Architecture, Engineering, and Construction Division

Geotechnical Evaluation

Report Template

Instructions to Geotechnical Consultant:

* The latest version of this document is available to Church Employees and Consultants on the AEC Website without needing a password:
* https://aec.churchofjesuschrist.org/design\_guidelines/: Select and download the *Geotechnical Evaluation Report Template* found under “REAL ESTATE ACQUISITION”.
* The template can also be directly downloaded using this hyperlink: [*Geotechnical Evaluation Report Template*](https://aec.churchofjesuschrist.org/design_guidelines/SupportDocs/Geotechnical_Evaluation_Report_Template.docx).
* The Geotechnical Consultant should replace all **RED** instructions, guidelines, and requirements with site specific information in **BLACK** text.
* The Geotechnical Consultant is to modify the Geotechnical Evaluation Report Template as dictated by the needs, findings, results, and recommendations of the geotechnical evaluation to generate a site-specific geotechnical evaluation report. The Geotechnical Consultant will ensure that the Geotechnical Evaluation Report Template does not limit or supersede industry best practices or the experience, knowledge, and judgment of the Geotechnical Consultant.
* Update the Table of Contents.

**THIS SHEET IS TO BE DELETED FROM THE FINAL EVALUATION REPORT**

Release Date: March 14, 2023

All previous versions of this document are obsolete.

Contact AEC with questions, feedback, or suggestions for improvement.

Salt Lake City, Utah

|  |  |  |
| --- | --- | --- |
| Geotechnical Evaluation Report | | |
| **Property Name**  **Property Address**  **Owner’s Property Number**  Prepared For:  The Church of Jesus Christ of Latter-day Saints  Client Address | | |
| **FIRM LOGO** | Prepared by **Firm Name**  Month, Day, Year | **Consultant’s  Stamp and Seal** |

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# EXECUTIVE SUMMARY

* Summarize the findings and recommendations of the geotechnical evaluation.
* Describe the general suitability of the site for Owner’s intended use. Provide general precautions and limitations.
* Note that the Owner’s representative should have provided the geotechnical consultant with a site plan for the property and a description of the type of structure planned for the site. If a site plan and description have not been provided, request this information from the Owner’s representative.
* Also note that after a design has been completed, but prior to bid, the Owner’s Representative will request the Consultant to review the project construction documents to verify that the recommendations and requirements of the geotechnical evaluation report have been accurately interpreted and incorporated into the contract documents. The Consultant will provide a letter to the Owner’s Representative stating that the review has taken place and that the recommendations and requirements have been incorporated. This work will be under a separate agreement.

# INTRODUCTION

* Provide an overview of the report, location, and audience.

# AUTHORIZATION

* Provide the name of the Client’s representative who authorized your firm to perform the geotechnical evaluation and the authorization date.

# PROJECT DESCRIPTION, PURPOSE OF EVALUATION, AND SCOPE OF WORK

## Project Description

## Purpose of Evaluation

## Scope of Work

* Provide a project description, purpose of evaluation, and scope of work.
  + Describe the purpose and scope of the report and the work completed. Include all items comprising the purpose and scope of work requested and provided. Provide an introduction to the figures and tables of the report.

# DESIGN CRITERIA

* For meetinghouses, seminaries and institutes, the following anticipated minimum design loads are to be used. The DESIGN CRITERIA is to be reiterated in the geotechnical evaluation report for review by users of the report. The actual loads will be evaluated and determined on a project-by-project basis based upon the usage of the project by the design team. Where the actual loads exceed the anticipated minimum design loads, the design team will use the actual loads for building and paving system design.
  + Building:
    - Wall loads will be between 2,000 plf and 4,000 plf.
    - Column loads will be between 10,000 pounds and 60,000 pounds.
  + Paving for Meetinghouse and CES projects:
    - The loads for which the paving is to be designed are to be determined on a project-by-project basis based upon the usage of the project. The design team will need to evaluate, determine, and discuss the actual loads to be used for the design of the project with the project manager. However, the paving is to be designed for the following minimum loads:
      * Parking areas, drive lanes, driveways, and paved areas:
        + Design for a “Light” Traffic Classification (equivalent single axle load, ESAL, of less 0.3 million per year) AND

Design paving to support six (6) equivalent single axle loads of 18 kips per week.

