APPENDIX D

GEOTECHNICAL INFORMATION

FILE COPY

MACTEC

REPORT OF GEOTECHNICAL EXPLORATION

Proposed Consolidated Aircraft Maintenance Facility

Robins Air Force Base, Warner Robins, Georgia

Prepared for:

TranSystems Corporation

Prepared by:

MACTEC ENGINEERING AND CONSULTING, INC.

December, 2003

MACTEC Project 6138-03-0457

MACTEC

December 16, 2003

Mr. Robert Shumer
TranSystems Corporation
4500 Salisbury Road,
Suite 300,
Jacksonville, Florida 32216

Subject: **Report of Geotechnical Exploration**
Proposed Consolidated Aircraft Maintenance Facility
Robins Air Force Base
Warner Robins, Georgia
MACTEC Project No. 6138-03-0457

Dear Mr. Shumer:

MACTEC Engineering and Consulting, Inc. (MACTEC) has completed the authorized subsurface exploration for the proposed Consolidated Aircraft Maintenance Facility at Robins Air Force Base in Warner Robins, Georgia. The work scope was described in the revised MACTEC Proposal Number PROP03ATLN.572 dated October 6, 2003.

This report discusses our understanding of the project, describes our exploratory procedures and presents our conclusions and recommendations. We appreciate the opportunity of working with you on this project and look forward to our continued association. Please contact us if you have any questions about this report, or if we may be of further service.

Sincerely,
MACTEC ENGINEERING AND CONSULTING, INC.

Daimia T. Gunning
Staff Engineer

Gary W. Rhodes, P.E.
Principal Engineer

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1.0 INTRODUCTION

MACTEC Engineering and Consulting, Inc. (MACTEC) has completed a geotechnical exploration for the proposed Consolidated Aircraft Maintenance Facility (CAMF) at Robins Air Force Base in Warner Robins, Georgia. The objective of this study was to explore the subsurface conditions within the area of the proposed building and to analyze these conditions as they relate to foundation design and construction. This report discusses our understanding of the project, describes the exploratory procedures and presents our conclusions and recommendations.

Our understanding of this project is based on conversation with Mr. Robert Shumer and Mr. Chris Jubran of TranSystems Corporation and the provided site plan.

A single story Consolidated Aircraft Maintenance Facility building will be constructed southwest of the existing Tower Building #37. Associated parking and driveways will be located north and west of the building. The structure is comprised of two adjoining rectangular buildings. The southern and larger building will be about 180 feet wide and 140 feet long while the northern building will be about 152 feet wide and 98 feet long. Foundation loads are expected to be relatively light with column loads of less than 150 kips and wall loads of less than 3 kips per linear foot. The site is relatively flat, as such, only minor grading is anticipated.

2.0 EXPLORATORY PROCEDURES

2.1 FIELD EXPLORATION

Subsurface conditions at the site were explored with 4 soil test borings at locations shown on the boring location plan in Appendix A. All of the borings were performed in the footprint of the proposed structure. Each boring was drilled to its planned termination depth of 25 feet.

The boring locations were established in the field by MACTEC personnel using a hand held GPS (Global Positioning System) unit. Since these measurements are not precise, the boring locations shown on Boring Location Plan in Appendix A should be considered approximate.

The borings were advanced using hollow stem augers. Soil samples were obtained by Standard Penetration Testing (SPT) at a maximum interval of 5 feet in each of the borings. Standard Penetration Tests are conducted by driving a split-barrel sampler a distance of 18 inches by dropping 140-lb hammer a distance of 30 inches. The number of blows required to drive the sampler the final 12 inches is designated the standard penetration resistance and provides an indication of the consistency of the soils sampled.

All drilling and sampling operations were performed in general accordance with ASTM designations as outlined in Appendix B. The detailed subsurface conditions encountered at the boring locations are shown on the Soil Test Boring Records in Appendix B. These records represent our interpretation of the field conditions based on the driller's field logs and an engineer's examination of the split-barrel samples. The groundwater levels shown on the Soil Test Boring Records represent measurements made at the time of drilling. The lines designating the interfaces between various strata represent approximate boundaries only, as transitions between materials may be gradual. Soil samples will be discarded after 30 days from the date of this report unless otherwise requested.

2.2 LABORATORY TESTING

Laboratory testing was performed on select samples to aid in our evaluation of the site. All laboratory testing was performed in general accordance with current ASTM standards. Four classification tests inclusive of grain size analysis, Atterberg limits, and natural moisture content were performed on select samples from borings B-1 to B-4. Two pH and soil resistivity tests and one California bearing ratio (CBR) test were performed in the upper 10 feet of subsurface material. Laboratory testing procedures and laboratory test results are located in Appendix C.

3.0 GENERAL SITE AND SUBSURFACE CONDITIONS

The following paragraphs provide a general discussion of existing site surface and subsurface conditions. More detailed descriptions are included in the Soil Test Boring Records in Appendix B.

3.1 SITE DESCRIPTION

The proposed CAMF Building site is located south and west of the existing Tower Building #37 at Robins Air Force Base in Warner Robins, Georgia. The site is currently covered by grass and pavement and several underground utilities traverse the site. The site is generally flat with minor slopes for surface drainage.

3.2 AREA AND SITE GEOLOGY

The site is in Providence Sand geologic unit of the Coastal Plan Physiographic Province. Coastal Plain soils consist of ancient marine deposits including interbedded limestones, gravels, sands, silts and clays. The Coastal Plain is a wedge-shaped deposit of Cretaceous and younger sediments which range in thickness

from near zero at the contact with the Piedmont Physiographic Province (the Fall Line) to the northwest, to thousands of feet at the coast.

3.3 SITE STRATIGRAPHY

Data from the soil test borings conducted during exploration of the site are shown on the Soil Test Boring Records in Appendix B. The subsurface conditions discussed in the following paragraphs and those shown on the Soil Test Boring Records represent an estimate of the subsurface conditions based on our interpretation of the boring data using normally accepted geotechnical engineering judgments. Although individual soil test borings are representative of the subsurface conditions at their locations on the dates shown, they are not necessarily indicative of subsurface conditions at other locations or other times.

Below the ground surface, the soil test borings encountered topsoil and coastal plain deposits. The following paragraphs provide generalized descriptions of the subsurface materials encountered by the borings performed for this exploration.

A surficial layer of topsoil was present below the grassed surface at the boring locations. The existing roadway that runs through the proposed building pad is covered with asphalt concrete. The topsoil was generally 6 inches thick and was underlain by clayey silty sands and sandy clays to boring termination. Clayey silty sands were most common at the site and were generally of medium dense to dense consistency. The soils at the site generally had reduced clay and silt content with increased depth.

Groundwater was encountered in all four borings at a depth of 12 feet. Groundwater levels fluctuate with seasonal and climatic variations and may be different at other times.

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 GENERAL

The following conclusions and recommendations are based on the previously discussed project information, our observations at the site, laboratory data, and our experience with similar subsurface conditions. Subsurface conditions in uninvestigated locations may vary from those encountered at specific boring locations.

Observations regarding subsurface conditions that may impact the planned construction are as follows:

- Presence of groundwater during utility excavation.
- Abandonment and relocation of the existing underground utilities.

4.2 SITE GRADING

Based on our understanding of the project, some minor grading may be required to prepare the site for construction. We have no information on proposed grades at the site, as such, we have assumed less than 2 feet of excavation or fill will be needed to achieve planned grades.

To prepare the site for construction all vegetation, root systems, topsoil, pavement, refuse and other deleterious non-soil materials should be stripped to 10 feet beyond the construction limits where possible. We recommend that topsoil be stockpiled for reuse in landscaped areas, if needed, or wasted off site. Abandoned buried utilities and utility trench backfill should be removed and backfilled with structural fill as described later in this report. If it is not practical to remove existing lines, the lines should be backfilled by pumping them full with flowable fill or similar materials.

After site preparation, areas intended to support slabs-on-grade and new structural fill should be evaluated by a qualified geotechnical engineer. At that time, the engineer may require proofrolling of the subgrade with a fully loaded tandem axle dump truck or other pneumatic-tired vehicle of similar size and weight. The purpose of proofrolling is to locate soft, weak, or excessively wet surficial soils present at the time of construction. Any materials judged to be unstable during proofrolling operations should be repaired as directed by our engineer, which may include undercutting and replacement with structural fill or in-place stabilization.

Structural fill to replace undercut areas or achieve finished grades should be low to moderate plasticity soil (PI less than 30), free of deleterious materials and rock fragments larger than about 3 inches in diameter. All structural fill should be placed in thin (8-inch thick loose measure) lifts and compacted to at least 95 percent of the soil's maximum dry density as determined by the standard Proctor compaction test (ASTM D 698). Where light compaction equipment is used, as is customary in utility trench excavations, the lift thickness may need to be reduced to achieve the required degree of compaction. The upper 8 inches of soil beneath all pavements and slabs-on-grade should be compacted to at least 98 percent of the same standard. The soil moisture content during fill placement should be maintained within 3 percent of the soil's optimum moisture content. All fill should be placed in horizontal lifts that are adequately benched into the prepared and scarified subgrade soils. Based on visual examination of the soils obtained from the soil test borings, it is our opinion that a majority of the soils on the site will be suitable for use as structural fill, provided that the larger rock pieces are removed. The moisture content test results and standard Proctor test data from the site indicated that some of the soils to be excavated will be wet and require drying prior to use as structural fill.

