

**CHAPTER 12**  
**GEOTECHNICAL**

**CHAPTER 12 – GEOTECHNICAL – TABLE OF CONTENTS**

**12.1 PREPARATION OF FULL PLANS AND SPECIFICATION SOLICITATION PACKAGES 3**

12.1.1 GEOTECHNICAL INVESTIGATIONS ..... 3

    12.1.1.1 *General* ..... 3

    12.1.1.2 *Submission of Drilling Program* ..... 3

    12.1.1.3 *Method of Exploration* ..... 3

    12.1.1.4 *Laboratory Testing of Soils Samples* ..... 4

    12.1.1.5 *Background Information* ..... 4

    12.1.1.6 *Specific Information Relative to Frost Penetration and use of the UFC:* ..... 4

    12.1.1.7 *Specific Information Relative to Required Spectral Accelerations:* ..... 4

12.1.2 GEOTECHNICAL REPORT ..... 4

    12.1.2.1 *General* ..... 4

    12.1.2.2 *Specific Requirements* ..... 5

12.1.3 SOIL COMPACTION AND FOUNDATION EXCAVATION ..... 6

12.1.4 GUIDE SPECIFICATIONS ..... 6

    12.1.4.1 *General* ..... 6

    12.1.4.2 *For Satisfactory/Unsatisfactory Material in Earthwork Specifications* ..... 6

    12.1.4.3 *Pavement Specifications* ..... 7

12.1.5 PLANS/DRAWINGS ..... 7

    12.1.5.1 *Data* ..... 7

    12.1.5.2 *Verify that the plans require that “all open foundation excavations be inspected and approved by a licensed geotechnical engineer prior to placing concrete.”* ..... 7

    12.1.5.3 *Verify the allowable bearing capacity recommended by the geotechnical engineer is used in the structural calculations.* ..... 7

    12.1.5.4 *Verify footing depths are below frost depths recommended in the geotechnical report.* ..... 7

    12.1.5.5 *Verify the pavement design in the geotechnical report is used in the pavement detail.* ..... 7

    12.1.5.6 *Physical Features* ..... 7

**12.2 PREPARATION OF DESIGN BUILD SOLICITATIONS PACKAGES ..... 7**

12.2.1 APPLICABILITY ..... 7

12.2.2 DISCUSSION OF GEOTECHNICAL STUDIES (GENERAL) ..... 8

12.2.3 AE SUBMISSION OF DRILLING PROGRAM ..... 9

12.2.4 GUIDE SPECIFICATIONS (01 02 00.00 48) ..... 10

    12.2.5.1 *Subsurface Characterization Report* ..... 10

    12.2.5.2 *Contractor’s Geotechnical Report* ..... 10

        12.2.5.2.1 *Additional Borings* ..... 11

        12.2.5.2.2 *Certification* ..... 11

        12.2.5.2.3 *Pavements* ..... 11

        12.2.5.2.4 *Soil Compaction and Foundation Excavations* ..... 12



## 12.1 PREPARATION OF FULL PLANS AND SPECIFICATION SOLICITATION PACKAGES

The purpose of this document is to outline Louisville District geotechnical requirements for Design Bid Build (DBB) military construction projects in order to assist the A/E in preparing full plans/specifications, providing geotechnical direction to the contractor and prepare the Earthwork specifications 31 00 00.00 06 and the plans. The proponent for this section is Steven A. Hite, P. E.

### 12.1.1 GEOTECHNICAL INVESTIGATIONS

#### 12.1.1.1 General

A geotechnical exploration is performed to obtain specific subsurface data at the site and to provide foundation and earthwork requirements for all projects. The geotechnical exploration shall be performed under the direction of a professional engineer specializing in geotechnical engineering with a minimum of 10 years experience. In addition, a geotechnical ITR member is required to perform Quality Control. The data shall include the depth, thickness, extent, and composition of each stratum and the groundwater conditions. If practicable, the geotechnical report shall be submitted at the 30% design stage of design. The purpose of completing the Geotechnical Report at the a30% design stage is to assist in locating structures, to identify potential site development problems, and to determine the foundation system before the design proceeds too far, or down the wrong path and to provide a cost effective design.

#### 12.1.1.2 Submission of Drilling Program

The A/E shall complete the "Proposed Geotechnical Exploration Data" sheet (see Exhibit 44 of this document) outlining the proposed scope of exploration and return it as an attachment to the fee proposal before negotiation of the original contract. The character and extent of the exploration shall be designed in consideration of the importance of the structure to be constructed. The "Proposed Geotechnical Exploration Data" sheet is merely a guide for the exploration and is flexible; the final program should develop as information accumulates in order to obtain the greatest amount of useful information in the most cost-effective manner.

