SERGENT, HAUSKINS & BECKWITH

DESIGN REPORT

McMicken Dam Restoration Study

Maricopa County, Arizona

SHB Job No. E82-111

Consulting Geotechnical Engineers

PHOENIX • ALBUQUERQUE • SANTA FE • SALT LAKE CITY

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SHB Job No. E82-111

FLOOD CONTROL DISTRICT
RECEIVED
JAN 27 '83

Attention: Mr. Ed Raleigh

Re: McMicken Dam Restoration Study
Maricopa County, Arizona

Gentlemen,

Transmitted herewith are ten copies of the Design Report for the referenced project. The report is submitted for your review as well as the review of other interested agencies including the Arizona Department of Water Resources.

This report includes the design concepts for the project, along with the various analyses and supporting calculations and test data.

Should any questions arise concerning this report, please do not hesitate to contact us.

Respectfully submitted,
Sergent, Hauskins & Beckwith Engineers

By Robert R. Koons
Robert R. Koons, P.E.

Registered Professional Engineer (Civil)
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1. INTRODUCTION

1.1 General Statement

This report is submitted pursuant to a final design for the repair of McMicken Dam. The project area is shown on the site plan in the map pocket, Appendix A.

Authority to proceed with Phase III of the project was granted by D.E. Sagramoso, P.E., Chief Engineer and General Manager of the Flood Control District of Maricopa County.

1.2 Purpose of Study

This investigation was undertaken with the intention of addressing the following details in the final design report:

A. Delineation of potential borrow source for dam crest raising.

B. Inspection and sampling of drain rock sources.

C. Test grouting program.

D. Subsurface investigation of embankment.

E. Toe drain depth investigation.

F. Laboratory testing of filter fabric.

G. Surveying and compilation of dam cross sections.

H. Laboratory analysis of construction materials.

I. Analysis of design concept.

J. Final design plans, specifications and contract documents.

1.3 Review of Phase II Investigation Results

1.3.1 Existing Cracking of Embankment

The primary cause of embankment cracking was found to be settlement of a surface layer of collapsing embankment foundation soils. The moisture sensitive soils and observed cracking intensity are greater in the Trilby Wash area in the northerly one-half of the dam, though at least a thin layer of collapsing soil and isolated cracking is present over most of the length of the dam.

Sufficient evidence exists to support the conclusion that the foundation soils have been wetted in the past due to ponding of water for extended periods behind the dam. It is thought that the probability for future settlement and cracking of the embankment is very low due to this past ponding.

1.3.2 Groundwater Withdrawal Induced Subsidence Fissuring

No evidence was found that earth fissures due to groundwater withdrawal cross the dam or contribute to embankment cracking. However, earth fissures were found near the southerly end of the dam. The 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 are 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 probably will produce an open, nearly vertical crack about ½ to 3/4 inch wide through the dam and the cemented foundation soils.

1.4 Recommended Repair Concept

The Phase II Geotechnical Investigation Report (SHB, 1982) analyzed four possible remedial alternatives including:

1. Central vertical drain.
2. Downstream rock-fill zone.
3. Upstream asphaltic concrete membrane.
4. Upstream gabion-mastic liner.

1.4.1 Central Vertical Drain Alternative

The central vertical drain concept of repair yields the least cost, as well as the only positive defense against subsidence induced fissuring through the dam. As described in the Phase II report (SHB, 1982), the following elements of design would be incorporated into this repair alternative.

1.4.1.1 Granular Center Drain

The granular center drain would consist of coarse gravel and cobbles which would intercept seepage through cracks in the embankment. The high degree of internal drainage would drain flow that runs through the cracks.

1.4.1.2 Geotextile Encapsulation

The center drain would be surrounded by a geotextile which would intercept erosion through cracks and cause plugging of cracks. The geotextile is very flexible and would be expected to withstand the differential settlement and tensile strains which could potentially occur.

The life expectancy of geotextiles of at least 20 years and more probably in excess of 50 years is indicated from field tested installations which have been monitored for more than ten years. This life expectancy is predicated on the use of an acceptable polypropylene-based geotextile.

1.4.1.3 Downstream Toe Cutoff

At the downstream toe of the dam, a single sheet of geotextile will be installed in a narrow trench approximately 9 to 11 feet deep. This sheet would also intercept flow through cracks and cause plugging, thereby preventing erosion in the shallow soils.

2. INVESTIGATION

2.1 Borrow Sources

A total of 39 backhoe test pits ranging in depth from 4.5 to 10.0 feet were excavated upstream of McMicken Dam. These test pits were located from 200 to 1,800 feet from the dam centerline. A majority of the excavations were placed in natural ground upstream of the existing borrow pit. During the exploration, flood waters inundated the low-lying areas of the existing borrow area which resulted in partial loss of access.

Test pit logs and a site plan which depicts the pit locations are presented in Appendix A. The locations, logs and photographs of other pits and trenches referred to in the following report sections are also presented in Appendix A.

2.2 Soil Cementation Properties

A total of 19 backhoe test pits ranging in depth from 6.5 to 11.5 feet were excavated along the downstream toe of the embankment. The purpose of these excavations was to observe the caliche development and cementation properties of the shallow alluvial soils. Selected pit walls were photographed and the soils were field logged in detail.

2.3 Grouting Test Program

A grouting test program was conducted at four locations

along the dam crest. The objectives of this program were to evaluate the effectiveness of the grout procedure in sealing the embankment cracks and to develop the proper grout mix design. The following procedures were undertaken.

A. Research of case histories and technical literature related to the grouting of cracks in soil.

B. Selection of four sections of the embankment known to possess a high incidence of cracking (ET-1 through ET-4).

C. Shallow trenching to a depth of about 1½ feet along the dam crest within the four test sections.

D. Washing and flooding of the shallow trenches in order to detect cracks.

E. Borrowing of shallow sandy clay at two locations near TP-3 and TP-19.

F. Mixing and subsequent pumping of various grout compositions into the exposed embankment cracks. No pressure was induced during grouting; the grout was allowed to flow into the cracks.

G. As discussed in the following report section, deep trenching along the grouted sections and logging of grout penetration and condition of the cracks.

Of the four test sections selected, only three contained groutable cracks. No grouting was performed at the ET-2 location. As presented on Table A-1, Appendix A, 16 1/3-yard batches of grout were introduced into the cracks. These mixes were composed of the natural clayey soil and water with small percentages of fly ash, Portland Cement, and/or bentonite.

2.4 Embankment Trenching

Seven trenches were excavated parallel to and along the centerline of the dam crest. The three trenches toward the southern end of the dam (ET-5 through ET-7) were completed by using a Case 580C backhoe to a maximum depth of 11 feet. The remaining four locations were excavated by utilizing an American 35A backhoe to a depth of 19 to 24 feet. Three of these trenches penetrated the grouted test sections.

For the purpose of evaluating future center trench stability, observing grout penetration and the character of the embankment cracks, the trench walls were logged and selectively photographed. Portable hydraulic shoring was installed prior to the logging of the four deep excavations.

3. DISCUSSIONS & CONCLUSIONS OF FIELD PROGRAM

3.1 Earth Borrow Sources

The entire area which contains the test pits referred to in Section 1.1 is deemed suitable for the excavation of earth borrow. The only limitation which appears to exist is the risk of inundation which would severely restrict access and cause overwetting of the borrow.

Two additional sources of borrow are available; the embankment materials removed from the dam breach between Stations 316+00 and 326+00 and a section of the downstream portion of the old embankment between Stations 360+00 and 480+00. The soils removed from the breach were placed along the upstream slope on both ends of the excavation. The portion of the old embankment available for borrow would be downstream of a projection of the 2:1 (horizontal to vertical) downstream slope of the upper embankment.

Results of laboratory testing of borrow and embankment soils are shown in Appendix B.

3.2 Determination of Toe Intercept Depth

Preliminary recommendations for the restoration of McMicken Dam state that the downstream toe intercept should penetrate an unspecified thickness of erosion-resistent cemented soil. Conditions observed in the 19

test pits completed along the dam toe indicate that this criterion for specifying intercept depth is not workable.

The degree of induration of the shallow soils in the dam foundation appears to be dependent, to a high degree, on soil particle-size distribution. To a depth of 10 to 11 feet, highly erratic soil caliche development was observed to generally occur below a depth of about 1½ feet. The degree of cementation afforded by the caliche is higher within the sandy to silty clay and clayey sand and gravel horizons. Where thick strata of silty sand and sandy silt were encountered, the binding agents generally do not form an erosion-resistent soil. In some cases, these looser soils occur below a highly cemented horizon which contains sandy clay and clayey sand and gravel.

3.3 Crack Grouting

The optimum grout mix was found to be a soil/water composition with approximately 1.5 percent by weight of pozzalan cement. The most effective grout properties appear to be produced by a 27/71 percent by weight water/soil relationship which produced a mix with a Marshall Funnel Viscosity of 60 seconds and a density of about 105 lbs/ft^3. Sandy clay soil with a plasticity ranging from about 12 to 15 and less than 1 percent retained on the No. 4 screen performed well and is available on-site. The cement additive limited the

amount of grout shrinkage and cracking upon drying. Fly ash added at varying amounts did not appear to change the basic properties of the grout. The introduction of bentonite in small percentages adversely increased the grout viscosity which resulted in a need for additional water, resulting in lower solid content.

The use of a 1½-foot deep trench and subsequent washing and flooding to expose embankment cracks is not a totally effective method. Several cracks were exposed by deeper trenching that had no expression on the surface or within the shallow trenches.

A vast majority of the cracks observed are not detectable below a depth of 5 feet. In no case were open cracks found below 8 feet. A large number of cracks contain natural sandy infillings located below a highly eroded, open area which extends to an average depth of about 4 feet. The deepest crack was found at location ET-1 where a narrow crack was visible to a depth of 12 feet. Two large cracks which are longitudinal to the dam axis, have no surface expression, and are open between a depth of 3.5 and 8.0 feet were found at location ET-4.

It was not practical to effectively grout narrow uneroded cracks which normally do not extend below 3 feet. Where grout takes were appreciable, the vertical penetration in all cases was complete. It was found that a major portion of the grout was filling the

eroded sections of the crack which are located near the top of the dam. The penetration of grout laterally was not accomplished in several cases. Some cracks which appeared to cross the deep trenches were grouted in one trench side and open on the opposite trench wall. It is probable that some cracks are highly discontinuous.

3.4 Trench Stability

The stability of the walls of the seven trenches excavated in the dam crest was excellent. In all cases, no sluffing or failure of compacted dam fill was experienced. These trenches were left open for periods ranging from 6 to 9.5 days.

During the excavation of pits near the downstream toe, some caving was experienced in silty sand and gravel horizons. All this caving occurred in pits between Stations 100+00 and 150+00.

4. RECOMMENDATIONS RESULTING FROM FIELD PROGRAM

4.1 Depth of Toe Intercept

The depth of the toe intercept should be determined by the following criteria and procedures:

A. A minimum depth of 9 feet and a maximum depth of 10 feet with the following exception: 3-foot continuous penetration of strongly cemented soils below a depth of 4 feet.

B. The trenching operation should be constantly monitored with the rate of penetration recorded and used as a guide in establishing trench depth.

4.2 Grouting of Cracks

The following approach to the grouting of embankment cracks should be implemented.

A. Logging and location survey of cracks from the top of the center drain trench during construction.

B. Selection of cracks which need grouting by a comprehensive review by the design engineer.

C. Subsequent grouting on the upstream side of the center drain of selected cracks after the completion of the drain system.

D. Grout mix should be a soil/water product with a small percentage of cement in accordance with the description of the optimum mix discussed in Section 3.3.

4.2.2 Optimum Grout Mix Design

A laboratory grout testing program was carried out to determine the optimum amount of cement to add to a 75 percent soil and 25 percent water by weight grout mix.

Portland Cement concentrations of .5 percent to 2 percent by weight were tested. The primary purpose of the testing was to find out if the cement additive concentration would reduce shrinkage and cracking when the soil grout dries.

Two test series were performed for cement concentrations of .5 percent, 1 percent, 1.5 percent and 2 percent. Soil samples were from areas where soil would be borrowed for the soil grout. In each test, 750 grams of soil was well mixed with 250 grams of water. To obtain a .5 percent cement mix, 5 grams of Portland Cement was added to the mix and well blended. A sample was removed, and 5 more grams of cement was added and well blended to obtain the 1 percent cement mix. Again, a sample was taken and the process was repeated until samples of .5 percent, 1 percent, 1.5 percent and 2 percent cement mixes had been obtained.

Soil grout samples were placed in containers used for the shrinkage factor of soils test ASTM D427 and were processed and dried according to ASTM D427. After drying, the samples were examined and measured for shrinkage and evidence of cracking.

Results from the testing show that 1 percent cement by weight permits volumetric shrinkage in excess of 20 percent and may have large cracks even in the small samples used. At 2 percent cement content, the grout's volumetric shrinkage was below 10 percent, and no large cracks developed in the 1.5 percent or 2 percent cement grout mixes.

4.3 Trench Stability

Within the embankment soils, trench stability during construction of the center drain does not appear to be of major concern. Based upon present data, no shoring should be required to install the filter fabric or drain aggregate. Should caving conditions be encountered in a limited dam section, these conditions should be re-evaluated and the necessary provisions developed.

Caving may cause some difficulty in the excavation of the toe intercept, especially along the south one-half of the structure. Water could be introduced in this trench to increase stability.

5. GEOTEXTILE TESTING

The geotextile which will line both the center drain and the downstream cutoff will have required elastic properties peculiar to this particular use which are not described by the standard suite of tests run on a fabric. In order to analyze a geotextile's ability to strain across a crack in the dam, a special new laboratory test was devised in which the fabric-soil interaction was modelled yielding a measurable strain. The results of this special testing, as well as conventional testing, allowed the selection of several suitable geotextiles.

5.1 Description of Tests

5.1.1 Standard Testing

The standard tests which were performed included the following.

	ASTM	
Grab Strength	D1682	
Trapezoidal Tear	D751	
EOS		CW-02215
Puncture	D751	

These tests were modified in the following ways to allow testing with available equipment as well as to better simulate anticipated conditions for this particular application.

Grab Strength: A Tinius Olsen Super L Tensile testing machine was used. A minimum of three samples were tested in two perpendicular directions for each geotextile. Time for test varied for each geotextile, within the range of from 10 to 50 seconds. Samples were tested in the laboratory atmosphere and were not preconditioned prior to testing. The grips were padded for one of the woven geotextiles to prevent slippage. Elongation of sample was manually determined with a scale during the test.

Trapezoidal Tear: A Tinius Olsen Super L Tensile testing machine was used. Four samples were tested in two perpendicular directions for each geotextile. Machine strained geotextile at a rate of 3 inches per minute. Trapezoidal Tear load was determined by averaging the maximum load with the load measured after tearing approximately ½ inch.

EOS: The EOS test was performed according to the CW-02215 specifications.

Puncture: A Versa-Tester Model AP-1000 series hydraulically operated tension-compression testing machine was used. The burst test as described in ASTM D751, Tension Testing Machine with Ring Clamp, was followed, except that the straining rate was 3 inches per minute.

5.1.2 Pullout Testing

In a specially designed pullout test, a ½-inch plate steel box was used to contain a geotextile sample placed between a compacted clay soil and subangular 3/8-inch gravel. These soils simulate the center drain in McMicken Dam, modelling the interface between the drain rock and the existing clay dam with the geotextile separation. The test box was 24 inches by 24 inches in plan view and 9 inches in height. This

height allowed for 4 inches of compacted clay over which a 12-inch by 18-inch geotextile was placed; then 4 inches of uniformly graded gravel. Over the gravel, a 24-inch by 24-inch rubber air bladder was placed which could be pressurized to provide a variable pressure load of gravel against geotextile. The test box had a ½-inch slot cut in one side 4 inches from the bottom and 18 inches long as shown in photos in Appendix C. The geotextile protruded 2 inches from the slot and was gripped by a 1½-inch by 18-inch grip along its 12-inch wide exposed side. Testing consisted of the following sequence.

A. Selection and cutting representative geotextile sample 12-inch by 18-inch. Samples were cut with 18-inch dimension taken from machine or warp of roll direction as opposed to width of roll direction. This assures testing anisotropic geotextiles in principal axis of loading should a crack develop in the dam across the center drain.

B. Geotextile was placed in test box and buried under 4 inches of gravel, then pressure loaded to either 5 psi or 10 psi to simulate at-rest earth pressure against the fabric at the mid-depth trench location of 12.5 feet or the deepest depth of 25 feet.

C. Geotextile was loaded with a hand operated tensioning device with load measured with a direct reading tension load cell. Load could be measured to 1,600 pounds in 1-pound increments. As geotextile was loaded, the strain was measured with a dial gauge located in the middle of the grip. Loads in excess of 1,600 pounds were not measured.

D. Each test was continued until the geotextile either failed or strained 1 inch.

5.1.3 Geotextile Permeability Testing

A permeability testing program was performed to determine the effects of water borne soil clogging on the center drain and toe cutoff geotextiles.

Seven permeable geotextiles were tested with a specially constructed constant head permeameter which allowed for gradual addition of known amounts of turbid water. The permeameter was designed such that the turbid water passed horizontally through a vertically held geotextile sample which was approximately 2.7 inches in diameter.

The turbid water was prepared by mixing a known weight of embankment soil with a known volume of water. This mixture was vigorously stirred for 1 minute and allowed to settle for 2 minutes. The turbid water sample was then decanted off the top of the mixture, leaving behind any coarse silt or sand size particles.

Testing consisted of establishing a constant head flow through the geotextile, then adding 50 milliliters (ml) of turbid water. The soil particles would either pass through the geotextile or be caught on the geotextile. The reduction in permeability of the particular geotextile after the addition of 50 ml of turbid water is shown in Table C-1, Appendix C. Next, 400 additional ml's of turbid water was added bringing the total to 450 ml. After the flow rates had

become stabilized, the apparent permeability of the geotextiles decreased to the values shown in Table C-1, Appendix C.

Five of the seven geotextiles were reduced in permeability to near the lower limit of measurement, approximately 10^{-8} cm/s. Two others, the Polyfilter X and Mirafi 140N, were still sufficiently permeable and an additional 200 ml of turbid water were added. This time the turbid water contained a homogeneous embankment soil and water mixture. The permeability values for this condition is shown in Table C-1, Appendix C. In all cases, the reduction in permeability occurred in less than 15 minutes, and usually in from 30 seconds to 2 minutes.

5.2 Results of Testing

5.2.1 Standard Testing

The results of standard testing described in Section 5.1.1 are shown in Table C-2, Appendix C.

5.2.2 Pullout Testing

The results of pullout testing described in Section 1.2.2 are shown in Figures 1 through 4, Appendix C. It was observed during testing that the portion of the geotextile sheet which elongated due to the pullout load would become smeared with the clay underlying it. This smearing allowed for an approximate

determination of the effective length of geotextile which was straining. Photos of this soil smear on the geotextiles after testing are shown in pictures in Appendix C. The length of smear was approximate and is listed with the pullout load results in Table C-3, Appendix C.

5.2.3 Results of Permeability Testing

The results of the permeability testing program yield the following information:

1. The passage of 450 ml of turbid water through the geotextile reduces the permeability from 3 to 4 orders of magnitude for 6 to 7 geotextiles.

2. The odd geotextile, Mirafi 140N, experienced a reduction in permeability of less than two orders of magnitude with the passage of 450 ml of turbid water. After the passage of an additional 200 ml of a homogeneous embankment soil-water mixture, the permeability was reduced to between 3 and 4 orders of magnitude.

5.3 Geotextile Testing Conclusions

5.3.1 Standard Testing Conclusions

Manufacturers frequently list geotextile test properties using differing criteria, such as average values, minimum average values, minimum specified values, etc. Additionally, each manufacturer frequently uses a variation of one of the standard test

procedures, making direct comparison of geotextiles difficult. To compare the geotextiles tested under the same procedures and conditions, the standard testing presented in Section 5.1 was used.

5.3.1.1 Puncture Testing

The puncture testing results exhibited a range from 101.6 pounds to 435.6 pounds. Primarily as a protection against installation stresses caused by handling the geotextile and placement of drain rock, a minimum puncture of 150 pounds is recommended.

5.3.1.2 Equivalent Opening Size (EOS) Testing

The EOS test (CW-02215) results exhibit a wide range of U.S. Standard sieve opening sizes for the geotextiles tested. The optimum geotextile would have a small enough EOS to catch turbid water particles which would be entering the gravel drain through either a crack or subsidence fissure. The particles would develop a filter cake on the upstream surface of the fabric, significantly reducing the permeability of the geotextile at the crack. The geotextile must have sufficient permeability to drain other areas of the dam where nonerosive head concentrations develop through hairline cracks and more permeable zones adjacent to major cracks or fissures.

The EOS testing is only applicable to geotextiles which will be used on the upstream side of the gravel drain and in the downstream toe cutoff.

To allow for the greatest range of geotextiles to select from, the average EOS may range from 30 to greater than 170.

5.3.1.3 Grab Testing

The grab test results are shown in Table C-2, Appendix C. These test results are for the two principal directions of the geotextile. Of major consideration is the orientation of the geotextile in the McMicken Dam center drain and toe cutoff. Subsidence fissuring would tend to cause elongation along the warp or machine direction of the installed fabric, and this direction as well as the perpendicular direction to it, or the weft of the geotextile, was tested. It is important to note that the grab strength at directions other than these two principal directions could be significantly less than indicated by these results, especially for woven geotextiles.

The results show the ranges of strengths for the geotextiles which passed the pullout test.

5.3.1.4 Trapezoidal Tear Testing

The trapezoidal tear test results are shown in Table

C-2, Appendix C. As with the grab test described in Section 5.3.1.3, the trapezoidal tear tests were run on the two principal directions for each geotextile.

The results show the ranges of tear strengths for the geotextiles which passed the pullout test.

5.3.2 Pullout Testing

As shown in Table C-3, Appendix C, the results of the pullout testing graphically determine which of the geotextiles will successfully bridge across a hypothetical 1-inch wide crack or fissure through the drain. The testing procedures modelled half of the crack, so a geotextile which elongated 1 inch in the test would successfully bridge a 2-inch crack or fissure in the dam. This 1-inch acceptance criteria yields a factor of safety of 2 to failure and is deemed prudent to allow for some loss of strength with time.

5.3.2.1 Pullout of Coated Geotextiles

Of four coated geotextiles tested at 5 psi surface loading, three successfully elongated 1 inch. These geotextiles were Mirafi MCF600, Mirafi MCF500 and Typar T063. Subsequent testing at 10 psi showed acceptable elongation in three of the four geotextiles tested. The Mirafi MCF500 and Typar T063 and two new geotextiles, AMOCO C7305 and AMOCO P6838, were

tested. The AMOCO P6838 continuously yielded from 0.807 to 1.2 inches prior to break and was not acceptable. Therefore, three coated geotextiles are acceptable for use in the center drain, Mirafi MCF-500, Typar T063 and Amoco C7305.

5.3.2.2 Pullout of Geotextiles

Seven geotextiles are acceptable with respect to pullout testing. These fabrics included Propex 1325, Polyfilter X, Fibertex Ten-1, Mirafi 140N, Mirafi 500X, Typar 3601 and Transguard 2000. A list of manufacturers of these and other potentially acceptable geotextiles is given in Appendix C.

5.3.3 Conclusions of Permeability Testing

Should an open crack or fissure through the McMicken Dam embankment ever allow flood storage water to come in contact with the permeable geotextile in the center drain or downstream toe cutoff, the erosive and turbid water flowing through the crack would rapidly plug the geotextile. This plugging would result in little flow through the geotextile and, therefore, little flow through the open crack. Erosion would be minimized by this action, both upstream erosion into the center drain, and downstream piping under the foundation soils under the toe of the embankment.

6. CONSTRUCTION CONCEPT

6.1 Embankment

The construction of the embankment to elevation 1361 MSL will be accomplished by adding sufficient fill on the upstream slope (at 2.5 horizontal to 1 vertical) to attain elevation 1361 and a 12-foot minimum crest width. To do this in the most economical manner (minimum volume of embankment), the downstream crest shoulder will be the control point on each section. Refer to typical sections in Appendix D. A possible construction sequence would bring the embankment up to elevation 1357-59, install the centerline drain trench, then add the "cap" embankment up to elevation 1361. The foundation will be prepared by stripping, scarifying, and adjusting moisture. The new embankment and the existing embankment will be bonded by benching approximately 2.5 feet horizontal by 1 foot vertical into the existing dam as the embankment advances.

Embankment materials will be obtained from the existing upstream borrow area, the embankment from the original dike lying on the downstream side of the dam north of Station 358+00, and the stockpiled material that was previously excavated from the breached areas.

6.2 Trench Drain

The trench drain concept was designed to minimize the need for workmen to enter the trench. Manufacturers of

geotextiles have advised the designers that the materials can be furnished in a fabricated form in rolls or folded sections to meet the contractor's installation requirements. As there is no known history of a similar installation of geotextiles, the production rate and cost of installation will be dependent on the resourcefulness of the contractor. The design, as conceived, should permit a continuous, relatively efficient production operation of installing the geotextiles and drain rock.

6.3 Drain Rock

Because of the large quantity (100,000 $yd^3 \pm$) and the lack of native local materials suitable for this specification, many area suppliers of aggregates were contacted. It was deemed desirable to obtain a uniform size material to provide a high permeability rate (from 3 to 30 cm/sec or greater). Several sources of suitable material were found that should be available at low cost as they are by-product or surplus to the operations that produce them. The large volume, along with anticipated production rate that will be required to maintain a reasonable progress schedule, would burden any single producer of aggregates along the Agua Fria River. The closest source of manufactured materials is about 7 miles from the project at the closest point. Other sources are available at distances up to about 20 miles.

6.4 Downstream Toe Cutoff

A single sheet of pervious geotextile material will be installed in a narrow trench at the downstream toe of the dam. The width of the sheet will be the same as the trench depth. It is anticipated that a trenching machine (wheel or ladder, continuous bucket) would be most efficiently used to excavate the trench. The geotextile will be installed and temporarily secured to lie against the upstream wall of the trench. Backfill will be placed in a loose condition without special compactive effort. This will minimize the restraint on the fabric to yield if a crack occurs.

The downstream toe cutoff was originally conceived as a blind drain to intercept flow through a fissure which might propagate through potentially erodible soils under the dam embankment. Any flow thus intercepted would flow longitudinally in the drain and eventually percolate into the soil. With this concept, the drain would have been similar in construction to the center drain trench.

It was later determined that the permeability of the geotextile would be quickly diminished from 2 to 4 orders of magnitude when exposed to a flow of water carrying soil fines. Therefore, it was decided that a single sheet of geotextile would form an effective barrier to crack propagation without the added cost of constructing this barrier as a dual function barrier and drain.

6.5 Quantities

Quantities for the various items of construction are listed in Appendix D.

6.6 Crack Grouting

It was deemed to be unnecessary to precede the drain construction with a crack grouting program. It was further deemed to be impractical to attempt to quantify the amount of grouting that may be required. The excavation of the drain trench will be inspected in its entirety by a qualified inspector. If any large cracks or voids are observed, the Design Engineer will be consulted for appropriate action. The exact location of the crack or void will be determined. An excavation or boring will be made to gain access to the crack or void after the drain trench has been constructed. Grout will be placed in the manner described in Section 4.

7. OUTLET DRAIN SPACING

The criteria for outlet drain spacing is a function of many variables. The drain rock which will be used in the center drain will have permeability coefficient (k) ranging from 3 cm/sec to 30 cm/sec. The following volume distribution of gravel in the center drain was assumed:

Gravel	Permeability (cm/s)	(ft/sec)	Percent Volume
1	3.0	.098	33.3
2	10.0	.328	33.3
3	30.0	.984	33.3

Given this center drain gravel, the capacity of an individual outlet drain is determined empirically.

7.1 Center Drain Capacity

The capacity of the granular drain is a function of the following parameters:

k = permeability (ft/sec)
d = length of drainage (ft) = ½ drain spacing
h = height of water in drain at point of inflow (ft)
b = width of drain (ft)

The capacity is calculated using the following equation:

$q = k\ (d^2+h^2 - d)$ (Casagrande, 1937*)

where q is the outflow capacity in cubic feet per second (cfs).

Various capacities are shown in Table E-1, Appendix E, for varying head, drain spacing, and permeability of drain rock.

7.2 Outlet Spacing

The capacity equation assumes the inflow into the drain occurs midway between drains and can be considered the worst case minimum capacity.

With the individual outlet capacities for the various variable parameters, the optimum drain layout plan was attempted. Consideration was given to provide extra drainage capacity in areas of observed collapse settlement cracking of the embankment, as well as to have greater drainage in an area of probable subsidence fissuring. Concentrations of observed cracking in Stations 270+00 to 285+00, 300+00 to 310+00, 355+00, 415+00 to 475+00, and 485+00 to 495+00 were considered. It is understood that a subsidence fissure could occur practically anywhere along the embankment's alignment; however, the higher tension straining of the embankment between Stations 50+00 to 100+00 indicates this area has the highest probability of fissuring.

*References are listed at end of report.

Physical geometric data for determining drain spacing at particular stationing along the dam is given in Table E-2, Appendix E. This information is based on the crest elevations reported in the Phase II report (SHB, 1982) and the design top elevation of the drain of 1357 feet. The design elevation of the drain top will allow all storage during the passing of a PMP event to be at or below this elevation.

The distribution of various permeability drain gravels by station along the embankment is shown in Table E-3, Appendix E. This distribution will allow for drains to be located at the stationing shown in Table E-4, Appendix E. The individual outlet capacity per foot of center drain width is also listed in Table E-4, Appendix E. Should the drain rock permeability quantities vary substantially from the assumed distribution, the outlet drains could be spaced differently using the established criteria and desired outlet capacity. A detail of a typical outlet is shown in Figure E-1, Appendix E.

8. HYDROLOGY

A hydrological analysis has been made. The report is submitted under SHB Job No. E82-114. The analysis concludes that the emergency spillway is adequate to pass the PMF outflow with a maximum pool elevation of 1357 feet MSL. This information is based on the existing topography and assumes the dam is repaired as designed.

9. EMBANKMENT STABILITY

The slope stability of the center drain repair concept was analyzed in Section 6.3 of the Geotechnical Investigation Report (SHB, 1982). The typical section analyzed was 26 feet high with 2:1 (horizontal to vertical) downstream slopes and 2½:1 upstream slopes. Full hydrostatic forces in the drain zone was assumed, while boundary water forces which would tend to stabilize the upstream face were not considered. The shear strength parameters utilized in the stability analyses are shown in Table 6 of the investigation report. The results of the analysis are shown in Figure 25 of the investigation report.

REFERENCES

Casagrande, A., 1937, "Seepage Through Dams", New England Water Works Association, Volume LI., No. 2.

Sergent, Hauskins & Beckwith Geotechnical Engineers, Inc., 1982, "Final Geotechnical Investigation Report, McMicken Dam Restoration Study, Maricopa County, Arizona", SHB Job No. E81-138, Phase II, July.

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. Where auger and tricone gear bits cannot be used to advance the hole due to cobbles or caving conditions, the ODEX (overburden drilling with the eccentric method) is used. A percussion down-the-hole hammer underreams the hole and 5 inch steel casing is introduced into the hole during drilling. The drill bit is eccentric and can be removed from the center of the casing to allow sampling of the material below the bit penetration depth.

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.