Design drive lanes and driveway paving system to support five (5) to fifteen (15) equivalent single axle loads of 18 kips per week from buses and garbage trucks.

Trash enclosure approach slab: One (1) 40,000-pound axle load per week.

* + - The design life of the concrete and asphalt paving systems is to be forty (40) years (minimum).
  + Paving for Welfare Services (Bishops Storehouses, Deseret Industries) projects:
    - The loads for which the paving is to be designed are to be determined on a project-by-project basis based upon the usage of the project. The design team will need to evaluate, determine, and discuss the actual loads to be used for the design of the project with the project manager. However, the paving is to be designed for the following minimum loads:
      * Parking areas, drive lanes, driveways, and paved areas:
        + Design for a “Medium” Traffic Classification (equivalent single axle load, ESAL, of less than 3.0 million per year) AND

Design paving to support six (6) equivalent single axle loads of 18 kips per week.

Design drive lanes and driveway paving system to support five (5) to fifteen (15) equivalent single axle loads of 18 kips per day from semi-trucks and garbage trucks.

Trash enclosure approach slab: One (1) 40,000-pound axle load per week.

* + - The design life of the concrete and asphalt paving systems is to be forty (40) years (minimum).
* All phases of field and laboratory testing shall be conducted in general conformance with applicable ASTM Specifications. The following are a few pertinent ASTM Standards:
  + ASTM D698 “Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort”
  + ASTM D1140 “Standard Test Methods for Amount of Material in Soils Finer than No. 200 (75-μm) Sieve”
  + ASTM D1557 “Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort”
  + ASTM D1586 “Penetration Test and Split-Barrel Sampling of Soils”
  + ASTM D1587 “Thin-Walled Tube Sampling of Soils”
  + ASTM D2216 “Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass”
  + ASTM D2487 “Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)”
  + ASTM D3740 “Standard Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction”.
  + ASTM D4318 “Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils”
  + ASTM D5434 “Standard Guide for Field Logging of Subsurface Exploration of Soil and Rock”

# SITE CONDITIONS

* Provide a description of the relevant site conditions including:
  + General site description
  + Present land use and condition
  + Description of vegetation
  + General site topography
  + Drainage and any observed drainage problems. Provide a description of any drainage onto the site from other properties and where water from the site drains.
  + Any observed on-site fill (i.e., type of fill, the depth of the fill, the date the fill was placed, if known, and the state of fill compaction, if known). (Note: If information about fill is not known, label as “undocumented fill” and provide recommendations for either complete removal or replacement with properly compacted structural fill, or partial removal and treatment whichever is most appropriate.)
  + Onsite and surrounding slopes and any indications of slope instability (landslides)
  + Canals, streams, ponds, lakes, wells, etc, and depth of the water
  + Water table depth including a description of seasonal fluctuations.
  + Indicate if project site is in a flood plain.
  + Existing pavements and roads
  + Any observed on-site structures, past and existing. Include a description of any basements and buried tanks.
  + Information regarding surrounding properties (i.e., structures, topography, water bodies, roads, etc)
  + Local geology.
  + Site elevation per USGS unless more accurate elevation data is available.
  + Site location (latitude and longitude)
  + Frost depth
  + Existing and projected final site grading
  + Miscellaneous information for items such as detention basins, rain gardens, retaining walls, etc.
* Some information germane to the geotechnical evaluation report might be obtained from the owners of the surrounding property.

