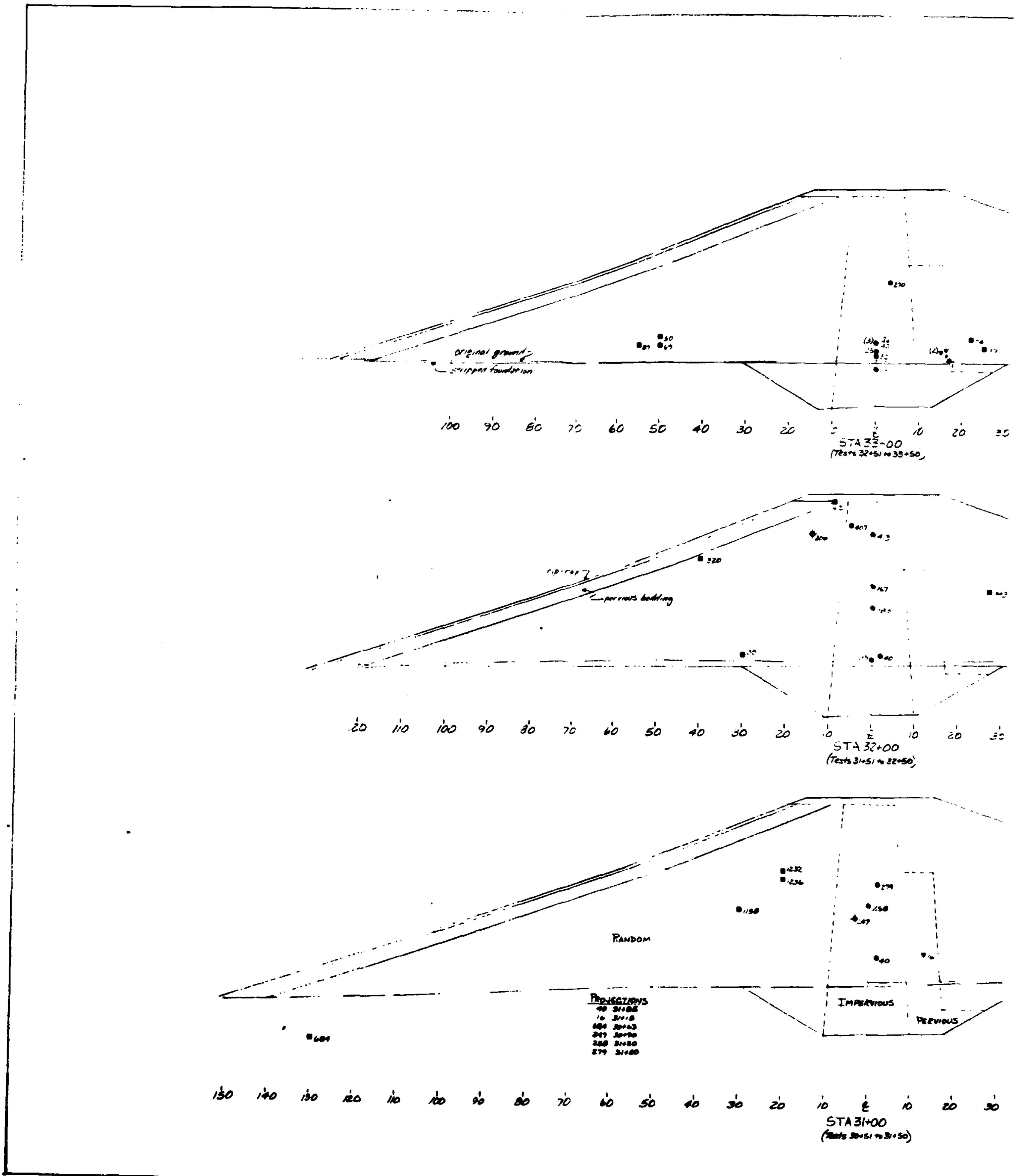
PLATE 42

CJB ER/CT 114


original ground
stripped foundation
STA 33+00
(Tests 32+51 to 33+50)
rip-rap
pervious bedding
STA 32+00
(Tests 31+51 to 32+50)
RANDOM
IMPERVIOUS
PERVIOUS
PROJECTIONS
STA 31+00
(Tests 30+51 to 31+50)

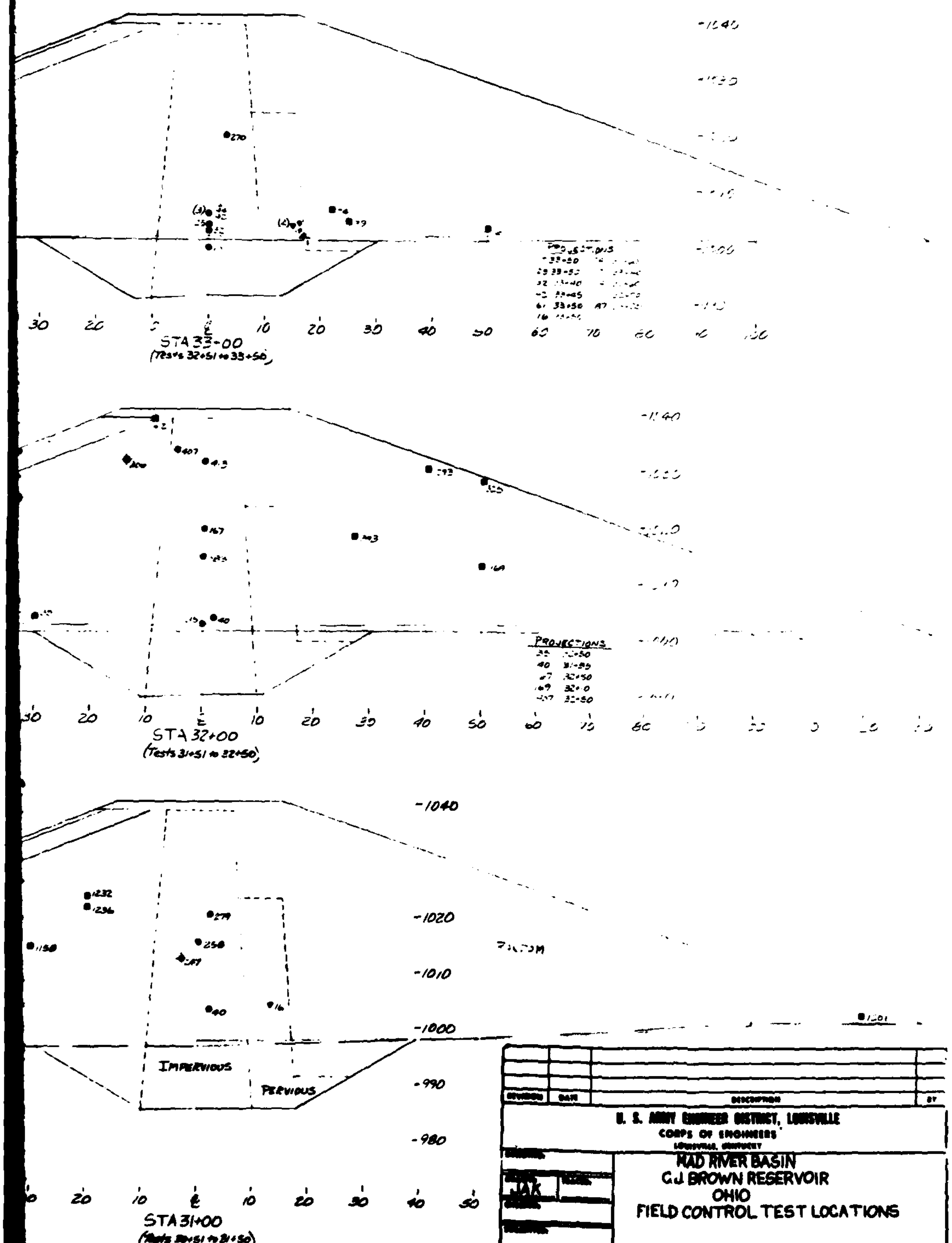


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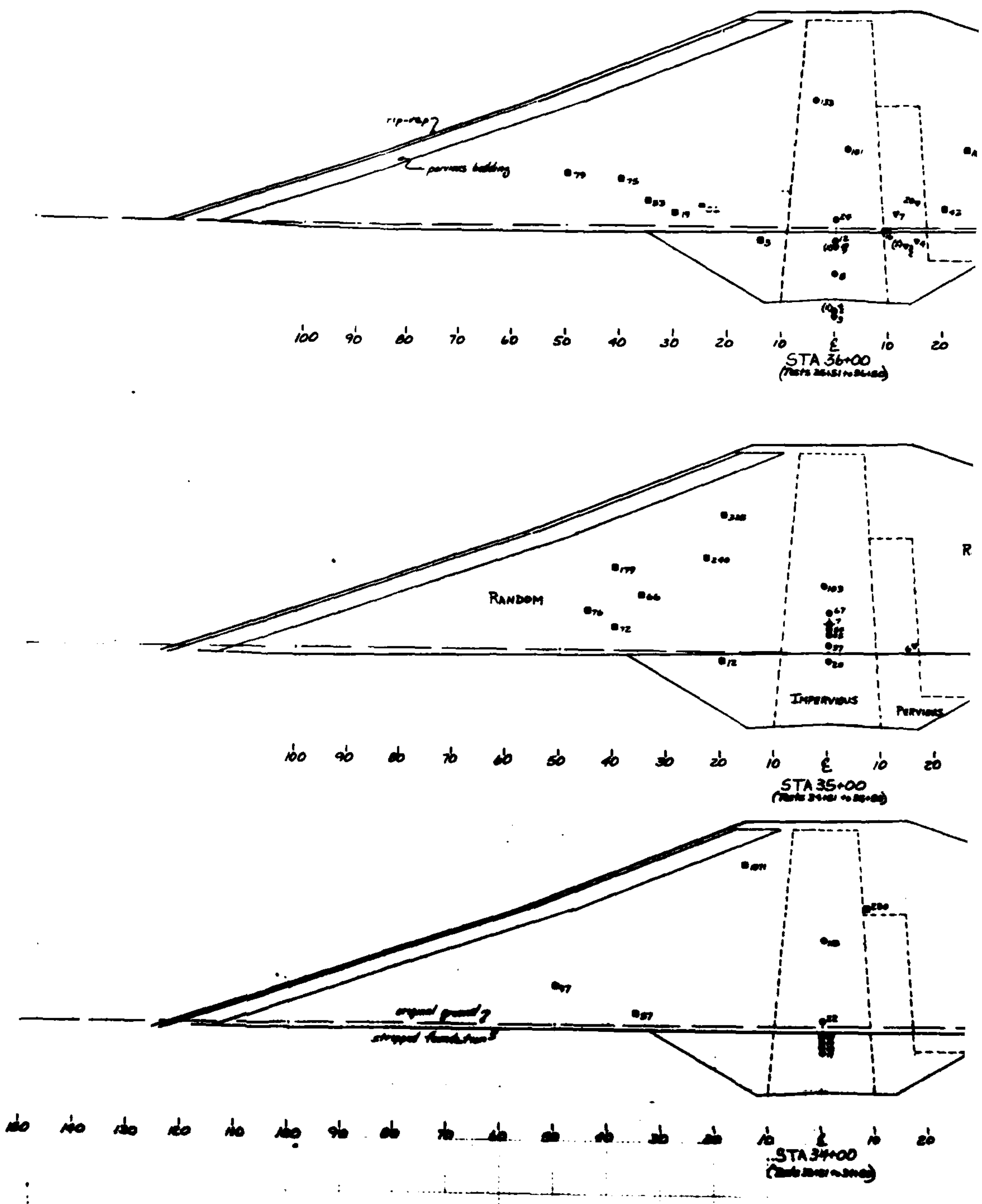
PLATE 43