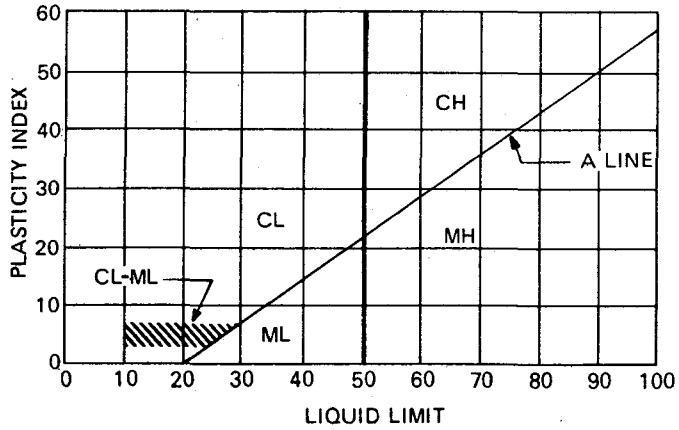
UNIFIED SOIL CLASSIFICATION SYSTEM

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

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. E82-111 DATE 10-8-82

LOG OF TEST PIT NO. TP-1

Backhoe Type Case 580C

Location

Elevation

Datum

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 fine sand, medium plasticity, brown
			D		CL	very slightly moist	SILTY CLAY, some sand & fine gravel, weakly to moderately lime cemented, medium plasticity, brown
5						very slightly moist	SILTY SAND, considerable clay in lenses, some gravel, predominantly fine to medium grained, cemented, very low plasticity, brown
			D		SM-SC	slightly moist	SAND, occasional lens of gravel, fine grained, cemented, nonplastic, brown
					SP		Stopped backhoe at 10'
10							

DATE 10-8-82

LOG OF TEST PIT NO. TP-2

Backhoe Type Case 580C

Location

Elevation

Datum

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, low to medium plasticity, brown
			D		CL	very slightly moist	SILTY CLAY, some sand, trace of gravel, weakly lime cemented, low to medium plasticity, brown
5			D		SP-SM	very slightly moist	SAND & SILTY SAND, some gravel, poorly graded, predominantly fine to medium grained, predominantly angular, nonplastic to low plasticity, brown
					CL	very slightly moist	SILTY CLAY, small amount of sand, weakly to moderately lime cemented, medium to low plasticity, brown
							Stopped backhoe at 7'6"
10							

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

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PROJECT McMicken Dam Restoration Study

JOB NO. E82-111 DATE 10-8-82

LOG OF TEST PIT NO. TP-3

Backhoe Type Case 580C

Location

Elevation

Datum

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, trace of sand & gravel, weakly lime cemented, medium plasticity, light brown
			D		CL	slightly moist	SILTY CLAY, considerable sand, small amount of gravel, medium plasticity, brown
5					CL	very slightly moist	SILTY CLAY, small amount of sand & gravel, weakly to moderately lime cemented, medium plasticity, light brown
							Stopped backhoe at 6'6"
10							

DATE 10-8-82

LOG OF TEST PIT NO. TP-4

Backhoe Type Case 580C

Location

Elevation

Datum

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 & fine, angular to subangular gravel, medium plasticity, brown note: very weakly cemented lens from 3' to 4'
5			D		SC	moist to slightly moist	CLAYEY SAND, some fine, angular to subangular gravel, well graded, weakly lime cemented in stringers, medium to high plasticity, dark brown
					CL	slightly moist	SILTY CLAY, some sand & fine gravel, weakly to moderately lime cemented, medium plasticity, light brown
10							Stopped backhoe at 9'

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

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JOB NO. E82-111 DATE 10-8-82

LOG OF TEST PIT NO. TP-5

Backhoe Type Case 580C

Location

Elevation

Datum

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, considerable well graded sand & fine, angular to subrounded gravel, medium plasticity, brown
			D		SC	slightly moist	CLAYEY SAND, some gravel, weakly lime cemented, medium plasticity, brown note: moderately cemented below 3½'
5			D		SP	very slightly moist	SAND, considerable silt, some fine, angular to subangular gravel, predominantly fine to medium grained, some well graded lenses, nonplastic, light gray to brown
10							Stopped backhoe at 7'6"

DATE 10-8-82

LOG OF TEST PIT NO. TP-6

Backhoe Type Case 580C

Location

Elevation

Datum

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, considerable sand, some fine, subangular to subrounded gravel, medium plasticity, brown
			D		CL	very slightly moist	SILTY CLAY, considerable sand & gravel, 6" lens of clayey sand at 3', weakly lime cemented, medium to low plasticity, light brown
5			D		SW	slightly moist	SAND, considerable silt & fine, subangular to subrounded gravel, well graded, weakly cemented, stratified, nonplastic, brown
					GP	slightly moist	SAND & GRAVEL up to 4" in diameter, poorly graded, rounded to subangular, weakly to moderately cemented, nonplastic, brown
10							Stopped backhoe at 7'6"

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

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JOB NO. E82-111 DATE 10-8-82

LOG OF TEST PIT NO. TP-7

Backhoe Type Case 580C

Location

Elevation

Datum

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, small amount of sand & fine gravel, weakly lime cemented below 1½', medium plasticity, brown to light brown
5			D		GM & ML	slightly moist	SILTY SAND & GRAVEL, some clay, silt & gravelly silt lenses, predominantly fine to medium sand, rounded to sub-angular gravel, up to 4" in diameter, weakly lime cemented, low plasticity, brown
10							Stopped backhoe at 9'6"

DATE 10-8-82

LOG OF TEST PIT NO. TP-8

Backhoe Type Case 580C

Location

Elevation

Datum

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, trace of gravel, medium plasticity, brown
5			D		GC	slightly moist	CLAYEY GRAVEL & SAND, some sandy clay lenses, occasional cobbles, predominantly fine to medium grained, sub-angular to subrounded, weakly lime cemented, medium plasticity, dark brown
			D		CL	very slightly moist	SILTY CLAY, small amount of sand, weakly to moderately lime cemented, medium plasticity, brown
10							Stopped backhoe at 7'6"

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

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JOB NO. E82-111 DATE 10-8-82

LOG OF TEST PIT NO. TP-9

Backhoe Type Case 580C

Location

Elevation

Datum

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, trace of fine, subangular to subrounded gravel, medium plasticity, brown
5			D		CL	very slightly moist	SILTY CLAY, some sand & fine, subangular to subrounded gravel, weakly lime cemented, medium plasticity, light brown
			D		SC	slightly moist	CLAYEY SAND & GRAVEL, considerable silt, some sandy clay lenses, well graded, angular to subrounded, weakly lime cemented, low to medium plasticity, brown
10							Stopped backhoe at 7'6"

DATE 10-8-82

LOG OF TEST PIT NO. TP-10

Backhoe Type Case 580C

Location

Elevation

Datum

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	moist to slightly moist	CLAY, considerable silt & sand, some fine gravel, medium plasticity, dark brown
			D		GM	very slightly moist	SILTY GRAVEL & SAND, some clay, well graded, angular to subangular, moderately to strongly lime cemented, nonplastic to low plasticity, gray
5							Backhoe refused at 4'6" on very strongly cemented material

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

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JOB NO. E82-111 DATE 10-11-82

LOG OF TEST PIT NO. TP-11

Backhoe Type Case 580C

Location

Elevation

Datum

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 & fine, sub-rounded to angular gravel, weakly cemented below 1½', medium plasticity, brown
			D		SP SC	very slightly moist	SAND, considerable fine, angular to subangular gravel in lenses, some clay, predominantly fine to medium grained, weakly to moderately lime cemented, low plasticity, light brown
5						slightly moist	CLAYEY SAND & GRAVEL, considerable silt, well graded, angular to sub-rounded, weakly to moderately cemented, low to medium plasticity, brown
							Stopped backhoe at 5'6"
10							

DATE 10-11-82

LOG OF TEST PIT NO. TP-12

Backhoe Type Case 580C

Location

Elevation

Datum

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		SC	slightly moist	CLAYEY SAND, some silt & fine, angular to subangular gravel, weakly cemented below 2', medium plasticity, brown
5			D		SM	slightly moist	SILTY SAND, some clay & fine, angular to subangular gravel, well graded, weakly cemented, moderately cemented below 5', stratified, low plasticity, brown
							Stopped backhoe at 6' in hard material
10							

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

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JOB NO. E82-111 DATE 10-11-82

LOG OF TEST PIT NO. TP-13

Backhoe Type Case 580C

Location

Elevation

Datum

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, small amount of fine, angular to subangular gravel, weakly lime cemented below 1', weakly to moderately lime cemented below 6', low to medium plasticity, brown note: thin lens of considerable gravel at 5'
5							
10							Stopped backhoe at 8'

DATE 10-11-82

LOG OF TEST PIT NO. TP-14

Backhoe Type Case 580C

Location

Elevation

Datum

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		SC	very slightly moist	CLAYEY SAND, some fine, angular to subangular gravel, weakly lime cemented below 3', low plasticity, brown
5			D		SM	very slightly moist	SILTY SAND, considerable gravel, well graded, angular to subrounded, areas of weak cementation, stratified, non-plastic to low plasticity, brown
10							Stopped backhoe at 8'6"

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

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JOB NO. E82-111 DATE 10-11-82

LOG OF TEST PIT NO. TP-15

Backhoe Type Case 580C

Location

Elevation

Datum

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	very slightly moist	SILTY CLAY, considerable fine to medium grained sand, some fine, angular to subangular gravel, very weakly cemented below 1½', medium to low plasticity, brown
5			D	4	SC	very slightly moist	CLAYEY SAND, considerable gravel, some silt, well graded, angular to subrounded, very weakly cemented, stratified, low plasticity to non-plastic, brown
10							Stopped backhoe at 8'

DATE 10-11-82

LOG OF TEST PIT NO. TP-16

Backhoe Type Case 580C

Location

Elevation

Datum

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	very slightly moist	SILTY CLAY, some sand, trace of gravel, very weakly lime cemented below 1½', very weakly stratified, medium plasticity, brown
5			D		SM	very slightly moist	SILTY SAND, some fine, angular to subangular gravel, lens of silty sand & gravel from 6' to 6½', predominantly fine to medium grained, weakly cemented, stratified, non-plastic to low plasticity, brown
10							Stopped backhoe at 7'6"

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

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JOB NO. E82-111 DATE 10-11-82

LOG OF TEST PIT NO. TP-17

Backhoe Type Case 580C

Location

Elevation

Datum

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						very slightly moist	SILTY SAND & GRAVEL, some clay, well graded, angular to subrounded, very weakly cemented, stratified, nonplastic to low plasticity, brown to dark brown
			D		SM		
5							
							Stopped backhoe at 7'6"
10							

DATE 10-11-82

LOG OF TEST PIT NO. TP-18

Backhoe Type Case 580C

Location

Elevation

Datum

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						very slightly moist	SILTY, SANDY CLAY, trace of fine, angular gravel, weakly cemented below 1', weakly to moderately cemented below 3', low to medium plasticity, brown
			D		CL		
5							
							Stopped backhoe at 5'6" on strongly cemented material
10							

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

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JOB NO. E82-111 DATE 10-11-82

LOG OF TEST PIT NO. TP-19

Backhoe Type Case 580C

Location

Elevation

Datum

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	very slightly moist	SANDY SILT, trace of clay & gravel, low plasticity, brown
5		X	D	2	SW-SM	very slightly moist	SILTY SAND, considerable angular to subrounded gravel in lenses, well graded, stratified, nonplastic, brown note: occasional thin 2½" sandy silt lenses
10							Stopped backhoe at 7'6"

DATE 10-12-82

LOG OF TEST PIT NO. TP-20

Backhoe Type Case 580C

Location

Elevation

Datum

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		CL	very slightly moist	SILTY CLAY, some sand, small amount of fine, angular to subrounded gravel, weakly lime cemented below 1', medium plasticity, light brown
5		X	D		SW-SM	slightly moist	SAND, some lenses of silty sand & gravel, predominantly well graded, angular to subangular, stratified, nonplastic, light brown
					CL	very slightly moist	SILTY CLAY, some sand & gravel, weakly to moderately lime cemented, medium plasticity, light brown to brown
10							Stopped backhoe at 7'6"

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

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JOB NO. E82-111 DATE 10-12-82

LOG OF TEST PIT NO. TP-21

Backhoe Type Case 580C

Location

Elevation

Datum

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, considerable sand, some fine gravel, weakly lime cemented below 1', medium plasticity, light brown
5			D	5	SC	slightly moist	CLAYEY SAND, some fine gravel, weakly lime cemented, stratified, medium plasticity, light brown
			D		SM	slightly moist	SILTY SAND, some lenses of clayey sand, silty sand & gravel, predominantly well graded, angular to subangular, stratified, low plasticity, brown
10							Stopped backhoe at 8'

DATE 10-12-82

LOG OF TEST PIT NO. TP-22

Backhoe Type Case 580C

Location

Elevation

Datum

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, trace of fine gravel, medium plasticity, brown
5			D		CL	very slightly moist	SILTY CLAY, some sand, small amount of gravel, weakly to moderately lime cemented, medium plasticity, light brown
10							Stopped backhoe at 6'

SAMPLE TYPE

B — Undisturbed Block Sample

D — Disturbed Bulk Sample

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PROJECT McMicken Dam Restoration Study

JOB NO. E82-111 DATE 10-12-82

LOG OF TEST PIT NO. TP-23

Backhoe Type Case 580C

Location

Elevation

Datum

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, small amount of fine gravel, medium plasticity, light brown
			D		CL	slightly moist	SILTY CLAY, some sand & gravel, weakly to moderately lime cemented, medium plasticity, light brown
5							Stopped backhoe at 5'

DATE 10-12-82

LOG OF TEST PIT NO. TP-24

Backhoe Type Case 580C

Location

Elevation

Datum

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, small amount of fine, angular to subangular gravel, weakly lime cemented below 3', medium to high plasticity, brown
5			D		SC	slightly moist	CLAYEY SAND, considerable fine, angular to subrounded gravel in lenses, predominantly well graded, weakly cemented, stratified, low to medium plasticity, brown
10							Stopped backhoe at 8'6"

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

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JOB NO. E82-111 DATE 10-12-82

LOG OF TEST PIT NO. TP-25

Backhoe Type Case 580C

Location

Elevation

Datum

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	8	CL	moist to slightly moist	SILTY CLAY, some sand, trace of fine gravel, weakly lime cemented below 2', medium plasticity, light brown to brown
5			D		SM	slightly moist	SILTY SAND, some clay, predominantly fine to medium grained, stratified, low plasticity, brown
10							Stopped backhoe at 8'

DATE 10-12-82

LOG OF TEST PIT NO. TP-26

Backhoe Type Case 580C

Location

Elevation

Datum

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		CH	moist	SILTY CLAY, some sand & fine gravel, medium to high plasticity, dark brown
			D		CL	slightly moist	SILTY CLAY, some sand & fine gravel, weakly lime cemented, medium plasticity, brown
5			D		SM	slightly moist	SILTY SAND, considerable gravel in lenses, some clay, predominantly fine to medium grained, well graded, angular to subangular, stratified, low plasticity, brown
10							Stopped backhoe at 7'6"

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

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JOB NO. E82-111 DATE 10-12-82

LOG OF TEST PIT NO. TP-27

Backhoe Type Case 580C

Location

Elevation

Datum

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						very slightly moist	CLAYEY SILT, some sand & fine gravel in thin lenses, low plasticity, light brown
			D	4	ML		
5							
10							Stopped backhoe at 8'

DATE 10-12-82

LOG OF TEST PIT NO. TP-28

Backhoe Type Case 580C

Location

Elevation

Datum

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						very slightly moist	SILTY CLAY, some fine sand & gravel, weakly lime cemented below 1½', medium plasticity, light brown
			D	9	CL		
5						very slightly moist	SILTY SAND, some fine, angular to subangular gravel, predominantly fine to medium grained, weakly cemented, stratified, low plasticity, light brown
			D		SM		
10							Stopped backhoe at 7'6"

SAMPLE TYPE

B — Undisturbed Block Sample

D — Disturbed Bulk Sample

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JOB NO. E82-111 DATE 10-12-82

LOG OF TEST PIT NO. TP-29

Backhoe Type Case 580C

Location

Elevation

Datum

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	very slightly moist	SILTY CLAY, some sand & gravel in lenses, low to medium plasticity, light brown
5			D		CL	slightly moist	SILTY CLAY, some sand & fine gravel, weakly lime cemented, medium plasticity, brown
10							Stopped backhoe at 7'6"

DATE 10-12-82

LOG OF TEST PIT NO. TP-30

Backhoe Type Case 580C

Location

Elevation

Datum

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	6	CL	slightly moist	SILTY, SANDY CLAY, some lenses of silty sand with considerable clay & clayey sand, small amount of fine, angular to subangular gravel, moderate stratification, low to medium plasticity, brown
5					CL	slightly moist	SILTY CLAY, considerable sand, weakly to moderately lime cemented, medium plasticity, brown
10							Stopped backhoe at 7'6"

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

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JOB NO. E82-111 DATE 10-12-82

LOG OF TEST PIT NO. TP-31

Backhoe Type Case 580C

Location

Elevation

Datum

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	very slightly moist	SILTY CLAY, considerable sand, some fine, angular to subangular gravel, medium plasticity, light brown
			D		SC	moist	CLAYEY SAND, considerable gravel, well graded, angular to subangular, weakly lime cemented, stratified, medium plasticity, dark brown
5			D		CH	moist	SILTY CLAY, some sand & fine gravel, weakly to moderately lime cemented, medium to high plasticity, dark brown to brown
							Stopped backhoe at 7'
10							

DATE 10-13-82

LOG OF TEST PIT NO. TP-32

Backhoe Type Case 580C

Location

Elevation

Datum

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	4	ML	slightly moist	CLAYEY SILT, some sand & fine, angular to subangular gravel, weakly lime cemented below 2', low plasticity, light brown
			D		CH	moist	SILTY CLAY, some fine sand & well graded sand in pockets, weakly lime cemented, high plasticity, dark brown
			D		CL	slightly moist	SILTY CLAY, some sand & fine gravel, weakly lime cemented, medium plasticity, brown
5					CL	slightly moist	SILTY CLAY, considerable angular to subangular gravel, some sand, weakly to moderately lime cemented, moderately stratified, medium plasticity, brown
							Stopped backhoe at 6'6"
10							

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

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JOB NO. E82-111 DATE 10-13-82

LOG OF TEST PIT NO. TP-33

Backhoe Type Case 580C

Location

Elevation

Datum

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		GM	very slightly moist	SILTY SAND & GRAVEL, occasional cobbles up to 4" in diameter, well graded, nonplastic to very low plasticity, light brown
5			D	5	CL	slightly moist	SILTY CLAY, some sand & fine to medium gravel, occasional pocket of medium to high plasticity clay & occasional pocket of clayey sand, weakly lime cemented below 5', moderately stratified, low plasticity, brown to light brown
10							Stopped backhoe at 7'6"

DATE 10-13-82

LOG OF TEST PIT NO. TP-34

Backhoe Type Case 580C

Location

Elevation

Datum

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		ML	slightly moist	CLAYEY SILT, some sand & fine gravel, low plasticity, brown
			D		GM	very slightly moist	SILTY SAND & GRAVEL, well graded, angular to subangular, moderately stratified, nonplastic to very low plasticity, brown note: test pit walls caved
5			D		CL	slightly moist	SILTY CLAY, small amount of sand & fine gravel, weakly lime cemented, medium plasticity, brown
10							Stopped backhoe at 7'6"

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

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JOB NO. E82-111 DATE 10-13-82

LOG OF TEST PIT NO. TP-35

Backhoe Type Case 580C

Location

Elevation

Datum

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	1	SW-SM	very slightly moist to slightly moist	SILTY SAND, considerable gravel, well graded, angular to subangular, moderately stratified, nonplastic, brown note: wall caving
5			D		ML	very slightly moist	CLAYEY SILT, some fine sand, weakly lime cemented, low plasticity, light brown
10							Stopped backhoe at 9'

DATE 10-13-82

LOG OF TEST PIT NO. TP-36

Backhoe Type Case 580C

Location

Elevation

Datum

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	very slightly moist	SILTY CLAY, some sand & fine, angular gravel, weakly lime cemented below 1', medium plasticity, brown
5			D	3	GC	very slightly moist	CLAYEY GRAVEL & SAND, some cobbles up to 1' in diameter, well graded, angular to subangular, weakly lime cemented, moderately stratified, nonplastic to low plasticity, brown
10							Stopped backhoe at 7'

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

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JOB NO. E82-111 DATE 10-13-82

LOG OF TEST PIT NO. TP-37

Backhoe Type Case 580C

Location

Elevation

Datum

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 & fine gravel, weakly lime cemented below 2', medium plasticity, brown
5			D		GM	very slightly moist	SILTY GRAVEL & SAND, some cobbles, well graded, angular to subangular, very weakly lime cemented, moderately stratified, nonplastic, light brown note: decrease in gravel & cobbles below 6'
10							Stopped backhoe at 7'6"

DATE 10-13-82

LOG OF TEST PIT NO. TP-38

Backhoe Type Case 580C

Location

Elevation

Datum

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	very slightly moist	SANDY SILT, low plasticity, brown
			D	1	GP-GM	very slightly moist	GRAVEL, considerable silt & sand, cobbles to 1½' in diameter, well graded, angular to subangular, stratified, nonplastic, brown note: wall caving
5					GC	slightly moist	CLAYEY SAND & GRAVEL, considerable silt, well graded, angular to subangular, stratified, low plasticity, brown
10							Stopped backhoe at 7'6"

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

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JOB NO. E82-111 DATE 10-13-82

LOG OF TEST PIT NO. TP-39

Backhoe Type Case 580C

Location

Elevation

Datum

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	4	CL	slightly moist	SILTY CLAY, considerable sand & gravel, weakly lime cemented below 1½', medium plasticity, brown
5		X	D		GM	very slightly moist	SILTY GRAVEL & SAND, some cobbles, well graded, angular to subangular, weakly lime cemented, moderately stratified, nonplastic to very low plasticity, light brown
10							Stopped backhoe at 6'6"

DATE

LOG OF TEST PIT NO.

Backhoe Type

Location

Elevation

Datum

GROUND WATER

DEPTH	HOUR	DATE

Depth in Feet	Graphical Log	Sample	Sample Type	Moisture Content Per Cent of Dry Wt.	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION

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

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McMicken Dam Restoration Study
Maricopa County, Arizona
SHB Job No. E82-111

Log of Test Trench ET-1 December 14, 1982

Centerline Station 281+45 to 281+65

Located parallel to centerline along crest of dam

Equipment Type: American 35A Backhoe with 26-inch bucket

Trench Length: 20 feet

Trench Depth: 20 to 24 feet

Condition of Excavation

Trench stability excellent; no sloughing of trench walls; top 1 foot loose due to previous shallow trenches. Trench left open for six days with no change in conditions.

Embankment Soil Description

Highly stratified sequence of clayey sand with fine gravel and sandy clay with a trace of fine gravel; weakly cemented throughout with moderate induration between 2 to 3½ feet; with the exception of top foot, very firm and moist; medium plasticity clays; light reddish-brown.

Description of Embankment Cracks

Station 281+55 - Transverse to dam axis; visible in both trench walls; extends from surface to a depth of 12 feet; varies in width from 3 inches to less than ¼ inch; 0-1½ feet - 3 inches wide, 1½-6 feet - 1 inch wide, 6-12 feet - less than 1 inch wide at an average of about ¼ inch; below 5½ feet, crack is completely infilled with natural silty sand; grout has completely filled crack above 5½ feet. Tracer stain and water has penetrated to 12 feet.

McMicken Dam Restoration Study
Maricopa County, Arizona
SHB Job No. E82-111

Log of Test Trench ET-2 December 8, 1982

Centerline Station 350+00 to 350+20

Located parallel to centerline along dam crest

Equipment Type: American 35A Backhoe with 26-inch bucket

Trench Length: 20 feet

Trench Depth: 24 feet

Condition of Excavation

Trench stability excellent; no sloughing of trench walls; top 1½ feet loose due to previous shallow trenches; trench left open for seven days with no drastic change in conditions; some drying and minor cracking caused by stress relief and desiccation noted; no shoring installed.

Embankment Soil Description

Depth	
0-6 feet	Stratified clayey sand and gravel; gravel is fine grained; moderately cemented with lime; clays are medium plasticity, very firm; slightly moist; reddish-brown.
6-24 feet	Silty clay with occasional lifts of more granular soils; small amount of fine gravel throughout; weakly to moderately cemented, very firm; moist; reddish-brown.

Description of Embankment Cracks

No cracks found throughout trench.

McMicken Dam Restoration Study
Maricopa County, Arizona
SHB Job No. E82-111

Log of Test Trench ET-3 December 8, 1982

Centerline Station 434+15 to 434+85

Located parallel to centerline along crest of dam

Equipment Type: American 35A Backhoe with 26-inch bucket

Trench Length: 70 feet

Trench Depth: 20 to 23 feet

Condition of Excavation

Trench stability excellent with the exception of two areas which have been previously excavated; filled backhoe pits encountered from Station 434+68 to 434+73 and in north end of trench at Station 434+85; some slumping of the loose backfill in these old excavations occurred; trench left open for 9½ days with no drastic change in trench stability; some drying and minor cracking due to stress relief and desiccation noted.

Embankment Soil Description

Highly stratified sequence of clayey sand with considerable fine gravel interbedded with sandy clay with some gravel; weakly lime cemented throughout; moderately indurated caliche zone from 2 to 4 feet; very firm and slightly moist; medium plasticity clays; light reddish-brown.

Log of Test Trench ET-3, (Cont'd.)

Description of Embankment Cracks

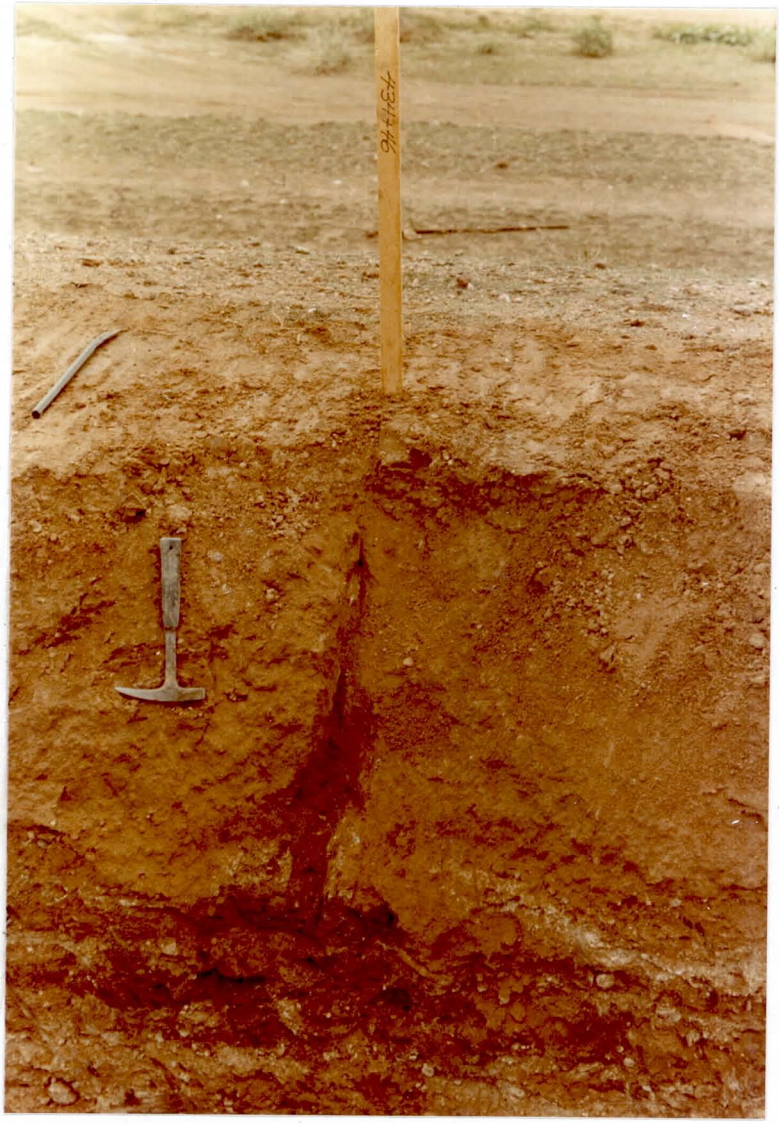
Station 434+20 - Crack transverse to dam axis; visible in both trench walls; extends from surface to depth of 4½ feet; varies in width from 3½ inches to less than ¼ inch; grout found to depth of 3¼ feet; natural sandy infilling below 3¼ feet.

Crack at Station 434+20 - East Trench Wall

Log of Test Trench ET-3, (Cont'd.)

Station 434+27 - No grout visible in very small transverse crack which extends to a depth less than 3 feet; crack not continuous across trench.

Station 434+46 - Transverse to dam axis; visible in both trench walls; extends from surface to a depth of 5 feet; varies in width from 4 inches to less than ¼ of an inch; complete grout filling from 0 to 2 feet; complete natural sandy infilling below 2 feet.



Crack at Station 434+46 - East Trench Wall

Log of Test Trench ET-3, (Cont'd.)

Stations 434+57, 434+68, 434+76 - Cracks at these locations are generally transverse to the dam axis but discontinuous across the trench; no grout visible; cracks do not extend below 2 feet and are not in excess of ¼ inch in width except where eroded. The continuity of these cracks is not likely.

McMicken Dam Restoration Study
Maricopa County, Arizona
SHB Job No. E82-111

Log of Test Trench ET-4 December 7, 1982

Two sections excavated; Centerline Stations 453+25 to 453+95 and 454+55 to 454+90

Located parallel to centerline along dam crest

Equipment Type: American 35A Backhoe with 26-inch bucket

Trench Length: 70 feet and 35 feet

Trench Depth: 19 to 23 feet

Condition of Excavation

Trench stability excellent; no sloughing of trench walls; top 1 foot loose due to previous trenching; trenches left open for nine days with no drastic change in conditions; some minor cracking and drying of trench walls noted; trenches shored for personnel safety, not required to hold excavations open.

Embankment Soil Description

Silty to sandy clay; considerable fine, angular gravel; occasional pockets of clayey sand with gravel; weakly to moderately cemented; medium plasticity clays; very firm and moist; light reddish-brown.

Log of Test Trench ET-4, (Cont'd.)

Description of Embankment Cracks

Station 453+30 - Substantial crack encountered which has no surface expression; highly eroded to a depth of 3½ feet and to a maximum width of 10 inches; eroded section partially infilled with soft, fine grained silty to clayey sand; crack entirely infilled with firm silty sand below 3½ feet; crack visible to depth of 6½ feet and is about ½ to ¼ inch in width below 3½ feet.

Crack at Station 453+30 - West Trench Wall

Log of Test Trench ET-4, (Cont'd.)

Station 453+45 - Transverse crack visible on both trench walls to a depth of 9½ feet; width of crack varies from an eroded 5 inches to less than ½ inch below 5 feet; grout infilling total between 5 and 6 feet on east trench wall; natural sandy infilling present below 6 feet; crack open between 2½ to 5 feet where it is eroded to a width of about 5 inches.

Crack at Station 453+45 - East Trench Wall

Log of Test Trench ET-4, (Cont'd.)

Station 453+53 - Transverse crack, 3/4 to 1 inch in width; visible to a depth of 4½ feet on the east trench wall; grout has completely infilled the crack.

Crack at Station 453+53 - East Trench Wall

Log of Test Trench ET-4, (Cont'd.)

Station 453+73 - Crack transverse to dam axis; extends across trench; reaches to a depth of 4½ feet on the east trench wall; crack is 3/4 to 1 inch in width, grout totally filled crack.

Crack at Station 453+73 - East Trench Wall

Log of Test Trench ET-4, (Cont'd.)

Station 453+84 - Crack visible in east trench wall to a depth of 2½ feet, width approximately 1 inch; partially infilled with silty sand; small amount of grout present at 2 feet.

Crack at Station 453+84 - East Trench Wall

Log of Test Trench ET-4, (Cont'd.)

Station 453+89 - Discontinuous crack visible in east trench wall to depth of 3½ feet; crack is approximately 3/4 inch wide; grout totally infilled crack to a depth of 3 feet; natural sandy infilling present below 3 feet.

Crack at Station 453+89 - East Trench Wall

Log of Test Trench ET-4, (Cont'd.)

Stations 454+55 & 454+90 - Cracks found in both ends of trench; features are generally longitudinal to dam axis; no surface expressions; at Station 454+90, open crack visible between 5½ to 8 feet with a maximum width of 3/4 inch; at Station 454+55, open crack visible between 3½ and 7½ feet with a maximum width of 2 inches.

Crack visible in end of trench at Station 454+90

McMicken Dam Restoration Study
Maricopa County, Arizona
SHB Job No. E82-111

Log of Test Trench ET-5 December 14, 1982

Centerline Station 75+00 to 75+10

Located parallel to centerline along crest of dam

Equipment Type: Case 580C Backhoe with 24-inch bucket

Trench Length: 10 feet

Trench Depth: 11 feet (backhoe refusal)

Condition of Excavation

Trench stability excellent; no sloughing of trench walls; trench left open for six days with little change in conditions.

Embankment Soil Description

Depth	
0-3 feet	Silty, sandy clay, small amount of gravel, moderately to strongly lime cemented, low to medium plasticity, brown to light brown.
5-11 feet	Very silty, sandy clay (as above) highly interbedded with lenses of clayey, silty sand with considerable gravel, well graded, moderately lime cemented, low plasticity, light brown

Description of Embankment Cracks

No embankment cracks encountered.

McMicken Dam Restoration Study
Maricopa County, Arizona
SHB Job No. E82-111

Log of Test Trench ET-6 December 14, 1982

Centerline Station 140+00 to 140+10

Located parallel to centerline along crest of dam

Equipment Type: Case 580C Backhoe with 24-inch bucket

Trench Length: 10 feet

Trench Depth: 11 feet (backhoe refusal)

Condition of Excavation

Trench stability excellent; no sloughing of trench walls; trench left open for six days with little change in conditions.

Embankment Soil Description

Depth	
0-11 feet	Very sandy clay, some gravel, moderately to strongly lime cemented, low plasticity, brown.
	Note: Homogeneous throughout in both soil type and cementation, sand is well graded.

Description of Embankment Cracks

No embankment cracks encountered.

McMicken Dam Restoration Study
Maricopa County, Arizona
SHB Job No. E82-111

Log of Test Trench ET-7 December 14, 1982

Centerline Station 210+00 to 210+10

Located parallel to centerline along crest of dam

Equipment Type: Case 580C Backhoe with 24-inch bucket

Trench Length: 10 feet

Trench Depth: 11 feet (backhoe refusal)

Condition of Excavation

Trench stability excellent; no sloughing of trench walls; trench left open for six days with little change in conditions.

Embankment Soil Description

Depth	
0-11 feet	Very sandy, silty clay, some gravel, moderately to strongly lime cemented, low plasticity, brown.
	Note: No sandy layers, uniformly cemented throughout, no desiccation cracking, sand is well graded.

Description of Embankment Cracks

No embankment cracks encountered.

McMicken Dam Restoration Study
Maricopa County, Arizona
SHB Job No. E82-111

Log of Test Trench TT-1 October 19, 1982

Station 467+25
Downstream Toe

Equipment Type: Case 580C Backhoe

Total Depth of Trench: 10.5 feet

Depth	Description
0 - 3.0 feet	Silty, sandy clay, firm, very moist, trace of fine, subangular to angular gravel, medium to low plasticity, brown Cementation Properties Very weakly lime cemented
3 - 4.5 feet	Clayey sand, hard, slightly moist, considerable silt & gravel, well graded, angular to subangular, weakly stratified, low to medium plasticity, gray Cementation Properties Moderately to strongly lime cemented, all space between grains has been filled with cement
4.5 - 10.5 feet	Silty sand, firm, slightly moist, some clayey sand in thin lenses, some clean sand in thin lenses, considerable angular to subangular gravel in lenses, well graded, stratified, nonplastic to medium plasticity, light brown to tan Cementation Properties Weakly clay cemented throughout, some extension of lime cemented unit above into this unit

McMicken Dam Restoration Study
Maricopa County, Arizona
SHB Job No. E82-111

Log of Test Trench TT-2 October 19, 1982

Station 435+00
Downstream Toe

Equipment Type: Case 580C Backhoe

Total Depth of Trench: 11.0 feet

Depth	Description
0 - 3.5 feet	Silty, sandy clay, firm to very firm, slightly moist, considerable gravel, medium plasticity, brown Cementation Properties Very weakly lime cemented
3.5 - 6.5 feet	Silty clay, very firm, slightly moist, some sand & fine gravel, medium plasticity, brown Cementation Properties Weakly to moderately lime cemented throughout with occasional nodules that have been strongly cemented
6.5 - 8.0 feet	Transition zone: clayey sand, firm, slightly moist, considerable fine gravel, well graded, low plasticity, brown Cementation Properties Generally weakly to moderately lime cemented, with a decrease in cementation with depth
8.0 - 11.0 feet	Sand & clayey sand, moderately firm, moist, considerable fine, angular to subangular gravel in lenses, well graded, stratified, nonplastic to low plasticity, brown

McMicken Dam Restoration Study
Maricopa County, Arizona
SHB Job No. E82-111

Log of Test Trench TT-2 (Cont'd.) October 19, 1982

Station 435+00
Downstream Toe

Equipment Type: Case 580C Backhoe

Total Depth of Trench: 11.0 feet

Cementation Properties

Weakly clay cemented with occasional thin lenses of lime cementation

8 - 9 feet deep intrusion of moderately to strongly lime cemented unit into weakly clay cemented unit.