#### 12.1.1.3 Method of Exploration

(a) The field investigation shall consist of a series of soil test borings. The number and spacing of the borings depend upon the type of structure as well as the uniformity of the soil formations. The spacing shall be smaller in those areas subjected to heavy loads and greater in less critical areas. Generally, a minimum of four soil test borings is required for building structures. The borings shall penetrate all soil strata that could shear or consolidate materially under the proposed structural loads. For very heavy or sensitive structures, the borings shall extend to refusal or to bedrock. If design or subsurface conditions warrant, core samples shall be obtained to verify the character and continuity of the refusal material. Borings located in pavement areas only extend to 5 feet below ground surface or design grade whichever is deeper.

(b) In conjunction with the soil test borings, the standard penetration test shall be performed to obtain disturbed soil samples for classification testing and to get an indication of the density of cohesionless soils and the strength of cohesive soils. Disturbed samples are generally taken every 0.75 m (2 ½ ft) for the first 3 m (10 ft), then every 1.5 m (5 ft) or at each change of material. The static, or Dutch, cone penetration test can be performed to complement the soil test borings. If quantitative laboratory testing is anticipated, relatively undisturbed thin-walled tube samples shall be taken (75 mm (3 in) diameter). Bag samples of auger cuttings shall be collected from pavement and borrow areas to investigate the compaction characteristics of the soil. Groundwater readings shall be taken upon completion of drilling and 24 hours after drilling is completed. In unusual circumstances (e.g., where deep excavations are anticipated in areas of high groundwater), observation wells shall be installed to monitor the groundwater level.

(c) All soil and rock samples taken during the exploration are to be retained by the A/E until the

Geotechnical Report is approved.

**12.1.1.4 Laboratory Testing of Soils Samples**

(a) The laboratory testing program shall be designed to facilitate analysis of the subsurface conditions on the basis of factual data. The program shall include classification tests to identify the soils within the Unified Soil Classification system, measure their physical properties, and enable an estimation of the behavior of the soils based on empirical correlations. Classification testing shall include visual examination, moisture content and Atterberg limits determinations, and when appropriate, grain size analyses and unit weight measurements.

(b) The allowable soil bearing pressure and the expected settlement of the structure must be determined. Quantitative laboratory tests such as the unconfined compression, consolidation, and swell pressure tests shall be performed on undisturbed soil samples to assist in these analyses. The California Bearing Ratio test is performed to quantify the subgrade strength for pavement design; remolded test specimens are prepared in accordance with the modified Proctor compaction test procedure.

(c) More sophisticated field and laboratory studies shall be performed only if warranted by the complexity of the project. Such field studies include pressure meter measurements, plate bearing tests, and geophysical explorations; laboratory tests include triaxial, direct shear, and permeability tests.

**12.1.1.5 Background Information**

For projects within and outside the Louisville Districts traditional military boundaries, such as many of the Reserves Projects, the A/E (or their geotechnical subcontractor) shall contact the project's nearest Military Corps of Engineer District (known as the Servicing Corps Geographic-District), Geotechnical Engineering Department and the engineering authority (such as the base civil engineer (BCE) or Department of Public Works (DPW)) at the facility where the construction will be performed and inquire about standard construction techniques relative to foundations, pavements and earthwork in the area and incorporate applicable requirements into the specifications. In addition, pavement minimums for projects outside the Louisville District boundaries will be obtained from the project's Servicing Corps Geographic-District. Take this opportunity to get background information relative to experience within the area, such as know swelling soil potential where bell shaped drilled piers are typically used instead of shallow spread footings and where lime stabilization is typically used beneath paving or if known seismic conditions requiring remediation are encountered, etc.... The name of the COE Servicing District Contact and BCE or DPW contact, their phone number and a summary of what was discussed should be included in the Design Analysis.

**12.1.1.6 Specific Information Relative to Frost Penetration and use of the UFC:**

The Louisville District considers the requirements in UFC 3-301-01 (Tables E-2 and F-2) dated 1 June 2013 (w/change 3 dated 12 September 2016) unreasonable relative to required frost depths in many instances. Therefore, frost penetration depth values may be obtained from the local jurisdiction or building code for a specific site.

**12.1.1.7 Specific Information Relative to Required Spectral Accelerations:**

Spectral accelerations shall be based on the local building code or UFC 3-301-01, whichever is greater. It is LRL experience that the USGS website is not always current.

