Section 3: Phase II Landfill Site Characterization

3.1 Introduction

Characterizing the site

Phase I Site Characterization (see Section 2), the initial stage of data collection, established a preliminary framework for understanding the soils, geology and hydrogeology and for planning the Phase II Site Characterization.
Phase II Site Characterization evaluates subsurface conditions in greater detail including the depth and extent of the uppermost (water bearing) geologic units and hydraulically interconnected units, the lithologic and hydraulic properties of these units, groundwater flow patterns, and other factors.

Basis for investigation

The scope of the investigations for Phase II site characterization should be based on the Phase I study results and the work plan developed as part of the Phase I study. If the proposed project involves a lateral expansion of an existing landfill unit, portions of the Phase II work may have previously been completed. If so, the appropriate documents should be referenced in the Phase II report.
Phase II Site Characterizations are frequently negotiated with the Department and may include direct Department involvement.

Objective of Phase II

The main objective of the Phase II site characterization study is to describe and evaluate the site geology and hydrogeology, including all stratigraphic units encountered, the uppermost aquifer or waterbearing zone, and all other potential zones of contaminant transport.

Definition: uppermost aquifer

U.S. EPA has defined the "uppermost aquifer" as the geologic formation nearest the natural ground surface that is an aquifer, as well as lower aquifers that are hydraulically interconnected with this aquifer within the facilities boundary. U.S. EPA guidance refers to any saturated strata capable of producing representative groundwater samples as an aquifer.

How to respond

Prepare and submit to the Department a report describing the work performed in the Phase II site characterization. Geologic and hydrogeologic tasks must be performed by or under the direct supervision of a Registered Geologist with current Oregon registration and with experience in conducting hydrogeologic investigations, in accordance with OAR 340-93-130.

Report content

The Phase II Site Characterization report should address, at a minimum, completion of the tasks described in this subsection. Following the organizational format of this guidance will expedite Department review of the report. The report should bear the stamp of the Registered Geologist who performed or supervised the investigation.

Report illustrations

The report should contain illustrations, including the following:

- maps showing the as-built location of all borings, monitoring wells and other sampling locations
- boring logs
- as-built well construction details
- geologic maps and cross sections
- water table or potentiometric surface maps for all major aquifers or water-bearing zones, and
- geologic-structure contour maps depicting the soil-bedrock interface or other important subsurface features

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In this section

This Section describes the recommended tasks that should be completed in preparation of the Phase II Site Characterization Report. The following topics are addressed:

- surface investigation
- subsurface exploration
- environmental testing
- groundwater quality testing

Related references

This Section focuses on technical guidance and format for the Phase II Site Characterization Report. Groundwater Monitoring requirements are addressed in more detail in Section 10 (Environmental Monitoring). Monitoring well construction standards are contained in a separate document ("Guidelines for Monitoring Well Drilling, Construction and Decommissioning," August 24, 1992).

3.2 Surface Investigations

Site characterization task	Conduct appropriate surface mapping and surface geophysical logging to generate surface geology information, provide a basis for subsurface exploration, and delineate areas of previous waste disposal activities.
Surface geological mapping	Map the site in sufficient detail to determine the areal distribution of all surficial and bedrock units exposed across the entire site.
Standards	Practices and techniques used to obtain site-specific geologic and hydrogeologic data should be up-to-date, and consistent with industry-wide standards. All work should conform to applicable American Society for Testing and Materials (ASTM) standards, and/or appropriate U.S. Environmental Protection Agency (U.S. EPA) or Department guidelines.
Geophysical techniques	Geophysical techniques for performing surface investigations may include, but are not limited to, surface seismic, resistivity, gravity, radar, or magnetic surveys.