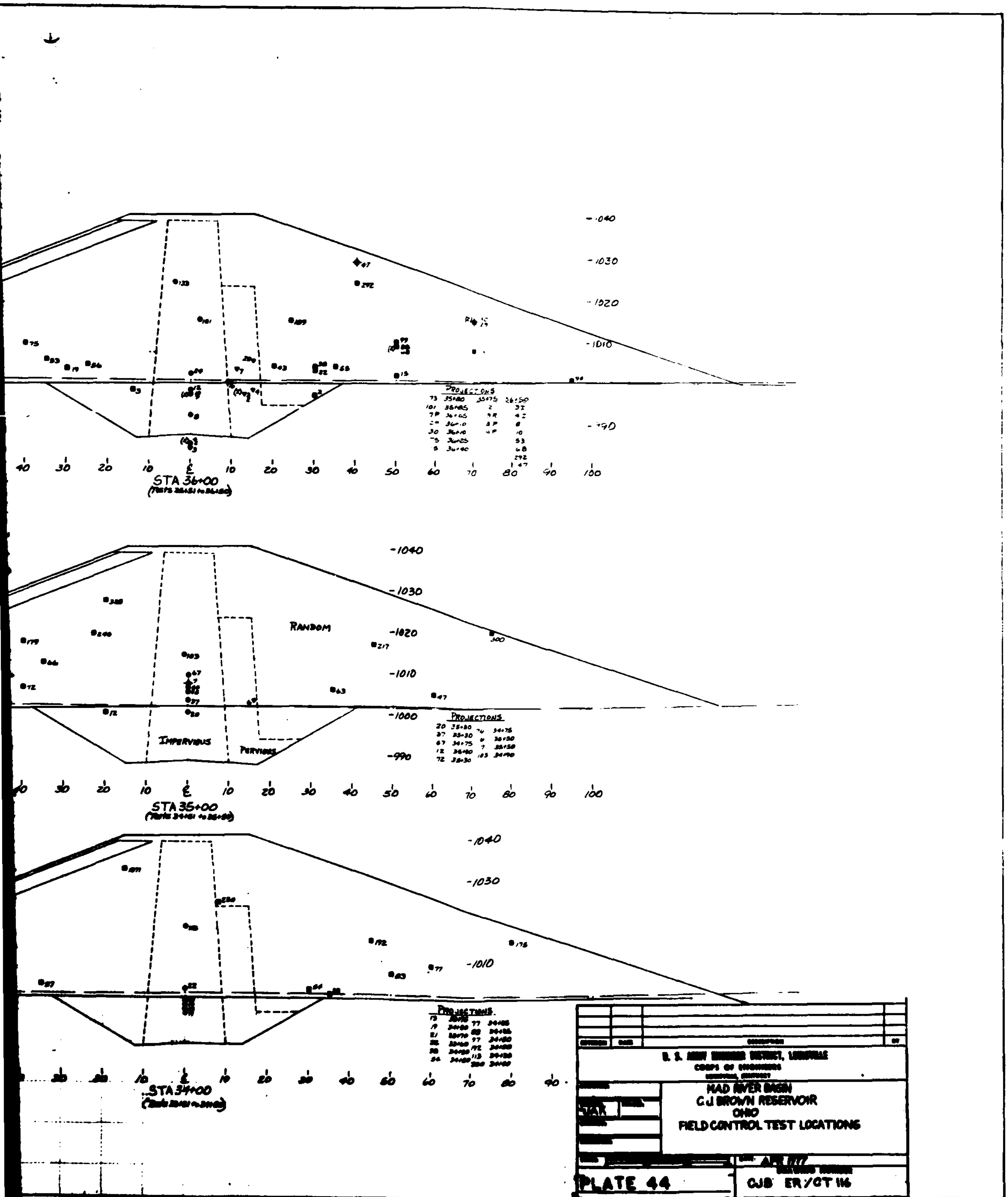
DRAWING NUMBER
CJB ER/CT 115

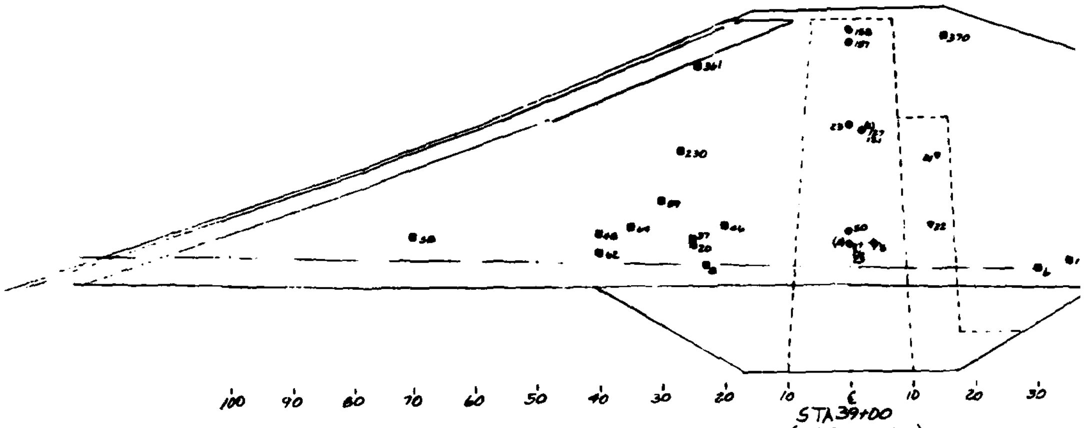
1

2

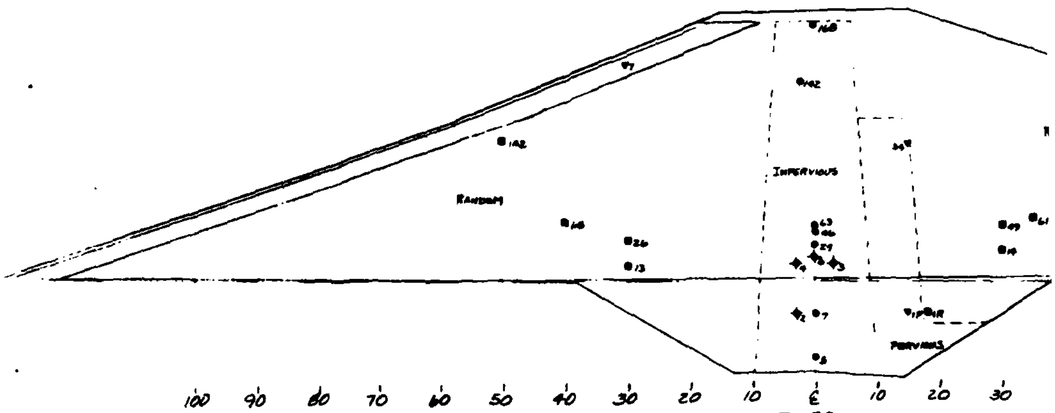

rip-rap
pervious bedding
100 90 80 70 60 50 40 30 20 10 ℄ 10 20
STA 36+00
RANDOM
IMPERVIOUS
PERVIOUS
100 90 80 70 60 50 40 30 20 10 ℄ 10 20
STA 35+00
original ground
stripped foundation
150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ℄ 10 20
STA 34+00

1

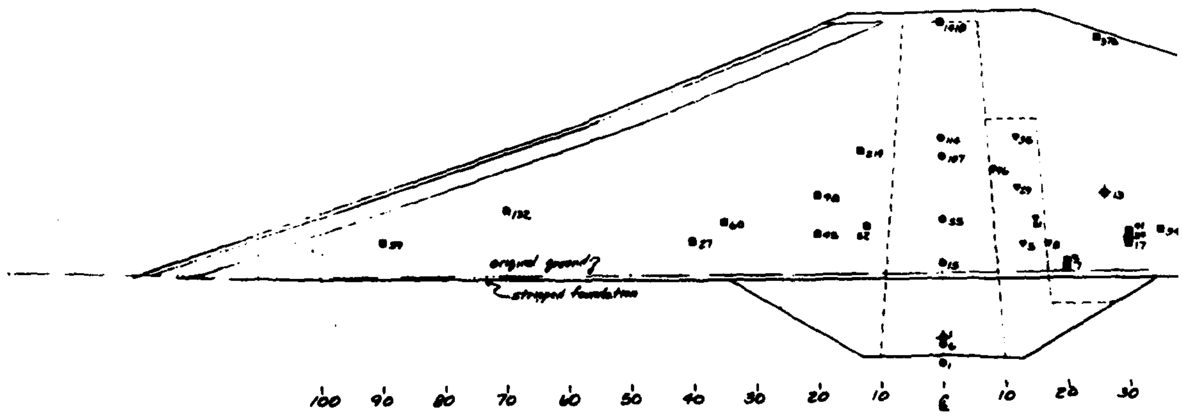

STA 36+00
STA 35+00
STA 34+00
RANDOM
PERVIOUS
PROJECTIONS
MAD RIVER BASIN
C.J BROWN RESERVOIR
OHIO
FIELD CONTROL TEST LOCATIONS
PLATE 44
CJB ER/CT 116



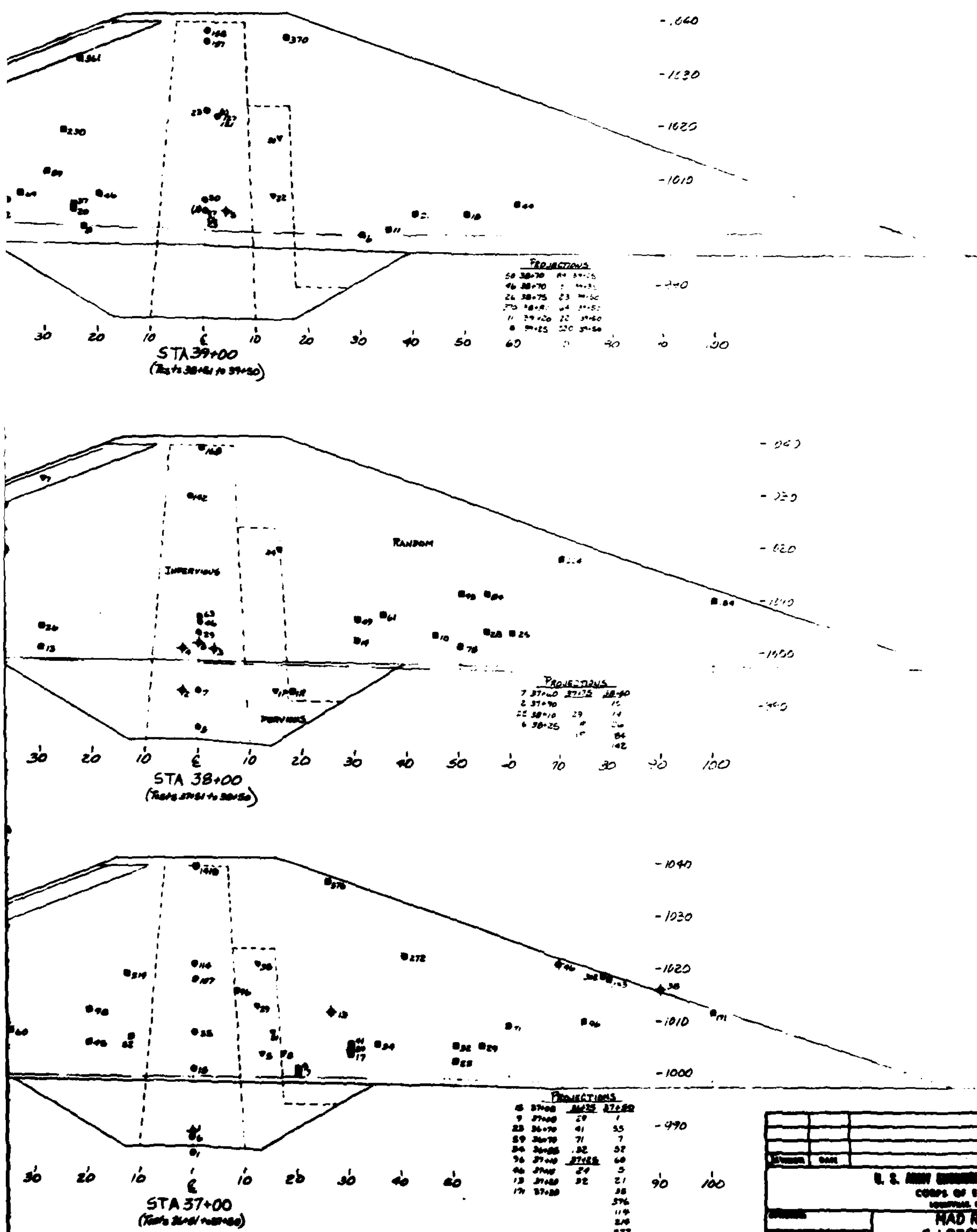
STA 39+00
(Tests 38+61 to 39+50)



STA 38+00
(Tests 37+51 to 38+50)



STA 37+00
(Tests [illegible])



