

Geotechnical & Paving Design Guide

- **Introduction**

The Appendix "A" defines the scope of A&E services. This Geotechnical and Paving Design Guide further defines the geotechnical and paving services identified in the Appendix "A" and identifies our technical and submittal requirements for geotechnical and paving engineers doing design work for the Atlantic Division.

- **Communications**

Direct communication with the LANTNAVFACENGCOM geotechnical and paving reviewer is encouraged. If you have a question concerning a particular comment, contact the LANTNAVFACENGCOM reviewer. This may avoid unnecessary re-submittal of plans and specifications due to a misunderstood comment.

The branch maintains record files pertaining to the geotechnical aspects of numerous previously constructed projects. Use of this resource is encouraged for preparation of fees or investigations, research of existing conditions or past design approaches for facilities, structures, or pavements. Viewing or discussion of the files' contents is possible by contacting members of the branch.

- **Geotechnical & Paving Design Requirements**

- **Registered Geotechnical Engineers**

The geotechnical engineers participating in the design shall be registered engineers and shall be familiar with both the physiographic conditions and common geotechnical design approaches and materials used in the location in which they are performing work.

- **Design Criteria**

The use of the Naval Facilities Engineering Command's Design Manual Series, DM-7.1,7.2 and 7.3 Soil Mechanics is recommended for the criteria for soil related design. However, other texts that are used in academia and the U.S. Army Corps of Engineers Technical Manuals are acceptable for the geotechnical criteria.

The pavements for airfields shall be designed using the Military Handbook and Design Manuals of the Mil-Hdbk-1021 series. The pavements for roads, streets, parking and open storage shall be designed using the Army Corps of Engineers TM-522 series.

- **Pre-Design Services**

- **Field Investigation**

- **General**

The A&E shall obtain all site and building data and investigate existing site conditions, utilities, and facilities as necessary to properly integrate the design of the project with the existing conditions. Except as otherwise contracted, field investigation shall include complete and accurate site investigation, noting any features or conditions that would influence the design, including topography, groundwater, climatic or tidal

action, availability of utility and drainage systems, etc. Applicable existing as-built record drawings and subsurface information from the Geotechnical & Paving Branch record files, when available, will be furnished for information. However, the A&E shall be responsible for field verification of the as-built drawings and other site features that may influence the design of the project.

All site investigations shall be coordinated with the Public Works Department. The exact location of the geotechnical excavation, whether by drilling or digging, shall be approved by the appropriate authorities, be it the local utility or the local utility location service or by a company hired by the geotechnical engineering firm to 'scope' utilities. During the execution of the field investigation work, the A&E shall be responsible for obtaining necessary permits, and complying with applicable laws, codes, and regulations, including OSHA regulations. The A&E shall be responsible for all damages to persons and property which occur as a result of the A&E's fault or negligence. The A&E shall take proper safety precautions to protect the public, the property of the public and the Government from physical hazards and unsafe conditions. Upon completion of field investigation, the A&E shall return the property to its original condition except as released in writing by the client activity.

- **Geotechnical Investigation**

A literature review of the existing borings, pile driving records, physiographic data and geologic maps should be accomplished early in the subsurface investigation program.

- **Subsurface Exploration**

Subsurface investigation and evaluations (including soil borings, test pits, ground penetrating radar surveys, seismic refraction surveys, and electrical resistivity testing) shall be in accordance with an acceptable standards such as ASTM or ASFE.

- **Soil Borings**

The soil borings shall be made in accordance with ASTM D1586, the latest revision. The procedure shall be modified to make continuous standard penetration and sampling tests for the initial 12 feet of the boring and commencing at 15 feet of depth below grade penetration and sampling every 5 feet is recommended. The location of the water table, if encountered shall be measured and recorded after 24 hours. If drilling techniques are used that prevent the measurement of the water table, install at least two piezometers per drilling site to more accurately measure the depth to the water table. Piezometers are required for storm water pond investigations. Piezometers are not required if there is good evidence that the water table is not within the depth of the borings or zone of influence for the foundation or structure. Samples above the water table shall be measured for moisture content. As a general rule, moisture content is determined in the uppermost 8 feet of surface soils (every 2 feet of depth). The driller shall visually classify all soils in accordance with ASTM D2488 or Burmister's Classification of Soils. The near surface conditions i.e., topsoil, pavement type and thicknesses of each shall be reported. If during the drilling evidence is discovered indicating contamination, this should be reported immediately to the project manager or the Geotechnical and Paving Branch. If soft cohesive materials are discovered in the near surface soils, they should be sampled with a thin wall tube for laboratory testing. Undisturbed sampling shall be performed at the discretion of the Geotechnical Engineer responsible for performing the investigation.

