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SECOND DRAFT

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GEOTECHNICAL INVESTIGATION REPORT
McMicken Dam Restoration Study
Maricopa County, Arizona

FLOOD CONTROL DISTRICT
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SHB Job No. E81-138
Phase II

Consulting Geotechnical Engineers
PHOENIX • ALBUQUERQUE
SHB

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April 19, 1982

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SHB Job No. E81-138
Phase II

DRAFT

Attention: William D. Mathews, P.E.
Chief Engineer & General Manager

Re: McMicken Dam Restoration Study
Maricopa County, Arizona

Gentlemen,

A second draft of our Geotechnical Investigation Report on the referenced project is herein submitted. The report includes the results of our photogeologic investigation, test drilling program and laboratory analyses. Discussions concerning embankment cracking and earth fissuring risks, the development of alternative approaches to repair, repair costs, and a schedule of maintenance and inspection are also presented.

Should any questions arise concerning this submittal, we would be pleased to discuss them with you.

Respectfully submitted,
Sergent, Hauskins & Beckwith Engineers

By _____
Ralph E. Weeks, P.G.

and _____
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1. INTRODUCTION

1.1 General Statement

This report is submitted pursuant to a geotechnical investigation of McMicken Dam which included special photogeologic studies of the general project area to analyze earth fissures due to groundwater withdrawal. McMicken Dam and project study area includes most of the area between the Agua Fria River and the White Tank Mountains and from Camelback Road north through T4N. The location of the dam is shown on the vicinity map (Figure 1).

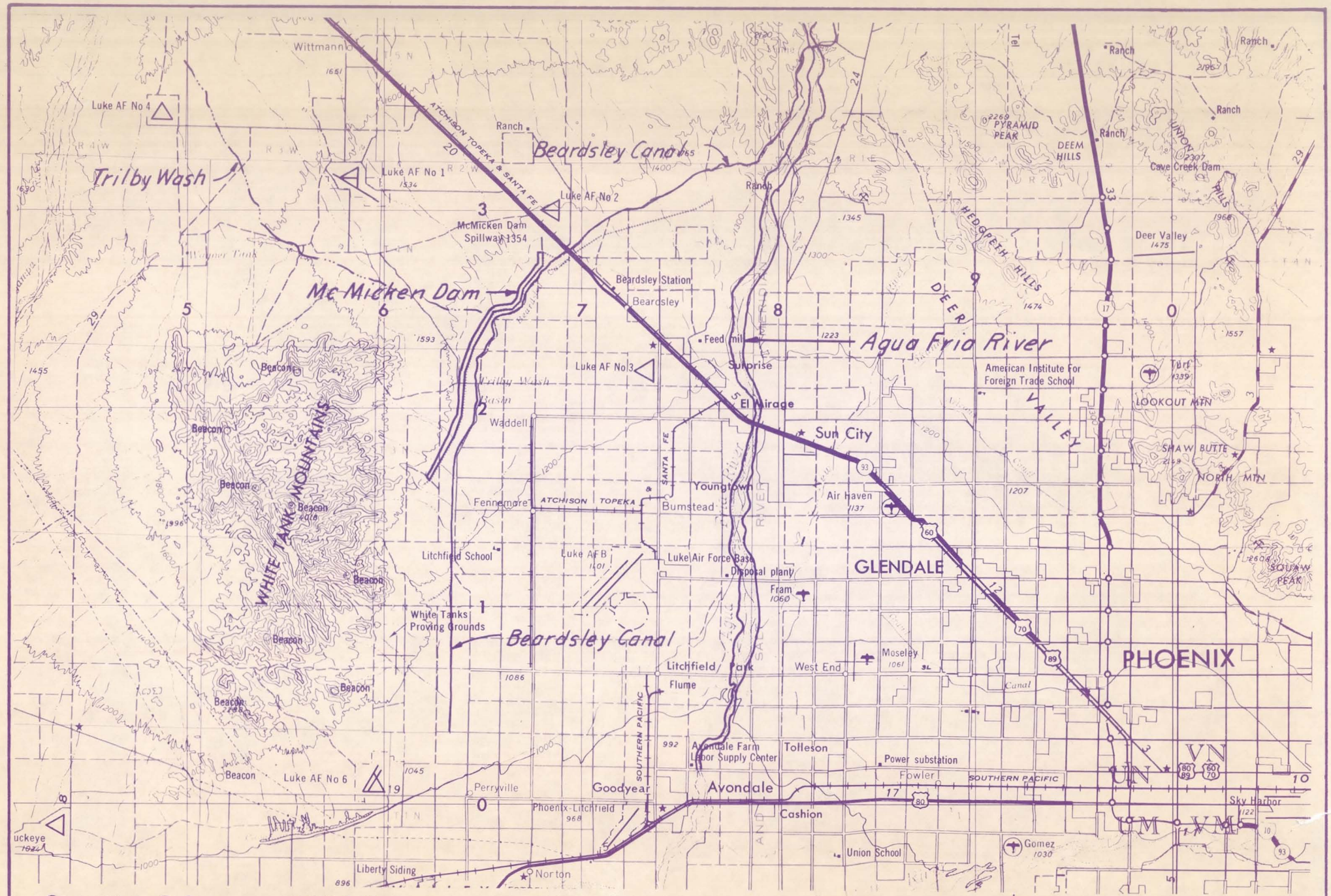
Authority to proceed with Phase II of the project was granted on November 27, 1981 by W.D. Mathews, Chief Engineer, of the Flood Control District of Maricopa County.

1.2 Purpose of Study

This investigation was undertaken with the intention of addressing the following questions:

A. Investigate the cause of cracking of the dam and determine the possible effects on the dam of subsidence and earth fissuring caused by groundwater withdrawal.

B. Identify regional fissuring network, subsurface conditions in and below the dam and the extent of cracking in the embankment.



Base Map Reference: U.S.G.S. Map
Phoenix, Arizona, 1954, 1:250,000.

VICINITY MAP Figure 1

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C. Evaluate the changes in embankment geometry which have occurred since construction of the dam.

D. Develop alternatives for repair of dam and channel embankments and recommend preferred approach.

E. Develop costs of two repair alternatives.

F. Prepare a schedule of maintenance and inspection activities.

1.3 Scope of Study

In order to accomplish the objectives outlined in Section 1.2, the following investigative elements were employed:

A. A review and analysis of the embankment design plans and specifications were performed. Studies by the Corps of Engineers (1973)* and Maricopa County Flood Control District (1977) which evaluated the cracking of McMicken Dam embankment were reviewed. Reports of embankment cracking of other dams were reviewed along with published and unpublished geologic literature on subsidence, fissuring, regional geologic setting and hydrogeologic conditions. Available aerial photography of the study area was reviewed to obtain a preliminary definition of geologic conditions.

B. An evaluation of earth fissuring in the study area was undertaken using special photogeologic techniques. This work included aerial reconnaissance of the site under low-sun-angle conditions and the performance of low-sun-angle photography of the entire study area. An

*References are listed at end of report.

analysis of the photography was performed and a field verification program consisting of visiting possible fissure locations and trenching probable fissure locations was completed.

C. A subsurface exploration program to investigate geotechnical conditions of McMicken Dam embankment and foundation soils was performed. This was accomplished using hollow stem auger drilling and sampling, backhoe test pits and shallow trenching and flooding of the crest.

D. Laboratory analysis of selected samples was performed in order to provide information on the engineering properties of embankment and foundation soils.

E. Engineering analysis was performed to evaluate causes of existing cracks and the risks of future cracking. Methods of repairs were developed along with estimates of costs of those measures. An operational plan of inspection and maintenance was also developed.

2. SUMMARY

The primary cause of existing cracks was found to be settlement of a surface layer of "collapsing" embankment foundation soils. Settlements within the embankment and shrinkage of the embankment may have contributed to the cracking to a minor degree. The extent of moisture sensitive foundation soils and intensity of cracking is much greater in the Trilby Wash area in approximately the northerly one-half of the dam. However, at least a thin layer of "collapsing" soil and isolated cracking is present over almost the entire length of the dam. "Collapsing" soils are very recent deposits of looser

silty and clayey sands which are perculiar to arid to semi-arid environment of the kind which has prevailed past 12,000 years.

The probability for future cracking due to "collapsing" foundation and embankment soils is believed to be very low in view of the fact that water has been impounded behind the dam for relatively long periods of time during its history. This is believed to have been sufficient to produce most, if not all, potential cracking from "collapsing" soils.

No evidence of earth fissures due to groundwater withdrawal crossing the dam or contributing to the cracking through the dam was found. However, an earth fissure was found near the southerly end of the dam. This history of pumpage of groundwater in the vicinity of the dam, the consequent groundwater declines and subsidence, and the anticipated future groundwater withdrawals and basin subsidence is such that the formation of numerous earth fissures in the vicinity of the dam is expected. Thus, it is considered highly probable that at least several earth fissures will form through the dam in the next few decades. Earth fissures would produce an open, nearly vertical crack about ½ to 3/4 inches wide through the dam and the cemented foundation soils. This kind of crack would in all probability lead to rapid failure of the dam when it filled. Accordingly, it is recommended that a defensive design against this type of crack be incorporated into the plan for repairs.

The recommended means of repair include a central vertical drain, a system of finger drains, and a toe drain consisting of coarse gravel and cobbles encapsulated in "filter fabric" (Figure 16). Grouting existing cracks and grading to compensate for past settlements and erosion are a part of the recommended repairs. It is estimated this can be accomplished for approximately $2,100,000.00 construction costs.

Intensive monitoring and surveillance is a part of the recommended operating plan for the dam.

3. PROJECT DESCRIPTION

3.1 Project Description & History

The following discussion and tables summarize pertinent information taken from several references cited in Section 4.1 which were reviewed in the course of the investigation.

3.1.1.1 Original Soils Investigation & Design Parameters

The dam was constructed in the 1955 to 1956 period. The original geotechnical investigation was performed in 1952 and consisted of 38 auger holes. An additional 24 auger holes were drilled in 1953. Density, as well as consolidation testing, was performed on samples taken. The surface soils from 2.5 to 16.5 deep were described as impervious sandy

clays, sandy silts, clayey and sandy silts, and silty sands. Caliche was noted as being present in all soils, with more caliche in the sandier soils. The soils in the drainages tended to be sandier.

The foundation soils were found to have densities of 82 to 105 pounds per cubic foot. The densities determined from undisturbed sampling of the existing dike varied from 99 to 108 PCF. For design purposes, the foundation material was assumed to have a density of 100 PCF, and the embankment soils were assumed to be placed at 95 percent of standard proctor with a density of 115 PCF.

Direct shear testing on remolded embankment soils at 95 percent standard proctor showed frictional strength (Ø) ranging from 28 to 34 degrees, and cohesive strengths (c) ranging from 0 to 0.16 tons per square foot. The ~~existing~~ old embankment had direct shear strengths ~~ranging from Ø~~ = 27 to 29 degrees, and c = o. For design, the embankment was assumed to be cohesionless with a Ø = 29 degrees. Triaxial testing of foundation soils yielded Ø = 32 degrees, and c = o, and triaxial testing of the existing embankment soils yielded Ø = 30 degrees and c = o.

Permeability testing on remolded borrow soils yielded permeabilities ranging from 3.5×10^{-3} cm/s to 7.0×10^{-5} cm/s. The permeability of the existing

embankment soils ranged from 3.5×10^{-3} to 7.0×10^{-4} cm/s. For design purposes, the vertical permeability was assumed to be 1.75×10^{-4} cm/s, and the horizontal permeability was 7.0×10^{-4} cm/s. This yielded an average permeability of 3.5×10^{-4} cm/s.

3.1.1.2 Older Existing Embankment

There was an older existing dam in place along a portion of the McMicken Dam alignment during its construction.

This dam was built across Trilby Wash during 1953 with funds provided by the Agricultural Conservation and Stabilization Service. The dam was called the Maricopa County Municipal Water Conservation District No. 1, and was built by the Soil Conservation Service. The dam was approximately 4 miles long, had a crest elevation of 1352.5 feet, and had upstream and downstream slopes of 2:1 (horizontal to vertical) and 1.75:1, respectively (Corps of Engineers, 1953). The Soil Conservation did not keep compaction records for this dam (Personnal Communication, 1982).

3.1.2 Tabular Summary of Pertinent Information

McMicken Dam - Trilby Wash Detention Basin

Length	49,500 feet
Maximum Height	31.5 feet

Average Height	23 feet
Crest Width	12 feet
Upstream Slope	2½ to 1
Downstream Slope	2 to 1
Crest Elevation	1361 feet
Earth Quantity	2,400,000 cubic yards
Cost	$2,180,000.00
Detention Volume at Spillway Crest	18,000 acre feet
Detention Volume at Design Surcharge	22,000 acre feet
Storage Area at Spillway	2,230 acres
Freeboard over Spillway	7 feet
Construction Period	July 1955 to July 1956

McMicken Dam - Flood Channel Within Storage Area

Flood Channel Width	200 to 400 feet
Average Depth	3 feet
Slope	Varies 0 - 0.00030
Capacity	1,400 Cubic feet per second (CFS)

McMicken Dam Spillway & Controlled Outlet

Spillway Width	2,000 feet
Spillway Capacity	16,000 CFS
Spillway Elevation	1354 feet
Controlled Outlet Width	20 feet
Controlled Outlet Height	11 feet
Controlled Outlet Capacity	4,500 CFS

Controlled Outlet Invert Elevation	1335 feet

Drainage Basin Data

Drainage Area	247 square miles
Maximum Drainage Length	38 miles
Drainage Width	5 to 16 miles
Maximum Elevation	4000 feet
Channel Slopes	321 to 77 feet per mile

Sediment Accumulation Rate

Sediment Accumulation Rate	0.2 acre feet per square mile per year
50 Year Sediment Accumulation	2,500 acre feet

Runoff & Flood Information

Standard Project Flood (SPF) Peak Inflow	35,000 CFS
Four Day SPF Volume	32,800 acre feet
Maximum Outflow Through Controlled Outlet for SPF	4,450 CFS
Peak Elevation of Storage for SPF	1354 feet
Spillway Design Flood (SDF) Peak Inflow	52,000 CFS
SDF Peak Outflow	22,000 CFS
SDF Peak Outflow Elevation	1356 feet

Maximum Probable Flood (MPF) Peak Inflow	120,000 CFS
MPF Peak Outflow	95,000 CFS
MPF Peak Outflow Elevation	1,360 feet
Time to Evacuate Storage With Water at Spillway Crest and No additional Inflow	3 to 4½ days

Spillway Outlet Channel

Spillway Outlet Channel Slope	0.0020 to 0.00040
Spillway Width	2,000 feet
Spillway Channel Capacity	4,450 to 14,000 CFS

Old Dike

Crest Elevation	1352.5 feet
Upstream Slope	2 to 1
Downstream Slope	1.75 to 1
Compaction Records	None

3.2 History of McMicken Dam Embankment Cracking

Several reports were reviewed to investigate the history of the development of cracks in the McMicken Dam embankment.

The U.S. Army Corps of Engineers, Los Angeles District (1973) provided the first detailed investigation of cracking.

This report notes that inspections were made in 1964, 1966, 1969 and 1971 to investigate surficial irregularities of the crest. The irregularities were described as surface erosion and small holes and tunnels. A trenching investigation conducted in March, 1972 exposed transverse cracks within the embankment, some of which exceeded 14.5 feet in depth. A summary of all cracks observed in this 1972 survey, as well as those found in our investigations, is shown on the plan and profile sheets om Appendix D.

The U.S. Army Corps of Engineers continued its investigation with additional shallow test trenches which showed that the cracks were predominantly located between Stations 265+00 to 295+00 and from Station 445+00 to 475+00.

Twelve auger test holes were drilled during July 1972 in an area of heavy cracking to determine the soil profiles there. Undisturbed sampling of the foundation soils, both upstream and downstream of the dam, were taken during August 1972.

Laboratory testing including sieve analysis, Atterberg Limits, shrinkage limit and consolidation testing were

performed on samples taken. Consolidation testing revealed changes in void ratio upon saturation of from 12 to 34 percent for downstream foundation soils. Upstream samples experienced void ratio changes of 8 to 9 percent upon saturation at embankment loading.

The U.S. Army Corps of Engineers notes that during the 1953 investigation, extrapolated consolidation testing indicated that foundation and existing dike samples would undergo a 30 percent and 25 percent reduction in void ratio, respectively, upon wetting.

The 1972 Corps embankment consolidation tests indicated that approximately 18 percent of the embankment materials were placed at densities or moisture contents low enough to have collapsible behavior.

The next report reviewed was prepared by the Maricopa County Flood Control District (1977). The Flood Control District noted that the dam had been bladed to provide a smooth roadway from 1966 to 1975. This action closed existing surface cracks in the dam. A visual survey was made in March 1977 for suspected cracks. All cracking, depressions, or rodent holes were noted and logged. The Flood Control District with the concurrence of the Los Angeles District Corps of Engineers began a program of trenching the crest of the dam. The trenches were flooded to help locate cracks, and any cracks found were to be excavated with a backhoe and refilled with

embankment soil compacted at 95 percent maximum density at the optimum moisture content.

The cracks were more numerous and severe than anticipated, with depths up to 17 feet and widths up to 3 inches. The crack filling was abandoned after examining the area between Stations 445+00 to 475+00.

The Flood Control District concluded that the cracking could be continuous throughout the northernmost two-thirds of the dam, and that the cracking was not totally caused by subsidence.

The Corps of Engineers (1977) issued a report in May 1977 which noted that both transverse and longitudinal cracking were found in 1972. Observing that a failure of the dam could drown many people and flood Luke Air Force Base, they described methods in which the dam could be safely breached.

The dam was breached in July 1977. Two breaks were made at sill level, one 700 feet wide near the center of the dam and another 110 feet wide near the controlled outlet.

4. INVESTIGATION

4.1 Preliminary Studies

A review of available data concerning the construction

and operation of McMicken Dam was completed. This review included studies by the Army Corps of Engineers (1973) and Maricopa County Flood Control District (1977) which evaluated the cracking of McMicken Dam. In addition, case histories of other dams in arid environments which have experienced cracking were reviewed and analyzed.

Published and unpublished geologic literature and data were reviewed in order to study the regional geologic setting and the hydrogeologic conditions of the study area. The phenomenon of subsidence and earth fissuring caused by groundwater withdrawal was investigated by reviewing existing water well logs, geodetic leveling data, available aerial photography, and geologic literature.

4.2 Earth Fissuring Investigation

4.2.1 Photogeologic Studies

An initial aerial reconnaissance of the study area was made under low-sun-angle conditions in order to accurately plan the schedule of photogeologic missions and to familiarize the participants with the area involved. This reconnaissance was performed by David B. Slemmons, Ph.D., and Mr. Robert Whitney of David B. Slemmons Consulting Geologists of Reno, and Mr. Michael R. Hulpke of this firm.

After scheduling of times and flight paths, low-sun-angle photography was performed by Messrs. Slemmons and Whitney along with representatives of SHB.

Low-sun-angle aerial photography is essentially conventional aerial photography taken when the sun is at a low angle to the horizon. The basic method uses either the highlighting effects on subtle geomorphic features by low sun illumination or shading effects by back illumination (Slemmons, 1981). This produces either shadows or highlights on geomorphic features, vegetation, or cultural objects having slopes steeper than the irradiation angle of the sun (Glass and Slemmons, 1978).

Since its inception, low-sun-angle aerial reconnaissance and photography has been found to be one of the most effective methods of searching for young fault scarps (Slemmons, 1982) and, as earth fissuring produces a similar geomorphic expression in many cases, low-sun-angle aerial photography methods were applied during the initial phase of this study. Special studies for major engineering structures have been conducted during the past 25 years that have shown the importance of this method in revealing detailed fracture patterns that would be impossible to observe on the ground. In some cases, low-sun-angle aerial photography has revealed 90 percent more geomorphic features than were observed in the field or with conventional photography (Glass and Slemmons, 1978).

Photography of the study area was taken at two scales. Low level photography at an approximate scale of 1:3,000 was taken along the axis of McMicken Dam and the outlet channel. Low level photography along the dam axis was taken during both morning and evening flights. This duplicate photography provided two low-sun-angles for subsequent analysis. Photography at a scale of approximately 1:9,000 was taken along east-west flight lines extending from the Agua Fria River on the east to the White Tank Mountains on the west, and from Indian School Road on the south through T4N on the north. The area covered by the 1:9,000 scale photography is about 200 square miles. This photography was taken in order to study regional patterns of lineaments identified in the 1:3,000 photography.

Prints of all of the low-sun-angle photography were sent to Dr. Slemmons in Reno for independent interpretation. Parallel interpretation was made by the SHB staff. The analysis was accomplished using magnified stereo viewing. Suspected lineations on the photography were rated as being either probable earth fissures, probable drainage, or probable vegetation lineaments.

A field survey of all suspected earth fissures found on the low-sun-angle photography within 1,000 feet of the dam was conducted. Most of the probable drainage

and vegetation lineaments were also checked for indications of earth fissuring. In all, over 200 suspected features were field checked. After elimination of lineaments caused by cultural activity, erosion or vegetation, eight sites remained that were suspicious enough to warrant subsurface investigation.

4.2.2 Trenching of Suspected Earth Fissures

The eight sites suspected of earth fissures were all trenched to a depth of 12 feet or refusal using a Case 580-C backhoe. All trenches were logged by an SHB geologist who was present during the entire trenching operation. Logs of the trenches are presented in Appendix A and the location of the trenches are shown on Plates 1 and 3 located in Appendix A. Expanded notes and photography were used when the trenching uncovered features which may have been caused by earth fissuring. A selected number of these photographs are presented in Appendix A.

Only two of the trenches showed any features related to earth fissuring. Both of the trenches were located along the same set of fissures, which is located near the southern end of the dam. Due to the presence of a considerable amount of cemented gravel and cobbles at the location of these two trenches, the Case backhoe was only able to penetrate the subsurface to a depth of 5 feet. A large truck-mounted backhoe was

subsequently used to perform a deeper investigation of the fissures. This equipment advanced three additional trenches to a maximum depth of 21 feet.

4.3 Inspection of Embankment

During January 1982, a detailed ground reconnaissance of McMicken Dam was undertaken. This survey covered the entire length of the dam, including the outlet channel embankment south of U.S. Highway 60. The crest of the dam and the upstream and downstream slopes were investigated and notations were made of all cracks, holes, surficial erosion features, and other conditions which may have an effect on the integrity of the dam. Pictures of some representative features were taken. A selected number of these photos are presented in Appendix B. A detailed log was developed which describes all cracks, holes, depressions and vegetation lineations found during the reconnaissance. This log is presented in Appendix B.

4.4 Subsurface Exploration of Dam

4.4.1 Hollow Stem Auger Drilling

Test drilling was performed on the crest of the dam near both the upstream and downstream toes and on the old crest which is located between Station 355+00 and 475+00. Seventy-five boreholes were advanced to

depths ranging from 8 to 60 feet and were normally drilled on 1,000 to 2,000 foot centers. Standard penetration testing was performed, and disturbed or undisturbed tube samples were obtained at 5 foot intervals or less within all borings.

Field borehole logging and drilling supervision was performed by Michael R. Hulpke, staff geologist, of this firm. All soils were classified by the Unified Soil Classification System (ASTM D2487) which is summarized in Appendix B.

A short description of drilling methods employed and boring logs are presented in Appendix B. A site plan (Figure ~~B-1~~ B-2) depicting the location of all boreholes is presented in Appendix B. Boring locations are also presented on the plan and profile sheets in Appendix D.

4.4.2 Trenching & Flooding Along Crest

During early February 1982, an investigation was undertaken in which 21 shallow trenches were dug at various locations on the crest of the dam in order to expose suspected cracks. The investigation consisted of utilizing a Ditch Witch J-19 to evacuate a trench approximately 8 inches wide and 18 inches deep and either 50 or 100 feet long. Water was pumped into the trench until it overflowed or until it was obvious that we would not be able to fill the trench due to the high rate of leakage through cracks.

In eight of the trenches, no cracks were found, and in the remainder, there were from 1 to 19 cracks. The locations of these trenches and the crack locations are shown on the plan and profile sheets, and logs of the trenches are presented in Appendix B. All of the trenches were backfilled after completing the investigation.

4.4.3 Backhoe Test Pits

A total of 36 backhoe test pits were advanced to depths ranging from 4 to 21 feet. Fourteen of the test pits were dug in areas of suspected earth fissuring and are discussed in Sections 4.2.2 and 5.4. The remaining 22 test pits were dug in the crest and near the upstream and downstream toes of the dam in areas suspected of containing collapsing soils.

The logs of the test pits dug in areas of suspected fissuring are presented in Appendix A. The logs of the test pits dug in areas of suspected collapsing soils as well as the McMicken Dam and old dike embankments are presented in Appendix B.

Locations of pits dug near the toes of the dam are shown on the plan and profile sheets in Appendix D and on Figure B-2 located in Appendix B. Locations of the pits dug in the earth fissure investigation are shown on Plates 1 through 4 located in Appendix A. ?

The test pits in and near the embankments were advanced using a Case 580-C backhoe. The pits were dug to a maximum depth of 10 feet. Block samples of undisturbed soils were removed from these pits to be used in consolidation testing of the foundation soils.

4.5 Laboratory Analysis

The laboratory testing to date includes the following types and numbers of tests:

Grain-Size Analysis & Atterberg Limits	91
Moisture Content	178
Density	26
Moisture Density Relations	4
Direct Shear	1
Consolidation	17
Permeability	4
Unconsolidated-Undrained Triaxial Shear	1
Specific Gravity	4
Pinhole & Related Dispersion Tests	4

The results of the tests are shown in Appendix C.

5. DESCRIPTION OF SURFACE FEATURES, GEOLOGY & GEOTECHNICAL PROFILE

5.1 Topography & Surface Conditions

South of U.S. Highway 60, the McMicken flood control

facility passes through two distinct geomorphic environments. The northern half of dam and its outlet channel cross the gently sloping, slightly dissected drainage system of Trilby Wash, its tributaries and secondary subparallel arroyos. This drainage system receives runoff from an extensive watershed north of the White Tank Mountains. These drainages trend southeasterly at a gradient of about 35 feet per mile. In contrast, the southern half of the dam alignment is located on the alluvial pediment of the White Tank Mountains. This pediment surface contains numerous moderately dissected arroyos which pass runoff eastward from the bedrock of the eastern slope of the White Tanks to the valley floor. Natural surface gradients near the mountain front range from about 65 to 90 feet per mile.

Due to agricultural, residential and industrial development, and borrowing of earthen materials for McMicken Dam, considerable disturbance of the natural surface is present. To the east, plowed fields are present within ½ to 1½ miles of the embankment. Beardsley Canal parallels the downstream toe of the embankment, is within about 200 feet of the dam along the northern one-third of the structure, and crosses the outlet channel. Construction of the canal has altered the natural drainage and surface considerably. Immediately downstream from the dam between Stations 190+00 and 280+00, the ground has been disked to control erosion. A strip of ground immediately upstream from the dam, which varies in width from about 200 to 800 feet, has been excavated for borrow used in the construction of the dam.

Within the depressions caused by borrowing, runoff water is intermittently standing along the upstream toe between Stations 365+00 and 450+00. Other low-lying areas along the northern half of the retention appear to hold runoff temporarily.

The embankment is generally void of vegetation and contains numerous erosion features on the upstream and downstream slopes along a major portion of the alignment. The narrow crest is deeply grooved longitudinal to its axis as a result of vehicular traffic. As a result of embankment cracking and burrowing animals, numerous potholes and depressions are present along the crest. A detailed description of the character and extent of embankment cracks is presented in Section 5.6.3.

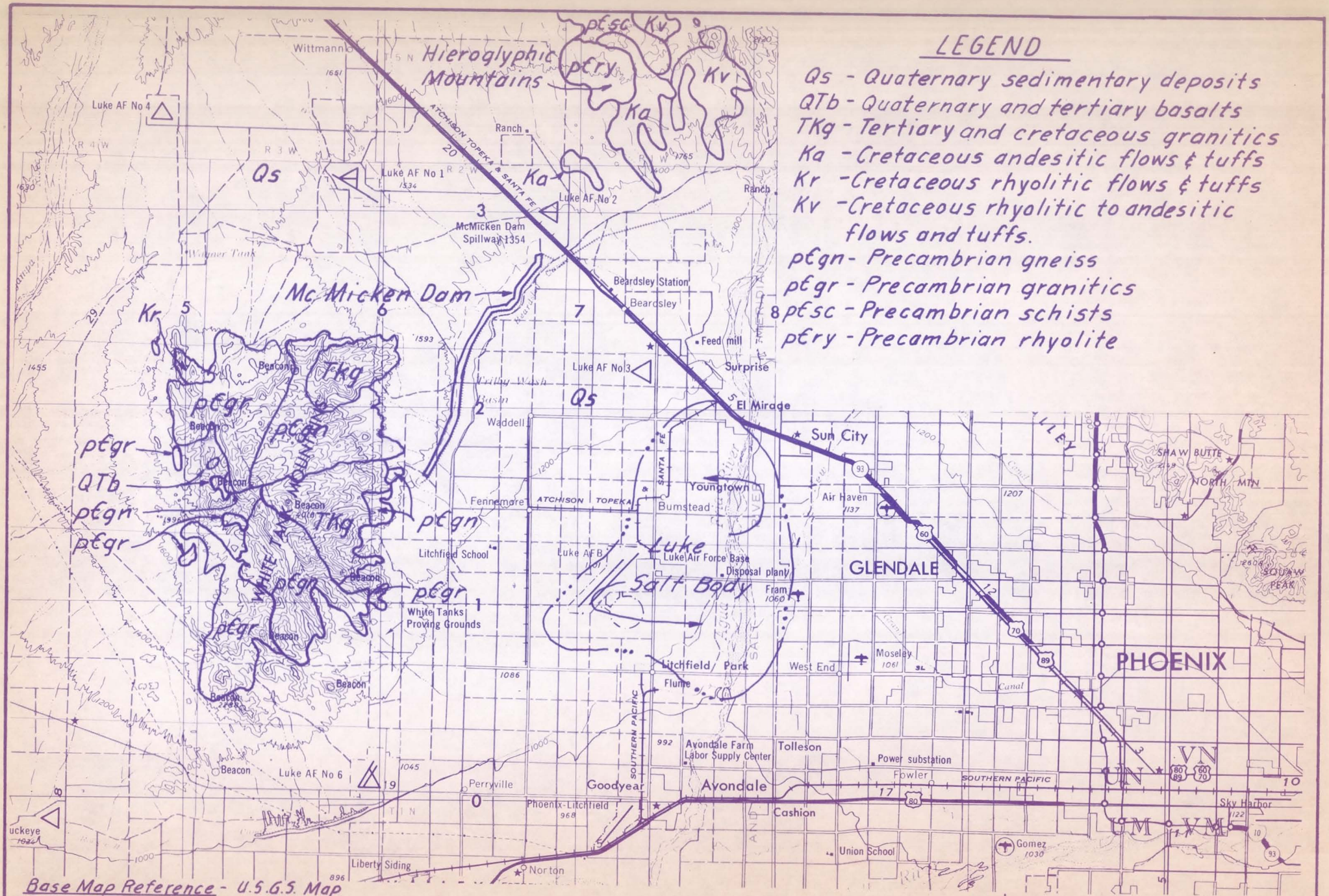
Based on the plan and profile survey completed for this investigation, the crest elevation varies from about 1362 to 1357 feet. Crest elevations in excess of 1360 feet occur along the southernmost segment of the alignment from Stations 40+00 to 87+00. The remainder of the crest is generally at an elevation of 1358 to 1360 feet. Considerable localized variance in the crest profile is evident within the following embankment segments: Stations 105+00 to 120+00, 170+00 to 182+00, 299+00 to 305+00, 340+00 to 351+00, 385+00 to 440+00, and 492+00 to 497+00. The crest elevation of the outfall channel dike varies from about 1335 to 1338 feet.

5.2 Regional Geologic Setting

The study area lies within the Southern Basin and Range Physiographic Province (Fenneman, 1946). This province is characterized by linear mountain ranges separated by broad alluvial basins containing deep unconsolidated deposits. McMicken Dam is situated near the western fringe of such an alluvial basin, commonly referred to as the Phoenix Basin. The northern half of the flood control structure crosses a protrusion of the basin which is situated between the Hieroglyphic Mountains to the north and the White Tank Mountains to the west, and which extends to the Vulture Mountains to the northwest. The southern half of the dam subparallels the easternmost exposure of bedrock on the eastern flank of the White Tank Mountains.

Trilby Wash and its associated drainages, which are in part intercepted by McMicken Dam, pass runoff to the Agua Fria River from an extensive watershed containing the southern flank of the Wickenburg and Hieroglyphic Mountains and the northern flank of the White Tank Mountains.

As depicted on Figure 2, the bedrock of the White Tank Mountains is predominantly composed of Precambrian granitic rocks, gneiss and schist, and Tertiary-Cretaceous granitic rocks which obtain a maximum elevation of about 4100 feet above MSL (Wilson and others, 1969). Of significance is the configuration of bedrock exposure along


LEGEND
Qs - Quaternary sedimentary deposits
QTb - Quaternary and tertiary basalts
TKg - Tertiary and cretaceous granitics
Ka - Cretaceous andesitic flows & tuffs
Kr - Cretaceous rhyolitic flows & tuffs
Kv - Cretaceous rhyolitic to andesitic flows and tuffs.
pЄgn - Precambrian gneiss
pЄgr - Precambrian granitics
pЄsc - Precambrian schists
pЄry - Precambrian rhyolite
Hieroglyphic Mountains
Mc Micken Dam
White Tanks Mountains
Salt Body
Luke
GLENDALE
PHOENIX
Wittmann
Luke AF No 4
Luke AF No 1
Luke AF No 2
Luke AF No 3
Luke AF No 6
McMicken Dam Spillway 1354
Beardsley Station
Beardsley
Feed mill
Surprise
El Mirage
Sun City
Waddell
Youngtown
Bumstead
Fennemore
Litchfield School
Luke AFB
Luke Air Force Base
Disposal plant
Fram
Air Haven
Litchfield Park
Flume
West End
Moseley
Avondale Farm Labor Supply Center
Tolleson
Power substation
Fowler
Avondale
Goodyear
Cashion
Perryville
Phoenix-Litchfield
Union School
Gomez
Liberty Siding
Norton
Sky Harbor
SHAW BUTTE
NORTH MTN
SQUAW PEAK
White Tanks Proving Grounds
ATCHISON TOPEKA & SANTA FE
SOUTHERN PACIFIC
Base Map Reference - U.S.G.S. Map Phoenix, Arizona, 1954, 1:250,000
Data Reference - "Geologic Map of Arizona" by Wilson & Moore, Az. Bureau of Mines & John R. Cooper, U.S.G.S. Dated 1969.
GEOLOGIC MAP
Figure 2
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its contact with the alluvium of the Phoenix Basin. This contact is quite irregular and several bedrock highs protrude through the alluvial cover. One of these protrusions, Fenne Knoll, is within one-half mile of the southern end of McMicken Dam.

Isolated and contiguous exposures of Cretaceous volcanics and Precambrian granitics and schist are exposed at the southern end of the Hieroglyphic Mountains. The nearest of these exposures to McMicken Dam occurs about 3 miles northeast of the intersection of the outfall channel and U.S. Highway 60.

As estimated by Cooley (1973) and depicted on Figure 3, the thickness of unconsolidated alluvial deposits under McMicken Dam exceeds 1,200 feet. Geophysical data interpreted by Oppenheimer and Sumner (1980) indicate that depth to bedrock is in excess of 1,600 feet below the northern two-thirds of dam and decreases in thickness quite abruptly to about 500 feet near the southern end of the structure (Figure 4). One water well (no. 3 on Figure 7) located approximately 1 mile east of Station 175+00 contacts granitic bedrock at 1,402 feet.

The protrusion of the Phoenix Basin located northwest of McMicken Dam and between the White Tank and Hieroglyphic Mountains appears to possess an alluvial thickness in excess of 1,200 feet (Cooley, 1973). Southeast of McMicken and east of the White Tank Mountains, the depth

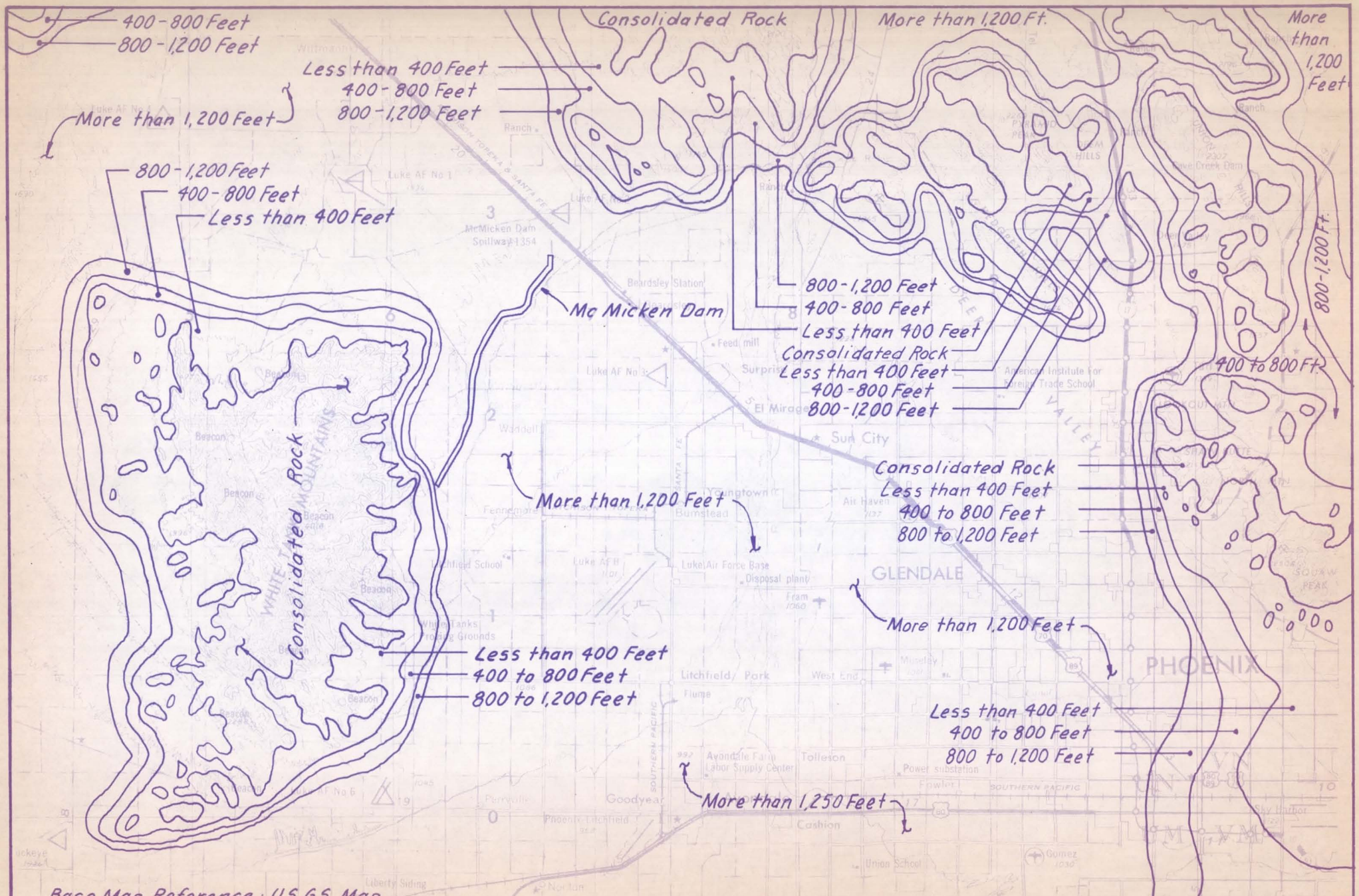

Figure 3

Thickness of Alluvial Deposits

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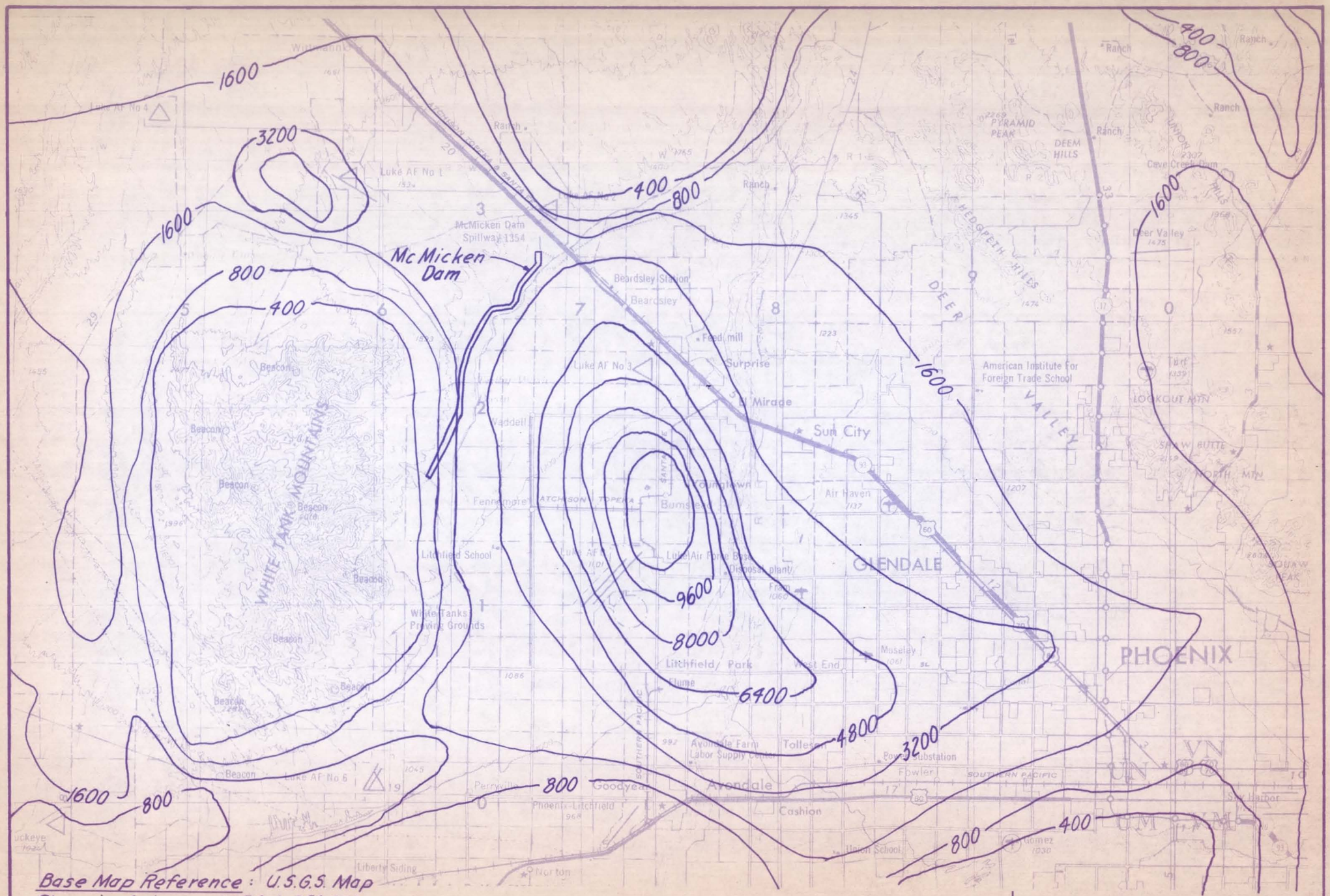

Base Map Reference: U.S.G.S. Map Phoenix, Arizona, 1954, 1:250,000.
Data Reference: "Depth to Bedrock Map of Southern Arizona" by Oppenheimer and Sumner, Dated 1980.

Depth to Bedrock Contours

Figure 4

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to bedrock increases to a maximum of about 10,000 feet near Luke Air Force Base (Oppenheimer and Sumner, 1980).

As described by Stulik and Twenter (1964), valley fill deposits within this area of the Phoenix Basin are composed of unconsolidated to semiconsolidated clay, silt, sand and gravel with subordinate caliche and evaporites. These deposits appear to be highly lenticular and laterally discontinuous. Based upon driller's logs, Stulik and Twenter (1964) further estimated that alluvium in the general vicinity of McMicken Dam consists of 40 to in excess of 60 percent fine grained material throughout the profile penetrated by water wells. From a review of water well driller's logs in the general vicinity of McMicken Dam, hard clay and gravel predominate the subsurface profile to a depth of 1,000 feet. This alluvium is highly variable, both vertically and laterally.

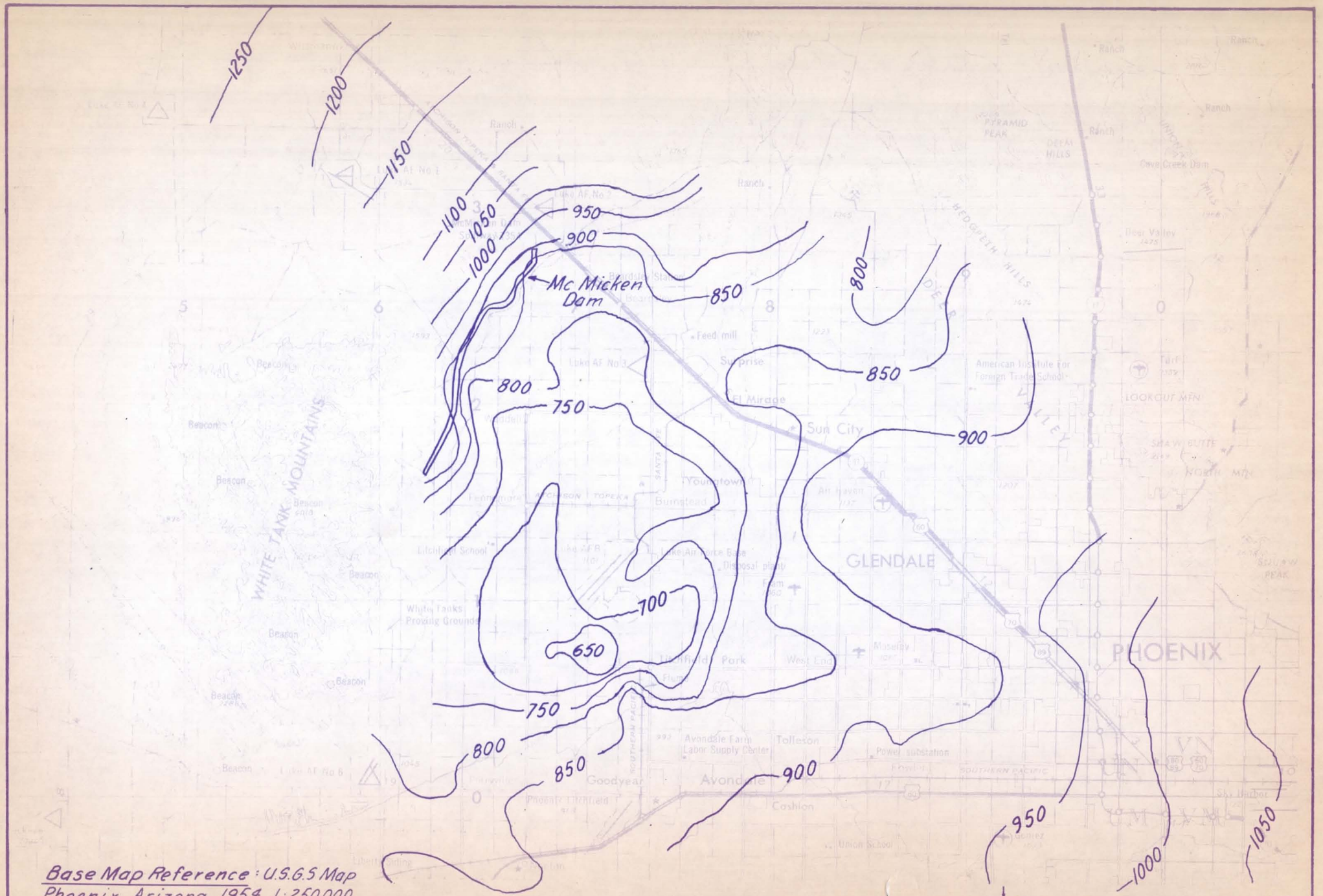
After the completion of the USGS studies discussed above, geophysical and geohydrological investigations by Eaton and others (1972) delineated the extent and nature of a large salt body located in the vicinity of Luke Air Force Base. The body is estimated to bottom at a depth of about 6,900 feet and have a lateral extent as depicted on Figure 2. Eaton and others (1972) further suggest that doming of the salt body has affected topographic relief in the vicinity of Luke Air Force Base, and that its presence has a relationship to the occurrence of earth fissuring in this area.

5.3 Hydrogeologic Conditions

According to Ross (1978), water table elevations within 1 mile of McMicken Dam varied between about 800 to 950 feet above MSL in 1977 (Figure 5). This translates to a depth to water of 450 to 500 feet. Water table elevations decrease significantly southeast of the dam to a minimum of about 650 feet above MSL (1977) immediately south of Luke Air Force Base (Ross, 1978).

Groundwater level declines range between 200 to in excess of 300 feet in the study area between 1923 and 1977 (Figure 6) (Ross, 1978). This decline is in response to pumpage far exceeding natural recharge rates. In the Salt River Valley, about 73 million acre feet of groundwater has been pumped from the alluvial aquifer from 1915 to 1976 (Ross, 1978). Within the study area, in excess of 100 wells are pumped to acquire water for irrigation, public supply and domestic use.

About 25 wells are present downstream from McMicken Dam within 2 miles of the structure. Figure 7 presents water table variations of eleven of these wells within the period of about 1938 through 1981. The depth to water has generally increased during this period from 200 to 500 feet in these selected wells. Two exceptions are well nos. 1 and 2. As shown on Figures 8 and 9, these wells have experienced recovery between 1965 and 1982. As depicted on Figures 8 through 13, groundwater



Base Map Reference: U.S.G.S Map Phoenix, Arizona, 1954, 1:250,000.
Data Reference: U.S.G.S. Water Resources Investigations 78-40 Open File Report Sheet 1 of 2, Dated 1977.

Water Level Contours

Figure 5

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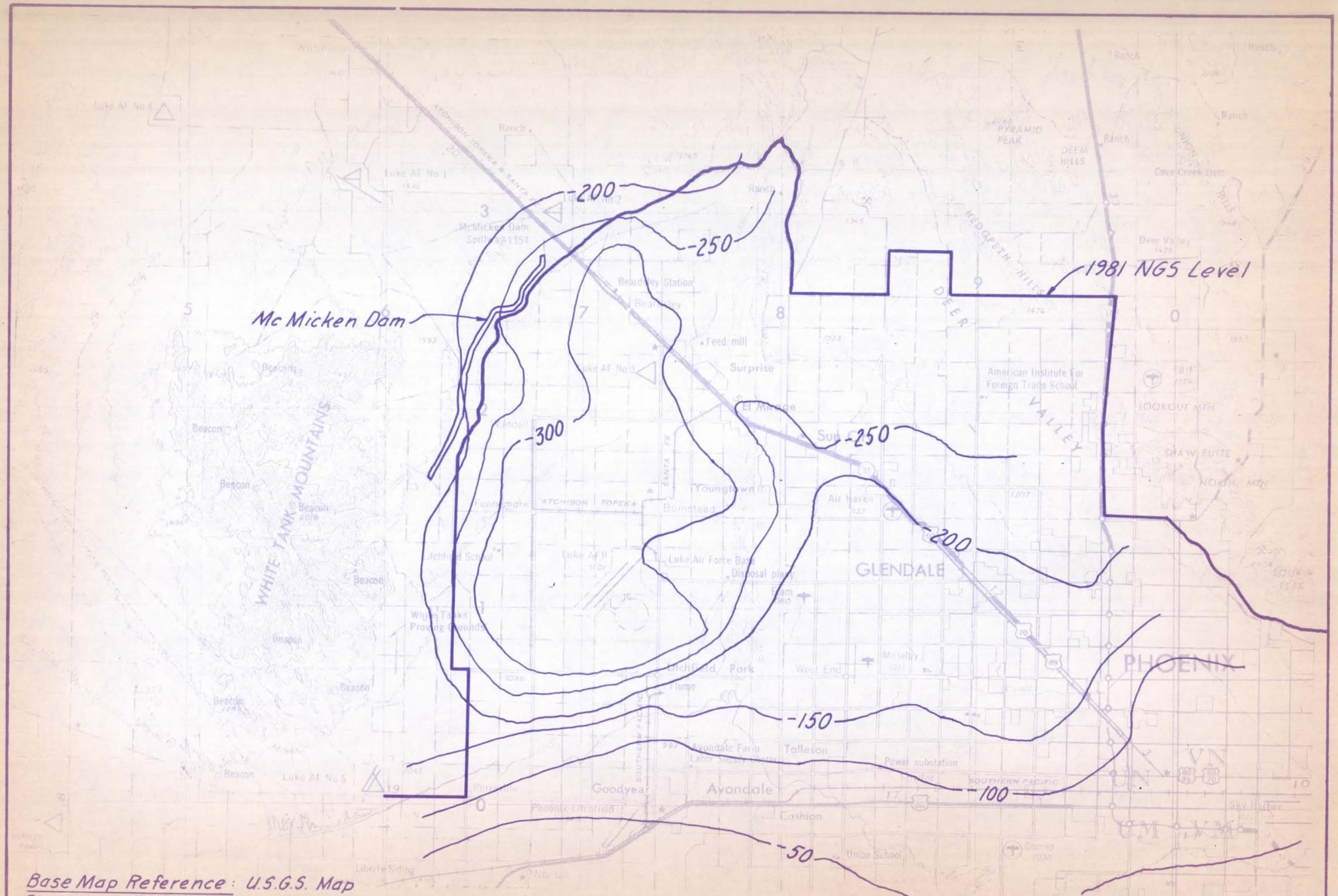

Base Map Reference: U.S.G.S. Map Phoenix, Arizona, 1954, 1:250,000.
Data Reference: U.S.G.S. Water Resources Investigations 78-83 Open File Report Sheet 2 of 2, Dated 1977.

Water Level Decline in Feet 1923 to 1977

Figure 6

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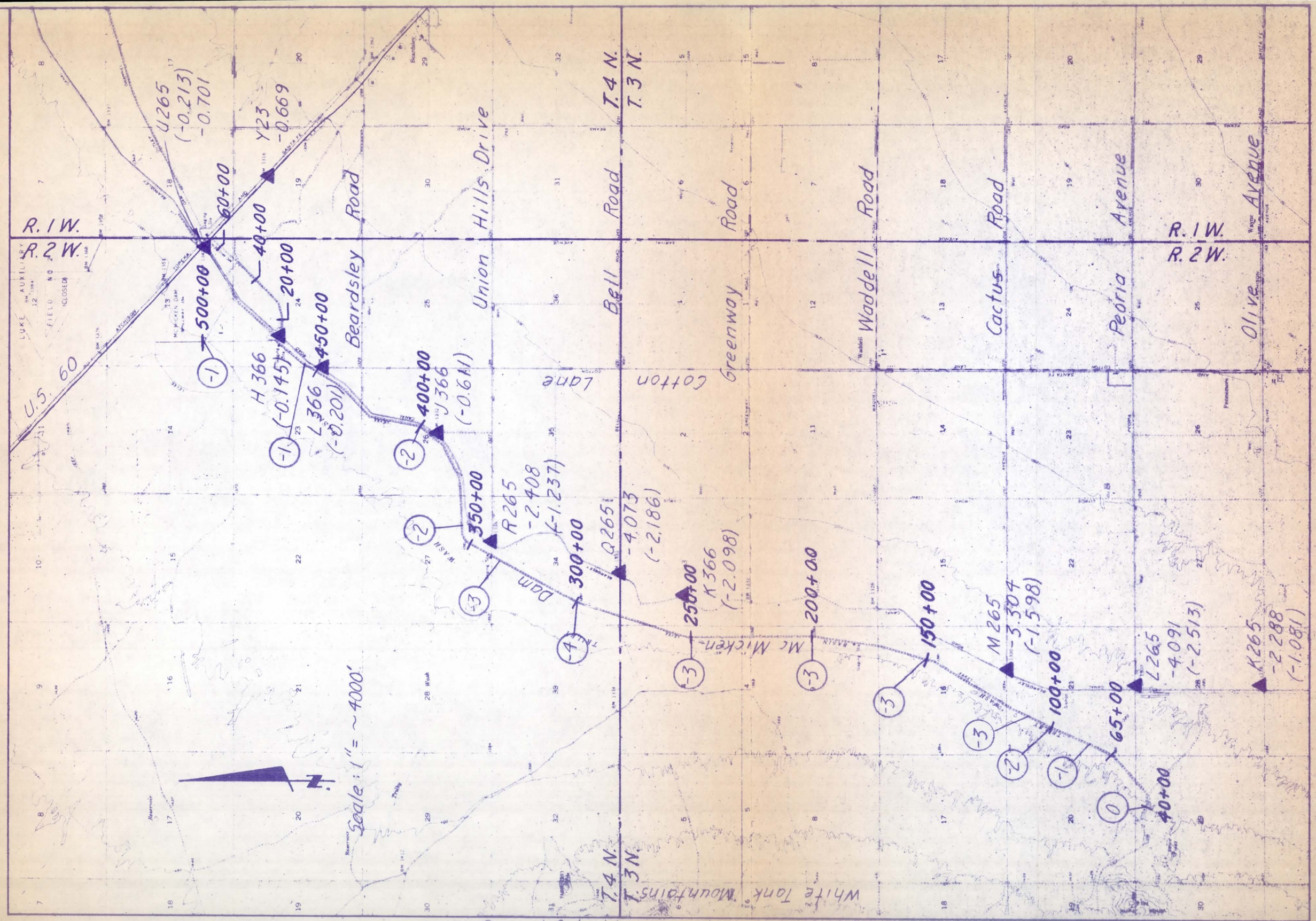

Legend
▲ J265 : NGS monitoring point
-4.011 : subsidence in feet 1948-1981
(-2.005) : subsidence in feet 1967-1981
(-1) : Apparent settlement of Mc Micken Dam Crest in feet; 1956-1982

Ground Subsidence in the Vicinity of Mc Micken Dam

Out of order

Figure 15?

Not referenced in the text

Map Base: U.S.G.S. 7.5 Minute Topographic Quadrangle Maps, Mc Micken Dam (1957); Waddell (1977). Data Reference: NGS published and unpublished Leveling Data.