We recommend that all fill placement be observed by a qualified soils technician under the direction of a geotechnical engineer and that frequent fill density and moisture tests be performed to determine if the specified degree of compaction is being achieved. During grading the testing frequency can be determined by our personnel based on the area to be tested, the grading equipment used and the construction schedule.

As a minimum, we recommend that tests be performed every 2 feet vertically as structural fill is being placed and for every 5,000 square feet of area.

4.3 GROUNDWATER CONTROL

Based on the data obtained during our subsurface exploration and our understanding of the finished grades, groundwater should not be encountered during mass grading and foundation construction. The extent and nature of any dewatering during construction will be dependent on the actual groundwater conditions prevalent at the time of construction and the effectiveness of construction drainage to prevent run-off into open excavations. As previously noted, groundwater levels are subject to seasonal, climatic and other variations and may be different at other times and locations than those stated in this report.

4.4 FOUNDATION RECOMMENDATIONS

It is our opinion that the CAMF Building can be supported by conventional, shallow, spread footings and/or continuous foundations bearing on Coastal Plain deposits or the newly placed structural fill. Foundations bearing on these materials may be designed using a uniform maximum allowable bearing pressure of 3,000 pounds per square foot (psf) based on total load. We recommend widths of not less than 24 inches for footings for ease of construction and to reduce the possibility of localized shear failures. Footings should be placed a minimum depth of 2 feet below the final ground surface.

Based on the estimated foundation column loads of 50 to 150 kips our calculations indicated that the individual foundations could settle between 1/2 to 1 inch due to the building loads. The maximum differential settlement between adjacent columns should be less than 1/2 inch.

A qualified geotechnical engineer must observe all footing excavations and assess if the foundations are placed on a competent bearing stratum similar to the soils encountered in our borings. Some over excavation of unsuitable soils may be required.

Footing excavation often produces a thin veneer of disturbed soil at the footing subgrade. We recommend that disturbed subgrade materials be hand cleaned prior to placing reinforcing steel. Furthermore, the footing bottom should be free of all fall-in prior to placing concrete.

4.5 SLAB ON GRADE RECOMMENDATIONS

Slabs-on-grade should be jointed around columns and along footing supported walls to minimize cracking because of possible differential movements. We do not believe that an under slab drainage layer will be required, however, at a minimum a vapor barrier should be used to help reduce the possibility of slab dampness due to soil moisture. The control of moisture is particularly important since the soils are suspected of containing organic vapors.

4.6 BELOW GRADE WALL RECOMMENDATIONS

We are not aware of any below grade wall; nonetheless, the following has been provided for your reference.

The following factors influence earth pressures on below grade walls: structural design of the walls, conditions of wall restraint, construction methods and the strength of the materials being restrained. The most common conditions assumed for earth retaining wall design are the active and at-rest conditions.

Active conditions apply to relatively flexible earth retention structures, such as freestanding walls, where some movement and rotation may occur to mobilize the soil's shear strength. Rigidly restrained walls, such as basement walls, should be designed for the at-rest condition. However, if the restrained walls are backfilled before they are braced, they should be designed as self-supporting cantilever walls to withstand active earth pressures.

Experience indicates that development of the full active earth pressure case requires a magnitude of horizontal wall movement that often can not be tolerated or can not occur due to the rigidity of the wall or other design restrictions such as the impact on adjacent structures. In such cases, walls are often designed for either the at-rest condition or a condition intermediate of the active and at-rest conditions, depending on the amount of permissible wall movement.

Passive earth pressure represents the maximum possible pressure when a structure is pushed against the soil, and is used in wall foundation design to help resist active or at-rest pressures. Because significant wall movements are required to develop the passive pressure, the total calculated passive pressure is usually reduced by one-half for design purposes. Lateral earth pressure parameters are summarized in Table 1 on page 7.

Table 1. Lateral Earth Pressure Parameters

Earth Pressure Condition	Earth Pressure Coefficient	Recommended Equivalent Fluid Unit Weight (pcf)
Active	$K_a = 0.33$	40
At-Rest	$K_0 = 0.50$	60
Passive	$K_p = 3.00$	150*

* Value is ½ of the total calculated passive value.

Our recommendations assume that the ground above the wall is level and that Coastal Plain deposits similar to those found in our borings will be used for wall backfill.

The recommended equivalent fluid pressures assume that constantly functioning drainage systems are installed between walls and soil backfill to prevent the build-up of hydrostatic pressures and lateral stresses in excess of those stated. If a functioning drainage system is not installed (elevator pits, etc.), then lateral earth pressures should be determined using the buoyant weight of the soil (approximately 58 pcf). Hydrostatic pressures calculated with the unit weight of water (62.4 pcf) should be added to these earth pressures to obtain the total stresses for design.

Heavy construction equipment should not operate within 10 feet of below grade walls to prevent lateral pressures in excess of those cited. If footings or other surcharge loadings are located a short distance outside below grade walls, they may also exert appreciable additional lateral pressures. If an imaginary line projected downward at a 45-degree angle from the bottom near edge of the surcharge load does not intersect the wall, the effect of the load on the wall may be neglected. If the line intersects the wall, the effect of the surcharge loads should be added to the recommended earth pressures to determine total lateral stresses. Foundation bearing levels may also be lowered to eliminate increased stresses on adjacent retaining walls.

4.7 ASPHALTIC CONCRETE PAVEMENT RECOMMENDATIONS

The following values may be used in pavement design for this project. Based on laboratory testing, a CBR of 10 or a modulus of subgrade reaction of 200 pci appears feasible for the subgrade soils at this site.

4.8 CONSTRUCTION OBSERVATIONS

Foundations: All foundation excavations should be observed by a qualified engineer prior to concrete and reinforcing steel placement. The engineer will assess if the exposed materials are similar to those encountered by the borings and if they are satisfactory for supporting the design bearing pressures. All foundation excavations should be clean, level and free of ponded water, mud, and loose, frozen or water-softened soils.

The strength properties of soil exposed at the footing subgrade will change if exposed to wetting, drying, or freezing. Every effort should be made to place concrete the same day as the excavation is completed. If subgrades are to be left open for more than one day, they should be covered with polyethylene sheeting. If inclement weather is expected, a lean (1000 psi) concrete veneer about 3 inches thick should be placed on the exposed subgrade. Excavation of disturbed soil may be required if these protective measures are not implemented.

Subgrade: Once cut and fill operations have been completed, the surface soils will be exposed to surface activities and weather conditions, which may have an adverse effect. A final evaluation of the subgrade should be performed by our geotechnical engineer immediately prior to placing pavements or slabs-on-grade. If practical, proofrolling may be performed to detect any unstable surficial soils which should be further compacted until stable or replaced with structural fill.

As was noted earlier, the subgrade in both cut and fill areas should be graded to allow positive draining to aid in preventing the accumulation of water. If the exposed subgrade becomes wet or frozen, our geotechnical engineer should re-evaluate the subgrade.

5.0 QUALIFICATIONS OF RECOMMENDATIONS

Our evaluation of foundation design and construction conditions has been based on our understanding of the site, the available project information and the data obtained during our field exploration as described herein. The general subsurface conditions used were based on interpolation of the subsurface data between the borings. The design recommendations in this report have been developed on the basis of the previously described project characteristics and subsurface conditions. If project criteria or locations change, we must be permitted to determine if our recommendations require modification. The findings of such a review will be presented in a supplemental report.

Subsurface conditions in unexplored locations may vary from those encountered at specific boring locations. The nature and extent of variations between the borings may not become evident until the course of construction. If such variations then appear evident, it will be necessary to re-evaluate the recommendations of this report after on-site observations of the conditions.

Regardless of the thoroughness of a subsurface exploration, there is the possibility that conditions between borings will differ from those at the boring locations, that conditions are not as anticipated by the designers, or that the construction process has altered the soil conditions. Therefore, experienced geotechnical engineers must observe earthwork and foundation construction to assess if the conditions anticipated in design actually exist.

Our professional services have been performed, our findings derived, and our recommendations prepared in accordance with generally accepted geotechnical engineering principles and practices. This warranty is in lieu of all other warranties either expressed or implied. This company is not responsible for the conclusions, opinions or recommendations of others based on these data.

