Chapter 3: Earth

This chapter describes the geology and soils in the vicinity of Cedar Hills Regional Landfill (CHRLF), including the potential for seismic and erosion concerns.

This environmental review determined that there would be no significant unavoidable adverse impacts to earth during construction or operation of any of the alternatives.

3.1 Affected Environment

3.1.1 Geologic Setting and Topography

The CHRLF lies in the middle portion of Puget Lowland, an elongated topographic and structural depression filled with a complex sequence of glacial and non-glacial sediments that overlie Tertiary bedrock. The Vashon Glaciation, which occurred about 15,000 years ago, is the most recent glaciation that affects site topography. Geologic evaluations of the CHRLF site and its vicinity have identified a complex history of sediments deposited by rivers, lakes, and glaciers over bedrock.

Vashon Glaciation

Over 15,000 years ago glaciers covering part of western Washington retreated to the north, leaving densely compacted layers of soil and rock called glacial till.

The site is on a glacial upland that separates the Cedar River Valley (approximately 1.5 miles west of CHRLF) from Issaquah Creek Valley (approximately 1 mile east of the site). The CHRLF is characterized by rolling topography, with pre-development elevations ranging from a high of about 650 feet above sea level along the western boundary to a low of slightly less than 350 feet above sea level at the northwestern corner. Past landfilling activities have raised the elevation in the central part of the site to about 780 to 800 feet above sea level. The land surface slopes down in all directions from the landfill site.

The CHRLF is located at the top of Cedar Mountain, a topographic high within a geographical region known as the Coalfield Drift Plain. This plain is a segment of a broad drift plain that occupies the Puget Sound Lowland from the Olympic Mountains to the Cascade Range (Luzier 1969). In the Cedar Mountain area, post-glacial valleys segment the Coalfield Drift Plain and form numerous small lakes and wetlands. Approximately one-half mile south of the site, an east–west trending valley (the Cedar Grove Channel) connects the Cedar River and Issaquah Creek valleys. Rosengreen (1965) interprets Cedar Grove Channel as an abandoned glacial meltwater channel created during the Vashon Glaciation. The channel currently contains several wetland areas and ponds but is not drained by a surface stream. In wet winter months, excavation along roadside ditches often shows groundwater seepage at the interface of permeable soils over glacial till. The May Creek Valley lies approximately one-half mile north of the landfill site. Mason Creek drains the portion of the May Creek Valley directly north of the landfill and flows east as a tributary of Issaquah Creek.

3.1.2 Soils and Geologic Units

Previous explorations at the CHRLF identified four primary soils and geologic units at the site. These units, from youngest to oldest, and from the surface down, are the following: 1) surface deposits and fill, 2) Vashon till, 3) advance outwash, and 4) pre-Vashon sediments. It is likely that recessional outwash materials (sand and gravel) were mined prior to development of the landfill.

Surface Deposits and Fill

Topsoil and fill materials cover the areas surrounding the landfill. The topsoil is typically a dark brown to brown, loose and soft, silty sand and silt with organics and occasional small, rounded gravel and trace cobbles. Fill includes materials placed for roads and facilities. In general, these surficial soils are less than 10 feet thick.

Vashon Till

From the top down, the Vashon till at the site includes a highly weathered zone, a weathered zone, and an un-weathered zone. The highly weathered zone is brown and medium dense; the weathered zone is grayish brown and dense; and the un-weathered zone is gray and very dense. All three zones contain silty sand with various amounts of gravel, few cobbles (about 5% to 10% by weight), and trace boulders (about 1% to 5% by weight). The weathered and un-weathered till also contains lenses of silt and sand. Past CHRLF operations have removed most of the till under active or closed areas of the landfill. Where the till has not been removed, the thickness varies from minimal in the northern portion to over 100 feet in the southern portion of the site.

Till has high shear strength and low compressibility. It is a competent material for foundation support. In general, the material is somewhat cemented. Temporary excavations as steep as 0.5H:1V (horizontal:vertical) are stable for a few months to a few years, and permanent excavations are stable at 2H:1V or flatter. Till soil is a suitable and commonly used structural fill material. However, since it typically contains more than 20% fines (silt and clay-size particles), it is moisture-sensitive and difficult to use in wet weather. These traits make the till layer a particularly good material for landfill siting and operations, providing an element of natural containment and attenuation to enhance the constructed landfill liners, and providing a good material for operations (daily cover) and landfill closure.

Advance Outwash

This geologic unit underlies till except in the northern portion of the site, where it becomes the surface material. Sand, silty sand, and sandy gravel form the majority of this unit. The soil matrix also contains rounded gravel, cobbles, and occasional boulders and inter-beds of sandy silt, silt, and silty clay. The thicknesses of outwash deposits vary from over 100 feet to less than 50 feet in the northern and southern portions of the site, respectively.

Advance outwash, like till, has high shear strength and low compressibility, and is also a competent material for foundation support. Temporary excavations as steep as 1.5H:1V are stable for a few months to a few years and permanent excavations are stable at 2H:1V or flatter. Outwash soil is suitable and commonly used as structural fill material. It contains fewer fines and is less moisture-sensitive than till.

Pre-Vashon Deposits

These deposits include coarse- and fine-grained soils and contain wood and other organic materials. The characteristics of these materials are not as well documented as the materials described above. However, since thick overburden has overridden the material for at least 14,000 years, the soils are heavily consolidated, and have high shear strength and low compressibility. The deeper portion of the units may be under the regional groundwater table. As such, the materials may have a low workability.