McMicken Dam Restoration Study
Maricopa County, Arizona
SHB Job No. E82-111

Log of Test Trench TT-3 October 19, 1982

Station 390+00
Downstream Toe

Equipment Type: Case 580C Backhoe

Total Depth of Trench: 11.5 feet

Depth	Description
0 - 3.0 feet	Sandy clay, firm to hard, slightly moist, some to considerable gravel, medium to high plasticity, brown Cementation Properties Weakly lime cemented in filaments
3.0 - 4.0 feet	Clayey sand, firm, slightly moist, considerable gravel, well graded, angular to subangular, low plasticity, brown Cementation Properties Weakly lime cemented with occasional soft, weakly cemented nodules
4.0 - 7.5 feet	Silty clay, very firm to hard, moist, some sandy clay in pockets, medium to high plasticity, brown Cementation Properties Occasional thin filaments of lime cementation
7.5 - 9.0 feet	Sandy clay, very firm, moist, low to medium plasticity, brown

McMicken Dam Restoration Study
Maricopa County, Arizona
SHB Job No. E82-111

Log of Test Trench TT-3 (Cont'd.) October 19, 1982

Station 390+00
Downstream Toe

Equipment Type: Case 580C Backhoe

Total Depth of Trench: 11.5 feet

Cementation Properties

Weakly lime cemented

9.0 - 11.5 feet Clayey sand, firm to moderately firm, moist, considerable silt, considerable gravel in lenses, well graded, angular to subangular, stratified, low to medium plasticity, brown

Cementation Properties

Weakly clay cemented, occasional filaments of lime cementation

McMicken Dam Restoration Study
Maricopa County, Arizona
SHB Job No. E82-111

Log of Test Trench TT-4 October 19, 1982

Station 345+00
Downstream Toe

Equipment Type: Case 580C Backhoe

Total Depth of Trench: 11.5 feet

Depth	Description
0 - 5.0 feet	Sandy silt, firm to moderately firm, slightly moist to dry, some clay, small amount of gravel, low plasticity, light brown Cementation Properties Very weakly lime cemented
5.0 - 9.0 feet	Clayey sand, firm, moist, some gravel in lenses, well graded, angular to sub-angular, low to medium plasticity, reddish-brown Cementation Properties No cementation
9.0 - 10.5 feet	Silty clay, very firm, moist, considerable fine sand, low to medium plasticity, brown Cementation Properties Occasional thin filaments of lime cementation
10.5 - 11.5 feet	Silty sand, firm, moist, some gravel, small amount of clay, predominantly

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Maricopa County, Arizona
SHB Job No. E82-111

Log of Test Trench TT-4 (Cont'd.) October 19, 1982

Station 345+00
Downstream Toe

Equipment Type: Case 580C Backhoe

Total Depth of Trench: 11.5 feet

Depth	Description
10.5 - 11.5 feet	fine to medium grained, nonplastic to low plasticity, brown

Cementation Properties

No cementation

McMicken Dam Restoration Study
Maricopa County, Arizona
SHB Job No. E82-111

Log of Test Trench TT-5 October 19, 1982

Station 290+00
Downstream Toe

Equipment Type: Case 580C Backhoe

Total Depth of Trench: 10.5 feet

Depth	Description
0 - 6.0 feet	Silty clay, very firm to hard, slightly moist, some sand, small amount of fine gravel, medium plasticity, brown to light brown Cementation Properties Weakly lime cemented throughout, occasional soft to hard cemented nodules, mottled light gray and brown appearance due to cementation
6.0 - 10.5 feet	Silty sand, firm to very firm, moist, considerable gravel below 9 feet, some clay, predominantly fine to medium grained with some well graded lenses, angular to subangular, low plasticity, gray to brown Cementation Properties Weakly clay cemented

McMicken Dam Restoration Study
Maricopa County, Arizona
SHB Job No. E82-111

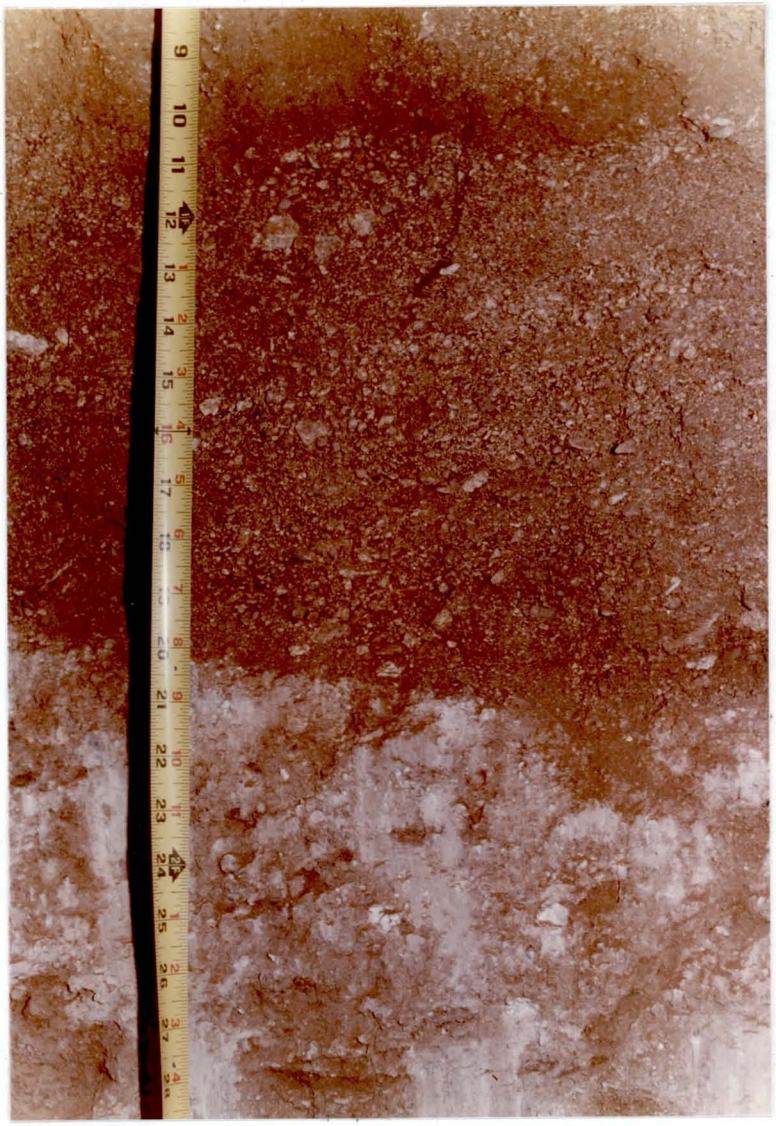
Log of Test Trench TT-6 October 19, 1982

Station 243+00
Downstream Toe

Equipment Type: Case 580C Backhoe

Total Depth of Trench: 9.0 feet (refusal)

Depth	Description
0 - 2.0 feet	Silty clay, firm, moist, some sand, medium plasticity, brown Cementation Properties No cementation
2.0 - 3.5 feet	Silty & clayey sand, firm to very firm, slightly moist, small amount of fine gravel, well graded, medium to low plasticity, brown to light brown Cementation Properties Very weakly lime cemented
3.5 - 9.0 feet	Silty clay, very hard, slightly moist, some sand & gravel, medium plasticity, gray Cementation Properties Moderately to strongly lime cemented throughout, similar to soft rock in character



2 - 3 feet deep contact between uncemented soils & underlying cemented soils.

McMicken Dam Restoration Study
Maricopa County, Arizona
SHB Job No. E82-111

Log of Test Trench TT-7 October 20, 1982

Station 185+00
Downstream Toe

Equipment Type: Case 580C Backhoe

Total Depth of Trench: 10.5 feet

Depth	Description
0 - 2.5 feet	Silty sand, firm, slightly moist, some gravel, well graded, angular to subangular, nonplastic to very low plasticity, light brown Cementation Properties No cementation
2.5 - 10.5 feet	Clayey silt, firm to hard, slightly moist, silty clay in thin lenses, occasional pockets of silty sand, low to medium plasticity, light brown Cementation Properties Weakly lime cemented above 7.5 feet, weakly to moderately lime cemented below 7.5 feet, cement filaments are abundant in places and absent in other places

McMicken Dam Restoration Study
Maricopa County, Arizona
SHB Job No. E82-111

Log of Test Trench TT-8 October 20, 1982

Station 135+00
Downstream Toe

Equipment Type: Case 580C Backhoe

Total Depth of Trench: 9.5 feet (refusal)

Depth	Description
0 - 6.0 feet	Silty sand & gravel, loose, slightly moist, well graded, angular to subangular, stratified, nonplastic, light brown, considerable caving within this unit Cementation Properties No cementation
6.0 - 9.5 feet	Silty clay, hard, slightly moist, some sand, low to medium plasticity, brown Cementation Properties Weakly to moderately lime cemented throughout in long, thin filaments and in small, soft nodules

McMicken Dam Restoration Study
Maricopa County, Arizona
SHB Job No. E82-111

Log of Test Trench TT-9 October 20, 1982

Station 85+00
Downstream Toe

Equipment Type: Case 580C Backhoe

Total Depth of Trench: 11.5 feet

Depth	Description
0 - 11.5 feet	Silty sand & gravel, loose, slightly moist, occasional interbedded lenses of very firm to hard silt & silty clay, some cobbles to 2 feet in diameter, well graded with some poorly graded lenses, angular to subangular, stratified, non-plastic to low plasticity, light brown, considerable caving within the upper 8 feet of this unit
	Cementation Properties
	Below 8 feet, the lenses of fine grained material are weakly lime cemented; below 10 feet, the lenses of coarse grained material are also weakly lime cemented

McMicken Dam Restoration Study
Maricopa County, Arizona
SHB Job No. E82-111

Log of Test Trench TT-10 October 20, 1982

Station 110+00
Downstream Toe

Equipment Type: Case 580C Backhoe

Total Depth of Trench: 6.5 feet (refusal)

Depth	Description
0 - 2.5 feet	Clayey, silty sand, firm, slightly moist, some fine gravel, predominantly fine grained, low plasticity, brown Cementation Properties No cementation
2.5 - 3.5 feet	2 inch cap of sandy gravel over a sandy silt, hard to firm, slightly moist, low plasticity, light brown Cementation Properties Sandy gravel cap in moderately lime cementation; sandy silt is weakly lime cemented throughout
3.5 - 5.5 feet	Clayey sand & gravel, hard, slightly moist, well graded, angular to subangular, stratified, low plasticity, light brown Cementation Properties Moderately lime cemented throughout, soils are partially coated and there are thin filaments & small nodules of soft lime cementation

McMicken Dam Restoration Study
Maricopa County, Arizona
SHB Job No. E82-111

Log of Test Trench TT-10 (Cont'd.) October 20, 1982

Station 110+00
Downstream Toe

Equipment Type: Case 580C Backhoe

Total Depth of Trench: 6.5 feet (refusal)

Depth	Description
5.5 - 6.5 feet	Silty clay, hard, slightly moist, medium plasticity, brown Cementation Properties Moderately to highly lime cemented throughout, mottled appearance from small nodules of soft lime cementation

Samples from 6 - 6.5 feet deep. Samples of moderately to strongly lime cemented silty clay. Mottled appearance due to small nodules of soft lime cement.

McMicken Dam Restoration Study
Maricopa County, Arizona
SHB Job No. E82-111

Log of Test Trench TT-11 October 20, 1982

Station 160+00
Downstream Toe

Equipment Type: Case 580C Backhoe

Total Depth of Trench: 9.5 feet

Depth	Description
0 - 1.5 feet	Silty sand, moderately firm, dry to slightly moist, some fine gravel, predominantly fine grained, subangular, nonplastic, light brown Cementation Properties No cementation
1.5 - 3.5 feet	Silty clay, firm, slightly moist, some fine sand, trace of fine gravel, medium plasticity, brown Cementation Properties Weakly lime cemented throughout as fine filaments & small vugs; & near vertical fissures as a coating
3.5 - 4.5 feet	Sandy silt, soft, dry, some fine to medium grained sand in thin lenses, nonplastic to low plasticity, tan Cementation Properties No cementation
4.5 - 9.5 feet	Sandy clay, hard, slightly moist, low to medium plasticity, brown

McMicken Dam Restoration Study
Maricopa County, Arizona
SHB Job No. E82-111

Log of Test Trench TT-11 (Cont'd.) October 20, 1982

Station 160+00
Downstream Toe

Equipment Type: Case 580C Backhoe

Total Depth of Trench: 9.5 feet

Cementation Properties

Moderately lime cemented throughout, predominantly as veinlets & thin filaments

McMicken Dam Restoration Study
Maricopa County, Arizona
SHB Job No. E82-111

Log of Test Trench TT-12 October 20, 1982

Station 210+00
Downstream Toe

Equipment Type: Case 580C Backhoe

Total Depth of Trench: 9.5 feet

Depth	Description
0 - 3.5 feet	Silty & clayey sands, moderately firm to firm, slightly moist, some fine, subangular gravel, well graded, nonplastic to low plasticity, brown Cementation Properties No cementation
3.5 - 5.5 feet	Silty sand & gravel, hard, dry, considerable cobbles from 4.5 to 5.5 feet, gap graded, subangular to subrounded, nonplastic, light gray to white Cementation Properties Weakly to moderately lime cemented, cementation occurs in the clayey silt matrix, in areas where matrix is missing, cementation is also missing
5.5 - 9.5 feet	Silty sand & gravel, loose, dry, well graded, subangular, crudly stratified, nonplastic, gray Cementation Properties No cementation from 5.5 to 8.5 feet, weakly lime cemented below 8.5 feet

McMicken Dam Restoration Study
Maricopa County, Arizona
SHB Job No. E82-111

Log of Test Trench TT-13 October 20, 1982

Station 265+00
Downstream Toe

Equipment Type: Case 580C Backhoe

Total Depth of Trench: 10.5 feet

Depth	Description
0 - 4.5 feet	Silty sand, soft to moderately firm, slightly moist, some gravel, 8 inch sandy gravel lens at the base of this unit, predominantly fine grained, well graded, bottom 8 inches crudly stratified, nonplastic to low plasticity, brown Cementation Properties Small amount of lime cementation occurs as a coating on some of the coarse grained material
4.5 - 7.5 feet	Silty clay, very firm to hard, moist, considerable fine sand, medium plasticity, light reddish-brown Cementation Properties Weakly lime cemented by thin filaments & coatings on fracture surfaces
7.5 - 10.5 feet	Clayey sand, hard, slightly moist, some fine, subangular gravel, well graded, medium plasticity, light tan Cementation Properties Moderately lime cemented throughout, mottled appearance due to cementation

McMicken Dam Restoration Study
Maricopa County, Arizona
SHB Job No. E82-111

Log of Test Trench TT-14 October 20, 1982

Station 315+00
Downstream Toe

Equipment Type: Case 580C Backhoe

Total Depth of Trench: 10.0 feet

Depth	Description
0 - 1.5 feet	Silty sand, soft, slightly moist, trace of gravel, fine to medium grained, low plasticity to nonplastic, light brown Cementation Properties No cementation
1.5 - 10.0 feet	Clayey sand, moderately firm to hard, slightly moist, some gravel, well graded, stratified, medium plasticity, reddish-brown Cementation Properties From 1.5 to 6 feet, there is weak lime cementation throughout, there are moderately to strongly cemented nodules up to 1.5 inches in diameter above 3 feet, & a stratification of cementation from 3 to 6 feet, from 6 to 7 feet there is no cementation & below 7 feet there is weak lime cementation

1.5 - 3 feet moderately to strongly lime cemented nodules in clayey sand.

McMicken Dam Restoration Study
Maricopa County, Arizona
SHB Job No. E82-111

Log of Test Trench TT-15 October 22, 1982

Station 302+50
Downstream Toe

Equipment Type: Case 580C Backhoe

Total Depth of Trench: 10.5 feet

Depth	Description
0 - 3.0 feet	Silty clay, firm to very firm, moist, considerable sand, medium plasticity, brown Cementation Properties Weakly lime cemented below 2 feet, predominantly in filaments
3.0 - 6.5 feet	Clayey sand, hard, slightly moist, some fine to medium, subangular gravel, well graded, low plasticity, light brown to gray Cementation Properties Moderately lime cemented throughout
6.5 - 10.5 feet	Silty sand, hard, slightly moist, considerable fine to medium, subangular to subrounded gravel in lenses, predominantly well graded, stratified, nonplastic to low plasticity, reddish-brown Cementation Properties Weakly clay cemented throughout, small amount of lime cementation in veinlets

McMicken Dam Restoration Study
Maricopa County, Arizona
SHB Job No. E82-111

Log of Test Trench TT-16 October 22, 1982

Station 330+00
Downstream Toe

Equipment Type: Case 580C Backhoe

Total Depth of Trench: 10.5 feet

Depth	Description
0 - 5.0 feet	Silty clay, very firm to hard, slightly moist to moist, considerable fine sand, small amount of fine gravel, medium plasticity, brown Cementation Properties Weakly lime cemented below 1 foot, some strongly cemented nodules below 3.5 feet, mottled appearance due to nodules & soft blotches of lime cementation
5.0 - 6.0 feet	Clayey sand, hard, moist, considerable gravel, predominantly fine to medium grained, weakly stratified, low to medium plasticity, light brown Cementation Properties Moderately lime cemented throughout
6.0 - 10.5 feet	Silty sand, loose to hard, moist to slightly moist, considerable gravel in lenses, occasional lenses of clean, loose sands, predominantly well graded, with lenses of predominantly fine & fine to medium grained sand, stratified, nonplastic to low plasticity, light brown

McMicken Dam Restoration Study
Maricopa County, Arizona
SHB Job No. E82-111

Log of Test Trench TT-16 (Cont'd.) October 22, 1982

Station 330+00
Downstream Toe

Equipment Type: Case 580C Backhoe

Total Depth of Trench: 10.5 feet

Cementation Properties

Most of this unit is weakly clay cemented, there is some weak lime cementation between 6 and 8 feet, & there are lenses without any cementation

McMicken Dam Restoration Study
Maricopa County, Arizona
SHB Job No. E82-111

Log of Test Trench TT-17 October 22, 1982

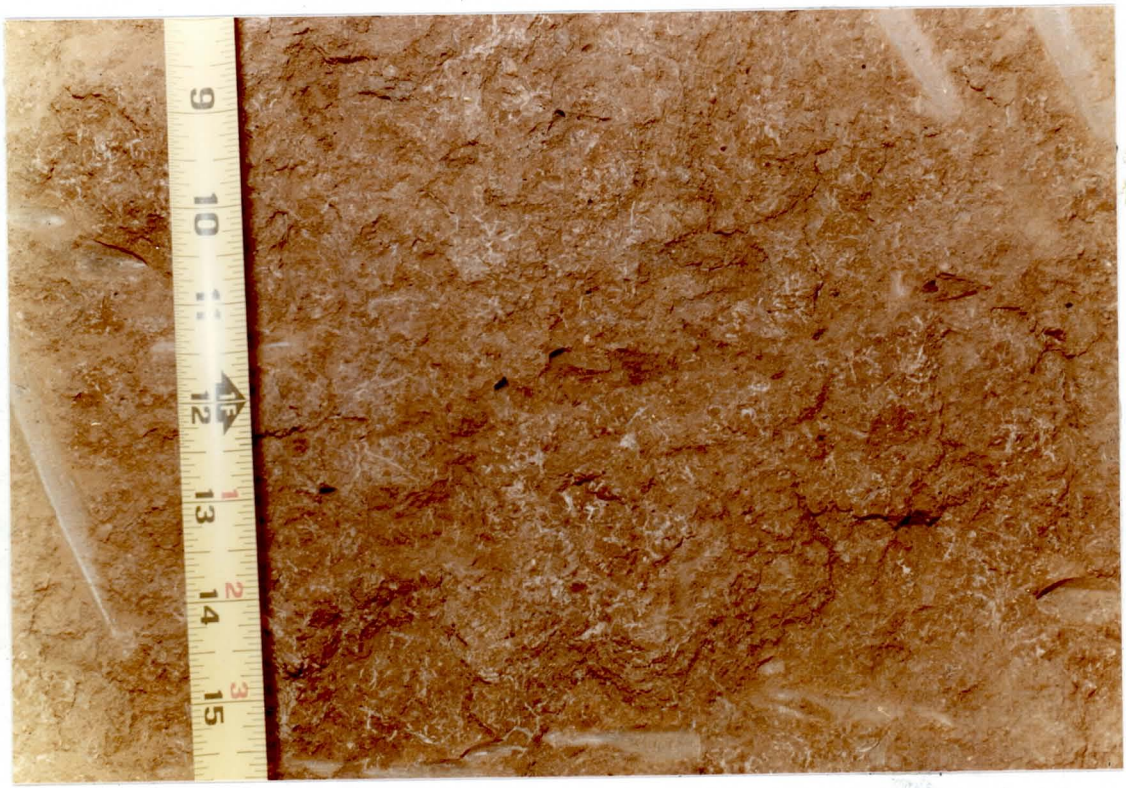
Station 362+85
Downstream Toe

Equipment Type: Case 580C Backhoe

Total Depth of Trench: 11.0 feet

Depth	Description
0 - 5.5 feet	Silty clay, very firm, slightly moist, some sand, trace of fine gravel, medium plasticity, brown to light brown Cementation Properties Weakly lime cemented from 1 to 3.5 feet, moderately lime cemented below 3.5 feet, all cementation in thin filaments
5.5 - 11.0 feet	Clayey sand, loose to hard, slightly moist, considerable gravel in lenses, occasional lenses of clean sand & silty sand, predominantly well graded, angular to subangular, stratified, nonplastic to low plasticity, reddish-brown Cementation Properties Weakly to moderately clay cemented throughout most of the unit, some weak lime cementation from 5.5 to 7 feet, some uncemented lenses throughout

McMicken Dam Restoration Study
Maricopa County, Arizona
SHB Job No. E82-111



3 - 4 feet deep. Silty clay with filaments of lime cementation.

McMicken Dam Restoration Study
Maricopa County, Arizona
SHB Job No. E82-111

Log of Test Trench TT-18 October 22, 1982

Station 375+20
Downstream Toe

Equipment Type: Case 580C Backhoe

Total Depth of Trench: 10.5 feet

Depth	Description
0 - 6.0 feet	Silty clay, firm to hard, slightly moist, considerable sand, some fine gravel, medium to low plasticity, brown to light brown Cementation Properties Weakly lime cemented below 2.5 feet, occasional moderately hard to hard lime cemented nodules
6.0 - 7.5 feet	Clayey sand & gravel, hard, slightly moist, well graded, subangular, weakly stratified, low plasticity to nonplastic, reddish-brown Cementation Properties Moderately lime cemented, some clay cementation also
7.5 - 10.5 feet	Sandy clay, hard, slightly moist, considerable silt, some clayey sand in pockets, weakly stratified, low to medium plasticity, light reddish-brown Cementation Properties Moderately lime cemented throughout, with occasional soft lime nodules giving a mottled appearance

McMicken Dam Restoration Study
Maricopa County, Arizona
SHB Job No. E82-111

Log of Test Trench TT-19 October 22, 1982

Station 412+50
Downstream Toe

Equipment Type: Case 580C Backhoe

Total Depth of Trench: 10.5 feet

Depth	Description
0 - 2.0 feet	Sandy clay, firm, slightly moist, considerable lenses of clayey sand, considerable fine, subangular to subrounded gravel, weakly stratified, low plasticity, light brown Cementation Properties No cementation
2.0 - 3.5 feet	Silty clay, very firm, moist, some sand, medium to high plasticity, dark brown Cementation Properties Very weakly lime cemented
3.5 - 8.0 feet	Clayey sand, hard, slightly moist, considerable sandy clay in pockets, some fine to medium, subangular gravel, predominantly fine to medium grained, low to medium plasticity, brown to light brown Cementation Properties Moderately lime cemented throughout, with occasional moderately to strongly cemented nodules giving a mottled appearance

McMicken Dam Restoration Study
Maricopa County, Arizona
SHB Job No. E82-111

Log of Test Trench TT-19 (Cont'd.) October 22, 1982

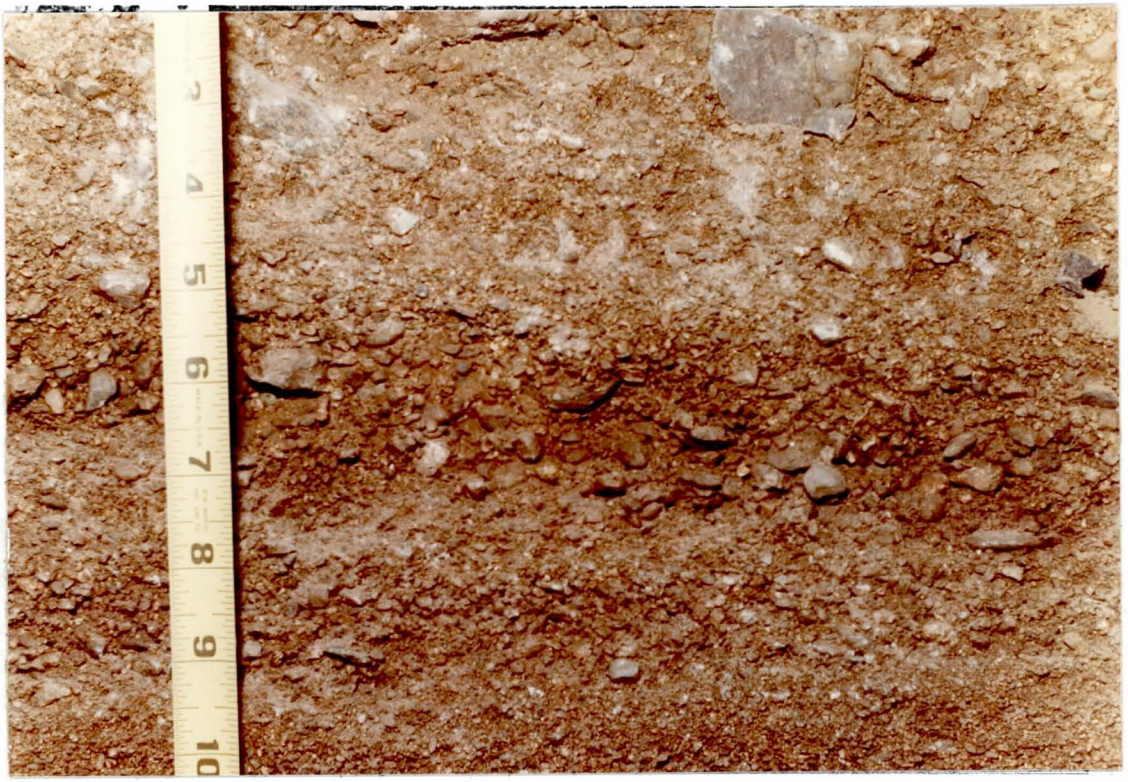
Station 412+50
Downstream Toe

Equipment Type: Case 580C Backhoe

Total Depth of Trench: 10.5 feet

Depth	Description
8.0 - 10.5 feet	Clayey sand, medium to loose to hard, slightly moist, considerable silty sand in lenses, some lenses of clean sand, considerable angular to subangular gravel in lenses, well graded, stratified, nonplastic to low plasticity, reddish-brown
	Cementation Properties
	Weakly lime cemented from 8 to 9 feet, primarily as a coating on grains, moderately clay cemented in many lenses, some lenses are uncemented

McMicken Dam Restoration Study
Maricopa County, Arizona
SHB Job No. E82-111



9 - 10 feet deep. Weakly clay cemented clayey sand, some weakly lime cemented lenses near top of picture.

TABLE A-1

MIX #	DATE	LOCATION TRENCH #	LOCATION CRACK #	MATERIALS USED WATER (LBS.) AMT.	WATER (LBS.) %	SOIL (LBS.) AMT.	SOIL (LBS.) %	ADDITIVES (LBS.) TYPE	ADDITIVES (LBS.) AMT.	ADDITIVES (LBS.) %	GROUT SPECS. MARSH FUNNEL VISCOSITY	GROUT SPECS. MUD DENSITY LBS./FT.^{3}	GROUT SAMPLE	REMARKS
1	11-17	ET-4	453+73	210	31	440	66	FLY ASH	20	3	29	92		PUMPED 1/2 LOAD INTO CRACK.
2	11-17	ET-4	453+73	210	21	770	76	FLY ASH	31	3	42	107		SAME AS ABOVE
3	11-17	ET-4	453+73 453+53	210	20	825	77	FLY ASH	31	3	41	111		FILLED CRACK 453+73 W/ 1/2 TON LOAD; REMAINDER - 453+53
4	11-19	ET-4	453+53	210	19.7	840	78.9	FLY ASH	15	1.4	40	109	X	1 LOAD INTO 453+53
5	11-19	ET-4	453+53	210	19.7	840	78.9	FLY ASH	15	1.4	37	107		USED 90% TO FILL 453+53; REFILLED 453+73, SOME INTO 453+45
6	11-19	ET-4	453+~~45~~, +84 & +89, & 454+64	200	20.9	735	76.8	CEMENT	22	2.3	36	108	X	453+~~45~~, +84 & +89 - TOOK ONLY SMALL AMT'S. 454+64 IS EXISTING ON DOWNSTREAM EMBANKMENT.
7	11-19	ET-4	454+64 454+82	200	19.8	787	77.9	BENTONITE	23	2.3	30+	106	X	THESE TWO CRACKS TOOK SMALL AMOUNTS OF GROUT.
				NOTE:	1/ ALL PERCENTAGES ARE CALCULATED BY WEIGHT									
					2/ GROUT LOAD IS APPROXIMATELY 1000 LBS. IN WEIGHT, 9.3 CU. FT.									

SERGENT, HAUSKINS & BECKWITH
CONSULTING GEOTECHNICAL ENGINEERS
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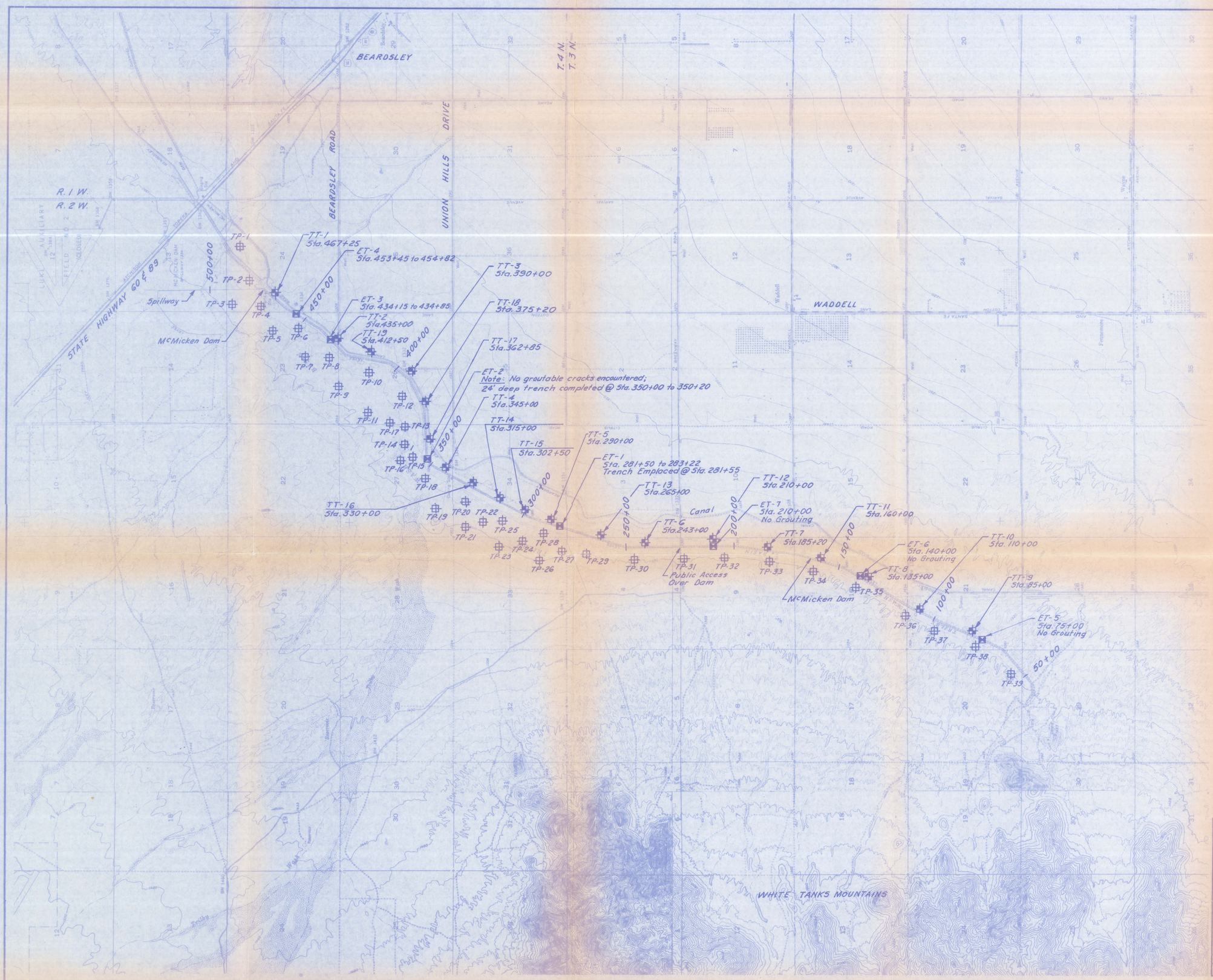
Project McMicken Dam
Job No: E 82-111
Computed by: M.R.H. Ckd. by: R.R.K.
Date 12-82 Page 1 of 2

TABLE A-1 (CONT'D.)

