Section 4: Geotechnical Investigations

4.1 Introduction

Investigation	As part of the Phase I Site Characterization, or other efforts to characterize the site, a Phase I Geotechnical Investigation may be performed.
How to respond	Prepare and submit a Geotechnical Report to support the Site Characterization Report. Geotechnical tasks must be performed by or under the direct supervision of a certified engineering geologist or professional civil engineer with current Oregon registration and experience in conducting engineering geology or geotechnical investigations.
Relation to engineering	Phase I and II Geotechnical Studies should produce sufficient site data to perform all relevant engineering analyses.
In this section	This section describes the tasks that should be performed as part of Phase I and Phase II Geotechnical Investigations.

4.2 Phase I Geotechnical Investigation

Objective of investigation

Conduct a preliminary geotechnical investigation designed to accomplish the following objectives:

- characterize the variability, depth, aerial extent and engineering properties of on-site soils and other overburden deposits
- inventory soils and other overburden deposits suitable for use in construction, and identify the proposed use for these materials
- identify geotechnical considerations (such as settlement and slope stability) which must be addressed in the engineering design and/or further characterized by a Phase II Geotechnical assessment, and
- develop a work plan for conducting a Phase II Geotechnical investigation, as necessary, to adequately characterize on-site soils and other geotechnical considerations

Tasks to be addressed

The Phase I Geotechnical Investigation should address, at a minimum, the tasks described in this subsection.

Describe surficial soils

Evaluate agricultural soil types and their distribution site-wide and within at least a one-mile radius of the site. At a minimum, prepare a soils map and describe the soils in the area. Basic data should be obtained from the U.S. Department of Agriculture Soil Conservation Service (SCS), and supplemented by additional site-specific reconnaissance or tests, as necessary, to confirm the accuracy and reliability of the SCS data.

Describe subsoils

Excavate backhoe test pits in a grid pattern across the site to characterize the depth, areal extent and uniformity of subsoils (overburden deposits). Collect representative soil samples for testing. Plot all test pits on a site map and log each test pit to include

- the location of the excavation
- a description of surface features before excavation
- the date excavated, excavator's name and affiliation
- the site geotechnical engineer's or engineering geologist's name and affiliation
- the elevation of the land surface surveyed to the nearest 0.01 foot
- depth of the excavation
- a detailed description of each stratigraphic unit, its depth, texture, color, mineralogy, grain properties, consistency or relative density, moisture content, degree of weathering, geologic origin, macroscopic features (e.g., root holes, slickensids), and other relevant or distinguishing characteristics
- each stratigraphic units Unified Soil Classification, using ASTM D-2488 visual method, and
- a clear, labeled, photographic record of all test pits

Supplemental tests

Supplement ASTM-D2488 with appropriate grain size and Atterberg limit tests on a representative number of samples of each stratigraphic unit.

Evaluate engineering properties of on-site materials

Analyze representative soil samples to evaluate their engineering properties as follows:

- determine the stability of on-site materials for foundation and sidewall construction
- determine the suitability of on-site materials facility construction, and
- inventory usable soils

Test soils

Perform the following tests:

- strength and compressibility (e.g., triaxial compression tests, consolidation tests) of foundation materials
- the following properites of low-permeability liner layer materials:
  - natural moisture content
  - in-situ density
  - compaction curves
  - Atterberg Limits
  - percent fines passing a #200 sieve
  - percent clay size content
  - percent coarse material retained on a #4 sieve, and
  - laboratory hydraulic conductivity
- grain size distribution and representative laboratory hydraulic conductivity of proposed drainage layer materials, correlate grain size distribution conductivity data

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Investigate site stability

Evaluate the site to identify and characterize any unstable conditions that could adversely impact facility structures, and to obtain sufficient data to plan more detailed Phase II studies. Stability analyses should be based on the investigator's professional judgment, published literature, field investigation, and data obtained from representative field and laboratory tests.

Stability factors

To determine if an area is stable, evaluate the following factors:

- weak and unstable foundation materials including soils, overburden, existing solid waste, peat deposits or other materials subject to excessive settlement
- active slope failure
- soils that may fail with a small increase in pore pressure or shear stress, or a small decrease in shear strength
- signs of pre-existing slope failure or slope failure in geologically similar material near the site
  - any other features that indicate the site is susceptible to instability

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Design considerations

Develop engineering measures to protect the integrity of the landfill structures.

Reference: OAR 340-94-030 and 40 CFR Part 258.15

Evaluation

Based on the results of the Phase I Geotechnical Investigation and Site Characterization, evaluate the following scenarios:

- Potentially unstable natural slopes and other on-site areas that could be destabilized by construction activities such as excavation, regrading or other site modifications;
- Stability of the landfill foundation considering site-specific topographic and geologic conditions, static and dynamic loads, pore-water pressures at the subgrade-liner interface, and any other relevant factors; and
- Compressibility of underlying geologic units and potential settlement of the landfill unit. Estimate total and differential settlement based on appropriate field and laboratory methods and design parameters.

Workplan

Prepare a workplan for the Phase II Geotechnical Investigation.

4.3 Phase II Geotechnical Investigations

Phase II study	Perform additional geotechnical investigations as required in the Phase II work plan and for design calculations and analyses.
Report	Document the results of the geotechnical investigations and present the findings in the Phase II Site Characterization report. Identify any geotechnical considerations that require additional investigation or analysis prior to detailed design and construction of landfill structures. As needed, confirm the engineering properties of on-site soil and rock materials that will be impacted by or used for landfill construction and operation activities.

4.4 Additional Resources

References

Sowers, G.F. (1979). "Soil Mechanics and Foundations: Geotechnical Engineering," The MacMillan Company, New York.

U.S. Navy (1986). "Design Manual - Soil Mechanics, Foundations, and Earth Structures," NAVFAC DM-7; Department of the Navy, Washington, D.C.

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U.S. EPA, (1993) "Solid Waste Disposal Facility Criteria Technical Manual" EPA 530-R-93-017.