3.3 Subsurface Explorations

Site characterization task	Determine the geology and hydrogeology beneath the site through subsurface exploratory methods. Select the appropriate method(s) of subsurface exploration for the site that will allow collection of representative samples of subsurface media. A sufficient number of borings or other exploratory holes must be completed to adequately characterize the stratigraphy, and groundwater dynamics beneath the entire site.
Depth of investigation	The depth of investigation should be 100 feet below the landfill unit's proposed base excavation, or until the first encountered saturated zone is fully penetrated, whichever is deeper.
Methods	Borings, core drilling, test holes, test pits, cone penetration tests or other methods should be used.
Boring density	At least one boring should be continuously cored to obtain precise stratigraphic data and to obtain relatively undisturbed samples for laboratory testing and analysis. If a site is geologically complex or larger than five acres, additional continuously cored holes may be required to interpret stratigraphic and structural variations.
Standards	All borings should be constructed in accordance with applicable standards and guidelines, including: • "Guidelines for Groundwater Monitoring Well Drilling, Construction and Decommissioning," August 24, 1992 • standards developed by ASTM [such as D-5092-90] • OAR 690-240 Sampling methods should conform to ASTM D-1587, ASTM D-1586 or ASTM D-2113, as applicable.

Describe soil and overburden deposits

Classify soil and overburden deposits according to ASTM D-2488 and describe in detail according to their texture, color, mineralogy, moisture content, degree of weathering, geologic origin, and other relevant characteristics. The ASTM D-2488 visual method should be supplemented by appropriate ASTM D-2487 laboratory tests (i.e., mechanical and/or hydrometer grain size and Atterberg Limit tests) on representative samples from each stratigraphic unit.

Rock classification

Classify rock according to its lithology, mineralogy, color, grain size, degree of cementation, degree of weathering, density and orientation of fractures, other primary and secondary features, physical characteristics, and rock quality designation.

Documentation

Prepare a detailed geological log of each boring incorporating all information. Prepare a clear, labeled, photographic record of representative rock cores

Reference: Section 8.0 of the Department's August 24, 1992 guidance entitled "Groundwater Monitoring Well Drilling, Construction and Decommissioning"

Log content

The geological log should include, but is not limited to:

- the location of the hole
- the date drilled, driller's name and affiliation
- the site geologist's name and affiliation
- the elevation of the land surface surveyed to the nearest 0.01 foot
- the size (diameter) and total depth of the hole
- the type of drilling rig and method of drilling
- the type and volume of drilling fluids or additives used
- the penetration rate or standard penetration resistance
- the sampled intervals and the percent recovery
- the stratigraphic and lithologic information
- any aquifers, water-bearing zones and high permeability or fracture zones encountered
- any contamination observed
- any other drilling observations, including lost circulation zones or other difficulties encountered during drilling
- deposit classifications and descriptions
- the classification system used for deposit classification, and
- rock classifications

Geophysical	Perform appropriate downhole geophysical logging techniques to supplement data collected in the surface investigations.
Geophysical techniques	Geophysical techniques for subsurface explorations may include, but are not limited to, downhole caliper, SP, resistivity, induction, natural gamma, gamma-gamma, neutron density, sonic, dielectric, or other logging techniques.
Related activities	Subsurface exploration activities should be planned to maximize data transfer between geologic/hydrogeologic and geotechnical investigations.

3.4 Hydrogeologic Testing

Site characterization task

Conduct appropriate hydrogeologic testing to characterize the rate and directions of groundwater movement.

Unsaturated zone testing

Determine the saturated and unsaturated hydraulic conductivity and the vacuum pressure of unsaturated soils through field testing. Determine the porosity and moisture content of unsaturated soils through laboratory testing or geophysical techniques. Evaluate the spatial and temporal variability of these properties.

Saturated zone testing

Determine the hydraulic conductivity of all saturated water-bearing zones and aquifers identified in the subsurface investigation through field testing, as outlined in the Department's August 24, 1992 guidance, "Groundwater Monitoring Well Drilling, Construction and Decommissioning."