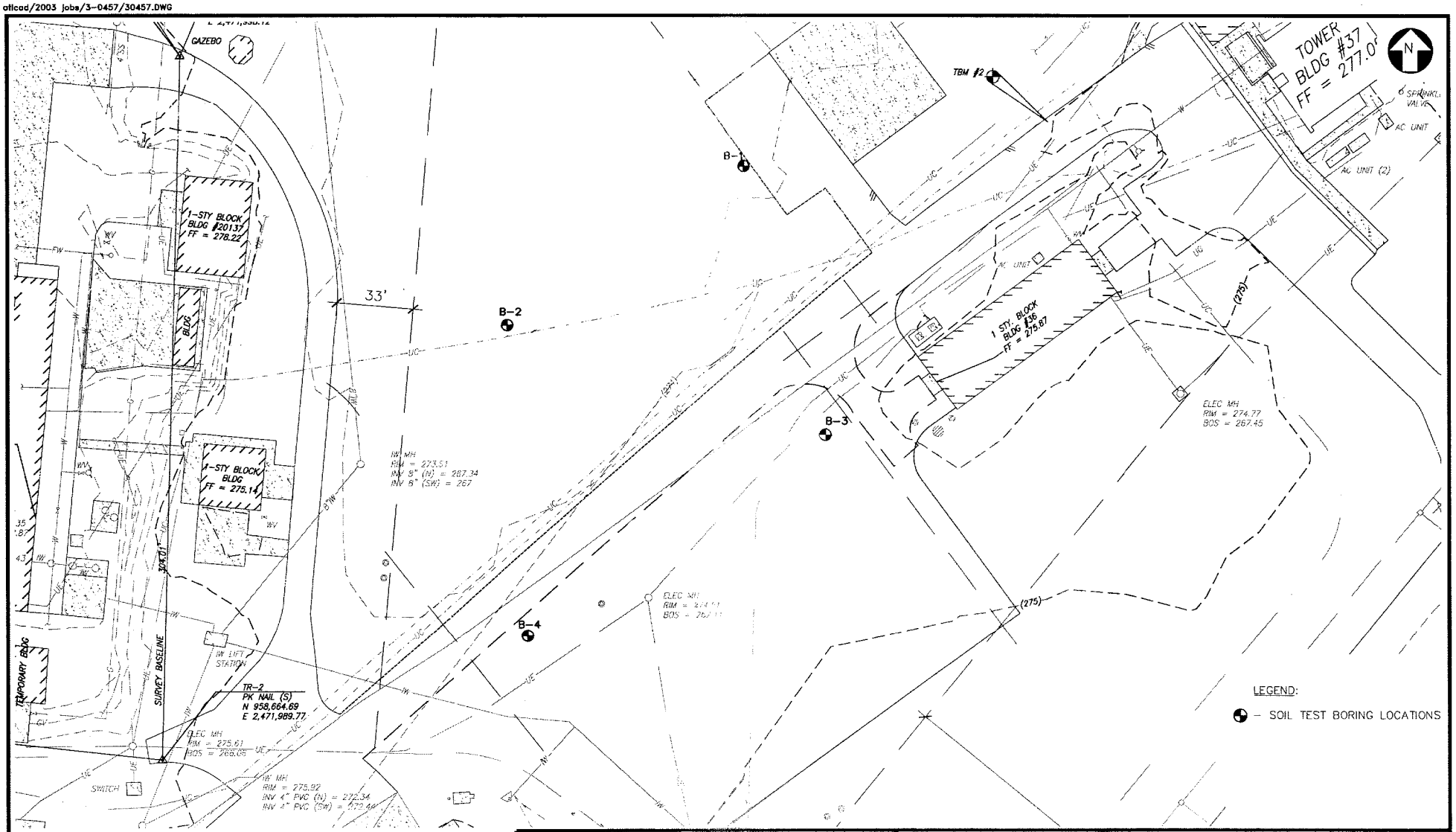
MACTEC

APPENDIX A

Figure 1. - Boring Location Plan

ASFE Information about Geotechnical Reports

atlcad/2003 jobs/3-0457/30457.DWG



LEGEND:

● – SOIL TEST BORING LOCATIONS

NOTE:

BORING LOCATION PLAN CREATED USING SITE PLAN PRODUCED BY TRANSYSTEMS CORPORATION.

0 20 40 80

APPROX. SCALE: 1 inch = 40 ft.

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ROBINS AIR FORCE BASE
CONSOLIDATED AIRCRAFT MAITENANCE FACILITY

BORING LOCATION PLAN

Job Number	Task	Date	Scale	Drawn By	Approved By	Figure
6138-03-0457	01	DEC. 2003	AS SHOWN	RBT		2

Important Information About Your Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

The following information is provided to help you manage your risks.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. *No one except you* should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one—not even you*—should apply the report for any purpose or project except the one originally contemplated.

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, *do not rely on a geotechnical engineering report* that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions *only* at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an *opinion* about subsurface conditions throughout the site. Actual subsurface conditions may differ—sometimes significantly—from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

MACTEC

APPENDIX B

Field Testing Procedures
Key to Symbols and Descriptions
Soil Test Boring Records

FIELD TESTING PROCEDURES

Field Operations: The general field procedures employed by MACTEC Engineering and Consulting, Inc. are summarized in ASTM D 420 which is entitled "Investigating and Sampling Soils and Rocks for Engineering Purposes." This recommended practice lists recognized methods for determining soil and rock distribution and groundwater conditions. These methods include geophysical and in situ methods as well as borings.

Borings are drilled to obtain subsurface samples using one of several alternate techniques depending upon the subsurface conditions. These techniques are:

a. Continuous 2-1/2 or 3-1/4 inch I.D. hollow stem augers;
b. Wash borings using roller cone or drag bits (mud or water);
c. Continuous flight augers (ASTM D 1425).

These drilling methods are not capable of penetrating through material designated as "refusal materials." Refusal, thus indicated, may result from hard cemented soil, soft weathered rock, coarse gravel or boulders, thin rock seams, or the upper surface of sound continuous rock. Core drilling procedures are required to determine the character and continuity of refusal materials.

The subsurface conditions encountered during drilling are reported on a field test boring record by the chief driller. The record contains information concerning the boring method, samples attempted and recovered, indications of the presence of various materials such as coarse gravel, cobbles, etc., and observations between samples. Therefore, these boring records contain both factual and interpretive information. The field boring records are on file in our office.

The soil and rock samples plus the field boring records are reviewed by a geotechnical engineer. The engineer classifies the soils in general accordance with the procedures outlined in ASTM D 2488 and prepares the final boring records that are the basis for all evaluations and recommendations.

The final boring records represent our interpretation of the contents of the field records based on the results of the engineering examinations and tests of the field samples. These records depict subsurface conditions at the specific locations and at the particular time when drilled. Soil conditions at other locations may differ from conditions occurring at these boring locations. Also, the passage of time may result in a change in the subsurface soil and groundwater conditions at these boring locations. The lines designating the interface between soil or refusal materials on the records and on profiles represent approximate boundaries. The transition between materials may be gradual. The final boring records are included with this report.

Soil Test Borings: Soil test borings were made at the site at approximate locations shown on the attached Boring Location Plan. Soil sampling and penetration testing were performed in general accordance with ASTM D 1586.

The borings were made by mechanically twisting a hollow stem steel auger into the soil. At regular intervals, the drilling tools were removed and soil samples obtained with a standard 1.4-inch I.D., 2-inch O.D., split tube sampler. The sampler was first seated 6 inches to penetrate loose cuttings, then driven an additional foot with blows of a 140-pound hammer falling 30 inches. The number of hammer blows required to drive the sampler the final foot was recorded and is designated the "penetration resistance". The penetration resistance, when properly evaluated, is an index to the soil strength and foundation supporting capability.

Representative portions of the soil samples, thus obtained, were placed in glass jars and transported to the laboratory. In the laboratory, the samples were examined to evaluate the driller's field classifications. Test Boring Records are attached which graphically show the soil descriptions and penetration resistances.

Water Level Readings: Water table readings are normally taken in conjunction with borings and are recorded on the "Test Boring Records". These readings indicate the approximate location of the hydrostatic water table at the time of our field investigation. Where impervious soils are encountered (clayey soils) the amount of water seepage into the boring is small, and it is generally not possible to establish the location of the hydrostatic water table through water level readings. The groundwater table may also be dependent upon the amount of precipitation at the site during a particular period of time. Fluctuations in the water table should be expected with variations in precipitation, surface run-off, evaporation and other factors.

The time of boring water level reported on the boring records is determined by field crews as the drilling tools are advanced. The time of boring water level is detected by changes in the drilling rate, soil samples obtained, etc. Additional water table readings are generally obtained at least 24 hours after the borings are completed. The time lag of at least 24 hours is used to permit stabilization of the groundwater table that has been disrupted by the drilling operations. The readings are taken by dropping a weighted line down the boring or using an electrical probe to detect the water level surface.

Occasionally the borings will cave-in, preventing water level readings from being obtained or trapping drilling water above the caved-in zone. The cave-in depth is also measured and recorded on the boring records.

Bulk Sampling: A bulk sample consists of 40 to 60 pounds of soil brought to the surface by the drilling augers. The sample is placed in a bag, with a sealed jar sample of the material, and is taken to our laboratory for testing.

MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES
COARSE GRAINED SOILS (More than 50% of material is LARGER than No. 200 sieve size)	GRAVELS (More than 50% of coarse fraction is LARGER than the No. 4 sieve size)	CLEAN GRAVELS (Little or no fines)	GW	Well graded gravels, gravel - sand mixtures, little or no fines.
			GP	Poorly graded gravels or grave - sand mixtures, little or no fines.
		GRAVELS WITH FINES (Appreciable amount of fines)	GM	Silty gravels, gravel - sand - silt mixtures.
			GC	Clayey gravels, gravel - sand - clay mixtures.
	SANDS (More than 50% of coarse fraction is SMALLER than the No. 4 Sieve Size)	CLEAN SANDS (Little or no fines)	SW	Well graded sands, gravelly sands, little or no fines.
			SP	Poorly graded sands or gravelly sands, little or no fines.
		SANDS WITH FINES (Appreciable amount of fines)	SM	Silty sands, sand - silt mixtures
			SC	Clayey sands, sand - clay mixtures.
FINE GRAINED SOILS (More than 50% of material is SMALLER than No. 200 sieve size)	SILTS AND CLAYS (Liquid limit LESS than 50)		ML	Inorganic silts and very fine sands, rock flour, silty of clayey fine sands or clayey silts and with slight plasticity.
			CL	Inorganic lays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
			OL	Organic silts and organic silty clays of low plasticity.
	SILTS AND CLAYS (Liquid limit GREATER than 50)		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
			CH	Inorganic clays of high plasticity, fat clays
			OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS			PT	Peat and other highly organic soils.

BOUNDARY CLASSIFICATIONS: Soils possessing characteristics of two groups are designated by combinations of group symbols.