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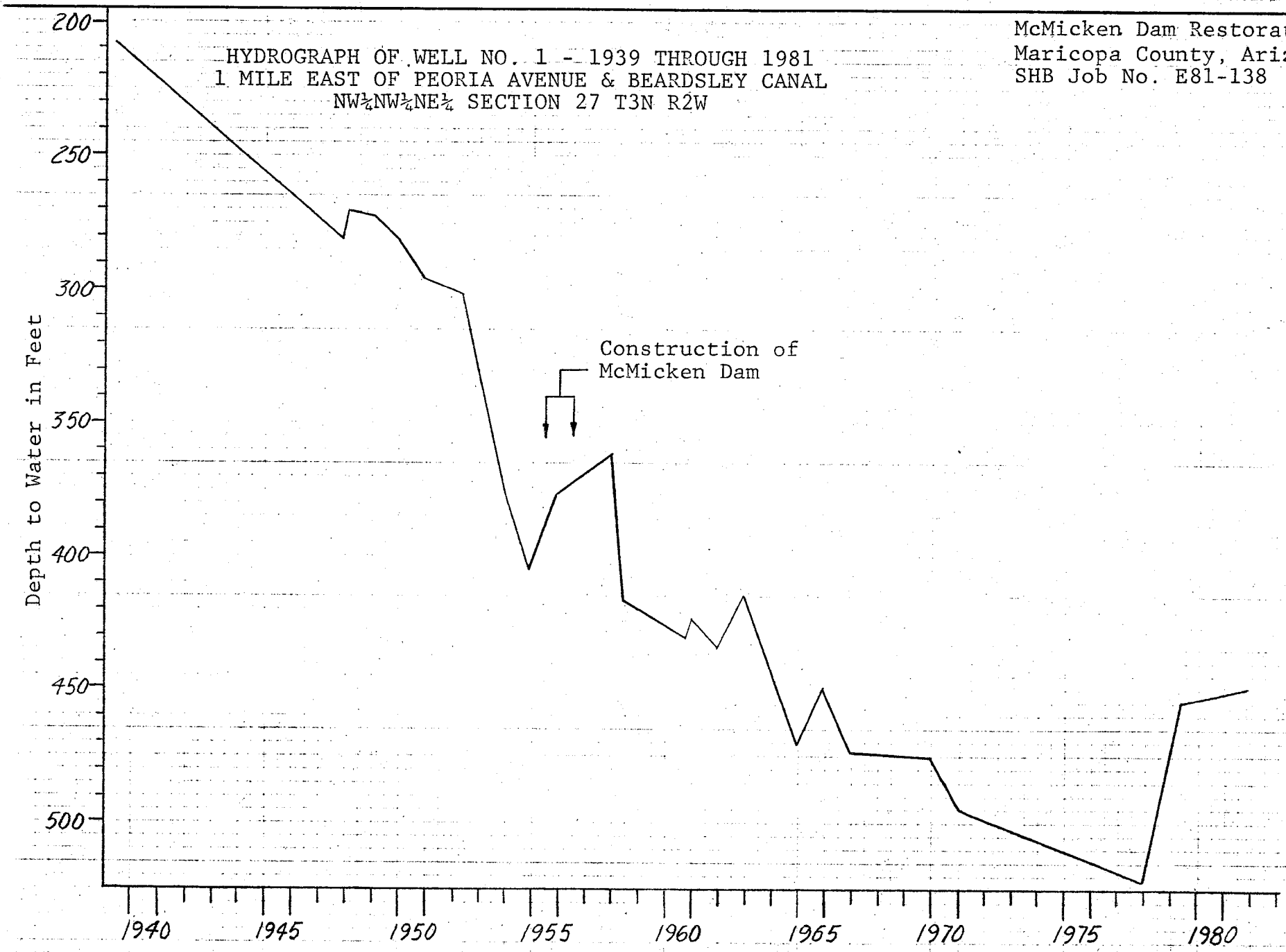

FIGURE 8

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HYDROGRAPH OF WELL NO. 2 - 1950 THROUGH 1981
BEARDSLEY CANAL & CACTUS ROAD
NE¼NW¼NE¼ SECTION 21 T3N R2W

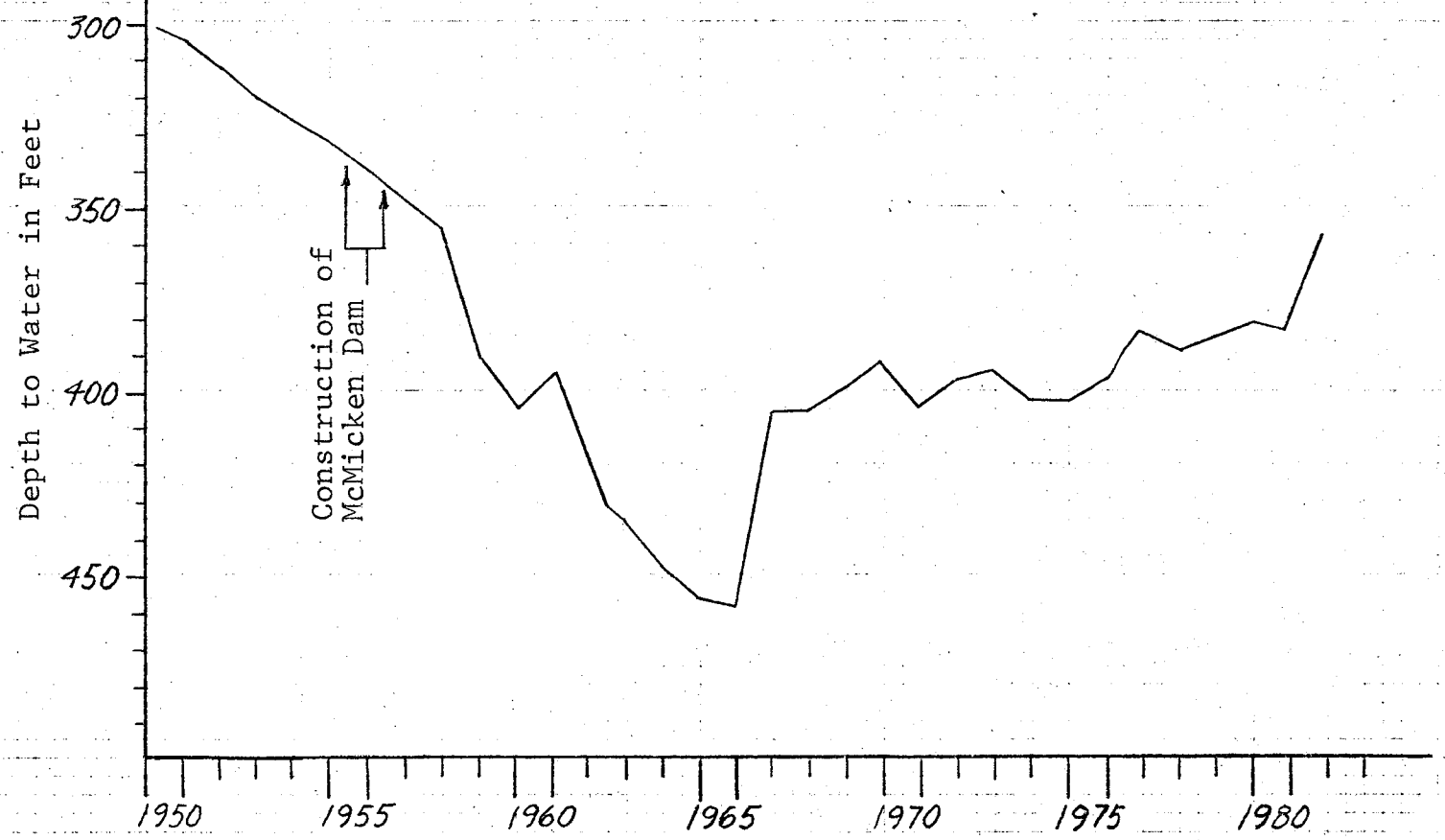

FIGURE 9

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HYDROGRAPH OF WELL NO. 4 - 1947 THROUGH 1981
BEARDSLEY CANAL & BELL ROAD
NE¼NE¼NW¼ SECTION 3 T3N R2W

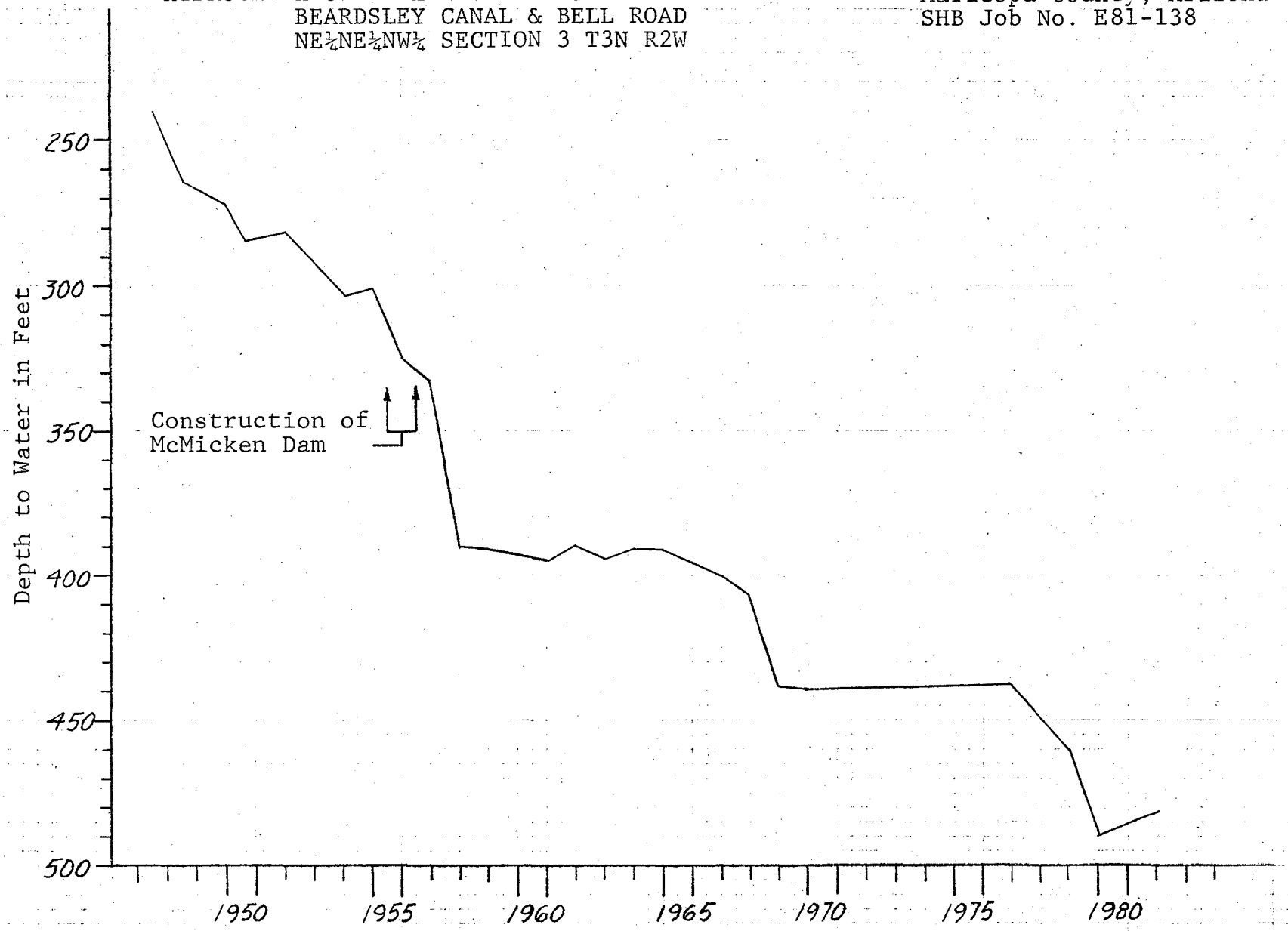

FIGURE 10

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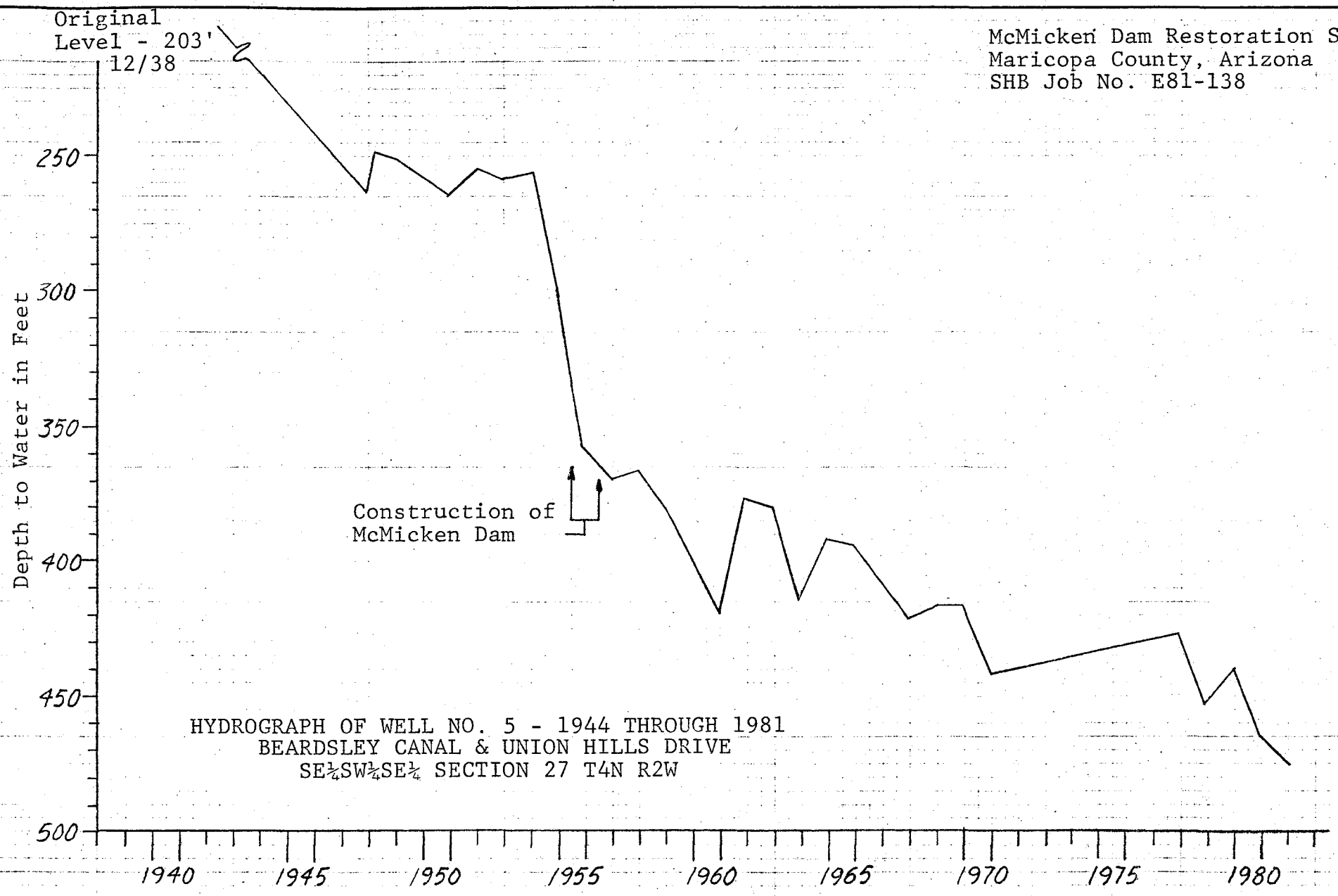

HYDROGRAPH OF WELL NO. 5 - 1944 THROUGH 1981
BEARDSLEY CANAL & UNION HILLS DRIVE
SE¼SW¼SE¼ SECTION 27 T4N R2W

FIGURE 11

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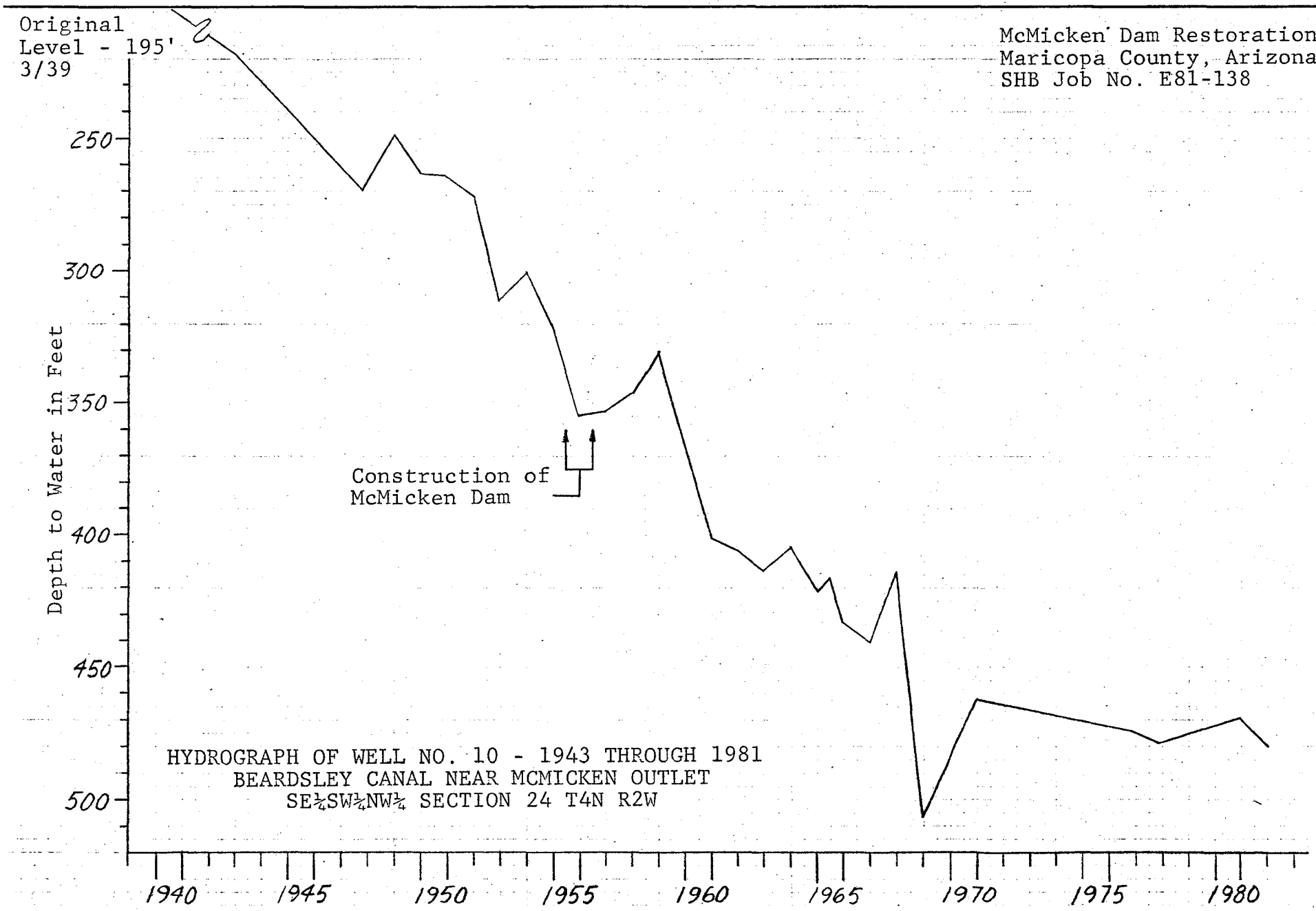

FIGURE 12

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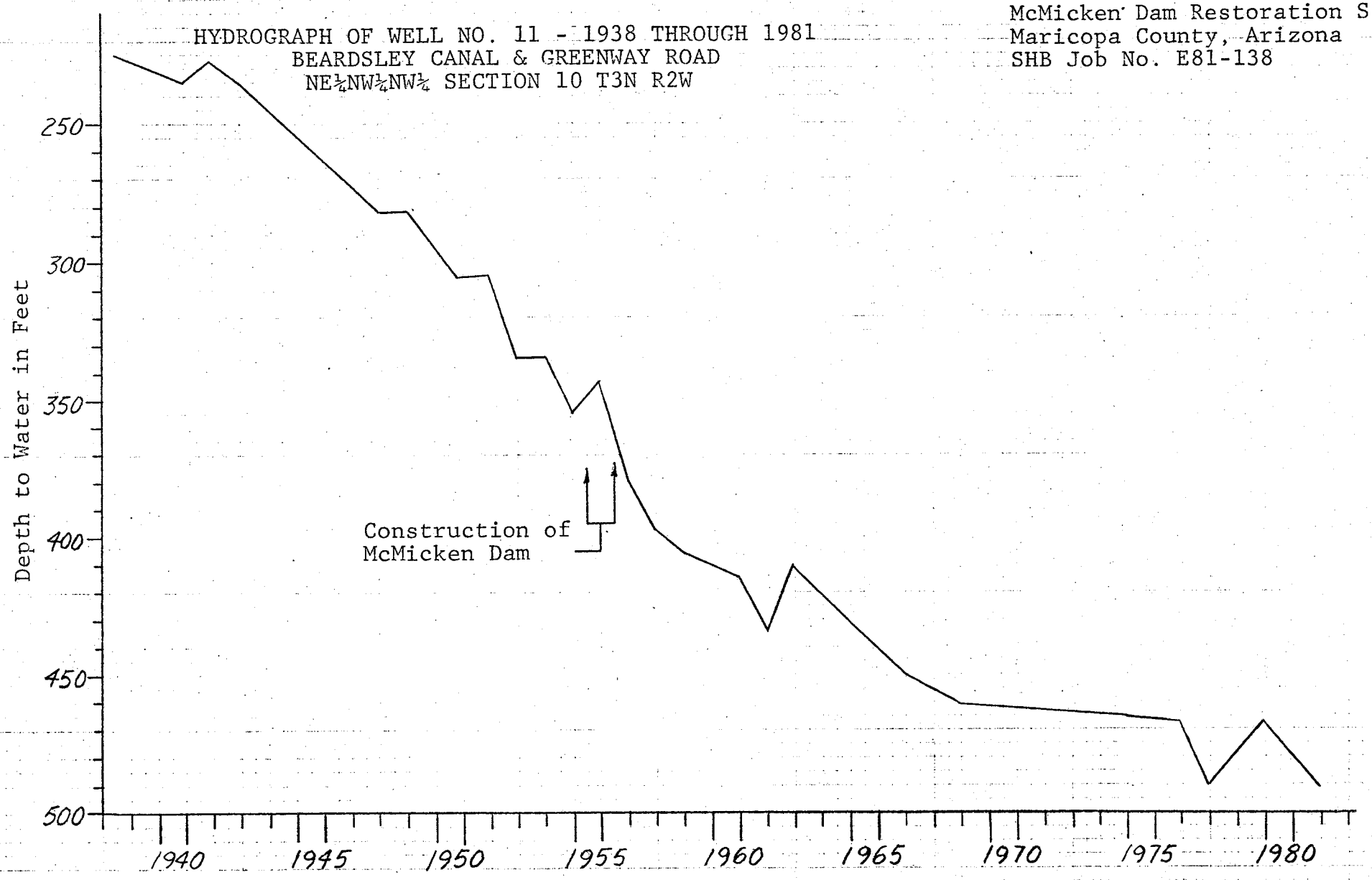

FIGURE 13

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decline overall appears to be progressing at a slower rate since 1970. In a majority of the well data analyzed, the rate of decline was generally 9 feet per year prior to 1970 and has decreased to between 3.5 to 1.5 feet per year between 1970 and the present.

Transmissivity of the alluvial aquifer of the study area first increases from about 25,000 GPD/day/foot basinward and away from McMicken Dam (Eaton and others, 1972). From values in excess of 50,000 GPD/day/foot, transmissivity decreases substantially in the vicinity of El Mirage and Luke Air Force Base. These changes in transmissivity appear to correlate, in part, with the occurrence of the Luke earth fissures, the Luke salt body, and collapsed wells.

Is this the proper unit of measure?

5.4 Earth Fissuring

Evidence of subsidence and earth fissuring has been compiled in the region between Phoenix and the White Tank Mountains as early as 1964 (Stulik and Twenter). More recent studies by Eaton, et al (1972) and Schumann (1979) have added considerable information on the extent of earth fissuring in the Salt River Valley. Within the study area, the most significant fissures described by these authors are those located about 4 miles east of the southern end of McMicken Dam in Sections 25 and 26, T3N, R2W. This location is near the Luke Salt Body described by Eaton, et al (1972).

The U.S. Army Corps of Engineers (1973) reported finding evidence of surficial ground cracking during a limited inspection of the area in the vicinity of McMicken Dam. This cracking was only found on cultural features such as roads, ditches and canal linings, and they were not nearly as large as the fissures located near the Luke Salt Body. These cracks are very likely not related to earth fissuring, but rather are due to moisture sensitive soils collapsing below these cultural features. The cracking found by the Army Corps of Engineers and the earth fissuring described by the above authors are shown on Plates 1 through 4 found in the map pocket at the back of Appendix ~~A.~~ C

Earth fissures detected by SHB photogeologic methods were for the most part concentrated near Luke Auxiliary Field No. 3 (Sections 3 and 4, T3N, R1W, Sections 33 and 34, T4N, R1W), the western edge of Luke Air Force Base (Sections 6, 5, 8 and 17, T2N, R1W) and an area several miles east of Luke Air Force Base (Sections 2, 3, 10 and 11, T2N, R1E). Other lineations which were not field checked were scattered in nearly all portions of the study area outside the vicinity of the dam.

Several of photo lineaments were initially identified within 1,000 feet of the McMicken Dam alignment. After ground reconnaissance and trenching efforts, only one set of lineaments are verified as being earth fissures. As depicted on a photograph presented in Appendix A,

these fissures trend north-south, are subparallel to the McMicken Dam alignment between Stations 50+00 to 63+00, and are surficially expressed about 600 to 1,000 feet east of the dam's downstream toe. These fissures are herein named the Fenne Knoll Fissures.

The surficial expression of the Fenne Knoll Fissures is a series of potholes that are generally less than 1 foot long, 6 inches wide and usually 6 to 18 inches deep. There are a few open cracks 2 to 3 feet long, 2 to 6 inches wide and 1 to 2 feet deep. Two major fissures are present which appear to splay where they converge. Each major fissure segment is about 750 feet long.

Five backhoe trenches were dug across the Fenne Knoll Fissures in order to observe their subsurface expression. In two of these trenches, a fissure was visible from the surface to the total depth of the trench. In both trenches, the crack was normally about ¼ to ½ inch wide and did not have any infilling of soil. In the southern trench (no. 1), the crack widened to about 4 inches between a depth of 4 to 5 feet on one wall and about 2 inches wide on the other wall. In one trench (no. 9), the exposed fissure was visible from the surface to 15 feet. The fissure was normally about 3/4 inch wide and has been filled with darker soil from about 5 to 15 feet. Between 8 and 15 feet, there is another crack about 2 feet east of the main crack. This crack is very similar in appearance to the main

crack. About 500 feet north of trench no. 9, another trench (no. 10) was advanced to a total depth of 20 feet. In this trench, the exposed fissure extends from the surface to the total depth of the trench. The fissure in this trench was normally about ½ to 3/4 inch wide, but at about 14 to 16 feet deep, the fissure divides and has left an area about 1 foot wide and 2 feet deep that is filled with loose, coarse sand. Below 16 feet, the fissure closes again to a crack ½ to 1 inch wide and remains that way to the bottom of the trench. The final trench (no. 11) on the Fenne Knoll Fissure system was dug in a location where the surface features indicated a lateral offset of 5 feet in the lineation of a fissure. This trench was advanced to a total depth of 13 feet, but fissuring was only found on the north wall between the surface and 5 feet. The fissure that was found was about ½ inch wide and was filled with dark soil. On the south wall of the trench, there were numerous rodent holes which may have obscured the fissure.

An additional three backhoe trenches were dug in the south one-half of Section 2, T2N, R1W, which is just east of Dysart Road and north of Glendale Avenue. These trenches were dug tranverse to several well developed earth fissures. These fissures were found to have a larger surface and subsurface expression than the Fenne Knoll Fissures. The fissures were open to depths exceeding 5 feet and were as wide as 3 feet in places.

These are older fissures which have been widened by erosion. In some areas, the fissures were continuously open for a distance of over 200 feet. The total length of the fissure system is probably in excess of ½ mile.

5.5 Ground Subsidence

As presented on Figure 14, ground subsidence from 1948 to 1981 at points along the NGS level line has ranged from about 0.7 to 4.1 feet. From 1967 to 1981, subsidence has been between about 0.1 to 2.5 feet for all 11 points. As shown on Figure 14, the rate of subsidence has increased from 0.062 to 0.099 feet/year (before 1967) to 0.077 to 0.156 feet/year (after 1967) at five of the six points which have 1948-67-81 data. Point U265 at U.S. Highway 60 is the only one of the six locations at which the rate of subsidence has decreased after 1967 from the rate previous to 1967.

The greatest subsidence occurs along the NGS level line at points east of Station 65+00 (L265) and Station 275+00 (Q265). Subsidence (1948 to 1981) appears to be about 3 feet between these stations and rapidly decreases to below 3 feet at points near and north of Station 350+00.

Based upon 1982 crest elevations of McMicken Dam, the southernmost portion of the alignment has experienced little, if any, settlement. Northward to Station 300+00, crest elevations lower to about 4 feet below

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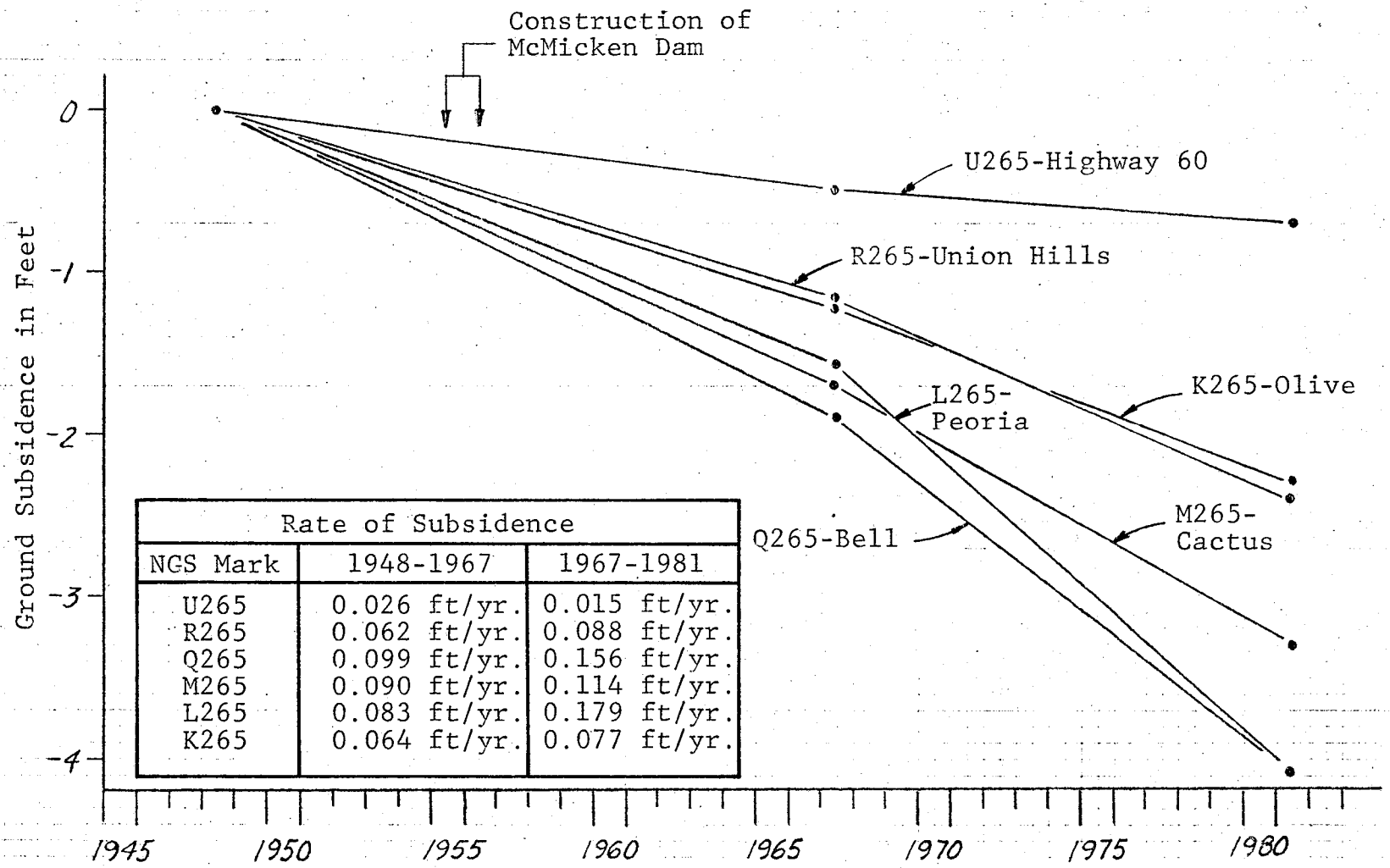
GROUND SUBSIDENCE ALONG NGS LEVEL LINE
1948 THROUGH 1981



Rate of Subsidence		
NGS Mark	1948-1967	1967-1981
U265	0.026 ft/yr.	0.015 ft/yr.
R265	0.062 ft/yr.	0.088 ft/yr.
Q265	0.099 ft/yr.	0.156 ft/yr.
M265	0.090 ft/yr.	0.114 ft/yr.
L265	0.083 ft/yr.	0.179 ft/yr.
K265	0.064 ft/yr.	0.077 ft/yr.

FIGURE 14

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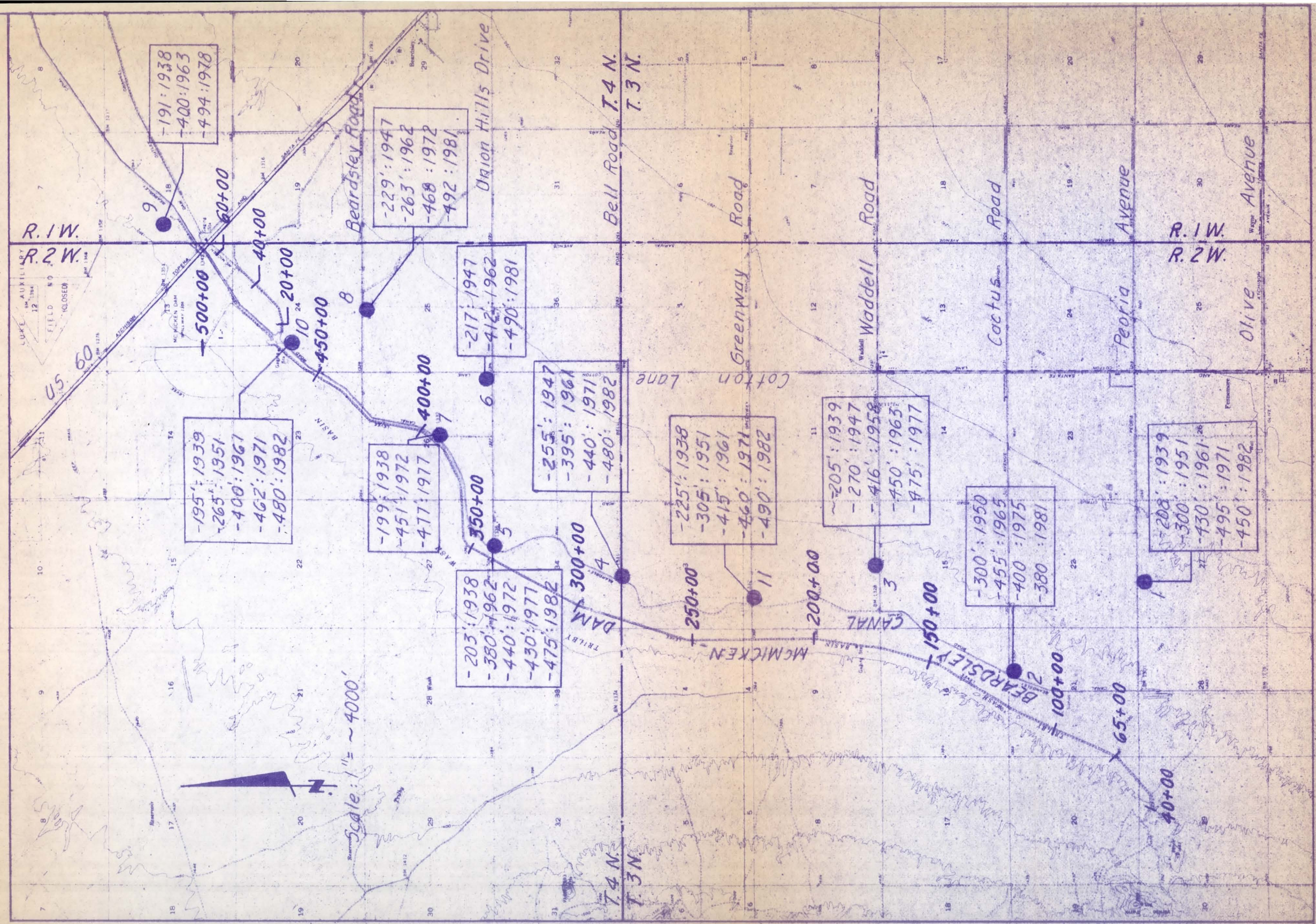
the as-built elevation of 1361 feet. North of Station 300+00, crest elevations again gradually rise to within 1 foot below the constructed altitude. This is shown graphically on Figure 15.

5.6 Geotechnical Profile of McMicken Dam

5.6.1 Embankment Soils

A description of the embankment soils can be divided into three general categories. From Station 40+50 to Station 250+00, the embankment soils consist of low plasticity silty and clayey sands with gravel and lesser amounts of low plasticity silts and clays. Standard penetration testing indicates the embankment is very firm to hard in this section with blow counts typically in excess of 50 blows per foot. Moisture content testing indicates a range from 2 to 9 percent in the embankment. Typically, fill within the upper 5 feet is in the 2 to 6 percent moisture range.

The embankment from Station 250+00 to the ending station at the spillway, Station 500+00, is divided into two distinct sections which are determined by whether the soil is in the older dike or the newer embankment. The newer embankment soils are predominantly low to moderately plastic clays and clayey sands. Standard penetration testing indicates the embankment is very firm to hard in this section, with blow counts typically in excess of 50 blows per foot. Moisture



Legend

-200 : 1975 ← date of measurement
← depth to water (approx.)

2 ● water well

Out of order Figure 7

Depth to Groundwater in Vicinity of McMicken Dam

Map Base: U.S.G.S. 7.5 Minute Topographic Quadrangle Maps, McMicken Dam, 1957; Waddell, 1971. Data Reference: U.S.G.S. and Maricopa County Municipal Water Conservation Dist. Well Data, 1938-1981.

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content testing indicates a range from 6 to 12 percent in the embankment. Typically, the upper 5 feet of the fill is in 6 to 8 percent moisture range. Consolidation testing of the embankment soils in this section showed collapse type settlements of from 2 to 7 percent upon saturation.

The third section consists of the older dike which is located between Stations 357+00 to Station 475+00. The soils are predominantly low to medium plasticity clays with silty and clayey sands and gravels. Standard penetration testing indicates the older dike is moderately firm to firm with blow counts typically ranging from 10 to 25 blow counts per foot. Moisture content testing indicates a range from 4 to 10 percent in the older dike. Typically, the upper 5 feet of fill is at the lower end of the moisture content range from 4 to 6 percent. The extent of the old dike beyond Station 475+00 was not determined. Consolidation testing of the embankment soils showed collapse type settlements of from 1 to 10 percent upon saturation.

? What this statement refers to ?

5.6.2 Foundation Soils

The foundation soils underlying the McMicken Dam embankment can be divided into two distinct regions. Between Stations 40+50 and approximately Station 250+00, there is typically a shallow surface layer of soil overlying denser, more cemented soils. The

shallow surface soils are predominantly silt with considerable silty and clayey sands and gravels. This layer varies in depth from 1 to 8 feet deep. Standard penetration testing indicates these surface soils are moderately firm to firm with blow counts typically in the range from 10 to 30 blows per foot. Moisture content testing indicates a range from 1 to 6 percent.

The denser soils underlying the shallow surface soils consist of weakly to moderately cemented, low plasticity silty sands and gravels with lesser amounts of low plasticity silts and clayey sands. Standard penetration testing indicates these soils are hard, with blow counts typically in excess of 100 blows per foot. Moisture content testing indicates these soils are slightly moist with in situ moisture contents ranging from 2 to 8 percent.

The second region extends from approximately Station 250+00 to the end of the dam near Station 500+00. The foundation soils in this region are composed of three distinct soil types. The first type consists of a surface layer of low to medium plastic clay with considerable silty and clayey sand. This layer varies in depth from approximately 3 to 8 feet deep. Standard penetration testing indicates these surface soils are moderately firm to firm with blow counts typically in the range from 10 to 25 blows per foot. Moisture content testing and visual observation indicate that

the moisture contents vary considerably depending on location. Variations from 1 to 25 percent are observed in the samples taken upstream of the dam, and variations from 1 to 15 percent are observed on samples taken downstream of the dam. Consolidation testing of the foundation soils in this region showed collapse type settlements of from 0 to 14 percent upon saturation.

Underlying the surface soils from Station 250+00 to 500+00 are more dense soils composed of moderate plastic silty and clayey sands. This layer varies in thickness from 25 to 35 feet thick, with resulting depths from 35 to 45 feet deep. Standard penetration testing indicates these soils are very firm to hard with blow counts typically in the range from 30 to 80 blows per foot. Moisture content testing and visual observation indicate that the moisture contents vary considerably depending on location. Variations from 2 to 25 percent are observed in the samples taken upstream of the dam, and variations from 2 to 14 percent are observed on samples taken downstream of the dam. Consolidation testing of the foundation soils from this region showed typical collapse type settlements upon saturation of less than 3 percent.

Underlying the first and second layers from Station 250+00 to Station 500+00 is a third soil stratum which is typically weakly to moderately cemented, low to moderately plastic silty and clayey sands. There are

lenses of silt and clay varying from low to high plasticity as well as lenses of well to poorly graded, nonplastic sands distributed through this stratum. Standard penetration testing indicates these soils are very firm to hard with blow counts typically in the range from 30 to 100 blows per foot. Moisture content testing and visual observation indicate that the moisture contents vary considerably depending on location. Variations from 1 to 14 percent are observed in the samples taken upstream of the dam, and variations from 1 to 10 percent are observed on samples taken downstream of the dam.

5.6.3 Embankment Cracking

As described in Section 4.3, a ground reconnaissance of the entire dam was performed noting all surficial expression of cracking. Cracks and holes were found varying from holes with openings less than 1 by 1 inch to as large as 1 by 3 feet. Most cracks were found to be between 6 inches and 1 foot deep, but some cracks exceeded 2 feet in depth. Areas of the dam that showed a higher concentration of surface cracks are as follows:

Station 125+00 to 150+00
Station 225+00 to 250+00
Station 275+00 to 325+00
Station 400+00 to the end of the dam.

Most of the larger cracks were located north of Station 425+00.

5.6.4 Outlet Channel

The controlled outlet channel from the concrete outlet at McMicken Dam to U.S. 60 was found to have some severe erosional features consisting of localized gullying and piping channels. These features are located in the upstream bank and are concentrated along the east end of the channel. The upstream bank is graded to drain away from the channel and apparently water has ponded upstream of the bank, then rapidly eroded or piped through the bank into the channel during periods of rainfall. Some minor cracking of the downstream channel dike was found in the trenching investigation.

6. DISCUSSION, CONCLUSIONS & RECOMMENDATIONS

It is concluded that the primary cause of the existing cracks in the dam is foundation settlement due to moisture increases in the collapsing soils which are present along most of the alignment. Possible secondary causes are internal settlements within portions of the embankment and shrinkage of the embankment soils.

A vertical drain in the center of the dam, a system of finger drains and a toe drain extending to firm cemented soils are the main elements of the recommended method of repairs.

A detailed evaluation of the cause of existing cracks and the potential future cracks is presented in Section 6.1. Evaluations of remedial measures and recommendations for repair are given in Section 6.2 while stability and related analysis of the recommended sections are presented in Section 6.3.

6.1 Causes of Existing Cracks & Potential for Future Cracking

Stability and seepage analysis of the embankment is presented in Section 6.3, while the recommended operating plan is given in Section 6.4.

6.1.1 Earth Fissures Due to Basin Subsidence

The investigation for earth fissuring in the vicinity of the dam made during this study is described in Section 4.2. The geology, groundwater hydrology and history of groundwater declines, existing earth fissures and history of ground subsidence are discussed in Sections 5.2 through 5.5.

No evidence of earth fissuring contributing to the existing cracks in the embankment was found during this investigation. Basin subsidence and earth fissuring as it relates to possible future effects on the dam are discussed in the following sections of this report. It is believed that there is a high probability of at least several earth fissures forming through the dam in the next several decades.

6.1.1.1 Ground Subsidence

In the United States, ground subsidence which has been related to the withdrawal and/or decline of groundwater has been identified in 17 general areas (Poland, 1981). Of these 17 areas, subsidence which exceeds about 3 feet occurs in four states; Texas, Arizona, Nevada and California (Poland, 1981). Within Arizona, known subsidence has been most severe in the following areas: the West Phoenix Basin near Luke Air Force Base, the Queen Creek area, the Stanfield area, the Bowie area, the Wilcox area and the Eloy area (Poland, 1981). Table 1 summarizes the amount of groundwater decline and subsidence which has occurred in basins in which measurements have been published.

Being within the Luke area, ground subsidence caused by a substantial decline in the groundwater table has and will continue to affect McMicken Dam. As described by Lofgren (1968), this subsidence results from the consolidation of the basin sediments in response to changes in the effective stresses created by groundwater declines. In the case of alluvial groundwater basins which contain fine grained deposits, this settlement is essentially nonelastic and a permanent decrease in porosity occurs.

Groundwater decline changes the effective stress on the alluvial profile in two basic ways (Lofgren,

TABLE 1

Groundwater Decline & Ground Subsidence in Arizona

Area	Water Level Decline	Maximum Subsidence
Luke	200 to >300 feet:1923-77(1)	>4 feet:1948-81(2)
Queen Creek	200 to >400 feet:1923-76(1)	>4.5 feet:1976(3)
Stanfield	300 to >450 feet:1923-77(1)	11.9 feet:1952-77(1)
Eloy	200 to 300 feet:1923-77(1)	12.5 feet:1952-77(1)
Wilcox	>90 feet:1913-78(4)	5.3 feet:1937-74(4)
Bowie	>270 feet:1952-76(4)	4.6 feet:1952-74(4)

References: (1) Laney and others (1978)
(2) NGS Leveling Data (1981)
(3) Poland (1981)
(4) Holzer (1980)

1968). As decline occurs, the buoyant support of the sediments which are being dewatered is lost. This condition causes additional vertical stress on the column of soil above the original water table. A seepage stress may also be induced by the lowering of the piezometric surface. This stress is caused by vertical hydraulic gradients across confining or semiconfining clayey beds within the subsurface profile.

In the case where fine grained sediments are present, the rate of consolidation resulting from the induced stress is dependent upon the rate of dissipation of pore water pressure during dewatering (Lofgren, 1968). The slow draining of fine grained sediments can cause the ultimate consolidation of the sediments to be delayed for years or in some cases many decades.

Assuming that water table conditions and not confined groundwater conditions exist under McMicken Dam, the effect of seepage stresses can be neglected. This assumption may or may not represent the true hydrogeologic condition; however, an estimate of the change in effective stress can be derived. Applying saturated and unsaturated unit weight relationships described by Lofgren (1968), the effective stress below the lowered water table is increased about 0.60 foot of water per foot of

water table lowering. In the case of the approximate 300 feet of decline experienced near McMicken Dam, the change in effective vertical stress below the existing water table is about 180 feet of water or about 77 pounds per square inch.

Near McMicken Dam, consolidation of the alluvium caused by effective stress changes is expressed in ground subsidence ranging from about 0.7 to 4.1 feet for the period of 1948 to 1981. In the most severe case, the ratio between ground subsidence and groundwater decline is presently about 1:75. Even though the rate of groundwater decline has decreased in the last ten years and, in the case of wells 1 and 2, ceased, the rate of subsidence has generally increased since 1967. This is probably an expression of the time lag between induced stress and consolidation as a result of the slow draining clayey alluvium present. The total consolidation caused by the 300 feet of groundwater decline probably will not be essentially complete for several decades or more. Also, further groundwater declines and, in turn, additional subsidence will almost certainly occur as a result of continued well pumpage. It is probable that subsidence at rates of equal to or in excess of those presently being experienced will continue to affect McMicken Dam in the foreseeable future.

The existing data indicate that two areas in the

vicinity of McMicken Dam have not experienced substantial ground subsidence even though groundwater declines nearby have been great. Along the southernmost segment of the dam, the lowering of the crest elevation since construction has been minor. The thickness of the alluvium is probably less than 500 feet in this area and the alluvium appears to be coarser grained due to its proximity to the mountain front and, thus, less compressible. In addition, the groundwater declines have been progressively less near the southernmost portion of the dam. Lessor rates and magnitudes of subsidence in the northern one-third of the dam are apparently due to smaller groundwater declines and thinner (and perhaps stiffer) alluvium.

6.1.1.2 Earth Fissuring

Earth fissuring which is associated with land subsidence due to groundwater withdrawal has been identified in ten alluvial basins within the Mojave and Sonoran desert regions (Holzer and Davis, 1981). Within Arizona, fissures have been detected in the areas listed on Table 2. Supplementary data concerning the character of these fissures is also presented on Table 2.

Earth fissuring related to ground subsidence and groundwater decline has been attributed to several

TABLE 2

Known Arizona Earth Fissures Which Are Associated With Ground Subsidence Due to Groundwater Withdrawal

Location	Approximate Number	Maximum Length	Vertical Displacements	Size of Fissure Openings	Remarks
Luke AFB and directly east of Fennemore	>9[1]	1.8 mi.[1]	None		Possibly associated with Luke Salt Body[2]. Group of fissures first observed in 1961[3]; no activity observed since 1971[4]. Suspected occurrence over bedrock ridge with relief of 30 to 45m at depth of less than 130m[5].
Paradise Valley near Phoenix Mountains	1[5]				Suspected occurrence over bedrock ridge with relief of 30 to 45m at depth of less than 130m[5].
Near Highway 60 - 6 miles east of Mesa	4[1]	0.5 mi.[6]		3.0 ft. - eroded[6]	Possibly controlled by bedrock ridge[6].
Baseline & Meridian Roads	>2[1]	~0.5 mi.[1]	None		Associated with near surface bedrock anomalies[7].
North flank of Santan Mountains	>17[1]	~1.0 mi.[1]	1.5 ft.[8]		Heavily eroded; up to 50 feet in depth[8].
Stanfield-Heaton Area	>21[1]	~1.0 mi.[1]			All fissures except one are along fringe of Stanfield Basin.
Picacho-Eloy Area	>150[1]	2.1 mi.[9]	>2.0 ft.[10]	<½ inch[1]	Major features occur along western flank of the Picacho Mountains - entire system in this area is approximately 8 miles long. Major portion of fissures occur around fringe of basin. Twelve fissures detected in areas of deep alluvium.
Bowie Area	>200[11]	1.5 mi.[11]	None[11]		Majority of fissures form complex polygonal patterns[11].
Wilcox Area	200[11]	0.75 mi.[11]	None[11]		Major portion of fissures are short and form complex polygonal patterns[11].
Tucson & Sells Areas					Only general locations noted[8].

References:
(1) Lahney and others (1978)
(2) Eaton and others (1972)
(3) Stulik and Twenter (1964)
(4) Scott, personal communication (1982)
(5) Larson and Pewe (1981)
(6) Anderson (1978)
(7) Carpenter, personal communication (1982)
(8) Raymond and others (1978)
(9) Holzer and Davis (1981)
(10) Holzer (1978)
(11) Holzer (1980)

factors by different investigators. Jachens and Holzer (1979) note several hypotheses which have been proposed. In summary, these contributing factors are related to horizontal tensile strain caused by (1) localized differential consolidation over buried bedrock irregularities, (2) horizontal seepage stresses, (3) horizontal contraction generated by capillary stresses in the dewatered zone, or (4) rotation of rigid overburden slabs caused by regional differential compaction. The mechanics involved in the formation of earth fissures due to basin subsidence is well understood. Horizontal tensile strains develop in zones of maximum differential settlements caused by variations in the stiffness and thickness of alluvium and groundwater declines. This is clearly demonstrated by both numerical and finite element models of subsidence (Lee and Shen, 1969, National Coal Board, 1975).

The phenomenon of earth fissuring has only been extensively investigated in three areas within Arizona. Larson and Pewe (1981) reported the results of a geophysical survey in the vicinity of the Paradise Valley fissure. Gravity anamolies indicate that the fissure lies near a buried bedrock ridge with a relief of about 100 to 130 feet at a depth of less than 430 feet. Localized differential consolidation is suspected as being the cause of the fissuring. A study of the earth fissures near

Baseline and Meridian Roads by the U.S. Geological Survey (USGS) and the U.S. Bureau of Reclamation (BurRec) is ongoing. Geophysical data again indicates that a shallow bedrock irregularity has caused localized differential consolidation and subsequent fissuring (Carpenter, personal communication, 1982). The remaining area in which considerable geologic research has been completed is the Picacho-Eloy Basin. T.L. Holzer of the USGS in conjunction with the BurRec and the Arizona Department of Transportation has conducted geophysical, exploratory drilling and hydrologic evaluations within the basin. One major fissure, the Picacho Fault, displays a maximum vertical offset of about 2 feet and appears to be coincident with a buried bedrock fault which offsets alluvium and bedrock and creates a groundwater barrier (Holzer, 1978). As is the case with the Luke area, fissures do occur near the center of the Picacho-Eloy Basin where deep alluvium is probably present (Lahney and others, 1978).

The depth to which earth fissures extend is not fully known. It is suspected that many may extend to a considerable depth, perhaps hundreds of feet. The deepest trenching of an earth fissure was performed in California on the Pixley Fissure (Guacci, 1978). This fissure was continuous to a depth of at least 55 feet.

Many earth fissures cross local drainage paths and

thereby capture a considerable amount of runoff. These fissures quickly erode and form fissure gullies. As an indication of the subsurface extent and erosion potential of some fissures, introduction of water at a rate of 550 gpm into the Meridian and Baseline Roads fissure system resulted in no overflow after five days of continuous pumping (Raymond, personal communication, 1982).

A geologic environment quite similar to sites of other known fissuring appears to exist near the Fenne Knoll Fissures. A substantial difference in the amount of subsidence exists between the southernmost alignment of McMicken Dam and the NGS Point L265. This segment of the dam appears to have subsided less than 1 foot since construction, where NGS Point L265 has subsided a calculated 3.4 feet since 1956. The depth to bedrock appears to be less than 800 feet in this area (Oppenheimer and Sumner, 1980) and the close proximity of exposed bedrock knolls suggests that a bedrock ridge or other irregularity could underlie the Fenne Knoll Fissures.

Considering the virtual certainty that major subsidence of the basin will continue, and the suspected geologic conditions discussed above, it is concluded that the portion of embankment between Stations 40+00 and 120+00 has the highest risk of being affected by earth fissures in the immediate future.

The variation in the amount of subsidence between NGS Points Q265, R265 and J366 indicates that substantial differential consolidation is occurring in this area. For this reason, the embankment zone between Stations 290+00 and 400+00 appears to have the second highest risk of experiencing earth fissuring in the near future. Taking into account that the Luke area and other basins have experienced fissuring where deeper alluvial profiles exist and no bedrock irregularities seem to control the location of the fissuring, the possibility of fissuring affecting other segments of the dam in the near future cannot be eliminated. Earth fissures which might extend through the dam in the next few decades would be unlikely to be at an angle of more than 30 degrees to the dam axis.

In the long-term, heavy pumping of groundwater in the portion of the basin north of the dam and north of the White Tank Mountains may well occur. This would produce a pattern of groundwater declines and settlements which would form earth fissures generally perpendicular to the northerly portion of the dam. This must be considered to be a strong possibility over a 50 to 100 year time frame.

Earth fissures would be expected to create cracks about ½ to 3/4 inch wide through the dam embankment and the more cemented soils below the embankment.

This kind of crack would in all probability lead to very rapid failure of the dam in the event of major runoff into the reservoir. for unimproved conditions

6.1.1.3 Embankment Cracking Directly Due to Basin Settlements

The possibility of the basin subsidence creating sufficient differential settlement to crack the embankment without an earth fissure occurring was investigated.

A simplified Lee and Shen analysis was performed on the dam using the observed subsidence settlements between 1955 and 1982, shown in Figures 21 and 22. The depth to bedrock was estimated from Figure 4. The settlement profile, horizontal crest movement plot and calculated horizontal strains are shown in Figure 23 and Table 5. This analysis determined that the dam has experienced minor amounts of both compressive and tensile horizontal strain due to the subsidence. Tensile strains were found between Stations 40+00 and 90+00, with a maximum value of 0.017 percent. The remainder of the dam was either in compression or zero strain due to subsidence. Leonards and Narain (1963) have determined that extension strains of greater than about 0.25 percent are sufficient to cause cracking. Therefore, cracking at McMicken Dam due to the basin subsidence that has taken place to date does not appear to be a

McMICKEN DAM CREST SETTLEMENT PROFILE
1955 - 1982

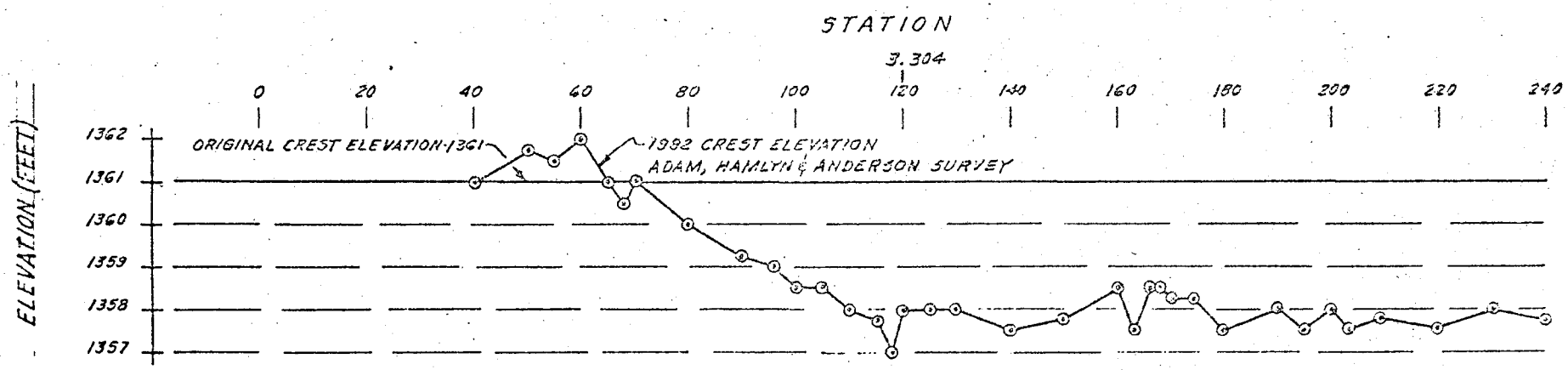

FIGURE 21

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Project: MCMICKEN DAM
Job No.: E 81-138
Computed by: J.D.D. Ckd. by:
Date: 2-22-82 Page 1 of 2

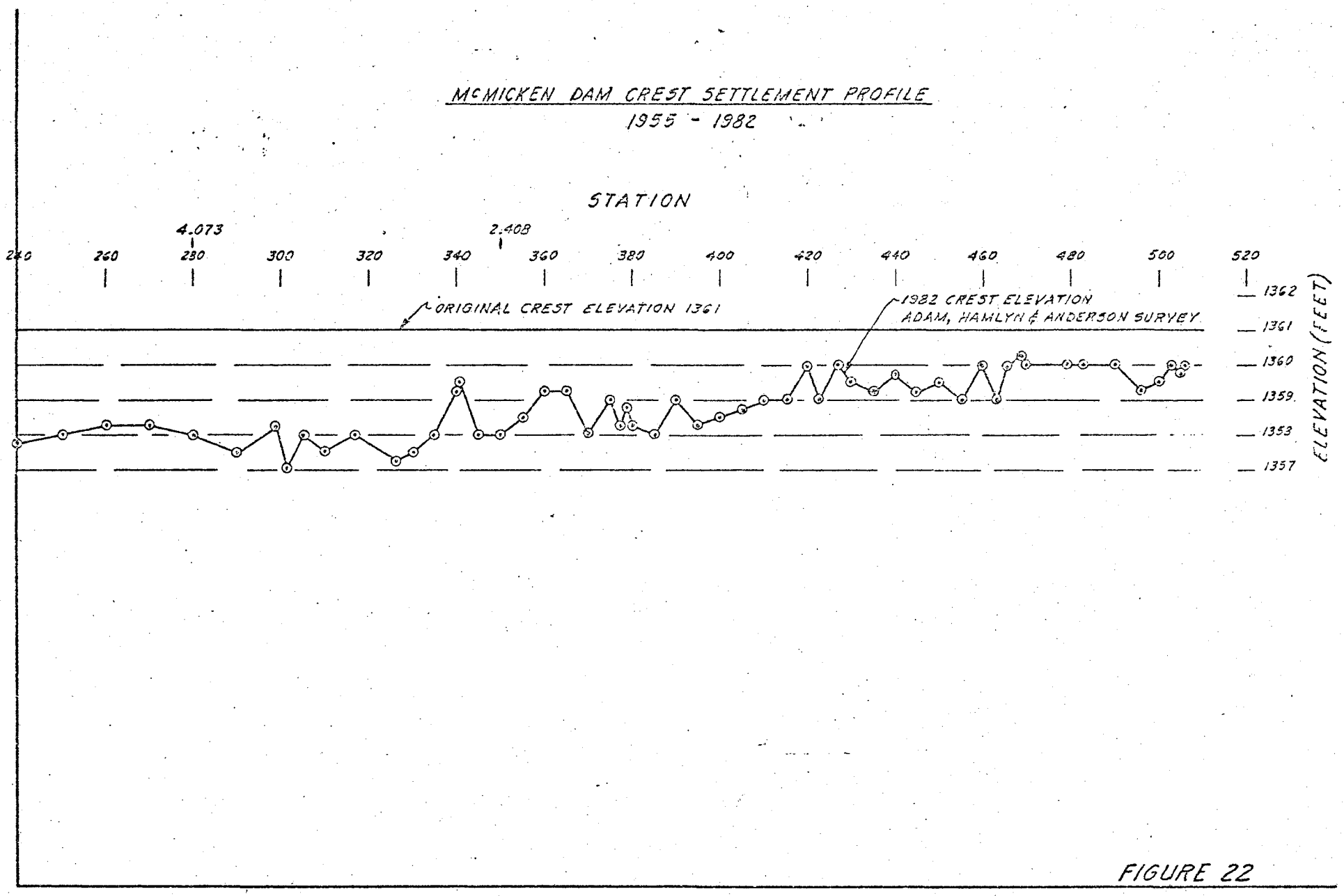

FIGURE 22

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Job No: E 81-138
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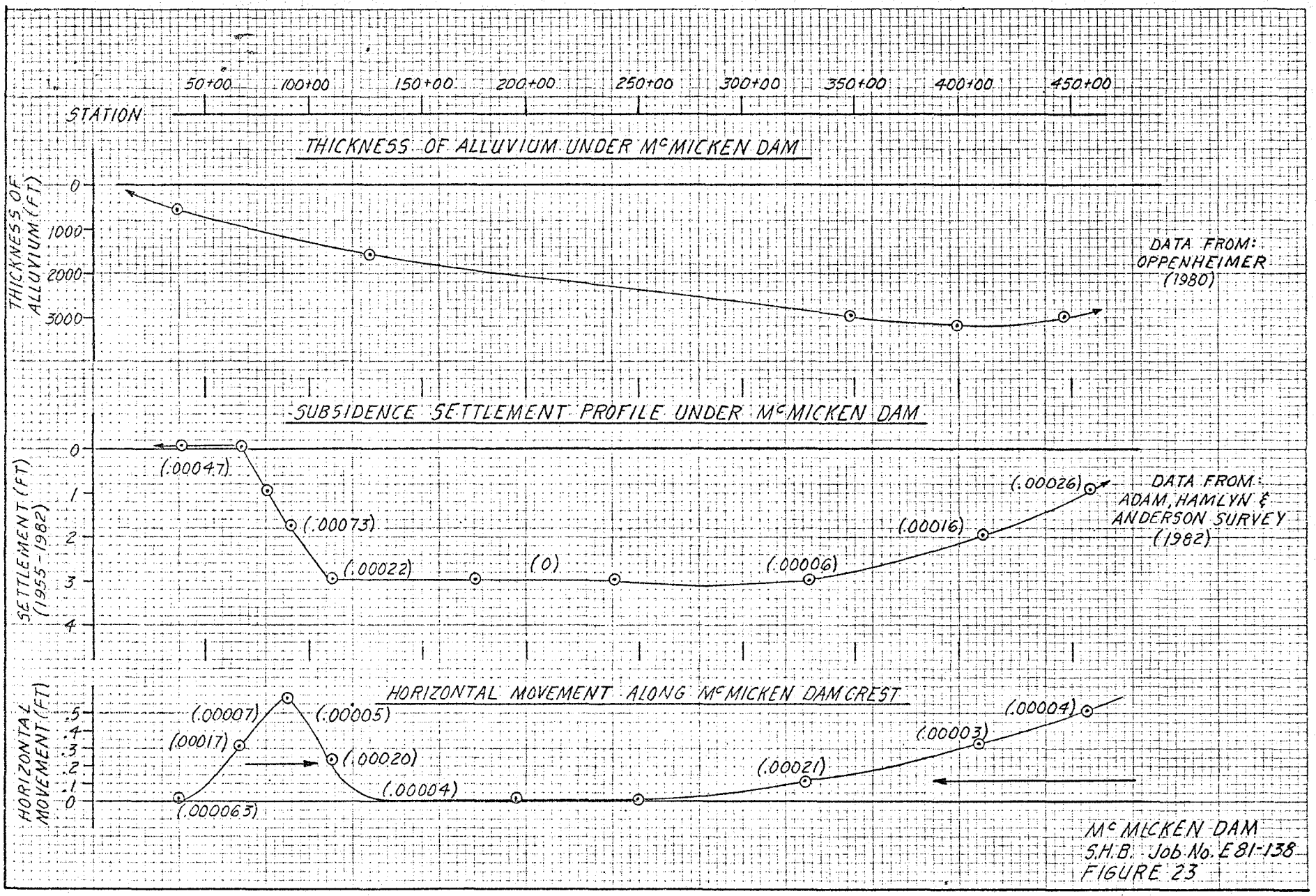
Date 2-22-82 Page 2 of 2



McMICKEN DAM
S.H.B. Job No. E81-138
FIGURE 23

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TABLE 5

Lee and Shen Simplified Analytical Procedure to Estimate Strains at Crest of Dam Due to Subsidence

Station (feet)	H (feet)	Slope of Settlement (α)	Horizontal Movement (feet)	Horizontal Strain (percent)	
40+00	600	0	0	0	Tension Region Tension Strains Less than .2% Therefore Cracking Not Indicated
50+00				.006	
70+00	1,000	.00047	.31	.017	
85+00				.007	
90+00	1,200	.00073	.584	0	
95+00				.005	Compression Region
110+00	1,500	.00022	.220	.02	
125+00				.004	
200+00	2,100	0	0	0	
250+00	2,400	0	0	0	
330+00	2,900	.00006	.116	.002	Compression Region
410+00	3,200	.00016	.341	.003	
460+00	2,900	.00026	.502	.004	

Then where do the Fenne Knoll Fissures come from?

possibility. Further it does not appear that the differential settlement profile of basin subsidence will become severe enough in the future to even approach the threshhold of cracking.

This statement seems to contradict other statements in the report that say future fissuring in the embankment is likely to occur.

6.1.2 Cracking Due to Collapsing Soils

The results of the geotechnical investigation of the embankment and foundation soils of McMicken Dam show that the primary cause of the embankment cracking is collapse type settlements of the moisture sensitive, low density soils.

The field boring investigation and laboratory analysis show that a portion of the dam from about Station 250+00 to Station 500+00 built on top of a natural deposit of collapsing soil.

Collapsing soils typically undergo large settlements upon wetting under their own weight or under their own weight plus low superimposed loads such as those of shallow fills.

The collapsing soils of the Southwest are predominantly low gradient alluvial deposits and alluvial deposits in the floodplains of intermittent streams. The sedimentation process involved for alluvial fans has been described by Blessenbach (1954). In this depositional sequence, each layer is laid down by a

flash flood or sheet flow. The layer dries out before the overlying layer is deposited. Deposition of the next layer wets only the surface of the underlying material. In this way, the deposit, as a whole, is built up without being consolidated under its own weight at high moisture contents.

In central and southern Arizona, these collapsing deposits are primarily silty sands, sandy silts and clayey sands of low plasticity. Lesser stratifications of clean sands and lean clays are often present.

Test criteria for evaluating the potential for severe collapse based on work by various authors and extensive experience with soils similar to those involved in this investigation have been summarized by Beckwith (1979) as follows:

Plasticity Index ≈10
Dry Density ≈95 lbs./cu.ft.
Initial Moisture Content ≈8%; sometimes ≈4%
Standard Penetration Resistance: generally ≈15, and sometimes ≈6 blows/ft.