- **Laboratory**

The minimum laboratory testing shall include grouping like samples and conducting a sieve analysis and Atterberg Limits on one sample from the group. Visual classification of soils performed during drilling shall be verified by laboratory testing, with the boring logs updated to reflect the laboratory test results. Other testing could include moisture contents, California Bearing Ratio, unconfined compressive strength, consolidations, triaxial testing, and potential volume change in accordance with FHA No. 595 in suspected expansive clay areas. Some environmental testing of soils may be required just to identify contaminated (predominantly petroleum) soils; however, if major contamination is suspected, the situation will be sent to the LANTNAVFACENGCOM Environmental Division for definition.

- **Other Field Testing**

Projects may require a variety of other testing from percolation tests for septic systems to seismic refraction surveys. In areas of near surface rock, seismic refraction surveys or ground penetrating radar may be required to determine the depth of rock or competent material. Soil resistivity by the Weener 4-pin method should be used when designing underground structures like piping.

- **Geotechnical Report**

Provide a report describing the physiographic and geologic features of the site. Describe the general situation as to topography, ground cover, and any other features that may influence the design. Describe the investigation program, drilling techniques/procedures used. Discuss the soil horizon, materials, and water condition of the subsurface site. The report shall specifically address the groundwater levels expected to be encountered in construction under normal conditions, and any site specific factors (such as tidal action, climate, seasonal flooding or droughts, etc.) that may influence the groundwater levels. Discuss the facility under design and make recommendations for the foundation type. Discuss the site preparation and susceptibility to rain and construction equipment. Describe and specify the improvements that are required for shallow foundations, such as compaction, removal and replacement, surcharging, wick drains, etc. Describe the soil bearing capacity, pile capacity, pile length, pile type and special instructions such as jetting, pre-drilling and testing required. If required by the A&E of record, show the pavement design parameters and the pavement design or, if someone else is doing the pavement design, provide design parameters determined from subsurface investigation. If multiple structures are being designed, address structures on an individual basis. Show location plan (to scale) with the borings located from existing features and not just the planned facility. Include on the boring logs complete information on who performed the borings, when and the drilling method used. Show the description of soil, standard penetration resistance, moisture contents, topsoil and pavement type and thicknesses of each, water table observations, contamination detected, rock types, Rock Quality Designation (RQD), any other information gathered during the exploration. Include copies of pertinent U.S. Geological Survey Maps used or excerpts from them. The laboratory data shall be included in detail and summary forms. The report, boring logs and laboratory testing results shall be provided on high density 3 ½" floppy disks in an AUTOCADD compatible format (either .DXF or .DWG) with text size conforming to the A/E Guide, in addition to two written copies of the geotechnical report.

- **Design Services**

- **Basis of Design**

The Basis of Design shall include a paragraph briefly describing the geotechnical investigation program, the recommendations for the site preparation, the foundation, and the pavement design. The foundation and pavement design selected should be also indicated.

It is preferred that the Geotechnical Report be included in the Basis of Design as an appendix however, many times the schedules preclude the completion of the field investigation prior to the submittal of the Basis of Design. If this is the case, indicate so and describe the assumed basis of design for the foundations and pavements and submit the Geotechnical Report as soon as possible.

- **Calculations**

- **General Requirements**

Generally the Geotechnical Report will contain the calculations relating to foundation and pavements. However, if the pavement calculations are done by a different consultant, they may appear here or in the civil engineering package.

- **Geotechnical and Paving Requirements**

The geotechnical calculations normally appear in the Geotechnical Report; however, they may be in a separate package if another consultant other than the geotechnical consultant prepares the calculations for foundations or pavement. The calculations should indicate the loadings, capacities, the safety factors, and the text from which the calculations were based for the foundation and pavements. Graphs and formula shall be clearly indicated along with the derivation of curve slopes and data derived from the laboratory testing.

- **Drawings**

A typical presentation of the borings on drawings is shown in attachment. It includes the logs as they appear in the Geotechnical Report, a summary table of the laboratory testing, notes concerning the drilling, logs, and testing, and any site preparation notes or details. Surcharging details with settlement plates should be shown here.