SILT OR CLAY	SAND			GRAVEL		Cobbles	Boulders
	Fine	Medium	Coarse	Fine	Coarse		

No.200 No.40 No.10 No.4 3/4" 3" 12"

U.S. STANDARD SIEVE SIZE

Reference: The Unified Soil Classification System, Corps of Engineers, U.S. Army Technical Memorandum No. 3-357, Vol. 1, March, 1953 (Revised April, 1960)

	Undisturbed Sample		Auger Cuttings
	Split Spoon Sample		Bulk Sample
	Rock Core		Crandall Sampler
	Dilatometer		Pressure Meter
	Packer		No Recovery
	Water Table at time of drilling		Water Table after 24 hours

Correlation of Penetration Resistance with Relative Density and Consistency

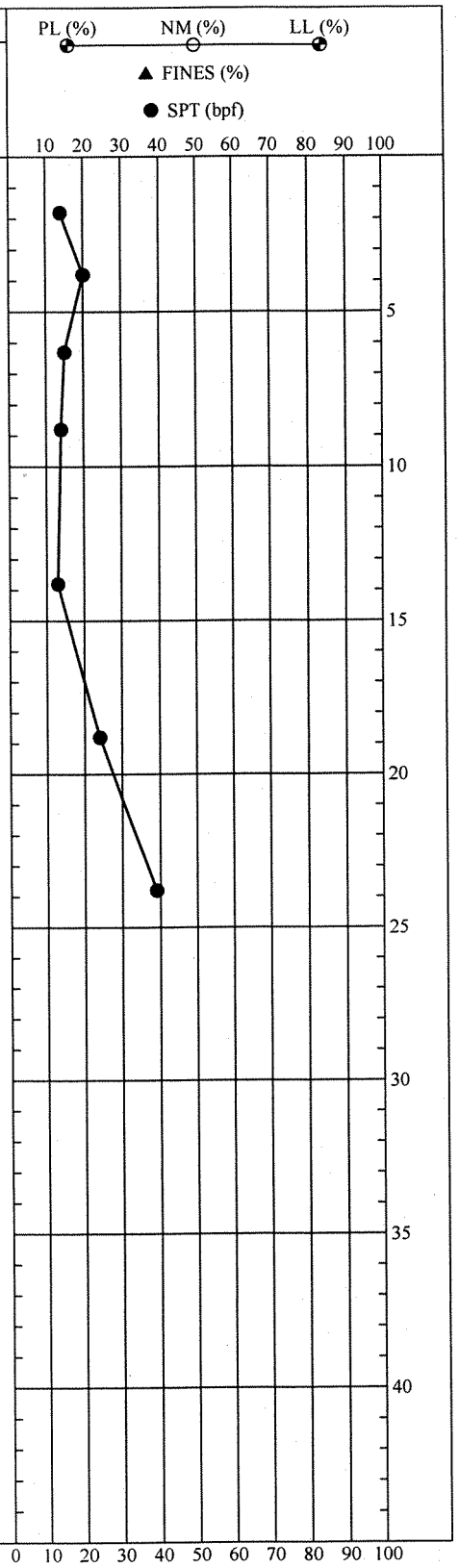
SAND & GRAVEL		SILT & CLAY	
No. of Blows	Relative Density	No. of Blows	Consistency
0 - 4	Very Loose	0 - 2	Very Soft
5 - 10	Loose	3 - 4	Soft
11 - 30	Medium Dense	5 - 8	Firm
31 - 50	Dense	9 - 15	Stiff
Over 50	Very Dense	16 - 30	Very Stiff
		31 - 50	Hard
		Over 50	Very Hard

KEY TO SYMBOLS AND DESCRIPTIONS

MACTEC

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.	LEGEND	ELEV (ft)
0	**TOPSOIL** Medium dense light-gray and red-brown clayey fine SAND		
5			
	Medium dense to dense yellow-brown and light-gray fine to coarse SAND with clay		
10			
15			
20			
25	Boring terminated at 25 feet		
30			
35			
40			
45			

SAMPLES IDENT	TYPE	N-COUNT 1st 6" 2nd 6" 3rd 6"
SPT-1	X	5-6-8 (N = 14)
SPT-2	X	3-10-10 (N = 20)
SPT-3	X	4-7-8 (N = 15)
SPT-4	X	7-7-7 (N = 14)
SPT-5	X	9-7-6 (N = 13)
SPT-6	X	13-11-13 (N = 24)
SPT-7	X	13-15-24 (N = 39)



SOIL TEST BORING CAMF.GPJ LAW_GIBB.GDT 12/16/03

DRILLER: Jimmy Oglesby (MACTEC)
EQUIPMENT: CME-550 (Auto-Hammer)
METHOD: 3 3/4" HSA
HOLE DIA.: 6 inches
REMARKS: Boring backfilled same day

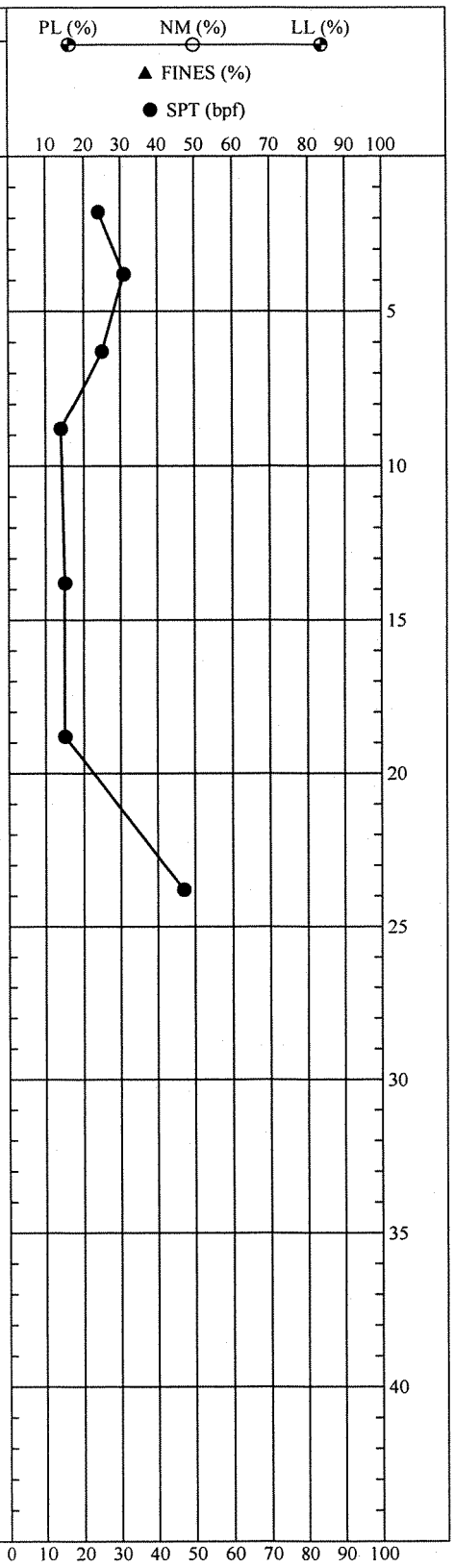
THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BEWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL TEST BORING RECORD

BORING NO.: B-1
PROJECT: Robins Air Force Base - CAMF
LOCATION: Warner Robins, Georgia
DRILLED: November 25, 2003
PROJECT NO: 6138-03-0457

MACTEC

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.	LEGEND	ELEV (ft)	SAMPLES IDENT	TYPE	N-COUNT 1st 6" 2nd 6" 3rd 6"
0	**TOPSOIL** Medium dense to dense light-gray and brown fine SAND with silt			SPT-1	X	6-9-15 (N = 24)
				SPT-2	X	10-15-16 (N = 31)
5	Medium dense to dense light-brown and light-gray fine to coarse SAND with clay			SPT-3	X	9-13-12 (N = 25)
				SPT-4	X	6-6-8 (N = 14)
10						
				SPT-5	X	6-9-6 (N = 15)
15						
				SPT-6	X	7-7-8 (N = 15)
20						
				SPT-7	X	28-24-23 (N = 47)
25	Boring terminated at 25 feet					
30						
35						
40						
45						



SOIL TEST BORING CAMF.GPJ LAW_GIBB.GDT 12/16/03

DRILLER:	Jimmy Oglesby (MACTEC)
EQUIPMENT:	CME-550 (Auto-Hammer)
METHOD:	3 $^{3}/_{4}$" HSA
HOLE DIA.:	6 inches
REMARKS:	Boring backfilled same day

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BEWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