Many of the soils underlying the fill placed for McMicken Dam fit into the category of severely collapsing soils by this criteria.

The test results show that many of the samples taken from borings are of low plasticity. Dry density

determinations were made from each of the samples taken with the 2.42 inch I.D. diameter sampler and undisturbed block samples. A range of densities measured for these samples was 88.6 lbs./ft.^{3} to 115.8 lbs./ft.^{3}. These densities represent undisturbed foundation soils as well as compacted embankment soils. Many fall within the range frequently measured for collapsing soils. The moisture contents of the samples from undisturbed areas downstream of the dam are very low, frequently less than 6 percent. This is indicative of the natural moisture contents of the soils underlying the dam prior to construction. The initial moisture contents are in the range typical for collapsing soils. The standard penetration results shown on the boring logs also are generally in the range for severely collapsing soils at natural moisture contents.

A widely used test to determine a soils potential for collapse is the one-dimensional consolidation test. This test is performed on a sample initially at its natural moisture content. The load on the sample is increased in increments until it reaches the approximate overburden weight at the depth from which the soil was sampled plus the stresses of superimposed structural loads. The height change of the sample is plotted as a function of the applied vertical load on a semilog plot.

When the soil reaches the load which corresponds to

approximately in situ overburden vertical stress plus structural loads, it is submerged and its height change observed at a constant vertical stress. A substantial drop in height at this constant load is indicative of the soil collapse mechanism caused by the increased moisture. The results of 17 consolidation tests of this kind are presented in Appendix C. These samples were subjected to inundation when loading approximately equal to overburden plus weight of typical embankment was reached. The amount of collapse as a percentage of initial height is given in Table 3.

As a conservative example of typical collapse settlements, if a 5 foot layer of soil underlying the dam was to collapse by 5 percent upon wetting, a settlement on the dam crest of 3 inches would be observed.

6.1.2.1 Analysis of Crack Mechanism

In order to confirm that potential collapse settlements are sufficient to explain cracks of the width and depth observed in the dam, an analysis of the mechanics of cracking were performed.

Lee and Shen (1969) and Covarrubias (1969) have used the finite element method of analysis to investigate the relationship between differential vertical settlements and horizontal movements occuring in earth dams.

TABLE 3

Boring No. or Test Pit No.	Depth (Feet)	Density Pounds or Cubic Feet	Percent Collapse	Initial Moisture Content Percent	Final Moisture Content Percent	Location
2	9½-10½	103.5	0	15.4	19.2	Downsteam 462+00
15	9½-10½	90.8	3.0	8.7	22.6	Upstream 260+50
16	4½-5½	111.7	0	7.9	14.6	Upstream 280+00
22	19½-20½	92.7	0	25.7	27.4	Upstream 425+00
24	1-2	107.6	3.0	10.8	12.9	Upstream 472+00
27	24½-25½	100.6	2.0	4.6	14.9	CL Dam 355+00
55	14½-16	93.8	4.0	11.0	18.4	CL Old Dike 455+00
56	14½-16	100.1	7.5	8.3	13.4	CL Old Dike 472+00
TP-15	3-4	88.7	6.0	6.6	21.5	Upstream 457+70
TP-16	3'3"-4'3"	103.6	6.0	4.7	13.6	Upstream 473+00
TP-18	3½-4½	88.6	11.0	5.7	19.5	Downstream 474+00
TP-24	2½-3½	93.4	14.0	5.9	15.4	Upstream 284+00
TP-25	3-3'9"	97.0	0.5	6.6	20.2	Downstream 292+25
TP-26	1'10"-2'6"	111.4	2.0	6.0	12.9	Downstream 282+05
TP-29	3½-4	105.1	7.0	4.2	11.9	CL Dam 464+00
TP-30	3½-4	115.8	1.5	6.0	12.3	CL Old Dike 284+00
TP-31	3½-4½	100.8	10.0	6.0	13.2	CL Old Dike 260+00

Covarrubias (1969) used a linear plastic soil model in analyzing the effect of embankment shape and bedrock profile on the development of tensile strains within the clay core of an earth dam. He also used the analysis method to predict the performance of three dams. Comparisons of predicted and documented performance were generally good.

Lee and Shen (1969) used a nonlinear elastic soil model to analyze cracking potential, reaching the same basic conclusions as Covarrubias (1969) regarding the effect of abutment profile on horizontal strains. Results of analyses of model tests were compared to the model test results, establishing the validity of the method.

More important, Lee and Shen (1969) showed that simplified analytical procedures could be used to make reasonable estimates of horizontal strains at the crest of a dam if a settlement profile is available. In this procedure, horizontal movements, m, are calculated using $m = 2/3\ H\ X$, where H is the depth of bedrock and X is the slope of the settlement profile.

This relationship was used to compute the horizontal strains at the crest of the McMicken Dam. Values of X were calculated using a hypothetical settlement profile induced by a localized collapse of the

foundation soils of 3 inches. As described previously, 3 inches is a conservative estimate of typical collapse settlements experienced under the dam. It is probable that areas of the dam have experienced from ½ to 1 feet of localized collapse settlement. This settlement is plotted as the upper curve of Figure 20. Values H were determined using the geotechnical profile. Calculated values of horizontal movement are plotted on Figure 20. Finally, horizontal strains are calculated and summarized on Table 4.

The computed horizontal strains are well beyond the threshhold of cracking of 0.25 percent estimated by the Leonards and Narain (1963) for the type of soils involved. The assumed differential settlement profile is believed to be realistic in that flow through isolation lenses of more permeable soils would be expected to saturate localized zones of the collapsing soil. In addition, variations in the collapse potential and thickness of the surface layer can explain the settlement profile assumed in analysis. The calculated horizontal strains for this profile are clearly consistant with the cracking present in the embankment.

6.1.3 Desiccation

The Corps of Engineers (1973) report described the

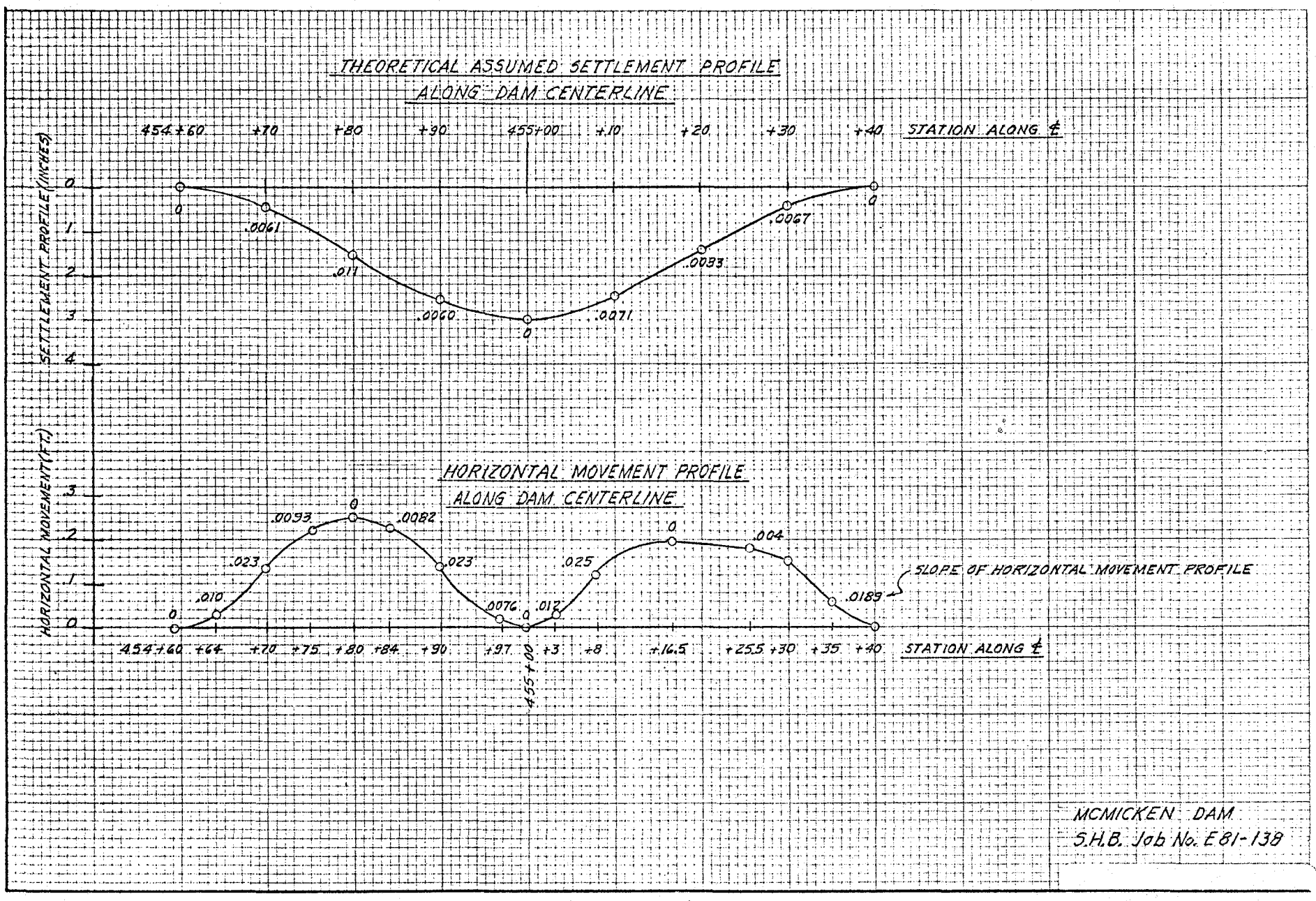

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FIGURE 20

TABLE 4

Lee and Shen Simplified Analytical Procedure to Estimate Horizontal Strains at Crest of Dam

Station (feet)	H (feet)	Slope of Settlement Curve (α)	Horizontal Movement $M = 2/3\ H\alpha$ (feet)	Horizontal Strain (percent)	
454+60	35	0	0	0	
454+64				1.0 Tension	Cracking Region Tension Strains >.2%
454+70	35	.0061	.142	2.3 Tension	
454+75				.93 Tension	
454+80	35	.011	.257	0	
454+84				.82 Comp.	
454+90	35	.0060	.140	2.3 Comp.	
454+97				.76 Comp.	
455+00	35	0	0	0	
455+03				1.2 Comp.	
455+08				2.5 Comp.	
455+10	35	.0071	.166		
455+16.5				0	
455+20	35	.0083	.194		
455+25.5				0.4 Tension	Cracking Region Tension Strains >.2%
455+30	35	.0067	.156		
455+35				1.89 Tension	
455+40	35	0	0	0	

Three inches of differential settlement distributed along 80 feet of dam length will produce two zones of tension straining considerably in excess of cracking threshold (>.2%).

results of shrinkage limit tests which indicated that the embankment materials undergo no further change in volume below a moisture content of 16 percent. They observed that construction records show that 90 percent of the embankment materials were placed at moisture contents less than 16 percent, indicating that major cracking due to shrinkage is very improbable.

Although desiccation may be a minor contributing factor, it is concluded that desiccation alone could not provide an explanation for the cracks present.

6.2 Remedial Measures & Estimated Costs

It is concluded that it is feasible to repair the dam in such a way as to achieve generally accepted standards of safety. The operating plan outlined in Section 6.4, however, is considered to be essential to the achievement of the necessary level of safety dictated by present and future downstream development.

Based on considerations discussed in Section 6.1, it is believed that formation of open cracks ½ to 3/4 inch in thickness due to earth fissures is probable over the next few decades. These cracks would be expected to form in a relatively continuous way through the dam and portions of the foundation. It is believed probable that at least several of these cracks will form through

the dam in the future. The provision of a defensive design against cracks of this nature was the criterion used in developing the recommendations for remedial measures.

A central horizontal drain, with finger drains at 200 foot centers and toe drain extending through the collapsing soils to firmer cemented soils are the major features of the recommended measures for repair. The drains would consist of coarse gravel and cobbles and be encapsulated in geotextile or "filter fabric". This design is believed to be the best approach to repair both from the standpoint of costs and the level of protection against internal erosion through cracks which would be afforded.

Other alternatives involving upstream membranes and a downstream granular zone were analyzed. Common to all approaches is a cutoff to the relatively strongly cemented soils. This feature will prevent development of a path for internal erosion at the base of the embankment or through the looser more erodible surface soils. The cutoff would force any flow in a crack through the more cemented soils which are relatively high in resistance to erosion. In that flow would be of short duration, a high degree of protection against piping through the foundation is afforded by this element.

The recommended design concept is based on the assumption that the dam would be inspected after all inflows

of water and repairs to any damage made. With the inspection program in fact, it is highly probable that cracks would be detected and repaired before any appreciable impoundment of water behind the dam.

Descriptions of the alternatives considered and estimated costs are given in the following sections.

6.2.1 Common Elements of Repair

Some of the remedial measures necessary to repair the dam would be common to all alternatives.

The dam should be raised back to elevation 1361.00 to regain the height lost due to subsidence. The dam height at this time could be raised to elevation 1360.5 feet due to the fact that the major outlet spillway elevation has subsided approximately ½ foot. However, it is considered advisable to build back to the original crest height of 1361 feet to provide a small leeway for future subsidence. This should be studied in detail during final design.

Both breaches must be repaired and brought back to original grade.

The cracks which were located in the trenching survey should be grouted with sand-cement or bentonite-cement mixtures. Additional trenching and flooding will have to be performed to locate additional cracks.

The controlled outlet channel will need a minimum amount of repair, as the erosional problems are more of an esthetic problem than a functional or safety related problem. It is recommended that all debris be removed from the existing gullies and a compacted clayey sand be placed to bring the erosional features back to grade. Periodic maintenance and repair will be necessary as the surface soils are moisture sensitive and erosive, however, other preventative measures are not deemed necessary.

The Beardsley Canal will restrict the flow of traffic during remedial construction, and it could be economical to build an additional crossing to reduce haul distances.

The costs of engineering and control of the various alternatives are not included.

The following estimated costs would be common to all anticipated remedial alternatives.

Raise Dam to Elevation 1361: 336,000 cy at $1.35/cy =	$ 453,600.00
Repair Both Breaches: 55,600 cy at $1.35/cy =	$ 75,060.00
Dam Construction Mobilization	$ 60,000.00
Grout Existing Cracks 200 cracks w/grout assuming approximately 1 inch cracks to bottom of dam (includes mobilization)	$ 88,250.00

Additional Cracks at $430.00/Crack	$ _____
Additional Crack Investigation Including Trenching & Flooding	$ 50,000.00
Total Common Costs Less Beardsley Canal Crossing & Additional Grouting	$ 726,910.00

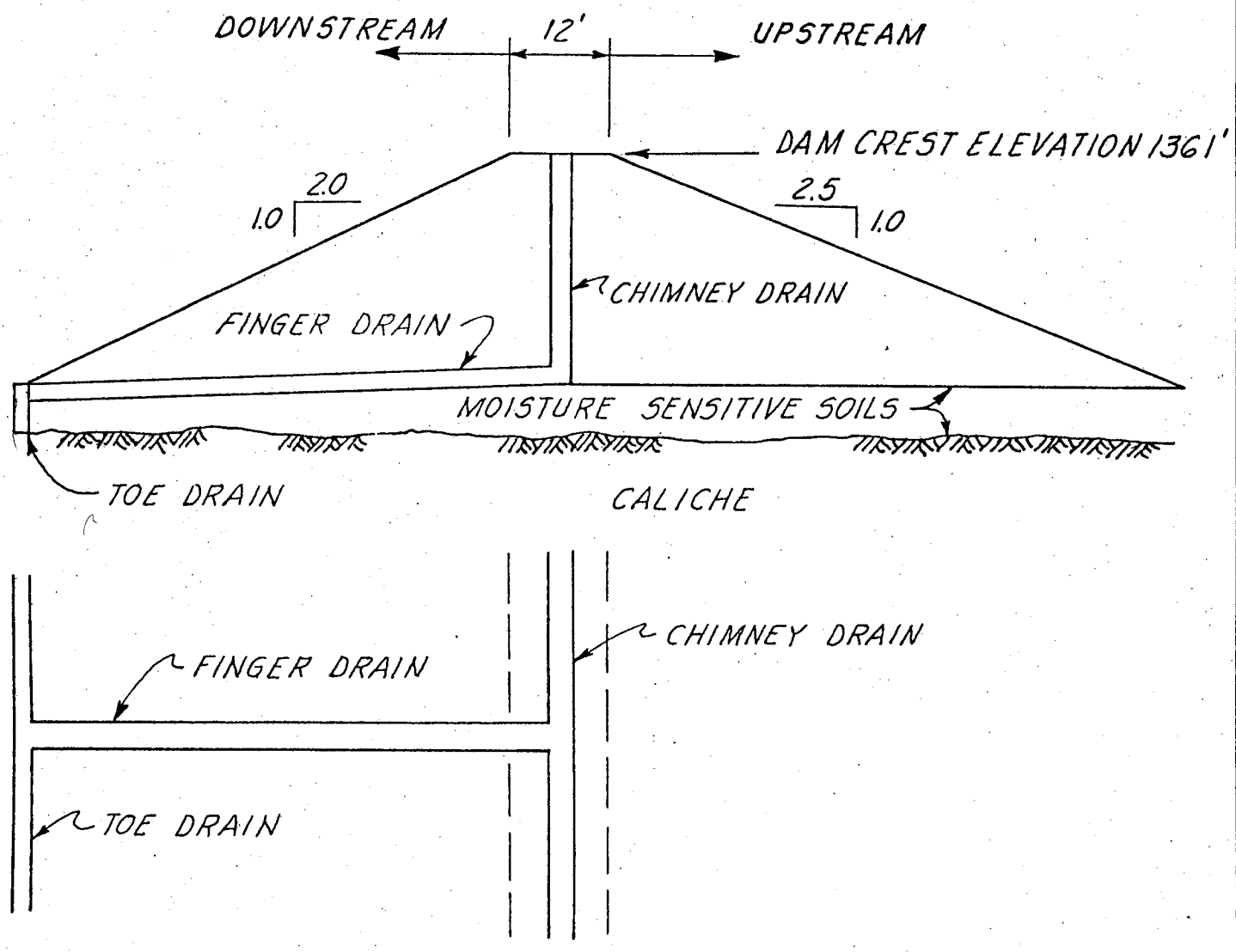
6.2.2 Alternative 1 - Central Vertical Drain

Alternative 1 (Figure 16) is the recommended approach to repair.

A granular center drain could be placed through the center of the existing dam as a remedial measure. This alternative would not only intercept any seepage through cracks in the embankment, but would also provide the greatest protection of any repair method against subsidence related ground fissuring under the dam. The drain material would be coarse gravel and cobbles and be encapsulated in "filter fabric".

Finger drains would be installed at approximately 200 to 1,000 foot centers to allow sufficiently safe downstream drainage of any water collected in the center drain. These drains would consist of coarse gravel and cobble filled trenches lined with impermeable filter fabric. The drainage trenches may require plastic PVC pipe depending on the capacity determined in final design.

PRIMARY ALTERNATIVE (ALT.#1)



McMICKEN DAM
S.H.B. Job No. E81-138
FIGURE 16

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Immediately downstream of the dam a toe drain would be placed which would intercept any water seeping in the moisture sensitive soils under the dam. This trench would be lined with permeable filter fabric and would allow free drainage of seeping water without removal of fines, thus, preventing a piping type failure at the toe. It would extend through the collapsing surface soils to relatively strongly cemented materials.

why wouldn't the fabric cause plugging of cracks

The filter fabric in the drain system would intercept erosion through cracks and cause plugging of cracks. The high degree of internal drainage provided would drain flow that ran through the cracks. The granular fabric lined drain is very flexible and would be expected to withstand the differential settlements and tensile strains which could potentially occur. Cracks would not translate through the gravel-cobble drain. The drainage system is designed to be quickly installed with relatively simple methods.

A possible disadvantage to this system would be that the life expectancy of filter fabrics has not been determined by field testing due to the fact that the filter fabric technology has only been available for approximately 20 years. Actual field installations using filter fabrics have been in place for more than 10 years, however, and testing of these fabrics has shown little or no deterioration with age. As long as the filter fabric is a polypropylene fabric and is

not exposed to sunlight during its useful life, there is every reason to expect a life expectancy of at least 20 years, and more probably in excess of 50 years. Due to this uncertainty, periodic testing of the fabric is incorporated into the operational plan. It would be feasible to remove the drain and replace the filter fabric, if necessary.

Estimated costs of Alternative 1 are as follows:

Excavate Trench and Toe Drain 50,000 ft. at $7.50/ft. =	$ 375,000.00
Filter Fabric Nonwoven 320,000 yd^2 at .75/yd^2 (Placed) =	$ 240,000.00
Woven 320,000 yd^2 at $1.10/$yd^2$ (Placed) =	$ 352,000.00
Drain Rock 100,000 cy at $10.00/$yd^3$ (Delivered and placed) =	$1,000,000.00
Total	$1,615,000.00
or, using woven fabric =	$1,727,000.00

6.2.3 Alternative 2 - Downstream Rock-fill Zone

Alternative 2 is depicted in Figure 17. In this alternative a downstream rock-fill drain could be constructed which consists of a granular filter layer approximately 3 feet thick over which a rock-fill shell would be placed. The granular filter would

ALTERNATIVE #2

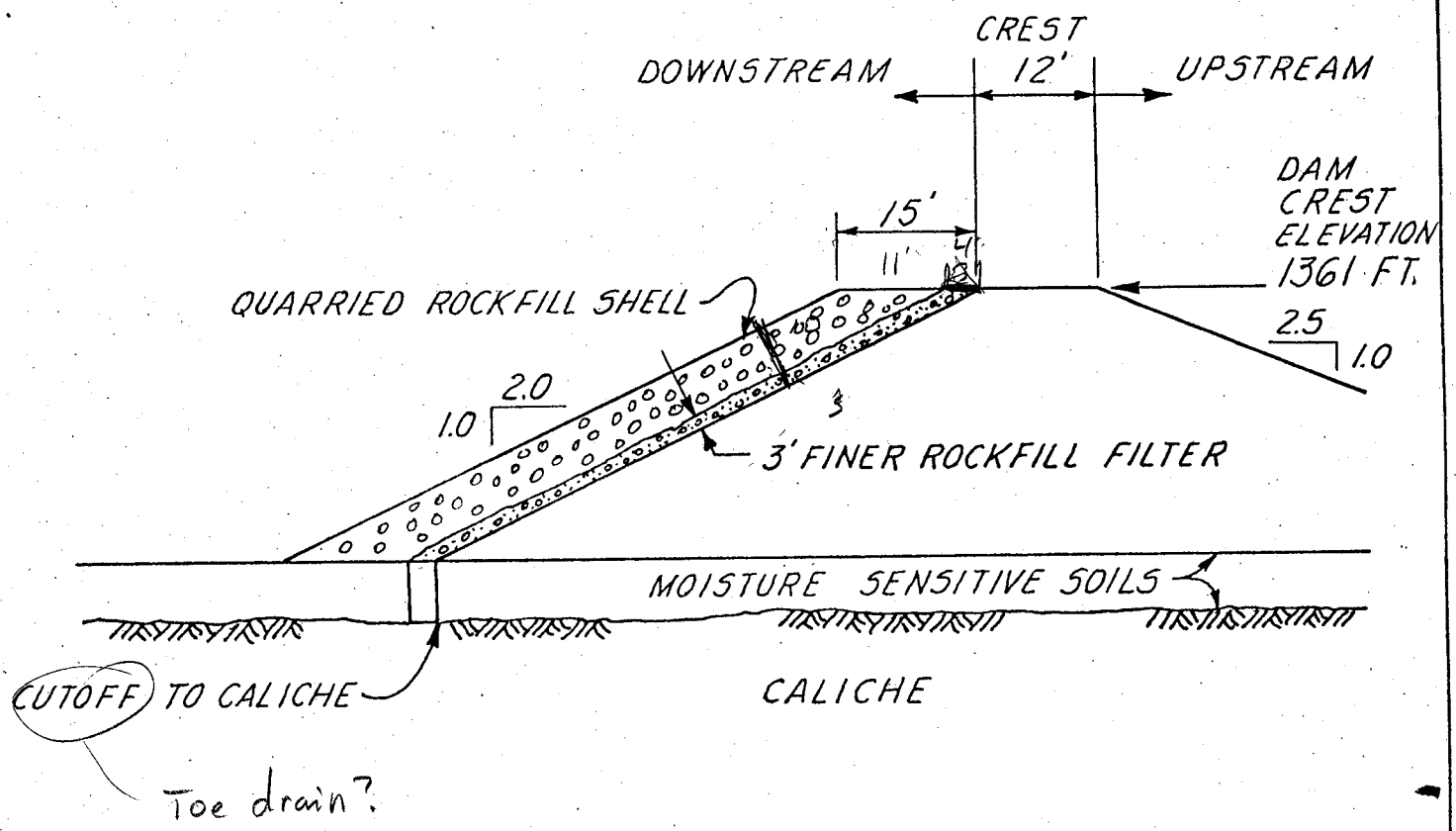

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FIGURE 17

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restrict the movement of fines travelling with the water through the cracks in the dam. The water would then be drained by the rock-fill zone. A cutoff would be installed in the downstream toe of the dam in the same manner as for Alternative 1.

Toe drain? or cutoff

The advantages of this alternative are that it is relatively simple to construct and involves a minimum of disturbance to the existing dam. The maintenance costs would be relatively low. Cracks could not translate through the cohesionless filter and rock-fill zone.

The disadvantages include very high initial cost due to the expense of quarrying, hauling and placing the rock-fill. This alternative would allow unobstructed cracks and consequent pore pressure buildup much further downstream than for Alternative 1.

Cost estimated for Alternative 2 are as follows:

Quarried Rock-fill Shell ≃463,071 cy at $15.00/cy = (Quarried, hauled and placed)	$6,946,078.00
Mobilization	$ 100,000.00
Finer Rock-fill Filter ≃103,828 cy at $15.00/cy =	$1,557,417.00
Slope Redressing (Downstream) ≃70,000 cy at $1.35/cy =	$ 94,500.00

wrong proportion

Toe drain or cutoff ?

Cutoff Trench	
Excavation 50,000 ft. at $1.00/ft. =	$ 50,000.00
Clay Backfill 28,000 cy at $2.50/cy =	$ 70,000.00
Total	$8,817,995.00

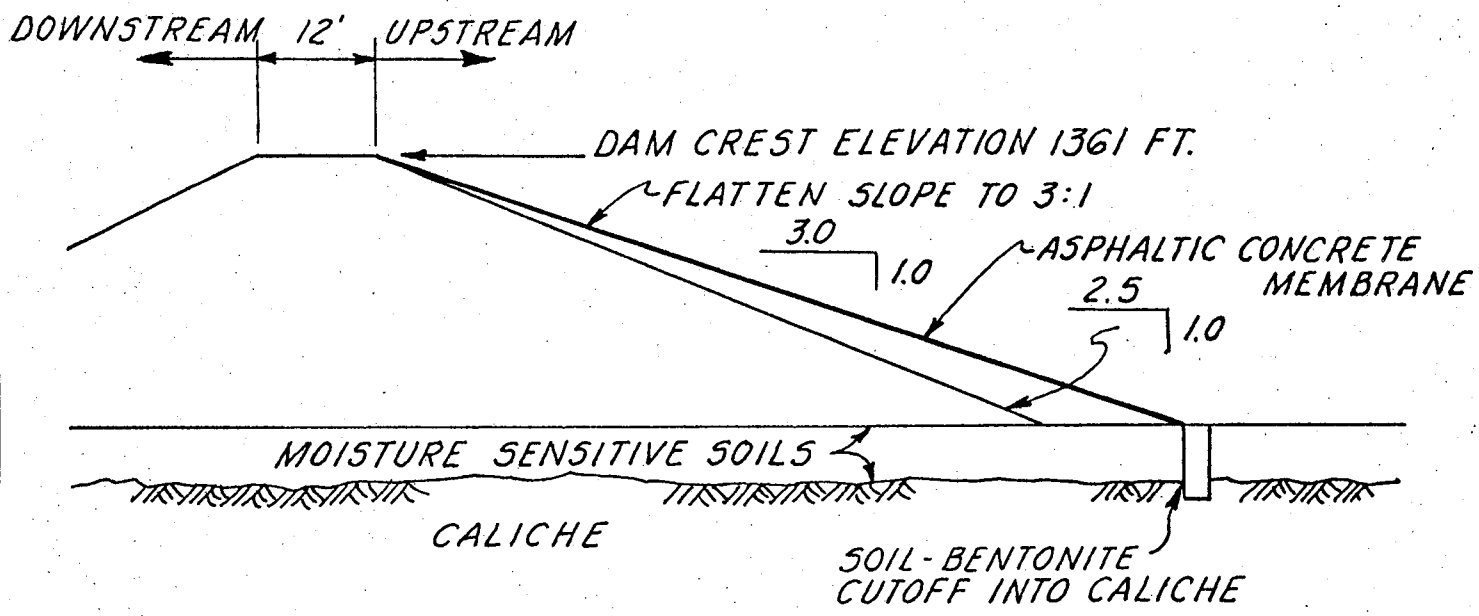
6.2.4 Alternative 3 - Upstream Asphaltic Concrete Membrane

In Alternative 3 (Figure 18), an asphaltic concrete liner could be placed on the upstream face of the dam to form an impermeable cutoff. This design would prevent water from entering the cracked sections of dam in that a flexible asphaltic concrete would be employed.

A soil-bentonite cutoff would be placed at the upstream toe of the dam, connecting with the asphaltic liner. This would stop water from seeping under the liner through the moisture sensitive surface soils under the dam and force flow through the deeper cemented soils.

The advantages of this alternative are that it is easily inspected from the exposed outer surface for any deterioration or cracking, and that any localized problem areas can be repaired or replaced relatively inexpensively.

ALTERNATIVE #3



McMICKEN DAM
S.H.B. Job No. E81-138
FIGURE 18

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The disadvantages to this approach include the difficulty of insuring that the asphaltic concrete would withstand the movements associated with an earth fissure. The asphaltic concrete would tend to deteriorate after several years and would have to be regularly maintained and eventually replaced due to oxidation and volatilization. A thicker liner could extend the life expectancy and would significantly increase the initial cost.

If earth cover were provided to reduce weathering, the membrane could no longer be inspected. Variations of Alternative 3 involving various types of artificial membranes would all share the disadvantages of the need for cover and/or rapid deterioration rates. Cover would have to consist of granular bedding with riprap to prevent erosion and thus would be relatively expensive. For upstream membrane alternatives, the slope would need to be flattened to about 3:1 or flatter to allow placement of the lining. This involves a substantial element of cost.

Estimated costs for Alternative 3 are as follows:

Redress Upstream Slope 86,500 cy at $1.35/cy =	$ 116,775.00
Place 3:1 (horizontal to vertical) Upstream Slope 260,000 cy at $1.35/cy =	$ 351,000.00

Cutoff Trench (Upstream)	
Excavation 50,000 ft. at $1.00/ft. =	$ 50,000.00
Clay backfill 28,000 cy at $2.50/cy =	$ 70,000.00
3 Inch Thick Asphaltic Liner 390,200 square yards at $7.00 square yard	$2,731,400.00
Seal Coat at $0.50 per square yard	$ 195,100.00
Total	$3,514,275.00

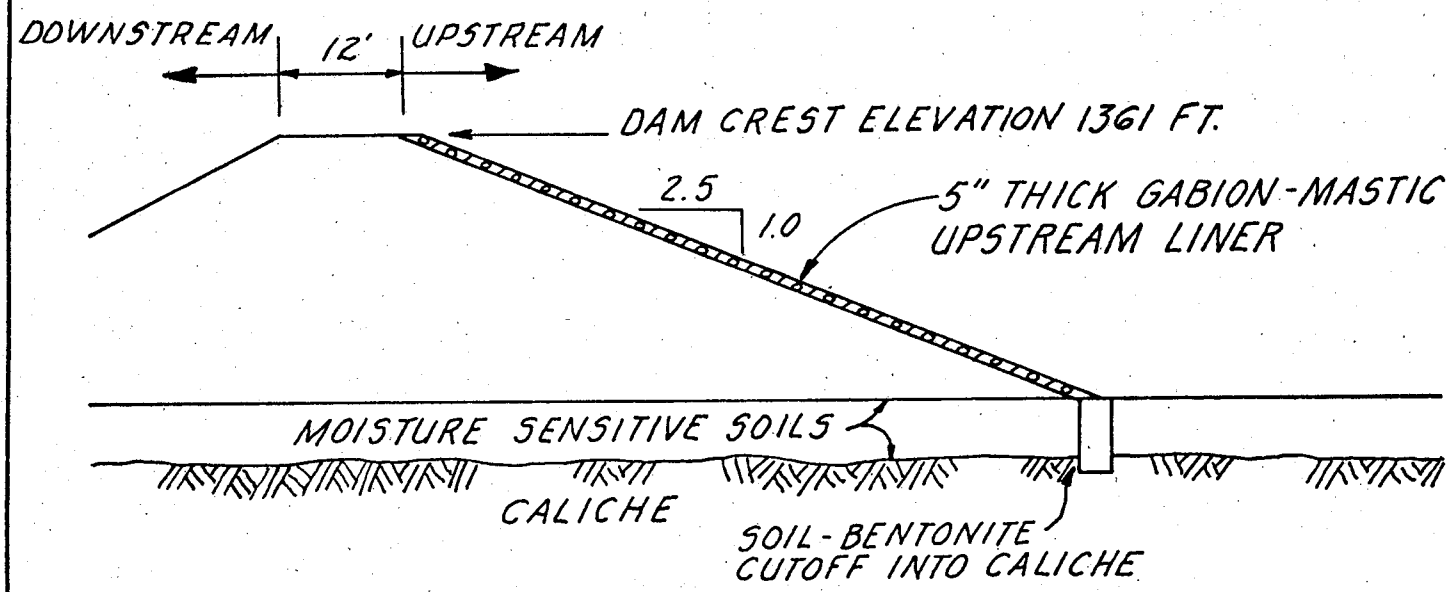
6.2.5 Alternative 4 - Upstream Gabion-Mastic Liner

In Alternative 4 (Figure 19), a newly developed method to provide impervious and flexible upstream protection on the dam face involves placing a gabion-mastic liner along the upstream surface. Steel wire cages are first placed directly on the dam's upstream face and filled with stones. An asphaltic mastic is then poured over the wire-stone cages; filling the voids and forming a flexible and water tight liner.

A soil-bentonite cutoff would be placed at the upstream toe of the dam, connecting with the gabion-mastic liner. This would inhibit water from seeping under the liner through the moisture sensitive surface soils under the dam.

The advantages of this method include flexibility to resist differential settlement, and relatively long expected life with low maintenance costs.

ALTERNATIVE #4



McMICKEN DAM
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FIGURE 19

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Disadvantages include high initial cost and a higher degree of specialty contracting than the other alternatives. The system would ultimately be susceptible to deterioration unless a cover were included.

Estimated costs for Alternative 4 are as follows:

5 Inch Thick Steel Wire Reinforced Gabion-Mastic Upstream Liner Placed Directly Over Prepared 2½:1 Existing Upstream Slope, 65 Feet Wide Toe to Crest: 9 Mile Treatment.

Area to be Covered = 343,200 square yards
Quantity of Mastic = 40,500 tons
Mastic $46.33/ton
Mastic Preparation $9.16/ton
Mastic Transportation $7.00/ton
Tankers to Deliver Mastic $4.44/ton
Installation of Mastic $2.67/ton
Gabion Mattress Installation,
Stone and Wire $15.39 per square yard
Total $23.60 square yard
23.60 x 343,200 = $8,099,520.00

6.3 Stability Analysis

6.3.1 Embankment Sections Analyzed

Static stability analyses were performed for model embankment sections representing each of the four

alternative designs considered. The embankment sections, shown in Figures 24, 25 and 26, are 26 feet high with 2:1 downstream slopes and either 2½:1 or 3:1 upstream slopes. The sections are essentially homogeneous, underlain by approximately 5 feet of clayey and sandy silts. The embankment soils are compacted on-site borrow materials. Below a depth of approximately 5 feet, the foundations soils are cemented to a substantial degree, and have a much greater stiffness and strength than the overlying soils.

The four alternative embankment sections are similar, with only the drainage details varying. Alternative 1, shown in Figure 24, includes a chimney drain below the center of the crest. A toe drain extending through the more permeable foundation soils to a depth of 10 feet, is connected to the chimney drain by regularly spaced finger drains. The finger drains are not depicted in Figure 24. Alternative 2 includes a sloping drain along the existing downstream face of the embankment, connected to a vertical drain extending through the more permeable foundation soils. The downstream face, as shown in Figure 25, is stabilized with a 12 foot thick granular fill. Alternatives 3 and 4, depicted in Figure 26, do not allow drainage. Instead, either an asphaltic liner with a 3:1 slope (Alternative 3) or a gabion mastic liner on a 2½:1 slope (Alternative 4) is to be placed on the existing upstream slope. In the stability analyses the strengths of these materials are not considered, with the slopes assumed to be soil only.

FIGURE 24

STABILITY ANALYSES
ALTERNATIVE #1

MAT. NO.	C PSF	$\phi°$	γ_M PCF	γ_{SUB} PCF
1	0	30	120	—
2	0	33	120	60
3	0	30	110	—
4	2000	40	130	—

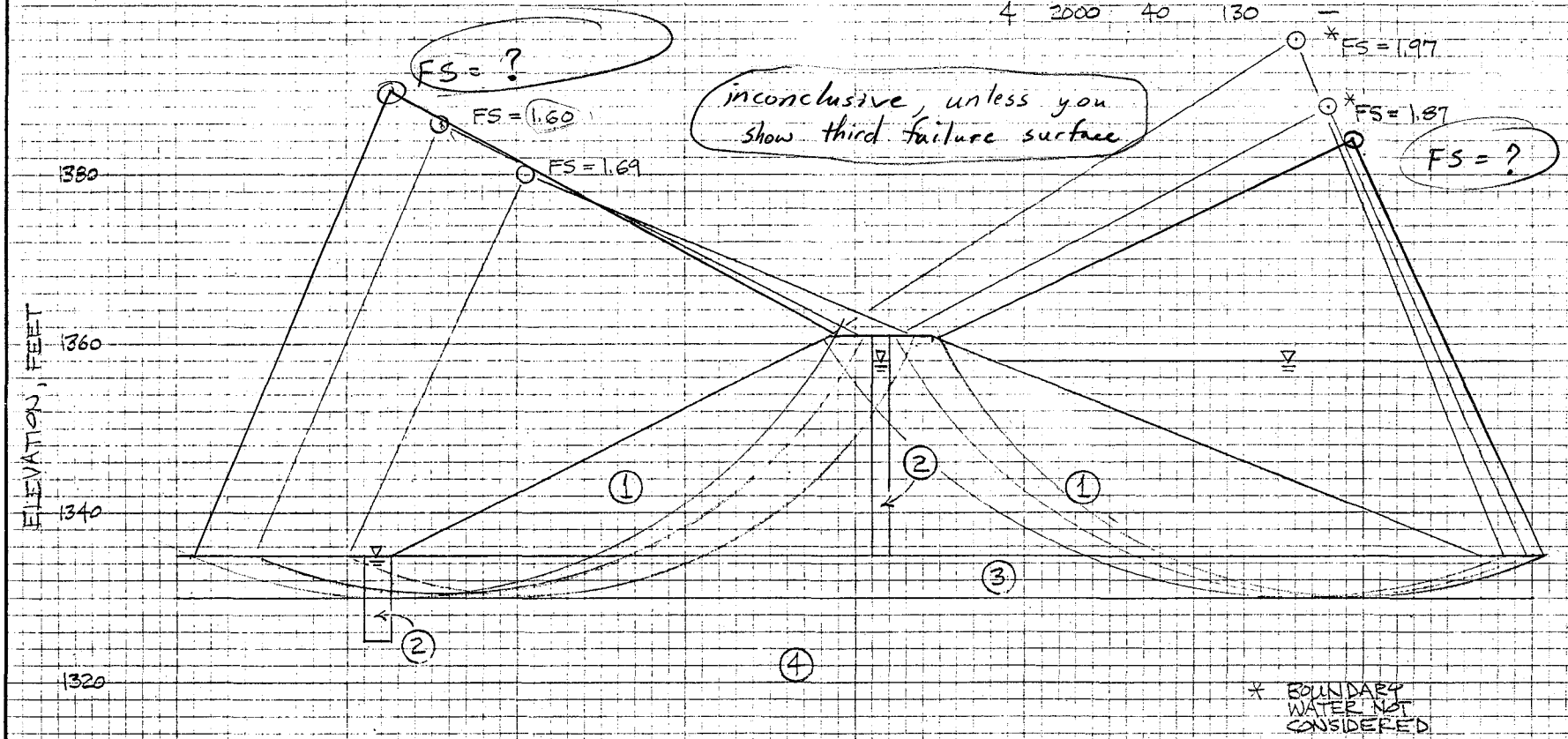

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FIGURE 25

STABILITY ANALYSES
ALTERNATIVE #2

MAT. NO.	c PSF	$\phi°$	γ_M PCF	γ_{SUB} PCF
1	0	30	120	—
2	0	33	125	60
3	0	35	135	—
4	0	30	110	—
5	2000	40	120	—

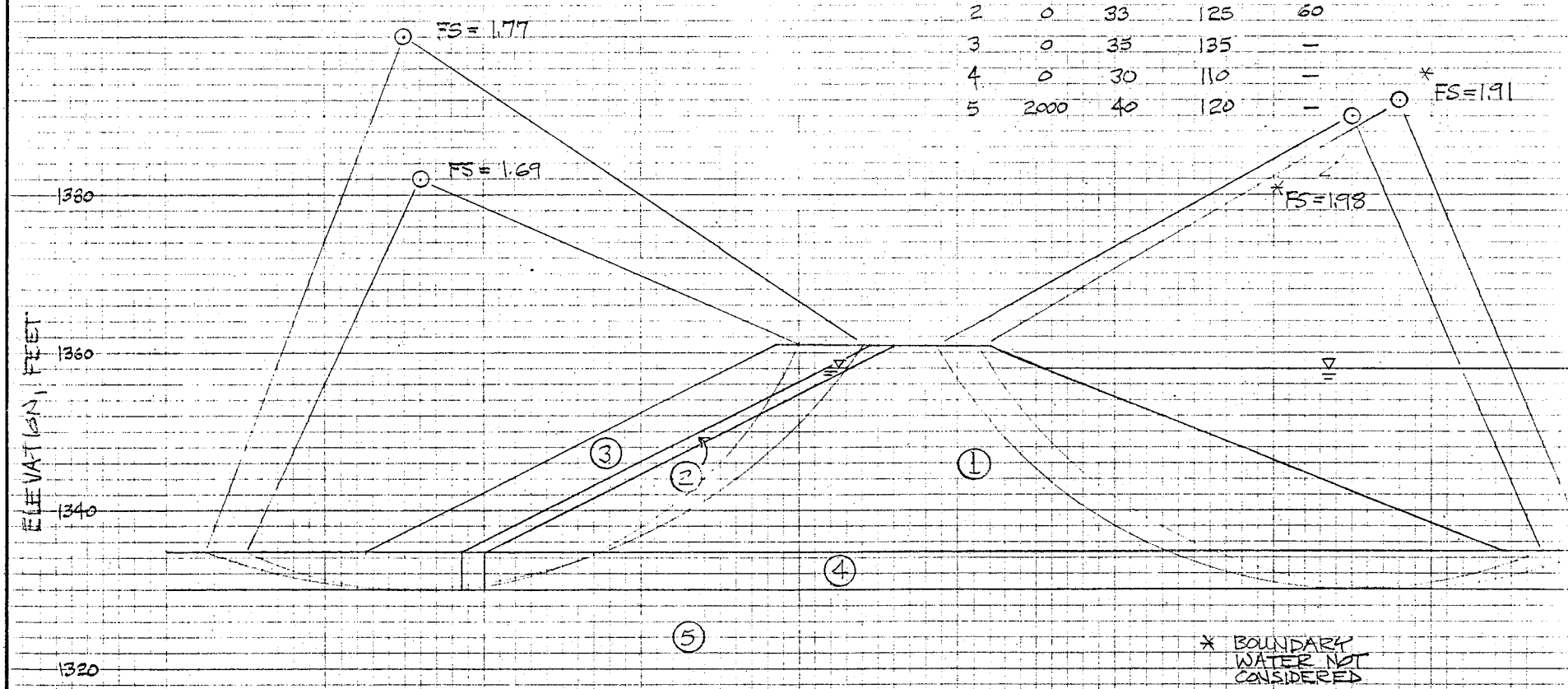

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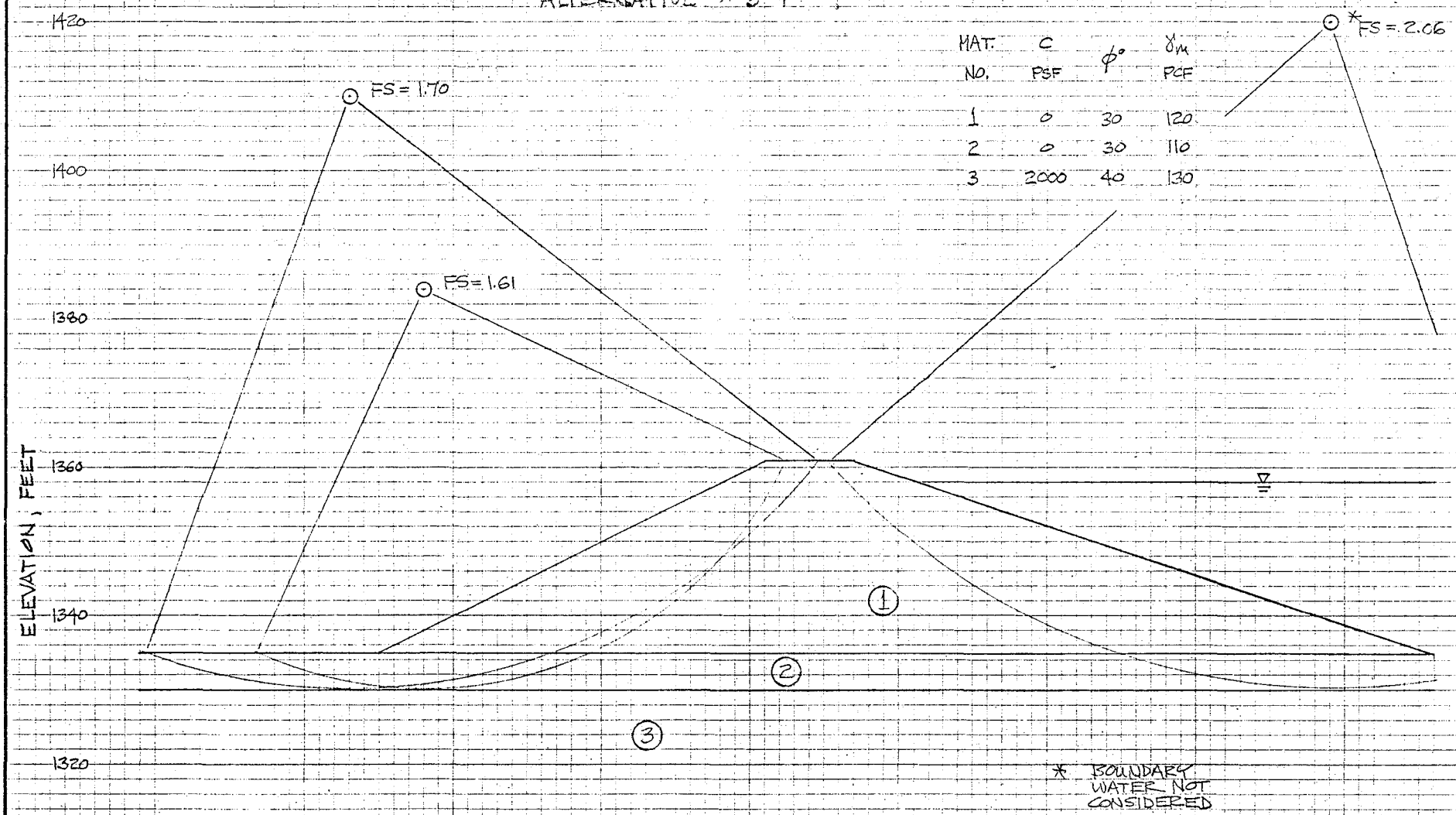
FIGURE 26

STABILITY ANALYSES
ALTERNATIVE #3 + #4



MAT. NO.	C PSF	$\phi°$	γ_m PCF
1	0	30	120
2	0	30	110
3	2000	40	130

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6.3.2 Boundary Conditions

The effect of flooding is expected to be very short-term, and the occurrence of flooding has a very low frequency, thus, the development of other than surficial saturated zones within the embankment is highly unlikely. Flood waters, then, are assumed to apply boundary forces only, with saturation and resulting seepage forces not considered. Phreatic surfaces are assumed for the drains of Alternatives 1 and 2, but development of full hydrostatic forces is limited to the zone of the drains.

Both the upstream and downstream slopes of the embankment sections were analyzed. Boundary water forces, which tend to stabilize the upstream face, were not considered in analyses of the upstream slope. Thus, the safety factors computed represent nonflood conditions, which are most critical for this face, if seepage through the homogeneous part of the embankment is not considered.

6.3.3 Embankment Strength Parameters

Results of strength testing included in the original design analysis by the U.S. Army Corps of Engineers (1954) indicate strength parameters of $\phi = 30^{o}$ and $c = o$ for both the embankment and upper foundation soils. Both consolidated drained triaxial shear and

direct shear tests were conducted on saturated samples. However, the direct shear samples were sheared at approximately 0.05 percent strain per minute, compared to approximately 1.0 percent strain per minute for the triaxial shear samples. The degree of drainage that occurred, particularly in the triaxial shear samples, is questionable, and the strength parameters determined represent neither an upper or lower bound.

Testing conducted as part of the present study was limited by the quality of samples obtained. A direct shear test series on samples of the upper foundation soils at in situ moisture contents determined ϕ = 29.5^{o} and c = 290 psf. These parameters are very similar to the earlier test results. Results of unconsolidated-undrained tests on embankment soils at in situ moisture contents were inconclusive, since only three samples were tested. However, a cohesion value of at least 2,000 psf is indicated.

What is wrong with the quality?

Shear strength parameters utilized in the stability analyses are listed in Table 6. Values listed for the homogeneous embankment and the upper foundation soils are based on the original Corps of Engineers tests described in the previous paragraphs. A cohesion of zero may be reasonable for saturated conditions, but is not realistic for the compacted, desiccated soils in the embankment. Thus, lower bound safety factors are calculated. Strength parameters for the lower

TABLE 6

Shear Strength Parameters
Utilized in Stability Analyses

Material	Ø°	C psf	Saturated Unit Weight pcf	Moist Unit Weight pcf
Homogeneous Embankment	30	0	-	120
Upper Foundation	30	0	-	110
Lower Foundation	40	2,000	-	130
Granular Drain (Alternatives 1 & 2)	33	0	60	120
Downstream Granular Fill (Alternative 2)	35	0	-	135

foundation soils are assumed, but set arbitrarily high to ensure slip circles will remain within the upper foundations soils. Friction angles for the granular drain and fill material are assumed, based on our experience with similar soils, and are conservative.

6.3.4 Methods of Analysis

Static stability analyses were performed using the computer program SSTAB1. This program was developed by Stephen G. Wright (1974), University of Texas at Austin, utilizing methods first introduced by E. Spencer (1967). The Spencer-Wright method is one which satisfies all the equations of static equilibrium, grouping this procedure into the same category as the Bishop Exact method and the Morgenstern-Price method. The difference in these approaches lies in the methods in which the side forces on each slice are treated. Spencer-Wright's approach assumes the inclination of the resultant of the interslice forces is a constant for all slices (parallel interslice forces).

Both circular arc and noncircular shear surfaces were analyzed using SSTAB1. Additionally, simple hand analyses of horizontal sliding blocks were made for Alternative 1, considering the lateral thrust of water in the chimney drains.

6.3.5 Analysis Results

The computer analyses indicate that for the boundary conditions and strength parameters described in the previous sections, the minimum safety factor is associated with an infinite slope type failure of either the upstream or downstream face of the dam. The safety factor for such a failure mode is computed as

$$FS = \frac{\tan \phi}{\tan B} + \frac{c}{h\gamma \sin\beta \cos\beta}$$

where β is the slope angle, γ is the unit weight of the soil and h is the depth to the sliding surface. The first term represents the component related to soil friction and the second term represents the additional component due to cohesion. Since infinite slope failures of the type of embankment considered typically result in local sloughing of the slopes, analyses were also made of more critical deep-seated failure surfaces. Analysis results for each alternative are discussed in the following paragraphs.

6.3.5.1 Alternative 1

For assigned strength parameters of $\phi = 30^{o}$, c = o, the infinite slope safety factor for the 2:1 downstream slope is 1.15, and for the 2½:1 upstream slope is 1.44. If a minimum cohesion of 200 psf is assumed and a sliding surface at a depth measured

vertically of 4 feet is considered, the respective infinite slope safety factors are increased to 2.19 and 2.65, respectively. It is likely the homogeneous embankment soil has a cohesion value greater than 200 psf, and thus, even higher safety factors are likely.

Typical deep-seated failure surfaces having safety factors of approximately 1.6 and 1.9 for the downstream and upstream slopes, respectively, are shown in Figure 24. The circles extend through the upper foundation soils, and are tangent to the lower foundation stratum. Boundary water forces, as described previously, were not considered to be acting on the upstream face.

For Alternative 1, a simple analysis can be made of the downstream section sliding along the interface between embankment and upper foundation soils. The driving force is assumed to be the sum of hydrostatic water forces in the drain, coupled with the active earth force of the drain material. The safety factor computed is 1.90. Computer analyses of other noncircular sliding surfaces indicate safety factors greater than 2.5.

6.3.5.2 Alternative 2

Analyses for the upstream section of Alternative 2 are identical to those of the upstream face of

Alternative 1. For the downstream section, the granular fill results in larger safety factors against deep-seated circular arc failures, with an approximate cirtical value of 1.7. Because the granular fill has a larger friction angle, $\emptyset = 35^{o}$, the infinite slope safety factor is 1.21. Sliding block type analyses, considering the interface between the drain and the homogeneous embankment zone as a potential sliding surface, result in computed safety factors typically greater than 2.0.

6.3.5.3 Alternatives 3 & 4

Results of analyses of the downstream section of Alternatives 3 and 4 are similar to those of the downstream section of Alternative 1, resulting in nearly the same factor of safety. The effect of the drains included in Alternative 1 is minimal. Similarly, results of analyses of the upstream sections of Alternatives 3 and 4 are nearly identical to those of the upstream section of Alternative 2. The upstream slope of Alternative 3, with a 3:1 slope angle, has a slightly larger safety factor, 2.1 compared to 1.9. In neither case is the impermeable layer directly considered in the analyses, since the deep-seated failure circles pass outside the slope.

6.3.6 Discussion

Stability analyses indicate that all four alternatives possess an adequate factor of safety against circular arc type failures of the upstream and downstream slopes. Safety factors exceed 1.5, assuming conservative strength parameters of $\emptyset = 30^{o}$ and c = o. More realistic cohesion values for the homogeneous embankment soils for the expected service conditions would result in higher safety factors. Analyses of infinite slope type failure surfaces indicate lower factors of safety for the same strength parameters. In these cases, however, a minimal increase in cohesion to 200 psf would dramatically increase the safety factor to values in excess of 2.0. In summary, all alternatives would possess adequate stability against slope failures.

6.4. Analysis of Seepage Through Cracks

In order to assess flow velocities through cracks and the required capacity of drains included in Alternatives 1 and 2, an analysis was made of the potential seepage through existing cracks at flood stage. Direct analytical solutions for flow through cracks in an embankment dam are not available. Therefore, two independent analyses adapted from established hydraulic principles were employed to provide an estimate of the flow.

6.4.1 Flow Between Parallel Plates

The equation for flow between parallel plates is

$$Q = \Delta P \frac{(\ell \ a^3)}{(12 \ \mu L)}$$

where Q is the flow in ft.^{3}/sec., ℓ is the length of flow in the vertical direction, L is the length of flow in the horizontal direction, μ is the viscosity of water and a is the crack width. Assuming the dimensions shown in Figure 27, the flow lengths are

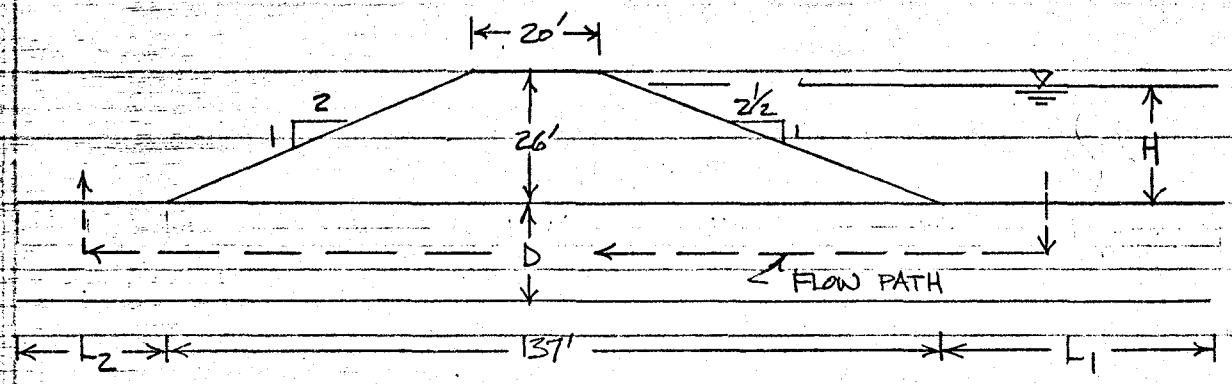
$\mu = 2.20 \times 10^{-5}$? @ 65°F

$$L = \frac{137}{\cos\theta} + \tfrac{1}{2}(L_1 + L_2) \text{ and } \ell = D.$$

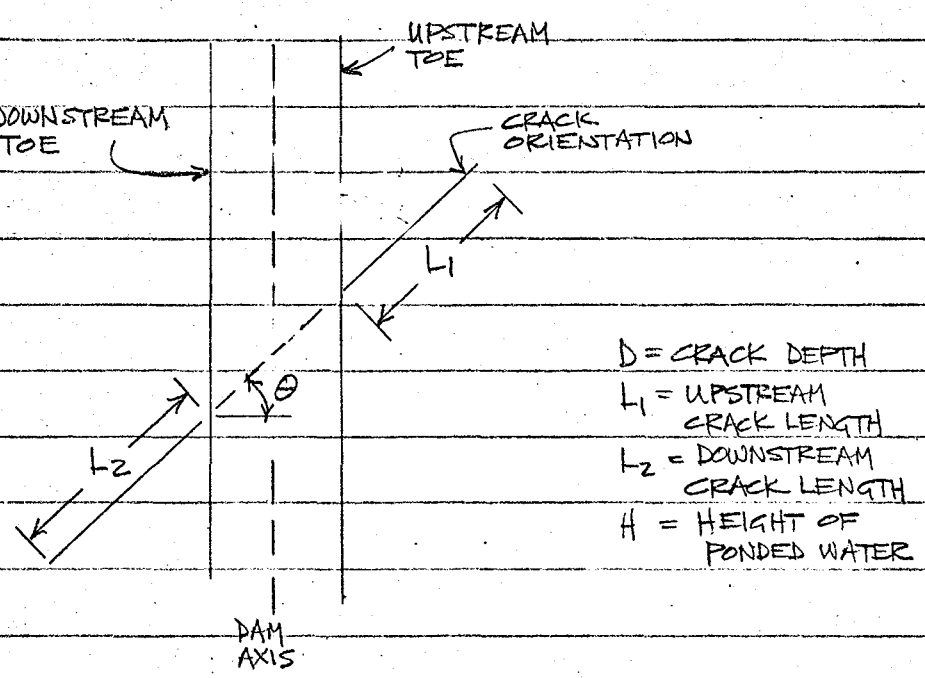
For $L_1 = L_2 = 100$ feet and $\theta = 45^\circ$, L = 294 feet. The pressure difference, ΔP, is equal to the hydrostatic head, or $\Delta P = H\gamma_w = 1435$ psf. Values of Q and average flow velocity V = D/a are listed below for various combinations of crack width, a, and crack depth, D. ?

D feet	a inches	Q ft.^{3}/sec.	V ft./sec.	R_e
50	¼	8.36	8.02	14,700
	½	66.90	32.10	118,000
25	¼	4.18	4.01	7,400
	½	33.40	16.00	58,000

?



ELEVATION VIEW



PLAN VIEW

FIGURE 27

DAM GEOMETRY ASSUMED FOR PARALLEL PLATE FLOW

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This analysis assumes fully developed, incompressible laminar flow. Applicability of the solution is readily checked by computing the Reynold's number

$\rho = 1.94$ slug/ft³ @ 65°F

$$R_e = pVa/\mu$$

where p is the mass density of water. Turbulent flow occurs at Reynold's numbers of approximately 1200. Calculated values listed in the above table indicate only very narrow, shallow cracks would fulfill the criteria of laminar flow. Under these conditions, flows of 1 or 2 ft.^{3}/sec. would be expected. So what?

6.4.2 Assumed Pipe Flow

Flow through a crack can be modeled as flow through a pipe with attendant frictional energy losses. If the crack is imagined as a rectangular pipe with dimensions equal to the crack width, a, and crack height, D, a hydraulic diameter can be computed. It is noted the aspect ration, D/a, will be much larger than the applicable upper bound value of 3. Assuming the energy loss is due to friction only, the flow velocity can be computed from

$$h_L = \frac{V^2}{2g} \left(f \frac{L}{D}\right)$$

where h_L is the head loss (or H in Figure ~~1~~ 27?, f is a friction factor and g = 32.2 ft./sec.^{2}. The

friction factor is dependent on the roughness, e/D. Assuming e/D = 0.05, a value of f = 0.072 is estimated. The length of flow, L, is approximately L + D, where L is the horizontal flow length. Values of Q and V for various combinations of crack width, a, and crack depth, D, are as follows:

D feet	a inches	Q ft.^{3}/sec.	V ft./sec.
50	¼	1.65	1.59
	½	4.64	2.23
25	¼	0.86	1.65
	½	2.41	2.31

These values are considerably less than those computed assuming flow between parallel plates. The analysis again assumes incompressible laminar flow, which computed Reynold's numbers indicate is more nearly met in this case. However, the high aspect ratios likely invalidate the analysis. If the analysis is modified to consider many circular pipes, thus eliminating the high aspect ratio, lower flows are computed, but only slightly lower velocities.

6.4.3 Summary

Neither of the preceeding analyses is strictly correct. However, it appears the solution for flow between parallel plates provides an upper bound estimate, and the solution for pipe flow provides a lower

bound estimate for seepage through a crack. A best estimate of flow through a ¼ inch crack extending to a depth of 50 feet is 5 $ft.^3$/sec. with a velocity of 5 ft./sec. Increasing the crack width to ½ inch increases the flow by a factor of 5 or more.

The toe drain for Alternative 1 forces flow through the cemented soils. The analysis suggest that velocities of flow through cracks would be below the maximum nonscouring velocities for these soils.

6.5 Inspection & Maintenance Schedule

The inspection and maintenance schedule given below is a general outline applicable to the alternative approach to repairs.

1. A yearly survey of the crest elevation monuments and surface profile as well as the N.G.S. survey line monuments should be taken. The results should be carefully compared with existing survey information to help detect areas of subsidence settlement as well as any further collapse settlements.

2. A quarterly visual inspection of the upstream, crest and downstream faces of the dam, with observations made similar to and compared with the SHB visual field log.

3. Careful monitoring and inspection of the dam should be continuously maintained any time water is impounded behind the structure. A crest elevation survey should be made approximately one month after any significant

retention occurs, and any areas of significant settlement should be carefully inspected for surface cracking. Significant retention could be considered more than 6 feet of water temporarily stored behind the dam, or continuous outflow through the controlled outlet in excess of 24 hours. Any localized areas of settlement should be trenched and flooded in a search for cracks. Any cracks found either visually or by flooding should be grouted.