- **Design Submittals**

- **35% Design Development Submittal**

- **Basis of Design**

Include the Geotechnical Report as an appendix if available. It is encouraged to have this report at this submittal to obtain any review comments at the earliest possible date.

- **Drawings**

Boring log drawings are encouraged, but not required, at this submittal.
- **Calculations**

Submit geotechnical foundation and pavement design calculations if not included in the Geotechnical Report.
- **100% Pre-final Submittal**
 - **Basis of Design**

The Geotechnical Report, if modified during the 35% review, shall be re-submitted as an appendix to the Basis of Design, otherwise do not submit.
 - **Drawings**

The boring log drawing(s) shall be complete. Drawings depicting any special site preparation details should be included.
 - **Calculations**

Submit any calculations not submitted or that were modified during the 35% submittal. Otherwise, do not submit.
- **Final Submittal**
 - **Final Basis of Design**

The Geotechnical Report, if modified during the 100% review, shall be re-submitted as an appendix to the Basis of Design, otherwise do not submit.
 - **Drawings**

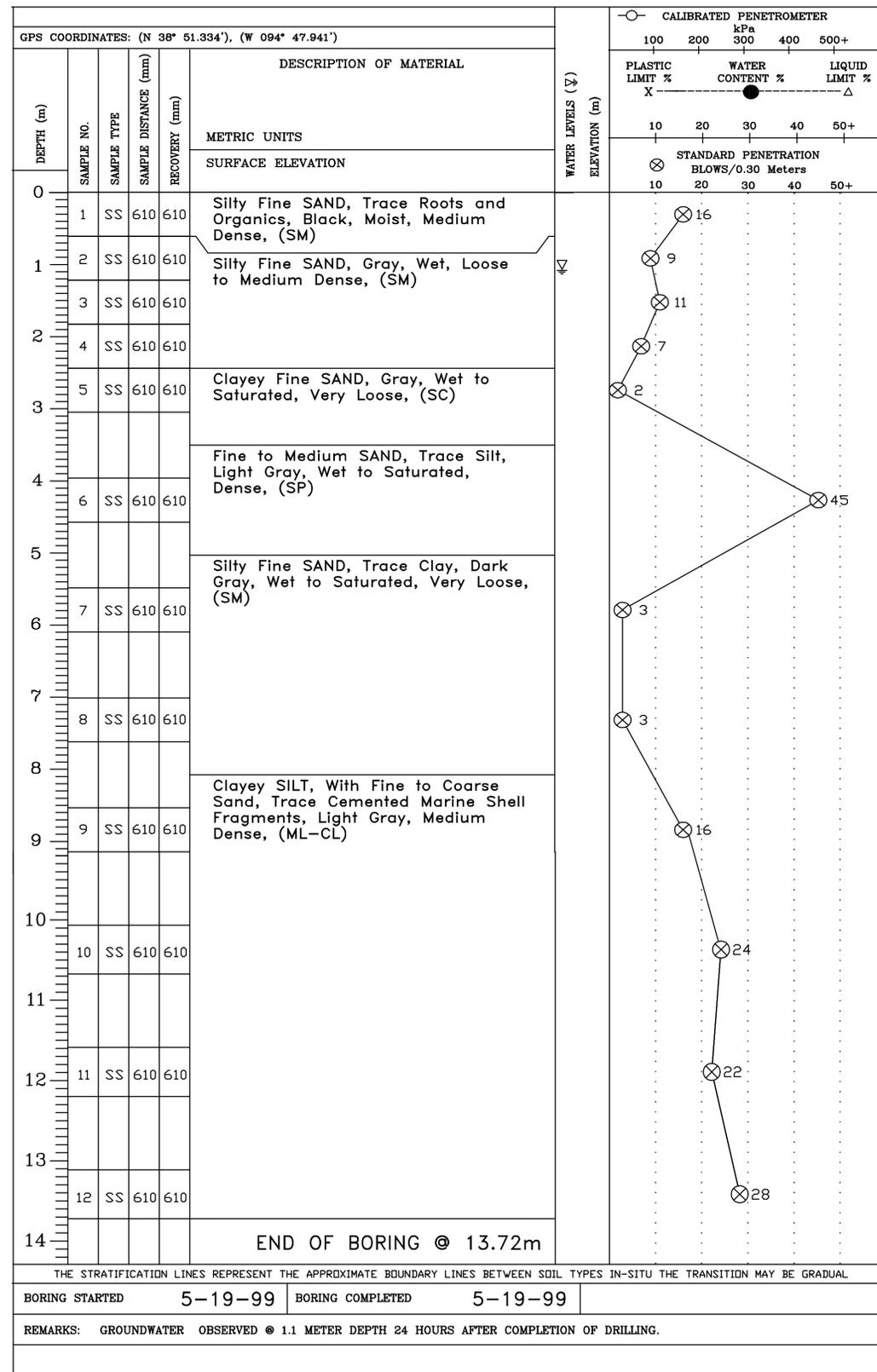
All geotechnical drawing(s) shall be complete and signed.
 - **Calculations**