MIX #	DATE	LOCATION TRENCH #	LOCATION CRACK #	MATERIALS USED WATER (LBS.) AMT.	WATER %	SOIL (LBS.) AMT.	SOIL %	ADDITIVES (LBS.) TYPE	ADDITIVES AMT.	ADDITIVES %	GROUT SPECS. MARSH. FUNNEL VISCOSITY	MUD DENSITY LBS./FT.^{3}	GROUT SAMPLE	REMARKS
3	11-22	ET-3	434+76 434+68 434+57	262	22.3	880	75.1	FLY ASH BENTONITE	20 10	1.7 0.9	100+	115	X	VERY THICK, CRACKS TOOK ONLY MINIMAL AMOUNT.
9	11-22	ET-3	434+46 434+27	175	21.0	648	77.8	FLY ASH	10	1.2	107	112	X	+46 TOOK 2/3 OF LOAD; +27 TOOK 10-20 GAL.
10	11-29	ET-3	434+20	208	23.0	680	75.3	CEMENT	15	1.7	—	—		CRACK TOOK V. LITTLE GROUT, ALTHOUGH IT APPEARED V. LARGE. TRIED TO FILL W/ WATER, BUT THE CRACK FILLED W/WATER
11	11-30	ET-1	283+22 283+24	260	27.2	680	71.2	CEMENT	15	1.6	60	107	X	MOST OF LOAD INTO 283+24
12	11-30	ET-1	283+22 283+24	260	27.2	680	71.2	CEMENT	15	1.6	54	104		MOST OF LOAD INTO 283+22
13	11-30	ET-1	283+14 282+96	250	26.6	680	72.3	CEMENT	10	1.1	71	106	X	MOST OF LOAD INTO 283+14, SOME INTO 282+96
14	11-30	ET-1	282+96 +99, +75 +58, +34	260	27.1	680	70.8	CEMENT FLY ASH	10 10	1.05 1.05	65	107	X	1/2 INTO 282+99, SMALL AMT. INTO 282+96, +75, +58, +34
15	12-1	ET-1	281+86 281+55	275	25.1	800	73.1	CEMENT FLY ASH	10 10	0.9 0.9	75	106		3/4 INTO 281+86, 1/4 INTO 281+55
16	12-1	ET-1	281+55	275	25.1	800	73.1	CEMENT FLY ASH	10 10	0.9 0.9	—	—		NO DYE, 3/4 INTO 281+55

SERGENT, HAUSKINS & BECKWITH
CONSULTING GEOTECHNICAL ENGINEERS
PHOENIX • ALBUQUERQUE • SANTA FE • SALT LAKE CITY

Project McMicken Dam
Job No: E82-111
Computed by: M.R.H. Ckd. by: R.R.K.
Date 12-82 Page 2 of 2



Scale: 1" = 2000'

LEGEND

TP-30	Borrow Source Test Pit
TT-4	Test Pit Emplaced at Downstream Toe of Dam to Observe Soil Cementation Properties.
ET-6	Test Grout Section and Position of Deep Trench Excavation in the Embankment.

Base Map Reference: U.S.G.S. 7.5 Minute Quadrangle Maps, McMicken Dam (1957) and Waddell (1977)

NO.	DESCRIPTION	DATE

REVISIONS

SERGENT, HAUSKINS & BECKWITH
CONSULTING GEOTECHNICAL ENGINEERS

Site Plan Showing Locations of Test Pits, Trenches & Test Grout Sections
McMicken Dam

JOB NO.	DATE	DESIGNED BY	DRAWN BY	CHECKED BY	SHEET NO
E82-111	12-82	R.E.W.	V.K.	R.E.W.	

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. E82-111
W/O 1

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
TP-3	1.5'-5'	CL	32	16	66	72	82	92	95	97	98	98	100				2-111-9
TP-4	6'-7.5'	SC	59	40	43	46	54	67	74	87	91	96	99	99	100		2-111-11
TP-5	1.5'-5'	SC	51	25	31	34	39	45	50	66	74	84	95	97	99	100	2-111-13
TP-8	2.5'-5.5'	GC	53	31	30	32	38	45	50	57	60	64	73	76	80	83	2-111-21
TP-11	2.5'-5.5'	SP-SC	31	11	11	13	19	29	39	61	68	76	90	94	100		2-111-29+30
TP-12	0.0'-3'	SC	42	22	44	46	56	71	78	88	90	93	97	98	100		2-111-31
TP-14	0.0'-4.5'	SC	29	9	34	40	56	75	82	91	93	96	99	100			2-111-34
TP-15	4'-8'	SC	26	10	19	22	30	47	55	67	73	79	89	92	96	97	2-111-37
TP-19	2.5'-7.5'	SW-SM	-	NP	11	13	28	60	72	84	87	91	96	97	100		2-111-43
TP-21	3.5'-5.5'	SC	43	22	47	51	61	80	88	94	96	97	100				2-111-47
TP-25	0.0'-7'	CL	37	17	68	73	82	94	97	100							2-111-55
TP-27	0.0'-8'	ML	21	2	54	62	75	84	89	95	97	99	100				2-111-60
TP-28	0.0'-5'	CL	48	26	62	66	75	88	93	97	98	98	100				2-111-61
TP-30	0.0'-4.5'	CL	31	12	54	60	68	79	85	95	97	98	100				2-111-65
TP-32	0.0'-2.5'	CL-ML	26	7	63	70	76	82	87	96	98	99	100				2-111-69
TP-33	1.5'-7.5'	CL	28	8	53	59	70	80	84	91	92	93	95	96	98	100	2-111-73
TP-35	0.0'-6.5'	SW-SM	-	NP	11	13	24	44	57	76	82	88	95	96	98	98	2-111-77
TP-36	1.5'-7'	GM-GC	27	7	14	17	23	30	34	40	42	45	51	54	58	63	2-111-80
TP-38	1'-7.5'	GP-GM	-	NP	9	12	21	36	44	54	57	60	67	71	73	79	2-111-83
TP-39	0.0'-3.5'	CL	30	10	58	63	71	82	87	92	93	95	97	99	100		2-111-84

TABULATION OF TEST RESULTS

Job No. E82-111
W/O 1
COARSE FRACTION

HOLE NO	DEPTH	UNIFIED CLASS	L.L.	P.I.	#4	.25"	.375"	.5"	.75"	1"	1.5"	2"	3"	4"	6"	LAB NO
					SIEVE ANALYSIS-ACCUM % PASSING											
TP-8	2.5′-5.5′	GC	53	31	57	60	64	69	73	76	80	83	89	89	100	2-111-21
TP-15	4′-8′	SC	26	10	67	73	79	84	89	92	96	97	100			2-111-37
TP-35	0.0′-6.5′	SW-SM	-	NP	76	82	88	92	95	96	98	98	100			2-111-77
TP-36	1.5′-7′	GM-GC	27	7	40	42	45	47	51	54	58	63	72	72	100	2-111-80
TP-38	1′-7.5′	GP-GM	-	NP	54	57	60	63	67	71	73	79	87	100		2-111-83

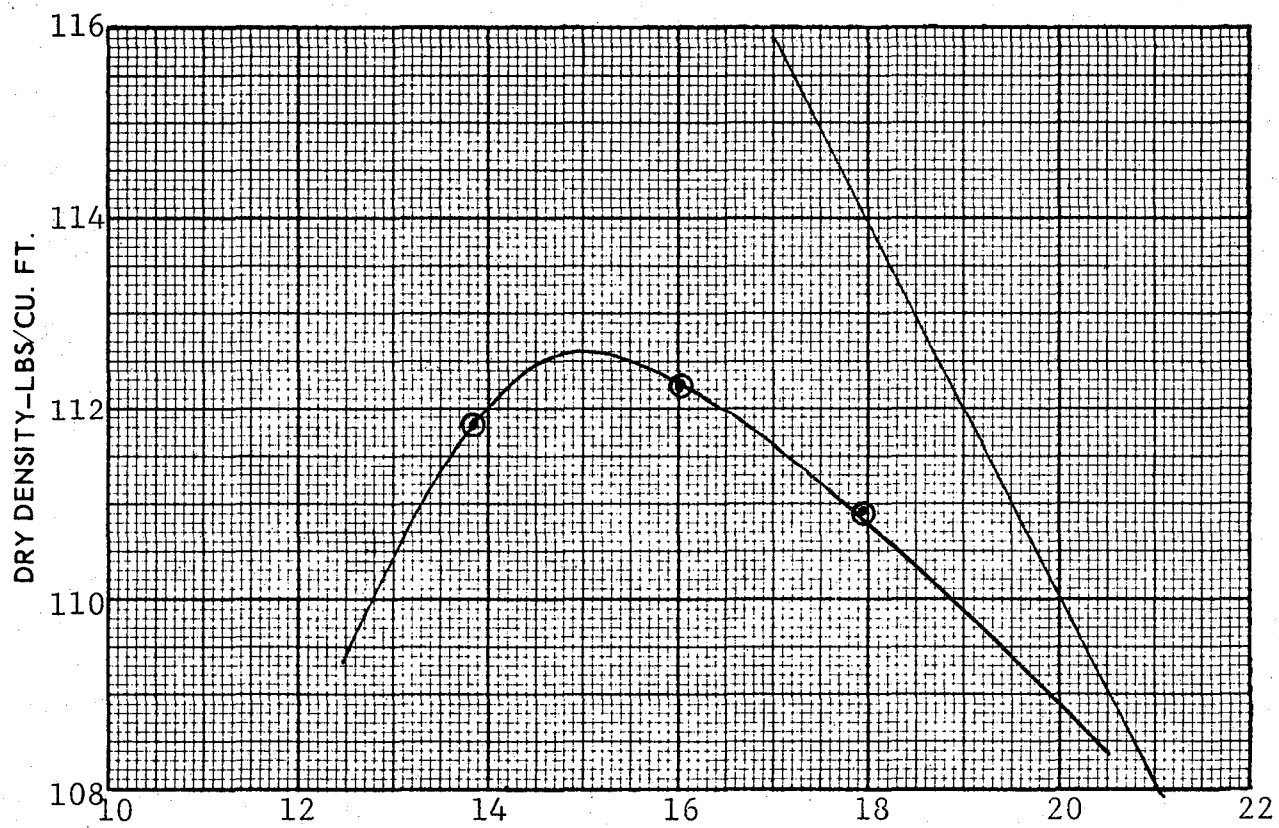
TABULATION OF TEST RESULTS

Job No. E82-111

HOLE NO	DEPTH	UNIFIED CLASS	L.L.	P.I.	#200	#100	#50	#40	#30	#16	#10	#8	#4	.25"	.375"	.5"	LAB NO
					.75"	1"	1.5"	2"	2.5"	3"	3.5"	4"	6"	8"	10"	12"	
STA 455	.-.	CL	39	19	51.4	58	65	69	73	80	84	86	92	95	99	100	2-111-85
STA 281+50	.-.	CL-ML	27	7	59	65	71	74	77	83	89	91	97	98	99	100	2-111-87

SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT McMicken Dam Restoration Study - Phase III **JOB NO.** E82-111



CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS./CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
	Test Pit #5 @ 1½'-5'	15.0	112.6	D698	A	2-111-13

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

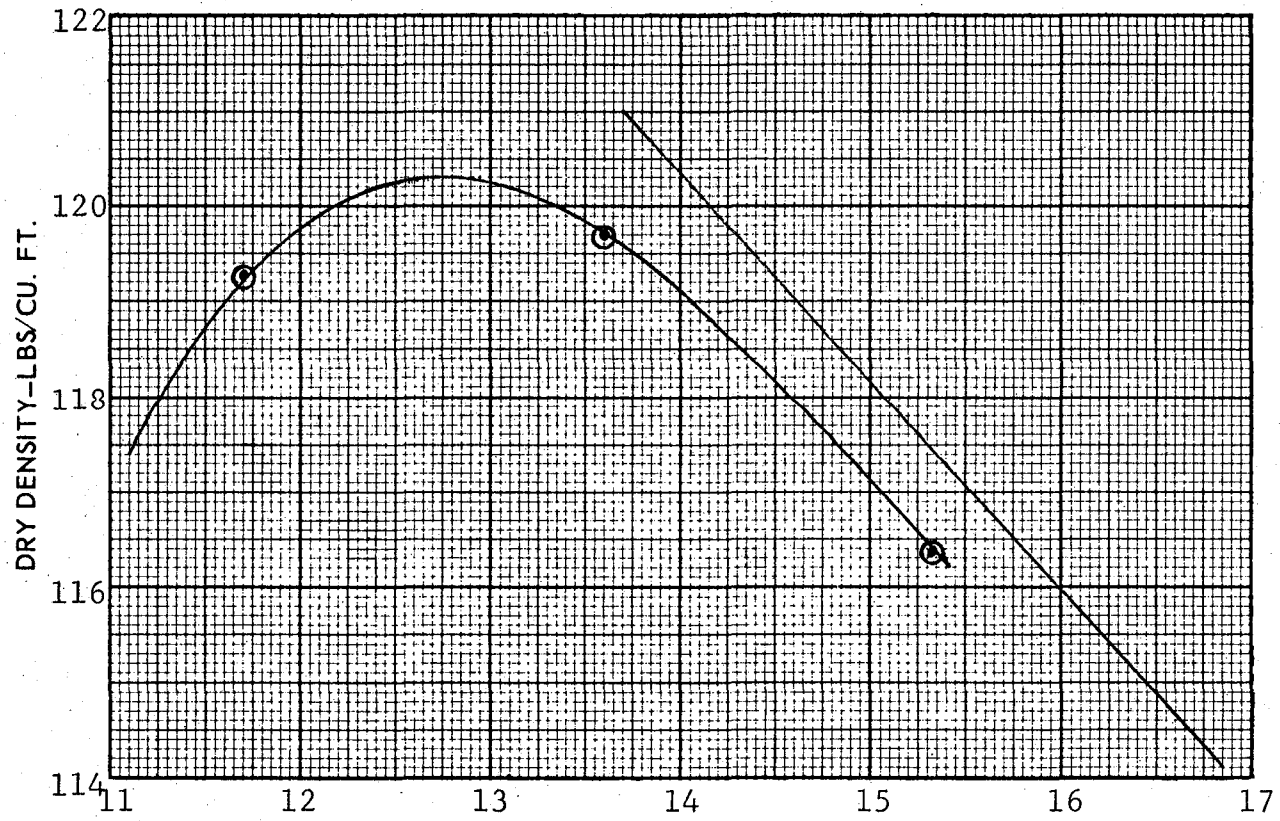
METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	3	25	5.5 LBS.	12"	12,375
B	-#4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
C	-3/4	4"	4.58"	3	25	5.5 LBS.	12"	12,375
D	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317

AASHTO T180 and ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	5	25	10.0 LBS.	18"	56,250
B	-#4	6"	4.58"	5	56	10.0 LBS.	18"	55,986
C	-3/4	4"	4.58"	5	25	10.0 LBS.	18"	56,250
D	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,986

SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT McMicken Dam Restoration Study - Phase III **JOB NO.** E82-111



CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS./CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
	Test Pit #12 @ 0-3'	12.8	120.3	D698	A	2-111-31

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

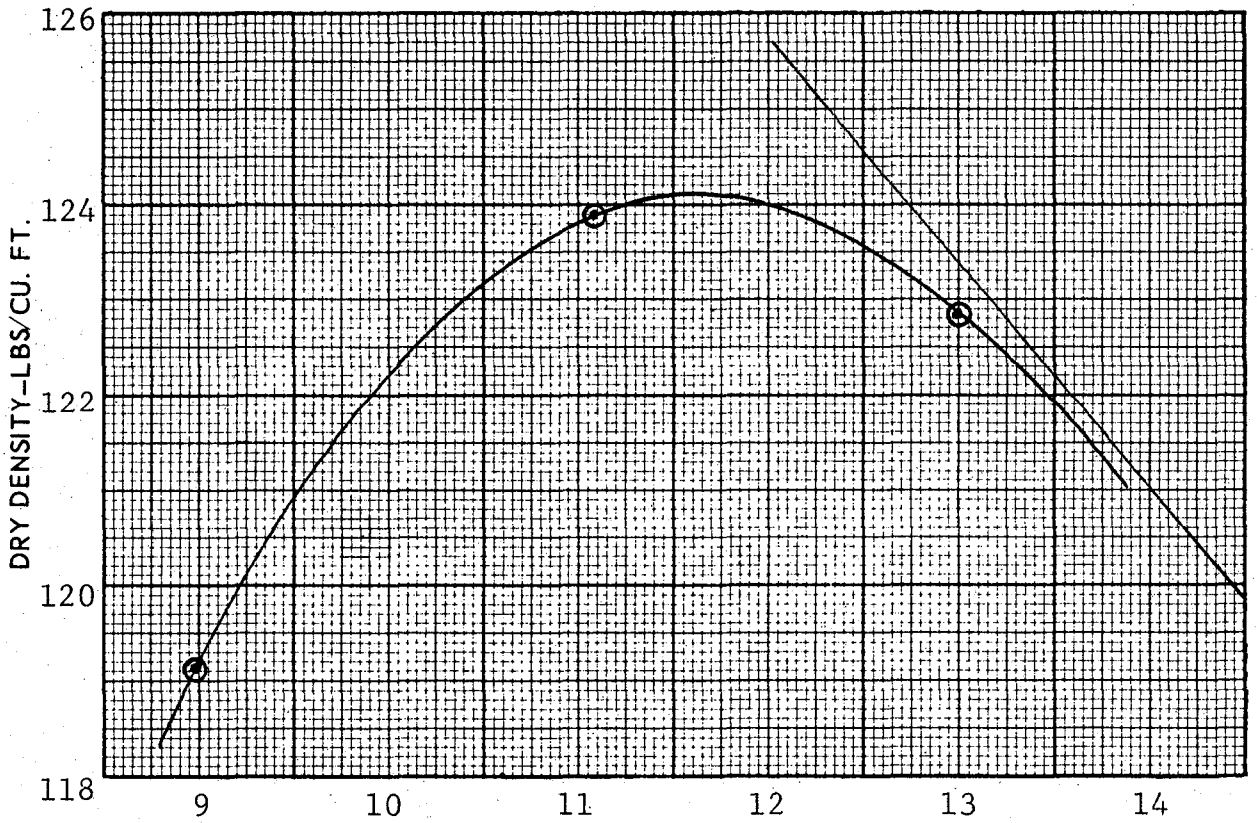
METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	3	25	5.5 LBS.	12"	12,375
B	-#4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
C	-3/4	4"	4.58"	3	25	5.5 LBS.	12"	12,375
D	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317

AASHTO T180 and ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	5	25	10.0 LBS.	18"	56,250
B	-#4	6"	4.58"	5	56	10.0 LBS.	18"	55,986
C	-3/4	4"	4.58"	5	25	10.0 LBS.	18"	56,250
D	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,986

SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT McMicken Dam Restoration Study - Phase III **JOB NO.** E82-111



CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS./CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
	Test Pit #14 @ 0-4½'	11.6	124.1	D698	A	2-111-34

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

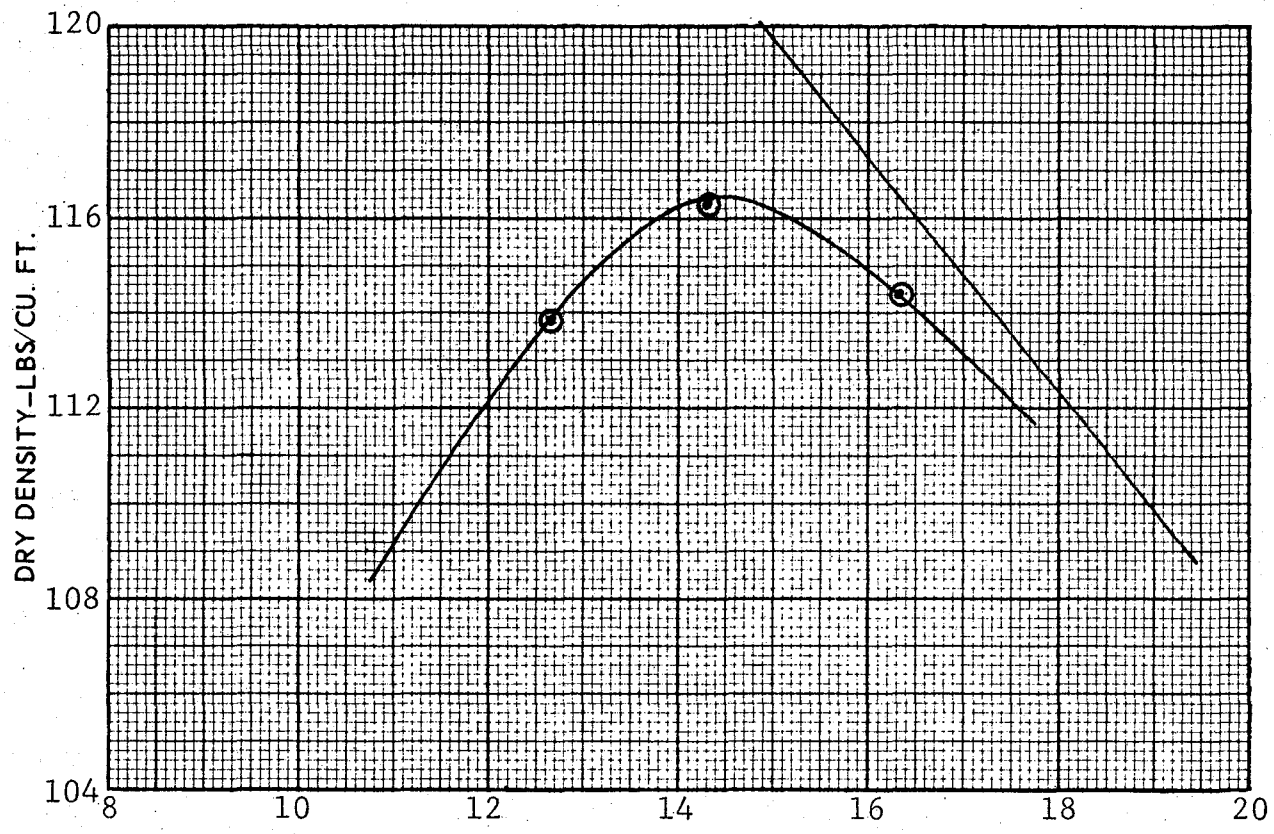
METHOD	MATERIAL	MOLD DIAMETER	MOLD HEIGHT	NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
A	-#4	4"	4.58"	3	25	5.5 LBS.	12"	12,375
B	-#4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
C	-3/4	4"	4.58"	3	25	5.5 LBS.	12"	12,375
D	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317

AASHTO T180 and ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD DIAMETER	MOLD HEIGHT	NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
A	-#4	4"	4.58"	5	25	10.0 LBS.	18"	56,250
B	-#4	6"	4.58"	5	56	10.0 LBS.	18"	55,986
C	-3/4	4"	4.58"	5	25	10.0 LBS.	18"	56,250
D	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,986

SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT McMicken Dam Restoration Study - Phase III **JOB NO.** E82-111



CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS./CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
	Test Pit #25 @ 0-7'	14.5	116.4	D698	A	2-111-55

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

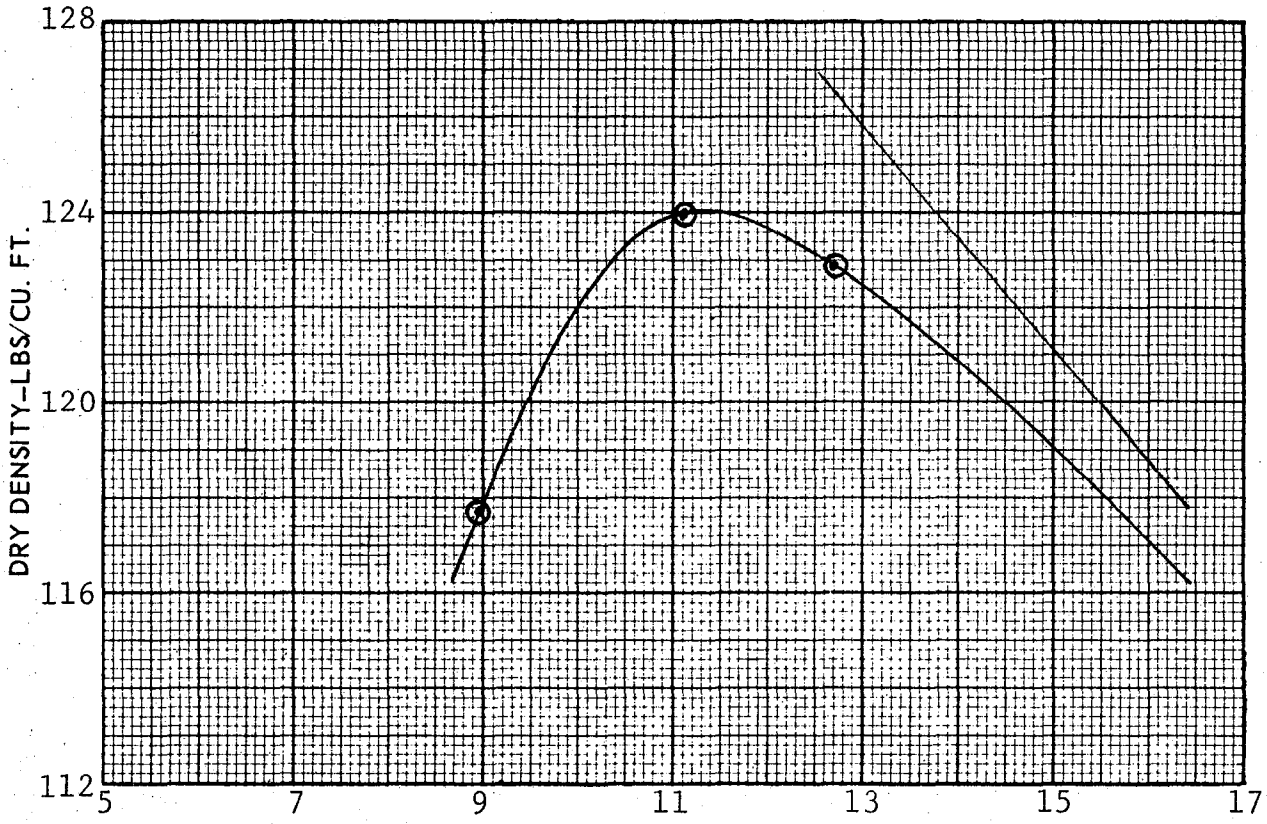
METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	3	25	5.5 LBS.	12"	12,375
B	-#4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
C	-3/4	4"	4.58"	3	25	5.5 LBS.	12"	12,375
D	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317

AASHTO T180 and ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	5	25	10.0 LBS.	18"	56,250
B	-#4	6"	4.58"	5	56	10.0 LBS.	18"	55,986
C	-3/4	4"	4.58"	5	25	10.0 LBS.	18"	56,250
D	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,986

SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT McMicken Dam Restoration Study - Phase III **JOB NO.** E82-111



CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS./CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
	Test Pit #30 @ 0-4½'	11.3	124.0	D698	A	2-111-65

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

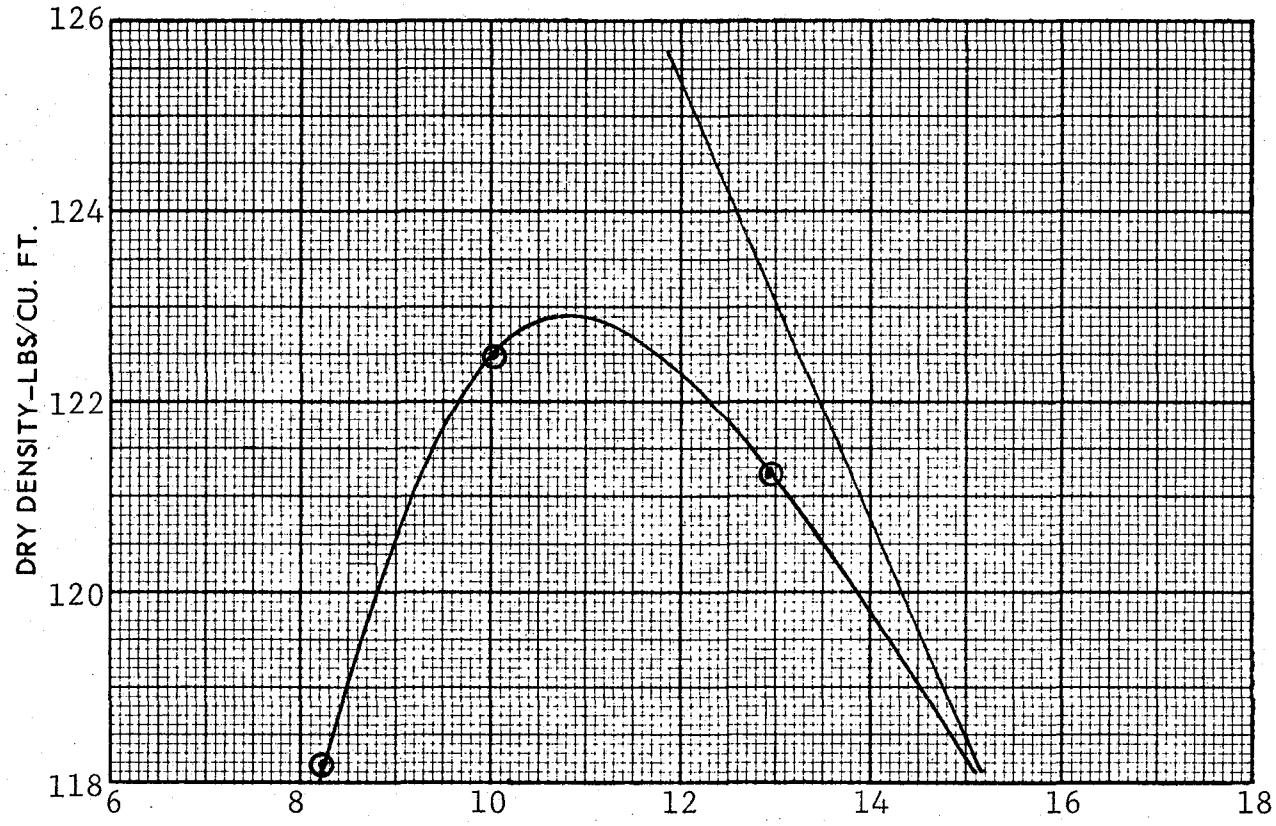
METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	3	25	5.5 LBS.	12"	12,375
B	-#4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
C	-3/4	4"	4.58"	3	25	5.5 LBS.	12"	12,375
D	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317

AASHTO T180 and ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	5	25	10.0 LBS.	18"	56,250
B	-#4	6"	4.58"	5	56	10.0 LBS.	18"	55,986
C	-3/4	4"	4.58"	5	25	10.0 LBS.	18"	56,250
D	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,986

SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT McMicken Dam Restoration Study - Phase III **JOB NO.** E82-111



CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS./CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
	Test Pit #33 @ 1½'-7½'	10.7	122.9	D698	A	2-111-73

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

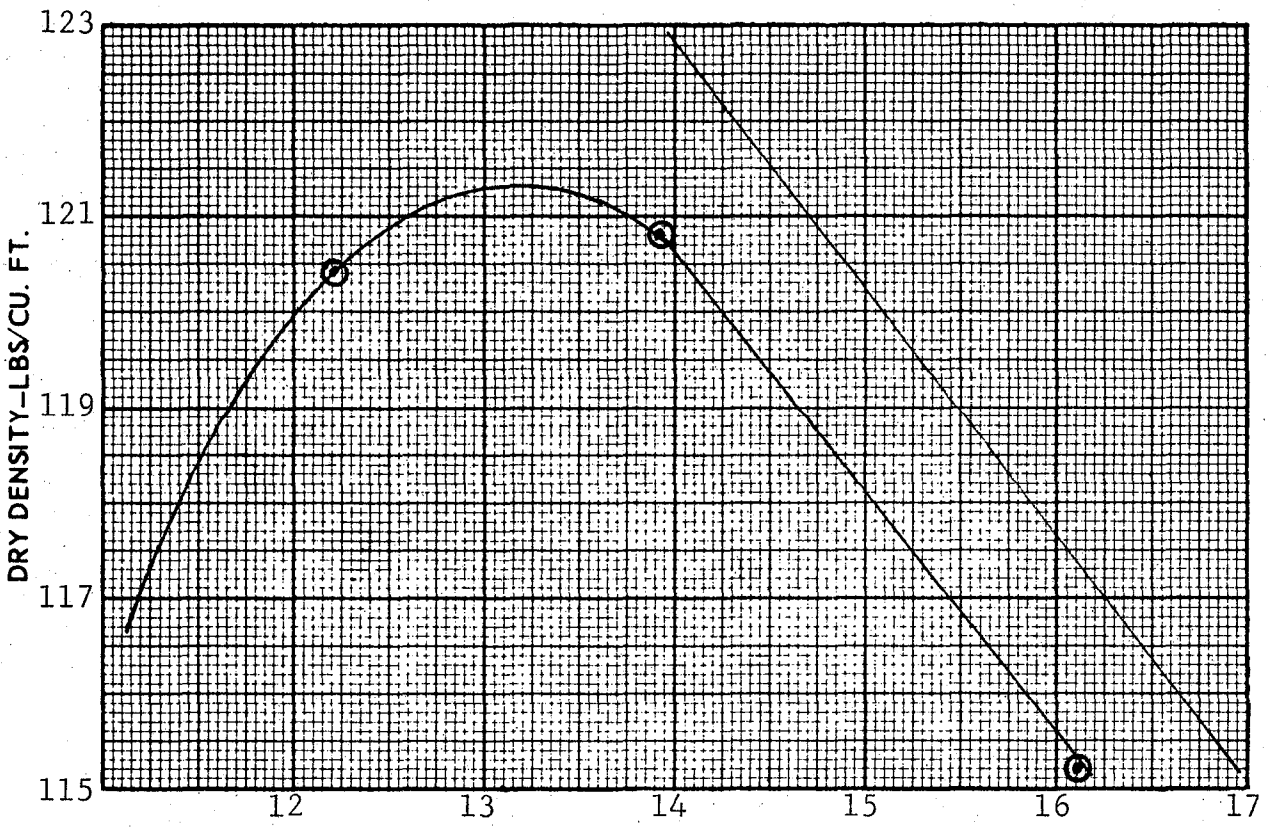
METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	3	25	5.5 LBS.	12"	12,375
B	-#4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
C	-3/4	4"	4.58"	3	25	5.5 LBS.	12"	12,375
D	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317

AASHTO T180 and ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	5	25	10.0 LBS.	18"	56,250
B	-#4	6"	4.58"	5	56	10.0 LBS.	18"	55,986
C	-3/4	4"	4.58"	5	25	10.0 LBS.	18"	56,250
D	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,986

SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT McMicken Dam Restoration Study - Phase III **JOB NO.** E82-111



CURVE	SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS./CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
	Sta. 455	13.2	121.3	D698	A	2-111-86