4. To alert the Flood Control District to any retention behind the dam, an automatic alarm should be installed. This alarm should be tested periodically to insure proper functioning.

5. The geotextiles should be tested every 5 years to check for deterioration. Five samples should be tested for grab tensile strength, ASTM D1682, and elongation to break, ASTM D1682.

6. Ground reconnaissance of the Fenne Knoll Fissures should be performed at 6 month intervals. This reconnaissance should include a careful surveying of the total length of the fissures to monitor their possible growth and encroachment upon McMicken Dam.

7. Monitoring of possible earth fissuring within 1,000 feet of the dam should be performed using low-sun-angle aerial photography. This reconnaissance should be performed at 3 years after completion of repairs.

   Based on the results of this survey, further photographic monitoring should be planned. To ensure photographic coverage of the area to be monitored, the following aspects need to be taken into consideration: Altitude of camera above mean terrain (AMT), film format, lense length, overlap necessary for stereo viewing, air speed versus frequency of photos, and sun azimuth.

As was performed for this study, photography should be taken at a scale of 1:3,000. This scale will provide a lateral coverage of 2,250 feet, and a 1,000 feet of coverage on either side of the dam with a safety margin built in. To produce the proper shading and/or highlighting effect on the possible earth fissures, the photographs should be taken when the sun is at an azimuth of between 8° and 25° above the horizon. Photography should be performed in the afternoon, since the shadows will be accentuated best in the afternoon due to the slope direction of the ground surface.

Lineament analysis of the aerial photography should be performed by two independent observers, with possible and probable fissuring being recorded on permanent acrylic overlays. These overlays can then be compared to the current set of photographic overlays, which were developed for this study, and future photographic overlays. In this way, it can be determined if there is an increase in the number of, or magnitude of recorded lineations.

What should be done if a fissure is found in the dam in the future?

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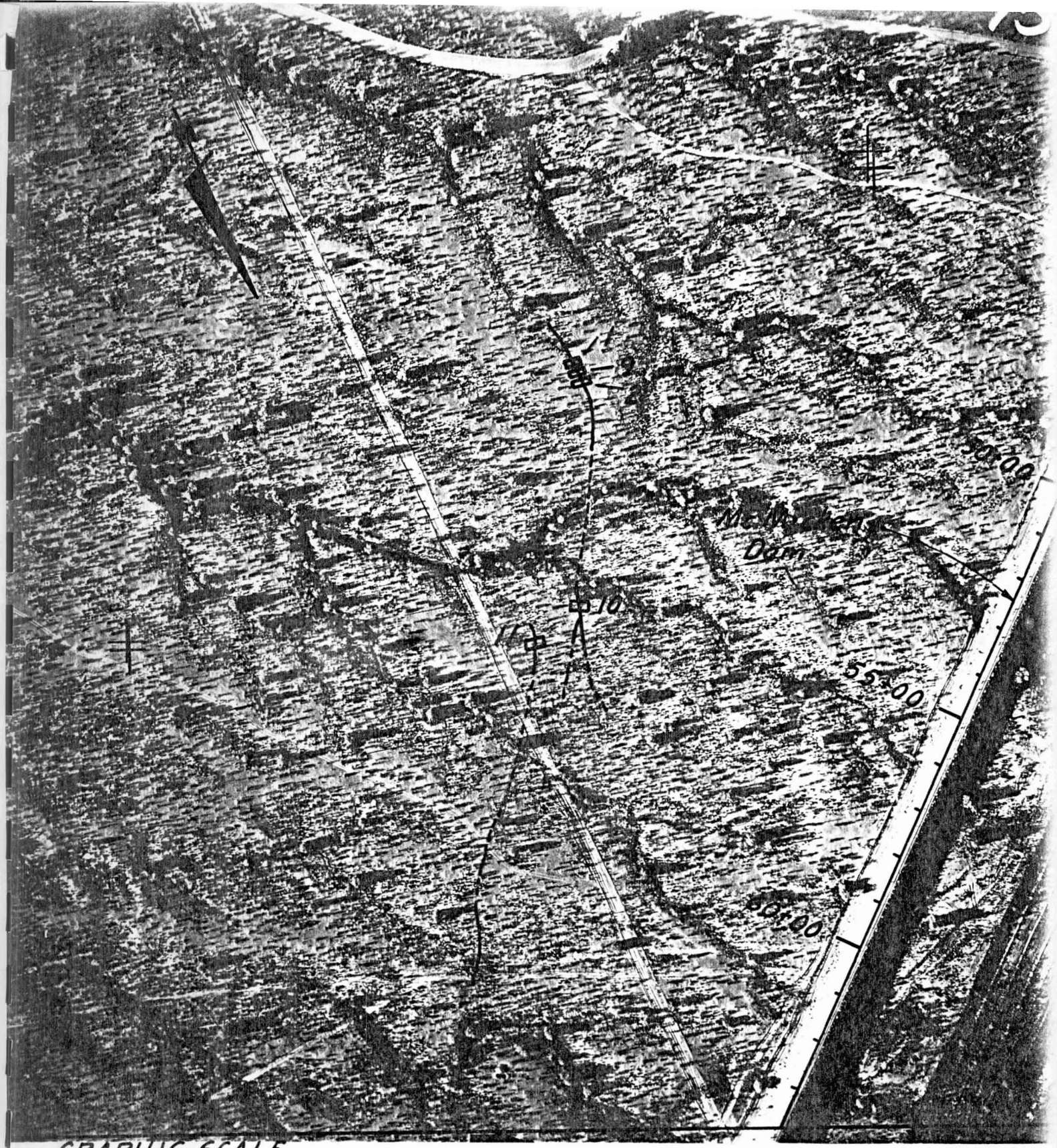

GRAPHIC SCALE

0' 500'

FENNE KNOLL FISSURES

LEGEND

—— -- EARTH FISSURE, Dashed where concealed.

1 ▭ BACK-HOE TRENCH LOCATION

Mc Micken Dam Restoration Study
Maricopa County, Arizona
S.H.B. Job No. E81-138

PROJECT McMicken Dam Restoration Study

JOB NO. E81-138 DATE 11-9-81

LOG OF TEST PIT NO. TP-1

Backhoe Type Case 580C

Location *See Below

Elevation 1326.0'

Datum U.S.G.S. Topo Map

GROUND WATER

DEPTH	HOUR	DATE
	none	

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0					CL	dry	SILTY CLAY, moderately to strongly cemented, low to medium plasticity, brown note: considerable sand, gravel & cobbles below 3½'
5							Backhoe refused at 5'
							*Station 51+00, 1150' downstream of ℄

DATE 11-9-81

LOG OF TEST PIT NO. TP-2

Backhoe Type Case 580C

Location *See Below

Elevation 1320.0'

Datum U.S.G.S. Topo Map

GROUND WATER

DEPTH	HOUR	DATE
	none	

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0					CL-ML	dry	SILTY CLAY & CLAYEY SILT, considerable sand, some gravel, moderately to strongly cemented, low to medium plasticity, brown note: considerable gravel & cobbles below 3½'
5							Backhoe refused at 4'
							*Station 56+00, 1300' downstream of ℄

SAMPLE TYPE
B — Undisturbed Block Sample
D — Disturbed Bulk Sample

SERGENT, HAUSKINS & BECKWITH
CONSULTING SOIL AND FOUNDATION ENGINEERS
PHOENIX • ALBUQUERQUE • SANTA FE

PROJECT McMicken Dam Restoration Study

JOB NO. E81-138 DATE 11-9-81

LOG OF TEST PIT NO. TP-3

Backhoe Type Case 580C

Location *See Below

Elevation 1355.0'

Datum U.S.G.S. Topo Map

GROUND WATER

DEPTH	HOUR	DATE
	none	

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0					CL	dry	SILTY CLAY, some sand, moderately to weakly cemented, medium plasticity, brown
5					SM	dry	SILTY SAND, some gravel, predominantly well graded, nonplastic to low plasticity, brown
10							Stopped backhoe at 10'
							*Station 209+00, 900' upstream of ℄

DATE 11-9-81

LOG OF TEST PIT NO. TP-4

Backhoe Type Case 580C

Location *See Below

Elevation 1364.0'

Datum U.S.G.S. Topo Map

GROUND WATER

DEPTH	HOUR	DATE
	none	

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0					CL	slightly moist to dry	SILTY CLAY, some sand, weakly cemented, medium plasticity, brown
5					SM	slightly moist to dry	SILTY SAND, some gravel & silty-sandy clay in lenses, predominantly well graded, low plasticity, brown
10					CL	slightly moist to dry	SILTY CLAY, some clayey-silty sand in lenses, weakly to moderately cemented, medium plasticity, brown note: highly lenticular
15							Stopped backhoe at 12'
							*Station 198+00, 1900' upstream of ℄

SAMPLE TYPE
B — Undisturbed Block Sample
D — Disturbed Bulk Sample

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PROJECT McMicken Dam Restoration Study

JOB NO. E81-138 DATE 11-9-81

LOG OF TEST PIT NO. TP-5

Backhoe Type: Case 580C

Location: *See Below

Elevation: 1342.0'

Datum: U.S.G.S. Topo Map

GROUND WATER

DEPTH	HOUR	DATE
	none	

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0					CL	slightly moist to dry	SILTY CLAY, some to considerable sand, weakly to moderately cemented, medium plasticity, brown
5					SM	slightly moist to dry	SILTY SAND, some to considerable gravel in lenses, predominantly well graded, low plasticity to nonplastic, brown
10							
15							Stopped backhoe at 12'

*Station 302+50, 250' downstream of ℄

DATE 11-9-81

LOG OF TEST PIT NO. TP-6

Backhoe Type: Case 580C

Location: *See Below

Elevation: 1342.0'

Datum: U.S.G.S. Topo Map

GROUND WATER

DEPTH	HOUR	DATE
	none	

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0						slightly moist to dry	SILTY CLAY, considerable sand in lenses, weakly cemented, medium to low plasticity, brown
5					CL		
10							
							Stopped backhoe at 10'

*Station 322+50, 270' downstream of ℄

SAMPLE TYPE
B — Undisturbed Block Sample
D — Disturbed Bulk Sample

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PROJECT McMicken Dam Restoration Study

JOB NO. E81-138 DATE 11-9-81

LOG OF TEST PIT NO. TP-7

Backhoe Type Case 580C

Location *See Below

Elevation 1327.0'

Datum U.S.G.S. Topo Map

GROUND WATER

DEPTH	HOUR	DATE
	none	

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0						slightly moist to dry	SANDY CLAY, considerable silt, small amount of gravel, occasionally weakly cemented, medium to low plasticity, brown note: highly stratified
5					CL		
10							Stopped backhoe at 10' *Station 336+00, 1900' downstream of ℄

DATE 11-9-81

LOG OF TEST PIT NO. TP-8

Backhoe Type Case 580C

Location *See Below

Elevation 1326.0'

Datum U.S.G.S. Topo Map

GROUND WATER

DEPTH	HOUR	DATE
	none	

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0						slightly moist to dry	SANDY, SILTY CLAY, trace of gravel, weakly cemented, medium to low plasticity, brown note: highly stratified
5					CL		
10							
15							Stopped backhoe at 11' *Outlet channel Station 37+00, 400' downstream of ℄

SAMPLE TYPE
B — Undisturbed Block Sample
D — Disturbed Bulk Sample

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JOB NO. E81-138 DATE 11-11-81

LOG OF TEST PIT NO. TP-9

Backhoe Type American 35A

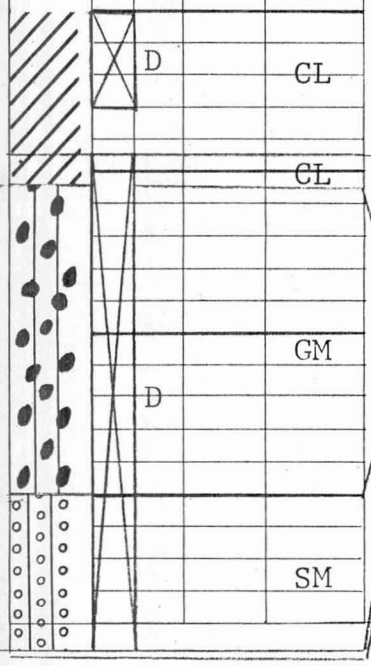
Location *See Below

Elevation 1322.0'

Datum U.S.G.S. Topo Map

GROUND WATER

DEPTH	HOUR	DATE
	none	



Depth in Feet	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0	X	D		CL	slightly moist to dry	SILTY CLAY, weakly cemented, low to medium plasticity, brown
5				CL	slightly moist to dry	SILTY CLAY, some sand, strongly cemented, low to medium plasticity, light brown
10				GM	slightly moist to dry	SILTY SAND & GRAVEL, some cobbles, predominantly well graded, nonplastic, light brown
		D			slightly moist to dry	SILTY SAND, predominantly well graded, weakly to moderately cemented, nonplastic, brown to light brown
15				SM		Stopped backhoe at 21' *Station 54+00, 1200' downstream of ℄
20						

DATE 11-11-81

LOG OF TEST PIT NO. TP-10

Backhoe Type American 35A

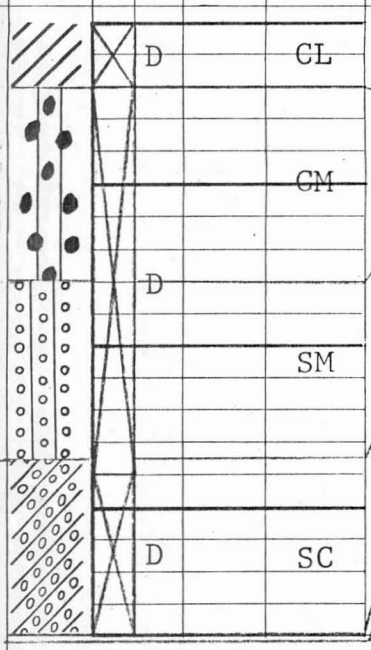
Location *See Below

Elevation 1330.0'

Datum U.S.G.S. Topo Map

GROUND WATER

DEPTH	HOUR	DATE
	none	



Depth in Feet	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0	X	D		CL	slightly moist	SILTY CLAY, low plasticity, light brown to brown
5				GM	slightly moist to dry	SILTY SAND & GRAVEL, predominantly well graded, weakly cemented in places, nonplastic to low plasticity, tan to brown
		D			slightly moist to dry	SILTY SAND, some clayey sand, predominantly fine to medium, weakly cemented, nonplastic to low plasticity, tan to brown
10				SM		
					slightly moist to dry	CLAYEY SAND, some silty sand & silty & sandy clay, predominantly fine to medium, weakly cemented, low plasticity, tan to brown
15		D		SC		Stopped backhoe at 20' *Station 49+50, 900' downstream of ℄
20						

SAMPLE TYPE
B — Undisturbed Block Sample
D — Disturbed Bulk Sample

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JOB NO. E81-138 DATE 11-11-81

LOG OF TEST PIT NO. TP-11

Backhoe Type American 35A

Location *See Below

Elevation 1330.0'

Datum U.S.G.S. Topo Map

GROUND WATER

DEPTH	HOUR	DATE
	none	

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		☒	D		CL	slightly moist	SILTY CLAY, some sand, weakly to moderately cemented, low to medium plasticity, light brown to brown
5					CL & GC	slightly moist to dry	SANDY, GRAVELLY CLAY & CLAYEY SAND & GRAVEL, some silty clay lenses, predominantly well graded sand, weakly to moderately cemented, low plasticity, light brown
10							
15							Stopped backhoe at 13'

*Station 49+50, 700' downstream of ℄

DATE 11-20-81

LOG OF TEST PIT NO. TP-12

Backhoe Type Case 580C

Location *See Below

Elevation 1182.0'

Datum U.S.G.S. Topo Map

GROUND WATER

DEPTH	HOUR	DATE
	none	

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0						moist	SILTY CLAY, considerable fine to medium sand, weakly to strongly cemented, medium to high plasticity, brown
5					CL		
10							Stopped backhoe at 9'

*NE¼ NE¼ SW¼ Section 2, T2N, R1W

SAMPLE TYPE
B — Undisturbed Block Sample
D — Disturbed Bulk Sample

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JOB NO. E81-138 DATE 11-20-81

LOG OF TEST PIT NO. TP-13

Backhoe Type: Case 580C

Location: *See Below

Elevation: 1184.0'

Datum: U.S.G.S. Topo Map

GROUND WATER

DEPTH	HOUR	DATE
	none	

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0						moist	SILTY CLAY, some fine sand, weakly to moderately cemented, occasionally strongly cemented, medium plasticity, brown note: some very strongly cemented nodules at about 6' note: very moist to nearly saturated in fissure
5					CL		
10		X	D		CL	very moist	SILTY CLAY, weakly to moderately cemented, some cementation forming sand sized grains, medium plasticity, greenish-brown
15							Stopped backhoe at 12' *NW¼ NE¼ SW¼ Section 2, T2N, R1W

DATE 11-20-81

LOG OF TEST PIT NO. TP-14

Backhoe Type: Case 580C

Location: *See Below

Elevation: 1186.0'

Datum: U.S.G.S. Topo Map

GROUND WATER

DEPTH	HOUR	DATE
	none	

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0						slightly moist to dry	SILTY CLAY, small amount of sand, medium plasticity, light brown note: desiccated 0 to 2' note: weakly to moderately cemented below 2'
5					CL		
10							
15							Stopped backhoe at 12' *SW¼ NE¼ SW¼ Section 2, T2N, R1W

SAMPLE TYPE
B — Undisturbed Block Sample
D — Disturbed Bulk Sample

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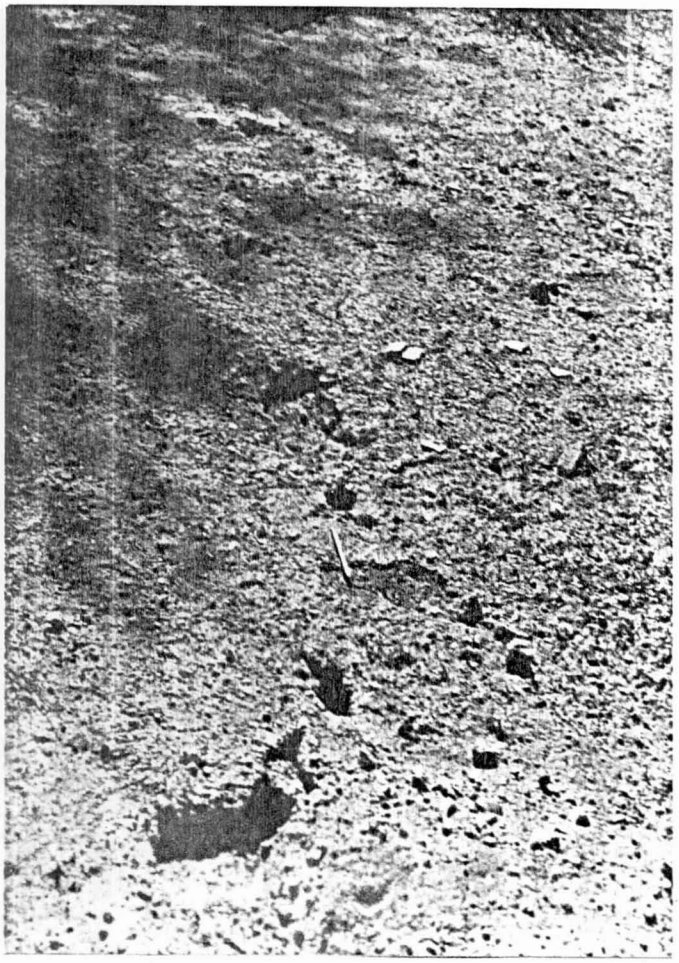
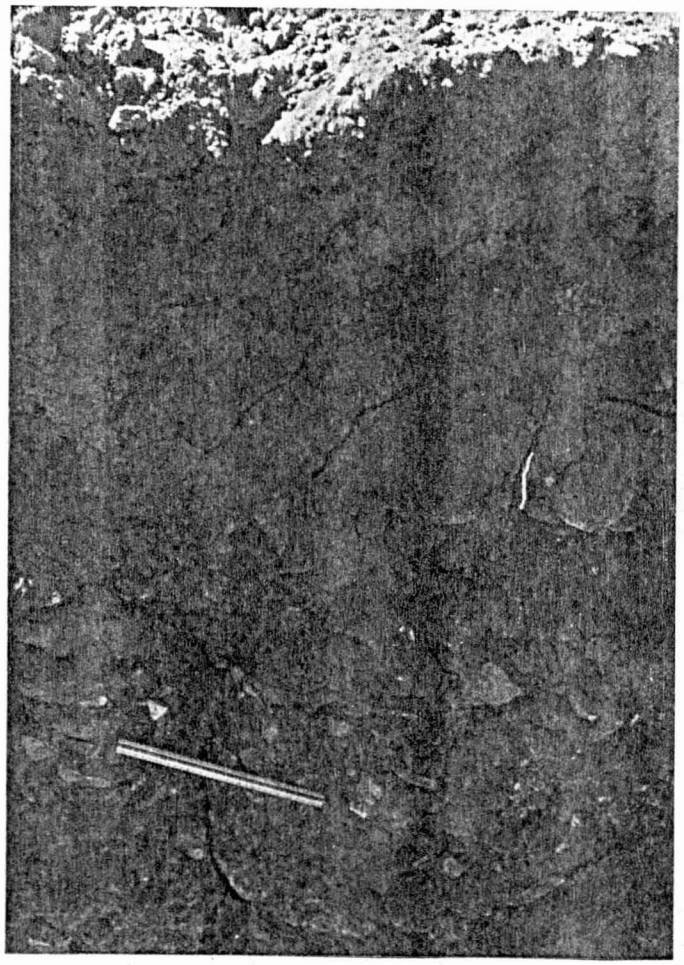
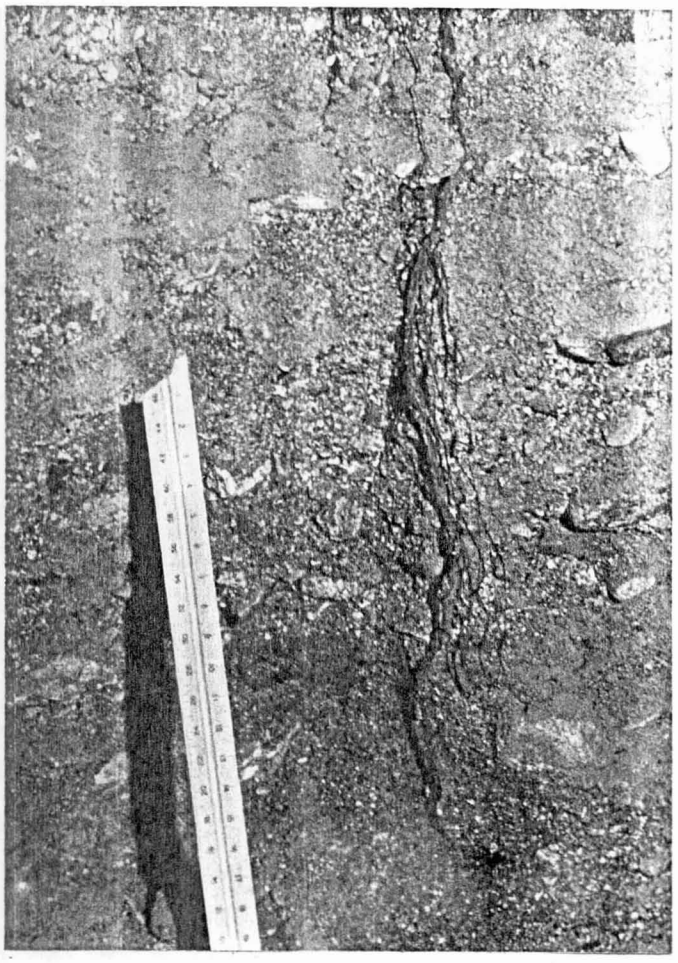


← Typical surface expression.

TP-1: Earth fissure visible for the bottom 1.5 feet in a 4.5 feet deep trench. →

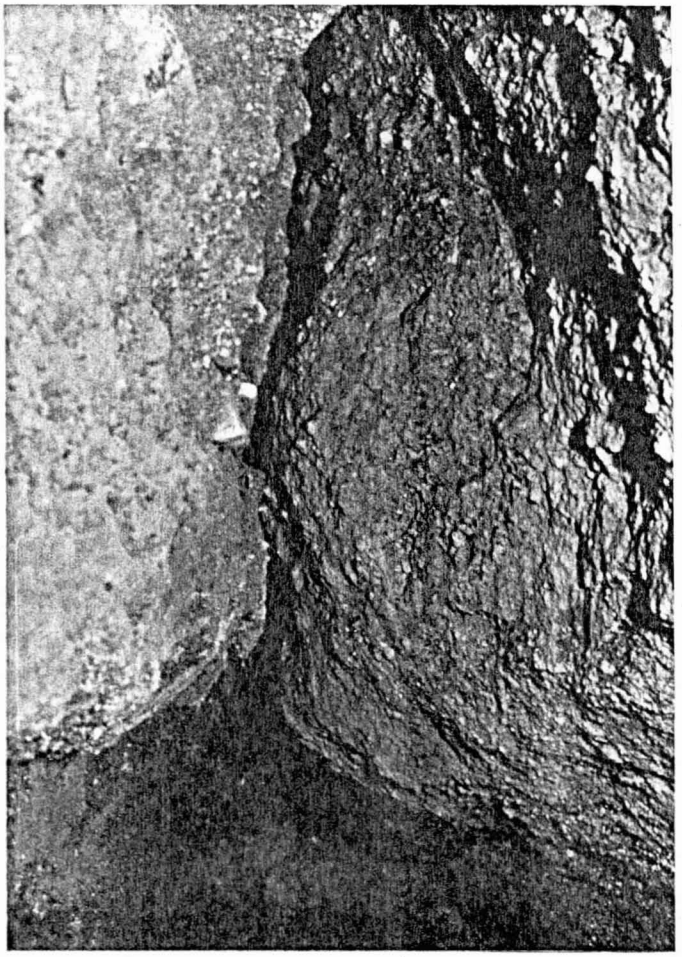


FENNE KNOLL FISSURES

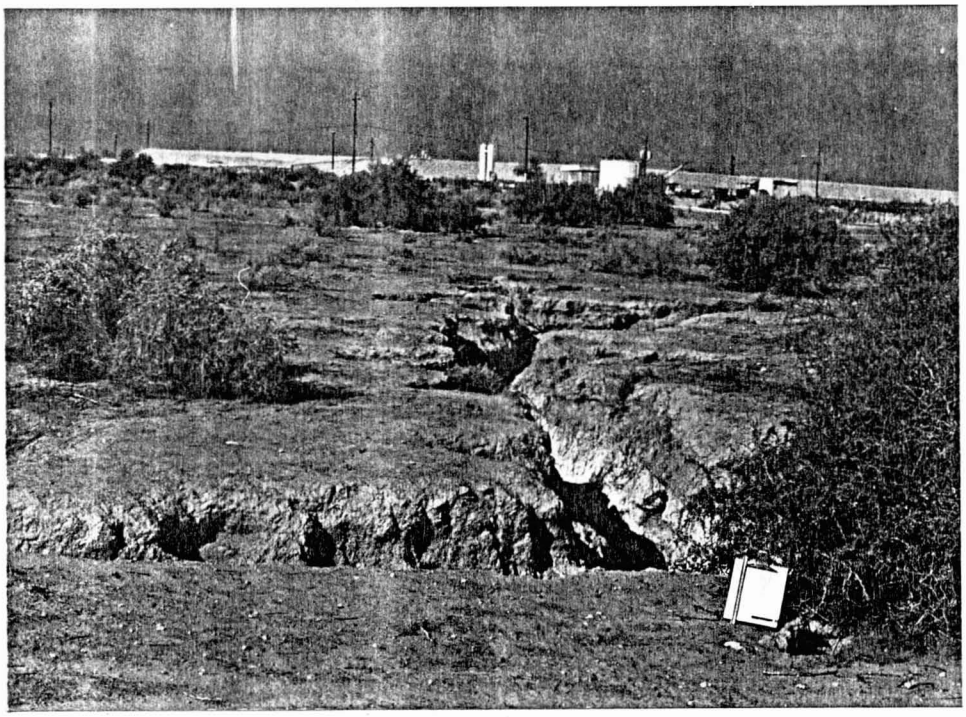


← TP-9: Typical subsurface expression of earth fissure.

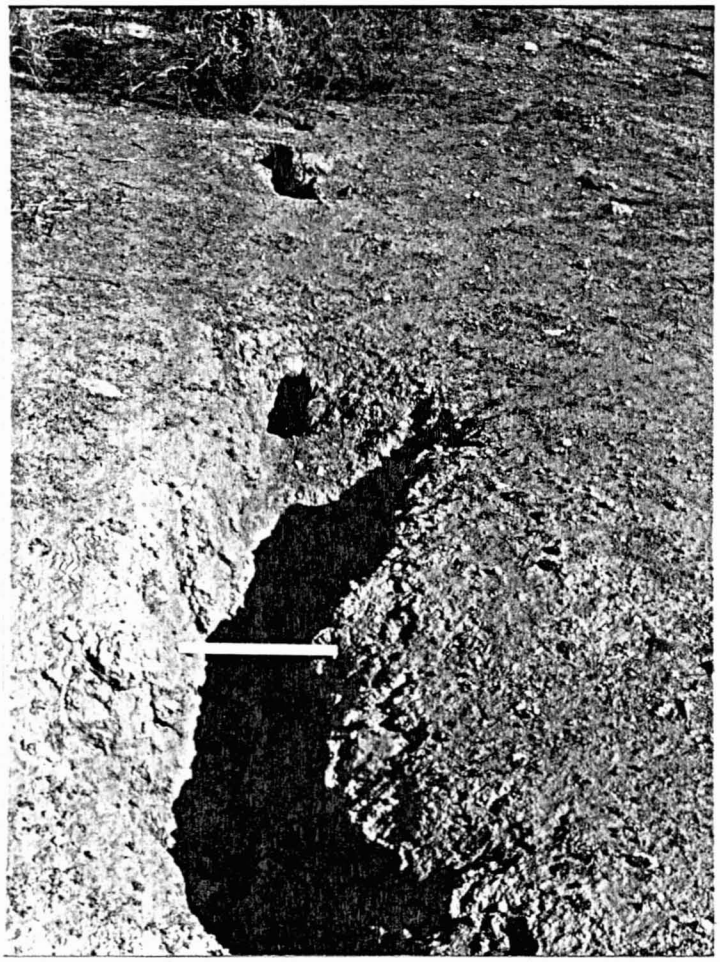
TP-10: 14 feet deep in trench. Fissure opens to about 2 feet wide. Filled with coarse, loose sand. →



FENNE KNOLL FISSURES



Intersection of fissure (right to left) and drainage (top to bottom).



Typical surface expression of fissure.

EARTH FISSURES LOCATED EAST OF LUKE A.F.B.

TEST DRILLING EQUIPMENT & PROCEDURES

Drilling Equipment Truck-mounted CME-55 drill rigs powered with 4 or 6 cylinder Ford industrial engines are used in advancing test borings. The 4 cylinder and 6 cylinder engines are capable of delivering about 4,350 and 6,500 foot/pounds torque to the drill spindle, respectively. The spindle is advanced with twin hydraulic rams capable of exerting 12,000 pounds downward force. Drilling through soil or softer rock is performed with 6 1/2 O.D., 3 1/4 I.D. hollow stem auger or 4 1/2 inch continuous flight auger. Carbide insert teeth are normally used on the auger bits so they can often penetrate rock or very strongly cemented soils which require blasting or very heavy equipment for excavation. Where refusal is experienced in auger drilling, the holes are sometimes advanced with tricone gear bits and NX rods using water or air as a drilling fluid.

Sampling Procedures Dynamically driven tube samples are usually obtained at selected intervals in the borings by the ASTM D1586 procedure. In many cases, 2" O.D., 1 3/8" I.D. samplers are used to obtain the standard penetration resistance. "Undisturbed" samples of firmer soils are often obtained with 3" O.D. samplers lined with 2.42" I.D. brass rings. The driving energy is generally recorded as the number of blows of a 140 pound 30 inch free fall drop hammer required to advance the samplers in 6 inch increments. However, in stratified soils, driving resistance is sometimes recorded in 2 or 3 inch increments so that soil changes and the presence of scattered gravel or cemented layers can be readily detected and the realistic penetration values obtained for consideration in design. These values are expressed in blows per foot on the logs. "Undisturbed" sampling of softer soils is sometimes performed with thin walled Shelby tubes (ASTM D1587). Where samples of rock are required, they are obtained by NX diamond core drilling (ASTM D2113). Tube samples are labeled and placed in watertight containers to maintain field moisture contents for testing. When necessary for testing, larger bulk samples are taken from auger cuttings.

Continuous Penetration Tests Continuous penetration tests are performed by driving a 2" O.D. blunt nosed penetrometer adjacent to or in the bottom of borings. The penetrometer is attached to 1 5/8" O.D. drill rods to provide clearance to minimize side friction so that penetration values are as nearly as possible a measure of end resistance. Penetration values are recorded as the number of blows of a 140 pound 30 inch free fall drop hammer required to advance the penetrometer in one foot increments or less.

Boring Records Drilling operations are directed by our field engineer or geologist who examines soil recovery and prepares boring logs. Soils are visually classified in accordance with the Unified Soil Classification System (ASTM D2487) with appropriate group symbols being shown on the logs.

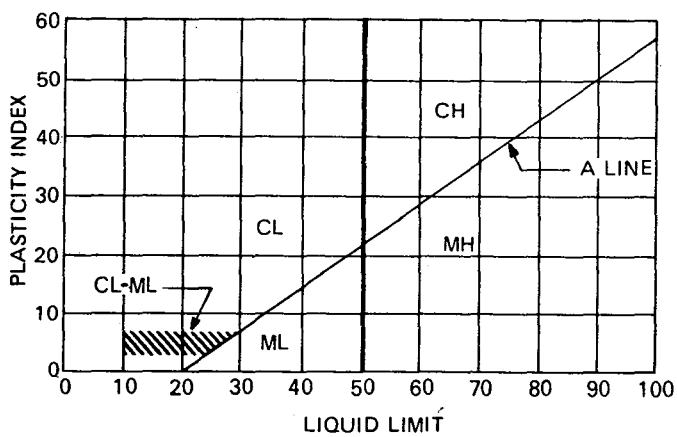
UNIFIED SOIL CLASSIFICATION SYSTEM

Soils are visually classified by the Unified Soil Classification system on the boring logs presented in this report. Grain-size analysis and Atterberg Limits Tests are often performed on selected samples to aid in classification. The classification system is briefly outlined on this chart. For a more detailed description of the system, see "The Unified Soil Classification System" Corp of Engineers, US Army Technical Memorandum No. 3-357 (Revised April 1960) or ASTM Designation: D2487-66T.

MAJOR DIVISIONS				GRAPHIC SYMBOL	GROUP SYMBOL	TYPICAL NAMES
COARSE-GRAINED SOILS (Less than 50% passes No. 200 sieve)	GRAVELS (50% or less of coarse fraction passes No. 4 sieve)	CLEAN GRAVELS (Less than 5% passes No. 200 sieve)			GW	Well graded gravels, gravel-sand mixtures, or sand-gravel-cobble mixtures.
					GP	Poorly graded gravels, gravel-sand mixtures, or sand-gravel-cobble mixtures.
		GRAVELS WITH FINES (More than 12% passes No. 200 sieve)	Limits plot below "A" line & hatched zone on plasticity chart		GM	Silty gravels, gravel-sand-silt mixtures.
			Limits plot above "A" line & hatched zone on plasticity chart		GC	Clayey gravels, gravel-sand-clay mixtures.
	SANDS (More than 50% of coarse fraction passes No. 4 sieve)	CLEAN SANDS (Less than 5% passes No. 200 seive)			SW	Well graded sands, gravelly sands.
					SP	Poorly graded sands, gravelly sands.
		SANDS WITH FINES (More than 12% passes No. 200 sieve)	Limits plot below "A" line & hatched zone on plasticity chart		SM	Silty sands, sand-silt mixtures.
			Limits plot above "A" line & hatched zone on plasticity chart		SC	Clayey sands, sand-clay mixtures.
FINE-GRAINED SOILS (50% or more passes No. 200 sieve)	SILTS (LIMITS PLOT BELOW "A" LINE & HATCHED ZONE ON PLASTICITY CHART)	SILTS OF LOW PLASTICITY (Liquid Limit Less Than 50)			ML	Inorganic silts, clayey silts with slight plasticity.
		SILTS OF HIGH PLASTICITY (Liquid Limit More Than 50)			MH	Inorganic silts, micaceous or diatomaceous silty soils, elastic silts.
	CLAYS (LIMITS PLOT ABOVE "A" LINE & HATCHED ZONE ON PLASTICITY CHART)	CLAYS OF LOW PLASTICITY (Liquid Limit Less Than 50)			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
		CLAYS OF HIGH PLASTICITY (Liquid Limit More Than 50)			CH	Inorganic clays of high plasticity, fat clays, sandy clays of high plasticity.

NOTE: Coarse grained soils with between 5% & 12% passing the No. 200 sieve and fine grained soils with limits plotting in the hatched zone on the plasticity chart to have double symbol.

PLASTICITY CHART



DEFINITIONS OF SOIL FRACTIONS

SOIL COMPONENT	PARTICLE SIZE RANGE
Cobbles	Above 3 in.
Gravel	3 in. to No. 4 sieve
Coarse gravel	3 in. to ¾ in.
Fine gravel	¾ in. to No. 4 sieve
Sand	No. 4 to No. 200
Coarse	No. 4 to No. 10
Medium	No. 10 to No. 40
Fine	No. 40 to No. 200
Fines (silt or clay)	Below No. 200 sieve

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TERMINOLOGY USED TO DESCRIBE THE RELATIVE DENSITY, CONSISTENCY OR FIRMNESS OF SOILS

The terminology used on the boring logs to describe the relative density, consistency or firmness of soils relative to the standard penetration resistance is presented below. The standard penetration resistance (N) in blows per foot is obtained by the ASTM D1586 procedure using 2" O.D., 1 3/8" I.D. samplers.

1. Relative Density. Terms for description of relative density of cohesionless, uncemented sands and sand-gravel mixtures.

N	Relative Density
0-4	Very loose
5-10	Loose
11-30	Medium dense
31-50	Dense
50+	Very dense

2. Relative Consistency. Terms for description of clays which are saturated or near saturation.

N	Relative Consistency	Remarks
0-2	Very soft	Easily penetrated several inches with fist.
3-4	Soft	Easily penetrated several inches with thumb.
5-8	Medium stiff	Can be penetrated several inches with thumb with moderate effort.
9-15	Stiff	Readily indented with thumb, but penetrated only with great effort.
16-30	Very stiff	Readily indented with thumbnail.
30+	Hard	Indented only with difficulty by thumbnail.

3. Relative Firmness. Terms for description of partially saturated and/or cemented soils which commonly occur in the Southwest including clays, cemented granular materials, silts and silty and clayey granular soils.

N	Relative Firmness
0-4	Very soft
5-8	Soft
9-15	Moderately firm
16-30	Firm
31-50	Very firm
50+	Hard

PROJECT McMicken Dam Restoration Study

JOB NO. E81-138 DATE 12-14-81

LOG OF TEST BORING NO. 1

location Station 472+00, 18' E of toe

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1336.0'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	26				slightly moist to dry	SANDY CLAY, considerable silt, some gravel, predominantly well graded, subangular, weakly to moderately cemented, medium plasticity, brown to light brown
			X	S	38				firm to hard	
5			X	S	25			CL		
10			X	S	50/4"				slightly moist very firm	CLAYEY SAND, considerable silt, some fine, subangular gravel, predominantly fine to medium, weakly cemented, medium to low plasticity, brown
15			X	S	46			SC	slightly moist hard	CLAYEY SILT, considerable fine sand, weakly to moderately cemented, low to medium plasticity, tan to light brown
20			X	S	50/2"			ML	slightly moist hard	SANDY, SILTY CLAY, some fine, subangular to subrounded gravel in lenses, moderately cemented, medium plasticity, brown to light brown
25			X	S	50/3"					
30			X	S	50/3"			CL	slightly moist very dense	SAND, considerable silt, predominantly fine to medium, nonplastic, brown
35			X	S	56			SP	slightly moist dense	SILTY SAND, predominantly fine to medium, nonplastic to low plasticity, brown
40			X	S	85				slightly moist hard	SANDY, SILTY CLAY, small amount of fine, subangular gravel, weakly to moderately cemented, medium plasticity, brown
45			X	S	40			SM		
50			X	S	50/5"			CL		Stopped auger at 49'6" Sampler refused at 49'11"

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-138 DATE 12-14-81

LOG OF TEST BORING NO. 2

location Station 462+00, 3' E of toe

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1336.0'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	65				slightly moist to moist	CLAYEY SAND, some silt, trace of gravel, fine to medium, subangular, weakly cemented, medium plasticity, light brown
			X	S	21				firm to hard	
5			X	S	33			SP-SC		
10			X	U	34					
15			X	S	30			SM-SC	moist firm	SILTY SAND, considerable clay, trace of gravel, predominantly fine to medium, very weakly cemented, low plasticity, brown
20			X	S	50/5"				slightly moist hard	CLAYEY SAND, some silt, predominantly fine, subrounded, weakly cemented, medium plasticity, light brown
25			X	S	50/5"			SC		
30			X	S	98					
35										Auger refused at 32'

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-138 DATE 12-14-81

LOG OF TEST BORING NO. 3

location Station 425+00, 10' E of toe

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1336.3'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				S	32				slightly moist	SILTY CLAY, some to considerable sand, trace of gravel, weakly to moderately cemented, medium plasticity, brown
				S	21			CL	firm to hard	
5				S	72					
10				S	78			SC	dry very dense	SAND, considerable clay & subrounded to subangular gravel in lenses, predominantly fine to medium, low plasticity, brown to light brown
15				S	50/4"				slightly moist to moist hard	SILTY CLAY, some fine to medium sand, weakly to moderately cemented, medium plasticity, brown
20				S	83			CL		
25				S	119					
30				S	39			SC	slightly moist very firm	CLAYEY SAND, trace of fine, angular to subangular gravel, predominantly fine to medium, occasionally very weakly cemented, low to medium plasticity, brown
35				S	50/4½"					
								CL	slightly moist hard	SANDY, SILTY CLAY, weakly to moderately cemented, medium plasticity, brown note: some subrounded to angular gravel below 38'
40				S	50/5"					
45										Stopped auger at 39'6" Sampler refused at 40'5"

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-138 DATE 12-15-81

LOG OF TEST BORING NO. 4

location Station 408+50, 20' E of toe

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1332.5'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0										FILL
			X	S	35				slightly moist	SILTY CLAY, considerable well graded sand, trace of fine gravel, occasionally weakly cemented, medium plasticity, brown
			X	S	37			CL		
5			X	S	50/5"				very firm	
								CL		
10			X	S	83				slightly moist hard	SANDY CLAY, considerable silt, weakly to moderately cemented, medium plasticity, brown
15			X	S	50/5½"			SC	dry to slightly moist hard	CLAYEY SAND, some silty sand lenses, small amount of fine, subangular gravel, predominantly well graded, occasionally weakly cemented, nonplastic to medium plasticity, brown to reddish-brown
20			X	U	49					
25			X	S	38				slightly moist to moist very firm to hard	SILTY SAND, trace of fine, subrounded gravel, predominantly fine to medium, nonplastic to low plasticity, tan to light brown
30			X	S	85					
35			X	S	40			SM		
40			X	S	50/5½"					note: some predominantly subangular gravel from 38' to 42' & angular to subangular gravel at 50'
45			X	S	63					
50			X	S	50/5½"					Stopped auger at 49'6" Sampler refused at 49'11½"

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-138 DATE 12-15-81

LOG OF TEST BORING NO. 5

location Station 344+00, 15' E of toe

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1336.2'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				S	25				slightly moist	SILTY CLAY, considerable fine to medium sand, small amount of fine, angular to subangular gravel, medium plasticity, brown
				S	22			CL	firm	
5				S	25					
10				S	50/3"			SM	slightly moist firm to hard	SILTY SAND, considerable clay in lenses & angular to subangular gravel in lenses, predominantly fine to medium, subangular, nonplastic to low plasticity, brown to reddish-brown
15				S	75					
20				S	50/5½"			SC	slightly moist to moist hard	CLAYEY SAND, considerable silt, small amount to considerable gravel in lenses, predominantly fine to medium, subangular, low to medium plasticity, reddish-brown
25				S	30				slightly moist	SANDY, SILTY CLAY, small amount of gravel in lenses, very fine sand, weakly to moderately cemented, low to medium plasticity, tan to light brown
30				S	50/5"				firm to hard	
								CL		note: considerable angular to subangular gravel from 37' to 39'
35				S	50/5" (no recovery)					
40				S	50/5½"				slightly moist hard	SILTY SAND, trace of angular to subangular gravel, predominantly fine to medium, weakly cemented, nonplastic to low plasticity, tan to gray
45				S	71			SM	slightly moist hard	SILT, some clay & fine sand, low plasticity, brown
50				S	50/2"			ML		Stopped auger at 49'6" Sampler refused at 50'2"

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-138 DATE 12-15-81

LOG OF TEST BORING NO. 6

location Station 328+00, 15' E of toe

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1338.0'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	20				slightly moist	SILTY CLAY, some fine sand, trace of gravel, weakly cemented, medium to low plasticity, light brown
			X	S	26				firm to hard	
5			X	S	50/6"			CL		
10			X	U	32 (no recovery)					
15			X	S	88				slightly moist	SILTY SAND, considerable angular to subangular gravel, some clay, predominantly fine to medium with considerable well graded lenses, occasionally weakly cemented, nonplastic to low plasticity, brown to reddish-brown
20			X	S	71			SM	very dense	note: some sandy silt lenses below 25', tan
25			X	S	56					
30			X	S	145					
35			X	S	50/5" (no recovery)					
40										Stopped auger at 34'6" Sampler refused at 35'5"

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-138 DATE 12-16-81

LOG OF TEST BORING NO. 7

location Station 311+00, 10' E of toe

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1336.5'

DATUM 1982 A.H.A. Survey

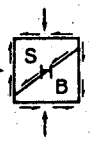
Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	31				slightly moist	SANDY CLAY, considerable silt, weakly cemented, medium plasticity, light brown to reddish-brown
			X	S	42			CL	very firm to hard	
5			X	S	77					
10			X	S	29			SC	slightly moist	CLAYEY SAND, considerable silt, some gravel, predominantly fine to medium, weakly cemented, low plasticity, tan to reddish-brown
									firm to very firm	
15			X	S	48					note: considerable subangular gravel below 14'
20			X	S	48				slightly moist to dry	SILTY SAND, some subangular gravel with considerable gravel in lenses, predominantly fine to medium with some well graded lenses, occasionally weakly cemented, non-plastic to low plasticity, tan to light brown
									very firm to hard	
25			X	S	50					
30			X	S	85					
								SM		
35			X	S	59					
40				S	50/4"					
45				S	50/2"					note: small amount of clay below 45'
50				S	50/3"					Stopped auger at 49'6" Sampler refused at 49'9"

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.



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JOB NO. E81-138 DATE 12-16-81

LOG OF TEST BORING NO. 8

location Station 294+00, 12' E of toe

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1337.5'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	11				moist	SILTY CLAY, some fine to medium sand, medium plasticity, brown
			X	S	76			CL	moderately firm to hard	note: some gravel weakly to moderately cemented below 3'
5			X	U	100/5½"					
									slightly moist	CLAYEY SAND, considerable silt, some subangular to subrounded gravel, predominantly fine to medium, some well graded lenses, weakly cemented, medium plasticity, brown to reddish-brown
10			X	S	50/6"				hard	
								SC		
15			X	S	84					note: occasional sandy or silty clay lenses
20			X	S	50/5½"					
									very slightly moist to dry	SILTY SAND, some silt in lenses & subrounded to subangular gravel in lenses, predominantly fine, nonplastic to low plasticity, tan to light brown
25			X	S	58				very firm to hard	
								SM		
30			X	S	43					
35			X	S	50/6"					
40										Stopped auger at 34'6" Sampler refused at 35'6"

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-138 DATE 12-16-81

LOG OF TEST BORING NO. 9

location Station 280+00, 10' E of toe

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1335.3'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	32				slightly moist	SILTY CLAY, some sand & gravel, weakly to moderately cemented below 2½', medium plasticity, brown
			X	S	58			CL	very firm to hard	
5			X	S	93					
10			X	S	21				slightly moist to dry firm to hard	SILTY SAND, some clay & subangular gravel in lenses, predominantly fine to medium, occasionally weakly to moderately cemented, nonplastic to medium plasticity, brown to reddish-brown
15			X	S	31					
20			X	S	50/5"					
25			X	S	72					
								SM		
30			X	S	68					
35			X	S	50/6"					
40			X	S	55					note: gray below 40' note: increase in gravels below 45'
45			X	S	57					
50			X	S	50/4"					Stopped auger at 49'6" Sampler refused at 50'4"

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-138 DATE 12-16-81

LOG OF TEST BORING NO. 10

location Station 260+00, 15' E of toe

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1338.5'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	15				slightly moist	CLAYEY SILT, some to considerable sand, trace of gravel, medium to low plasticity, light brown
			X	S	9			ML	moderately firm to hard	
5			X	S	59					note: weakly to moderately cemented below 3'
10			X	U	100/9"			CL	slightly moist hard	SILTY CLAY, some sand, weakly to moderately cemented, medium plasticity, light brown
15			X	S	42				slightly moist very firm to hard	CLAYEY SAND, considerable silt, small amount of angular to subangular gravel, predominantly fine to medium, low plasticity, reddish-brown to light brown
								SC		
20			X	S	50/5"					
25			X	S	50/6"				slightly moist hard	CLAYEY SILT, small amount of sand, occasional silty sand lenses, weakly to moderately cemented, medium plasticity, light brown
								ML		
30			X	S	50/4"					
								SM	dry dense	SILTY SAND, small amount of fine, subangular gravel, predominantly fine to medium, nonplastic to low plasticity, light brown
35			X	S	44					
40										Stopped auger at 34'6" Stopped sampler at 36'

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT McMicken Dam Restoration Study

JOB NO. E81-138 DATE 12-16-81

LOG OF TEST BORING NO. 11

location Station 163+50, 10' E of toe

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1342.0'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	12			ML	dry moderately firm	SANDY SILT, some clay & gravel, low plasticity, brown
			X	S	16					
5			X	S	19				dry medium dense to very dense	SILTY SAND & GRAVEL, some clay, occasional thin lenses of clayey silt, weakly to moderately cemented, low to medium plasticity, predominantly fine to medium, angular to subangular, occasionally weakly cemented, non-plastic, light brown note: weakly to moderately cemented from 16½' to 18'
10			X	S	50/5"			SM		
15			X	S	50/2½"					
20										Auger refused at 18'

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-138 DATE 12-17-81

LOG OF TEST BORING NO. 12

location Station 147+00, 10' E of toe

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1339.0'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	12			ML	slightly moist	CLAYEY SILT, some sand & gravel, weakly to moderately cemented, low plasticity, brown
			X	S	19				moderately firm to firm	
5			X	S	82			GM	dry hard	CLAYEY SILT, small amount of fine sand, weakly cemented, low to medium plasticity, tan to light brown
10			X	S	50/5"				dry hard	SANDY SILT, considerable angular to subangular gravel in lenses, some clay & silty sand lenses, predominantly fine to medium, occasionally weakly cemented, nonplastic to medium plasticity, tan to light brown
15			X	S	50/2½"					
20			X	S	50/2"			ML & SM		
25			X	S	50/4"					
30			X	S	50/3"					note: moderately cemented gravels at 30' to 31'
35										Auger refused at 31' on cemented gravels

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-138 DATE 12-17-81

LOG OF TEST BORING NO. 13

location Station 147+65, 10' W of toe

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1339.0'

DATUM 1982 A.H.A. Survey

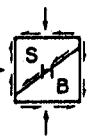
Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				S	27			SC & CL	slightly moist firm to hard	SANDY CLAY, considerable silt, some clayey sand lenses & gravel, weakly to moderately cemented, medium to low plasticity, brown
				S	50/4"					
5				S	100					
10				S	44				dry to slightly moist hard	SANDY, CLAYEY SILT, some lenses of silt, silty sand & silty gravel, angular to subangular, weakly cemented, low plasticity, tan to light brown note: considerable gravel from 11' to 18'
15				S	109					
								ML & SM		
20				S	50/3"					
25				S	50/3½"					
30				S	50/4"					
				A				SM	dry very dense	SILTY SAND, considerable angular gravel, predominantly fine to medium, occasionally weakly cemented, non-plastic, light brown
35				S	50/5"					
40										Stopped auger at 34'6" Sampler refused at 35'5"

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.



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JOB NO. E81-138 DATE 12-17-81

LOG OF TEST BORING NO. 14

location Station 163+50, 12' W of toe

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1343.8'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			☒	S	50/5"			CL	slightly moist hard	SILTY CLAY, some well graded sand, trace of gravel, weakly to moderately cemented, medium plasticity, brown
			☒	S	27					
5			☒	S	19					
									dry firm to hard	SANDY SILT, considerable gravel, predominantly fine to medium, weakly cemented in places, nonplastic to low plasticity, light brown to brown
10			☒	S	50/5"			ML		
15			☒	S	50/4"					
20			—	S	50/1"					
									dry hard	SILT, occasional thin lenses of silty sand, moderately cemented, low plasticity, tan
25			☒	S	50/5"					
30			☒	S	50/4½"			ML		
35			☒	S	50/4½"					
										Stopped auger at 34'6" Sampler refused at 34'10½"

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-138 DATE 12-17-81

LOG OF TEST BORING NO. 15

location Station 260+50, 10' W of toe

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1339.5'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			☒	S	18			SM	slightly moist firm	SILTY SAND, some fine, angular gravel, predominantly well graded, nonplastic to low plasticity, brown
			☒	S	16			ML		
5			☒	S	16				slightly moist firm	SANDY SILT, small amount of fine, angular gravel, weakly cemented, low plasticity, light brown
								ML		
10			☒	U	100/10"				slightly moist firm to hard	SILT, considerable clay & well graded sand, weakly cemented, medium plasticity, light brown
15			☒	S	50/6"					
								SM	slightly moist hard	SILTY SAND, considerable clayey lenses, some subangular gravel, predominantly fine to medium, weakly cemented, low plasticity, light brown to reddish-brown
20			☒	S	50/5½"					
25			☒	S	50/4½"			CL	slightly moist hard	SILTY CLAY, some fine sand, moderately cemented, medium plasticity, brown
30			☒	S	80			CL	dry to slightly moist hard	SANDY CLAY, considerable silt, trace of gravel, moderately cemented, medium plasticity, light brown
35			☒	S	50/5" (no recovery)					
40										Stopped auger at 34'6" Sampler refused at 35'5"

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-138 DATE 12-17-81

LOG OF TEST BORING NO. 16

location Station 280+00, 10' W of toe

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1338.0'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	10				moist to slightly moist	SILTY CLAY, some fine to medium sand, weakly cemented, medium plasticity, brown
			X	S	23			CL		
5			X	U	48				moderately firm to very firm	
10			X	S	13			SM	slightly moist moderately firm to firm	SILTY SAND, considerable clay, some angular to subangular gravel, predominantly fine to medium, weakly cemented, nonplastic to low plasticity, reddish-brown to brown
15			X	S	27					
20			X	S	50/6"			ML	slightly moist hard	CLAYEY SILT, some sand, weakly to moderately cemented, low plasticity, light brown
25			X	S	39			SW-SM	slightly moist dense	SILTY SAND, trace of gravel, well graded, weakly cemented, nonplastic to low plasticity, brown note: increase in gravel below 27'
30			X	S	36					
35			X	S	34			CL	moist very firm	SILTY CLAY, some fine to medium sand, low to medium plasticity, brown to dark brown
40										Stopped auger at 34'6" Stopped sampler at 36'

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-138 DATE 12-18-81

LOG OF TEST BORING NO. 17

location Station 294+00, 15' W of toe

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1339.0'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	28				moist to slightly moist	SILTY CLAY, some sand, trace of gravel, weakly to moderately cemented, medium plasticity, brown to dark brown
			X	S	52			CL	firm to hard	
5			X	U	99					
10			X	S	30			SM	slightly moist firm to hard	SILTY SAND, some lenses of clayey sand, clayey silt & subangular to subrounded gravel, predominantly fine to medium, occasionally weakly to moderately cemented, low to medium plasticity, brown to reddish-brown
15			X	S	50/4"					
20			X	S	96			CL	slightly moist hard	SILTY CLAY, considerable fine to medium sand, some clayey sand lenses, trace of fine gravel, weakly to moderately cemented, medium plasticity, brown to light brown
25			X	S	65					
30			X	S	49(no recovery)			SM	slightly moist to dry hard to very dense	SILTY SAND, some silt & sandy silt lenses, small amount of angular to subangular gravel, predominantly fine to medium, occasionally weakly cemented, non-plastic to low plasticity, light brown
35			X	S	50/5"					
40										Stopped auger at 34'6" Sampler refused at 35'5"

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-138 DATE 12-18-81

LOG OF TEST BORING NO. 18

Location Station 311+00, 10' W of toe

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1337.5'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	31				moist to slightly moist	SILTY CLAY, considerable sand, weakly to moderately cemented, medium plasticity, dark reddish-brown to light brown
			X	S	74			CL	very firm to hard	
5			X	S	45					
10			X	S	50				slightly moist to dry	SILTY SAND, some clayey sand & clayey silt lenses with some subrounded to subangular gravel lenses, predominantly fine to medium, nonplastic to low plasticity, tan to light brown
									hard to firm	
15			X	S	24					
20			X	S	40			SM		note: considerable well graded, angular to subangular sand & gravel below 20'
25			X	S	39					
30			X	S	50/3"					
				S	50/1"					
35										Stopped auger at 34'6" Sampler refused at 34'7"

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-138 DATE 12-18-81

LOG OF TEST BORING NO. 19

location Station 328+00, 17' W of toe

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1339.5'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	15			CL	slightly moist firm to hard	SILTY CLAY, some fine to medium sand, weakly to moderately cemented, medium plasticity, light brown to reddish-brown
			X	S	80					
5			X	S	27				slightly moist firm to hard	SILTY SAND, some clayey sand lenses & subangular gravel in lenses, some well graded lenses, predominantly fine to medium, occasionally weakly cemented, nonplastic to medium plasticity, light brown to tan to reddish-brown
10			X	S	18					
15			X	S	62					
20			X	S	27			SM		
25			X	S	36					
30			X	S	50/5"					note: considerable gravel below 33'
35			X	S	50/6"					Stopped auger at 34'6" Sampler refused at 35'

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. , B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-138 DATE 12-18-81

LOG OF TEST BORING NO. 20

location Station 344+00, 5' W of toe

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1337.5'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	7			CL	slightly moist	SILTY CLAY, some sand, weakly cemented, medium plasticity, light brown
			X	S	5				soft	
5			X	U	5			CL	very moist soft to moderately firm	SILTY CLAY, considerable interbedded lenses of SANDY CLAY & CLAYEY SAND with gravel, medium plasticity, reddish-brown
10			X	S	14					
15			X	S	42			SC	moist very firm	CLAYEY SAND, considerable subrounded to subangular gravel in lenses, some silty & sandy clay in lenses, predominantly well graded, occasionally weakly cemented, low to medium plasticity, reddish-brown
20			X	S	37					
25			X	S	13			ML	very moist moderately firm	CLAYEY SILT, considerable fine to medium sand, occasionally weakly cemented, low plasticity, brown
30			X	S	20			SM	moist firm to hard	SILTY SAND, some clay, predominantly well graded, nonplastic to low plasticity, brown to reddish-brown note: considerable gravel in lenses below 32'
35			X	S	50/4"					Stopped auger at 34'6" Sampler refused at 34'10"

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-138 DATE 12-18-81

LOG OF TEST BORING NO. 21

location Station 408+50, 15' W of toe

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1333.0'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	41			SM	moist to very moist very firm	SILTY SAND, considerable sand, some gravel in lenses, weakly to moderately cemented, low plasticity, light brown to reddish-brown
			X	S	32					
5			X	S	37					
								MH	moist very firm	SILT, some clay, gravel & sandy silt lenses, weakly cemented, medium plasticity, brown to light brown
10			X	S	34					
								SM	moist very firm to hard	SILTY SAND, some clay, small amount of gravel, predominantly fine to medium, nonplastic to low plasticity, light brown to reddish-brown
15			X	S	53					
20			X	S	42				slightly moist to moist dense to medium dense	SAND, considerable silt, some silty sand lenses & angular to subangular gravel, predominantly fine to medium with some well graded lenses, nonplastic, brown to light brown
25			X	S	40			SP		
30			X	S	26					
35			X	S	31					
40										Stopped auger at 34'6" Stopped sampler at 36'

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-138 DATE 1-4-82

LOG OF TEST BORING NO. 22

location Station 425+00, 8' W of toe

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1335.2'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	14			CL	moist moderately firm to firm	SILTY CLAY, some well graded sand, occasionally weakly cemented, medium plasticity, brown to light brown
			X	S	21					
5			X	S	41				moist very firm to hard	CLAYEY SAND, considerable gravel in lenses, some clay & sandy clay in lenses, predominantly well graded, angular to subangular, medium plasticity, brown to reddish-brown
								SC		
10			X	S	68					
15			X	S	71				moist hard	SILTY CLAY, some fine silty sand in lenses, occasionally weakly cemented, occasional moderately cemented nodules, medium to high plasticity, brown
20			X	U	60			CH		
25			X	S	104					
30			X	S	39			SM	moist very firm to hard	SILTY SAND, some clay, small amount of subangular gravel, predominantly fine to medium, nonplastic to low plasticity, light brown
35			X	S	51					
40										Stopped auger at 34'6" Stopped sampler at 36'

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-138 DATE 1-4-82

LOG OF TEST BORING NO. 23

location Station ≈463+00, 8' W of toe

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1335.0'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				U	18				moist to slightly moist	SILTY SAND & CLAYEY SAND, trace of fine gravel, weakly cemented, medium plasticity, brown
				S	39			SM-SC	firm to hard	
5				S	50/5"					
10				S	98			CL	slightly moist to dry hard	SILTY CLAY, some fine to medium sand, weakly to moderately cemented, low to medium plasticity, light brown
15				S	62					
20				S	43			SM	slightly moist to dry very firm to hard	SILTY SAND, some clay & subangular gravel, predominantly fine to medium, nonplastic to low plasticity, brown
25				S	50/1"					
30				S	50/3"			SC	dry hard	SILT, considerable fine sand, some clay, trace of fine gravel, weakly to moderately cemented, low to medium plasticity, light brown
35				S	50/3"					Stopped auger at 34'6" Sampler refused at 34'9"

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT McMicken Dam Restoration Study

JOB NO. E81-138 DATE 1-4-82

LOG OF TEST BORING NO. 24

location Station ≈472+00, 5' W of toe

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1336.3'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	U	13			CL	very moist moderately firm	CLAY, considerable silt & fine to medium sand, low to medium plasticity, brown
			X	S	10					
5			X	S	18			CL	moist firm to hard	SILTY CLAY, considerable fine sand in lenses, occasionally weakly cemented, medium plasticity, brown
10			X	S	51					
15			X	S	148			ML	slightly moist to moist hard	CLAYEY SILT, some fine to medium sand & gravel in lenses, weakly cemented, low plasticity, light brown to brown note: trace of gravel below 18'
20			X	S	50/2"					
25			X	S	50/3½"					
30			X	S	56			SM	moist hard	SILTY SAND, small amount of clay & fine gravel, predominantly fine to medium, non-plastic to low plasticity, brown
35			X	S	67					
40										Stopped auger at 34'6" Stopped sampler at 36'

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT McMicken Dam Restoration Study

JOB NO. E81-138 DATE 1-4 & 1-5-82

LOG OF TEST BORING NO. 25

location Station 328+23, ℄ of dam

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1357.5'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	59				dry to moist hard to very firm	SANDY CLAY, considerable silt, some subangular to subrounded gravel, medium plasticity, brown
								CL		
5			X	S	104					
10			X	S	38				slightly moist to moist very firm to hard	SILTY CLAY with lenses of sandy clay & clayey sand, some gravel, predominantly fine to medium sand, medium plasticity, brown
								CL & SC		
15			X	S	60					
								CL	slightly moist firm	SILTY CLAY, some to considerable sand, weakly cemented, medium plasticity, brown to light brown
20			X	S	30					
25			X	S	19				slightly moist to dry firm to hard	CLAYEY SAND, some angular to subangular gravel, well graded, nonplastic to low plasticity, light brown
30			X	S	35					
35			X	S	94			SC		
40			X	S	38					
45			X	S	79					
50										

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT McMicken Dam Restoration Study

JOB NO. E81-138 DATE 1-4 & 1-5-82

LOG OF TEST BORING NO. 25

location Station 328+23, ¢ of dam

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1357.5'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
50			X	S	92					note: considerable gravel below 50'
55			=	S	50/3"			SC		
60			=	S	50/3"					Stopped auger at 59'6" Sampler refused at 59'9"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-138 DATE 1-5-82

LOG OF TEST BORING NO. 26

location Station 344+15, ℄ of dam

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1358.0'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			☒	S	50/5"				slightly moist to moist hard	SANDY, SILTY CLAY, some angular to subangular gravel, occasionally weakly cemented, medium plasticity, brown
5			☒	S	66			CL		
10			☒	S	54					
15			☒	S	21			CL	moist firm	SILTY CLAY, some to considerable sand, trace of gravel, medium plasticity, brown to light brown
20			☒	U	24			SM	moist firm	SILTY SAND, some clay, sandy silt lenses & subrounded to subangular gravel, predominantly fine to medium, nonplastic to low plasticity, brown
25			☒	S	38			CL	very moist very firm	SILTY CLAY, some sand, medium plasticity, dark brown
30			☒	S	19			SP	moist medium dense	SAND, some silt, small amount of angular to subangular gravel, predominantly fine to medium, nonplastic, light brown
35			☒	S	29			ML	moist firm	CLAYEY SILT, medium plasticity, brown to reddish-brown
40			☒	S	45			SM	moist to slightly moist very firm to hard	SILTY SAND, some clay & angular to subangular gravel, predominantly fine to medium, low plasticity to nonplastic, light brown to reddish-brown
45			☒	S	50/3"					
50								ML		

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT McMicken Dam Restoration Study

JOB NO. E81-138 DATE 1-5-82

LOG OF TEST BORING NO. 26

location Station 344+15, ¢ of dam

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1358.0'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
50			X	S	54			ML	moist hard	CLAYEY SILT, considerable sand, trace of gravel, weakly cemented, medium plasticity, light brown
55										Stopped auger at 49'6" Stopped sampler at 51'

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-138 DATE 1-5-82

LOG OF TEST BORING NO. 27

location Station 355+00, ℄ of dam

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1359.0'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	96			CL	slightly moist to moist hard	SILTY, SANDY CLAY, some clayey sand lenses & gravel, medium plasticity, light brown to brown
5			X	S	87					
10			X	S	55			CL	moist hard	SILTY CLAY, some sand, small amount of gravel, medium plasticity, dark brown
15			X	S	58					
20			X	S	13			ML	moist moderately firm	SANDY SILT, some clay & angular to subangular gravel, medium to low plasticity, brown
25			X	U	13				moist to slightly moist moderately firm	SILTY CLAY, some fine to medium sand, low plasticity, tan to light brown
30			X	S	17			CL		
35			X	S	31					
40			X	S	50/5"					
45			X	S	82			SM	dry to slightly moist hard	SILTY SAND, well graded, nonplastic to low plasticity, light tan
50			X	S	50/4½"					Stopped auger at 49'6" Sampler refused at 50'4½"

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT McMicken Dam Restoration Study

JOB NO. E81-138 DATE 1-5 & 1-7-82

LOG OF TEST BORING NO. 28

location Station 365+00, ℄ of dam

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1359.0'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	85				slightly moist to moist hard to very firm	SANDY CLAY, some angular to subangular gravel, some moderate cementation, medium plasticity, brown
5			X	S	39					
								CL		
10			X	S	57					
15			X	S	25				moist very firm	SILTY CLAY, some fine to medium sand, small amount of fine, subangular to subrounded gravel, trace of weak cementation, low plasticity, dark brown
20			X	S	36			CL-ML		
25			X	S	38					
30			X	S	39			CL-ML	slightly moist very firm	CLAYEY SILT, some sand, predominantly fine, small amount of fine, subangular to subrounded gravel, low plasticity, brown
35			X	S	50/4½"				moist to slightly moist very firm to hard	SILTY SAND, some clay & fine, angular to subangular gravel, predominantly well graded to predominantly fine, nonplastic to low plasticity, brown to reddish-brown
40			X	S	32			SM		
45			X	S	93					
								ML		
50			X	S	50/5"					

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT McMicken Dam Restoration Study

LOG OF TEST BORING NO. 28

JOB NO. E81-138 DATE 1-5 & 1-7-82

location Station 365+00, ¢ of dam

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1359.0'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
50									moist to slightly moist	CLAYEY SILT, small amount of sand, moderately cemented, medium to low plasticity, light brown
55				S	50/3"			ML	hard	note: occasional lense of considerable sand
60				S	107					
65										Stopped auger at 59'6" Sampler refused at 60'11"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.