Submit any calculations not submitted or that were modified during the 100% submittal. Otherwise, do not submit.
- **Overseas Requirements**
 - **Geotechnical Report**

The Geotechnical Report shall be translated into English.
 - **Drawings**

The boring logs shall be shown in two languages, English and the country of bidding and construction.

SOIL BORING LOG B-1



SOIL BORING GENERAL NOTES

- BORINGS WERE ADVANCED USING MUD ROTARY DRILLING TECHNIQUES.
- STANDARD PENETRATION - BLOWS/0.30m COLUMN INDICATES DEPTH OF SAMPLE AND STANDARD PENETRATION TEST DATA PRESENTED FOR A PENETRATION OF THE SAMPLER ADVANCED IN TWO 0.15m INCREMENTS.

STANDARD PENETRATION TEST (ASTM D-1586) - DRIVING A 50.8mm O.D., 38.1mm I.D., SAMPLER A DISTANCE OF 0.30m INTO UNDISTURBED SOIL WITH A 63.5 Kg HAMMER FREE FALLING A DISTANCE OF 0.76m. THE NUMBER OF HAMMER BLOWS REQUIRED TO ACHIEVE THREE SUCCESSIVE PENETRATIONS OF 0.15m ARE RECORDED. THE BLOW COUNT FOR THE FIRST PENETRATION IS DISREGARDED DUE TO DISTURBANCE THAT IS LIKELY TO EXIST IN THE BOREHOLE. THE RESULT (BLOWS/0.30m) IS OBTAINED BY ADDING THE BLOW COUNT FOR THE LAST TWO SUCCESSIVE PENETRATIONS OF 0.15m.
- IN THE COLUMN "DESCRIPTION OF MATERIAL" THE HORIZONTAL LINE INDICATES AN OBSERVED CHANGE OF SOIL STRATA. THESE OBSERVATIONS ARE CONFIRMED BY LABORATORY TESTING OF SOIL SAMPLES TAKEN FROM THE BORINGS.
- ALL DEPTHS AND LOCATIONS ARE APPROXIMATE. BORING DEPTHS AND GROUNDWATER OBSERVATIONS ARE REFERENCED TO THE GROUND SURFACE EXISTING AT TIME OF BORING.
- FOR BORING LOCATIONS SEE SHEET C-2.
- THE SOIL CLASSIFICATION INDICATED (SP, ML, CL, ETC.) ARE FROM THE UNIFIED SOIL CLASSIFICATION SYSTEM (USCS). DESCRIPTION OF SOIL AND CLASSIFICATION ARE IN ACCORDANCE WITH USCS AND IS BASED ON VISUAL EXAMINATION SUPPLEMENTED BY LABORATORY TESTS.
- THE NATURAL MOISTURE CONTENT AND ATTERBERG LIMITS OF SOIL SAMPLES WAS DETERMINED IN ACCORDANCE WITH ASTM D-2216 AND D-4318, RESPECTIVELY.
- BORINGS ARE NOT SHOWN TO SCALE.
- FOR SOIL SAMPLES CONSISTING OF TWO OR MORE TYPES, RELATIVE PROPORTIONS OF SECONDARY COMPONENTS (PERCENT BY WEIGHT) ARE INDICATED AS FOLLOWS:

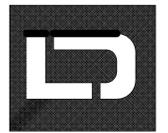
DESCRIPTIVE TERM	PERCENT
TRACE	1-10
LITTLE	11-20
SOME	21-35
AND	36-50

WATER LEVEL OBSERVATIONS WERE MADE AT THE TIME OF THE SUBSURFACE INVESTIGATIONS AND DO NOT NECESSARILY REPRESENT GROUNDWATER ELEVATIONS AT THE TIME OF CONSTRUCTION.