U. S. ARMY ENGINEER DISTRICT, LOUISVILLE
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OHIO
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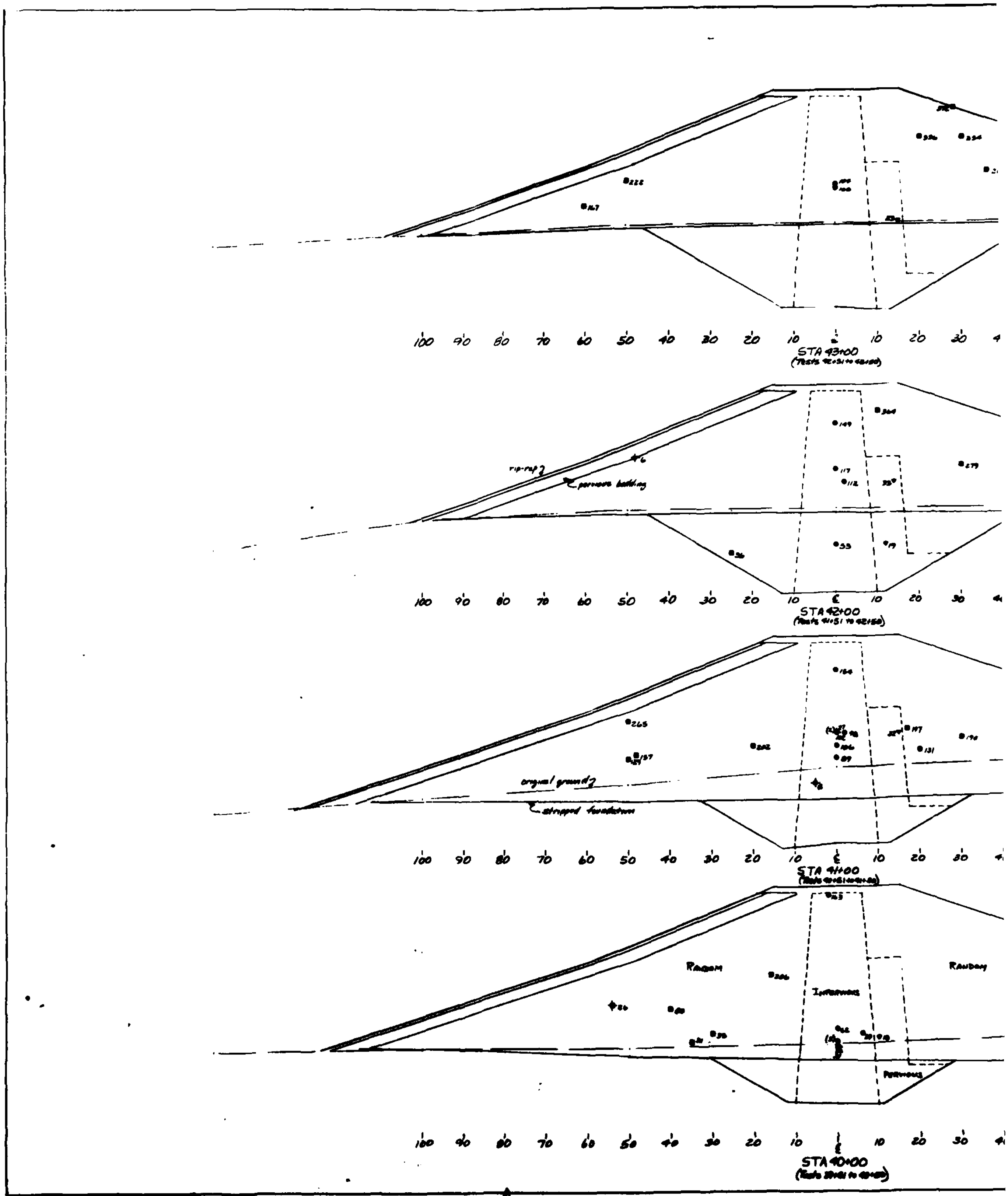
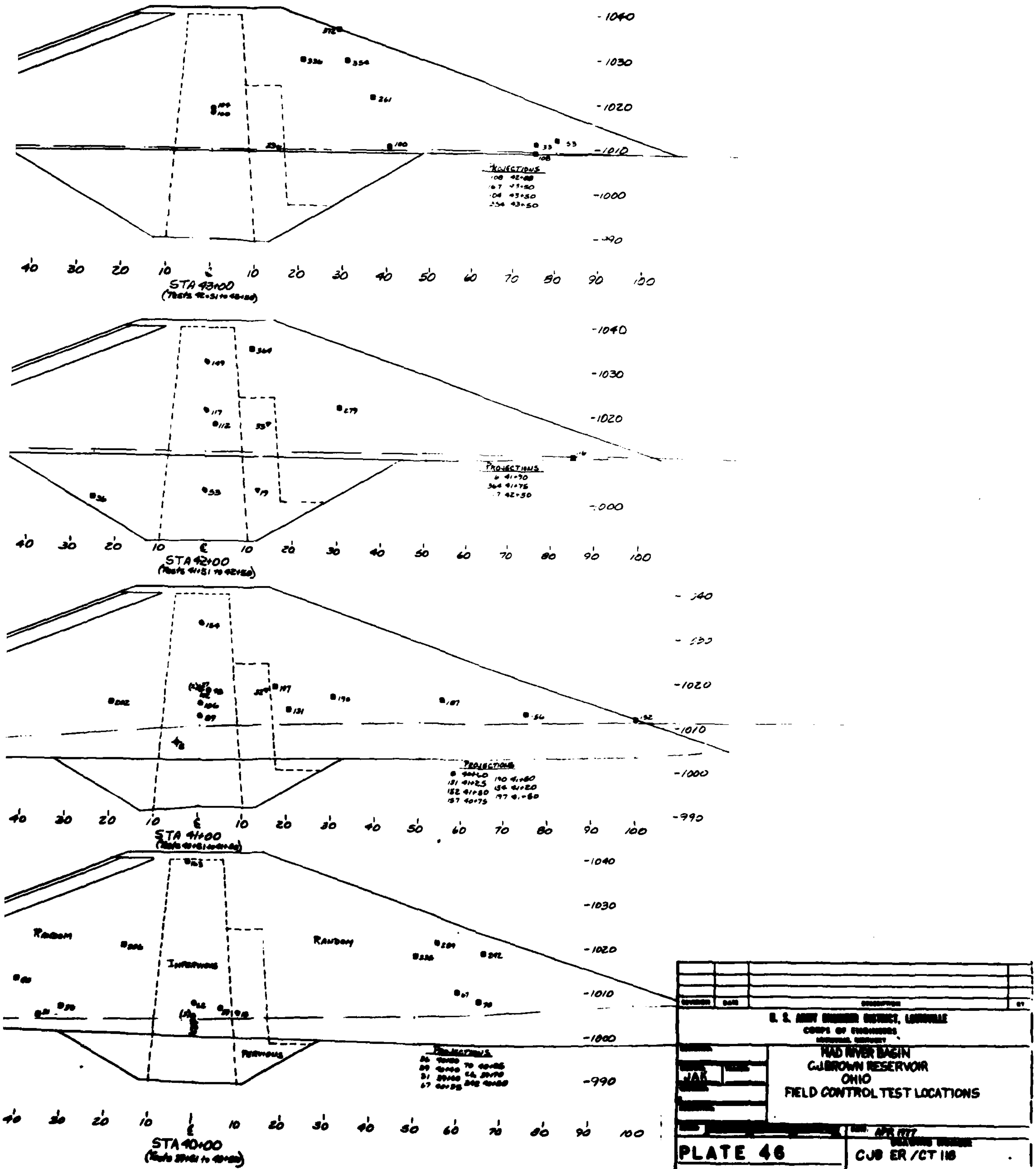
PLATE 45

CJB ER/CT 117

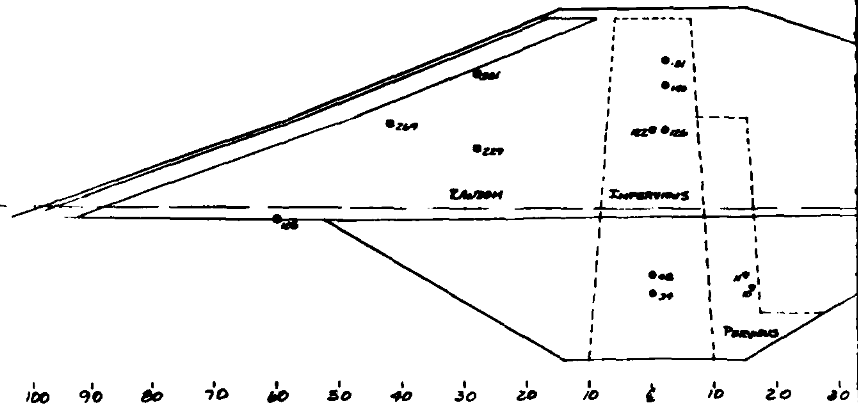


STA 43+00
STA 42+00
rip-rap
pervious bedding
STA 41+00
original ground
stripped foundation
Random
Impervious
Random
Pervious
STA 40+00
100 90 80 70 60 50 40 30 20 10 ℄ 10 20 30

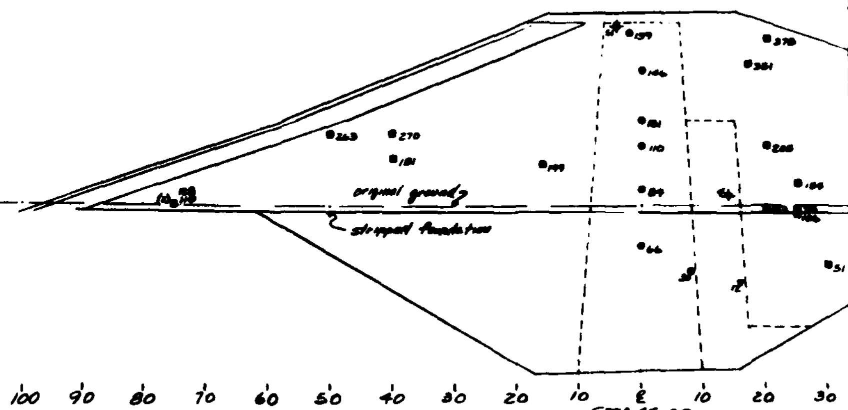

STA 43+00
STA 42+00
STA 41+00
STA 40+00
PROJECTIONS
RANDOM
IMPERVIOUS
PERVIOUS
U. S. ARMY ENGINEER DISTRICT, LOUISVILLE
CORPS OF ENGINEERS
MAD RIVER BASIN
C.J.BROWN RESERVOIR
OHIO
FIELD CONTROL TEST LOCATIONS
JAK
APR 1977
PLATE 46
CJB ER/CT 118

1

2



STA 46+00
(Tests [illegible])



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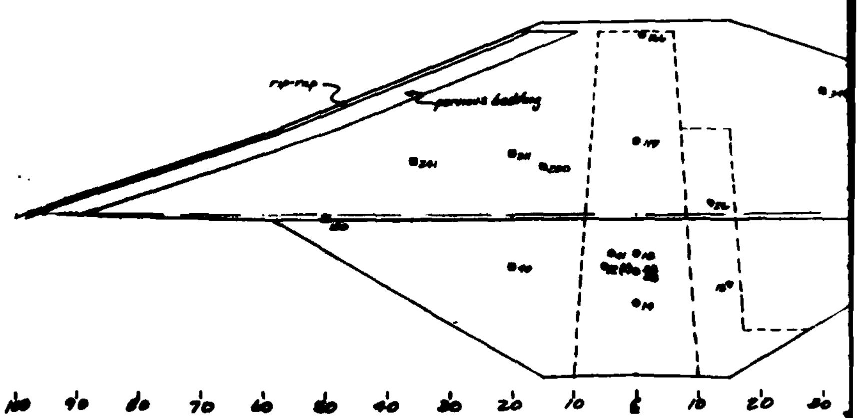
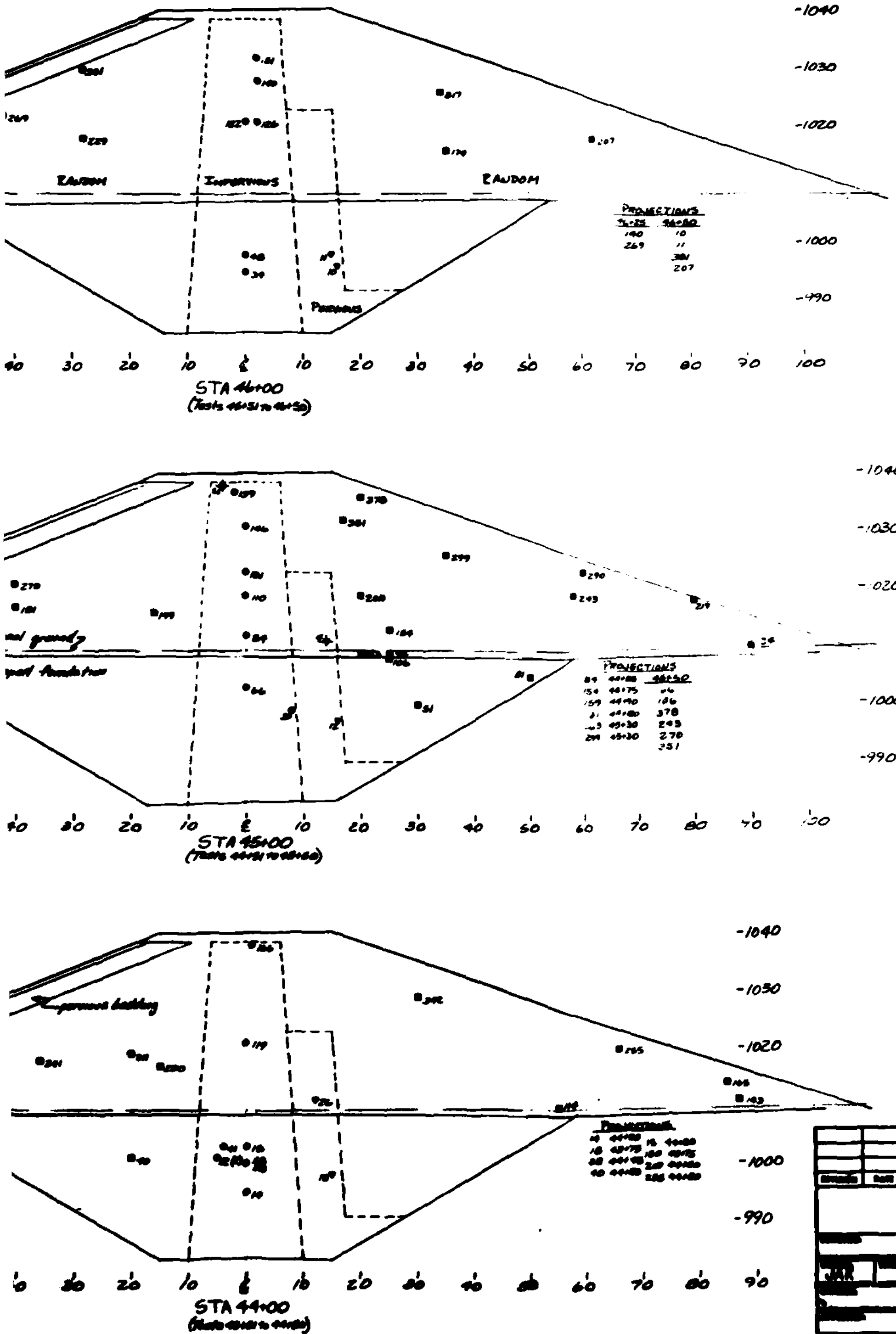
(Tests [illegible])