# FIELD STUDY

* Adjust the method and magnitude of field testing to technically satisfy the Client’s needs based on the site, groundwater, and in-situ soil conditions as well as the type of building to be constructed.
* Adjust the boring depth for anticipated site development cuts and fills as shown on the site plan provided by the Client and as needed for a liquefaction analysis, if required. Space borings evenly throughout building and parking areas.
* Test Borings:
  + Under Building Footprint (depth of borings are measured from top of existing grades):
    - Take a minimum of three (3) test borings (or use test pits) 20 feet deep into native (non-fill) soils with at least one (1) test boring extending to 25 feet, or deeper, where expansive soils or collapsible soils are known to be present for building footprints up to16,000 square feet (including any future phased additions). Provide one (1) additional test boring for every 10,000 square feet of building footprint, or portion thereof, beyond 16,000 square feet. Include all future phase areas. Adjust the depth of holes for anticipated site development cut and fill.
    - If unusual conditions exist, or conditions require, or drilled piers or pilings are anticipated for the building, then the number and depth of borings should be appropriately adjusted as recommended by the Consultant and agreed to by the Client.
    - Take soil samples every 2.5 feet to 5 feet or at each change in stratum, whichever requires the greater number, to a depth of 10 feet below the proposed foundation elevation and at 5 feet intervals below a depth of 10 feet beyond the foundation elevation.
  + Under Parking Lot Footprint (depth of borings are measured from top of existing grades):
    - Take a minimum of three (3) test borings (or use test pits) 6 feet deep for parking footprints up to 20,000 square feet (including any future phased parking additions). Provide one (1) additional test boring for every 20,000 square feet of parking footprint, or portion thereof, beyond 20,000 square feet.
    - If unusual conditions exist, then the number and depth of borings should be appropriately adjusted as recommended by the Consultant and as agreed to by the Client.
* Backhoe excavations may be more appropriate where competent bedrock is encountered near-surface or when coarse (cobbles and boulders) deposits are encountered. The backhoe excavations should supplement at least one (1) deeper boring to confirm subsurface conditions.
* Obtain groundwater levels during drilling and at the completion of drilling. Leave boreholes open for a period of at least twenty-four (24) hours, or until the ground water level has stabilized, before backfilling. Alternately, the Consultant is to install at least one temporary piezometer to be left in place for a period of one (1) week with a minimum observation period of one (1) week and one (1) reading at the end of the week prior to abandoning the observation boring.
* Describe the types of explorations completed, the depth of the borings, the equipment used, and the type of sampling and the qualifications of the person doing the explorations.
  + Depth
  + Type of sampling:
    - Sampler used.
    - Driving method.
* Describe the method used to determine groundwater elevation.
* List any miscellaneous field tests performed.
* If requested by the Client, a percolation test for a septic system drain field is to be completed. The test, with results and recommendations, is to be included in the report.
* If requested by the Client, an infiltration test on subgrade soils is to be completed if pervious concrete paving is being considered (these tests might not be requested until design for a building project is initiated, and the use of pervious concrete paving is being considered).
  + Determine the subgrade permeability for pervious pavement design in accordance with ASTM D3385, ‘Standard Test Method for Infiltration Rate of Soils in Field Using Double-Ring Infiltrometer’. This test can be difficult to complete in very pervious soils, rocky or cobble soils, or in dense or very stiff soils. The test can also be expensive to run.
  + The Consultant is allowed to use a standard percolation test, such as ASTM D5084, ‘Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter’, coupled with correlations with materials gradations, or in the case of fine-grained soils, laboratory permeability tests. The intent of the test is to determine whether the use of pervious concrete with the water percolating into the subgrade is feasible.

# SUBSURFACE WATER AND SUBSURFACE CONDITIONS

## Groundwater

## Subsurface Profile

* Provide information regarding the relevant subsurface conditions including:
  + The water table depth, including the anticipated seasonal fluctuations.
  + Depth to bedrock and, if cored, type and quality of bedrock
  + Soil conditions including a summary of moisture content, dry unit weight, unconfined compressive strength, and all other laboratory test results.
* Provide a brief written description of the soil profile and its relevance to or impacts on the recommendations for design and construction of foundations and site elements such as paving systems.

# LABORATORY TESTING

## General

* + Describe the laboratory tests provided and the procedures used in the sections that follow. Adjust for the type, and number, of tests used as determined by the site conditions.

## Gradation Analysis

### Full Gradation Analysis

* + - Provide sieve analysis of the distribution of particle sizes in the soil.