**12.1.2 GEOTECHNICAL REPORT**

**12.1.2.1 General**

A foundation analysis is required to show that the type of foundation selected is the most feasible one capable of supporting the structure. The Geotechnical Report must include a narrative describing the design approach and all estimates and assumptions made, as well as soil bearing and settlement calculations IAW the guidelines and general requirements of UFC 3-220-01

entitled, "Geotechnical Engineering."

**12.1.2.2 Specific Requirements**

The Geotechnical Report shall be submitted at the 30% stage of design. The written report is prepared after the project information has been reviewed and the collective subsurface information has been analyzed. All conclusions and recommendations shall be supported with appropriate calculations and/or discussion. The report shall include:

- (a) a review of information on existing structures in the area;
- (b) a review of the area geologic conditions and site topographic features;
- (c) a review of the subsurface stratigraphy with the results of all testing conducted;
- (d) a general evaluation of the site considering the proposed project and the estimated subsurface conditions;
- (e) comprehensive foundation and earthwork recommendations including bearing capacity and settlement calculations and discussions to support the recommended foundation system;
- (f) Provide backup for any design parameters such as shear strength, earth pressure coefficients, friction factors, subgrade modulus, CBR, etc.
- (g) Provide Seismic design criteria (Ss, S1, and site class).
- (h) Include Pavement Design Calculations. Pavements: The A/E's Geotechnical Report shall contain flexible and rigid pavement design(s) including design CBR and modulus of subgrade reaction and the required compaction effort for subgrades. Information shall be offered on the types of base course materials available in the area and design strengths. Pavement should typically have a design life of typically 20 years using appropriate traffic loading. Pavement Designs shall be in accordance with UFC 3-250-01, dated 14 November 2016, which requires the use of PCASE. Regardless of the pavement design, a minimum flexible pavement section shall consist of 3.5 inches of asphalt (1.5 inches of surface course and 2 inches of base course) and 8 inches of aggregate subbase and/or base. Regardless of the pavement design, a minimum rigid pavement section shall consist of 6 inches of concrete and 8 inches of aggregate subbase and/or base, or as stated otherwise by the Geographic Servicing District. The minimum subbase/base can be neglected if the subgrade has a CBR greater than 30. [Note to preparer, the above minimums are for the Louisville District traditional military boundaries only, pavement minimums in other parts of the country need to be obtained from the closest corps district or experienced pavement designer in the area]

Subsurface Drainage associated with pavements shall be in accordance with the Unified Facilities Criteria (UFC 3-250-01) dated 14 November 2016.

Plans and specifications shall detail all of the specific aggregates proposed in the pavement design per state DOT designations and gradations including the aggregate used to choke off drainage layer aggregates to accommodate paving equipment.

It is USACE experience that binder grades for parking lots have been improperly chosen resulting in easily rutting unacceptable pavements. The common characteristic has been that the state DOT standard specification was used resulting in the usage of lower grade binder resulting in easily rutting unacceptable pavements. This is an inappropriate standard since the DOT recommended binder grades are intended for use in pavements with high speed traffic. It is highly recommended that the LTPPBind program (Version 3.1) be used when determining the proper binder grade with the standard selections: Desired Reliability" = 98% and "Traffic Speed" = SLOW for parking lots and entrances, and other low-traffic roads.

- (i) If requested, the Geotechnical Report will also include percolation rates, resistivity readings, corrosion potential, and shear wave velocities of the subsurface materials.
- (j) Soils information obtained from field logs, laboratory tests and geologists' logs shall be

presented on the contract drawings in the form of boring plans, final boring logs and explanatory notes. See Exhibit 45 attached to this document for example of boring logs. It is particularly important that complete subsurface information such as dates, elevations, depths to rock, depths to groundwater drilling equipment used, and the presence of unsatisfactory materials, etc. be presented to the Contractor for bidding purposes.

**12.1.3 SOIL COMPACTION AND FOUNDATION EXCAVATION**

Soil Compaction shall be achieved by equipment approved by a professional geotechnical engineer. Material shall be moistened or aerated as necessary to provide the moisture content that shall readily facilitate obtaining the compaction specified with the equipment used. Each layer of fill placement shall be no greater than 8 inches thick. Compact each layer to not less than the percent of maximum density specified in Table 12 1, determined in accordance with ASTM D-1557.