STA 44+00
([illegible])



U. S. ARMY ENGINEER DISTRICT, LOUISVILLE
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C.J. BROWN RESERVOIR
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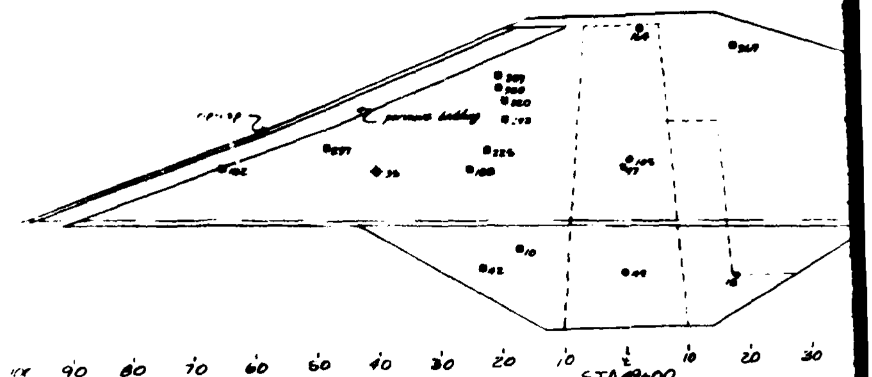
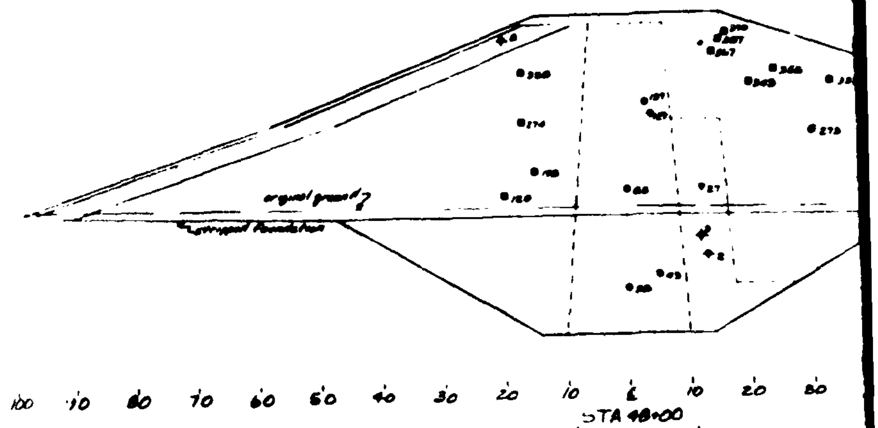
APR 1977

PLATE 47

CJB ER/CT H9



STA 49+00
(Tests [illegible])



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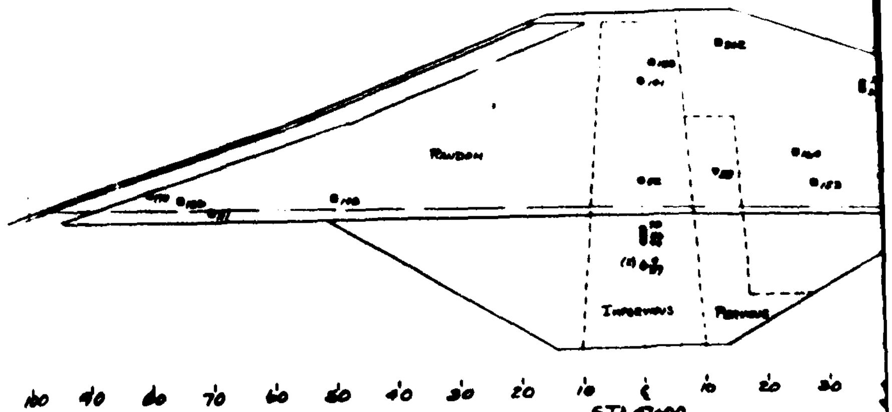
(Tests [illegible])



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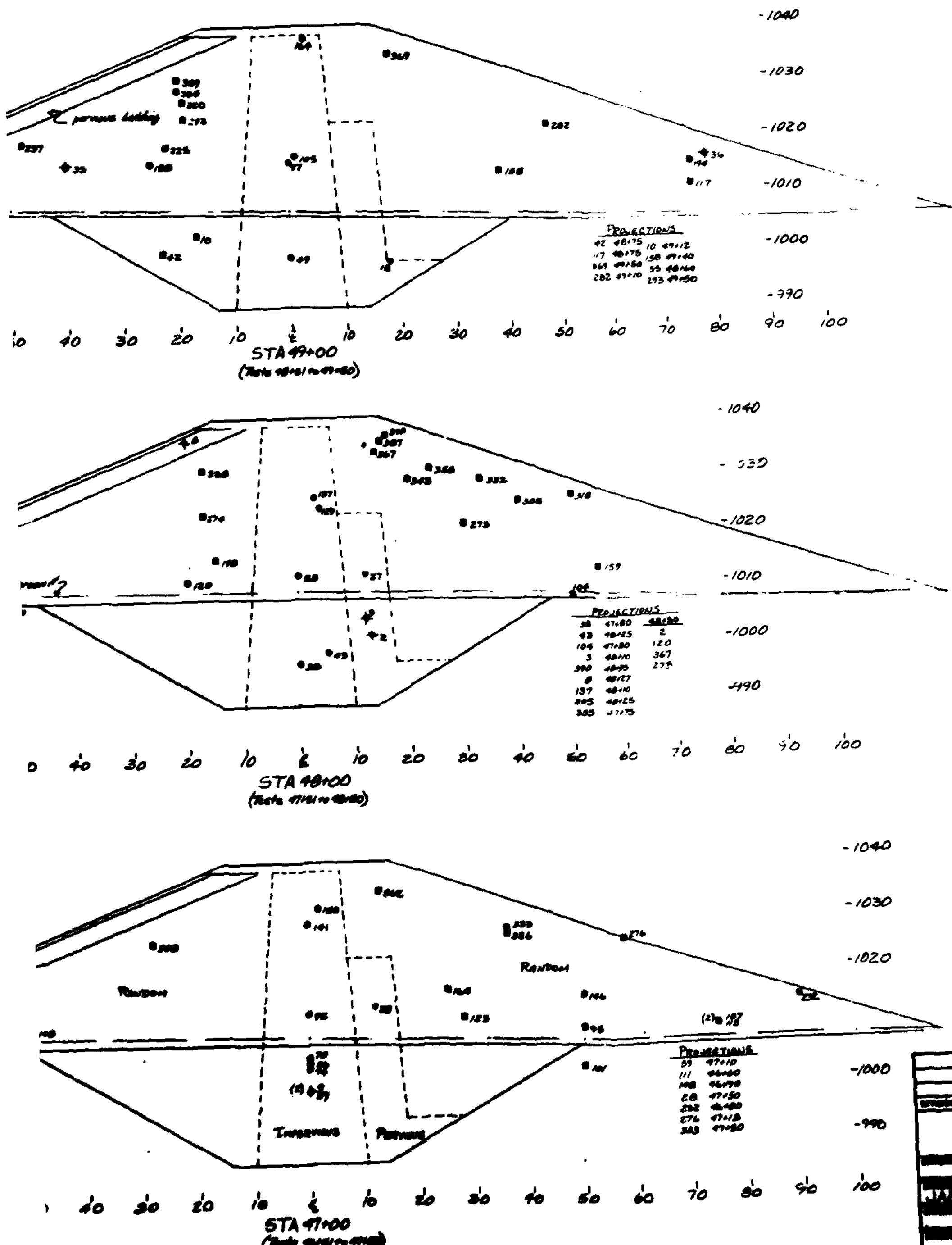
(Tests [illegible])



U. S. ARMY ENGINEER DISTRICT, LOUISVILLE
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MAD RIVER BASIN
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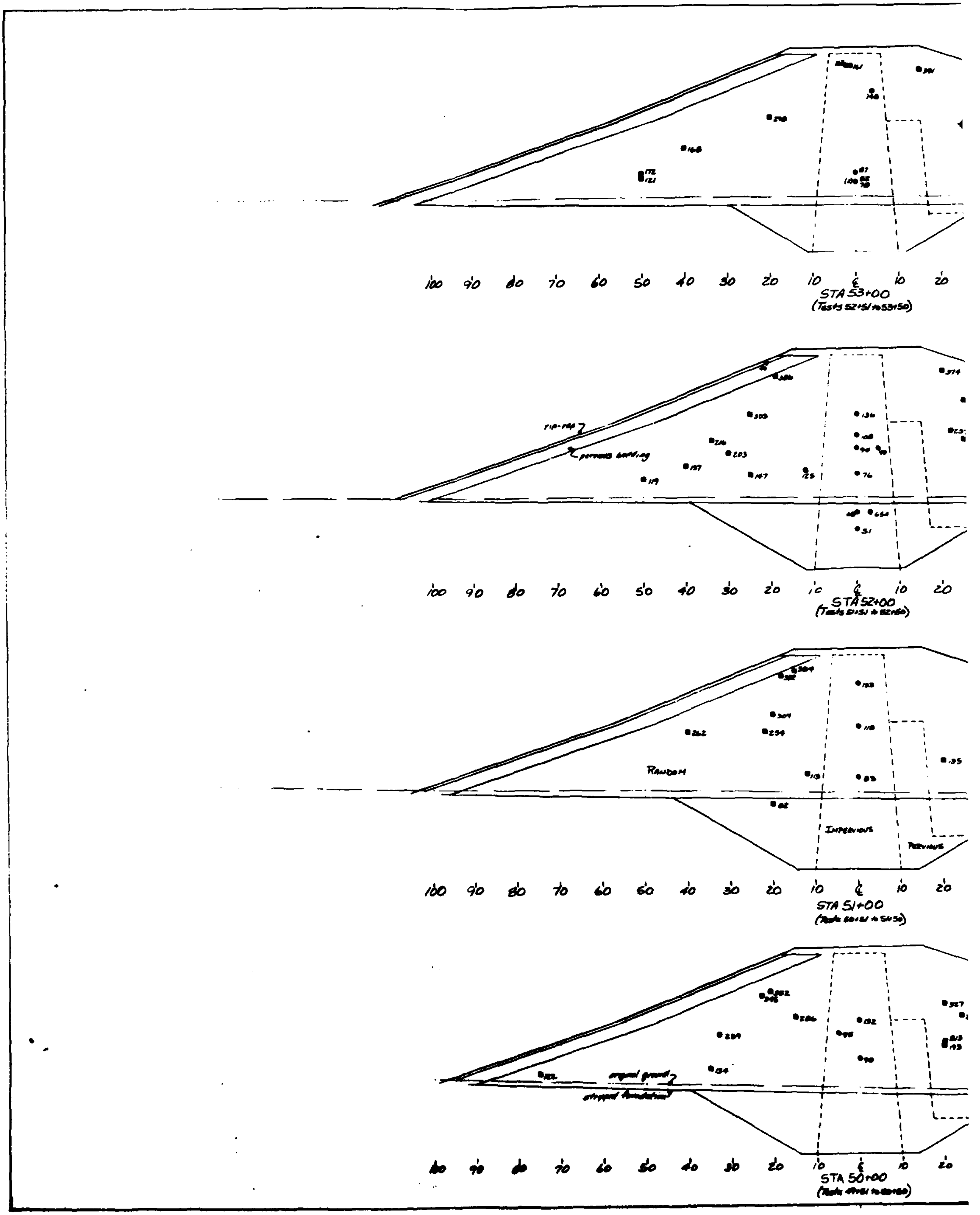
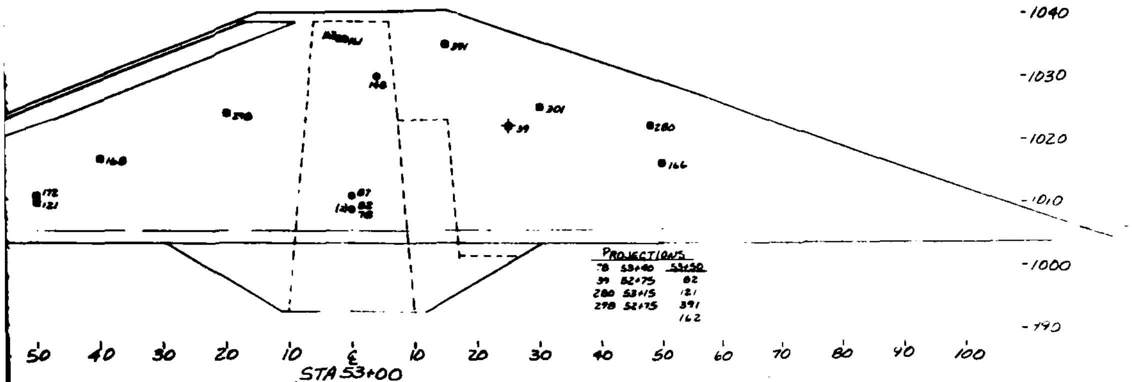
PLATE 48