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

AASHTO T99 and ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	3	25	5.5 LBS.	12"	12,375
B	-#4	6"	4.58"	3	56	5.5 LBS.	12"	12,317
C	-3/4	4"	4.58"	3	25	5.5 LBS.	12"	12,375
D	-3/4	6"	4.58"	3	56	5.5 LBS.	12"	12,317

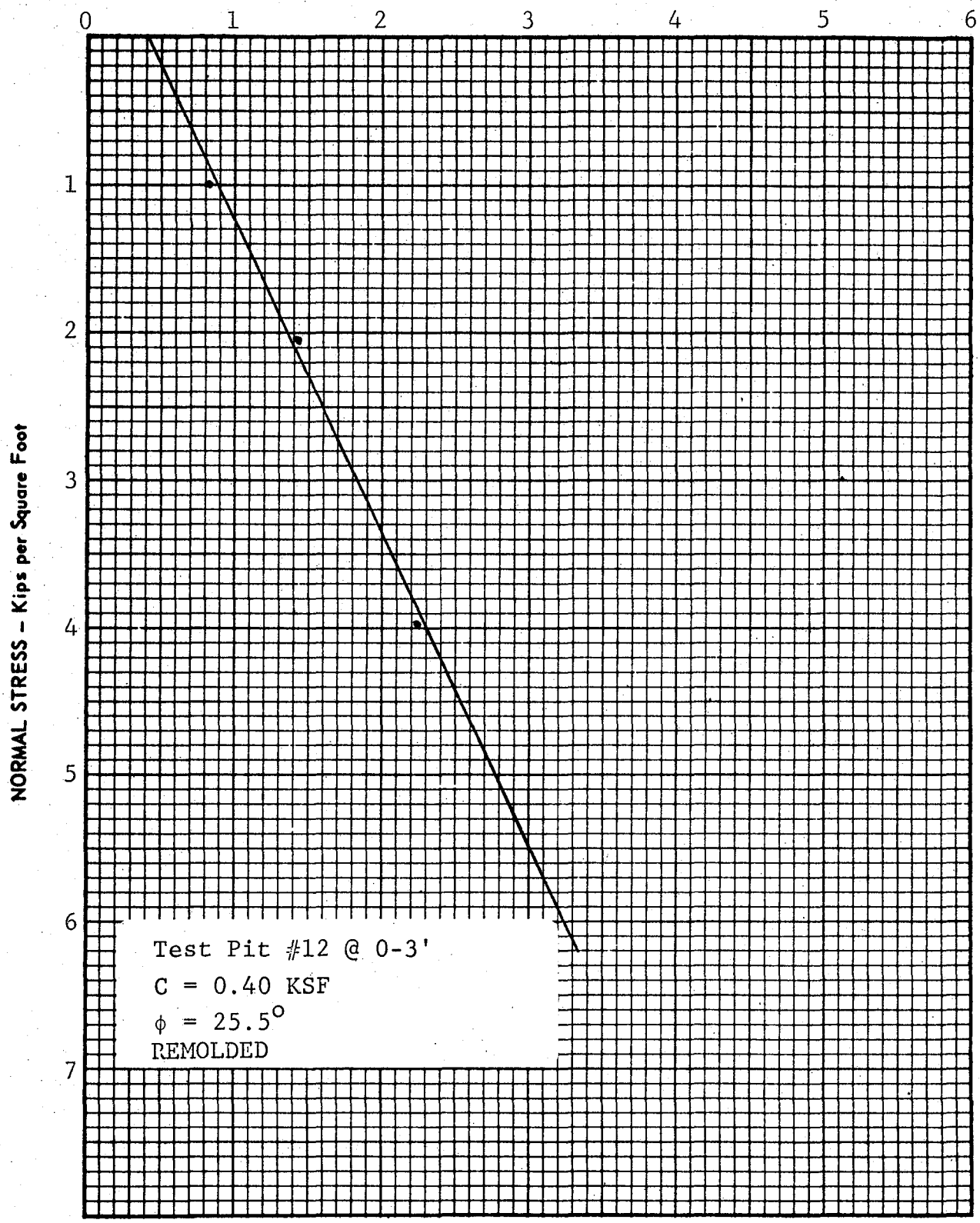
AASHTO T180 and ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS/CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	5	25	10.0 LBS.	18"	56,250
B	-#4	6"	4.58"	5	56	10.0 LBS.	18"	55,986
C	-3/4	4"	4.58"	5	25	10.0 LBS.	18"	56,250
D	-3/4	6"	4.58"	5	56	10.0 LBS.	18"	55,986

SUMMARY OF DIRECT SHEAR TESTS

PROJECT McMiken Dam Restoration Study - Phase III **JOB NO.** E82-111

Lab No. 2-111-31



SHEARING STRESS – Kips per Square Foot

SOIL MOISTURE CONDITION

O – INSITU
● – SUBMERGED

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REPORT ON LABORATORY TESTS

DATE

PROJECT McMicken Dam Restoration Study - Phase III JOB NO. E82-111

LOCATION Maricopa County, Arizona LAB NO. 2-111-31

SAMPLE Test Pit #12 @ 0-3'

REMOLDED DIRECT SHEAR TESTS

In Situ - Point No. 1 (= ± 1.00 KSF)

Initial Moisture Content	13.5	%
Dry Density (PCF)	113.7	
Submerged		
Final Moisture Content	18.8	%
Maximum Vertical Deformation @ T Max.	( ) 0.000	Inches
Shearing Stress, T Max.	0.82	KSF

In Situ - Point No. 2 (= ± 2.06 KSF)

Initial Moisture Content	13.7	%
Dry Density (PCF)	113.3	
Submerged		
Final Moisture Content	18.8	%
Maximum Vertical Deformation @ T Max.	(-) 0.001	Inches
Shearing Stress, T Max.	1.42	KSF

In Situ - Point No. 3 (= ± 3.97 KSF)

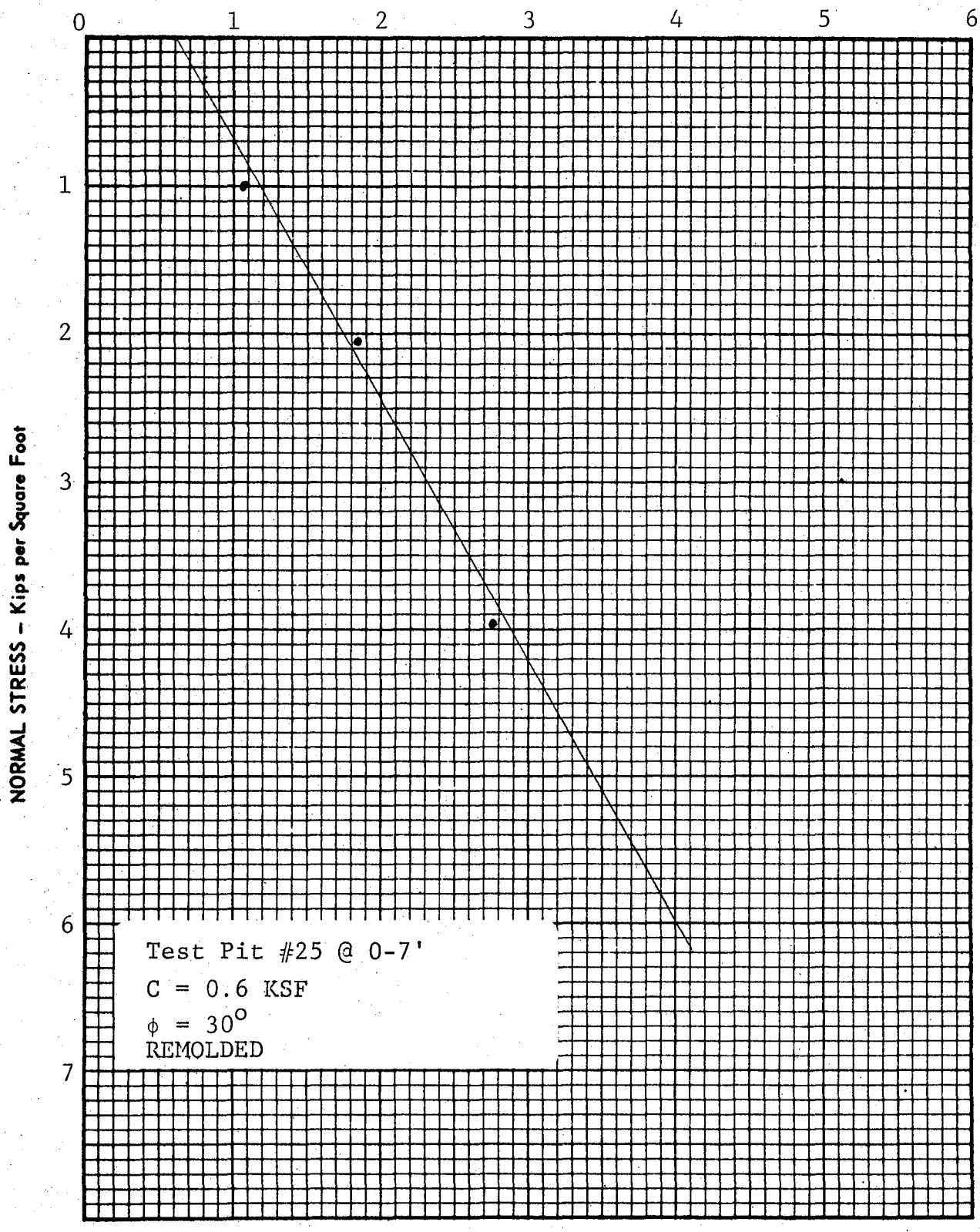
Initial Moisture Content	14.0	%
Dry Density (PCF)	113.4	
Submerged		
Final Moisture Content	18.9	%
Maximum Vertical Deformation @ T Max.	(-) 0.011	Inches
Shearing Stress, T Max.	2.24	KSF

Remolded to 94.3 % of ASTM D698

SUMMARY OF DIRECT SHEAR TESTS

PROJECT McMicken Dam Restoration Study - Phase III **JOB NO.** E82-111

Lab No. 2-111-55



SHEARING STRESS – Kips per Square Foot

SOIL MOISTURE CONDITION

- o – INSITU
- ● – SUBMERGED

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REPORT ON LABORATORY TESTS

DATE

PROJECT McMicken Dam Restoration Study - Phase III

JOB NO. E82-111

LOCATION

LAB NO. 2-111-55

SAMPLE Test Pit #25 @ 0-7'

DIRECT SHEAR TESTS
REMOLDED

In Situ - Point No. 1 (= ± 1.00 KSF)

Initial Moisture Content	15.4	%
Dry Density (PCF)	110.1	
Submerged		
Final Moisture Content	19.6	%
Maximum Vertical Deformation @ T Max.	(+) 0.002	Inches
Shearing Stress, T Max.	1.08	KSF

In Situ - Point No. 2 (= ± 2.06 KSF)

Initial Moisture Content	15.6	%
Dry Density (PCF)	110.0	
Submerged		
Final Moisture Content	19.6	%
Maximum Vertical Deformation @ T Max.	(+) 0.003	Inches
Shearing Stress, T Max.	1.84	KSF

In Situ - Point No. 3 (= ± 3.97 KSF)

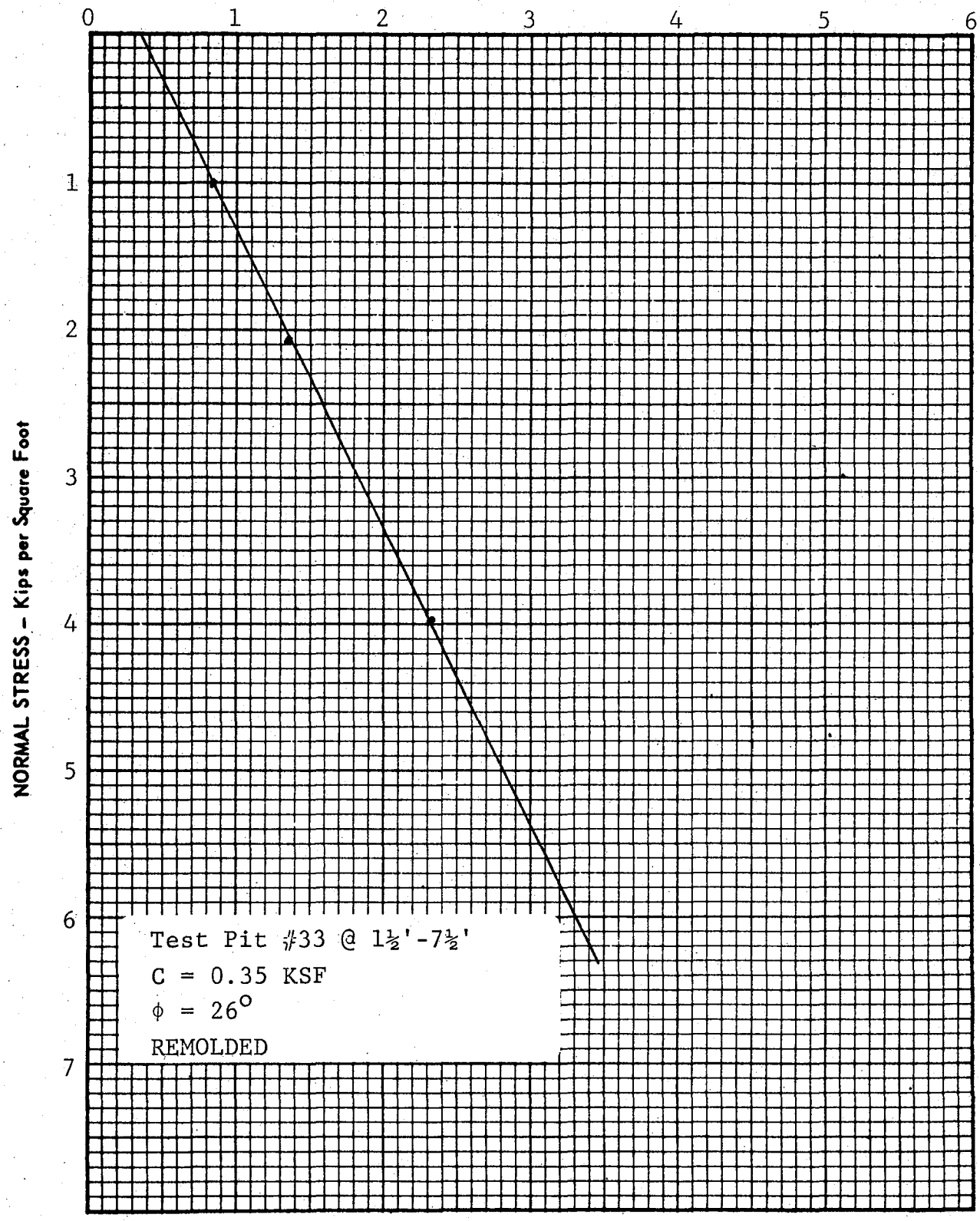
Initial Moisture Content	15.4	%
Dry Density (PCF)	110.1	
Submerged		
Final Moisture Content	19.5	%
Maximum Vertical Deformation @ T Max.	(+) 0.002	Inches
Shearing Stress, T Max.	2.76	KSF

REMOLDED TO 94.6 % of ASTM D698

SUMMARY OF DIRECT SHEAR TESTS

PROJECT McMicken Dam Restoration Study - Phase III **JOB NO.** E82-111

Lab No. 2-111-73



SHEARING STRESS – Kips per Square Foot

SOIL MOISTURE CONDITION

O – INSITU
● – SUBMERGED

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REPORT ON LABORATORY TESTS

DATE _____

PROJECT McMicken Dam Restoration Study - Phase III **JOB NO.** E82-111

LOCATION Maricopa County, Arizona **LAB NO.** 2-111-73

SAMPLE Test Pit #33 @ 1½'-7½'

REMOLDED DIRECT SHEAR TESTS

In Situ - Point No. 1 (= ± 1.00 KSF)

Initial Moisture Content	12.0 %
Dry Density (PCF)	114.5
Submerged	
Final Moisture Content	18.1 %
Maximum Vertical Deformation @ T Max.	(+) 0.003 Inches
Shearing Stress, T Max.	0.86 KSF

In Situ - Point No. 2 (= ± 2.06 KSF)

Initial Moisture Content	11.9 %
Dry Density (PCF)	115.3
Submerged	
Final Moisture Content	17.9 %
Maximum Vertical Deformation @ T Max.	( ) 0.000 Inches
Shearing Stress, T Max.	1.36 KSF

In Situ - Point No. 3 (= ± 3.97 KSF)

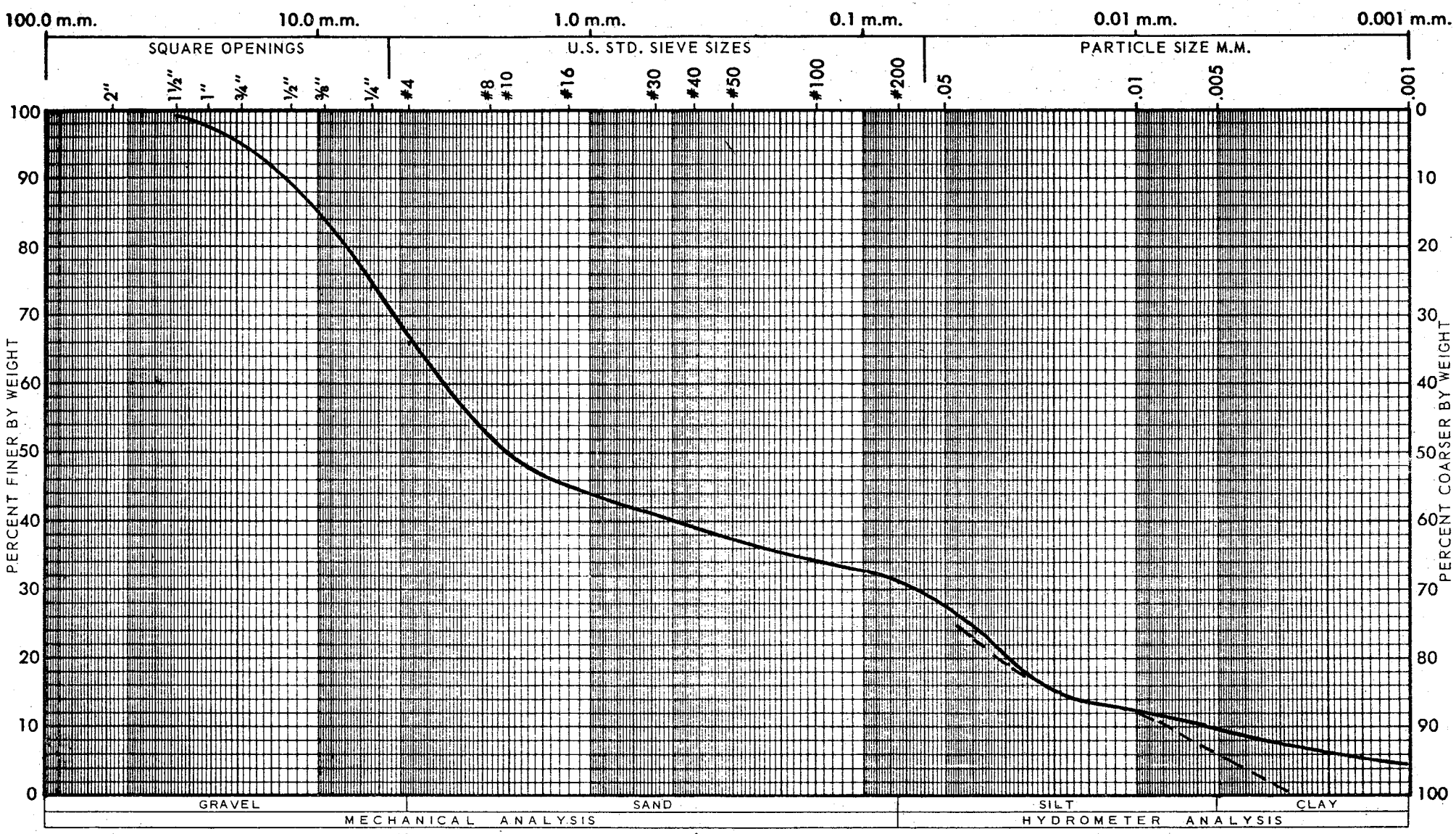
Initial Moisture Content	11.8 %
Dry Density (PCF)	115.5
Submerged	
Final Moisture Content	17.7 %
Maximum Vertical Deformation @ T Max.	(-) 0.005 Inches
Shearing Stress, T Max.	2.33 KSF

Remolded to 93.8 % of ASTM D698

JOB NO. 32-

PARTICLE SIZE DISTRIBUTION CURVE

PROJECT McMicken Dam Restoration Study - Phase III **LOCATION** Maricopa County, Arizona



Specific Gravity = 2.720

CURVE	SAMPLE	LIQUID LIMIT	PLASTICITY INDEX	ACTIVITY	UNIFIED SOIL CLASSIFICATION	LAB NO.
	Test Pit #5 @ 1½'-5'	51	25	25.0	SC	2-111-13
	% Dispersion = $\frac{6}{10}$ x 100 =	60%				

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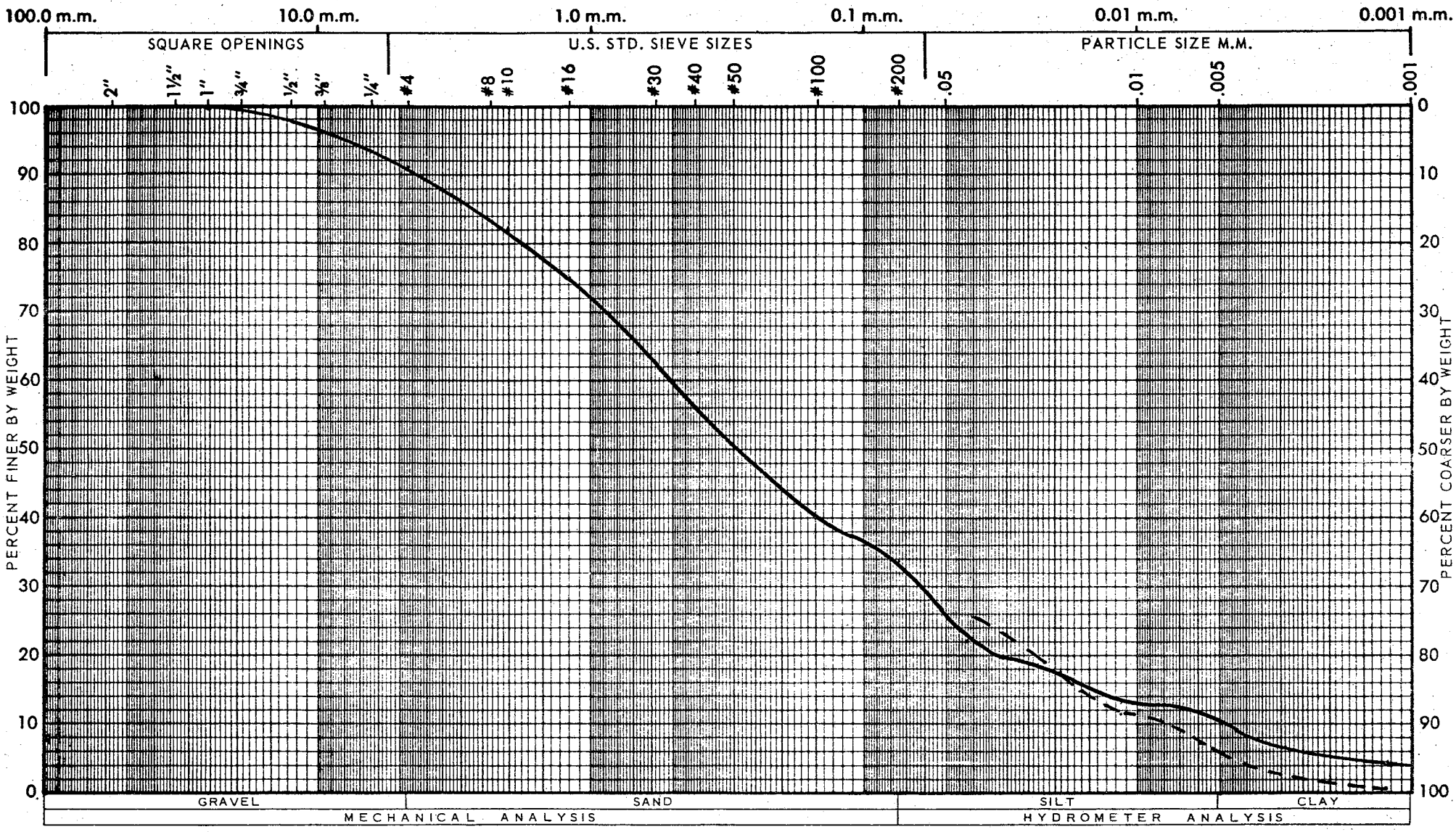
[redacted] B NO. E82-111 [redacted]

PARTICLE SIZE DISTRIBUTION CURVE

PROJECT McMicken Dan Restoration Study - Phase III **LOCATION** Maricopa County, Arizona



Specific Gravity = 2.739

CURVE	SAMPLE	LIQUID LIMIT	PLASTICITY INDEX	ACTIVITY	UNIFIED SOIL CLASSIFICATION	LAB NO.
	Test Pit #14 @ 0-4½'	29	9	18.0	SC	2-111-34
	% Dispersion = $\frac{6}{10}$ x 100 =	60%				

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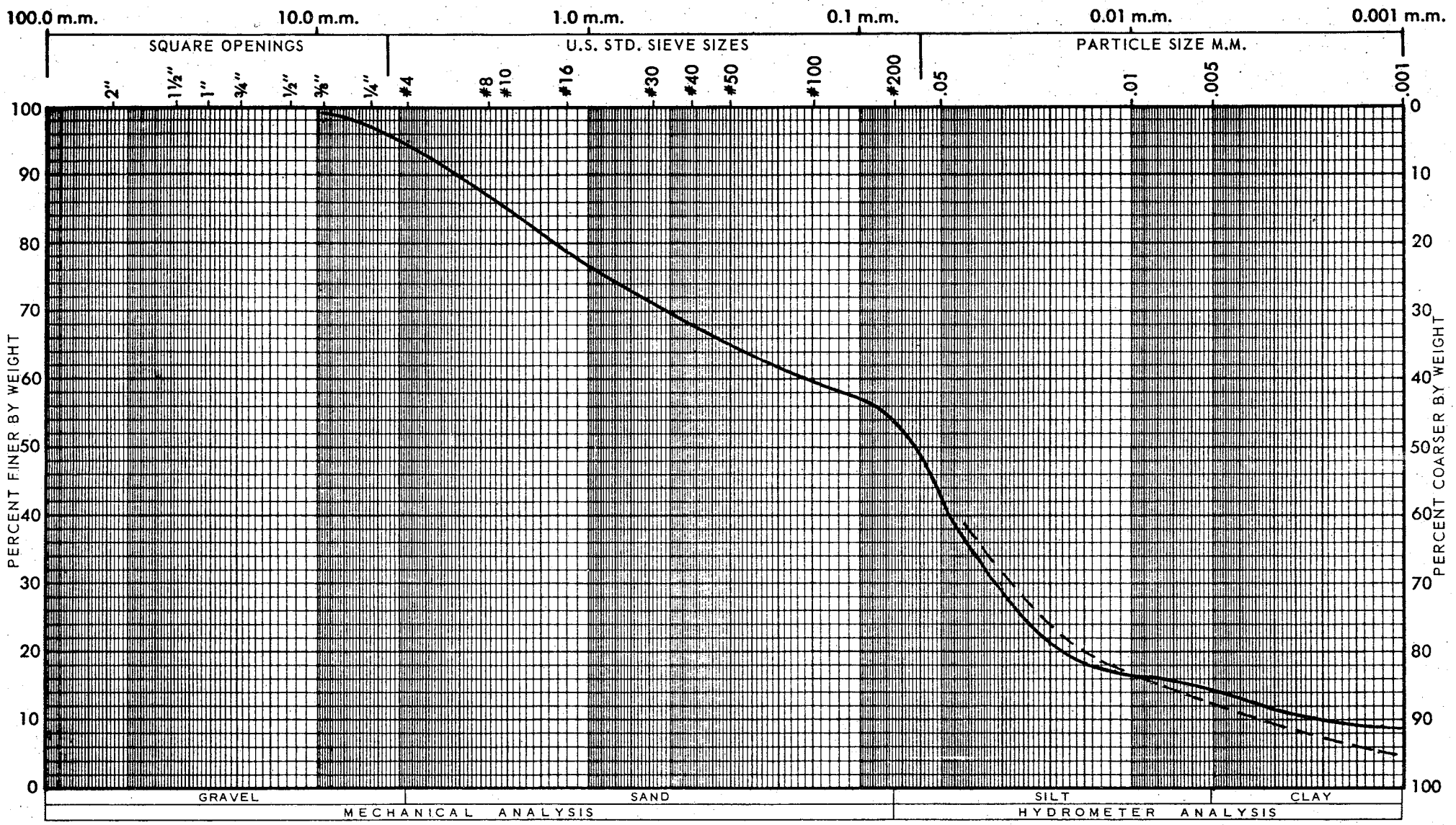
LAB NO. E82-111

PARTICLE SIZE DISTRIBUTION CURVE

PROJECT McMicken Dam Restoration Study - Phase III **LOCATION** Maricopa County, Arizona



Specific Gravity = 2.709

CURVE	SAMPLE	LIQUID LIMIT	PLASTICITY INDEX	ACTIVITY	UNIFIED SOIL CLASSIFICATION	LAB NO.
	Test Pit #30 @ 0-4½'	31	12	2.4	CL	2-111-65
	% Dispersion = $\frac{12}{14}$ x 100 =	86%				

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REPORT ON LABORATORY TESTS

DATE _____

PROJECT McMicken Dam Restoration Study - Phase III JOB NO. E82-111

LOCATION Maricopa County, Arizona LAB NO. 2-111-13

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

PINHOLE TEST EVALUATION

Sample: Test Pit #5 @ 1½'-5'

Curing Time: 6 days Soil Classification: SC

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)

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

Classify Soil as: Nondispersieve - No effect on hole size

PHOENIX (602) 272-6848 TUCSON (602) 884-9333 ALBUQUERQUE (505) 345-8606 EL PASO (915) 591-8188

REPORT ON LABORATORY TESTS

DATE _____

PROJECT McMicken Dam Restoration Study - Phase III JOB NO. E82-111

LOCATION Maricopa County, Arizona LAB NO. 2-111-34

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

PINHOLE TEST EVALUATION

Sample: Test Pit #14 @ 0-4½'

Curing Time: 6 days Soil Classification: SC

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)

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

Classify Soil as: Nondispersive - No effect on hole size

PHOENIX (602) 272-6848 TUCSON (602) 884-9333 ALBUQUERQUE (505) 345-8606 EL PASO (915) 591-8188

REPORT ON LABORATORY TESTS

DATE _____

PROJECT McMicken Dam Restoration Study - Phase III JOB NO. E82-111

LOCATION Maricopa County, Arizona LAB NO. 2-111-65

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

PINHOLE TEST EVALUATION

Sample: Test Pit #30 @ 0-4½'

Curing Time: 5 days Soil Classification: CL

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)

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

Classify Soil as: Nondispersive - No effect on hole size

PHOENIX (602) 272-6848 TUCSON (602) 884-9333 ALBUQUERQUE (505) 345-8606 EL PASO (915) 591-8188

REPORT ON LABORATORY TESTS

DATE _____

PROJECT McMicken Dam Restoration Study - Phase III JOB NO. E82-111

LOCATION Maricopa County, Arizona LAB NO. 2-111-13

REMOLDED PERMEABILITY TEST (Pressurized Permeameter)

Sample Test Pit #5 @ 1½'-5'

Remolded to 94.8 % of Maximum Density 112.6 PCF at 15.0 %

Diameter 4.915 cm Length 7.635 cm Area 18.973 cm^2 Vol. 144.86 cc

W_s 247.8 grms. w_o 14.9 % w_f 19.5 % G_s Assumed 2.65 V_s 93.51 cc

Void Ratio 0.5491 Dry Density 106.7 PCF Trials 7 days

S_o = 71.9% S_f = 94.1%

Pressure (PSI)	Head (inches)	Q (cc)	Time (min.)	K (cm/sec)	K (ft/yr)	Remarks
10	318.8	285	4145	5.7×10^{-7}	0.6	Exit "Q"
	322.0	115	5690	5.8×10^{-7}	0.6	Exit "Q"
	323.2	120	7330	5.8×10^{-7}	0.6	Exit "Q"
	316.8	78	1157	5.6×10^{-7}	0.6	Exit "Q"
	322.4	94	1456	5.3×10^{-7}	0.5	Exit "Q"

PHOENIX (602) 272-6848 EL PASO (915) 772-3088 ALBUQUERQUE (505) 344-9940

REPORT ON LABORATORY TESTS

DATE _____

PROJECT McMicken Dam Restoration Study - Phase III JOB NO. E82-111

LOCATION Maricopa County, Arizona LAB NO. 2-111-34

REMOLDED PERMEABILITY TEST (Pressurized Permeameter)

Sample Test Pit #14 @ 0-4½'

Remolded to 94.4 % of Maximum Density 124.1 PCF at 11.6 %

Diameter 4.915 cm Length 7.635 cm Area 18.973 cm^2 Vol. 144.86 cc

W_s 272.0 grms. w_o 11.7 % w_f 13.3 % G_s Assumed 2.65 V_s 102.64 cc

Void Ratio 0.4113 Dry Density 117.2 PCF Trials 7 days

So = 75.3% S_f = 85.7%

Pressure (PSI)	Head (inches)	Q (cc)	Time (min.)	K (cm/sec)	K (ft/yr)	Remarks
10	326.9	54	4145	1.1×10^{-7}	0.1	Input "Q"
	326.5	70	5690	9.95×10^{-8}	0.1	Input "Q"
	326.1	87	7330	9.6×10^{-8}	0.1	Input "Q"
15	461.6	41	2618	8.9×10^{-8}	0.1	Input "Q"

REPORT ON LABORATORY TESTS

DATE _____

PROJECT McMicken Dam Restoration Study - Phase III JOB NO. E82-111

LOCATION Maricopa County, Arizona LAB NO. 2-111-65

REMOLDED PERMEABILITY TEST (Pressurized Permeameter)

Sample Test Pit #30 @ 0-4½'

Remolded to 94.8 % of Maximum Density 124.0 PCF at 11.3 %

Diameter 4.915 cm Length 7.635 cm Area 18.973 cm^2 Vol. 144.86 cc

W_s 272.9 grms. w_o 11.3 % w_f 14.0 % G_s Assumed 2.65 V_s 102.98 cc

Void Ratio 0.4066 Dry Density 117.6 PCF Trials 7 days

S_o = 73.6% S_f = 91.2%

Pressure (PSI)	Head (inches)	Q (cc)	Time (min.)	K (cm/sec)	K (ft/yr)	Remarks
10	325.5	71	4145	1.4×10^{-7}	0.1	Input "Q"
	324.9	96	5690	1.4×10^{-7}	0.1	Input "Q"
	324.2	126	7330	1.4×10^{-7}	0.1	Input "Q"
15	458.1	71	2618	1.6×10^{-7}	0.2	Input "Q"

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CHEMONICS

CHEMONICS INDUSTRIES / POST OFFICE DRAWER 21568 / PHOENIX, ARIZONA 85036 / TELEPHONE (602) 262-5401

SOIL ANALYSIS REPORT

CLIENT:

Sergent, Hauskins & Beckwith
3940 W. Clarendon Avenue
Phoenix, AZ 85019

Submitted By: P.O.#L3636
Date Received: 10/26/82
Date Reported: 11/1/82

LABORATORY NUMBER		82-5113	82-5114	82-5115		
SAMPLE MARKING		Job#E82-111 w/o#1 Lab#21	Job#E82-111 w/o#1 Lab#61	Job#E82-111 w/o#1 Lab#77		
SATURATION PERCENTAGE						
pH		8.0	7.9	7.9		
ELECTRICAL CONDUCTIVITY (EC_e)	(1)	0.3	1.5	4.0		
SODIUM (Na)	(2)	0.7	9.1	28.5		
CALCIUM (Ca) + MAGNESIUM (Mg)	(2)	2.8	5.0	20.8		
SODIUM ADSORPTION RATIO (SAR)		0.6	5.8	8.8		
EXCHANGEABLE SODIUM PERCENTAGE (ESP*)						
NITRATE NITROGEN (N)	(3)					
PHOSPHORUS (P)	( )					
POTASSIUM (K)	(8) (6)	2	2.5	8.0		
ORGANIC NITROGEN (N)	(3)					
GYPSUM REQUIREMENT	(7)					
% CALCIUM CARBONATE ($CaCO_3$)						
SOIL TEXTURE						
MECHANICAL ANALYSIS	% SAND					
	% SILT					
	% CLAY					

(1) Results expressed in Millimhos/CM on Saturation Paste Extract.
(2) Results expressed in Milliequivalents/Liter on Saturation Paste Extract.
(3) Results expressed in Parts Per Million on the Air Dry Soil.
(4) Carbon Dioxide Extractable Phosphorus in ppm Air Dry Soil.
(5) Bicarbonate Extractable Phosphorus in ppm Air Dry Soil.
(6) Water Soluble plus Exchangeable Potassium in ppm Air Dry Soil.
(7) Results expressed in Milliequivalents/100 gm Air Dry Soil.
*Estimated ESP calculated from Sodium and Calcium plus Magnesium.
(8) Expressed in Parts Per Million off Saturation Paste.