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PROJECT McMicken Dam Restoration Study

JOB NO. E81-138 DATE 1-7 & 1-8-82

LOG OF TEST BORING NO. 29

location Station 376+00, ¢ of embankment

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1358.2'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	85				slightly moist to moist hard	SILTY, CLAYEY SAND, some angular to subangular gravel, occasional lenses of sandy clay or silty sand with angular to subrounded gravel, medium plasticity, brown to dark brown
5			X	S	60					
								SC		
10			X	S	101					
15			X	U	52					
20			X	S	28				moist firm to very firm	SILTY CLAY, some fine sand, medium plasticity, brown note: some strongly cemented nodules below 30'
25			X	S	21					
								CL		
30			X	S	40					
35			X	S	51				moist hard	SILTY SAND, predominantly fine to medium, low plasticity, tan to light brown
								SM	moist medium dense to very dense	SAND, considerable silt, predominantly fine to medium, nonplastic, tan to light brown note: small amount of fine, angular to subangular gravel below 42'
40			X	S	27					
								SP-SM		
45			X	S	94					
50			X	S	50/6"					Stopped auger at 49'6" Sampler refused at 50'6"

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT McMicken Dam Restoration Study

JOB NO. E81-138 DATE 1-11-82

LOG OF TEST BORING NO. 30

location Station 386+00, ℄ of dam

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1358.5'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	22			SC	moist firm	CLAYEY SAND, some angular to subangular gravel, predominantly well graded, low plasticity, brown
5			X	S	56				moist hard to very firm	SILTY CLAY, considerable well graded sand in lenses, some angular to subrounded gravel in lenses, occasionally weakly cemented, medium plasticity, brown to reddish-brown to dark brown
10			X	S	55					
15			X	S	44			CL		
20			X	S	75					
25			X	S	35				moist firm	CLAYEY SILT, considerable fine to medium sand, low plasticity, light brown to brown
30			X	S	19			CL-ML	moist hard to very firm	CLAYEY SAND, considerable silt, some fine, predominantly angular to subangular gravel, predominantly well graded, low plasticity to nonplastic, brown to reddish-brown
35			X	S	50/5"			SC		
40			X	S	48				moist very firm	CLAYEY SILT & SILTY CLAY, medium plasticity, light gray to brown; SILTY SAND, fine, low plasticity, light brown & CLAYEY SAND, fine to medium, low to medium plasticity, brown note: lenticular
45			X	S	48			ML-CL & SC		
50								SP		

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT McMicken Dam Restoration Study

JOB NO. E81-138 DATE 1-11-82

LOG OF TEST BORING NO. 30

Location Station 386+00, ℄ of dam

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1358.5'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
50			X	S	80			SP	moist very dense	SAND, some to considerable silt, trace of subrounded gravel, predominantly fine to medium, nonplastic, tan to light brown
55										Stopped auger at 49'6" Stopped sampler at 51'

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-138 DATE 1-11-82

LOG OF TEST BORING NO. 31

Location Station 397+00, ℄

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1358.0'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	35				slightly moist to moist	SILTY CLAY, some sand, trace of gravel, well graded, trace of weak cementation, medium plasticity, brown
5			X	S	101			CL	very firm to hard	
10			X	S	75					
15			X	S	25				moist	CLAYEY SAND, some silt, well graded, subangular to subrounded, low to medium plasticity, brown
20			X	S	40			SC	moderately firm to very firm	
25			X	S	14					
			X	U	31					
30			X	S	24					
35			X	S	24			ML	moist firm	CLAYEY SILT, some sand, predominantly fine, medium plasticity, brown
40			X	S	38			SP	moist dense	SAND, considerable clay, some silt, predominantly fine, non-plastic, brown to orangish-brown
45			X	S	37					
50										Stopped auger at 44'6" Stopped sampler at 46'

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT McMicken Dam Restoration Study

JOB NO. E81-138 DATE 1-12-82

LOG OF TEST BORING NO. 32

location Station 427+00, ℄, top of dam

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1360.0'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			☒	S	50/5"				slightly moist to moist hard to very firm	SILTY CLAY, considerable well graded sand, some predominantly angular to subangular gravel, occasionally weakly cemented, medium plasticity, brown
5			☒	S	50/5½"			CL		
10			☒	S	48					
15			☒	S	25				very moist to moist firm to very firm	SILTY CLAY, considerable fine to medium sand in lenses, some predominantly angular to subangular gravel & silty clay in lenses, occasionally weakly cemented, medium plasticity, light brown
20			☒	S	44			CL		
25			☒	S	37					
30			☒	S	45					
35			☒	S	78			SM	moist hard	SILTY SAND, considerable clay, some fine, angular to subangular gravel & sandy silt lenses, predominantly well graded, weakly cemented, medium plasticity, brown
40			☒	S	50/5"			CL-ML		
45									moist hard	CLAYEY SILT, small amount of fine sand, medium plasticity, brown
										Stopped auger at 39'6" Sampler refused at 40'5"

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-138 DATE 1-12-82

LOG OF TEST BORING NO. 33

location Station 462+50

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1359.5'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	23				dry to moist firm to hard	CLAYEY SAND, some silt, trace of gravel, well graded, rounded to subangular, medium plasticity, brown
5			X	S	78					
10			X	S	34			SC		
15			X	S	43					
20			X	S	46					
25			X	S	50/5"				dry to slightly moist hard	CLAYEY SAND, some silt, occasional gravel, well graded, rounded to subangular, some weak to moderate cementation, low to medium plasticity, light brown
30			X	S	50/4"			SC		
35			X	S	50/3"				dry to slightly moist very dense	SAND, some silt, predominantly fine, subangular to subrounded, nonplastic, light brown to tan
40			X	S	40			SP	dry to slightly moist hard	CLAYEY SILT, some sand, predominantly fine to medium, subangular to subrounded, low plasticity, light tan
45			X	S	50/1"			ML		Stopped auger at 49'6" Sampler refused at 49'8"
50			X	S	50/2"					

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT McMicken Dam Restoration Study

JOB NO. E81-138 DATE 1-13-82

LOG OF TEST BORING NO. 34

location Station 311+00, ℄ of dam

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1357.2'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	37			SC	slightly moist very firm to hard	CLAYEY SAND, considerable silt, occasional fine gravel, predominantly fine, subangular, low to medium plasticity, tan
5			X	S	109					
								SP	slightly moist dense	SAND, some silt, occasional gravel, predominantly fine & some medium, subangular, nonplastic, light brown
10			X	S	45					
								SC	moist very firm to hard	CLAYEY SAND, some silt, predominantly fine to medium, subangular, low to medium plasticity, brown with some light tan mottling
15			X	S	81					
								SW	slightly moist very dense	SAND, considerable gravel, occasional silt, well graded, subangular to subrounded, nonplastic, light tan
20			X	S	52			SM		
25			X	S	55					
								SC	slightly moist hard	SILTY SAND, predominantly fine, subangular, low plasticity, light brown
30			X	S	50/5"					
								ML	moist hard	CLAYEY SAND, some silt, predominantly fine, subrounded to rounded, weakly cemented, medium to high plasticity, brown
35			X	S	50/1½"					
									slightly moist hard	SILT, some fine sand, occasional clay, weakly cemented, low plasticity, light brown
40			X	S	107			SW		
									slightly moist very dense	SAND, occasional gravel, trace of silt, well graded, subangular to subrounded, nonplastic, light brown note: considerable well graded gravel from 40½' to 44'
45			X	S	80					
50										

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT McMicken Dam Restoration Study

JOB NO. E81-138 DATE 1-13-82

LOG OF TEST BORING NO. 34

location Station 311+00, ℄ of dam

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1357.2'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
50		o o	X	S	93			SW		
55										Stopped auger at 49'6" Sampler refused at 50'11½"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT McMicken Dam Restoration Study

JOB NO. E81-138 DATE 1-13-82

LOG OF TEST BORING NO. 35

location Station 280+00, ¢ of dam

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1358.0'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	62				moist hard	SANDY SILT, occasional gravel & lense of some clay, low plasticity, brown note: some granitic gravels are highly weathered to decomposed
5			X	S	50/5½"			ML		
10			X	S	51					
15			X	S	80			ML-CL SM	moist hard	SILT & CLAY, some sand, occasional gravel, medium plasticity, brown
20			X	S	104			ML	moist hard	SILTY SAND, occasional gravel, predominantly fine, subangular, nonplastic to low plasticity, brown
25			X	S	21				moist firm to hard	SANDY SILT, occasional gravel, predominantly fine, low plasticity, brown
			X	A						
30			X	U	27				slightly moist firm to hard	SILTY SAND, occasional gravel, well graded, subrounded, nonplastic, light brown
35			X	S	19					
40			X	S	248			SM		
45			X	S	42					
50										

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT McMicken Dam Restoration Study

JOB NO. E81-138 DATE 1-13-82

LOG OF TEST BORING NO. 35

location Station 280+00, ¢ of dam

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1358.0'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
50			X	S	40			SM		
55										Stopped auger at 49'6" Stopped sampler at 51'

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT McMicken Dam Restoration Study

JOB NO. E81-138 DATE 1-13-82

LOG OF TEST BORING NO. 36

location Station 240+00, ℄ of dam

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1357.8'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	92				slightly moist to moist very firm to hard	SILTY CLAY, some fine to medium sand, low to medium plasticity, light brown with some light tan mottling note: some white angular gravel below 8'
5			X	S	75					
10			X	S	30			CL		
15			X	S	35					
20			X	S	32				slightly moist hard	SILTY SAND & GRAVEL, well graded, angular to subangular, low plasticity, light tan
25			X	S	50/4½"			SM	slightly moist hard	SILTY CLAY, considerable fine sand, occasional gravel, weakly cemented, low to medium plasticity, light brown mottling with light tan note: considerable well graded, angular to subangular sand below 33'
30			—	S	50/2"			CL		
35			—	S	50/2"				slightly moist hard	SILTY CLAY, some very fine sand, occasionally weakly cemented, low to medium plasticity, light brown
40			—	S	50/2½"			CL	slightly moist hard	CLAYEY SAND, some silt, predominantly fine, subrounded, weakly cemented, medium plasticity, brown
45			—	S	50/1"(no recovery)			SC		Stopped auger at 49'6" Sampler refused at 49'8"
50			—	S	50/2"					

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT McMicken Dam Restoration Study

JOB NO. E81-138 DATE 1-14-82

LOG OF TEST BORING NO. 37

location Station 365+00, 15' W of toe

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1354.5'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	13			CL	moist moderately firm	SILTY CLAY, considerable fine sand, medium plasticity, brown
			X	S	10			CL-ML		
5			X	S	10				moist moderately firm	SANDY SILT & CLAY, predominantly fine to medium, low plasticity, brown
10			X	S	72			SW & CL	moist dense to hard	SAND, some gravel, well graded, subrounded, nonplastic, brown with lenses of SILTY CLAY, some fine sand, medium plasticity, brown
15			X	S	30			SP	moist medium dense	SAND, occasional gravel & silt, predominantly fine to medium, subrounded, nonplastic, orangish-brown
20			X	S	34			SW-SC	moist very firm	SAND, considerable gravel, well graded, subrounded to subangular, nonplastic, brown with lenses of CLAYEY SAND, some gravel, predominantly coarse, subangular to subrounded, medium plasticity, brown
25			X	S	21			ML		
30			X	S	44					
35			X	S	41			SM	moist firm to very firm	CLAYEY SILT, considerable sand, predominantly fine, well graded, subrounded, low plasticity, brown
40									moist very firm	SILTY SAND, occasional gravel, predominantly fine, subrounded, nonplastic to low plasticity, light brown
										Stopped auger at 34'6" Stopped sampler at 36'

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT McMicken Dam Restoration Study

JOB NO. E81-138 DATE 1-14-82

LOG OF TEST BORING NO. 38

location Station 386+00, 15' W of toe

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1333.5'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	9				very moist to moist	SILTY CLAY, some fine sand, medium plasticity, brown
			X	S	8			CL	soft to moderately firm	note: light brown below 4'
5			X	S	15					
10			X	S	39			SW	moist dense	SAND, some gravel & silt, well graded, angular to subangular, nonplastic, orangish-brown
15			X	S	32				moist dense	SAND, some gravel, occasional silt, predominantly fine, subangular, nonplastic, light brown
20			X	S	44			SP		
25			X	S	48				moist dense to very dense	SAND, some gravel, well graded, subangular, nonplastic, light brown
								SW		
30			X	S	79					
35			X	S	34			SP	moist dense	SAND, occasional gravel, predominantly fine, subangular, nonplastic, light brown
40										Stopped auger at 34'6" Stopped sampler at 36'

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT McMicken Dam Restoration Study

JOB NO. E81-138 DATE 1-14-82

LOG OF TEST BORING NO. 39

location Station 365+00, 15' E of toe

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1354.0'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	9			CL	slightly moist	SILTY CLAY, considerable sand, well graded, low plasticity, light brown
			X	S	16			CL	moderately firm	
5			X	S	16			SM-SC	slightly moist	SILTY CLAY, occasional fine to medium sand, low plasticity, light brown
									moderately firm	
10			X	S	50/5"			SW	slightly moist	SILTY, CLAYEY SAND, some gravel, predominantly fine, well graded, subangular to subrounded, low plasticity, light brown
									moderately firm	
15			X	S	31			SP	slightly moist	SAND, some clay coatings, occasional gravel, well graded, subangular to subrounded, nonplastic to low plasticity, reddish-brown
									very dense	
20			X	S	64			SW		
25			X	S	146			SM	slightly moist	SAND, some silt, predominantly fine, subangular, nonplastic, tan
									dense	
30			X	S	50/2"			ML	slightly moist	SAND, occasional silt, well graded, predominantly fine to medium, subangular, nonplastic, light brown
									very dense	
35			X	S	50/4½"				slightly moist	SILTY SAND, occasional gravel, well graded, subangular, weakly cemented, nonplastic to low plasticity, light tan
									hard	
40									slightly moist	CLAYEY SILT, some very fine sand, weakly to moderately cemented, low plasticity, light tan
									hard	

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT McMicken Dam Restoration Study

LOG OF TEST BORING NO. 39

JOB NO. E81-138 DATE 1-14-82

location Station 365+00, 15' E of toe

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1354.0'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
										note: SAND, occasional gravel, predominantly fine, well graded, sub-angular, nonplastic, light brown at 34'6" to 34'9"
										Stopped auger at 34'6" Sampler refused at 35'4½"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.

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JOB NO. E81-138 DATE 1-14-82

LOG OF TEST BORING NO. 40

location Station 386+00, 15' E of toe

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1333.5'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	37			CL	slightly moist very firm	SILTY CLAY, considerable sand, well graded, subrounded, low plasticity, light brown
			X	S	14					
5			X	S	8			CL	slightly moist soft to firm	SILTY CLAY, occasional fine sand, some weak cementation, low to medium plasticity, tan
			X	U	35					
10			X	S	50/5½"			SM	slightly moist hard	SILTY SAND, some gravel, predominantly fine, well graded, subangular, low plasticity, tan
15			X	S	87			SW	slightly moist hard	SAND, considerable gravel, some clay coatings, well graded, subrounded to subangular, nonplastic to low plasticity, reddish-brown
20			X	S	50/5½"					
25			X	S	46				slightly moist dense to very dense	SAND, occasional silt & gravel, predominantly fine, some well graded lenses, subangular, nonplastic, light brown
30			X	S	50/4½"			SP		
35			X	S	70					
40			X	S	41					
45										Stopped auger at 39'6" Stopped sampler at 41'

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT McMicken Dam Restoration Study

JOB NO. E81-138 DATE 1-15-82

LOG OF TEST BORING NO. 41

location Station 427+00, ¢ of old dike

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1351.0'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	23			SM	slightly moist firm	SILTY SAND, some gravel, predominantly fine, occasionally well graded, subangular, low plasticity, light brown
5			X	S	25					
								SC	slightly moist to moist firm to very firm	CLAYEY SAND, considerable to occasional gravel, well graded, subangular, medium plasticity, brown
10			X	S	42					
15			X	S	19			ML	slightly moist firm	SANDY SILT, predominantly fine, subangular, low plasticity, light brown
20			X	S	19			ML	slightly moist firm	SILT, occasional fine sand, medium plasticity, light brown mottled with light tan
25			X	S	55				slightly moist very dense	SAND, some gravel & silt, predominantly fine, occasionally well graded, nonplastic, light brown
30			X	S	50/4"					
								SP-SW		
35			X	S	50/5½"					
40			X	S	105					
								SM	slightly moist hard	SILTY SAND, some gravel, predominantly fine, subangular, low plasticity, light brown
45			X	S	97					
50										Stopped auger at 44'6" Stopped sampler at 46'

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT McMicken Dam Restoration Study

JOB NO. E81-138 DATE 1-15-82

LOG OF TEST BORING NO. 42

location Station 445+00, ¢ of old dike

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1351.0'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	45				slightly moist	SANDY SILT, occasional fine gravel, predominantly fine, subangular, low plasticity, light brown
								ML	firm to very firm	
5			X	S	22					
10			X	S	28				slightly moist	SAND, considerable clay, some lenses of predominantly fine clayey sand, occasional gravel, well graded, subangular, nonplastic to low plasticity, brown
								SC	firm	
15			X	S	16					
20			X	S	13				slightly moist	SILTY CLAY, occasional sand, predominantly coarse, low plasticity, light brown mottled with light tan
								CL	moderately firm	
25			X	U	42			GW	slightly moist	SAND & GRAVEL, occasional silt, well graded to predominantly fine, subangular, nonplastic, light brown
									dense	
30			X	S	49			SM	slightly moist	SILTY SAND, some gravel, well graded to predominantly fine, subangular, low plasticity, light brown
									very firm	
35			X	S	45			SM	slightly moist	SILTY SAND, occasional gravel, predominantly fine, subangular, low plasticity, light brown
									very firm	
40			=	S	50/3½"			CL	slightly moist	SANDY CLAY, some silt, predominantly fine, low plasticity, light brown mottled with light tan
									hard	
45			X	S	40			SM	slightly moist	SILTY SAND, occasional gravel, predominantly fine, subangular, nonplastic to low plasticity, light brown
								GW	very firm	
50										

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT McMicken Dam Restoration Study

JOB NO. E81-138 DATE 1-15-82

LOG OF TEST BORING NO. 42

location Station 445+00, ℄ of old dike

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1351.0'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
50			X	S	78				slightly moist very dense	SAND & GRAVEL, occasional silt, well graded, subangular, nonplastic, light grayish-brown note: occasional reddish-brown clay below 54'
55			X	S	50/4½"			GW		
60			X	S	76					
65										Stopped auger at 59'6" Stopped sampler at 61'

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT McMicken Dam Restoration Study

JOB NO. E81-138 DATE 1-15-82

LOG OF TEST BORING NO. 43

location Station 462+50, ℄ of old dike

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1352.0'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	16				slightly moist firm	SANDY SILT, well graded, subangular, low plasticity, light brown
								ML		
5			X	S	25					
10			X	S	24				slightly moist firm to very firm	SILTY SAND, considerable gravel, occasional sandy clay lense, medium plasticity, brown note: light tan below 15'
								SM		
15			X	S	40					
20			X	S	11				slightly moist medium dense to dense to very dense	SAND, some silt, occasional gravel, predominantly fine, some well graded, nonplastic, light brown note: moderately cemented below 23½'
25			X	U	100/4½"					
30			X	S	44					note: some gravel below 30'
								SP		
35			X	S	230					note: moderately to weakly cemented, tan below 35½'
40				S	50/1"					
45			X	S	50/5"					
								SM		
50			X							

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT McMicken Dam Restoration Study

JOB NO. E81-138 DATE 1-15-82

LOG OF TEST BORING NO. 43

location Station 462+50, ℄ of old dike

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1352.0'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
50			X	S	92			SM	slightly moist hard	SILTY SAND, occasional gravel, predominantly fine, subangular, occasional weakly cemented nodules, nonplastic, light brown
55										Stopped auger at 49'6" Stopped sampler at 51'

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT McMicken Dam Restoration Study

JOB NO. E81-138 DATE 1-18-82

LOG OF TEST BORING NO. 44

location Station 127+00, ¢ of dam

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1358.0'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	44				slightly moist very firm to hard	SILTY SAND, some clay, predominantly fine, low to medium plasticity, brown
5			X	S	75					
10			X	S	50/5½"			SM		
15			X	S	41					
20			X	S	50/5"			ML	slightly moist hard	SILT, some fine to medium sand, some weak cementation, low plasticity, light brown
25			X	S	101			SW	slightly moist very dense	SAND, some silt, trace of subangular to subrounded gravel, non-plastic, light brown to light gray
30			X	S	50/5½"			SP	slightly moist very dense	SAND, considerable silt, predominantly fine to medium, non-plastic, light brown
										Stopped auger at 29'6" Sampler refused at 29'11½"

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT McMicken Dam Restoration Study

JOB NO. E81-138 DATE 1-18-82

LOG OF TEST BORING NO. 45

location Station 147+00, ¢ of dam

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1358.0'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	25			ML	slightly moist firm	SANDY SILT, trace of gravel & clay, low to medium plasticity, light brown
5'			X	S	50/5½"			CL	slightly moist hard	SANDY CLAY, considerable silt, some weak cementation, medium plasticity, light brown
10			X	S	56					
15			X	S	50/4"			SC	moist hard	CLAYEY SAND, trace of angular gravel, predominantly fine, low plasticity, brown
20			X	S	90				slightly moist to moist very firm to hard	SAND, some clay & silt, trace of gravel, predominantly fine, non-plastic, light brown
25			X	S	34			SP		
30			X	S	38					
35			X	S	50/5"					note: considerable angular white gravel below 34'
40										Stopped auger at 34'6" Sampler refused at 35'5"

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT McMicken Dam Restoration Study

JOB NO. E81-138 DATE 1-18-82

LOG OF TEST BORING NO. 46

Location Station 163+50, ¢ of dam

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1358.5'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	52			SM	slightly moist hard	SILTY SAND, predominantly fine, nonplastic, brown
5			X	S	50/5"			ML	slightly moist hard	SANDY SILT, trace of gravel, predominantly fine, medium plasticity, brown
10			X	S	50			CL	slightly moist to moist very firm	SILTY CLAY, trace of weak to moderate cementation, medium plasticity, brown
15			X	S	50/5"			SW	slightly moist very dense to medium dense	SAND, some silt, trace of gravel, well graded, nonplastic, light brownish-gray
20			X	S	19					
25			X	S	55			CL	slightly moist hard	SANDY CLAY, trace of cemented nodules & gravel, predominantly fine to medium, medium plasticity, light brown
30			X	S	50/5"			SW	slightly moist very dense	SAND, some rounded gravel, trace of clay, well graded, nonplastic to low plasticity, light brown
35										Stopped auger at 29'6" Sampler refused at 30'5"

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-138 DATE 1-19-82

LOG OF TEST BORING NO. 47

location Station 180+00, ¢ of dam

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1357.5'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	102				slightly moist hard	CLAYEY SAND, considerable silt, trace of gravel, predominantly fine, low plasticity to nonplastic, light brown
5			X	S	57					
10			X	S	50/5½"			SC		
15			X	S	61					
20			X	S	45			CL	slightly moist to moist very firm	SILTY CLAY, trace of sand & weakly to moderately cemented nodules, medium plasticity, brown
25			X	S	61			GW	slightly moist very dense	SANDY GRAVEL, some silt, well graded, subangular to subrounded, nonplastic, light gray
30			X	S	50/5"					Stopped auger at 29'6" Sampler refused at 29'11"

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-138 DATE 1-19-82

LOG OF TEST BORING NO. 48

location Station 200+00, ¢ of dam

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1358.0'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	35				slightly moist very firm to hard	CLAYEY SAND, some gravel, trace of silt, well graded to predominantly fine, low to medium plasticity, brown
5			X	S	50/5½"			SC		
10			X	S	44					
								CL	moist very firm	SILTY CLAY, some sand, trace of angular gravel, trace of weak cementation, medium plasticity, brown
15			X	S	96					
									moist hard to firm	CLAYEY SAND, some silt, trace of gravel, predominantly fine, non-plastic to low plasticity, brown
20			X	S	23			SC		
25			X	S	19					
								SC	slightly moist to moist very dense	SAND, some clay & gravel, well graded, low plasticity, light grayish-brown
30			X	S	120					
35										Stopped auger at 29'6" Sampler refused at 30'10"

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-138 DATE 1-19-82

LOG OF TEST BORING NO. 49

location Station 220+00, ¢ of dam

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1357.5'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	37			ML	slightly moist very firm	SILT, some sand, trace of weak cementation, low plasticity, light brown
5			X	S	50				slightly moist hard	SILTY SAND, considerable clay, predominantly fine to medium, low to medium plasticity, light gray note: trace of gravel below 10'
10			X	S	61			SM		
15			X	S	30					
20			X	S	28			ML	slightly moist very firm to hard	SILT, trace of sand, low plasticity to nonplastic, light brown
25			X	S	50/4½"					
30			X	S	56			SW	slightly moist very dense	SAND, considerable silt, trace of rounded gravel, well graded, nonplastic, light brown
35										Stopped auger at 29'6" Stopped sampler at 31'

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-138 DATE 1-19-82

LOG OF TEST BORING NO. 50

location Station 260+00, ¢ of dam

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1358.5'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	49				slightly moist to moist very firm	CLAY, considerable sand, predominantly fine, some weak cementation, medium plasticity, brown
5			X	S	40			CL		
10			X	S	37					
15			X	S	45			SC	moist very firm	CLAYEY SAND, trace of gravel, predominantly fine to medium, medium plasticity, brown
20			X	S	14				moist moderately firm to very firm	CLAY, some sand & silt, predominantly fine to medium, medium plasticity, brown
25			X	S	44			CL		
30			X	S	53					
35			X	S	74			SW	slightly moist very dense	SAND, some silt, trace of gravel, well graded, nonplastic, brown
40										Stopped auger at 34'6" Stopped sampler at 36'

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-138 DATE 1-19-82

LOG OF TEST BORING NO. 51

location Station 294+00, ¢ of dam

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1357.5'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	50				slightly moist very firm	CLAY, some sand, some weak to moderate cementation, medium plasticity, brown
5			X	S	39			CL		
10			X	S	52					
15			X	S	25			CL	moist firm	SANDY CLAY, considerable silt, trace of weak cementation, medium plasticity, brown
20			X	S	23					
25			X	S	37				slightly moist dense	SAND, considerable silt, trace of subrounded gravel, well graded with some predominantly fine lenses, nonplastic, light brown to reddish-brown
30			X	S	40			SW		
35			X	S	50/5½"					
40			X	S	50/5½"			SC	slightly moist hard	CLAYEY SAND, predominantly fine, some weak cementation, nonplastic, light brown
45			X	S	43			SP	slightly moist dense	SAND, predominantly fine, nonplastic, light brown
50										

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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LOG OF TEST BORING NO. 51

JOB NO. E81-138 DATE 1-19-82

location Station 294+00, ¢ of dam

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1357.5'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
50		• • •	X	S	37			SP		
55										Stopped auger at 49'6" Stopped sampler at 51'

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-138 DATE 1-19-82

LOG OF TEST BORING NO. 52

Location Station 355+00, 10' E of toe

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1334.0'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	18				slightly moist to moist	SILT, some sand occasionally in lenses, trace of gravel, well graded, low plasticity, brown
			X	S	21			ML	firm	
5			X	S	25					
10			X	S	26			SP	slightly moist medium dense	SAND, considerable silt, predominantly fine, nonplastic, light brown
15			X	S	50/5"			ML	slightly moist hard	SILT, some sand, nonplastic to low plasticity, light brown
20			X	S	28			SP	slightly moist medium dense to very dense	SAND, predominantly fine, nonplastic, light brown
25			X	S	50/4"					
30										Stopped auger at 24'6" Sampler refused at 25'4"

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-138 DATE 1-20-82

LOG OF TEST BORING NO. 53

location Station 408+50, ¢ of old dike

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1350.0'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	20				dry to moist firm to very firm	SILTY CLAY, some fine sand, weakly cemented, medium plasticity, brown to light brown note: small amount of subangular gravel below 5' note: some gravel below 15'
5			X	S	36					
								CL		
10			X	S	25					
15			X	S	37					
20			X	S	50/5½"				slightly moist hard	SILTY SAND, some clay & subangular gravel, predominantly fine to medium, occasionally weakly cemented, low plasticity to nonplastic, tan to light brown
25			X	S	50/5"			SM		
30			X	S	121					
35			X	S	44				slightly moist to dry dense to very dense	SAND, some silt, trace of fine, subangular gravel, predominantly fine to medium, nonplastic, light brown note: some predominantly angular to subangular gravel below 40'
40			X	S	64					
								SP		
45			X	S	50/5"					
50			X							

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-138 DATE 1-20-82

LOG OF TEST BORING NO. 53

location Station 408+50, ℄ of old dike

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1350.0'

DATUM 1982 A.H.A. Survey

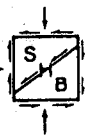
Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
50			X	S	76			SP		
55										Stopped auger at 49'6" Stopped sampler at 51'

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.



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JOB NO. E81-138 DATE 1-20-82

LOG OF TEST BORING NO. 54

location Station 437+50, ℄ of old dike

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1351.5'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	21			CL	slightly moist firm	SILTY CLAY, some sand, weakly cemented, medium plasticity, light brown
5			X	S	23			CL	slightly moist firm	SANDY CLAY, considerable silt, some subangular to subrounded gravel, medium plasticity, light brown
10			X	S	42			SM	very slightly moist very firm	SILTY SAND & GRAVEL, some clay, predominantly fine to medium sand, predominantly subangular gravel, nonplastic to low plasticity, light brown
15			X	S	17					
20			X	S	36			ML	moist firm to hard	SANDY SILT, some silty sand lenses, silty clay lenses, clay & gravel, occasionally weakly cemented, low to medium plasticity, light brown
25			X	S	75					
30			X	S	50/5"					
35			X	S	50/5½"			SM	moist to slightly moist hard	SILTY SAND, some sandy silt lenses, small amount of gravel, predominantly fine, low plasticity to nonplastic, light brown
40			X	S	78					
45			X	S	50/2½"			ML	slightly moist hard	SILT, some clay & fine sand, moderately cemented, medium plasticity, light brown
50								SM		

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-138 DATE 1-20-82

LOG OF TEST BORING NO. 54

location Station 437+50, ℄ of old dike

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1351.5'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
50			X	S	48			SM	slightly moist very firm	SILTY SAND, predominantly fine, nonplastic, light brown to tan
55										Stopped auger at 49'6" Stopped sampler at 51'

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-138 DATE 1-20-82

LOG OF TEST BORING NO. 55

location Station 455+00, ¢ of old dike

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1351.5'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	9				slightly moist to moist	SILTY CLAY, some sand, trace of gravel, weakly cemented, medium plasticity, light brown to brown
5			X	S	25				moderately firm to firm	
10			X	S	15			CL		
15			X	U	12					
20			X	S	20					
25			X	S	32			SC	moist very firm	CLAYEY SAND, considerable silt, some fine, angular to subangular gravel, predominantly well graded, low plasticity, reddish-brown
30			X	S	50/5"			ML	slightly moist hard	CLAYEY SILT, some fine sand, low to medium plasticity, brown
35			X	S	94			SW	slightly moist very dense	SAND, some silt, predominantly well graded, nonplastic, light brown
40			X	S	77					
45			X	S	50/5"			ML	moist hard	SILT, some clay, trace of sand, low plasticity, brown
50								SC		

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT McMicken Dam Restoration Study

JOB NO. E81-138 DATE 1-20-82

LOG OF TEST BORING NO. 55

location Station 455+00, ¢ of old dike

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1351.5'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
50		%%%.	X	S	105			SC	slightly moist hard	CLAYEY SAND, predominantly fine, low to medium plasticity, brown
55										Stopped auger at 49'6" Sampler refused at 50'11"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT McMicken Dam Restoration Study

JOB NO. E81-138 DATE 1-20-82

LOG OF TEST BORING NO. 56

location Station 472+00, ℄ of old dike

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1351.5'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	16				slightly moist firm	SANDY SILT, considerable clay, predominantly fine, low plasticity, brown
								ML		
5			X	S	24					
10			X	S	9				slightly moist moderately firm to very firm	SILTY CLAY, some to considerable sand, predominantly fine, low to medium plasticity, light brown
15			X	U	13					
								CL		
20			X	S	21					
25			X	S	46					note: considerable gravel, occasionally weakly cemented below 24'
30			X	S	16			SC	slightly moist to moist firm	CLAYEY SAND, predominantly well graded, some weak cementation, medium plasticity, light brown
35			X	S	50/5"				slightly moist hard	SILT, some sand & clay, low plasticity, light brown
40				S	50/2"			ML		
45				S	50/5"					
								SP		
50										

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT McMicken Dam Restoration Study

JOB NO. E81-138 DATE 1-20-82

LOG OF TEST BORING NO. 56

location Station 472+00, ¢ of old dike

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1351.5'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
50		• • •	X	S	84			SP	slightly moist very dense	SAND, predominantly fine, nonplastic, light brown to tan
55										Stopped auger at 49'6" Stopped sampler at 51'

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT McMicken Dam Restoration Study

JOB NO. E81-138 DATE 1-21-82

LOG OF TEST BORING NO. 57

location Station 172+00, ℄ of dam

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1358.0'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	28			ML	slightly moist firm	SANDY SILT, trace of gravel, predominantly fine, low plasticity, light brown
5			X	S	50/5"				moist hard to firm	CLAYEY SAND, predominantly fine, weakly cemented, low plasticity, brown note: some angular gravel below 15'
10			X	S	54			SC		
15			X	S	34					
20			X	S	28					
25			X	S	17			CL	moist firm	SANDY CLAY, some silt, medium plasticity, brown
30			X	S	22			ML	moist firm	SILT, some clay, trace of sand, low plasticity, light brown to brown
35			X	S	44			SP	slightly moist dense	GRAVELLY SAND, some silt, predominantly fine to medium, angular gravel, nonplastic to low plasticity, light brown
40			X	S	62			SM	slightly moist hard	SILTY SAND, predominantly fine, low plasticity, light brown
45			X	S	50/3"			ML	slightly moist hard	SILT, trace of sand, low plasticity, light brown
50			X	S	50/5"					Stopped auger at 49'6" Sampler refused at 49'11"

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT McMicken Dam Restoration Study

JOB NO. E81-138 DATE 1-18-82

LOG OF TEST BORING NO. 58

location Station 67+00, ¢ of dam

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1360.5'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	52				slightly moist hard	SILTY SAND, some angular to subrounded gravel, predominantly fine, nonplastic to low plasticity, light brown note: gravel & cobbles cover much of dam note: occasional lense of medium plasticity clayey silt
5			X	S	50/3"			SM		
10			X	S	50/5"					
15			X	S	64			CL	moist hard	SILTY, SANDY CLAY, some gravel, 8" lense of clayey sand, medium plasticity, brown
20			X	S	13			SW	slightly moist medium dense	SAND, considerable silt, trace of gravel, predominantly well graded, nonplastic to low plasticity, light brown
25			X	S	34-(50/0")				slightly moist very dense	SAND, considerable gravel, some silt, well graded, nonplastic, light brown
30			X	S	50/5½"			SW		
35				S	50/0"					Stopped auger at 34'6" Sampler refused at 34'6"

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-138 DATE 1-18-82

LOG OF TEST BORING NO. 59

location Station 87+00, ¢ of dam

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1360.0'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	18				slightly moist firm to hard	CLAYEY SAND, some silt, predominantly well graded, low to medium plasticity, light brown note: trace of gravel, weak cementation below 4'
5			X	S	72			SC		
10			X	S	50/4½"			SM	moist hard	SILTY SAND, some clay & subangular gravel, low plasticity, brown
15			X	S	50/5"				slightly moist hard	SILTY GRAVEL & SAND, well graded, subrounded to angular, nonplastic, light brown
20				S	50/2"			GM		
25			X	S	50/5¾"					
30			X	S	50/4"					Stopped auger at 29'6" Sampler refused at 30'4"
35										

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-138 DATE 1-18-82

LOG OF TEST BORING NO. 60

location Station 107+00, ¢ of dam

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1358.3'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	38				slightly moist very firm to hard	SILT, some sand & sub-angular gravel, trace of clay, low plasticity, light brown
5			X	S	92					note: occasional silty sand lenses below 5'
10			X	S	50/3"			ML		note: considerable gravel & cobbles below 13'
15			X	S	27					
20			X	S	20			SW	slightly moist medium dense	SAND, some subrounded gravel, trace of silt, well graded, nonplastic, light brown to gray
25			X	S	50/5½"			SM	slightly moist hard	SILTY SAND, predominantly fine, nonplastic, light brown
30			X	S	50/5½"			ML	slightly moist hard	SILT, trace of sand, low plasticity, light brown note: trace of gravel at 34½'
35			X	S	50/2"					Stopped auger at 34'6" Sampler refused at 34'8"

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT McMicken Dam Restoration Study

JOB NO. E81-138 DATE 1-22-82

LOG OF TEST BORING NO. 61

location Station 397+00, 10' E of toe

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1333.0'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	32			SC	slightly moist to moist	CLAYEY SAND, some gravel, predominantly fine, medium plasticity, light brown to brown
			X	S	20				very firm	
5			X	S	34			CL	slightly moist	SILTY CLAY, trace of sand, some weak cementation, medium plasticity, light brown
10			X	S	109				firm to very firm	
									moist	SAND, some clay & silt, some lenses of considerable gravel, predominantly well graded, with some lenses predominantly fine, non-plastic, reddish-brown
15			X	S	36				very dense to medium dense	
20			X	S	72					
								SW		
25			X	S	27					
30			X	S	86					
35			X	S	96					
40										Stopped auger at 34'6" Sampler refused at 35'11½"

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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PROJECT McMicken Dam Restoration Study

JOB NO. E81-138 DATE 1-22-82

LOG OF TEST BORING NO. 62

location Station 376+00, 10' E of toe

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1333.5'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	51				moist to slightly moist	SANDY CLAY, considerable silt, trace of fine gravel, medium plasticity, brown
			X	S	22			CL	firm to hard	
5			X	S	101					
10			X	S	28			SP	slightly moist medium dense	SAND, trace of silt, predominantly fine, nonplastic, light brown
15			X	S	33				slightly moist dense to very dense	SAND, some silt, trace of clay & subangular gravel, well graded, nonplastic, light brown
20			X	S	36			SW		
25			X	S	67					
30										Stopped auger at 24'6" Stopped sampler at 26'

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT McMicken Dam Restoration Study

JOB NO. E81-138 DATE 1-22-82

LOG OF TEST BORING NO. 63

location Station 355+00, 10' W of toe

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1335.5'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	30			CL	moist firm	SANDY CLAY, some silt, weakly cemented, medium plasticity, brown
			X	S	24					
5			X	S	11			ML	slightly moist moderately firm	SILT, some sand & clay, low plasticity, light brown
10			X	S	50/5"			GP	dry to slightly moist very dense	SAND & GRAVEL, predominantly fine, angular, nonplastic, light gray to white
15			X	S	50/5½"			ML	slightly moist hard	SILT, some clay, low plasticity, light brown
20			X	S	34			SP-SW	slightly moist dense	SILTY SAND, trace of gravel, predominantly fine, well graded, nonplastic, light brown
25			X	S	45					
30										Stopped auger at 24'6" Stopped sampler at 26'

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-138 DATE 1-22-82

LOG OF TEST BORING NO. 64

location Station 376+00, 10' W of toe

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1333.0'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	12				moist	SANDY CLAY, trace of gravel, predominantly fine, medium plasticity, brown
			X	S	15			CL	moderately firm	
5			X	S	20				slightly moist	GRAVELLY SAND, well graded, subangular to angular, nonplastic, light gray to white
								SW	medium dense	
10										Auger refused at 8'

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample

S – 2" O.D. 1.38" I.D. tube sample.

U – 3" O.D. 2.42" I.D. tube sample.

T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-138 DATE 1-22-82

LOG OF TEST BORING NO. 65

location Station 396+00, 10' W of toe

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1333.0'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	16				moist	SANDY CLAY, medium plasticity, brown
			X	S	13			CL	moderately firm to firm	
5			X	S	19					
10			X	S	16				slightly moist to moist	SAND, occasional clay & gravel, well graded, some lenses predominantly fine, occasional weak cementation, non-plastic, light brown to brown
15			X	S	45				medium dense to very dense	
20			X	S	38			SW		
25			X	S	44					
30			X	S	43					
35			X	S	56					
40										Stopped auger at 34'6" Stopped sampler at 36'

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-138 DATE 1-22-82

LOG OF TEST BORING NO. 66

location Station 15+00, ¢ outlet channel

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1338.0'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	22				slightly moist firm to hard	SILT, some clay & sand, trace of gravel, occasional weak cementation, low plasticity, light brown
5			X	S	50/5"					
10			X	S	22			ML		
15			X	S	50/5½"					
20			X	S	52				slighlty moist very dense	SAND, occasional silt, trace of gravel, well graded, subangular to subrounded, nonplastic, light brown
25			X	S	50/4"			SW		
30			X	S	50/4"			ML	slightly moist hard	SANDY SILT, some clay, low plasticity, light brown
35			X	S	50/5"			SW	slightly moist very dense	SAND, trace of clay & gravel, nonplastic, light brown

Stopped auger at 34'6"
Sampler refused at 34'11"

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT McMicken Dam Restoration Study

JOB NO. E81-138 DATE 1-25-82

LOG OF TEST BORING NO. 67

location Station 502+00, ¢ of dam

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1360.0'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	50/5"				slightly moist hard	CLAY, considerable sand, occasional silt, trace of gravel, some moderate cementation, medium plasticity, light brown
								CL		
5			X	S	81					
10			X	S	100				slightly moist very firm to hard	CLAYEY SAND, trace of gravel, predominantly fine, some weak cementation, low to medium plasticity, light brown
15			X	S	47			SC		
20			X	S	50/5½"					
25			X	S	50/5"			ML	slightly moist hard	SILT, considerable clay, some sand, some moderate cementation, low to medium plasticity, light brown
30			X	S	70				slightly moist very dense	SAND, trace of sub-rounded gravel, predominantly fine with occasional lense well graded, nonplastic, light brown
35			X	S	50/4½"					
								SP		
40			X	S	50/5¾"					
45			X	S	50/3"					
								SW		
50										

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT McMicken Dam Restoration Study

JOB NO. E81-138 DATE 1-25-82

LOG OF TEST BORING NO. 67

location Station 502+00, ¢ of dam

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1360.0'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
50				S	50/5½"			SW	slightly moist very dense	SAND, some gravel, well graded, subrounded to rounded, nonplastic, light gray
55										Stopped auger at 49'6" Sampler refused at 50'5½"

GROUND WATER

DEPTH	HOUR	DATE

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT McMicken Dam Restoration Study

JOB NO. E81-138 DATE 1-25-82

LOG OF TEST BORING NO. 68

location Station 496+50, ¢ of dam

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1359.5'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	95				slightly moist to moist hard	SANDY CLAY, some subrounded gravel, some weak cementation, medium plasticity, light brown to brown
5			X	S	96					
								CL		
10			X	S	50/5¾"					
15			X	S	53					
20			X	S	46			ML	slightly moist very firm	SILT, some sand & clay, low plasticity, light brown
25			X	S	24				slightly moist medium dense to very dense	SAND, some silt, trace of subrounded gravel, well graded, occasional lense predominantly fine, nonplastic, light brown
30			X	S	60					
35			X	S	50/5½"					
								SW		
40			X	S	102 (no recovery)					
45			X	S	61					
50				S	50/2"					Stopped auger at 49'6" Sampler refused at 49'8"

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT McMicken Dam Restoration Study

JOB NO. E81-138 DATE 1-25-82

LOG OF TEST BORING NO. 69

location Station 487+50, ℄ of dam

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1360.0'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	50/5½"				slightly moist to moist	CLAYEY SAND, trace of gravel, nonplastic to low plasticity, light brown to brown
5			X	S	50/5"			SC	hard	
10			X	S	20				moist	CLAY, some sand, medium plasticity, brown
15			X	S	34			CL	firm to hard	
20			X	S	61			SC	moist	CLAYEY SAND, trace of gravel, low plasticity, brown
25			X	S	89			ML	hard	SILT, considerable clay, low plasticity, light brown
30			X	S	51				slightly moist	SILTY SAND, considerable clay, predominantly fine, low plasticity, light brown
35			X	S	50/5"			SM	hard to very firm	
40			X	S	30					
45				S	50/1"					Stopped auger at 44'6" Sampler refused at 44'7"

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT McMicken Dam Restoration Study

JOB NO. E81-138 DATE 1-25-82

LOG OF TEST BORING NO. 70

Location Sta. 27+50, ¢ outlet channel

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1336.5'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	30				slightly moist to moist very firm	SILTY, SANDY CLAY, moderately cemented, medium plastictiy, light brown
5			X	S	44			CL		
10			X	S	33					
15			X	S	27			ML-CL	slightly moist firm	SILTY CLAY & CLAYEY SILT, some sand, medium plasticity, light brown
20			X	S	50/5¾"					
25			X	S	82			SP	slightly moist very dense	SAND, some clay, predominantly fine, some weak cementation, non-plastic, light brown
30										Stopped auger at 24'6" Stopped sampler at 26'.

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT McMicken Dam Restoration Study

JOB NO. E81-138 DATE 1-26-82

LOG OF TEST BORING NO. 71

location Sta. 40+00, ℄ outlet channel

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1335.0'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	40				moist to slightly moist	SILTY CLAY, some sand, moderately cemented, medium plasticity, brown to light brown
5			X	S	54				very firm to hard	
								CL		
10			X	S	33					
15			X	S	68					
20			X	S	50/5"			SP	slightly moist to moist very dense	SAND, trace of clay & silt, predominantly fine, nonplastic, reddish-brown
25			X	S	93				slightly moist to moist very dense	SAND, trace of silt & clay, well graded, non-plastic, reddish-brown
								SW		
30			X	S	60					
35			X	S	74			SP	slightly moist very dense	SAND, trace of silt & clay, predominantly fine, nonplastic, reddish-brown
40										Stopped auger at 34'6" Stopped sampler at 36'

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT McMicken Dam Restoration Study

JOB NO. E81-138 DATE 1-26-82

LOG OF TEST BORING NO. 72

location Sta. 52+50, ¢ outlet channel

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1337.0'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	15			SM	slightly moist moderately firm	SILTY SAND, considerable clay, predominantly fine, low to medium plasticity, light brown
5			X	S	88			CL	moist hard to firm	SILTY CLAY, some sand, weak cementation, medium plasticity, brown note: uncemented below 8'
10			X	S	16					
15			X	S	36			SW	moist dense	SAND, trace of clay & gravel, well graded, nonplastic, light brown
20			X	S	50/5"			SM	moist hard	SILTY SAND, some clay, trace of gravel, predominantly fine, low plasticity to nonplastic, reddish-brown to light gray
25			X	S	76					
30										Stopped auger at 24'6" Stopped sampler at 26'

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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JOB NO. E81-138 DATE 1-26-82

LOG OF TEST BORING NO. 73

location Sta. 65+00, ℄ outlet channel

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1338.5'

DATUM 1982 A.H.A. Survey

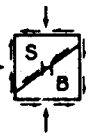
Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	28				moist moderately firm to very firm	SANDY CLAY, considerable silt, some weak cementation, medium plasticity, dark brown
5			X	S	13			CL		
10			X	S	40					note: moderately cemented below 9'
15			X	S	40				slightly moist dense to very dense	SAND, trace of gravel, well graded, some weak cementation, nonplastic, light brown
								SW		
20			X	S	50/5¾"					
25			X	S	60			CL	moist hard	CLAY, some silt, medium to high plasticity, brown
								SW	slightly moist very dense	SAND, some clay, trace of gravel, well graded, nonplastic, light brown
30			X	S	50/3"					
										Auger refused at 30'

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.



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PROJECT McMicken Dam Restoration Study

JOB NO. E81-138 DATE 1-26-82

LOG OF TEST BORING NO. 74

location *See Below

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. ≈1390.0'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	17			SC	slightly moist firm	CLAYEY SAND, considerable silt, predominantly fine, low plasticity, light brown
5			X	S	27				slightly moist to moist firm to hard	CLAYEY SILT & SILTY CLAY, some sand, trace of gravel, some weak cementation, medium plasticity, light brown
10			X	S	50					
15			X	S	24			~~ML~~-CL		
20			X	S	46					
25			X	S	82					
30			X	S	7			SW	slightly moist to moist loose to very dense	SAND, trace of silt & gravel, well graded, nonplastic, brown note: considerable gravel below 34'
35			X	S	50/4"					
40										Stopped auger at 34'6" Sampler refused at 35'4" *3,000' North of South End of Levee, on Crest of Levee

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT McMicken Dam Restoration Study

JOB NO. E81-138 DATE 1-26-82

LOG OF TEST BORING NO. 75

location Station 408+50, ℄ of dam

RIG TYPE CME-55

BORING TYPE 6½" Hollow Stem Auger

SURFACE ELEV. 1358.7'

DATUM 1982 A.H.A. Survey

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows per foot 140 lb. 30" free-fall drop hammer	Dry Density Lbs. per cu. ft.	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0			X	S	39				slightly moist to moist	SILTY CLAY, trace of sand, some moderate cementation, medium plasticity, light brown
								CL	very firm	
5			X	S	47					
10			X	S	30				moist very firm to hard	CLAYEY SAND, trace of gravel, predominantly fine, low to medium plasticity, brown
15			X	S	52			SC		
20			X	S	40					note: considerable angular, white gravel below 19'
25			X	S	17				moist firm to very firm	SILTY CLAY, trace of sand, medium plasticity, brown
								CL		
30			X	S	41					
35			X	S	42				moist medium dense to dense	SAND & GRAVEL, considerable clay, well graded, subrounded, nonplastic, reddish-brown to tan
								SW		
40			X	S	20					
45										Stopped auger at 39'6" Stopped sampler at 41'

GROUND WATER

DEPTH	HOUR	DATE
	none	

SAMPLE TYPE

A – Auger cuttings. B – Block sample
S – 2" O.D. 1.38" I.D. tube sample.
U – 3" O.D. 2.42" I.D. tube sample.
T – 3" O.D. thin-walled Shelby tube.