<b>Table 12-1 Soil Compaction</b>	
Foundations	<b>[95%]</b>
Concrete Work and Pavements	<b>[90%]</b>
Landscaping	<b>[85%]</b>
Retaining Wall Backfill	<b>[85 – 90%]</b>

The requirements shall be verified or modifications recommended by the consulting professional geotechnical engineer in the report whenever engineering, soils or climatic factors indicate the necessity. Any modifications to the stated compaction requirements shall require approval from the COR.

**NOTE: The generic earthwork spec might not be specific enough to make it clear that the contractor is responsible to retain a geotechnical engineer relative to field QC of earthwork such as to oversee Subgrade testing and fill placement; therefore, here is some guidance language that should be integrated into the earthwork spec:** Subgrade suitability (via proof rolling), fill placement and compaction operations shall be observed and tested on a full time basis by a qualified independent testing agency as directed by the contractor’s project geotechnical engineer. Representative Optimum Moisture and Laboratory Maximum Density Tests shall be made for each type of material or source of material. Upon completion of all earthwork, the contractor’s geotechnical engineer shall certify in writing that the fill was placed in accordance with the requirements and provide the backup data including but not limited to: Proctor curves (moisture/density relationship), moisture contents, Atterberg limits, field density checks, sieve analysis, etc... Testing locations and elevations for all results shall be documented so that their position can be substantiated and relocated if necessary. The Contractor's QC plan shall detail these testing requirements and outline his plan to report the testing results.

During construction, all foundation excavations shall be inspected and approved by the contractor’s professional geotechnical engineer prior to placing concrete.

Earthwork and other recommendations (such as undercutting of soft materials, etc) from the geotechnical report, because the geotechnical report is generally not part of the contract documents so to be contractually binding, this information must be transferred to the plans and specs. If it is the desire of the A/E to include the geotechnical report with the contract documents, it shall be marked “For Information Only” (FIO) and stated as such on the plans and in the specifications.

**12.1.4 GUIDE SPECIFICATIONS**

**12.1.4.1 General**

Please modify the “Louisville District” version of the Earthwork Guide Specifications 31 00 00.00 06.

**12.1.4.2 For Satisfactory/Unsatisfactory Material in Earthwork Specifications**

The A/E shall review all subsurface information and make determination of which soil types are satisfactory and which are unsatisfactory with respect to the project requirements.

#### 12.1.4.3 Pavement Specifications

UFGS 32 12 16 Hot-Mix Asphalt (HMA) for Roads is the preferred guide specification for asphalt pavement. In the guide specification, there are pay factors that set the requirements for asphalt compaction. The pay factors are based on a specified unit price that the specification author determines from typical geographical area pricing. The target specification for asphalt pavements is 94% to 96%.

### 12.1.5 PLANS/DRAWINGS

#### 12.1.5.1 Data

Where applicable, the allowable soil or rock bearing pressure shall be shown on the plans. This pressure shall be indicated in such a manner that it is understood that the pressure is the design (allowable) pressure used in sizing the foundations and that this pressure is not the ultimate pressure which the soil or rock can withstand.

#### 12.1.5.2 Verify that the plans require that “all open foundation excavations be inspected and approved by a licensed geotechnical engineer prior to placing concrete.”

We generally see this statement on the “Structural Notes” Plan Sheet under “Foundation Notes.”

#### 12.1.5.3 Verify the allowable bearing capacity recommended by the geotechnical engineer is used in the structural calculations.

Verify that floor slab calculations have been performed in accordance with UFC 3-301-01 “Structural Engineering,” UFC 3-320-06A “Concrete Floor Slabs on Grade Subjected to Heavy Loads,” and the recommendations in the geotechnical report.

#### 12.1.5.4 Verify footing depths are below frost depths recommended in the geotechnical report.

#### 12.1.5.5 Verify the pavement design in the geotechnical report is used in the pavement detail.

Verify the pavement detail specifies specific aggregates and include underdrain details if underdrains are required.

#### 12.1.5.6 Physical Features

Show all physical surface features of the site such as rock outcrops, wet areas (swamps, marshy areas), sanitary landfills, existing pavement condition, etc. This information can influence the design, construction, and bidder’s estimate of the earthwork, foundations, and paving features of the project.

## 12.2 PREPARATION OF DESIGN BUILD SOLICITATIONS PACKAGES

The purpose of this document is to outline the geotechnical requirements for the preparation of Design Build (DB) solicitation packages for Louisville District’s military construction projects. This document is to assist the A/E with preparation of the geotechnical portion of the Guide Specification and to provide direction to its geotechnical specialist/subcontractor.