### Partial Gradation Analysis

* + - Provide sieve analysis of soils with particles less than a #200 sieve. **Provide partial gradation analysis only if determined necessary by the consultant for relevant information.**

## Atterberg Tests

* + Provide Atterberg tests for liquid limit, plastic limit, and plasticity index. **Provide Atterberg tests only if determined necessary by the consultant for relevant information.**
  + For soils beneath the building:
    - Whenever the Atterberg limits of a soil reach a plastic limit of about 22 or a liquid limit of 50 or above, and the thickness of the strata involved would cause movements over ¾” when only limited water gains access to the soil, positive precautionary measures must be taken such:
      * Using a suspended floor system using a deep foundation system
      * Removal and replacement of the soils
  + For soils beneath paving:
    - If plasticity index of subgrade soils is more than about 15, provide options to mitigate the expansive and shrinkage potential of the subgrade soils. These could include:
      * Mixing lime, flyash or cement into the subgrade soils
      * Subgrade drain systems.
      * Geogrid and other soil strengthening systems.
      * Removal and replacement of subgrade soils

## Natural In-Place Moisture and Density Tests

* + Provide this information for each stratum from undisturbed soil samples.

## Consolidation Test

* + Provide the consolidation, settlement, collapsible and expansive nature of on-site soils. Provide information of expected changes for these properties with changes in moisture content and intensity of loading.

## Compaction Test

* + Determine the maximum dry density and optimum moisture content of the soils.

## California Bearing Ratio (CBR) Test (or modulus of subgrade reaction k, resistance value R, SSV or LBR)

* + Provide the California Bearing Ratio (CBR) test (or other appropriate test such as modulus of subgrade reaction k, resistance value R, SSV or LBR) for subgrades where the thicknesses of the paving are not dictated by the Client’s minimum thickness requirements.

## Chemical Tests

* + Provide tests to determine if the soils will react detrimentally with concrete.

## Other

# FINDINGS AND RESULTS

* Provide the findings and results of the field study and of the laboratory tests including:
  + Provide the soil characteristics obtained by test borings or test pits. Locate explorations on the preliminary site plan provided by the Client. Include in the record exploration logs the top of test boring elevations relative to a fixed, temporary benchmark on or near the site which will be unaffected by the proposed construction and will be available throughout and after construction.
  + Identify all soils according to the Unified Classification System. Provide a chart for the Unified Classification System. Identify, and classify, bedrock appropriately.
  + Describe the layering, distortion, structure, etc of the soil and bedrock.
  + Define the depth of major roots associated with surface growth.
  + Define the depth of loose or disturbed soils.
  + Provide the percolation test results for a septic drain field, if performed.
  + Provide the infiltration test results on subgrades for pervious concrete, if performed.

# RECOMMENDATIONS AND CONCLUSIONS

## General Geotechnical Considerations

* + Recommendations should consider local construction practices.
  + Describe the general suitability of the site for the Client’s intended use.
  + Describe recommended precautions and limitations.
  + Do not use engineered fill under or within the area of the building or parking area with “plastic limits” greater than 15 or “liquid limits” greater than 32.

## Temporary Excavations and Utility Trenches

* + Provide recommendations for temporary excavation cut and fill slopes.
  + Provide recommendations for utility trenches including backfill material.

## Site Grading and Earthwork

### Engineered Fill Requirements

### Compaction Requirements

### Grading, Slopes and Drainage

* + Provide site grading recommendations including:
    - Recommendations for removal of topsoil, disturbed soils, loose surficial soils, non-engineered fill, etc.
    - A list of recommendations for using on-site materials as engineered fill
    - Compacted fill material recommendations including testing and inspection requirements.
    - Slope stabilization recommendations
    - Recommended permanent slope configurations. If slopes steeper than one (1) vertical to three (3) horizontal are proposed, perform a global stability analysis to confirm an adequate factor of safety for the slope.
    - Recommendations for proof rolling, scarification, and compaction
    - Recommendations regarding site grading with respect to groundwater elevation or high soil moisture content

## Water Soluble Sulfates

* + Discuss water-soluble sulfate content and it’s corrosivity to concrete, reinforcing steel and pipes as dictated by soil conditions. State general precautions and limitations including soil sulfate and the type of cement to be used. The four (4) -pin test may be used to determine soil resistivity and ph.
  + Tests for oxidation reduction and sulfides are not normally needed but should be provided as recommended by the Consultant.