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PROJECT McMicken Dam Restoration Study

JOB NO. E81-138 DATE 2-10-82

LOG OF TEST PIT NO. TP-15

Backhoe Type: Case 580C

Location: *See Below

Elevation: 1342.0'

Datum: U.S.G.S. Topo Map

GROUND WATER

DEPTH	HOUR	DATE
	none	

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		X	D		ML	slightly moist	SILT, some sand & gravel, weakly to moderately cemented, low plasticity, light reddish-brown
		X	B		ML	slightly moist to dry	SILT, trace of sand & gravel, moderately cemented, low plasticity, tan with some light tan mottling
5		X	D		SM	slightly moist to dry	SILTY SAND, considerable gravel, predominantly fine to medium, subrounded to subangular, moderately cemented, nonplastic to low plasticity, light tan
10							Stopped backhoe at 7'
							*Station 457+70, 940' upstream of ℄

DATE 2-10-82

LOG OF TEST PIT NO. TP-16

Backhoe Type: Case 580C

Location: *See Below

Elevation: 1342.0'

Datum: U.S.G.S. Topo Map

GROUND WATER

DEPTH	HOUR	DATE
	none	

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		X	D		ML	slightly moist	SILT, occasional sand & gravel, low plasticity, tan
		X	B		ML	slightly moist to dry	SILT, occasional sand & gravel, weakly cemented, low plasticity, blocky structure, reddish-brown with white lineations
5		X	D		GW	slightly moist	SAND & GRAVEL, trace of cobbles, well graded, subangular to subrounded, nonplastic, light grayish-brown
10							Stopped backhoe at 8'
							*Station 473+00, 900' upstream of ℄

SAMPLE TYPE
B — Undisturbed Block Sample
D — Disturbed Bulk Sample

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JOB NO. E81-138 DATE 2-10-82

LOG OF TEST PIT NO. TP-17

Backhoe Type: Case 580C

Location: *See Below

Elevation: 1333.0'

Datum: U.S.G.S. Topo Map

GROUND WATER

DEPTH	HOUR	DATE
	none	

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0					ML	slightly moist	SILT, some sand, trace of gravel, predominantly well graded, subrounded to rounded, low plasticity, tan
		X	D				
					ML	slightly moist to dry	SILT, some sand & gravel, weakly to moderately cemented, low plasticity, tan mottled with light tan
5		X	D				
					SW & GW	slightly moist to dry	SAND & GRAVEL, some clay, well graded, subrounded, weakly cemented, nonplastic to low plasticity, reddish-brown
		X	D				
10							Stopped backhoe at 7'3"
							*Station 455+22, 420' downstream of ℄

DATE 2-10-82

LOG OF TEST PIT NO. TP-18

Backhoe Type: Case 580C

Location: *See Below

Elevation: 1332.0'

Datum: U.S.G.S. Topo Map

GROUND WATER

DEPTH	HOUR	DATE
	none	

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0					ML	slightly moist	SILT, trace of sand & gravel, low plasticity, light brown
		X	B				
5					ML	slightly moist to dry	SILT, occasional sand, trace of gravel, moderately cemented, low plasticity, blocky structure, light brown with light tan mottling
10					SW & GW	slightly moist to dry	SAND & GRAVEL, occasional silt, well graded, subrounded to subangular, weakly cemented, nonplastic, light grayish-brown
							Stopped backhoe at 10'
							*Station 474+00, 360' downstream of ℄

SAMPLE TYPE
B — Undisturbed Block Sample
D — Disturbed Bulk Sample

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JOB NO. E81-138 DATE 2-10-82

LOG OF TEST PIT NO. TP-19

Backhoe Type: Case 580C

Location: *See Below

Elevation: 1333.0'

Datum: U.S.G.S. Topo Map

GROUND WATER

DEPTH	HOUR	DATE
	none	

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0					ML	slightly moist	SILT, trace of sand & gravel, low plasticity, tan
		X	D		ML	slightly moist to dry	SILT, considerable sand & gravel, predominantly well graded, subrounded to subangular, weakly cemented, low to medium plasticity, blocky structure, tan with light tan mottling
5		X	D		GW	slightly moist to dry	SAND & GRAVEL, some clay, well graded, rounded to subangular, weakly cemented, nonplastic, reddish-brown
							Stopped backhoe at 5'
							*Station 433+20, 350' downstream of ℄

DATE 2-10-82

LOG OF TEST PIT NO. TP-20

Backhoe Type: Case 580C

Location: *See Below

Elevation: 1331.0'

Datum: U.S.G.S. Topo Map

GROUND WATER

DEPTH	HOUR	DATE
	none	

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0					ML	slightly moist	SILT, occasional sand & gravel, low plasticity, tan
5		X	D		ML	slightly moist to dry	SILT, occasional sand & gravel, weakly to moderately cemented, low plasticity, blocky structure, tan with occasional light tan mottling
10							note: considerable lenses of SAND & GRAVEL, trace of clay, well graded, subrounded, nonplastic, reddish-brown
							Stopped backhoe at 8'
							*Station 390+72, 460' downstream of ℄

SAMPLE TYPE
B — Undisturbed Block Sample
D — Disturbed Bulk Sample

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JOB NO. E81-138 DATE 2-10-82

LOG OF TEST PIT NO. TP-21

Backhoe Type: Case 580C

Location: *See Below

Elevation: 1336.0'

Datum: U.S.G.S. Topo Map

GROUND WATER

DEPTH	HOUR	DATE
	none	

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0					ML	slightly moist to dry	SILT, trace of sand & gravel, low plasticity, tan note: weakly to moderately cemented at 1½' to 4½'
		☒	B				
5					ML	dry	SILT, considerable gravel, some sand, well graded, subrounded, weakly to moderately cemented, low plasticity, light tan
10							Stopped backhoe at 7' *Station 350+36, 150' downstream of ℄

DATE 2-11-82

LOG OF TEST PIT NO. TP-22

Backhoe Type: Case 580C

Location: *See Below

Elevation: 1341.0'

Datum: U.S.G.S. Topo Map

GROUND WATER

DEPTH	HOUR	DATE
	none	

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0					ML	slightly moist to dry	CLAYEY SILT, trace of sand & gravel, low to medium plasticity, tan note: weakly cemented & some tan mottling at 1' to 3'
		☒	D				
5					SW & GW	slightly moist to dry	SAND & GRAVEL, considerable silt, well graded, subrounded to subangular, nonplastic to low plasticity, brown
10							Stopped backhoe at 7' *Station 297+42, 310' downstream of ℄

SAMPLE TYPE
B — Undisturbed Block Sample
D — Disturbed Bulk Sample

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JOB NO. E81-138 DATE 2-11-82

LOG OF TEST PIT NO. TP-23

Backhoe Type Case 580C

Location *See Below

Elevation 1342.0'

Datum U.S.G.S. Topo Map

GROUND WATER

DEPTH	HOUR	DATE
	none	

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		☒	D		SM	moist	SILTY SAND, predominantly well graded, subrounded to subangular, low plasticity, brown
		☒	D		ML-CL		note: occasional lense of well graded sand, subrounded to subangular, nonplastic, light brown
5					SW & GW	slightly moist	SILTY CLAY, some sand, weakly cemented, medium plasticity, blocky structure, brown
10						slightly moist to dry	SAND & GRAVEL, some clay, well graded, subrounded to subangular, weakly cemented, nonplastic, reddish-brown
							Stopped backhoe at 8'6"
							*Station 301+40, 130' downstream of ℄

DATE 2-11-82

LOG OF TEST PIT NO. TP-24

Backhoe Type Case 580C

Location *See Below

Elevation 1336.0'

Datum U.S.G.S. Topo Map

GROUND WATER

DEPTH	HOUR	DATE
	none	

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		☒	B		ML	slightly moist	SILT, occasional sand, trace of gravel, low plasticity, tan
5					ML	slightly moist to dry	SILT, some sand & gravel, well graded, weakly to moderately cemented, low plasticity, tan with light tan mottling
					GW		
10						slightly moist to dry	SAND & GRAVEL, some cobbles & silt, well graded, rounded to subrounded, weakly cemented, nonplastic, light brown
							Stopped backhoe at 8'
							*Station 284+00, 600' upstream of ℄

SAMPLE TYPE
B — Undisturbed Block Sample
D — Disturbed Bulk Sample

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JOB NO. E81-138 DATE 2-11-82

LOG OF TEST PIT NO. TP-25

Backhoe Type: Case 580C

Location: *See Below

Elevation: 1341.0'

Datum: U.S.G.S. Topo Map

GROUND WATER

DEPTH	HOUR	DATE
	none	

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0					ML	slightly moist to moist	SILT, some sand, predominantly fine to medium, subangular, low plasticity, brown
		☒	B		ML	slightly moist to dry	SILT, trace of sand & gravel, weakly cemented, low plasticity, tan mottled with light tan
5					SW & GW	slightly moist to dry	SAND & GRAVEL, occasional silt & lenses of well graded sand, well graded, subangular to subrounded, some weak cementation, nonplastic, light brown to reddish-brown
10							Stopped backhoe at 8'
							*Station 292+25, 145' downstream of ℄

DATE 2-11-82

LOG OF TEST PIT NO. TP-26

Backhoe Type: Case 580C

Location: *See Below

Elevation: 1338.0'

Datum: U.S.G.S. Topo Map

GROUND WATER

DEPTH	HOUR	DATE
	none	

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0					ML-CL	slightly moist	CLAYEY SILT, some sand, predominantly fine, low to medium plasticity, light brown
		☒	B		ML-CL	slightly moist to moist	CLAYEY SILT, some sand, weakly cemented, medium plasticity, blocky structure, brown
5					SW & GW	slightly moist	SAND & GRAVEL, some silt, well graded, subrounded to subangular, weakly cemented, nonplastic, brown with considerable light tan mottling
10							Stopped backhoe at 7'
							*Station 282+05, 120' downstream of ℄

SAMPLE TYPE
B — Undisturbed Block Sample
D — Disturbed Bulk Sample

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JOB NO. E81-138 DATE 2-11-82

LOG OF TEST PIT NO. TP-27

Backhoe Type: Case 580C

Location: *See Below

Elevation: 1344.0'

Datum: U.S.G.S. Topo Map

GROUND WATER

DEPTH	HOUR	DATE
	none	

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0					ML	slightly moist to dry	SILT, considerable sand, well graded, subangular to subrounded, low plasticity, tan note: predominantly fine, very soft sand from 3' to 4'
		X	D				
5					SW	slightly moist to dry	SAND & GRAVEL, occasional clay, well graded, subangular, nonplastic, reddish-brown to brown
10							Stopped backhoe at 6' *Station 196+78, 160' downstream of ℄

DATE 2-11-82

LOG OF TEST PIT NO. TP-28

Backhoe Type: Case 580C

Location: *See Below

Elevation: 1340.0'

Datum: U.S.G.S. Topo Map

GROUND WATER

DEPTH	HOUR	DATE
	none	

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0						slightly moist to dry	SANDY SILT, some well graded sand & gravel, predominantly very fine, low plasticity, tan
		X	B		SM		
5		X	B				
					ML-CL	slightly moist to dry	SILTY CLAY, low to medium plasticity, blocky structure, reddish-brown
10					SM	slightly moist to dry	SANDY SILT, trace of gravel, very fine, low plasticity, tan
							Stopped backhoe at 10' *Station 179+30, 165' downstream of ℄

SAMPLE TYPE
B — Undisturbed Block Sample
D — Disturbed Bulk Sample

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JOB NO. E81-138 DATE 2-12-82

LOG OF TEST PIT NO. TP-29

Backhoe Type: Case 580C

Location: *See Below

Elevation: 1360.0'

Datum: A.H.A. 1982 Survey

GROUND WATER

DEPTH	HOUR	DATE
	none	

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0					ML	slightly moist	SILT, considerable fine sand, some clay & gravel, weakly to moderately cemented, low plasticity, tan note: gravelly lense at 1'9" to 2'
			B				
5					SW	slightly moist to dry	SAND & GRAVEL, considerable silt, well graded, moderately cemented, nonplastic, light brown
10							Stopped backhoe at 5'6" *Station 464+00, ¢ of dam

DATE 2-12-82

LOG OF TEST PIT NO. TP-30

Backhoe Type: Case 580C

Location: *See Below

Elevation: 1352.0'

Datum: A.H.A. 1982 Survey

GROUND WATER

DEPTH	HOUR	DATE
	none	

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0					ML	slightly moist to moist	SILT, occasional fine sand, trace of sand & gravel, occasionally weakly cemented, low plasticity, tan note: SAND & GRAVEL, occasional silt & clay, well graded, subrounded to subangular, nonplastic, brown to reddish-brown at 6" to 18"
			B				
5			B				
10							Stopped backhoe at 6'6" *Station 464+00, ¢ of old dike

SAMPLE TYPE
B — Undisturbed Block Sample
D — Disturbed Bulk Sample

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JOB NO. E81-138 DATE 2-12-82

LOG OF TEST PIT NO. TP-31

Backhoe Type: Case 580C

Location: *See Below

Elevation: 1350.0'

Datum: A.H.A. 1982 Survey

GROUND WATER

DEPTH	HOUR	DATE
	none	

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0		X	B		SM	slightly moist to moist	SANDY SILT, some gravel, fine, low plasticity, light brown
					GW		
5		X	B		SM	slightly moist	SANDY GRAVEL, some silt, well graded, subrounded, low plasticity, grayish-brown
					GW		
						slightly moist	SANDY SILT, some gravel, fine, low plasticity, light brown
10						slightly moist	SANDY GRAVEL, some silt, well graded, subrounded, low plasticity, light greenish-brown
							Stopped backhoe at 7'
							*Station 370+00, ¢ of old dike

DATE 2-15-82

LOG OF TEST PIT NO. TP-32

Backhoe Type: Case 580C

Location: *See Below

Elevation: 1358.0'

Datum: A.H.A. 1982 Survey

GROUND WATER

DEPTH	HOUR	DATE
	none	

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0					CL-ML	slightly moist	CLAY, considerable silt & sand, low plasticity, brown
		X	B		GM	slightly moist	SILT, considerable gravel, some clay & sand, well graded, subrounded to subangular, weakly to moderately cemented, low plasticity, light brown
5		X	B				note: trace of cobbles at 5'
10							Stopped backhoe at 7'
							*Station 260+00, ¢ of dam

SAMPLE TYPE
B — Undisturbed Block Sample
D — Disturbed Bulk Sample

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JOB NO. E81-138 DATE 2-15-82

LOG OF TEST PIT NO. TP-33

Backhoe Type: Case 580C

Location: *See Below

Elevation: 1340.0'

Datum: U.S.G.S. Topo Map

GROUND WATER

DEPTH	HOUR	DATE
	none	

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0						slightly moist to dry	SILTY SAND, considerable gravel, predominantly well graded, subrounded to subangular, trace of weak cementation, low plasticity, tan note: weakly cemented & some light tan clay at 4' to 4'3"
5		X	D		SM		
					SW	slightly moist to moist	SAND, occasional clay, predominantly well graded, angular to subangular, nonplastic to low plasticity, white & reddish-brown
10							Stopped backhoe at 9'
							*Station 272+87, 90' downstream of ℄

DATE 2-15-82

LOG OF TEST PIT NO. TP-34

Backhoe Type: Case 580C

Location: *See Below

Elevation: 1340.0'

Datum: U.S.G.S. Topo Map

GROUND WATER

DEPTH	HOUR	DATE
	none	

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0					SM	slightly moist	SAND, some gravel & silt, well graded, subangular, nonplastic, brown with white specks
					SM		
					GW	slightly moist	SILTY SAND, occasional gravel, predominantly fine, subrounded to subangular, nonplastic to low plasticity, light brown
5						slightly moist	SAND & GRAVEL, some small cobbles, occasional silt, well graded, subangular to subrounded, nonplastic, light brown & white
							Stopped backhoe at 5'6"
							*Station 141+32, 140' downstream of ℄

SAMPLE TYPE
B — Undisturbed Block Sample
D — Disturbed Bulk Sample

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JOB NO. E81-138 DATE 2-15-82

LOG OF TEST PIT NO. TP-35

Backhoe Type: Case 580C

Location: *See Below

Elevation: 1340.0'

Datum: U.S.G.S. Topo Map

GROUND WATER

DEPTH	HOUR	DATE
	none	

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0					SM	moist to slightly moist	SILTY SAND, predominantly very fine, nonplastic to low plasticity, brown
					GM	slightly moist to dry	SILTY SAND, GRAVEL & COBBLES, well graded, subangular to subrounded, some weak cementation, nonplastic to low plasticity, tan with some light tan mottling
5							
10							Stopped backhoe at 4'

*Station 119+12, 110' downstream of ℄

DATE 2-15-82

LOG OF TEST PIT NO. TP-36

Backhoe Type: Case 580C

Location: *See Below

Elevation: 1335.0'

Datum: U.S.G.S. Topo Map

GROUND WATER

DEPTH	HOUR	DATE
	none	

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0					SM	slightly moist to moist	SILTY SAND, predominantly very fine, nonplastic to low plasticity, light brown
		X	D		GW	slightly moist	SAND, GRAVEL & COBBLES, some silt, well graded, subrounded to subangular, trace of weak cementation, nonplastic, light brown to light tan
5							
10							Stopped backhoe at 6'

*Station 79+22, 168' downstream of ℄

SAMPLE TYPE
B — Undisturbed Block Sample
D — Disturbed Bulk Sample

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LOG OF SUSPECTED CRACK RELATED FEATURES FOUND DURING INSPECTION OF MCMICKEN DAM EMBANKMENT

Station	Remarks
116+10	Shallow depression on east side of crest.
125+76	Small hole or crack on west side of crest 1 in. x 2 in. x 1 in. deep.
131+58	Shallow depression across crest.
139+17	Small crack on west edge of crest 1 in. x 2 in. x 6 in. deep.
140+94	Shallow depression and small hole on west edge of crest and small hole on east side of crest.
142+45	Shallow depression on west side of crest.
146+10	Shallow depression on east side of crest, line of vegetation perpendicular to dam axis extending 5 ft. down downstream embankment.
146+32	Hole on west side of crest 1 ft. x 1 ft. x 6 in. deep.
158+81	Crack on west side of crest 4 in. x 1 ft. x 4 in. deep, perpendicular to axis.
195+47	Shallow depression on east side of crest.
196+43	Line of vegetation perpendicular to axis extending 6 ft. down downstream embankment.

McMicken Dam Restoration Study
Maricopa County, Arizona
SHB Job No. E81-138

Station	Remarks
196+50	Crack across most of crest, two holes, larger on the east side, 1 ft. x 2 ft. x 6 in. deep, line of vegetation perpendicular to axis on downstream embankment.
211+86	Shallow depression on east side of crest.
224+15	Small crack or burrow on east side of crest and a group of burrows about halfway down downstream embankment.
233+04	Shallow depression across crest, line of vegetation perpendicular to axis extending at least 5 ft. down both embankments.
234+19	Small crack or burrow on west edge of crest.
234+93	Crack across crest, largest opening 3 in. x 1 ft. x 1½ ft. deep, some vegetation in a line perpendicular to axis down downstream embankment.
235+54	Shallow holes on both edges of crest.
236+00	Depression across crest.
240+86	Small hole in crest.
242+53	Small hole on east side of crest 1 in. x 2 in. x 2 in. deep, line of vegetation perpendicular to axis extending at least 3 ft. down downstream embankment.

McMicken Dam Restoration Study
Maricopa County, Arizona
SHB Job No. E81-138

Station	Remarks
243+08	Holes on both edges of crest about 3 in. x 8 in. x 6 in. to 8 in. in depth.
243+20	Line of vegetation perpendicular to axis and group of burrows on bottom third of downstream embankment.
245+97	Hole on east side of crest perpendicular to axis 2 in. x 6 in. x 4 in. in depth.
247+68	Hole in center of crest perpendicular to axis 2 in. x 8 in. x 8 in. to 10 in. deep.
250+07	Hole on west side of crest 2 in. x 2 in. x 4 in. deep.
251+50	Shallow depression on west side of crest and group of burrows just below crest on upstream embankment.
252+95	Groups of burrows just below crest on both embankments.
269+30	Depression on west side of crest parallel to axis, about 10 ft. long.
269+75	Holes across crest and extending in a line perpendicular to axis 8 ft. to 10 ft. down both embankments.
272+64	Depression across crest, line of vegetation perpendicular to axis extending 5 ft. to 15 ft. down both embankments.

McMicken Dam Restoration Study
Maricopa County, Arizona
SHB Job No. E81-138

Station	Remarks
274+83	Hole in center of crest, groups of burrows just down from crest on both embankments.
275+20	Crack on west side of crest perpendicular to axis 4 in. x 1 ft. x 1 ft. deep.
275+35	Erosion enlarged crack on east side of crest 10 in. x 1½ ft. x 1½ ft. deep. Perpendicular to axis, small hole on west side of crest and line of burrows perpendicular to axis 6 ft. to 8 ft. down downstream embankment.
277+85	Depression across crest, hole on east side of crest, burrows in a line perpendicular to axis 5 ft. to 10 ft. down from crest on both embankments.
278+43	Two holes within 5 ft. of the crest on the upsteam embankment, larger hole is 4 in. x 6 in. x 1 ft. deep.
278+70	Two holes on downstream embankment about 1 ft. x 1 ft. x 1 ft. deep, about halfway down upstream embankment.
280+05	Depression on east side of crest 6 in. x 1½ ft. x 3 in.
280+97	Depression and holes across crest and top 5 ft. of both embankments, largest hole is 2 in. x 6 in. x 10 in. deep.
282+99	Hole at center of crest, several more on east side of crest.

McMicken Dam Restoration Study
Maricopa County, Arizona
SHB Job No. E81-138

Station	Remarks
283+18	Several small holes on crest, several more in a line perpendicular to axis on the downstream embankment.
283+47	Hole on east edge of crest 5 in. x 10 in. x 6 in. deep.
284+62	Hole on east edge of crest, burrows in a line perpendicular to axis on downstream embankment.
300+45	Shallow depression across center of crest.
300+70	Large hole or burrow 20 ft. above downstream toe 10 in. x 18 in.
301+19	Depression in center of crest.
302+04	Crack on east side of crest 2 in. x 5 in. x at least 6 in. deep.
302+70	Hole on east side of crest 1 in. x 1 in. x at least 6 in. deep.
303+48	Hole on east side of crest 1 in. x 1 in. x at least 6 in. deep.
303+99	Crack on east side of crest 2 in. x 1½ ft. x 6 in. to 12 in. deep.
305+65	Depression in roadway between crest and toe parallel to axis, 2 ft. x 6 ft. x 4 in. to 6 in. deep.
310+23	Shallow depression on east side of crest.

McMicken Dam Restoration Study
Maricopa County, Arizona
SHB Job No. E81-138

Station	Remarks
310+30	Crack near center of crest perpendicular to axis 2 in. x 8 in. x 6 in. deep.
310+77	Probable crack on east side of crest, four holes, maximum of 2 in. x 3 in. and up to 6 in. deep, nearly perpendicular to axis.
312+20	Two holes on east side of crest 2 in. x 3 in. x 3 in. deep, perpendicular to axis.
312+57	Small hole on east side of crest 2 in. x 2 in.
312+78	Two small holes on east side of crest, maximum 1 in. x 3 in.
342+89	Shallow depression on east side of crest 2 ft. x 2 ft.
343+08	Shallow depression on west side of crest 1 ft. x 1 ft.
343+30	Shallow depression on east side of crest 1 ft. x 1 ft.
349+72	Shallow depression on west side of crest 8 in. x 8 in. x 1 in.
355+38	Small hole on east side of crest.
355+60	Large hole in center of crest 8 in. x 8 in. x 6 in. to 10 in. deep.
356+38	Crack on east side of crest perpendicular to axis 3 in. x 10 in. x 3 in. to 5 in. deep.

McMicken Dam Restoration Study
Maricopa County, Arizona
SHB Job No. E81-138

Station	Remarks
357+05	Shallow depression on east side of crest 8 in. x 8 in. x 1 in. deep.
357+25	Large hole on east side of crest 6 in. x 1 ft. x 10 in. to 12 in. deep. Likely related to road between crest and old crest.
383+75	Small holes on crest and a few feet down both embankments.
393+93	Hole near crest perpendicular to axis 3 in. x 4 in. x 8 in. deep.
407+59	Hole in center of crest 2 in. x 2 in. by 2 in. deep.
409+95	Small hole and increase in vegetation in center of old crest.
411+19	Small hole in center of old crest.
411+75 to 412+96	Small holes, probably burrows, every 2 ft. to 15 ft. along old crest.
416+25	Hole on upstream embankment 2 ft. below crest 2 in. x 4 in. x 2 in. deep.
416+85	Hole on upstream embankment 1 ft. below crest 3 in. x 4 in. x 4 in. deep.
417+85	Two holes on old crest about 2 in. x 2 in., likely burrows.
417+91	Two holes on old crest about 2 in. x 2 in., likely burrows.

McMicken Dam Restoration Study
Maricopa County, Arizona
SHB Job No. E81-138

Station	Remarks
418+06 to 418+28	Eight holes on old crest, likely burrows.
418+42	Several holes on old crest, one hole just below new crest on the downstream embankment.
418+52	Hole on west side of crest perpendicular to axis 3 in. x 10 in. x 8 in. deep.
419+16	Small hole on east side of crest and down 1 ft. of the downstream embankment.
421+00	Hole on west edge of crest perpendicular to axis 2 in. x 6 in. x 2 in. deep.
422+55	Hole on east edge of crest perpendicular to axis 2 in. x 8 in. x 6 in. deep.
428+00	Hole 1 ft. below crest on upstream embankment 2 in. x 8 in.
428+40	Holes 1 to 2 ft. below crest on downstream embankment 1 in. to 3 in. wide, 6 in. to 12 in. long and 6 in. to 12 in. deep.
428+90	Small hole just below crest on downstream embankment.
429+45	Holes on downstream embankment from 3 ft. below crest to near toe, 2 in. wide maximum.
430+69	Two holes about 18 in. apart, approximately 10 ft. below upstream embankment.

McMicken Dam Restoration Study
Maricopa County, Arizona
SHB Job No. E81-138

Station	Remarks
430+98	Hole in upstream embankment about 20 ft. below crest 2 in. x 2 in. x 8 in. x 10 in. deep.
431+00	Several holes in downstream embankment, one near crest, one 3 ft. below crest and several more near toe.
431+79	Line of holes perpendicular to axis beginning halfway down upstream embankment and extending 5 ft. toward the toe.
432+79	Hole on downstream embankment 2 ft. below crest, 3 in. x 3 in.
433+11	Hole on upstream embankment 2 ft. below crest.
434+19	Crack across crest and down upstream embankment 8 ft. and down downstream embankment 4 ft.
434+46	Hole on west edge of crest 2 in. x 6 in.
434+67	Small hole on east edge of crest.
434+74	Hole on west edge of crest another 3 ft. below the crest on the upstream embankment.
435+25	Hole on upstream embankment 3 ft. below crest, 2 in. x 1 ft.
435+32	Small hole on east edge of crest.
435+42	Hole across west two-thirds of crest.
436+93	Small hole on west side of crest 1 in. x 2 in.

McMicken Dam Restoration Study
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SHB Job No. E81-138

Station	Remarks
437+29	Several holes on downstream embankment in a line from the crest to the toe of the new embankment.
437+65	Hole on downstream embankment 5 ft. below crest.
438+05	Two small holes on new downstream embankment, one 2 ft. above toe and the other 10 ft. above toe.
438+75	Hole on east edge of crest 2 in. x 1 ft.
439+48	Small hole on east edge of crest.
439+73	Crack across east half of crest, nearly perpendicular to axis and 2 in. x 4 in. wide and 4 ft. long.
440+65	Two holes, one on west edge of crest, one 2 ft. below the crest on the upstream embankment.
442+47	Small hole on west side of crest.
442+54	Small hole on old crest.
446+32	Small hole on upstream embankment near crest 2 in. x 4 in.
446+80	Crack in upstream embankment 5 ft. below crest perpendicular to axis.
447+02	Small hole on new downstream embankment halfway down from crest and perpendicular to axis and 1 in. x 4 in.

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Maricopa County, Arizona
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Station	Remarks
447+84	Hole on new downstream embankment 8 ft. to 10 ft. below crest and 4 in. x 6 in.
448+21	Several holes in a line perpendicular to axis on new downstream embankment from near crest to toe.
448+38	Hole on east side of crest perpendicular to axis and 2 in. x 8 in.
448+98	Crack on new downstream embankment halfway down from crest and 4 in. x 8 in. x 1 ft. deep.
449+63	Several holes in a line perpendicular to axis on new downstream embankment from halfway down from crest to toe.
450+89	Crack on upstream embankment about 8 ft. below crest perpendicular to axis and 8 in. x 1½ ft.
451+25	Holes on both embankments about 10 ft. below crest, both perpendicular to axis. Hole on upstream embankment is about 4 in. x 10 in., on new downstream embankment hole is 6 in. x 1 ft. (pictured).
451+73	Hole on new downstream embankment about 10 ft. below crest and 1 ft. x 1 ft.

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Station	Remarks
451+89	Crack on upstream embankment about 10 ft. below crest perpendicular to axis, 3 in. x 1 ft. on surface and opens up inside to about 1 ft. x 2 ft.
452+24	Crack on upstream embankment about 8 ft. below crest nearly perpendicular to axis and about 6 in. x 1 ft. x 1 ft. deep.
452+37	Group of five cracks, all nearly perpendicular to axis, one on the crest, two on west edge of crest, two about 8 ft. below the crest on the upstream embankment. Photo shows largest crack in group located on the embankment and about 8 in. x 1 ft. x 2 ft.
452+89	Crack on upstream embankment about 8 ft. below crest, perpendicular to axis and 1 in. x 4 in.
453+00	Hole on upstream embankment about 10 ft. below crest perpendicular to axis and 6 in. x 8 in. x 1 ft. deep.
453+23	Hole on upstream embankment about 10 ft. below crest perpendicular to axis and 6 in. x 6 in. x 10 in. deep.
453+37	Small hole on new downstream embankment about 10 ft. below crest.
453+74	Crack on crest perpendicular to axis and 4 in. x 8 in. x 10 in. deep.

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Station	Remarks
453+85	Crack on west side of crest perpendicular to axis and 4 in. x 10 in. x 1 ft. deep.
454+64	Cracks on both sides of crest perpendicular to axis and over 1 ft. deep.
454+82	Hole on east side of crest, 1 ft. x 1 ft. x 1 ft.
455+22	Large crack on east side of crest.
455+41	Large crack on east side of crest.
455+51	Large crack on east side of crest.
455+63	Large crack on east side of crest.
455+98	Large crack on east side of crest.
456+46	Small but deep crack (1 ft.+) on east side of crest.
456+82	Large cracks on both east and west side of crest. Photo shows west side crack, east side crack and downstream embankment. Large hole about 10 ft. below the crest on the downstream embankment. Small hole about 5 ft. below the crest on the upstream embankment.
457+24	Large crack on east side of crest perpendicular to axis and 6 in. x 1 ft. x 2 ft. deep. Extends beyond sight under the crest in both directions.

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Maricopa County, Arizona
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Station	Remarks
457+58	Hole on east side of crest and 4 in. x 6 in. x 8 in. deep.
458+57	Hole on east side of crest and 8 in. x 2 ft. x 4 in. deep.
459+80	Hole across west side of crest, 6 in. wide x 4 ft. long and perpendicular to axis. Small hole on east side of crest.
460+22	Hole on upstream embankment 15 ft. below crest and 3 in. x 6 in. x 10 in. deep.
466+00	Hole on edge of crest, 1 in. x 3 in.
466+34	Two holes, one on edge of crest, 2 in. x 3 in. and the other 2 ft. below crest, 2 in. x 1 in. x 1 ft.
466+83	Hole on crest, 2 in. x 3 in.
466+86	Two holes on crest, 4 in. x 3 in. and 4 in. x 4 in.
466+89	Hole 1 ft. below crest and 2 in. x 2 in. x 8 in. deep.
468+17	Hole 1 ft. below crest and 1 in. x 1 in. x 3 in.+ deep.
468+67	Crack 2 ft. below crest perpendicular to axis and 22 in. x 8 in. x 20 in. deep (downstream embankment top lift).
468+69	Hole on edge of crest and 3 in. x 4 in. x 6 in. deep.

McMicken Dam Restoration Study
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Station	Remarks
469+25	Hole 1 ft. below crest on downstream embankment and 12 in. x 2 in. x 6 in. deep.
469+40	Two holes on downstream embankment 1 ft. to 2½ ft. below crest, 8 in. x 4 in. x 3 in. deep, 2 in. x 3 in. x 6 in. deep and perpendicular to axis.
469+75	Five holes on upstream embankment between 2 and 15 ft. below crest and average size 2 in. x 3 in. x 6 in. deep.
469+76	Hole on downstream embankment about 7 ft. below crest. Hole is in a depression about 12 in. x 16 in. x 3 in. deep.
469+89	Hole near crest on upstream embankment and 2 in. x 2 in. x 8 in. deep.
469+98	Hole near crest on downstream embankment and 12 in. x 6 in. x 5 in. deep.
470+36	Hole 6 ft. below crest on downstream embankment perpendicular to axis and 2 in. x 2 in. x 6 in.+ deep.
470+56	Two holes on downstream embankment about 5 ft. below crest, perpendicular to axis, 2 in. x 2 in. x 4 in. deep and 4 in. x 2 in. x 1 ft. deep.
471+08	Shallow depression and small hole on edge of crest.

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Station	Remarks
471+70	Hole on edge of crest and 1 ft. x 2 ft. x 2 ft. deep.
472+70	Hole on downstream embankment ± 3 ft. below crest and 4 in. x 8 in. x 15 in. deep.
472+77	Hole just below crest on upstream embankment and 2 in. x 3 in. x 12 in.+ deep.
472+95	Small hole just below crest on upstream embankment.
474+71	Crack on downstream embankment, 3 ft. below crest, perpendicular to axis and 3 in. x 12 in.
474+90	Hole on upstream embankment 25 ft. below crest and 3 in. x 5 in. x 12 in. deep.
478+57	Small hole on upstream embankment 18 ft. below crest, perpendicular to axis and 1 in. x 1 in. x 6 in. deep.
478+73	Hole near crest and 12 in. x 8 in. x 20 in. deep.
478+93	Depression with small hole on upstream embankment 1 ft. below crest. 1 in. x 1 in. hole and 12 in. x 12 in. x 3 in. deep depression.
478+97	Holes on crest and largest is 12 in. x 14 in. x 10 in. deep.
479+59	Hole on upstream embankment about 25 ft. below crest and 2 in. x 2 in. x 12 in. deep.

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Station	Remarks
482+59	Hole on upstream embankment 5 ft. below crest and 4 in. x 6 in. x 20 in. deep.
484+72	Shallow depression on crest and 6 in. x 8 in. x 2 in. deep.
485+23	Shallow depression on edge of crest and 6 in. x 16 in. x 1 in. deep.
485+59	Hole in crest 3 in. x 9 in. x 9 in. deep.
485+78	Several small holes on crest up to 6 in. x 2 in. x 8 in. deep.
486+41	Hole on edge of crest 2 in. x 4 in. x 4 in. deep.
486+80	Hole on upstream embankment 25 ft. below crest 5 in. x 8 in.
487+15	Hole on upstream embankment 20 ft. below crest, perpendicular to axis and 5 in. x 7 in. x 18 in. deep.
487+56	Hole near crest parallel to dam and 10 in. x 4 in. x 20 in. deep.
488+91	Hole on crest 8 in. x 10 in. x 20 in. deep.
489+16	Hole on upstream embankment about 20 ft. below crest and 4 in. x 4 in. x 16 in. deep.
489+31	Hole on upstream embankment about 20 ft. below crest and 10 in. x 6 in. x 20 in. deep.

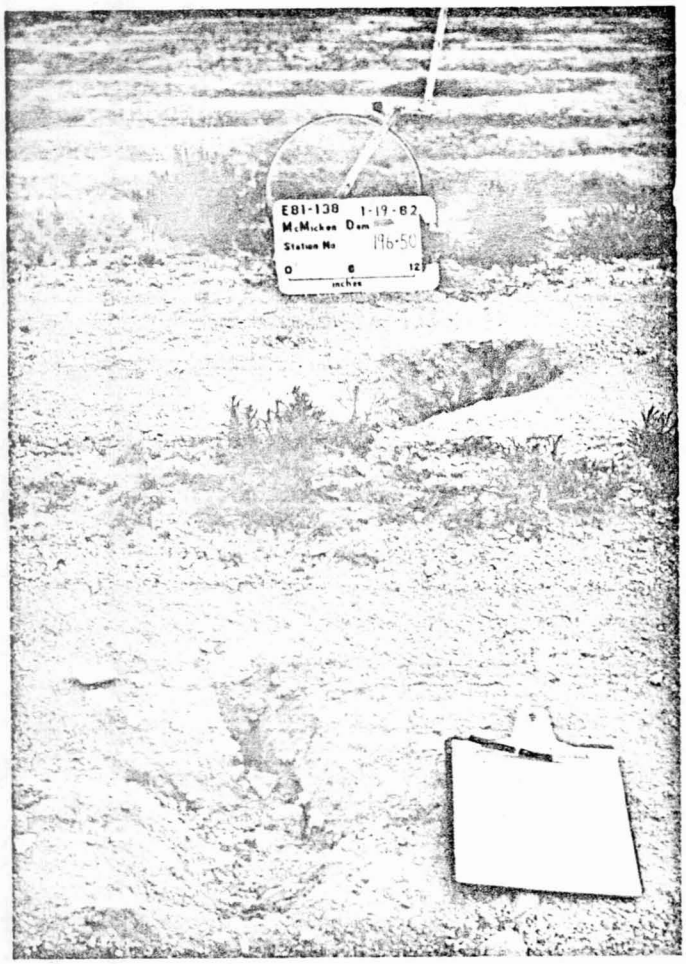
McMicken Dam Restoration Study
Maricopa County, Arizona
SHB Job No. E81-138

Station	Remarks
489+56	Hole on downstream embankment about 10 ft. below crest and 2 in. x 3 in. x 8 in. deep.
490+23	Depression in crest 30 in. x 8 in. x 2 in. deep.
490+56	Several holes on upstream embankment about 6 ft. below crest and largest hole is 6 in. x 5 in. x 12 in. deep.
491+50	Hole on edge of crest 2 in. x 4 in. x 12 in. deep.
492+25	Depression on edge of crest 7 in. x 11 in. x 1 in. deep.
492+40	Depression on edge of crest 8 in. x 12 in. x 1 in. deep.
492+58	Hole on downstream embankment 4 ft. below crest and 2 in. x 2 in. x 12 in. deep.
492+92	Shallow hole on downstream embankment 2 ft. below crest and 4 in. x 5 in. x 2 in. deep.
494+26	Small hole on downstream embankment 2 ft. below crest and 3 in. x 8 in. x 3 in. deep.
494+45	Hole on edge of crest subparallel to axis and 4 in. x 8 in. x 12 in. deep.
495+45	Hole on downstream embankment about 15 ft. below crest and 20 in. x 8 in. x 12 in. deep.
495+95	Hole near center of crest 3 in. x 2 in.

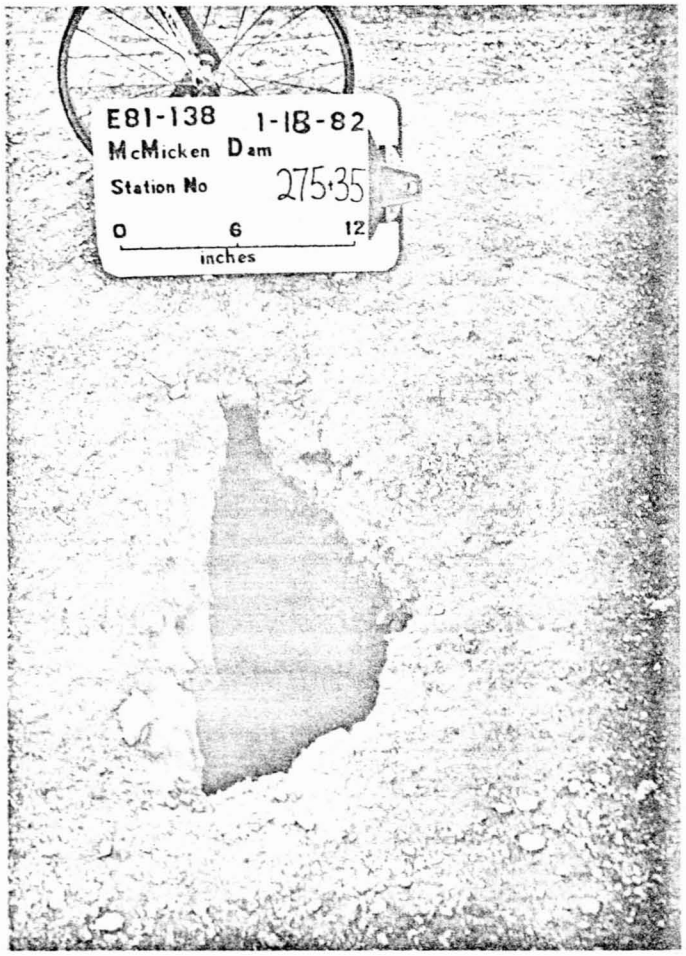
Station	Remarks
496+96	Hole on downstream embankment about 5 ft. below crest, perpendicular to axis and 7 in. x 6 in. x 12 in. deep.

OUTLET CHANNEL EMBANKMENT

Station	Remarks
16+62	Large hole on crest 6 in. x 1 ft. x 1 ft. deep, perpendicular to axis.
16+65	Two aligned holes 4 in. x 6 in. x 6-12 in. deep, perpendicular to axis.



Station 196+50: Crack across crest of dam. Crack is perpendicular to axis.



Station 275+35: Erosion enlarged crack, 1.5 feet deep, perpendicular to axis.

Station 434+19 : Two views showing cracks across crest of dam. Cracks are perpendicular to axis.

McMicken Dam Restoration Study
Maricopa County, Arizona
SHB Job No. E81-138

Log of Shallow Trenches on Crest of Dam

Trench No.	Location	Depth (inches)	Width (inches)	Crack Locations	Comments
1	50+00 to 50+50	8-14	8-14	No Cracking Observed	
2	95+00 to 95+50	12-16	8-15	No Cracking Observed	
3	116+00 to 116+50	18	8	No Cracking Observed	
4	132+00 to 133+00	14	8	No Cracking Observed	
5	146+00 to 147+00	20	8	146+82	2 in. wide by 1 ft. deep
6	168+00 to 169+00	18	8	No Cracking Observed	
7	196+25 to 196+75	20	7	196+46	
8	211+00 to 212+00	15	8	211+79	Water broke out of upstream embankment
9	242+50 to 243+50	15	8	242+54	
				243+09	Large crack
10	269+00 to 270+00	15	8	269+02	
				269+56	
				269+76	4 ft. deep crack, water broke out of upstream embankment
				269+89	

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McMicken Dam Restoration Study
Maricopa County, Arizona
SHB Job No. E81-138

Log of Shallow Trenches on Crest of Dam

Trench No.	Location	Depth (inches	Width (inches)	Crack Locations	Comments
11	278+00 to 279+00	18	8	278+04	
				278+18	
				278+47	
				278+59	Water broke out downstream embankment
				278+95	
12	285+00 to 286+00	18	8	285+24	
				285+57	45 degrees to axis
				285+64	
				285+68	
				285+98	Water broke out upstream embankment
13	303+00 to 304+00	10-16	8	303+03	
				303+06	
				303+11	
				303+16	
				303+20	
				303+25	
				303+32	
				303+39	
				303+52	
				303+55	
				303+62	

McMicken Dam Restoration Study
Maricopa County, Arizona
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Log of Shallow Trenches on Crest of Dam

Trench No.	Location	Depth (inches)	Width (inches)	Crack Locations	Comments
				303+69	
				303+73	
				303+77	Water broke out upstream embankment
				303+83	
				303+87	Very large crack 4 ft. long
				303+93	
14	330+00 to 330+50	12	8	No Cracking Observed	
15	355+00 to 356+00	18	8	355+32	
				355+34	
				355+44	Water broke out of downstream & upstream embankments
				355+48	Water broke out of upstream embankment
				355+64	Very large crack
				355+71	
				355+93	
16	380+00 to 381+00	18	8	No Cracking Observed	
17	403+00 to 404+00	15	8	403+94	Water broke out of upstream embankment

McMicken Dam Restoration Study
Maricopa County, Arizona
SHB Job No. E81-138

Log of Shallow Trenches on Crest of Dam

Trench No.	Location	Depth (inches)	Width (inches)	Crack Locations	Comments
18	434+00 to 435+00	14	8	434+22	
				434+48	Water broke out of downstream embankment
				434+59	Water broke out of downstream & upstream embankments
				434+61	
				434+70	Water broke out of upstream embankment
				434+79	
19	453+00 to 454+00	15	8	453+29	
				453+45	
				453+54	Very large crack
				453+90	Large crack
20	474+00 to 475+00	12	8	474+22	Very small crack
				474+73	
21	16+50 to 17+00	8-14	8	16+55	
	outflow channel embankment			16+58	
				16+66	Connection between this crack & cracks at 16+69 & 16+71; 3 in. wide by 6 in. deep
				16+69	
				16+71	

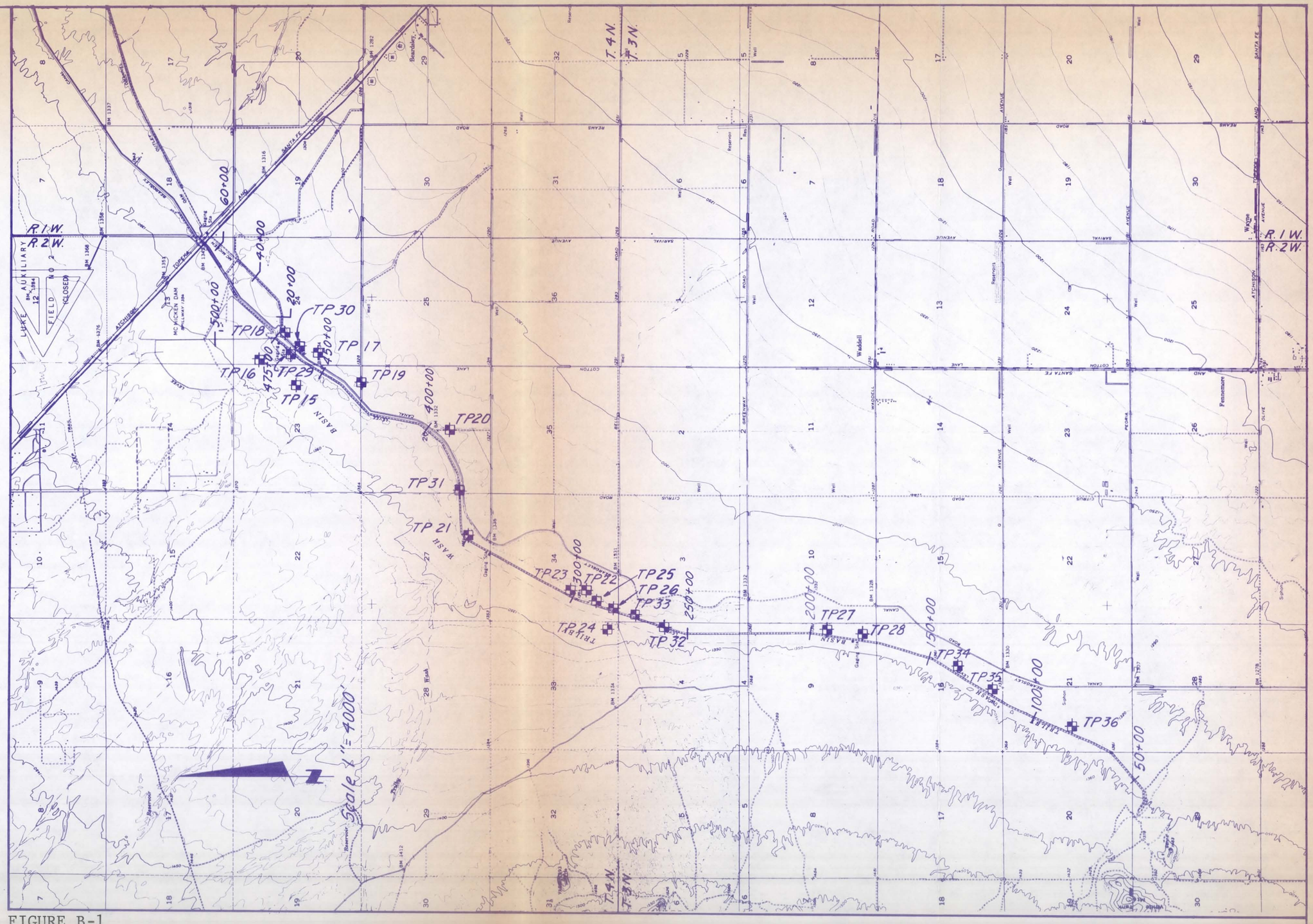

FIGURE B-1

SITE PLAN
Showing Test Pit Locations

Mc Micken Dam Restoration Study
Maricopa County, Arizona
SHB Job No. E81-138

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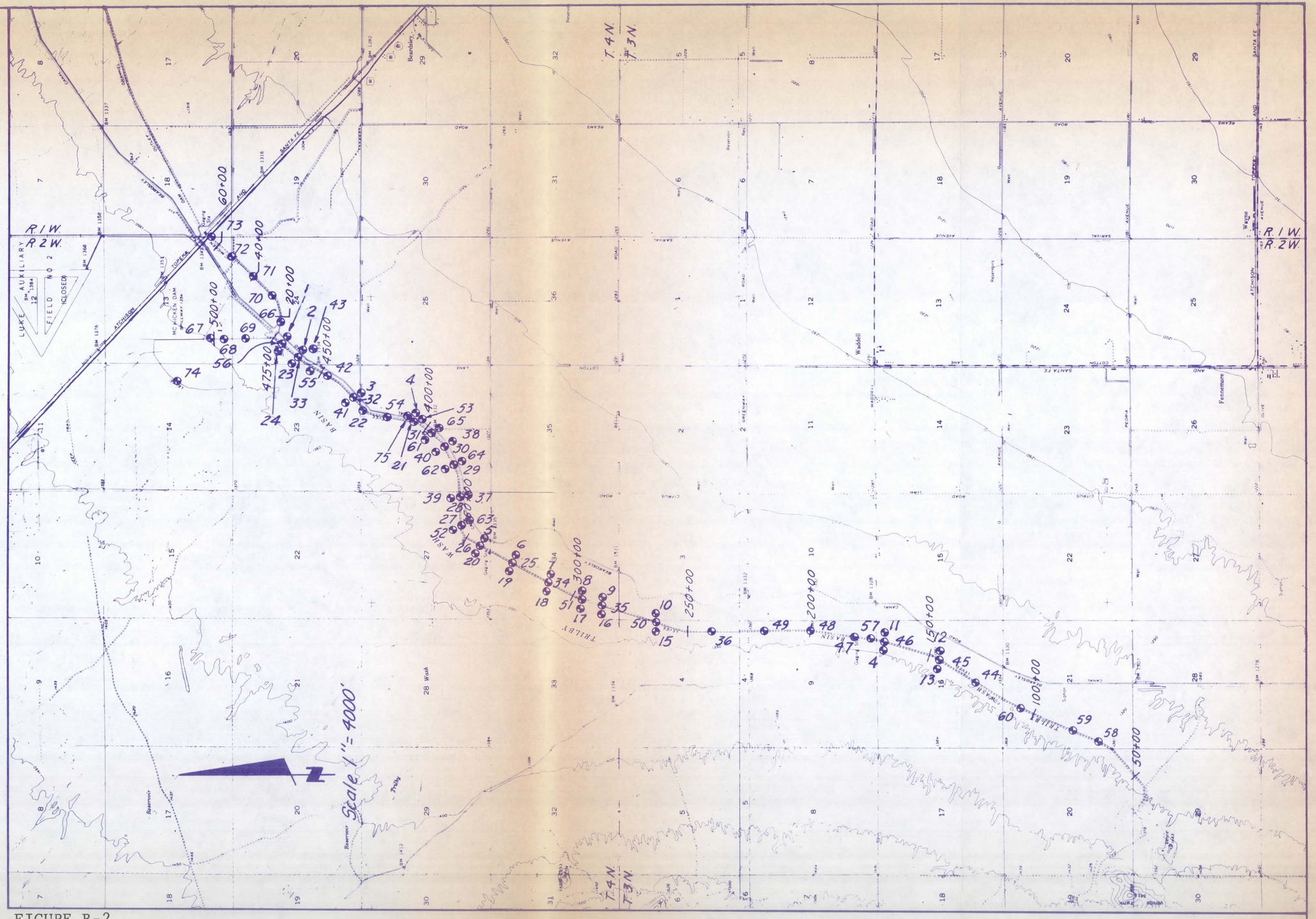

FIGURE B-2

SITE PLAN
Showing Test Boring Locations

Mc Micken Dam Restoration Study
Maricopa County, Arizona
SHB Job No. E81-138

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LABORATORY TESTING PROCEDURES

Consolidation Tests Soiltest or Clockhouse apparatus of the "floating-ring" type are employed for the one-dimensional consolidation tests. They are designed to receive one inch high 2.5 inch O.D. brass liner rings with soil specimens as secured in the field. Procedures for the tests generally are those outlined in ASTM D2435. Loads are applied in several increments to the upper surface of the test specimen and the resulting deformations are recorded at selected time intervals for each increment. For soils which are essentially saturated, each increment of load is maintained until the deformation versus log of time curve indicates completion of primary consolidation. For partially saturated soils, each increment of load is maintained until the rate of deformation is equal or less than 1/10,000 inch per hour. Applied loads are such that each new increment is equal to the total previously applied loading. Porous stones are placed in contact with the top and bottom of the specimens to permit free addition or expulsion of water. For partially saturated soils, the tests are normally performed at in situ moisture conditions until consolidation is complete under stresses approximately equal to those which will be imposed by the combined overburden and foundation loads. The samples are then submerged to show the effect of moisture increase and the tests continued under higher loadings. Generally, the tests are continued to about twice the anticipated curve due to overburden and structural loads with a rebound curve then being established by releasing loads.

Expansion Tests The same type of consolidometer apparatus described above is used in expansion testing. Undisturbed samples contained in brass liner rings are placed in the consolidometers, subjected to appropriate surcharge loads and submerged. The loads are maintained until the expansion versus log of time curve indicates the completion of "primary swell".

Direct Shear Tests Direct shear tests are run using a Clockhouse or Soiltest apparatus of the strain-control of approximately 0.05 inches per minute. The machine is designed to receive one of the one inch high 2.42 inch diameter specimens obtained by tube sampling. Generally, each sample is sheared under a normal load equivalent to the effective overburden pressure at the point of sampling. In some instances, samples are sheared at several normal loads to obtain the cohesion and angle of internal friction. When necessary, samples are saturated and/or consolidated before shearing in order to approximate the anticipated controlling field loading conditions.

TABULATION OF TEST RESULTS

Job No. E81-138

+#4 FRACTION

HOLE NO	DEPTH	UNIFIED CLASS	L.L.	P.I.	#200	#100	#40	#16	#10	#4	.25"	.375"	.75"	1"	1.5"	2"	LAB NO
					SIEVE ANALYSIS-ACCUM % PASSING												
21	14.5′-16′	SM	35	10	29	31	37	45	53	70	80	93	100				1-138-195
21	29.5′-31′	SW-SM	-	NP	5	7	20	51	65	80	83	89	100				1-138-198
22	2.5′-4′	CL	37	18	60	64	74	88	92	97	98	100					1-138-201
22	9.5′-11′	SC	41	22	16	20	33	58	60	67	71	75	79	79	100		1-138-203
22	19.5′-20.5′	CH	60	35	88	92	94	95	96	96	97	99	100				1-138-205
23	1′-2′	SM-SC	25	6	41	52	73	83	87	94	96	98	100				1-138-209
23	9.5′-11′	CL	31	10	67	73	84	91	92	95	95	96	100				1-138-212
23	29.5′-31′	SC	34	12	47	62	87	96	98	100							1-138-216
24	1′-2′	CL	25	8	55	71	90	99	99	100							1-138-218
24	19.5′-21′	ML	39	4	53	63	81	88	89	90	91	92	92	100			1-138-222
25	9.5′-11′	SC	51	29	37	41	52	72	80	89	92	95	100				1-138-228
25	24.5′-26′	SC	30	9	16	19	30	48	57	76	82	89	94	100			1-138-231
26	9.5′-11′	CL	48	26	67	75	83	92	94	97	97	100					1-138-240
26	19.5′-20.5′	SM	-	NP	15	18	31	48	56	68	74	79	94	100			1-138-242
26	29.5′-31′	SP	-	NP	5	8	29	75	84	92	93	95	100				1-138-244
27	24.5′-25.5′	ML	20	3	61	72	85	93	96	99	100						1-138-254
27	29.5′-31′	CL	29	14	81	86	91	95	97	99	99	100					1-138-255
27	44.5′-46′	SM	-	NP	13	20	47	78	87	100							1-138-258
28	14.5′-16′	CL-ML	21	4	51	59	73	83	87	93	96	97	100				1-138-263
28	29.5′-31′	CL-ML	24	4	62	73	86	95	97	100							1-138-266
28	39.5′-41′	SM	-	NP	14	26	88	97	97	98	98	100					1-138-268
29	4.5′-6′	SC	34	14	14	17	27	44	55	70	74	79	98	100			1-138-274
29	14.5′-15.5′	SC	34	13	26	28	37	49	56	66	69	73	81	84	100		1-138-276

TABULATION OF TEST RESULTS

Job No. E81-138

+#4 FRACTION

HOLE NO	DEPTH	UNIFIED CLASS	L.L.	P.I.	#200	#100	#40	#16	#10	#4	.25"	.375"	.75"	1"	1.5"	2"	LAB NO
					SIEVE ANALYSIS-ACCUM % PASSING												
29	24.5'-26'	CL	35	14	56	63	72	82	87	93	95	98	100				1-138-278
29	34.5'-36'	CL	28	10	52	64	88	96	98	100							1-138-280
29	39.5'-41'	SP-SM	-	NP	6	14	67	96	98	100							1-138-281
30	29.5'-31'	CL-ML	25	7	61	72	86	93	97	100							1-138-290
31	28'-29'	SC	32	14	27	31	43	58	65	76	79	82	92	100			1-138-301
32	14.5'-16'	CL	39	22	53	58	70	83	87	92	93	95	100				1-138-309
33	4.5'-6'	SC	40	20	43	47	57	69	75	86	90	96	100				1-138-316
33	19.5'-21'	SC	31	13	42	47	58	70	76	86	89	95	100				1-138-319
33	39.5'-41'	SC	29	8	16	21	55	89	94	97	98	98	100				1-138-323
34	9.5'-11'	SC	36	13	50	52	63	82	89	97	100						1-138-328
34	29.5'-29.92'	SC	42	20	46	54	73	93	98	100							1-138-332
35	29.5'-30.5'	SM	-	NP	17	20	48	85	93	97	98	100					1-138-344
36	9.5'-11'	CL	47	24	53	58	65	73	80	91	95	98	100				1-138-351
36	24.5'-25.38'	SC	35	13	42	47	55	65	72	89	94	98	100				1-138-354
37	2.5'-4'	CL-ML	25	7	63	72	83	93	96	98	99	100					1-138-360
37	9.5'-11'	SC	37	20	23	26	36	60	72	88	93	97	100				1-138-362
37	19.5'-21'	SW-SC	33	15	10	12	32	53	63	77	81	87	100				1-138-364
38	4.5'-6'	CL	34	13	66	75	87	93	96	99	99	100					1-138-370
39	2.5'-4'	CL	27	9	53	61	74	86	89	93	94	97	100				1-138-378
39	4.5'-6'	SM-SC	27	6	47	57	74	88	93	98	99	99	100				1-138-379
40	6'-7'	CL	33	14	82	90	94	96	96	97	98	98	100				1-138-389
59	4.5'-6'	SC	33	12	41	48	59	71	78	89	91	94	100				1-138-436
59	14.5'-16'	GM	-	NP	15	19	28	39	45	56	61	65	84	100			1-138-438

TABULATION OF TEST RESULTS

Job No. E81-138

+#4 FRACTION

HOLE NO	DEPTH	UNIFIED CLASS	L.L.	P.I.	#200	#100	#40	#16	#10	#4	.25"	.375"	.75"	1"	1.5"	2"	LAB NO
					SIEVE ANALYSIS-ACCUM % PASSING												
48	4.5′-6′	SC	30	9	43	49	57	64	69	77	79	82	90	100			1-138-476
48	29.5′-31′	SC	30	8	14	19	27	37	45	62	68	72	77	91	100		1-138-481
55	14.5′-16′	CL	29	11	70	79	88	94	97	99	100						1-138-536
56	14.5′-16′	CL	25	9	54	66	86	96	98	99	100						1-138-547
TP-15	3′-4′	CL	35	12	83	92	97	99	99	100							1-138-609
TP-16	3.25′-4.25′	CL	26	9	55	65	80	89	91	93	94	95	97	100			1-138-612
TP-18	3.5′-4.5′	CL	32	11	70	82	94	98	99	99	99	100					1-138-617
TP-24	2.5′-3.5′	CL	30	12	61	66	76	89	93	97	97	98	100				1-138-625
TP-25	3′-3.75′	CH	56	27	62	67	76	87	92	97	98	99	100				1-138-626
TP-26	1.83′-2.5′	SC	31	15	48	55	74	94	97	99	99	100					1-138-627
TP-29	3.5′-4′	SM	-	NP	44	53	69	81	87	93	95	97	100				1-138-630
TP-30	3.5′-4′	CL	31	18	54	62	76	89	94	97	98	100					1-138-631
TP-31	3.5′-4.5′	SM-SC	22	5	44	51	63	76	82	89	91	92	95	95	100		1-138-635

TABULATION OF TEST RESULTS

Job No. E81-138
W/O 2

+#4 FRACTION

HOLE NO	DEPTH	UNIFIED CLASS	L.L.	P.I.	SIEVE ANALYSIS-ACCUM % PASSING #200	#100	#40	#16	#10	#4	.25"	.375"	.75"	1"	1.5"	2"	LAB NO
21	4.5'-6'	MH	53	20	51	56	65	73	75	80	81	83	84	100			1-138-193

TABULATION OF TEST RESULTS

Job No. E81-138
W/O 2

+#4 FRACTION

HOLE NO	DEPTH	UNIFIED CLASS	L.L.	P.I.	#200	#100	#40	#16	#10	#4	.25"	.375"	.75"	1"	1.5"	2"	LAB NO
					SIEVE ANALYSIS-ACCUM % PASSING												
21	14.5'-16'	SM	35	10	29	31	37	45	53	70	80	93	100				1-138-195
21	29.5'-31'	SW-SM	-	NP	5	7	20	51	65	80	83	89	100				1-138-198
2	9.5'-10.5'	SP-SC	39	19	9	25	57	81	86	93	97	100					1-138-21
2	14.5'-16'	SM-SC	23	4	21	26	57	87	89	91	92	92	100				1-138-22
2	24.5'-26'	SC	46	22	48	60	84	93	95	97	97	97	100				1-138-24
3	2.5'-4'	CL	46	23	75	80	87	95	97	100							1-138-27
3	9.5'-11'	SC	30	10	29	32	41	61	69	82	86	96	100				1-138-29
3	19.5'-21'	CL	40	20	55	73	92	97	98	99	100						1-138-31
8	4.5'-5.5'	CH	50	29	60	64	74	86	91	97	98	100					1-138-80
12	0.5'-2'	ML	21	1	54	65	76	84	57	94	95	96	100				1-138-113
12	4.5'-6'	GM	34	7	32	38	42	44	45	47	48	50	73	100			1-138-115
12	19.5'-21'		NA	-	46	50	54	59	60	63	63	63	63	63	100		1-138-118
14	0.5'-2'		NA	-	49	54	64	78	80	87	90	93	100				1-138-131
14	4.5'-6'		NA	-	15	22	43	68	80	92	94	98	100				1-138-133
14	14.5'-16'	ML	27	5	54	63	77	94	96	100							1-138-135
14	24.5'-26'		NA	-	78	85	91	96	98	100							1-138-137
15	9.5'-10.5'	ML	43	13	60	62	73	87	93	100							1-138-143
16	4.5'-5.5'	CL	31	16	55	57	66	87	94	99	100						1-138-150
16	14.5'-16'	SM	-	NP	16	21	44	80	91	100							1-138-152
16	24.5'-26'	SW-SM	-	NP	10	16	48	85	93	100							1-138-154
16	34.5'-36'	CL	31	11	53	59	68	77	80	85	86	92	100				1-138-156
19	2.5'-4'	CL	37	18	58	65	77	90	94	98	100						1-138-174
21	0.5'-2'	SM	23	1	14	19	36	69	82	93	95	98	100				1-138-191

TABULATION OF TEST RESULTS

Job No. E81-138
W/O 3

+#4 FRACTION

HOLE NO	DEPTH	UNIFIED CLASS	L.L.	P.I.	#200	#100	#40	#16	#10	#4	.25"	.375"	.75"	1"	1.5"	2"	LAB NO
					SIEVE ANALYSIS-ACCUM % PASSING												
22	2.5'-4'	CL	37	18	60	64	74	88	92	97	98	100					1-138-201
22	9.5'-11'	SC	41	22	16	20	33	58	60	67	71	75	79	79	100		1-138-203
22	19.5'-20.5'	CH	60	35	88	92	94	95	96	96	97	99	100				1-138-205
23	1'-2'	SM-SC	25	6	41	52	73	83	87	94	96	98	100				1-138-209
23	9.5'-11'	CL	31	10	67	73	84	91	92	95	95	96	100				1-138-212
23	29.5'-31'	SC	34	12	47	62	87	96	98	100							1-138-216
24	1'-2'	CL	25	8	55	71	90	99	99	100							1-138-218
24	19.5'-21'	ML	39	4	53	63	81	88	89	90	91	92	92	100			1-138-222
25	9.5'-11'	SC	51	29	37	41	52	72	80	89	92	95	100				1-138-228
25	24.5'-26'	SC	30	9	16	19	30	48	57	76	82	89	94	100			1-138-231
26	9.5'-11'	CL	48	26	67	75	83	92	94	97	97	100					1-138-240
26	19.5'-20.5'	SM	-	NP	15	18	31	48	56	68	74	79	94	100			1-138-242
26	29.5'-31'	SP	-	NP	5	8	29	75	84	92	93	95	100				1-138-244
27	24.5'-25.5'	ML	20	3	61	72	85	93	96	99	100						1-138-254
27	29.5'-31'	CL	29	14	81	86	91	95	97	99	99	100					1-138-255
27	44.5'-46'	SM	-	NP	13	20	47	78	87	100							1-138-258
28	14.5'-16'	CL-ML	21	4	51	59	73	83	87	93	96	97	100				1-138-263
28	29.5'-31'	CL-ML	24	4	62	73	86	95	97	100							1-138-266
28	39.5'-41'	SM	-	NP	14	26	88	97	97	98	98	100					1-138-268

TABULATION OF TEST RESULTS

Job No. E81-138
W/O 4
+#4 FRACTION

HOLE NO	DEPTH	UNIFIED CLASS	L.L.	P.I.	#200	#100	#40	#16	#10	#4	.25"	.375"	.75"	1"	1.5"	2"	LAB NO
					SIEVE ANALYSIS-ACCUM % PASSING												
29	4.5'-6'	SC	34	14	14	17	27	44	55	70	74	79	98	100			1-138-274
29	14.5'-15.5'	SC	34	13	26	28	37	49	56	66	69	73	81	84	100		1-138-276
29	24.5'-26'	CL	35	14	56	63	72	82	87	93	95	98	100				1-138-278
29	34.5'-36'	CL	28	10	52	64	88	96	98	100							1-138-280
29	39.5'-41'	SP-SM	-	NP	6	14	67	96	98	100							1-138-281
30	29.5'-31'	CL-ML	25	7	61	72	86	93	97	100							1-138-290
31	28'-29'	SC	32	14	27	31	43	58	65	76	79	82	92	100			1-138-301
32	14.5'-16'	CL	39	22	53	58	70	83	87	92	93	95	100				1-138-309
33	4.5'-6'	SC	40	20	43	47	57	69	75	86	90	96	100				1-138-316
33	19.5'-21'	SC	31	13	42	47	58	70	76	86	89	95	100				1-138-319
33	39.5'-41'	SC	29	8	16	21	55	89	94	97	98	98	100				1-138-323
34	9.5'-11'	SC	36	13	50	52	63	82	89	97	100						1-138-328
34	29.5'-29.92'	SC	42	20	46	54	73	93	98	100							1-138-332
35	29.5'-30.5'	SM	-	NP	17	20	48	85	93	97	98	100					1-138-344
36	9.5'-11'	CL	47	24	53	58	65	73	80	91	95	98	100				1-138-351
36	24.5'-25.38'	SC	35	13	42	47	55	65	72	89	94	98	100				1-138-354
37	2.5'-4'	CL-ML	25	7	63	72	83	93	96	98	99	100					1-138-360
37	9.5'-11'	SC	37	20	23	26	36	60	72	88	93	97	100				1-138-362
37	19.5'-21'	SW-SC	33	15	10	12	32	53	63	77	81	87	100				1-138-364
38	4.5'-6'	CL	34	13	66	75	87	93	96	99	99	100					1-138-370
39	2.5'-4'	CL	27	9	53	61	74	86	89	93	94	97	100				1-138-378
39	4.5'-6'	SM-SC	27	6	47	57	74	88	93	98	99	99	100				1-138-379
40	6'-7'	CL	33	14	82	90	94	96	96	97	98	98	100				1-138-389

TABULATION OF TEST RESULTS

Job No. E81-138
W/O 5

+#4 FRACTION

HOLE NO	DEPTH	UNIFIED CLASS	L.L.	P.I.	SIEVE ANALYSIS-ACCUM % PASSING #200	#100	#40	#16	#10	#4	.25"	.375"	.75"	1"	1.5"	2"	LAB NO
59	4.5'-6'	SC	33	12	41	48	59	71	78	89	91	94	100				1-138-436
59	14.5'-16'	GM	-	NP	15	19	28	39	45	56	61	65	84	100			1-138-438
48	4.5'-6'	SC	30	9	43	49	57	64	69	77	79	82	90	100			1-138-476
48	29.5'-31'	SC	30	8	14	19	27	37	45	62	68	72	77	91	100		1-138-481
55	14.5'-16'	CL	29	11	70	79	88	94	97	99	100						1-138-536
56	14.5'-16'	CL	25	9	54	66	86	96	98	99	100						1-138-547

TABULATION OF TEST RESULTS

Job No. E81-138
W/O 6

+#4 FRACTION

HOLE NO	DEPTH	UNIFIED CLASS	L.L.	P.I.	#200	#100	#40	#16	#10	#4	.25"	.375"	.75"	1"	1.5"	2"	LAB NO
					SIEVE ANALYSIS-ACCUM % PASSING												
TP-15	3'-4'	CL	35	12	83	92	97	99	99	100							1-138-609
TP-16	3.25'-4.25'	CL	26	9	55	65	80	89	91	93	94	95	97	100			1-138-612
TP-18	3.5'-4.5'	CL	32	11	70	82	94	98	99	99	99	100					1-138-617
TP-24	2.5'-3.5'	CL	30	12	61	66	76	89	93	97	97	98	100				1-138-625
TP-25	3'-3.75'	CH	56	27	62	67	76	87	92	97	98	99	100				1-138-626
TP-26	1.83'-2.5'	SC	31	15	48	55	74	94	97	99	99	100					1-138-627
TP-29	3.5'-4'	SM	-	NP	44	53	69	81	87	93	95	97	100				1-138-630
TP-30	3.5'-4'	CL	31	18	54	62	76	89	94	97	98	100					1-138-631
TP-31	3.5'-4.5'	SM-SC	22	5	44	51	63	76	82	89	91	92	95	95	100		1-138-635