If the estimated hydraulic conductivity is...	Then...
greater than 10^{-3} cm/sec	an aquifer pumping test should be performed
less than 10^{-3} cm/sec	rising or falling head slug tests should be performed

Aquifer parameters

Determine the following:

- water table or potentiometric surface gradient
- rate and direction of groundwater flow for each aquifer or water-bearing zone
- vertical gradient between water bearing zones
- porosity for all aquifers and water-bearing zones identified during subsurface exploration, using laboratory or geophysical techniques, and
- hydraulic conductivity of all aquitards through laboratory and/or field testing

3.5 Environmental Testing

Site characterization task

Conduct appropriate environmental testing to assess background environmental quality prior to waste placement or to identify impacts from prior waste disposal practices.

Groundwater quality testing

Collect groundwater samples that are representative of formation water. Analyze these samples for the constituents and parameters listed in the table below.

Group	Parameters	Notes
Field indicators	Elevation of water level Specific Conductance pH Dissolved Oxygen Temperature Eh	These parameters must be measured in the field at the time samples are collected, either down-hole in situ, in a flow-through well, or immediately following sample recovery, with instruments calibrated to relevant standards
Laboratory indicators	Hardness (as $CaCO_3$) Total Dissolved Solids Total Alkalinity (as $CaCO_3$) Total Suspended Solids Specific Conductance (lab) Chemical Oxygen Demand pH (lab) Total Organic Carbon	Sample handling, preservation, and analysis are determined by requirements for each individual analyte: EPA or AWWA Standard Methods techniques must be followed.
Common anions and cations	Calcium (Ca) Manganese (Mn) Sulfate (SO_4) Magnesium (Mg) Ammonia (NH_4) Chloride (Cl) Sodium (Na) Carbonate (CO_3) Nitrate (NO_3) Potassium (K) Bicarbonate (HCO_3) Silica (SiO_2) Iron (Fe)	Dissolved concentrations must be measured. Samples must be field-filtered and field-preserved according to standard DEQ and/or EPA guidelines and analyzed by appropriate EPA or AWWA Standard Methods techniques. Results must be reported in mg/L and meq/L.

<table>
<tr><td>Trace metals</td><td>Antimony (Sb)
Chromium (Cr)
Selenium (Se)
Arsenic (As)
Cobalt (Co)
Silver (Ag)
Barium (Ba)
Copper (Cu)
Thalladium (Tl)
Beryllium (Be)
Lead (Pb)
Vanadium (V)
Cadmium (Cd)
Nickel (Ni)
Zinc (Zn)</td><td><table><tr><th>If the Total Suspended Solids concentration is...</th><th>then analyze for...</th></tr><tr><td>less than or equal to 100 mg/L in the sample</td><td>total concentrations (unfiltered)</td></tr><tr><td>greater than 100 mg/L in the sample</td><td>both total (unfiltered) and dissolved (field-filtered)</td></tr></table>
Samples must be field-preserved according to standard DEQ and/or EPA guidelines and analyzed by EPA Method 6010 or Department-approved equivalent. Results must be reported in mg/L.</td></tr>
<tr><td>Volatile organics</td><td>Analysis for all compounds detectable by EPA Method 8260 or EPA Method 524.2, including a library search to identify any unknown compounds present.</td><td>Method 8260 comprises the volatile organic constituents parameter group. Facilities that want to use Methods 8010 and 8020 as an alternative must obtain approval by the Department prior to use.</td></tr>
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Surface water quality testing

Collect surface water samples as needed to characterize surface water quality up- and down-stream of the facility.

Other environmental testing

Conduct appropriate landfill gas testing, air quality test, or other environmental test as required to establish background environmental quality or to identify impacts from previous waste disposal practices.

Methods

Sample collection, handling, preservation, shipment, analysis and QA/QC should conform to procedures described in the approved work plan and in U.S. EPA SW-846, Test Methods for Evaluating Solid Waste, and Chapter 4 of the RCRA Technical Enforcement Guidance Document (TEGD), or other Department-approved methods.

3.6 Additional Resources

References

"Guidelines for Monitoring Well Drilling, Construction and Decommissioning," August 24, 1992 (DEQ)