### 12.2.1 APPLICABILITY

The A/E will use the requirements herein for preparation of DB solicitation packages (RFPs) for Military Construction projects for the Louisville District Corps of Engineers (COE). There are multiple RFP templates being used and most templates contain dated language with respect to geotechnical (soils) requirements. Therefore, no matter what RFP template or guide specification the A/E is using, it must be updated with the geotechnical language using the requirements herein.

In general, this guidance is applicable in its entirety to Traditional Military projects within LRL traditional military boundaries. For MILCON Transformation, Army and Air Force Reserves Projects exceptions to the requirements herein generally include requirements to use UFC 3-250-01 for Pavement Design.

There are so many different guide specs and templates used for DB RFP's. With the most commonly used template, the language presented herein can be found in Section 01 02 00.00 48 (Statement of Work) under Part 3 – Site Civil Engineering and Part 7 – Design - Structural. This template may also include conflicting or redundant language in Section 01 03 00.00 48 (Design After Award). The AE should verify that the most current language as presented in this document is being used, and that any redundant or conflicting language be removed. Any deviations from the requirements presented herein must be approved through the COE AE manager for all Louisville District Projects. It should be noted that the guidance herein is changed on a regular basis (based on lessons learned), please verify that you access the Louisville Design Guide Website for each job to assure you are using the most up to date requirements.

### 12.2.2 DISCUSSION OF GEOTECHNICAL STUDIES (GENERAL)

For DB solicitation packages (RFPs), in general, the geotechnical report in the RFP package shall not include recommendations, just appropriate background information, boring logs and laboratory testing. This is so the DB Contractor's Designer of Record (DOR) is responsible for the extraction of design parameters from the data given and thus is responsible for the design. This requires the DB Contractor to have a geotechnical team member involved early.

Defining the subsurface conditions at a site is most complete if the RFP package includes a "Full Geotechnical Characterization Report" (enough boring and laboratory information to get complete coverage and representation of the site). A Full Characterization Report is most appropriate to avoid differing site conditions and thus claims. Sometimes the RFP will only contain a "Preliminary Geotechnical Characterization" (fewer borings). In this case LRL requires the DB Contractors to base their bid on the preliminary information then to verify that the data is representative by performing additional investigation after award and prior to his design. This requirement is described in the verbiage in Section 4.0 of this document. Make sure you get with your COE A/E manager to discuss the approach they wish to take on each individual project (see Section 3. of this document for more detail). In addition to other data collection described herein, the A/E might be requested to obtain samples of topsoil and subsoil for organic content determination in accordance with ASTM D 2974-07a. If this is desired (typically at Ft. Knox and Ft. Campbell), general guidance is: Take at least two representative samples of the material visually described as topsoil in the borings for organic analysis. Take at least three representative samples (from three different boring locations) of the subsoil to a depth of one foot below the material visually described as topsoil. Representative means "most typical of the site" and the individual samples should be taken such that they represent the full depth increment. In other words, if visual topsoil is 1 foot thick, "subsamples" of equal volume should be taken from 0 inches to 12 inches, mixed up then put in the jar for laboratory organic content analysis. In this case the sample directly below the topsoil would be comprised of "subsamples" taken 13 inches to 24 inches.

Please understand that all the standard language below is not cut in stone (it is guidance). It is primarily applicable problems are not anticipated with foundation and pavement support conditions or unknowns such as large quantities of unexpected rock removal. If the geotechnical data obtained for the DB solicitation package indicates problem conditions such as soft soils, uncontrolled fills, shallow or unpredictable bedrock removal quantities, seismic issues, etc; it may be necessary to modify the DB solicitation packages to try to proactively avoid potential issues that may be encountered after award (such as modifications due to differing site conditions). For example, if it is known that the soils are not suitable for shallow foundations based on the borings, it may be prudent to specify a foundation type in the DB solicitation package; therefore, the expectation is that the A/E should not just plug the language given below without considering the

geotechnical ramifications. The requirement that the geotechnical borings be done in a timely manner is so if there are indications of problems; the A/E's will call us with notice that there may be issues and seek our input to the solution. Sometimes, it may be desirable to direct bidders to design the foundation system or pavements or other geotechnical features specifically requested based on customer preference or other reasons. This is acceptable as long as the language makes it clear in the RFP package. Communication with the Corps of Engineer's A/E manager is key.