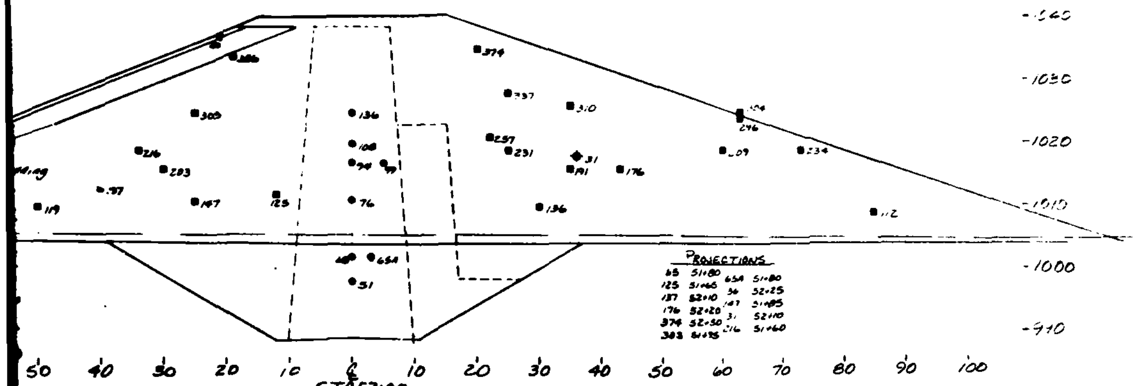
CJB ER/CT 120


STA 53+00
(Tests 52+51 to 53+50)
rip-rap
pervious bedding
STA 52+00
(Tests 51+51 to 52+50)
RANDOM
IMPERVIOUS
PERVIOUS
STA 51+00
(Tests 50+51 to 51+50)
original ground
stripped foundation
STA 50+00
(Tests 49+51 to 50+50)
100 90 80 70 60 50 40 30 20 10 ℄ 10 20

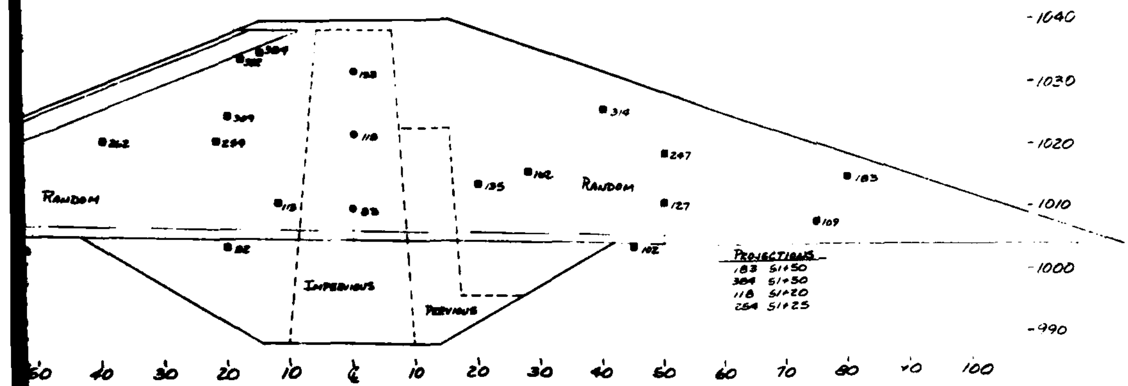
1



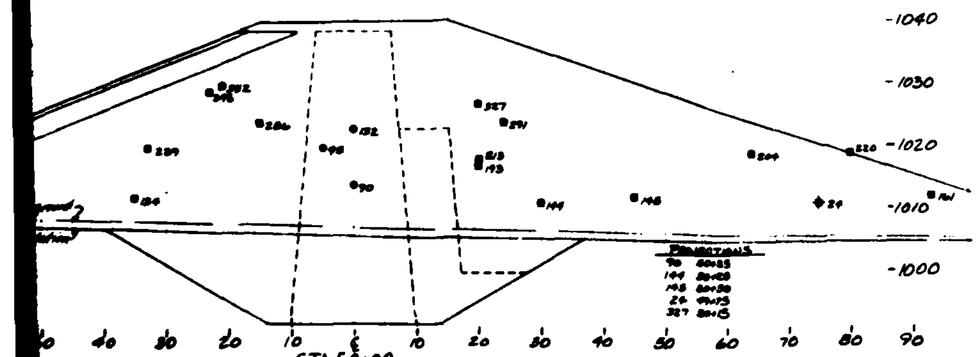
STA 53+00
(Tests 52+51 to 53+50)



STA 52+00
(Tests 51+51 to 52+50)



STA 51+00
(Tests 50+51 to 51+50)



STA 50+00
(Tests 49+51 to 50+50)

U. S. ARMY ENGINEER DISTRICT, LOUISVILLE
CORPS OF ENGINEERS
LOUISVILLE, KENTUCKY

MAD RIVER BASIN
C J BROWN RESERVOIR
OHIO
FIELD CONTROL TEST LOCATIONS

JAK

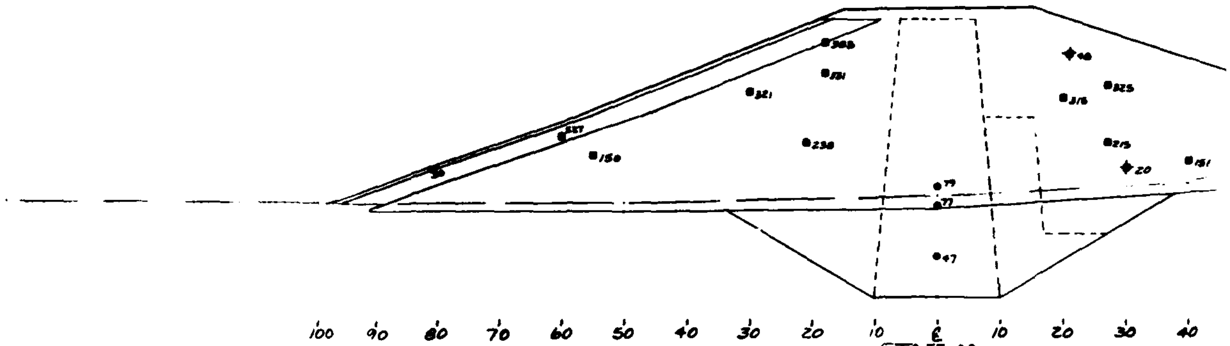
DATE MAY 1977

PLATE 49

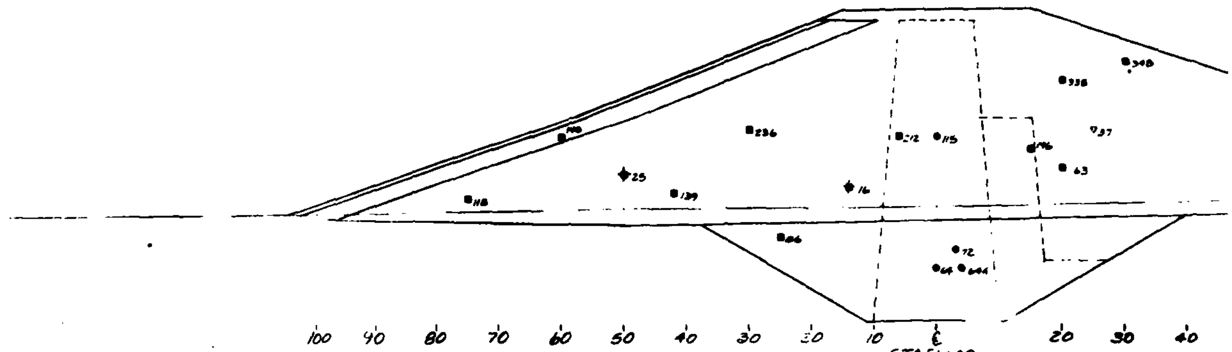
DRAWING NUMBER
CJB ER/CT 121

2

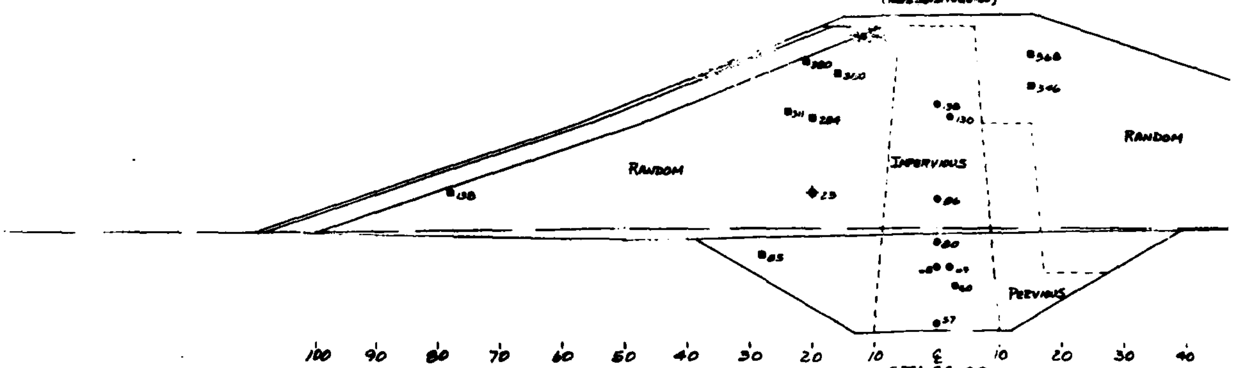
1



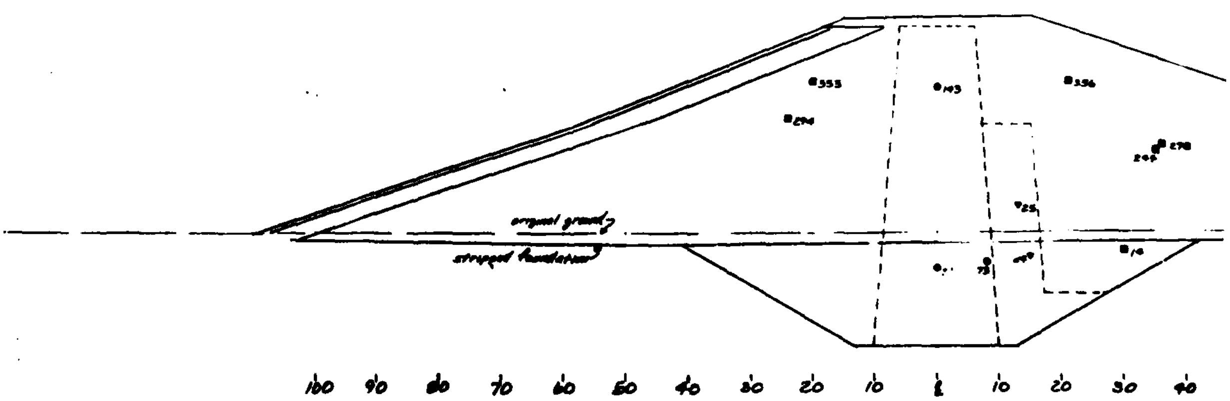
STA 57+00
(Tests 56+51 to 57+50)