## Foundation Recommendations

### Design Recommendations

### Construction Considerations

* + Provide foundation system recommendations including the following:
    - Bearing depth of conventional foundation systems or deep foundation systems including required.
    - Provide frost depth.
    - Conventional or deep foundation system design
    - Expected total and differential settlements.
    - Possible foundation systems in order of preference. It is possible that there is only one foundation system that is practical, feasible, economical and is the obvious choice for the subject site. In this case provide information only for that foundation system. Outline the advantages, the bearing capacities, and the potential settlements of each system. Provide a time frame over which potential settlements are expected to occur. Provide relative cost comparisons between the different proposed foundation systems. Provide provisions only for foundation systems that are practical and feasible for the site:
      * Recommendations for a conventional foundation system of strip and spot footings
      * Recommendations for a deep foundation system
      * Recommendations for a stiffened beam foundation system
      * Recommendations for a post tensioned foundation system
      * Recommendations for soil improvements such as stone columns, “geopiers”, deep dynamic compaction, etc.
    - Mitigation of the following:
      * The effects of expansive soils if present. Provide design and construction recommendations.
      * The effects of collapsible soils if present. Provide design and construction recommendations.
      * The effects of non-engineered, or undocumented, fill if present. Provide design and construction recommendations.
      * Excessive settlement. Provide design and construction recommendations.
      * The effects of differential settlement, if greater than 3/4 inch. Provide design and construction recommendations.
      * Ground improvement methods to provide uniform foundation support, if applicable.
      * Problems due to the loads of adjacent buildings, parking, or slopes being placed on new foundations or loads from new foundations being placed on adjacent buildings. Provide design and construction recommendations.

## Concrete Slabs on Grade

### Interior Concrete Slabs on Grade

* + - * Provide recommendations for interior concrete slabs on grade, including subgrade preparation, subbase preparation, base preparation and Portland cement concrete type based on chemical reactivity test results. Also provide recommendations for capillary breaks and top of slab elevation recommendations with respect to the groundwater elevation.
      * Provide required composition of aggregate base beneath interior concrete slabs on grade. Is “road base” acceptable?
      * For meetinghouses, seminaries and institutes, the interior concrete slabs on grade are 4 inches thick and are constructed without control joints and are reinforced with #4 bars at 18 inches on center each way.
        + Control joints are used in welfare services projects, but the slabs are still reinforced with #4 bars at 18 inches on center each way. The slab thicknesses vary from area to area within the projects. The warehouse area of the bishops’ storehouse projects is sometimes placed without control joints.
      * All projects require a 15-mil vapor retarder. It is placed directly under the concrete over the type and thickness of base recommended by the geotechnical evaluation report.

### Exterior Concrete Slabs on Grade (Sidewalks, Curbs, Gutters, Misc.)

* + - * Provide recommendations for exterior concrete slabs on grade (sidewalks, curbs, gutters, and misc.) including subgrade preparation, subbase preparation, base preparation and Portland cement concrete type based on chemical reactivity test results.

### Construction Considerations

## Pavement Design Recommendations

* + Provide recommendations for paving systems including:
    - Anticipated design loads: Refer to ‘Design Criteria’.
      * The design life of the concrete and asphalt paving systems is to be forty (40) years (minimum).
    - Parking areas, drive aisles, fire lanes, entryways, and areas around trash enclosures separately
    - Design for asphalt and concrete paving systems indicating which is preferred for the project.
      * The Client requires:

For Meetinghouse and CES projects:

* + 1. A minimum asphalt pavement thickness of 3 inches over 6 inches of base. The minimum concrete pavement thickness is 4 inches over 4 inches of base.
    2. Also provide information for paving systems for which these requirements could be reduced.