TABULATION OF TEST RESULTS

Job No. E81-138
W/O 7

+#4 FRACTION

HOLE NO	DEPTH	UNIFIED CLASS	L.L.	P.I.	#200	#100	#40	#16	#10	#4	.25"	.375"	.75"	1"	1.5"	2"	LAB NO
					SIEVE ANALYSIS-ACCUM % PASSING												
68	9.5'-11'	GC	43	21	30	34	42	50	54	62	65	68	75	75	100		1-138-647
68	24.5'-26'	SP-SM	-	NP	5	9	20	38	45	60	66	76	100				1-138-650
68	34.5'-36'	SM-SC	26	7	16	19	35	65	77	91	93	99	100				1-138-652
70	4.5'-6'	CL	37	21	64	73	84	91	94	98	99	100					1-138-666
73	0.5'-2'	CL-ML	23	5	58	74	89	92	95	97	97	99	100				1-138-684
32	3.5'-4.5'	SC	49	23	41	45	52	62	69	83	87	92	100				1-138-707

TABULATION OF TEST RESULTS

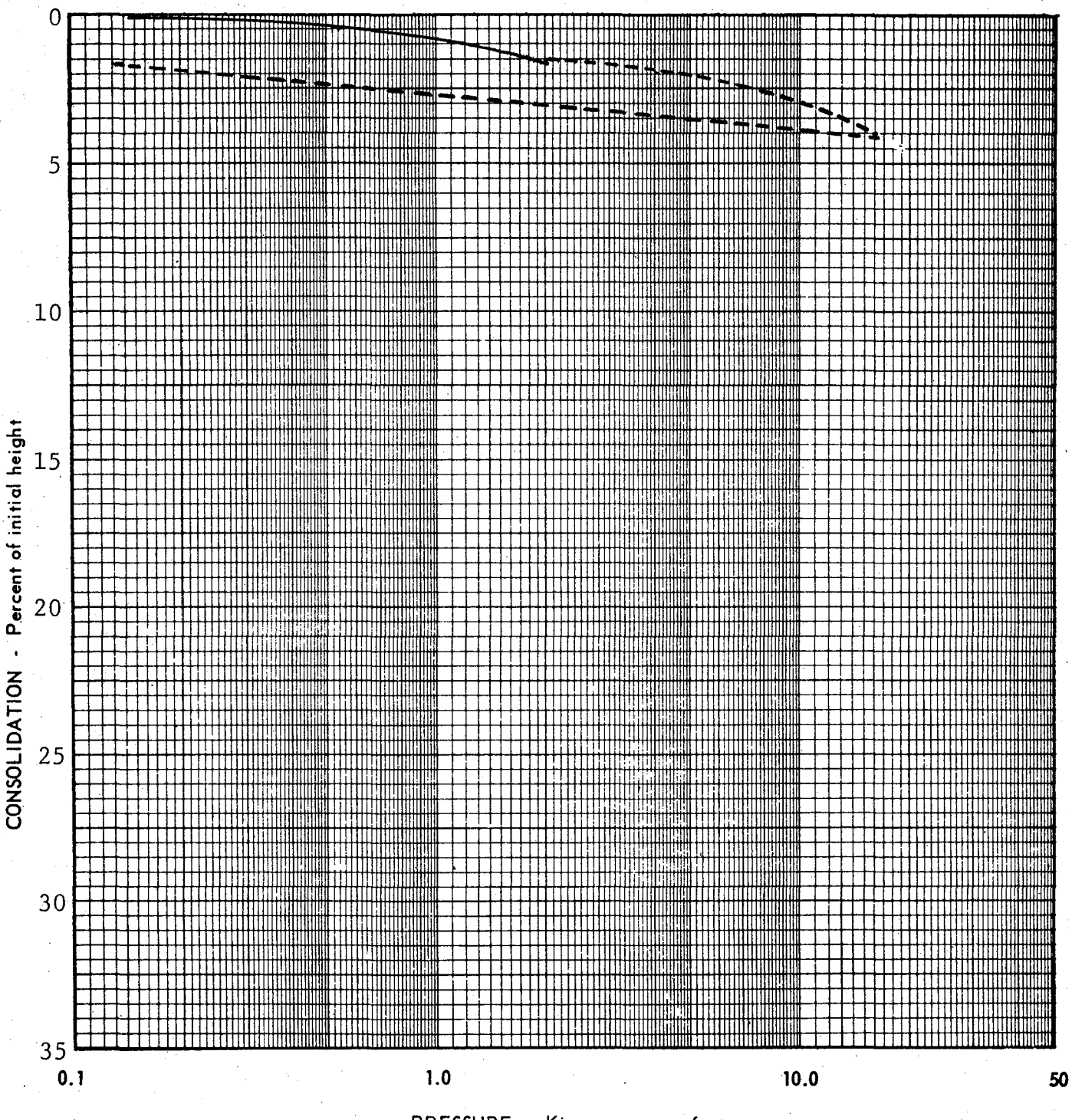
Job No. E81-138
W/O 8

+#4 FRACTION

HOLE NO	DEPTH	UNIFIED CLASS	L.L.	P.I.	#200	#100	#40	#16	#10	#4	.25"	.375"	.75"	1"	1.5"	2"	LAB NO
					SIEVE ANALYSIS-ACCUM % PASSING												
20	4.5'-5.5'	SM	-	NP	48	69	94	99	100								1-138-184
TP-28	3'-3.5'	CL-ML	22	4	58	70	84	92	95	97	98	99	100				1-138-629

SUMMARY OF CONSOLIDATION TESTS

PROJECT McMicken Dam Restoration Study **JOB NO.** E81-138



CURVE	SAMPLE	INITIAL DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT % DRY WEIGHT		UNIFIED SOIL CLASSIFICATION
			INITIAL	FINAL	
A	Boring #2 @ 9½'-10½'	103.5	15.4	19.2	SP-SC

SOIL MOISTURE CONDITION

——— INSITU

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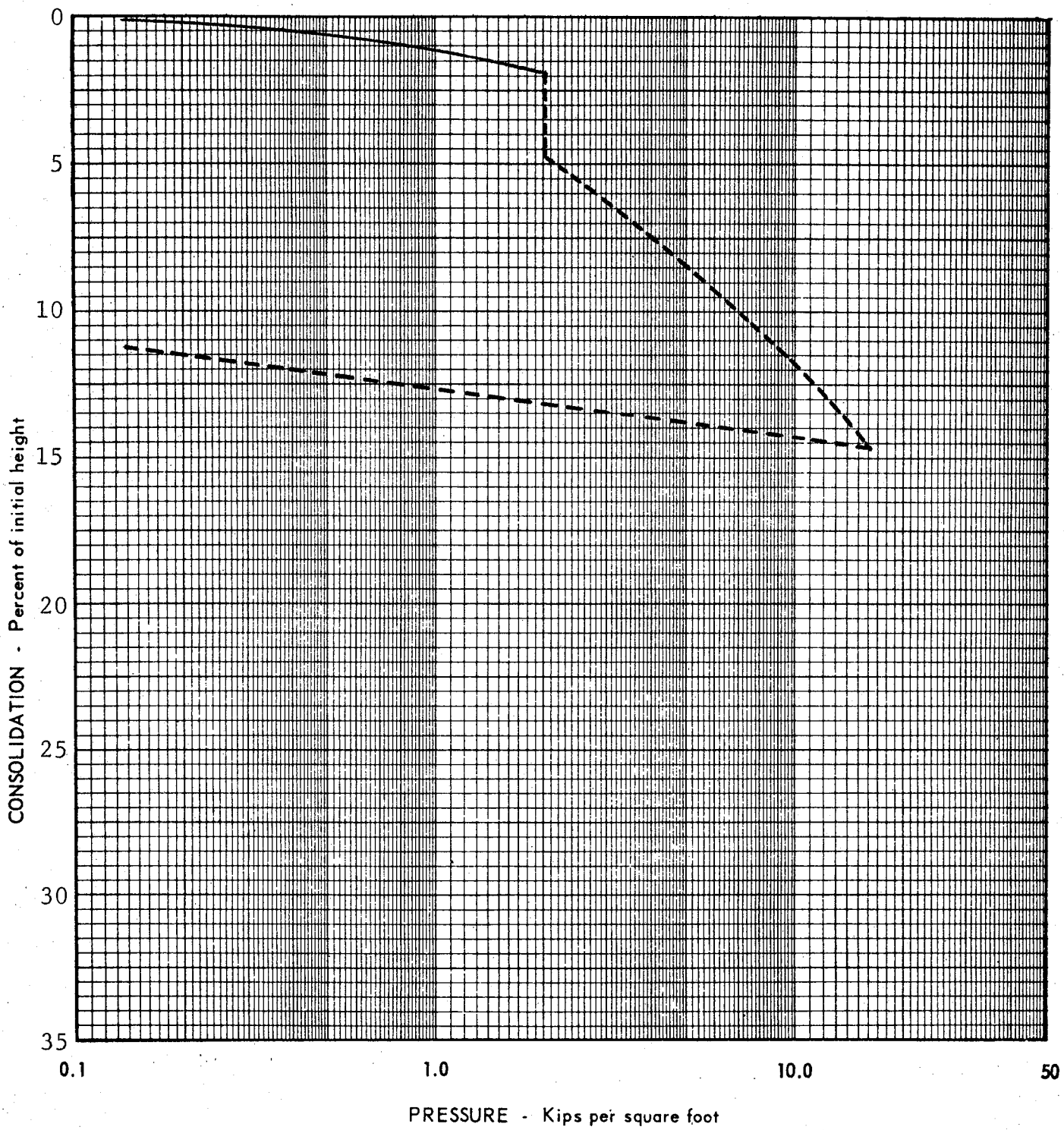
SUMMARY OF CONSOLIDATION TESTS

PROJECT McMicken Dam Restoration Study **JOB NO.** E81-138



CURVE	SAMPLE	INITIAL DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT % DRY WEIGHT		UNIFIED SOIL CLASSIFICATION
			INITIAL	FINAL	
B	Boring #15 @ 9½'-10½'	90.8	8.7	22.6	ML

SOIL MOISTURE CONDITION

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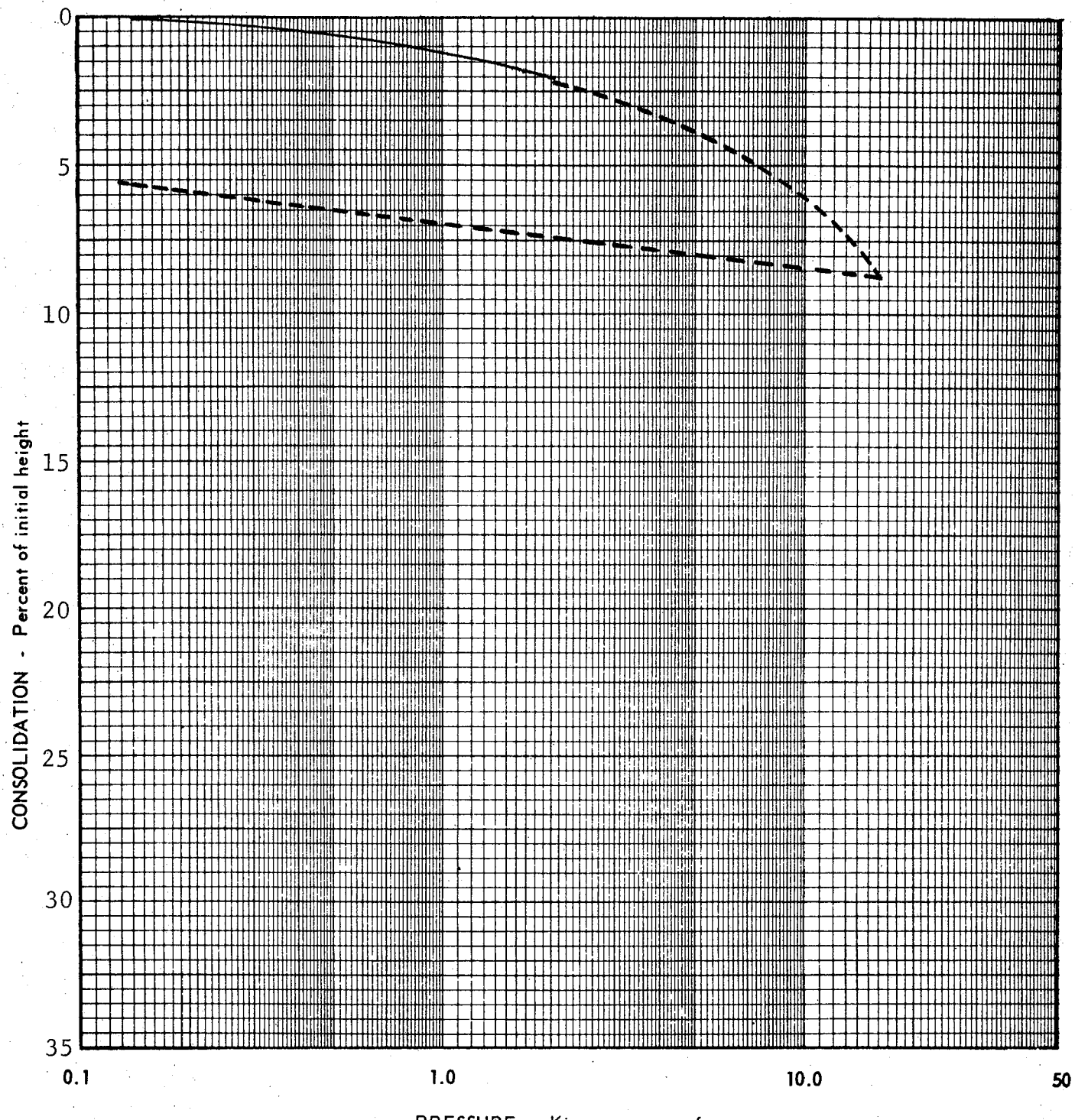

CURVE	SAMPLE	INITIAL DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT % DRY WEIGHT		UNIFIED SOIL CLASSIFICATION
			INITIAL	FINAL	
C	Boring #16 @ 4½'-5½'	111.7	7.9	14.6	CL

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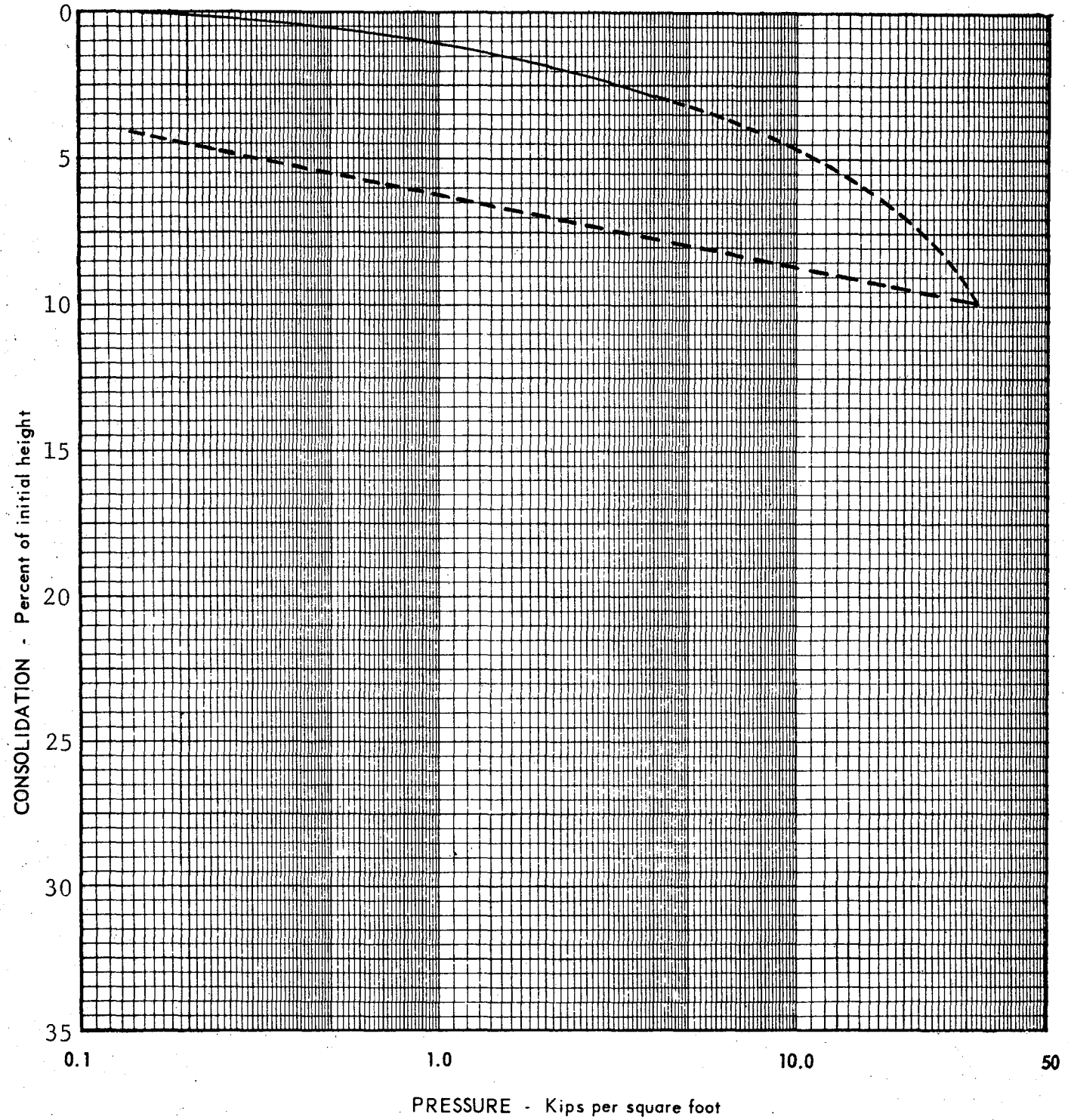

CURVE	SAMPLE	INITIAL DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT % DRY WEIGHT		UNIFIED SOIL CLASSIFICATION
			INITIAL	FINAL	
D	Boring #22 @ 19½'-20½'	92.7	25.7	27.4	CH

SOIL MOISTURE CONDITION

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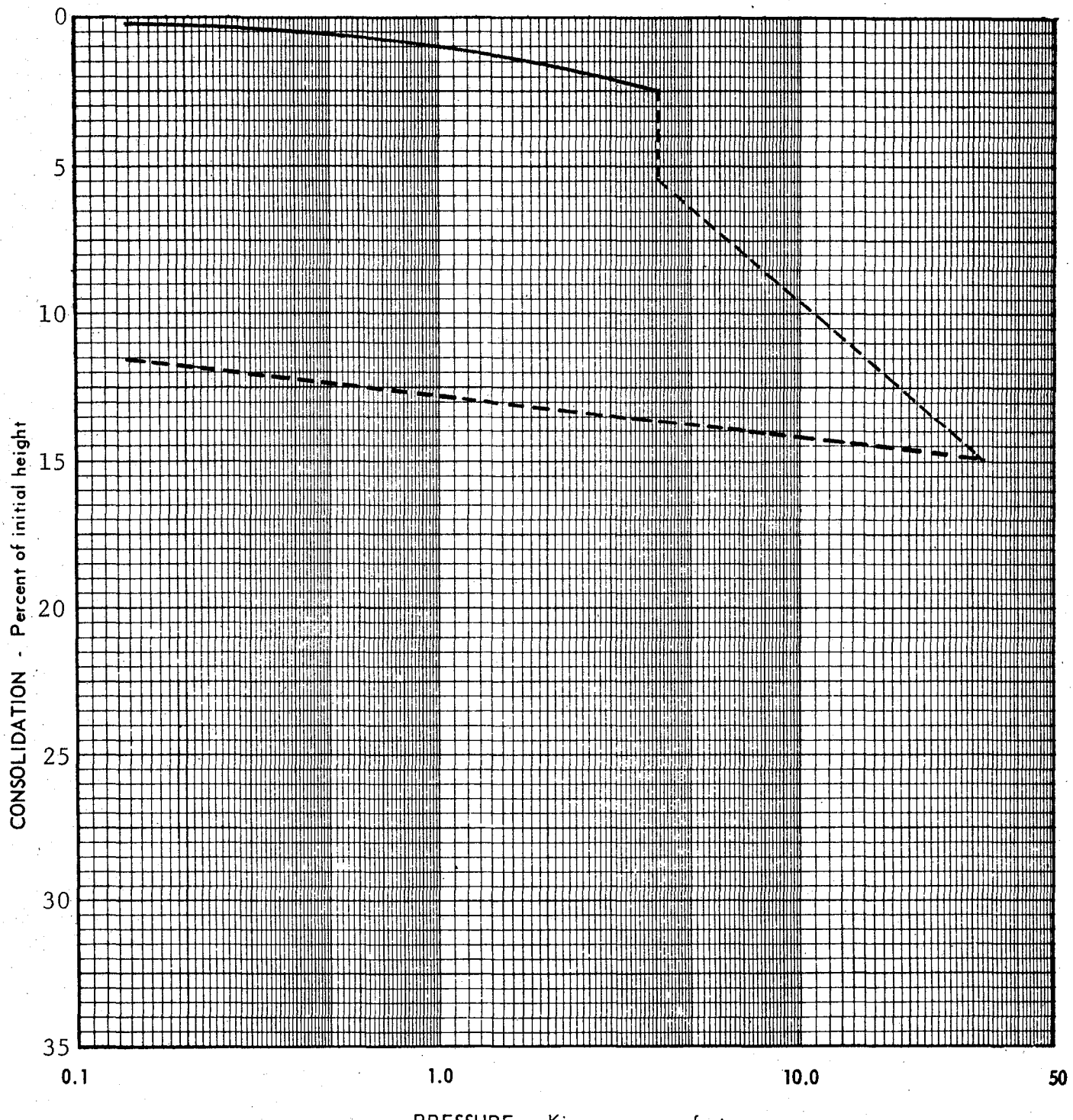

CURVE	SAMPLE	INITIAL DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT % DRY WEIGHT		UNIFIED SOIL CLASSIFICATION
			INITIAL	FINAL	
E	Boring #24 @ 1'-2'	107.6	10.8	12.9	CL

SOIL MOISTURE CONDITION

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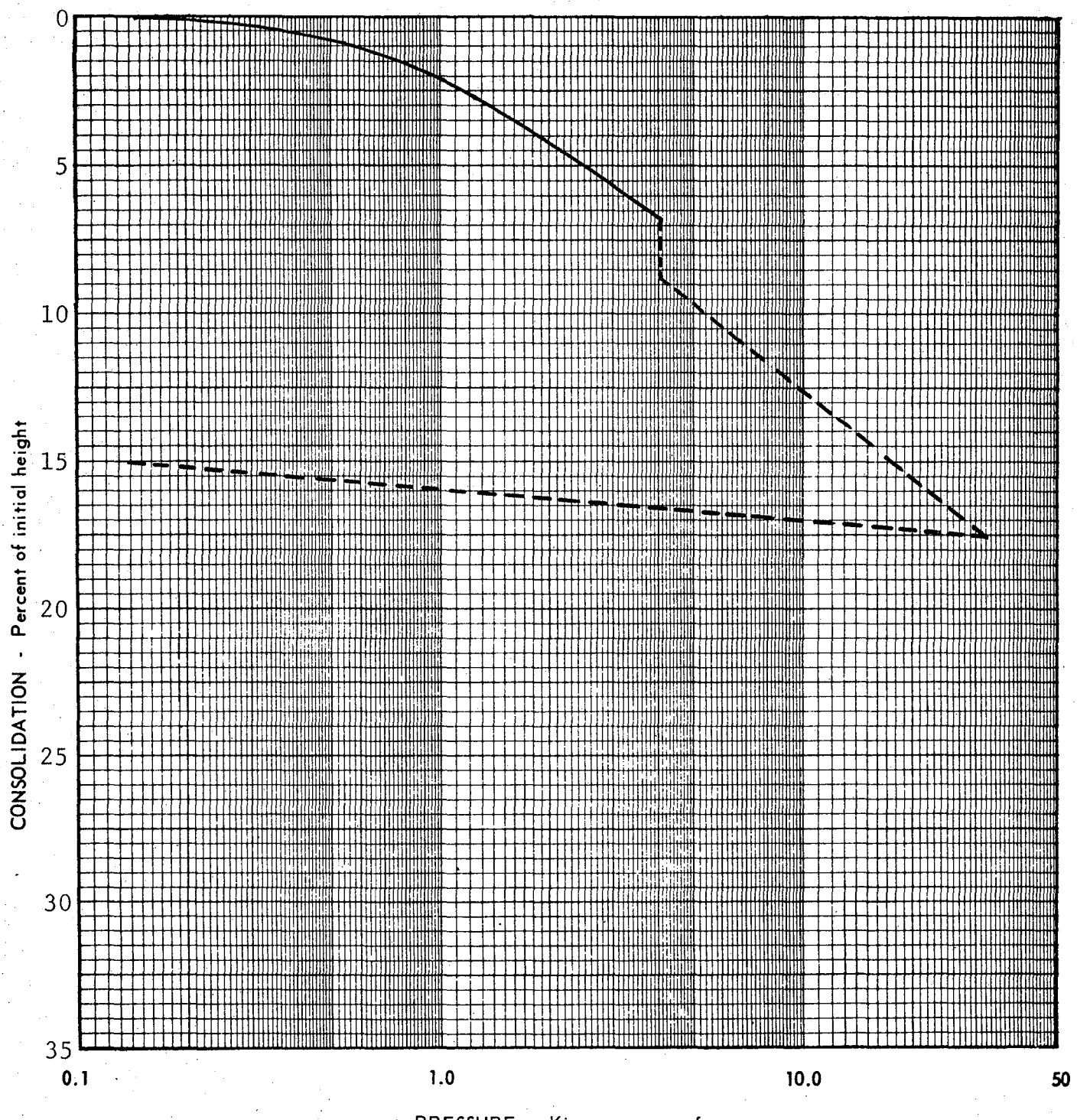

CURVE	SAMPLE	INITIAL DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT % DRY WEIGHT		UNIFIED SOIL CLASSIFICATION
			INITIAL	FINAL	
F	Boring #27 @ 24½'-25½'	100.6	4.6	14.9	ML

SOIL MOISTURE CONDITION

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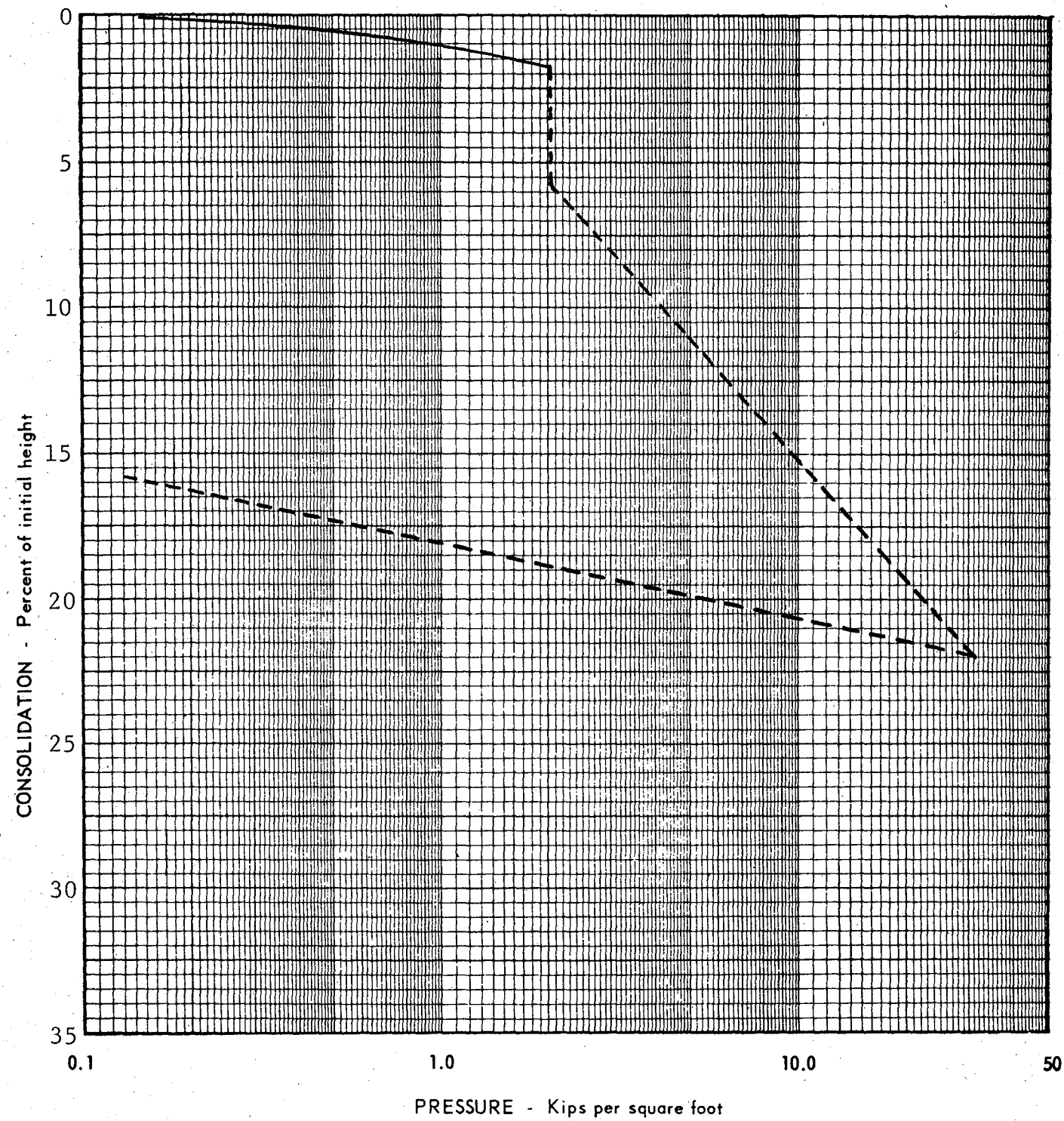

CURVE	SAMPLE	INITIAL DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT % DRY WEIGHT		UNIFIED SOIL CLASSIFICATION
			INITIAL	FINAL	
G	Boring #55 @ 14½'-16'	93.8	11.0	18.4	CL

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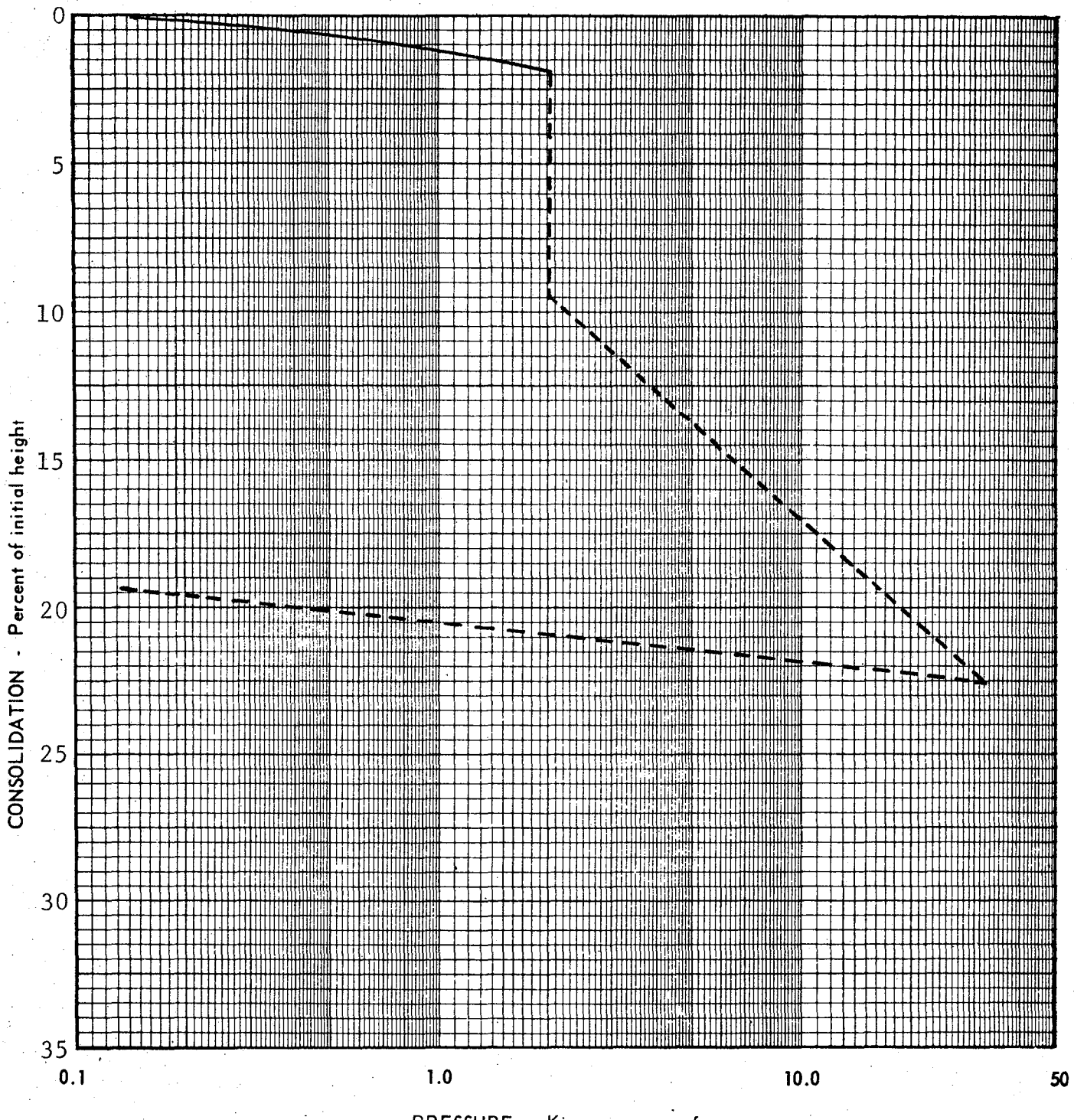

CURVE	SAMPLE	INITIAL DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT % DRY WEIGHT		UNIFIED SOIL CLASSIFICATION
			INITIAL	FINAL	
H	Boring #56 @ 14½'-16'	100.1	8.3	13.4	CL

SOIL MOISTURE CONDITION

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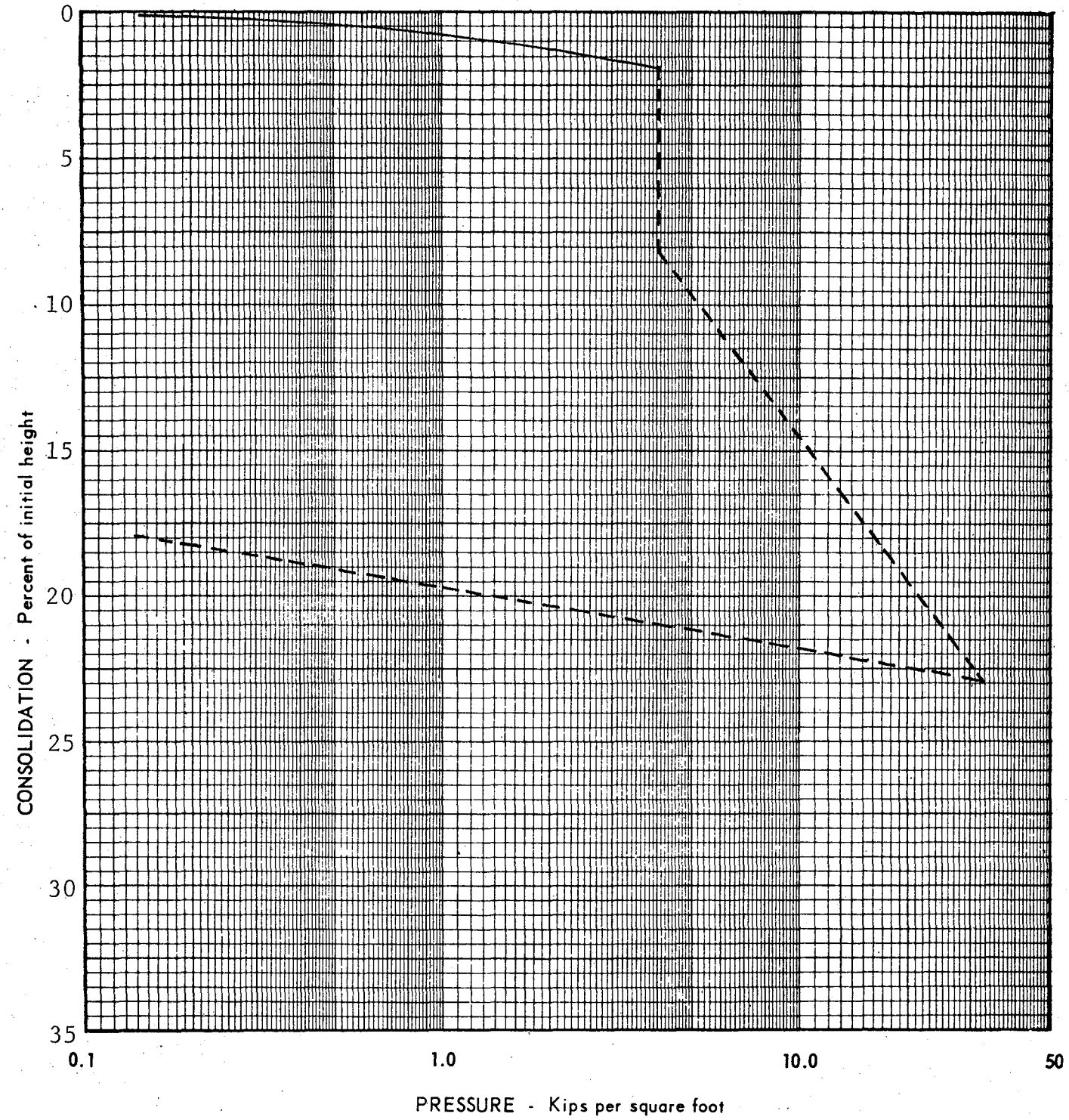

CURVE	SAMPLE	INITIAL DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT % DRY WEIGHT		UNIFIED SOIL CLASSIFICATION
			INITIAL	FINAL	
I	Test Pit #15 @ 3'-4'	88.7	6.6	21.5	CL

SOIL MOISTURE CONDITION

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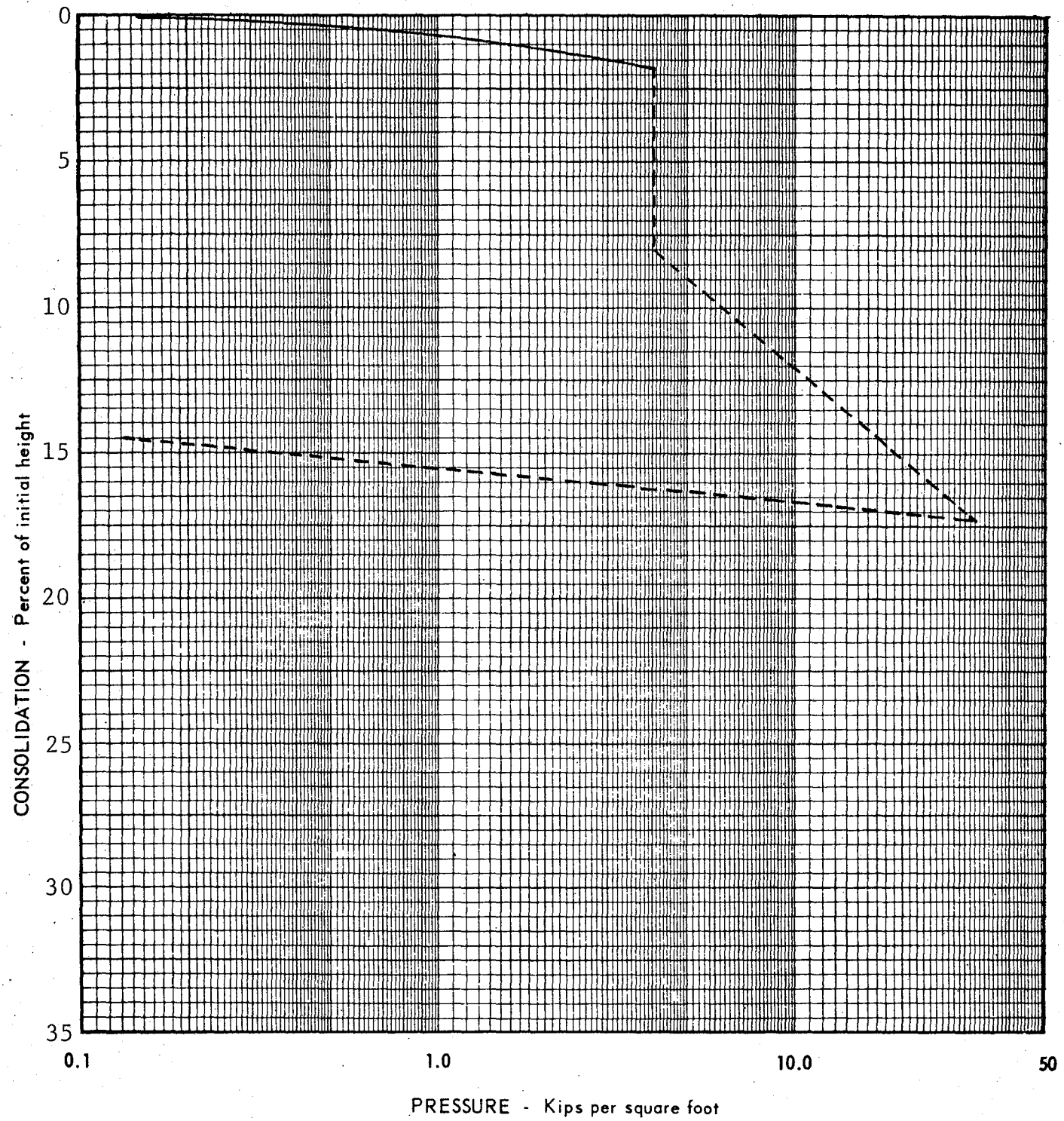

CURVE	SAMPLE	INITIAL DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT % DRY WEIGHT		UNIFIED SOIL CLASSIFICATION
			INITIAL	FINAL	
J	Test Pit #16 @ 3'3"-4'3"	103.6	4.7	13.6	CL

SOIL MOISTURE CONDITION

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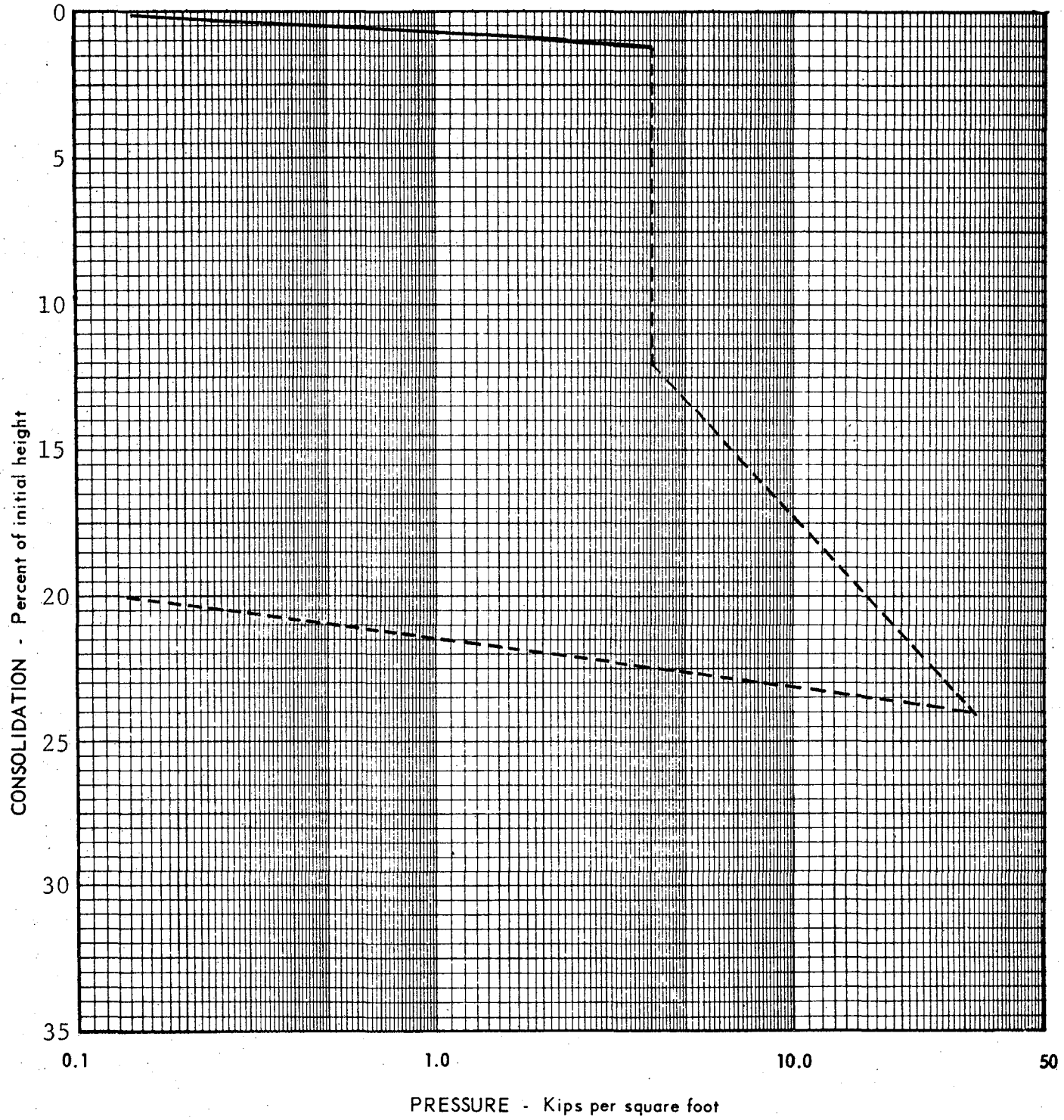

CURVE	SAMPLE	INITIAL DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT % DRY WEIGHT		UNIFIED SOIL CLASSIFICATION
			INITIAL	FINAL	
K	Test Pit #18 @ 3½'-4½'	88.6	5.7	19.5	CL

SOIL MOISTURE CONDITION

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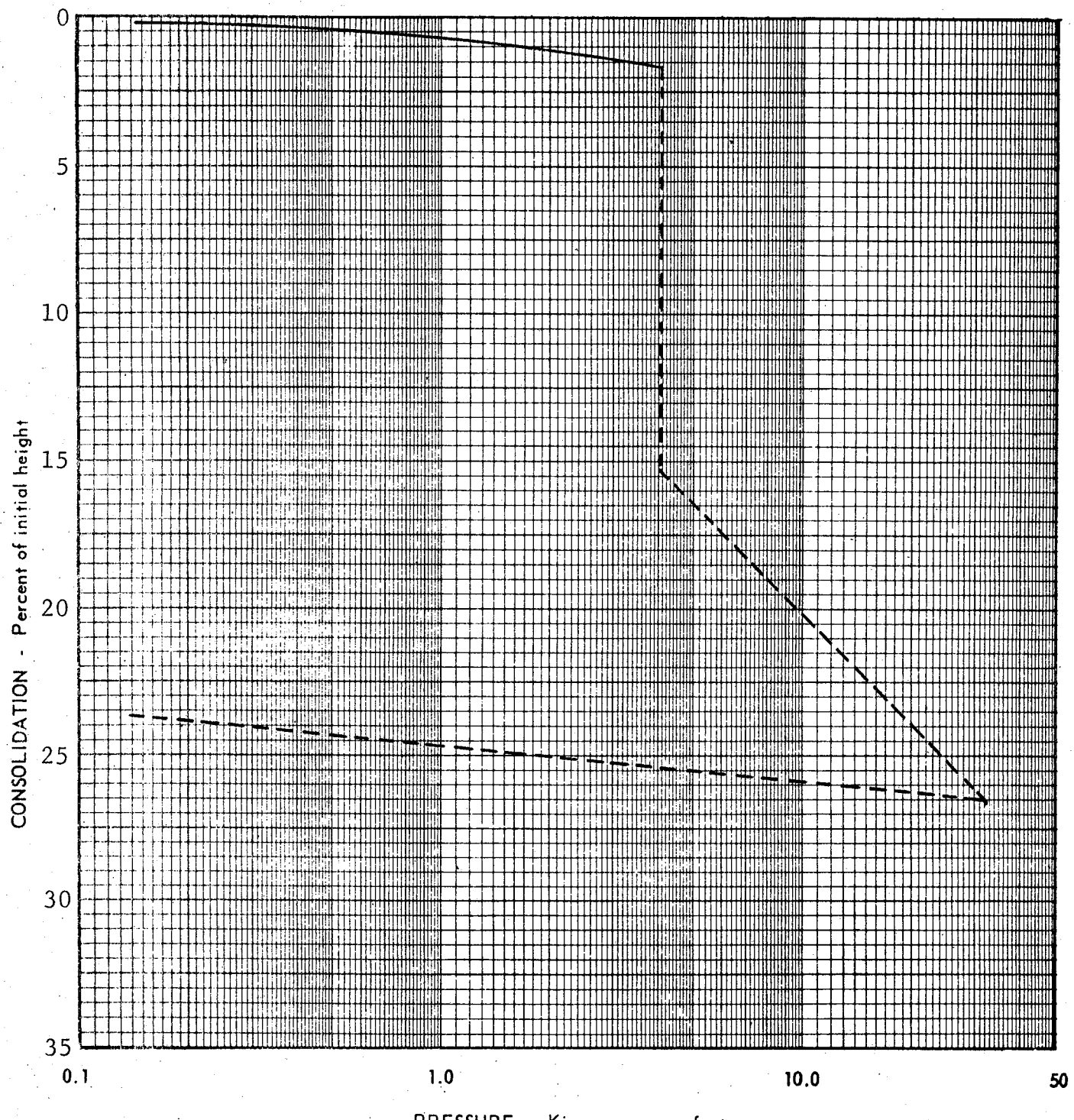
PROJECT McMicken Dam Restoration Study JOB NO. E81-138



CURVE	SAMPLE	INITIAL DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT % DRY WEIGHT		UNIFIED SOIL CLASSIFICATION
			INITIAL	FINAL	
L	Test Pit #24 @ 2½'-3½'	93.4	5.9	15.4	CL

SOIL MOISTURE CONDITION

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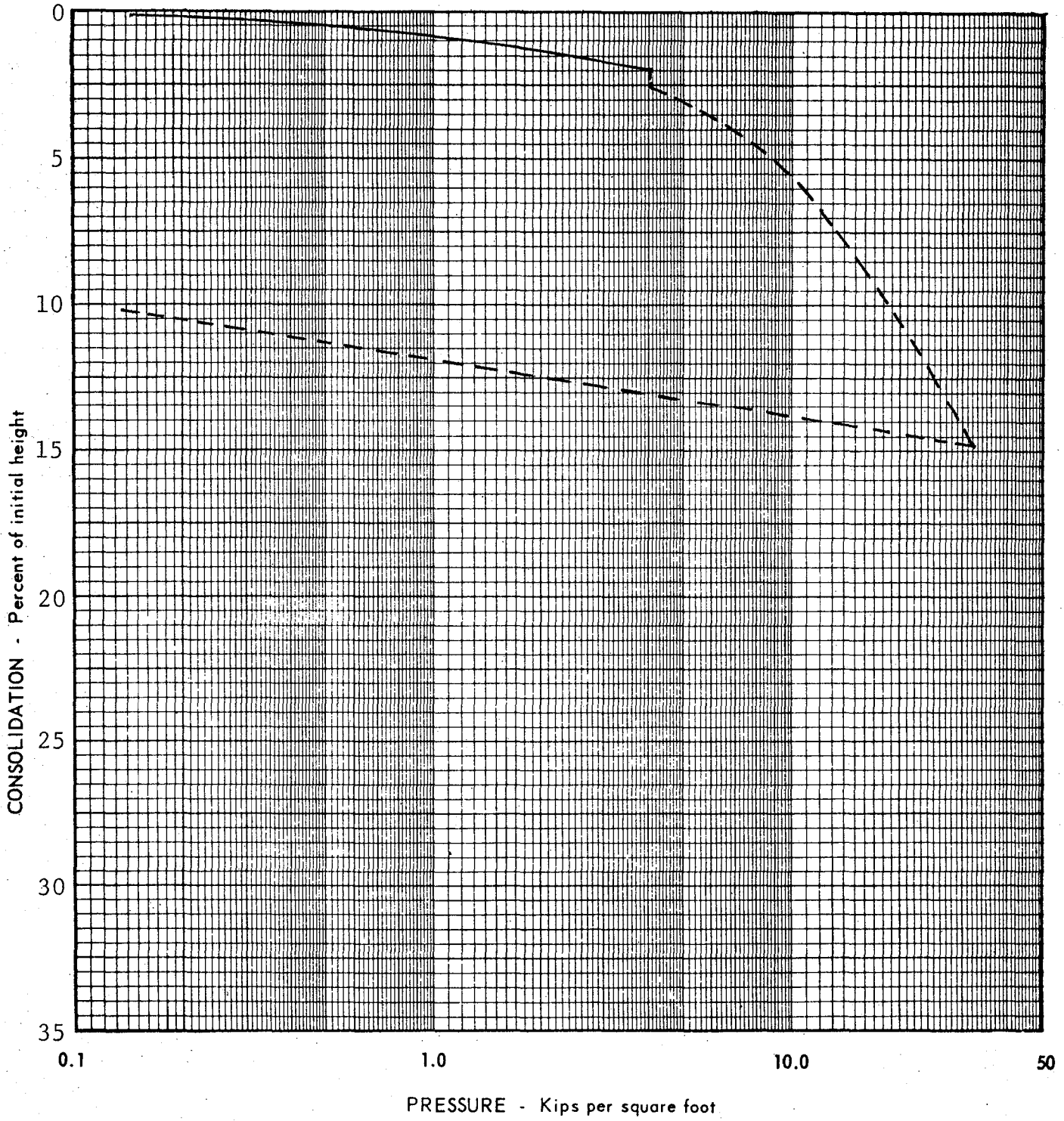

CURVE	SAMPLE	INITIAL DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT % DRY WEIGHT		UNIFIED SOIL CLASSIFICATION
			INITIAL	FINAL	
M	Test Pit #25 @ 3'-3'9"	97.0	6.6	20.2	CH

SOIL MOISTURE CONDITION

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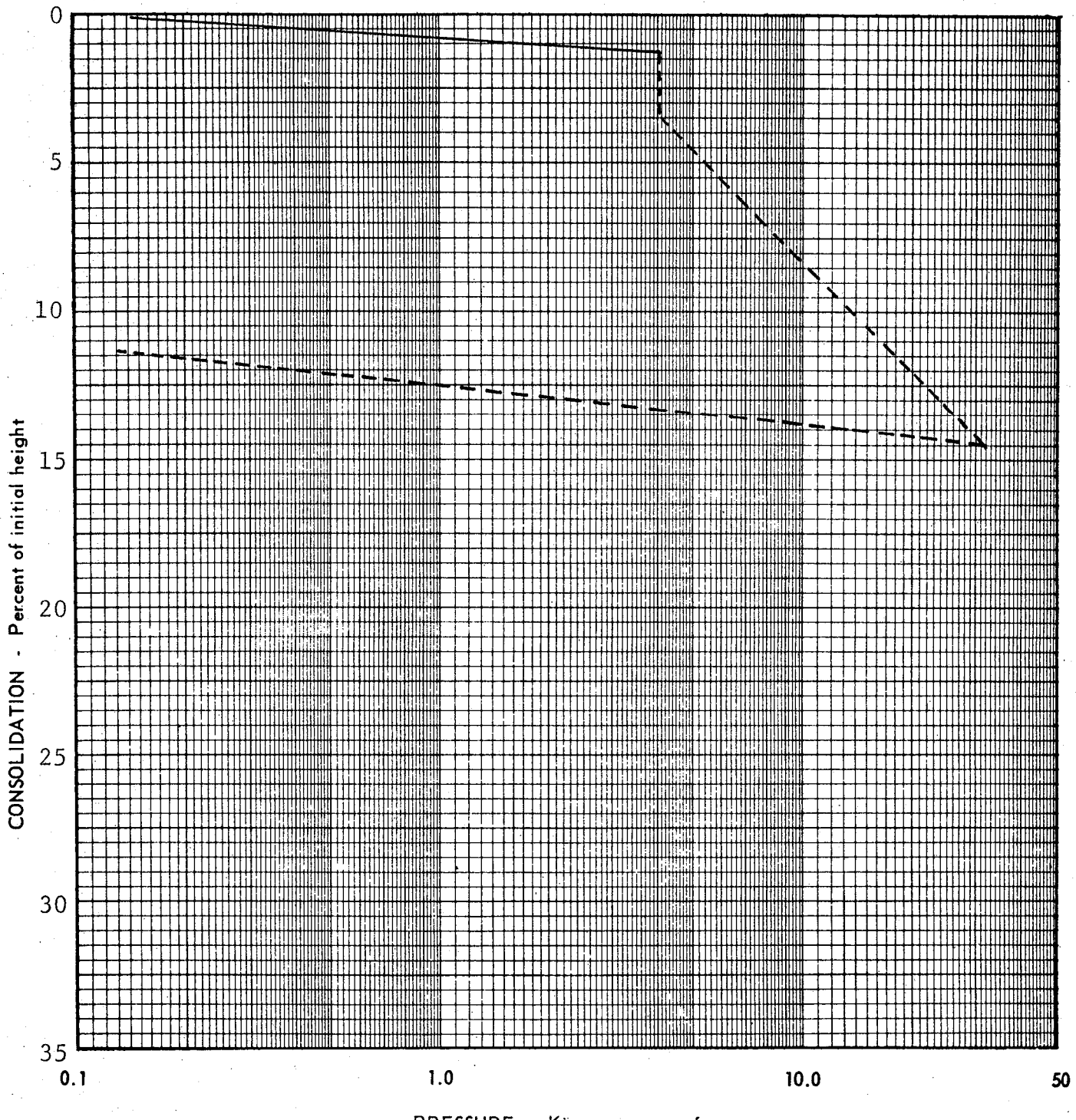
SUMMARY OF CONSOLIDATION TESTS

PROJECT McMicken Dam Restoration Study **JOB NO.** E81-138



CURVE	SAMPLE	INITIAL DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT % DRY WEIGHT		UNIFIED SOIL CLASSIFICATION
			INITIAL	FINAL	
N	Test Pit #26 @ 1'10"-2'6"	111.4	6.0	12.9	SC

SOIL MOISTURE CONDITION

——— INSITU

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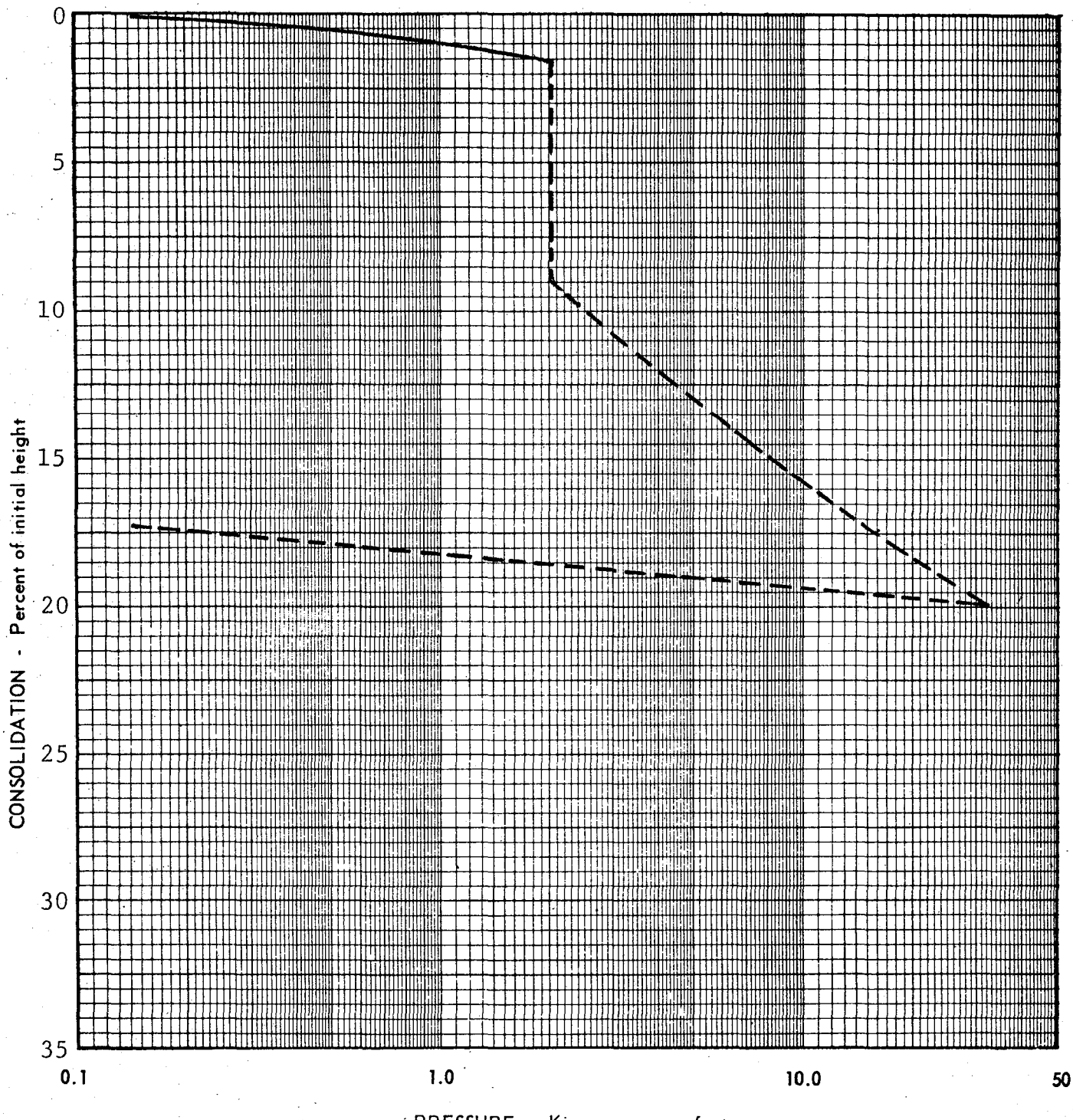
PROJECT McMicken Dam Restoration Study **JOB NO.** E81-138



CURVE	SAMPLE	INITIAL DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT % DRY WEIGHT		UNIFIED SOIL CLASSIFICATION
			INITIAL	FINAL	
0	Test Pit #29 @ 3½'-4'	105.1	4.2	11.9	SM