CONVERSIONS:
N x 4.4 = NO_3
P x 2.3 = P_2O_5
K x 1.2 = K_2O
PPM x 4 = Lb/Ac. Ft.

Respectfully Submitted,
CHEMONICS

Ann L Pollock

B-27

CHEMONICS

CHEMONICS INDUSTRIES / POST OFFICE DRAWER 21568 / PHOENIX, ARIZONA 85036 / TELEPHONE (602) 262-5401

REPORT OF ANALYSIS

CLIENT:

Sergent, Hauskins & Beckwith
3940 W. Clarendon Avenue
Phoenix, AZ 85019

Submitted By:
Sample Of: Soil
Date Received: 10/26/82
Date Reported: 11/1/82
Laboratory No.: 82-5113 thru 5115

RESULTS

Sample Marking	Job E82-111 Lab #21	Job E82-111 Lab #61	Job E82-111 Lab #77
*Water Soluble Sodium (Na) (meq./100 gm)	.03	.41	.69
Exchangeable Sodium (Na) (meq./100 gm)	.27	.93	.15
Cation Exchange Capacity (CEC) (meq./100 gm)	30.97	25.06	4.96
Exchangeable-Sodium-Percentage (ESP)	0.87	3.71	3.02

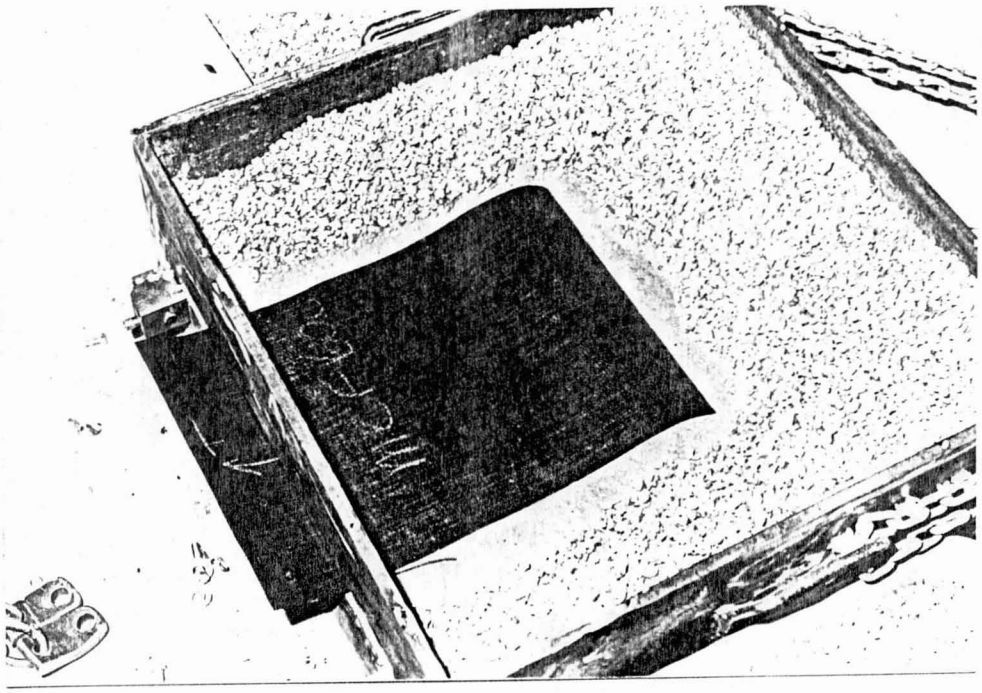
*Results expressed on Saturation Paste Extract.

RESULTS EXPRESSED ON AIR DRY SOIL.

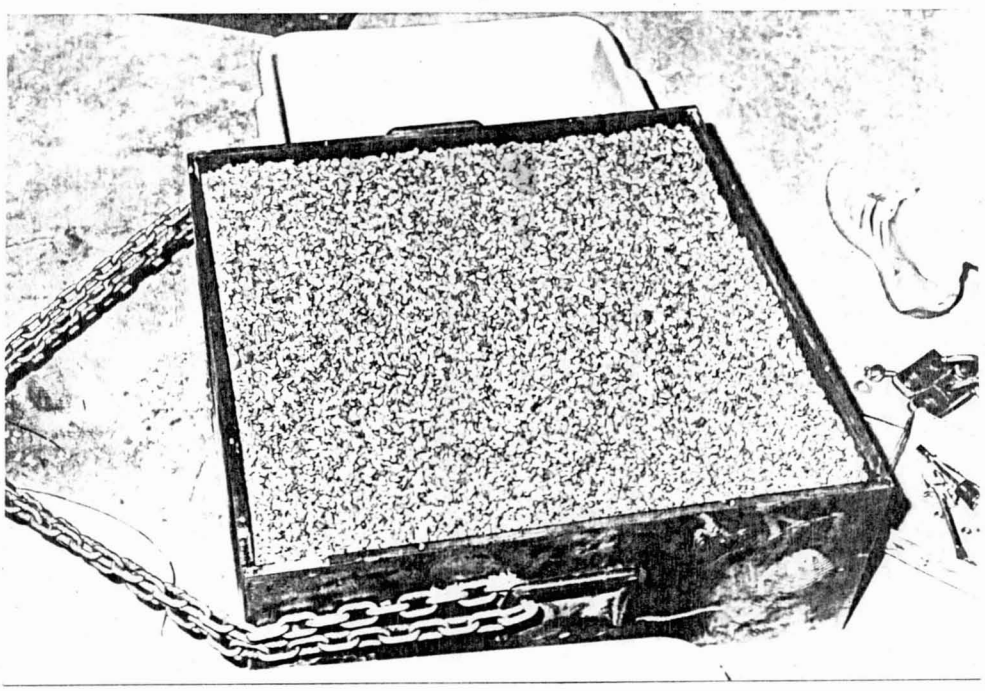
The results reported herein were obtained by following standard laboratory procedures and apply only to the sample tested. They are not to be considered representative of the qualities of any apparently identical samples and/or similar materials. This report is intended for the sole use of the above named client. Client must obtain prior written permission from Chemonics Industries in order to use Chemonics' name in any connection with this report and/or its contents.

Respectfully submitted,
CHEMONICS

Ann L Pollock
Agricultural Chemist

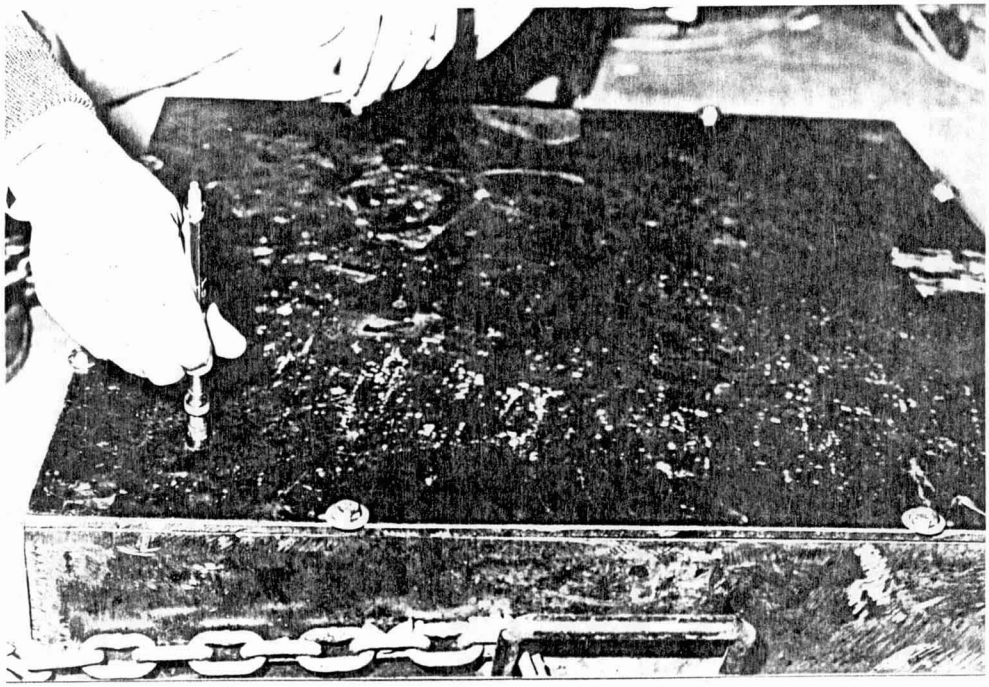


Pullout Test - MCF 600 geotextile in test box prior to testing.

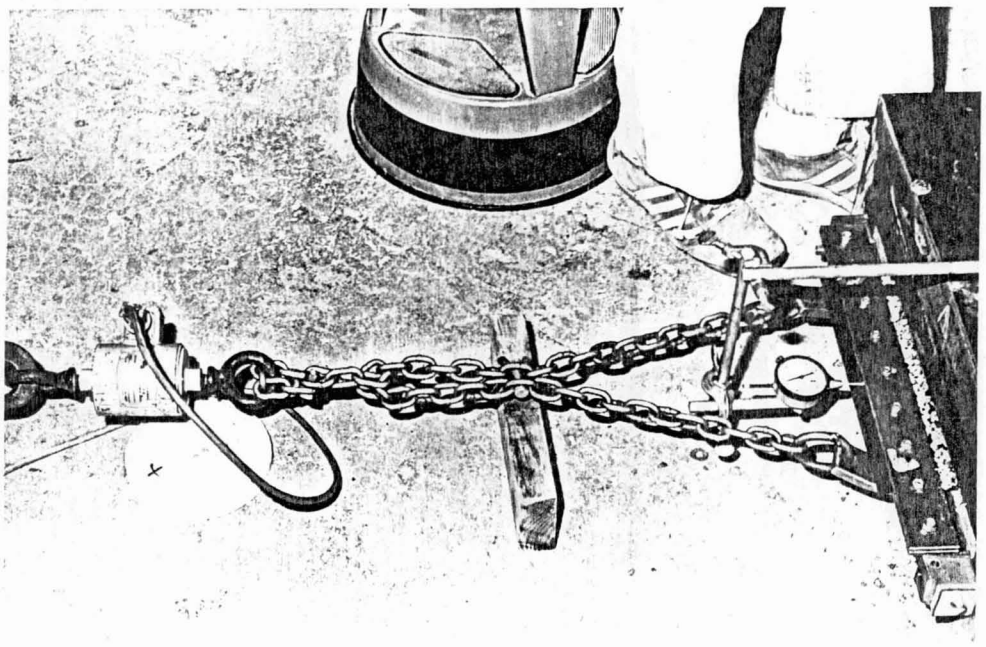


Pullout Test - 4 inch gravel cover over geotextile.

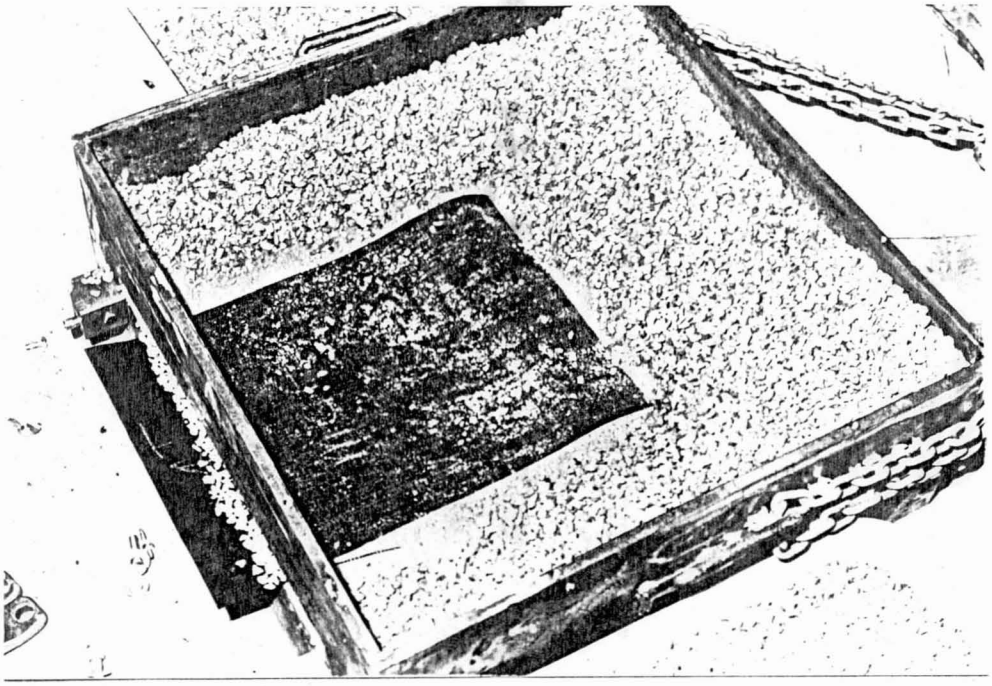
Pullout Test - Air bladder in place over gravel and geotextile.



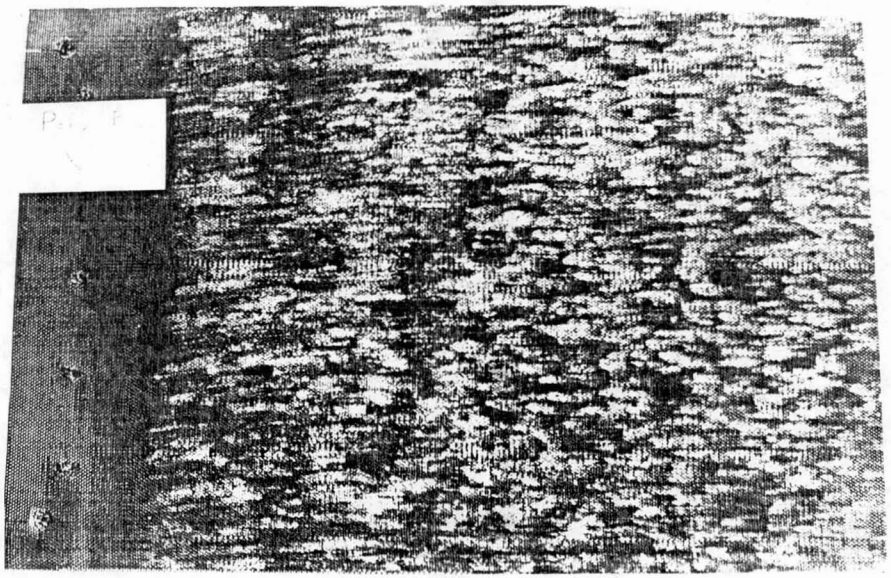
Pullout Test - Steel plate top bolted over air bladder with air pressure measurement.



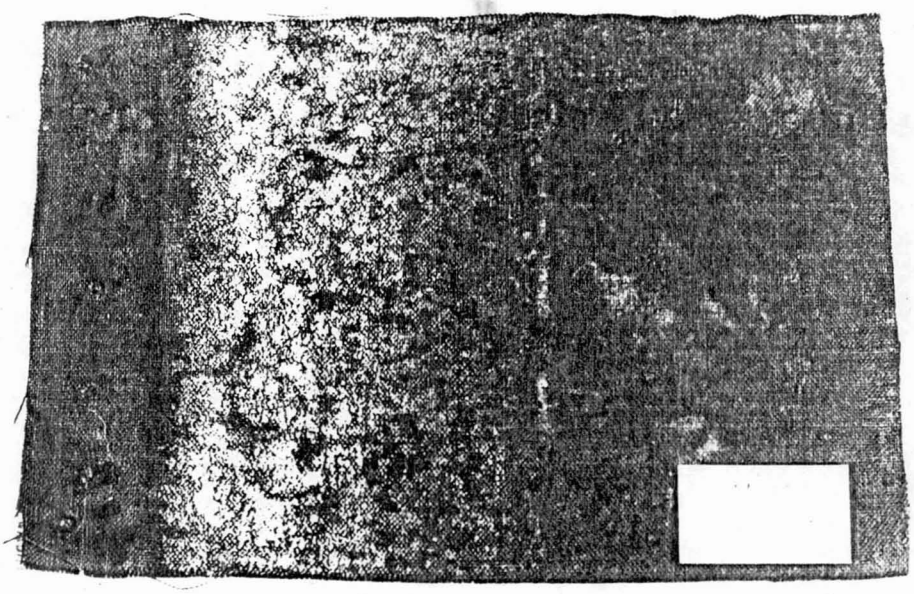
Pullout Test - Geotextile clamp and tension load measurement unit.



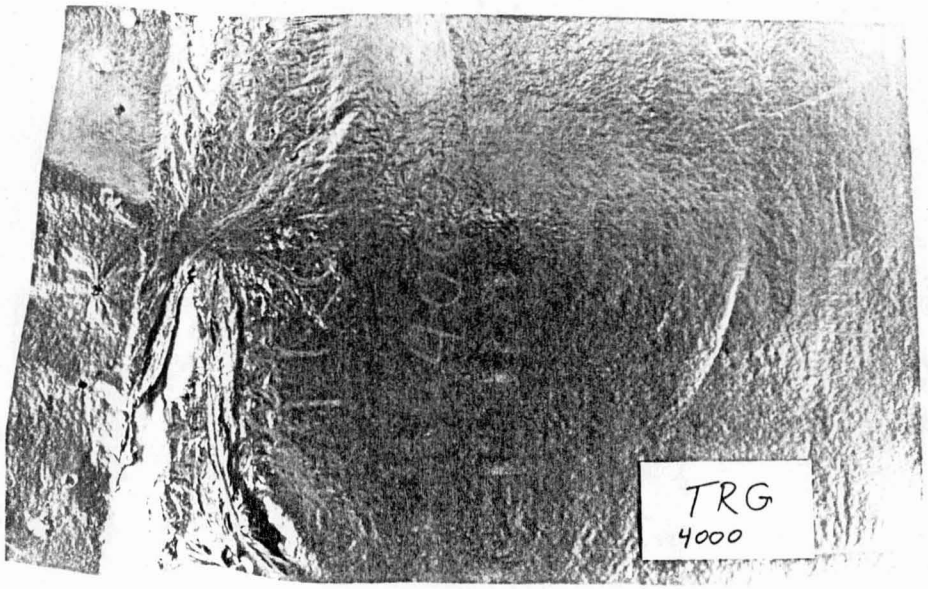
Pullout Test - Geotextile after test.



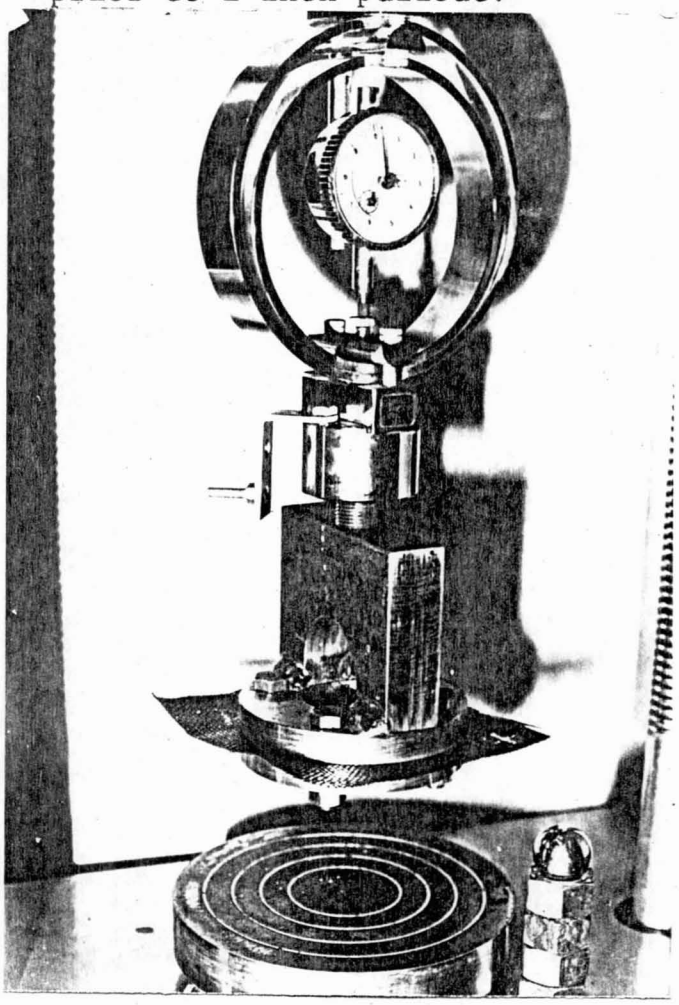
Pullout Test - Polyfilter X geotextile with entire length smeared with soil.



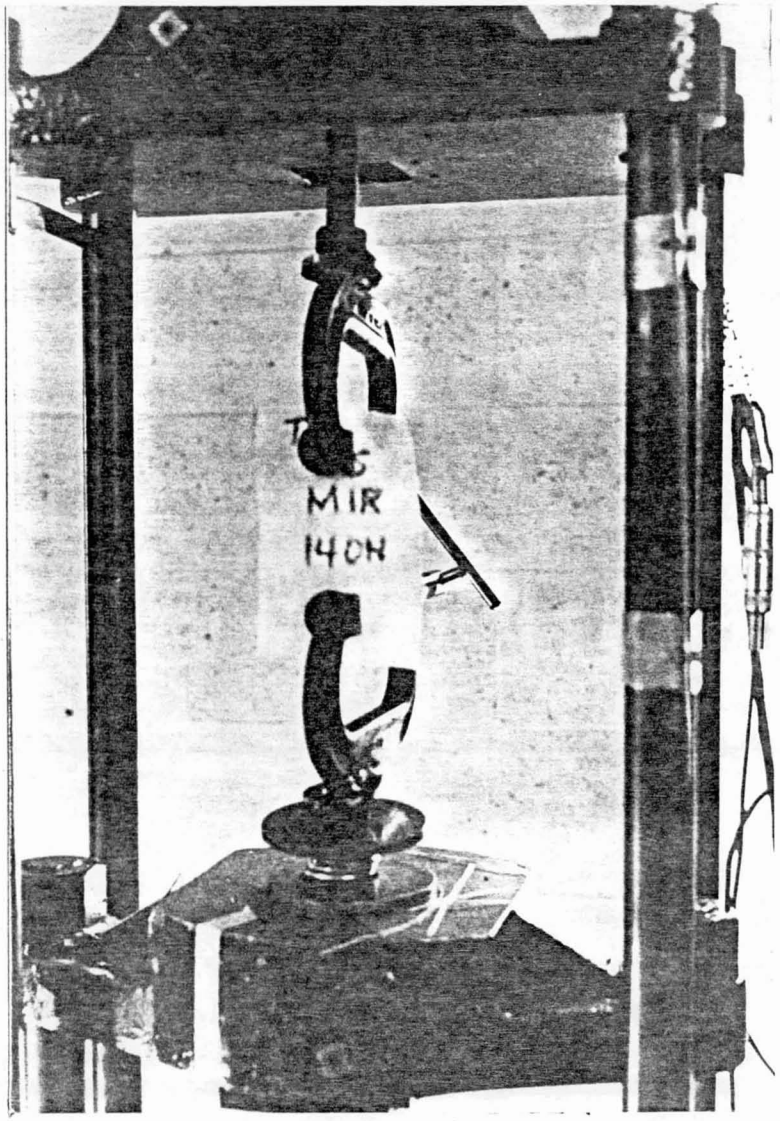
Pullout Test - Amoco 1325 geotextile with approximately 5 inches smeared with soil.



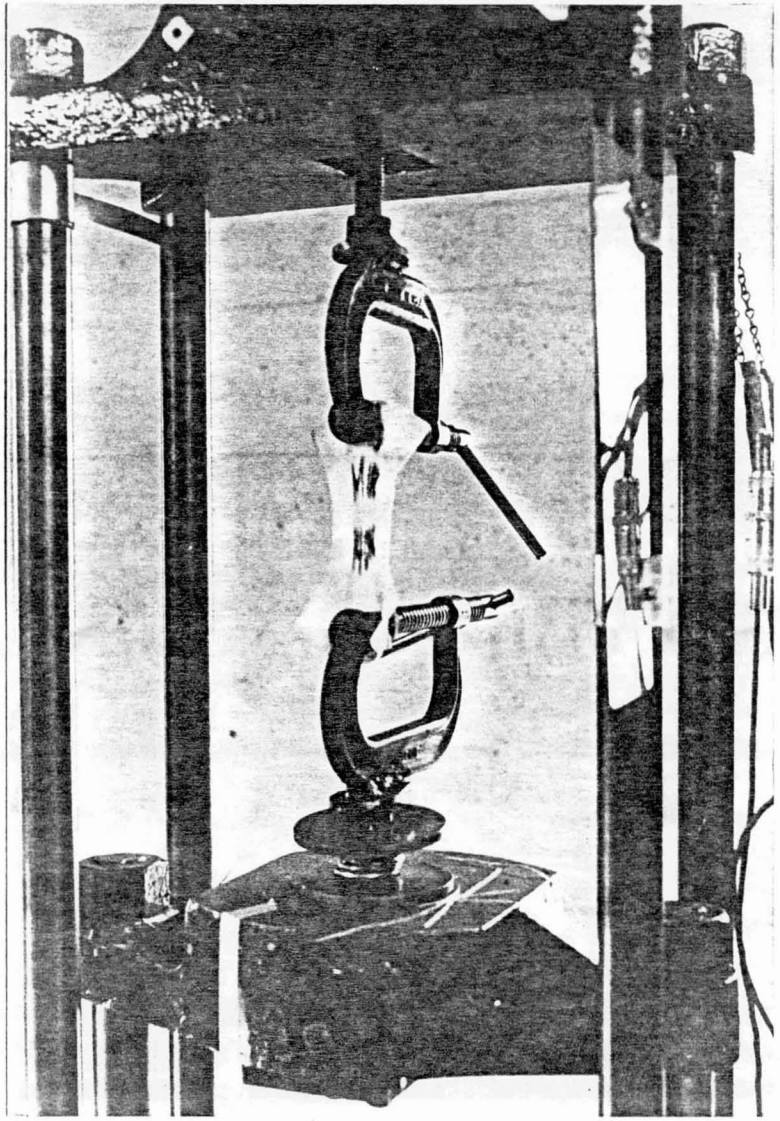
Pullout Test - Transguard 4000 geotextile break prior to 1 inch pullout.



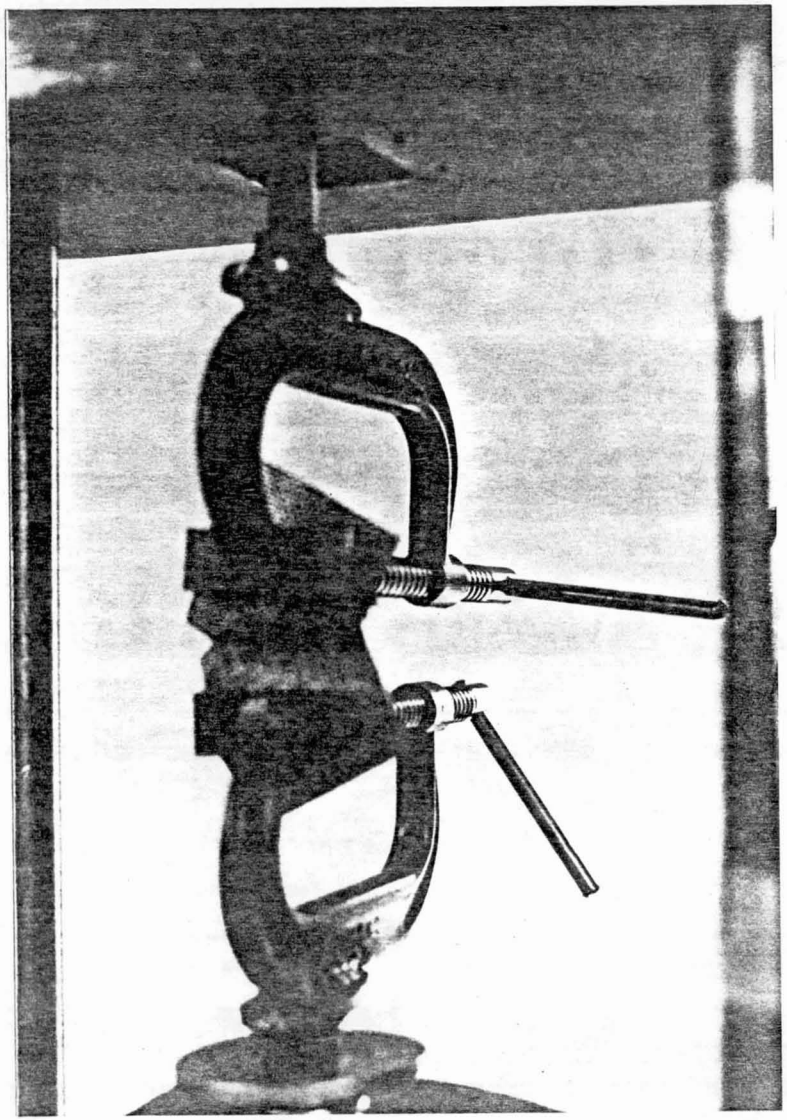
Puncture Test



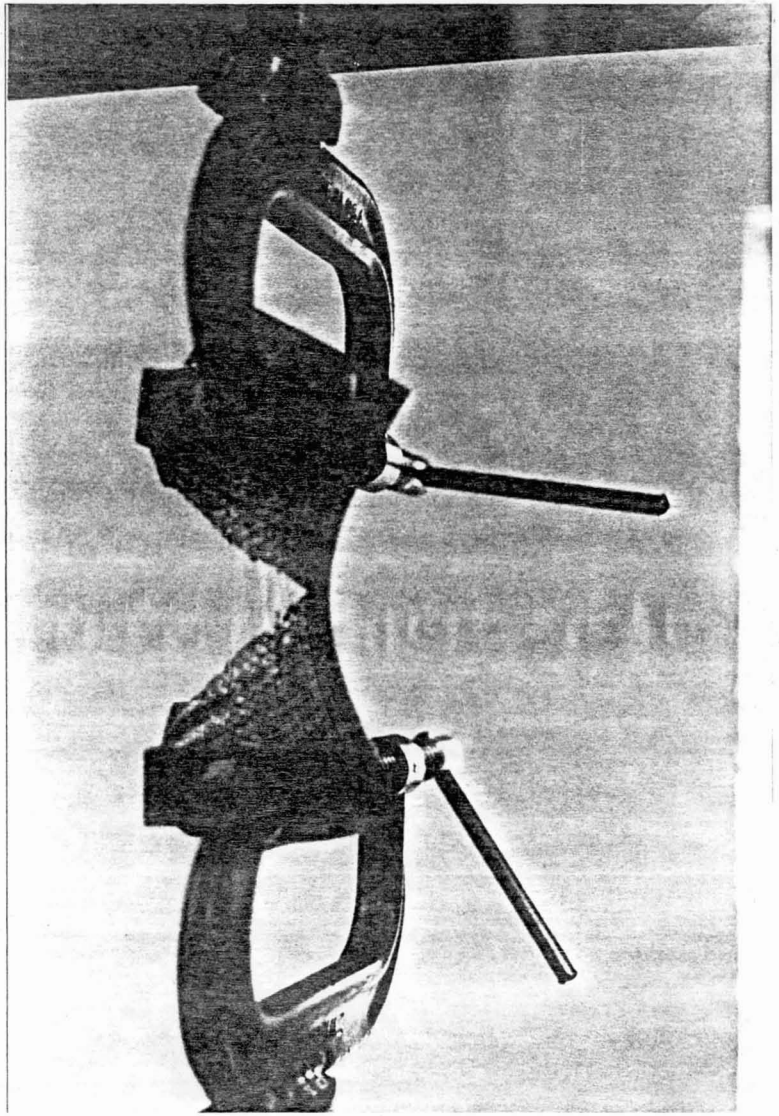
Grab Test - Mirafi 140N geotextile prior to test.