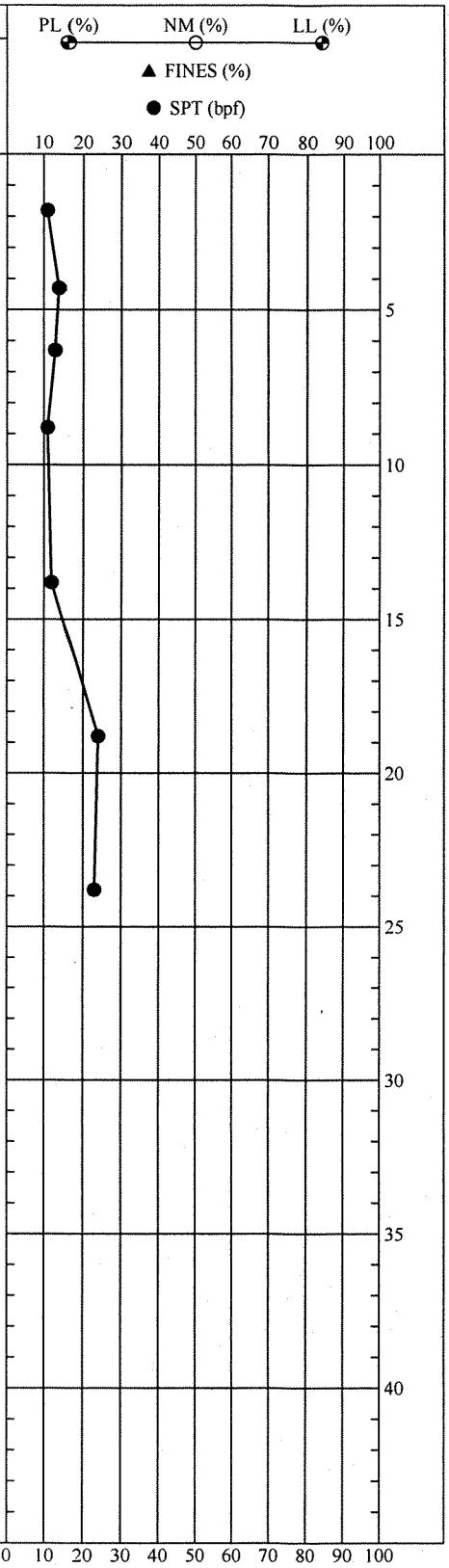
SOIL TEST BORING RECORD

BORING NO.: B-2
PROJECT: Robins Air Force Base - CAMF
LOCATION: Warner Robins, Georgia
DRILLED: November 25, 2003
PROJECT NO: 6138-03-0457

MACTEC

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.	LEGEND	ELEV (ft)
0	**TOPSOIL** Stiff light-gray sandy CLAY		
	Medium dense light-gray clayey fine SAND		
5			
	Medium dense brown and light-gray fine to coarse SAND with clay		
10			
15			
20			
25	Boring terminated at 25 feet		
30			
35			
40			
45			

SAMPLES IDENT	TYPE	N-COUNT 1st 6" 2nd 6" 3rd 6"
SPT-1	X	6-5-6 (N = 11)
SPT-2	X	3-4-10 (N = 14)
SPT-3	X	4-4-9 (N = 13)
SPT-4	X	5-5-6 (N = 11)
SPT-5	X	4-5-7 (N = 12)
SPT-6	X	7-9-15 (N = 24)
SPT-7	X	13-13-10 (N = 23)



SOIL TEST BORING CAMF.GPJ LAW_GIBB.GDT 12/16/03

DRILLER:	Jimmy Oglesby (MACTEC)
EQUIPMENT:	CME-550 (Auto-Hammer)
METHOD:	3 $^3/_4$" HSA
HOLE DIA.:	6 inches
REMARKS:	Boring backfilled same day

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BEWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

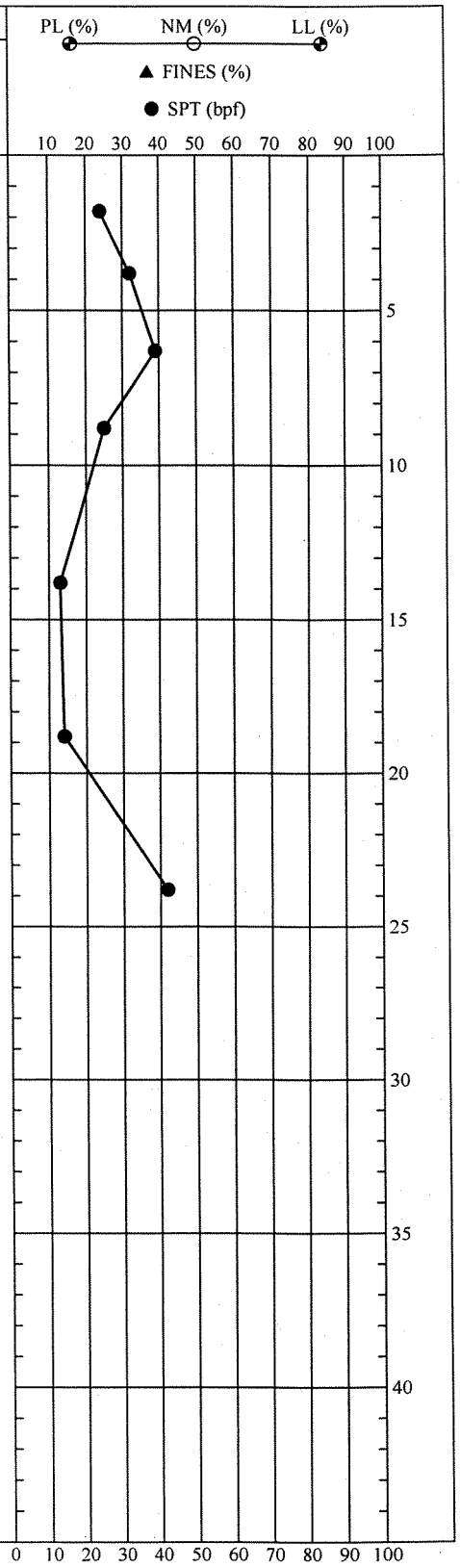
SOIL TEST BORING RECORD

BORING NO.: B-3
PROJECT: Robins Air Force Base - CAMF
LOCATION: Warner Robins, Georgia
DRILLED: November 25, 2003
PROJECT NO: 6138-03-0457

MACTEC

DEPTH (ft)	SOIL CLASSIFICATION AND REMARKS SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS USED BELOW.	LEGEND	ELEV (ft)
0	**TOPSOIL**		
	Medium dense to dense gray and brown silty fine to medium SAND		
5			
	Medium dense to dense brown and gray fine to coarse SAND with clay		
10			
15			
20			
25	Boring terminated at 25 feet		
30			
35			
40			
45			

SAMPLES IDENT	TYPE	N-COUNT 1st 6" 2nd 6" 3rd 6"
SPT-1	X	6-11-13 (N = 24)
SPT-2	X	5-6-26 (N = 32)
SPT-3	X	12-19-20 (N = 39)
SPT-4	X	10-12-13 (N = 25)
SPT-5	X	6-6-7 (N = 13)
SPT-6	X	5-6-8 (N = 14)
SPT-7	X	20-22-20 (N = 42)



SOIL TEST BORING CAMF.GPJ LAW_GIBB.GDT 12/16/03

DRILLER:	Jimmy Oglesby (MACTEC)
EQUIPMENT:	CME-550 (Auto-Hammer)
METHOD:	3 $^{3}/_{4}$" HSA
HOLE DIA.:	6 inches
REMARKS:	Boring backfilled same day

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BEWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL TEST BORING RECORD

BORING NO.:	B-4
PROJECT:	Robins Air Force Base - CAMF
LOCATION:	Warner Robins, Georgia
DRILLED:	November 25, 2003
PROJECT NO:	6138-03-0457

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APPENDIX C

Laboratory Testing Procedures
Grain Size Distribution Test Results with
Moisture Content and Plasticity Test Results
Moisture-Density Relationships for CBR Test Sample
California Bearing Ratio Test Result
Resistivity and pH Test Results

LABORATORY TESTING PROCEDURES

Soil Classification: Soil classifications provide a general guide to the engineering properties of various soil types and enable the engineer to apply past experience to current situations. In our investigations, samples obtained during drilling operations are examined in our laboratory and visually classified by an engineer. The soils are classified according to consistency (based on number of blows from standard penetration tests), color and texture. These classification descriptions are included on our "Test Boring Records."

The classification system discussed above is primarily qualitative and for detailed soil classification two laboratory tests are necessary: grain size tests and plasticity tests. Using these test results the soil can be classified according to the AASHTO or Unified Classification Systems (ASTM D 2487). Each of these classification systems and the in-place physical soil properties provide an index for estimating the soil's behavior. The soil classification and physical properties determined are presented in this report.

Atterberg Limits: Portions of the samples are taken for Atterberg Limits testing to determine the plasticity characteristics of the soil. The plasticity index (PI) is the range of moisture content over which the soil deforms as a plastic material. It is bracketed by the liquid limit (LL) and the plastic limit (PL). The liquid limit is the moisture content at which the soil becomes sufficiently "wet" to flow as a heavy viscous fluid. The plastic limit is the lowest moisture content at which the soil is sufficiently plastic to be manually rolled into tiny threads. The liquid limit and plastic limit are determined in accordance with ASTM D 4318.

Moisture Content: The Moisture Content is determined according to ASTM D 2216.

Grain Size Tests: Grain Size Tests are performed to determine the soil classification and the grain size distribution. The soil samples are prepared for testing according to ASTM D 421 (dry preparation) or ASTM D 2217 (wet preparation). The grain size distribution of soils coarser than a number 200 sieve (0.074 mm opening) is determined by passing the samples through a standard set of nested sieves. Materials passing the number 200 sieve are suspended in water and the grain size distribution calculated from the measured settlement rate. These tests are conducted in accordance with ASTM D 422.

Percent Finer Than 200 Sieve: Selected samples of soils are washed through a number 200 sieve to determine the percentage of material less than 0.074 mm in diameter.

Compaction Tests: Compaction tests are run on representative soil samples to determine the dry density obtained by a uniform compactive effort at varying moisture contents. The results of the test are used to determine the moisture content and unit weight desired in the field for similar soils.

Proper field compaction is necessary to decrease future settlements, increase the shear strength of the soil and decrease the permeability of the soil.