SOIL MOISTURE CONDITION

——— INSITU

– – – – SUBMERGED

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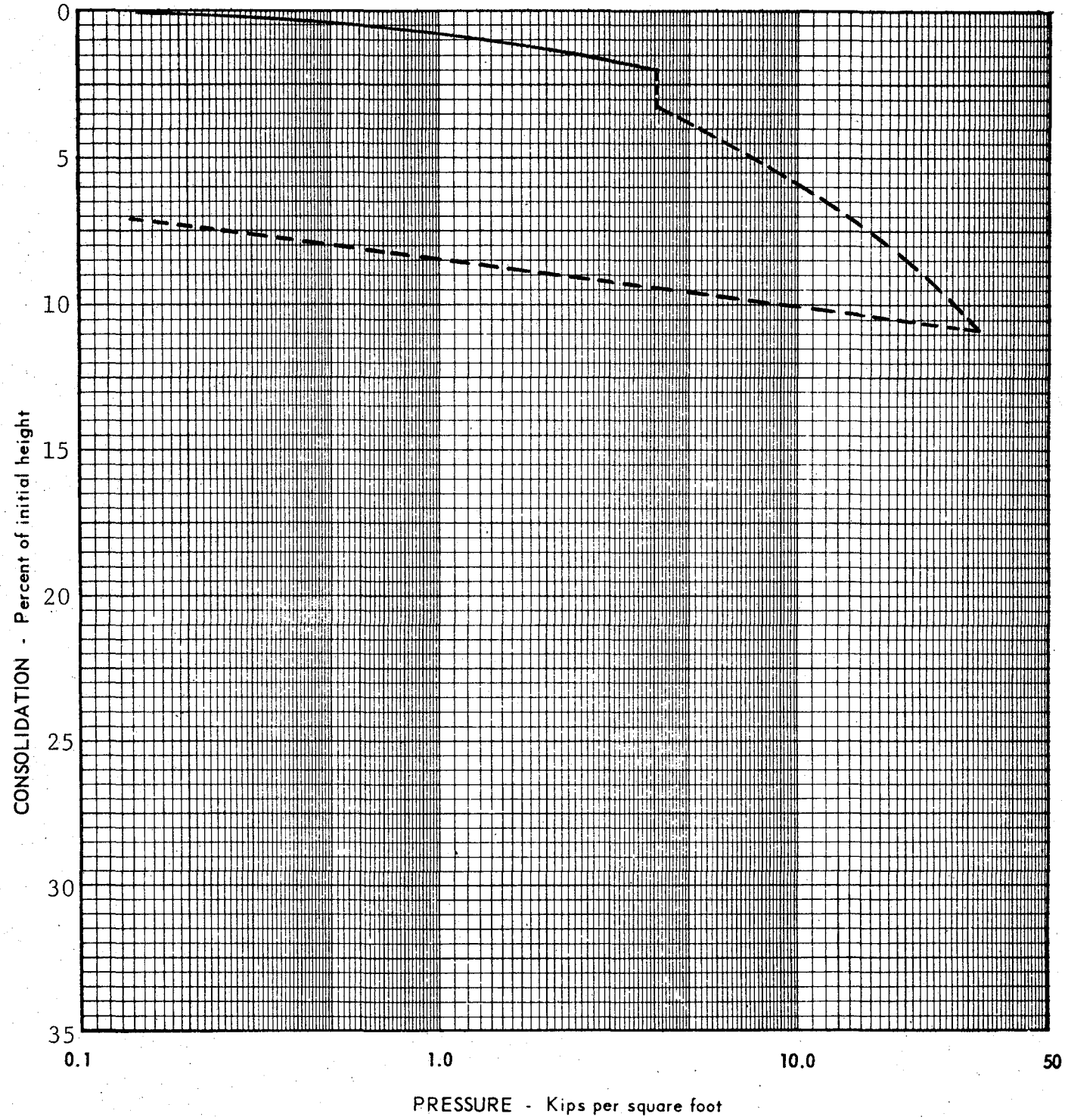
SUMMARY OF CONSOLIDATION TESTS

PROJECT McMicken Dam Restoration Study **JOB NO.** E81-138



CURVE	SAMPLE	INITIAL DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT % DRY WEIGHT		UNIFIED SOIL CLASSIFICATION
			INITIAL	FINAL	
P	Test Pit #30 @ 3½'-4'	115.8	6.0	12.3	CL

SOIL MOISTURE CONDITION

——— INSITU

– – – – SUBMERGED

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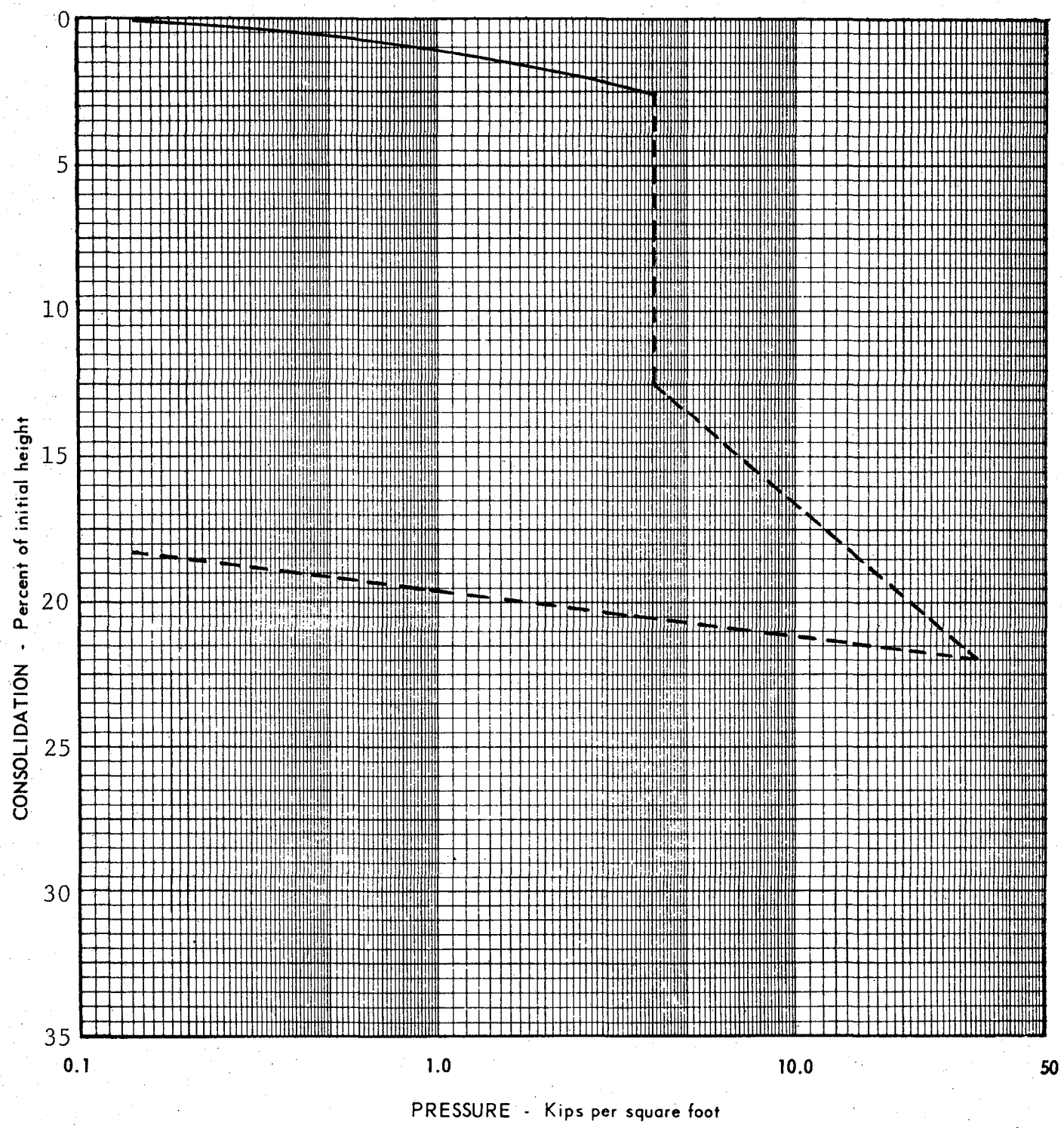
SUMMARY OF CONSOLIDATION TESTS

PROJECT McMicken Dam Restoration Study **JOB NO.** E81-138



CURVE	SAMPLE	INITIAL DRY DENSITY LBS./CU. FT.	MOISTURE CONTENT % DRY WEIGHT		UNIFIED SOIL CLASSIFICATION
			INITIAL	FINAL	
Q	Test Pit #31 @ 3½'-4½'	100.8	6.0	13.2	SM-SC

SOIL MOISTURE CONDITION

——— INSITU

- - - - SUBMERGED

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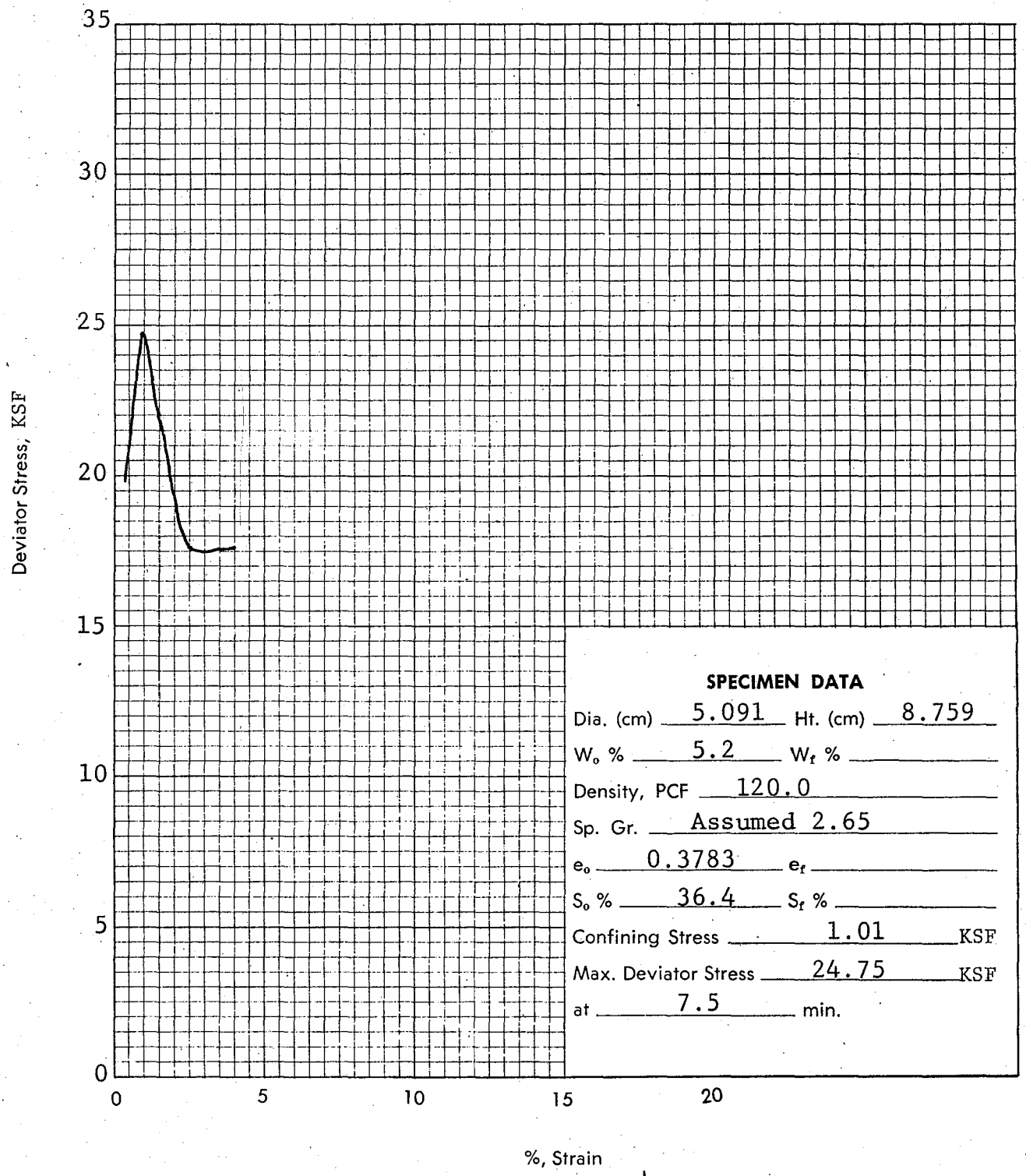
PROJECT McMicken Dam Restoration Study JOB NO. E81-138

SAMPLE TP-31 @ 3½'-4½' LAB NO. 138-635-A

TRIAXIAL DATA

Test: Unconsolidated-Undrained



SPECIMEN DATA

Dia. (cm) 5.091 Ht. (cm) 8.759

W_o % 5.2 W_f %

Density, PCF 120.0

Sp. Gr. Assumed 2.65

e_o 0.3783 e_f

S_o % 36.4 S_f %

Confining Stress 1.01 KSF

Max. Deviator Stress 24.75 KSF

at 7.5 min.

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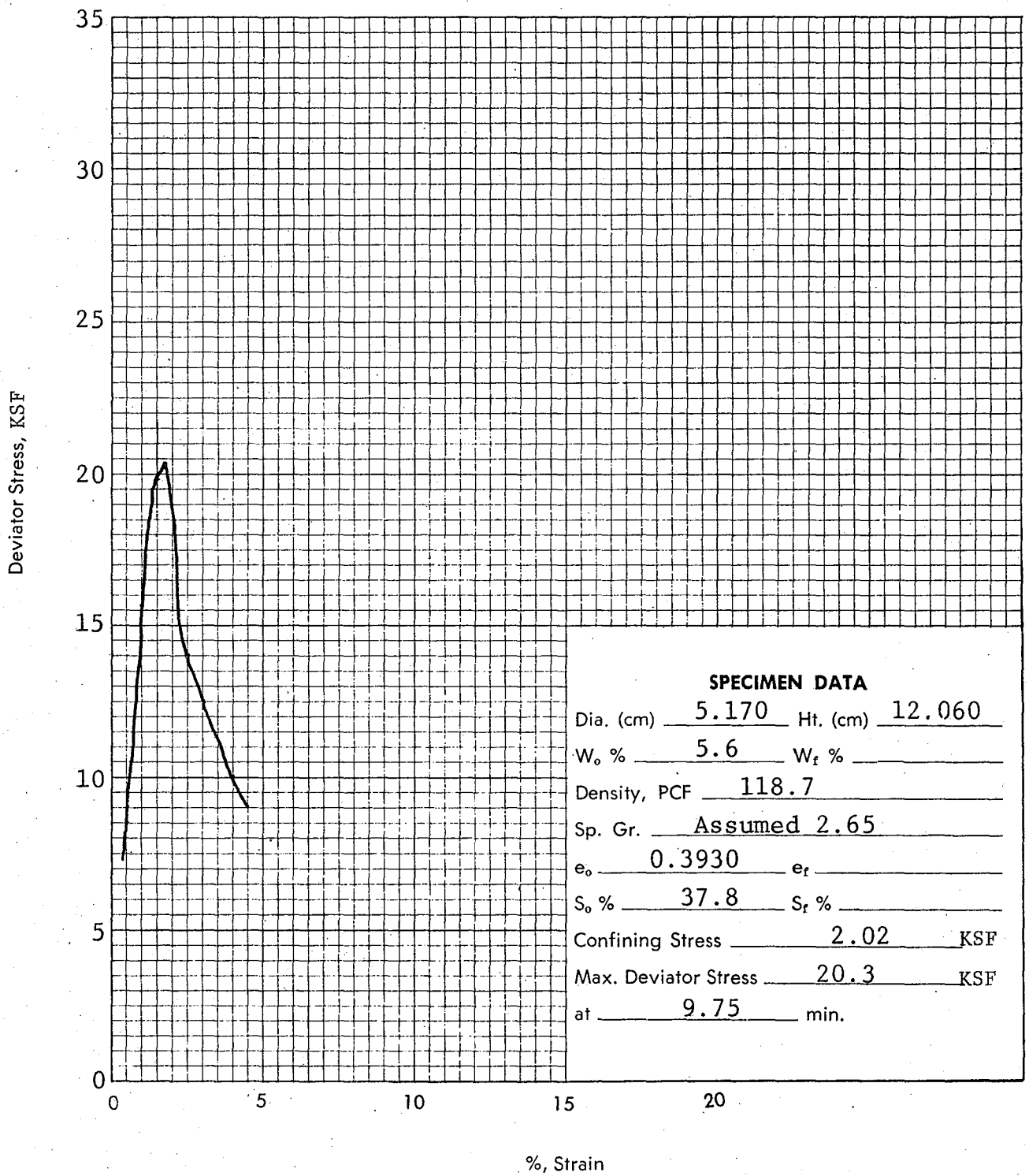
PROJECT McMicken Dam Restoration Study JOB NO. E81-138

SAMPLE TP-31 @ 3½'-4½' LAB NO. 138-635-B

TRIAXIAL DATA

Test: Unconsolidated-Undrained



SPECIMEN DATA

Dia. (cm) 5.170 Ht. (cm) 12.060

W_o % 5.6 W_f %

Density, PCF 118.7

Sp. Gr. Assumed 2.65

e_o 0.3930 e_f

S_o % 37.8 S_f %

Confining Stress 2.02 KSF

Max. Deviator Stress 20.3 KSF

at 9.75 min.

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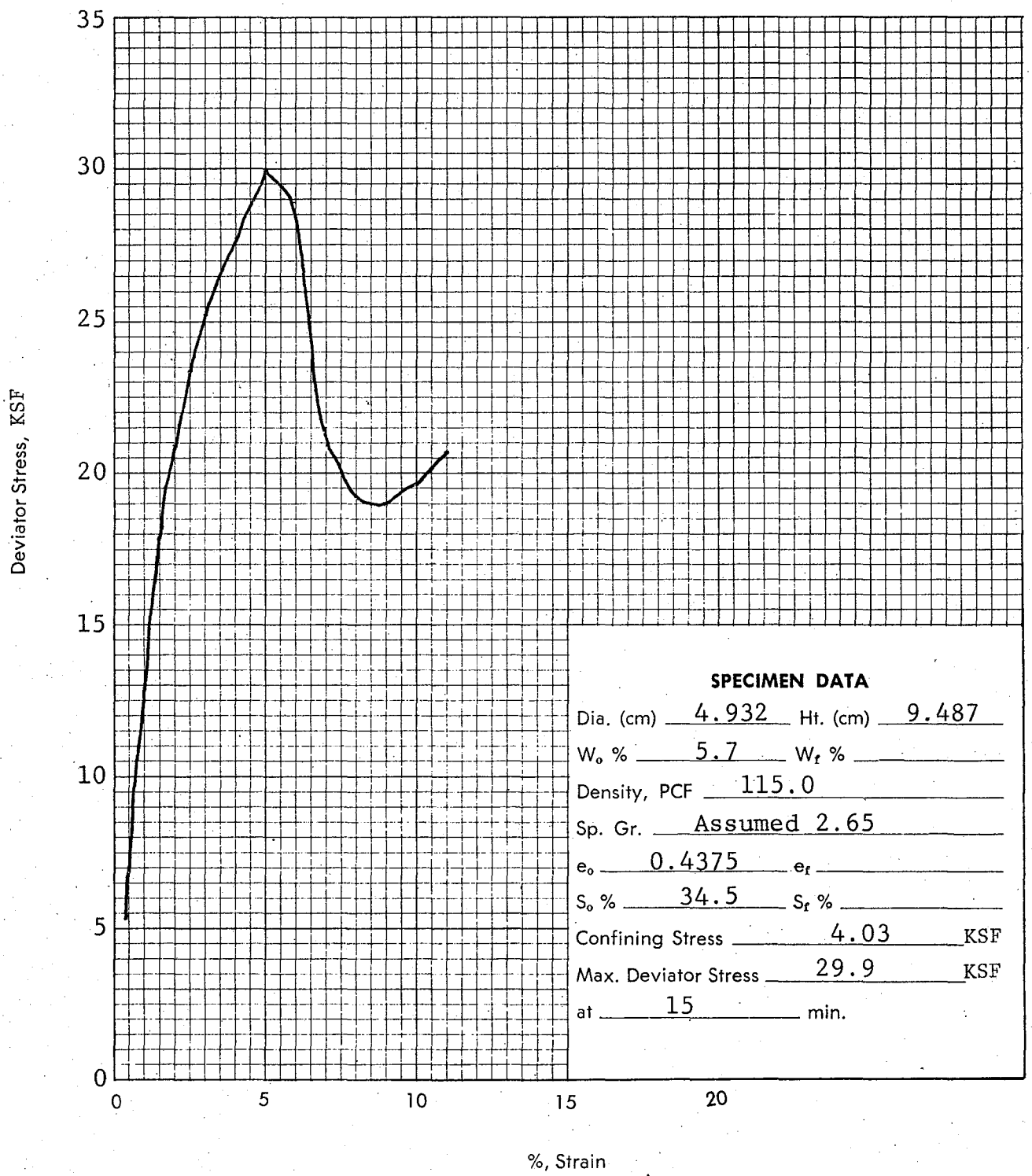
PROJECT McMicken Dam Restoration Study JOB NO. E81-138

SAMPLE TP-31 @ 3½'-4½' LAB NO. 138-635-C

TRIAXIAL DATA

Test: Unconsolidated-Undrained



SPECIMEN DATA

Dia. (cm) 4.932 Ht. (cm) 9.487

W_o % 5.7 W_f %

Density, PCF 115.0

Sp. Gr. Assumed 2.65

e_o 0.4375 e_f

S_o % 34.5 S_f %

Confining Stress 4.03 KSF

Max. Deviator Stress 29.9 KSF

at 15 min.

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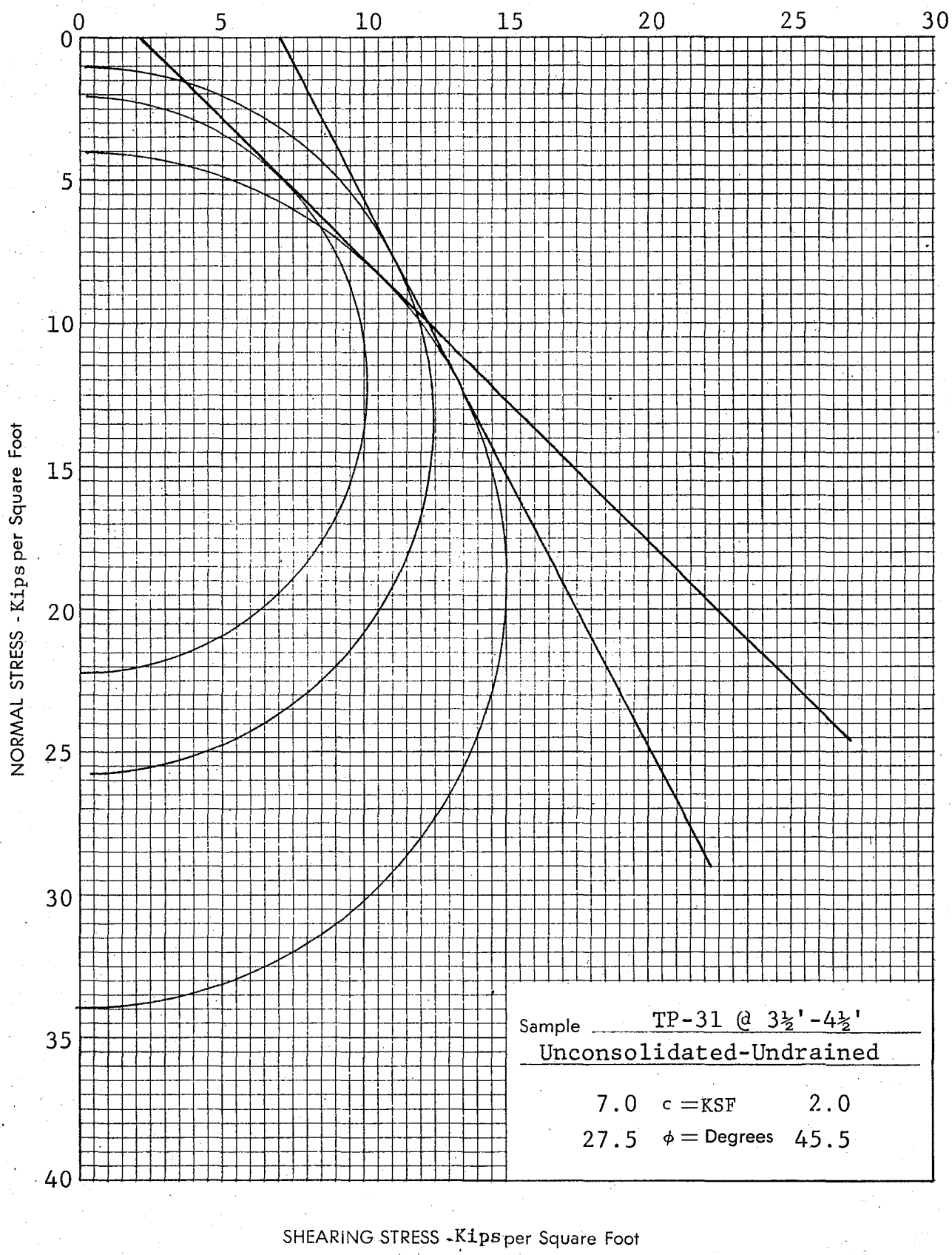
SUMMARY OF TRIAXIAL SHEAR TESTS

PROJECT McMicken Dam Restoration Study JOB NO. E81-138

LAB NO. 138-635



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REPORT ON LABORATORY TESTS

DATE _____

PROJECT McMicken Dam Restoration Study JOB NO. E81-138

LOCATION Maricopa County, Arizona LAB NO. 138-612

Test Method: Sherard, et al, Journal Geotechnical Engineering, Vol. 102, GTI Jan. 1976

PINHOLE TEST EVALUATION

Sample: Test Pit #16 @ 3'3"-4'3"

Curing Time: 5 days Soil Classification: ML

General Classification of Individual Test Results	Classification of Soils
D1 and D2	Dispersive Soils: Fail rapidly under 2 inches head
ND4 and ND3	Intermediate Soils: Erodes slowly under 2 inch or 7 inch head
ND2 and ND1	Nondispersive Soil: No colloidal erosion under 15 inch or 40 inch head

EVALUATION OF RESULTS

_____ 2 inch head; strong color & visibly cloudy, hole 2x(D1, D2, ND4)

_____ 7-15 inch head; slight but visibly cloudy, +2.5 ml/sec, hole 2x (ND3)

X 40 inch head; bare trace of color to completely clear -4 to +5 ml/sec (ND2 to ND1)

Classify Soil as: ND1 No Effect on Hole Size - Nondispersive

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REPORT ON LABORATORY TESTS

DATE _____

PROJECT McMicken Dam Restoration Study JOB NO. E81-138

LOCATION Maricopa County, Arizona LAB NO. 138-617

Test Method: Sherard, et al, Journal Geotechnical Engineering, Vol. 102, GTI Jan. 1976

PINHOLE TEST EVALUATION

Sample: Test Pit #18 @ 3½'-4½'

Curing Time: 5 days Soil Classification: ML

General Classification of Individual Test Results	Classification of Soils
D1 and D2	Dispersive Soils: Fail rapidly under 2 inches head
ND4 and ND3	Intermediate Soils: Erodes slowly under 2 inch or 7 inch head
ND2 and ND1	Nondispersive Soil: No colloidal erosion under 15 inch or 40 inch head

EVALUATION OF RESULTS

_____ 2 inch head; strong color & visibly cloudy, hole 2x(D1, D2, ND4)

_____ 7-15 inch head; slight but visibly cloudy, +2.5 ml/sec, hole 2x (ND3)

__X__ 40 inch head; bare trace of color to completely clear -4 to +5 ml/sec (ND2 to ND1)

Classify Soil as: ND2 Hole Size 1.5 x - Nondispersive

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REPORT ON LABORATORY TESTS

DATE _____

PROJECT McMicken Dam Restoration Study JOB NO. E81-138

LOCATION Maricopa County, Arizona LAB NO. 138-625

Test Method: Sherard, et al, Journal Geotechnical Engineering, Vol. 102, GTI Jan. 1976

PINHOLE TEST EVALUATION

Sample: Test Pit #24 @ 2½'-3½'

Curing Time: 5 days Soil Classification: ML

General Classification of Individual Test Results	Classification of Soils
D1 and D2	Dispersive Soils: Fail rapidly under 2 inches head
ND4 and ND3	Intermediate Soils: Erodes slowly under 2 inch or 7 inch head
ND2 and ND1	Nondispersive Soil: No colloidal erosion under 15 inch or 40 inch head

EVALUATION OF RESULTS

_____ 2 inch head; strong color & visibly cloudy, hole 2x(D1, D2, ND4)

_____ 7-15 inch head; slight but visibly cloudy, +2.5 ml/sec, hole 2x (ND3)

__X__ 40 inch head; bare trace of color to completely clear -4 to +5 ml/sec (ND2 to ND1)

Classify Soil as: ND1 No Effect on Hole Size - Nondispersive

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REPORT ON LABORATORY TESTS

DATE _____

PROJECT McMicken Dam Restoration Study JOB NO. E81-138

LOCATION Maricopa County, Arizona LAB NO. 138-629

Test Method: Sherard, et al, Journal Geotechnical Engineering, Vol. 102, GTI Jan. 1976

PINHOLE TEST EVALUATION

Sample: Test Pit #28 @ 3'-3½'

Curing Time: 5 days Soil Classification: CL-ML

General Classification of Individual Test Results	Classification of Soils
D1 and D2	Dispersive Soils: Fail rapidly under 2 inches head
ND4 and ND3	Intermediate Soils: Erodes slowly under 2 inch or 7 inch head
ND2 and ND1	Nondispersive Soil: No colloidal erosion under 15 inch or 40 inch head

EVALUATION OF RESULTS

_____ 2 inch head; strong color & visibly cloudy, hole 2x(D1, D2, ND4)

_____ 7-15 inch head; slight but visibly cloudy, +2.5 ml/sec, hole 2x (ND3)

X 40 inch head; bare trace of color to completely clear -4 to +5 ml/sec (ND2 to ND1)

Classify Soil as: ND1 No Effect on Hole Size - Nondispersive

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REPORT ON LABORATORY TESTS

DATE _____

PROJECT McMicken Dam Restoration Study JOB NO. E81-138

LOCATION Maricopa County, Arizona LAB NO. 138-631

Test Method: Sherard, et al, Journal Geotechnical Engineering, Vol. 102, GTI Jan. 1976

PINHOLE TEST EVALUATION

Sample: Test Pit #30 @ 3½'-4'

Curing Time: 5 days Soil Classification: ML

General Classification of Individual Test Results	Classification of Soils
D1 and D2	Dispersive Soils: Fail rapidly under 2 inches head
ND4 and ND3	Intermediate Soils: Erodes slowly under 2 inch or 7 inch head
ND2 and ND1	Nondispersive Soil: No colloidal erosion under 15 inch or 40 inch head

EVALUATION OF RESULTS

_____ 2 inch head; strong color & visibly cloudy, hole 2x(D1, D2, ND4)

_____ 7-15 inch head; slight but visibly cloudy, +2.5 ml/sec, hole 2x (ND3)

X 40 inch head; bare trace of color to completely clear -4 to +5 ml/sec (ND2 to ND1)

Classify Soil as: ND1 No Effect on Hole Size - Nondispersive

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REPORT ON LABORATORY TESTS

DATE _____

PROJECT McMicken Dam Restoration Study JOB NO. E81-138

LOCATION Maricopa County, Arizona LAB NO. 138-612

PERMEABILITY TEST
(Pressurized Permeameter)

Sample Test Pit #16 @ 3¼'-4¼'

Density of 118.0 PCF at 10.7 %

Diameter 4.943 cm Length 8.145 cm Area 19.190 cm^2 Vol. 156.3 cc

W_s 295.5 grms. w_o 10.7 % w_f 14.2 % G_s 2.65 assumed V_s 111.5 cc

Void Ratio 0.4016 Dry Density 118.0 PCF Trials 20 days

S_o = 70.6 % S_f = 93.7 %

Pressure (PSI)	Head (inches)	Q (cc)	Time (min.)	K (cm/sec)	K (ft/yr)	Remarks
5	185.9	115	4294	4.0×10^{-7}	0.4	Input "Q"
5	185.9	114	4640	3.7×10^{-7}	0.4	Input "Q"

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REPORT ON LABORATORY TESTS

DATE _____

PROJECT McMicken Dam Restoration Study JOB NO. E81-138

LOCATION Maricopa County, Arizona LAB NO. 138-625

PERMEABILITY TEST
(Pressurized Permeameter)

Sample Test Pit #24 @ 2½'-3½'

Density of 118.0 PCF at 14.9 %

Diameter 4.970 cm Length 8.140 cm Area 19.400 cm^2 Vol. 157.92 cc

W_s 283.0 grms. w_o 14.9 % w_f 17.0 % G_s 2.65 (assumed) V_s 106.79 cc

Void Ratio 0.4787 Dry Density 111.8 PCF Trials 22 days

S_o = 82.5 % S_f = 94.1 %

Pressure (PSI)	Head (inches)	Q (cc)	Time (min.)	K (cm/sec)	K (ft/yr)	Remarks
5	186.7	81	1803	6.6×10^{-7}	0.7	Input "Q"
5	184.3	18	1082	2.5×10^{-7}	0.3	Input "Q"
5	188.0	24	1404	2.5×10^{-7}	0.3	Input "Q"
10	323.2	42	1165	3.1×10^{-7}	0.3	Input "Q"
10	320.0	90	8267	9.4×10^{-8}	0.1	Input "Q"
10	326.3	38	2890	1.1×10^{-7}	0.1	Input "Q"

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REPORT ON LABORATORY TESTS

DATE _____

PROJECT McMicken Dam Restoration Study **JOB NO.** E81-138

LOCATION Maricopa County, Arizona **LAB NO.** 138-629

PERMEABILITY TEST
(Pressurized Permeameter)

Sample Test Pit #28 @ 3'-3½ ' Remolded

Remolded to 94.5% of Maximum ASTM 698 Density of 125.3 PCF at ____ %

Diameter 4.763 cm Length 8.110 cm Area 17.814 cm^2 Vol. 144.5 cc

W_s 274.0 grms. w_o 11.9 % w_f 15.1 % G_s - V_s - cc

Void Ratio - Dry Density 118.4 PCF Trials 10 days

Pressure (PSI)	Head (inches)	Q (cc)	Time (min.)	K (cm/sec)	K (ft/yr)	Remarks
5	182.7	200	1802	1.81×10^{-6}	1.9	Exit "Q"
5	181.9	240	1847	2.1×10^{-6}	2.2	Exit "Q"

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REPORT ON LABORATORY TESTS

DATE _____

PROJECT McMicken Dam Restoration Study JOB NO. E81-138

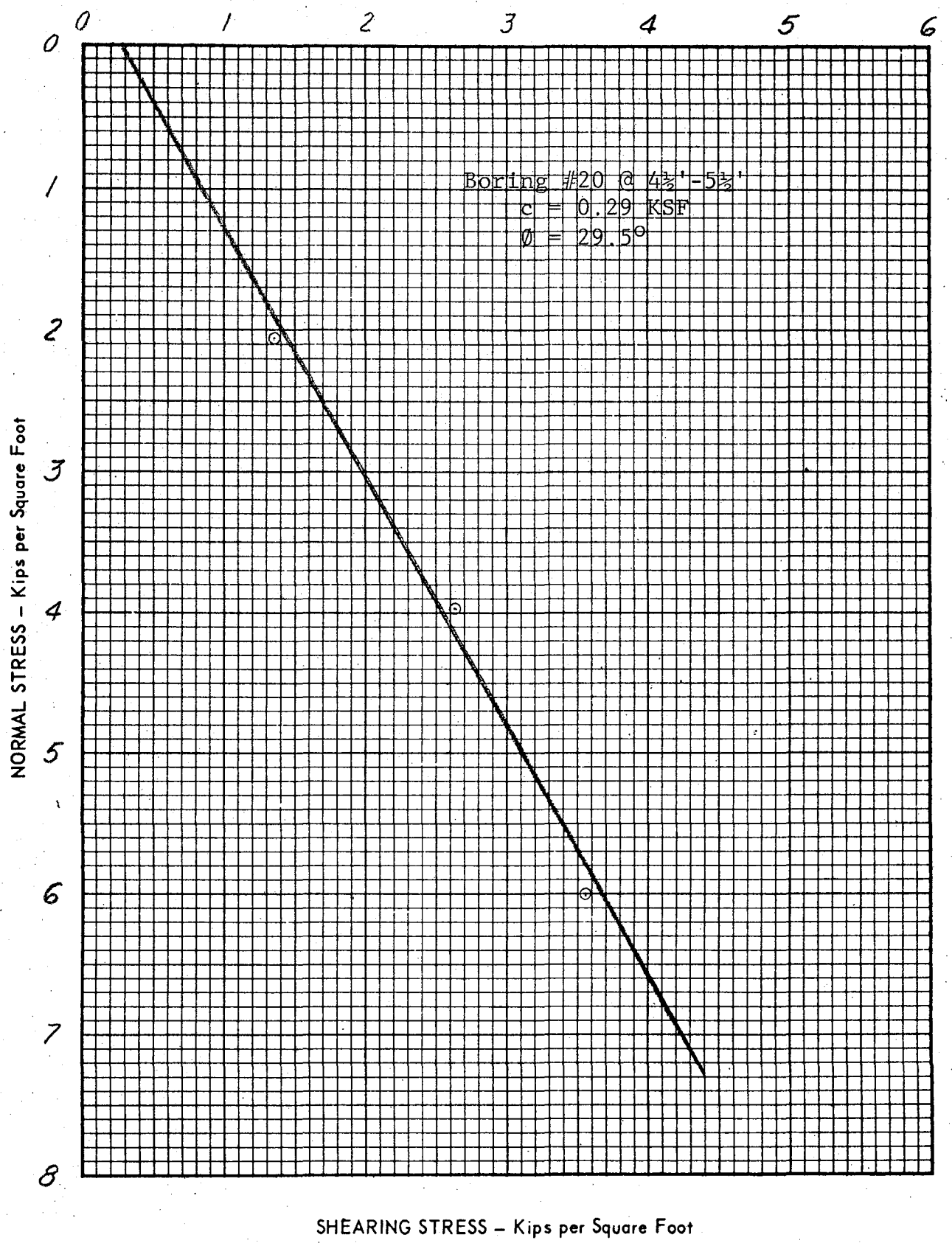
LOCATION Maricopa County, Arizona LAB NO. See Below

SOIL SPECIFIC GRAVITY ASTM D854

Lab No.	Sample	Specific Gravity
138-157	Boring #17 @ 4½'-5½'	2.675
138-184	Boring #20 @ 4½'-5½'	2.732
138-344	Boring #35 @ 29½'-30½'	2.636
138-536	Boring #55 @ 14½'-16'	2.701

SUMMARY OF DIRECT SHEAR TESTS

PROJECT McMicken Dam Restoration Study **JOB NO.** E81-138



SOIL MOISTURE CONDITION

○ – INSITU
● – SUBMERGED

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REPORT ON LABORATORY TESTS

DATE

PROJECT McMicken Dam Restoration Study JOB NO. E81-138

LOCATION Maricopa County, Arizona LAB NO. 138-184

SAMPLE Boring #20 @ 4½'-5½'

DIRECT SHEAR TESTS

In Situ - Point No. 1 (= ± 1.00 KSF)

Initial Moisture Content	13.7	%
Dry Density (PCF)	96.3	
Submerged		
Final Moisture Content		%
Maximum Vertical Deformation @ T Max.	(+) 0.001	Inches
Shearing Stress, T Max.	0.83	KSF

In Situ - Point No. 2 (= ± 2.06 KSF)

Initial Moisture Content	11.3	%
Dry Density (PCF)	98.2	
Submerged		
Final Moisture Content		%
Maximum Vertical Deformation @ T Max.	(-) 0.003	Inches
Shearing Stress, T Max.	1.36	KSF

In Situ - Point No. 3 (= ± 3.97 KSF)

Initial Moisture Content	12.1	%
Dry Density (PCF)	102.8	
Submerged		
Final Moisture Content		%
Maximum Vertical Deformation @ T Max.	(-) 0.004	Inches
Shearing Stress, T Max.	2.63	KSF

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REPORT ON LABORATORY TESTS

DATE _____

PROJECT McMicken Dam Restoration Study JOB NO. E81-138

LOCATION Maricopa County, Arizona LAB NO. 138-184

SAMPLE Boring #20 @ 4½'-5½'

DIRECT SHEAR TESTS

In Situ - Point No. 4 (= ± 6.00 KSF)

Initial Moisture Content	12.0	%
Dry Density (PCF)	103.5	
Submerged		
Final Moisture Content		%
Maximum Vertical Deformation @ T Max.	(-) 0.010	Inches
Shearing Stress, T Max.	3.56	KSF

In Situ - Point No. 5 (= ± _____ KSF)

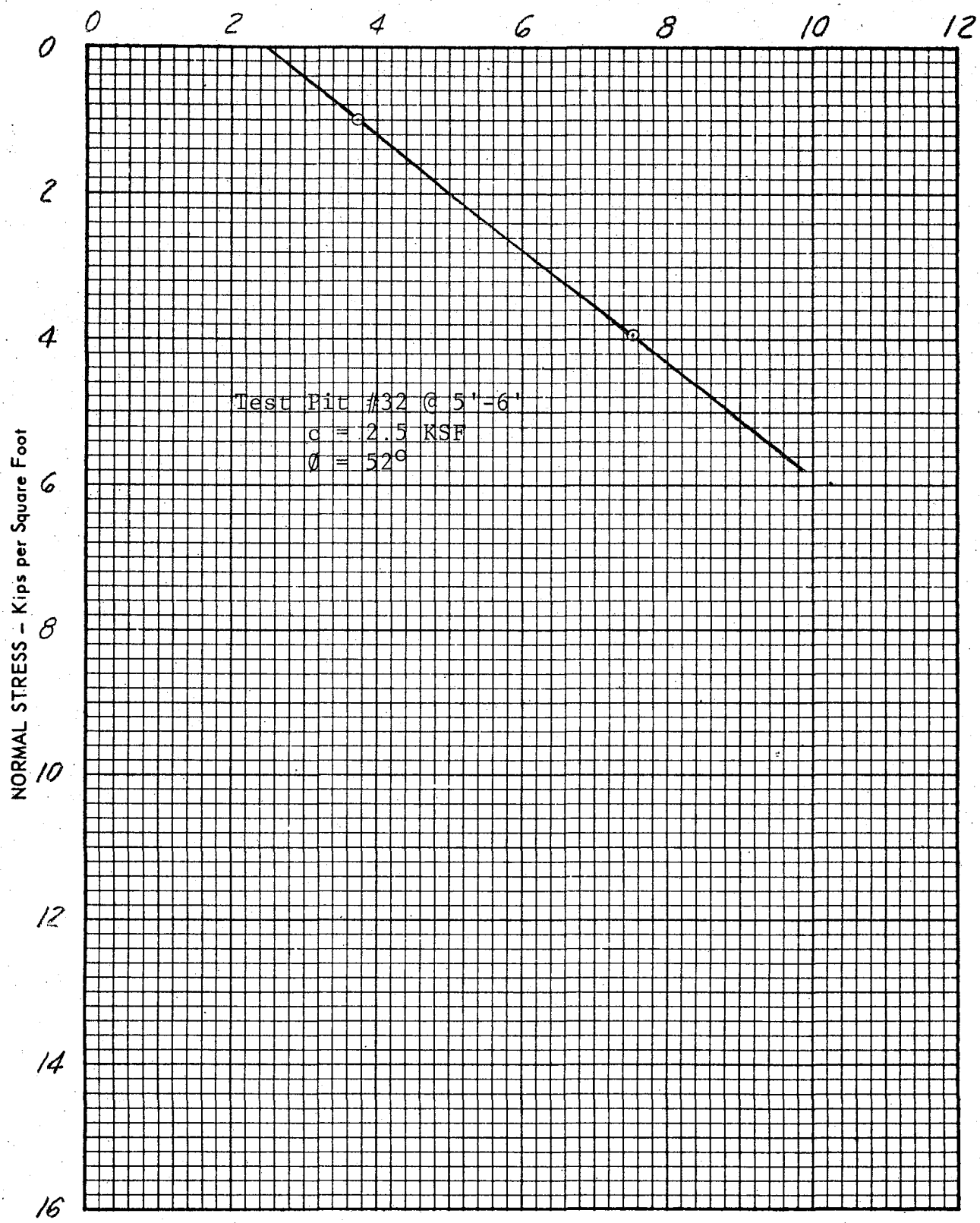
Initial Moisture Content		%
Dry Density (PCF)		
Submerged		
Final Moisture Content		%
Maximum Vertical Deformation @ T Max.		Inches
Shearing Stress, T Max.		KSF

In Situ - Point No. 6 (= ± _____ KSF)

Initial Moisture Content		%
Dry Density (PCF)		
Submerged		
Final Moisture Content		%
Maximum Vertical Deformation @ T Max.		Inches
Shearing Stress, T Max.		KSF

SUMMARY OF DIRECT SHEAR TESTS

PROJECT McMicken Dam Restoration Study **JOB NO.** E81-138



SOIL MOISTURE CONDITION

o – INSITU
● – SUBMERGED

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REPORT ON LABORATORY TESTS

DATE _____

PROJECT McMicken Dam Restoration Study **JOB NO.** E81-138

LOCATION Maricopa County, Arizona **LAB NO.** 138-707

SAMPLE Test Pit #32 @ 5'-6' Trimmed from Block

DIRECT SHEAR TESTS

In Situ - Point No. 1 (= ± 1.00 KSF)

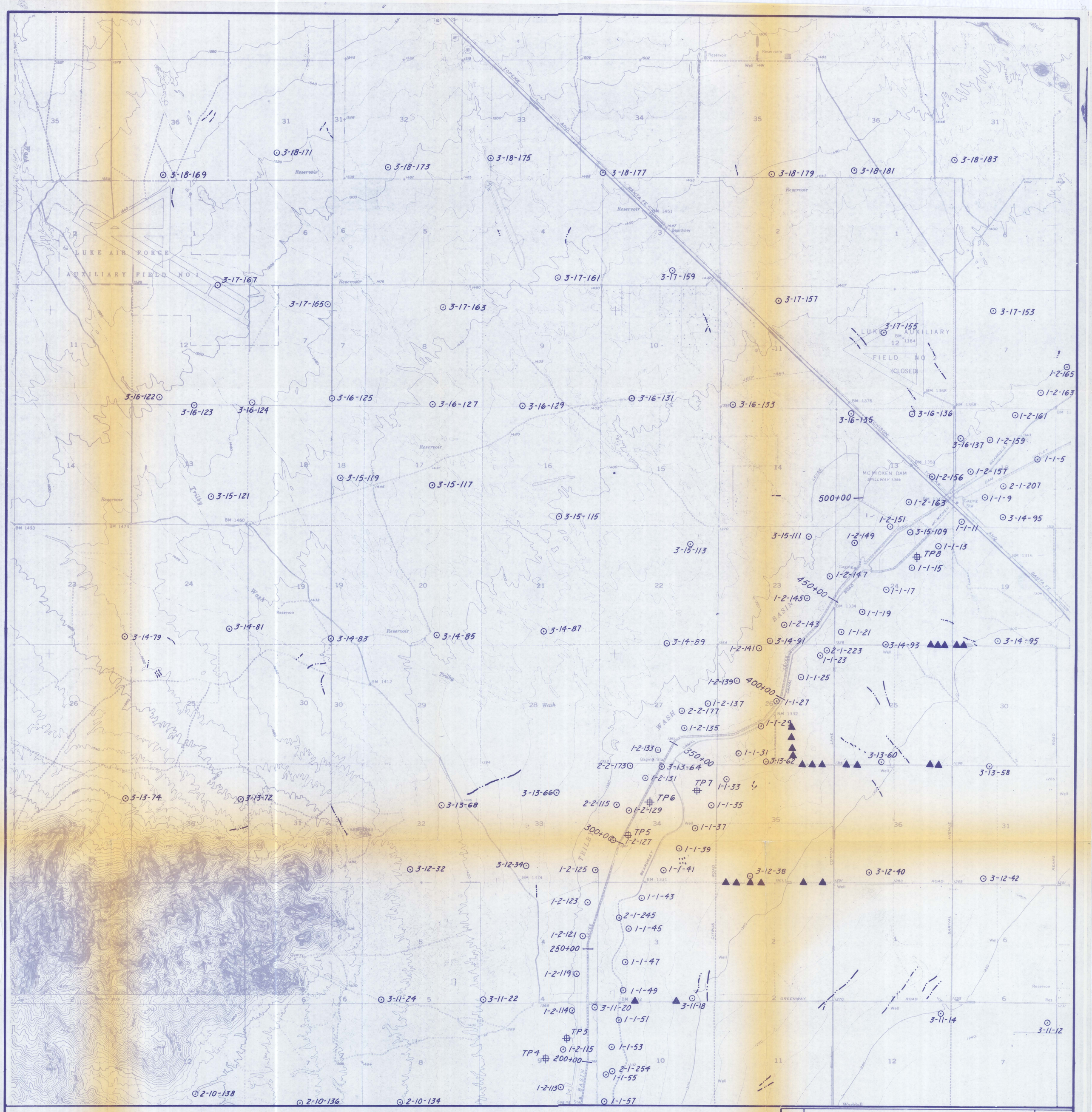
Initial Moisture Content		%
Dry Density (PCF)		
Submerged		
Final Moisture Content		%
Maximum Vertical Deformation @ T Max.		Inches
Shearing Stress, T Max.	3.74	KSF

In Situ - Point No. 2 (= ± 2.06 KSF)

Initial Moisture Content	4.1	%
Dry Density (PCF) (1" Rock in Sample)	122.5	
Submerged		
Final Moisture Content		%
Maximum Vertical Deformation @ T Max.	(+) 0.020	Inches
Shearing Stress, T Max.	7.86	KSF

In Situ - Point No. 3 (= ± 3.97 KSF)

Initial Moisture Content		%
Dry Density (PCF)		
Submerged		
Final Moisture Content		%
Maximum Vertical Deformation @ T Max.	(+) 0.022	Inches
Shearing Stress, T Max.	7.56	KSF



BASE MAP REFERENCES:

U.S.G.S. 7.5 Minute Series Topographic Quadrangle Maps, Mc Micken Dam, Arizona, 1957., White Tank Mtns, N.E., Arizona, 1957.

EARTH FISSURE LOCATIONS

⊕ Back Hoe Test Pit

LEGEND

⊙ Low-sun angle aerial photography photo centers

—— Schumann, H. H., 1974, Land Subsidence and Earth Fissures in Alluvial Deposits in the Phoenix Area, Arizona, U.S.G.S. Misc. Investigations Series Map I-845H.

—··— Possible Earth Fissures identified by S.H.B. photogeologic methods, not field verified.

▲▲▲ U.S. Army Corps of Engrs., 1973, (Unpublished Submittal), Trilby Wash Detention Basin, Lower Agua Fria River, Maricopa Cty., AZ., Surficial Ground Cracking, Figure 19.

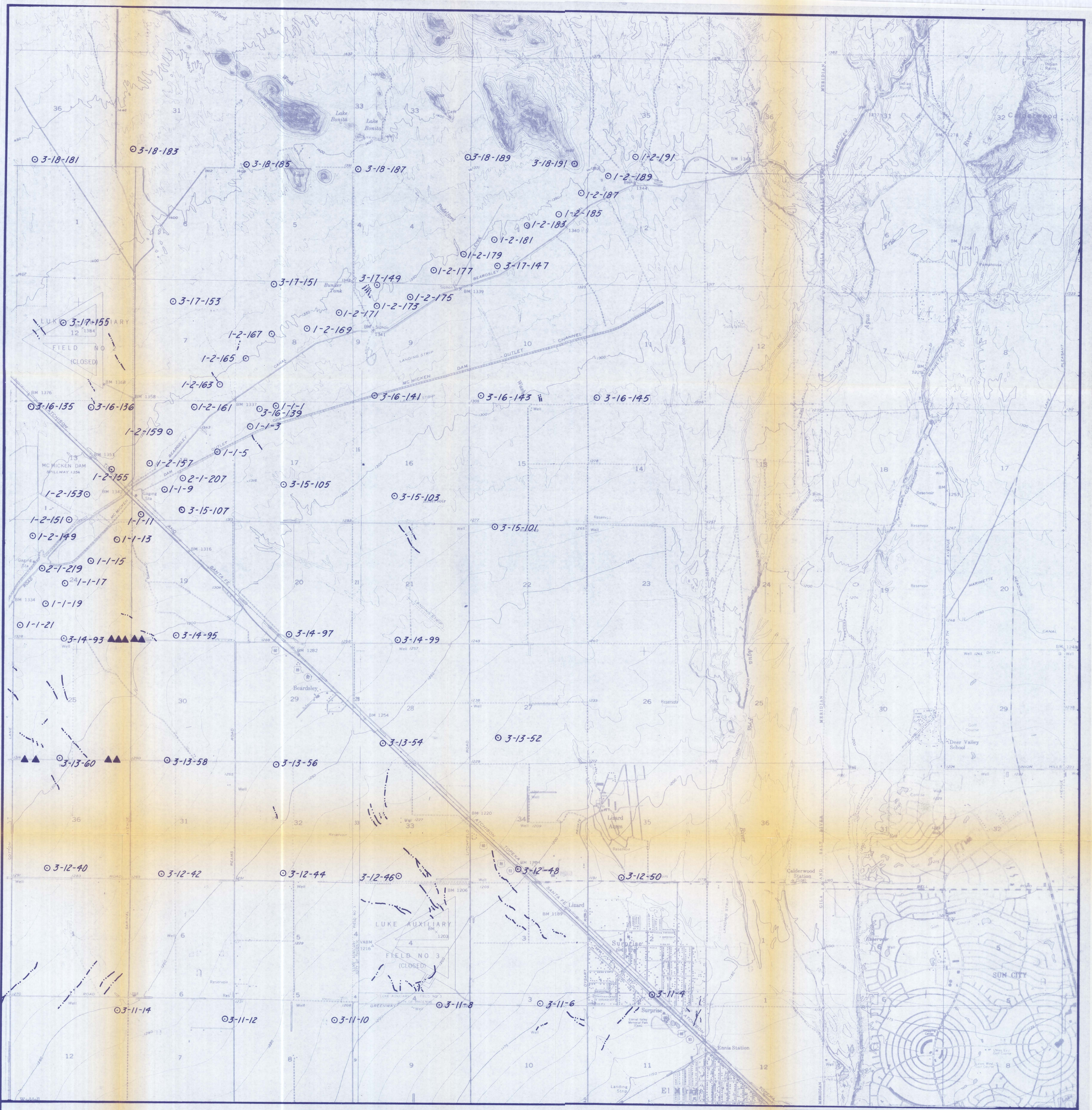
NO.	DESCRIPTION	DATE

REVISIONS

SERGENT, HAUSKINS & BECKWITH
CONSULTING GEOTECHNICAL ENGINEERS

Mc Micken Dam Restoration Study
Maricopa County, Arizona
SHB Job No. E81-138

JOB NO.	DATE	DESIGNED BY	DRAWN BY	CHECKED BY	SHEET NO
E81-138	2/82	M.R.H.	G.L.	G.H.B.	1 of 4



EARTH FISSURE LOCATIONS

BASE MAP REFERENCES:
U.S.G.S. 7.5 Minute Series Topographic Quadrangle Maps, Mc Micken Dam, Arizona, 1957., Calderwood Butte, Arizona, 1957.

LEGEND

⊙ Low-sun angle aerial photography photo centers.

——— Schumann H.H., 1974, Land Subsidence and Earth Fissures in Alluvial Deposits in the Phoenix Area, Arizona, U.S.G.S. Misc. Investigations Series Map I-845H.

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▲▲▲ U.S. Army Corps of Engineers, 1973, (Unpublished Submittal), Trilby Wash Detention Basin, Lower Agua Fria River, Maricopa Cty., AZ., Surficial Ground Cracking, Figure 19

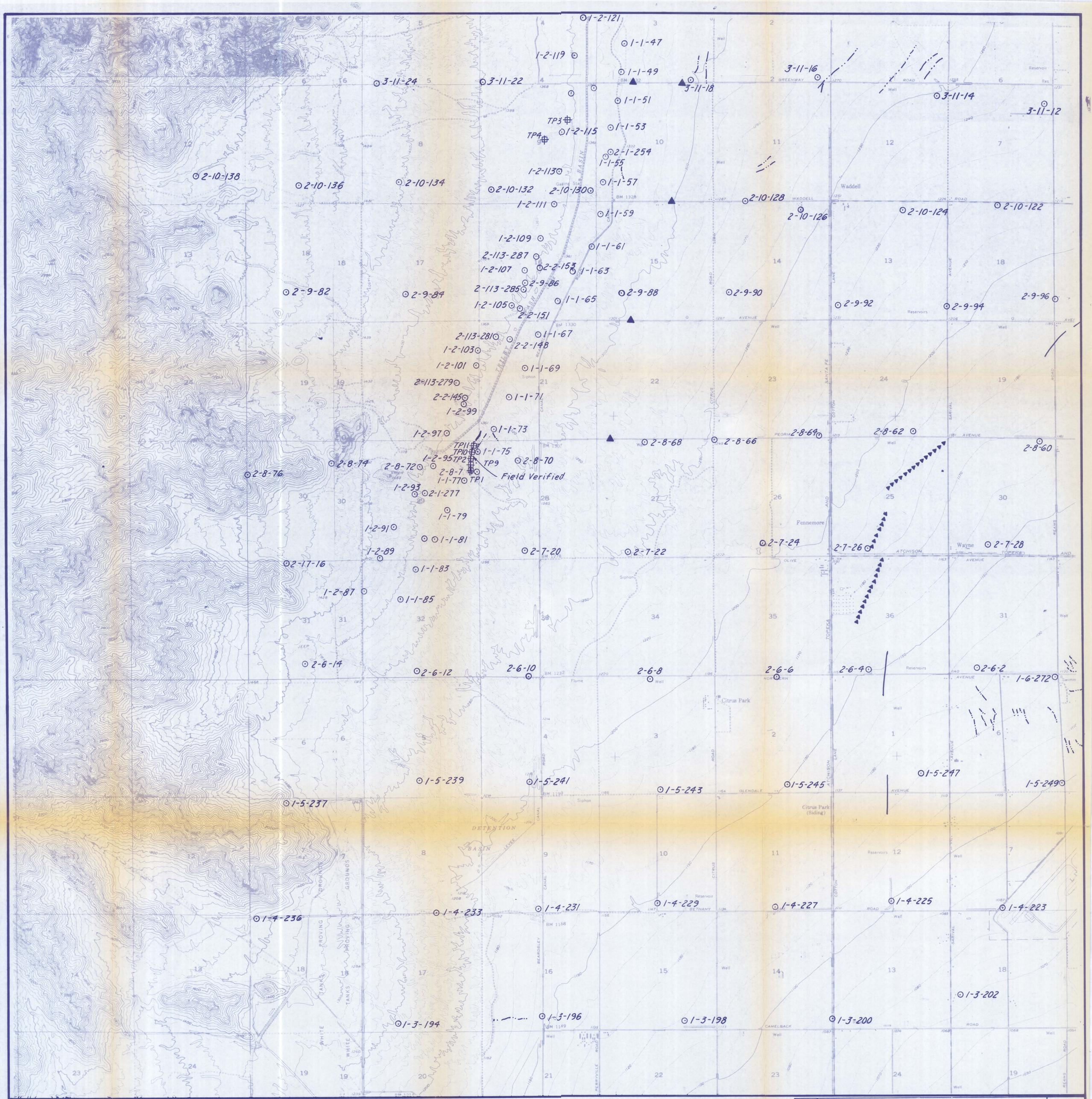
NO.	DESCRIPTION	DATE

REVISIONS

SERGENT, HAUSKINS & BECKWITH
CONSULTING GEOTECHNICAL ENGINEERS

Mc Micken Dam Restoration Study
Maricopa County, Arizona
SHB Job No. E81-138

JOB NO.	DATE	DESIGNED BY	DRAWN BY	CHECKED BY	SHEET NO
E81-138	2/82	M.R.H.	G.L.	G.H.B.	2 of 4



BASE MAP REFERENCES:
U.S.G.S. 7.5 Minute Series Topographic Quadrangle Maps, Waddell, Arizona, 1957., White Tank Mtns, S.E., Arizona, 1957.

EARTH FISSURE LOCATIONS

⊕ Back Hoe Test Pit

LEGEND

⊙ Low-sun angle aerial photography photo centers.

—— Schumann, H.H., Land Subsidence and Earth Fissures in Alluvial Deposits in the Phoenix Area, Arizona, U.S.G.S. Misc. Investigations Series Map I-845H.

—··— Possible Earth Fissures identified by S.H.B. photogeologic methods, not field verified.

▲▲▲ U.S. Army Corp of Engineers, 1973, (Unpublished Submittal), Trilby Wash Detention Basin, Lower Agua Fria River, Maricopa County Arizona, Surficial Ground Cracking, Figure 19.

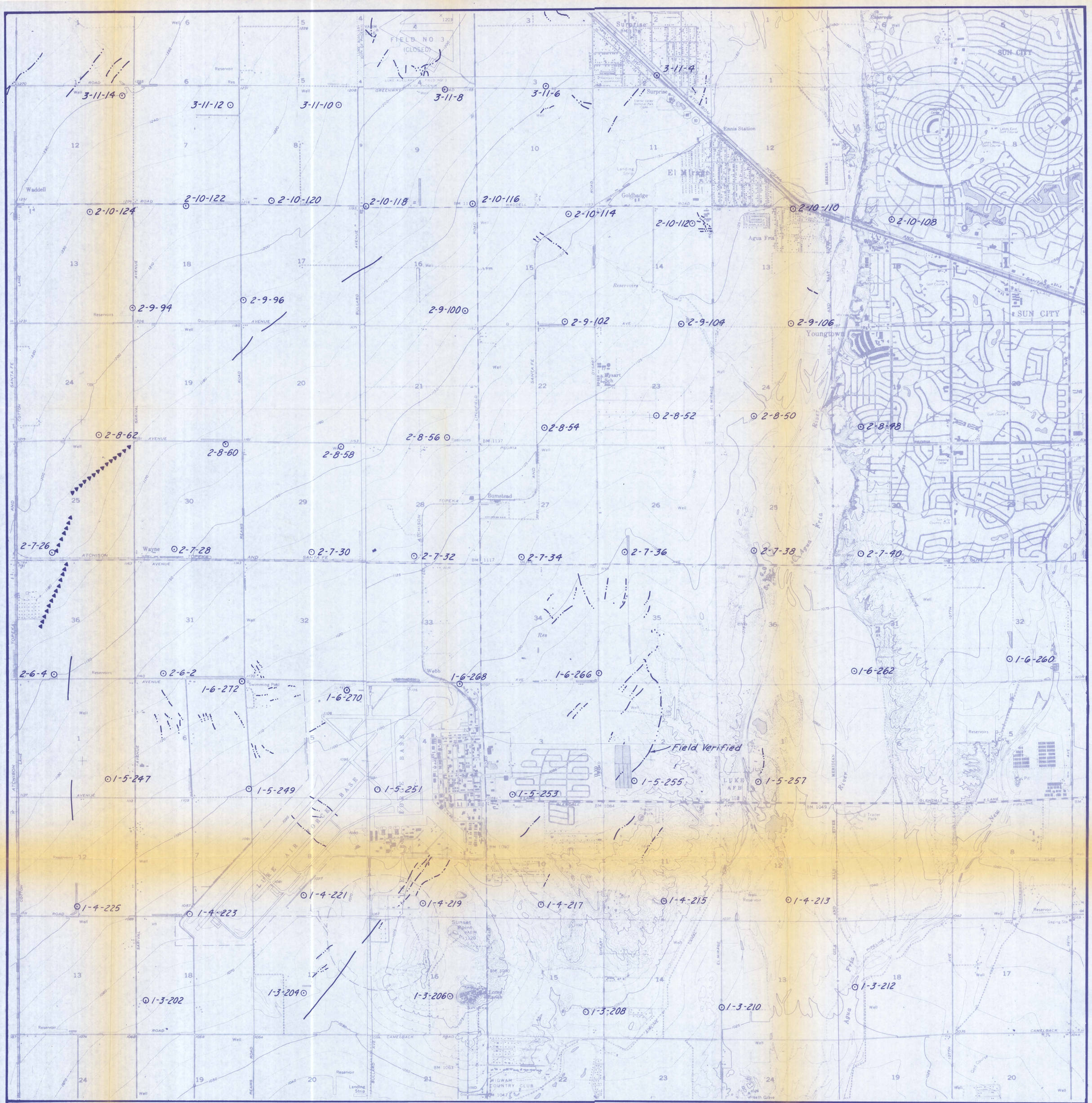
NO.	DESCRIPTION	DATE

REVISIONS

SERGENT, HAUSKINS & BECKWITH
CONSULTING GEOTECHNICAL ENGINEERS

Mc Micken Dam Restoration Study
Maricopa County, Arizona
S.H.B. Job No. E81-138

JOB NO.	DATE	DESIGNED BY	DRAWN BY	CHECKED BY	SHEET NO
E 81-138	2/82	M.R.H.	G.L.	G.H.B.	3 of 4



BASE MAP REFERENCES:
U.S.G.S. 7.5 Minute Series Topographic Quadrangle Maps, El Mirage, Arizona, 1957., Waddell, Arizona, 1957.

EARTH FISSURE LOCATIONS

LEGEND

- ⊙ Low-sun angle aerial photography photo centers.
- —— Schumann H.H., Land Subsidence and Earth Fissures in Alluvial Deposits in the Phoenix Area, Arizona, U.S.G.S. Misc. Investigations Series Map I-845H.
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