For Welfare Services (Deseret Industries, Bishops Storehouses) projects:

* + 1. A minimum asphalt pavement thickness of 4.1/2 inches over 8 inches of base in parking areas and 12 inches of base in truck lanes. The minimum concrete pavement thickness is 6 inches over 8 inches of base, except use 12 inches of base in truck lanes.
    2. Also provide information for paving systems for which these requirements could be reduced.
    - Base thickness and preparation, subbase thickness and preparation and subgrade preparation. Note any special conditions.
    - Modulus of subgrade reaction.
    - Required composition of aggregate base beneath paving. Is “road base” acceptable?
    - California bearing ratio (CBR) test (or other appropriate test such as modulus of subgrade reaction k, resistance value R, SSV or LBR) for subgrades where the thicknesses of the paving are not dictated by the Client’s minimum thickness requirements.
      * Subgrade soils with a CBR Value of less than 5 should be stabilized or removed and replaced using suitable material.
    - Testing and inspection recommendations for earthwork and paving systems.
    - Pervious concrete pavement recommendations if requested by Client.
      * Pervious concrete is to be 6 inch thick for parking areas, 8 inch thick for driveways and 10 inches thick for vehicles heavier than single axle service/delivery trucks and requires single-course placement. In “dry freeze” areas, “hard dry freeze” areas, “wet freeze” areas, the base is to be at least 8 inches thick. In “hard wet freeze” areas, the base will vary from 8 inches to 24 inches depending upon how much water needs to be stored in the base to prevent it from accumulating in the pervious concrete. Provide input regarding the percolation rate of water through the pervious concrete, base, and subgrades. If a groundwater recharge bed is being used, it is best if the percolation rate of water through the subgrade is more than about 0.01 to 0.5 in/hr. With low percolation rates, the site may not be suitable for pervious concrete using a groundwater recharge bed.
  + Concrete used as paving shall have a minimum compressive strength of 4000 psi except that 4500 psi should be used in areas of freeze thaw or where required by soil conditions.

## Sliding Resistance of Soils

* + Provide coefficients for active, at-rest and passive sliding resistance.

## Lateral Earth Pressures

### Design Recommendations

### Construction Considerations

* + Provide lateral earth pressure values and recommendations for retaining wall design. Provide a phi angle for site soils if used as the retained soil for an MSE wall system. MSE walls need to have a chimney drain behind the retained section for drainage. Provide recommended lateral earth pressure values for retaining wall design with and without seismic loading.

## Seismic Considerations

* + Provide seismicity and seismic coefficients.
  + List the seismic site class for the site.
  + Describe the general seismic characteristics of the area and the relationship of the subject site to the area.
  + Recommend precautions to protect new structures from damage due to seismic loading if that hazard exists.
  + Include information about faults near or on the site. Indicate the need for a fault trench study, if applicable.
  + Evaluate induced settling, liquefaction, lateral spread, and ground rupture (faulting) potential at the site and if these hazards exist. Provide recommendations to mitigate the effects.

## Topsoil

* + Provide topsoil testing whenever more than 5,000 square feet of area will be landscaped (these tests might be deferred until design and/or construction begins or as otherwise arranged by the Owner).
  + The Topsoil Testing Report form is to be used by the Consultant to tabulate the testing data. No other format is acceptable. The Topsoil Testing Report form can be accessed from the AEC website at http://aec.churchofjesuschrist.org/aec/ in Specification Section 32 9120 – Topsoil and Placement. Contact your local project manager or facilities manager to obtain a password.
  + The Consultant, and with input as needed from a testing agency employed by the Consultant, is responsible for providing recommendations for topsoil including recommendations for short term and long-term fertilizers and soil amendments. Imported topsoil is to be tested and approved prior to being installed. It is vital that tested soil samples are representative of the overall topsoil conditions. Tests shall be in accordance with the testing agency guidelines.

# GENERAL COMMENTS

* Note any general comments or limitations.

# REFERENCES

* Provide references used in preparing the report.

# FIGURES

* Provide figures and tables needed to complete the report. Use *Insert Caption* from the *References* tab to identify the figure or table, and then update the table of figures to generate an automatic list. Figures should include:
  + Vicinity map to locate the site.
  + A site plan with locations of exploratory borings, location of percolation test (if applicable), and location of subgrade permeability tests (if applicable).
  + Logs of exploratory borings and/or test pits
  + Legend and notes for the exploratory borings log
  + Laboratory test results. Include all laboratory test data such as consolidation curves, etc.

# 

# APPENDIX A: FIGURES

* Provide appendix items needed to complete the report including the **Topsoil Testing Report.**

# APPENDIX B: LABORATORY TESTING RESULTS

* Provide appendix items needed to complete the report including the **Topsoil Testing Report.**