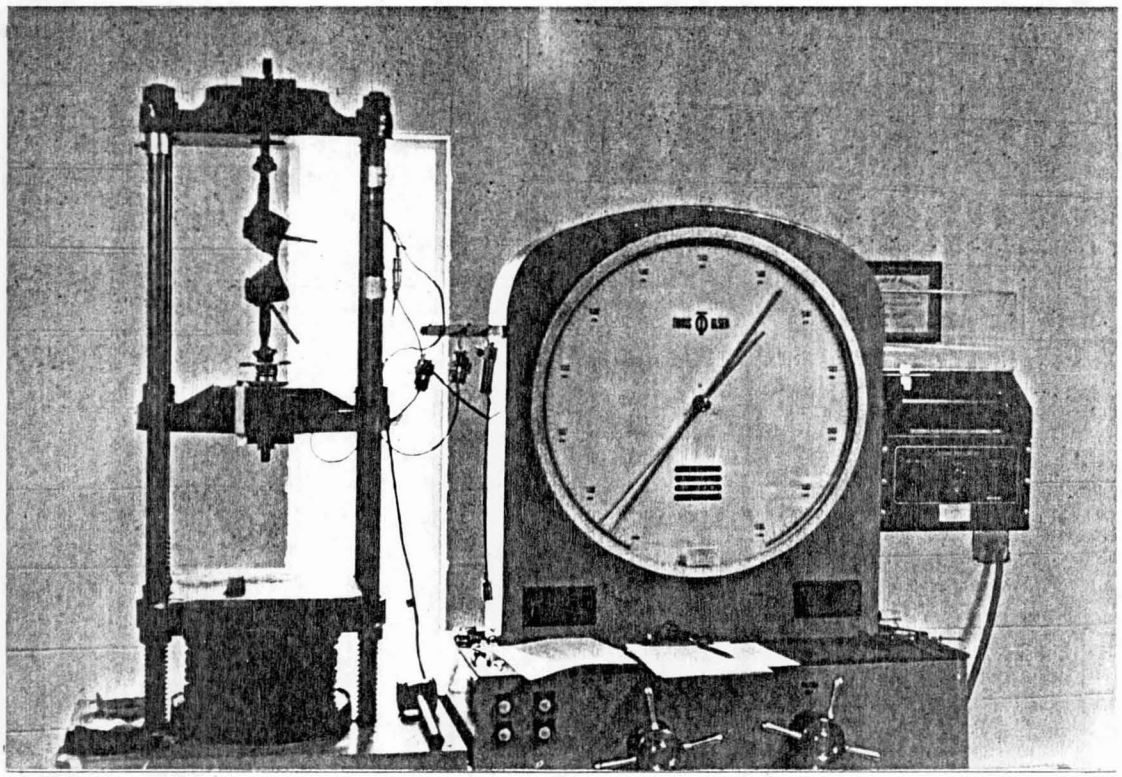
Grab Test - Mirafi 140N geotextile during test.



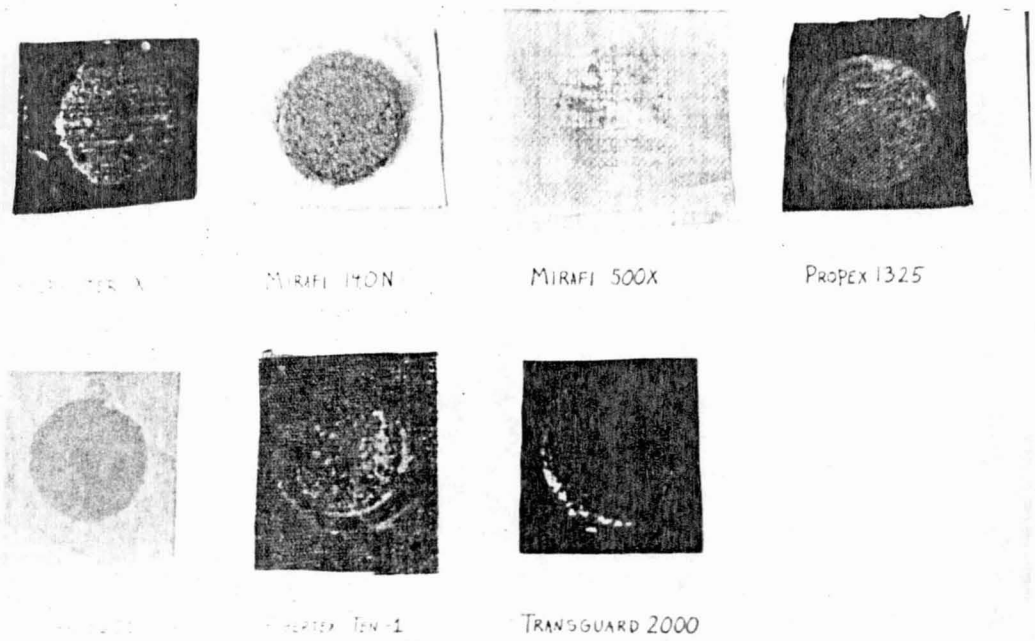
Trapezoidal Tear Test - Mirafi MCF 500 geotextile prior to test.



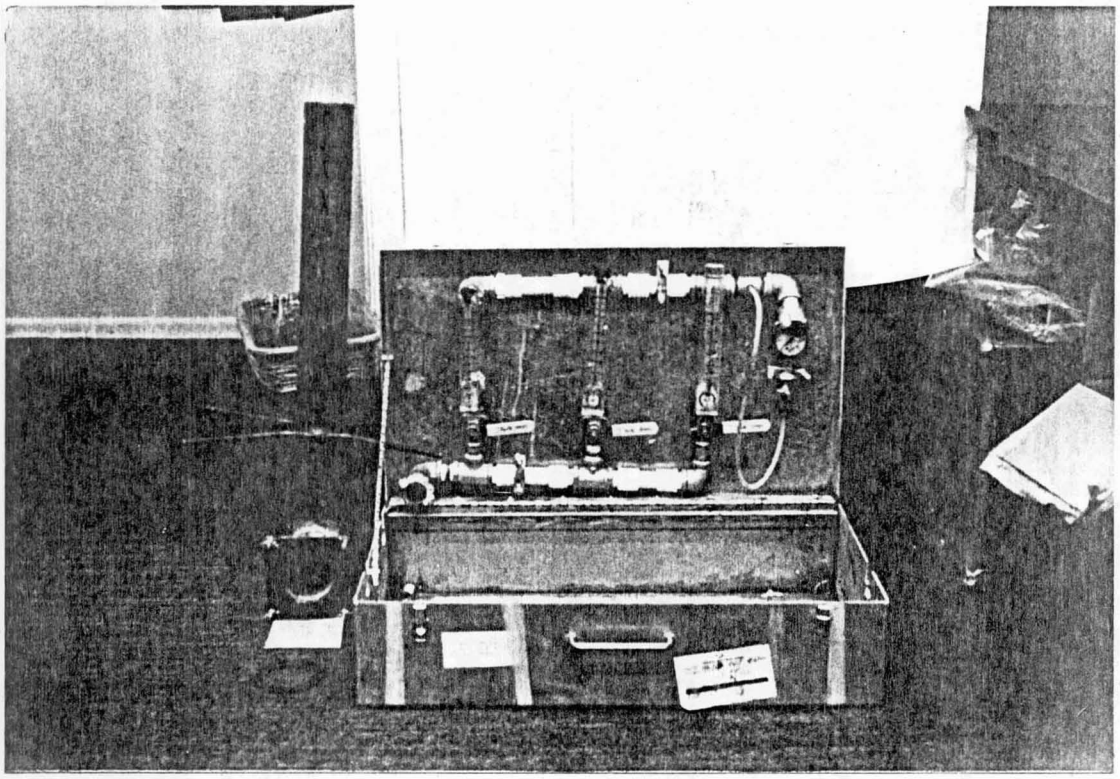
Trapezoidal Tear Test - Mirafi MCF 500 geotextile during test.

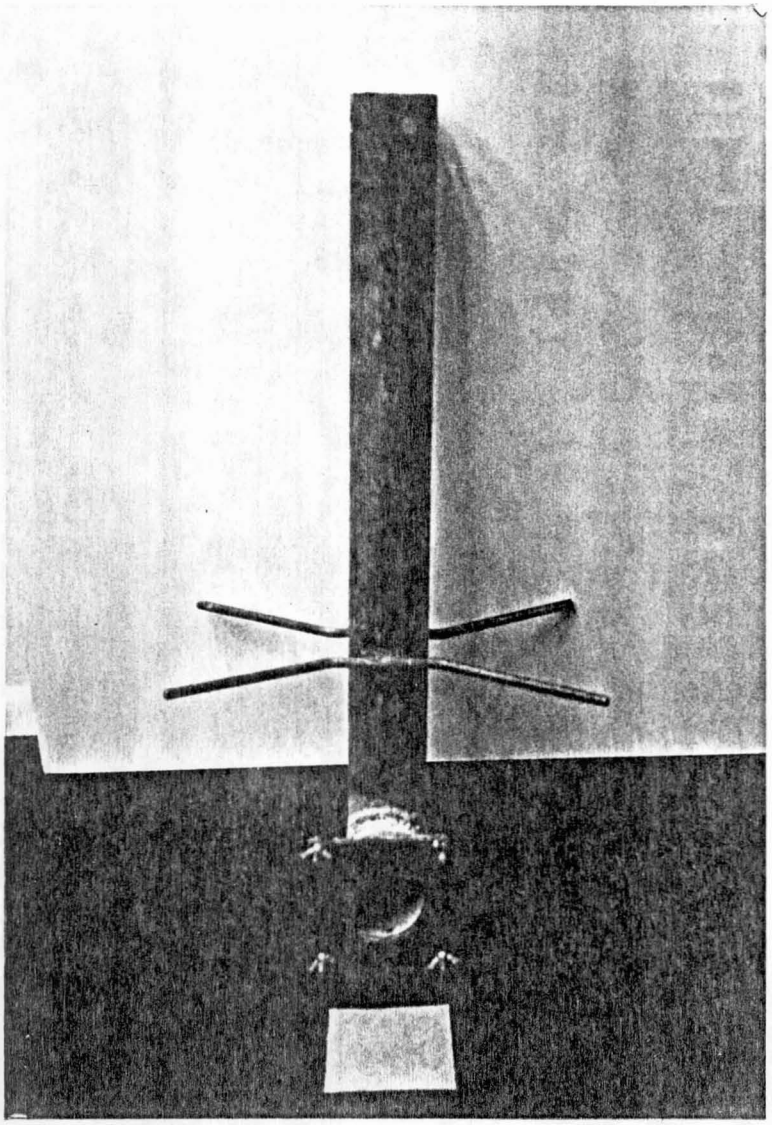


Trapezoidal Tear Test Apparatus



Permeability - Clogging test results of seven geotextiles.





Permeability Clogging
Test Apparatus

TABLE C-1

RESULTS OF GEOTEXTILE PERMEABILITY TESTING

	Initial Permeability (cm/s)	50 ml Turbid Water Permeability (cm/s)	450 ml Total Turbid Water Permeability (cm/s)	Additional 200 ml Embankment Soil & Water Permeability (cm/s)
Polyfilter X	9.1×10^{-2}	6.1×10^{-3}	9.6×10^{-5}	3.4×10^{-6}
Mirafi 140N	8.2×10^{-2}	5.5×10^{-2}	2.1×10^{-3}	2.3×10^{-5}
Mirafi 500X	1.5×10^{-3}	9.5×10^{-4}	$<1.9 \times 10^{-7}$	---
Amoco 1325	2.3×10^{-3}	2.6×10^{-3}	2.0×10^{-6}	---
Typar 3601	6.1×10^{-3}	2.6×10^{-4}	2.4×10^{-7}	---
Fibertex Ten-1	1.3×10^{-3}	3.2×10^{-4}	1.3×10^{-7}	---
TRG 2000	5.8×10^{-3}	3.4×10^{-3}	1.9×10^{-7}	---

TABLE C-2

RESULTS OF STANDARD TESTING OF GEOTEXTILES*

Manufacturer	Geotextile Type	Puncture ASTM D751 (Pounds)	Grab ASTM D1682 (Pounds) T x S**	Trapezoidal Tear ASTM D751 (Pounds) T x S**	EOS
Amoco	Propex 4545	158.2			
	Propex 1325	379.2	240 x 337	177 x 88	<120
	Propex 2002	301.4			
	C7305	144	130 x 92	43 x 45	
	P6838	193			
Carthage Mills	Polyfilter X	361	281 x 232	102 x 89	50-60
	Polyfilter GB	-			
Crown Zellerbach	Fibertex 200	181			
	Fibertex Ten-1	187.6	127 x 91	68 x 69	70-80
	Fibertex Ten-3	-			
Dominion Textile	Mirafi 140N	216.6	121 x 92	61 x 48	<120
	Mirafi 500X	209.7	148 x172	82 x 87	30-35
	Mirafi 600X	407.1			
	Mirafi 700X	-			
	Mirafi MCF500	319	228 x 231	53 x 60	
	Mirafi MCF600	-			
DuPont	Typar 3341	132.6			
	Typar 3401	156.3			
	Typar 3601	245.4	207 x 203	89 x 117	<120
	Typar T063	208	150 x 144	64 x 77	
Griffolyn	Transguard 2000	435.6	291 x 311	89 x 87	70-80
	Transguard 4000	101.6			

*Modified as described in design report.
**T = Machine direction (warp).
S = Perpendicular to machine direction (weft).

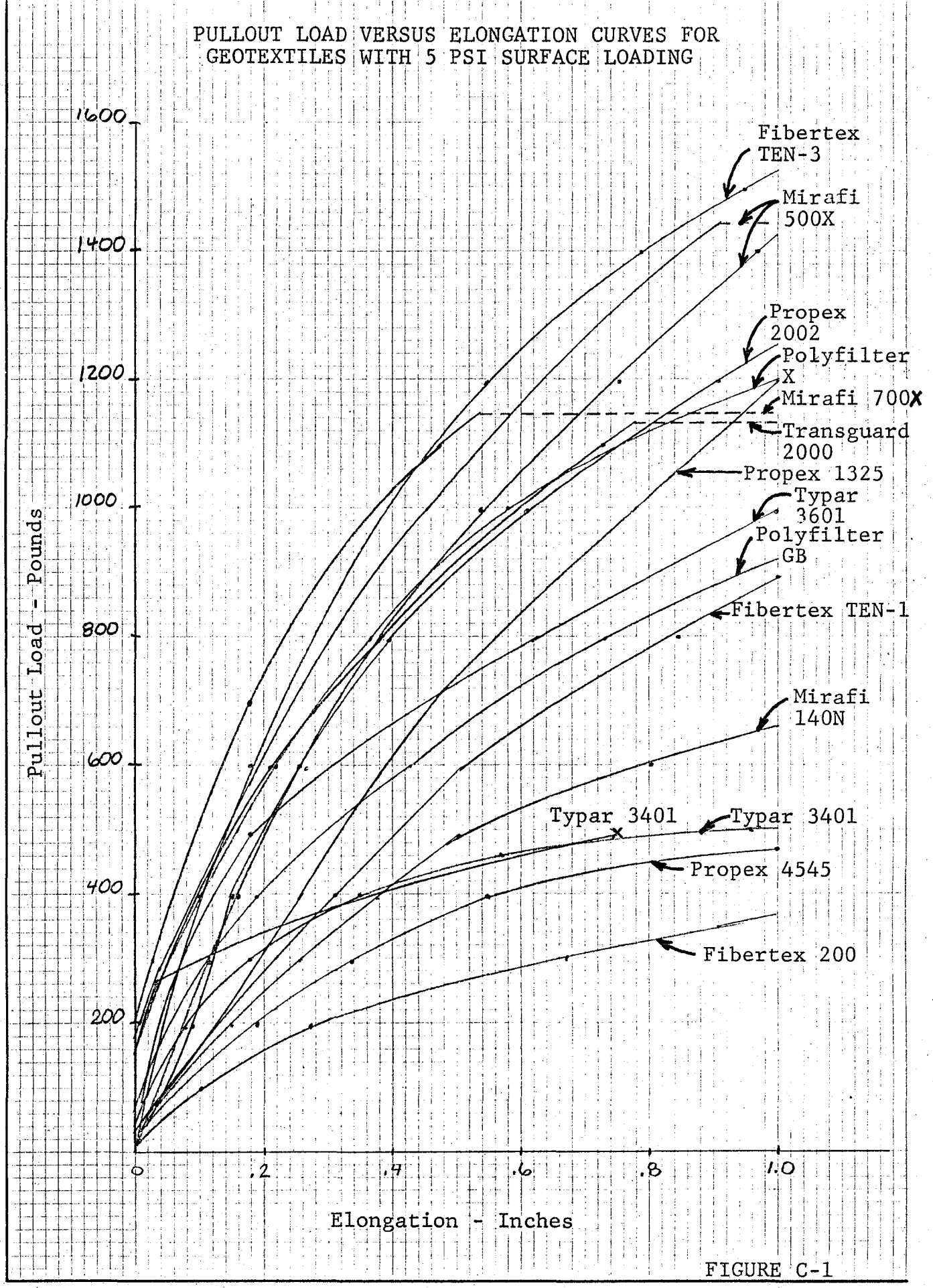


FIGURE C-1

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PULLOUT LOAD VERSUS ELONGATION CURVES FOR GEOTEXTILES WITH 10 PSI SURFACE LOADING

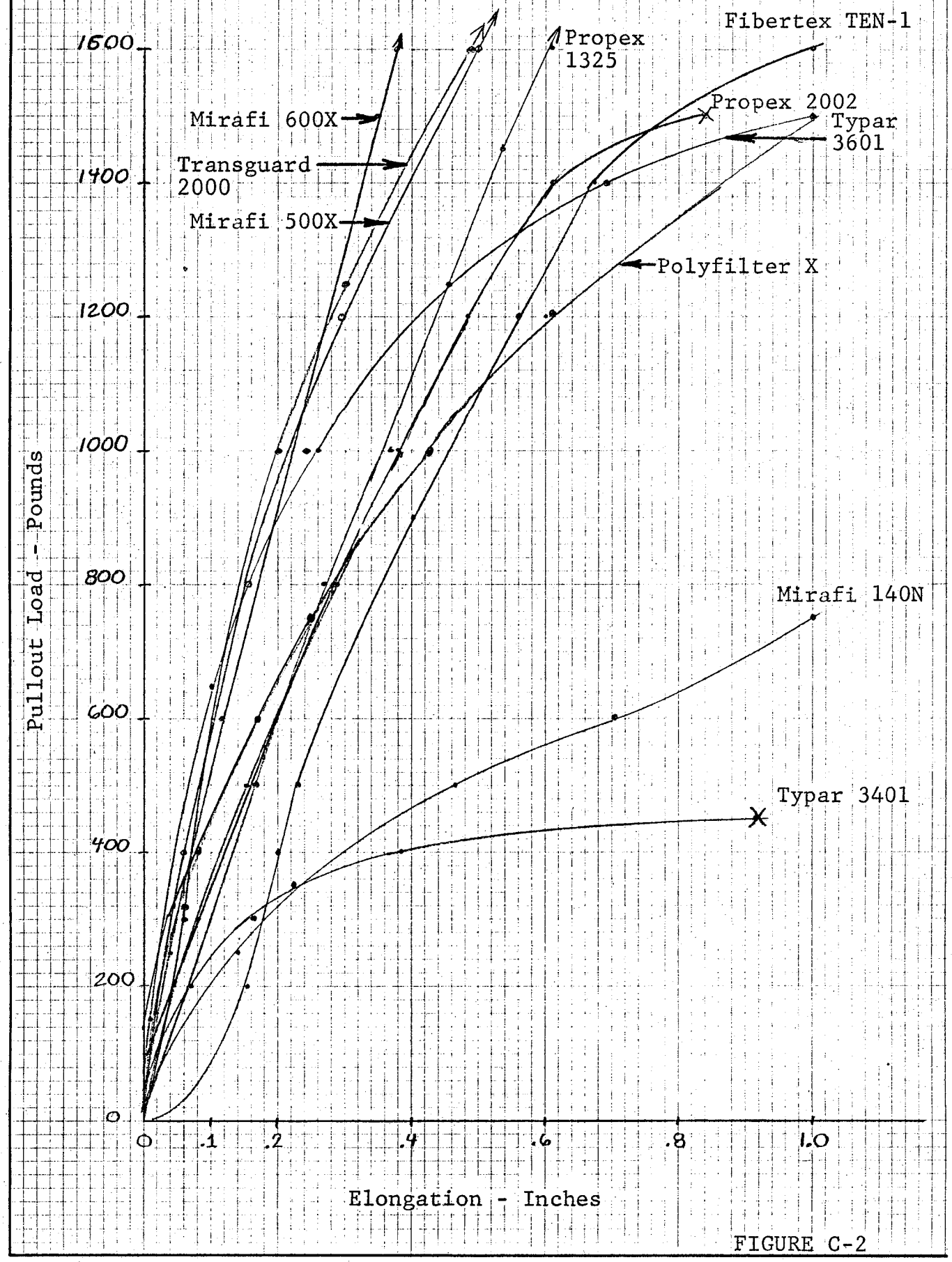

FIGURE C-2

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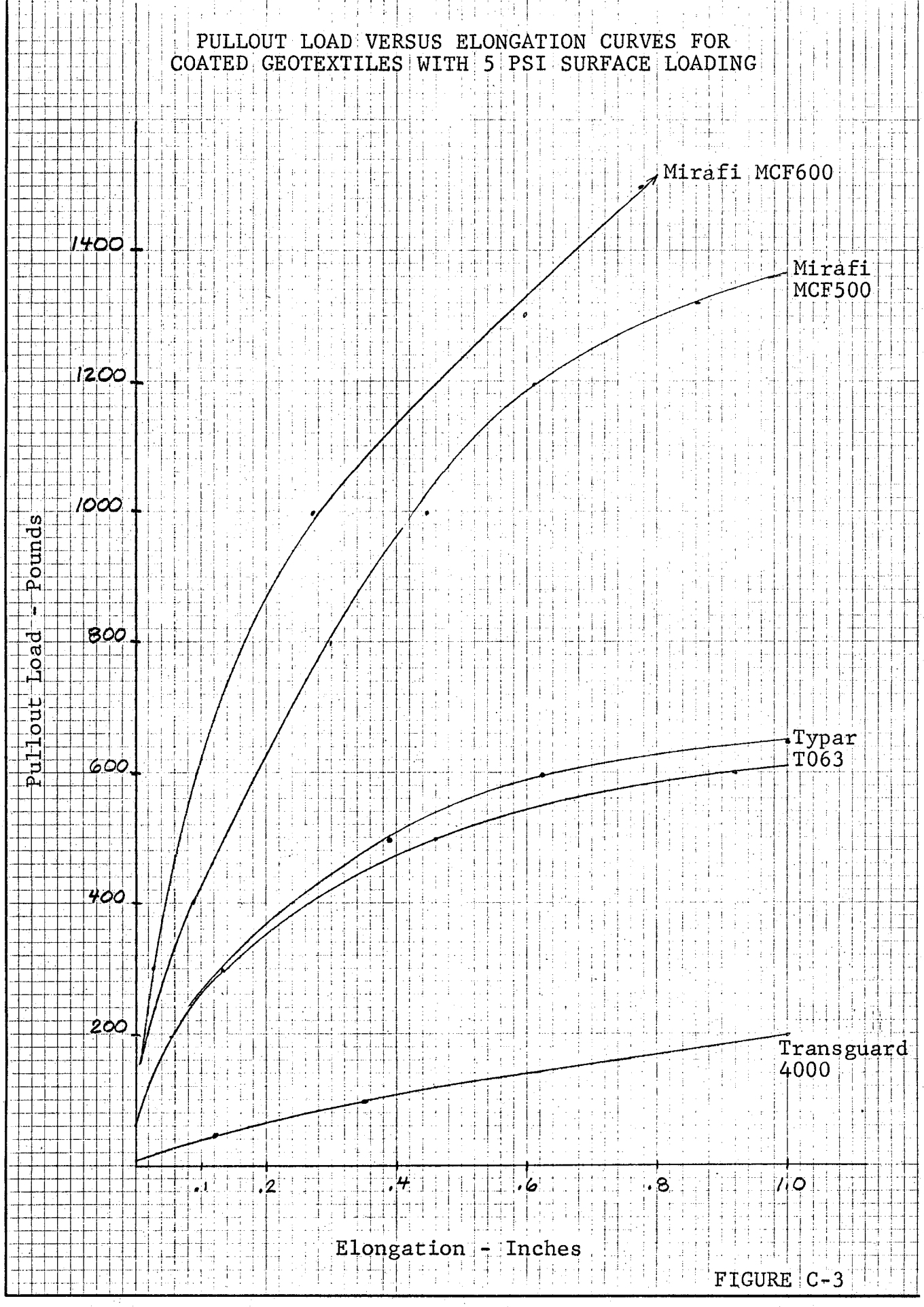

FIGURE C-3

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PULLOUT LOAD VERSUS ELONGATION CURVES FOR
COATED GEOTEXTILES WITH 10 PSI SURFACE LOADING

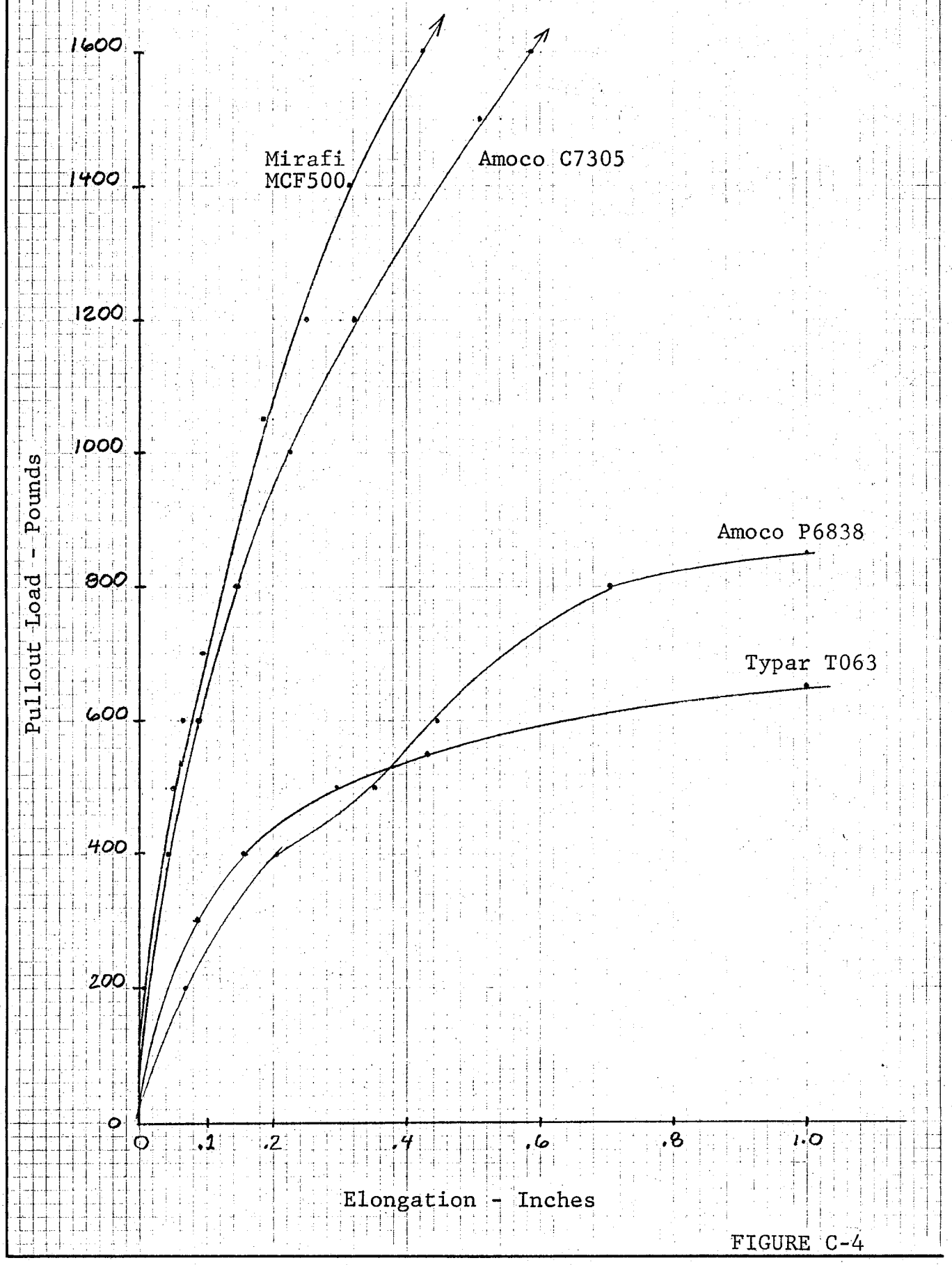

FIGURE C-4

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TABLE C-3

RESULTS OF PULLOUT TESTING FOR PERMEABLE & COATED GEOTEXTILES

Manufacturer	Geotextile Type	Pullout Load at 5 psi With 1" Elongation (Pounds)	Soil Smear (Inches)	Pullout Load at 10 psi With 1" Elongation (Pounds)	Soil Smear (Inches)
Amoco	Propex 4545	475	3.5		
	Propex 1325	1,200	5.0	>1,600	5.0
	Propex 2002	1,200	6.5	1,500 Break @ .84"	7.0
Carthage Mills	Polyfilter X	1,200	Entire Sheet	1,500	Entire Sheet
	Polyfilter GB	1,000	8.0		
Crown Zellerbach	Fibertex 200	350	2.5		
	Fibertex Ten-1	900	7.0	1,600	5.5
	Fibertex Ten-3	1,500	6.5		
Dominion Textile	Mirafi 140N	650	3.5	750	4.5
	Mirafi 500X	1,400 (1,450)	7.0 (6.0)	>1,600	6.5
	Mirafi 600X			>1,600	7.0
	Mirafi 700X	1,150 Pulled Out	Entire Sheet		
	Mirafi MCF500*	1,400	11.0	>1,600	10.0
	Mirafi MCF600*	1,500	Entire Sheet		
DuPont	Typar 3341	500 Break @ .75"	3.5		
	Typar 3401	550	4.5	450 Break @ .91"	3.5
	Typar 3601	1,000	5.0	1,500	5.5
	Typar T063*	650 (600)	5.0 (6.5)	650	6.5
Griffolyn	Transguard 2000	1,150 Pulled Out	Entire Sheet	>1,600	8.0
	Transguard 4000*	200	3.0		
	C7305*			>1,600	7.0
	P6838			850 Failed @ 1.2"	3.0

*Indicates coated geotextile.