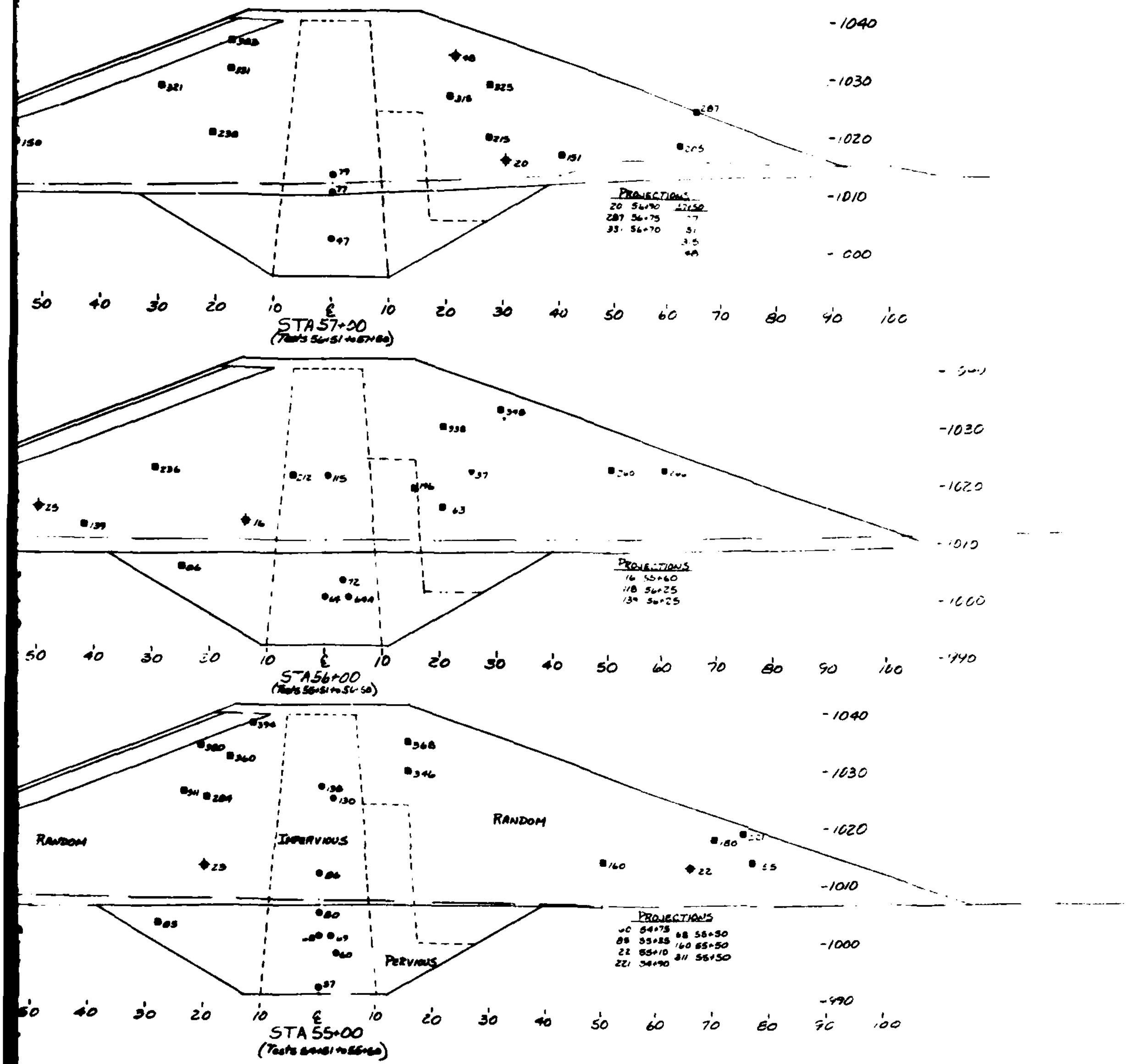
STA 56+00
(Tests 55+51 to 56+50)

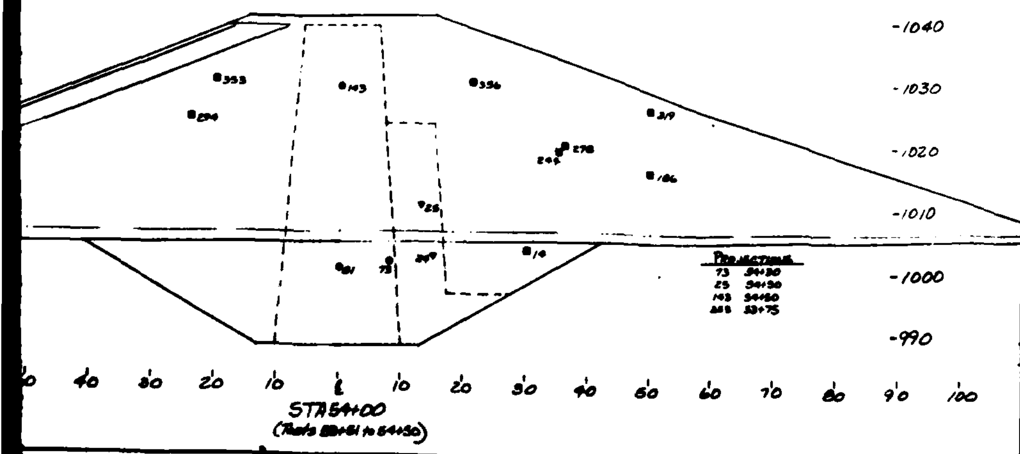


STA 55+00
(Tests 54+51 to 55+50)



STA 54+00
(Tests 53+51 to 54+50)





U. S. ARMY ENGINEER DISTRICT, LOUISVILLE
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MAD RIVER BASIN
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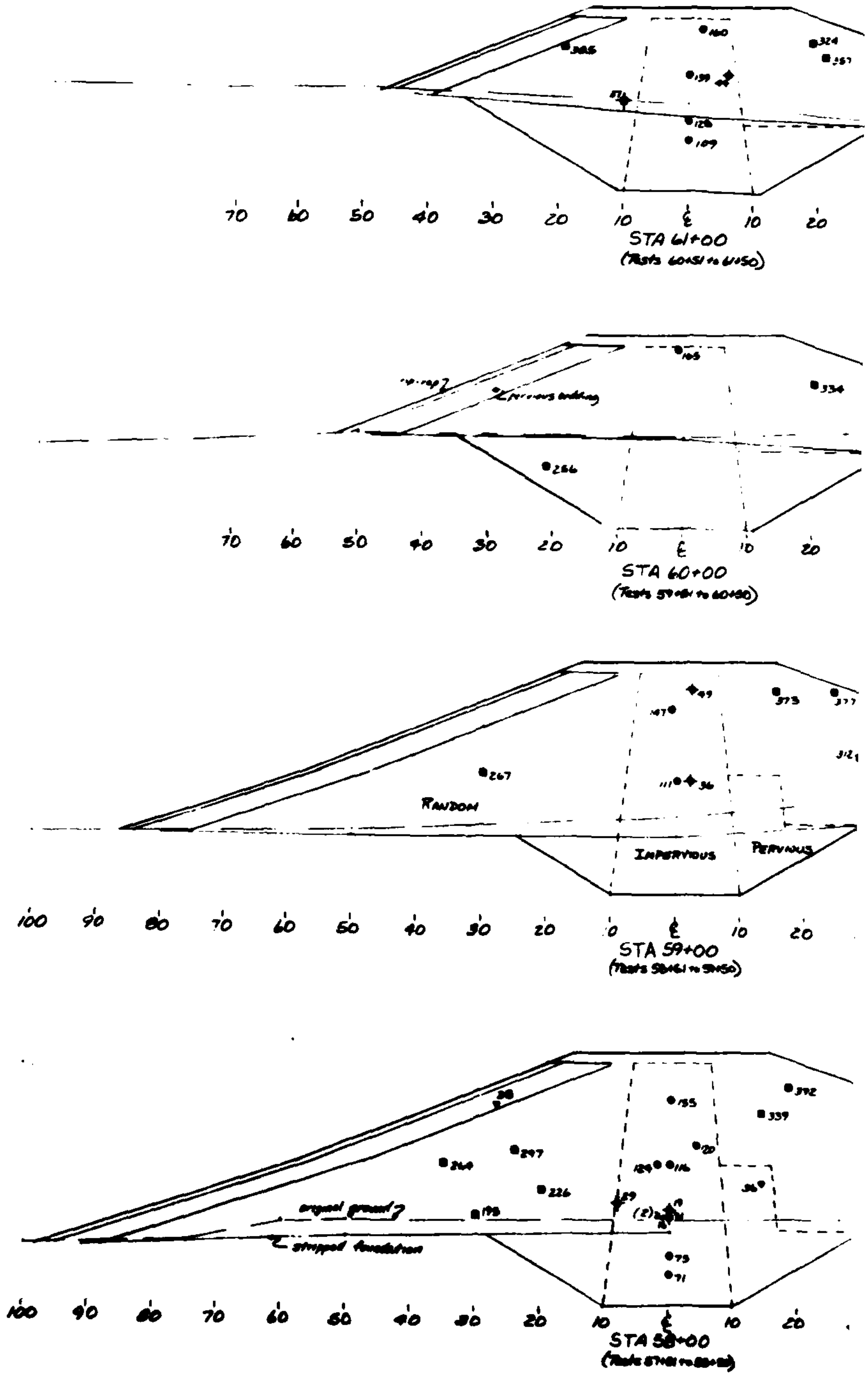
FIELD CONTROL TEST LOCATIONS

JAR

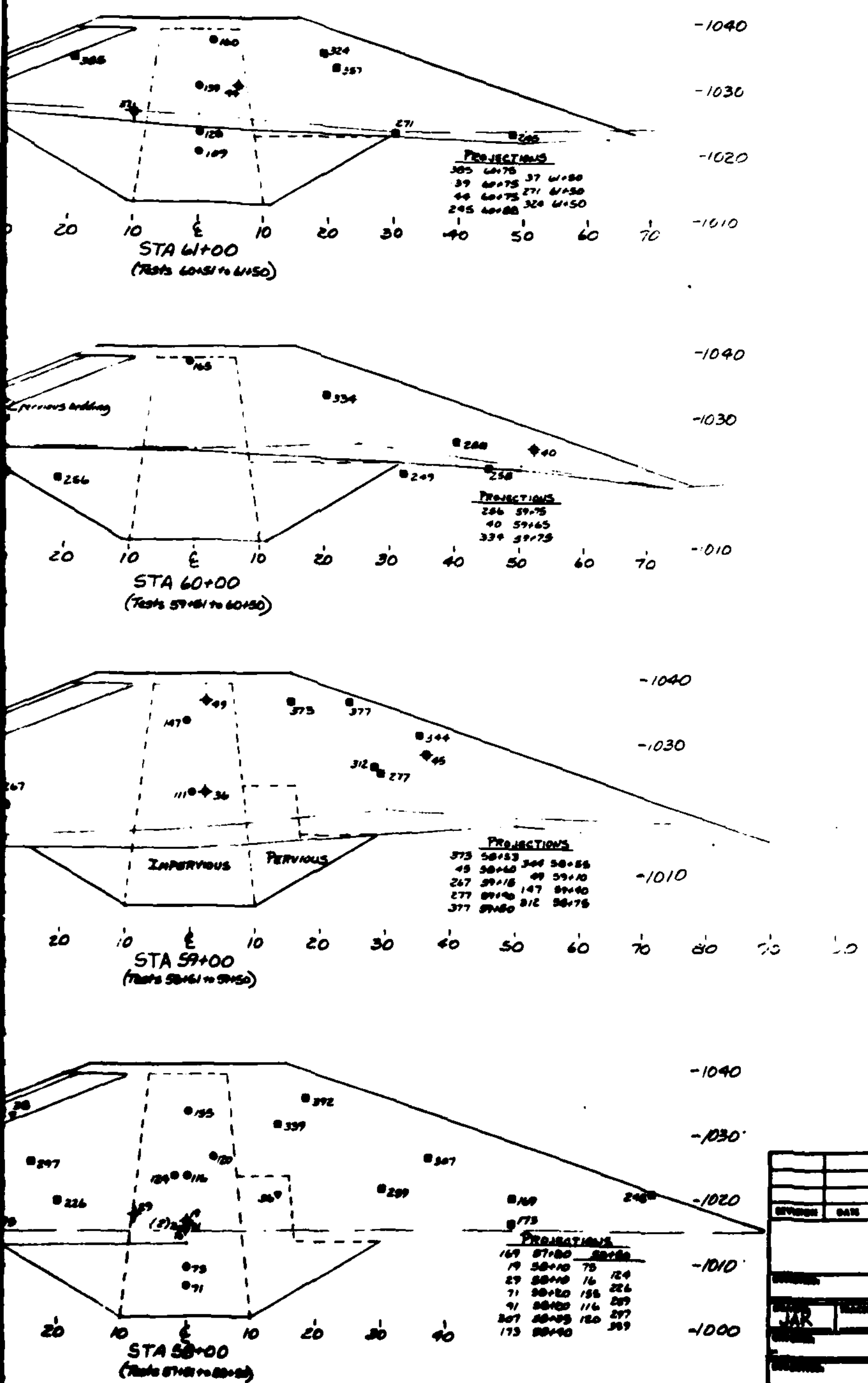
MAY 1977

PLATE 50

CJB ER/CT 122



STA 61+00
STA 60+00
RANDOM
IMPERVIOUS
PERVIOUS
STA 59+00
original ground
stripped foundation
STA 58+00