**Pavements:** It is important that expected traffic loading criteria for the design of proposed roads and parking lots is gathered by the preparer of the solicitation package so potential design-build contractors have the correct parameters on which to base their bid. Traffic loading criteria shall include the exact vehicle types and the number of passes for each vehicle over the design life of the pavement. The basis for this information must be obtained from the customer by an experience pavement designer who can make sound judgments to interpret the customer information and translate it into a reasonable traffic loading criteria on which the DB contractor can base his bid. In addition, the desired design life of the pavement (generally 20 years) must be obtained from the customer and specified in the DB RFP. It is also important that data be obtained and presented in the RFP solicitation package relative to the subgrade stiffness (typically given in terms of CBR). If it is not practical to do CBR analysis for whatever reason, a sound judgment must be made based on the other geotechnical data obtained as to an appropriate CBR value to give the DB contractor to base his design.

**Background information:** For projects within and outside the Louisville Districts traditional military boundaries, such as many of the Reserves Projects, the AE (or his geotechnical subcontractor) shall to contact the project's nearest Military Corps of Engineer District (known as the Servicing Corps Geographic-District), Geotechnical Engineering Department and the engineering authority (such as the Base Civil Engineer (BCE) or Department of Public Works (DPW)) at the facility where the construction will be performed and inquire about standard construction techniques relative to foundations, pavements and earthwork in the area and incorporate applicable requirements into the DB specifications. In addition, pavement minimums for projects outside Louisville District boundaries will be obtained from the project's Servicing Corps Geographic-District. Take this opportunity to get background information relative to experience within the area, such as known swelling soil potential where drilled piers or mat foundations are typically used instead of shallow spread footings, where lime stabilization is typically used beneath paving, or if known seismic conditions requiring remediation are encountered, etc.. The name of the COE Servicing District Contact and BC or DPW contact, their phone number and a summary of what was discussed should be included in the Design Analysis.

**Specific Information Relative to Frost Penetration and use of the UFC:**

The Louisville District considers the requirements in UFC 3-301-01 (Table E-2 and F-2) dated 1 June 13 (w/change 3 dated 12 September 2016) unreasonable relative to required frost depths in many instances. Therefore, allowable frost penetration values may be obtained from the local jurisdiction or building code for a specific site.

**Specific Information Relative to Required Spectral Accelerations:** Spectral accelerations shall be based on the local building code or UFC 3-301-01, whichever is greater. It is LRL experience that the USGS website is not always current.

### **12.2.3 AE SUBMISSION OF DRILLING PROGRAM**

The A/E shall complete the "Proposed Geotechnical Exploration Data" sheet (see Exhibit 44 of this document) outlining the proposed scope of exploration and return it as an attachment to the fee proposal before negotiation of the original contract. The character and extent of the exploration shall be designed in consideration of the importance of the structure to be constructed. The submission shall contain enough information such that the A/E demonstrates an understanding of the guidance and requirements presented herein. The "Proposed Geotechnical Exploration Data" sheet is merely a guide for the exploration and is flexible; the final program

shall be developed as information accumulates in order to obtain the greatest amount of useful information in the most cost effective manner.

#### **12.2.4 GUIDE SPECIFICATIONS (01 02 00.00 48)**

Specific language associated with Geotechnical Studies within Guide Specification 01 02 00.00 48 is presented below (**notes are bolded**). Paragraph numbering below is consistent with 01 02 00.00 48 and will need to be rearranged for projects where other Guide Specification formats are used.

#### **12.2.5 GEOTECHNICAL STUIDES**

##### **12.2.5.1 Subsurface Characterization Report**

Note: Use the 1st paragraph below (Example 1) as a guide if a “Full Characterization Report” as described in the under Section 2 above is being provided in the solicitation package and use the 2nd paragraph below (Example 2) if a “Preliminary Characterization Report” as described in Section 2 above is being provided in the solicitation package. Appropriately modify the language below if other than a “Full Characterization Report or Preliminary Characterization Report” is being provided in the solicitation package.

##### **Example 1.**

A report has been prepared to characterize the subsurface conditions at the project site and is appended to these specifications. The report provides a general overview of the soil and geologic conditions with detailed descriptions at discrete boring locations. The Contractor’s team shall include a licensed geotechnical engineer (with at least 10 years experience specializing in geotechnical engineering) to interpret the report and develop earthwork and foundation requirements and design parameters on which to base the Contractor's proposal. Foundation type, pavement and earthwork requirements on which the Contractor’s bid is based shall be presented in his proposal along with the resume of the geotechnical engineer. If any additional subsurface investigation or laboratory analysis is required to better characterize the site or develop the final design, it shall be performed subsequent to the award under the direction of a licensed geotechnical engineer and shall be the full responsibility of the Contractor.