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GEOTEXTILE MANUFACTURERS WITH TESTED FABRICS IN THIS REPORT

AMOCO (Propex Engineering Fabrics) 1-602-243-6201

Border Products Corporation
3880 East Broadway
Phoenix, Arizona
Attn: Mr. Dennis Umble
Account Manager

Carthage Mills (Poly-Filter X) 1-513-242-2740

1821 Summit Road
Cincinnati, Ohio 45237
Attn: Mr. Ed Burnett

Crown Zellerbach (Fibertex) 1-800-426-0700

Non-Woven Division
P. O. Box 1115
Camas, Washington 98607
Attn: Mr. Richard Schmidt

Griffolyn Division - Reef Industries 1-800-231-6074

P. O. Box 33248
Houston, Texas 77233
Attn: Mr. Patrick Brown

Dominion Textile (Mirafi) 1-602-257-0091

Western Tech-Sales
1833 West Lincoln Street
Phoenix, Arizona 85007
Attn: Mr. Patrick McGuckin

DuPont (Typar) 1-303-424-5100

445 Union Boulevard, Suite 304
Denver, Colorado 80228
Attn: Mr. Ray Hartman

GEOTEXTILE MANUFACTURERS WHICH WERE NOT REPRESENTED IN TESTING PROGRAM

Hoechst (Trevira) 1-602-278-6234

Armco Construction Products Division
P. O. Box 14348
5555 West Van Buren Street
Phoenix, Arizona 85063
Attn: Mr. William Johnson

Phillips Fibers Corporation (Supac) 1-303-850-3064

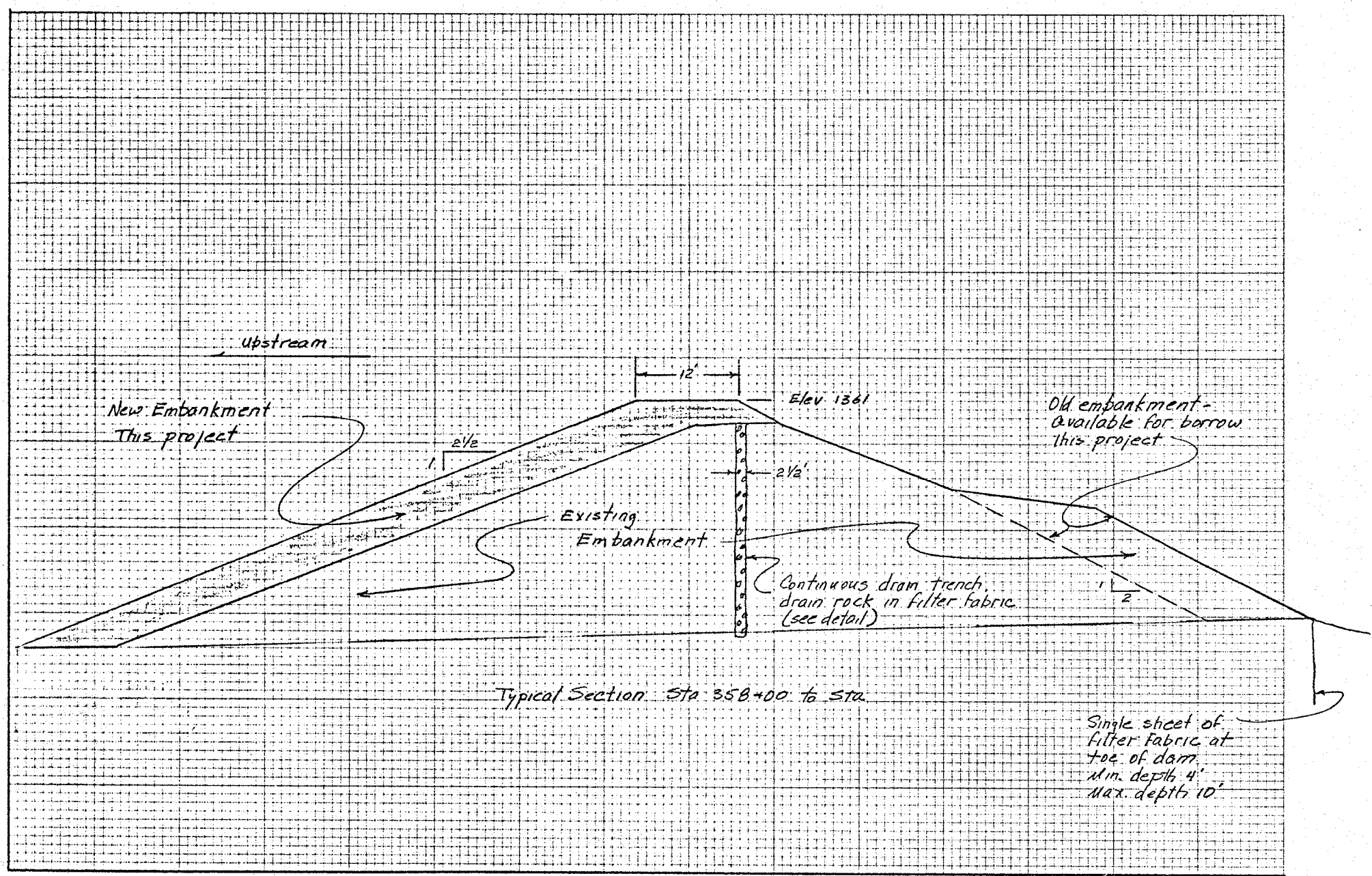
8055 Tufts Avenue Parkway
Denver, Colorado 80237
Attn: Mr. Dane Spaulding

Nicolon 1-800-241-9691

Suite 1990
Peachtree Corners Plaza
Norcross/Atlanta, Georgia 30071
Attn: Mr. P. J. Richardson

American Enka Company (Stabilenka) 1-600-254-6377

American Excelsior Company
2235 West McDowell Road
Phoenix, Arizona
Attn: Mr. Bob Pressendo



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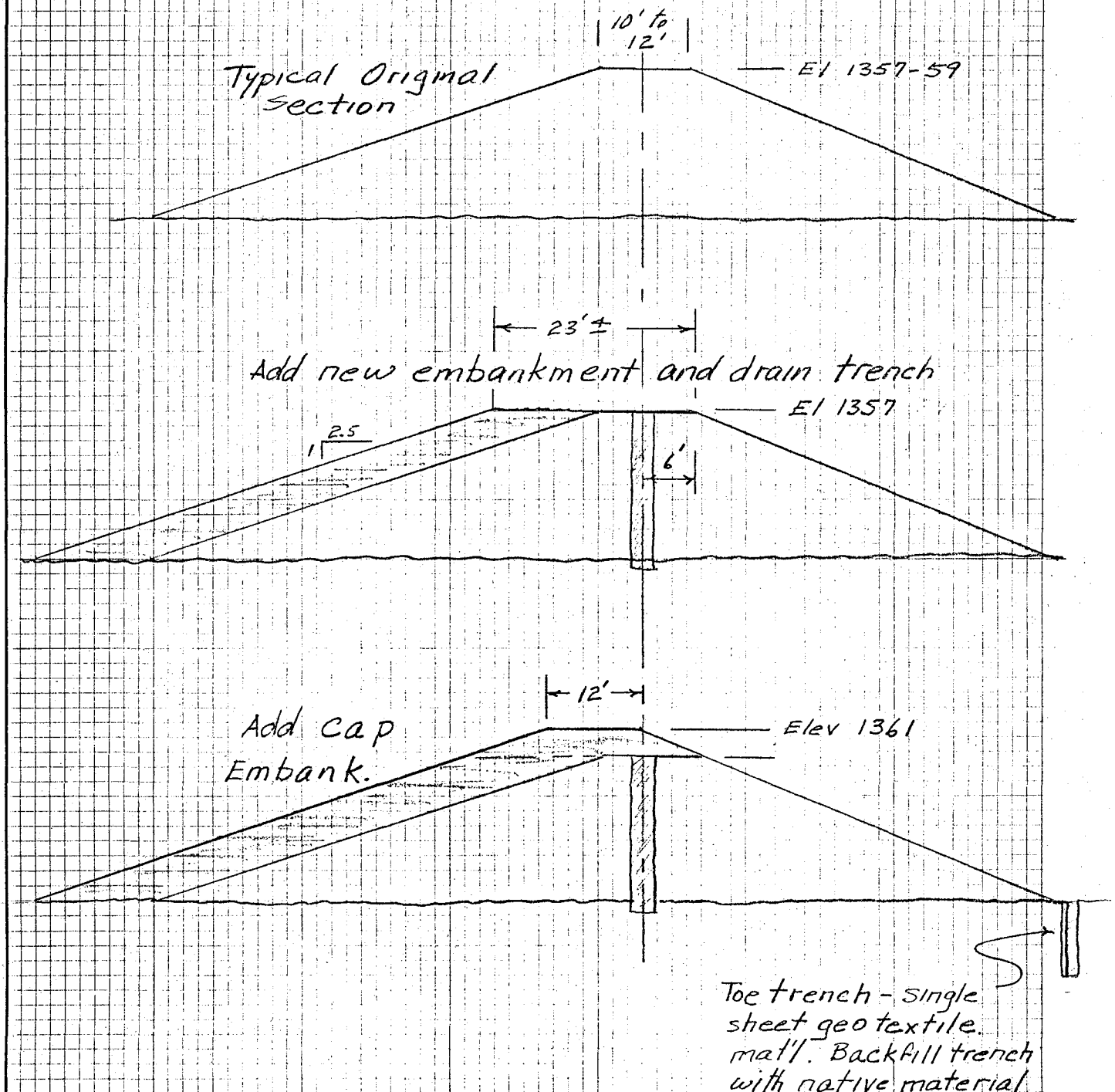
McMicken Dam

Proposed Construction Sequence



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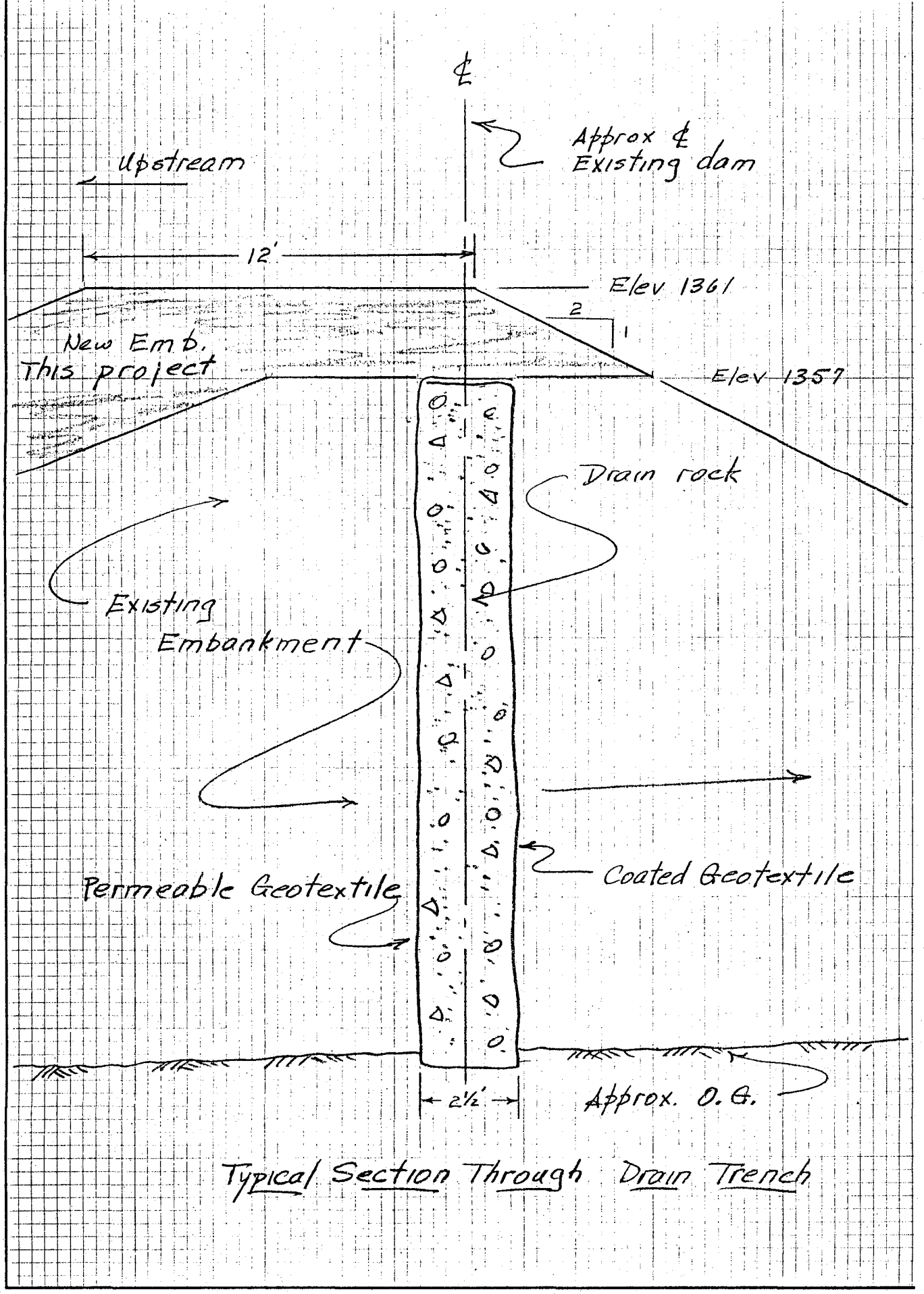
D-2



Typical Section Through Drain Trench

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QUANTITIES

1. Embankment to close breaches and restore dam to elev 1361 — 460,473 yd^3

2. Geotextile
   - Center drain — 241,917 yd^2
   - Toe trench — 53,103 yd^2
   - Outlets — 6,164 yd^2

3. Trench Exc
   - Center drain (2.5' wide) — 90,344 yd^3
   - Outlets (2.5' wide) — 3,890 yd^3
   - Toe trench 2' wide — 34,370 yd^3
   - 46,400 lin. ft

4. Drain Rock
   - Center drain — 81,752 yd^3
   - Outlets — 3,890 yd^3

Sta	End Area	Avg	Sta Vol	d	Trench Area
	ft^2		yd^3		yd^2
42 +00	0	7.0	51.9	10.7'	255.6
44+00	14.0	25.1	185.9	12.3	263.3
46+00	36.2	50.1	370.7	11.4	303.3
48+00	63.9	47.7	353.3	15.9	304.4
50+00	31.5	15.8	116.7	11.5	316.7
52+00	0	0	0	17.0	330.0
54+00	0	28.0	207.4	12.7	288.9
56+00	56.0	28.0	207.4	13.3	290.0
58+00	0	0	0	12.8	282.2
60+00	0	0	0	12.6	287.8
62+00	0	0	0	13.3	357.8
64+00	0	32.0	236.7	18.4	384.4
66+00	63.9	66.8	494.8	15.7	340.0
68+00	69.7	57.9	428.9	14.9	386.7
70+00	46.1	89.0	658.9	19.9	466.7
72+00	131.8	110.5	818.5	22.1	432.2
74+00	89.2	98.8	731.9	16.8	385.6
76+00	108.4	113.9	843.3	17.9	405.6
78+00	119.3	120.0	888.9	18.6	411.1
80+00	120.7	119.2	883.0	18.4	362.2
82+00	117.7	122.9	910.4	14.2	337.8
84+00	128.1	135.9	1006.3	16.2	380.0
86+00	143.6	163.5	1211.1	18.0	405.6
88+00	183.4	189.6	1404.4	18.5	405.6
90+00	195.8	183.7	1360.7	18.0	403.3
92+00	171.6	214.6	1589.6	18.3	398.9
94+00	257.6	256.4	1899.3	17.6	411.1
96+00	255.2	234.1	1733.7	19.4	435.6
			18593.7		10032.4

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Sta	End Area	Avg	Sta Vol	d	Trench Area
			yd^3		yd^2
98+00	212.9			19.8'	
		287.1	2126.7		408.9
100+00	319.0			17.0	
		227.7	1686.7		370.0
102+00	136.4			16.3	
		165.3	1224.1		397.2
104+00	194.1			19.0	
		216.7	1604.8		401.1
106+00	239.2			17.1	
		222.3	1646.3		357.8
108+00	205.3			15.1	
		202.1	1496.7		340.0
110+00	198.8			15.5	
		184.4	1365.6		361.1
112+00	169.9			17.0	
		212.3	1572.6		400.0
114+00	254.7			19.0	
		236.0	1747.8		414.4
116+00	217.2			18.3	
		354.5	2625.9		412.2
118+00	491.8			18.8	
		376.6	2789.6		374.4
120+00	261.4			14.9	
		271.6	2011.9		358.9
122+00	281.8			17.4	
		295.0	2184.8		392.2
124+00	308.1			17.9	
		337.6	2500.7		426.7
126+00	367.1			20.5	
		329.8	2443.0		411.1
128+00	292.5			16.5	
		331.0	2451.9		391.1
130+00	369.5			18.7	
		373.9	2769.6		458.9
132+00	378.3			22.6	
		357.8	2650.0		476.7
134+00	337.2			20.3	
		341.4	2528.5		432.2
136+00	345.5			18.6	
		350.4	2595.2		401.1
138+00	355.2			17.5	
		386.3	2861.1		441.1
140+00	417.3			22.2	
		417.5	3092.6		492.2
142+00	417.7			22.1	
		420.0	3110.7		488.9
144+00	422.2			21.9	
		398.3	2950.4		490.0
146+00	374.4			22.2	
		386.6	2863.7		497.8
148+00	398.8			22.9	
		381.7	2827.4		483.3
150+00	364.6			20.6	
		346.0	2563.0		460.0
152+00	327.4			20.8	
		306.1	2267.4		452.2
			64558.7		11791.5

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Sta	End Area	Avg	Sta Vol	d	Trench Area
154+00	284.8	290.9	2154.4	19.9	440.0
156+00	296.9	293.1	2171.1	19.7	451.1
158+00	289.3	288.0	2133.3	20.9	425.6
160+00	286.7	320.7	2375.2	17.4	406.7
162+00	354.6	320.7	2375.2	19.2	414.4
164+00	286.7	275.9	2043.7	18.1	392.2
166+00	265.1	269.7	1997.4	17.2	382.2
168+00	274.2	272.0	2014.8	17.2	364.4
170+00	269.8	291.7	2160.7	15.6	375.6
172+00	313.6	269.3	1994.8	18.2	370.0
174+00	225.0	255.6	1893.0	15.1	350.0
176+00	286.1	285.5	2114.4	16.4	374.4
178+00	284.8	288.6	2137.8	17.3	351.1
180+00	292.4	225.1	1667.4	14.3	326.7
182+00	157.8	212.5	1574.1	15.1	358.9
184+00	267.2	269.7	1997.8	17.2	400.0
186+00	272.2	284.3	2105.6	18.8	418.9
188+00	296.3	294.2	2179.3	18.9	397.8
190+00	292.1	321.8	2383.3	16.9	403.3
192+00	351.4	332.2	2460.7	19.4	418.9
194+00	313.0	313.1	2319.3	18.3	400.0
196+00	313.2	312.9	2317.4	17.7	391.1
198+00	312.5	295.7	2190.0	17.5	383.3
200+00	278.8	295.3	2187.0	17.0	385.6
202+00	311.7	315.7	2338.5	17.7	407.8
204+00	319.7	316.4	2343.3	19.0	431.1
206+00	313.0	318.3	2357.4	19.8	427.8
208+00	323.5	319.8	2368.9	18.7	403.3
			60341.8		15052.2

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Sta	End Area	Avg	Sta Vol	d	Trench Area
210+00	316.1	298.1	2207.8	17.6	378.9
212+00	280.0	297.0	2199.6	16.5	391.1
214+00	313.9	308.9	2288.1	18.7	400.0
216+00	303.9	321.1	2378.5	17.3	404.4
218+00	338.3	338.8	2509.6	19.1	413.3
220+00	339.3	293.5	2173.7	18.1	398.9
222+00	247.6	230.0	1703.7	17.8	384.4
224+00	212.4	214.7	1590.0	16.8	377.8
226+00	216.9	257.2	1904.8	17.2	383.3
228+00	297.4	284.4	2106.3	17.3	377.8
230+00	271.3	278.8	2064.8	16.7	376.7
232+00	286.2	300.6	2226.7	17.2	384.4
234+00	315.0	310.9	2303.0	17.4	386.7
236+00	306.8	312.6	2315.6	17.4	407.8
238+00	318.4	319.3	2365.2	19.3	431.1
240+00	320.2	318.7	2360.7	19.5	435.6
242+00	317.2	320.8	2375.9	19.7	436.7
244+00	324.3	323.4	2395.2	19.6	424.4
246+00	322.4	304.2	2253.3	18.6	397.8
248+00	286.0	261.3	1935.2	17.2	387.8
250+00	236.5	281.0	2081.1	17.7	402.2
252+00	325.4	315.7	2338.1	18.5	420.0
254+00	305.9	309.5	2292.2	19.3	438.9
256+00	313.0	323.8	2398.5	20.2	447.8
258+00	334.6	310.7	2301.1	20.1	450.0
260+00	286.7	311.8	2309.6	20.4	463.3
262+00	336.9	344.2	2549.3	21.3	480.0
264+00	351.4	349.3	2587.4	21.9	483.3
			62515.0		11564.4

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Sta	ft^2 End Area	ft^2 Avg	yd^3 Sta Vol	ft d	yd^2 Trench Area
266+00	347.2			21.6	
		341.0	2525.9		496.7
268+00	334.8			23.1	
		328.3	2431.9		514.4
270+00	321.8			23.2	
		325.4	2410.4		523.3
272+00	328.9			23.9	
		334.8	2479.6		537.8
274+00	340.6			24.5	
		363.2	2690.0		545.6
276+00	385.7			24.6	
		390.8	2894.4		542.2
278+00	395.8			24.2	
		384.8	2850.4		528.9
280+00	373.8			23.4	
		361.0	2673.7		507.8
282+00	348.1			22.3	
		329.2	2438.1		484.4
284+00	310.2			21.3	
		330.9	2451.1		463.3
286+00	351.6			20.4	
		324.0	2399.6		443.3
288+00	296.3			19.5	
		321.9	2384.4		434.4
290+00	347.5			19.6	
		344.3	2550.4		438.9
292+00	341.1			19.9	
		332.4	2461.9		447.8
294+00	323.6			20.4	
		311.5	2307.0		453.3
296+00	299.3			20.4	
		287.9	2132.2		458.9
298+00	276.4			20.9	
		347.4	2573.3		470.0
300+00	418.4			21.4	
		329.3	2439.3		467.8
302+00	240.2			20.7	
		189.3	1401.9		446.7
304+00	138.3			19.5	
		150.2	1112.2		443.3
306+00	162.0			20.4	
		154.2	1142.2		475.6
308+00	146.4			22.4	
		154.7	1145.6		502.2
310+00	162.9			22.8	
		172.8	1279.6		506.7
312+00	182.6			22.8	
		176.5	1307.0		501.1
314+00	170.3			22.3	
		160.2	1186.7		486.7
316+00	150.1			21.5	
		564.2	4179.3		455.6
318+00	978.3			19.5	
		1112.9	8243.3		453.3
320+00	1247.4			21.3	
		1233.8	9138.9		471.1
			75230.3		13501.1

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Sta	End Area	Avg	Sta Vol	d	Trench Area
322+00	1220.1	1222.4	9054.8	21.1	468.9
324+00	1224.7	678.4	5024.8	21.1	464.4
326+00	132.0	133.7	990.0	20.7	458.9
328+00	135.3	142.5	1055.2	20.6	460.0
330+00	149.6	155.8	1154.1	20.8	476.7
332+00	162.0	163.8	1213.3	22.1	495.6
334+00	165.6	212.2	1571.9	22.5	524.4
336+00	258.8	317.4	2350.7	24.7	552.2
338+00	375.9	297.8	2205.6	25.0	552.2
340+00	219.6	294.9	2184.1	24.7	565.6
342+00	370.1	367.3	2720.7	26.2	563.3
344+00	364.5	388.3	2875.9	24.5	542.2
346+00	412.0	417.5	3092.2	24.3	541.1
348+00	422.9	402.4	2980.7	24.4	543.3
350+00	381.9	329.1	2437.8	24.5	530.0
352+00	276.3	248.8	1843.0	23.2	517.8
354+00	221.3	205.5	1522.2	23.4	510.0
356+00	189.7	220.8	1635.2	22.5	507.8
358+00	251.8	284.0	2103.7	23.2	527.8
360+00	316.2	320.6	2374.4	24.3	544.4
362+00	324.9	328.8	2435.6	24.7	543.3
364+00	332.7	339.9	2517.8	24.2	555.6
366+00	347.1	355.0	2629.6	25.8	577.8
368+00	362.9	377.3	2794.8	26.2	575.6
370+00	391.7	408.0	3021.9	25.6	578.9
372+00	424.2	379.7	2812.2	26.5	570.0
374+00	335.1	356.8	2642.6	24.8	552.2
			69244.8		14300.0

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Sta	End Area	Avg	Sta Vol	d	Trench Area
376+00	378.4			24.9	
		342.6	2537.4		542.2
378+00	306.7			23.9	
		336.5	2492.2		553.3
380+00	366.2			25.9	
		386.4	2861.9		576.7
382+00	406.5			26.0	
		390.3	2890.7		584.4
384+00	374.0			26.6	
		365.0	2703.7		593.3
386+00	356.0			26.8	
		358.2	2653.0		590.0
388+00	360.3			26.3	
		362.0	2681.1		587.8
390+00	363.6			26.6	
		393.2	2912.6		581.1
392+00	422.8			25.7	
		396.7	2938.1		547.8
394+00	370.5			23.6	
		347.1	2570.7		533.3
396+00	323.6			24.4	
		327.0	2422.2		570.0
398+00	330.4			26.9	
		360.6	2670.7		567.8
400+00	390.7			24.2	
		354.6	2626.7		535.6
402+00	318.5			24.0	
		263.6	1952.2		533.3
404+00	208.6			24.0	
		255.0	1888.9		534.4
406+00	301.4			24.1	
		286.5	2121.9		530.0
408+00	271.5			23.6	
		267.1	1978.5		530.0
410+00	262.7			24.1	
		239.7	1775.6		537.8
412+00	216.7			24.3	
		247.7	1834.4		541.1
414+00	278.6			24.4	
		273.5	2025.6		535.6
416+00	268.3			23.8	
		252.9	1873.3		528.9
418+00	237.5			23.8	
		207.9	1539.6		516.7
420+00	178.2			22.7	
		189.4	1403.0		493.3
422+00	200.6			21.7	
		188.3	1394.8		475.6
424+00	176.0			21.1	
		153.7	1138.1		502.2
426+00	131.3			24.1	
		181.8	1346.7		536.7
428+00	232.3			24.2	
		221.3	1639.3		538.9
430+00	210.3			24.3	
		198.1	1467.4		538.9
			60340.3		15236.7

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Sta	End Area	Avg	Sta Vol	d	Trench Area
432+00	185.9			24.2	535.6
		159.5	1181.5		
434+00	133.1			24.0	521.1
		173.6	1285.9		
436+00	214.1			22.9	527.8
		211.7	1568.1		
438+00	209.3			24.6	548.9
		234.7	1738.1		
440+00	260.0			24.8	535.6
		233.0	1725.9		
442+00	206.0			23.4	523.3
		211.6	1567.4		
444+00	217.2			23.7	531.1
		237.4	1758.1		
446+00	257.5			24.1	530.0
		234.9	1740.0		
448+00	212.3			23.6	526.7
		202.8	1501.9		
450+00	193.2			23.8	524.4
		195.0	1444.4		
452+00	196.8			23.4	522.2
		198.2	1468.1		
454+00	199.6			23.6	514.4
		213.0	1577.8		
456+00	226.4			22.7	504.4
		171.6	1271.1		
458+00	116.8			22.7	494.4
		150.4	1114.1		
460+00	184.0			21.8	454.4
		167.5	1240.4		
462+00	150.9			19.1	452.2
		126.0	933.0		
464+00	101.0			21.6	486.7
		127.5	944.4		
466+00	154.0			22.2	507.8
		152.0	1125.6		
468+00	149.9			23.5	531.1
		148.7	1101.1		
470+00	147.4			24.3	545.6
		170.3	1261.1		
472+00	193.1			24.8	540.0
		174.7	1293.7		
474+00	156.2			23.8	530.0
		151.5	1122.2		
476+00	146.8			23.9	534.4
		153.1	1133.7		
478+00	159.3			24.2	548.9
		173.3	1283.3		
480+00	187.2			25.2	475.6
		155.3	1409.2		
482+45	123.4			17.6	405.6
		134.2	770.4		
484+00	145.0			18.9	415.6
		127.5	944.1		
			35504.6		13767.8

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Sta	End Area	Avg	Sta. Vol	d	Trench Area
486+00	109.9			18.5	
		119.3	883.7		413.3
488+00	128.7			18.7	
		121.1	896.7		397.8
490+00	113.4			17.1	
		104.1	771.1		375.6
492+00	94.8			16.7	
		91.7	679.3		351.1
494+00	88.6			14.9	
		86.4	640.0		311.1
496+00	84.2			13.1	
		89.1	659.6		275.6
498+00	93.9			11.7	
		82.5	610.7		260.0
500+00	71.0			11.7	
		67.2	497.4		265.6
502+00	63.3			12.2	
		63.1	467.0		267.8
504+00	62.8			11.9	
		70.6	522.6		248.9
506+00	78.3			10.5	
508+00					
510+00					
			6628.1		3166.8
			452,957.3		108,412.9

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TABLE E-1

DRAIN CAPACITY PER FOOT OF WIDTH AS A FUNCTION OF OUTLET SPACING, DRAIN ROCK PERMEABILITY & WATER HEAD

(Assumes Inflow Midway Between Drains)

Permeability		Drain Spacing		Water Head			
cm./sec.	ft./sec.	ft.	Drainage Length (ft.)	6 ft.	10 ft.	20 ft.	25 ft.
3	.098	200	100	.018	.049	.194	.302
		500	250	.007	.020	.078	.122
		1,000	500	.004	.010	.039	.061
10	.328	200	100	.059	.164	.650	1.009
		500	250	.024	.066	.262	.409
		1,000	500	.012	.033	.131?	.205
30	.984	200	100	.177	.491	1.949	3.028
		500	250	.071	.197	.786	1.227
		1,000	500	.035	.098	.393	.615

TABLE E-2

CENTER DRAIN DETAILS

Station	Current Elevation (ft.)	Average Height of Drain Top Elevation 1357 (ft.)	Average Elevation For Bottom Of Center Drain (ft.)
37+50		0	
40+00	1,361	4	1,353
50+00	1,362	7	1,351
60+00	1,362	10	1,347
100+00	1,358	15	1,342
150+00	1,358	16	1,341
200+00	1,358	15	1,342
250+00	1,358	17	1,340
300+00	1,358	18	1,339
310+00	1,358	20	1,337
350+00	1,358	22	1,335
400+00	1,358	25	1,332
450+00	1,359	23	1,334
475+00	1,360	20	1,337
500+00	1,360	10	1,347
507+00		0	

TABLE E-3

DRAIN ROCK ZONES, OUTLET SPACING & APPROXIMATE VOLUMES

Zone	Zone Length (ft.)	Station	Average Zone Height (ft.)	Drain Gravel Permeability (ft./sec.)	Outlet Drain Spacing (ft.)	Approximate Drain Gravel Volume ($ft.^3$)
1	250	37+50-40+00	2.0	.984	200	500
2	1,000	40+00-50+00	5.5	.984	500	5,500
3	1,000	50+00-60+00	8.5	.984	500	8,500
4	4,000	60+00-100+00	12.5	.984	500	50,000
5	5,000	100+00-150+00	15.5	.098	1,000	77,500
6	5,000	150+00-200+00	15.5	.098	1,000	77,500
7	5,000	200+00-250+00	16.0	.098	1,000	80,000
8	2,000	250+00-270+00	17.5	.098	1,000	35,000
9	1,500	270+00-285+00	17.5	.984	500	26,250
10	1,500	285+00-300+00	18.0	.328	1,000	26,625
11	1,000	300+00-310+00	19.0	.984	500	19,000
12	4,000	310+00-350+00	21.0	.328	1,000	84,000
13	500	350+00-355+00	23.0	.984	500	11,250
14	6,000	355+00-415+00	23.5	.328	1,000	141,000
15	6,000	415+00-475+00	22.5	.984	500	138,000
16	1,000	475+00-485+00	18.0	.984	1,000	17,500
17	1,500	485+00-500+00	14.0	.984	500	21,000
18	700	500+00-507+00	5.0	.984	200	3,500

TABLE E-4

OUTLET LOCATION & CAPACITY PER
FOOT OF CENTER DRAIN WIDTH

(Assumes Inflow Midway Between Drains)

Station	Capacity (cfs)	Station	Capacity (cfs)	Station	Capacity (cfs)
40+00	.15	210+00	.02	405+00	.15
45+00	.07	220+00	.02	415+00	.15
50+00	.07	230+00	.02	420+00	.8
55+00	.14	240+00	.02	425+00	.8
60+00	.2	250+00	.02	430+00	.8
65+00	.2	260+00	.03	435+00	.8
70+00	.2	270+00	.6	440+00	.8
75+00	.2	275+00	.6	445+00	.8
80+00	.2	280+00	.6	450+00	.8
85+00	.2	285+00	.6	455+00	.8
90+00	.2	290+00	.1	460+00	.8
95+00	.2	300+00	.1	465+00	.8
100+00	.02	305+00	.8	470+00	.8
110+00	.02	310+00	.8	475+00	.8
120+00	.02	320+00	.13	485+00	.6
130+00	.02	330+00	.13	490+00	.4
140+00	.02	340+00	.13	495+00	.4
150+00	.02	350+00	.13	500+00	.4
160+00	.02	355+00	.8	502+00	.4
170+00	.02	365+00	.15	504+00	.2
180+00	.02	375+00	.15	506+00	.2
190+00	.02	385+00	.15		
200+00	.02	395+00	.15		

DETAIL OF TYPICAL OUTLET DRAIN

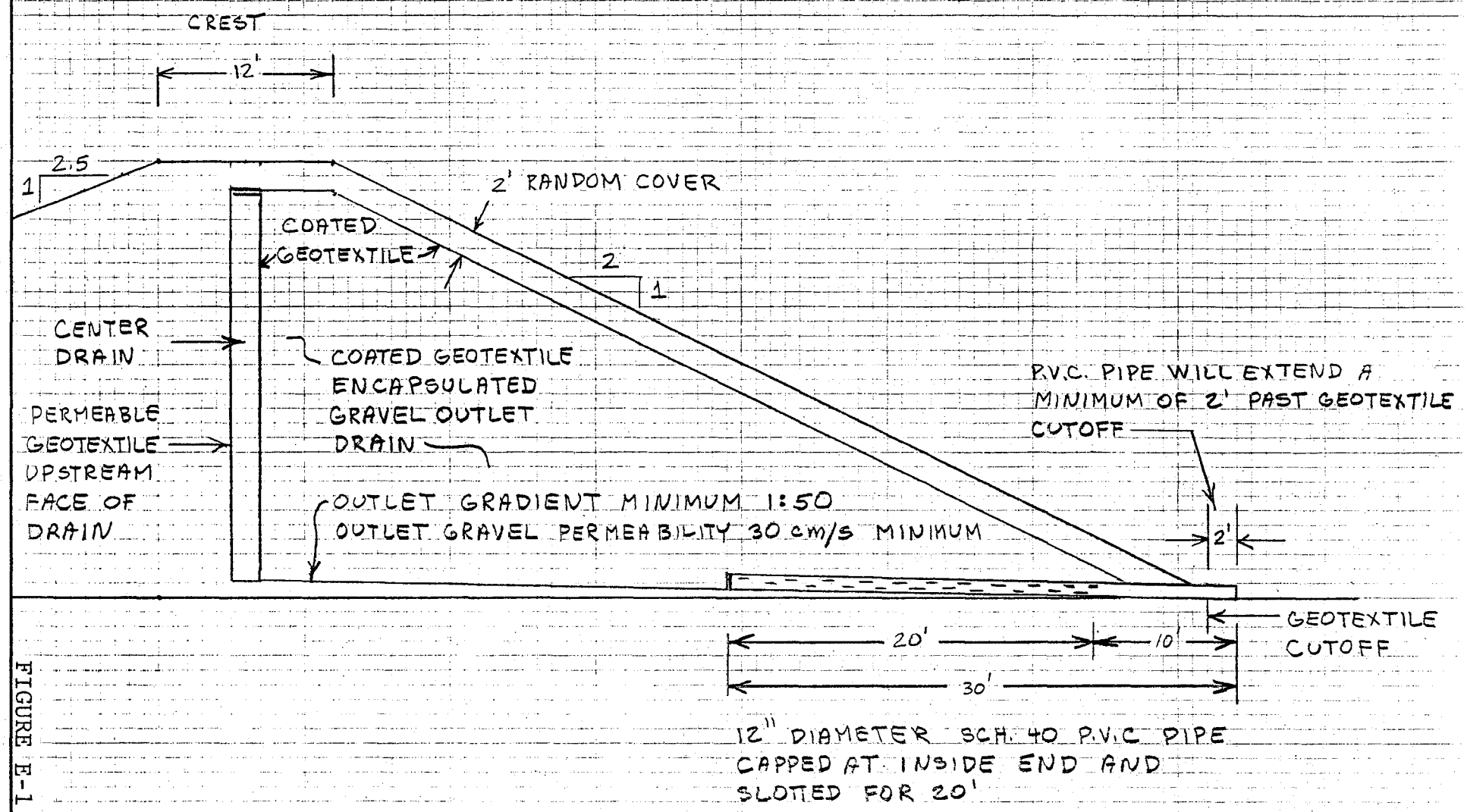

FIGURE E-1

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Project: Proposed Dam
Job No: [illegible]
Computed by: [illegible] Ckd. by: ____
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