U. S. ARMY ENGINEER DISTRICT, LOUISVILLE
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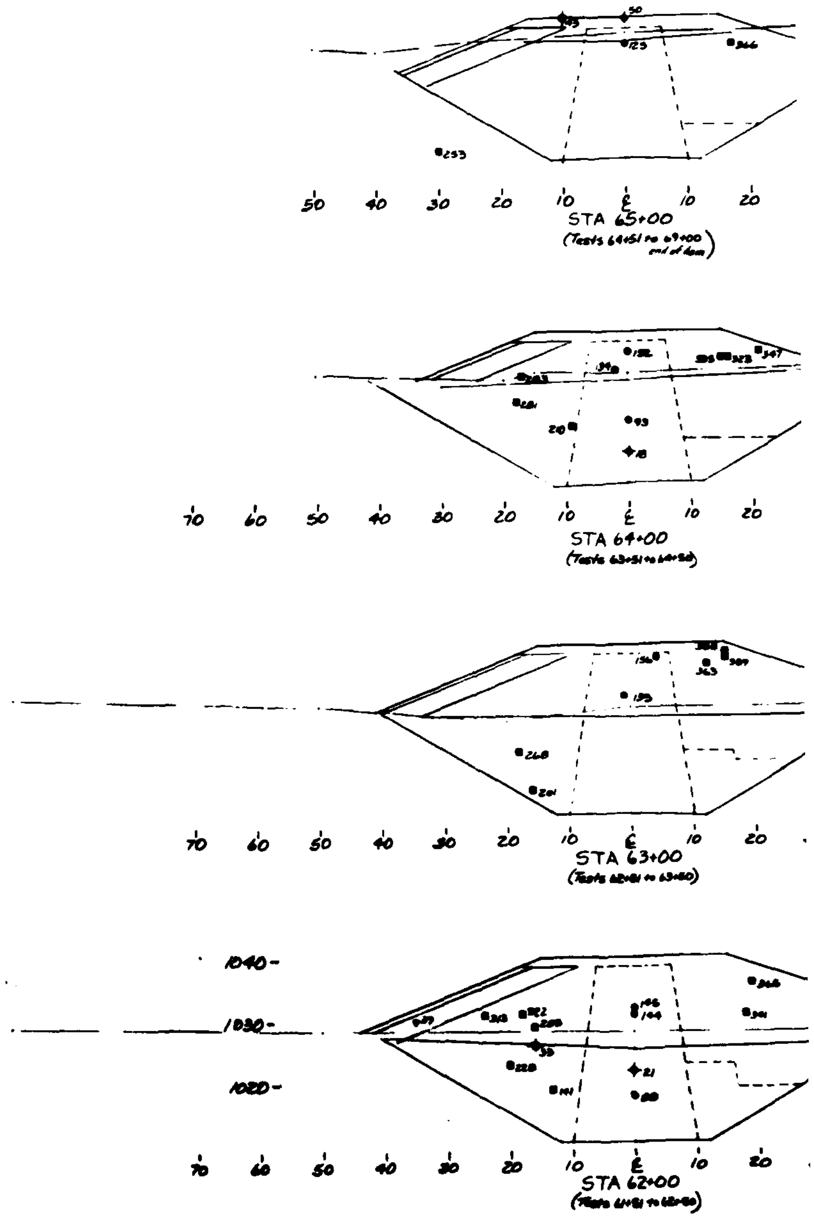
MAD RIVER BASIN
C.J. BROWN RESERVOIR
OHIO
FIELD CONTROL TEST LOCATIONS

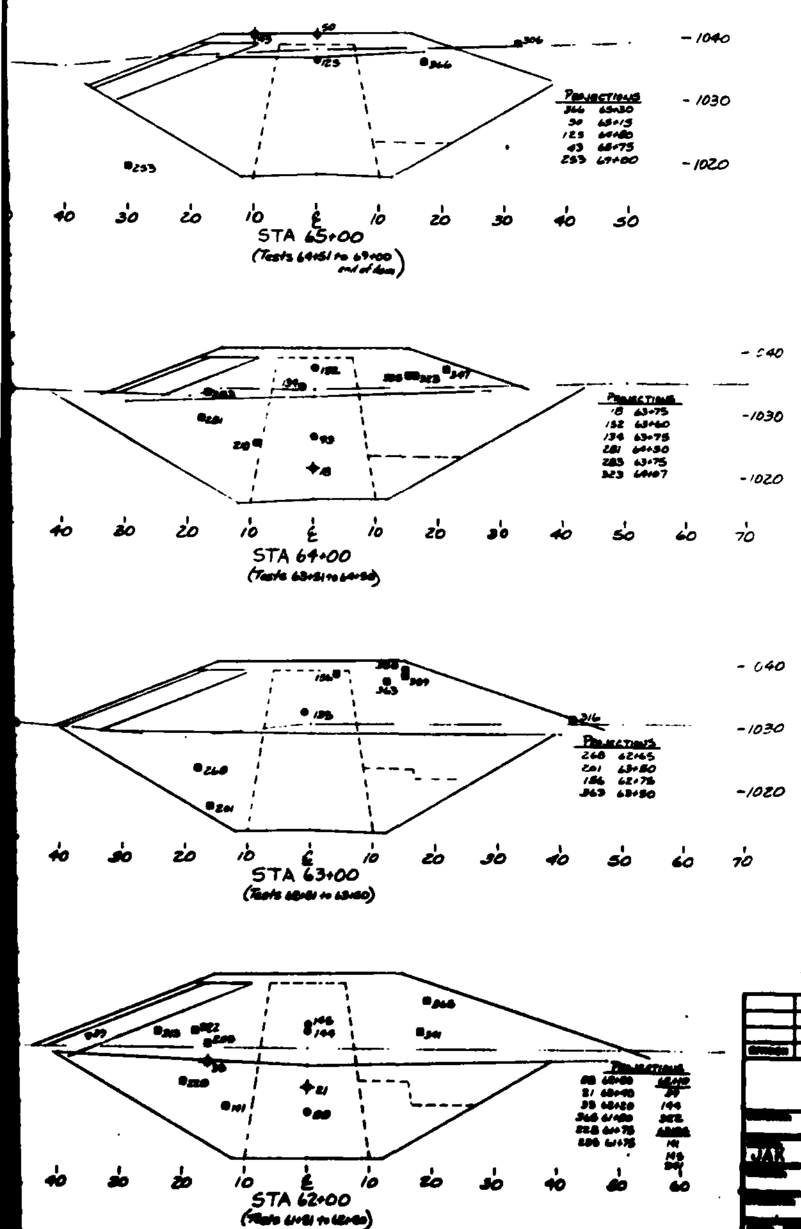
JAR

DATE: JUNE 1977

PLATE 51

DRAWING NUMBER
CJB ER/CT 123


STA 65+00
STA 64+00
STA 63+00
1040-
1030-
1020-
STA 62+00
70 60 50 40 30 20 10 ℄ 10 20



U. S. ARMY ENGINEER DISTRICT, LOUISVILLE

CORPS OF ENGINEERS

LOUISVILLE, KENTUCKY

MAD RIVER BASIN

C.J. BROWN RESERVOIR

OHIO

FIELD CONTROL TEST LOCATIONS

JAK

DATE: JUNE 1977

PLATE 52

DRAWING NUMBER

CJB ER/CT 124

CONTRACTOR FIELD

MATERIAL (ZONE)	NUMBER OF TESTS	DRY DENSITY				PERCENT COMP		
		HIGH	LOW	AVERAGE	DESIGN	HIGH	LOW	AVERAGE
RANDOM	1439 *	145.5	97.2	122.0	107.0	115.5	94.7	100.6
IMPERVIOUS	446 **	138.2	99.4	125.0	114.5	114.5	96.1	100.7
PERVIOUS	93 ***	147.9	104.2	130.5	125.0	114.1	85.0	98.8

* OF THE 1439 TESTS RUN ON THE RANDOM MATERIAL 354 TESTS FA OPTIMUM, 41 TESTS INDICATED THE MATERIAL WAS TOO WET THE COMPACTION DESIRED AND 7 TESTS INDICATED THE MATERIAL DESIRED). ALL OF THE TEST SECTIONS THAT FAILED WERE REWOR THESE TESTS WERE ACCEPTABLE.

** OF THE 446 TESTS RUN ON THE IMPERVIOUS MATERIAL 29 TESTS FAI OPTIMUM). ALL OF THE TEST SECTIONS THAT FAILED WERE REWORK

*** OF THE 93 TESTS RUN ON THE PERVIOUS MATERIAL 0 TESTS FA

CORPS OF ENGINEER

MATERIAL (ZONE)	NUMBER OF TESTS	DRY DENSITY				PERCENT COMP		
		HIGH	LOW	AVERAGE	DESIGN	HIGH	LOW	AVERAGE
RANDOM	225 *	146.7	107.3	126.0	107.0	114.8	98.0	101.7
IMPERVIOUS	82 **	139.6	103.8	123.5	114.5	111.9	96.9	100.5
PERVIOUS	18 ***	141.4	115.7	130.5	125.0	114.0	85.0	94.0

* OF THE 225 TESTS RUN ON THE RANDOM MATERIAL 65 TESTS F DRY OF OPTIMUM). ALL OF THE TEST SECTIONS THAT FAILED WE WERE ACCEPTABLE.

** OF THE 82 TESTS RUN ON THE IMPERVIOUS MATERIAL 5 TESTS ALL OF THE TEST SECTIONS THAT FAILED WERE REWORKED.

*** OF THE 18 TESTS RUN ON THE PERVIOUS MATERIAL 0 TES

1. STANDARD PROCTOR TEST USED ON THE RANDOM AND IMPERVIOUS M
2. NOT APPLICABLE - NO MOISTURE CONTROL SPECIFIED
3. INDICATE RESULTS OF ALL TESTS FOR HIGH AND LOW VALUES AND INDICAT

ELD COMPACTION CONTROL - DAM

OMPACTION ① ③		WATER CONTENT ③				DEVIATION FROM OPTIMUM ③			
RAGE	DESIRED	HIGH	LOW	AVERAGE	DESIGN	HIGH	LOW	AVERAGE	SPECIFIED
).6	95.0	25.0	3.6	12.3	18.6	+5.7	-7.1	- .20	-2.0 +2.0
).7	95.0	23.2	7.0	9.7	16.8	+2.0	-4.0	-1.00	-2.0 +2.0
8.8	85.0	N/A ②	N/A ②	N/A ②	N/A ②	N/A ②	N/A ②	N/A ②	N/A ②

S FAILED (300 TESTS INDICATED THE MATERIAL WAS TOO DRY OF
ET OF OPTIMUM, 6 TESTS INDICATED THE MATERIAL WAS BELOW
RIAL WAS BOTH TOO DRY OF OPTIMUM AND BELOW THE COMPACTION
WORKED. THERE WERE 136 AREAS THAT WERE RETESTED AND ALL

FAILED (ALL OF THE TESTS INDICATED THE MATERIAL WAS TOO DRY OF
WORKED. ALL AREAS WERE RETESTED AND THE TESTS WERE ACCEPTABLE.
S FAILED.