##### **Example 2.**

A preliminary report has been prepared to characterize the subsurface conditions at the project site and is appended to these specifications. The report provides a general overview of the soil and geologic conditions with detailed descriptions at discrete boring locations. The Contractor’s team shall include a licensed geotechnical engineer to interpret the subsurface conditions (assuming they are consistent with the site subsurface conditions) and develop earthwork and foundation requirements and design parameters on which to base the Contractor’s proposal. Foundation type, pavement and earthwork requirements on which the Contractor’s bid is based shall be presented in his proposal along with the resume of the geotechnical engineer. Subsequent to award, the Contractor is required to perform and provide a complete geotechnical exploration of the proposed site to develop the final design. The geotechnical exploration shall be performed under the direction of a licensed professional engineer with at least 10 years experience specializing in geotechnical engineering. This exploration shall be the full responsibility of the Contractor and detailed requirements are outlined below. It is possible that site specific subsurface conditions encountered by the Contractor will differ from those appended herein. Therefore, it is the responsibility of the Contractor to establish a meeting with the COR subsequent to completion and evaluation of his site specific geotechnical exploration to outline any differences encountered that are not consistent with the information provided herein. Should those differences require changes in the foundation type, pavement and earthwork requirements proposed with the bid that result in more cost, these differences shall be clearly outlined for the meeting.

##### **12.2.5.2 Contractor’s Geotechnical Report**

A final geotechnical evaluation report shall be prepared by the Contractor’s licensed geotechnical engineer and submitted along with the first foundation design submittal (Note: add the following

statement to the end of this sentence if a full characterization report is performed: “using the data in RFP package”). This report shall summarize the subsurface conditions; provide requirements for the design of appropriate foundations, floor slabs, retaining walls, embankments, and pavements. The Contractor’s Geotechnical Report shall specify the type foundation system to be used, lateral load resistance capacities for foundation systems, allowable bearing elevations for footings, grade beams, slabs, etc. An assessment of post-construction settlement potential including total and differential shall be provided. Requirements regarding lateral earth pressures (active, at-rest, passive) to be used in the design of retaining walls shall be provided. The report shall include the required spectral accelerations and Site Class for seismic design along with an evaluation of any seismic hazards and requirements for mitigation, if necessary. The spectral accelerations shall be based on the local building code or UFC 3-301-01, whichever is greater. Calculations shall be included to support the requirements for bearing capacity, settlement, and pavement sections. Supporting documentation shall be included for all required design parameters such as Site Class, shear strength, earth pressure coefficients, friction factors, subgrade modulus, California Bearing Ratio (CBR), etc. In addition, the report shall provide earthwork requirements, expected frost penetration, expected groundwater levels, requirements for dewatering and groundwater control, possible presence of any surface or subsurface features that may affect the construction of the project such as sinkholes, boulders, shallow rock, old fill, old structures, soft areas, or unusual soil conditions. The report shall include pH tests, salinity tests, resistivity measurements, etc., required to design corrosion control and grounding systems. The raw field data shall be provided in the report. The Contractor shall design all corrosion control and grounding systems required for the project. The report shall determine project dewatering requirements. If temporary construction dewatering is required due to a high water table, the Contractor shall prepare and present a dewatering plan. The Contractor shall be responsible for securing all the required information necessary for the design of the system.

### ***12.2.5.2.1 Additional Borings***

Any additional borings shall be sampled with a split spoon sampler in accordance with ASTM D-1586, with samples visually classified at 1.5 foot intervals in accordance with the Unified Soil Classification System (ASTM D 2487). The depth to water shall be recorded. Standard Penetration Blow counts shall be recorded. A dated drilling log shall be provided for each boring drilled. Soils information obtained from field logs, laboratory tests and geologist’s logs shall be presented on the contract drawings in the form of boring plan, final boring logs and explanatory notes. See Exhibit 45 attached to this document for an example of boring logs.

### ***12.2.5.2.2 Certification***

The DB Contractor and the professional geotechnical engineer consultant shall certify in writing that the design of the project has been developed consistent with the Contractor’s final Geotechnical Report. The certification shall be stamped by the consulting professional geotechnical engineer and shall be submitted with the first design submission. If revisions are made to the initial design submission, a new certification shall be provided with the final design submission.