The two most commonly used compaction tests are the standard Proctor test and the modified Proctor test. They are performed in accordance with ASTM D 698 and D 1557, respectively. Generally, the standard Proctor compaction test is run on samples from building or parking areas where small compaction equipment is anticipated. The modified Proctor compaction test is generally performed for heavy structures, highways, and other areas where large compaction equipment is expected. In both tests a representative soil sample is placed in a mold and compacted with a compaction hammer. Both tests have three alternate methods.

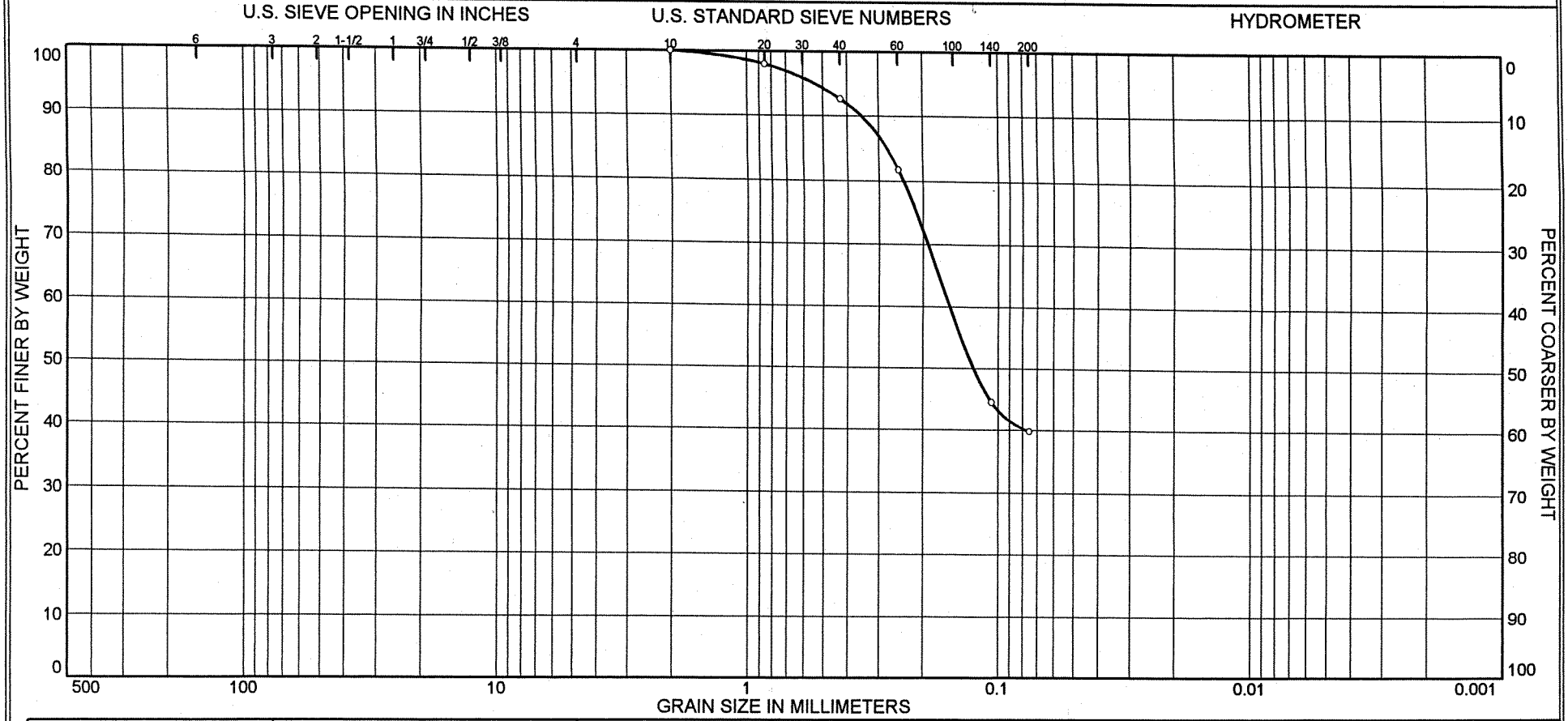
The moisture content and unit weight of each compacted sample is determined. Usually 4 to 5 such tests are run at different moisture contents. Test results are presented in the form of a dry unit weight versus moisture content curve. The compaction method used and any deviations from the recommended procedures are noted in this report.

California Bearing Ratio: The California Bearing Ratio (CBR) is a punching shear test which provides data that is a semi-empirical index to the strength and deflection characteristics of the soil, and has been widely correlated with pavement performance to establish criteria for selecting pavement thicknesses. The test is performed on a 6-inch diameter, 5-inch thick disk of compacted soil that is confined in a steel cylinder. The sample is first compacted in accordance with Method B or D of ASTM D698 or D 1557. The samples may be tested unsoaked or in a soaked condition. For the soaked test, the sample is inundated under a confining pressure to approximate the weight of future pavement, in order to evaluate the potential swell characteristics of the soil.

The test is performed by forcing a piston approximately 2 inches in diameter into the soil sample at the rate of 0.05 inch per minute to a depth of 0.5 inch to determine the resistance to penetration. The CBR is the ratio, expressed as a percentage, of the actual load required to penetrate the soil to a 0.1 inch depth compared to the load it takes to penetrate a standard crushed stone to the same depth. The results of the CBR tests are presented in the Appendix.

pH and Resistivity Tests: The resistivity of the soil is determined according to ASTM G 57-95a. The pH of the soil is determined according to ASTM D 4972.

Particle Size Distribution Report ASTM D422/D1140



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
○	0.0	0.0	60.2	39.8	

	SOURCE	SAMPLE #	DEPTH/ELEV.	DATE SAMPLED	USCS	MATERIAL DESCRIPTION	NM %	LL	PL
○	B-1	1	1.5-3'	12/9/03	SC	Lt. Gray with Reddish Yellow Clayey sand	24.1	46	24

Client TranSystems

Project Robins AFB - Consolidated Aircraft Maintenance

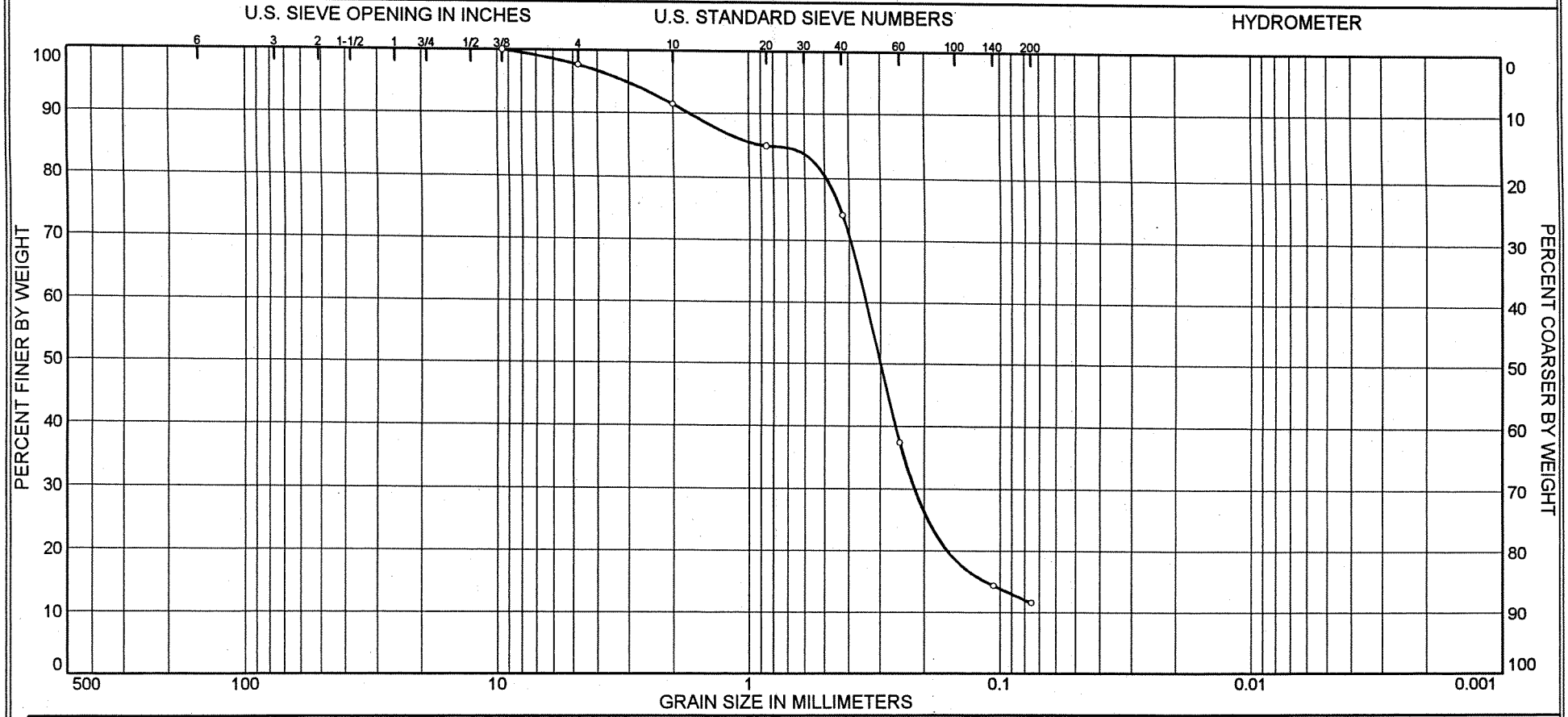
Facility

Project No. 6138-03-0457 ID 002674

MACTEC ENGINEERING AND CONSULTING, INC.