IEERS ACCEPTANCE TESTS - DAM

OMPACTION ① ③		WATER CONTENT ③				DEVIATION FROM OPTIMUM ③			
RAGE	DESIRED	HIGH	LOW	AVERAGE	DESIGN	HIGH	LOW	AVERAGE	SPECIFIED
1.7	95.0	19.5	2.9	8.4	18.6	+1.8	-6.9	-1.20	-2.0 +2.0
).5	95.0	22.5	3.4	10.8	16.8	+2.0	-6.4	-1.00	-2.0 +2.0
1.0	85.0	N/A ②	N/A ②	N/A ②	N/A ②	N/A ②	N/A ②	N/A ②	N/A ②

S FAILED (ALL OF THE TESTS INDICATED THE MATERIAL WAS TOO
WERE REWORKED. ALL AREAS WERE RETESTED AND THE TESTS

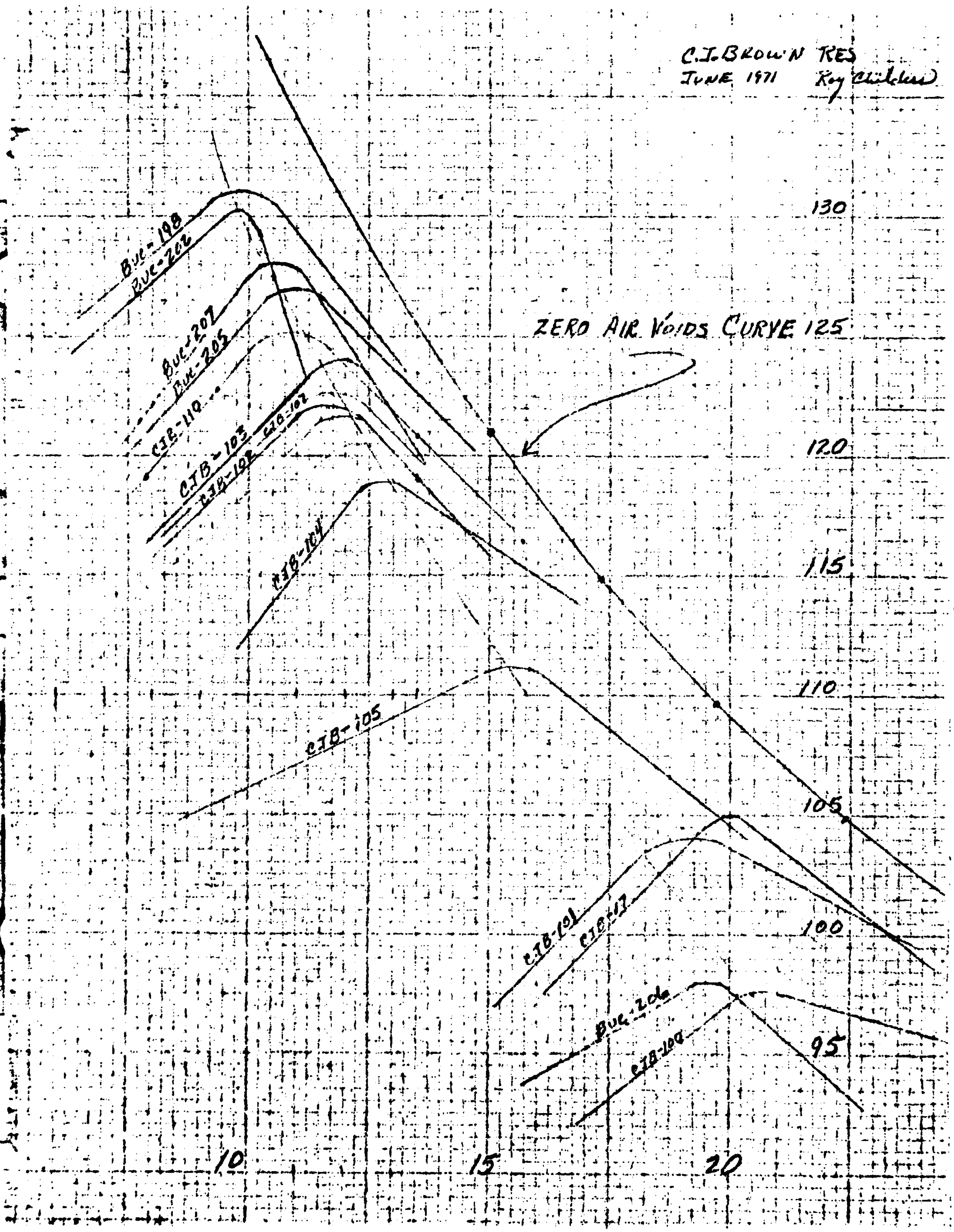
ESTS FAILED (5 TESTS INDICATED THE MATERIAL WAS TOO DRY OF OPTIMUM).
ED. ALL AREAS WERE RETESTED AND THE TESTS WERE ACCEPTABLE.

TESTS FAILED.

S MATERIAL, RELATIVE DENSITY TEST USED ON THE PERVIOUS MATERIAL

ICATE RESULTS OF ACCEPTABLE TESTS AND RETESTS FOR AVERAGE VALUES

PLATE 53


C.I. BROWN RES
JUNE 1971
ZERO AIR VOIDS CURVE
130
125
120
115
110
105
100
95
10
15
20
BUC-198
BUC-202
BUC-207
BUC-205
CJB-110
CJB-103
CJB-102
CJB-104
CJB-105
CJB-101
CJB-117
BUC-206
CJB-100

Appendix I
Photographs

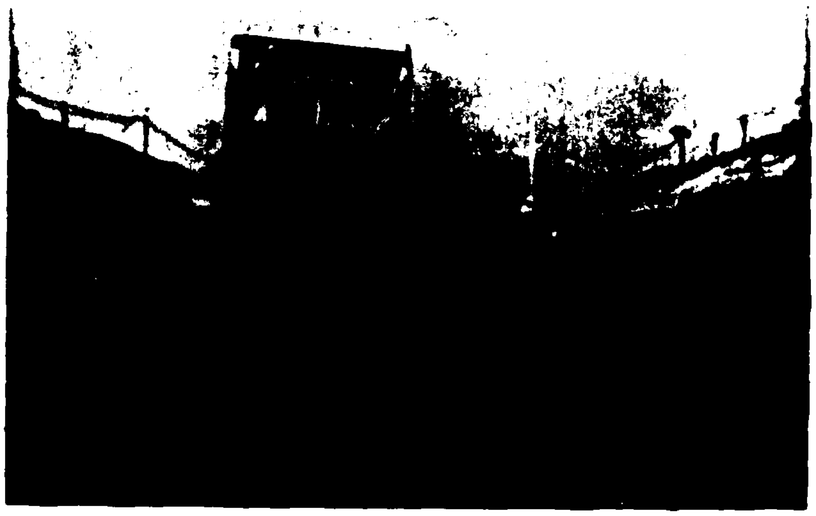
(1) Dam embankment excavation September 1971 on north leg of core trench.

(2) Water accumulation in core trench area after encountering artesian well in core trench at station 24+10.

(3) View of 8' x'8' x 5' excavation around artesian well at dam ℄ station 24+10 prior to placing concrete plug to shut-off minor leakage. (September 1971).

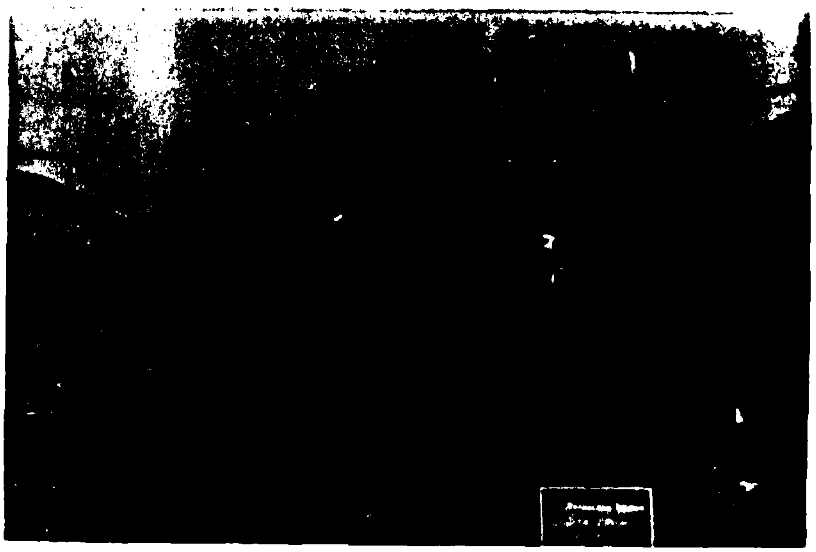
(4) Placing 8' x 8' x 5' concrete plug around 12" pipe drain into artesian well at ℄ station 24+10.

(5) View of artesian well and extension of 12" casing at dam ℄ station 24+10. (September 1971).



(6) Station 27+50 looking ahead during initial placement of impervious material in core trench.

(7) Station 28+00 looking ahead during initial placement within core trench. (1 October 1971).



(8) Station 28+00 in core trench. (1 October 1971).

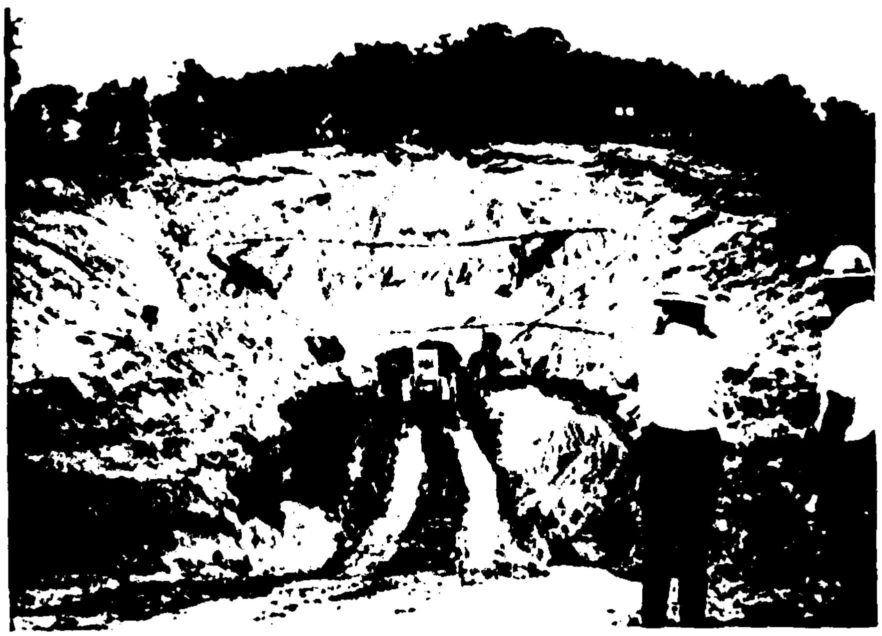
(9) Station 29+00 in core trench. (1 October 1971).

(10) Stage II from ground level on partially completed embankment looking north.

(11) Looking north at stage embankment. (Elevation of embankment is 982.0±).

(12) View looking south from overlook area at Stage II and III Embankment.

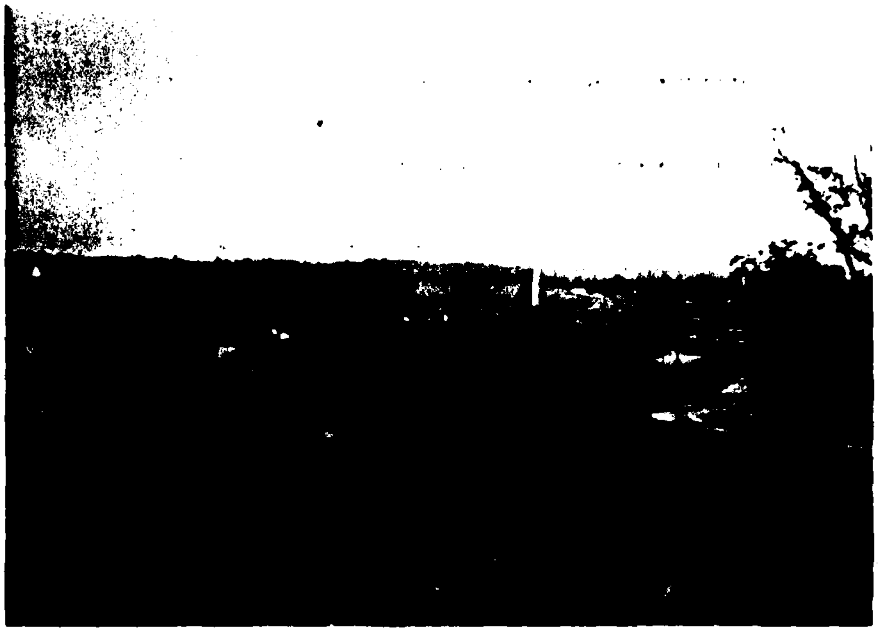
(13) Embankment looking toward right abutment with fill at elevation 993. (August 1972).



(14) Right abutment station 5+00±. High point of fill elevation 995. (August 1972).

(15) View of till-gravel deposit and sand window around right abutment. (August 1972)

(16) Close-up of area shown in Photo 15. (August 1972).



(17) Looking south from right abutment.

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