### ***12.2.5.2.3 Pavements***

The Contractor’s Geotechnical Report shall contain flexible and rigid pavement design(s) including design CBR and modulus of subgrade reaction and the required compaction effort for subgrades. Information shall be offered on the types of base course materials available in the area and design strengths. Pavement designs shall be included in the report and should have a design life of [typically 20] years using the traffic loading requirements presented herein. Pavement Designs shall be in accordance with UFC 3-250-01 Dated 14 November 2016, which requires the use of PCASE software. Regardless of the pavement design, a minimum flexible pavement section shall consist of 3.5 inches of asphalt (1.5 inches of surface course and 2 inches of base course) and 8 inches of aggregate subbase and/or base. Regardless of the pavement design, a minimum rigid pavement section shall consist of 6 inches of concrete and 8 inches of aggregate subbase and/or base. The minimum subbase/base can be neglected if the subgrade

has a CBR greater than 30. [Note to preparer, the above minimums are for the Louisville District traditional military boundaries only]

Subsurface Drainage associated with pavements shall be in accordance with the Unified Facilities Criteria (UFC 3-250-01) dated 14 November 2016.

Plans and specifications shall detail all of the specific aggregates proposed in the pavement design per state DOT designations and gradations including the aggregate used to choke off drainage layer aggregates to accommodate paving equipment.

This paragraph is presented to warn the DB contractor of possible inappropriate results when evaluating binder grades for SuperPave designed pavements. It is USACE experience that binder grades for parking lots have been improperly chosen resulting in easily rutting unacceptable pavements. The common characteristic has been that the state DOT standard specification was used resulting in the usage of lower grade binder. This is an inappropriate standard since the DOT recommended binder grades are intended for use in pavements with high speed traffic. It is highly recommended that the LTPPBind program (Version 3.1) be used when determining the proper binder grade with the standard selections of "Desired Reliability" = 98% and "Traffic Speed" = SLOW for parking lots, entrances, and low-traffic roads.

For bidding purposes, the contractor shall perform the design of the pavement under the provisions of this RFP (as the basis for his bid) using the following subgrade CBR and traffic loading for a design service life of 20 years. [NOTE: The A/E preparing the DB RFP will put site specific CBR (laboratory CBR is not always used as the design CBR, an experience designer in the area should determine the CBR to be placed here for design, don't only depend on the laboratory test results) and traffic loading criteria here: Traffic loading criteria shall include the exact vehicle types and the number of passes for each vehicle over the design life of the pavement. The "basis" for this information must be obtained from the customer by an experience pavement designer who can make sound judgments to interpret the customer information and translate it into a reasonable traffic loading criteria in which the DB contractors can base their bids.] Should this design result in a pavement section less than the minimums required above, the contractor shall bid the minimum.

**12.2.5.2.4 Soil Compaction and Foundation Excavations**

Soil Compaction shall be achieved by equipment approved by a professional geotechnical engineer. Material shall be moistened or aerated as necessary to provide the moisture content that shall readily facilitate obtaining the compaction specified with the equipment used. Each layer of fill placement shall be no greater than [usually 8] inches thick. Compact each layer to not less than the percent of maximum density specified in Table 12-2, determined in accordance with ASTM D-1557.

<b>Table 12-2 Soil Compaction</b>	
Foundations	<b>[95%]</b>
Concrete Work and Pavements	<b>[90%]</b>
Landscaping	<b>[85%]</b>
Retaining Wall Backfill	<b>[85 – 90%]</b>

The requirements shall be verified or modifications recommended by the Contractor's consulting professional geotechnical engineer in the report whenever engineering, soils or climatic factors indicate the necessity. Any modifications to the stated compaction requirements shall require approval from the COR.

Subgrade suitability (by proof rolling operations), fill placement and compaction operations shall be observed and tested on a full time basis by a qualified independent testing agency as directed by the Contractor's project geotechnical engineer. Field in-place density shall be determined and checked in accordance with the appropriate ASTM methodologies. The rate of

in-place density testing shall be specified in the earthwork specifications. Representative Optimum Moisture and Laboratory Maximum Density Tests shall be made for each type of material or source of material. Upon completion of all earthwork, the contractor's geotechnical engineer shall certify in writing that the fill was placed in accordance with the requirements and provide the backup data including but not limited to: Proctor curves (moisture/density relationship), moisture contents, Atterberg limits, field density checks, sieve analysis, etc... Testing locations and elevations for all results shall be documented so that their position can be substantiated and relocated if necessary. The Contractor's QC plan shall detail these testing requirements and outline his plan to report the testing results.

During construction, all foundation excavations shall be inspected and approved by the Contractor's project professional geotechnical engineer prior to placing concrete.

---END OF SECTION---