○ Tested By: JM/ TLW Reviewed By:

Particle Size Distribution Report ASTM D422/D1140



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
○	0.0	2.4	86.0	11.6	

	SOURCE	SAMPLE #	DEPTH/ELEV.	DATE SAMPLED	USCS	MATERIAL DESCRIPTION	NM %	LL	PL
○	B-2	2	3.5-5'	12/9/03	SP-SM	Pale Gray & Yellowish Brown Poorly graded sand with silt	13.1	NV	NP

Client TranSystems

Project Robins AFB - Consolidated Aircraft Maintenance

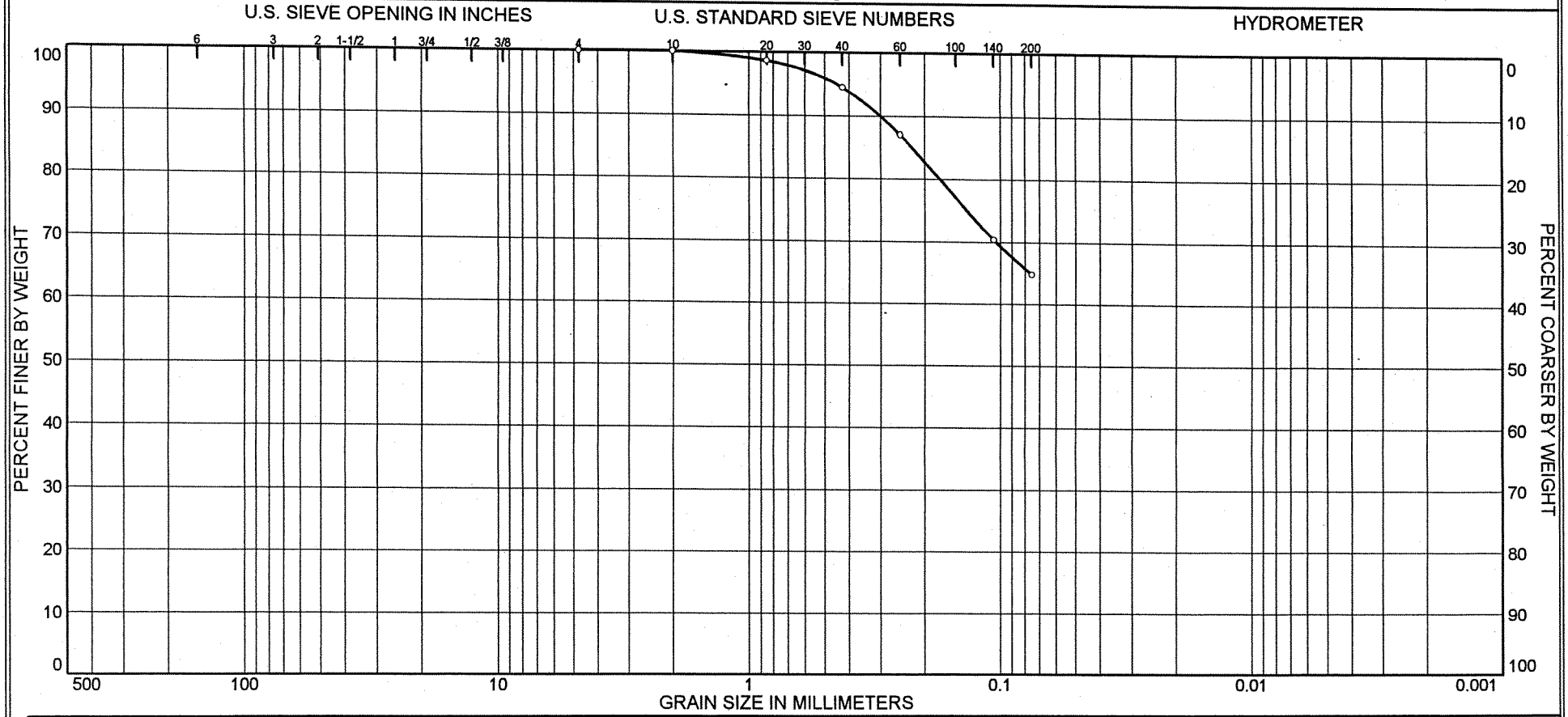
Facility

Project No. 6138-03-0457 ID 002675

MACTEC ENGINEERING AND CONSULTING, INC.

○ Tested By: JM/ TLW Reviewed By:

Particle Size Distribution Report ASTM D422/D1140



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
○	0.0	0.0	35.2	64.8	

	SOURCE	SAMPLE #	DEPTH/ELEV.	DATE SAMPLED	USCS	MATERIAL DESCRIPTION	NM %	LL	PL
○	B-3	1	1.5-3'	12/9/03	CH	Lt. Gray with Browninsh Yellow Sandy fat clay	25.5	55	26

Client TranSystems

Project Robins AFB - Consolidated Aircraft Maintenance

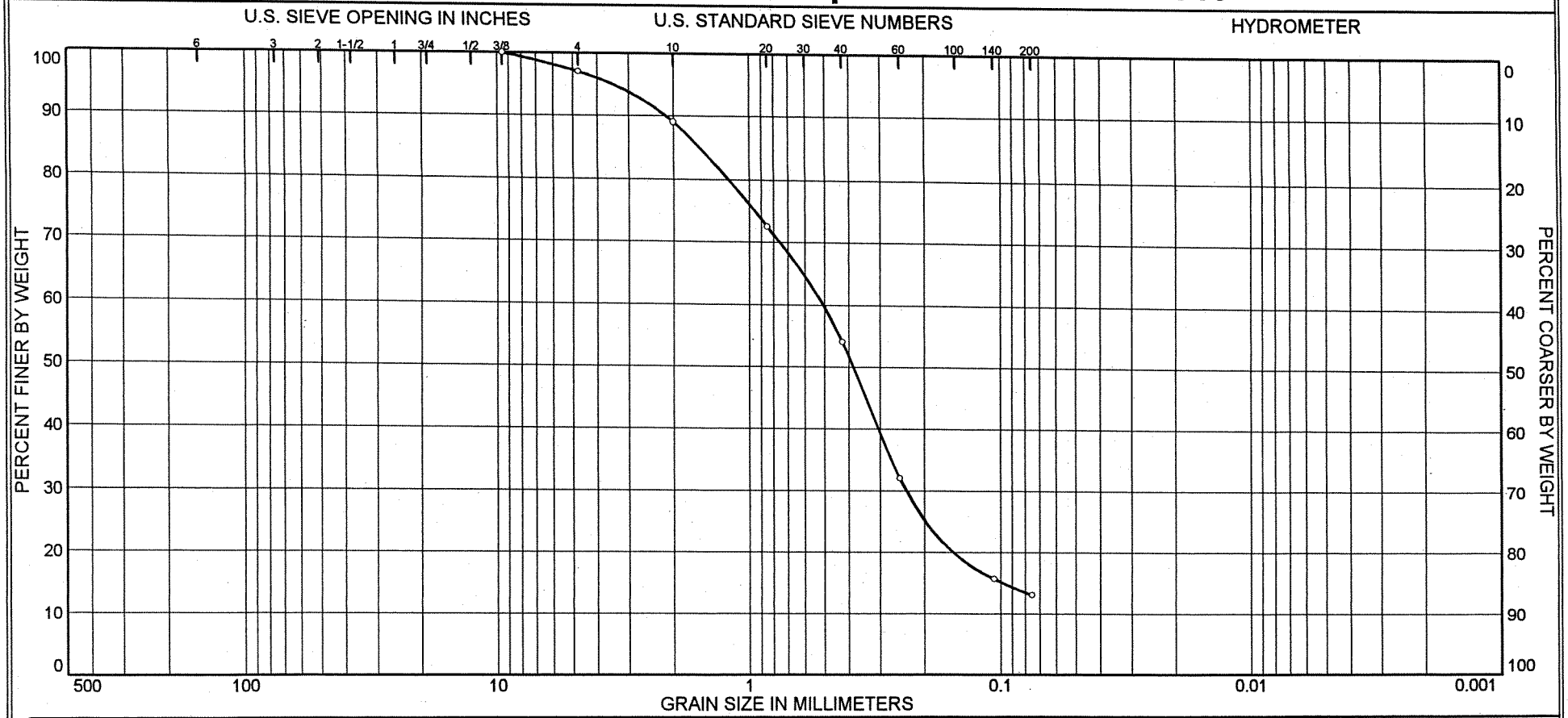
Facility

Project No. 6138-03-0457 ID 002676

MACTEC ENGINEERING AND CONSULTING, INC.

○ Tested By: TLW Reviewed By:

Particle Size Distribution Report ASTM D422/D1140



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
○	0.0	3.0	83.9	13.1	

	SOURCE	SAMPLE #	DEPTH/ELEV.	DATE SAMPLED	USCS	MATERIAL DESCRIPTION	NM %	LL	PL
○	B-4	1	3.5-5'	12/9/03	SM	Pale Gray with Yellowish Brown Silty sand	12.8	32	24

Client TranSystems

Project Robins AFB - Consolidated Aircraft Maintenance

Facility

Project No. 6138-03-0457 ID 002677

MACTEC ENGINEERING AND CONSULTING, INC.