UNDER USUAL CIRCUMSTANCES GROUNDWATER EXISTS 1.0 TO 1.25 METERS BELOW EXISTING GRADES. NOTE THAT GROUNDWATER LEVELS MAY FLUCTUATE WITH SEASONAL CHANGE, TEMPERATURE VARIATION, RAINFALL, AND TIDAL INFLUENCES AND THEREFORE SHOULD NOT BE CONSTRUED AS ABSOLUTE.

SITE PREPARATION GENERAL NOTES

- BASE BIDS ON THE UPPERMOST 0.30 METERS OF SOIL IN THE SITE BEING REMOVED PRIOR TO FILL PLACEMENT OR FOUNDATION CONSTRUCTION.
- DEPENDING ON THE TIME OF CONSTRUCTION THE PRESENCE OF GROUNDWATER OR PERCHED WATER IN THE SURFACE SOILS IS LIKELY TO PRESENT A DETRIMENTAL EFFECT ON SITE PREPARATION AND/OR GRADING ACTIVITIES, PARTICULARLY DURING THE WETTER WINTER SEASON WHEN GROUNDWATER LEVELS ARE LIKELY TO BE ELEVATED. THIS CONDITION SHALL BE ANTICIPATED BY THE CONTRACTOR, AND CONTROL OF SURFACE AND SHALLOW WATER SHALL BE ACCOMPLISHED BY CUTTING A SERIES OF PARALLEL V-PROFILE DITCHES ACROSS THE WET AREAS AND TYING THE DITCHES TOGETHER TO A COMMON LOW POINT WHICH PROMOTES POSITIVE DRAINAGE TO THE LOWER ELEVATIONS OF THE SITE. THE V-DITCHES SHOULD BE CUT TO DEPTHS NO SHALLOWER THAN 24 INCHES BELOW EXISTING GRADE AT SPACINGS OF 75 TO 100 FEET. THE DITCHES SHALL BE MAINTAINED THROUGH CONSTRUCTION UNTIL FINAL GRADING, WHEN THEY SHALL BE FILLED WITH APPLICABLE FILL MATERIAL, PER SPECIFICATION REQUIREMENTS, TO FINISH GRADE.
- CLEARING, GRUBBING, AND SITE PREPARATION CAN BE ACCOMPLISHED USING EQUIPMENT CAPABLE OF MANEUVERING OVER SOFT MATERIAL. THE USE OF EQUIPMENT WITH HEAVY WHEEL LOADS (E.G., SCRAPERS, DUMP AND CONCRETE TRUCKS, ETC.) WILL CAUSE DETERIORATION OF THE SUBGRADE AND UNDERCUTTING WILL BE REQUIRED. IF THE CONTRACTOR ANTICIPATES USING SUCH EQUIPMENT, COSTS ASSOCIATED WITH UNDERCUTTING SHALL BE INCLUDED IN THE BID.

DATE	APPR
DESCRIPTION	
SYN	
 DESIGNED & ENGINEERED BY: LANTDIV <small>NAVAL FACILITIES ENGINEERING COMMAND</small>	
APPROVED	SEAL
ACTIVITY - SATISFACTORY TO	
DATE	
APPROVED	
FOR EFD FOR COMMANDER NAVFAC	
DATE	
A/E	EFD
DESIGN	JMW
DRAWN	JMW
REVIEW	DGB
QC	
CHIEF ARCH/ ENGR.	
PROJECT MANAGER	KON
FIRE PROTECTION	
BRANCH MANAGER	
DESIGN DIRECTOR	
DEPARTMENT OF THE NAVY	NORFOLK, VIRGINIA
NAVAL STATION	NORFOLK, VA
ATLANTIC DIVISION	
NAVAL STATION	
EXAMPLE BORING SHEET	
BORING LOGS AND NOTES	
CODE ID. NO. 80091	SIZE D
SCALE:	
EFD NO.	
STA. PROJ. NO. P-1123	
SPEC. NO.	
CONSTR. CONTR. NO.	
NAVFAC DRAWING NO.	
SHEET	OF
B-1	
<small>DRAWING REVISION MAY 2000</small>	

REV/DAT