Physical Features

The majority of subsoils at the landfill consist of glacially deposited and consolidated soils. These soils have high shear strength and low compressibility. Therefore, the landfill has a strong foundation. During the excavation of new cells, the excavation sidewalls generally have great stability with temporary cuts as steep as 0.5H:1V. The glacial soils also have relatively high frictional resistance. The combination of the existing soil stability and the current leachate collection system in the landfill body, which keeps the solid waste and leachate drainage material relatively dry, creates a very stable base and high stability for the landfill and surrounding infrastructure.

The subsoils consist primarily of sand and gravel and have low clay contents. As such, the subsoils have good workability. Past operations have utilized the soils to generate select fill for various purposes that required high-quality fill. From a geological perspective, the CHRLF site is well-suited as a landfill for the following reasons:

- Glacially deposited and consolidated soils underlie the site. The high strength and low compressibility of these materials provide a strong and stable base for the facility.
- The on-site glacial soils provide stable temporary side slopes that facilitate the construction of new cells and other infrastructure such as roads, ponds, and underground utilities.
- The regional groundwater table is below the bottom of the landfill cells. This allows for deep excavations without dewatering or impacts to the water table.
- The on-site soils are high-quality fill materials. The coarse aggregates are suitable for use as drainage media, the fine materials are suitable for use as select fill, and the unprocessed materials are suitable for use as daily cover soil.

Seismic Conditions

The CHRLF is located in a region of substantial seismic risk. The largest historical earthquake in the Puget Sound Basin occurred in 1949. Centered near Olympia, this earthquake had a magnitude of 7.1. Recent research indicates that earthquakes substantially stronger than magnitude 7.5 have occurred in the past in the Puget Sound region, but the frequency of such earthquakes is less than once in several hundred years.

According to the U.S. Geological Survey's Earthquake Hazard Program (USGS 1996), the peak accelerations at the CHRLF site include the levels shown in Table 3-1.

Table 3-1. Peak Ground Accelerations at the CHRLF Site

Probability of Exceedance in 50 years	Return Period (years)	Peak Bedrock Acceleration
10%	475 years	$0.28g_n$[1]
5%	975 years	$0.39\ g_n$
2%	2,475 years	$0.57\ g_n$

[1] g_n =gravity

Previous evaluations have used a seismic (pseudostatic) coefficient of 0.3 to determine whether the past developments would be stable under seismic loading conditions. The seismic coefficient meets the criteria for landfill siting suggested by the U.S. Environmental Protection Agency (EPA;1995) and corresponds to the 2,475-year event in Table 3-1.

3.1.3 Erosion

Ground cover along the landfill boundaries includes dense forest and thick undergrowth. Soil erosion at the boundaries and sediment transport off-site are practically non-existent.

KCSWD uses best management practices (BMPs) in its operations at the landfill. In the active landfill areas and truck maintenance locations, the drainage system collects contaminated surface water and detains the water in lagoons prior to discharging to the King County sanitary sewer system. Away from the landfill areas, the system collects and detains all runoff before discharge. Minor erosion in the landfill areas occurs occasionally during wet winter months, but CHRLF operations typically resolve these situations within hours or a few days.

Best Management Practices

Policies and procedures designed to minimize erosion, control sedimentation, and protect water quality are collectively referred to as best management practices (BMPs).

Typical on-site BMPs include the following:

- Control erosion at the source, when possible, in accordance with the 2009 King County *Surface Water Design Manual* (SWDM; King County 2009a).
- Provide and size sediment ponds in accordance with Section D.4.5 of the SWDM.
- Intercept and convey surface water from disturbed areas to sediment ponds.
- Properly identify clearing limits prior to clearing.
- Provide perimeter protection (e.g., silt fence) downslope of areas to be disturbed prior to construction.
- Provide a location for stabilized construction entrances to limit the tracking of sediment off the construction area.

- Identify additional measures for wet-season construction. These may include covering stockpiled soil during the winter, hydroseeding, and runoff management.
- Inspect and maintain erosion and sedimentation control measures on a regular basis.

3.2 Environmental Impacts

The evaluation of impacts to earth assumes that well-recognized and proven engineering methods and techniques would be used to design and construct each of the action alternatives. In particular, the design and construction would need to consider the following:

- Increase of landfill mass instability due to the increase of overall landfill weight.
- Potential of hydrostatic pressure build-up due to the increase in demand on the internal drainage, or leachate collection system.
- Differential settlement as solid waste decomposes at varying rates within landfill cells.
- Seismic conditions of the area.

BMPs to control erosion and sedimentation during both construction and operation would be used to minimize the impacts of each action alternative.

3.2.1 Direct Impacts

Based on the considerations noted above, no significant impacts to earth during either construction or operation would be anticipated as a result of implementing any of the alternatives.

3.2.2 Indirect and Cumulative Impacts

Because there would be no direct impacts to earth as a result of implementing any of the alternatives, no indirect or cumulative impacts would be anticipated.

3.3 Mitigation Measures

Because no impacts to earth would be anticipated as a result of implementing any of the alternatives, mitigation measures would not be necessary.

3.4 Significant Unavoidable Adverse Impacts

There would be no significant unavoidable adverse impacts to earth as a result of implementing any of the alternatives.