○ Tested By: TLW Reviewed By:

COMPACTION TEST REPORT

Curve No.: 002680

Project No.: 6138-03-0457 **Date:** 12-03-03

Project: Robins AFB - Consolidated Aircraft Maintenance Facility

Location: B-2

Elev./Depth: 0-10' **Sample No.** Bag

Remarks: Tested By: GW Reviewed By:

MATERIAL DESCRIPTION

Description: Tan

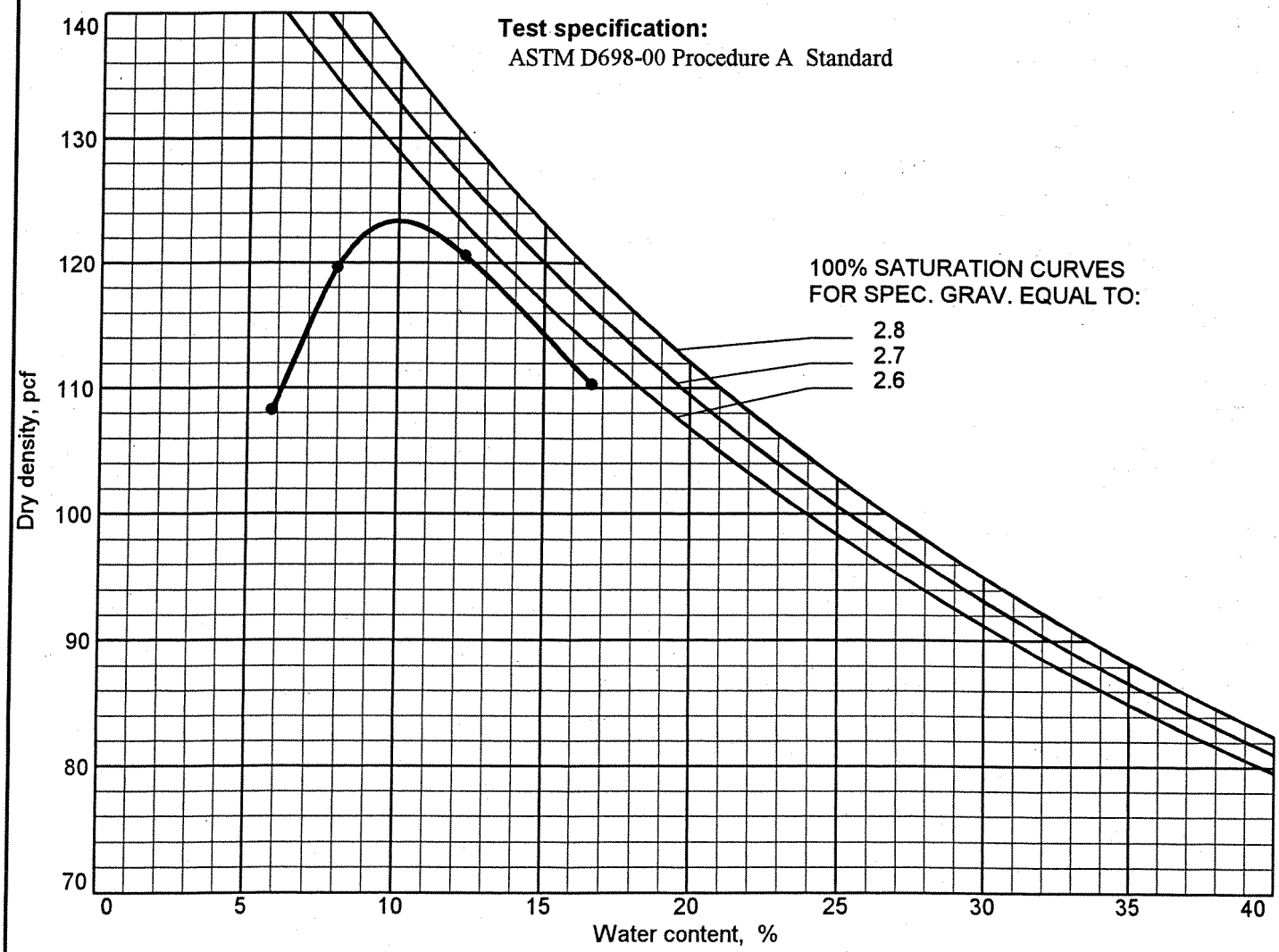
Classifications - **USCS:** **AASHTO:**

Nat. Moist. = **Sp.G. =** 2.7

Liquid Limit = **Plasticity Index =**

% > No.4 = % **% < No.200 =**

TEST RESULTS
Maximum dry density = 123.4 pcf
Optimum moisture = 10.0 %



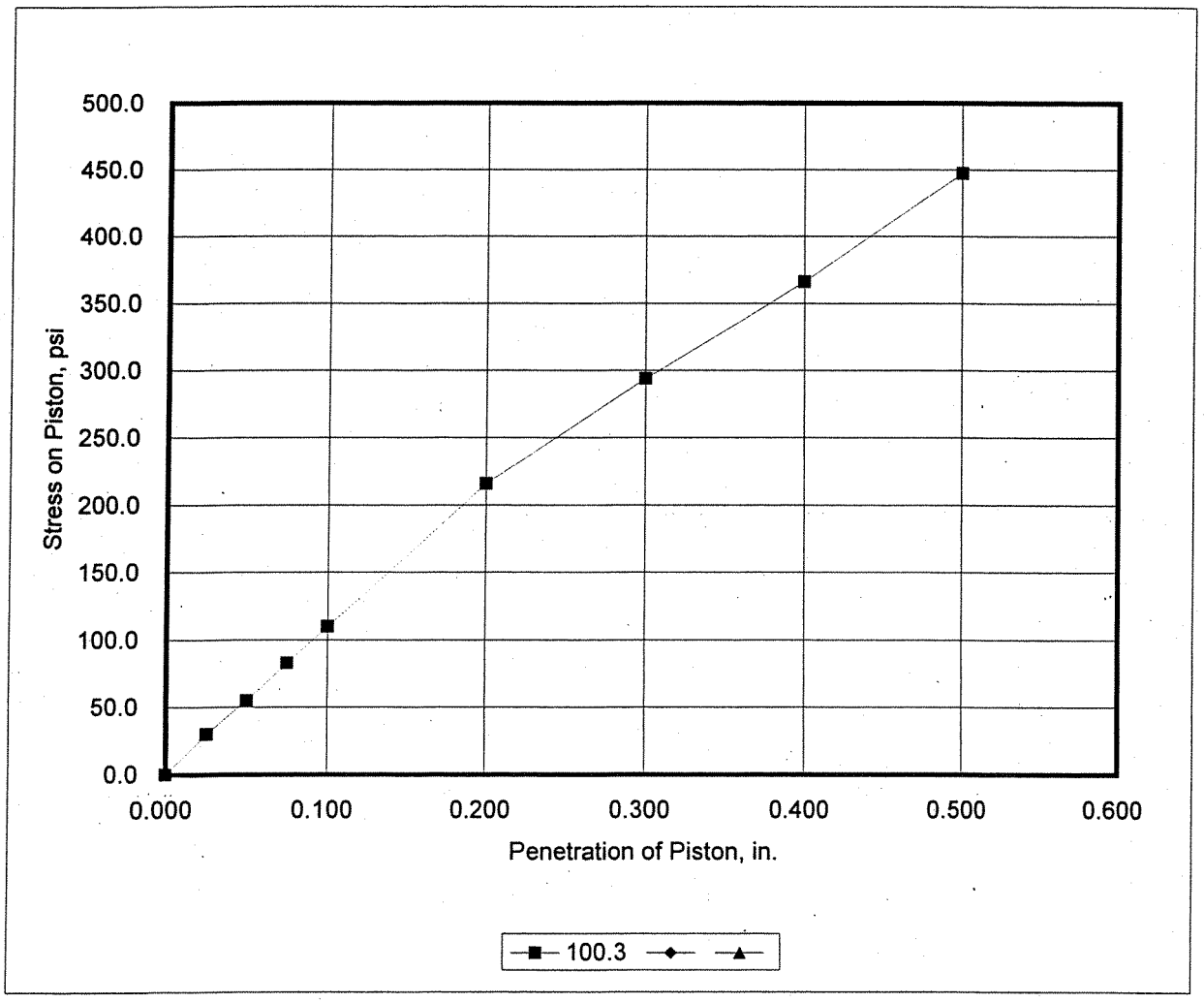
ID 002680

MACTEC

California Bearing Ratio
(ASTM D1883-92)

Project No.	6138-03-0457	**Tested By**	GE
Project Name	Robins AFT - Consolidated Aircraft Maint. Facility	**Test Date**	Dec-8-03
Boring No.	B-2	**Reviewed By**	[illegible]
Depth	0-10'	**Review Date**	12/9/03

Compaction, %	100.3		
Before Soak Dry Density, pcf	123.8		
Before Soak Moisture Content, %	9.9		
After Soak Dry Density, pcf	123.6		
After Soak Moisture Content, %	9.9		
CBR @ 0.1 in.	11.0		
CBR @ 0.2 in.	14.4		



MACTEC

Resisitivity Test & pH

ASTM D 4972-01 and ASTM G 57-95a

Project No. 6138-03-0457
Tested By TLW
Test Date 12/5/2003

Project Name Robins AFB
Reviewed By
Review Date 12/9/03

Sample Lab ID#	Boring No.	Sample Depth	Natural Moisture Content	Resistivity Ω-cm	pH
002678	B-2	6'-10'	8.4%	1.8×10^5	7.88
002679	B-3	4'-7.5'	18.0%	1.0×10^5	7.31